Joint Integrated Resource Plan (IRP) Stakeholder Presentation

February 3, 2016

Agenda

Welcome

1. IURC Director's Report Development Process
2. Public Advisory Process Overview
3. IRP Building Blocks & Development
4. Load Forecasting
5. Resources
6. Scenarios and Sensitivities

Lunch Break

7. Regional Transmission Organizations
8. Resource Modeling

Day in Review/Feedback

Closing Remarks

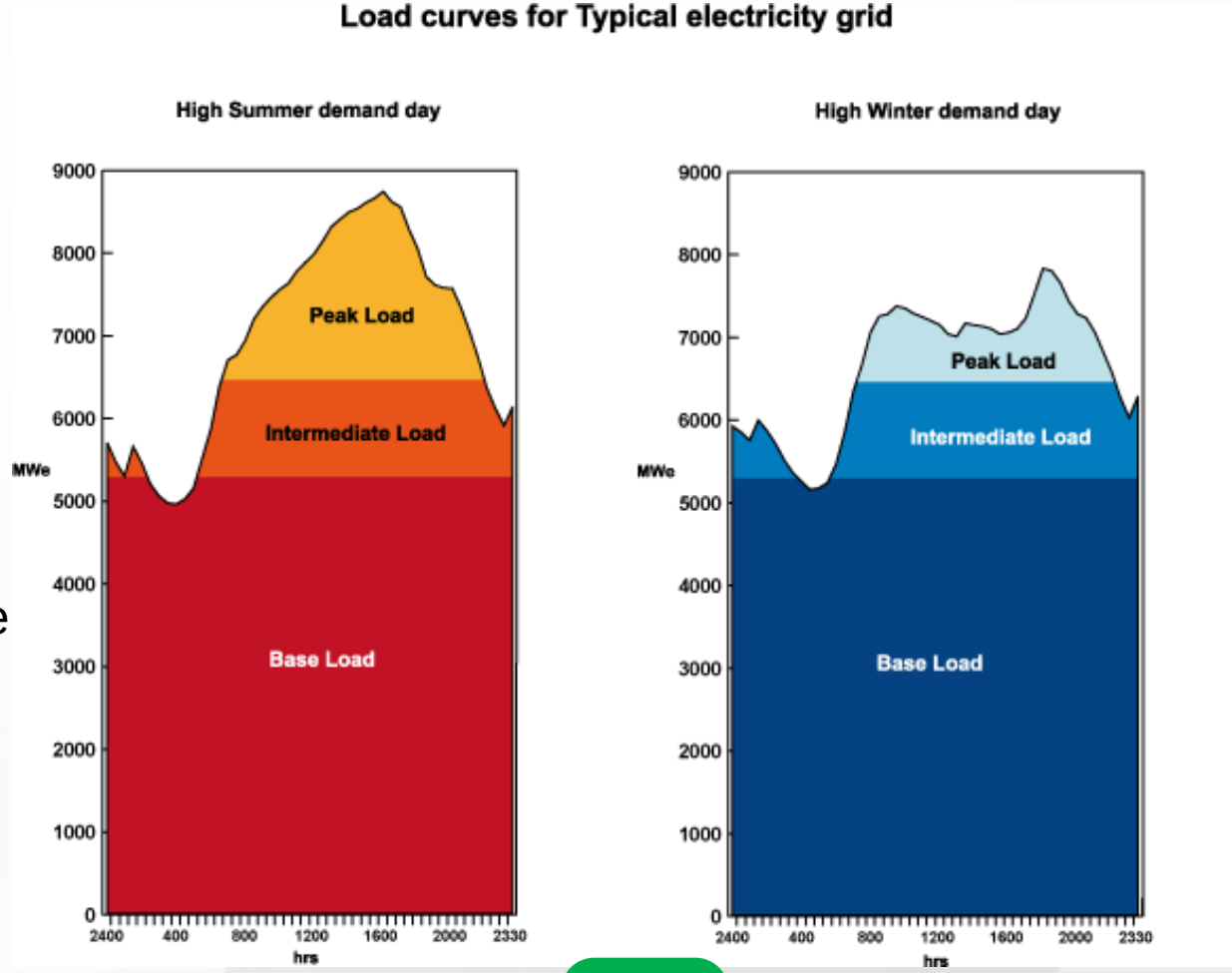
4 LOAD FORECASTING (VECTREN)

