Load Forecasting for the NFAT

Wayne Simpson, PhD
Professor of Economics
University of Manitoba

Douglas Gotham, PhD
Director, State Utility Forecasting Group
Purdue University

Outline

- Standard Forecasting Approaches
- Review of the MH Load Forecast
- Response to MH Rebuttal and New Developments
- Summary and Conclusion

Standard Forecasting Approaches

- Top-down
  - Trend analysis
  - Econometric
- Bottom-up
  - Survey-based
  - End-use
- Hybrid

Trend Analysis

- AKA trend analysis or regression analysis.
- Relies solely on the historical load to project future load (does not account for causal factors).
- Easy to do but generally inaccurate, especially under changing circumstances.
- MISO considers this to be an unacceptable method.

Econometric

- Estimate the historical relationship between load and various factors.
- Use that relationship with projections of the factors to forecast load.
- Generally improved accuracy but has difficulty accounting for things that change the historical relationship (like efficiency standards).
- MISO considers this to be an acceptable method.

Survey-based

- AKA informed opinion.
- Use information regarding select customers' future plans as basis for the forecast.
- Will account for expected fundamental changes in demand from large users.
- A lack of reliable information tends to result in poor long-term accuracy.
- Lacks transparency.
- MISO considers this to be an unacceptable method.

End-use

- Total load is built up from the individual device level while tracking the number of devices at different ages and efficiencies.
- Addition of new devices and replacement of existing devices is estimated going forward.
- Forecast obtained by summing across all devices.
- Can directly capture changing efficiency standards.
- Data intensive and does not capture changes in customer behavior well.
- MISO considers this to be an acceptable method.

Hybrid

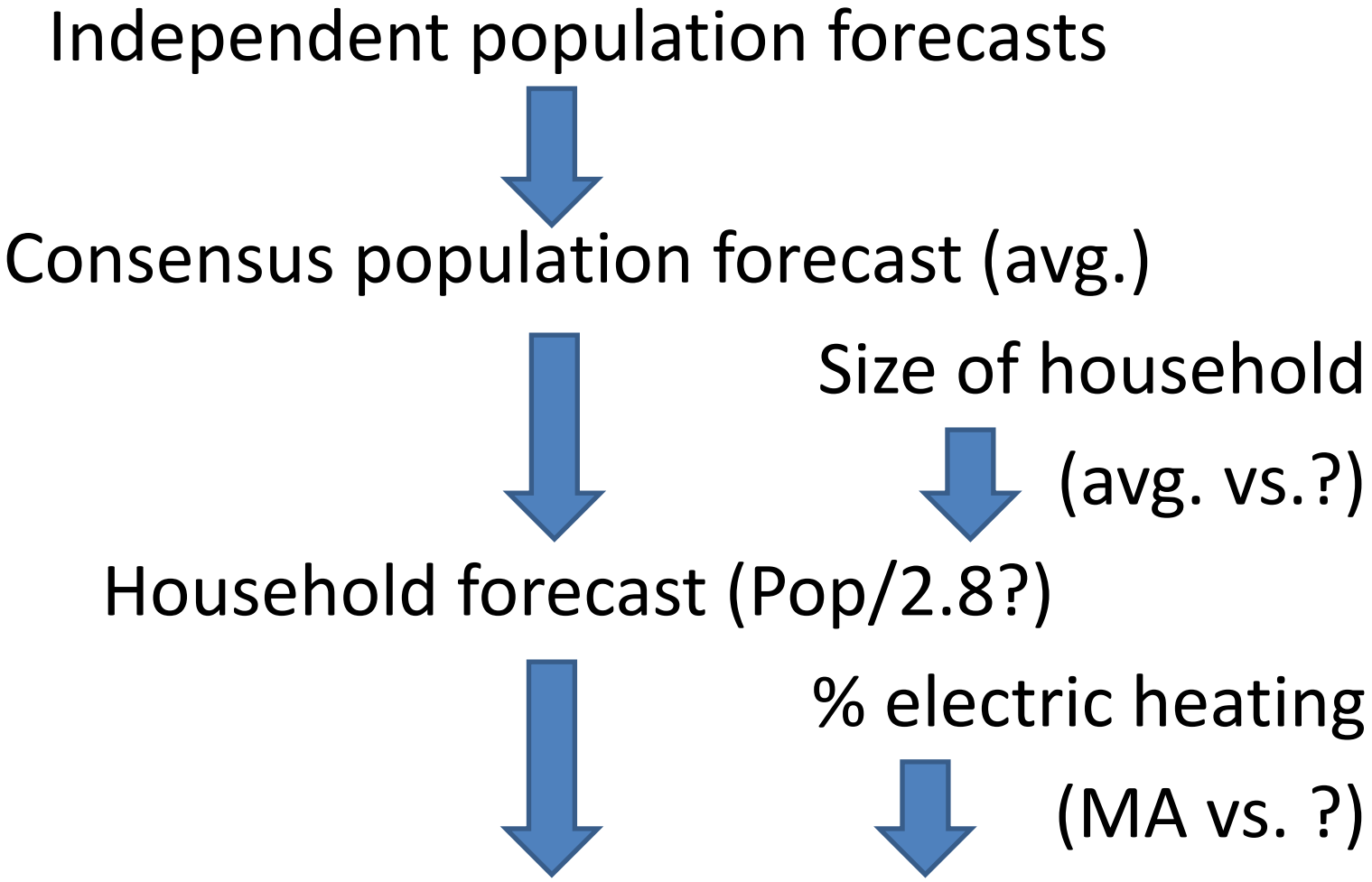
- Employ facets of both top-down and bottom-up approaches.
- Statistically-adjusted end-use (SAE) is most common.
- Attempts to combine the relative advantages of both types.
- Increased model complexity.
- MISO considers this to be an acceptable method.

