FORECAST AND MANAGE ELECTRICAL MAXIMUM DEMAND

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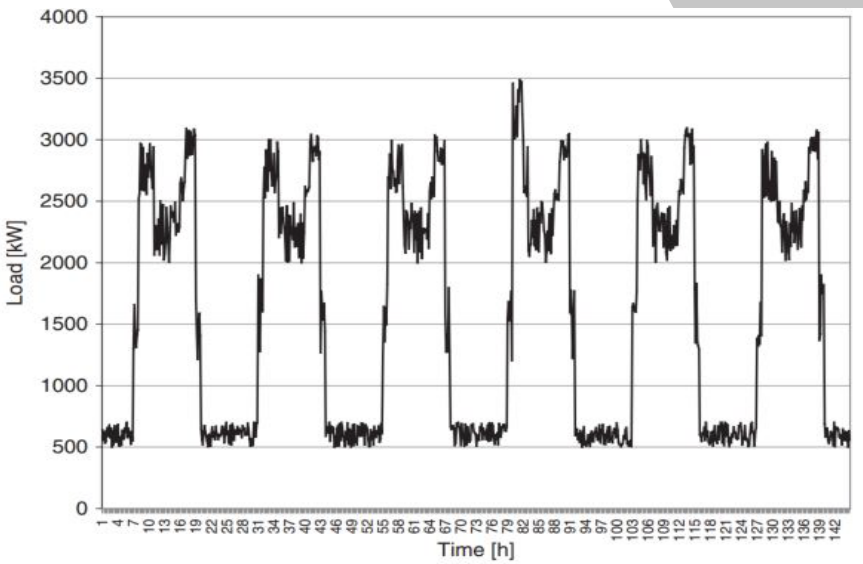
SUMMARY

- Introduction
  - Load Diagram
- Load Forecasting
  - Types
  - Benefits
- Methodology
  - Adaptive-Rate-of-Change (ARC)
- Demand Management System
- Case Study
- Result Analysis
- Conclusion
- Q&A

LOAD DIAGRAM

- **What is Load Diagram (also called Load Profile)?**
  - The curve showing the electric demand of an electric system as a function of time, on a daily, weekly, or monthly basis.

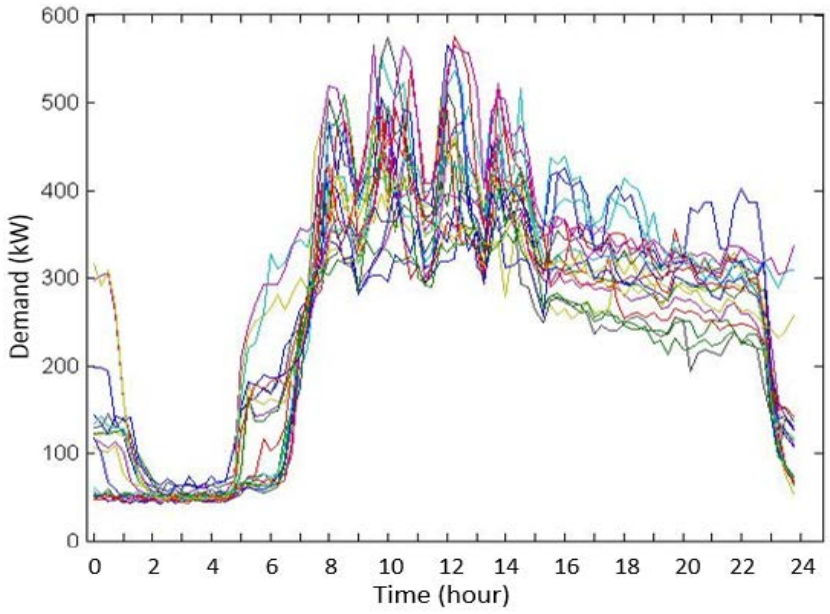
- **Why Load Diagram is important?**
  - Hours of operation
  - Daily schedule
  - Number of shifts
  - Occupied period
  - Procedure to start-up



