



Small Customer Aggregations in CCAs

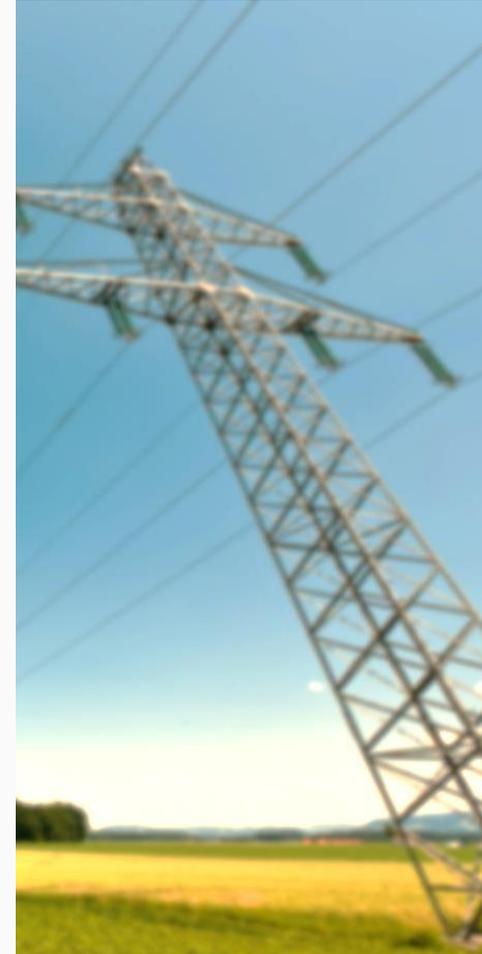
June 1, 2017

1. Goals

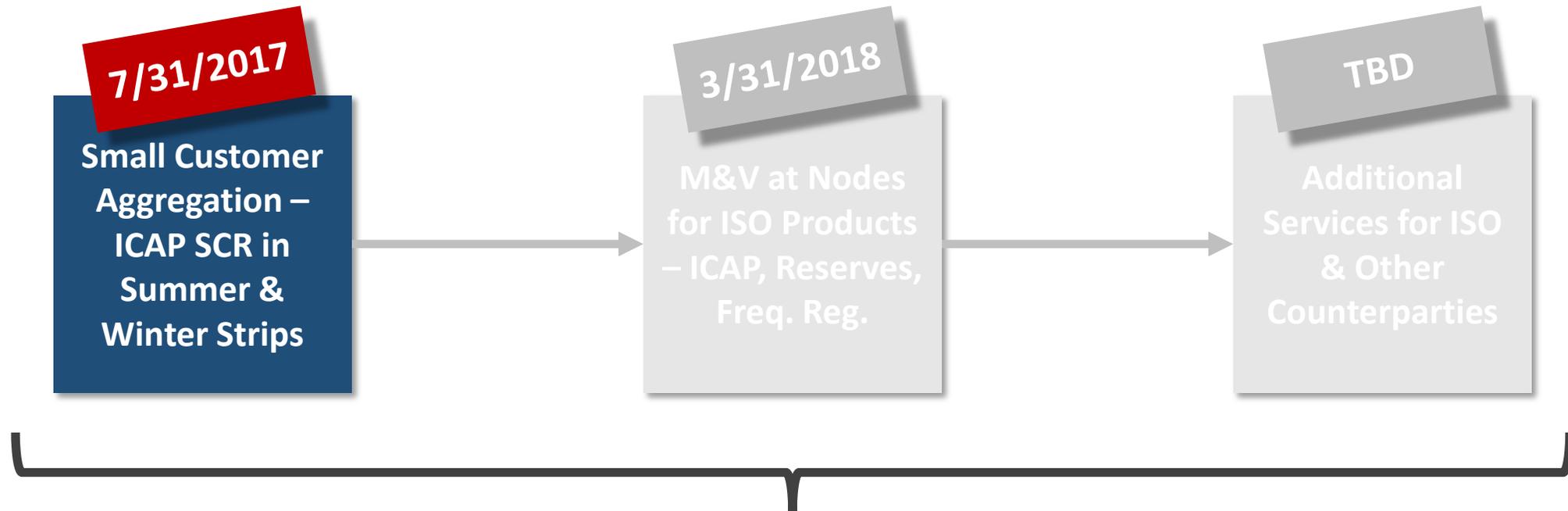
2. Customer Overview

3. Implementation

4. Example



Goals



for comment and discussion...

