Using AMI Data: From Modeling to Variance Analysis

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Agenda

» AMI Data for Weather Splines

» AMI Data for Monthly Forecast Models

» AMI Data for Monthly Variance Analysis

» AMI Data for COVID Adjustments

» AMI Data for Extreme Events

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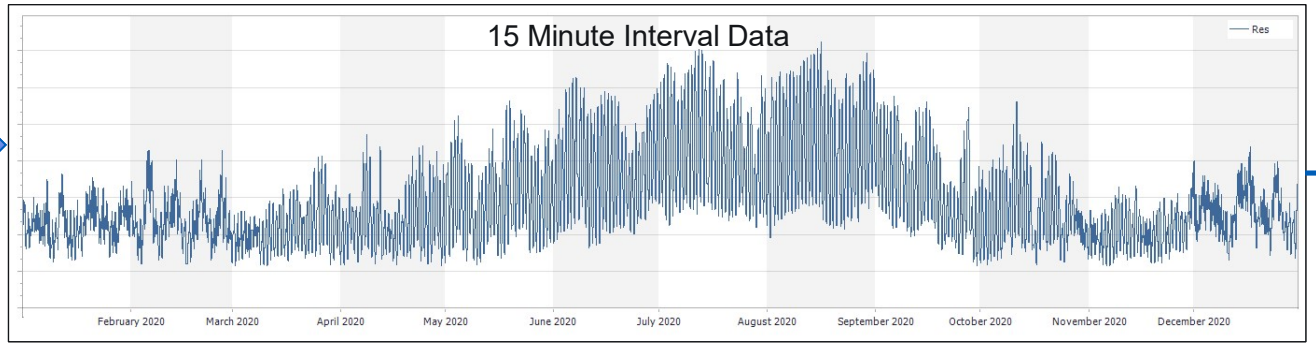
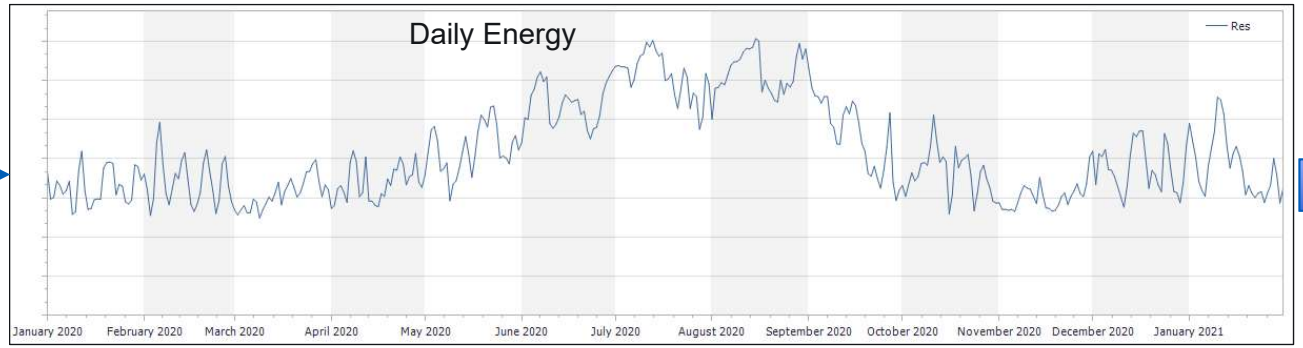
AMI Data

Interval Meters

Class Aggregation



Aggregate Data to Daily Energy



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Import to Modeling Software

AMI Data for Weather Splines

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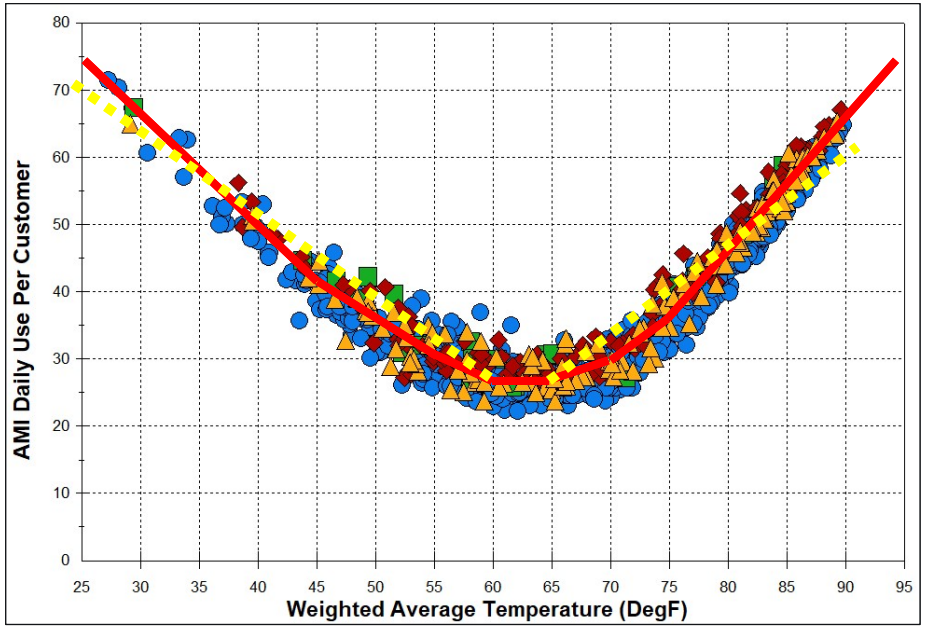
Modeling the Weather Response



Multi-part slopes can be estimated from daily class AMI data. The slopes summarize the relative impact of low, medium, and high-powered degrees.