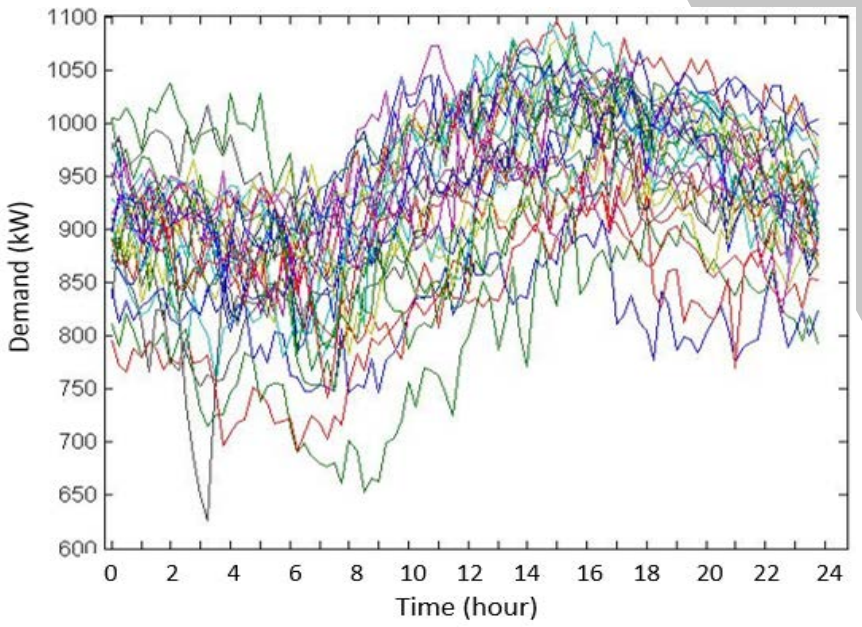
Weekly load diagram of a company working two shifts, six days a week

TYPICAL LOAD VS. NON-TYPICAL LOAD FOR A DAY

typical load pattern



Non-typical load pattern



LOAD FORECASTING TYPES

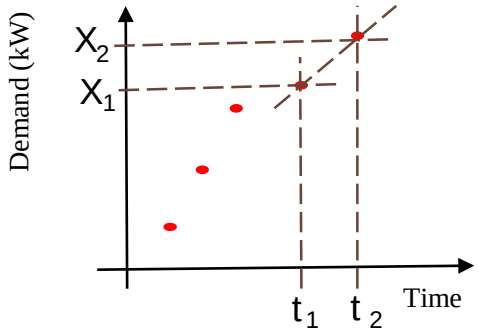
- **Types based on timescale**
  - Very short-term load forecasting (VSTLF) *an hour to several hours*
  - Short-term load forecasting (STLF) *hours to a day ahead*
  - Medium-term load forecasting (STLF) *one week to one year*
  - Long-term load forecasting (LTLF) *years to decades*

LOAD FORECASTING BENEFITS

- **Utility Side**
  - Assist demand dispatch to optimize peak load management and energy efficiency
  - Maintain demand capacity in order to avoid large investment on capacity expansion
- **Consumer Side**
  - Demand cost reduction
  - Provide clearer insight of operation via energy consumption monitoring