- Joule Assets represents residential and municipal clients in a transparent (showing ALL market cash flows) and aligned manner (retaining a transparent share of market revenues)
- We aim to expand to other ancillary services with Small Customer Aggregations in the future (2018)

Customer Overview

SCAs for CCAs & Microgrids



- *Joule serves as CCA Administrator and works in partnership with community-based Local Organizer in each CCA region*
 - Local Organizer:
 - Convenes and builds consensus amongst local officials and community leaders
 - Spearheads public engagement and education
 - Identifies and signs customers for participation in DR programs
 - Post-launch: staffing, customer relations, program expansion
- *Joule led implementation of Westchester Power, first CCA in NYS*
 - Launched May 2016
 - Serving 105,000 customers in 20 Westchester communities
- *Issuing solicitations for commodity procurement on behalf of 100,000+ consumers in Q4 '17 and Q1 '18*
- *Joule is serving as DR provider on two NY Prize microgrid projects in Freeport and Albany*

Customer Overview

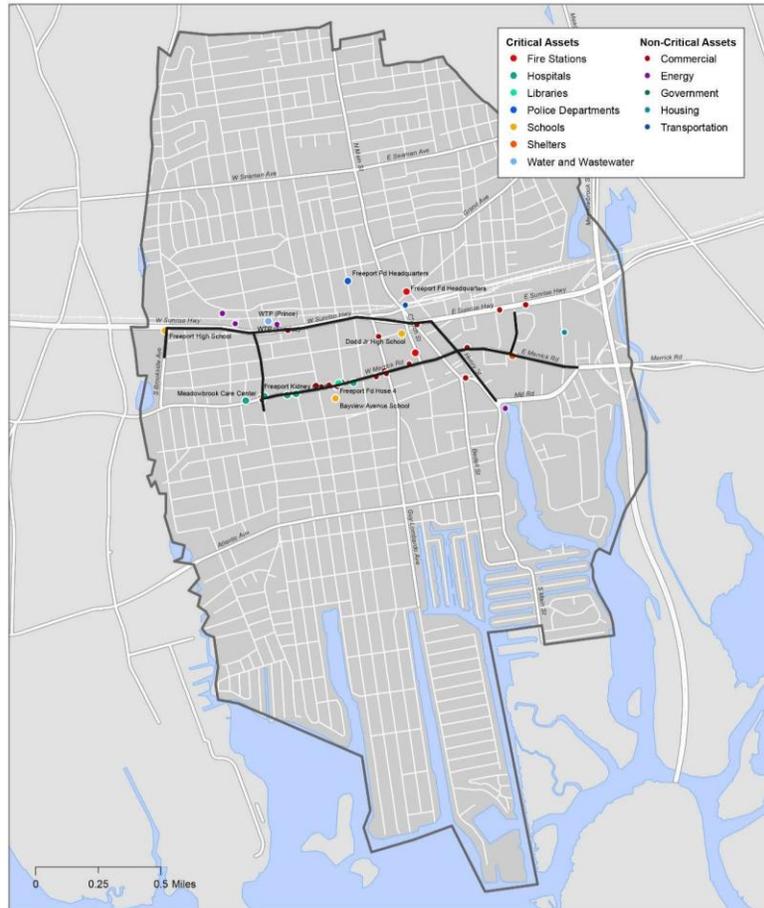
CCAs & Micro-grids



Capacity Zone	Client Households	Identified Participants	Participants w/Electric Heat (subset of last column)
ROS	102515	2772	398
LHV	190019	3173	413
Zone J	46750	834	68
Zone K	38375	1289	207

Customer Overview

Microgrids



Freeport Microgrid
Assets

— Microgrid Boundary

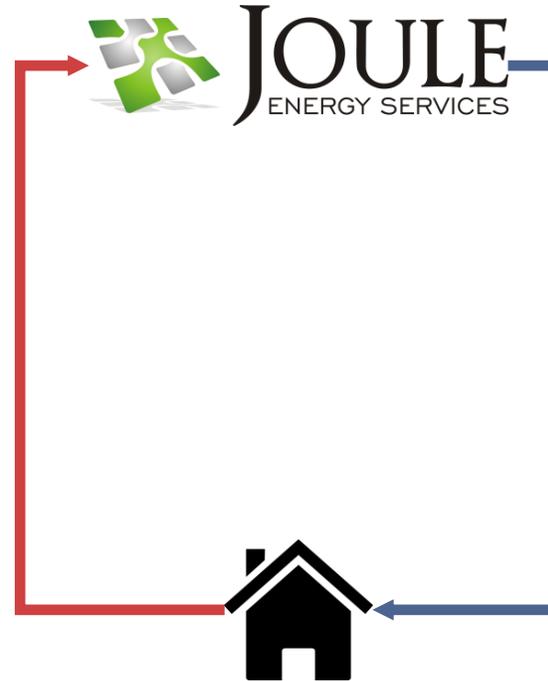


Albany Microgrid

Customer Overview

Thermostat

1. Customer signs agreement & completed questionnaire, which includes:
 - a. Address
 - b. Utility Account Number or ID number
 - c. Event contact information
 - d. Square footage estimate or pull down menu of house descriptions to estimate square footage.
 - e. Current thermostat
 - f. What your thermostat controls: heating, cooling, or both
 - g. Instructions for authorizing Joule's access



2. Joule controls thermostat remotely via its API access
 - a. When NYISO or other Market Participant calls Joule, Joule sends API signal to each control point and notifies each participant by text message and/or email.
 - b. Customer receives text/emails notifying of event
 - c. Set point is **increased by 5°**
 - d. When event is over, Joule makes second API call
 - e. During event, any **set point changes are recorded in database, available for ISO audit.**

Customer Overview

Thermostat Authorization Instructions



Example for Honeywell RTH Series Wi-Fi Thermostats

Please provide us with the following information from your thermostat ID card. This information can also be found on the back of your thermostat:

MAC ID#: _____

MAC CRC#: _____



We this information, we will be able to connect to their thermostat through Honeywell's servers.

