2021 IRP – Load Forecasting Workshop

IDAHO POWER
An IDACORP Company

February 23, 2021

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Safety First: We are committed to the safety of our employees, our customers and the communities we serve.

Integrity Always: Customers, shareholders and employees can count on us to be fair and ethical.

Respect for All: We treat our customers, partners, employees and the environment with care and dignity.

Remote Meetings – What to Expect

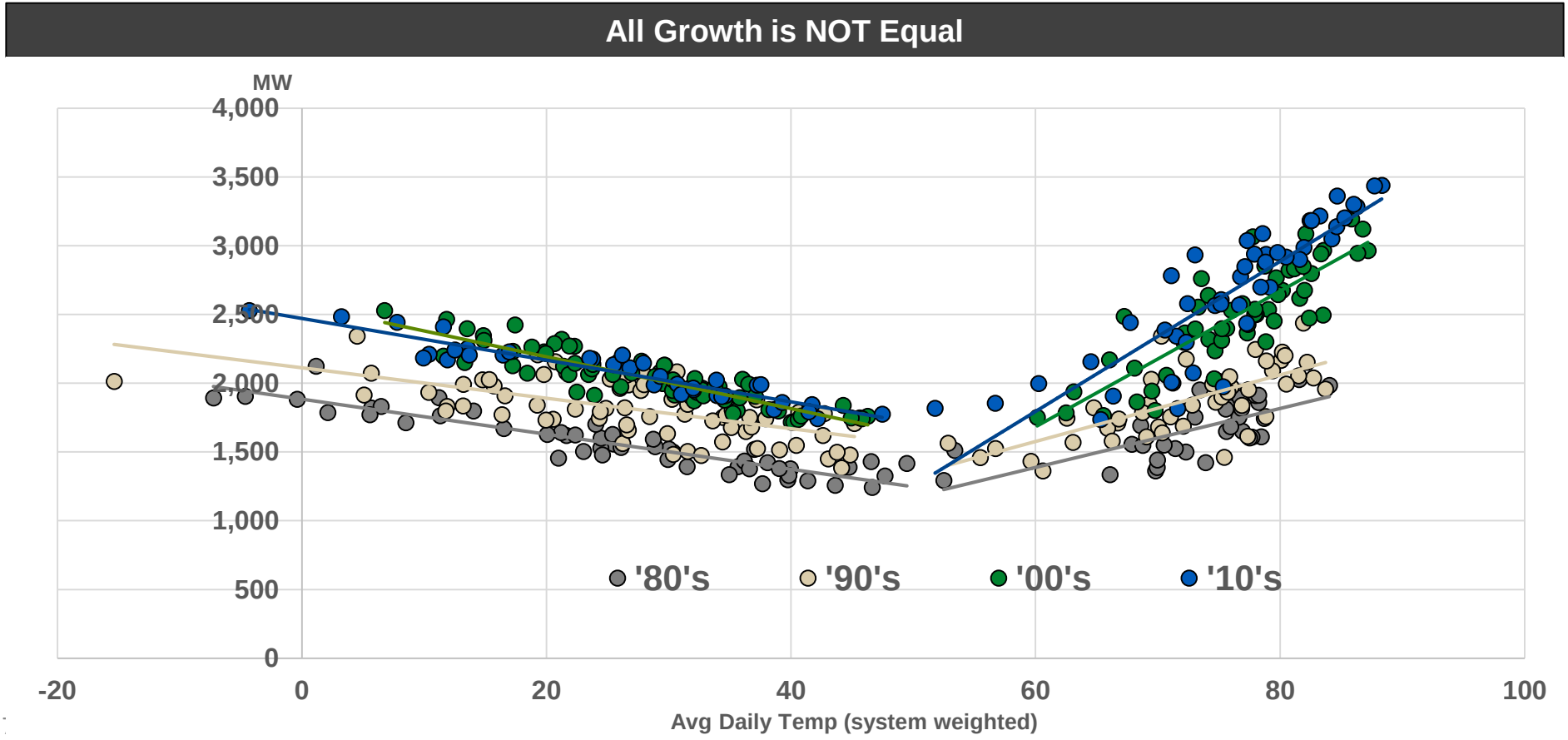
Meeting Topics and Flow

Meeting	Date	Topics
~~Energy Efficiency Subcommittee Meeting~~	~~January 12~~	~~Energy Efficiency~~
~~IRPAC Meeting #1~~	~~February 9~~	~~Overview, Carbon Outlook~~
Load Forecast Workshop	February 23	Load Forecast Workshop
IRPAC Meeting #2	March 11	Forecasts (PURPA Generation, Natural Gas, Load, Hydro)
IRPAC Meeting #3	April 8	Solar & Storage, Energy Efficiency (EE), Distributed Energy Resources (DER), Demand Response (DR)
IRPAC Meeting #4	May 13	Resource Adequacy, Transmission, Future Supply-Side Resources
IRPAC Meeting #5	June 10	Transmission & Distribution (T&D) Deferral, Reserve Requirements, Storage
IRPAC Meeting #6	July 13	Portfolio Development & Sensitivities, Risk Metrics
Optional: Analysis Update & Feedback Workshop	August 10	
IRPAC Meeting #7	September 16	Results, Preferred Portfolio

Today's Agenda

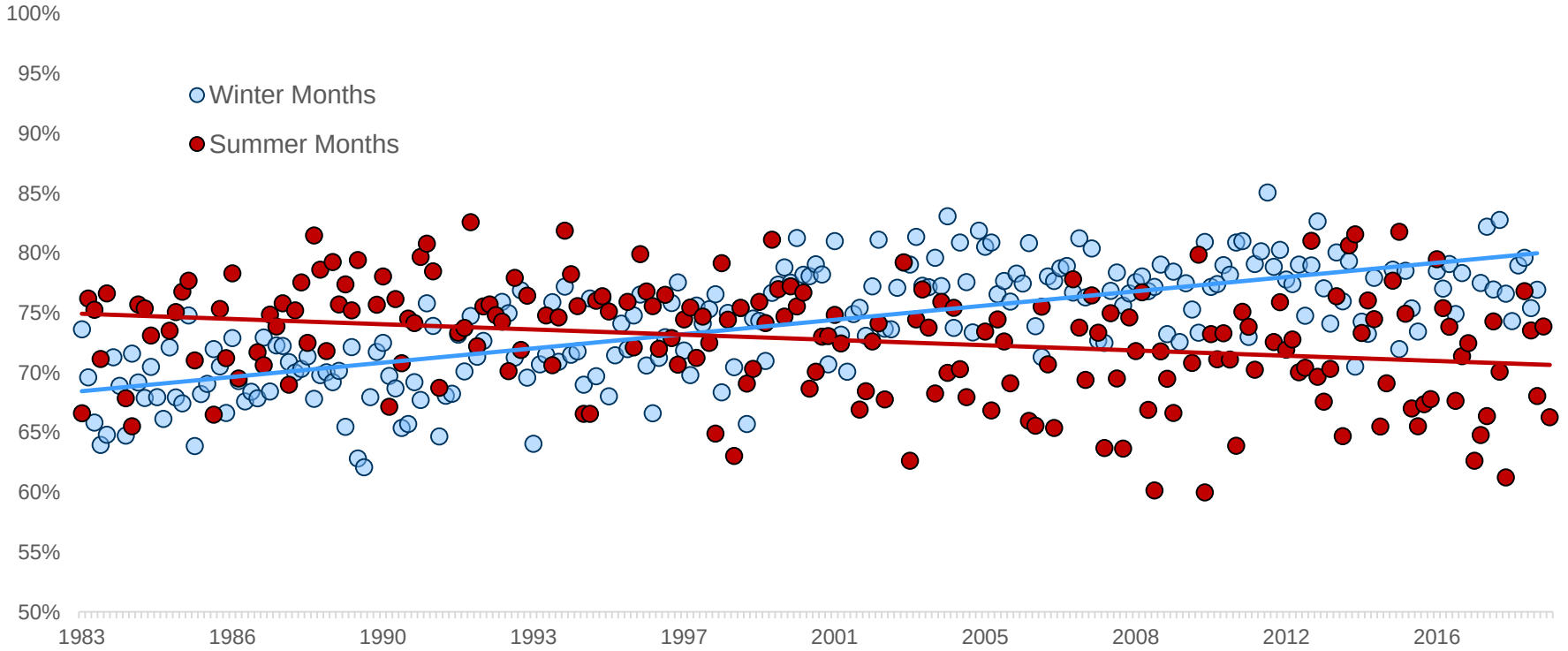
Tuesday, February 23rd, 2021 (IRPAC Special Meeting)		
Allotted Time	***Discussion Topic***	***Presenter***
9:00-9:15	Introductions/Objective for Today	Jordan Prassinos
9:15-9:30	System Peak History, Modeling, Enhancements	Jordan Prassinos
9:30-9:35	Previous IRP Sales Performance	Jordan Prassinos
9:35-10:00	C/I Economic Environment, Data Framework, Philosophy	Brad Snow
10:00-10:10	*Break*	
10:10 – 10:45	Data Segmentation, Out-of-Sample Performance, Evolution	Brad Snow
10:45-11:00	Discussion Wrap-Up	Brad Snow

