Welcome!

The meeting will start momentarily.

Questions during the presentation?

Questions can be taken over the audio bridge or submit a question to us in the chat function at any time.

Audio Details

All lines are muted. Following the presentation, unmute your line by selecting your Attendee Name and clicking the microphone icon. If you are dialing from a touch tone, you will press *6 to unmute your line.

Skype Layout

In the upper right corner, you can click the layout icon ( ) to select your preferred layout. To maximize your screen size, you can “X” the left-hand windows for “participants” and “conversation.” To re-enable this view, click on the participation icon.

ipl
an AES company

IPL 2019 IRP: PUBLIC ADVISORY MEETING #2

March 26, 2019

WELCOME & OPENING REMARKS

Lisa Krueger

President, AES US SBU

MEETING OBJECTIVES & AGENDA

Stewart Ramsay

Meeting Facilitator

AGENDA

Topic	Time (EST)	Presenter
Registration	9:00 – 9:30	-
Welcome & Opening Remarks	9:30 – 9:35	Lisa Krueger, President AES US SBU
Meeting Objectives & Agenda	9:35 – 9:45	Stewart Ramsay, Meeting Facilitator
Meeting 1 Recap	9:45 – 9:55	Patrick Maguire, Director of Resource Planning
Stakeholder Presentation: Sierra Club, Beyond Coal Campaign	9:55 – 10:10	Matt Skuya-Boss, Lead Organizer, Sierra Club
Detailed Load Forecast – Base, High & Low Peaks and Energy	10:10 – 11:00	Erik Miller, Senior Research Analyst
BREAK	11:00 – 11:15	
IPL DSM MPS and End Use Results	11:15 – 12:00	Jeffrey Huber, GDS Associates
LUNCH	12:00 – 12:45	
Commodity Prices and Modeling	12:45 – 1:15	Patrick Maguire, Director of Resource Planning
Assumptions for Replacement Resources	1:15 – 1:45	
BREAK	1:45 – 2:00	
Scenario Analysis Framework & Proposed Scenarios	2:00 – 2:30	Patrick Maguire, Director of Resource Planning
Final Q&A, Concluding Remarks & Next Steps	2:30 – 3:00	Stewart Ramsay, Meeting Facilitator

MEETING 1 RECAP

Patrick Maguire

Director of Resource Planning

2019 IRP STAKEHOLDER PROCESS

January 29th	March 26th	May	August	October
• 2016 IRP Recap • 2019 IRP Timeline, Objectives, Stakeholder Process • Capacity Discussion • IPL Existing Resources and Preliminary Load Forecast • Introduction to Ascend Analytics • Supply-Side Resource Types • DSM/Load Forecast Schedule	• Stakeholder Presentations • Commodity Assumptions • Capital Cost Assumptions • IPL-Proposed Scenario Framework • MPS Update and Plan	• Stakeholder Presentations • Summary of Stakeholder Feedback • Present Final Scenarios • Modeling Update • Assumptions Review and Updates	• Stakeholder Presentations • Summary of Stakeholder Feedback • Preliminary Model Results • Scenario Descriptions and Results • Preliminary Look at Risk Analysis and Stochastics	• Stakeholder Presentations • Final Model Results • Scenario Updates • Updates on Stakeholder Scenarios • Preferred Plan

STAKEHOLDER PRESENTATION: SIERRA CLUB, BEYOND COAL CAMPAIGN

Matt Skuya-Boss

Lead Organizer, Sierra Club

DETAILED LOAD FORECAST – PEAKS & ENERGY

Erik Miller

Senior Research Analyst

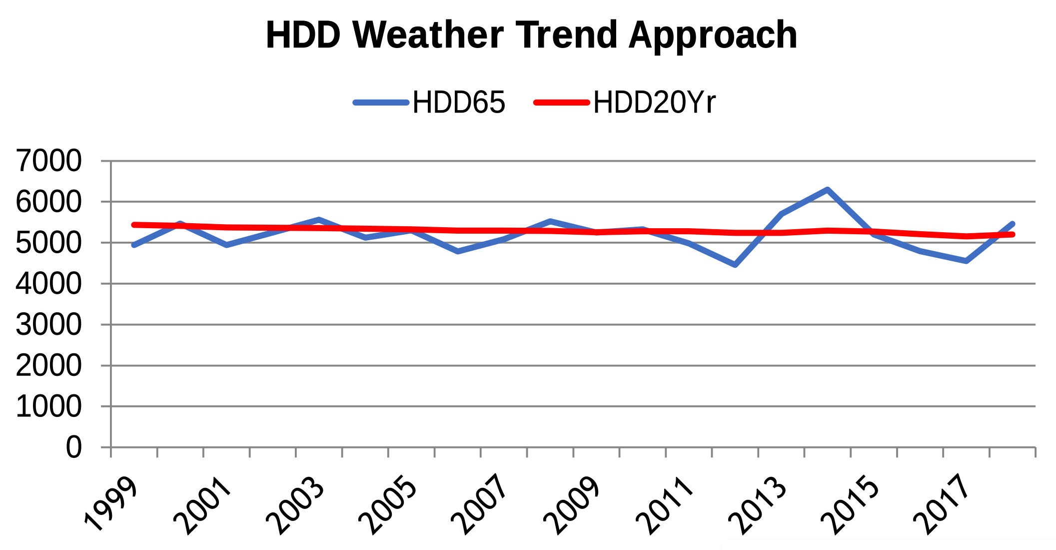
AGENDA

- Load Forecast Data Inputs
- Residential
- Small C&I
- Large C&I
- System Energy & Peaks

MODEL INPUTS

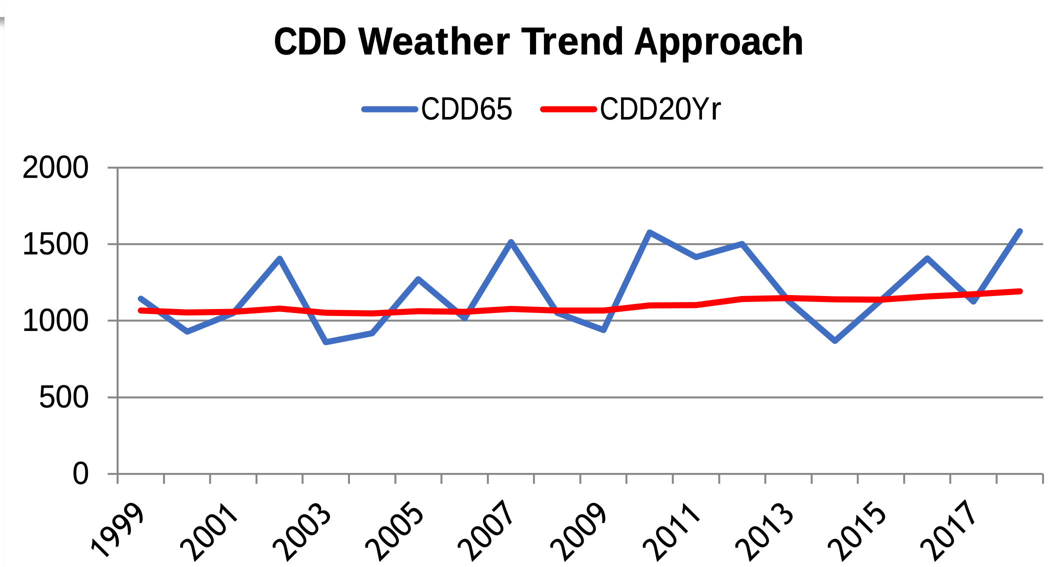
- Historic Sales & Customers
- End Use: EIA Regional End Use Saturations and Efficiency Trends
- Economics: Moody’s Q4 2018 Forecast
- IPL Price Forecast
- Weather: 20-Yr Trended
- Future utility DSM will be selected in IRP

WEATHER 20-YR TRENDED



Trend line (red) developed for the 20-yr rolling average HDDs

-0.3% decline in 20-yr rolling average HDDs; Rate of decline applied to original forecast HDDs

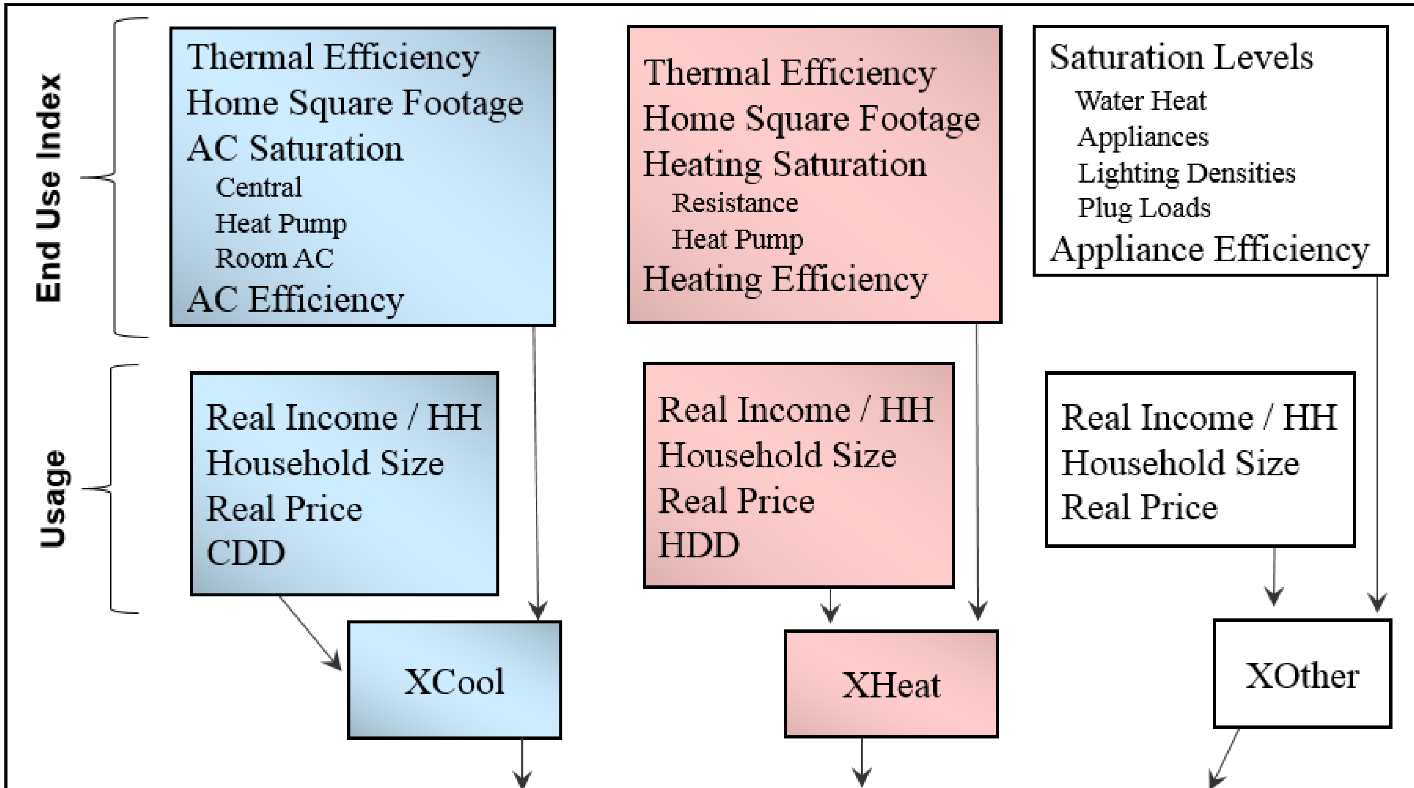


Trend line (red) developed for the 20-yr rolling average CDDs

0.6% increase in 20-yr rolling average CDDs; Rate of growth applied to original forecast CDDs

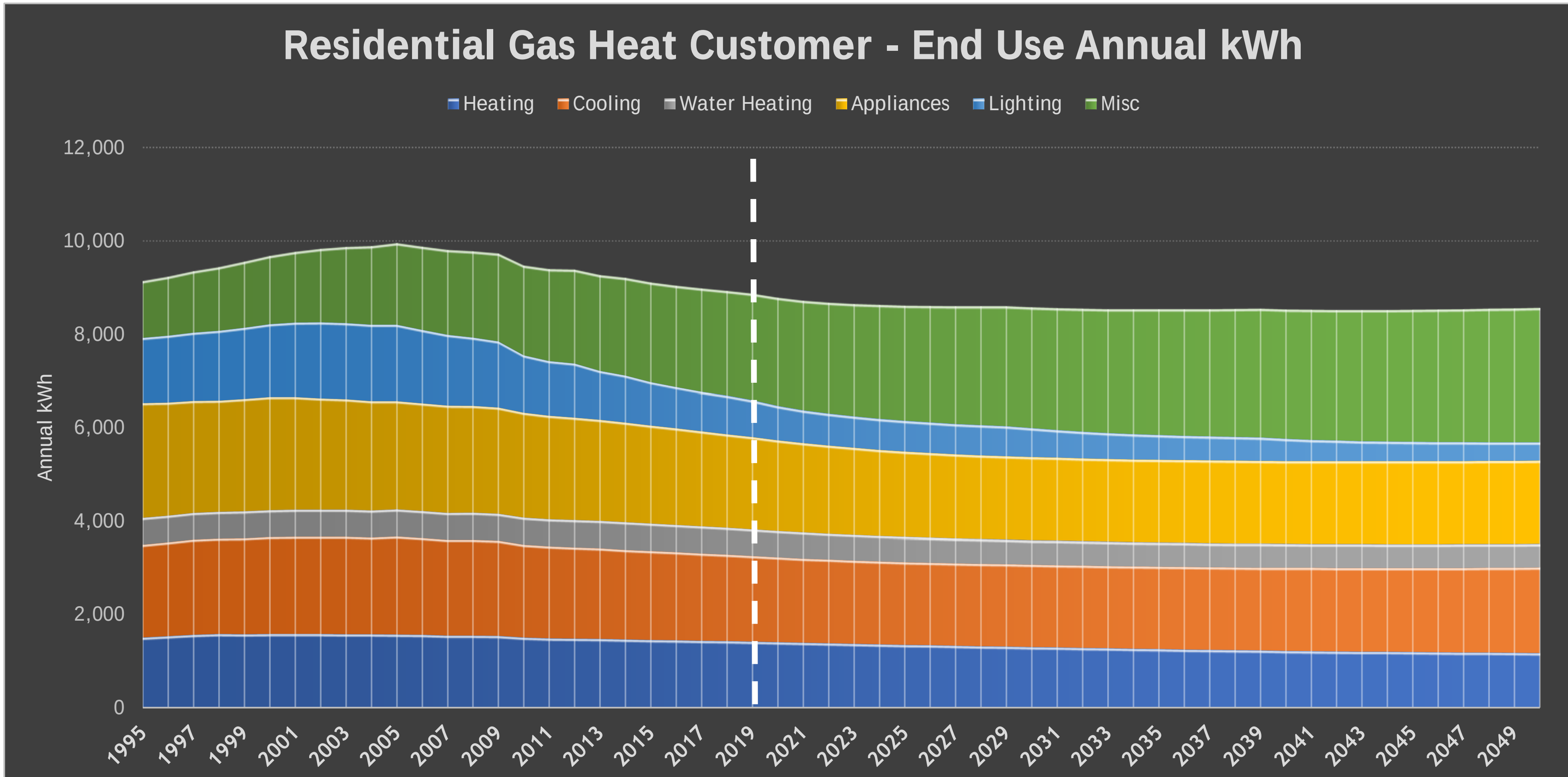
HDD = Heating Degree Day
CDD = Cooling Degree Day

RESIDENTIAL MODEL



$$AvgUse_m = a + b_c \times XCool_m + b_h \times XHeat_m + b_o \times XOther_m + e_m$$

RESIDENTIAL END USE TRENDS



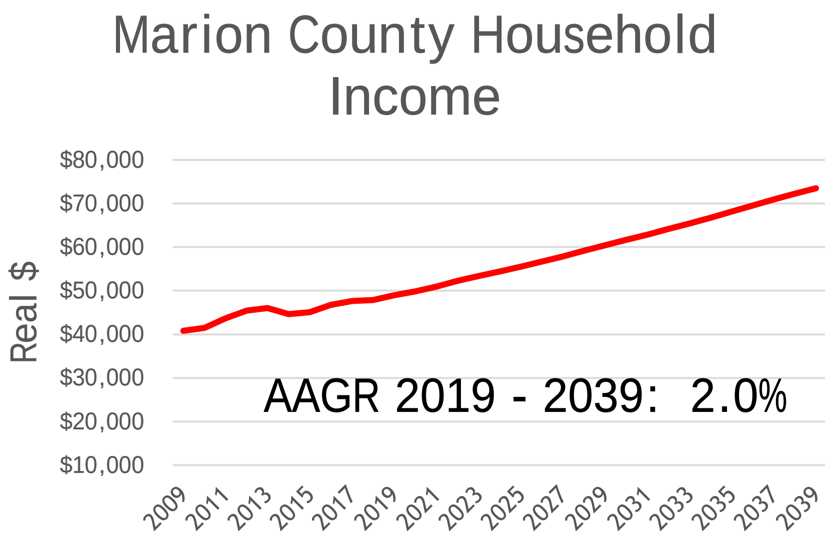
Cool AAGR 2019 - 2039: 0.13%

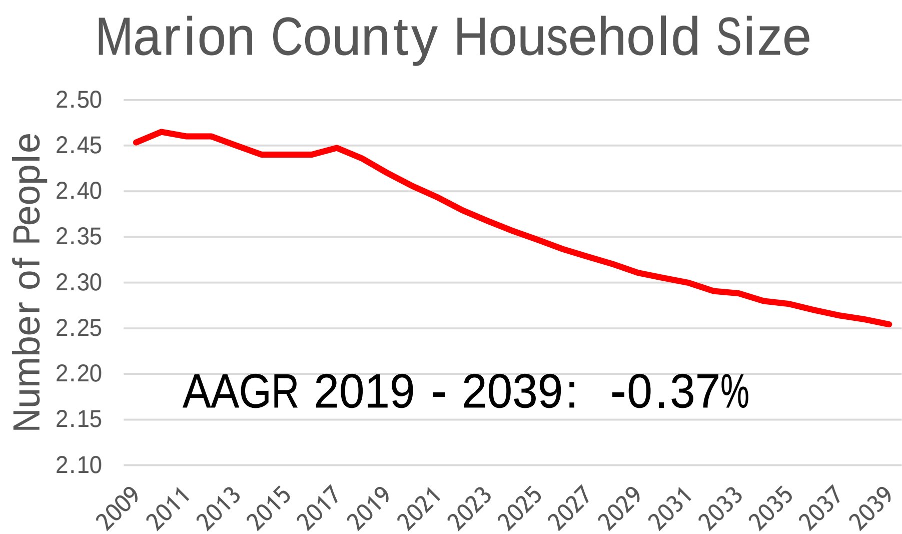
Heat AAGR 2019 - 2039: -0.39%

AAGR = Average Annual Growth Rate

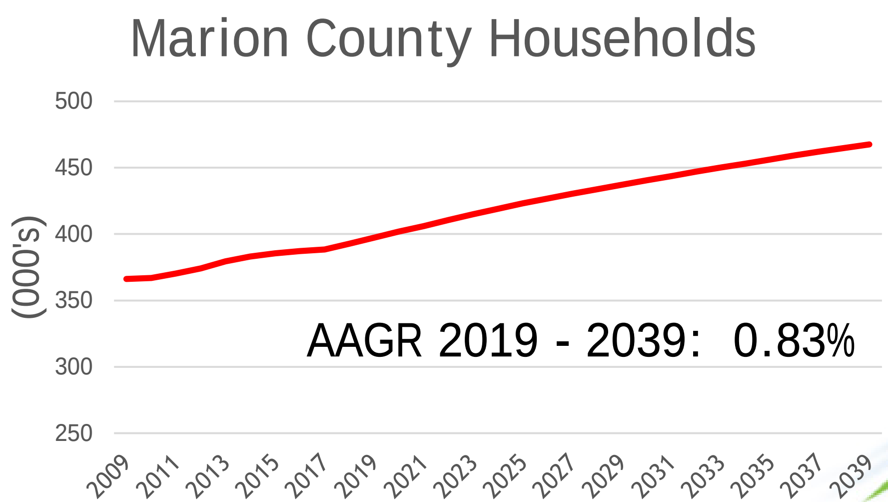
Source: 2018 EIA Annual Energy Outlook

RESIDENTIAL ECONOMIC DRIVERS



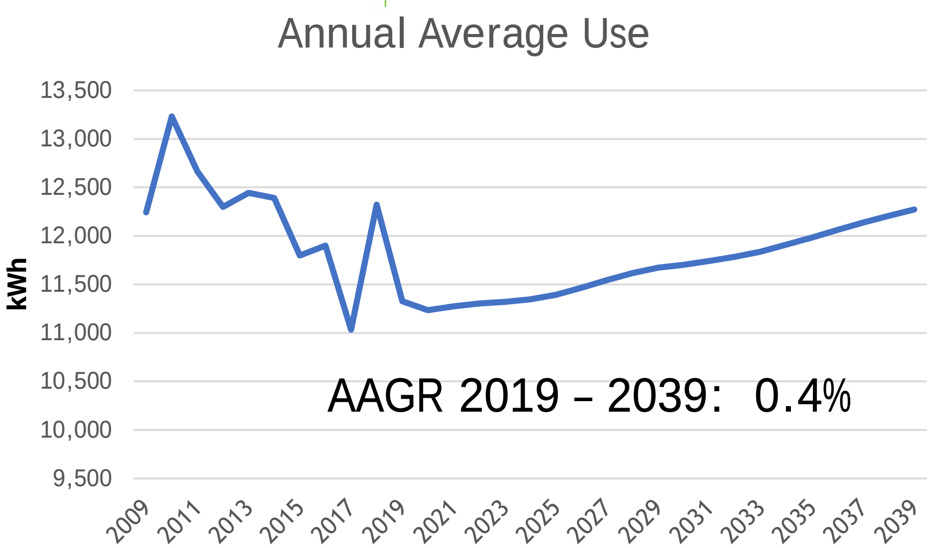


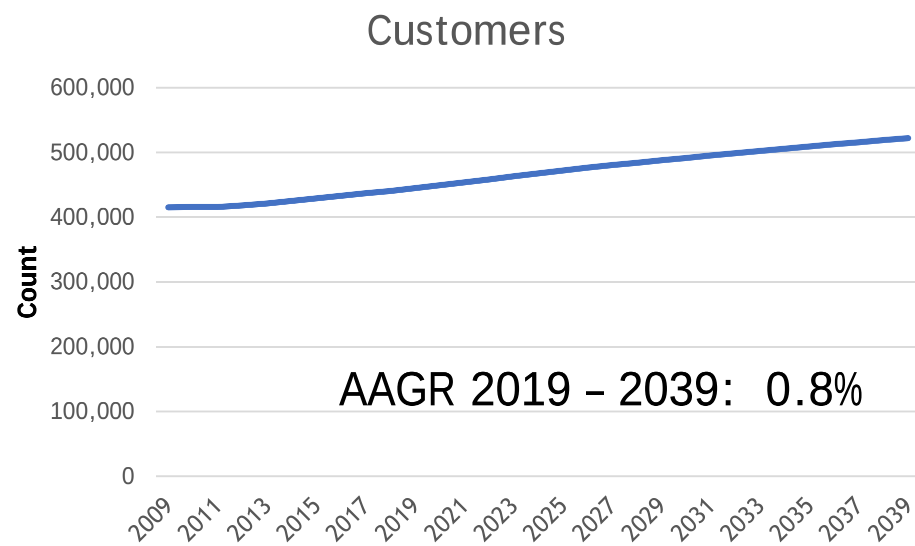
- Moody's Analytics Marion County Economic Forecast
- Multifamily Growth:
  - Increasing # of households
  - Decreasing persons / household

