Ameren Illinois
Section 285.5025
Schedule E-4(a) (2): Billing Units

Ameren Illinois Company's weather normalization process was performed at the rate zone level. Daily ordinary least squares (OLS) regression models were developed to estimate weather adjustment coefficients for weather sensitive rate classes. The following customer classes were determined to be weather sensitive:

Rate DS1_SH – Residential Space Heat Delivery Service
Rate DS1_NSH – Residential Non-Space Heat Delivery Service
Rate DS2 – Small General Delivery Service

The following steps outline the weather normalization process for each rate zone:

1. First, separate weather response functions were created for each class in the Metrix ND software. These models were based on daily weather data (Heating Degree Days and Cooling Degree Days). Daily load research sales data for the test year 2015 was used in the models because the load research is an accurate representative sample of the population load. The next 2 bullet points provide a brief description of the variables used in the weather response functions as well as evidence of the descriptive capacity of these models.

- Daily load was the dependent variable and the independent variables were temperature based variables, seasonal variables and day type variables. Heating and Cooling Degree Day splines with different base temperature were created to allow load to respond to temperature in a non-linear fashion. Seasonal and day type variables were binaries based on criteria like month, weekend, weekday, major holidays, and the like. Interactions of such temperature, seasonal and day type independent variables were used in the models to capture the weather response of load to these variables.

- The chart below shows that each class weather response function fits the data well because Mean Absolute Percentage Errors (MAPE) and R-Squared, which explains the amount of variation in the dependent variable explained by the model, were in a reasonable range.

Rate Zone	MAPE Range	R-Squared
Rate Zone I	DS1_SH 8.22% DS1_NSH 7.15% DS2 5.82%	DS1_SH 95.7% DS1_NSH 87.8% DS2 76.7%
Rate Zone II	DS1_SH 8.88% DS1_NSH 7.23% DS2 5.74%	DS1_SH 94.4% DS1_NSH 85.7% DS2 79.0%
Rate Zone III	DS1_SH 8.69% DS1_NSH 5.93% DS2 4.59%	DS1_SH 94.6% DS1_NSH 91.3% DS2 85.0%

2. Next, the same weather response functions were used in conjunction with normal daily weather (Heating and Cooling Degree Days) data to simulate normal daily loads. Normal here was defined as the 10 year period from 2006-2015.

3. Once the daily calendar actual and normal sales were calculated from the models described above, calculations to ultimately derive the monthly billed weather normalized sales began.

4. First, the actual daily load was calculated from the models described above on a given day in a billing cycle. (There are 21 billing cycles in a billing month). Secondly, the sum of the actual daily loads from the models for the entire billing cycle was calculated. The start and end dates of the cycle were determined from the meter read schedules. Then, the ratio of the load on a given day over the total load in a billing cycle was determined.

5. The actual billed cycle sales were converted to daily billed sales by multiplying with the ratio of daily load to total cycle load calculated in step 4. The sum of the daily billed actual sales across all months and billing cycles tie to each rate zone billing for the year for the rate class being normalized.

6. Next, a daily normal ratio was calculated by dividing daily normal sales calculated from the regression models by actual sales obtained from the load research data.

7. Finally, the daily billed sales calculated in step 5 were multiplied by the normal ratio to calculate the daily weather normalized billed sales. The sum of the daily billed normal sales across all months and billing cycles was the normal level of each rate zone billing for the year.

8. These daily billed and weather normalized daily billed sales were then summarized by month and presented in the tables.

Tables 1 (a) and (b) present weather normalized values for revenue month electric sales calculated using the methodology described above.

Table 1(a): DS1 Electric Sales (KWh) - Revenue Month- 2015

	Rate Zone I			Rate Zone II			Rate Zone III		
Month	Actual	Normal	Ratio	Actual	Normal	Ratio	Actual	Normal	Ratio
1	434,276,843	426,048,175	98.1%	397,307,544	401,755,914	101.1%	589,130,032	581,547,813	98.7%
2	384,161,661	382,081,085	99.5%	186,719,069	172,813,143	92.6%	521,499,036	521,960,328	100.1%
3	406,173,796	358,552,853	88.3%	158,689,708	158,196,957	99.7%	523,780,846	471,804,129	90.1%
4	254,380,262	260,362,476	102.4%	120,700,035	126,386,772	104.7%	366,098,135	372,831,714	101.8%
5	215,598,291	216,135,791	100.2%	140,351,773	132,353,418	94.3%	330,289,561	330,707,603	100.1%
6	270,411,507	276,570,986	102.3%	181,054,890	172,194,266	95.1%	434,579,343	438,092,598	100.8%
7	349,160,292	368,578,654	105.6%	221,126,019	218,765,695	98.9%	551,246,232	587,836,076	106.6%
8	382,630,748	389,038,115	101.7%	196,020,785	198,469,321	101.2%	601,642,260	610,625,201	101.5%
9	332,737,737	334,890,685	100.6%	176,891,923	142,717,623	80.7%	524,402,967	532,249,173	101.5%
10	251,700,015	250,981,618	99.7%	123,834,503	128,484,660	103.8%	386,735,655	381,369,648	98.6%
11	219,261,840	234,331,051	106.9%	331,336,867	330,711,916	99.8%	334,872,074	351,061,962	104.8%
12	294,371,874	319,781,292	108.6%	362,476,160	390,780,742	107.8%	426,643,957	464,636,022	108.9%
DS1 Total	3,794,864,866	3,817,352,781	100.6%	2,596,509,276	2,573,630,425	99.1%	5,590,920,098	5,644,722,267	101.0%