Review of MH Forecast

NFAT Load Forecast: General Issues

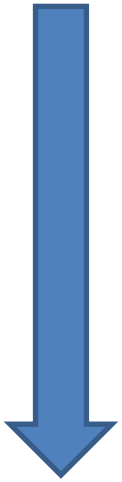
- A unified approach vs. a hybrid model of forecasting methods as in the NFAT
- Blend of approaches in hybrid model makes overall assessment complex, e.g. within-sample reliability (vs., say, a unified econometric approach)
- Is the NFAT load forecasting methodology clear? We found it difficult to understand at some points.
- Are the individual components of the blended forecast justified compared to standard alternatives, including a more unified approach? Unclear from the NFAT.

Residential Load Forecast



General Service Mass Market Forecast

Growth Forecast (Regression – Specification?
Justification?
Reliability?)



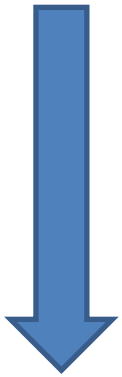
Electricity utilization
(MA vs. ?)

GSMM electricity demand forecast

Top Customer Forecast

MH Expert Assessments

- Not MISO standard (econometric or other)
  - consistent upward bias
  - Justification? reliability?



Top Customer electricity demand forecast

Trend vs. Volatility

- MH focus on weather (heating/cooling days) affects short-term volatility but less important than long-term trends e.g climate change …
- … but also population, GDP, energy prices
- Unclear how alternative population, GDP scenarios affect comparison of plans (Elenchus)

Consumer Demand for Electricity

- Economic theory and evidence suggests important factors are:
  - Income (GDP)
  - Population (per capita demand)
  - **Own Price (Real Price of Electricity)**
  - Prices of Close Substitutes and Complements (Other energy prices)
  - Other relevant factors e.g. weather?