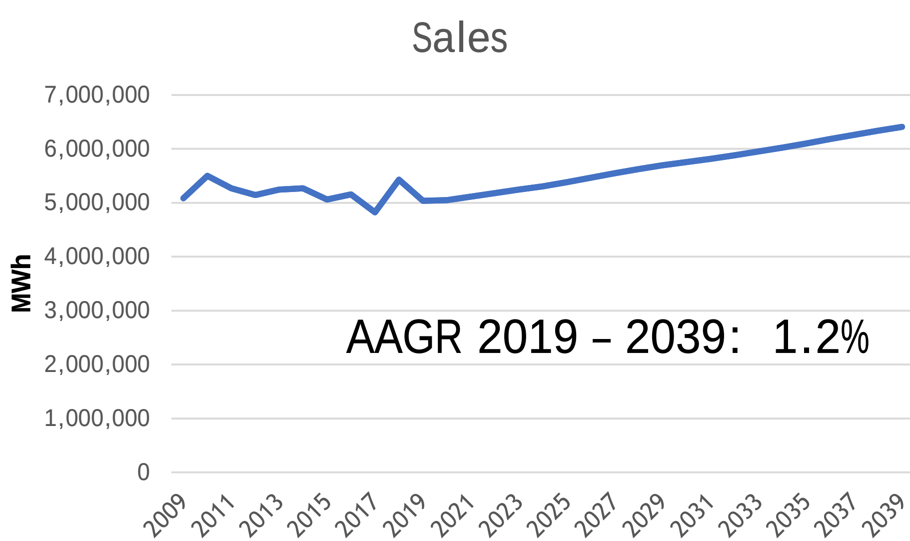


AAGR = Average Annual Growth Rate

RESIDENTIAL FORECAST

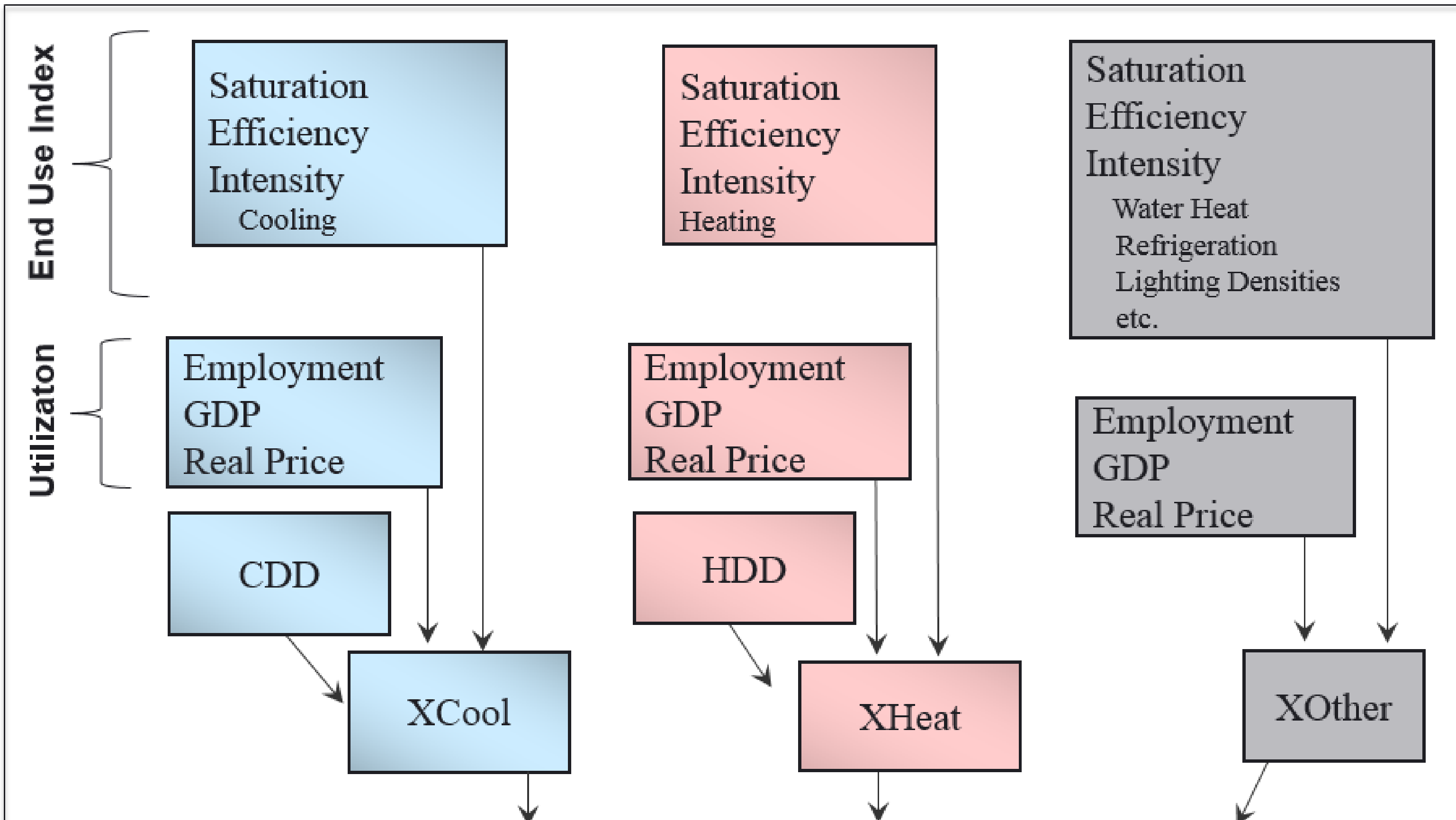






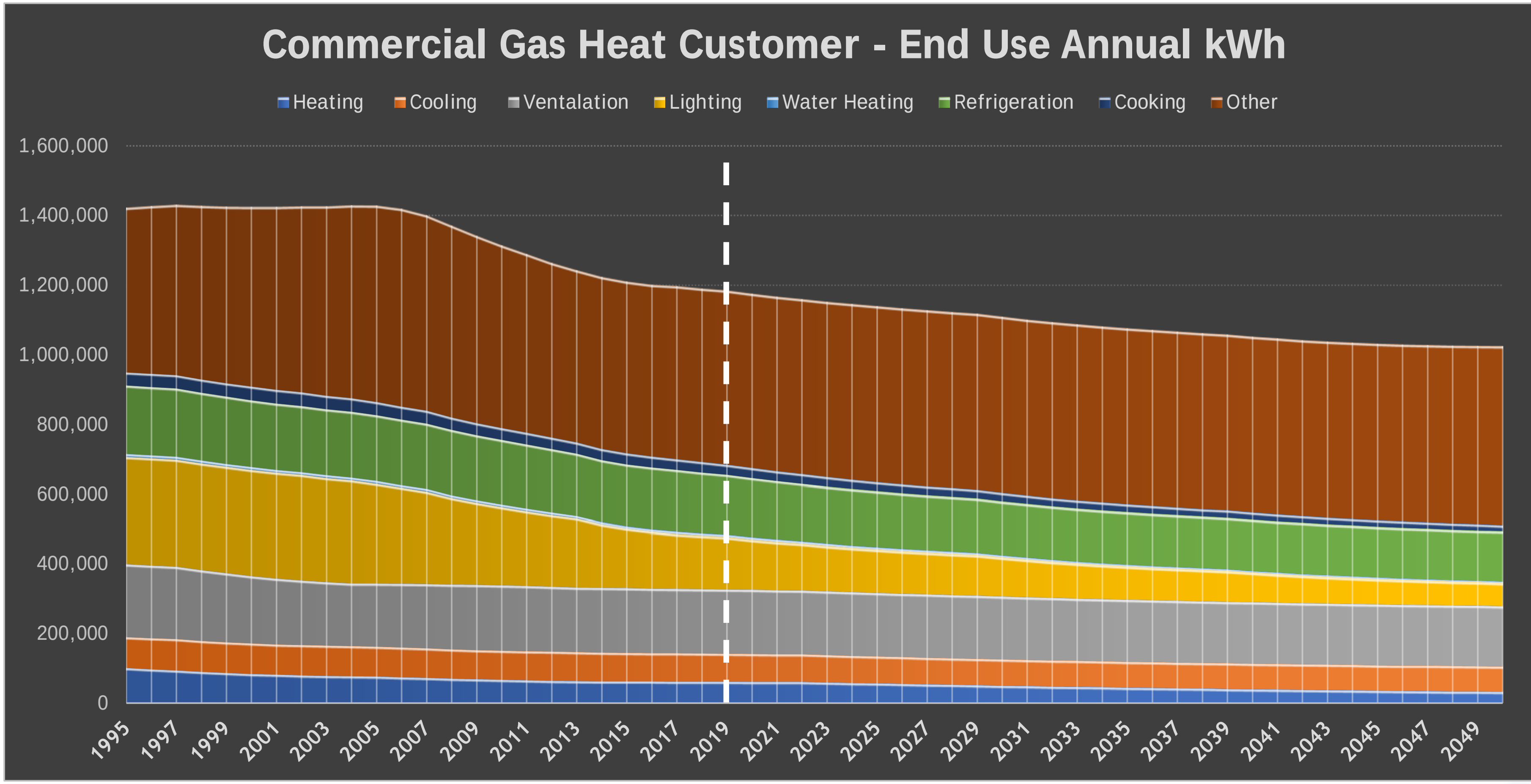
AAGR = Average Annual Growth Rate

COMMERCIAL MODEL



$$Sales_m = a + b_c \times XCool_m + b_h \times XHeat_m + b_o \times XOther_m + e_m$$

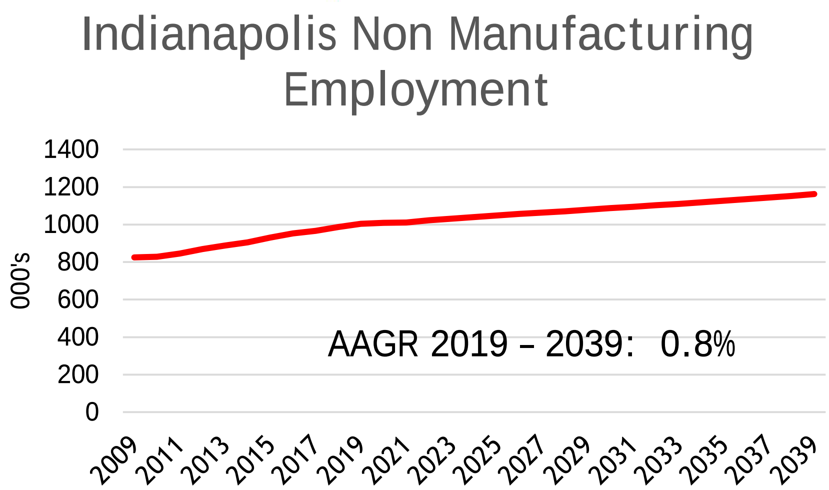
COMMERCIAL END USE TRENDS

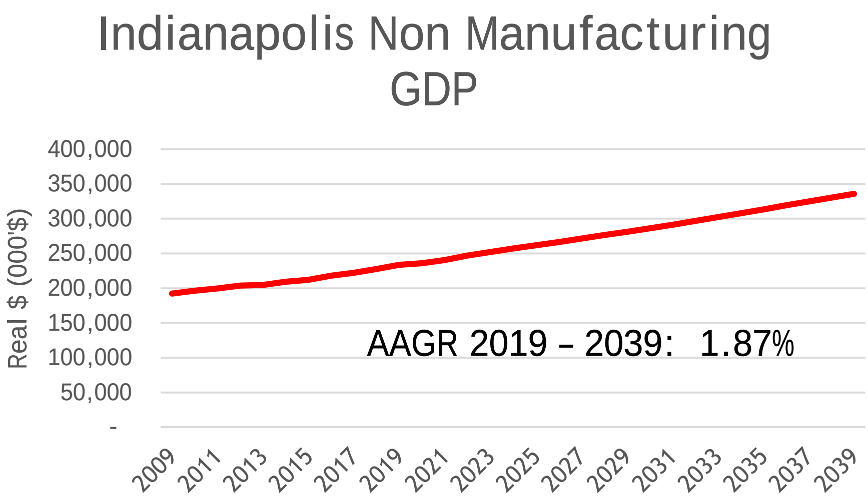


Cool AAGR 2019 - 2039: -0.45%
Heat AAGR 2019 - 2039: -1.9%
AAGR = Average Annual Growth Rate

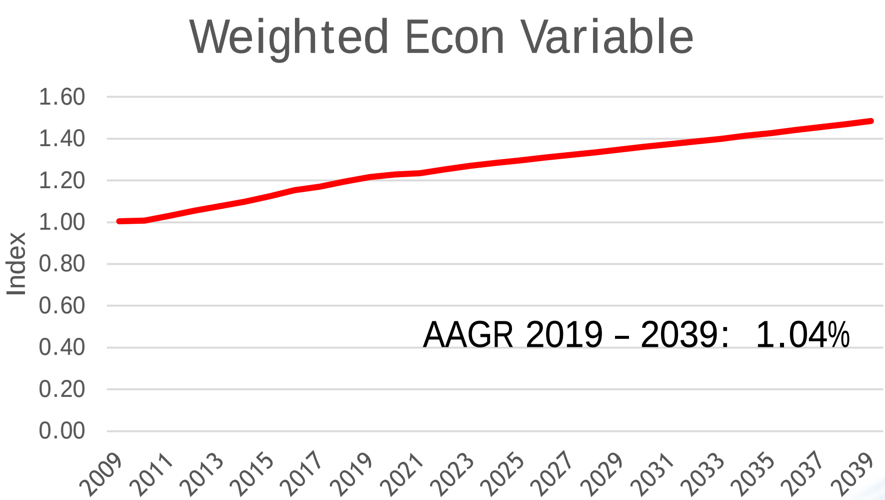
Source: 2018 EIA Annual Energy Outlook

COMMERCIAL ECONOMIC DRIVERS





- Moody's Analytics Indianapolis Metropolitan Statistical Area (MSA)
- Weighted Economic Variable: 80% Employment / 20% GDP



AAGR = Average Annual Growth Rate

INDUSTRIAL MODEL

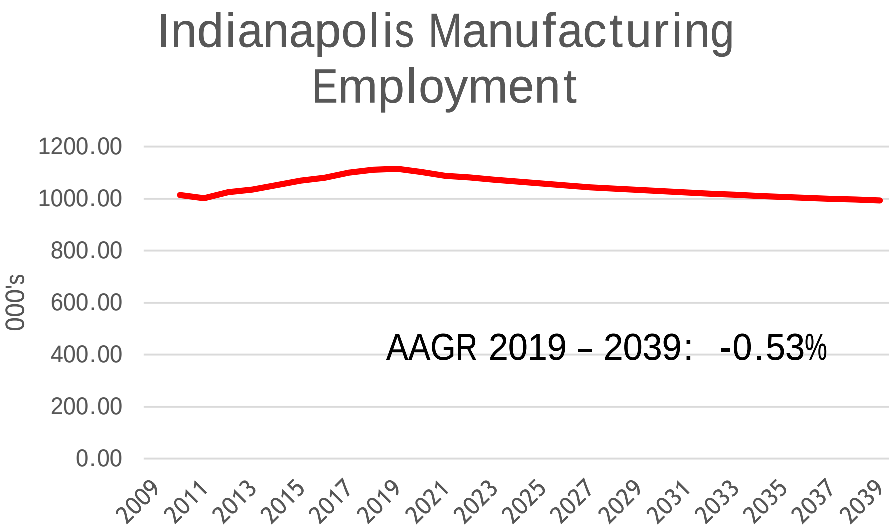
Industrial sales are estimated with a generalized econometric model

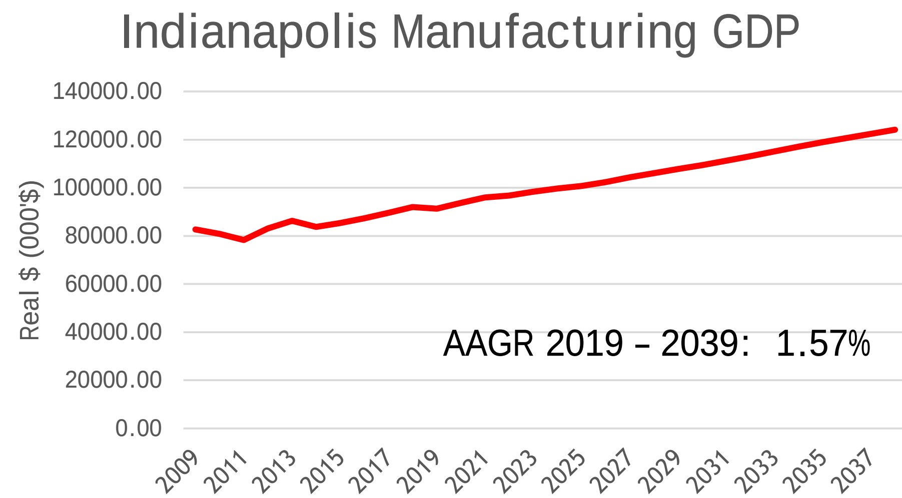
Cooling Degree Days

Manufacturing Employment
Manufacturing Output
Price

$$Sales_m = a + b_{cdd} \times CDD_m + b_{Econ} \times EconVariable_m + e_m$$

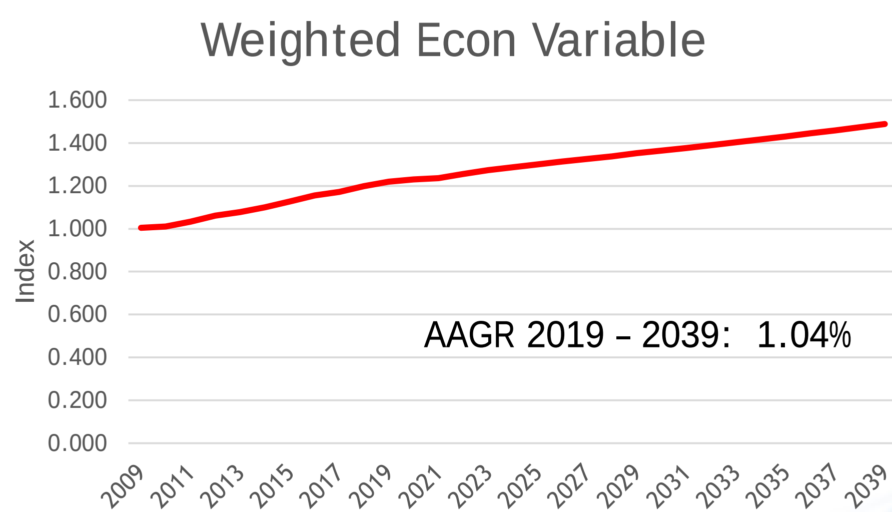
INDUSTRIAL ECONOMIC DRIVERS





- Moody's Analytics Indianapolis MSA

- Weighted Economic Variable: 90% Employment / 10% GDP

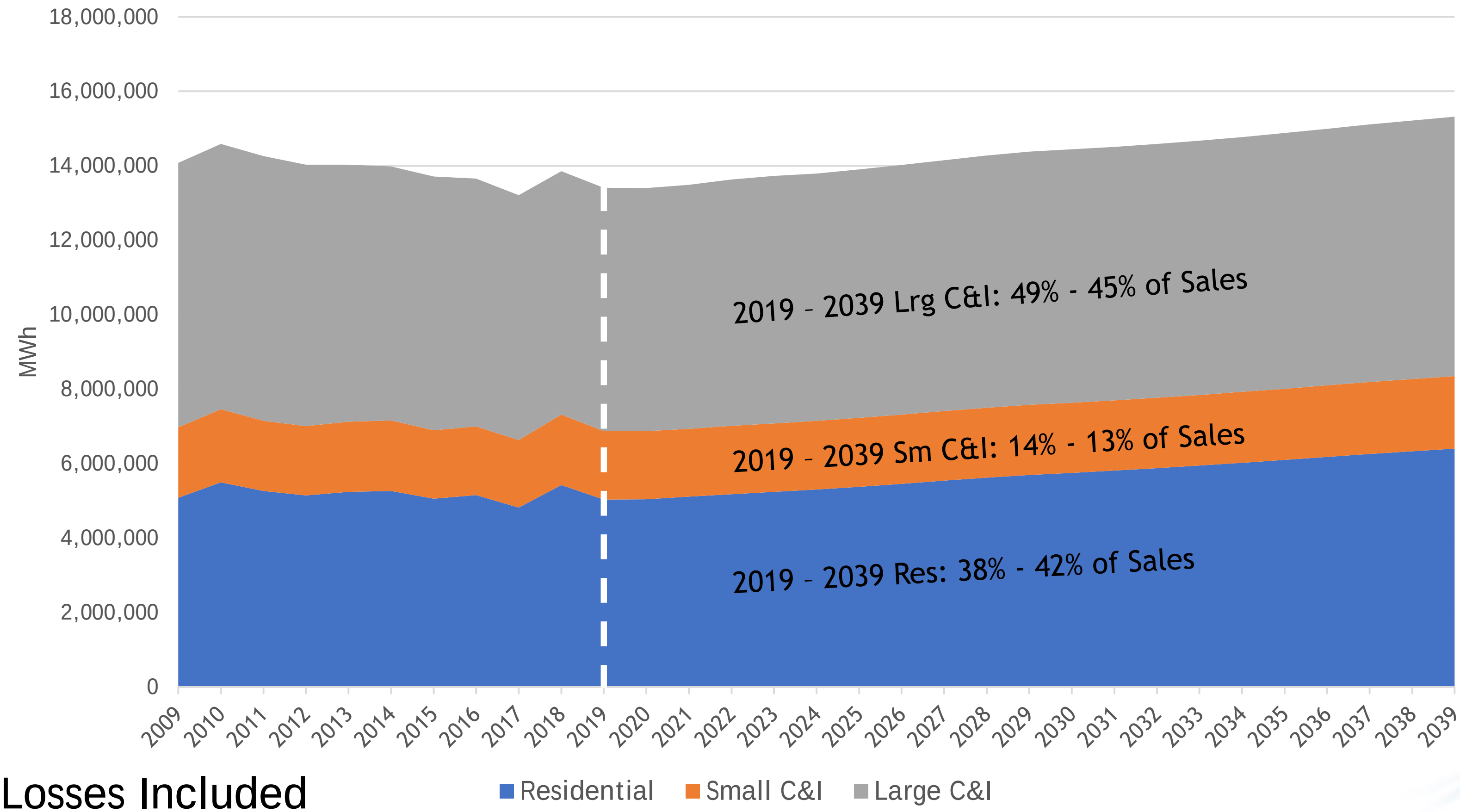


AAGR = Average Annual Growth Rate

CLASS SALES FORECAST

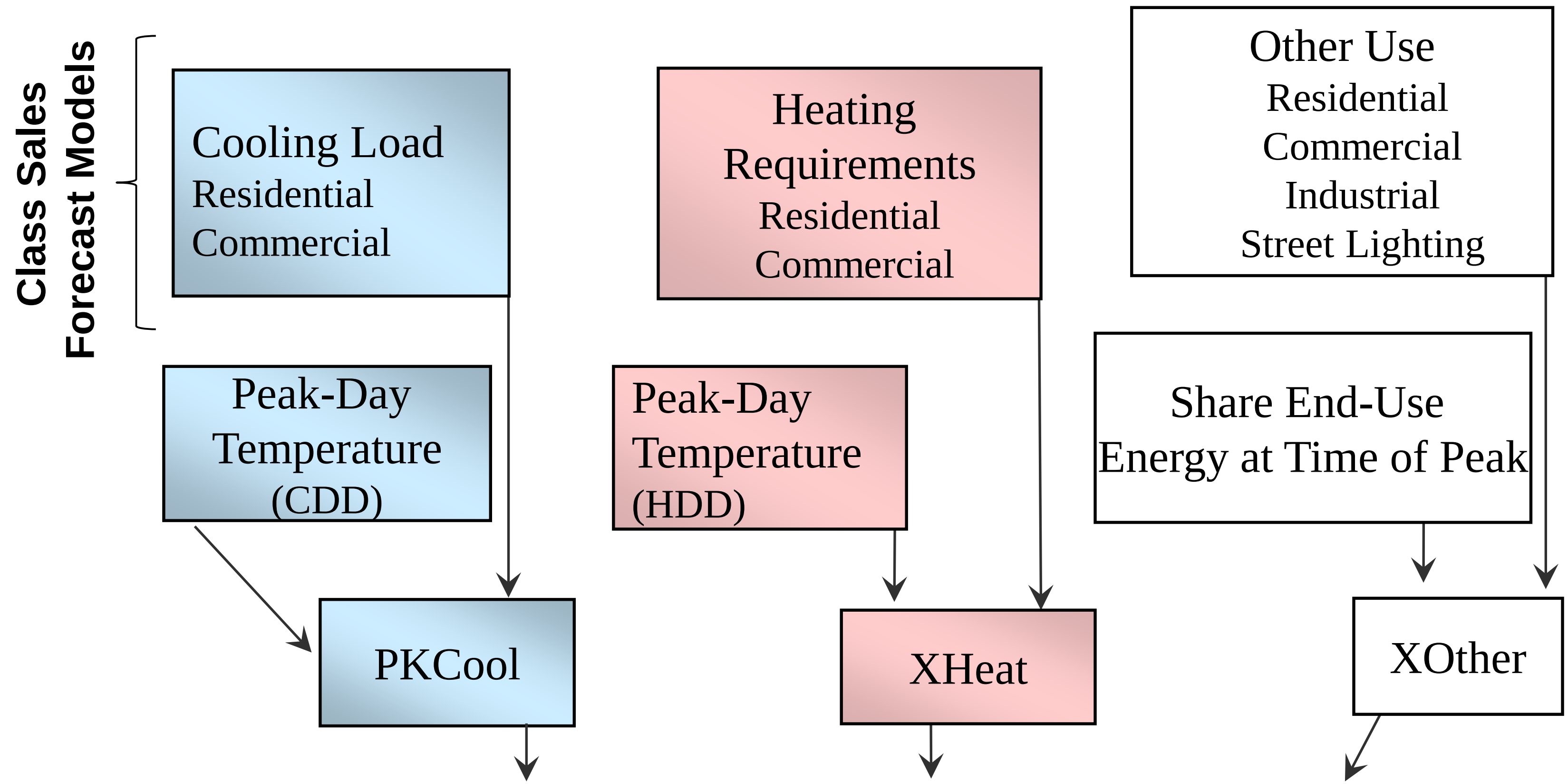
INCLUDES PRIOR YEAR DSM IMPACTS; FUTURE DSM WILL BE MODELED IN THE IRP

	Residential	Small C&I	Large C&I
Average Annual Growth Rate 2019 - 2039:	**1.2%**	**0.2%**	**0.3%**