Seasonal Peak Growth



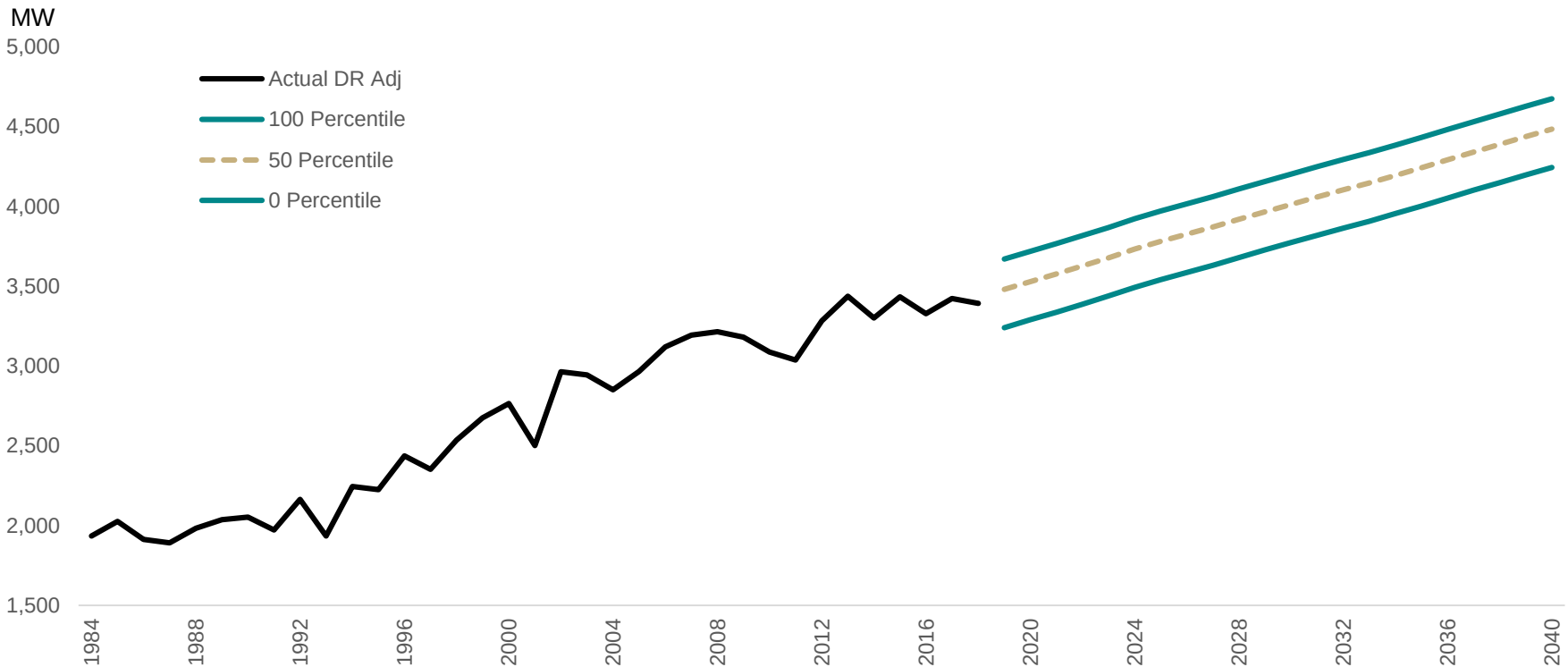
Seasonal Load Factors

Falling System Load Factor in Summer



The Peak Trend

Is the Peak Forecast Far off from Trend?



Class Peak Contribution Method

- Top-Down approach preferred

- System peak forecast accuracy should not be in question

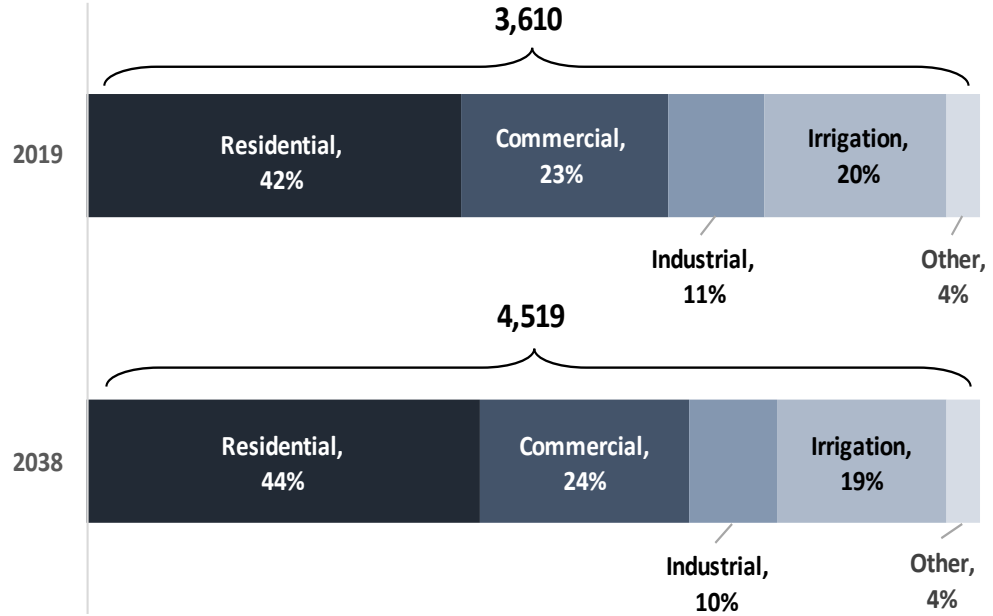
- Rich history of system sales and peaks at generation level going back 50+ years to build models

- Class AMI history is limited to 2014 and beyond, collected at the meter

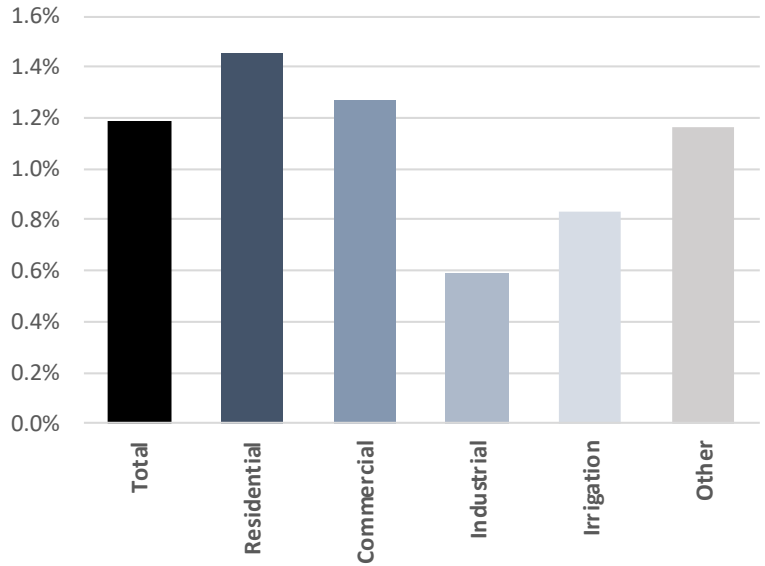
Class Contribution to Peak

ILLUSTRATIVE

Customer Class Compositional Analysis of System Coincident Peak (MW)



