# Independent Load Forecast Workshop

July 28, 2014

# Topics

- Review of stakeholder comments
- Revised state econometric models
- Allocation factors to convert statewide annual energy to LRZ level annual energy
- Conversion from LRZ level annual energy to seasonal peak demand
- Next steps

# Stakeholder Comments

- We received a number of comments after the first workshop. If there are any questions regarding the responses to those comments, please let us know. If you have comments, questions, or concerns at any time, please let us know.

# Stakeholder Comments

- In some cases, we made adjustments to the models or approach based on the stakeholder comments
- In some cases, while the recommendation may have merit, we did not feel that we could implement it in Year 1 and will consider it in Year 2
- In some cases, we felt the recommended approach was not practical for some reason, such as lack of available data or insufficient resources

# Minnesota Weather Station

- SUFG's use of the St. Cloud weather station for the MN state model
  - We re-examined the proximity of the St. Cloud and St. Paul stations to the population center and agreed that St. Paul is more appropriate
  - We re-formulated the MN model using the St. Paul station.

# Revised State Models

- We made slight revisions to the following state econometric models
  - IL (change in population data source)
  - IA (change in population data source)
  - KY (change in population data source)
  - MN (change in weather station)

# Dependent and Explanatory Variables

| Variables | Eviews name | Data Source |
|---|---|---|
| ***Dependent variable:*** | | |
| **Electricity sales** | **ELECTRICITY_SALES** | **EIA** |
| ***Explanatory variables:*** | | |
| **Electricity prices** | **REAL_ELECTRICITY_PRICE** | **EIA*** |
| **Natural gas prices** | **REAL_NATURAL_GAS_PRICE** | **EIA*** |
| **Real personal income** | **REAL_INCOME** | **BEA*** |
| **Population** | **POPULATION** | **IHS Global Insight** |
| **Manufacturing employment** | **MANUFACTURING_EMP** | **BLS** |
| **Non-manufacturing employment** | **NON_MANUFACTURING_EMP** | **BLS** |
| **Non-farm employment** | **NON_FARM_EMP** | **BLS** |
| **Gross state product** | **REAL_GSP** | **BEA** |
| **Cooling degree days** | **CDD** | **NOAA** |
| **Heating degree days** | **HDD** | **NOAA** |

***** Original data was in nominal dollars. SUFG converted it to real 2005 dollars using state level CPI from IHS Global Insight.***

# New Illinois Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2012
Included observations: 23

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity at 2012 (weather at Means) |
|---|---|---|---|---|---|
| C | 57313.69 | 23795.24 | 2.408619 | 0.0276 | |
| @MOVAV(REAL_ELECTRICITY_PRICE,5) | -2960.353 | 732.7669 | -4.039966 | 0.0009 | -0.166134 |
| REAL_INCOME/POPULATION | 1117.896 | 381.7323 | 2.928482 | 0.0094 | 0.307317 |
| NON_MANUFACTURING_EMP | 0.007250 | 0.003488 | 2.078529 | 0.0531 | 0.260972 |
| CDD | 11.39225 | 1.531595 | 7.438161 | 0.0000 | 0.099273 |
| HDD | 2.500394 | 0.855162 | 2.923883 | 0.0095 | 0.099790 |

| | | | |
|---|---|---|---|
| R-squared | 0.988629 | Mean dependent var | 132802.6 |
| Adjusted R-squared | 0.985284 | S.D. dependent var | 10924.26 |
| S.E. of regression | 1325.211 | Durbin-Watson stat | 2.015528 |
| F-statistic | 295.5968 | | |
| Prob(F-statistic) | 0.000000 | | |

# Previous Illinois Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2012
Included observations: 23

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity at 2012 (weather at means) |
|---|---|---|---|---|---|
| C | 57564.28 | 23828.46 | 2.415779 | 0.0272 | |
| @MOVAV(REAL_ELECTRICITY_PRICE,5) | -2976.033 | 732.3127 | -4.063884 | 0.0008 | -0.167014 |
| REAL_INCOME/POPULATION | 1114.134 | 382.9021 | 2.909710 | 0.0098 | 0.306283 |
| NON_MANUFACTURING_EMP | 0.007244 | 0.003500 | 2.070016 | 0.0540 | 0.260752 |
| CDD | 11.41321 | 1.533661 | 7.441811 | 0.0000 | 0.099455 |
| HDD | 2.501311 | 0.857782 | 2.916023 | 0.0096 | 0.099827 |

| | | | |
|---|---|---|---|
| R-squared | 0.988580 | Mean dependent var | 132802.6 |
| Adjusted R-squared | 0.985221 | S.D. dependent var | 10924.26 |
| S.E. of regression | 1328.060 | Durbin-Watson stat | 2.014057 |
| F-statistic | 294.3155 | | |
| Prob(F-statistic) | 0.000000 | | |

# New Iowa Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2012
Included observations: 23

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity at 2012 (weather at means) |
|---|---|---|---|---|---|
| C | 15314.01 | 4720.060 | 3.244453 | 0.0048 | |
| REAL_ELECTRICITY_PRICE | -1649.176 | 354.3460 | -4.654139 | 0.0002 | -0.239605 |
| REAL_INCOME/POPULATION | 389.9282 | 159.4461 | 2.445518 | 0.0256 | 0.322735 |
| REAL_GSP | 0.152352 | 0.042107 | 3.618251 | 0.0021 | 0.431059 |
| CDD | 2.633157 | 0.670060 | 3.929732 | 0.0011 | 0.072200 |
| HDD | 0.719806 | 0.272836 | 2.638235 | 0.0173 | 0.113379 |

| | | | |
|---|---|---|---|
| R-squared | 0.992234 | Mean dependent var | 38922.22 |
| Adjusted R-squared | 0.989950 | S.D. dependent var | 5428.231 |
| S.E. of regression | 544.1910 | Durbin-Watson stat | 1.790356 |
| F-statistic | 434.3908 | | |
| Prob(F-statistic) | 0.000000 | | |

# Previous Iowa Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2012
Included observations: 23

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity at 2012 (weather at means) |
|---|---|---|---|---|---|
| C | 15371.50 | 4715.051 | 3.260093 | 0.0046 | |
| REAL_ELECTRICITY_PRICE | -1655.225 | 354.6526 | -4.667174 | 0.0002 | -0.240484 |
| REAL_INCOME/POPULATION | 390.9441 | 159.5598 | 2.450142 | 0.0254 | 0.323576 |
| REAL_GSP | 0.151856 | 0.042223 | 3.596505 | 0.0022 | 0.429654 |
| CDD | 2.632238 | 0.669726 | 3.930323 | 0.0011 | 0.072175 |
| HDD | 0.719842 | 0.272699 | 2.639696 | 0.0172 | 0.113385 |

| | | | |
|---|---|---|---|
| R-squared | 0.992241 | Mean dependent var | 38922.22 |
| Adjusted R-squared | 0.989959 | S.D. dependent var | 5428.231 |
| S.E. of regression | 543.9232 | Durbin-Watson stat | 1.791950 |
| F-statistic | 434.8220 | | |
| Prob(F-statistic) | 0.000000 | | |

# New Kentucky Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2012
Included observations: 23

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity at 2012 (weather at Means) |
|---|---|---|---|---|---|
| C | -74279.80 | 9960.544 | -7.457404 | 0.0000 | |
| @MOVAV(REAL_ELECTRICITY_PRICE,3) | -2326.018 | 474.2090 | -4.905047 | 0.0001 | -0.160187 |
| @MOVAV(REAL_NATURAL_GAS_PRICE,3) | 994.1832 | 234.2793 | 4.243582 | 0.0005 | 0.067771 |
| POPULATION | 0.035164 | 0.002071 | 16.97781 | 0.0000 | 1.729506 |
| CDD | 3.616164 | 1.596908 | 2.264478 | 0.0369 | 0.054171 |
| HDD | 2.931803 | 1.002025 | 2.925877 | 0.0094 | 0.164439 |

| | | | |
|---|---|---|---|
| R-squared | 0.982525 | Mean dependent var | 80805.80 |
| Adjusted R-squared | 0.977385 | S.D. dependent var | 9725.946 |
| S.E. of regression | 1462.621 | Durbin-Watson stat | 2.424052 |
| F-statistic | 191.1598 | | |
| Prob(F-statistic) | 0.000000 | | |

