Discovery Park

Energy Center

State Level Forecasting Methods

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Outline

- State/regional forecasting
- Determining peak demand
  - Load Diversity
- Determining resource requirements
  - Reserve/capacity margins
  - Loss of load probability
- Determining type of resources needed
- Integrated resource planning

State/Regional Level Forecasting

- Underlying methodology is similar
  - same types of forecasting models
- Many states and RTOs build up a regional forecast from smaller forecasts (bottom-up approach)
- Others use a central approach

Problems with Bottom-Up Forecasts

- Inconsistent assumptions
  - two utilities both assume that the new manufacturing plant will be in their own territories (or neither do)
- One utility may include certain loads (requirement sales) while another may not
- Retail choice may influence a utility's projections
- All of these can lead to overcounting or undercounting

Problems with Central Approach

- Volume of data makes detailed modeling problematic
- Growth is not likely to be the same in different areas

Example - PJM

- PJM recently moved from a bottom-up to a central forecasting methodology
- Explanatory variables are gross product by metropolitan area and weather

Example - EIA

- National Energy Modeling System (NEMS) models nine census divisions
- Numerous sectors modeled, such as residential, commercial, industrial, transportation, oil supply, natural gas supply)

Energy → Peak Demand

- Constant load factor / load shape
  - Peak demand and energy grow at same rate
- Constant load factor / load shape for each sector
  - Calculate sectoral contribution to peak demand and sum
  - If low load factor (residential) grows fastest, peak demand grows faster than energy
  - If high load factor (industrial) grows fastest, peak demand grows slower than energy

Energy → Peak Demand

- Day types
  - Break overall load shapes into typical day types
    - low, medium, high
    - weekday, weekend, peak day
  - Adjust day type for load management and conservation programs
  - Can be done on a total system level or a sectoral level

SUFG Example

- Forecast growth rates

– residential energy	2.22%
– commercial energy	2.61%
– industrial energy	1.99%
– total energy	2.22%
– peak demand	2.24%

- Note: Growth rates for total energy and peak demand have not been this similar in previous forecasts

Load Diversity

- Each utility does not see its peak demand at the same time as the others
- Thus, the statewide peak demand is less than the sum of the individual peaks
- Actual statewide peak demand can be calculated by summing up the load levels of all utilities for each hour of the year
- Diversity factor is an indication of the level of load diversity
- Historically, Indiana’s diversity factor has been about 96 – 97 percent
  - that is, statewide peak demand is usually about 96 percent of the sum of the individual utility peak demands

Load Diversity Example

- In 2001, the peak demand for the individual utilities occurred at the following dates and times
- The sum of the individual peak demands was 19,948 MW
- The statewide peak demand occurred at 3:00 PM on 8/8 and was 19,043 MW

• 6/14	11:00 AM
• 7/23	3:00 PM
• 7/24	4:00 PM
• 7/31	4:00 PM
• 8/7	4:00 PM
• 8/8	1:00 PM
• 8/8	6:00 PM
• 8/9	1:00 PM

Example

- Three utility, single day example on Excel spreadsheet
- This is normally done for each of the 8,760 hours in a year

Peak Demand → Capacity Needs

- Target reserve margin
- Loss of load probability (LOLP)
- Expected unserved energy (EUE)
- Assigning capacity needs to type
  - peaking
  - baseload
  - intermediate
- Optimization

Reserve Margin vs. Capacity Margin

$$RM = \frac{capacity - demand}{demand} x100\% \quad CM = \frac{capacity - demand}{capacity} x100\%$$

- Both reserve margin (RM) and capacity margin (CM) are the same when expressed in megawatts
  - difference between available capacity and demand
- Normally expressed as percentages

Reserve Margins

- Reserve/capacity margins are relatively easy to use and understand, but the numbers are easy to manipulate
  - Contractual off-system sale can be treated as a reduction in capacity or increase in demand
    - does not change the MW margin, but will change the percentage
  - Similarly, interruptible loads and direct load control is sometimes shown as an increase in capacity

Example

- Say a utility has 800 MW of native load on peak, 1100 MW of generation, and a 200 MW contractual sale off-system
  - What is the reserve margin if it subtracts the sale from its capacity?
  - What if it adds the sale to its peak demand?
- What if it had 1200 MW of generation?

Loss of Load Probability

- Probabilistic method that accounts for the reliability of the various sources of supply

- Given an expected demand for electricity and a given set of supply resources with assumed outage rates, what is the likelihood that the supply will not be able to meet the demand?

Expected Unserved Energy

- Similar calculation to LOLP, used to find the expected amount of energy that would go unmet
- Both are used in resource planning to ensure that sufficient capacity is available for LOLP and/or EUE to be less than a minimum allowable level

Capacity Types

- Once the amount of capacity needed in a given year is determined, the next step is to determine what type of capacity is needed
  - peaking (high operating cost, low capital cost)
  - baseload (low operating cost, high capital cost)
  - intermediate or cycling (operating and capital costs between peaking and baseload)
    - some planners only use peaking and baseload

Assigning Demand to Type

- SUFG uses historical load shape analysis for each of the utilities to assign a percentage of their peak demand to each load type
- Percentages vary from utility to utility according to the characteristics of their customers
  - utilities with a large industrial base tend to have a higher percentage of baseload demand
  - those with a large residential base tend to have a higher percentage of peaking demand
- Rough breakdown:
  - baseload 60%, intermediate 15%, peaking 20%

Assigning Existing Resources

- SUFG then assigns existing generation to the three types according to age, size, fuel type, and historical usage patterns
- Purchased power contracts are assigned to type according to time period (annual or summer only) and capacity factor
- Power sales contracts are also assigned to type

Assigning Capacity Needs to Type

- Future resource needs by type are determined by comparing existing capacity to projected demand, while accounting for interruptible and buy through loads, as well as firm purchases and sales and retirement of existing units
- Breakdown of demand by type is not projected to change across the forecast horizon

NEMS Electricity Market Module

- Eleven fossil generation technologies
  - i.e., advanced clean coal with sequestration
- Two distributed generation technologies
  - baseload and peak
- Seven renewable generation technologies
  - i.e., geothermal
- Conventional and advanced nuclear
- Fifteen supply regions based on NERC regions and sub-regions

Optimization and Integrated Resource Planning

- Individual utilities may attempt to optimize their future capacity choices to find the least cost set of resources to meet future loads
- Demand-side options may be included to develop an Integrated Resource Plan

Further Information

- State Utility Forecasting Group
  - http://www.purdue.edu/dp/energy/SUFG/
- Energy Information Administration
  - http://www.eia.doe.gov/index.html