Customer Class System Coincident Peak 20-yr Growth Rates



Modeling Performance in IRP's

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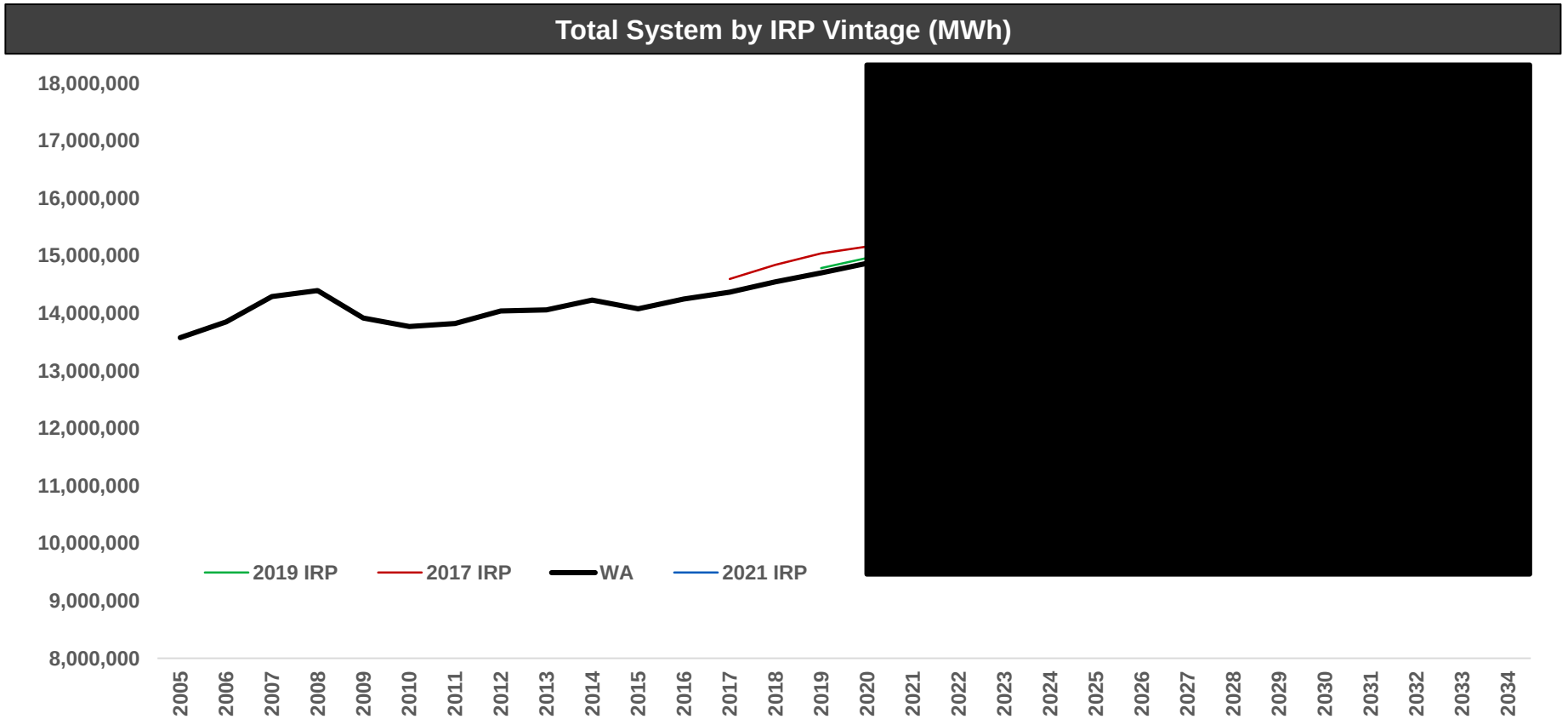


C&I Modeling - Outline

- Overview of Economic Environment
- Data Framework
- Modeling Philosophy
- Data Segmentation and Analysis
- Out-of-Sample Performance
- Evolution and Future Work

IPC Key Economic Overview

- Idaho – An agriculture economy – albeit transitioning – BOISE MSA
  - → Potato, Dairy, Sugar Beet Processors are Dominant in Manufacturing
    - Dairy leads the growth – up 6% in 2020
  - → Non-Food Manufacturing is the fastest growing in terms of new customers- eight new in 2020, via in-migration
  - → Population up 21.5% in last ten years

- Boise/Nampa MSA is unique as most geographically isolated in top 100 geographically, serves as trading center (retail, services, health etc.) for N. Utah, E. Oregon, N. Nevada, Idaho

- These characteristics, among others, define unique attributes that distinguish IPC, and each of its sister utilities in Idaho and Oregon, in forecast modeling

"Boise City [MSA]has come roaring out of the gate, and the economy will shake off recent slowing without too much trouble…. Over the long run, positive demographics will ensure BOI bests the West and U.S."
- Moody's Analytics December 2020

Modeling in a Unique Environment

Why Is Idaho Power Unique?

- **IPC Service Territory is one of the Fastest Growing Areas in the Country**
  - → Residential Customers last 12 months: +3.0%
  - → Commercial Customers last 12 months: +2.1%
  - → Large Load Customer last 12 months +6.1%

- **Unique Challenges at the Margin**
  - → Rate Schedule Changes
  - → Commercial Birth/Death
    - In-Migration
    - Covid Structural Impact (Consolidations)
    - New customer/ramp rates

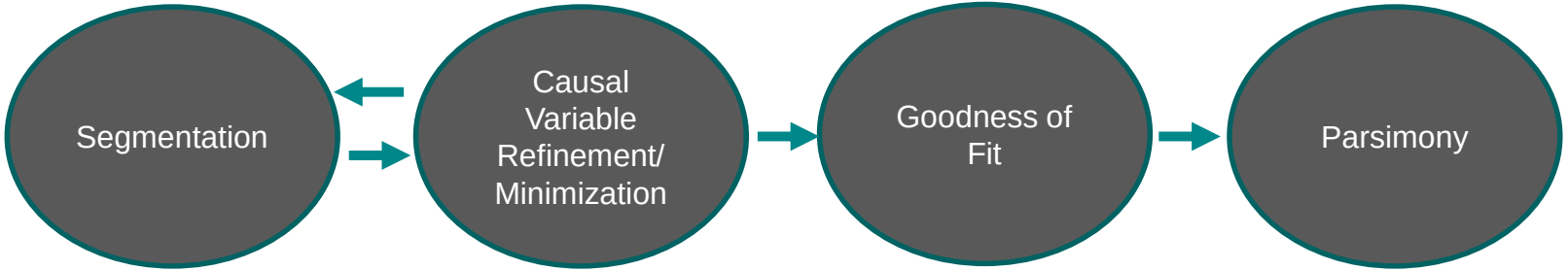
C&I Class Distinction in Modeling

- Commercial and Industrial Customers, in Contrast to Residential Customers Cannot be Modeled as a Homogeneous Population
  - → Coefficient of Variation
    - Residential 71.4%
    - Commercial 326.7%
    - Industrial 201.6%

- Proper Specification of Structural Models Demands the Causal Variables Reflect Regional Relationships as they Relate to Energy Use
  - → Broad Macro Variables (e.g. US GDP) are Avoided in Favor of County and NAICS Level Series

- Manufacturers and Service Providers are Distinct in causal relationships and demand separate models

C&I Modeling Approach/Philosophy



Recursive process to understand and develop the relationship between customer energy use and independent variables

Consistent good fit to a diverse array of data patterns.
Capable of fitting to sample periods without reaching for fit.

Empirically and theoretically correct/true model

*As developed in Quantifying Parsimony in Structural Equation Modeling, Kristopher J. Preacher, University of North Carolina at Chapel Hill 2006.