# Previous Kentucky Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2012
Included observations: 23

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity at 2012 (weather at means) |
|---|---|---|---|---|---|
| C | -73242.26 | 9984.345 | -7.335710 | 0.0000 | |
| @MOVAV(REAL_ELECTRICITY_PRICE,3) | -2333.131 | 477.3511 | -4.887662 | 0.0001 | -0.160677 |
| @MOVAV(REAL_NATURAL_GAS_PRICE,3) | 1010.142 | 235.3190 | 4.292652 | 0.0005 | 0.068859 |
| POPULATION | 0.034946 | 0.002073 | 16.85586 | 0.0000 | 1.718772 |
| CDD | 3.603448 | 1.607973 | 2.240987 | 0.0387 | 0.053980 |
| HDD | 2.915704 | 1.008896 | 2.889993 | 0.0102 | 0.163536 |

| | | | |
|---|---|---|---|
| R-squared | 0.982285 | Mean dependent var | 80805.80 |
| Adjusted R-squared | 0.977075 | S.D. dependent var | 9725.946 |
| S.E. of regression | 1472.608 | Durbin-Watson stat | 2.425481 |
| F-statistic | 188.5297 | | |
| Prob(F-statistic) | 0.000000 | | |

# New Minnesota Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2012
Included observations: 23

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity at 2012 (weather at means) |
|---|---|---|---|---|---|
| C | 9792.845 | 4056.166 | 2.414311 | 0.0273 | |
| @MOVAV(REAL_ELECTRICITY_PRICE,3) | -751.6947 | 298.6641 | -2.516857 | 0.0222 | -0.084335 |
| @MOVAV(REAL_NATURAL_GAS_PRICE,3) | 338.9010 | 131.5096 | 2.577005 | 0.0196 | 0.030419 |
| REAL_INCOME | 0.000217 | 8.69E-06 | 24.99242 | 0.0000 | 0.694308 |
| CDD | 5.226810 | 0.975240 | 5.359510 | 0.0001 | 0.068711 |
| HDD | 1.443649 | 0.310209 | 4.653789 | 0.0002 | 0.180303 |

| | | | |
|---|---|---|---|
| R-squared | 0.993427 | Mean dependent var | 59548.41 |
| Adjusted R-squared | 0.991494 | S.D. dependent var | 7398.364 |
| S.E. of regression | 682.3407 | Durbin-Watson stat | 1.818326 |
| F-statistic | 513.8751 | | |
| Prob(F-statistic) | 0.000000 | | |

# Previous Minnesota Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2012
Included observations: 23

| Variable | Coefficient | Std. Error | t-Statistic | Prob. | Elasticity at 2012 (weather at means) |
|---|---|---|---|---|---|
| C | 7388.648 | 4235.610 | 1.744412 | 0.0991 | |
| @MOVAV(REAL_ELECTRICITY_PRICE,3) | -654.4179 | 303.6498 | -2.155173 | 0.0458 | -0.073421 |
| @MOVAV(REAL_NATURAL_GAS_PRICE,3) | 453.7845 | 133.8691 | 3.389762 | 0.0035 | 0.040730 |
| REAL_INCOME | 0.000220 | 8.27E-06 | 26.56632 | 0.0000 | 0.703519 |
| CDD | 7.223193 | 1.357260 | 5.321893 | 0.0001 | 0.058357 |
| HDD | 1.405156 | 0.300272 | 4.679606 | 0.0002 | 0.198212 |

| | | | |
|---|---|---|---|
| R-squared | 0.993054 | Mean dependent var | 59548.41 |
| Adjusted R-squared | 0.991011 | S.D. dependent var | 7398.364 |
| S.E. of regression | 701.4585 | Durbin-Watson stat | 1.934167 |
| F-statistic | 486.0632 | | |
| Prob(F-statistic) | 0.000000 | | |

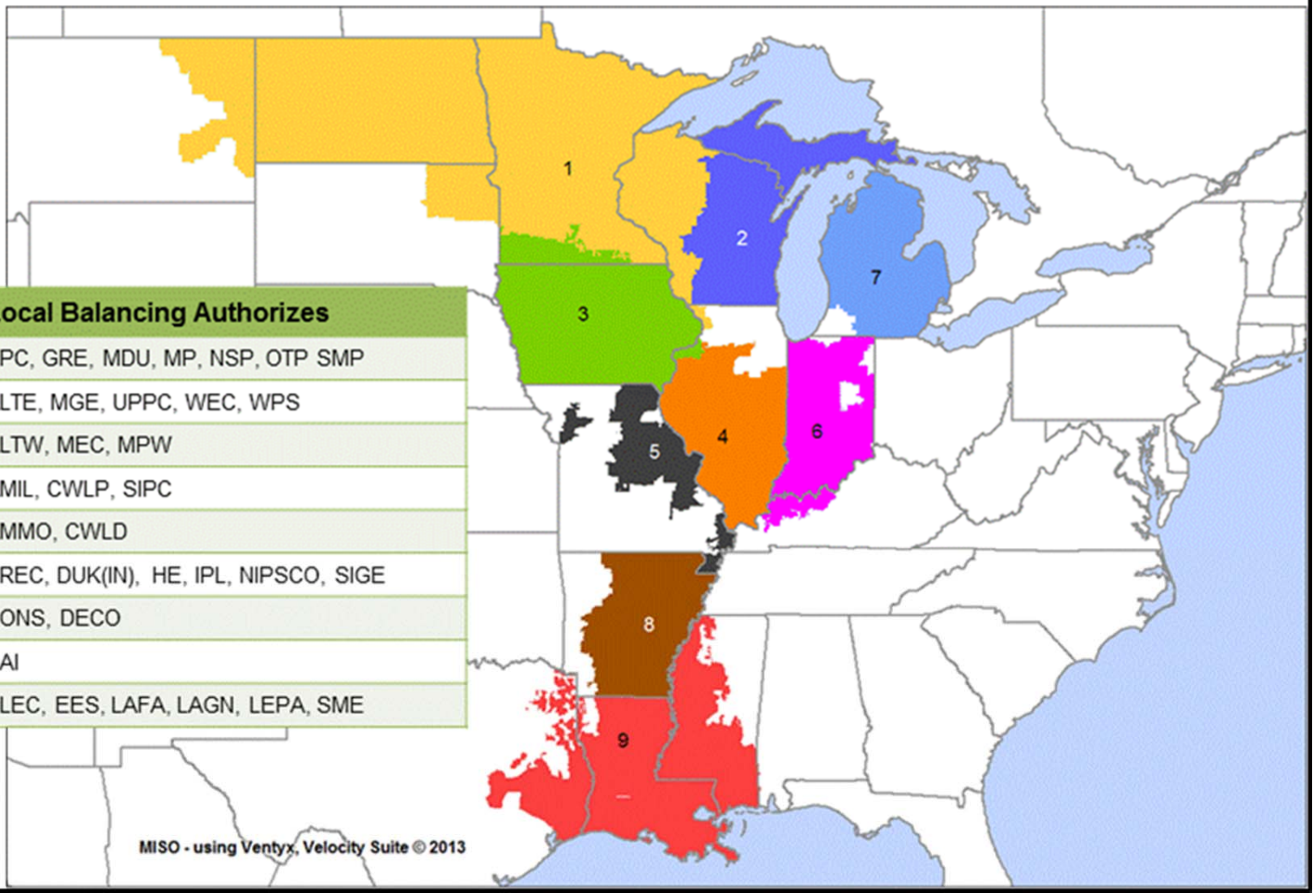
# Allocation Factors

- Using EIA-861 data, we allocated retail sales (MWh) in each state to one of the MISO LRZs or as non-MISO
- We looked for consistency and trends in the shares over time
- We also compared metropolitan statistical area economic projections to state-level projections where appropriate
- Indiana and Kentucky have been combined (as have Montana and North Dakota) at the request of MISO staff