Table 1(b): DS2 Electric Sales (KWh) - Revenue Month- 2015

	Rate Zone I			Rate Zone II			Rate Zone III		
Month	Actual	Normal	Ratio	Actual	Normal	Ratio	Actual	Normal	Ratio
1	179,943,415	178,184,154	99.0%	151,730,549	152,594,300	100.6%	240,469,450	239,263,944	99.5%
2	161,925,376	160,919,713	99.4%	70,470,085	67,951,854	96.4%	219,734,634	219,585,316	99.9%
3	168,809,418	157,793,307	93.5%	69,395,888	69,458,653	100.1%	223,750,088	215,685,438	96.4%
4	136,963,154	138,118,625	100.8%	61,260,233	62,079,215	101.3%	193,980,364	196,003,066	101.0%
5	132,045,954	132,310,713	100.2%	67,634,152	65,725,971	97.2%	188,897,161	187,047,103	99.0%
6	145,794,183	147,084,780	100.9%	77,139,167	75,236,138	97.5%	214,224,411	214,457,000	100.1%
7	167,392,644	171,391,556	102.4%	80,464,855	79,957,381	99.4%	238,464,693	244,382,269	102.5%
8	172,964,433	174,489,111	100.9%	84,024,630	84,574,395	100.7%	245,923,823	246,876,532	100.4%
9	163,133,006	163,281,661	100.1%	75,835,375	68,500,782	90.3%	236,265,087	238,536,034	101.0%
10	147,694,697	147,307,994	99.7%	65,758,497	66,119,548	100.5%	210,932,337	208,373,177	98.8%
11	130,164,648	132,833,083	102.1%	135,315,920	135,248,127	99.9%	190,415,026	193,329,349	101.5%
12	142,841,219	148,631,566	104.1%	143,085,295	147,844,433	103.3%	202,347,226	208,575,573	103.1%
DS2 Total	1,849,672,147	1,852,346,263	100.1%	1,082,114,647	1,075,290,796	99.4%	2,605,404,300	2,612,114,801	100.3%

Tables 2 (a) and (b) show the number of actual and normal heating degree days and cooling degree days in the historic year used in the weather normalization process for each rate zone. The normal degree days were based on ten year rolling arithmetic means from 2006-2015.

Table 2(a): Calendar Month HDDs

	Rate Zone I		Rate Zone II		Rate Zone III	
Month	Actual HDD	Normal HDD	Actual HDD	Normal HDD	Actual HDD	Normal HDD
1	1,103	1,092	1,213	1,231	1,124	1,110
2	1,197	967	1,297	1,101	1,195	987
3	717	622	752	716	730	633
4	262	295	282	360	265	303
5	82	101	90	129	84	104
6	7	4	7	7	8	4
7	1	1	5	2	1	1
8	0	3	0	2	1	1
9	23	49	17	63	18	47
10	237	295	235	346	231	301
11	479	610	516	679	507	628
12	669	927	741	1,060	699	953
Total	4,778	4,967	5,153	5,695	4,864	5,073

Table 2(b): Calendar Month CDDs

	Rate Zone I		Rate Zone II		Rate Zone III	
Month	Actual CDD	Normal CDD	Actual CDD	Normal CDD	Actual CDD	Normal CDD
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	8	0	5	0	7
4	10	24	10	12	8	19
5	137	126	138	101	139	121
6	285	299	281	245	286	291
7	361	378	358	348	350	374
8	281	350	294	304	273	347
9	220	148	271	132	216	141
10	23	32	26	22	18	27
11	2	1	3	0	0	0
12	1	0	0	0	0	0
Total	1,318	1,366	1,379	1,170	1,290	1,227

