Ameren Illinois Company ("AIC")
Load Forecast for the period June 1, 2017 – May 31, 2022

Purpose and Summary

The creation of the load forecast is an essential step in the development of the IPA procurement plan for AIC. The load forecast provides the basis for subsequent analysis resulting in a projected system supply requirement. The load forecast process includes a multi-year historical analysis of loads, analysis of switching trends, and competitive retail markets by customer class, known and projected changes affecting load, customer class specific growth forecasts and an impact analysis of statutory programs related to energy efficiency and renewable energy. The results of this analysis and modeling include a 5 year summary analysis of the projected system supply requirements.

Load Forecast Methodology

The models developed for the June 1, 2017 – May 31, 2022 load forecast use econometric and the statistically adjusted end use (SAE) approaches. The traditional approach to forecasting monthly sales is to develop an econometric model that relates monthly sales to weather, seasonal variables, and economic conditions. The strength of econometric models is that they are well suited to identify historical trends and to project these trends into the future. In contrast, the strength of the end-use modeling approach is the ability to identify the end use factors that are driving energy use. By incorporating an end-use structure into an econometric model, the statistically adjusted end-use modeling framework exploits the strengths of both approaches. This SAE approach was used for all residential and commercial classes, while traditional econometric models were developed for the industrial and public authority classes. Lighting sales were forecasted by either exponential smoothing models or econometric models. Economic variables were obtained from Moody's Analytics. Saturation and efficiency data were obtained from EIA. Revenue month weather data was created using billing cycles and weighting daily average temperatures according to the billing cycles. After revenue month sales models were created, the models were simulated with calendar month weather (and calendar month days where applicable) to obtain the calendar month sales forecast.

Since the rate structure changed in 2007 and it was not possible to reclassify the historical data according to the new rates; therefore, modeling was done on each revenue class, i.e., residential, commercial, industrial, public authority and lighting. The next step in the energy forecast was to allocate the sales forecast into the delivery service rates. DS1 class is equivalent to residential class, and lighting sales are equivalent to DS5. Commercial, industrial and public authority sales were separated into the DS2, DS3A, DS3B and DS4 classes after calculating the shares of each delivery service class within a revenue class.

Residential SAE Model

The SAE modeling framework defines energy use in residential sector (USEy,m) in year (y) and month (m) as the sum of energy used by heating equipment (Heat$_{y,m}$), cooling equipment (Cool$_{y,m}$) and other equipment (Other$_{y,m}$). The equation for this is as follows:

$$Use_{y,m} = Heat_{y,m} + Cool_{y,m} + Other_{y,m} \tag{1}$$

Although monthly sales are measured for individual customers, the end-use components are not. Substituting estimates for the end-use elements gives Equation 2,

$$Use_{y,m} = a + b_1 \times XHeat_{y,m} + b_2 \times XCool_{y,m} + b_3 \times XOther_{y,m} + \varepsilon_{y,m} \tag{2}$$

where XHeat $_{y,m}$, XCool$_{y,m}$, and XOther$_{y,m}$ are explanatory variables constructed from end-use information, weather data, and market data. As shown below, the equations used to construct these X variables are simplified end-use models, and the X variables are the estimated usage levels for each of the major end use based on these models. The estimated model can then be thought of as a statistically adjusted end-use model, where the estimated slopes are the adjustment factors.

Constructing XHeat- Electric

Energy use by space heating systems depends on heating degree days, heating equipment share levels, heating equipment operating efficiencies, billing days, average household size, household income, and energy price. The heating variable is represented as the product of an annual equipment index and a monthly usage multiplier. That is,

$$XHeat_{y,m} = HeatIndex_y \times HeatUse_{y,m} \tag{3}$$

where XHeat$_{y,m}$ is estimated heating energy use in year (y) and month (m), HeatIndex$_y$ is the annual index of heating equipment, and HeatUse$_{y,m}$ is the monthly usage multiplier.