Role of Prices in Load Forecasting

- “There are also linkages between electricity prices and demand. Lower power prices tend to spur demand and reduce the incentive for efficiency, which over time puts upward pressure on prices. Higher power prices, on the other hand, tend to do the opposite, spurring new supply and depressing demand, which in turn moderates those high power prices over time” (NFAT, ch.3, p.7)
- But no consideration of prices in MH/NFAT 2012 or 2013 load forecasts

Does Price of Electricity Matter?

- “The real electricity price is forecast to increase by 1.7% in 2013/14, and then increase by 2.0% per year throughout the rest of the forecast period” (NFAT, App.D, p.55)
- Implies an 80% increase in electricity prices above general price inflation over 30 years
- What impact?

Does Price of Electricity Matter?

- MH/NFAT says impact of price increases on customer demand will be zero or small
- No experience/data with price increases of this magnitude in Manitoba
- Evidence elsewhere suggests response is significant
  - Indiana since 2005
  - "Based on a review of these surveys, the numbers that come up most often are 0.2 for the short run elasticity, and 0.7 for the long run" (http://www.e3network.org/ElasticitySurvey2_matt.pdf)

Does Price Matter? Illustrative Calculation

- 0.5 long-run price elasticity for electricity, 80% price increase over 30 years

  → 40% reduction in load

- MH residential forecast: 1.6% load growth (1.2% due to population, 0.4% load growth due to usage)

  → 60% load growth (45% due to pop, 15% due to use) over 30 years (no price effects))

- 40% reduction in load (price effects)

  → 25% load decline (usage),
  20% load increase overall (1/3 of forecast)

Does Price Matter? Illustrative Calculation

- NFAT (ch.12, 2-3) projects load growth of 7.9 Gwh to 2031/32 of which ≈1/3 residential or 2.63 Gwh
- Price effect is to reduce load growth by ≈2/3 or 1.76 Gwh or reduce load growth by 4.2 yrs
- 2013 load forecast revisions reduce load growth by 3 years and defer need for new resources 1 year

  → residential price response alone

  (1/3 of load) would defer resources 1+ years

- General Service Mass Market, Top Customers (2/3 of load)?

Load Forecast Reliability

- Within sample reliability difficult (perhaps not impossible) to assess with blended approach compared to econometric approach
- Beyond sample reliability
  - Likely more important over 30 year horizon
  - Depends on reliability of projections for pop, income and sensitivity of load forecast to these projections (Elenchus)
  - Should also depend on projections for prices (2% p.a.) which could inflate load forecast and new system requirements significantly