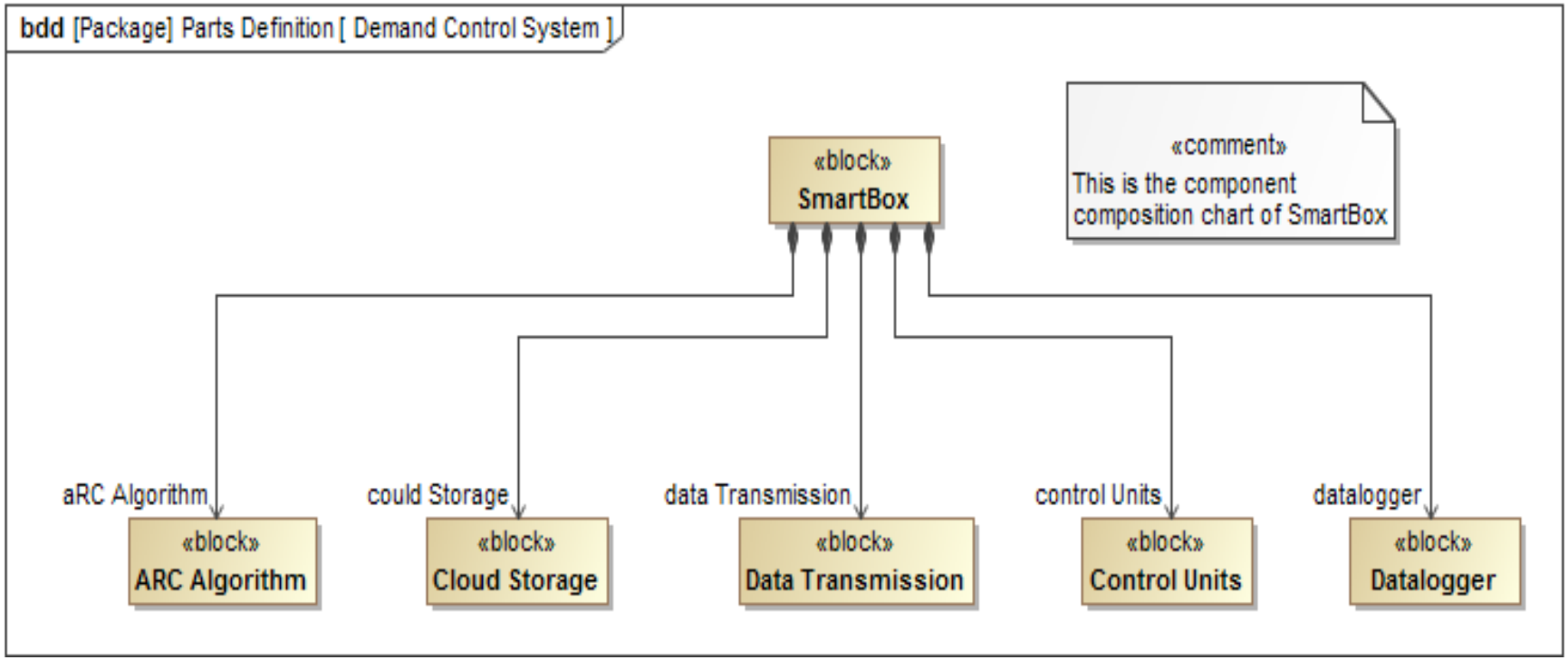
ADAPTIVE-RATE-OF-CHANGE (ARC) ALGORITHM

- Forecasting the time that the maximum daily demand would occur (Not the magnitude)
- A Rate-of-Change (ROC) methodology
- The only input is the historical demand data provided by utility provider
- Every local or global maximum demand is the last incident of a single or series of positive slope