Develop the class daily model with AMI data

- Control for days of week, seasons, holidays, and growth
- Use HDD and CDD splines
- Create weights from the spline coefficients

Spline	Coeff	Weight
HDD60	0.71	43.5%
HDD55	0.39	24.0%
HDD45	0.53	32.5%
HDD Total	1.63	

HDD weights

CDD weights

Spline	Coeff	Weight
CDD65	0.43	22.1%
CDD70	0.89	45.6%
CDD75	0.63	32.3%
CDD Total	1.95	

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AMI Data for Monthly Forecast Models

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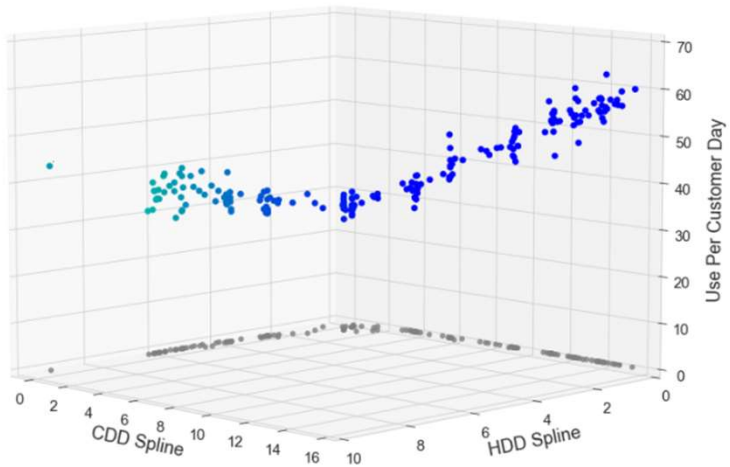
Constructing a Monthly Forecast Model

- » Process daily HDDs & CDDs through cycles
  - Actual and normal
- » Apply spline weights to monthly values
  - By cycle and calendar month
- » Use actual in monthly models
  - Y = Billed Sales (Use per Customer per Day)
  - X = Cycle Degree Days per Day
- » Forecast with normal monthly values



	Coef	StdErr	Tstat
CDDSpline	1.925	0.331	5.813
HDDSpline	1.576	0.278	5.676

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AMI Data for Monthly Variance Analysis

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Traditional Weather Normalization

$$Sales_n = Sales_a + (PredictedSales_n - PredictedSales_a)$$

Modeling:

- Monthly model based on Billed Sales
- Align daily weather to meter read schedule to obtain Billed Weather

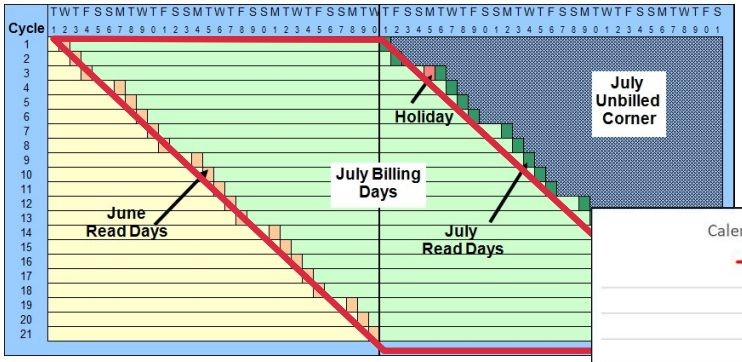
$$Sales_{billedmonth} = f(Weather_{billedmonth})$$

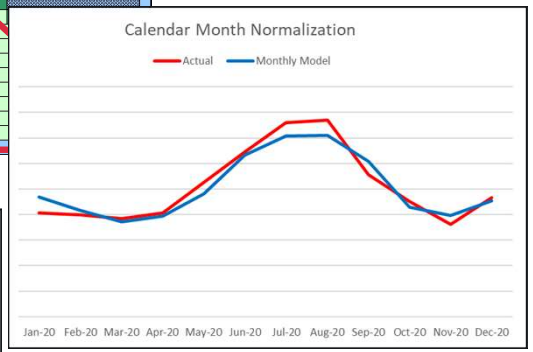
Model Variables:

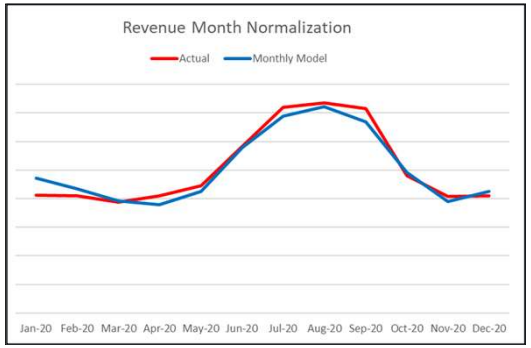
- Month Binaries
- Annual Shifts or Trends
- Weighted HDD
- Weighted CDD

Weather Normalization and Calendar Sales

- Monthly model coefficients
- Actual and normal weather (billing month)
- Calendar normal weather







Daily Weather Normalization

Modeling:

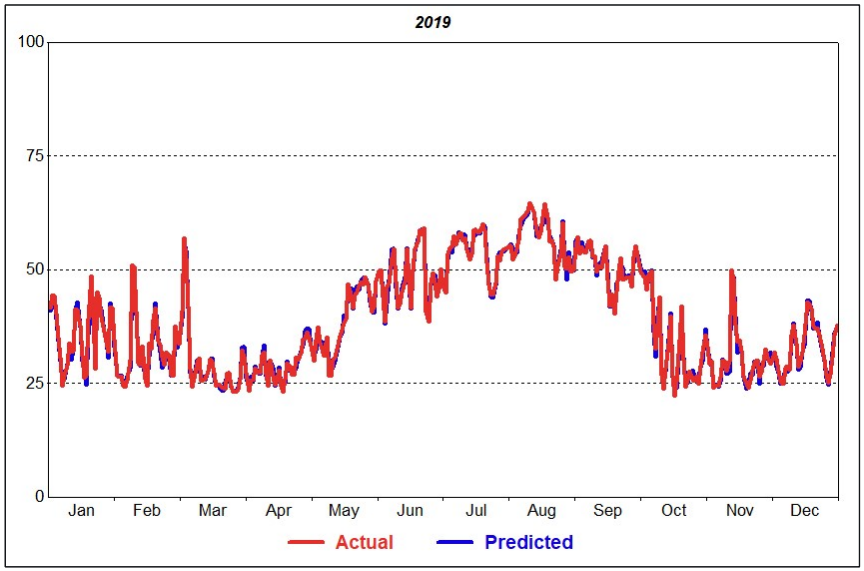
- Daily model based on AMI data

$$Sales_{day} = f(Weather_{day})$$

Model Variables:

- Day of Week Binaries
- Month Binaries
- Holiday Binaries
- Annual Shifts
- Weighted HDD
- Weighted CDD
- Weighted HDD Seasonal Interactions*
- Weighted CDD Seasonal Interactions*
- Weighted HDD Weekend Interactions*
- Weighted CDD Weekend Interactions*
- Prior Day Weighted HDD*
- Prior Day Weighted CDD*

* Add variables as needed.



