MISO Independent Load Forecast Stakeholder Workshop

July 23, 2015

STATE ECONOMETRIC MODELS UPDATE

Models

- We presented this year's state econometric models at the April workshop
- There was concern expressed by a stakeholder that the Louisiana model would not capture the load growth that is expected from the petrochemicals industry
  - If the economic projections for the GSP driver from IHS Global Insight reflects the growth in output, the forecast should capture that load growth

Louisiana Model

- The GSP elasticity is on the low end of the normal range, most likely because of the high levels of industrial self-generation in the state
  - Increasing GSP produces less growth in retail sales

Louisiana Model

Dependent Variable: ELECTRICITY_SALES
Method: Least Squares
Sample: 1990 2013
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Elasticity at 2013 (weather at means)
C	59374.89	8871.980	6.692406	0.0000	
@MOVAV(REAL_ELECTRICITY_PRICE,3)	-3588.096	532.2390	-6.741512	0.0000	-0.3074
REAL_GSP	0.141978	0.020493	6.928105	0.0000	0.3673
CDD	4.906066	1.772056	2.768573	0.0122	0.1871
HDD	3.945677	1.488811	2.650220	0.0158	0.0776

R-squared	0.960884	Mean dependent var	76559.79
Adjusted R-squared	0.952649	S.D. dependent var	6438.349
S.E. of regression	1401.006	Durbin-Watson stat	1.781461
F-statistic	116.6830		
Prob(F-statistic)	0.000000		

Change: per capita income and manufacturing employment have been replaced by GSP

Global Insight Projections

- GSP growth is only modest (2.03%)
- We spoke with Global Insight and this is because growth in the petrochemicals industry is partially offset by lower expected oil and natural gas production (due to low market prices)

Current Louisiana Model

- Using the current model with the Global Insight GSP forecast would not capture the shift in the state from an non-electric intensive industry (drilling) to an electric intensive one

Other Drivers

- Global Insight does show robust growth in manufacturing GSP (5.17%) and non-durables manufacturing GSP (5.65%), but we were unable to get a model that would accept those as a driver
- We were able to produce a model using non-mining GSP, but the elasticity was too low to produce a credible forecast

Options

- Use the current model with the GSP projections and produce a forecast that is likely too low
- Use the current model with a higher GSP projection to attempt to capture the shift in industries
- Other?

Kentucky (review)

- As discussed in the last workshop, the Paducah Gaseous Diffusion Plant (PGDP) closed in mid-2013, a large (3 GW) load on the TVA system
  - Accounted for more than 10% of the state's retail sales
- SUFG could not fit an econometric model with that drop in load

KY Load Adjustment

- We adjusted the 2013 historical load up to what it would have been with PGDP operational, developed the econometric model, then will subtract the PGDP load from the forecast
- We made the same adjustments when determining the allocation factor

ALLOCATION FACTORS

Assignment to LRZ

- Last year, we identified a number of utilities that did not have an LBA assignment in the EIA data and requested assistance in assigning those to either a MISO LRZ or as non-MISO
- We received some information but did not get full coverage
  - Unknowns were classified as non-MISO

This Year

- In the most recent EIA filing, a number of the unknowns had LBAs listed
- We worked with MISO to get a more accurate assignation of utility to LRZ
- We also discovered that very small portions of Oklahoma and Tennessee are served by MISO entities

New Assignments

State	Utility Name	Sales (MWh)
AR	City of Hope	280,429
AR	Riceland Foods Inc	33,463
IA	City of Graettinger	9,162
IL	University of Illinois	17,552
IN	Portside Energy Corp	288,491
MI	EQ-Waste-Energy Services Inc	450
MI	Midland Cogeneration Venture	444,323
MI	Alpena Power Co	338,060
MI	Michigan State University	855
MN	Melrose Public Utilities	102,749
MN	Koda Energy LLC	37,010
MN	Franklin Heating Station	157,795

State	Utility Name	Sales (MWh)
MN	City of Warroad	51,626
MN	Cleveland Cliffs Inc	643,755
MN	Olmsted County Public Works	5,398
MS	Dixie Electric Power Assn	791,976
ND	Dakota Valley Elec Coop Inc	561,023
ND	Northern Plains Electric Coop	404,277
SD	City of Flandreau	27,482
TX	E I DuPont De Nemours & Co	363,135
TX	SRW Cogeneration LP	2,126,331
WI	City of Medford - (WI)	123,157

Changed Assignments

State & Utility	LRZ Classification in 2014 Study	LRZ Classification in 2015 Study
MN		
Federated Rural Electric Assn	1	3
Nobles Cooperative Electric	1	3
TX		
Southwest Arkansas E C C	9	8
WI		
City of Bangor - (WI)	2	1
City of Boscobel	2	1
City of Medford - (WI)	2	1
City of New Richmond	2	1
City of River Falls	2	1
City of Westby	2	1
Dahlberg Light & Power Co	2	1
Superior Water and Light Co	2	1
Whitehall Electric Utility	2	1

- Mississippi LSEs were assigned to LRZ 9 in the 2014 study and are now assigned to LRZ 10

Feedback

- Any insight that could be provided on these assignments would be appreciated

Historical Percentages

LRZ	State	State Level MISO Load Fraction					
		Average	2009	2010	2011	2012	2013
1	IA	1.8%	1.8%	1.8%	1.8%	1.7%	1.8%
	IL	0.0002%	0.0002%	0.0002%	0.0002%	0.0002%	0.0002%
	MI	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	MN	96.8%	96.6%	96.7%	96.8%	96.9%	96.9%
	ND+MT	37.1%	36.0%	37.3%	37.9%	36.7%	37.5%
	SD	24.3%	24.6%	25.0%	24.3%	24.2%	23.5%
	WI	16.8%	16.9%	16.7%	16.9%	16.3%	17.1%
2	MI	4.9%	4.3%	5.2%	5.3%	4.9%	4.9%
	WI	83.2%	83.1%	83.3%	83.1%	83.7%	82.9%
3	IA	91.1%	90.3%	91.1%	91.3%	91.5%	91.1%
	IL	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
	MN	2.0%	2.1%	2.0%	2.0%	1.9%	1.9%
	SD	1.8%	1.8%	1.9%	1.8%	1.8%	1.8%
4	IL	32.9%	32.6%	33.1%	33.4%	32.5%	33.2%
5	MO	49.3%	48.6%	49.4%	49.2%	50.1%	49.3%
6	IN+KY	48.4%	47.3%	47.5%	48.5%	48.6%	49.9%
7	MI	90.9%	90.8%	90.7%	90.8%	91.2%	91.0%
8	AR	70.4%	70.0%	70.6%	70.4%	70.5%	70.5%
	MO	0.2%	0.3%	0.3%	0.2%	0.2%	0.2%
	TX	0.006%	0.006%	0.006%	0.006%	0.006%	0.006%
9	LA	91.9%	91.8%	91.8%	91.7%	92.1%	92.2%
	TX	5.7%	5.5%	5.7%	5.5%	6.0%	5.7%
10	MS	45.2%	45.6%	45.9%	45.2%	44.8%	44.7%

Changes of MISO State Level Load Fraction After Adjustments

State	2015 Estimates	2014 Estimates	Differences
AR	70.4%	69.7%	0.7%
IA	92.8%	92.8%	0.0%
IL	34.4%	34.3%	0.1%
IN+KY	51.3%	48.1%	3.2%
LA	91.9%	91.8%	0.1%
MI	96.0%	95.3%	0.7%
MN	98.7%	97.4%	1.3%
MO	49.6%	49.6%	0.0%
MS	45.2%	43.7%	1.5%
ND+MT	37.1%	33.7%	3.4%
SD	26.2%	26.5%	-0.3%
TX	5.7%	5.4%	0.3%
WI	100.0%	99.8%	0.2%

