U.S. Case Studies

Technical Workshop on Evaluating Demand Forecasts and Least-Cost Expansion Plans

Lusaka, Zambia

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State Utility Forecasting Group (SUFG)

- SUFG is a university-based research group that specializes in economic and policy analysis for the electric utility industry
- SUFG has been working with the Indiana Utility Regulatory Commission (IURC) since 1985
- SUFG provides long-term (20-year) forecasts of electricity usage, prices, and resource needs for the state of Indiana
- SUFG has been providing long-term (20-year) forecasts to the local wholesale market and transmission operator (MISO – Midcontinent Independent System Operator) since 2014

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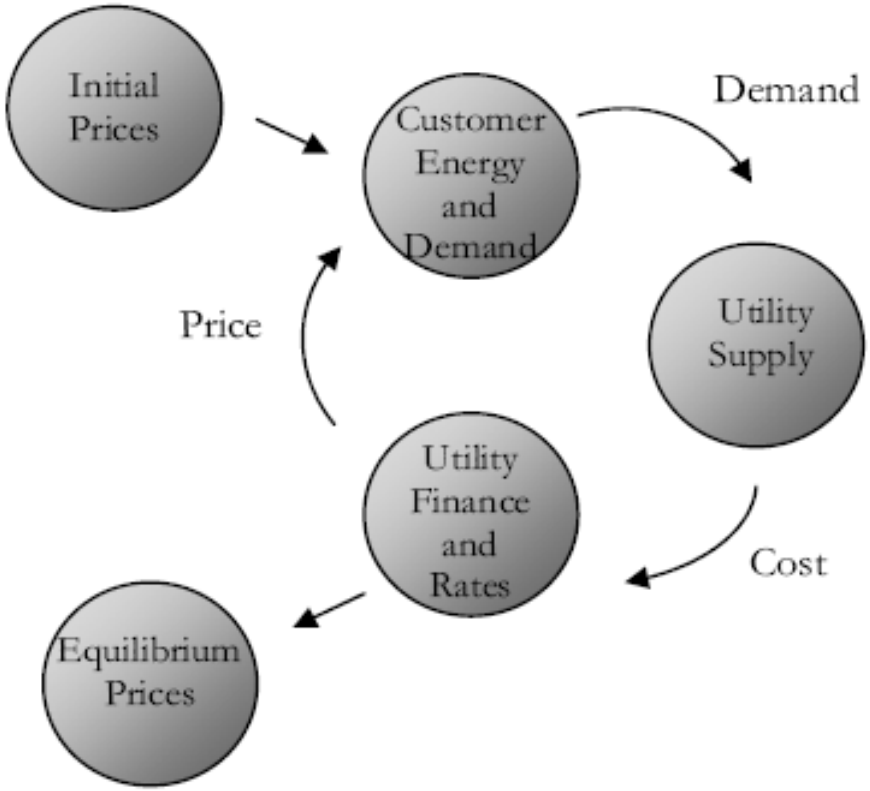
SUFG INDIANA FORECASTING MODELING SYSTEM

SUFG Indiana Forecasting Modeling System

- Consists of 3 types of models
  - Load forecasting models
  - A production costing and resource expansion model
  - Utility finance and rates models



Indiana Forecasting Models

- 3 customer sector-specific models for each of the 5 investor-owned utilities (IOUs)
  - Residential
  - Commercial (business)
  - Industrial (manufacturing)
- A single econometric model for each of the 3 major not-for-profit (NFP) utilities

IOU Residential Models

- For each IOU, we use a bottom-up end-use model
- 3 building types
  - Single family, multiple family, mobile
- 3 fuel types
  - Electricity, natural gas, fuel oil
- 10 end uses per building type
  - Space heat, water heat, air conditioning, refrigeration, freezing, cooking, dishwashing, clothes drying, lighting, miscellaneous

SUFG Residential End-Use Models

- For each end use/building type combination there is an initial stock of equipment
- Initial stock is separated by age (vintage) and efficiency
- Additional stock for next year is determined by economic drivers
- Some existing stock will be replaced due to failure or early replacement
- Older vintages are more likely to be replaced

Major Drivers for Residential Models

- Demographic projections
- Real personal income projections
- Electricity price projections from SUFG rates models
- Natural gas price projections

IOU Commercial Models

- For each IOU, we use a bottom-up end-use model
- 21 building types
  - Office, grocery, etc.
- 3 fuel types
  - Electricity, natural gas, fuel oil
- 10 end uses per building type
  - Space heating, water heating, air conditioning, ventilation, refrigeration, cooking, interior lighting, exterior lighting, equipment, other