Weather Normalization and Calendar Sales

- Daily model coefficients
- Daily actual weather and normal weather
- Monthly impacts calculated by summing the daily impacts over the calendar month or billing month

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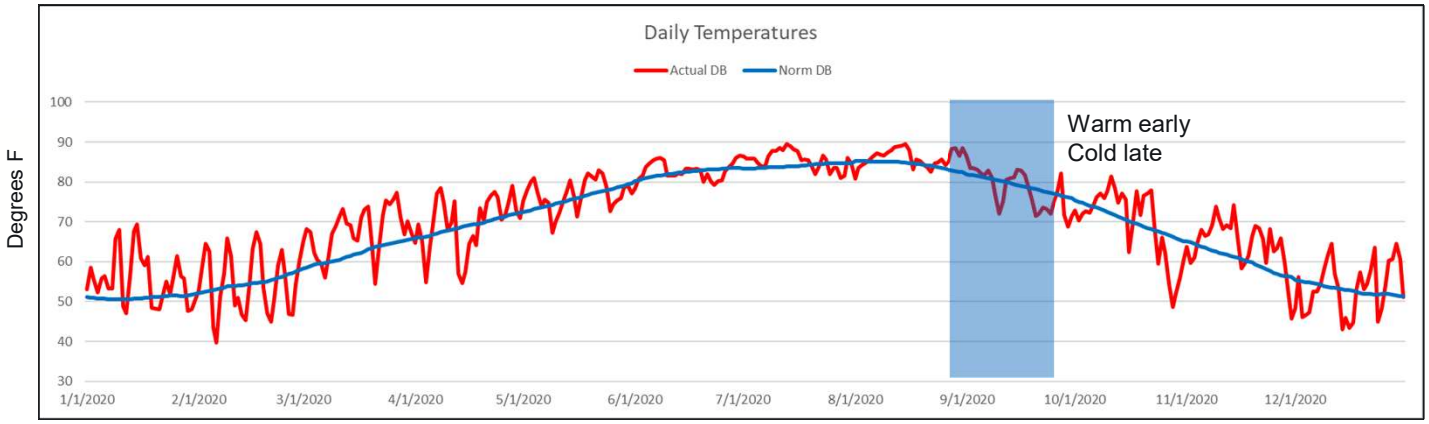
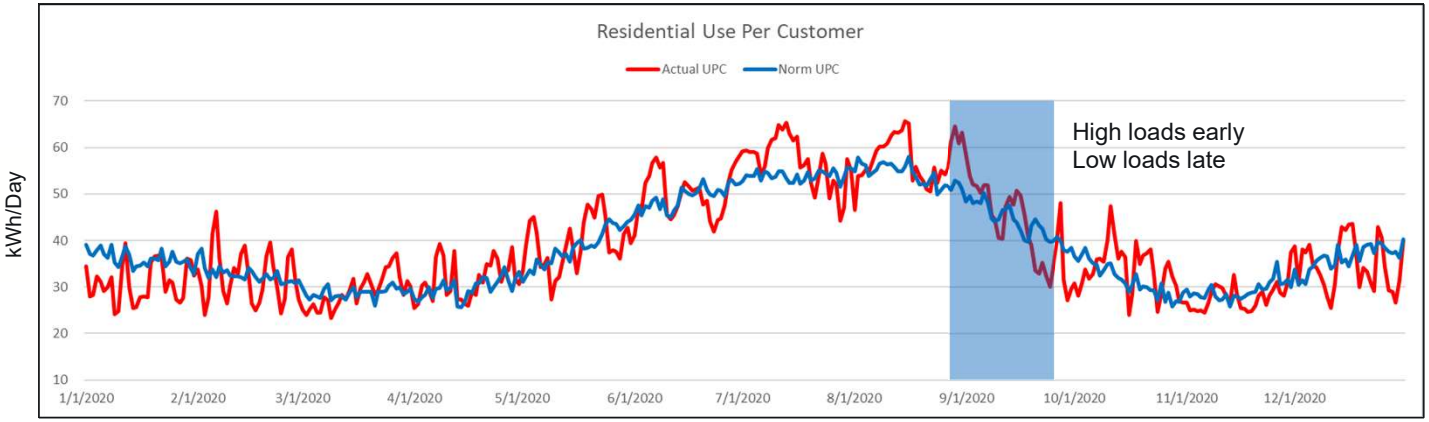
Daily Weather Normalization