The HeatIndex is defined as a weighted average across equipment saturation levels normalized by operating efficiency levels. Given a set of fixed weights, the index will change over time with changes in equipment saturations (Sat) and operating efficiencies (Eff). Formally, the equipment index is defined as:

$$HeatIndex_y = StructuralIndex_y \, x \sum_{Type} Weight^{Type} \, x \, \frac{\left(Sat_y^{Type} \Big/ Efficiency_y^{Type} \right)}{\left(Sat_{05}^{Type} \Big/ Efficiency_{05}^{Type} \right)} \tag{4}$$

In the above expression, 2009 is used as a base year for normalizing the index. The ratio is equal to 1 in 2009. In other years, it will be greater than 1 if equipment saturation levels are above their 2009 level. This will be counteracted by higher efficiency levels, which will drive the index downward. The weights are defined as follows.

$$\text{Weight}^{\text{Type}} = (\text{Energy}^{\text{Type}}_{09} / \text{HH}_{09}) \times \text{HeatShare}^{\text{Type}}_{09}$$

(5)

$(\text{Energy}_{09}^{\text{Type}}/\text{HH}_{09})$ is the unit energy consumption of each end-use in 2009 according to EIA data adjusted for each service territory. $\text{HeatShare}_{09}^{\text{Type}}$ is the saturation levels for each heating end-use in 2009 multiplied by a structural index with base year 2009, which is a function of surface area and building shell efficiency.

$$\text{HeatShare}_{09}^{\text{Type}} = \text{Saturation}_{09}^{\text{Type}} \times \text{Structural Index}_{09} \qquad (6)$$

where

Structural Index$_y$ = (Building Shell Efficiency$_y$ x Surface Area$_y$) / (Building Shell Efficiency$_{09}$ x Surface Area$_{09}$) (7)

where

Surface Area = 892 + 1.44 x House Size (8)

The end-use saturation and efficiency trends are developed from Energy Information Administration (EIA)'s regional projections.

Heating system usage levels are impacted on a monthly basis by several factors, including weather, household size, income levels, prices and billing days. Since the revenue month heating degree days are used in the SAE index, HDD is not used as a separate variable in the model. The estimates for space heating equipment usage levels are computed as follows:

$$HeatUse_{y,m} = \left(\frac{BDays_{y,m}}{AvgBDays}\right) x \left(\frac{WgtHDD_{y,m}}{HDD_{09,7}}\right) x \left(\frac{Income_{y,m}}{Income_{09,7}}\right)^{0.20} x \left(\frac{HHSize_{y,m}}{HHSize_{09,7}}\right)^{0.25} x \left(\frac{Elec\,Price_{y,m}}{Elec\,Price_{09,7}}\right) x \left(\frac{Gas\,Price_{y,m}}{Gas\,Price_{09,7}}\right)$$

(9)

where Price$_{y,m}$ is the average residential real price of electricity in year (y) and month (m), Price$_{09}$ is the average residential real price of electricity in 2009, HHIncome$_{y,m}$ is the average real income per household in a year (y) and month (m), HHIncome$_{09}$ is the average real income per household in 2009, HHSize$_{y,m}$ is the average household size in a year (y) and month (m), HHSize$_{09}$ is the average

household size in 2009, $HDD_{y,m}$ is the revenue month heating degree days in year (y) and month (m), and HDD_{09} is the annual heating degree days for 2009.

Constructing XCool- Electric

To construct XCool index, the same procedures as in XHeat index are followed; the only difference is that cooling degree days are used instead of heating degree days.

Constructing XOther- Electric

Monthly estimates of non-weather sensitive sales can be derived in a similar fashion to space heating and cooling. Based on end-use concepts, other sales are driven by appliance and equipment saturation levels, appliance efficiency levels, average household size, real income, real prices, and billing days. The explanatory variable for other uses is defined as follows:

$$XOther_{y,m} = OtherIndex_y \times OtherUse_{y,m}$$

(10)

The methodology for constructing OtherIndex is the same as heating and cooling indices except for the fact that there is no weather variable used in this index.

Peak Forecast

The monthly peak forecast for AIC's eligible customer retail load was performed at the total Ameren Illinois level. Historical hourly data from 2010 to 2014 was collected.

Daily Peak Model

Daily peak models were obtained by combining actual past loads from a chosen model year with the monthly projections. For our model year, we used 2012 as it most closely resembled a "typical" year, where a typical year was determined from looking at historical load data. Each day in the projected year was matched based on calendar adjustments to a day in the model year. Holidays were matched to the same holiday in the model year, while non-holidays were matched to the nearest date with the same day of week to obtain the most similar daily shapes (Sunday 1/3 to Sunday 1/5, for example).

For each day in a given projected year, the daily load pattern for the corresponding day in the model year was adjusted by a ratio such that the totals for that month matched exactly with the monthly projections. The result is a model where daily shapes and peaks closely resemble those of a real historical year, with correct monthly totals.