# Unclassified Sales

- There are a handful of entities that either have no balancing authority listed in EIA-861 or list it as “Other”
  - Majority are retail power marketers in Texas
- We have classified those as non-MISO but have sought clarification
- We would be happy to provide the list to anyone that would like it
  - Let us know if any of them should be included
- We will adjust the allocation factors based on feedback on these sales

# 2014 Planning Year – MISO LRZ Map




| LRZ | Local Balancing Authorizes |
|---|---|
| 1 | DPC, GRE, MDU, MP, NSP, OTP SMP |
| 2 | ALTE, MGE, UPPC, WEC, WPS |
| 3 | ALTW, MEC, MPW |
| 4 | AMIL, CWLP, SIPC |
| 5 | AMMO, CWLD |
| 6 | BREC, DUK(IN), HE, IPL, NIPSCO, SIGE |
| 7 | CONS, DECO |
| 8 | EAI |
| 9 | CLEC, EES, LAFA, LAGN, LEPA, SME |

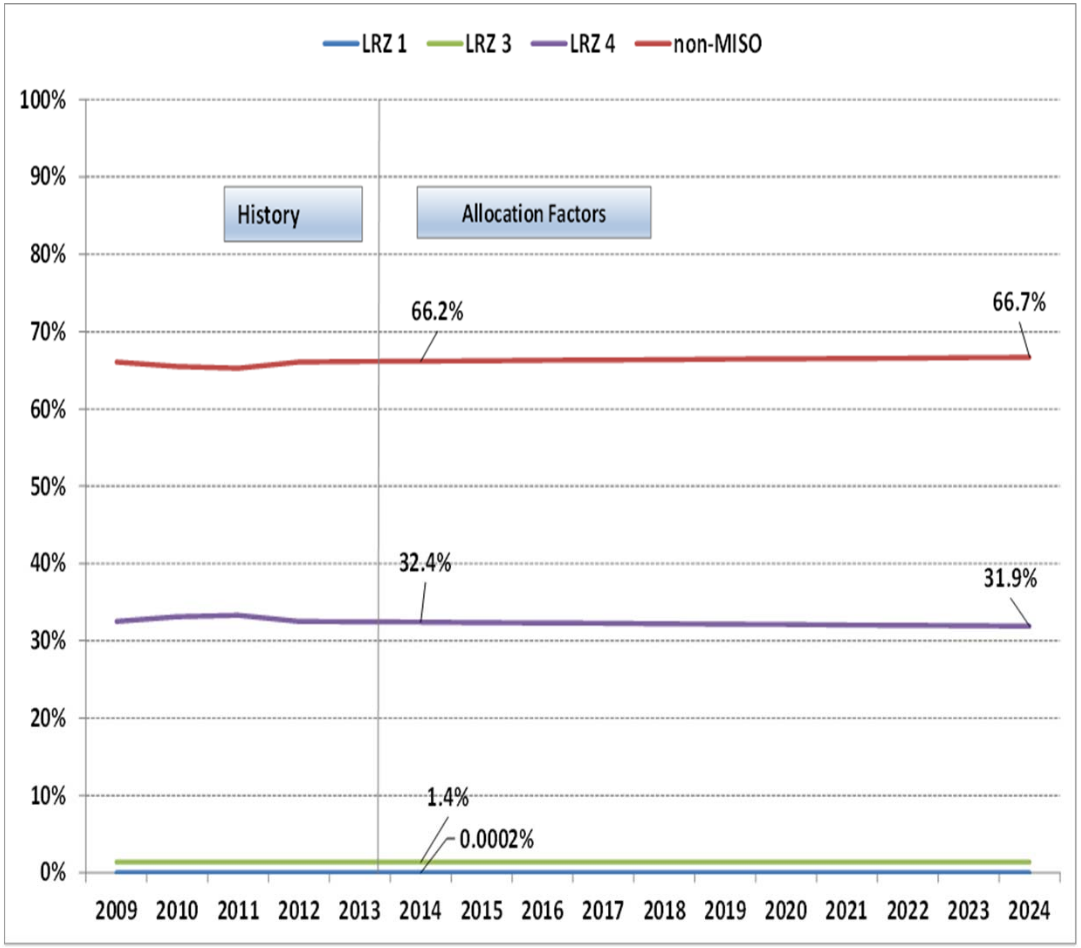
| MISO LRZ | State | State Level MISO Load (MWh) Fraction | | | | |
|---|---|---|---|---|---|---|
| | | Average | 2009 | 2010 | 2011 | 2012 |
| 1 | IA | ***1.8%*** | 1.8% | 1.8% | 1.8% | 1.7% |
| | IL | ***0.0002%*** | 0.0002% | 0.0002% | 0.0002% | 0.0002% |
| | MI | ***0.1%*** | 0.1% | 0.1% | 0.1% | 0.1% |
| | MN | ***94.8%*** | 94.8% | 94.8% | 94.9% | 94.8% |
| | ND+MT | ***33.7%*** | 32.9% | 34.0% | 34.5% | 33.3% |
| | SD | ***24.7%*** | 24.8% | 25.1% | 24.4% | 24.4% |
| | WI | ***14.8%*** | 15.0% | 14.8% | 15.1% | 14.4% |
| 2 | MI | ***4.9%*** | 4.3% | 5.2% | 5.3% | 4.9% |
| | WI | ***84.9%*** | 84.7% | 85.0% | 84.7% | 85.3% |
| 3 | IA | ***90.8%*** | 90.0% | 90.9% | 91.1% | 91.3% |
| | IL | ***1.4%*** | 1.4% | 1.4% | 1.4% | 1.4% |
| | MN | ***1.3%*** | 1.3% | 1.3% | 1.2% | 1.2% |
| | SD | ***1.8%*** | 1.8% | 1.9% | 1.8% | 1.8% |
| 4 | IL | ***32.9%*** | 32.5% | 33.1% | 33.3% | 32.5% |
| 5 | MO | ***49.6%*** | 48.8% | 49.7% | 49.5% | 50.3% |
| 7 | MI | ***90.2%*** | 90.1% | 90.3% | 90.0% | 90.4% |
| 8 | AR | ***66.6%*** | 66.1% | 66.8% | 66.7% | 66.7% |
| 6 | IN+KY | ***47.8%*** | 47.1% | 47.4% | 48.3% | 48.4% |
| 9 | LA | ***88.9%*** | 88.7% | 88.7% | 88.7% | 89.6% |
| | MS | ***43.7%*** | 43.9% | 44.2% | 43.6% | 43.1% |
| | TX | ***6.6%*** | 6.3% | 6.7% | 6.7% | 6.8% |

## ARKANSAS

The blue line represents the MISO LRZ8 share in AR and the red line for the non-MISO share. The variation in the historical share is moderate (between 66.1% and 66.8%). Therefore, the allocation factor is held at the average of the historical values (66.6%).