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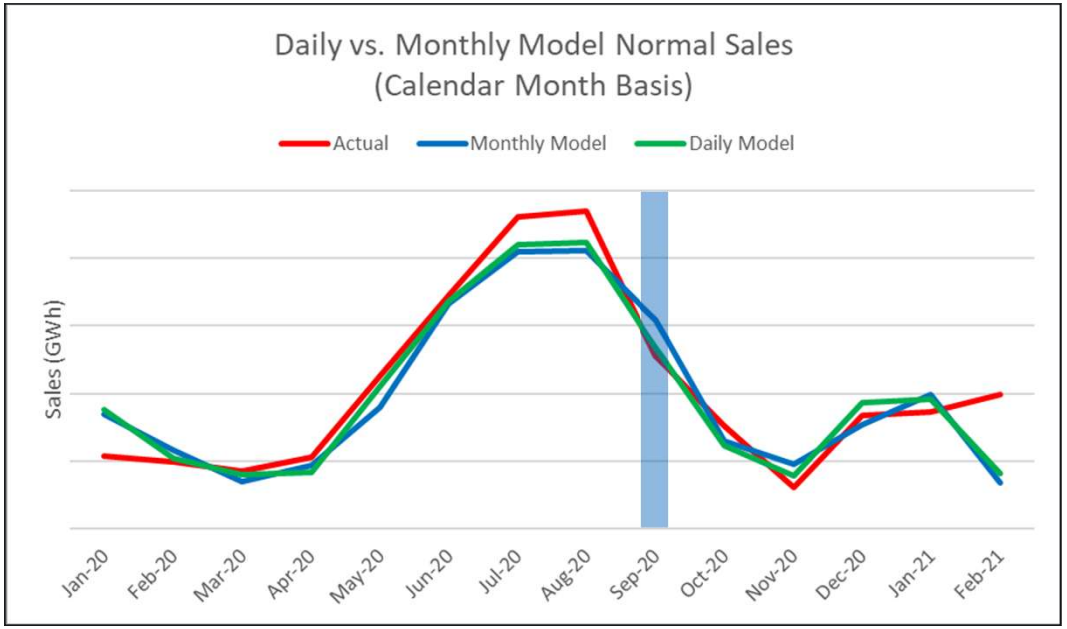
Residential Daily vs Monthly Weather Normalization



- Daily Approach:
  - Calendar month actual is the sum of daily AMI data
  - Calendar month adjustment is sum of daily adjustments
- Monthly Approach:
  - Revenue month models simulated to calendarize and normalize
- Conclusions:
  - Results are similar but…
  - Daily models go through fewer mathematical transformations
  - Daily approach is more accurate
  - Daily approach can capture unusual effects such as COVID and Outages

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AMI Data for COVID Impacts

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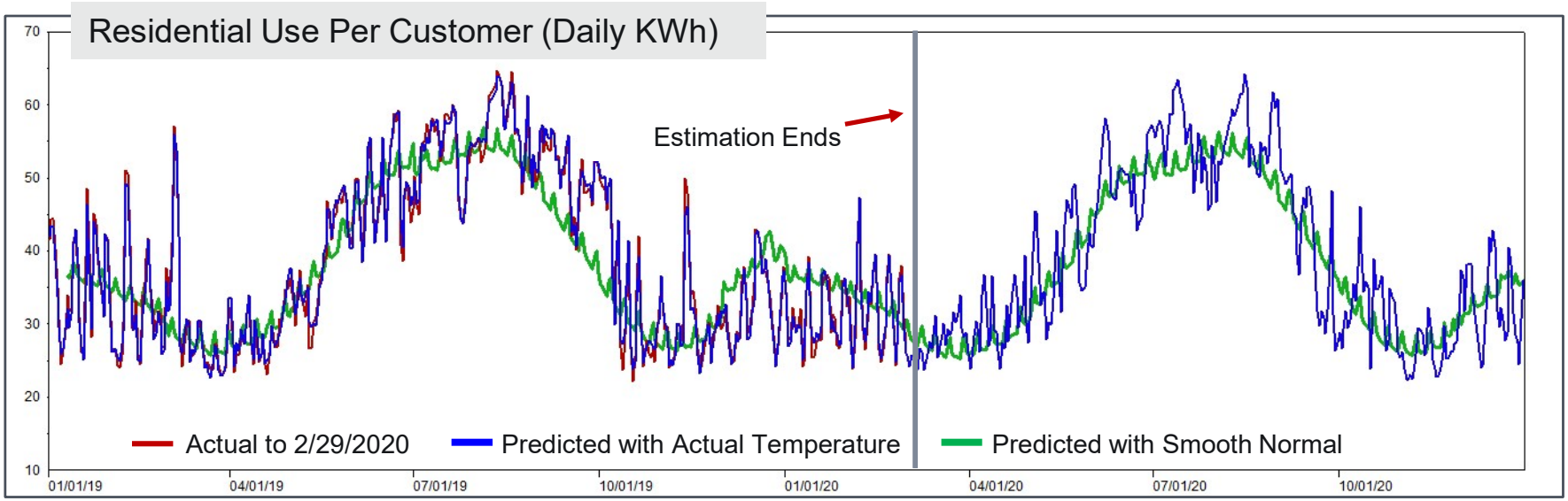
Using AMI Data to Estimate COVID Impacts

Daily Energy Model for Business-as-Usual Predictions:

- Daily sales forecasting model (as discussed above)
- Estimate 1/1/2017 to 2/29/2020
- Forecasts are “Business-as-Usual” (BAU) baseline values
- As we move through 2020, use model to compute predicted values with actual daily weather