C/I Causal Data

Broad based coverage in the Economic Data Buckets

- **Extensive database for multiple economic time series**
  - → Moody's
    - Macroeconomic National
    - County Level
    - MSA
  - → Woods and Poole
    - Import/Export Model Constraint
    - Gross Regional Output
    - Earnings
    - County Level

- **Databases retain all versions of history and forecast data**
  - → Data is validated for continuity within and across versions
  - → Analysis of changes in trend, anomalies, comparative change

Causal Variable Evaluation

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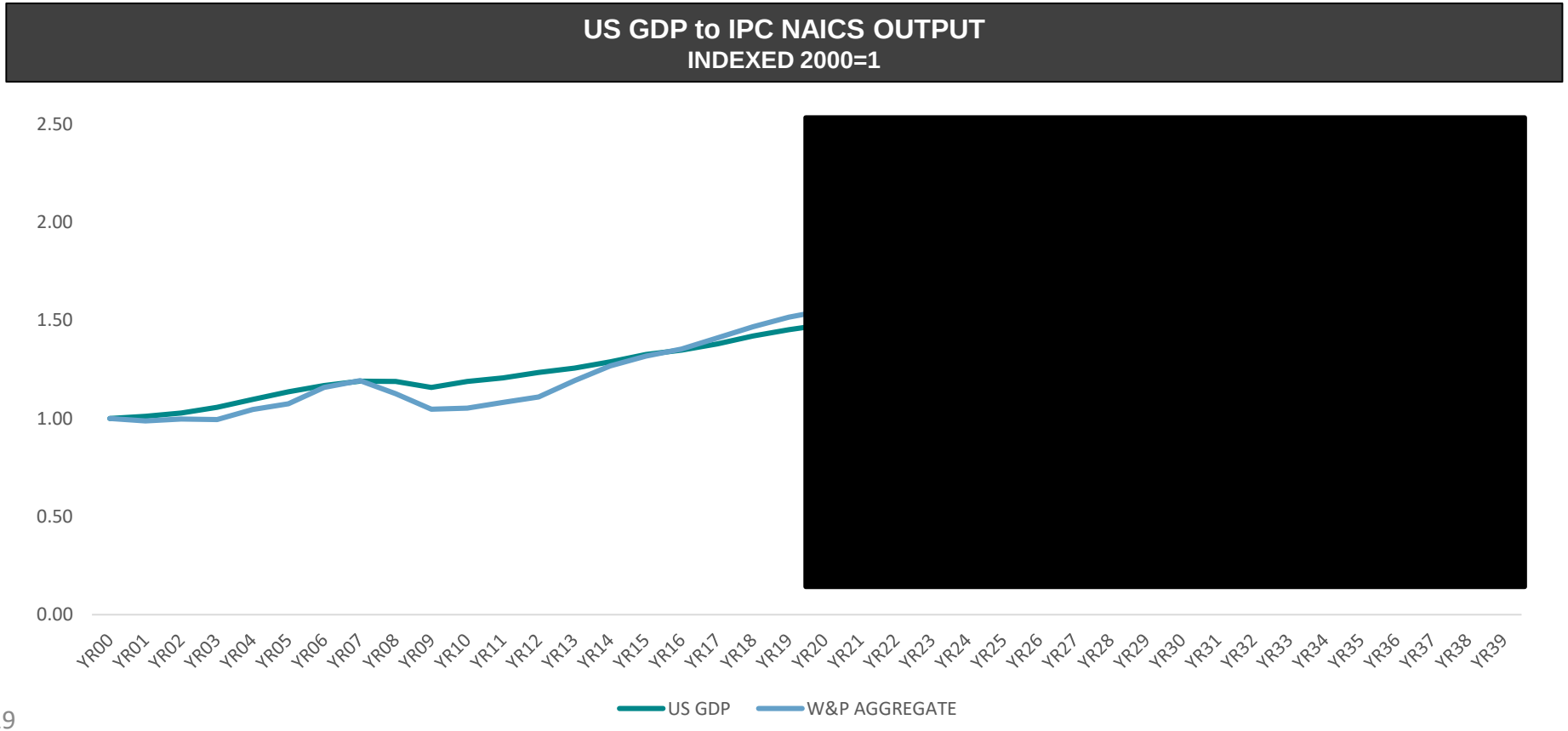

Causal Variable Evaluation

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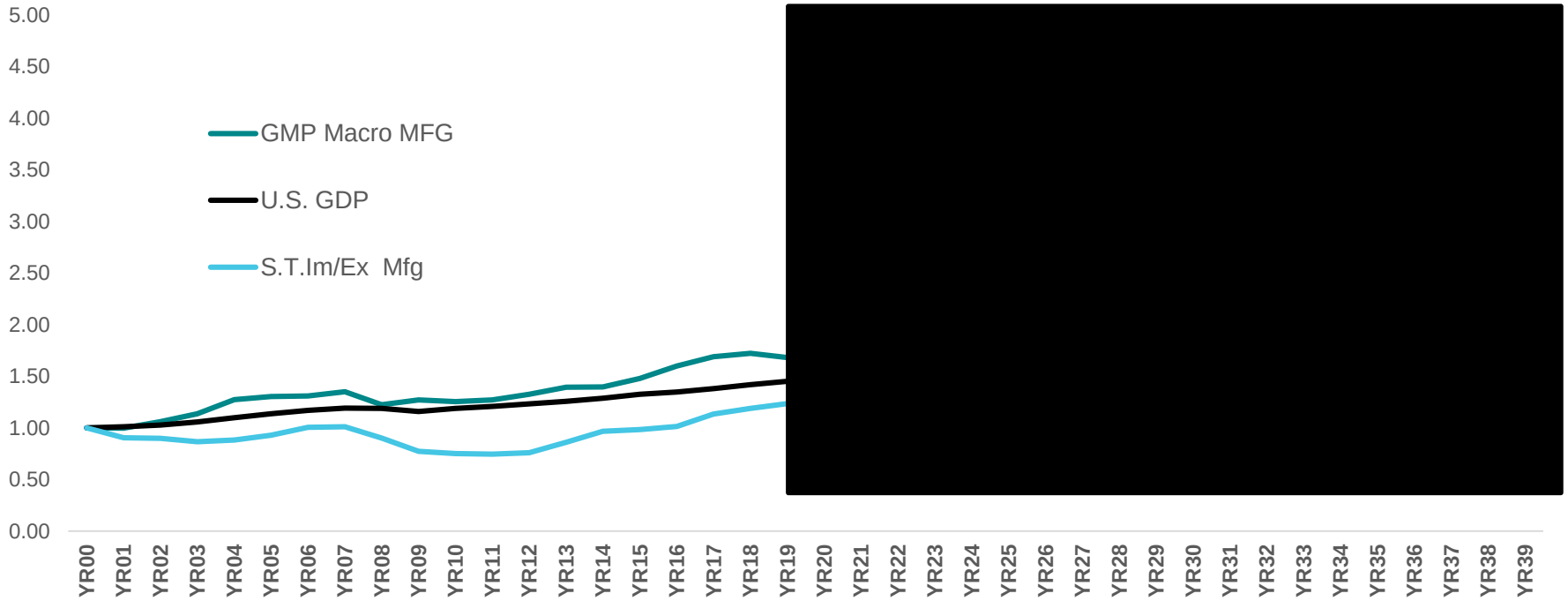
COMPARATIVE AGGREGATE OUTPUT SERIES
INDEXED 2000=1