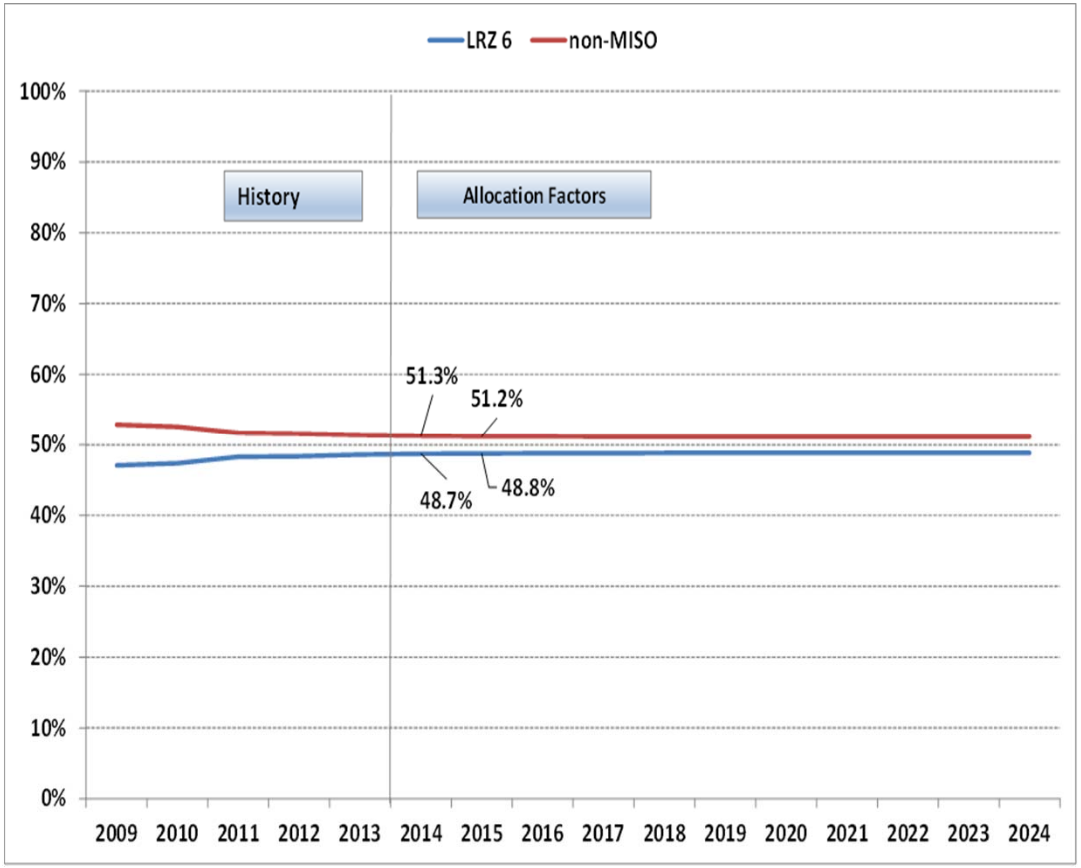
# ILLINOIS

Based on the projections of the values for the model drivers for the state of Illinois and for the Chicago metropolitan statistical area, the non-MISO region is projected to grow slightly faster than the MISO region. The allocation factors for LRZ 1 (0.0002%) and LRZ 3 (1.4%) are held constant at their historical values. The allocation factor for LRZ 4 declines from 32.4% to 31.9% over the 10-year period to reflect the declining portion of statewide sales in the MISO footprint.



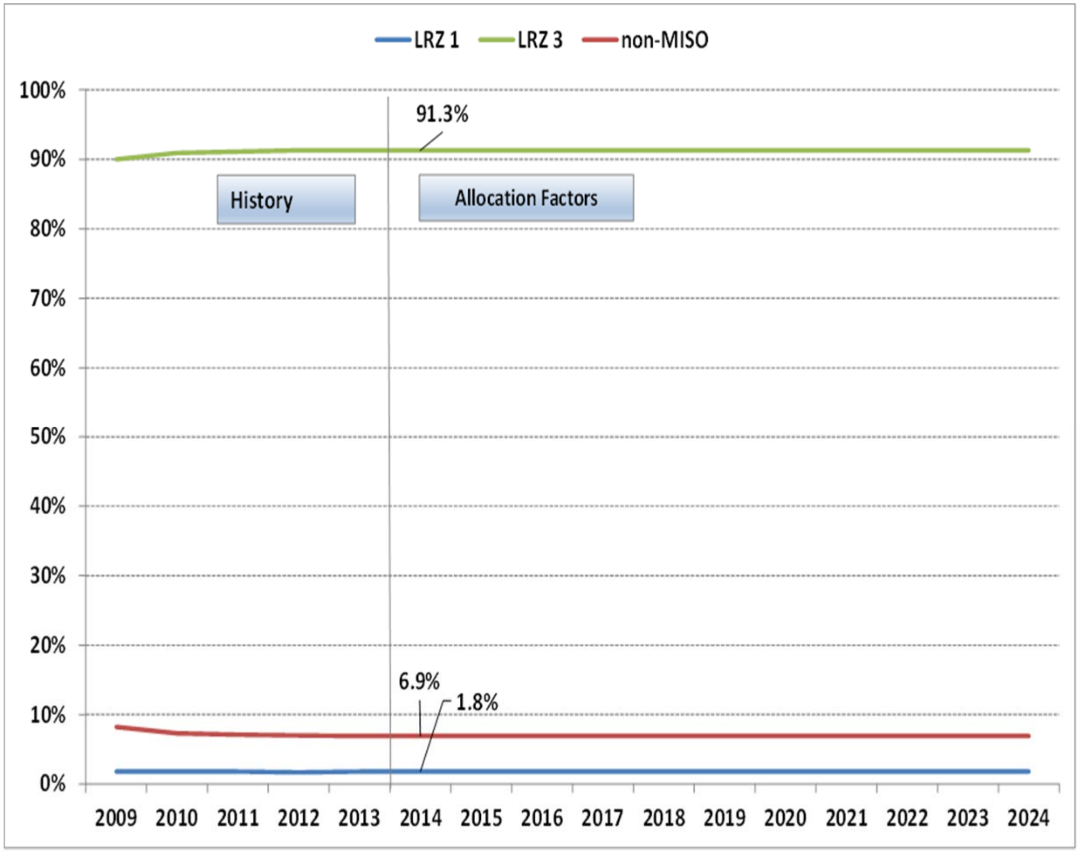
## INDIANA + KENTUCKY

The historical share in the MISO footprint has risen throughout the observations (from 47.1% to 48.4%). The allocation factor reflects that growth in the future, growing to 48.8% and then leveling off.



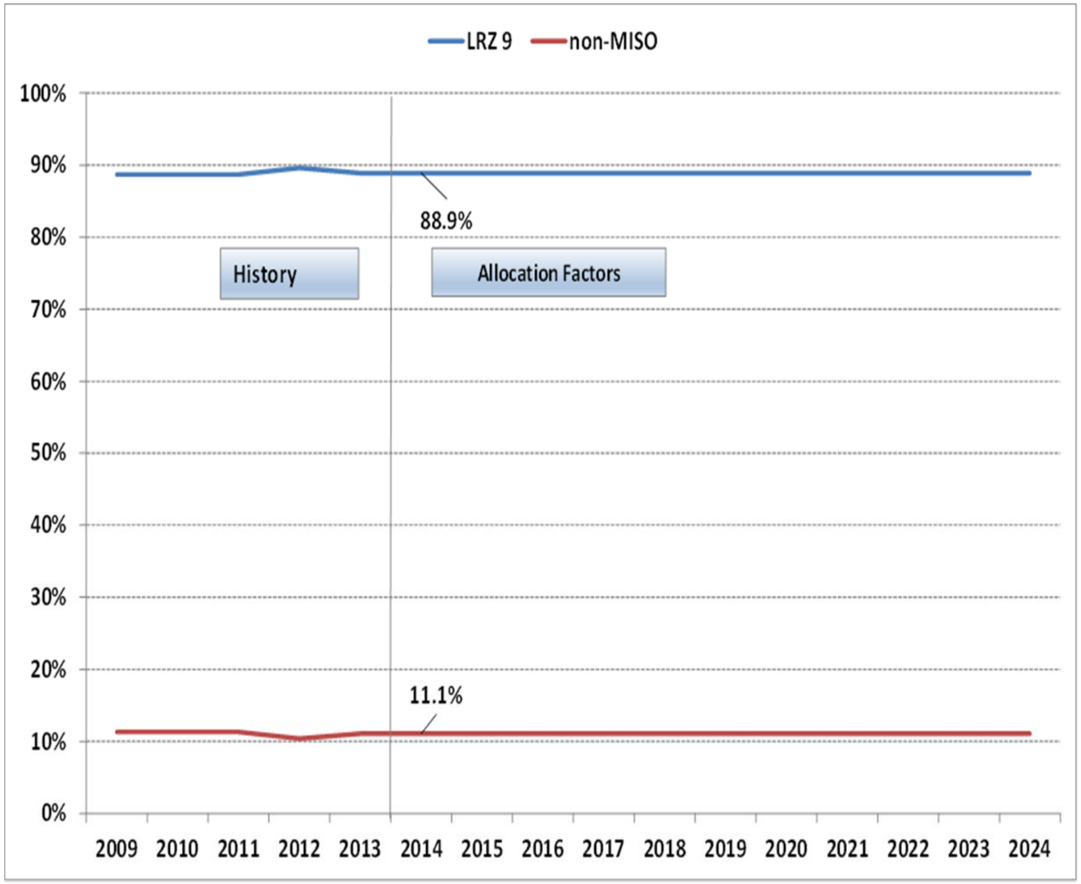
## IOWA

Historical values for LRZ 1 are all either 1.7% or 1.8%.  The allocation factor is held at the average of the historical values (1.8%). For LRZ 3, the 2009 value (90.0%) is lower than the others, which have little variation. The allocation factor is held at the last observed value (91.3%).