We will access this through Honeywell's APIs, but thermostat data will be stored on Joule's servers.

API calls and thermostat communication will be done by Joule.

Customer Overview

Data Storage

Meter data storage and security will be handled by MDSP. Joule will have backup data stored locally.

Thermostat data and feedback data will be stored on servers of a third party host (i.e. Amazon) and a backup will be stored locally.

Data includes set points during events, event dates and times, thermostat credentials, customer feedback after events, and questionnaire responses.



Customer Overview

Thermostat

1. Customer signs agreement & completed questionnaire, which includes:
 - a. *Address*
 - b. *Utility Account Number or ID number*
 - c. *Event contact information*
 - d. *Square footage estimate or pull down menu of house descriptions to estimate square footage.*
 - e. *Current thermostat*
 - f. *What your thermostat controls: heating, cooling, or both (determines if you're put in summer and/or winter periods)*
 - g. *Instructions for authorizing Joule's access*

NOTE:

Participants will be broken into groups based on square footage:

1. < 1000 sq. ft.
2. 1000 – 3000 sq. ft.
3. > 3000 sq. ft.

...and Capacity Zone.

Sampling must be done separately in each group.

more on this shortly...

Customer Overview



Metering



Joule's approach to MDSPs is open source—we use those who qualify in the wake of RFQ issued in May. Currently qualified MDSPs are:

- Enetics, Inc. (Model #: XXXXXX)
- Energy Tracking, LLC (Model #: XXXXXX)
- A2A Energy (Model #: XXXXXX)



- ✓ *Baseline calculations & other administrative procedures all done according to NYISO ICAP-SCR requirements (mix of CBL & ACL, outlined on the next slide)*

- ✓ *All sites chosen for meters must meet all ICAP-SCR requirements, including ANSI C12 metering*
- ✓ *Those without meters must meet all requirements other than metering*

Customer Overview



Baseline

Note About Baselines:

Joule intends to baseline using ACL method as early as possible. This means using CBL method for one like availability period until meters have ACL. This will mean that meters added to the sample will be contributing CBL numbers to a mean and meters with 1+ periods (by winter/summer) will be contributing ACL numbers.

Alternatively, we could simplify and use CBL

Customer Overview



Services

One Customer Feedback:

“We didn’t event notice.”

Average: ~50% of load curtailed,

Worst: ~20% of load curtailed

Best: ~60% of load curtailed

Graph to go here:

“Sample Residential Meter Data on Day of Event”

Our Calculations conservatively project 1 kW of curtailment per thermostat & 1.2 kW per thermostat for a large one-zone home. This will be applied to both heating and cooling loads.