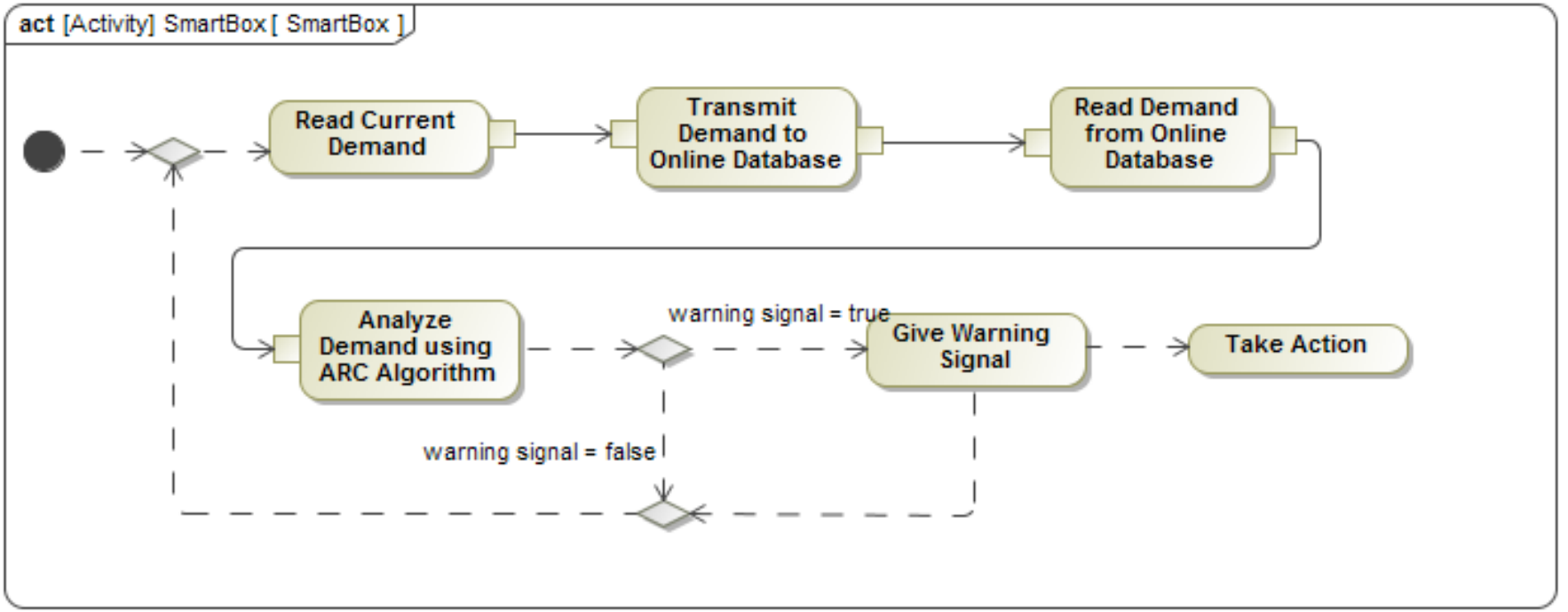


$$ROC = \frac{X_t - X_{t-1}}{t_t - t_{t-1}}$$

DEMAND MANAGEMENT SYSTEM



SYSTEM FLOWCHART



CASE STUDY I

- Case study I is a metal die casting company in Shelbyville, Indiana.
- Operating hours = 24/7
- Demand for this facility is being recorded every 30 min

Shift hours for case study I

Shift	Shift starts- Shift ends
1^{st}	6:30 AM- 3 PM
2^{nd}	2:30 PM- 11 PM
3^{rd}	10:30 PM- 7 AM