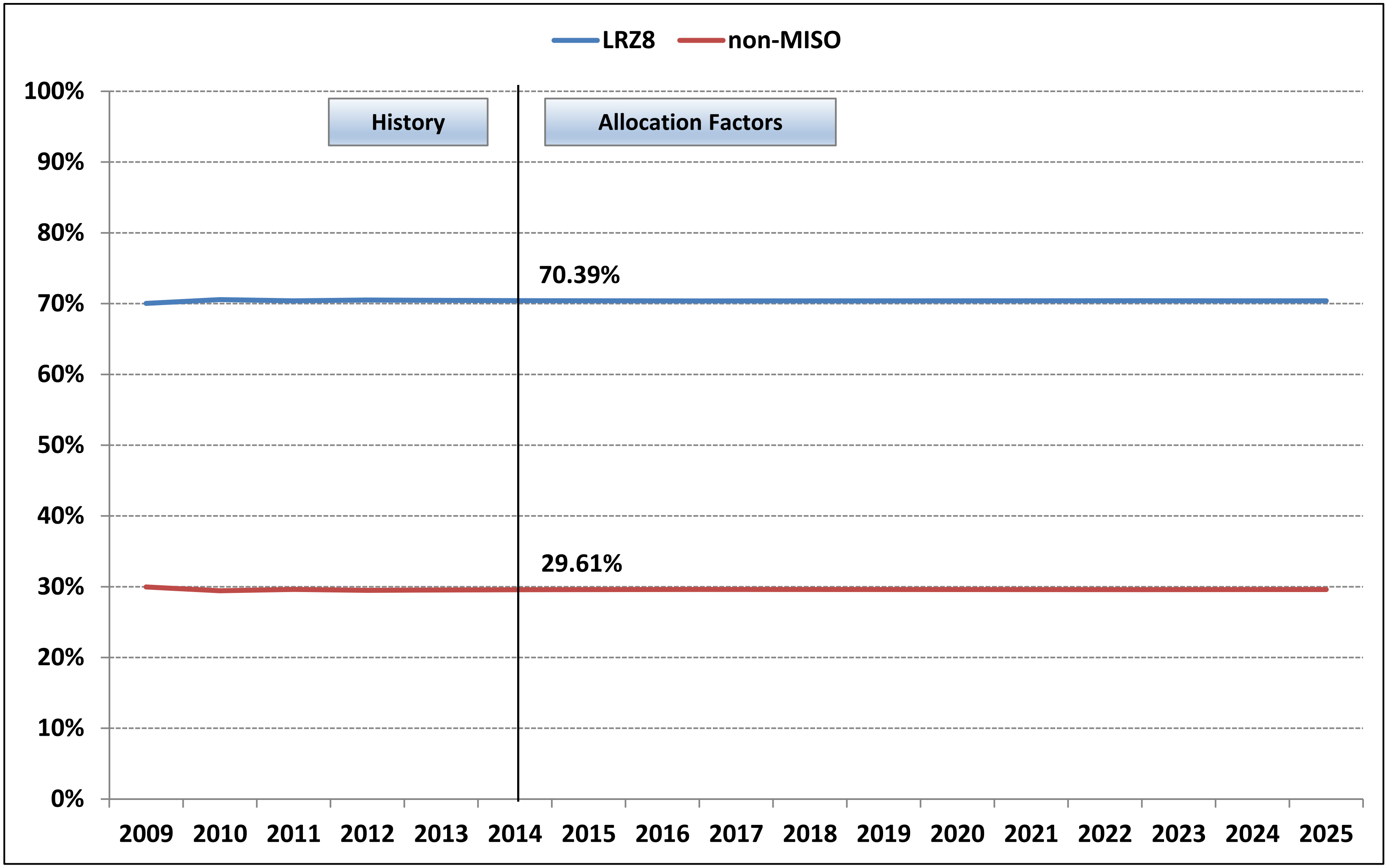
Changes of MISO LRZ Level Load Fraction After Adjustments

LRZ	State	2015 Estimates	2014 Estimates	Differences
1	IA	1.8%	1.8%	0.0%
	IL	0.0002%	0.0%	0.0%
	MI	0.1%	0.1%	0.0%
	MN	96.8%	96.1%	0.7%
	ND+MT	37.1%	33.7%	3.4%
	SD	24.3%	24.7%	-0.4%
	WI	16.8%	14.9%	1.9%
2	MI	4.9%	4.9%	0.0%
	WI	83.2%	84.9%	-1.7%
3	IA	91.1%	91.0%	0.1%
	IL	1.4%	1.4%	0.0%
	MN	2.0%	1.3%	0.7%
	SD	1.8%	1.8%	0.0%
4	IL	32.9%	32.9%	0.0%
5	MO	49.3%	49.3%	0.0%
6	IN+KY	51.3%	48.1%	3.2%
7	MI	90.9%	90.2%	0.7%
8	AR	70.4%	69.7%	0.7%
	MO	0.2%	0.3%	-0.1%
	TX	0.006%	N/A	N/A
9	LA	91.9%	91.8%	0.1%
	TX	5.7%	5.4%	0.3%
10	MS	45.2%	43.7%	1.5%