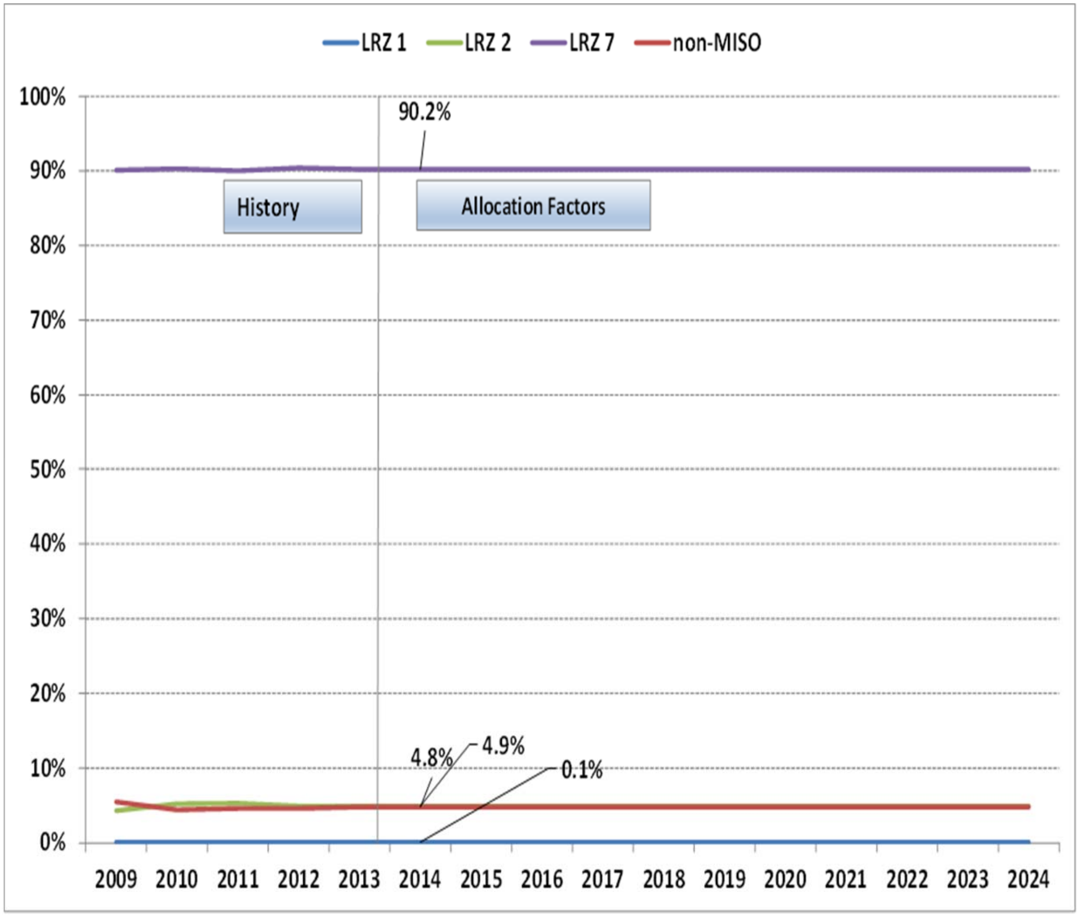
## LOUISIANA

The historical shares have been consistent with a slight increase in 2012. The allocation factor is held at the average of the historical values (88.9%).



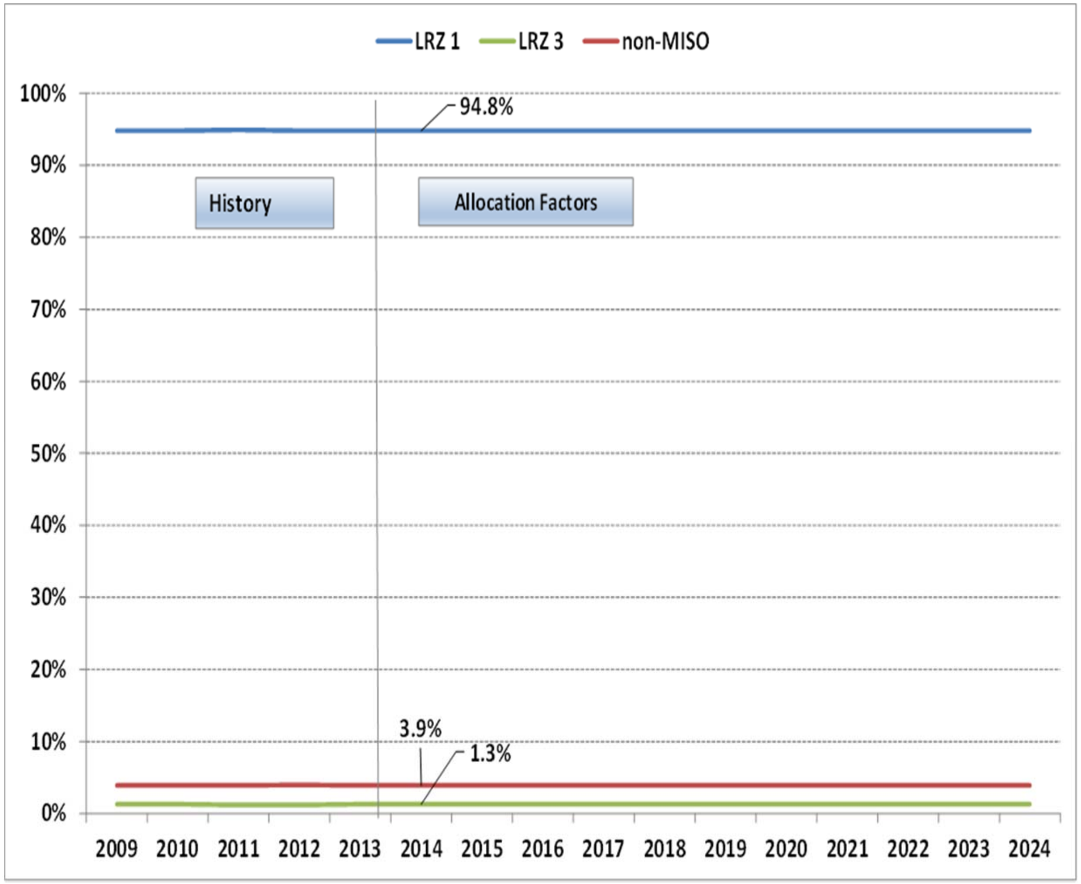
## MICHIGAN

LRZ 1 has had a constant share (0.1%) and is held constant at that level. LRZ 2 has been consistent since a lower level in 2009 (4.3%). The allocation factor is held constant at the last historical observation (4.9%). The variation in LRZ 7 has been low (between 90.0% and 90.4%). The allocation factor is held at the average of the historical values (90.2%).