No Losses Included

PEAK MODEL

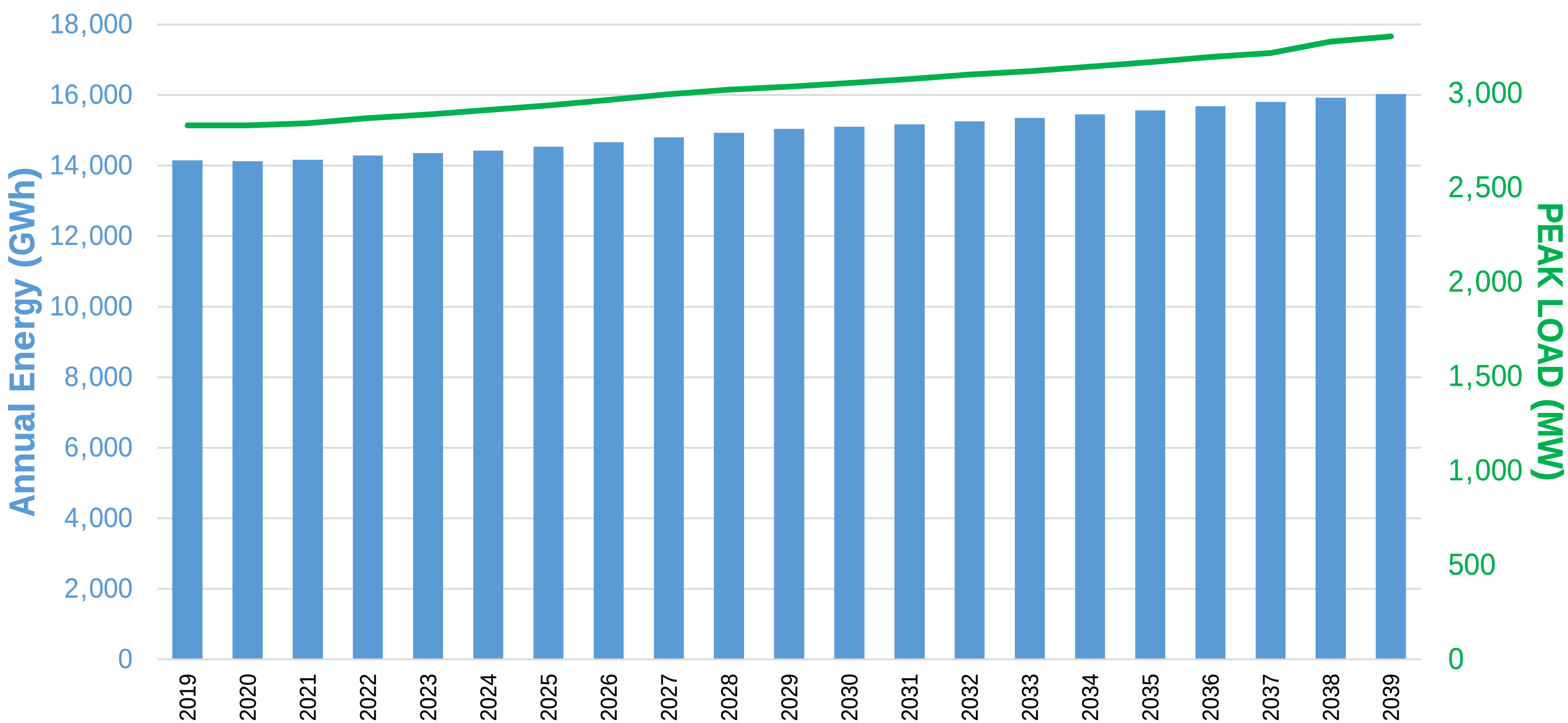


$$Peak_m = a + b_c \times PkCool_m + b_h \times PkHeat_m + b_o \times PKOther_m + e_m$$

IRP ENERGY & PEAK FORECAST

INCLUDES PRIOR YEAR DSM IMPACTS; FUTURE DSM WILL BE MODELED IN THE IRP

	Energy	Peaks
Average Annual Growth Rate 2019 - 2039:	**0.4%**	**0.8%**



ADDITIONAL LOAD FORECAST ITEMS

- High and low load forecasts still being developed
  - Alternate Moody's economic scenarios
  - Standard deviation in Itron models
  - Verified with PowerSimm
- EV & PV Forecast by MCR Consultants
  - Close to final
  - MCR will present forecast at next Stakeholder meeting
- Above items will be developed & incorporated and presented at the next Stakeholder Meeting

BREAK

IPL DEMAND SIDE MANAGEMENT (DSM) MARKET POTENTIAL STUDY (MPS) AND END USE RESULTS

GDS ASSOCIATES

END-USE ANALYSIS AND DRAFT RESULTS FOR 2020-2039 DSM MARKET POTENTIAL STUDY

MARCH 26, 2019 – IRP Public Advisory Meeting #2

Presented by **THE GDS TEAM**

2018 IPL END USE ANALYSIS RESULTS

END USE ANALYSIS OBJECTIVES

RESEARCH TO IMPROVE UPON INPUTS TYPICALLY USED IN LOAD FORECAST

- ***Primary & Secondary Research***
  - Surveys & onsite visits
  - Building energy simulation models
  - CBECS*
- ***Residential***
  - End Use Market Share
  - Unit Energy Consumption
- ***Small Commercial & Industrial***
  - End-use intensity
  - Distribution of customers by building type
  - End-use saturation

**commercial building energy consumption survey*

UNDERSTANDING ENERGY EFFICIENCY BEHAVIOR

- ***Large Commercial & Industrial***
- ***Onsite Visits***
- ***Interview Questions to Assess Attitudes Toward Energy Efficiency***

RESEARCH DESIGN-RESIDENTIAL END USE ANALYSIS

SELF-REPORT SURVEY

Online/Mail

384 responses (95/5)

Sample stratified by average usage

Data elements

End-use saturation

Miscellaneous end-uses

Hours of use

Willingness to participate in a site visit

Demographics

the research goal was to recruit site visits from the survey respondents

SITE VISITS

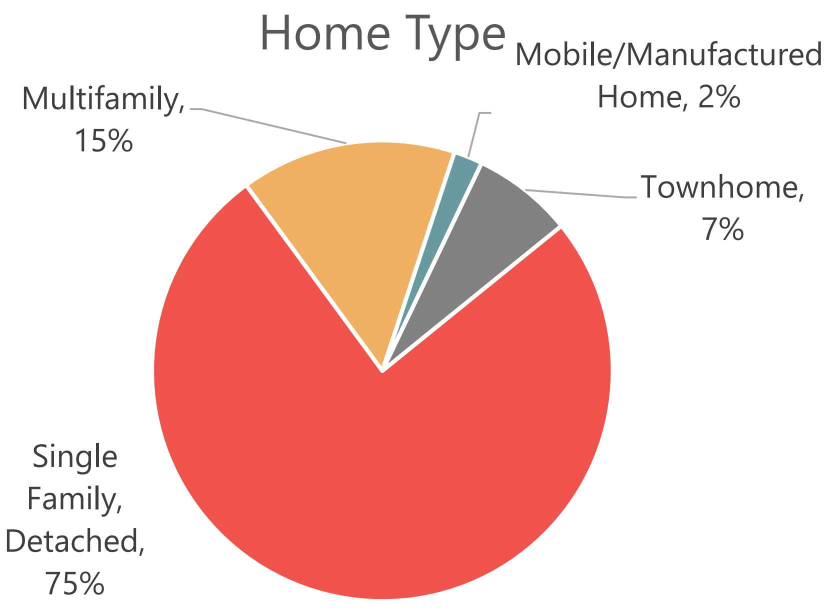
Sub-sample of survey respondents (n=68)

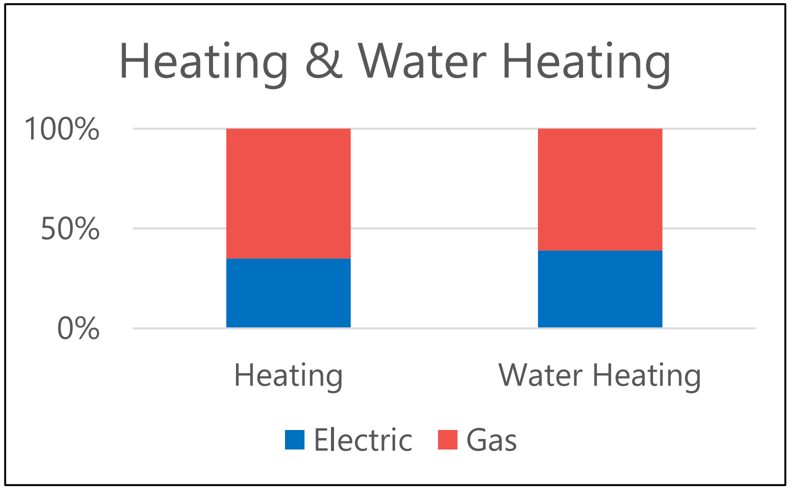
Verify accurate reporting on survey

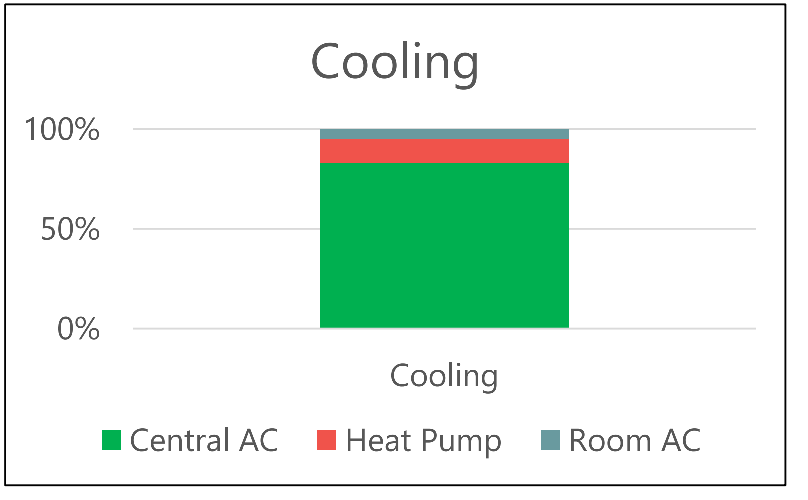
Catalogue of misc. end-uses

Evaluate willingness to participate in programs

Market Segmentation



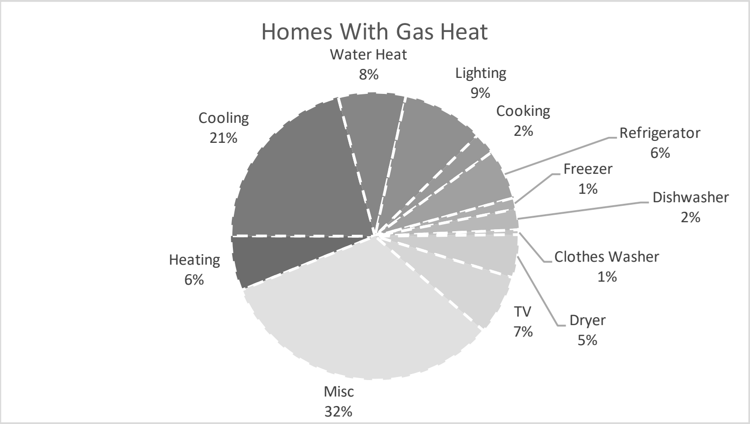


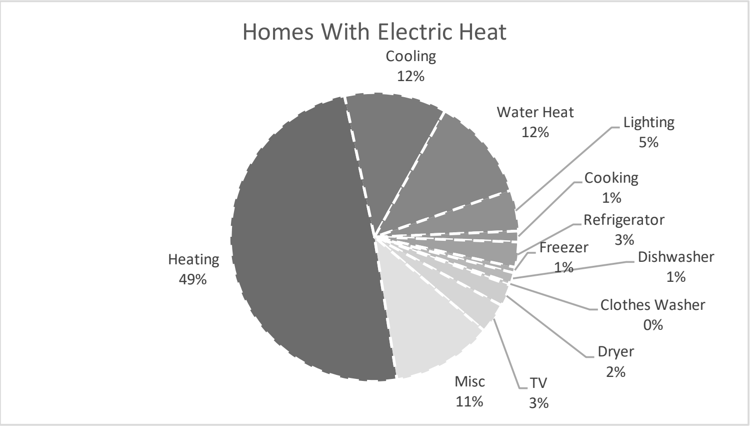


End Use Profiles

average annual kWh per home

Gas Heat		Electric Heat
6%	*heating intensity*	49%
21%	*cooling intensity*	12%
8%	*water heating intensity*	12%



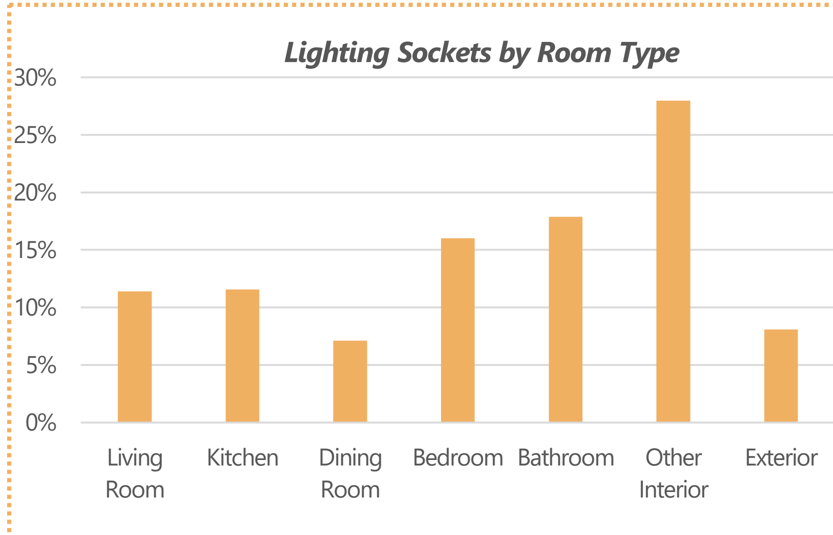


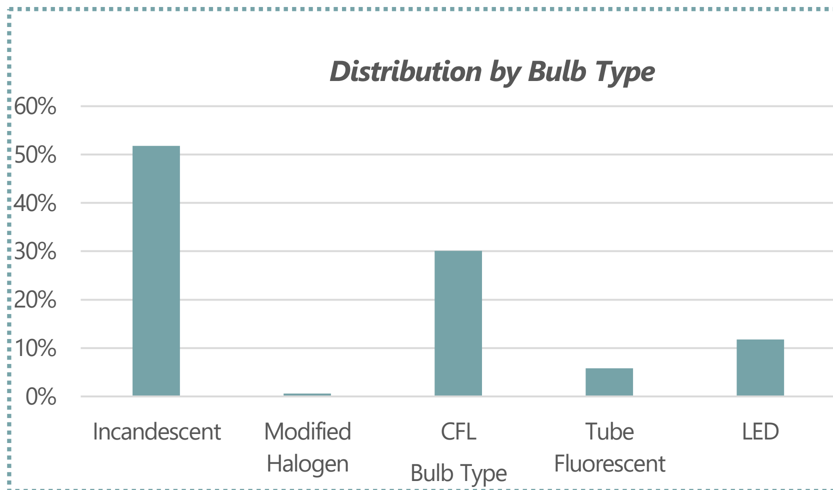
LIGHTING *averages per home*

40.5 *sockets*

5.5 *bulbs in storage*

61% *of storage are incandescent*





LIGHTING

01 **Self-responders tend to understate the number of lighting sockets in the home**

02 **They reported an average of 20 bulbs per home, whereas site visits indicated an average of 41 per home**

03 **The site visits are considered the accurate representation, since technicians perform a detailed count and inventory of all bulbs**

RESEARCH DESIGN-SMALL C&I END USE ANALYSIS

ENERGY INTENSITY

- **CBECS**
- **Basic assumption for energy intensity by end-use per sq. ft.**
- **Regional data**
- **Update to 2012 version**
  - *Decline in lighting intensity*
  - *Increase in computer intensity*

END-USE SATURATION

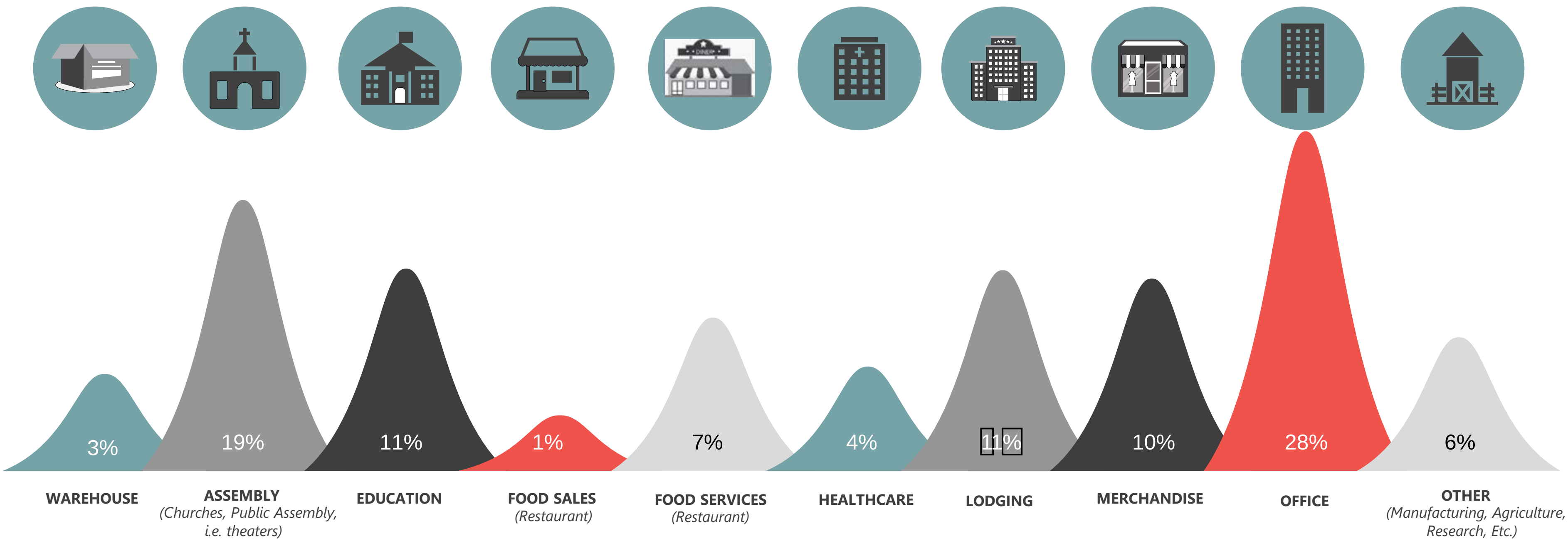
- **70 site visits**
- **Building type representation**
- **Compare end-use saturation with CBECS assumptions**

BUILDING TYPES

- **Use *InfoUSA* SIC codes to classify accounts to industry codes**
- **Map industry codes to CBECS building types**
- **Summarize energy sales by building type**
- **Update % of energy sales by building type assumption in forecast**

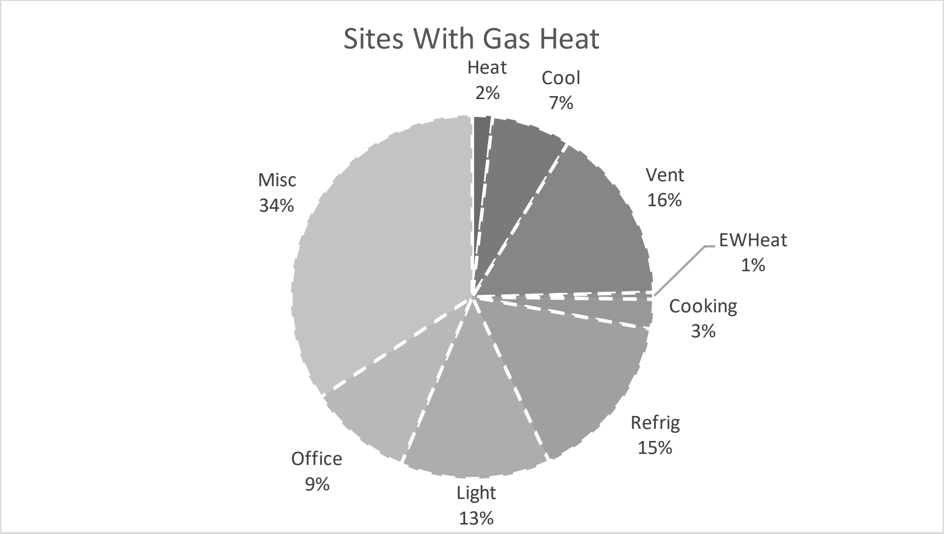
SEGMENTATION *by Electric Consumption*

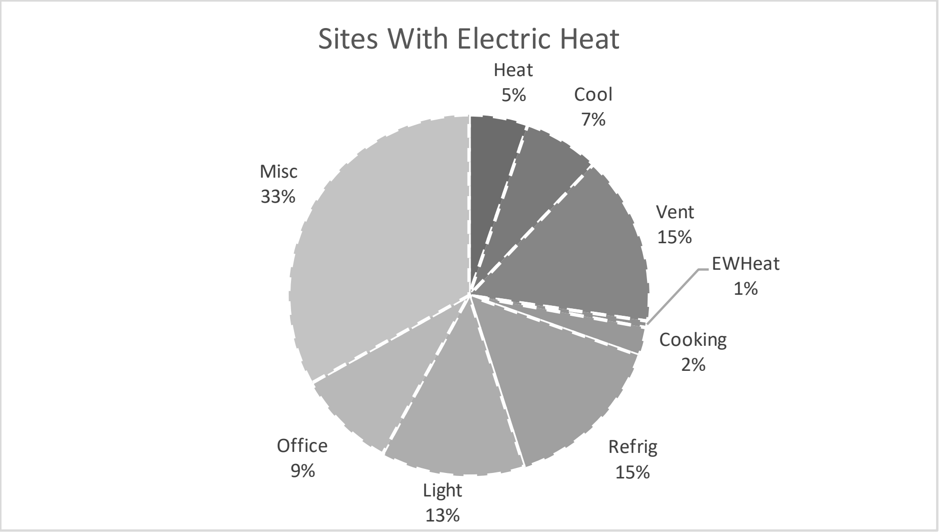
Commercial Segmentation by Commercial Building Type



