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

Ameren Illinois utilities 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 rate 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 rate class in the Metrix ND software. These models were based on calendar month weather data (Heating Degree Days and Cooling Degree Days). Daily load research sales data for the test year 2013 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 rate 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 the reasonable range.

Rate Zone	MAPE Range	R-Squared
Rate Zone I	DS1_SH 6.63% DS1_NSH 5.10% DS2 5.04%	DS1_SH 95.5% DS1_NSH 95.3% DS2 78.6%
Rate Zone II	DS1_SH 7.05% DS1_NSH 6.08% DS2 3.86%	DS1_SH 94.8% DS1_NSH 93.5% DS2 89.6%
Rate Zone III	DS1_SH 8.25 % DS1_NSH 5.09% DS2 4.03%	DS1_SH 94.2% DS1_NSH 92.5% DS2 88.2%

2. Next, the same weather response functions were estimated with normal calendar month weather (Heating and Cooling Degree Days) data to create normal daily loads. Normal here was defined as the 10 year period from 2004-2013.

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- 2013

	Rate Zone I			Rate Zone II			Rate Zone III		
Month	Actual	Normal	Ratio	Actual	Normal	Ratio	Actual	Normal	Ratio
1	410,506,512	413,461,272	100.7%	213,021,740	214,038,440	100.5%	561,982,497	564,296,772	100.4%
2	365,121,181	374,915,169	102.7%	186,076,609	188,664,444	101.4%	491,909,559	502,984,797	102.3%
3	356,638,186	344,380,476	96.6%	183,370,169	180,251,943	98.3%	485,298,716	473,249,440	97.5%
4	309,190,827	293,715,289	95.0%	159,459,120	155,121,801	97.3%	421,020,751	405,754,079	96.4%
5	232,300,723	229,846,180	98.9%	131,288,647	129,935,588	99.0%	349,316,697	346,257,500	99.1%
6	262,633,460	269,559,459	102.6%	153,995,835	156,479,412	101.6%	412,853,228	422,794,002	102.4%
7	352,115,688	358,171,386	101.7%	209,265,949	204,828,028	97.9%	556,540,669	568,637,303	102.2%
8	336,320,137	366,243,621	108.9%	195,835,376	205,750,102	105.1%	531,629,349	586,369,274	110.3%
9	360,049,781	346,600,306	96.3%	214,613,059	200,054,103	93.2%	571,869,741	555,309,483	97.1%
10	264,086,358	256,443,470	97.1%	153,557,174	149,084,182	97.1%	413,651,022	398,729,254	96.4%
11	250,491,378	246,212,378	98.3%	143,820,011	141,744,343	98.6%	379,500,748	373,751,817	98.5%
12	366,127,813	354,542,808	96.8%	192,223,188	188,659,141	98.1%	508,668,757	495,284,277	97.4%
DS1 Total	3,865,582,044	3,854,091,814	99.7%	2,136,526,877	2,114,611,527	99.0%	5,684,241,734	5,693,417,998	100.2%

Table 1(b): DS2 Electric Sales (KWh) - Revenue Month- 2013

	Rate Zone I			Rate Zone II			Rate Zone III		
Month	Actual	Normal	Ratio	Actual	Normal	Ratio	Actual	Normal	Ratio
1	169,425,619	170,195,162	100.5%	76,256,448	76,341,550	100.1%	227,943,572	228,186,599	100.1%
2	154,125,551	156,599,358	101.6%	70,396,784	70,647,881	100.4%	212,158,679	213,497,039	100.6%
3	152,037,900	149,163,700	98.1%	69,338,562	68,985,011	99.5%	208,779,871	207,219,776	99.3%
4	146,098,017	142,706,592	97.7%	67,294,625	67,006,425	99.6%	201,890,945	199,810,111	99.0%
5	131,258,829	130,999,412	99.8%	62,958,319	62,820,384	99.8%	190,076,453	189,408,353	99.6%
6	147,963,200	149,607,806	101.1%	70,664,395	70,697,517	100.0%	210,787,676	211,630,489	100.4%
7	169,042,874	170,267,832	100.7%	81,754,817	80,789,898	98.8%	245,269,708	245,941,247	100.3%
8	164,820,930	171,246,039	103.9%	80,904,043	83,038,415	102.6%	232,841,649	240,970,341	103.5%
9	173,527,972	170,882,279	98.5%	86,375,002	83,636,277	96.8%	246,265,539	242,015,328	98.3%
10	151,393,562	149,680,762	98.9%	73,387,838	71,940,860	98.0%	225,806,230	221,897,912	98.3%
11	141,766,572	140,838,400	99.3%	66,950,661	66,723,489	99.7%	200,424,633	199,505,276	99.5%
12	167,841,565	164,923,580	98.3%	76,770,332	76,399,445	99.5%	223,603,033	222,025,600	99.3%
DS2 Total	1,869,302,591	1,867,110,922	99.9%	883,051,826	879,027,152	99.5%	2,625,847,988	2,622,108,071	99.9%

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 2004-2013.