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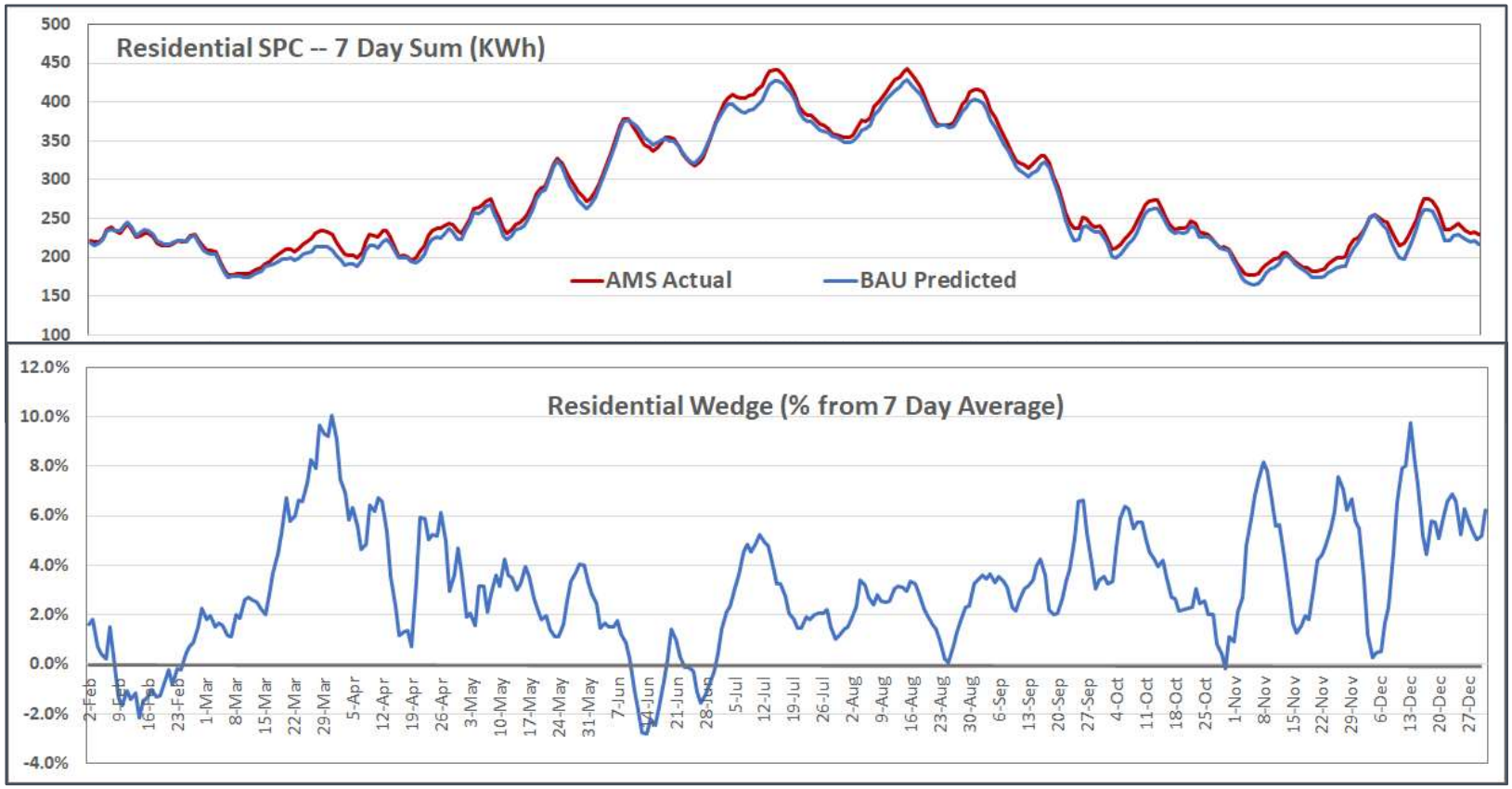
Analysis of Differences (BAU vs. Actual) – Residential



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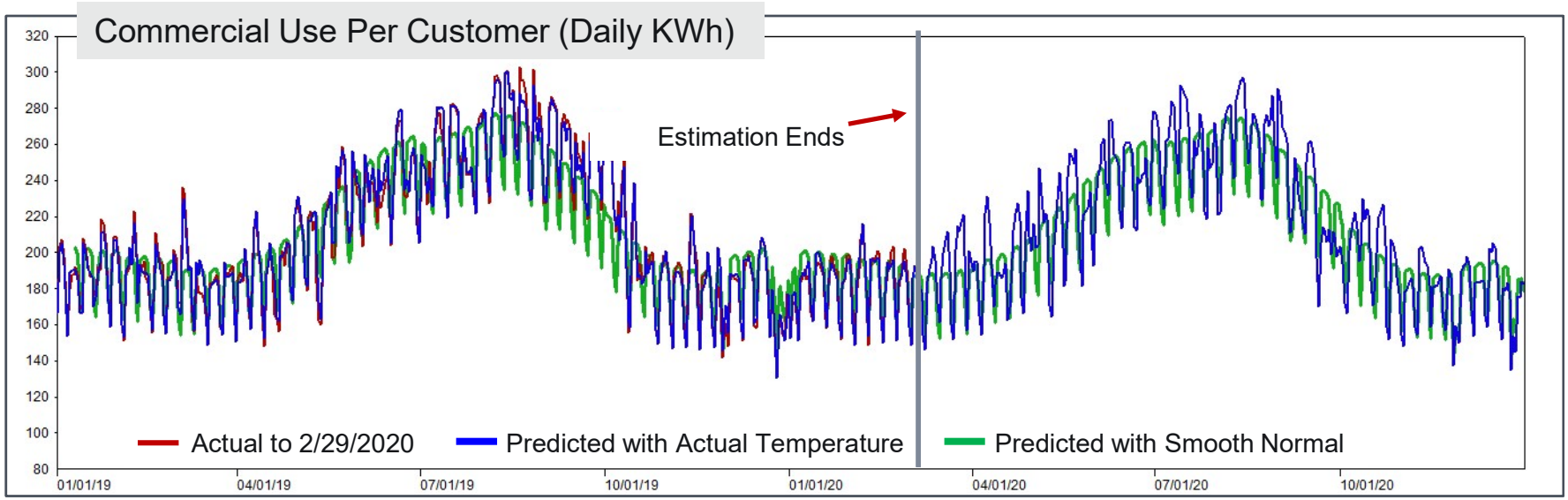
Commercial BAU Model

Daily Energy Model for Business-as-Usual Predictions:

- Daily sales forecasting model (as discussed above)
- Estimate 1/1/2017 to 2/29/2020
- Forecasts are “Business-as-Usual” (BAU) baseline values
- As we move through 2020, use model to compute predicted values with actual daily weather