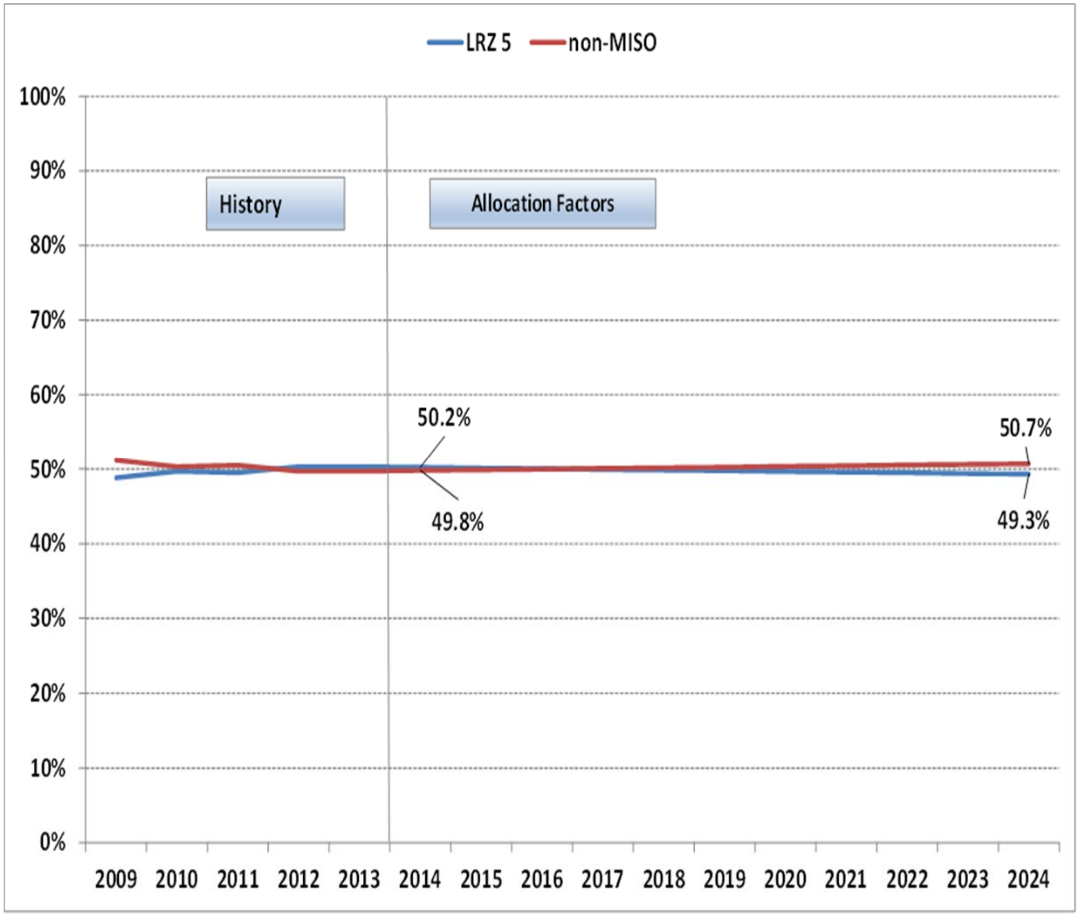
## MINNESOTA

The variation in LRZ 1 has been very low (between 94.8% and 94.9%). The allocation factor is held at the average of the historical values (94.8%). The variation in LRZ 3 has also been low (between 1.2% and 1.3%). The allocation factor is held at the average of the historical values (1.3%).



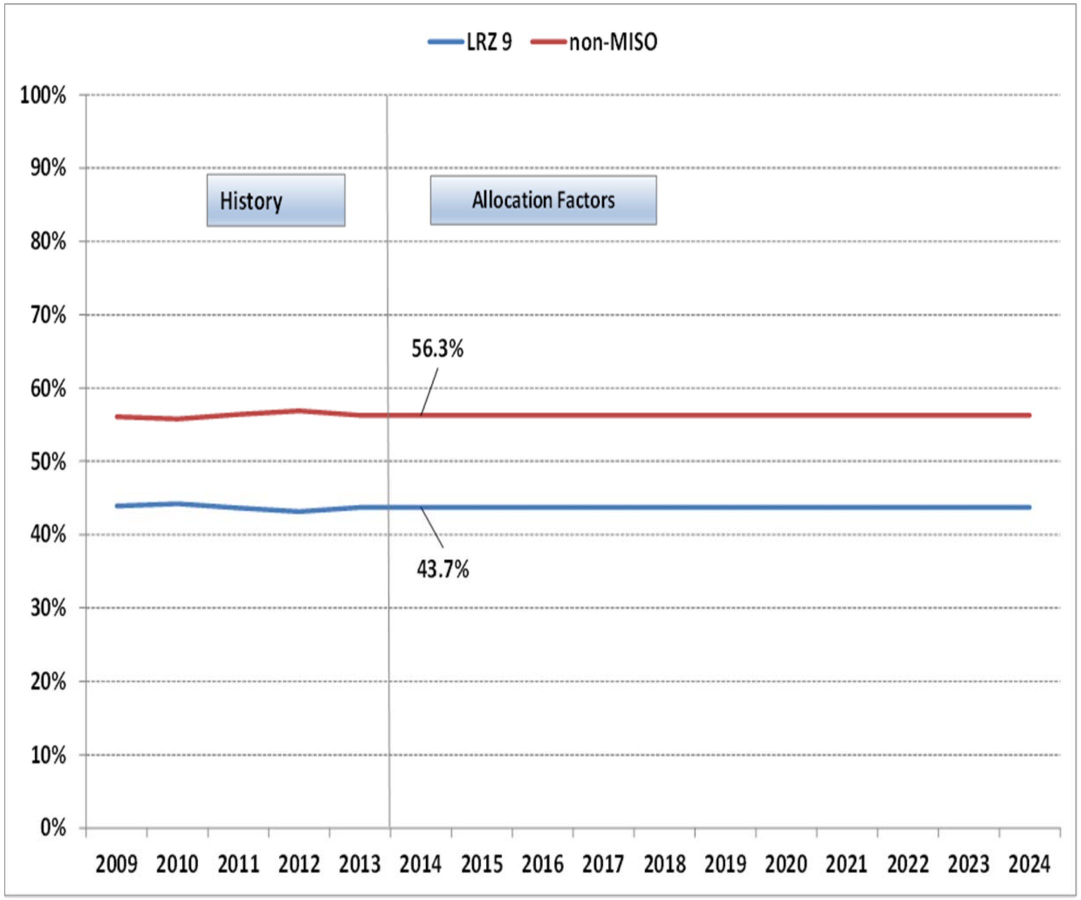
# MISSOURI

Based on the projections of the values for the model drivers for the state of Missouri and for the St. Louis metropolitan statistical area, the non-MISO region is projected to grow faster than the MISO region. The allocation factor for LRZ 5 declines from 50.3% to 49.3% over the 10-year period to reflect the declining portion of statewide sales in the MISO footprint.