MH Rebuttal Evidence and New Developments

Focus of Our Evidence

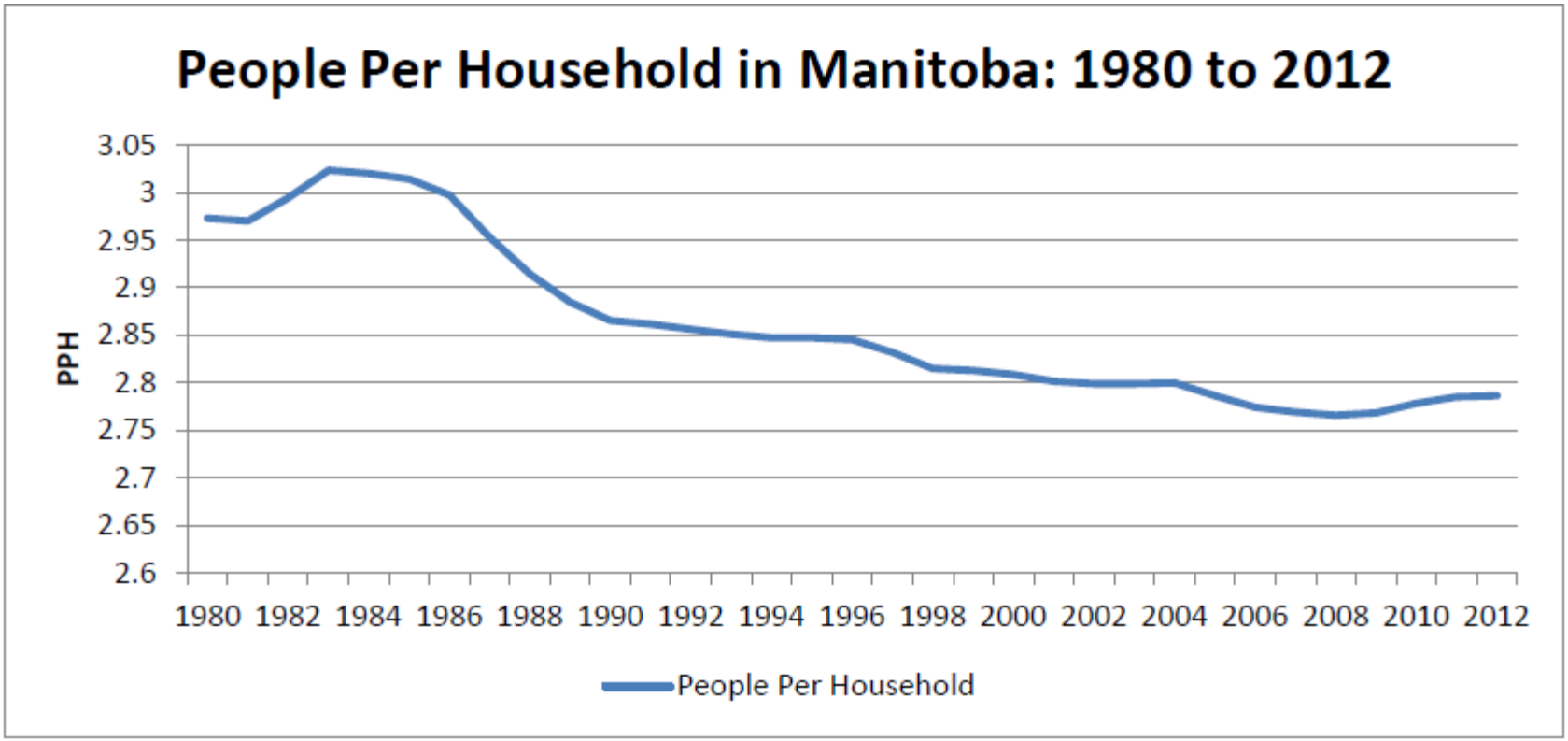
- Page 3, “The evidence of Elenchus and Drs. Simpson & Gotham focus their review on Manitoba load growth over the last ten years.”
  - This is untrue for us. Our evidence focuses on issues associated with the methodology, assumptions, and transparency. At no point in our evidence do we focus on Hydro’s recent load growth.

Manitoba Growth vs. Other Jurisdictions

- On page 5, in response to our concern over the projected load growth in light of other forecasts, Hydro presented an outdated table from the North American Electric Reliability Corporation (NERC) that had generally higher forecasts than the most recent version.
  - MH-94 provided the most recent version.

People per Household

- Page 8 provides the historical number of people per household



People per Household

- Page 9, “This trend has clearly demonstrated an overall decline and levelization of people per household to around 2.79.”
  - The levelization is not clear. What is clear is that it changes over time in response to some phenomena, which is why we state that a more analytically sound approach is appropriate.

People per Household

- Page 13, “Through the econometric model used to create the General Service Mass Market forecast, Manitoba Hydro has found a significant relationship between customer growth in the Residential Basic sector and growth in GDP to customer growth in the General Service Mass Market sector, and forecasts using this relationship.”
  - Since the number of residential customers is also an input to the General Service Mass Market forecast, it is even more important to have a reasonably good, analytically sound method of projecting the number of residential customers.