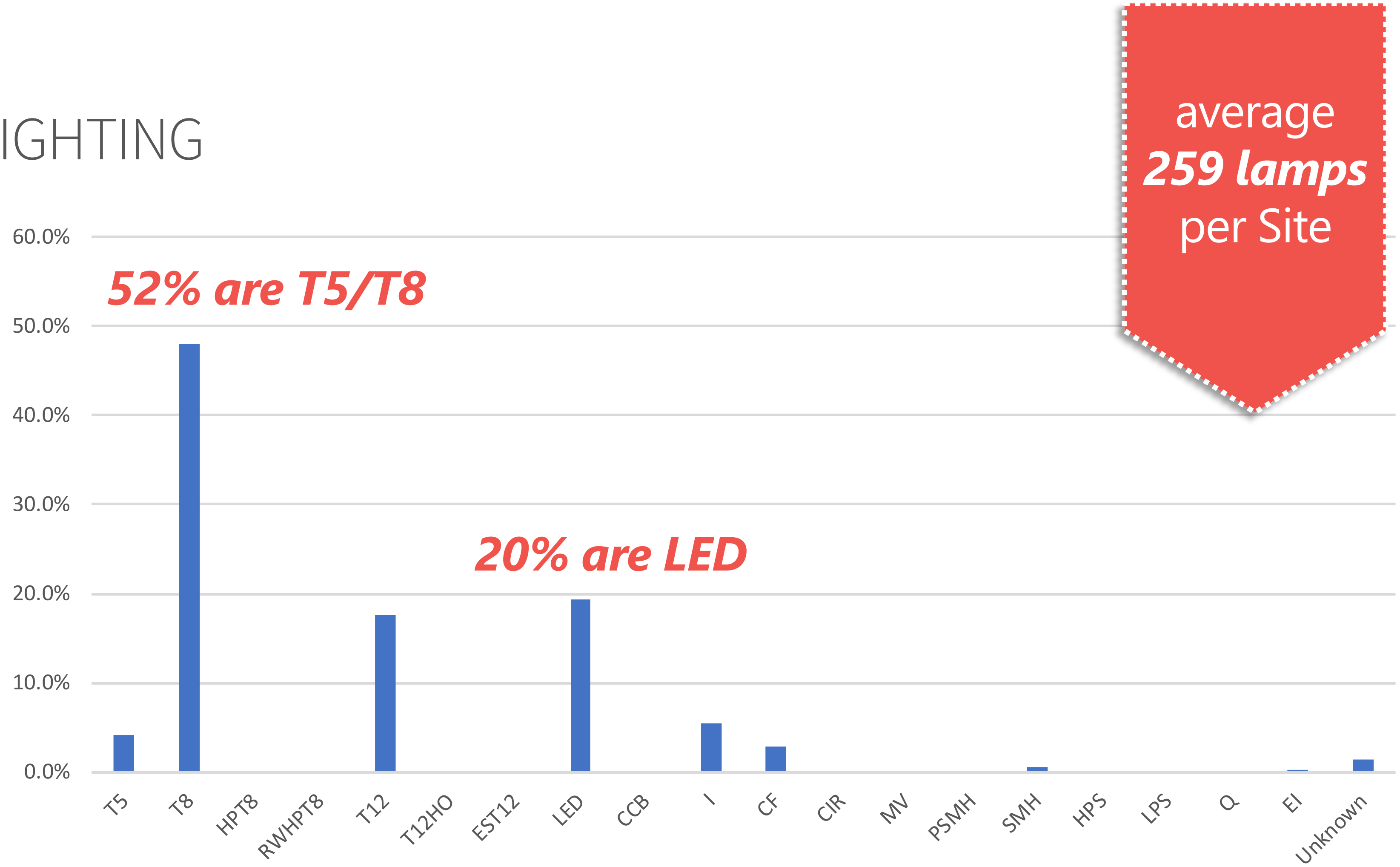
End Use Profiles

average annual kWh per commercial site





LIGHTING


average
259 lamps
per Site
52% are T5/T8
20% are LED
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
T5
T8
HPT8
RWHPT8
T12
T12HO
EST12
LED
CCB
I
CF
CIR
MV
PSMH
SMH
HPS
LPS
Q
EI
Unknown

RESEARCH DESIGN LARGE C&I END-USE ANALYSIS

IDENTIFY POPULATION FRAME

Work with IPL staff, want to include opt-out accounts

RECRUIT PARTICIPANTS *(45 accounts)*

Attempt to get representative sample
- by industry type
- by usage amount

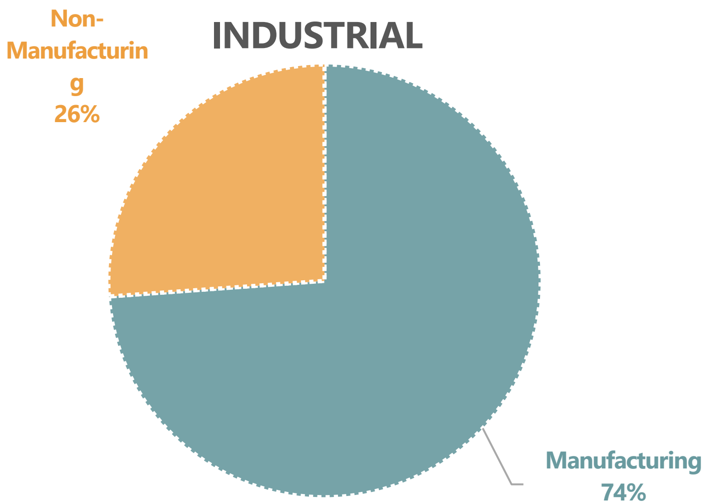
CONDUCT ON-SITE SURVEYS

Collect equipment characteristics Willingness to participate

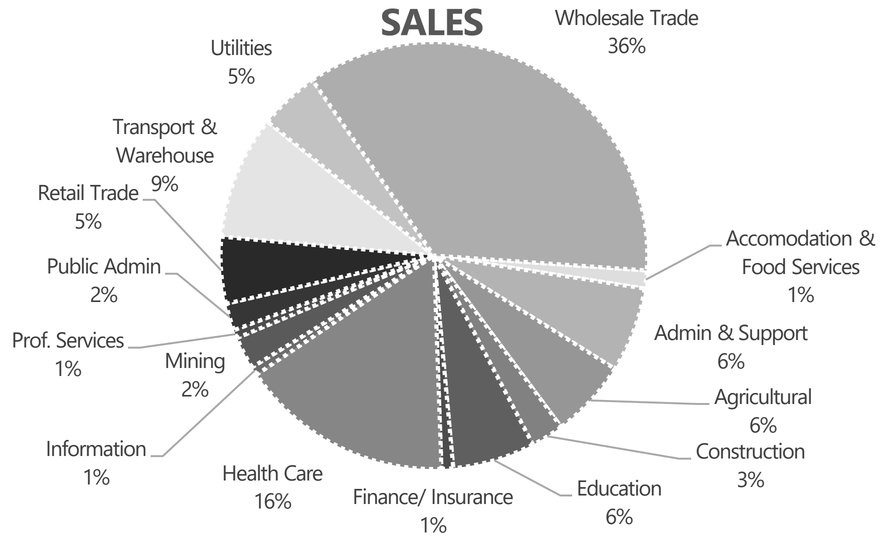
COLLECT INFORMATION ON EFFICIENCY ACTIVITY

INDUSTRY SEGMENTATION

DISTRIBUTION OF ENERGY SALES - INDUSTRIAL

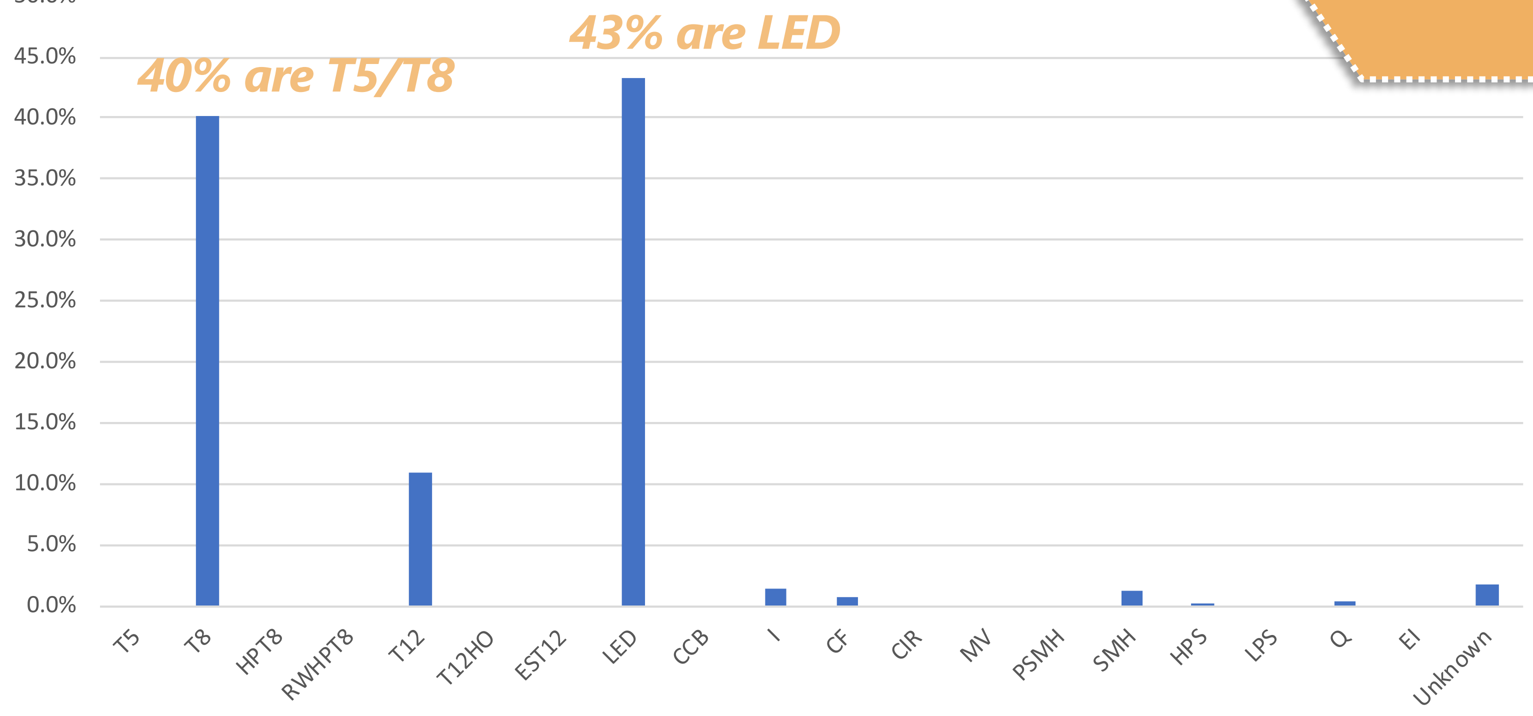


DISTRIBUTION OF NON-MANUFACTURING SALES



LIGHTING

average ***347 lamps*** per site



IPL DSM MARKET POTENTIAL STUDY (MPS) PRELIMINARY RESULTS

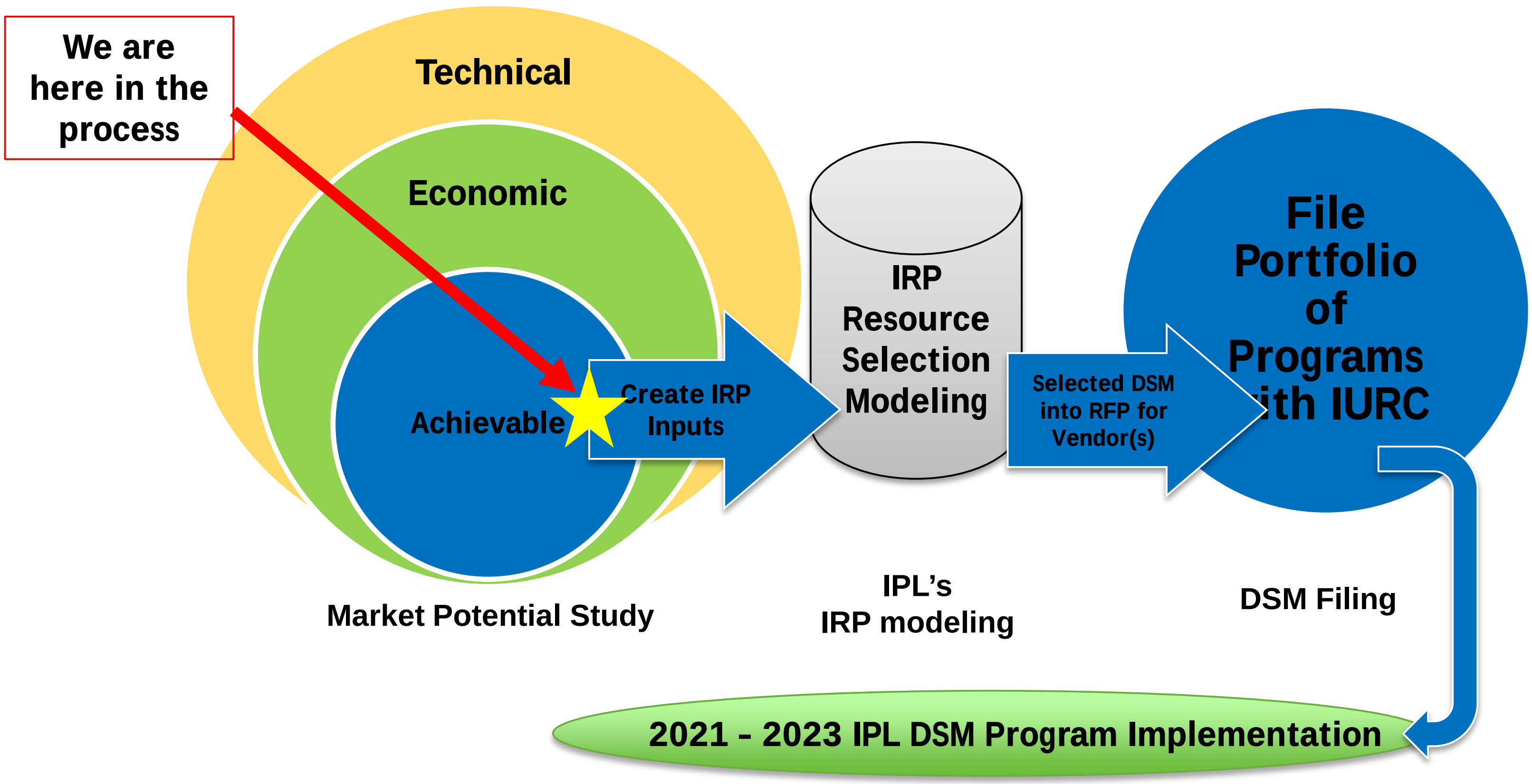
- Please note that the following information represents the preliminary results of the Market Potential Study (MPS) completed by GDS.

- This information does not necessarily represent either the amount of DSM:
  a) that will ultimately be selected by the IRP modeling, or
  b) the amount of DSM IPL will seek approval to deliver during the 2021-2023 period or subsequent years beyond 2023

- This information will serve as the starting point for IPL to develop the DSM inputs (DSM as a resource) for the IRP modeling.

- The eventual DSM plan that will be proposed for the 2021-2023 period will be the product of the IRP modeling and proposals by implementation vendors.

DSM PROCESS & THE IRP



POTENTIAL STUDY METHODOLOGY

METHODOLOGY-MEASURE CHARACTERIZATION

Draft Results

01 INCLUDES…

- Savings
- Incremental/full costs
- Measure interaction
- Measure life
- Measure applicability

02 DATA SOURCES…

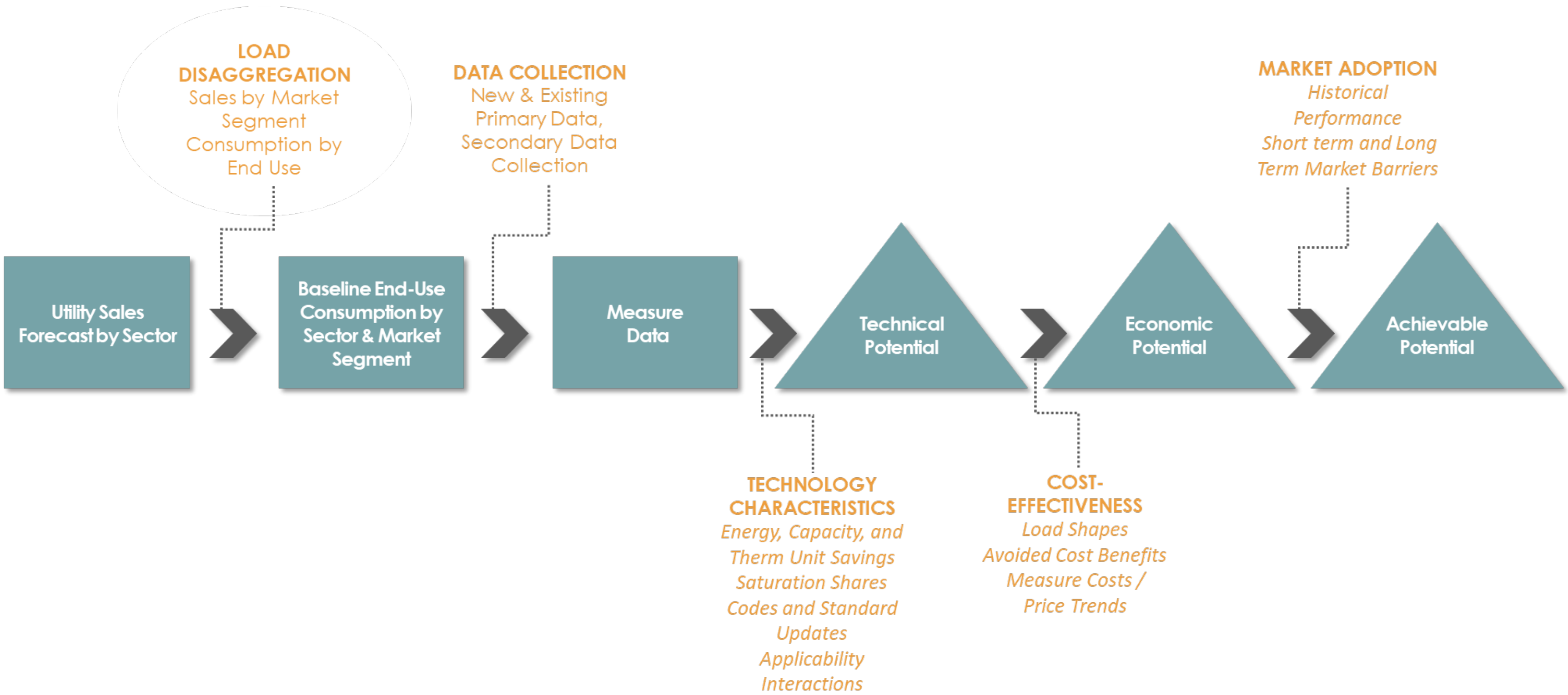
- Current catalog of IPL Measures
- Indiana TRM, Illinois TRM, Michigan Energy Measures Database
- Regional and national costs databases
- Building energy modeling
- IPL market data and survey data

03 ASSUMPTIONS…

Assumptions were collected and sourced in a spreadsheet that was shared for review and comment by OSB

METHODOLOGY-STUDY APPROACH

Draft Results



METHODOLOGY-TECHNICAL POTENTIAL

Draft Results

Residential Example *(electric)*

TECHNICAL POTENTIAL OF EFFICIENT MEASURE = **total number of households** X **base case end use intensity** (kWh/unit) X **saturation share** X **remaining factor** X **feasibility factor** X **savings factor**

analysis covers a 20-year timeframe

TECHNICAL POTENTIAL

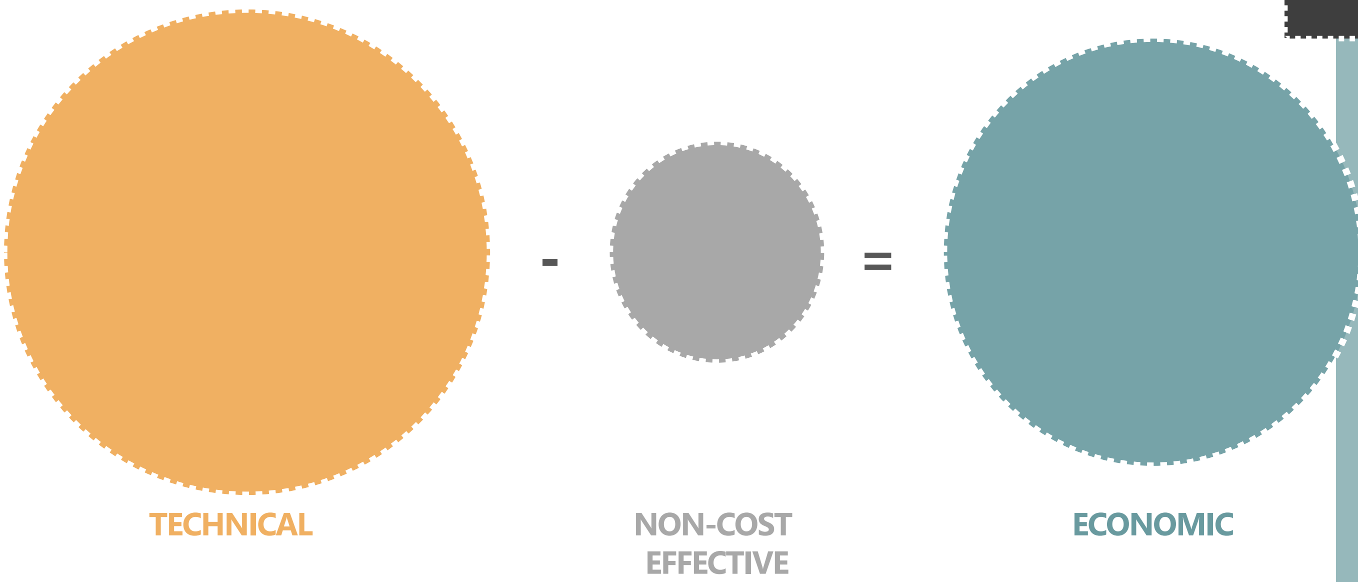
Theoretical maximum, only constrained by technical feasibility & applicability of measures

METHODOLOGY-ECONOMIC POTENTIAL

Draft Results

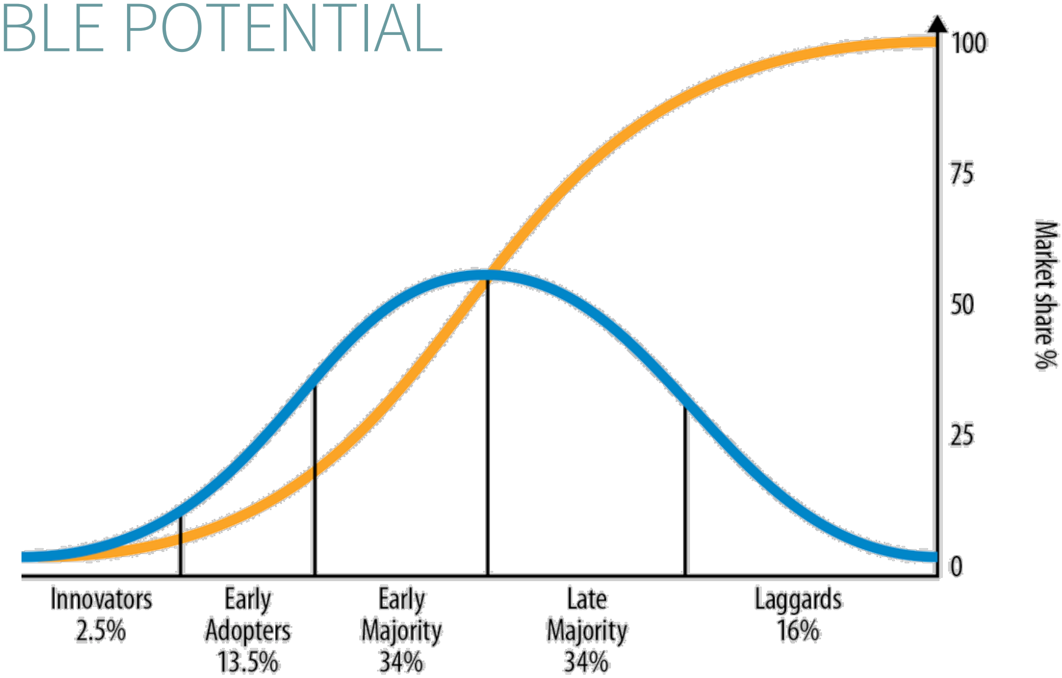
ECONOMIC POTENTIAL

Subset of the Technical Potential that is economically cost effective (based on screening with the Utility Cost Test)



METHODOLOGY-ACHIEVABLE POTENTIAL

Draft Results



ADOPTION RATES

– **short term adoption rate** (a)