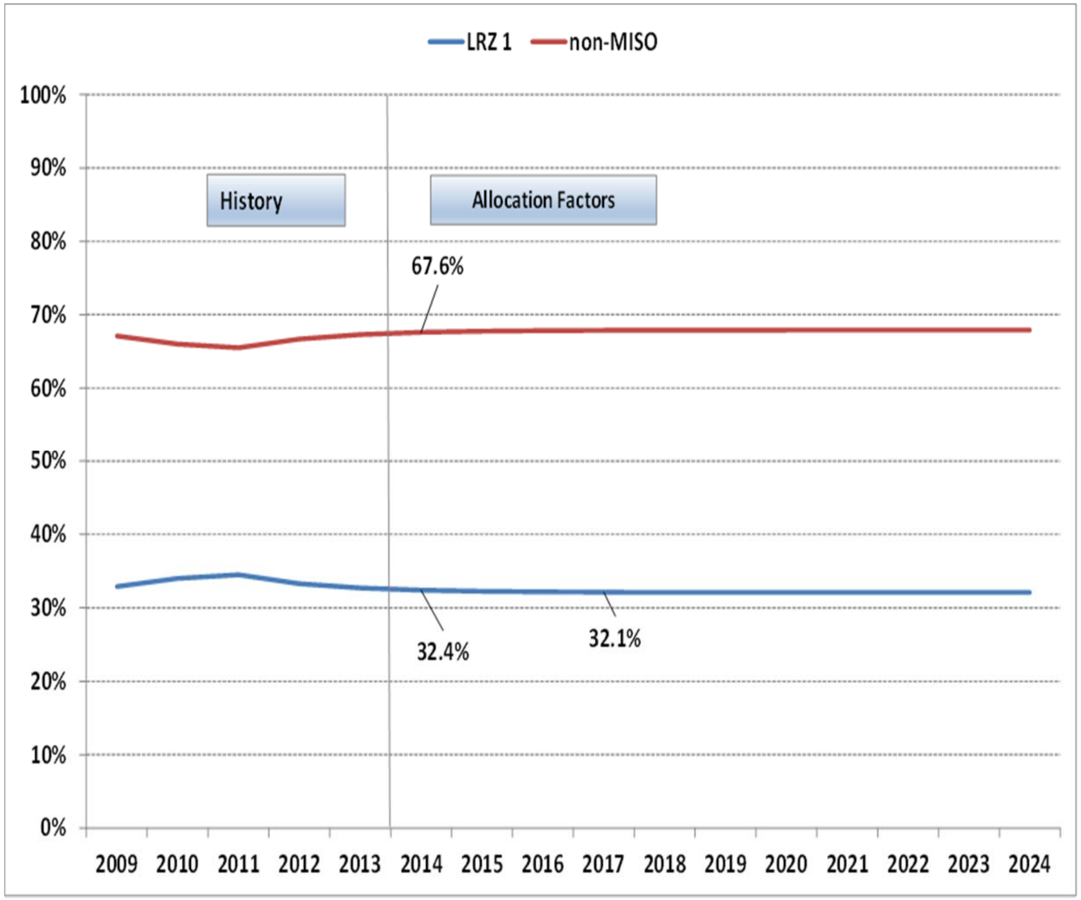
## MISSISSIPPI

While there is some variation in the historical share (between 43.1% and 44.2%), there is no consistent pattern of growth or shrinkage. The allocation factor is held at the average of the historical values (43.7%).



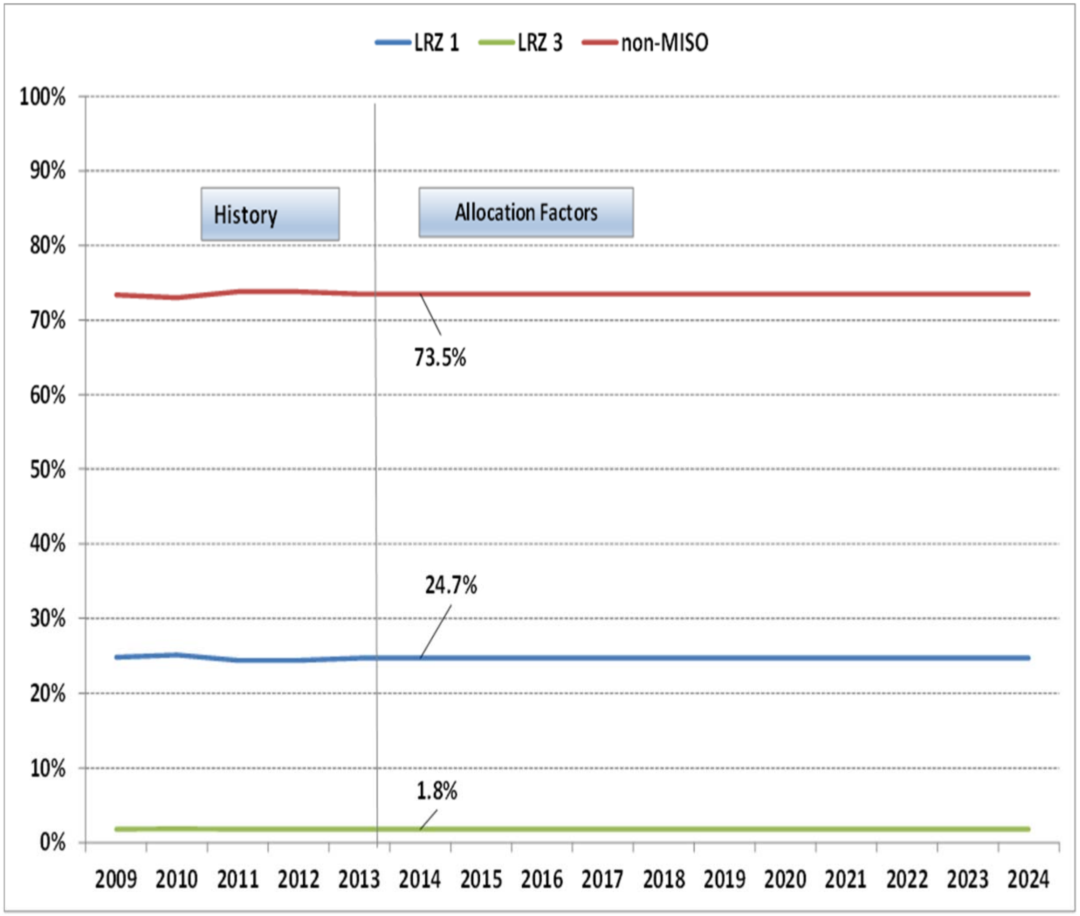
## MONTANA + NORTH DAKOTA

The share of sales in LRZ 1 dropped significantly in 2012 (from 34.5% to 33.3%) due to very strong growth in non-MISO utilities in the Bakken region. While strong growth is expected to continue in that region, the extreme growth (in excess of 50% in one year for some) is not expected to continue indefinitely. The allocation factor for LRZ 1 drops from the 2012 level to 32.1% before leveling off.



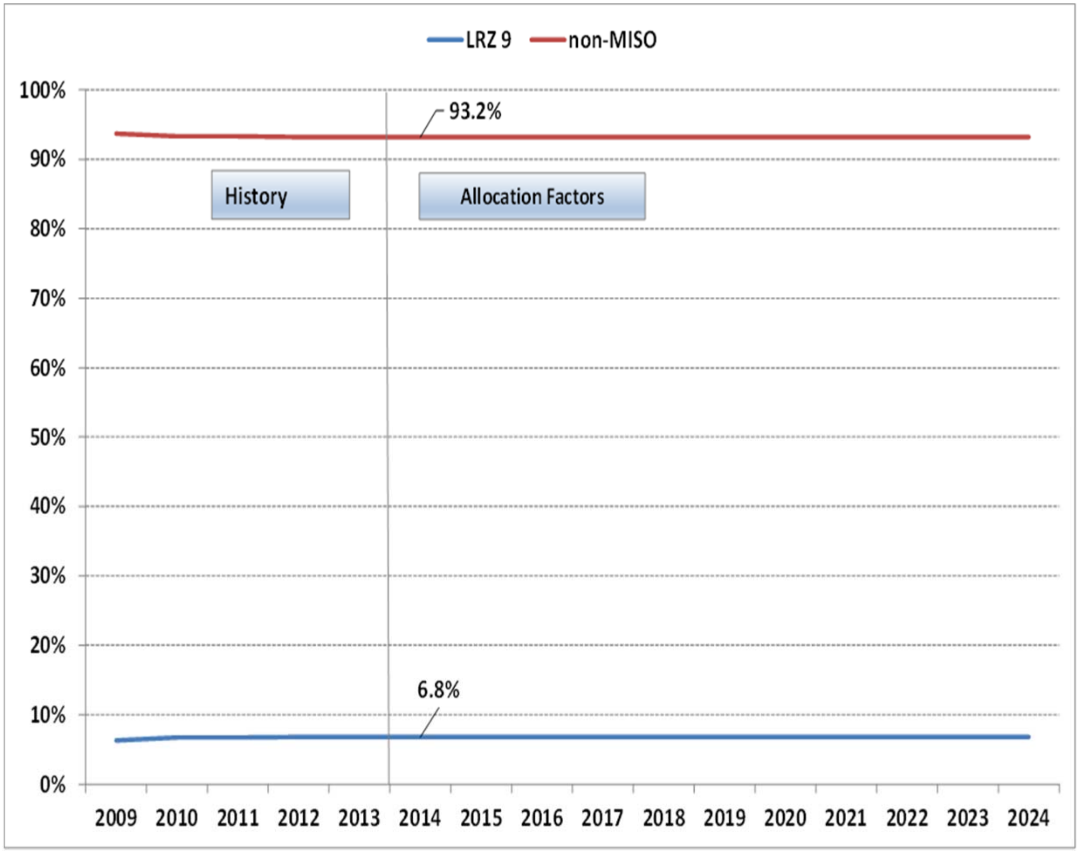
## SOUTH DAKOTA

The variation in the historical share of LRZ 1 is moderate (between 24.4% and 25.1%). The allocation factor is held at the average of the historical values (24.7%). The variation in the historical share of LRZ 3 is low (between 1.8% and 1.9%). The allocation factor is held at the average of the historical values (1.8%).