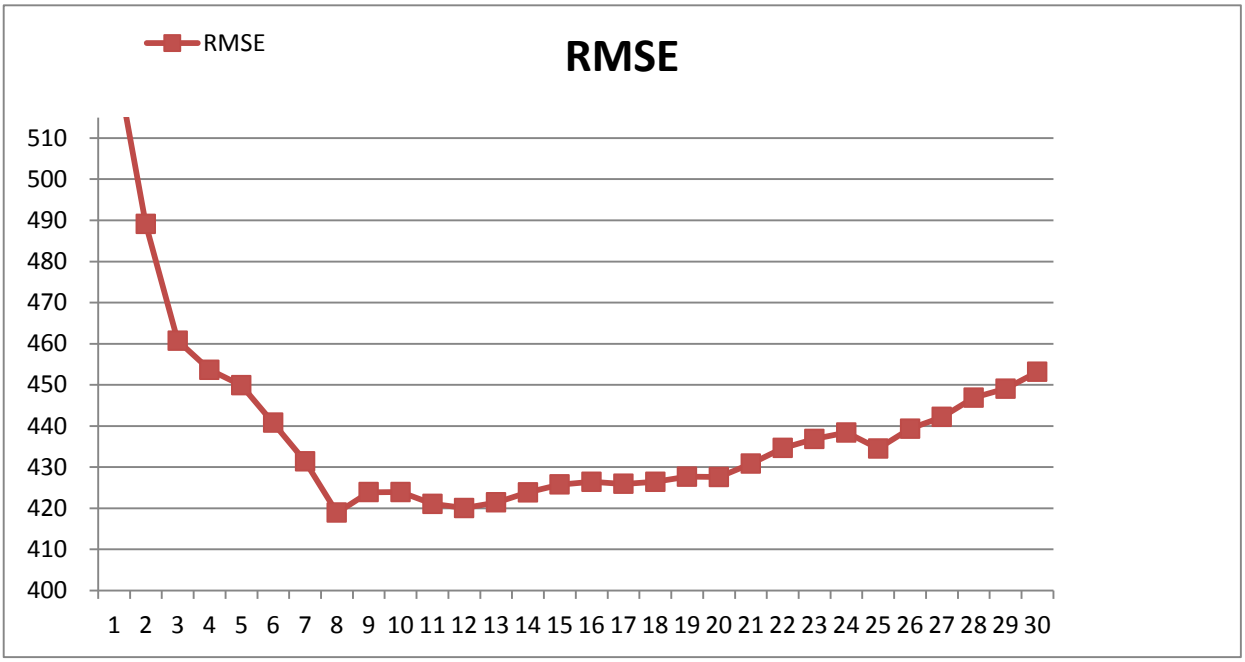
The basis of the ten year normal was an analysis conducted by Ameren that compared different normal periods. 127 years of Midwest Regional Climate Center (MRCC) monthly weather data (1889-2015) for Urbana, IL station were used to calculate yearly actual

ROOT MEAN SQUARED ERROR

Sorted

# of Years	RMSE	# of Years	RMSE
1	531	8	419
2	489	12	420
3	461	11	421
4	454	13	421
5	450	14	424
6	441	9	424
7	431	10	424
8	419	15	426
9	424	17	426
10	424	18	426
11	421	16	426
12	420	20	428
13	421	19	428
14	424	21	431
15	426	7	431
16	426	25	434
17	426	22	435
18	426	23	437
19	428	24	438
20	428	26	439
21	431	6	441
22	435	27	442
23	437	28	447
24	438	29	449
25	434	5	450
26	439	30	453
27	442	4	454
28	447	3	461
29	449	2	489
30	453	1	531
Min	419		
Max	531		
Mean	439		

heating degree days (actual HDD). In seeking the optimal rolling period to use for normal weather determination, all possible averaging periods, 1 to 30 years, were considered and calculated as HDD moving averages. The moving averages in this study were first calculated for a given base period, and then the base period was shifted forward 1 year to come up with a new mean. For instance, a 10-year moving average used 1996-2005 data range to predict 2006 value; next, same moving average used 1997-2006 data to estimate 2007 value.

After calculating different HDD moving averages to be used as normal weather, the root mean square error (RMSE) was used to evaluate the predictive ability of moving averages. The first step was to calculate the prediction error (ΔX), which meant the difference between actual HDD for a particular year and an HDD moving average. Each year had up to 30 HDD moving averages. Therefore, the number of the prediction error for each year depended on the number of HDD moving averages. The second step was to square each prediction error $(\Delta X)^2$ and to accumulate them by rolling period $\sum (\Delta X)^2$.
30 different accumulations were then divided by the respective number of prediction errors (n) accumulated and the square root was taken of each quotient: **$RMSE = [1/n \sum (\Delta X)^2]^{1/2}$**

The RMSE results were sorted from the smallest to the largest because the smaller error meant being closer to the actual value. According to the result summary shown below, 8 to 13 years rolling periods had the best predictive capability to forecast 1 year into the future. For this reason a 10 year average was chosen for normal weather. The table also indicated that a short time period was better than longer period.