SUFG Commercial End-Use Models

- Structure is similar to the residential end-use model, except it is modeled based on the amount of floor space to account for size differences among commercial buildings (residential model is based on the number of dwellings)

Major Drivers for Commercial Models

- Non-manufacturing employment
- Demographics
- Electricity price projections from SUFG rates models
- Natural gas price projections

IOU Industrial Models

- For each IOU, SUFG uses a top-down econometric model for each of 15 industry types
  - Food; lumber & wood products; furniture & fixtures; paper; printing & publishing; chemicals; rubber & plastics; stone, clay, & glass; primary metals; fabricated metal; industrial machinery; electronics; transportation equipment; instruments; miscellaneous
- Given a projection of the output of each industry type, the model examines the tradeoff of different potential inputs to find the least-cost option

Major Drivers for Industrial Models

- Manufacturing employment – CEMR
- Manufacturing gross state product by industry type
- Electricity price projections from SUFG rates models
- Natural gas, petroleum, and coal price projections

NFP Econometric Models

- SUFG constructed unique econometric models for each of the 3 major NFP utilities
- Drivers
  - Population
  - Electricity price projections from SUFG rates models
  - Weather

New Industrial Forecasting Models

- SUFG is working on developing new econometric models for the IOUs
- Major industries (primary metals, transportation equipment) will be modeled individually, while other industries will be grouped together (durable goods, non-durable goods)

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LOAD FORECASTING BY INDIANA UTILITIES

Forecasting Approaches by Indiana Utilities

- Each utility is responsible for developing its own forecast, which it uses in its integrated resource planning process
- A variety of approaches are used, including
  - Econometric, which is a top-down method
  - Statistically Adjusted End-Use (SAE), which is a hybrid of bottom-up and top-down
  - Time series approaches, like Autoregressive Integrated Moving Average (ARIMA), which do not use explanatory variables
  - Analyst judgment

IOUs

- AES Indiana, Duke Energy, and Vectren use SAE models for residential and commercial, econometric for industrial
- Indiana Michigan Power uses ARIMA for the short-term and combination of SAE (residential/commercial) and econometric (industrial) for long-term
- NIPSCO uses econometric models (combination of forecasts of number of customers and forecasts of usage per customer) for all sectors

NFPs

- Hoosier Energy uses econometric models for residential; commercial and industrial that are largely based on judgment
- Indiana Municipal Power Agency uses an econometric model at the total system level, and does not break down by customer class
- Wabash Valley Power Association uses SAE models at an individual member level, with adjustments for large customers

INDIANA UTILITY INTEGRATED RESOURCE PLANS

Utility Integrated Resource Plans (IRPs)

- Each utility is required to file an IRP at least once in a 3-year period
- IRPs include the load forecast, scenario and risk analysis, and preferred mix of resources for the future
- Resource mix include supply-side (generators and purchases from other suppliers) and demand-side (utility-sponsored efficiency programs)
- The IURC does not require specific approaches or models

IRP Stakeholder Meetings

- The 5 IOUs are required to hold a series of meetings with stakeholders (customers, government employees, public-interest groups) to explain their process and assumptions and receive feedback from the stakeholders
- The NFP utilities are exempt from this requirement

IURC Review

- After the utility files its IRP, commission staff review it and take comments from stakeholders
- The Director of the Research Policy & Planning Division prepares a draft report detailing their findings
  - Includes any concerns about methodology and assumptions
- The utility and stakeholders are given time to respond to the draft report
- After taking those responses into account, the final Director's Report is released
- The Commission does not formally approve or deny the utility's IRP

IURC Review Considerations

- Continual improvement in all aspects of plan development
  - Data
  - Process
  - Modeling
- Risk analysis and scenarios
  - Including low probability, high impact
- Invite outside critique
- Flexibility in the face of change

IURC Review Considerations (continued)

- Coordination at all levels
  - Generation
  - Transmission (including with neighboring regions)
  - Distribution
- Other metrics besides least-cost
  - Societal costs and benefits
- Prudence and security
  - Once the commission approves resources, it would be inappropriate to penalize the utility if it continues to use best practices

IURC IRP Site

- Contains both draft and final Director's reports going back to 2013
- Contains individual utility IRPs going back to 2011
- Could be helpful in seeing what the IURC looks for when reviewing utility load forecasts and resource plans

https://www.in.gov/iurc/energy-division/electricity-industry/integrated-resource-plans/