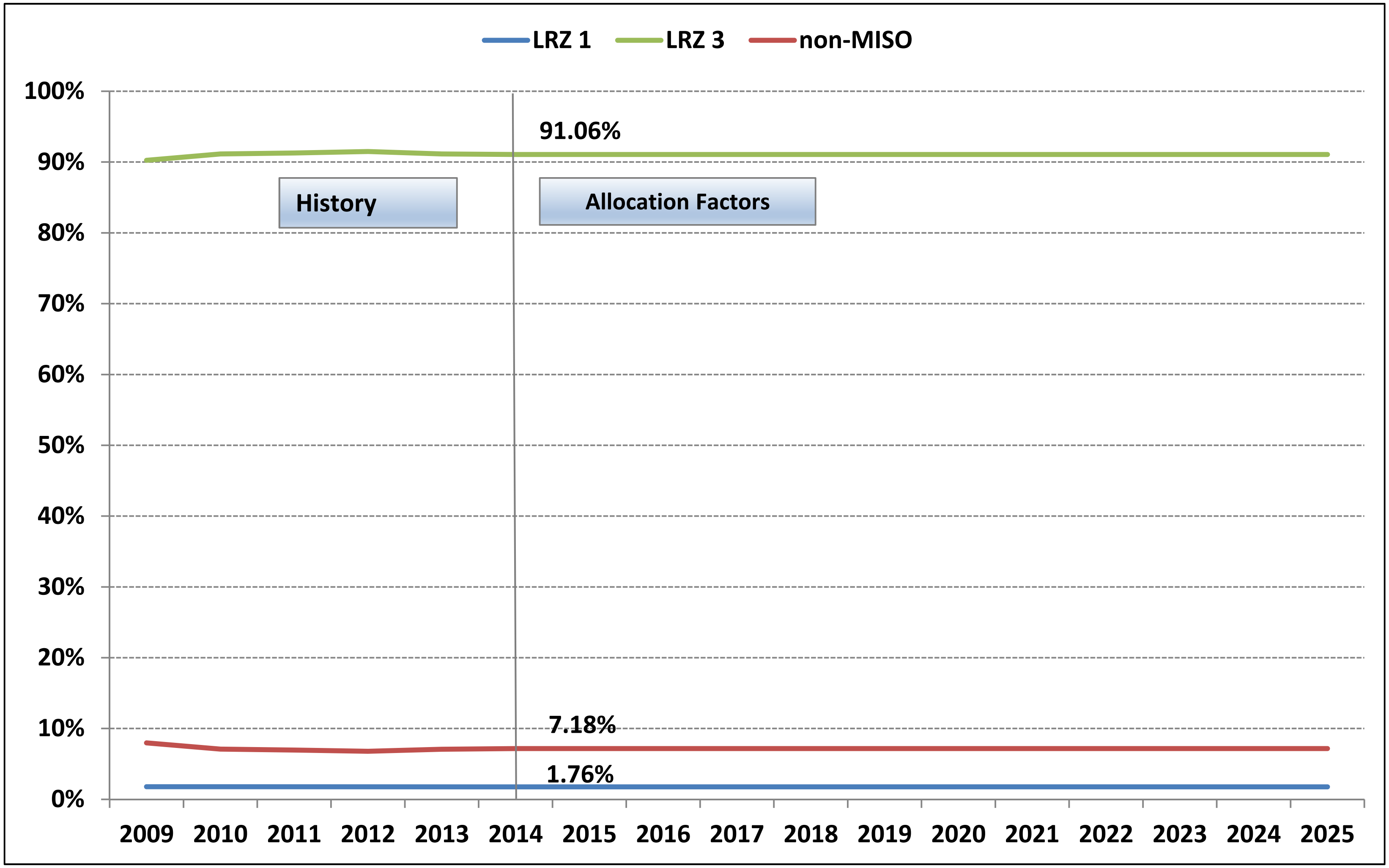
New Allocation Factors

- As we did last year, we also looked at the Chicago and St. Louis metropolitan statistical areas to see if the MISO and non-MISO load growths would be different in those states
  - no adjustment in IL
  - LRZ 5 allocation factor in MO drops over time
- The IN+KY allocation factor has been adjusted for the shutdown of the Paducah Gaseous Diffusion Plant
- All other states use the historical average from 2009-2013