Load Forecasting

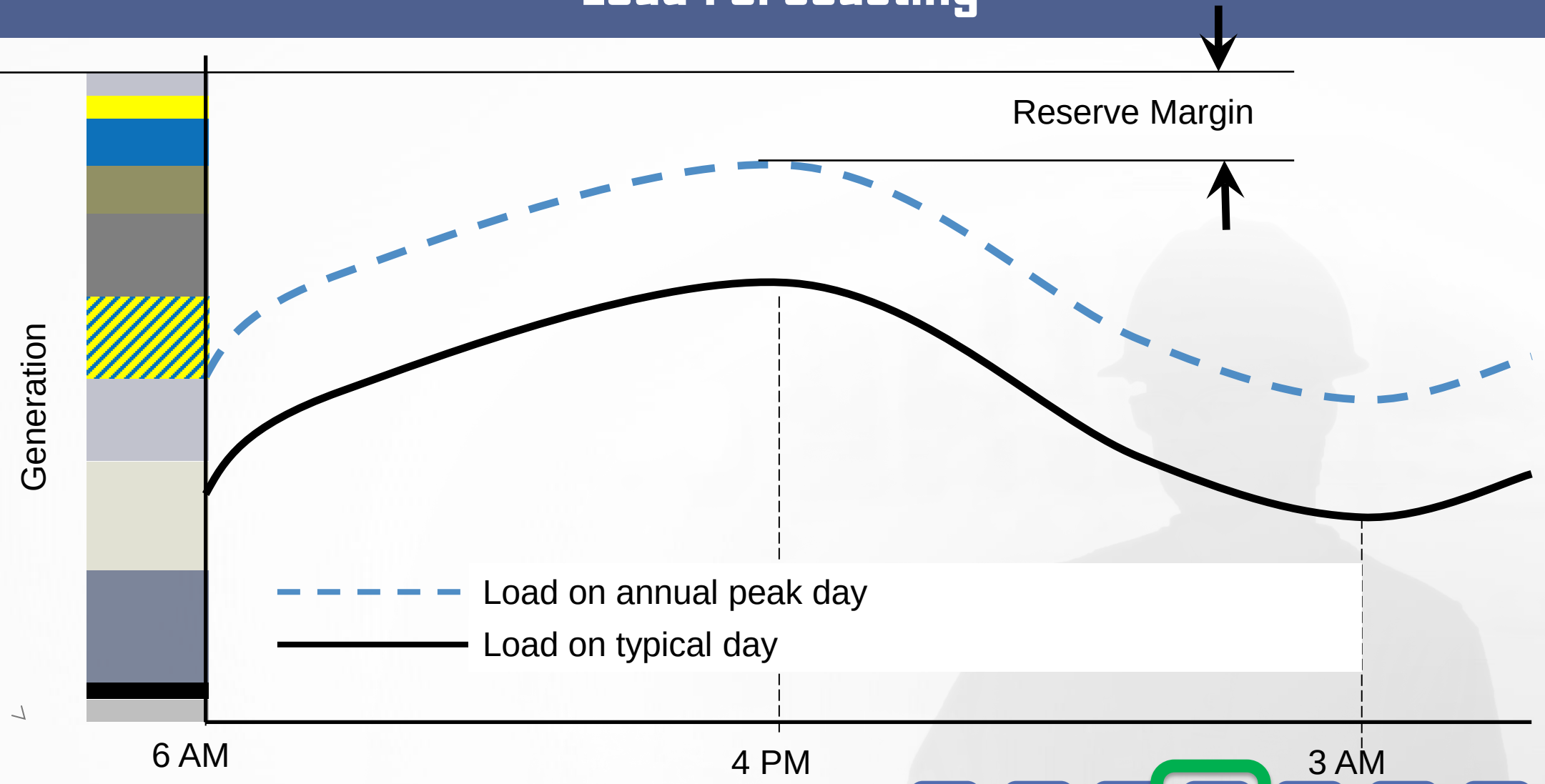
- Load forecasting is a fundamental building block of the IRP process
  - Use historical data and known/projected future drivers to predict future energy and demand requirements
  - Indiana requires a 20 year forecast period for the IRP
- The utility is required to serve its peak load + a reserve margin
  - Peak demand is the maximum power consumption in a given year for the utility's service area, typically measured in Mega Watts (MW)
  - Energy is the product of power and time, Kilowatt Hour (kWh)
  - Reserve Margin is required capacity by the Regional Transmission Operator (RTO) to ensure reliability

Load Forecasting

- Base Load
  - Minimum level of demand on an electrical supply system over 24 hours
  - Power sources: those plants which can generate consistent and dependable power
- Intermediate Load
  - Medium level of demand
  - Power sources: plants which can operate between extremes and generally have output increased in the morning and decreased in the evening
- Peak Load
  - Highest level of demand within a 24 hour period
  - Power sources: plants which can be switched “on” when the additional power is needed without much delay