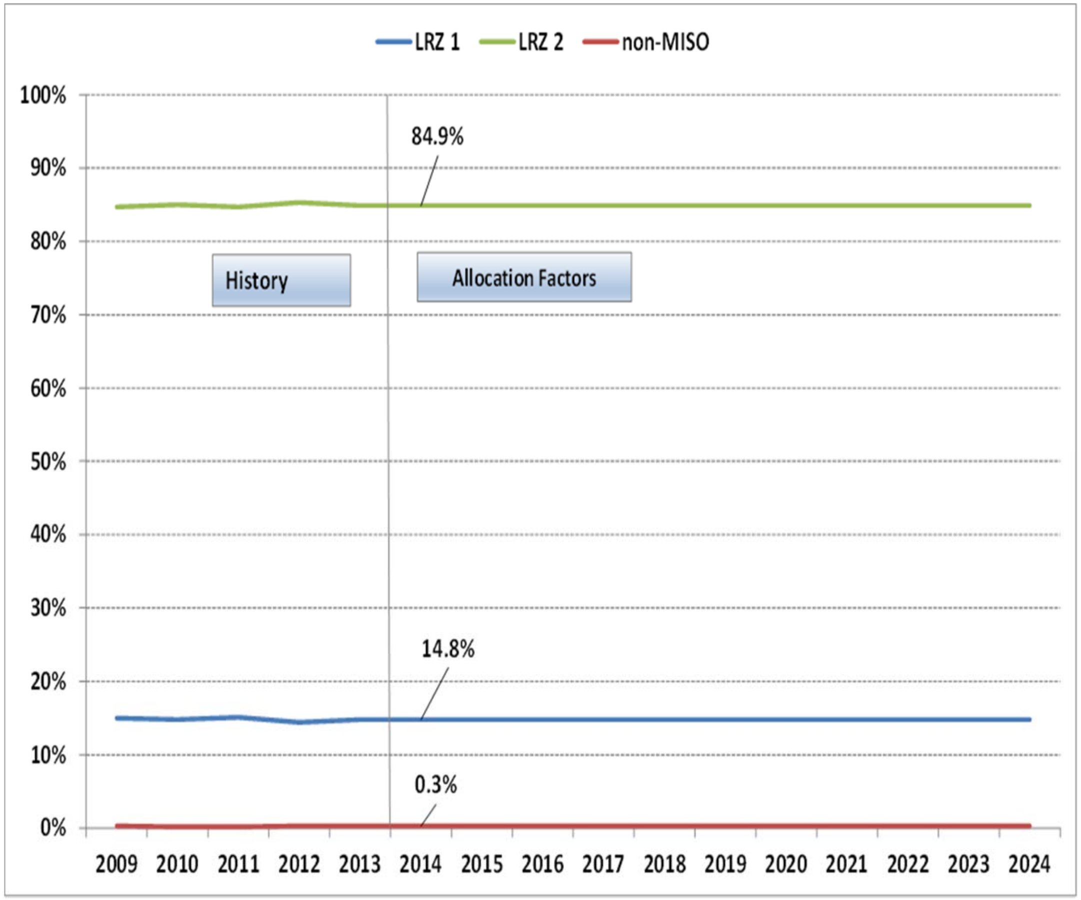
## TEXAS

The variation has been very low (between 6.7% and 6.8%) since a lower level in 2009 (6.3%). The allocation factor is held constant at the last historical observation (6.8%).



## WISCONSIN

The variation in the historical share of LRZ 1 is moderate (between 14.4% and 15.1%). The allocation factor is held at the average of the historical values (14.8%). The variation in the historical share of LRZ 2 is also moderate (between 84.7% and 85.3%). The allocation factor is held at the average of the historical values (84.9%).



| MISO LRZ | State | Allocation Factor | |
|---|---|---|---|
| | | Basis | Result |
| 1 | IA | *Historical average* | Constant at 1.8% |
| | IL | *Historical average* | Constant at 0.0002% |
| | MI | *Historical average* | Constant at 0.1% |
| | MN | *Historical average* | Constant at 94.8% |
| | ND+MT | *Historical trend* | Declining from 32.7% to 32.1% |
| | SD | *Historical average* | Constant at 24.7% |
| | WI | *Historical average* | Constant at 14.8% |
| 2 | MI | *Historical average* | Constant at 4.3% |
| | WI | *Historical average* | Constant at 84.9% |
| 3 | IA | *Last observed* | Constant at 91.3% |
| | IL | *Historical average* | Constant at 1.4% |
| | MN | *Historical average* | Constant at 1.3% |
| | SD | *Historical average* | Constant at 1.8% |
| 4 | IL | *Chicago vs. state growth* | Declining from 32.4% to 31.9% |
| 5 | MO | *St. Louis vs. state growth* | Declining from 50.3% to 49.3% |
| 7 | MI | *Historical average* | Constant at 90.2% |
| 8 | AR | *Historical average* | Constant at 66.6% |
| 6 | IN+KY | *Historical trend* | Increasing from 48.6% to 48.8% |
| 9 | LA | *Historical average* | Constant at 88.9% |
| | MS | *Historical average* | Constant at 43.7% |
| | TX | *Last observed* | Constant at 6.8% |

# Energy to Peak Conversions

- Determine historical relationships between annual energy, summer/winter peak demand, and weather conditions at the time of peak
- Estimate the historical peak demand weather conditions for earlier years to determine normal peak demand weather
  - We do not have hourly load data for earlier years
- Determine energy to peak demand conversion factors under normal peak demand weather

# Energy to Peak

- We looked at how extreme weather conditions (temperature and heat index) historically affects hourly demand (relative to average demand levels) for summer and winter for each LRZ.
- This provides a numerical estimation of demand as a function of weather.

# "Normal" Peak Weather Conditions

- We looked at hourly weather data for different stations within each LRZ
- We focused on hours when peak demands have occurred
  - not weekends or holidays
  - not night time
- Peak demand does not always occur on absolute max/min temperature
- Estimate the average weather conditions for peak demand

# General Observations

- Temperature was a better indicator of summer peak demand than heat index was
- Winter peak demand was more likely to occur at the minimum temperature in the southern LRZs than in the northern ones

# Determine Conversion Factors

- Using the relationship between peak demand and weather developed in the first step and the normal peak demand weather conditions in the second step, we determined the conversion factors under “normal” weather.

# Conversion Factors

- Multiply average hourly demand (annual demand divided by number of hours per year) to find summer/winter peak demand

| LRZ | Summer | Winter |
|---|---|---|
| 1 | 1.567 | 1.282 |
| 2 | 1.660 | 1.267 |
| 3 | 1.632 | 1.275 |
| 4 | 1.717 | 1.306 |
| 5 | 1.753 | 1.394 |
| 6 | 1.542 | 1.339 |
| 7 | 1.824 | 1.247 |
| 8 | 1.741 | 1.407 |
| 9 | 1.634 | 1.387 |

# Weather Stations for Peaks

| LRZ | Primary | Secondary |
|---|---|---|
| 1 | St. Paul, MN | Bismarck, ND; Fergus Falls, MN |
| 2 | Milwaukee, WI | Green Bay, WI; Marquette, MI |
| 3 | Des Moines, IA | Davenport, IA |
| 4 | Springfield, IL | Carbondale, IL |
| 5 | St. Louis, MO | |
| 6 | Indianapolis, IN | Evansville, IN; South Bend, IN |
| 7 | Lansing, MI | Grand Rapids, MI |
| 8 | Little Rock, AR | |
| 9 | Alexandria, LA | Houston, TX; Jackson, MS; New Orleans, LA |

# Next Steps

- Incorporate econometric model drivers (done)
- Run and evaluate state econometric models
- Adjust for energy efficiency
- Determine LRZ level energy and peak demand forecasts
- Determine MISO system energy and peak demand forecasts
- September workshop
- Develop forecast report