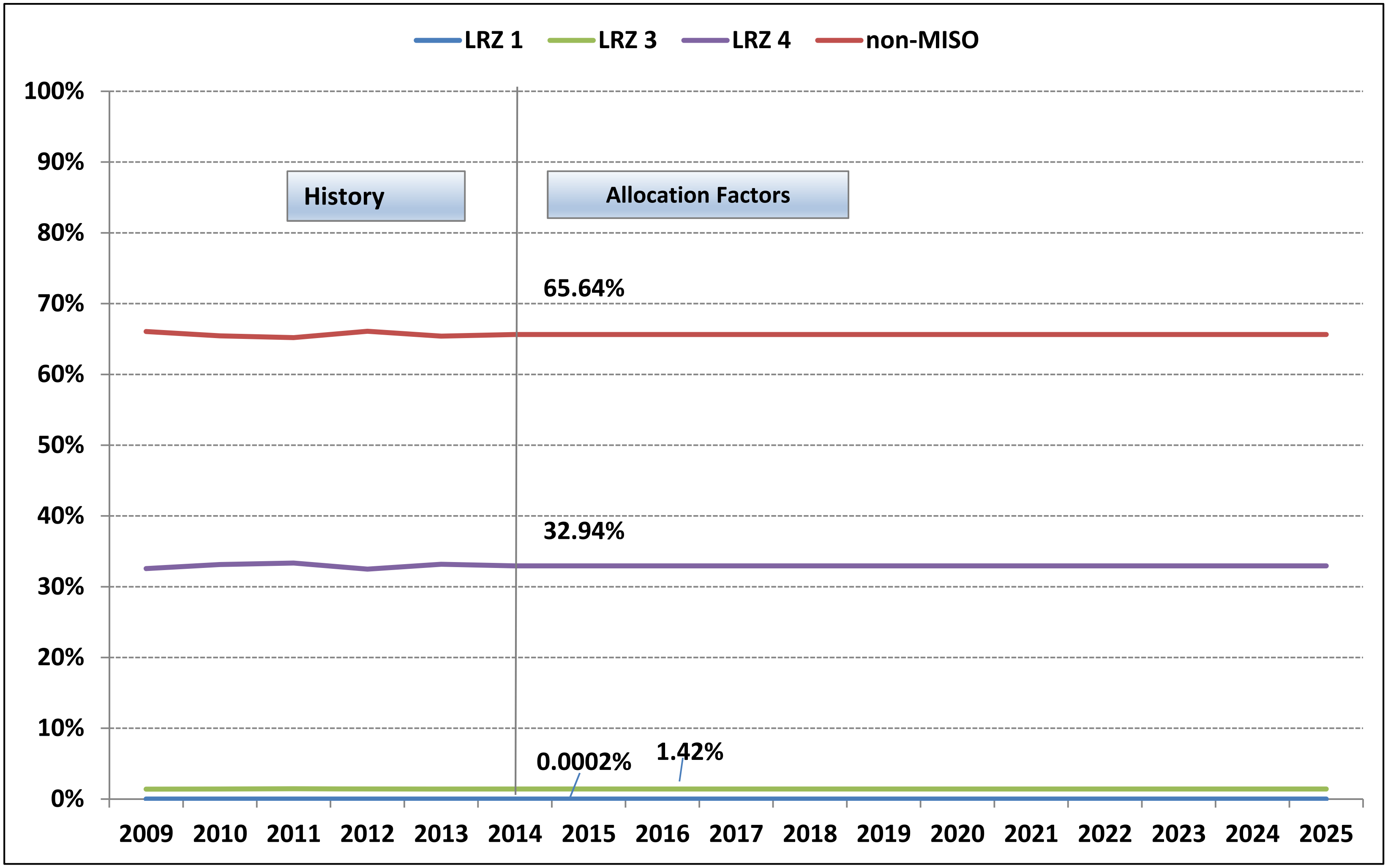
MISO Allocation Factors - AR



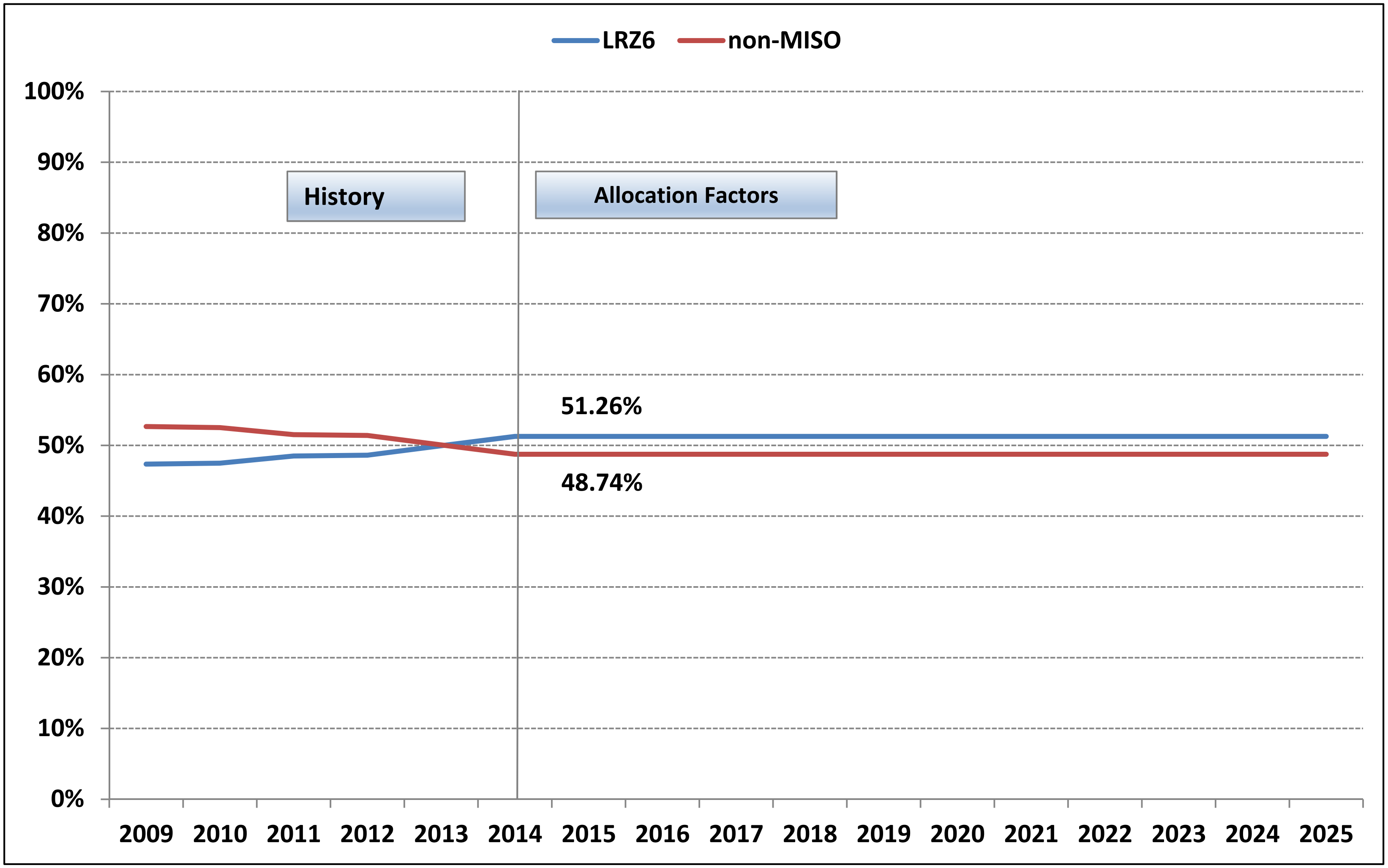
MISO Allocation Factors - IA



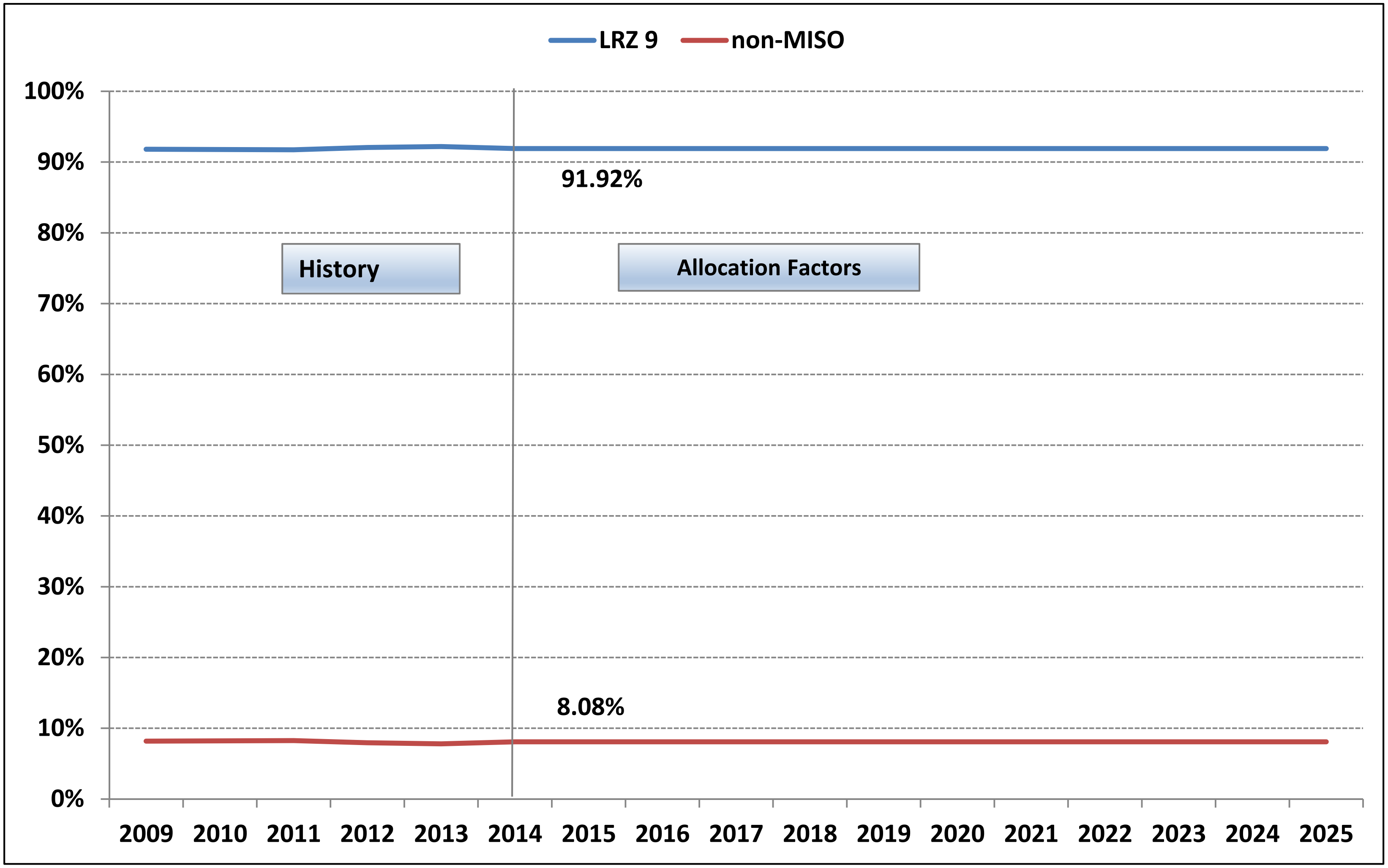
MISO Allocation Factors - IL



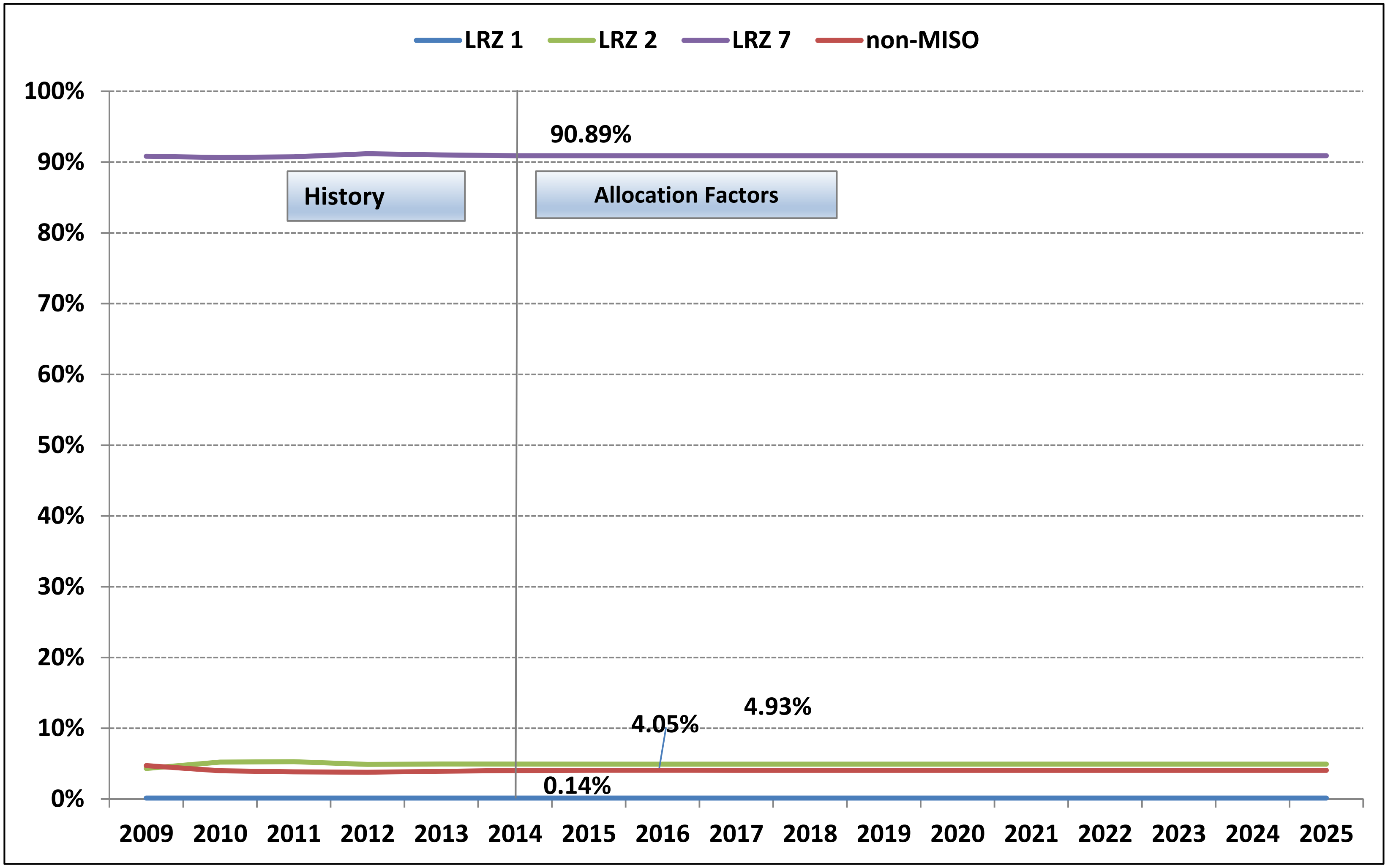
MISO Allocation Factors – IN+KY



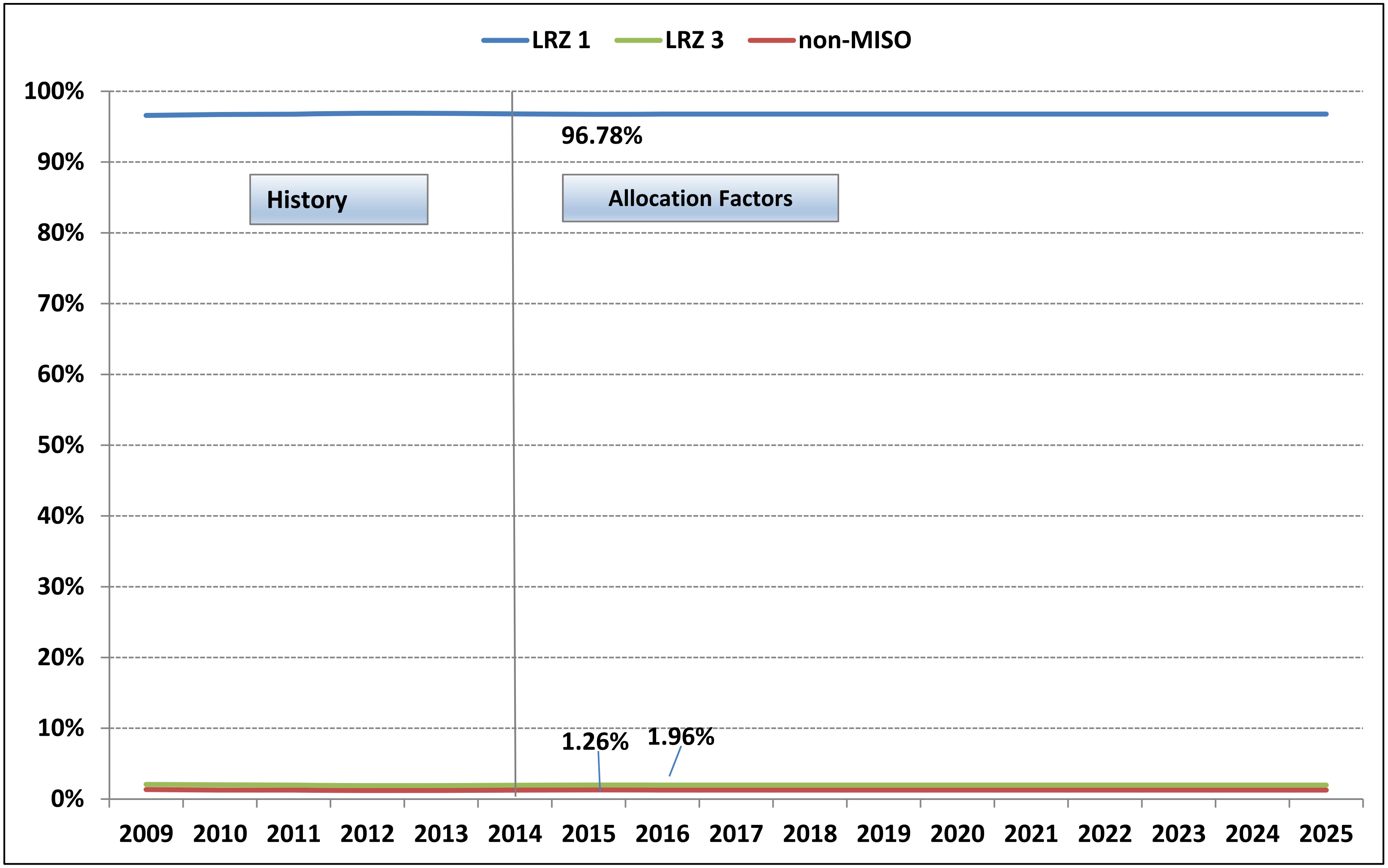
MISO Allocation Factors – LA



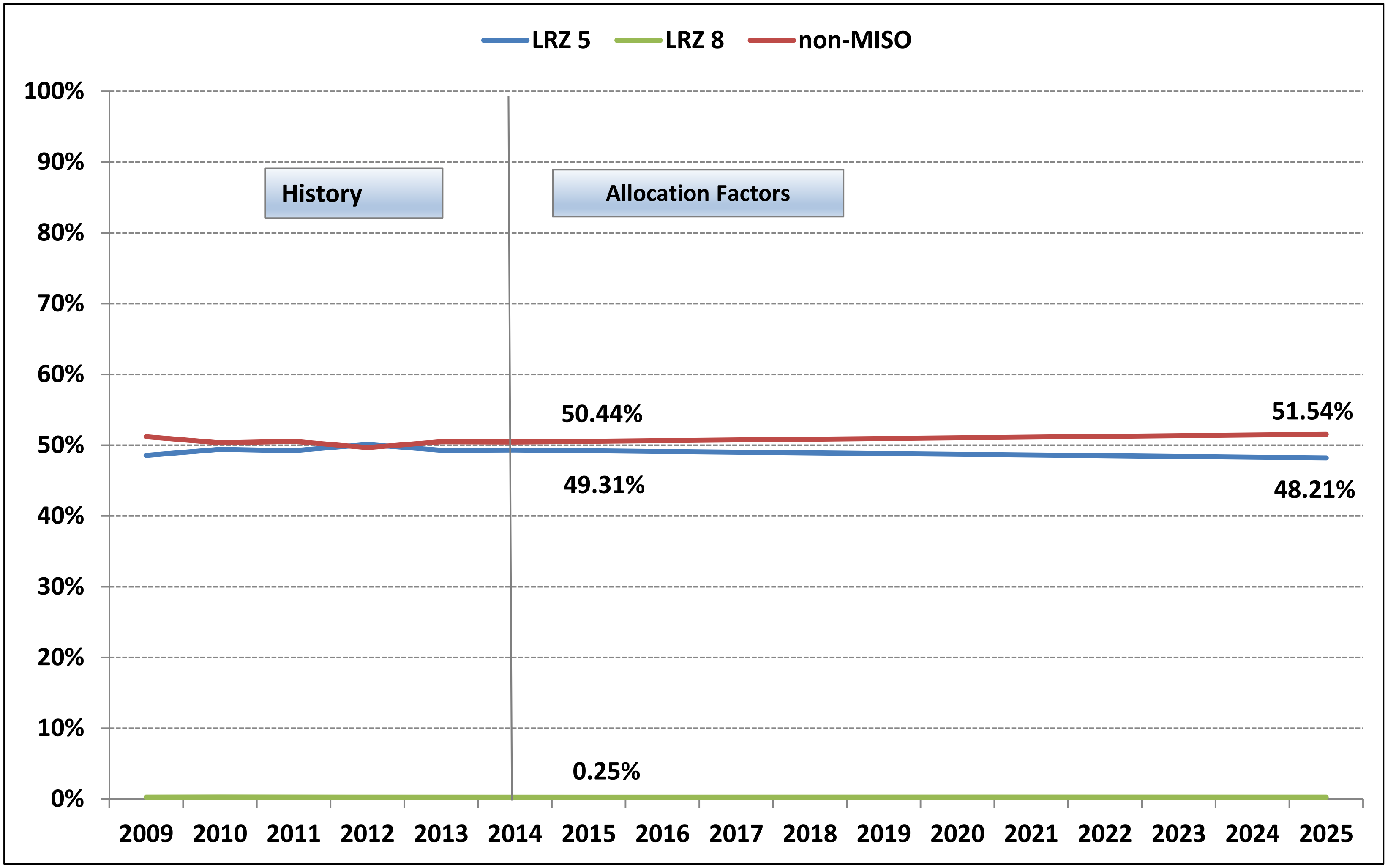
MISO Allocation Factors – MI



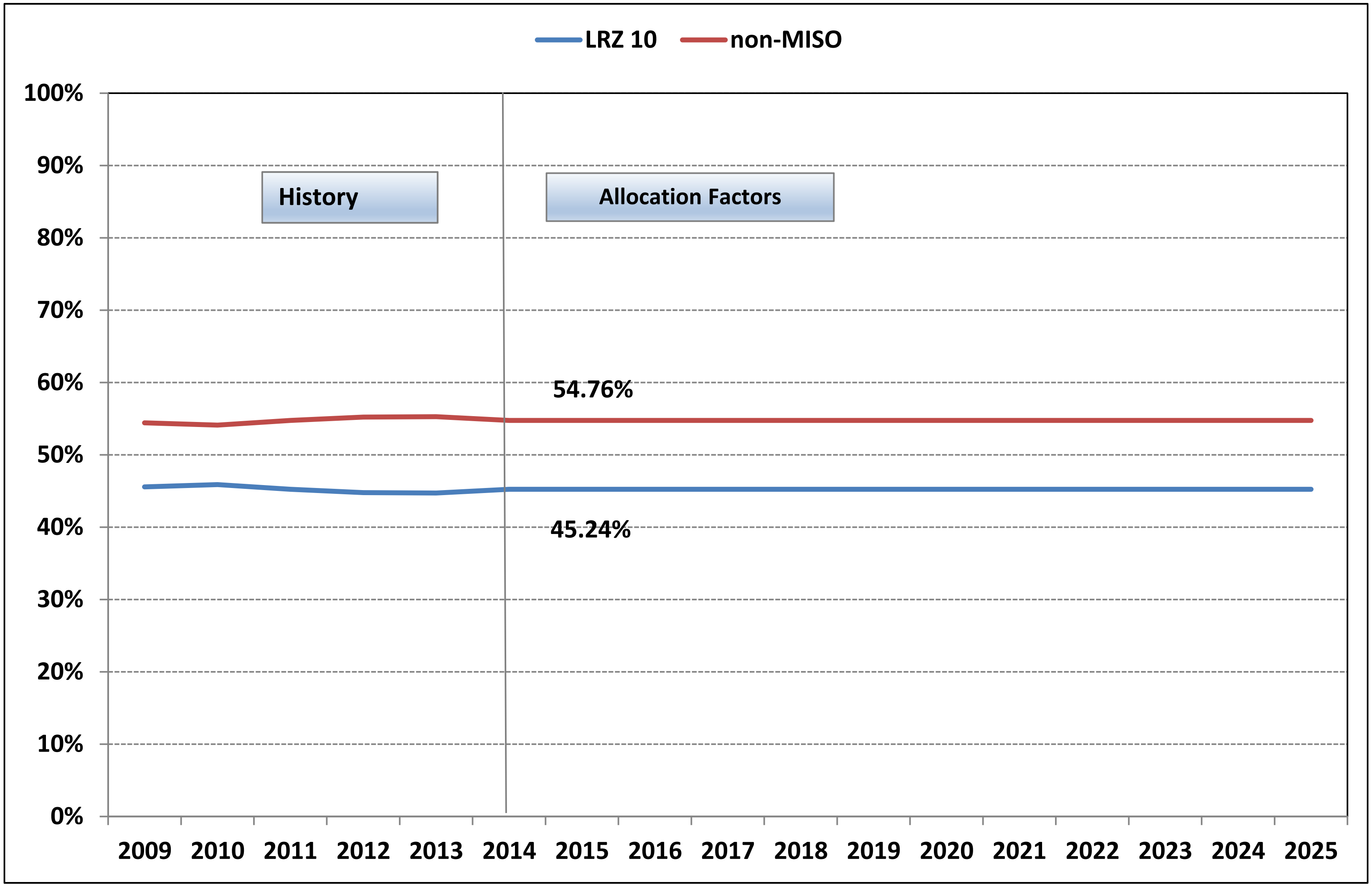
MISO Allocation Factors – MN



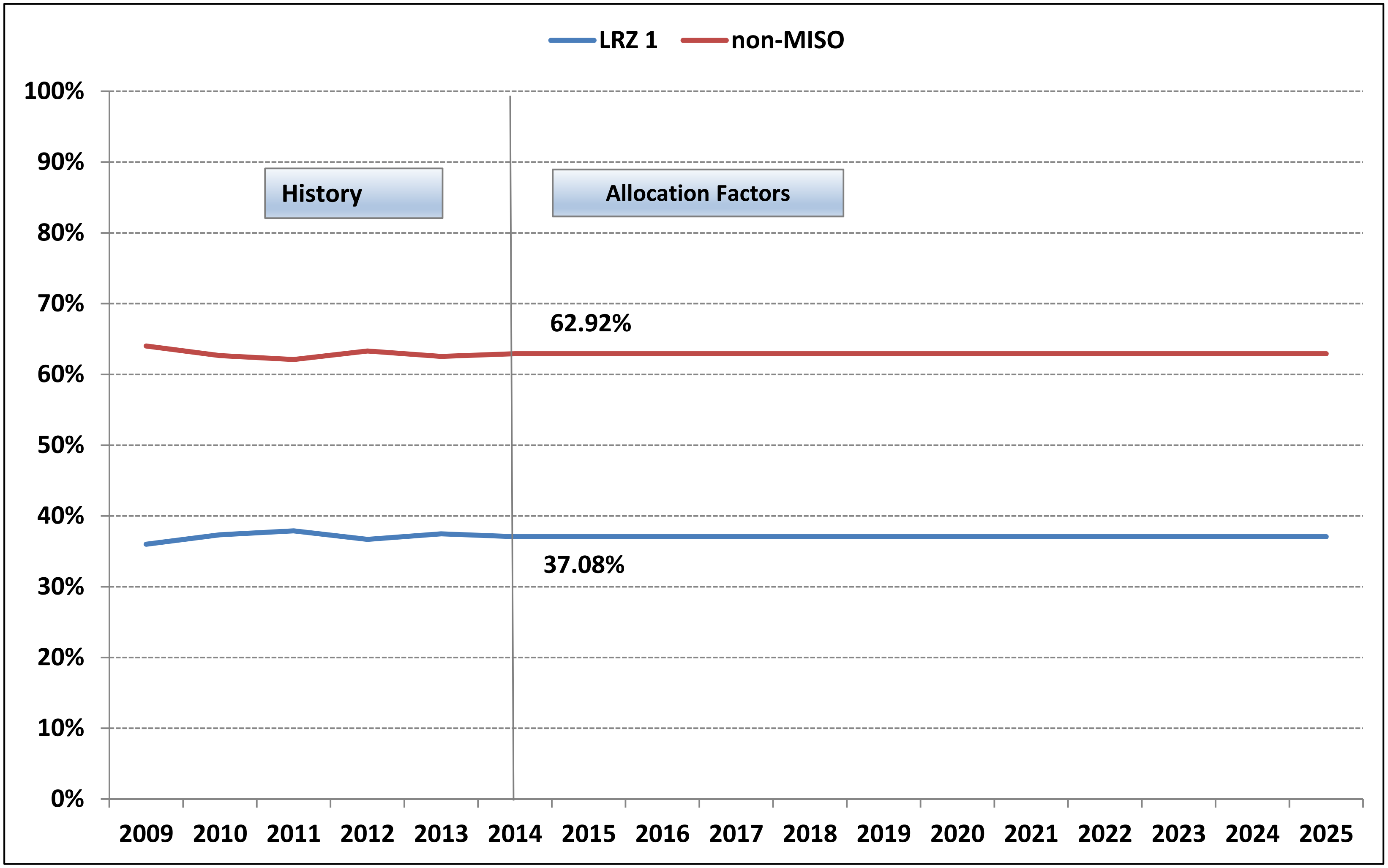
MISO Allocation Factors – MO



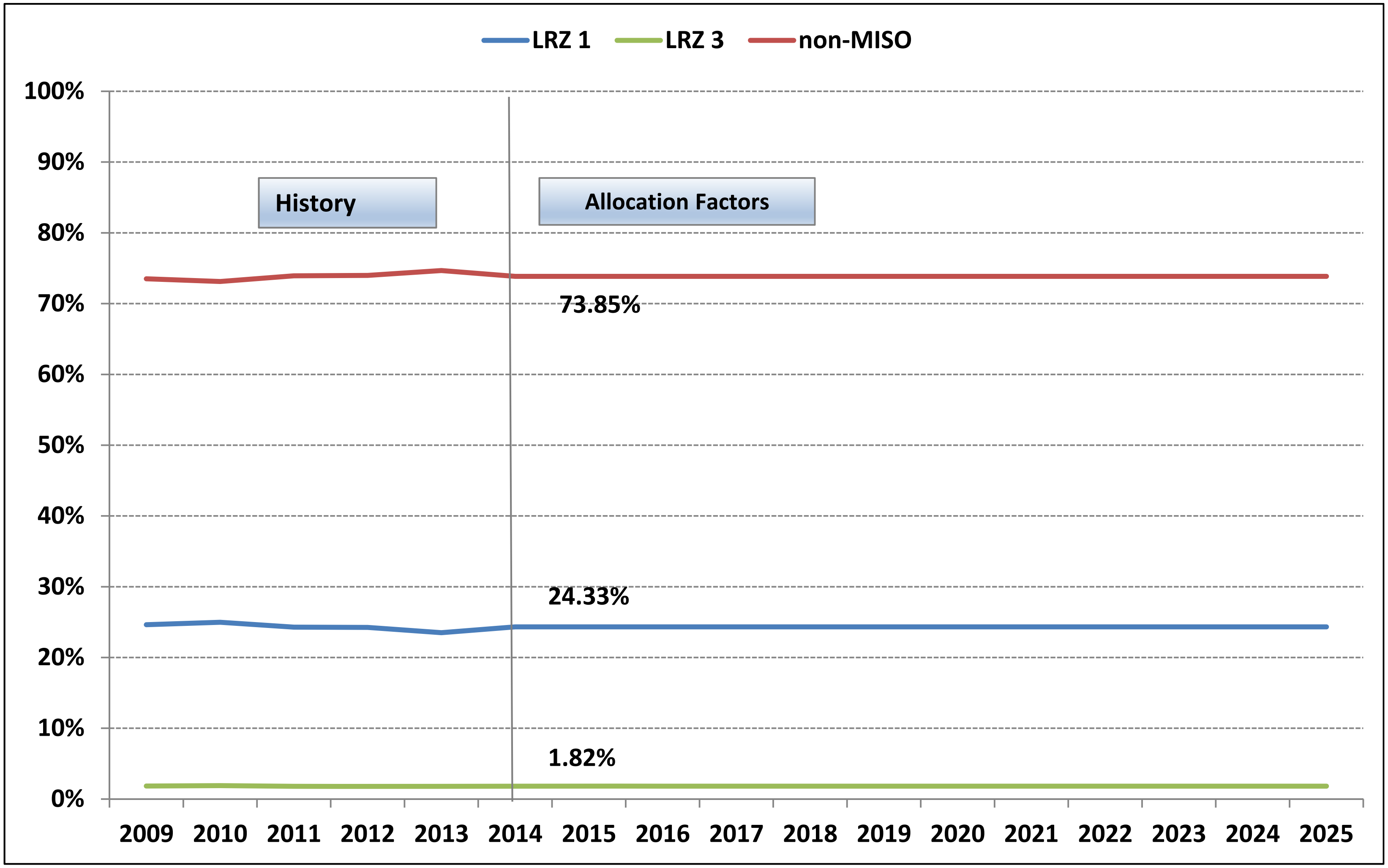
MISO Allocation Factors – MS



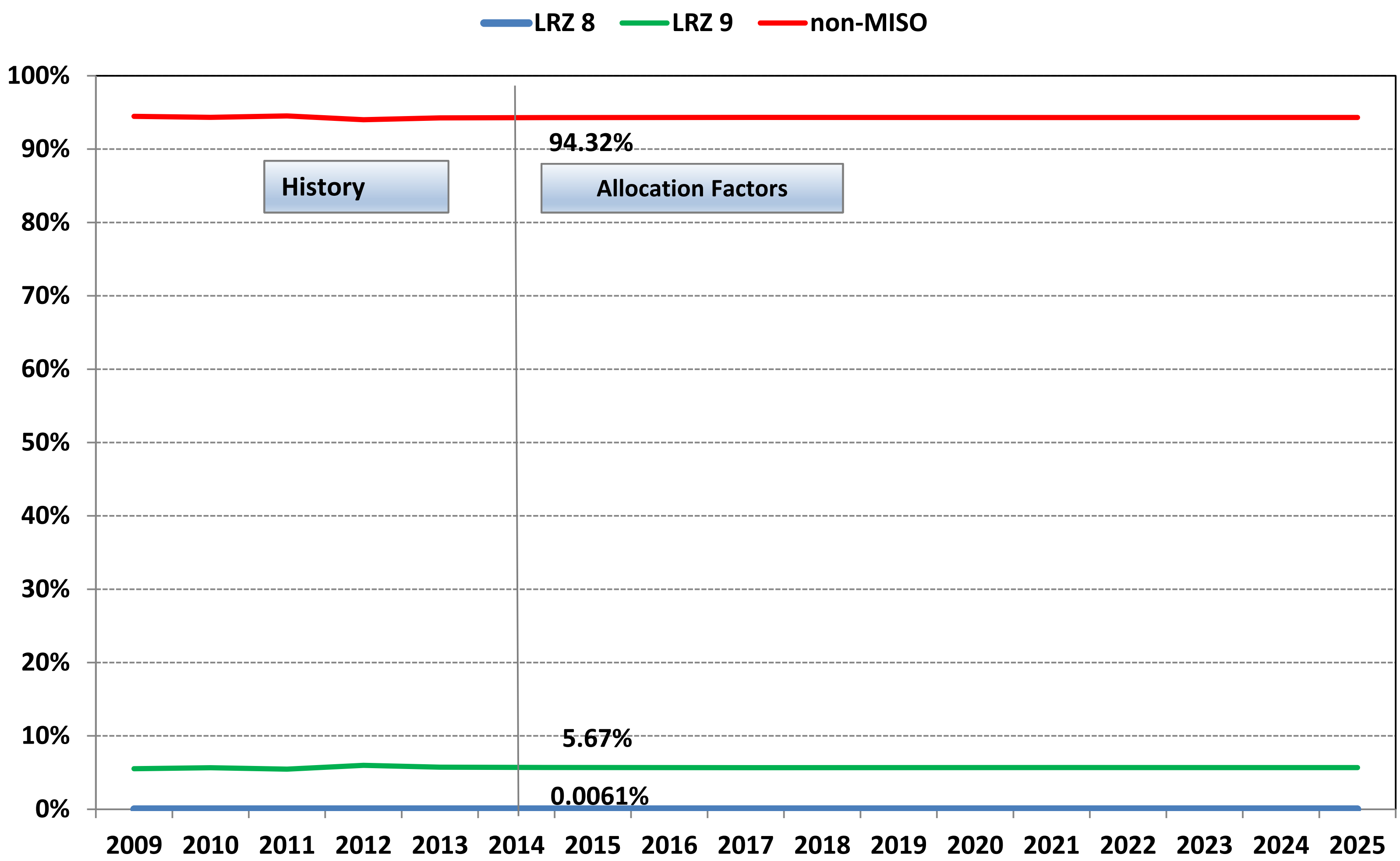
MISO Allocation Factors – ND+MT



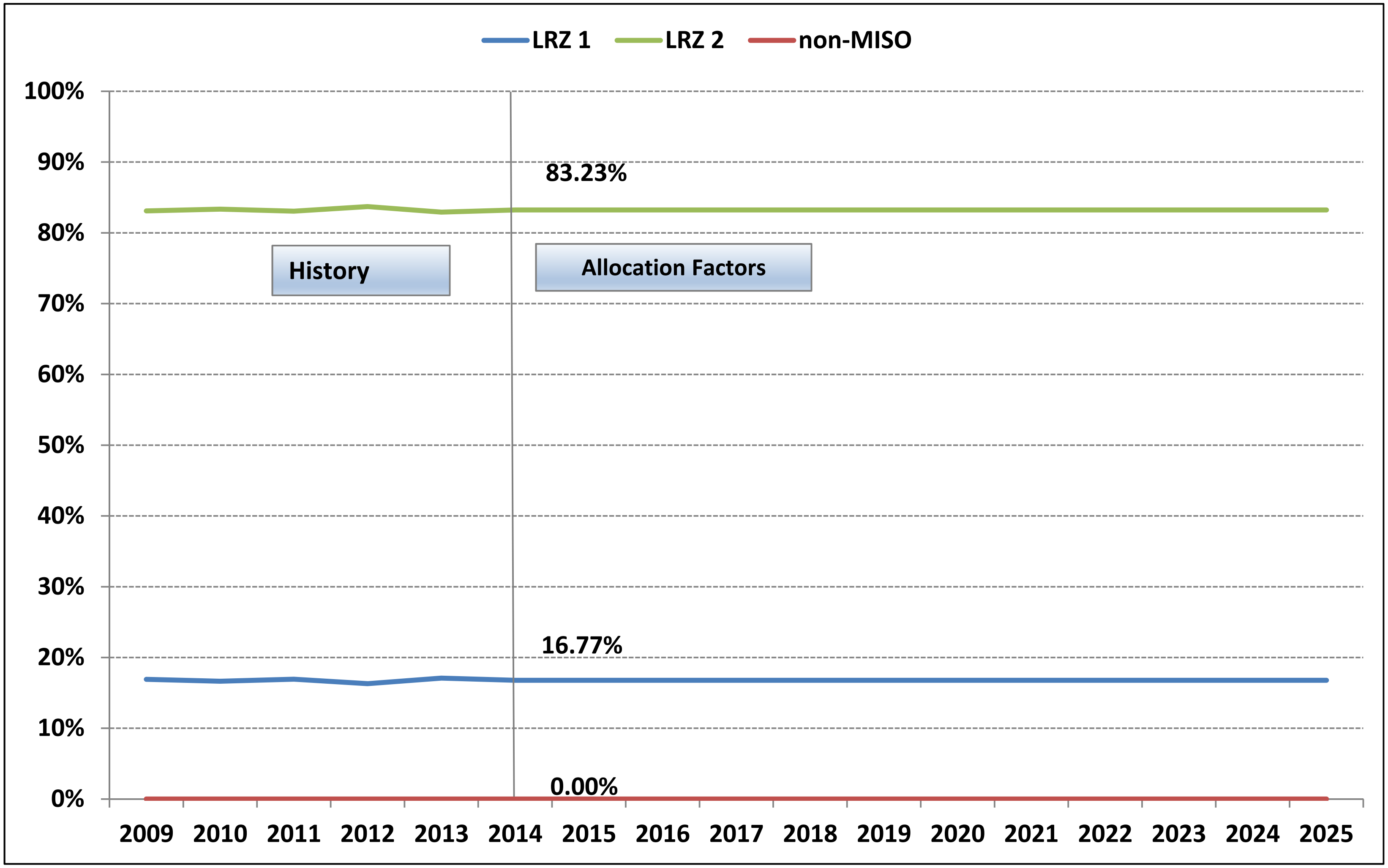
MISO Allocation Factors – SD



MISO Allocation Factors – TX