Load Forecasting



Load Forecasting

- Utilities typically forecast energy by customer class
  - Residential, Commercial, Industrial
  - Street Lighting, Government Use, Wholesale
- System energy derived by aggregating across the sales forecast and adjusting for line losses
- Peak demand forecast is typically based on the historical demand/energy relationship
  - Load factors
  - Regression models that relate peak demand to total energy or end-use energy trends, and weather

Load Forecasting - Drivers

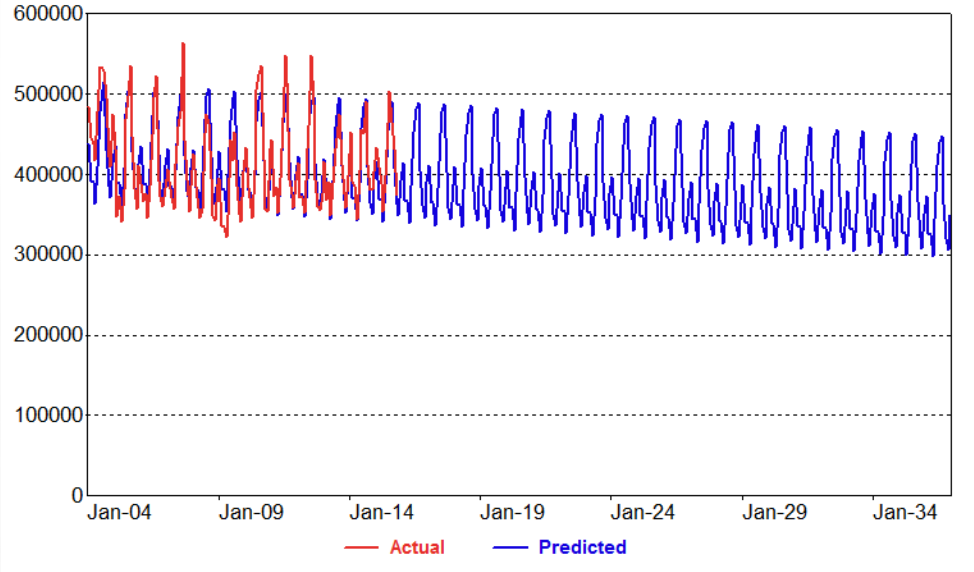
- Weather
- Economy
- Demographics
- Appliance saturation and size
- Appliance efficiency trends driven by
  - Consumer demand
  - Utility sponsored demand side management (DSM) programs
  - Government codes and standards
- Consumer behavior and technology changes
- Thermal shell of homes or businesses
- Price of electricity
- Customer owned generation

Load Forecasting – Typical Methods

- Simple Pattern or Trend Model
  - Extrapolate past usage trends into the future
- Econometric Model
  - Relate historical energy sales to weather, demographics, economic activity, efficiency trends with statistical models and project this relationship forward based on these factors
- End Use Forecasting
  - Engineering based model that projects end-use sales based on appliance ownership, efficiency, utilization and changes in codes and standards using known information about appliance shares, usage, and changes in codes and standards
- Statistically Adjusted End Use (SAE) Model
  - Blend of econometric modeling and end use forecasting
- Survey Customers
  - Speak to customers about their future plans

Patterns and Trend Models

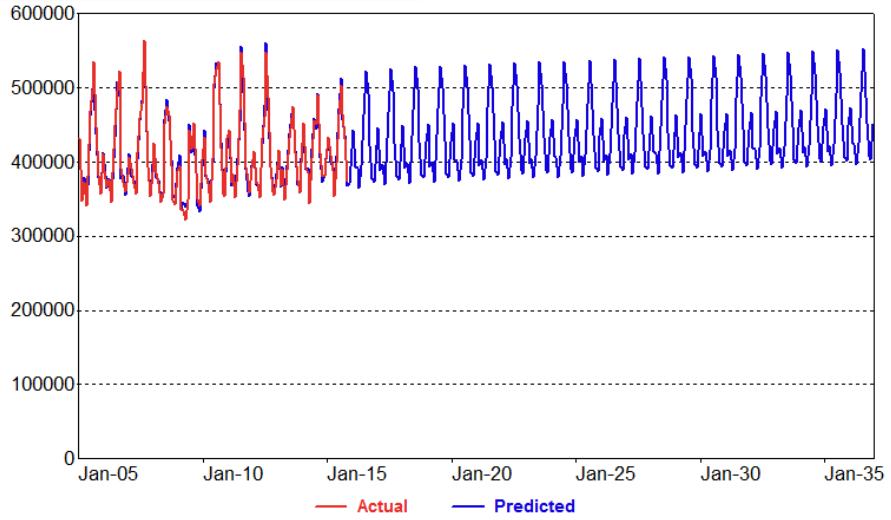
- The forecast is extrapolated from past energy trends and monthly/seasonal patterns
  - Exponential Smoothing
  - ARIMA Models
  - Simple trend-based linear regression models