Customer Overview

Approach

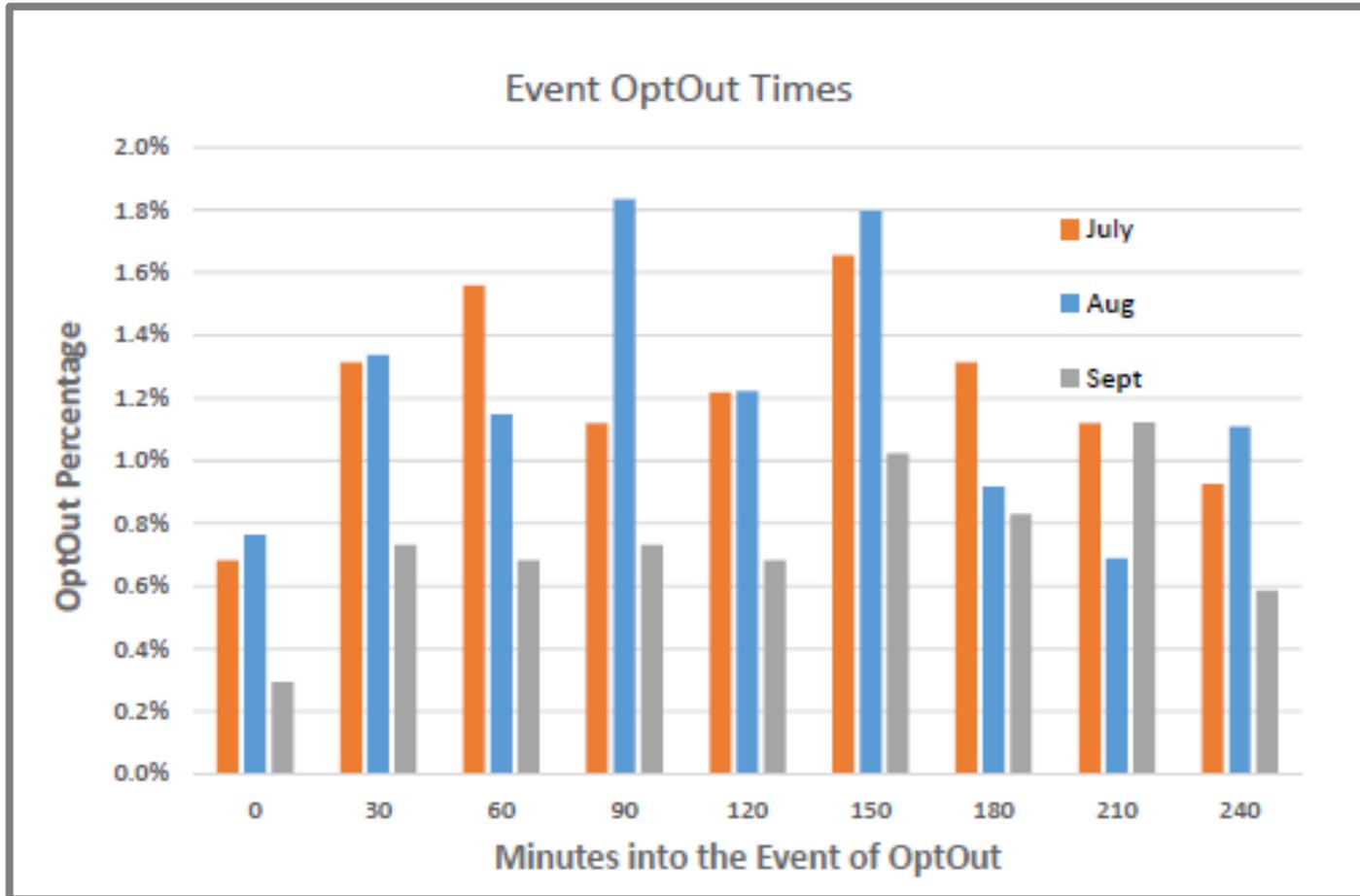


- During an event, if a set point is reduced, it will be moved back to its curtailment-level set point 90 minutes later.
- This will continue for the entire event.
- Our experience shows that opt-out rates increase ~10X when those who opted out are called again 90 minutes later