Causal Variable Segmentation

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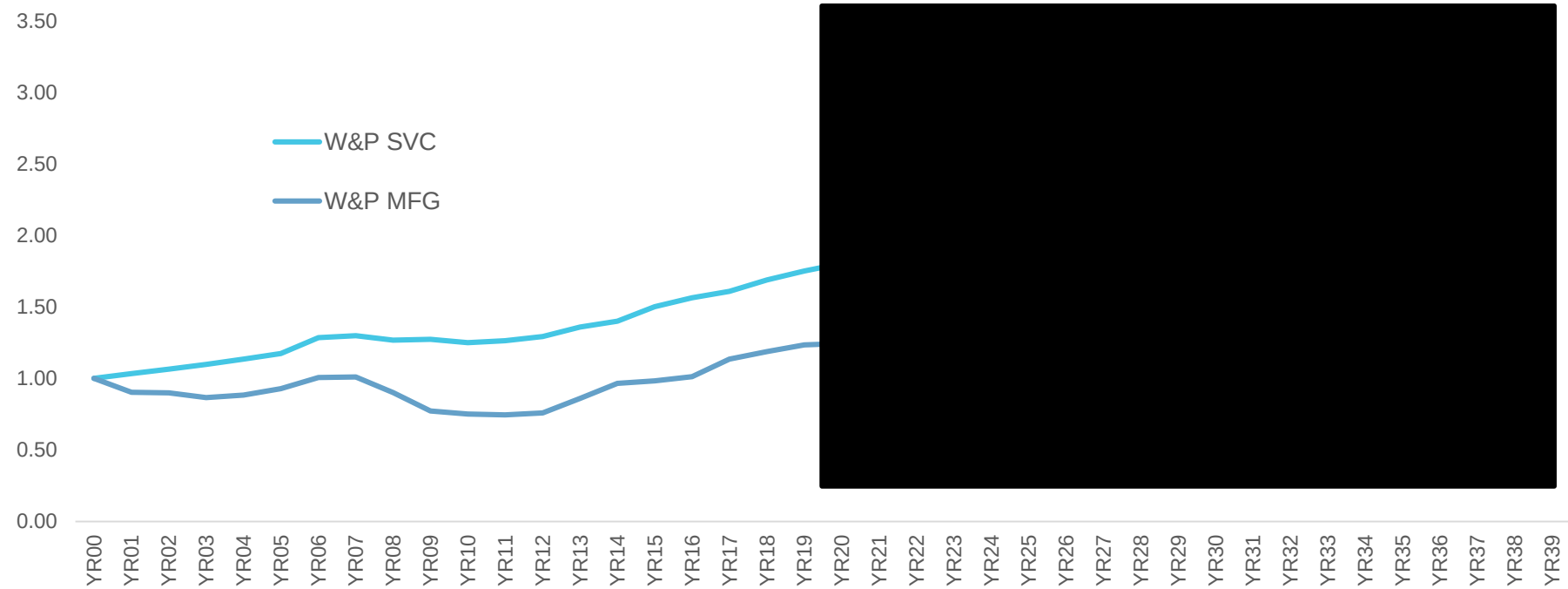
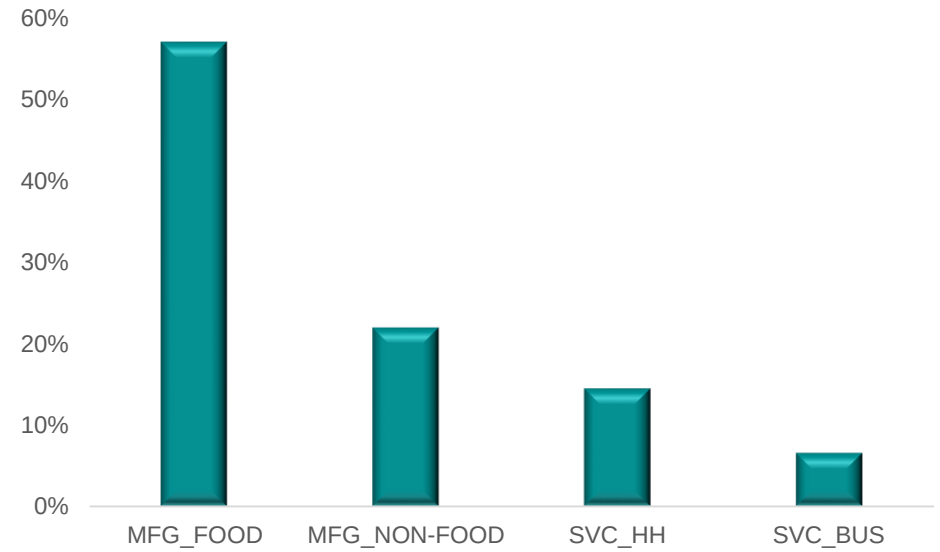
IPC AGGREGATE MFG v SERVICE BUSINESS OUTPUT
(INDEXED 2000=1)