Switching Trends and Competitive Retail Market Analysis

It is important to note in any discussion of retail switching the inherent difficulty in projecting future activity. AIC necessarily must make some assumption of future switching levels given that 16-111.5(b) of the PUA requires a five year analysis of the projected balance of supply and demand. In making these assumptions, AIC has utilized an extension of existing trends and their best judgment to arrive at the expected values. This was accomplished by first establishing the current trend line utilizing actual switching data by customer class for the post rate freeze period (January 2007 through April 2016). AIC then reviewed these trends and made adjustments using data associated with municipal aggregation contract expiration dates as well as qualitative judgment. The end result is a forecast characterized by flat switching for the balance of the planning horizon. Given the difficulties inherent with projecting switching, it is expected that subsequent switching projections for future planning periods could differ substantially, and thus will impact the projection of AIC power supply requirements for eligible retail customers. In addition, AIC has also developed additional switching scenarios that address high and low switching scenarios for this planning period.

Residential

As of June 1, 2016, there were 38 Alternative Retail Electric Suppliers (ARES) certified by the ICC and registered with Ameren. 27 ARES are certified by the ICC to supply both residential and non-residential load and 11 ARES are certified by the ICC to supply only non-residential load (including 6 that are Subpart E ARES). Residential switching has remained relatively flat over the last year and as of May 1, 2016, about 62% of residential usage of AIC was supplied by ARES (a small amount of RTP is included in this calculation since the IPA procurement plan pertains to utility fixed price load). AIC expects the amount of load supplied by ARES to remain flat across the planning horizon. Our expectation is driven in part by the vast majority of municipal aggregation contracts which were renewed after their recent expiration. In addition, our current plan year tariff price listed on pluginillinois.org suggests our price is similar to comparable ARES prices for individual customers.

In addition to the ARES options, residential customers may opt for real time pricing through a program administered for AIC by Elevate Energy. Since program inception in 2007 through 2013, participation in the program increased steadily. However, the impact of higher prices caused by the polar vortex resulted in a modest amount of customers leaving the program in search of fixed price options with Ameren Illinois or ARES. As of May 1, 2016, the real time pricing program accounts for approximately 1.3% of residential load.

AIC estimates that the combination of residential switching to ARES and real time pricing will be about 62% of energy by the end of the five year planning

period. But it should be noted that the variability in this forecast could be considerable and such variability could be driven by the aggressiveness of ARES marketing campaigns, the fate of municipal aggregation initiatives going forward, customer response and perhaps most importantly, the headroom between ARES contracts and AIC fixed price tariffs. Due to the nature of a three year procurement cycle, forecasting switching is inherently difficult. During times of declining power prices, AIC's fixed tariff price will tend to be higher than the market rate, but in turn, during times of escalating power prices, one would expect AIC to have a lower tariff price than the current market rate. Our expected forecast predicts a flat trend across the planning horizon. A more aggressive return to utility supply was included in our low switching scenario. Conversely, should the future AIC tariff price exceed what ARES can provide, a higher switching scenario is also possible and this scenario is illustrated by our high switching scenario. The resulting difference between the expected, high and low switching scenarios is substantial and while this is not an ideal situation for planning purposes, AIC believes it properly reflects the significant uncertainty over the planning horizon. While AIC believes the expected switching scenario is a reasonable assessment, the high and low switching scenarios could also occur. Therefore, in order to assist the IPA in its hedging efforts, AIC proposes that it monitor switching in the residential class and provide an updated residential switching forecast to the IPA in March 2017 (this is consistent with the protocol recommended and approved in prior IPA procurement plans). The IPA may wish to utilize this updated forecast for its final procurement quantities in the spring of 2017.

0-149 kW Non-Residential

This customer class has seen approximately 65% load switching since January 1, 2007 and switching has been relatively flat over the last year. Future switching patterns are difficult to predict due to uncertain market conditions. Similar to the residential class, we predict flat switching across the planning horizon. However, similar to the high and low scenarios for residential, alternative scenarios for small commercial are reflective of considerable uncertainty.

AIC estimates that switching in this class will be about 65% of load by the end of the five year planning period. However, the substantial difference between the expected, low and high switching scenarios previously described in the residential section also applies to this customer class and is reflective of significant uncertainty over the planning horizon.

150-399 kW Non-Residential

Effective May 1, 2014, all customers in this class are fully competitive and must receive supply from either ARES or AIC real time pricing.

Given this development, AIC assumes that none of this load is included in the eligible retail forecast (100% switching).

400-999 kW Non-Residential

This customer class is competitive and AIC therefore assumes none of this load is included in the eligible retail forecast (100% switching).