Cost breakdown for case study I in 2016

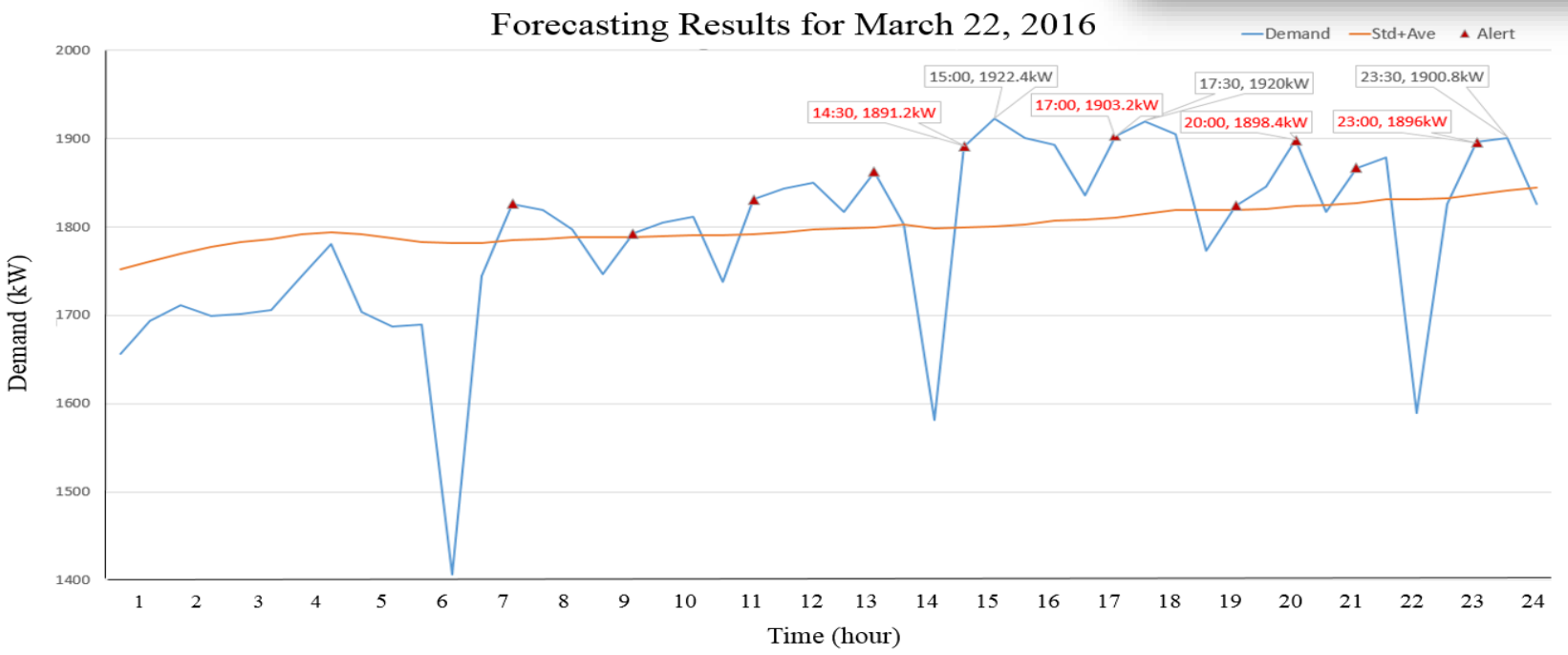
Demand Cost	Energy Cost	Total
$582,143	$405,610	$996,751
%58	%42	%100

CASE STUDY I

- Forecast peak demand for the last week in March 2016.

Forecasting results for case study I on Mar. 22, 2016

Demand (kW)	Actual Time	Forecasted Time	Success
1922.4	15:00	14:30	✓
1920	17:30	17:00	✓
1905.6	18:00	17:00	✓
1900.8	23:30	23:00	✓
1898.4	20:00	20:00	✓
1893.6	16:00	—	×



CASE STUDY II

- Case study II is a company produces sheet metal enclosures for generators located in Monticello, Indiana.
- Operating hours = 24/5
- Demand for this facility is being recorded every 15 min

Shift hours for case study II

Shift	Shift starts- Shift ends
1^{st}	7 AM- 3 PM
2^{nd}	3 PM- 11 PM
3^{rd}	11 PM- 7 AM