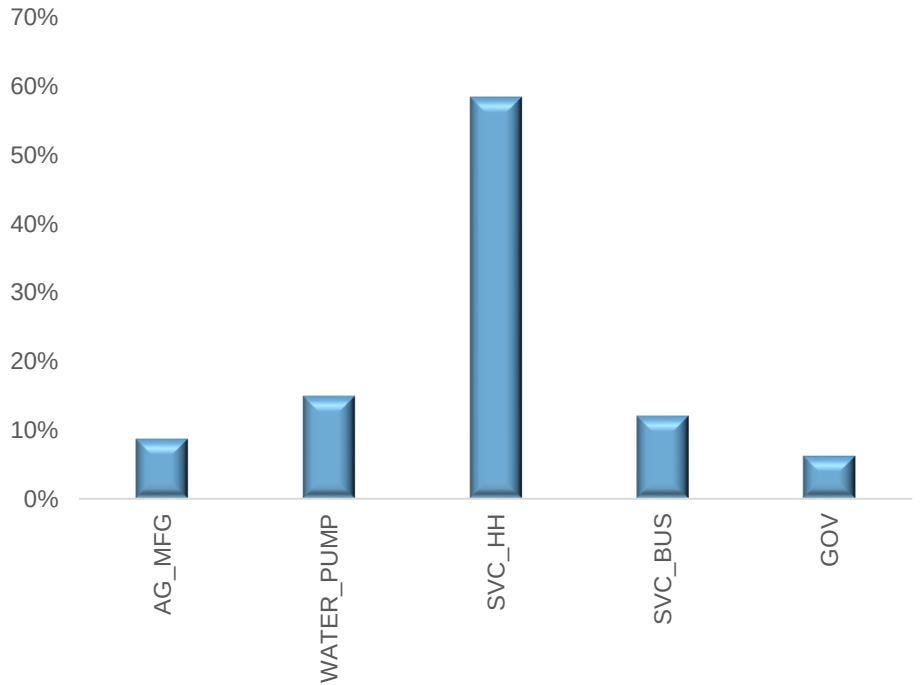


C v I Energy-use Segmentation

Energy Share of Major Industrial Segments at IPC



Energy Share of Major Comm Segments at IPC



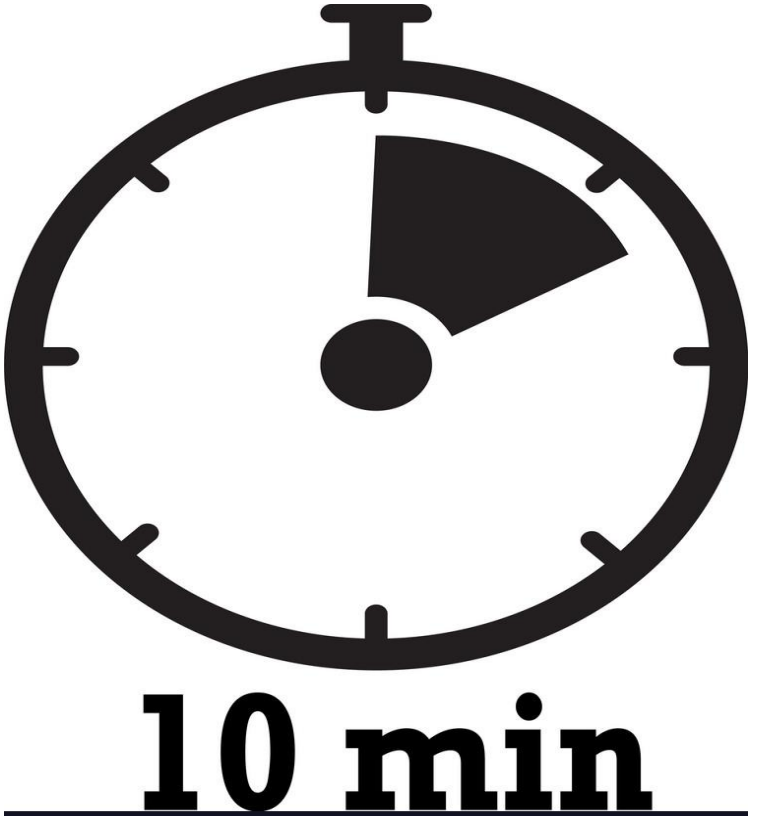
C/I Sales Data

Robust Validation of Customer Data Bucket

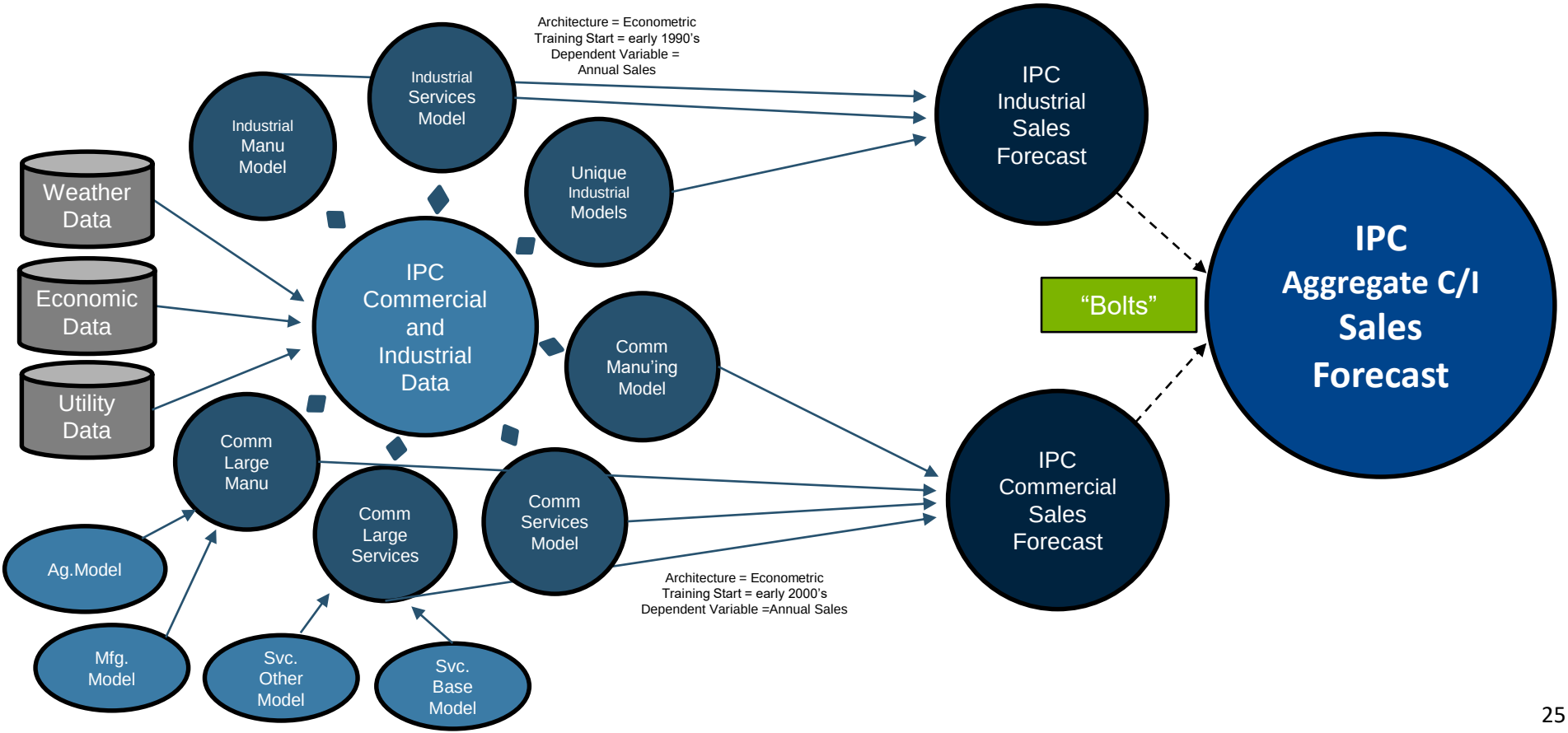
- **Base Forecast (Y) data is annual billed sales**
  - → Industrial customer data 1991 – present
  - → Commercial data 2001 – present
  - → New Customer Birth/Death Evaluation
  - → DSM added back to billed sales
  - → Data validated to booked energy / savings
  - → Rate classification changes evaluated

- **New customers and major plant expansions/contractions with in-determinant or startup or total-plant impact are removed**
  - → Forecast occurs out-of-model with input from customers/engineering

Break



C/I Modeling Schema



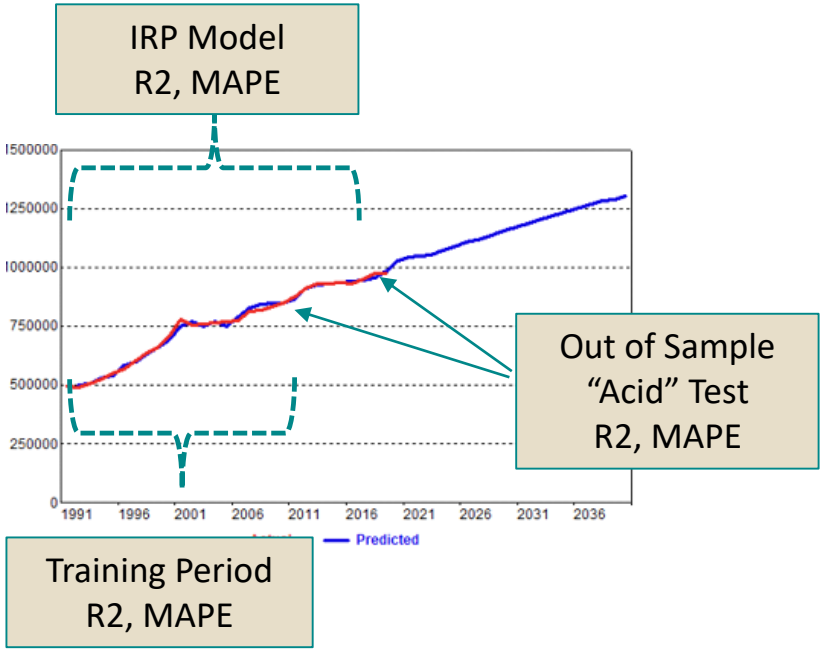
Model Validation Test

- **Best Practice**
  - → "The acid test for forecasting is to determine accuracy based on out-of- sample evaluations. RMSE, MAE and MAPE are the yardstick to determine forecast accuracy"

National Association of Business Economists – Advanced Econometrics

- **Performance Metrics based on ex-Ante Sample**
  - → Existing Model (2021 IRP) v. ex-Ante
    - Training Period = 70% of Observations
    - Out of Sample = 30%
    - R2 and MAPE Evaluation Statistics

- **All Models Validated for acceptable distribution and autocorrelation of residuals from forecast**



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Model v Sample Output
End-year (2040) Forecast Comparison

Table of Backcast Sample of Models

	[redacted]	MWH Wgt.	Var Pct	Wgtd. Var
Mfg_Ind		35%	-1.4%	-0.5%
Svc_Ind		17%	-2.9%	-0.5%
Mfg 7_9S		17%	-2.6%	-0.4%
Svc 7_9S		17%	-2.6%	-0.4%
Mfg_Food 9PT		3%	-4.2%	-0.1%
Mfg_Oth 9PT		3%	-4.2%	-0.1%
Svc_Bldg 1		1%	-1.9%	0.0%
Svc_Bldg2		7%	20.2%	1.5%
		100%	-0.6%	**-0.6%**

NOTES:

- *Slight bias in majority of models, 20-year model shows a slight upward, non-material bias*
- *Largely, bias attributed to CV19 impacts not captured in causal variables*
- *Models were manually adjusted downward*

Model Performance

What can we learn?