MISO Allocation Factors – WI



ELECTRICITY PRICE AND NATURAL GAS PRICE FORECAST

Electricity and Gas Prices

- Last year, we used state-specific electricity and natural gas price projections that were provided by IHS Global Insight
- They no longer produce these forecasts
- Thus, we had to develop our own forecasts using EIA's regional projections

Step 1

- Obtain annual energy price forecasts by sector (residential, commercial, industrial and transportation) from the EIA Annual Energy Outlook 2015 for the five census regions to which MISO states belong

Step 2

- State-specific energy consumption shares by sector are calculated based on historic annual retail sales of energy by sector retrieved from EIA
- The sectorial shares are used to estimate the consumption-weighted average energy prices

Step 3

- State-specific energy consumption shares by sector are applied to the corresponding regional energy price forecasts by sector to calculate annual consumption-weighted average energy prices for each forecast period of each state

FORECAST BAND METHODOLOGY

Last Year

- SUFG used statistical bands of the state econometric model to determine low and high forecasts.
- In essence, this assumes there is no uncertainty in the projections of the model drivers and that all uncertainty stems from the model error
- IHS Global Insight does not provide confidence intervals for the drivers

This Year

- SUFG will estimate confidence intervals based on the historical variance of the drivers
  - except weather variables since the forecasts are for normal weather
- This assumes that history is indicative of the future (as is also the case with econometric models)