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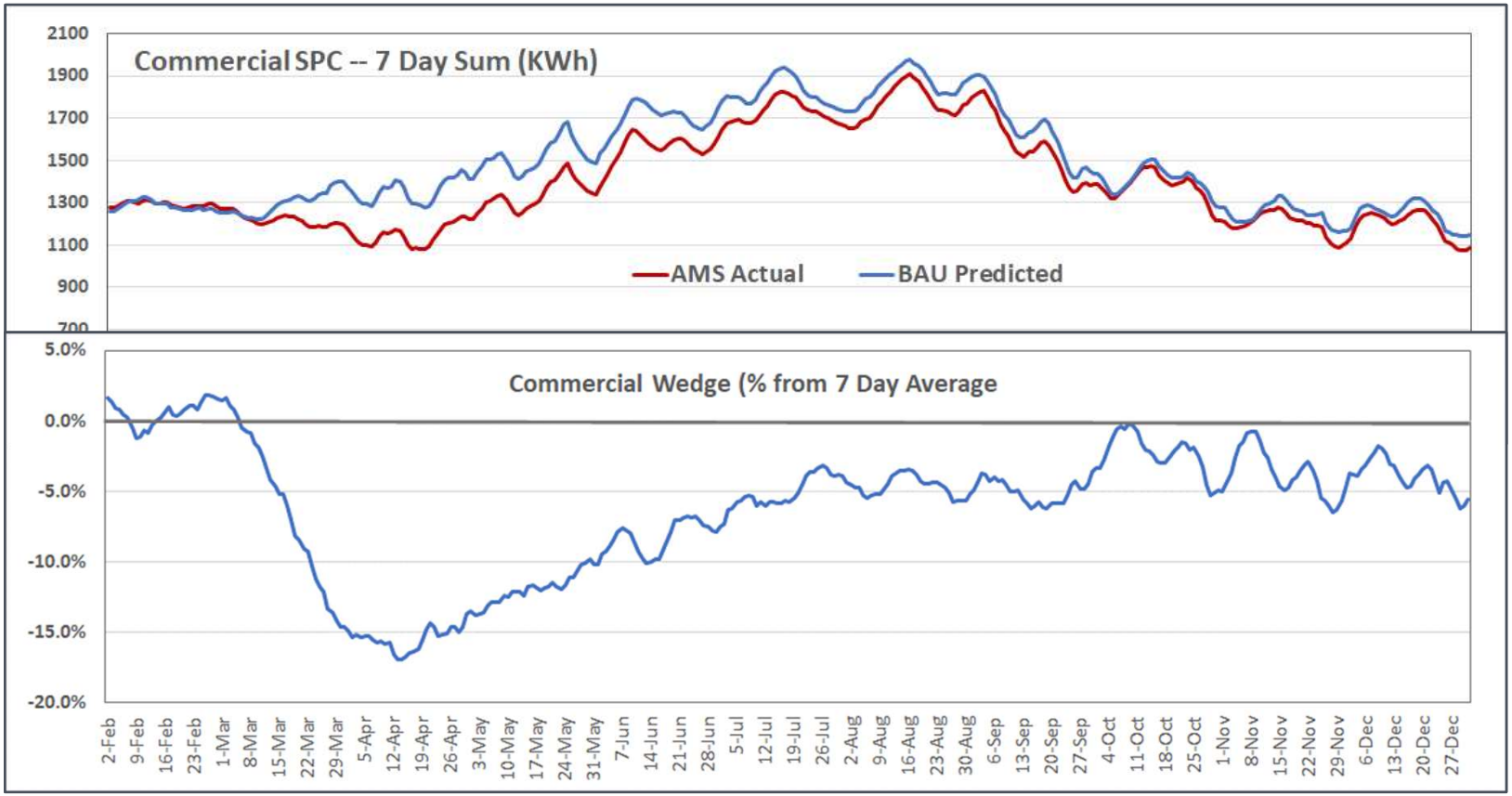
Analysis of Differences (BAU vs. Actual) – Commercial



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AMI Data for Extreme Event Impacts

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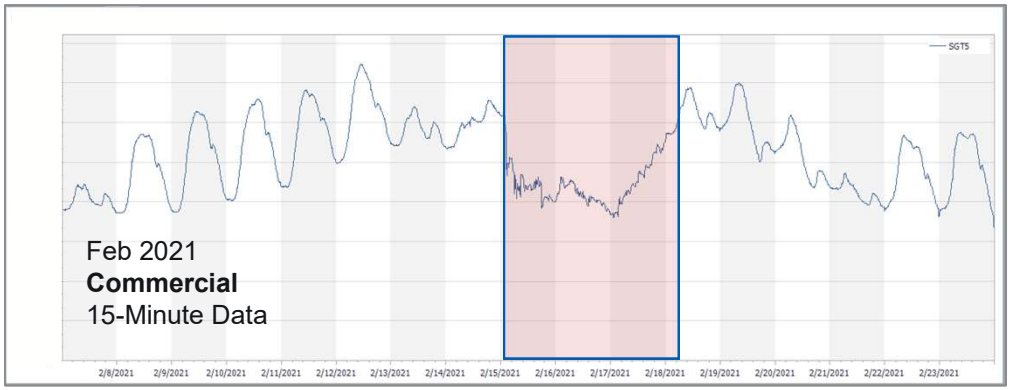
Evaluating Supply Side Disturbance

- Unusually cold weather Feb 15th – 19th
- Ensuing supply side disruptions
  - Rolling blackouts
- 15-minute data shows the disruption
- What was the impact of the event relative to baseline with COVID?