- **We conclude from the aggregate end-point (2040) values that the models are Trend Stationary**
- **Slight bias where training periods are coming from recessionary period**
  → Considered a rigorous test for fitting propensity/parsimony
- **Rate class 9 PT is a necessary evil to square the Large Load forecast to a rate class forecast, it understandably exhibits lesser stability in the test**

Large Load Model Forecasts

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Model ID	IRP Models	Out of Sample Test
Mfg_Ind	[redacted]	
Svc_Ind		

Small Commercial Model Forecasts

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Model ID	IRP Models	Out of Sample Test
Mfg 7_9S	[redacted]	[redacted]
Svc 7_9S		

Large Commercial Model Forecasts

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Model ID	IRP Models	Out of Sample Test
Mfg_food 9PT	[redacted]	
Mfg_Oth 9PT		

Large Commercial Model Forecasts

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Model ID	IRP Models	Out of Sample Test
Svc_Bldg 1	[redacted]	
Svc_Bldg 2		

Model v Out of Sample Comparison

Mfg_Ind	Model	Model Obs	Train Obs	Out of Sample	R^2 adj	MAPE
	IRP	28			0.984	1.58%
	Training		19		0.967	1.71%
	Out of Sample			9		2.15%

Svc_Ind	Model	Model Obs	Train Obs	Out of Sample	R^2 adj	MAPE
	IRP	28			0.992	1.21%
	Training		19		0.984	1.46%
	Out of Sample			9		1.26%

Mfg 7_9S	Model	Model Obs	Train Obs	Out of Sample	R^2 adj	MAPE
	IRP	17			0.965	1.32%
	Training		8		0.936	1.24%
	Out of Sample			4		1.98%

Svc 7_9S	Model	Model Obs	Train Obs	Out of Sample	R^2 adj	MAPE
	IRP	17			0.965	1.32%
	Training		8		0.936	1.24%
	Out of Sample			4		1.98%

Model v Out of Sample Comparison

Mfg_Food 9PT	Model	Model Obs	Train Obs	Out of Sample	R^2 adj	MAPE
	IRP	22			0.986	2.70%
	Training		12		0.953	3.08%
	Out of Sample			6		3.26%

Mfg_Oth 9PT	Model	Model Obs	Train Obs	Out of Sample	R^2 adj	MAPE
	IRP	22			0.933	12.93%
	Training		11		0.897	17.08%
	Out of Sample			6		11.47%

Svc_Bldg 1	Model	Model Obs	Train Obs	Out of Sample	R^2 adj	MAPE
	IRP	22			0.893	5.95%
	Training		12		0.504	7.05%
	Out of Sample			6		3.04%

Svc_Bldg2	Model	Model Obs	Train Obs	Out of Sample	R^2 adj	MAPE
	IRP	22			0.976	4.13%
	Training		11		0.97	3.58%
	Out of Sample			6		7.10%

Continuous Improvement Paradigm

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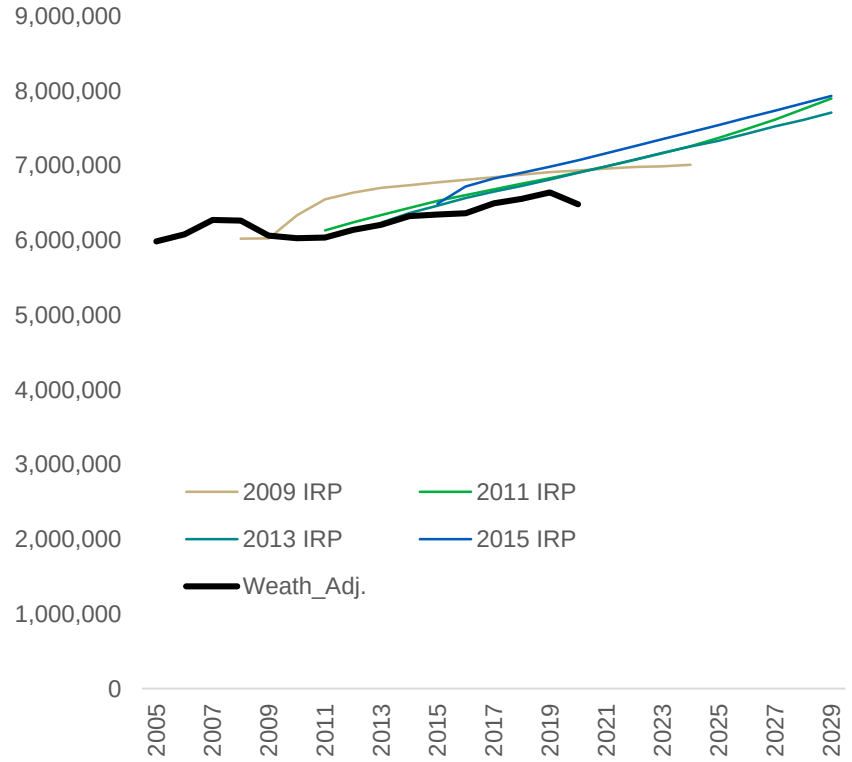
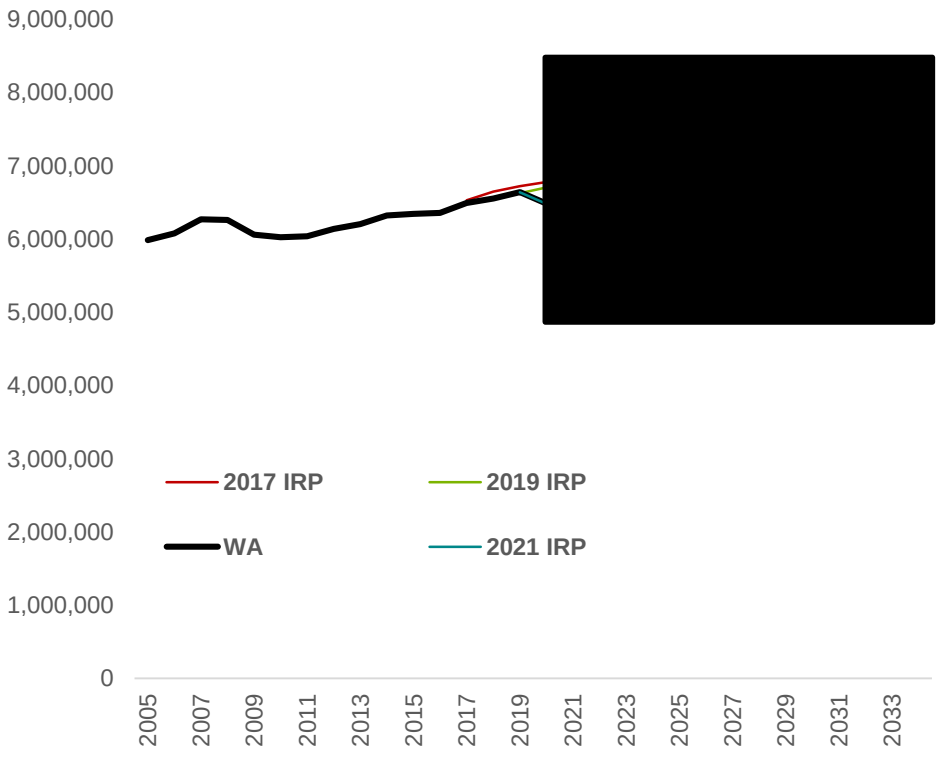
C/I IRP VERSION FORECASTS 2009-2015



C/I IRP VERSION FORECASTS 2017-2021



Ongoing Considerations

Action Items to Continue to Monitor

- Continued evaluation of 9PT rate models for re-specification
- 9PT customer classification is the most rapidly growing rate class
- Consolidations of smaller commercial facilities focus
- Validate facility assumptions vis-a-vis segmentation
- DSM Reporting lag/Rate Classification

APPENDIX

Commercial/Industrial Modeling

What Are We Modeling, Start with a Goal

- Changes in billed sales as a result of decisions as dictated environmental changes which lead to changes in energy-consuming plant and equipment utilization

  → Internal changes in plant and equipment utilization and subsequent energy use
    - Investment/ dis-investment
    - Legal/Governmental Policy/Regulation
    - Codes & Standards
    - DSM/DE
    - Price
    - Competitors
    - Customers
    - Supply Chain
    - Weather/Climate
    - Financial Markets
    - Etc.