1,000 kW and Greater Non-Residential

This customer class is competitive and AIC therefore assumes none of this load is included in the eligible retail forecast (100% switching).

Street Lighting

Although a small part of the overall load, AIC estimated the quantity of switching for this class as well. Under the expected scenario, load switching for this class was held flat throughout the planning horizon and is estimated to be approximately 41% at the end of the five year period. Similar to forecasts for residential and small commercial, the low and high switching scenarios reflect uncertainty relative to the expected case.
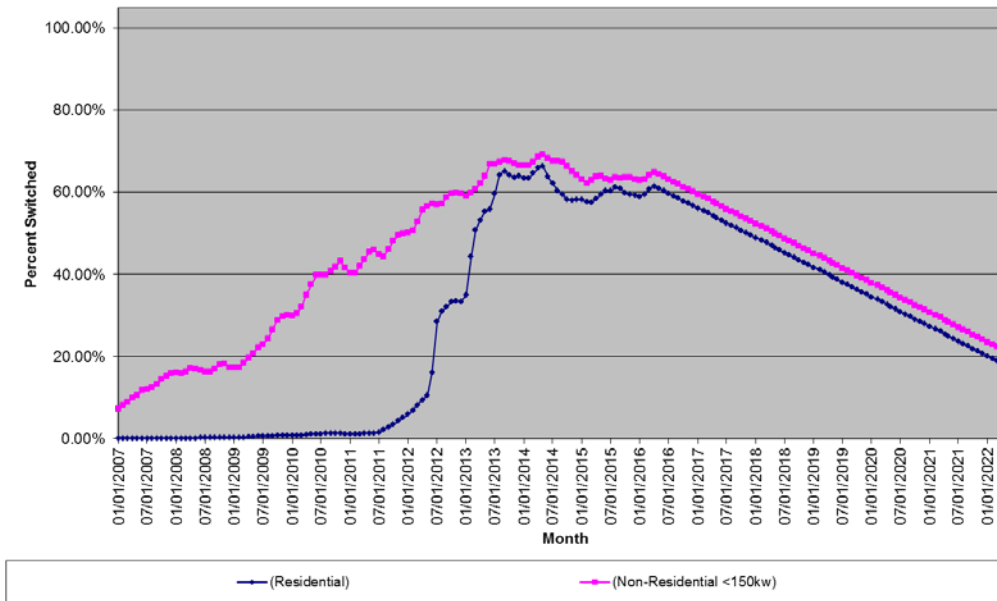
Switching Patterns