- Hourly AMI models give the answer
  - 24-hourly regression models
  - Estimated through Feb 13
  - Model predicts loads with COVID



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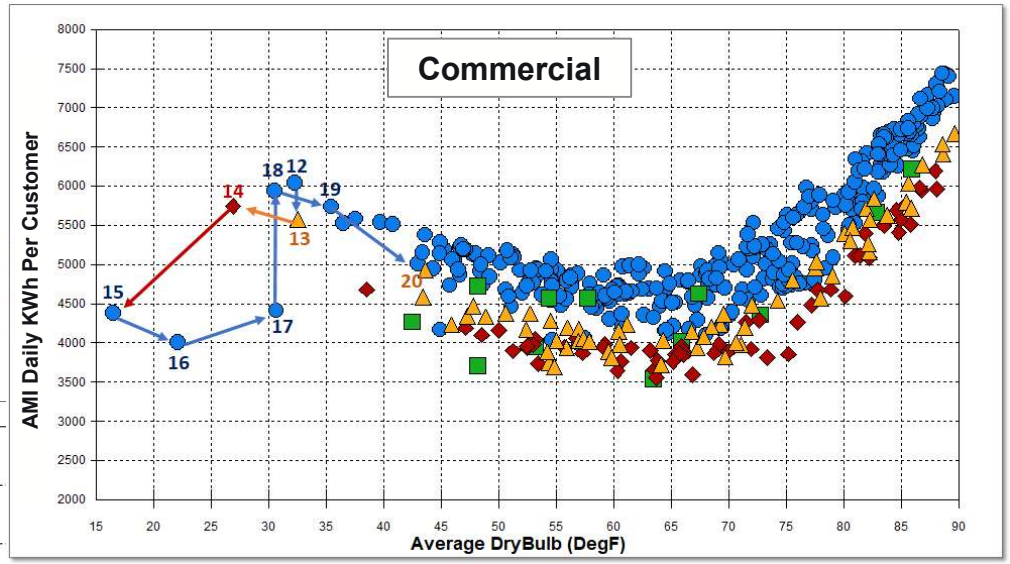
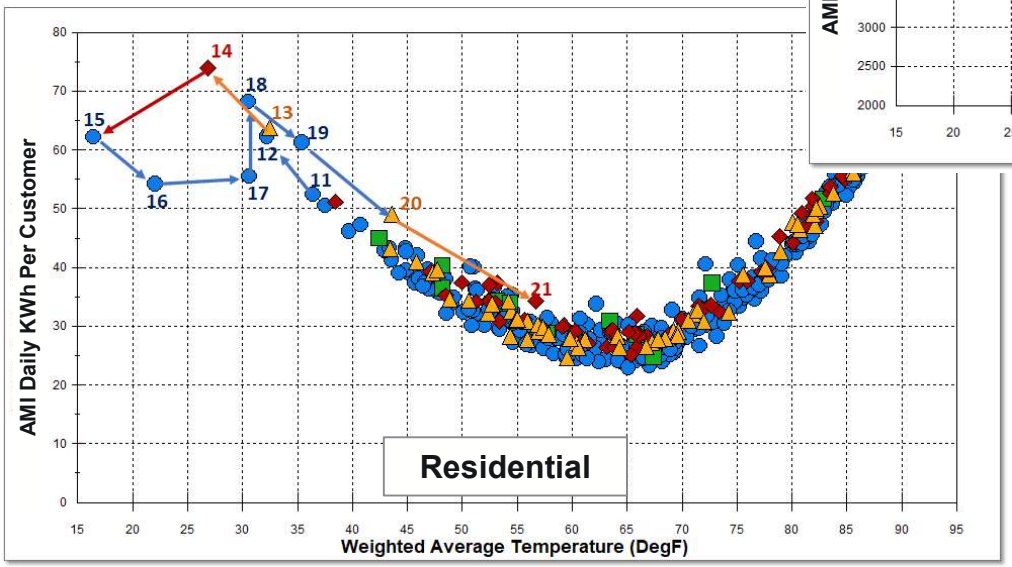
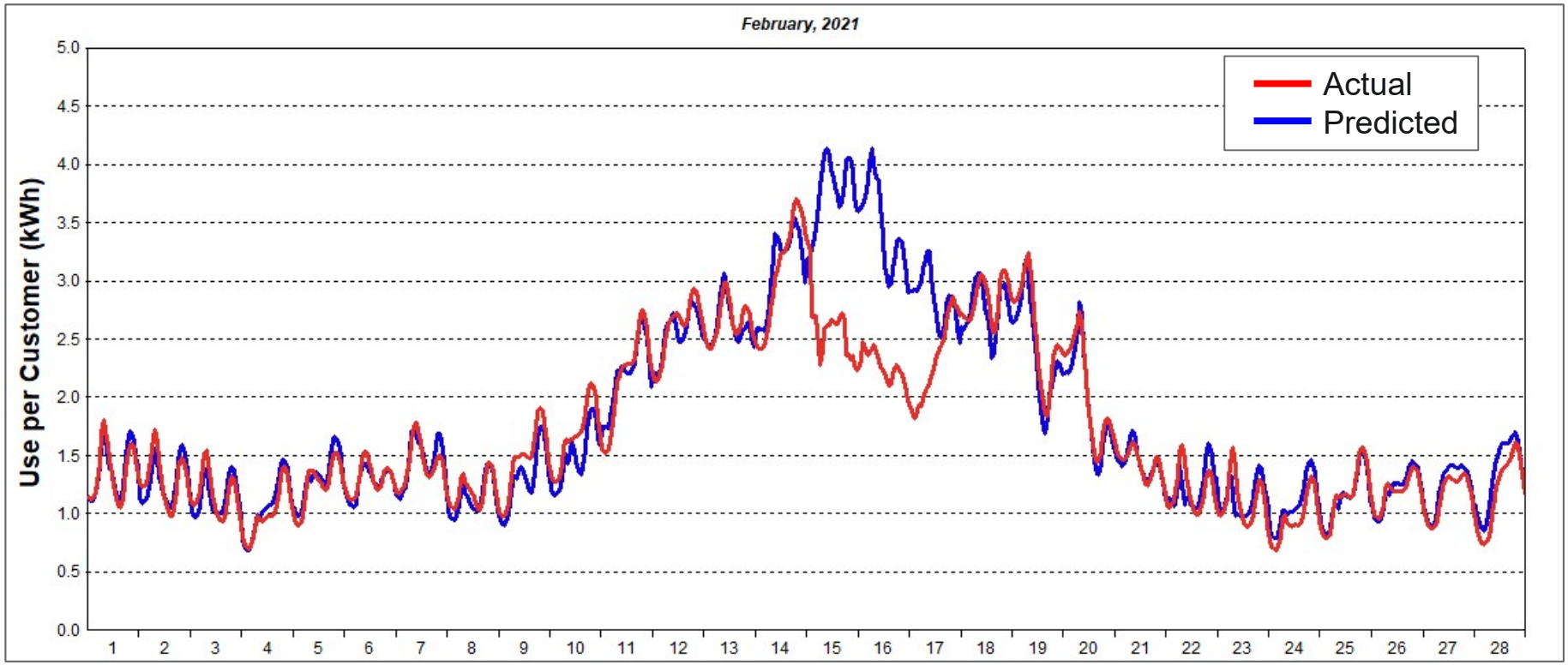
Daily View of Disturbance