Inter-rate Customer Shifts Over Time

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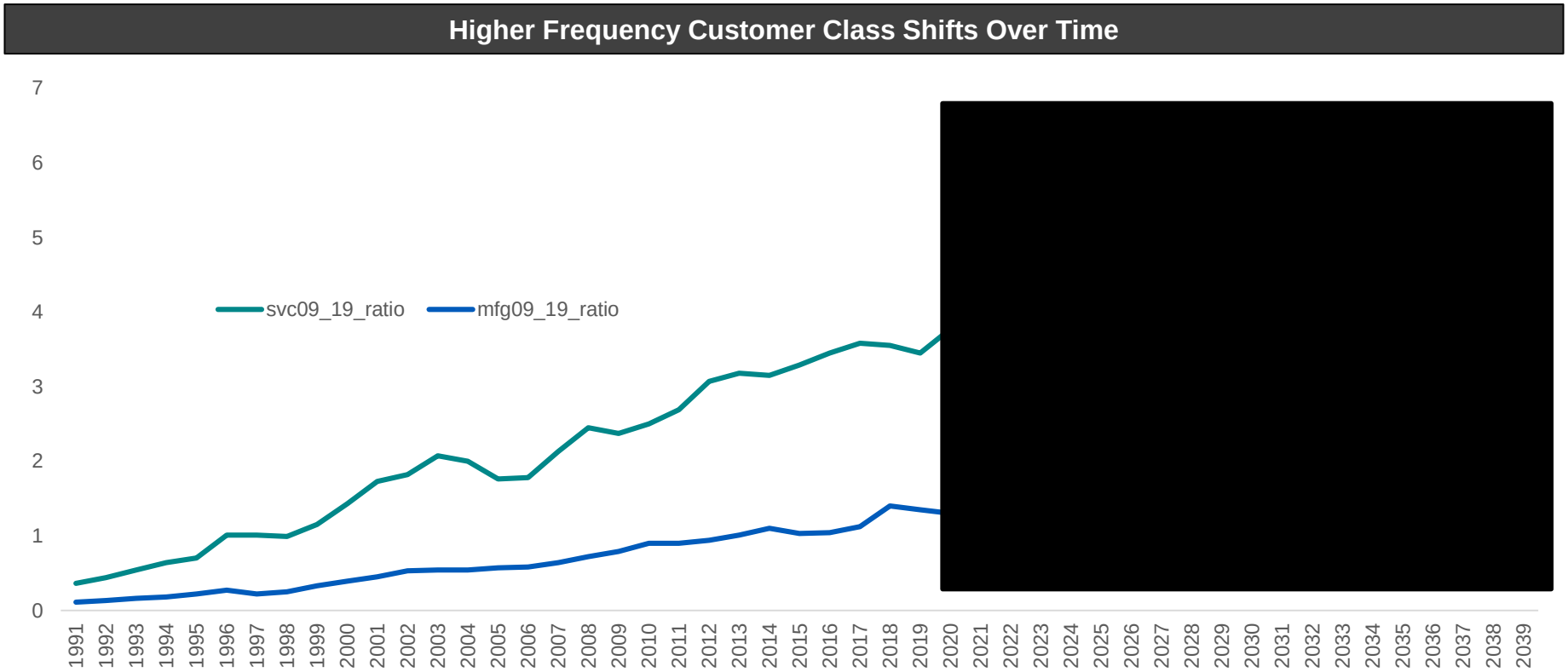

Modeling Performance in IRP's

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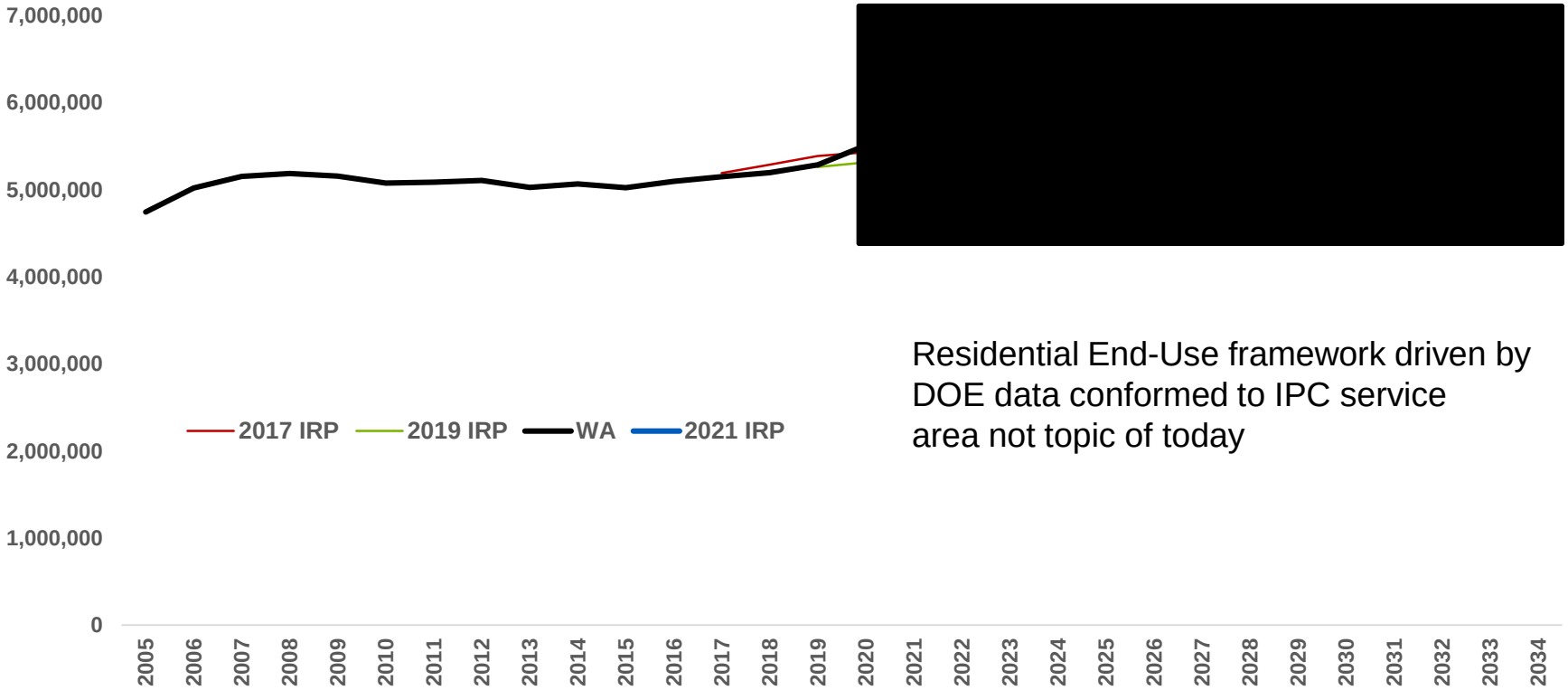
Residential Forecast by IRP Vintage (MWh)



Residential End-Use framework driven by DOE data conformed to IPC service area not topic of today

Modeling Benchmarking

What are our peers doing?

- **Portland General Electric**
  - Dual time period approach, short term and long term
  - Long term segmentation approach matches IPC
  - Short term aggregate approach uses US GDP, time series

- **Avista**
  - One aggregated model per commercial and industrial approach
  - Uses time series, stationary adjustment as data is not segmented like IPC

- **ITRON Load Forecasting**
  - Position is structural econometric forecast properly specified “parsimonious” assumes and establishes trend stationarity.
  - Missing the point that most utilities structural models IS trend stationary in causal variables and not an issue

Forecast Philosophy

- **Structural Econometric (Causal) Models Serve as the Foundation for Robust Forecasts, Both Operationally and for IRP**
  - → Proper segmentation of sales (Y) variable in conjunction with vetted causal variables is the means for achieving consistently defendable forecasts

- **Model selection* - We do not model to "goodness of fit" i.e. chasing R2**
  - → Fitting Propensity - models' ability to fit a diverse array of data patterns well
  - → Parsimony - constrain possible outcomes, restrict the proportion of data sets consistent with the model.
  - → R2 Follows as a by-product

C/I Sales – EE Adjustments

Historical Energy Efficiency Acquisition in Commercial and Industrial