– **long term adoption rate** (b)

– **adoption curve**

- *i.e. how you get from (a) to (b)*

METHODOLOGY-ACHIEVABLE POTENTIAL

Draft Results

SHORT TERM ADOPTION RATE

historical performance & current saturation of EE equipment is a key indicator

LONG TERM ADOPTION RATE

incentive and payback are two primary variables; others considered

IPL willingness to participate research

RESIDENTIAL

RESIDENTIAL POTENTIAL RESULTS

Draft Results

01

Nearly 3,000,000 MWh of Technical Potential

(cumulative, 2021-2039)

- HVAC Equipment, Water Heating and HVAC Shell are leading end uses

02

Economic Potential is about 85% of Technical Potential

- Utility Cost Test used for benefit-cost screening
- Low-income measures retained in Economic Potential, regardless of UCT ratio

03

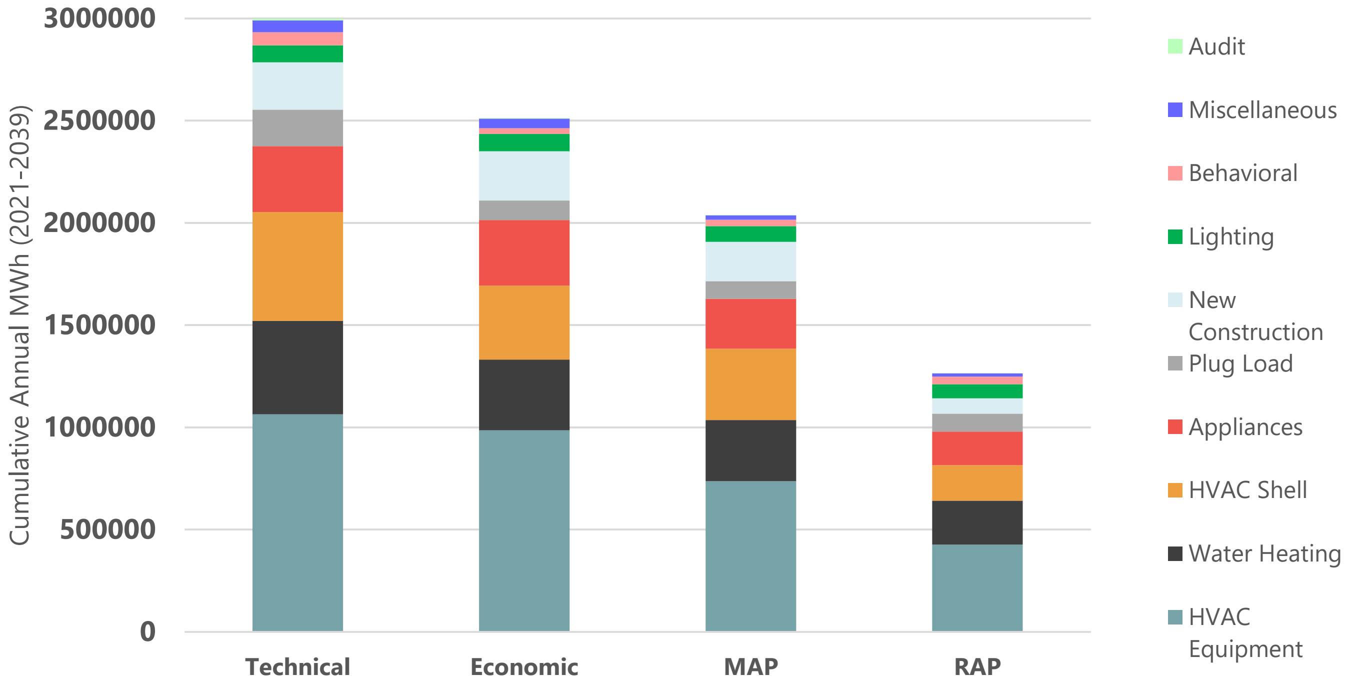
Realistic Achievable Potential is approximately 1,250,000 MWh

(cumulative, 2021-2039)

RESIDENTIAL POTENTIAL RESULTS

Draft Results

2021-2039 Cumulative (gross MWh)

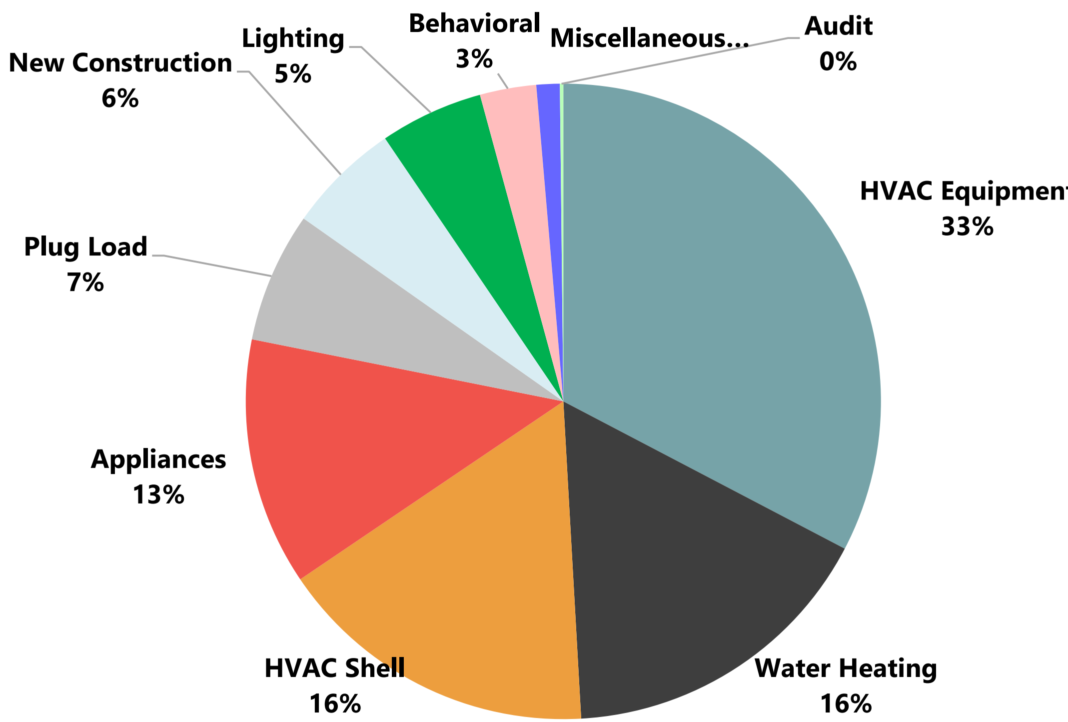


current cost effectiveness screening is based on gross savings and excludes delivery (non-incentive) costs

RESIDENTIAL POTENTIAL RESULTS

Draft Results

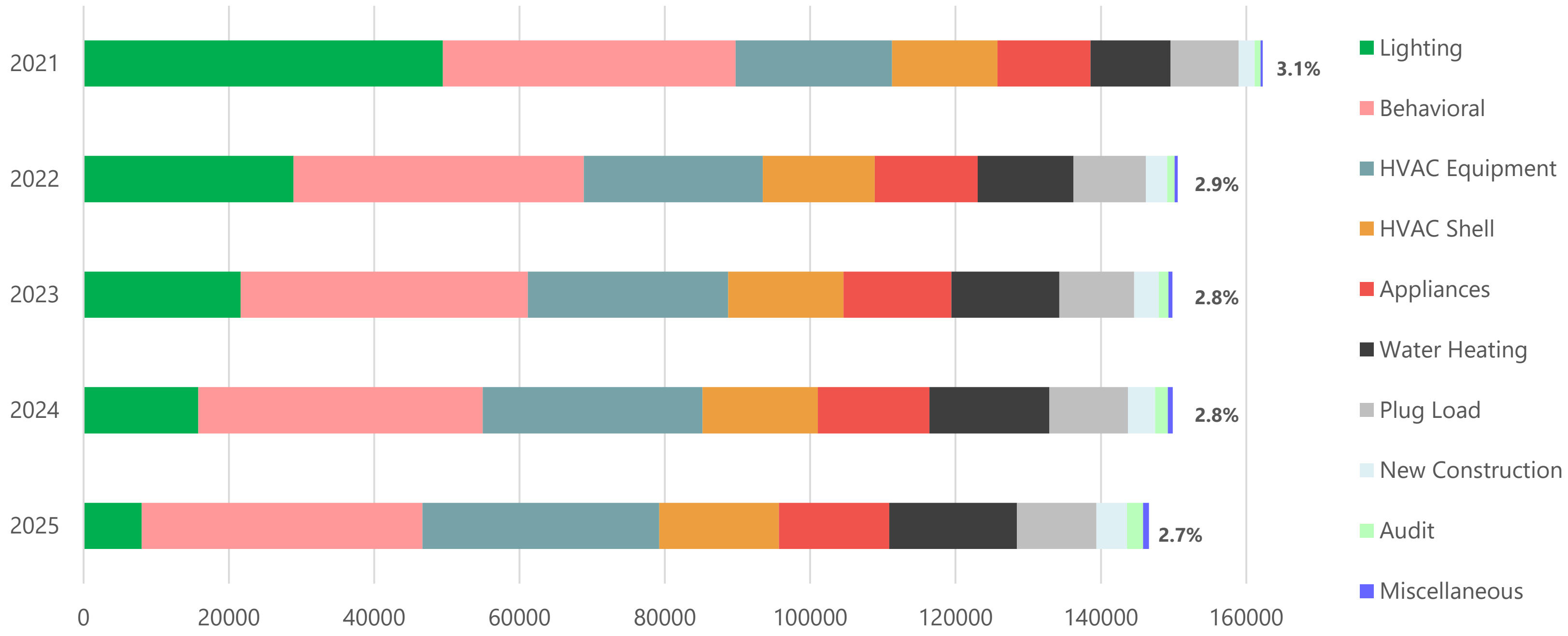
2021-2039 Cumulative RAP (percent savings by end use)



RESIDENTIAL POTENTIAL RESULTS

Draft Results

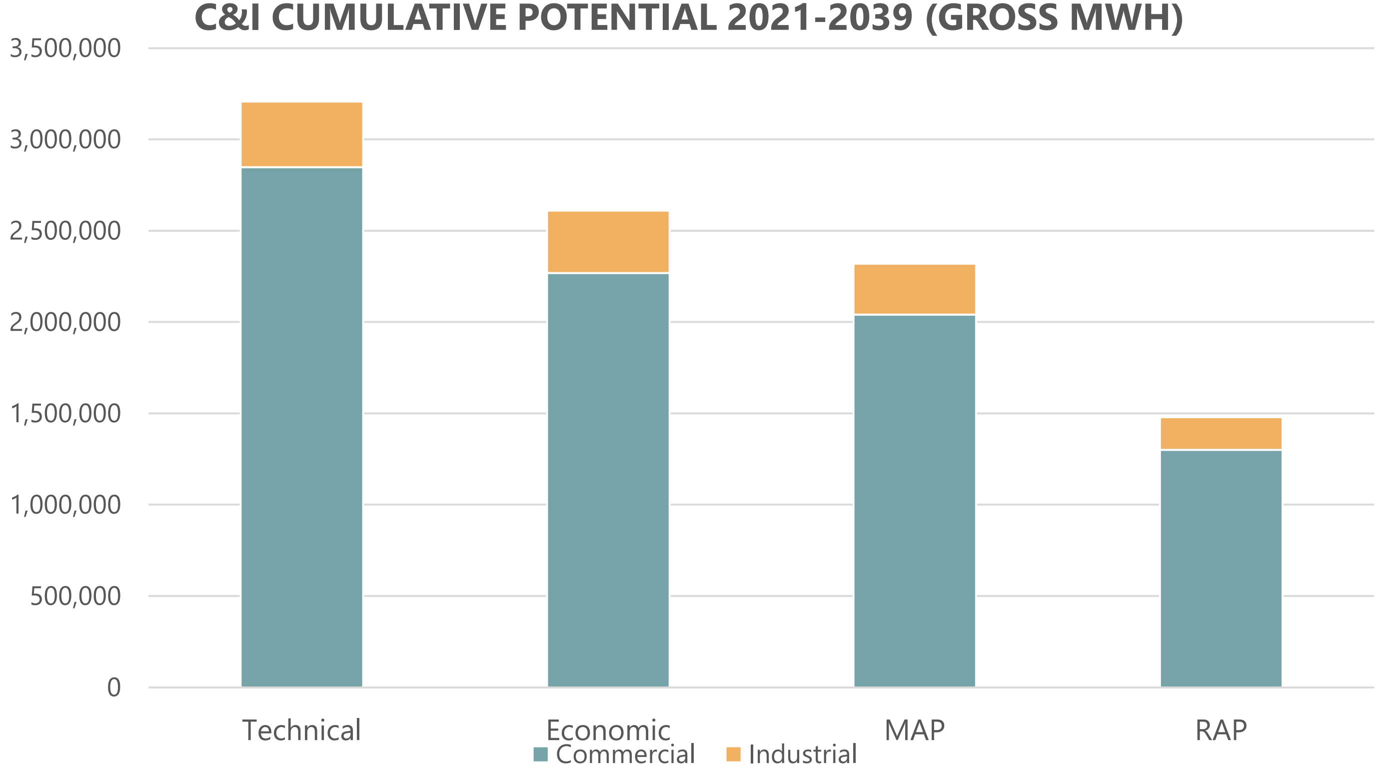
Annual Incremental RAP 2021-2025 (gross MWh)



COMMERCIAL & INDUSTRIAL

C&I POTENTIAL RESULTS

Draft Results

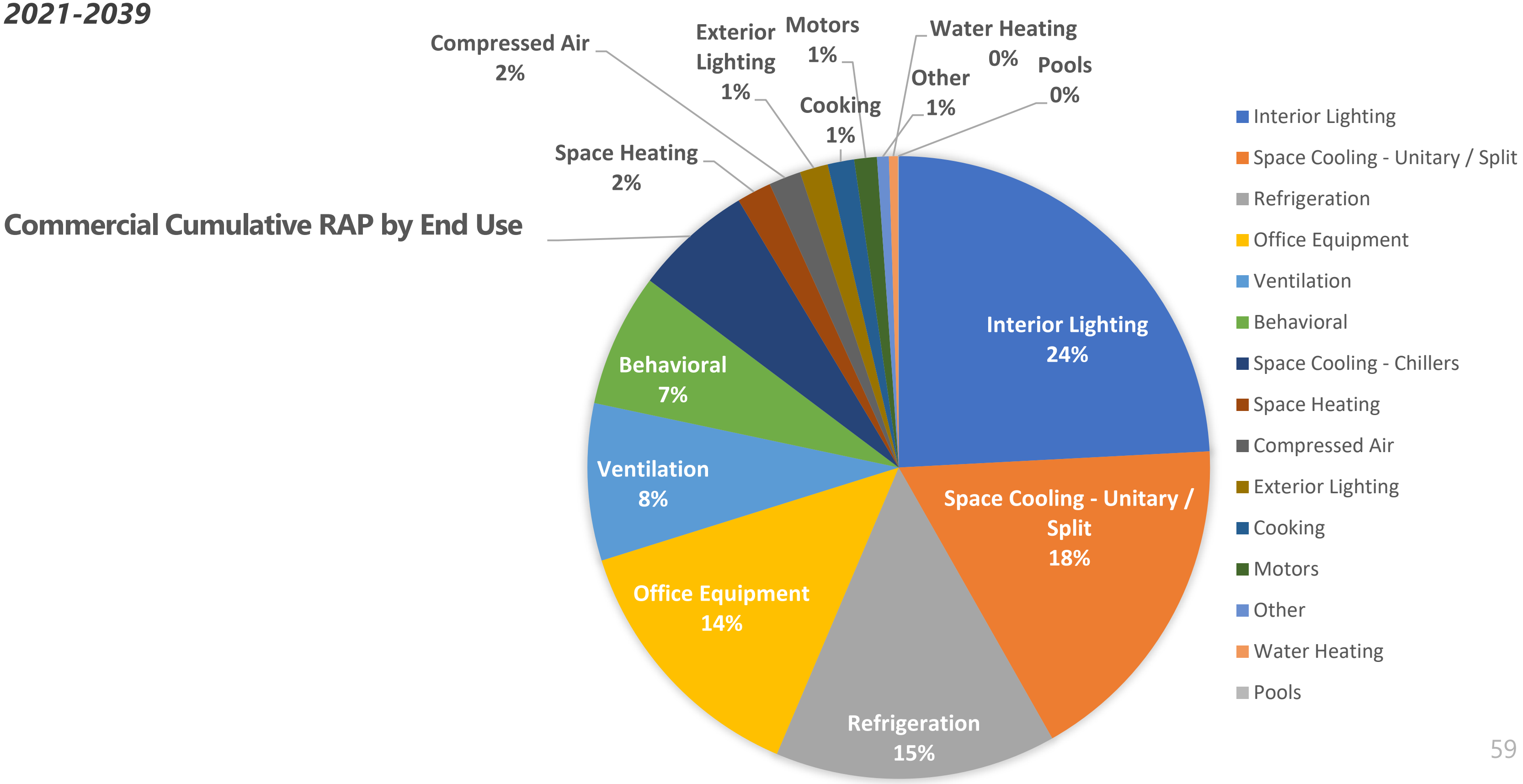


Current cost effectiveness screening is based on Gross savings and excludes delivery (non-incentive) costs

COMMERCIAL POTENTIAL RESULTS

Draft Results

2021-2039

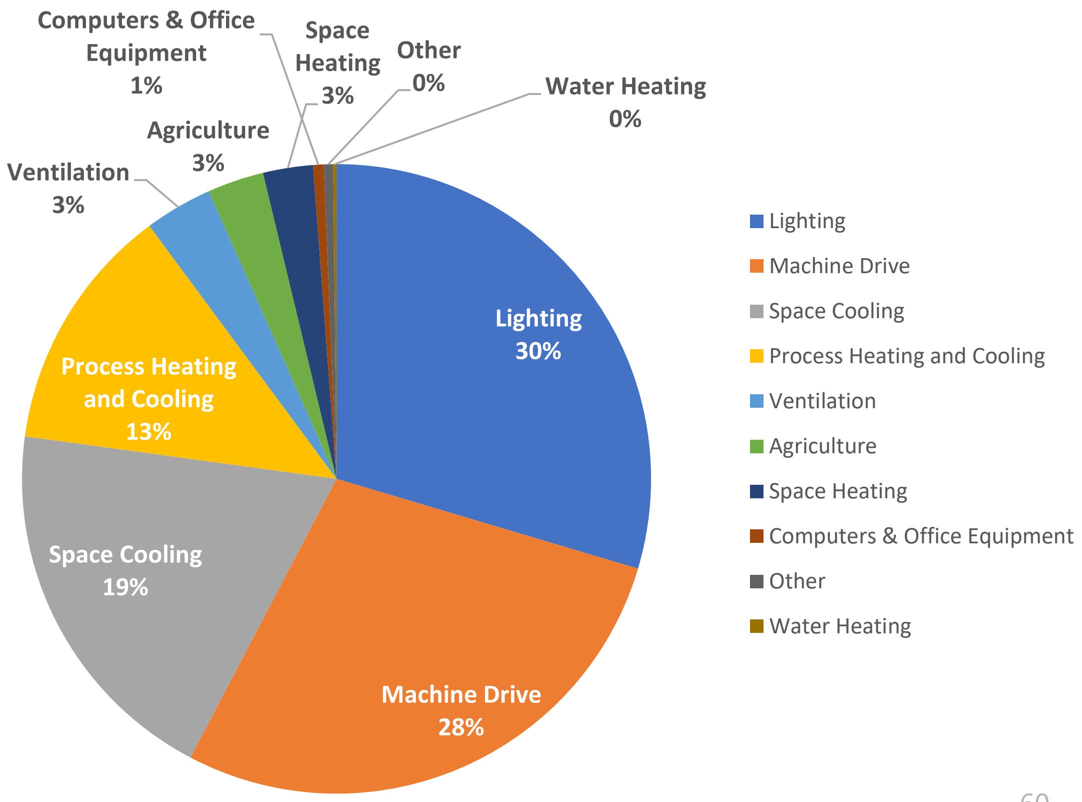


INDUSTRIAL POTENTIAL RESULTS

Draft Results

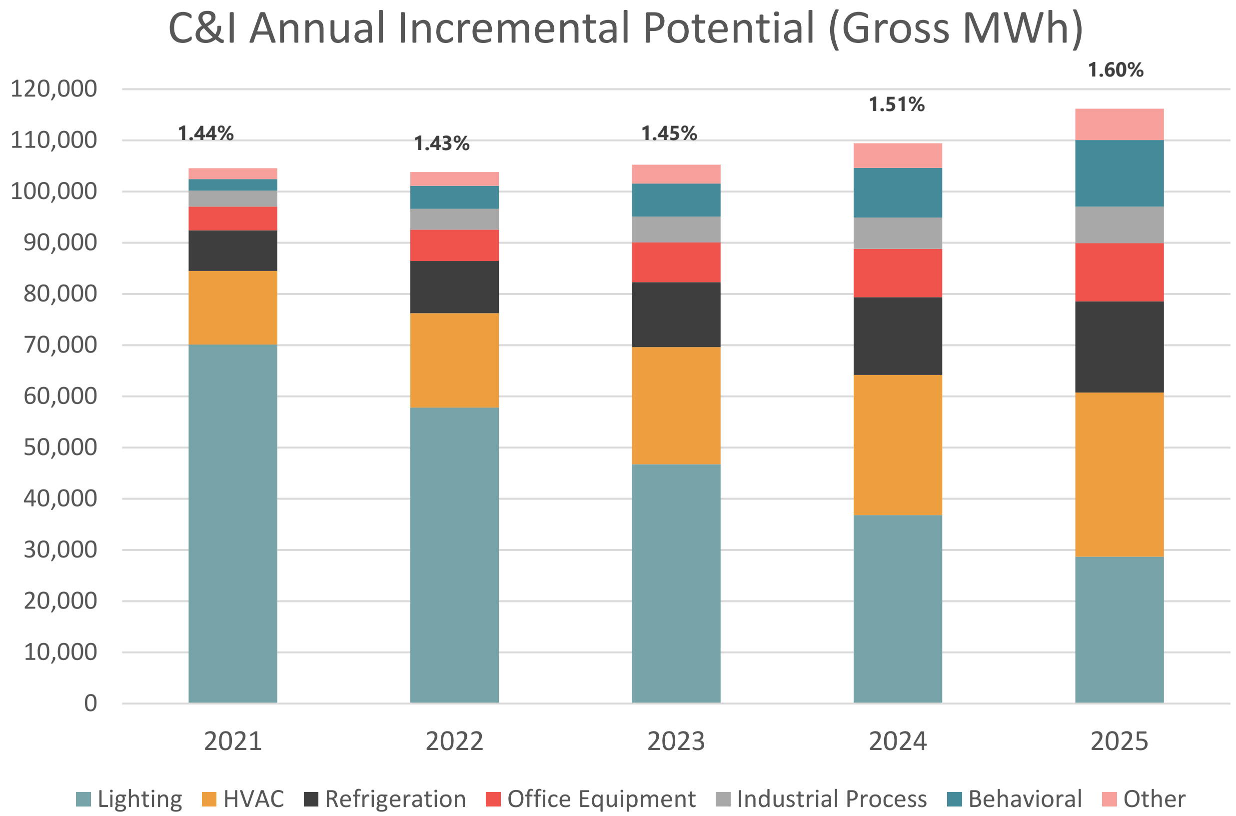
2021-2039

Industrial Cumulative RAP by End Use



TOTAL C&I 2021-2025 POTENTIAL

Draft Results

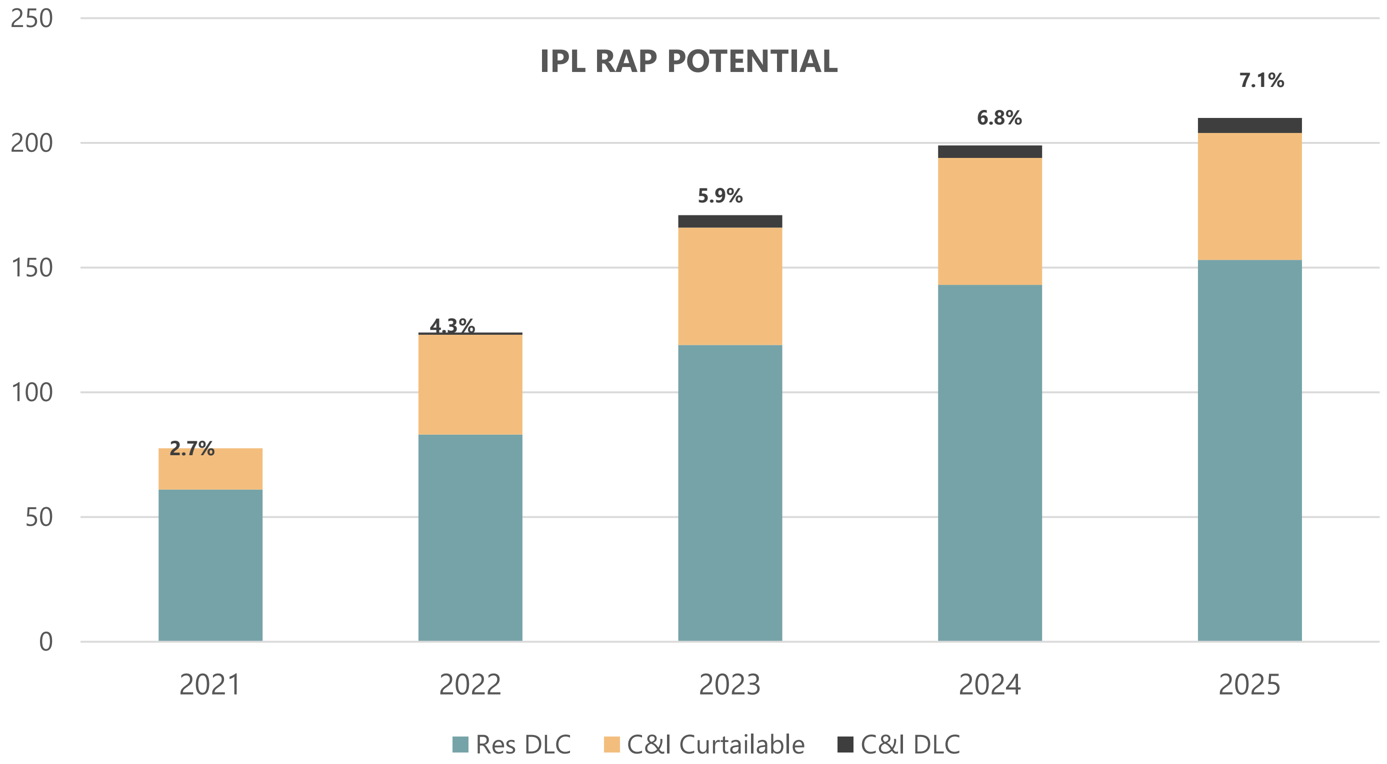


Percent of adjusted C&I sales
(net of opt-out customers)