» Scatterplots of AMI data show:
- The evolution of the event
- The extent of the modeling challenge





Estimated Outage Impacts: Residential



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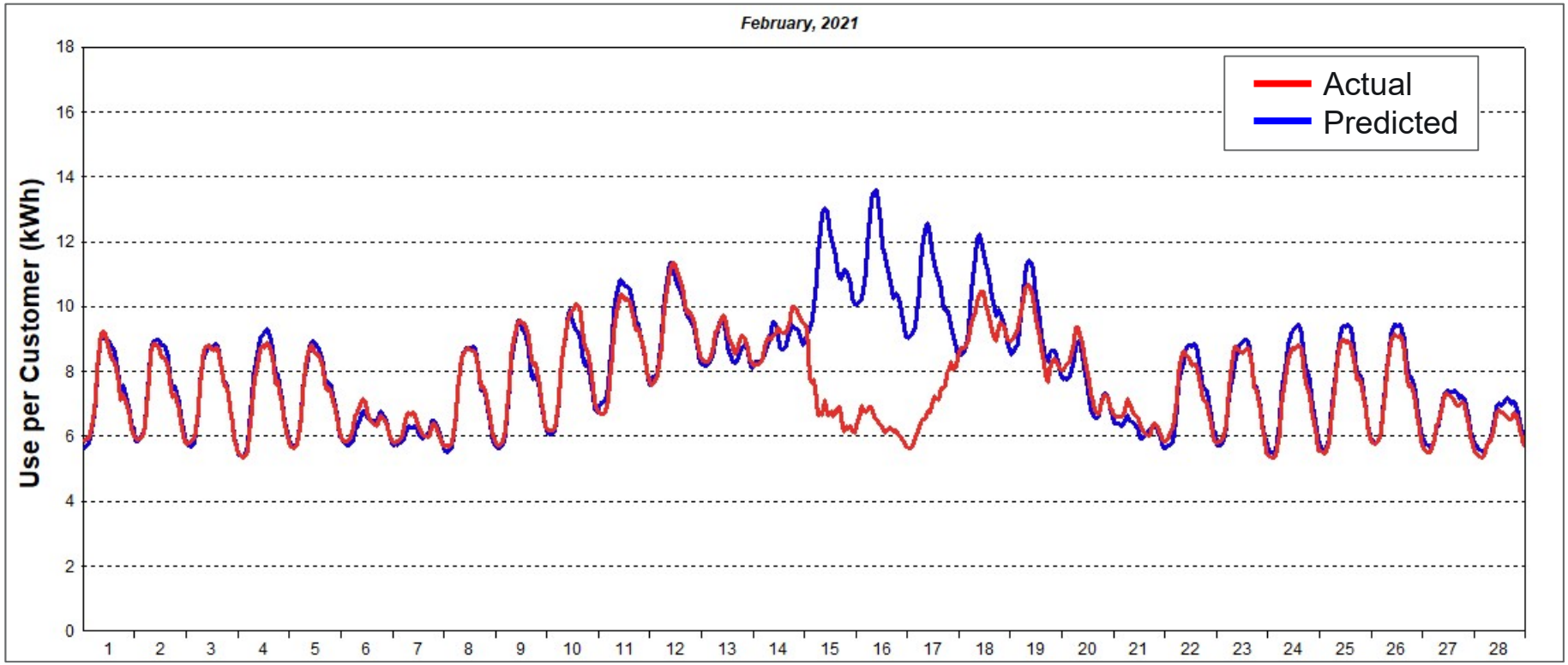
Estimated Outage Impacts: Commercial



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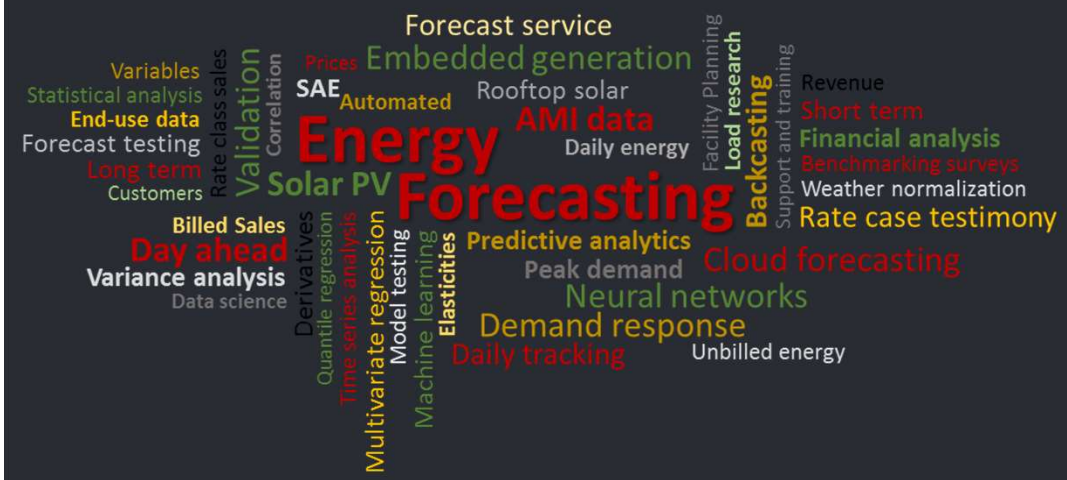

Thank You

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