Customer Overview

Approach

2016 Opt-Out Rates for Residential DR in Mass.

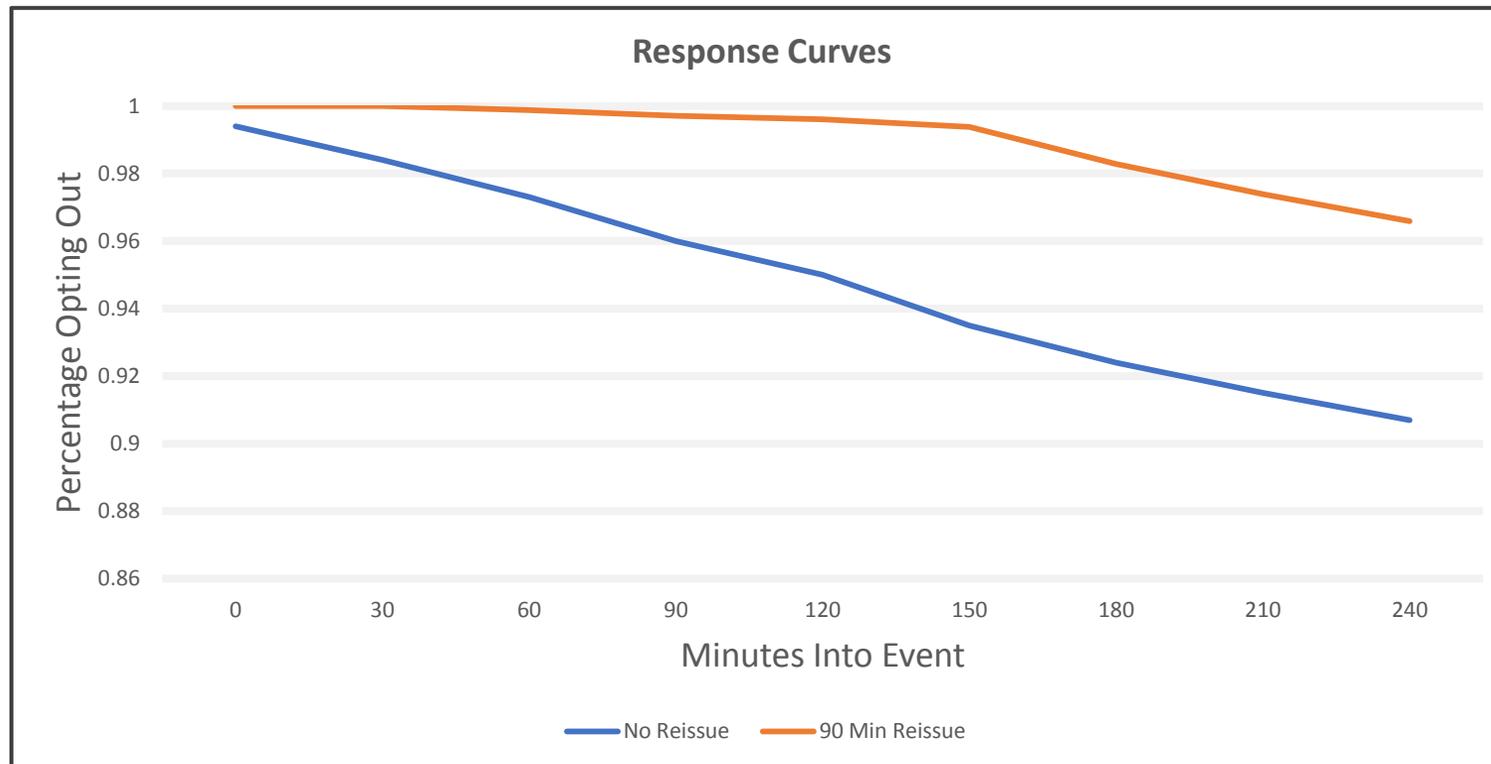


- Without 90 minute reissue of control signal, simple **opt-out rate is projected to be 10.2%**
- Using these numbers and our opt-out assumptions from the previous slide, we would expect a **final opt-out rate of about 3.5%**

Customer Overview

Approach

With 90 minute reissue of control signal, opt-outs (for those customers reissued) increase a shade less than 10X, yielding the following response curves:



➤ *We will also add reserve margins to these numbers, to achieve as close to 100% performance as is possible*

Implementation

Note: taken extensively from PJM

Implementation

Sampling Procedure

$$\text{Sample Size} = \left(\frac{Z_{\frac{\alpha}{2}}}{t} \right)^2 \frac{\text{Variance}}{\text{Margin}^2}$$

where:

$$Z_{\frac{\alpha}{2}} = 1.645 \text{ for } 90\% \text{ confidence } (\alpha=0.1)$$

$$\frac{\text{Variance}}{\text{Mean}^2} = \text{Coefficient of Variation}$$

Measures how dispersed values are.

In a simple variance study, say where we only have two values “yes” and “no”, the coefficient of variation will be 50% and sample size would generally get as high as about 68.

- Formulas taken directly from PJM’s Residential DR Sampling Program
- Are also frequently used when designing surveys
- PJM sample sizes usually end up being about **150 – 180**

Implementation

Sampling Procedure

1. *Collect hourly interval data from 75 randomly selected customers in each load zone*
2. Calculate mean and variance for each interval
3. Calculate sample size needed for 10% error at 90% confidence by interval
4. Average across intervals to determine final sample size

- Randomization means NYISO chooses customers from our pre-stratified customer list

- All customer contracts and questionnaire information can be audited by NYISO at any time without notice

Implementation

Sampling Procedure

1. Collect hourly interval data from 75 randomly selected customers in each load zone
2. *Calculate mean and variance for each interval*
3. Calculate sample size needed for 10% error at 90% confidence by interval
4. Average across intervals to determine final sample size

$Mean(X_t)$ = average hourly demand each hour of all customers

$$= \frac{1}{n} \sum_{i=1}^n X_{i,t}$$

$Avg\ Variance(X_t)$ = average of difference from mean, squared, per hour of all customers

$$= \frac{1}{n} \sum_{i=1}^n (X_{i,t} - Mean(X_t))^2$$

Implementation

Sampling Procedure

1. Collect hourly interval data from 75 randomly selected customers in each load zone
2. Calculate mean and variance for each interval
3. *Calculate sample size needed for 10% error at 90% confidence by interval*
4. Average across intervals to determine final sample size

$$\text{Sample Size By Interval} = \left(\frac{Z_{\frac{\alpha}{2}}}{e} \right)^2 \frac{\text{Variance}}{\text{Mean}^2}$$

where:

$$Z_{\frac{\alpha}{2}} = 1.645 \text{ for 90\% confidence } (\alpha=0.1)$$

$$e = 0.1 \text{ (10\% error)}$$

Implementation

Sampling Procedure



Spreadsheet Example for 75 Customers:

Please provide input (EDC account load data) and calculation used to determine sample size that will provide for 90% Confidence and 10% precision																																			
Results																																			
Sample intervals	745																																		
Sample size =	46																																		
Hourly Sample size										Data Input Below																									
N	mean	mean ²	variance	a	b	n = a*b	Date	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	EDCAcc	
75	3.73	13.88	2.33	270.60	0.17	45.50	7/15 0:00	2.03	4.68	5.24	3.27	5.00	3.88	4.17	5.97	2.55	4.93	4.06	1.64	5.14	1.76	4.69	1.44	5.99	4.99	5.03	3.80	4.04	5.83	4.82	4.13	2.48	5.54	3.25	2.40
75	3.45	11.87	1.96	270.60	0.17	44.69	7/15 1:00	5.34	4.43	4.03	5.98	3.08	3.23	2.87	2.14	2.53	4.72	1.23	2.42	3.85	4.44	5.80	2.58	2.69	4.58	4.61	5.97	3.08	2.73	3.32	1.78	3.83	4.69	4.80	1.63
75	3.49	12.20	2.09	270.60	0.17	46.40	7/15 2:00	2.89	1.86	2.40	4.47	1.33	5.23	2.39	5.53	3.30	5.47	3.87	5.61	3.19	2.41	3.53	4.79	2.82	4.01	3.16	1.37	1.48	5.08	4.10	2.58	5.85	2.36	1.33	2.49
75	3.60	12.95	2.09	270.60	0.16	43.70	7/15 3:00	4.75	4.27	3.19	4.30	5.24	5.57	2.58	4.59	3.16	4.73	3.19	1.27	3.85	3.73	3.10	4.40	1.93	4.33	1.81	4.79	5.47	5.56	5.77	3.12	1.15	1.22	1.09	4.84
75	3.57	12.74	1.86	270.60	0.15	39.46	7/15 4:00	1.97	5.72	4.86	3.07	5.28	4.57	4.46	5.03	5.62	4.20	4.92	2.16	4.28	5.27	3.12	1.31	4.87	2.83	4.66	3.88	2.48	2.70	2.02	5.25	1.31	4.63	1.56	2.69
75	3.31	10.96	1.98	270.60	0.18	48.79	7/15 5:00	2.20	1.52	3.81	1.33	3.62	1.77	4.36	3.03	3.41	3.36	5.03	3.15	2.69	1.18	4.92	2.85	2.30	1.30	1.77	3.30	2.85	2.88	1.86	2.29	5.18	1.32	5.18	2.08
75	3.57	12.78	2.11	270.60	0.16	44.59	7/15 6:00	1.56	1.22	1.84	5.26	5.80	2.79	5.42	4.38	2.80	4.97	4.59	5.08	5.93	5.05	3.33	2.83	2.49	5.26	5.70	1.91	4.29	1.91	5.02	1.56	3.86	1.71	5.53	2.93
75	3.45	11.94	2.07	270.60	0.17	47.04	7/15 7:00	2.48	2.00	5.03	2.16	5.61	2.10	4.59	1.95	2.81	5.17	3.58	1.39	5.83	4.80	1.11	2.49	5.97	4.43	3.04	5.75	3.28	4.02	3.87	5.42	5.00	4.56	2.18	2.10
75	3.55	12.58	2.06	270.60	0.16	44.37	7/15 8:00	4.67	5.57	2.58	3.10	3.33	1.83	4.67	3.64	1.21	1.13	5.84	4.61	5.94	3.58	1.32	2.30	1.49	2.97	4.35	2.29	5.21	3.52	2.47	3.31	2.47	3.13	3.21	1.18
75	3.10	9.62	2.20	270.60	0.23	61.87	7/15 9:00	1.12	1.57	2.98	2.48	2.41	5.84	2.32	5.99	1.01	3.28	4.33	1.84	3.63	2.53	2.40	1.75	2.25	4.74	4.11	1.76	2.44	1.51	1.02	1.61	4.73	2.59	5.75	4.92