Step 1

- Construct autoregressive models for drivers other than CDD and HDD in the state model and estimate autoregressive models as a system using seemingly unrelated regression (SUR) based on historic data
  - A separate SUR analysis is performed for each state

Example

- State model:

Electricity sales = C1+C2*@MOVAV(Electricity Price,3)+C3*GSP +C4*CDD + C5*HDD

- Autoregressive models:

Electricity Price = A1+A2*Electricity Price(-1)

GSP = B1+ B2*GSP(-1)

Step 2

- Use the estimated simple autoregressive models to obtain forecast mean and forecast lower bound and upper bound based on a 90% confidence level for each forecast period and each driver

Step 3

- Derive high and low projections of the model drivers using the bounds from the autoregressive models and the mean from the IHS projections
  - Autoregression models are only used for the confidence intervals, not the forecast itself

Example

- 90% GSP forecast = Mean GSP_{IHS} forecast + (90% GSP_{auto} forecast – mean GSP_{auto} forecast)
- 10% GSP forecast = Mean GSP_{IHS} forecast + (10% GSP_{auto} forecast – mean GSP_{auto} forecast)

Step 4

- Use the new 90/10 forecasts of the drivers in the state econometric models (accounting for the sign of the coefficient) to determine the high and low forecasts

Caveats

- Assumes that past is indicative of the future
- Does not account for correlation between uncertainties in different states

NEXT STEPS

Next Steps

- We would appreciate your feedback on the topics discussed today
- We will continue to work on improved energy to peak demand models
- September workshop will cover draft forecast results