DEMAND RESPONSE

DEMAND RESPONSE
Draft Results

Cumulative Annual DR Savings (Gross MW)



MPS PRELIMINARY RESULTS
NEXT STEPS

- April 2019: Review OSB comments, finalize MPS results and create IRP inputs from the MPS results
- Stakeholder Meeting #3: Present IRP/DSM modeling approach
- Stakeholder Meeting #4: Present DSM results; volume of DSM for 2021 – 2039 selected in Reference Case
- Fall/Winter 2019: Issue RFP for DSM implementation
- Spring 2020: Submit DSM filing for 2021 - 2023

LUNCH

COMMODITY PRICES AND MODELING

Patrick Maguire

Director of Resource Planning

FORWARD CURVES USED IN IRP MODELING

- Power Prices (Indiana Hub On/Off)
- Henry Hub Natural Gas
  - Gas basis for delivered prices
- IPL delivered coal
- Fuel oil
- Emissions (NO_x, SO_2, carbon)
- Capacity Prices
  - MISO Zone 6

FUNDAMENTAL FORECAST VENDOR

- **Wood Mackenzie H1 2018 Long Term Outlook**
- Provided Cases:
  1. Federal Carbon Case (Carbon tax starting 2028)
  2. Federal Carbon Case + High Gas Sensitivity
  3. No Carbon Case
  4. No Carbon + Low Gas Sensitivity

FORWARD CURVE NOTES

	Deterministic Modeling	Stochastic Ranges	Notes
Power	✓	✓	On/Off peak monthly power prices from Wood Mackenzie. Hourly shapes created in PowerSimm.
Natural Gas	✓	✓	Wood Mackenzie monthly gas prices with delivery adders. Daily price shapes created in PowerSimm.
Coal	✓	✓	Internally sourced IPL coal curves.
Fuel Oil	✓	✓	Wood Mackenzie
Emissions	✓	✗	NOx and SO2 curves will be sourced from forward curves. Carbon prices from Wood Mackenzie.
Capacity	✓	✓	Capacity will be valued at the estimated bilateral price for MISO Zone 6.

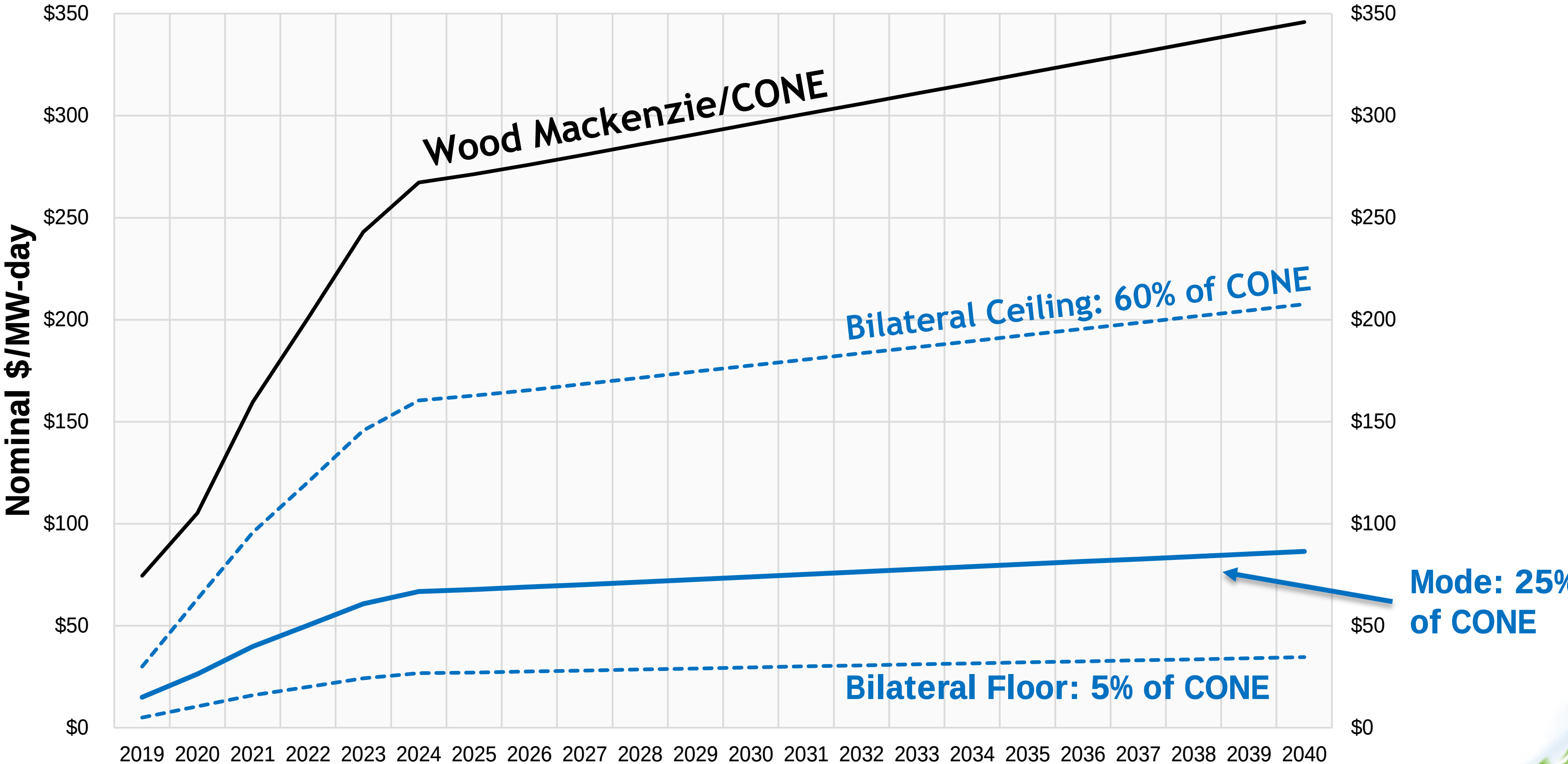
MISO CAPACITY PRICE FORECAST

- MISO Capacity Market is a residual market for balancing prompt year positions
- IPL price construction:
  - “Most likely” / Mode capacity price: 25% of Cost of New Entry (CONE) for a new Combustion Turbine
  - Bilateral Floor: 5% of CONE
  - Bilateral Ceiling: 60% of CONE
- Deterministic Runs: “Most Likely” capacity price
- Stochastic Runs: triangular distribution based on floor, mode, and ceiling prices

MISO CAPACITY PRICE FORECAST (CONT.)

MISO's Residual Capacity Market Results in Low Capacity Prices

Highly Uncertain Future Modeled with Triangular Distribution



ASSUMPTIONS FOR REPLACEMENT RESOURCES

Patrick Maguire

Director of Resource Planning

JAN 29TH MEETING: REPLACEMENT RESOURCES MODELED

NATURAL GAS

- CCGT
- CT
- Reciprocating Engine/ICE

WIND

- Land-Based Wind

SOLAR

- Utility-Scale
- C&I
- Residential

STORAGE

- Standalone Front-of-meter

DSM/EE

- Measures bundled into tranches by cost and shape

KEY ASSUMPTIONS FOR NEW RESOURCES

Variable	Description
Capital Costs	Overnight costs to construct, typically represented in $/kW
Operating Costs	Fixed O&M Variable O&M
Operating Characteristics	Heat Rates (natural gas units) MW limits Ramp rates Capacity Factors/Profiles (wind/solar)

GENERIC RESOURCE COST

- Methodology:
  - Evaluated publicly available data and forecasts from third party vendors
  - Vetted for reasonableness and alignment with market intelligence
- **Capital Costs: average of NREL "Mid" case and three other vendors:**
  - IHS Markit
  - Wood Mackenzie
  - Bloomberg New Energy Finance
- Averages benchmarked against Lazard LCOE report and NIPSCO's average bid responses from 2018 RFP

RESOURCE COST DATA SOURCES

PUBLIC DATA SOURCES

National Renewable Energy Laboratory (NREL)

- 2018 Annual Technology Baseline (ATB)
- https://atb.nrel.gov/electricity/2018/

Lazard

- Levelized Cost of Energy Analysis, Version 12.0
- Levelized Cost of Storage Analysis, Version 4.0
- https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2018/

NIPSCO RFP Average Bid Prices

- NIPSCO 2018 Integrated Resource Plan
- 7-24-2018 Public Advisory Presentation
- https://www.nipsco.com/about-us/integrated-resource-plan

Lazard's Levelized Cost of Energy (LCOE) reports and NIPSCO's public RFP data provide useful cost benchmarks but are not used directly

RESOURCE COST DATA SOURCES (CONT.)

CONFIDENTIAL DATA SOURCES AVAILABLE WITH SIGNED NDA

IHS Markit

- US wind capital cost and required price outlook: 2018
- US solar PV capital cost and required price outlook: 2018
- US battery energy storage system capital cost outlook (August 2018)
- 2018 Update of Rivalry Scenario
- Subscription Required: https://ihsmarkit.com/products/energy-outlooks-2040-power-gas-coal-renewables.html

Bloomberg New Energy Finance (BNEF)

- Energy Project Asset Valuation Model (EPVAL 8.8.4)
- 2H 2018 LCOE: Data Viewer
- Subscription Required: https://www.bnef.com

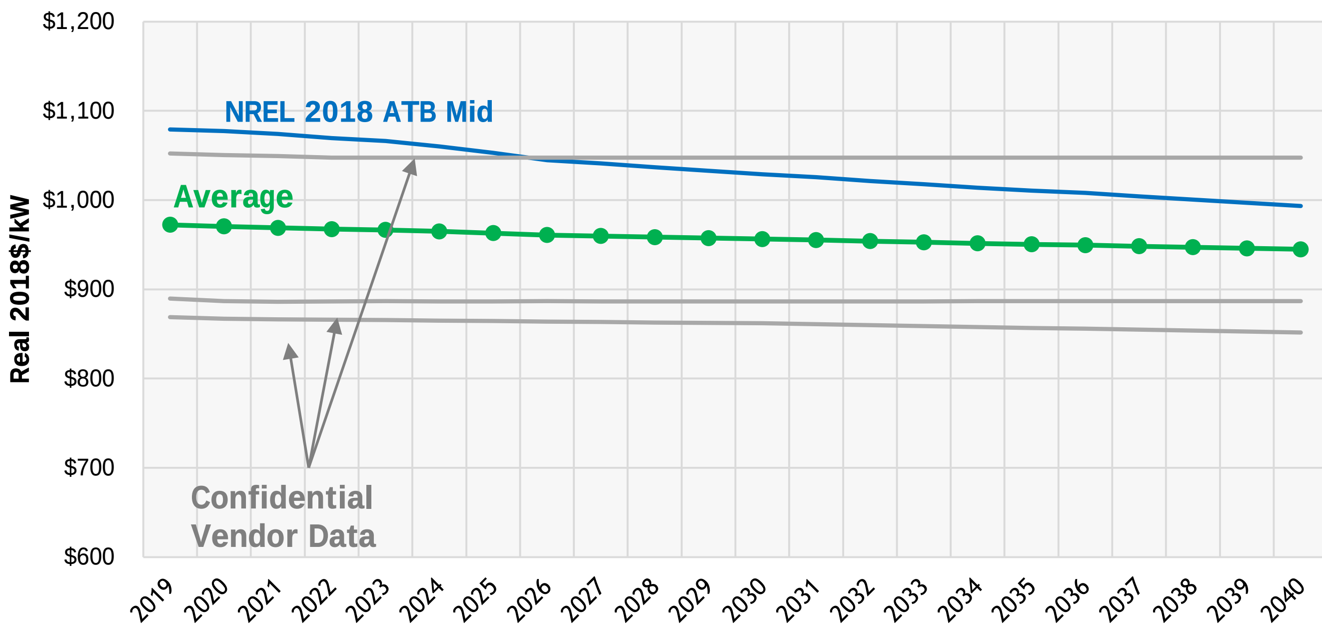
Wood Mackenzie

- North America Power & Renewables
- H1 2018 Long Term Outlook
- Subscription Required: https://www.woodmac.com/research/products/power-and-renewables/north-america-power-and-renewables-service/

NATURAL GAS TECHNOLOGIES

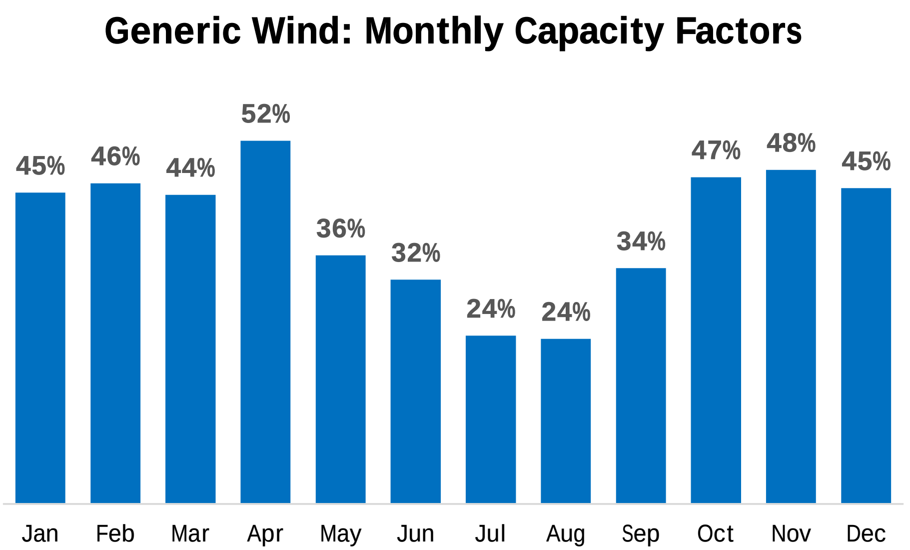
Type	Capital Cost (2018$/kW)	Fixed O&M (2018$/kW-year)	Variable O&M (2018$/MWh)
1x1 CCGT	$967	$14.22	$3.04
Frame CT	$754	$10.96	$6.94

EXAMPLE: Gas Combined Cycle Capital Costs (Real 2018 $/kW)

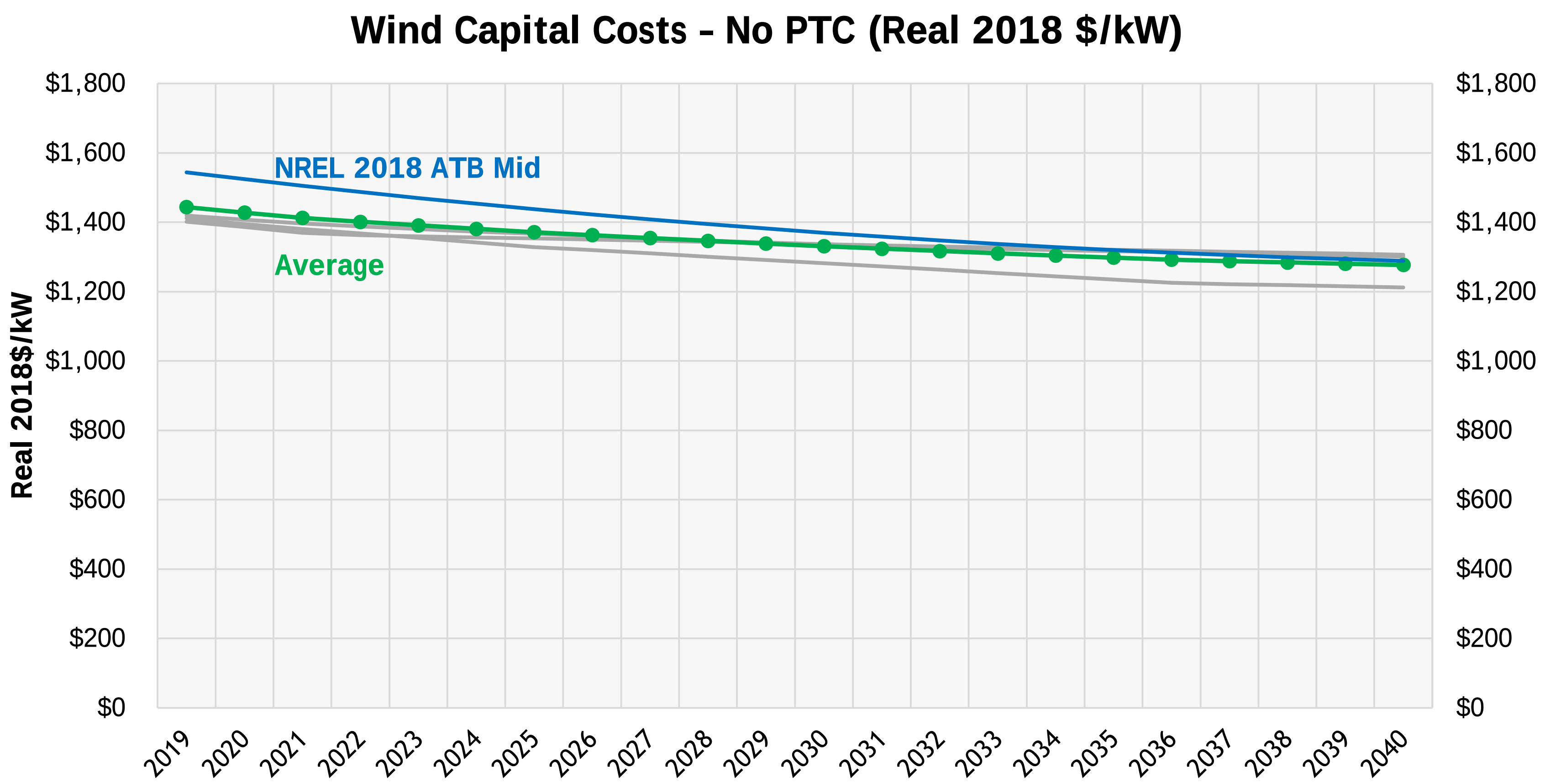


WIND: OPERATIONAL PARAMETERS

- **Location:** Northwestern Indiana
- **Annual Capacity Factor:** 42%
- **Profile Source:** NREL Wind Toolkit, 2009-2012 simulated wind data
- **Generic Project Size:** 50 MW ICAP
- **Capacity Credit:** 7.8% (3.9 MW per 50 MW project)