75	3.41	11.63	1.88	270.60	0.16	43.85	7/15 10:00	2.65	1.47	2.88	2.23	4.19	3.03	1.62	3.13	4.09	1.99	2.89	3.50	3.21	3.55	5.40	5.62	2.64	4.84	2.32	4.10	3.97	5.30	1.40	1.48	2.29	5.70	2.03	1.20
75	3.27	10.72	2.02	270.60	0.19	51.01	7/15 11:00	3.61	2.60	4.21	3.92	4.98	2.89	2.57	5.95	5.31	1.99	5.34	2.61	2.75	2.08	4.28	1.08	1.66	5.13	1.37	2.73	4.20	1.94	3.13	2.51	4.57	3.53	1.14	4.58
75	3.41	11.65	2.15	270.60	0.18	49.92	7/15 12:00	4.17	2.50	1.26	4.25	2.09	3.82	2.19	1.64	2.03	2.85	2.80	3.20	3.36	2.64	5.16	3.39	5.59	4.54	4.78	2.68	5.27	3.85	2.06	1.58	3.60	3.21	1.54	1.78
75	3.50	12.25	2.20	270.60	0.18	48.51	7/15 13:00	5.93	4.21	4.29	2.70	3.94	1.12	2.75	1.53	1.28	3.72	5.49	1.83	2.48	3.63	2.26	4.71	2.62	2.29	5.47	5.10	2.96	4.48	4.39	3.17	1.63	5.41	2.89	4.87
75	3.52	12.37	2.02	270.60	0.16	44.13	7/15 14:00	2.01	3.23	2.08	4.59	5.28	3.78	5.72	1.18	4.52	3.26	4.95	4.90	1.56	3.13	1.56	2.38	3.46	4.34	1.51	5.57	1.50	2.71	1.83	3.65	3.50	3.34	4.19	4.45
75	3.35	11.24	1.98	270.60	0.18	47.67	7/15 15:00	1.81	4.26	3.30	3.66	1.91	4.64	2.31	5.77	1.97	1.48	3.07	3.96	2.24	1.84	5.93	4.46	4.27	5.14	2.88	5.25	1.40	3.69	1.89	3.70	2.23	5.97	5.53	3.89
75	3.54	12.50	2.24	270.60	0.18	48.46	7/15 16:00	2.21	5.34	2.75	3.46	1.01	2.71	2.60	3.86	5.29	1.88	5.14	4.48	5.34	1.24	4.41	5.13	2.37	5.87	1.24	2.25	4.06	3.41	5.86	2.79	5.02	1.95	2.51	4.64
75	3.36	11.32	2.19	270.60	0.19	52.35	7/15 17:00	5.86	2.74	2.87	3.25	2.98	2.46	1.14	5.27	3.52	1.31	3.06	1.61	3.73	1.73	5.05	4.94	5.94	1.41	1.92	2.36	3.07	3.45	4.38	5.27	1.28	1.65	3.08	5.67
75	3.30	10.87	2.18	270.60	0.20	54.33	7/15 18:00	2.13	1.43	2.08	2.27	5.23	2.97	3.74	5.33	4.33	5.84	4.76	1.75	2.98	3.86	1.64	2.37	5.02	3.49	4.12	5.90	2.80	5.49	1.84	4.46	4.44	2.16	2.44	2.91
75	3.77	14.21	2.26	270.60	0.16	43.01	7/15 19:00	4.86	5.39	3.09	3.01	1.95	5.57	2.20	4.62	3.59	4.68	4.66	5.49	4.93	2.13	4.72	5.48	5.28	5.19	5.41	3.92	1.45	5.93	1.29	2.27	4.58	4.35	4.49	1.61
75	3.55	12.64	2.50	270.60	0.20	53.43	7/15 20:00	2.30	1.72	5.35	3.16	3.12	3.23	2.30	4.51	1.83	1.61	4.36	2.41	5.76	5.77	5.45	1.03	3.56	5.50	2.33	4.15	5.30	3.41	1.97	3.85	5.11	2.33	1.36	1.61
75	3.01	9.06	1.77	270.60	0.20	52.86	7/15 21:00	3.22	2.05	3.11	3.54	3.01	4.43	1.17	3.38	3.28	1.98	1.68	1.54	1.36	1.98	3.14	2.38	2.10	2.49	4.46	2.06	4.64	5.21	5.77	1.44	3.08	1.98	4.11	2.71