The AIC expected, low and high switching scenarios for residential and small commercial through May 31, 2022 are included in the graphs below (update graphs):
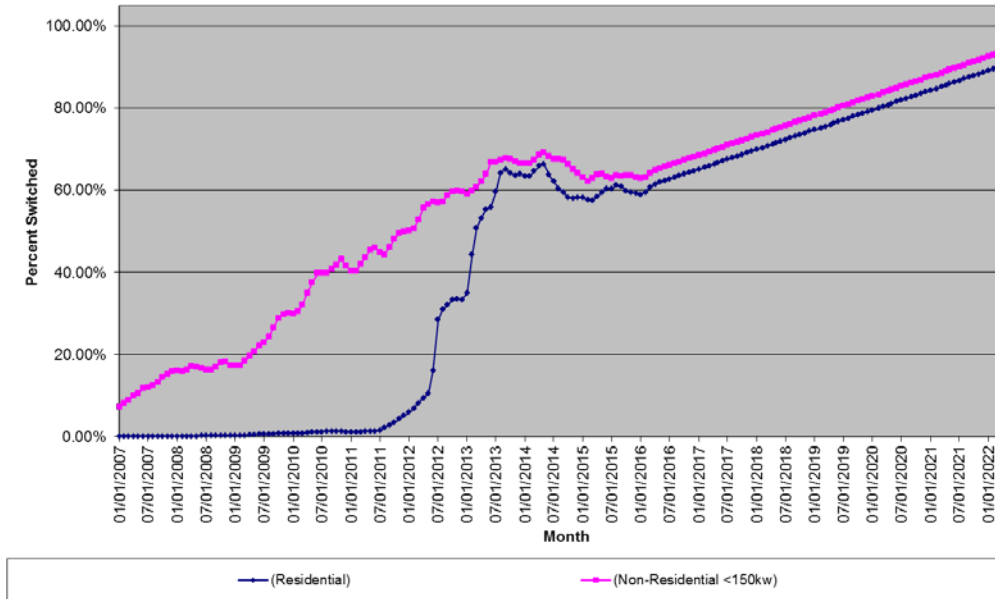
Expected Switching Forecast (Actual through April 2016)
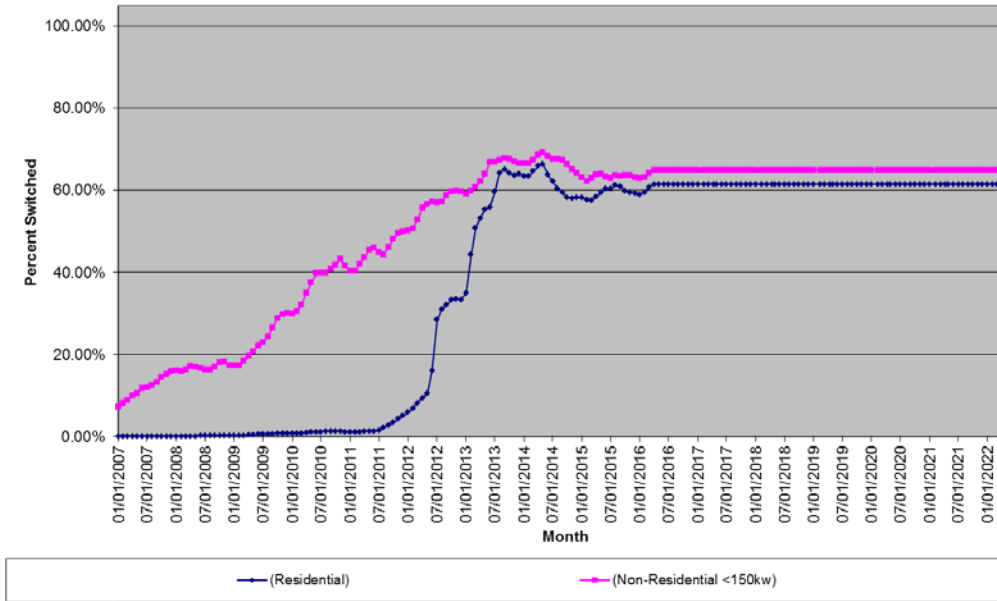
Low Switching Forecast (Actual through April 2016)

High Switching Forecast (Actual through April 2016)

Known or Projected Changes to Future Loads

Known or projected changes to future loads include:

1)   Customer switching estimates as previously discussed.
2)   Potential incremental Energy Efficiency initiatives as discussed below.

Growth Forecasts by Customer Class

For the residential electric customer class, Ameren Illinois currently projects a 5-year Compound Annual Growth rate of -0.1%.   Commercial growth rates for Ameren Illinois are projected to be 0.7% due to a major DS4 Customer expansion. Industrial sales are forecasted to remain flat over the forecast horizon.

Impact of Energy Efficiency on Power Supply Forecast:
Existing Energy Efficiency Programs

Please reference the AIC EE 2017 IPA Submission documents for more detailed information. There is no impact from *existing* energy efficiency programs for PY10/2017 as no programs under Section 5/8-103 or Section 5/16-111.5B have been approved by the Commission at this point.

Impact of Energy Efficiency Codes & Appliance Standards

The AIC procurement plan forecast utilizes a statistical adjusted end use (SAE) model approach for the residential and commercial classes. The SAE modeling framework defines energy usage as the sum of energy used for heating equipment, cooling equipment and other equipment. The other end use incorporates the impact of the new lighting standard as well as efficiency improvements across other household appliances.

The models are based on the Energy Information Administration's annual energy outlook. The information from EIA includes the following:

> Updated equipment efficiency trends
> Updated equipment and appliance saturation trends
> Updated structural indices
> Updated annual heating, cooling, water heating & Non-HVAC indices

Impact of Energy Efficiency on Power Supply Forecast:

Incremental Energy Efficiency Programs

Please reference the AIC EE 2017 IPA Submission documents in regards to the incremental energy efficiency impact should the IPA decide to continue programs in its procurement plan.

Capacity Forecast

Effective June 1, 2013, MISO implemented an *annual* capacity construct with zonal differences as compared to the *monthly* capacity construct with no zonal differences previously employed.

The current transmission losses assumed in the AIC forecast are 2.2% and the reserve assumptions are 7.6%. These values should be unchanged for the balance of the 2016 calendar year, but it is likely that these values will be updated by MISO prior to any 2017 procurement events. As in past procurement cycles, AIC will provide updated capacity quantities to the IPA once the revised transmission losses and reserves are published.