Cost breakdown for case study II in 2014-15

Demand Cost	Energy Cost	Total
$103,772	$92,266	$196,038
%53	%47	%100

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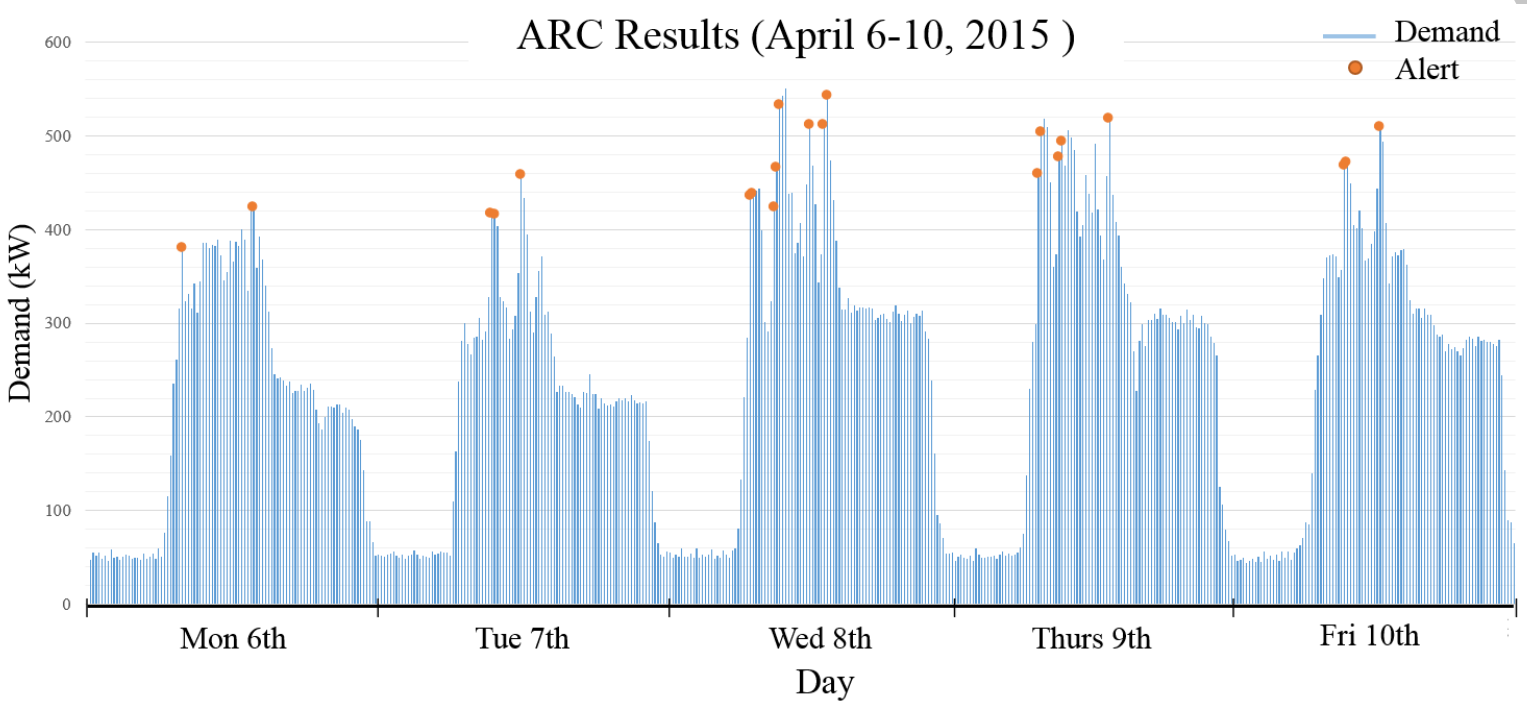
CASE STUDY II

- Forecast peak demand from April, 6th , 2015 to June, 26th , 2015.



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RESULT ANALYSIS

- Validation via Pearson's Chi-squared test.
- 72 operating days = 6,912 demand data.
- 84.72% of MDD have been forecasted.
- 15.28% of MDD have been missed.
- 116 times method issues undesired signals. They might include local maximums throughout a day.
- The ARC algorithm has the potential to save 5% ($20k) of the annual demand cost in this case.

Data * Prediction Cross tabulation

			Prediction		***Total***
			0	*1 (Peak)*	
Data	0	Count	6724	116	6840
		% within Prediction	***98.30%***	1.70%	100.00%
		% within Data	99.84%	65.54%	98.96%
		% of Total	97.28%	1.68%	98.96%
	1 (Peak)	Count	11	61	72
		% within Prediction	15.28%	***84.72%***	100.00%
		% within Data	0.16%	34.46%	1.04%
		% of Total	0.16%	0.88%	1.04%
Total		Count	6735	177	6912
		% within Data	97.44%	2.56%	100.00%
		% within Prediction	100.00%	100.00%	100.00%
		% of Total	97.44%	2.56%	100.00%

CONCLUSION

- The proposed forecasting algorithm has the simplicity that not only needs less input but also runs faster.
- The proposed method has been validated by using chi-square method and shown to be accurate for VSTLF, STLF, and MTLF.
- The ARC algorithm is adaptive to the growing and dynamic systems (i.e., increasing production, or expanding the electric network in the facility).
- The integrated management system can help both the consumers and utility providers to manage maximum demands.

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Thank you!

QUESTIONS?

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