Implementation

Sampling Procedure

1. Collect hourly interval data from 75 randomly selected customers in each load zone
2. Calculate mean and variance for each interval
3. *Calculate sample size needed for 10% error at 90% confidence by interval*
4. Average across intervals to determine final sample size

- Joule will send a monthly report to NYISO with any changes to our customer list
- Report on sample size and representativeness will be provided if there were any changes
- If sample size needs to increase, that must be completed before new customers can participate
- Joule will use its override data to report on whether or not its override expectations have been accurate. If they are not, we will report how we are going to respond to the inaccuracies.

Implementation

Sampling Procedure

1. Collect hourly interval data from 75 randomly selected customers in each load zone
2. Calculate mean and variance for each interval
3. Calculate sample size needed for 10% error at 90% confidence by interval
4. *Average across intervals to determine final sample size*

Example:

Results							
Sample intervals	700						
Sample size =	139						
Hourly Sample size							
N	mean	mean^2	variance	a	b	n = a*b	Data Input E
75	3.73	13.88	7.00	270.60	0.50	136.51	7/15 0:00
75	3.45	11.87	5.88	270.60	0.50	134.06	7/15 1:00
75	3.49	12.20	6.28	270.60	0.51	139.21	7/15 2:00
75	3.60	12.95	6.28	270.60	0.48	131.10	7/15 3:00
75	3.57	12.74	5.58	270.60	0.44	118.38	7/15 4:00
75	3.31	10.96	5.93	270.60	0.54	146.37	7/15 5:00
75	3.57	12.78	6.32	270.60	0.49	133.76	7/15 6:00
75	3.45	11.94	6.22	270.60	0.52	141.11	7/15 7:00
75	3.55	12.58	6.19	270.60	0.49	133.10	7/15 8:00
75	3.10	9.62	6.60	270.60	0.69	185.61	7/15 9:00
75	3.41	11.63	5.65	270.60	0.49	131.56	7/15 10:00
75	3.27	10.72	6.06	270.60	0.57	153.04	7/15 11:00
75	3.41	11.65	6.45	270.60	0.55	149.76	7/15 12:00
75	3.50	12.25	6.59	270.60	0.54	145.52	7/15 13:00
75	3.52	12.37	6.05	270.60	0.49	132.38	7/15 14:00
75	3.35	11.24	5.94	270.60	0.53	143.02	7/15 15:00
75	3.54	12.50	6.71	270.60	0.54	145.38	7/15 16:00
75	3.36	11.32	6.57	270.60	0.58	157.05	7/15 17:00
75	3.30	10.87	6.55	270.60	0.60	163.00	7/15 18:00
75	3.77	14.21	6.78	270.60	0.48	129.03	7/15 19:00
75	3.55	12.64	7.49	270.60	0.59	160.29	7/15 20:00
75	3.01	9.06	5.31	270.60	0.59	158.59	7/15 21:00
75	3.50	12.22	5.79	270.60	0.47	128.21	7/15 22:00
75	3.26	10.60	5.39	270.60	0.51	137.73	7/15 23:00
75	3.70	13.68	5.88	270.60	0.43	116.28	7/2/15 0:00
75	3.41	11.63	5.75	270.60	0.49	133.78	7/2/15 1:00
75	3.52	12.37	6.41	270.60	0.52	140.21	7/2/15 2:00

Example

Example

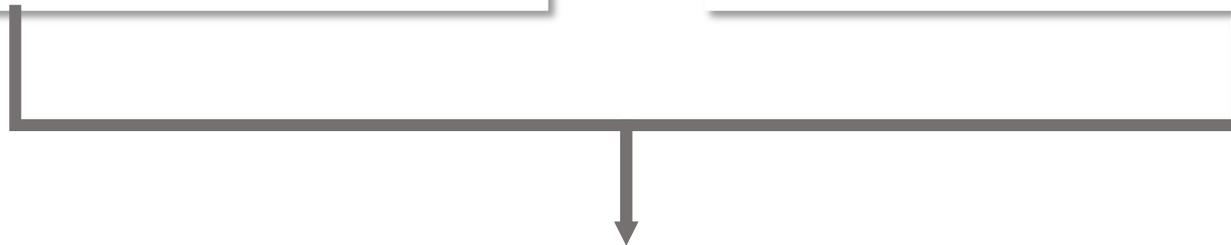
Sign Up

CCA

1. Customer receives Joule offer by mail, email, or word of mouth
2. Customer signs agreement and completes questionnaire with many fields auto-filled
3. Joule receives information and turns to internal database to complete customer profile
4. Joule confirms qualification criteria are met (i.e. customer has thermostat Joule can connect to and it controls at least cooling or heating)

MICROGRID

1. Customer receives Joule offer by word of mouth , generally a door-to-door canvass
2. Customer signs agreement and completes questionnaire
3. Joule receives information and confirms qualification criteria are met (i.e. customer has thermostat Joule can connect to and it controls at least cooling or heating)



Example

Pre-Participation Preparation

1. Joule batches 100 customers in a given stratification, and sends customer list to NYISO for that load zone and size.
2. NYISO staff chooses 75 customers randomly from the stratification(s) and notifies Joule. In consultation with NYISO staff Joule submits an analysis to determine if there is any bias in the selection. We will evaluate income, stratification, resource, and latitude across the entire population and NYISOs selections.
3. Joule coordinates install at each location with the designated MDSP in the region. MDSP will install meters at each location. Meters will be approved for ICAP-SCR participation.
4. After getting one month of meter data, Joule will complete the variance test and determine the required sample sizes for the stratifications currently participating. This triggers a reiteration of steps 1 through 3, until the necessary sample size is installed.
5. Joule sends report to NYISO. NYISO chooses more customers from participating stratifications to meet the required size. NYISO notifies MDSP and meters are installed.

Example

Pre-Participation Preparation

Note About Existing Metering:

If a chosen customer already has an ICAP-eligible meter in place we will use that meter and work with the existing MDSP.

Example

Ongoing Maintenance



1. Joule, MDSP, and NYISO continue with information flow according to all ICAP-SCR requirements.
2. As Joule receives new customers, it holds on to the information. At the end of the month, if Joule has received more than 100 new customers or lost more than 100 customers in a given stratification since the last check, it will conduct a new variance test and send the report to NYISO.
3. If new meters need to be installed, NYISO will receive the updated customer list, choose the required number of new sites, and notify MDSP for install.
4. When meters have been installed, new sites will be enrolled in ICAP.

Example

Event Call

1. NYISO sends event call to Joule (or partner Market Participant). 45 minutes before event start Joule reduces set points by three degrees across entire group to precool. 15 minutes before event start, Joule will increase set points to 5 degrees above what set points were at before event call occurred.
2. Joule continues through the 4 hours implementing strategy described earlier.
3. After event NYISO, MDSP, and Joule (or partner) conduct M&V for metered customers according to typical ICAP-SCR protocols