

Northern States Power - Minnesota Company
2021 South Dakota Electric Lag Study Population Census Methodology
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Process

The current Lag Study is based on analysis of South Dakota electric jurisdiction twelve-months ended December 2021 revenue receipts. The revenue lag analysis was calculated based on a census of the total population of billing records information available for each rate group. The census contained all the customers and all revenue with metered consumption or lighting loads in that rate class.

1. Select and aggregate the population census customers (debtor number) records for each customer rate class. The South Dakota lag study's debtor number records list is based on the total unique records population for the twelve months ended December 2021 as a "census" of the rate codes. No rate code records are sampled in the analysis.
2. Send census debtor accounts to IBM staff to extract all billing and payment records for the test year data.
3. Include all premises as a census of each rate class.
4. Restrict data to non-reversed invoices with amounts > \$0.
5. Match the payment records with the billing records based on the debtor number, premise number and service number.
6. Determine the rate of each invoice:
 - a. For non-metered classes, use the tariff from the invoice.
 - b. For metered classes, determine the rate group from the population data (table "Rates" and relate to the invoice data by debtor (account), premise and service numbers.
7. Calculate lag days for each invoice:
 - a. Calculate service days and midpoint date.
 - b. Relate payment and transaction data to invoices. Calculate lag days for each invoice and the payment weight of each invoice.
 - c. Calculate the weighted lag days for each invoice by applying the payment weight to the lag days of each payment/transaction.
 - d. Sum weighted lag days for each invoice.
 - e. Adjust lag days for any invoices that were not paid in full, using the date of the CRS data extraction (4/5/2022) as the date that the remaining invoice amount was paid.
8. Invoices with an Account Status Code equal to 4 or higher (which indicates the balance is "In Receivership or Bankrupt", "To be Written Off", or "Has been Written Off") were excluded from the analysis.
9. Calculate results:
 - a. Calculate mean lag days and variance by rate group.
 - b. Apply percent revenue weight to rate group average and variance and total across all rate classes.

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Analysis Calculations

Lag days for each revenue invoice are calculated by first determining the lag days for each payment using the following equations:

$$ServiceDays_i = InvoiceToDate_i - InvoiceFromDate_i + 1$$

$$MidptDate_i = InvoiceFromDate_i + ServiceDays_i / 2$$

$$LagDays_{i,j} = PaymentDate_{i,j} - MidptDate_i + 0.5$$

where i denotes the invoice and j the payment applied to the invoice.

Since multiple payments and transactions can occur for each invoice, the lag days for each payment are then weighted by the payment amount, such that

$$LagDays_i = \frac{p_{i,j}}{q_i} LagDays_{i,j}$$

where

$p_{i,j}$ = payment j for invoice

q_i = invoice amount for invoice i

If any payments were not paid in full, then the date the data extraction was performed (4/5/2022) is used as the payment date for any remaining balance on the invoice, such that

$$LagDaysTotal_i = \frac{p_{i,j}}{q_i} LagDays_{i,j} + (1 - \frac{p_{i,j}}{q_i})(4/5/2022) - MidptDate_i + 0.5$$

Once the lag days for each invoice have been determined, the estimate of the stratified mean lag days can then be calculated as

$$\bar{x}_{st} = W_h \bar{x}_h$$

where

W_h = rate group revenue stated as a percent of total revenue across all rate groups

\bar{x}_h = mean lag days by rate group

The variance of the stratified estimate of the mean lag days is

$$v(\bar{x}_{st}) = \sum_h W_h^2 \frac{s_h^2}{n_h}$$

where

s_h^2 = variance of the mean lag days by rate group

n_h = rate group size (invoices)

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Census sizes by rate group are shown in Table 1.

Table 1. Electric Retail Revenue Lag Population Statistics by Rate Class

| Rate Code | Rate Description | Total Revenues | % Total Revenues | Average Lag Days | Weighted Average Lag Days | Number Invoices | Std. Deviation | Variance |
|-----------|--|------------------|------------------|------------------|---------------------------|-----------------|----------------|------------|
| E01 | Residential (w/o spc htg) | \$44,878,257.85 | 18.66% | 36.7397 | 6.8557 | 530,727 | 23.4061 | 547.8453 |
| E02 | Residential Time of Day | \$10,633.89 | 0.00% | 36.0495 | 0.0016 | 102 | 9.8370 | 96.7665 |
| E03 | Residential Underground w/o Space Ht | \$58,210,082.69 | 24.20% | 37.0727 | 8.9729 | 470,237 | 16.9577 | 287.5638 |
| E04 | Residential Time of Day Underground | \$11,710.86 | 0.00% | 39.1079 | 0.0019 | 84 | 9.0008 | 81.0146 |
| E06 | Residential Heat Pump Service | \$155,057.40 | 0.06% | 38.7489 | 0.0250 | 721 | 9.8900 | 97.8127 |
| E10 | Energy Controlled Service - Residential Standard | \$101,760.71 | 0.04% | 31.2464 | 0.0132 | 761 | 58.3867 | 3,409.0052 |
| E11 | Limited Off Peak Service | \$29,648.65 | 0.01% | 41.0187 | 0.0051 | 31 | 5.7232 | 32.7550 |
| E12 | Automatic Protective Lighting Service | \$420,711.63 | 0.17% | 33.8709 | 0.0593 | 11,794 | 15.4748 | 239.4704 |
| E13 | Small General Service | \$9,833,563.34 | 4.09% | 39.1057 | 1.5989 | 81,948 | 26.5106 | 702.8096 |
| E14 | Small General Time of Day Service - Metered | \$299,088.77 | 0.12% | 41.1551 | 0.0512 | 3,990 | 12.5616 | 157.7937 |
| E15 | General Service | \$70,420,722.95 | 29.28% | 41.0155 | 12.0096 | 45,083 | 13.6682 | 186.8191 |
| E16 | General Time of Day Service | \$41,523,109.31 | 17.27% | 40.7424 | 7.0342 | 2,685 | 9.7065 | 94.2160 |
| E18 | Small General Time of Day - Unmetered | \$8,373.50 | 0.00% | 28.5236 | 0.0010 | 780 | 4.3323 | 18.7684 |
| E20 | Peak Controlled Service | \$6,193,804.49 | 2.58% | 39.8551 | 1.0264 | 899 | 7.6953 | 59.2171 |
| E21 | Peak Controlled Time of Day Service | \$4,813,002.53 | 2.00% | 34.7791 | 0.6960 | 128 | 5.9538 | 35.4480 |
| E22 | Energy Controlled Service | \$1,842,671.37 | 0.77% | 38.7805 | 0.2971 | 156 | 6.6954 | 44.8286 |
| E30 | Street Lighting Service - Leased Equipment | \$773,757.10 | 0.32% | 34.6559 | 0.1115 | 1,309 | 9.3036 | 86.5567 |
| E31 | Street Lighting Service - Purchased Equipment | \$329,796.62 | 0.14% | 33.3452 | 0.0457 | 156 | 12.1214 | 146.9290 |
| E32 | Street Lighting Energy Service - Metered | \$569,957.67 | 0.24% | 40.2150 | 0.0953 | 237 | 9.7771 | 95.5922 |
| E33 | Street Lighting - Ornamental - Metered Energy Only | \$74,064.49 | 0.03% | NA | NA | NA | NA | NA |
| E40 | Fire and Civil Defense Siren Service | \$2,963.67 | 0.00% | NA | NA | NA | NA | NA |
| Total | | \$240,502,739.49 | 100.00% | | 38.9016 | 1,151,828 | | |