Average Use Per Dwelling

- Pages 10-11, paragraphs labeled 2 and 3 indicate that the percentage of dwellings using electricity for space and water heating is expected to increase, based on current trends.
  - These expectations are predicated on the Hydro assumption that the current trend (which was built on years of low electricity prices and high natural gas prices) will continue, even after electricity prices increase considerably.
  - MH-87, slide 82 indicates that MH will be considering DSM initiatives involving fuel switching.

Growth in Top Consumers

- Page 13, “Drs. Simpson and Gotham discount Manitoba Hydro’s use of “informed opinion” and “time series” in its forecast of Top Consumers on the basis that such approaches are deemed unacceptable under MISO’s list of forecasting methods (Simpson and Gotham, page 1).
  - The rebuttal attempts to defend the use of informed opinion forecasts in the short-term but does not address the use of a linear trend for the long-term, which is also unacceptable per MISO. Furthermore, Section 2.3.5.2 on the long term forecast only covers issues associated with the Elenchus report, not to any of our criticism.

Top Consumers

- Page 14, “This assessment is based upon only the most recent five year period and is dominated by the unexpected closure of one Top Consumer and by the recent economic downturn.”
  - The fact that the closure of one Top Consumer was unexpected goes to a major flaw in informed opinion forecasting. That is, very few consumers expect to fail.

Price Elasticity

- Page 19, “Manitoba Hydro has among the lowest electricity prices in North America. As outlined in Manitoba Hydro’s response to PUB/MH I-256, electricity prices have increased slowly at or close to the rate of inflation. As a result, the effect of price changes on customers’ use of electricity would have been largely overwhelmed by the effect of other factors that affect demand for electricity, such as population increases, economic growth, improvements in residential construction, appliance efficiency, and the underlying random year-to-year variation in load.”
  - This will no longer be true when the expected rate increases take place.

Price Elasticity

- Page 19, “In 2012, the model incorporating the Price of Gas/Price of Electricity ratio predicted a decline in the percentage of New Electric Heat customers to the total number of new customers while the price of natural gas continued to fall. However, the actual market penetration of electric heat billed homes increased in 2011 and 2012.”
  - Without knowing the specifics of the model used, it is not possible to know whether the model was truly appropriate. For instance, did they use (or consider using) lagged prices to account for the delay in customer perception of prices to catch up with the reality of prices?

Price Elasticity

- Page 20, “As well, price increases on higher starting prices, which result in a greater absolute expense to a consumer, may result in higher price elasticity than in jurisdictions with low and stable electricity prices.”
  - It could also result in lower price elasticity if the starting price is high enough. For areas with very high prices, most of the customer’s ability to adjust behavior has been squeezed out already, with only essential use left. At this point, there would be very little reaction to a price increase.

Price Elasticity

- MH-87, Slide 12 indicates that MH will consider incorporating price elasticity in the next forecast
  - It should be noted that the estimated impact (a reduction of 500-600 GWh) represents a price elasticity of less than -0.05 to -0.056, which is on the low end of what has been seen elsewhere
  - While it is understood that these numbers are not being proposed by MH, it should be noted that if the elasticity is higher, a greater reduction will occur.
  - For instance, a price elasticity of -0.4 (as was used in the export price modeling by The Brattle Group), would indicate a load reduction of about 4,000 GWh.

Forecast Accuracy

- Page 25, “Manitoba Hydro agrees that “a perfectly accurate forecast is unattainable”, and as such presents a forecast created to be a midpoint for the potential range of variability. The expectation is that there will be a 50% chance that actual growth will be higher than the forecast, and a 50% chance that it will be lower.”
  - In our opinion, they have failed to achieve a 50/50 forecast, especially with respect to the price elasticity issue. In order for this to be true, there would have to be an equal chance that the price elasticity would be either too high or too low, which is not the case here.

Summary

- MH's forecasting methodology lacks clarity and consistency, making it difficult to evaluate
- MH relies on non-standard methods for some components and overly simplistic assumptions for others
- Lack of price elasticity introduces an upward bias in the forecast