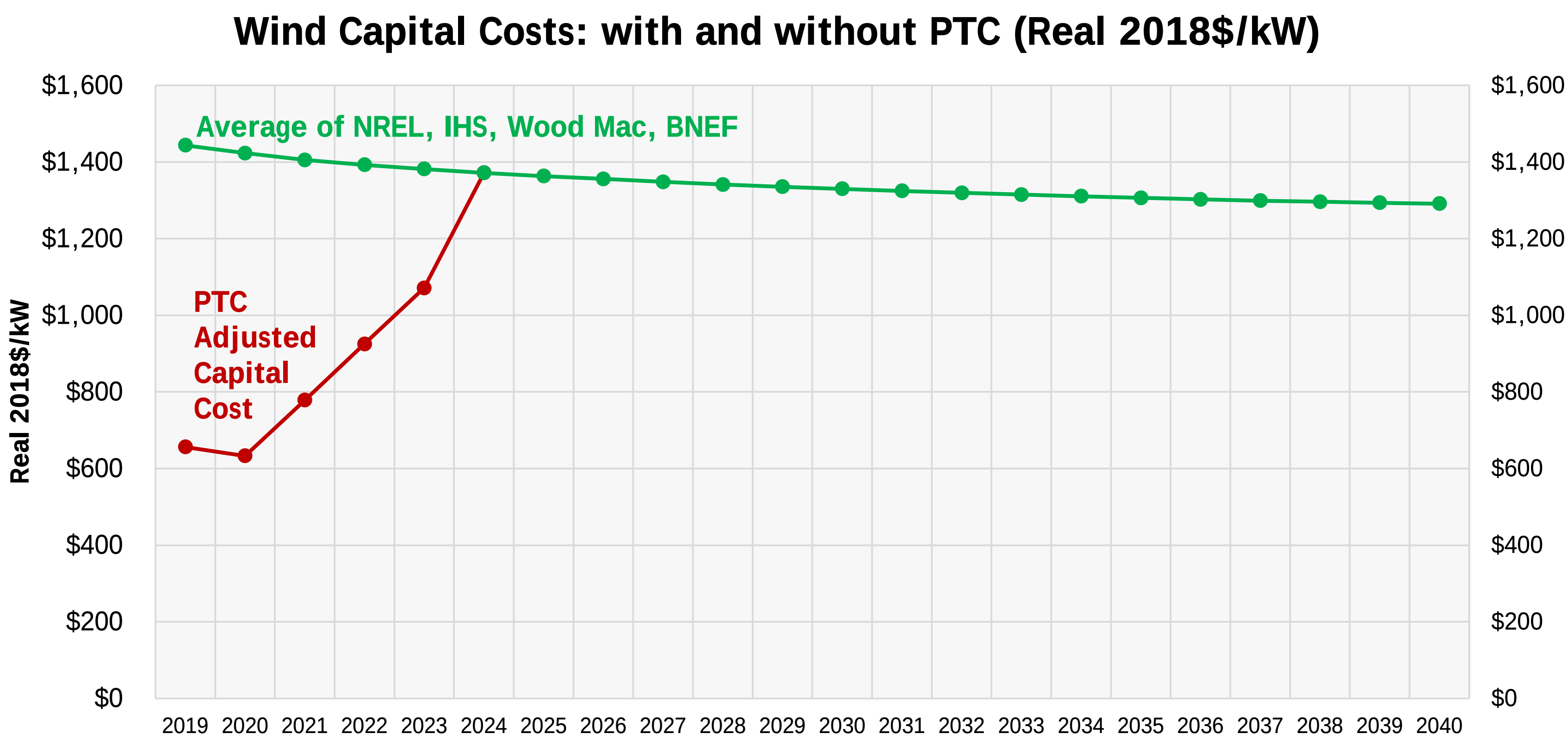


WIND: CAPITAL COSTS



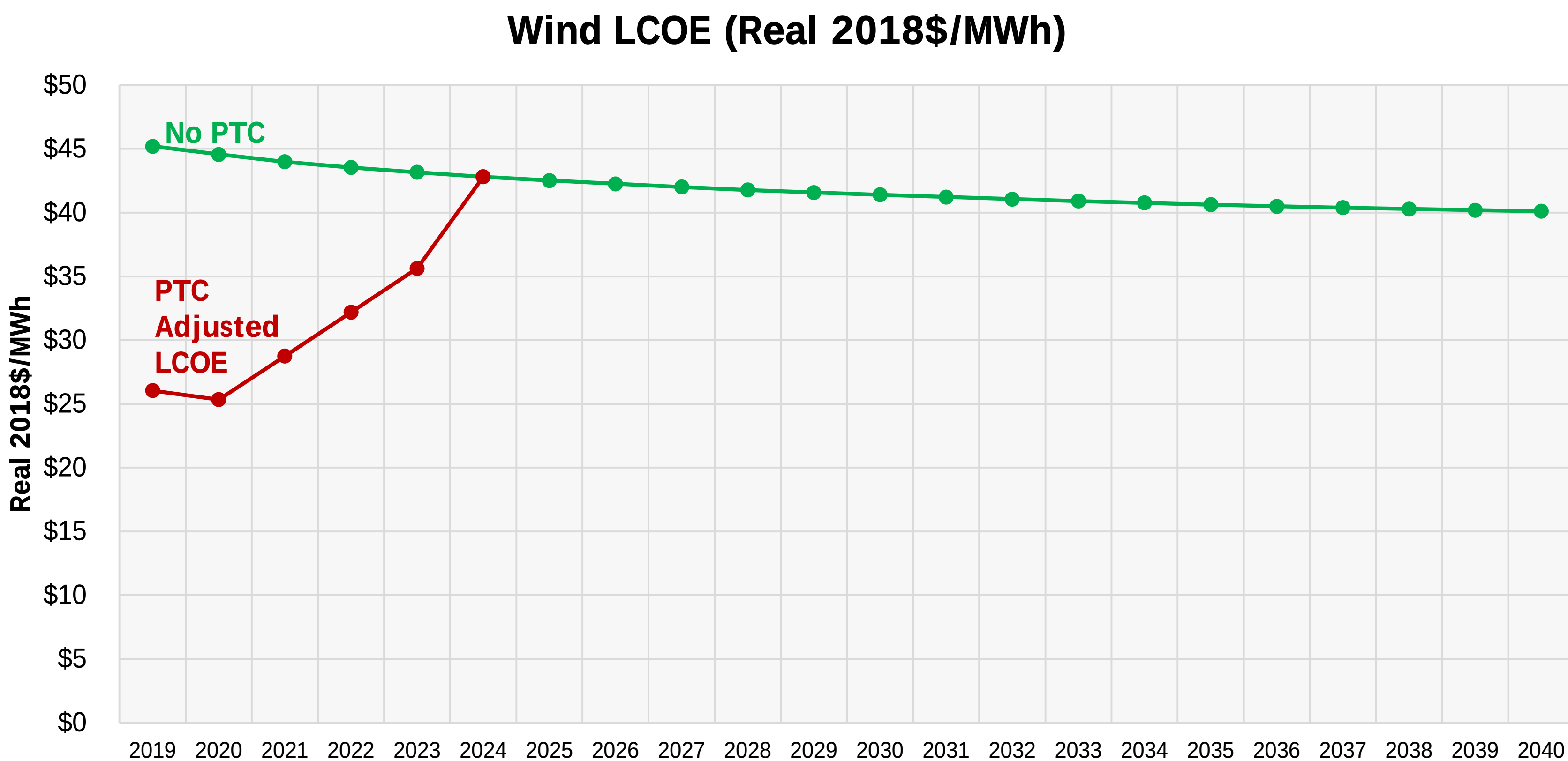
WIND: CAPITAL COSTS (CONT.)

	2020	2021	2022	2023	2024+
PTC Safe Harbor	100%	80%	60%	40%	0%



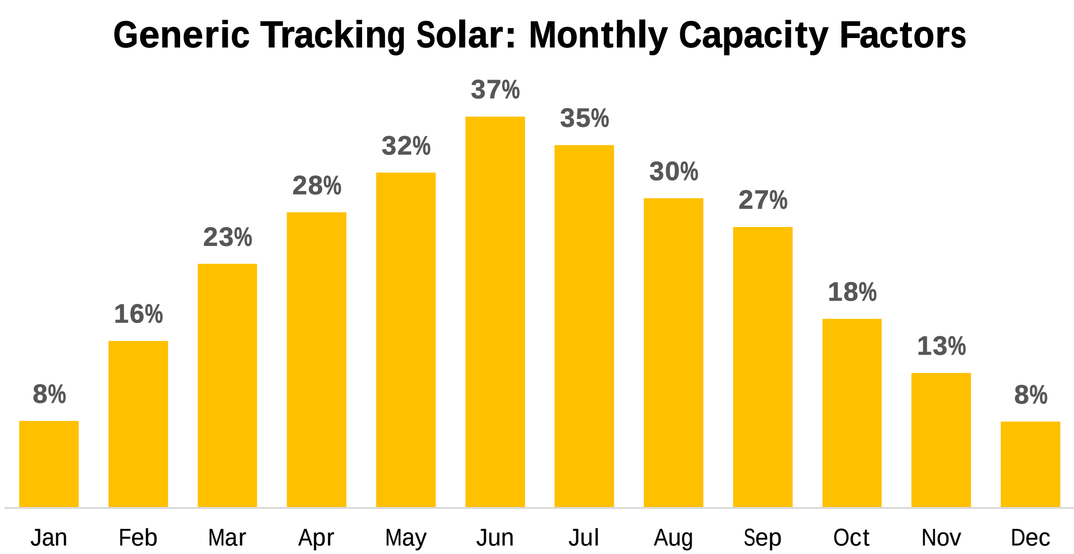
WIND LCOE

	2020	2021	2022	2023	2024+
PTC Safe Harbor	100%	80%	60%	40%	0%



SOLAR: OPERATIONAL PARAMETERS

- **Location:** Central Indiana
- **Annual Capacity Factor:** 23% (single-axis tracking)
- **Profile Source:** IPL Rate REP Projects, hourly data 2016-2018
- **Generic Project Size:** 25 MW for utility-scale



SOLAR: CAPACITY FACTORS

IPL Rate REP Solar: 2016-2018 Monthly Capacity Factors

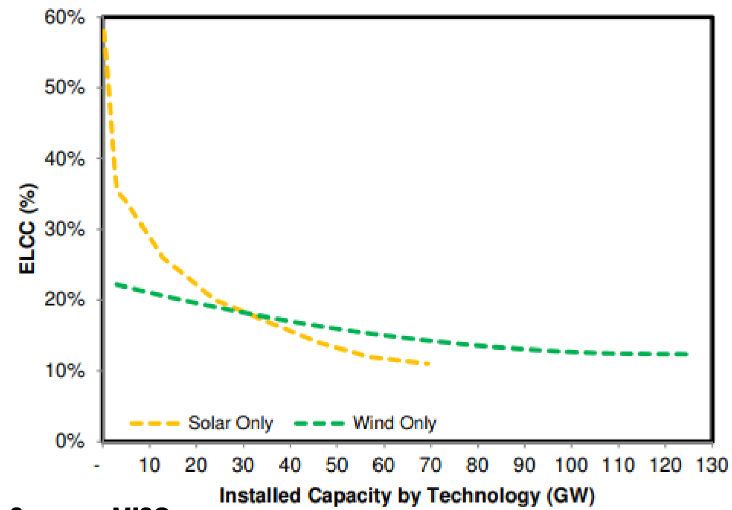
	GROUND FIXED TILT			TRACKING			COMMERCIAL ROOFTOP		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
Jan	9.8%	5.8%	7.0%	9.7%	6.1%	7.1%	6.7%	4.0%	4.7%
Feb	16.5%	15.7%	9.9%	17.3%	16.4%	10.4%	13.2%	12.6%	9.4%
Mar	19.5%	18.6%	15.7%	23.0%	21.6%	19.8%	16.4%	16.7%	15.2%
Apr	19.3%	21.3%	21.8%	27.1%	24.8%	26.2%	18.4%	19.0%	16.1%
May	21.9%	22.9%	24.4%	27.8%	30.1%	30.6%	19.0%	18.8%	17.3%
Jun	26.8%	25.2%	24.5%	36.2%	35.6%	31.6%	20.9%	14.8%	18.9%
Jul	22.9%	25.3%	24.4%	29.5%	35.3%	31.0%	19.8%	14.7%	21.8%
Aug	21.0%	23.5%	22.6%	25.5%	28.8%	27.4%	16.6%	9.8%	21.0%
Sep	22.0%	21.6%	18.5%	25.8%	25.7%	22.7%	17.3%	9.7%	16.7%
Oct	18.9%	12.6%	16.9%	20.1%	11.9%	17.9%	13.4%	9.3%	12.7%
Nov	15.0%	13.4%	9.5%	14.9%	10.9%	9.8%	10.5%	8.6%	7.4%
Dec	7.1%	9.6%	8.9%	7.3%	7.2%	8.4%	5.2%	6.3%	6.4%
Annual	**18.4%**	**17.9%**	**17.0%**	**22.0%**	**21.2%**	**20.3%**	**14.8%**	**12.0%**	**14.0%**

Avg: 17.8% **Avg: 21.2%** **Avg: 13.6%**

SOLAR CAPACITY CREDIT

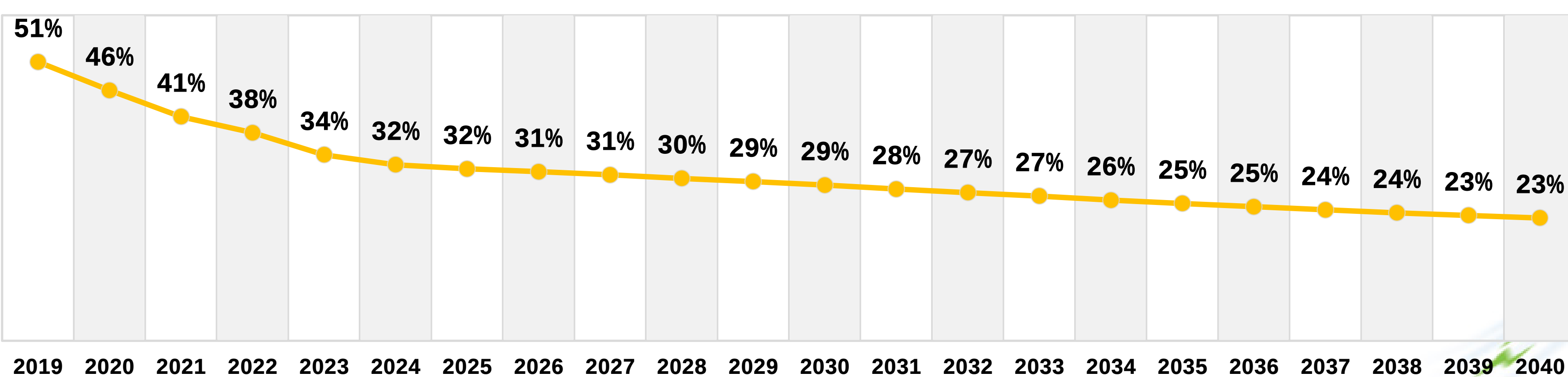
- Solar capacity credit changes as more solar is added to the MISO system
- "Duck curve" phenomenon of shifting net peak load
- Annual capacity credit calculated using forecasted annual installed GW of utility solar in MISO Central
- Installed solar forecast from Wood Mackenzie

Wind and Solar ELCC as a function of installed capacity

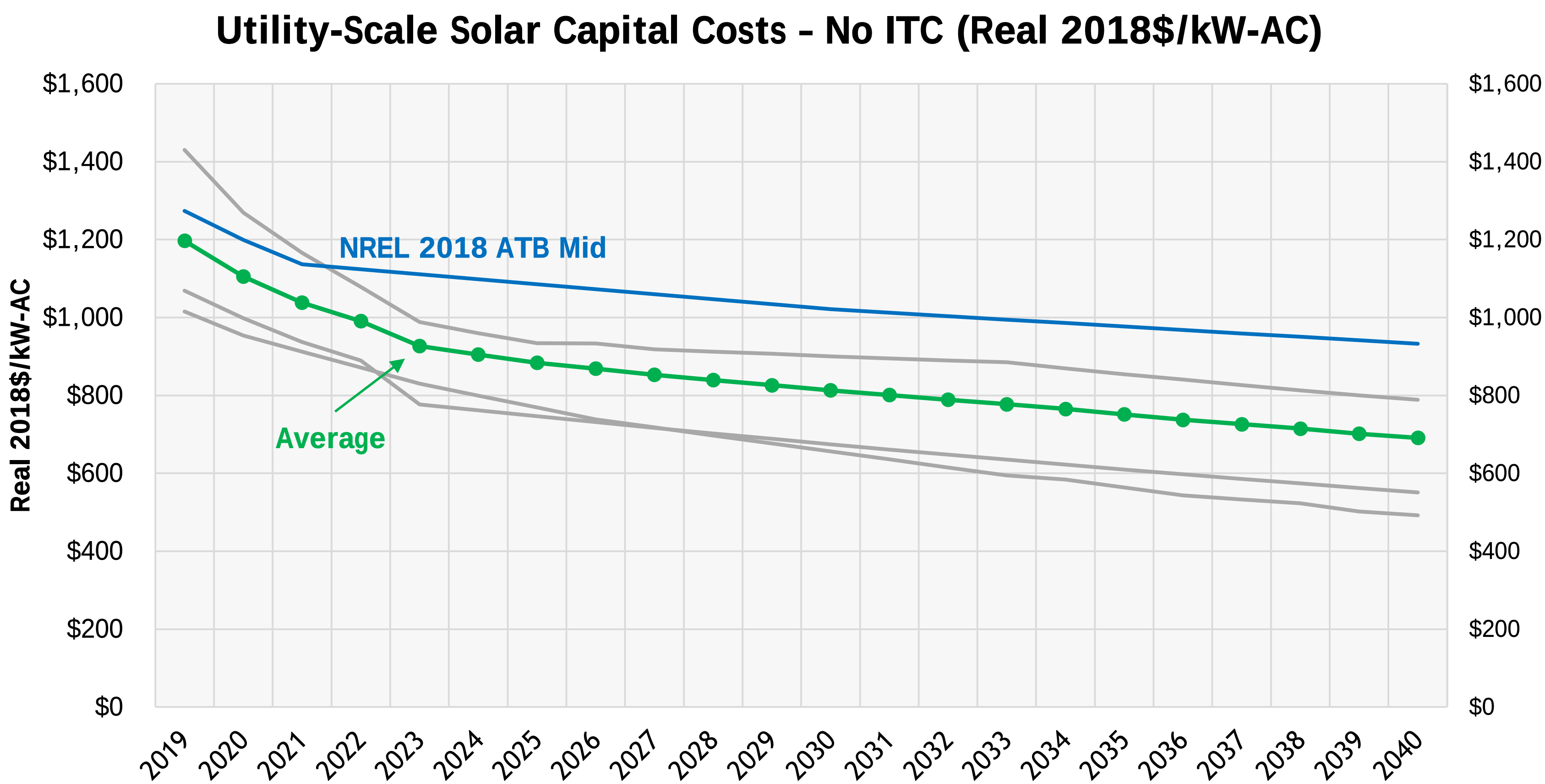


Source: MISO

Annual Solar Capacity Credit

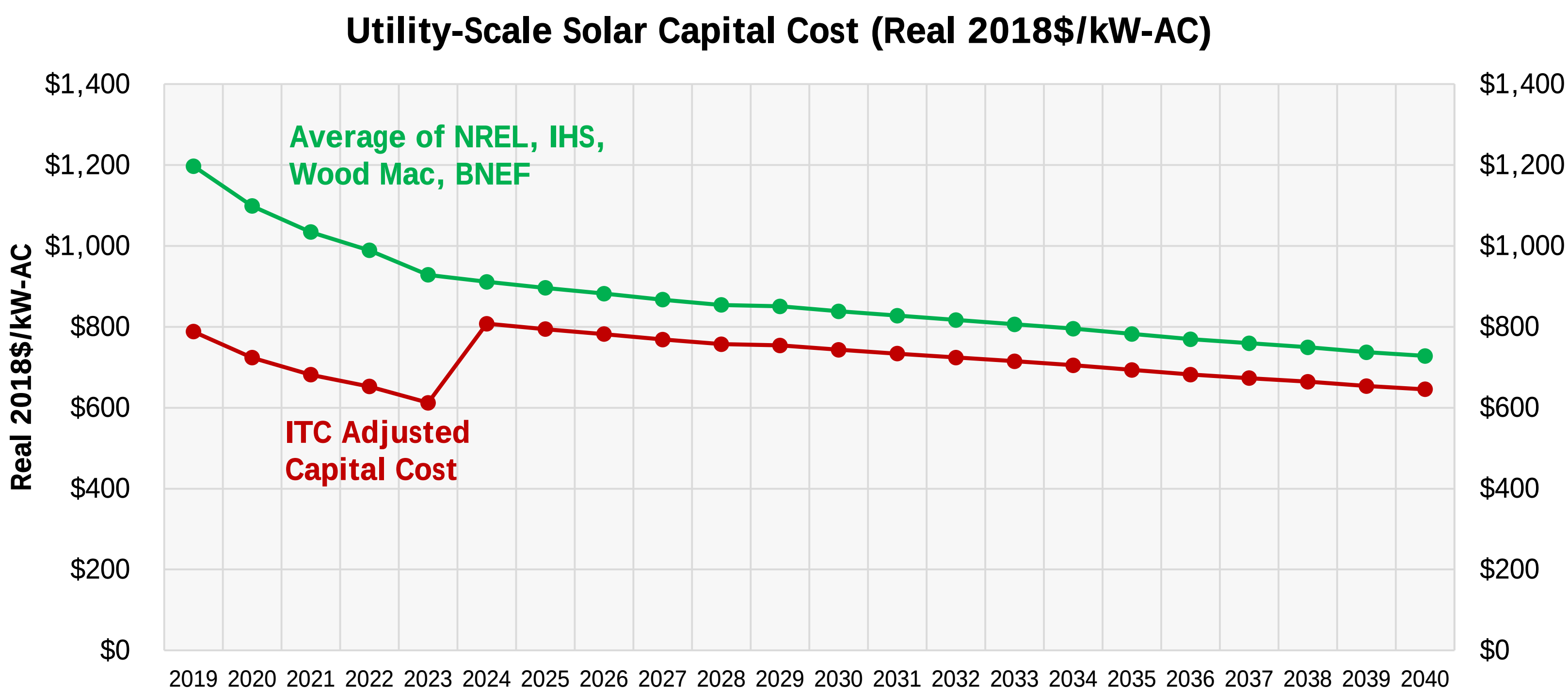


SOLAR: CAPITAL COSTS



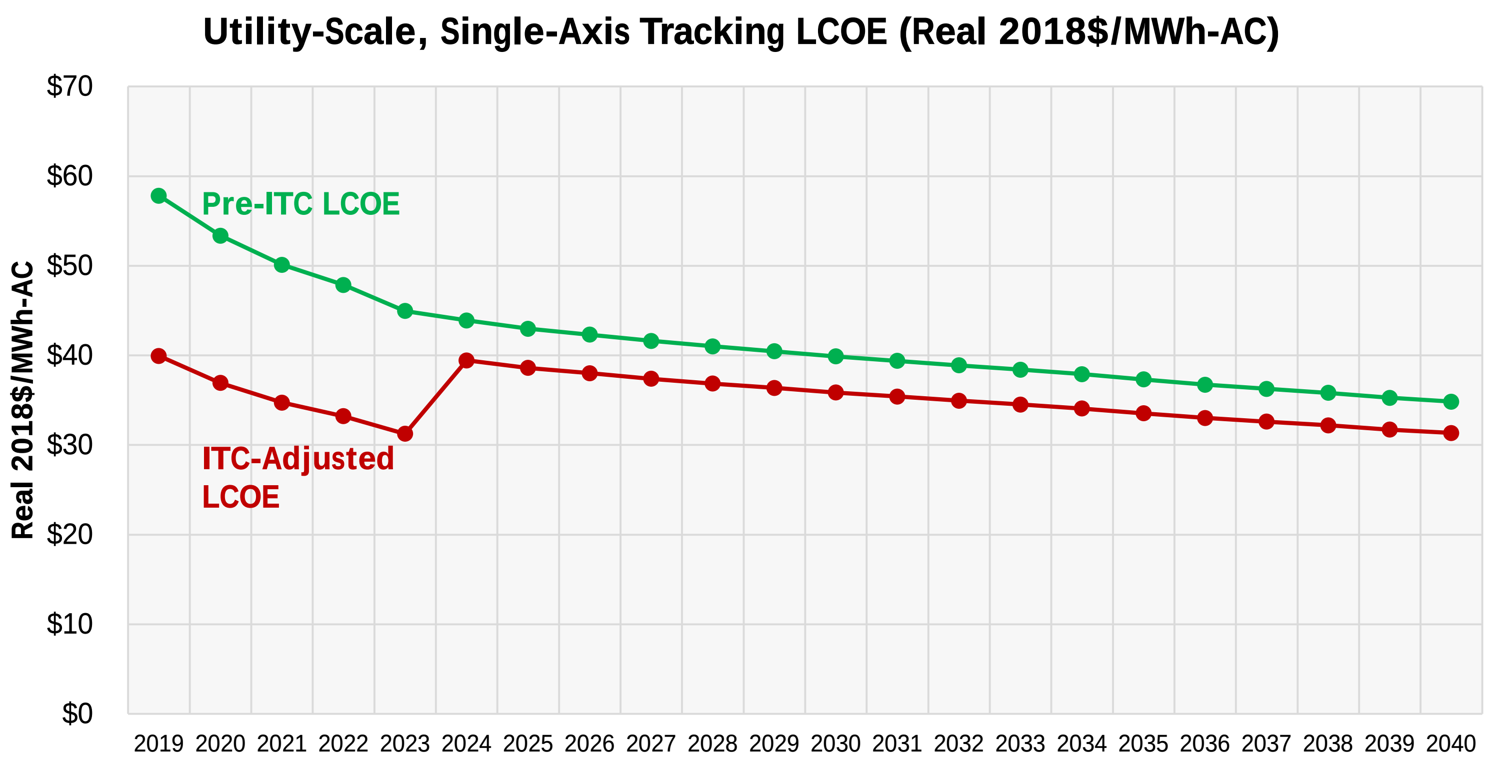
SOLAR: CAPITAL COSTS (CONT.)