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	1,018	1,094	1,151	1,196	1,039	1,070
2	881	911	1,012	1,002	905	892
3	852	579	960	735	860	640
4	373	295	456	367	389	310
5	118	103	124	146	121	107
6	9	7	19	16	12	10
7	2	0	5	1	3	1
8	4	4	1	5	3	4
9	24	43	31	62	27	47
10	304	285	353	362	316	306
11	722	557	813	663	737	593
12	1,078	960	1,251	1,130	1,101	1,014
Total	5,385	4,840	6,174	5,684	5,512	4,993

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	4	0	0	0	0	0
3	0	8	0	1	0	3
4	17	25	8	17	15	28
5	128	111	94	69	109	96
6	263	281	216	216	255	263
7	297	398	293	319	285	357
8	321	356	304	290	307	337
9	206	150	188	126	189	143
10	51	31	39	23	42	30
11	0	1	0	0	0	1
12	0	0	0	0	0	0
Total	1,288	1,361	1,142	1,061	1,201	1,260

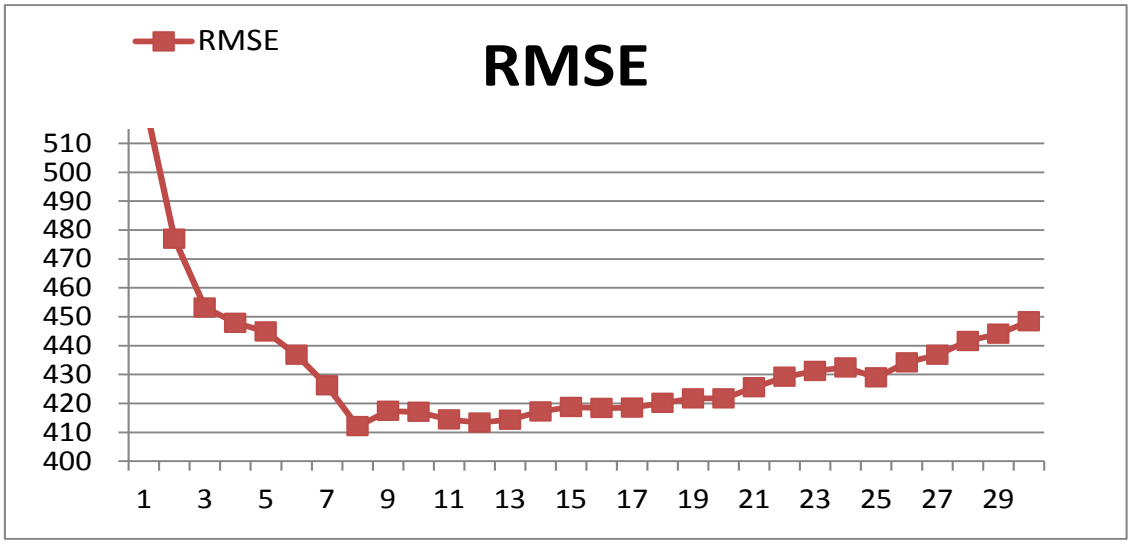
The basis of the ten year normal was an analysis conducted by Ameren that compared different normal periods.125 years of Midwest Regional Climate Center (MRCC) monthly weather data (1889-2013) for Urbana, IL station were used to calculate yearly actual heating degree days (actual HDD). In seeking the 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.

ROOT MEAN SQUARED ERROR

			Sorted		
# of Years	RMSE		# of Years	RMSE	
1	526		8	412	Best
2	477		12	413	
3	453		13	414	
4	448		11	414	
5	445		10	417	
6	437		14	417	
7	426		9	417	
8	412		16	418	
9	417		17	419	
10	417		15	419	
11	414		18	420	
12	413		20	422	
13	414		19	422	
14	417		21	426	
15	419		7	426	
16	418		25	429	
17	419		22	429	
18	420		23	431	
19	422		24	432	
20	422		26	434	
21	426		27	437	
22	429		6	437	
23	431		28	442	
24	432		29	444	
25	429		5	445	
26	434		4	448	
27	437		30	448	
28	442		3	453	
29	444		2	477	
30	448		1	526	Worst
Min	412				
Max	526				
Mean	433				

After calculating different HDD moving averages to be used as normal weather, one of the most commonly statistical methods was the root mean square error (RMSE) and it 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 accumulation was then divided by the number of prediction error (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-year rolling period had the best predictive capability to forecast 1 year into the future. The table also indicated that a short time period was better than longer period. It also showed that Ameren Illinois' 10 year normal value was superior to a 30 year average. The 10 year average had the 5th lowest RMSE compared to the 30 year average which had the 27th lowest RMSE.



Tables 3 presents the calendar month 30 year normal weather, 1984-2013, as used by the national weather service.

Table 3: 30 year calendar normal weather

	30 year calendar normal HDD			30 year calendar normal CDD		
Month	Rate Zone I	Rate Zone II	Rate Zone III	Rate Zone I	Rate Zone II	Rate Zone III
1	1,100	1,233	1,107	0	0	0
2	878	1,000	884	0	0	0
3	643	738	647	5	3	5
4	316	386	315	25	15	24
5	103	145	99	102	71	110
6	10	17	10	280	224	283
7	0	1	3	393	337	389
8	3	5	3	341	276	334
9	59	85	60	150	113	147
10	289	360	296	26	15	24
11	616	706	622	1	0	1
12	983	1,109	991	0	0	0
Total	5,001	5,786	5,035	1,325	1,053	1,318