- Trend models are simple to estimate and can be useful in projecting near-term trends. Trend models implicitly assume that future energy usage will look like the past

Econometric Model

- Captures the factors that impact electricity use
  - Weather, population, economic activity, more efficient appliances
    - Linear and non-linear regression models: estimate the relationship between monthly electric sales (the dependent variable) and the variables that cause electricity to change (the independent variables)



Variable	Coefficient	StdErr	T-Stat
Days	9042.6	946.6	9.6
HDD	83.3	4.6	18.0
CDD	417.4	9.4	44.6
GDP	3176.8	1911.1	1.7

The estimated coefficients tell us how much monthly energy changes given a change in the number of days in the month, heating degree days (HDD) , cooling degree days (CDD), and the economy (GDP)

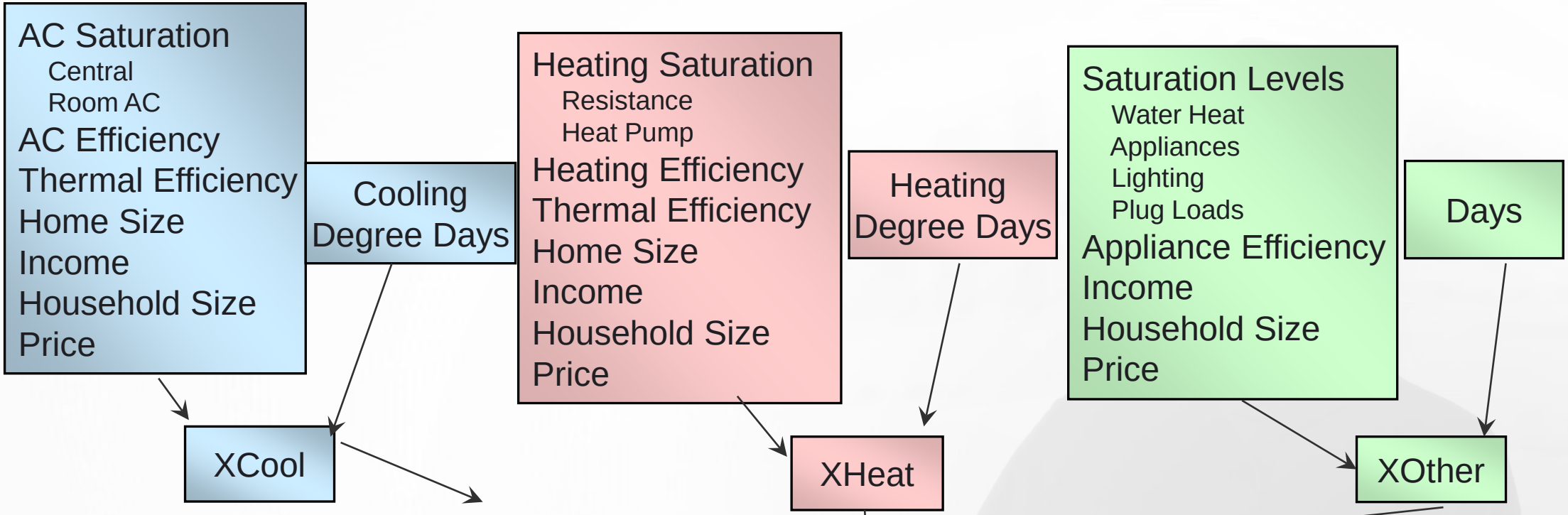
- This regression model assumes that the relationship between sales and model variables are the same in the future as it has been in the past

End Use Forecasting

- End-use models: An engineering-based approach were we develop annual kWh forecasts for defined end-uses
  - *Electric Power Research Institute (EPRI) End-Use models: REEPS* and *COMMEND*
- Collect and maintain detailed end-use database
  - Number of units, appliance age distribution, technology options, technology costs, starting average and marginal unit energy consumption (UEC), housing square footage, thermal shell integrity
- Embed assumption as to how these characteristics will change over time with households, income, energy price, appliance costs, and standards
- Generate and sum resulting end-use energy requirements

Statistically Adjusted End Use (SAE) Model

- Blend of econometric and end use modeling
  - Incorporates end-use ownership and efficiency trends as well as weather, price, and economic data



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

Estimate monthly model with historical billed sales data

Load Forecasting - Conclusion