	2020	2021	2022	2023	2024+
ITC Safe Harbor	30%	30%	30%	30%	10%

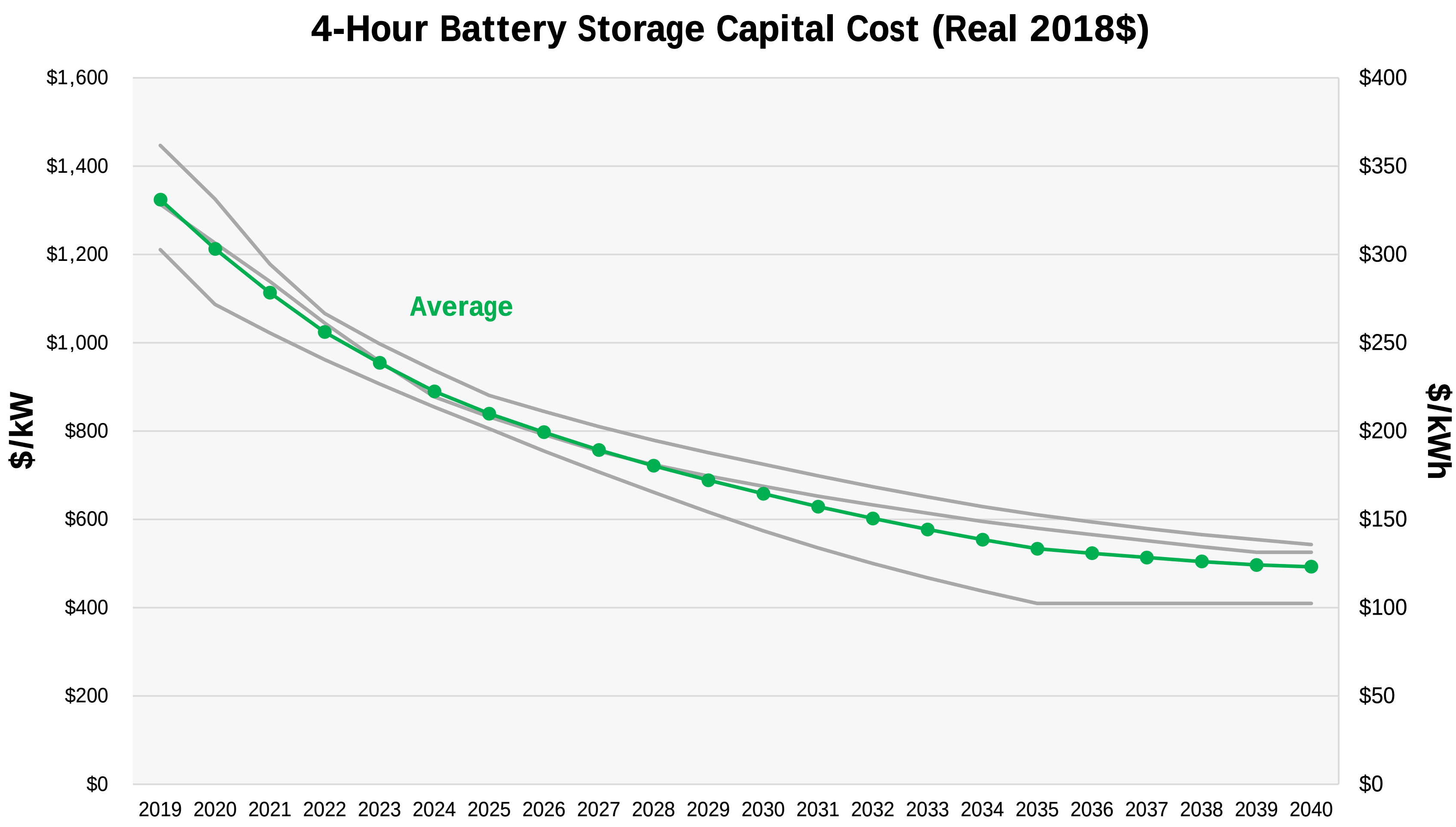


SOLAR: LCOE

	2020	2021	2022	2023	2024+
ITC Safe Harbor	30%	30%	30%	30%	10%



STORAGE CAPITAL COST



SCENARIO ANALYSIS FRAMEWORK & PROPOSED SCENARIOS

Patrick Maguire

Director of Resource Planning

ROLE OF SCENARIOS IN IPL'S IRP

- Scenarios are used to generate a set of different optimized portfolios
- IPL is net long capacity with existing resources and planned, age-based retirements

Scenario modeling framework is designed to evaluate accelerated retirements in conjunction with portfolio optimization via capacity expansion

SCENARIO DRIVERS

	Reference Case	Scenario A: Carbon Tax	Scenario B: Carbon Tax + High Gas	Scenario C: Carbon Tax + Low Gas	Scenario D: No Carbon Tax + High Gas
Natural Gas Prices	Base	Base	**HIGH ↑**	**LOW ↓**	**HIGH ↑**
Carbon Tax	No Carbon Price	**Carbon Price (2028+)**	**Carbon Price (2028+)**	**Carbon Price (2028+)**	No Carbon Price
Coal Prices	Base	Base	Base	Base	Base
IPL Load	Base	Base	Base	**LOW ↓**	**HIGH ↑**
Capital Costs for Wind, Solar, and Storage	Base	Base	Base	Base	Base

PROPOSED SCENARIO FRAMEWORK

CURRENT PROPOSED FRAMEWORK EVALUATES STAGGERED RETIREMENTS WITH OPTIMIZED PORTFOLIOS FOR REPLACMENT CAPACITY

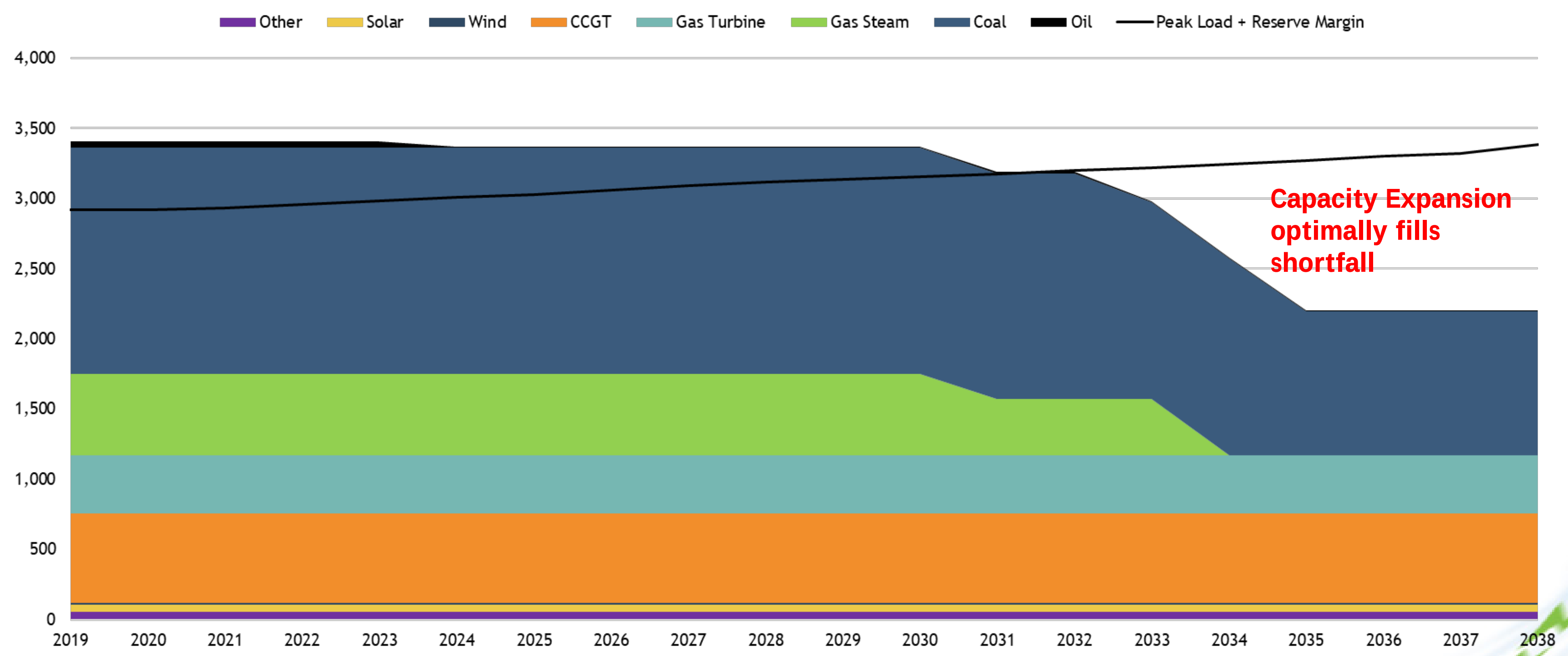
	Reference Case	Scenario A	Scenario B	Scenario C	Scenario D
No Accelerated Retirements	**Portfolio 1**	1a	1b	1c	1d
Pete Unit 1 Retire **2021** Pete Units 2-4 Operational	**Portfolio 2**	2a	2b	2c	2d
Pete 1 Retire **2021**; Pete 2 Retire **2023** Pete Units 3-4 Operational	**Portfolio 3**	3a	3b	3c	3d
Pete 1 Retire **2021**; Pete 2 Retire **2023**; Pete 3 Retire **2026**; Pete Unit 4 Operational	**Portfolio 4**	4a	4b	4c	4d
Pete 1 Retire **2021**; Pete 2 Retire **2023**; Pete 3 Retire **2026**; Pete 4 Retire **2030**	**Portfolio 5**	5a	5b	5c	5d

Retirement dates fixed for base set of scenarios. Other sensitivities and flexible retirement date optimization will be conducted.

IPL STARTING POSITION

	Reference Case	Scenario A	Scenario B	Scenario C	Scenario D
No Accelerated Retirements	**Portfolio 1**	1a	1b	1c	1d

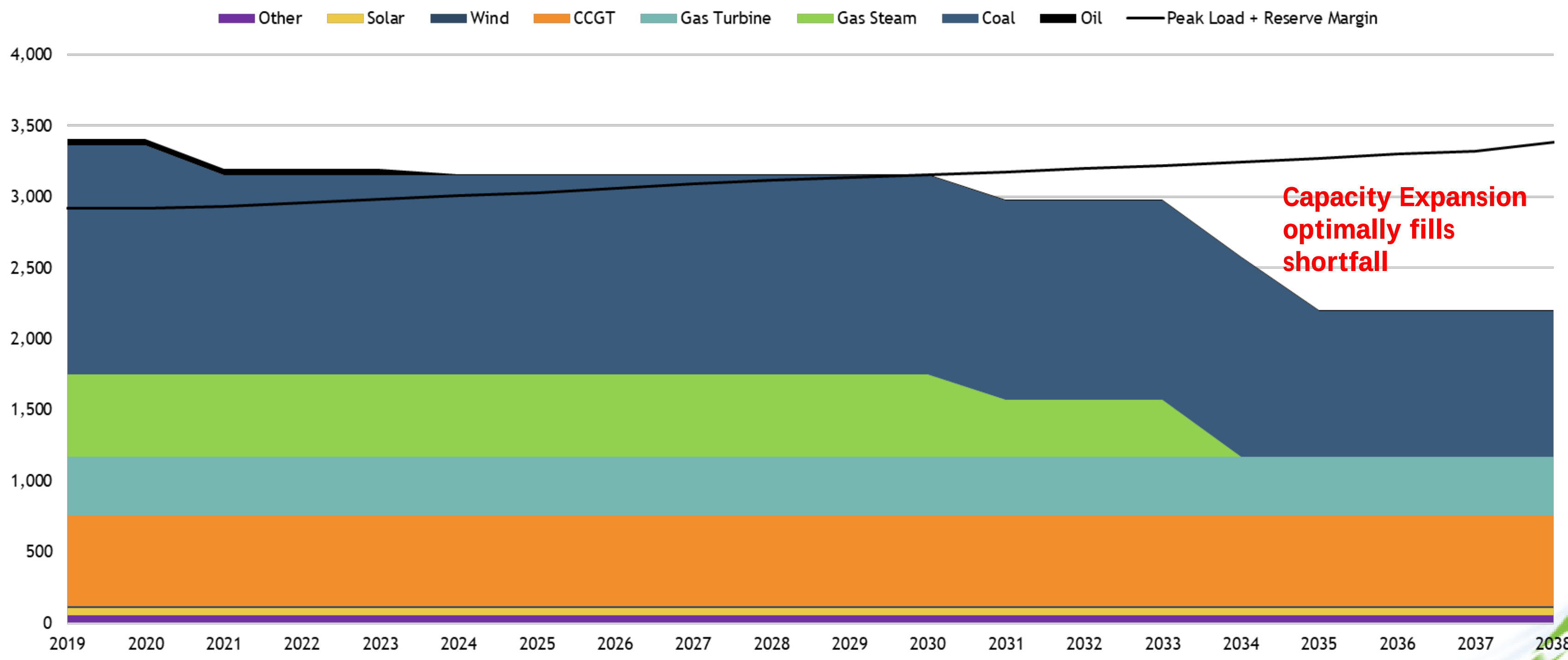
BASE CASE: NO ACCELERATED RETIREMENTS



RETIREMENT PORTFOLIOS (1 OF 4)

	Reference Case	Scenario A	Scenario B	Scenario C	Scenario D
Pete Unit 1 Retire **2021** Pete Units 2-4 Operational	**Portfolio 2**	2a	2b	2c	2d

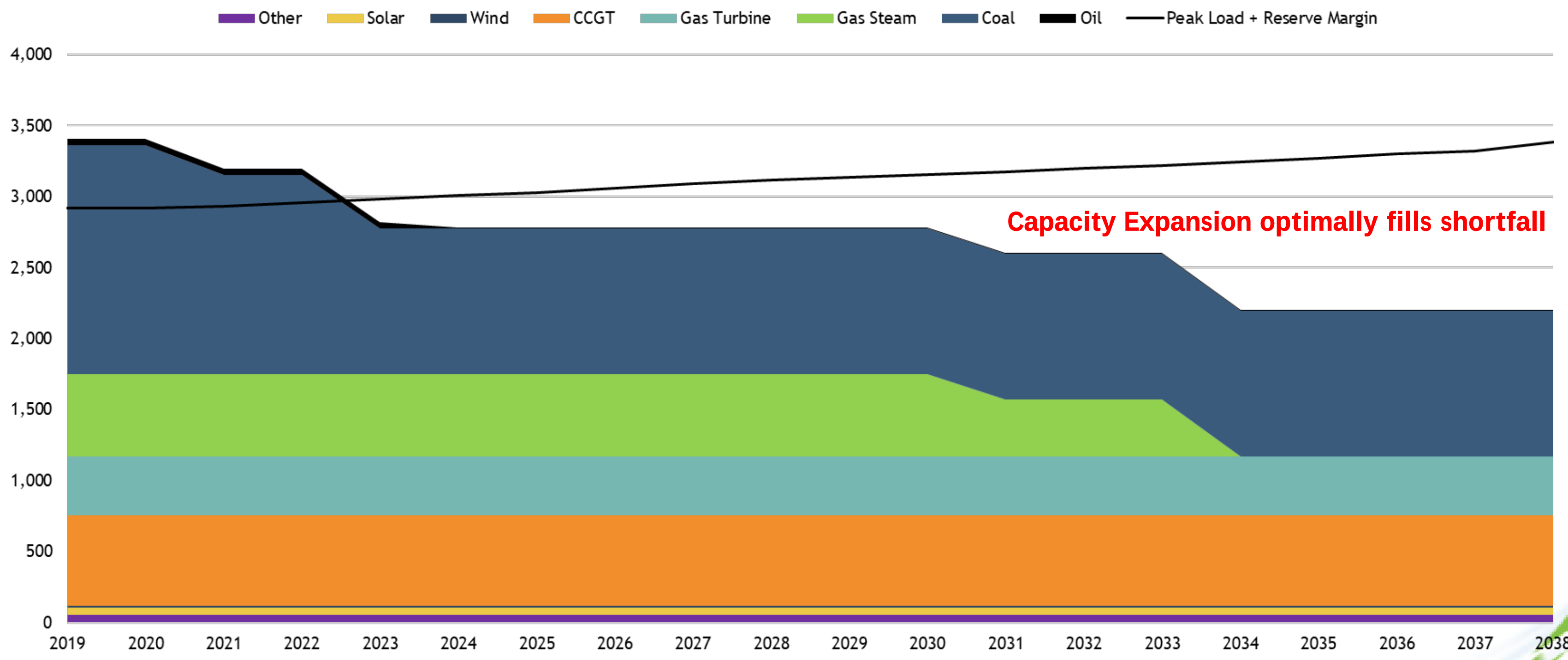
PETE 1 EARLY RETIRE



RETIREMENT PORTFOLIOS (2 OF 4)

	Reference Case	Scenario A	Scenario B	Scenario C	Scenario D
Pete 1 Retire **2021**; Pete 2 Retire **2023** Pete Units 3-4 Operational	**Portfolio 3**	3a	3b	3c	3d

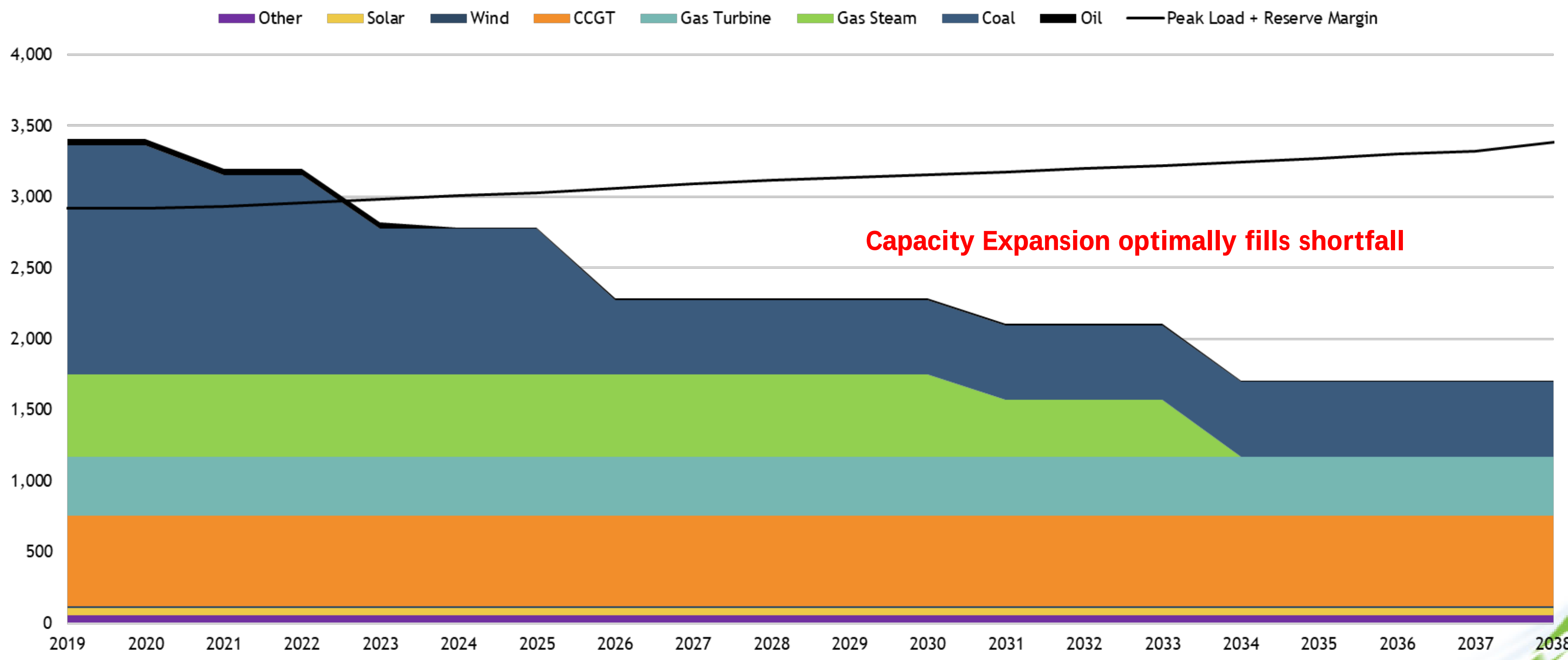
PETE 1-2 EARLY RETIRE: SHORT IN 2023



RETIREMENT PORTFOLIOS (3 OF 4)

	Reference Case	Scenario A	Scenario B	Scenario C	Scenario D
Pete 1 Retire **2021**; Pete 2 Retire **2023**; Pete 3 Retire **2026**; Pete Unit 4 Operational	**Portfolio 4**	4a	4b	4c	4d

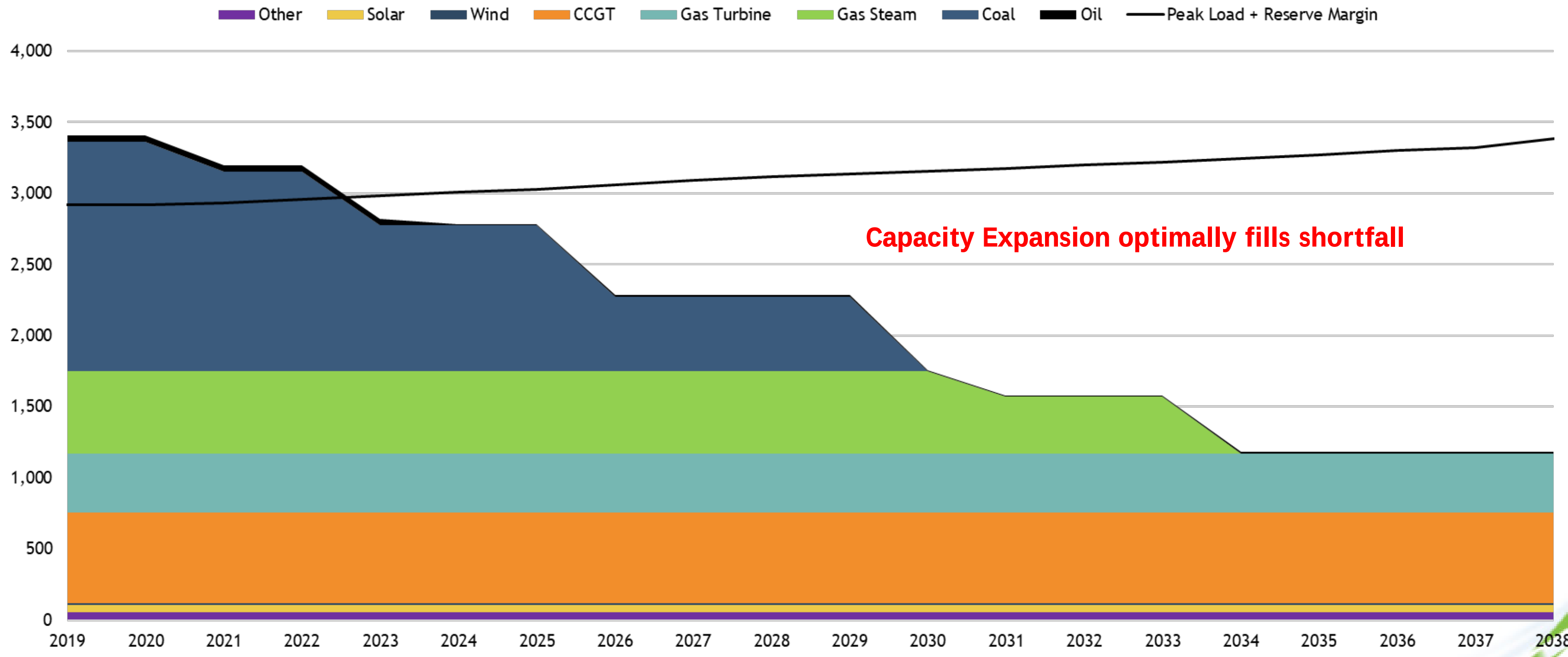
PETE 1 + PETE 2 + PETE 3 EARLY RETIRE



RETIREMENT PORTFOLIOS (4 OF 4)

	Reference Case	Scenario A	Scenario B	Scenario C	Scenario D
Pete 1 Retire **2021**; Pete 2 Retire **2023**; Pete 3 Retire **2026**; Pete 4 Retire **2030**	**Portfolio 5**	5a	5b	5c	5d

PETE 1 + PETE 2 + PETE 3 + PETE 4 RETIRE BY END OF 2030



PORTFOLIO COMPARISON

PORTFOLIO COST WILL BE COMPARED ACROSS SCENARIOS TO DETERMINE OPTIMIAL PATH FORWARD

	Reference Case	Scenario A	Scenario B	Scenario C	Scenario D
No Accelerated Retirements	**Portfolio 1**	1a	1b	1c	1d
Pete Unit 1 Retire **2021** Pete Units 2-4 Operational	**Portfolio 2**	2a	2b	2c	2d
Pete 1 Retire **2021**; Pete 2 Retire **2023** Pete Units 3-4 Operational	**Portfolio 3**	3a	3b	3c	3d
Pete 1 Retire **2021**; Pete 2 Retire **2023**; Pete 3 Retire **2026**; Pete Unit 4 Operational	**Portfolio 4**	4a	4b	4c	4d
Pete 1 Retire **2021**; Pete 2 Retire **2023**; Pete 3 Retire **2026**; Pete 4 Retire **2030**	**Portfolio 5**	5a	5b	5c	5d

Each portfolio will be compared on cost (PVRR) and other metrics

Scenarios inform optimal decision: which resource types are consistently selected in scenarios and retirement portfolios?

ROLE OF STOCHASTICS

- Phase 1: Deterministic scenario analysis and portfolio construction
- Phase 2: Stochastic capacity expansion
- Goal: stochastic ranges envelope high/low scenario drivers, allowing us to capture full range of uncertainty
- **Result: broad range of scenarios and resource portfolios that are the foundation of a robust and flexible preferred portfolio**

FINAL Q&A AND NEXT STEPS

NEXT STEPS

- **Next Meeting: May 14, 2019**
  - IPL Morris Street Operations Center
  - Register at http://iplpower.com/irp
- Meeting #3 Material:
  - Modeling Update
  - Final Scenarios
  - Updated Load Forecast
  - Stochastic distributions from PowerSimm

Email questions, comments, or other feedback to ipl.irp@aes.com