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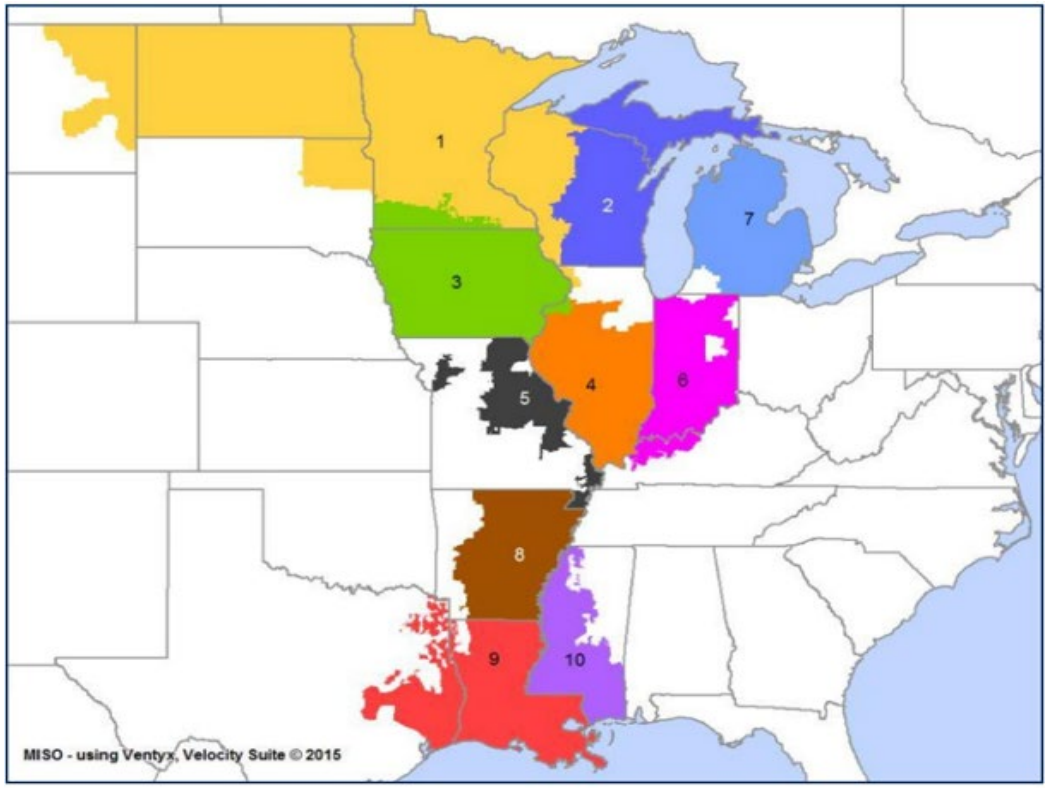
FORECASTING FOR THE MID-CONTINENT INDEPENDENT SYSTEM OPERATOR (MISO)

SUFG MISO Forecasts

- SUFG provides 20-year load forecasts for MISO, which uses them as an input to its transmission planning process



Source: MISO 2018

MISO Forecasting Models

- For transparency, MISO wants models based on publicly available data
  - This makes it difficult to use a bottom-up approach
- SUFG develops econometric models for each of the 15 states in the MISO region
  - Each model uses a linear formulation

$$Y = \beta + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \ldots$$

- The state forecasts are allocated to 10 local resource zones, which are then summed to the total system level

Blending with Other Forecasts

- MISO also gets forecasts provided by some of the individual utilities, and has SUFG blend those with ours
- The SUFG forecast was blended with a bottom-up forecast in the first 5 years to better capture the effects of government codes and standards
  - Uncertainty over future codes and standards means the accuracy of the bottom-up models is largely unknown in the long-term
- This blended forecast was then used to account for the utilities that did not provide a forecast

MISO Forecasting Methodology Whitepaper

- A few years ago, MISO published a review of forecasting methodologies
- According to the paper, the qualities of a good forecasting system are
  - Understandability
  - Credibility
  - Accuracy
  - Reasonable cost
  - Maintainability
  - Adaptability

MISO Forecasting Methodology Whitepaper

- "Acceptable"
  - End-use
  - Econometric
  - Hybrid
- "Unacceptable"
  - Time trend
  - Autoregressive
  - Informed opinion

https://cdn.misoenergy.org/Peak%20Forecasting%20Methodology%20Review%20Whitepaper173766.pdf

Thank You

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https://www.purdue.edu/discoverypark/sufg/

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