Large-scale deployment of Transformation Wave's CATALYST Advanced Rooftop Unit Controller



Overview and Results of the NYSERDA Supported Pilot November 8, 2018





Outline





Program Initiative Team







Implementer



Technology partner



Project funded through NYSERDA's Emerging Technology and Accelerated Commercialization (ETAC) Initiative, showcasing solutions and strategies to achieve market acceptance of under-used technologies and business strategies.

About Energy Solutions

- Founded in 1995
- Employee-owned
- Offices in CA, MA, OR, WA, LA

market transformation programs & policies

Intelligent Energy Services group focuses on projects at the intersection of data, analytics and controls and how they can unlock new savings and business opportunities







Outline





Why target Rooftop Units (RTUs)?

Wide prevalence and long product lifetimes

- RTUs cool about 60% of commercial building space nationwide
- Long product lifetimes (15-20+ years) mean that existing units are likely to stay in operation for quite a long time.
- Retrofits technologies can defer major capital upgrades, addressing a much larger portion of the market

Inefficient operation and out of sight

- 90% of RTUs run continually at a single fan speed regardless of need, creating significant energy waste.
- Units always provide set amount of ventilation to meet code minimum for maximum occupancy
- Economizer typically kept at fixed location or not working
- "Out of sight, out of mind" faults or operational issues may wait months until routine maintenance or occupant complaints



DOE's Advanced Rooftop Unit Campaign targets technology due to energy savings opportunity



Technology Overview – CATALYST + eIQ (energy savings plus real-time insight)



CATALYST – full retrofit kit



Variable speed supply fan with synchronous damper control decreases fan power draw



Adds 4-5 new sensors which provide insight into actual unit performance



CO2-based demand control ventilation to provide the amount of ventilation needed based on real time occupancy



Advanced economizer sequencing optimizes use of outside air as free cooling and ensures good indoor air quality



eIQ – Software Platform



Web-based visualization of RTU performance enables remote insight into unit performance



Portfolio feature groups all sites into single access point



Built in trend analysis tools can highlight deviations in performance



Fault detection and diagnostic feature decreases failure diagnosis time

CATALYST installations to date

- Over **11,900** CATALYST installations across the United States and Canada.
- Numerous performance awards, including DOE's Advanced RTU campaign and the Department of Defense.
- Numerous third party demonstrations to date most have primarily been at smaller scale and focused only on validating technical performance



66 units, tested across 8 buildings in 4 states monitored for 12 months – published July 2013





6 sites, 30 Units, across 3 building types. Sites were monitored for between 3-6 months – published April 2016





Building on these demonstrations, the NYSERDA deployment focused on laying the broader commercial groundwork for this and other ARC technologies to achieve scale.

Initiative Overview – Deployment Goals

Support customer adoption of ARC technologies and further integration into utility programs in three ways:



Demonstrate CATALYST's broad market applicability

- Increase installations across RTU sizes and customer types
- Increase number of certified affiliate contractors



- CATALYST technology and sales tools
- New York rate structures and demand response

Build consumer awareness and confidence

- Report performance using a dashboard using real-time monitoring data
- Develop case studies to build customer confidence
- Conduct webinars highlighting the program results and performances



Deployment Overview – Program Details

Technology:



CATALYST plus eIQ software

Who:



Commercial businesses or institutions with a NY State address that paid a System Benefits Charge (SBC)





\$2,400 per unit incentive for advanced retrofit controls on existing RTUs, discounted at point of purchase (incentive paid to the contractor).

Incentive includes a 3 year remote data monitoring agreement for validation purposes.



Deployment Process Flow



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Average time from application submission and completed installation was **1.7 months.**

Average time from installation to incentive delivery was **1 month**.

Outline



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Deployment Summary – 24 sites, 191 units, 5 building types



• The Interim report provides results from 130 units at 13 sites, each of which had over 12 months of monitoring data available

• The Final report in June 2019 will include results from all 191 units with an average duration of 20 months of monitoring.

Deployment Summary – Geographic Distribution



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Deployment Summary – Building and RTU characteristics



Unit age ranged from 1 – 19 years RTU size ranged from 3-20 tons

Average – 11 years

Average – 13 tons

Single zones are more effective as controls are optimized over smaller space

Contractors reported that the CATALYST:

- Works best with units that are well maintained
- Have at least 5-7 years of remaining useful life
- With single zone units



Findings: Energy Savings

Sites achieved an average of 42% electricity savings and 7% therms savings

- Education, office, restaurant and retail all had similar electricity savings, with variations based on average annual occupancy
- Electricity savings for assembly were lower because they had low overall daily occupancy and little variation during occupancy
- Variation in blended electricity rate drives differences in cost savings (which includes demand charges)



Findings: Energy Savings

The bulk of the savings comes from the VFD

• Fan power draw at reduced speed is proportional to the cube of the change of speed:

10% decrease = 27% savings

25% decrease = 58% savings

60% decrease = 88% savings

elQ and other features provide system visibility, additional comfort benefits plus modest incremental electricity savings

- The elQ interface provides significant customer benefits by increasing visibility of a previously invisible unit.
- Advanced economizer control and demand control ventilation provide increased space comfort and achieved modest electricity savings



Findings: Financial Performance

Project economics are primarily driven by operating hours and unit size (to a lesser degree). Program incentives were a particularly key driver in improving project economics for buildings with lower operating hours.





Savings to Investment Ratio

Takes into account time value of money, useful life, and ratio holds among investments of varying sizes

Note: A previous version of this slide included a site that did not have 12 months worth of data reported. In addition, one office site with 12 months worth of data was left off because project cost was reported for only the 2 units that qualified for incentives while cost savings was reported in aggregate for all 37 units at the site.

Findings: Which buildings make a good fit for the CATALYST?

The CATALYST is particularly well-suited to buildings with long operating hours, large capacity units, and/or proportionally large HVAC loads, such as restaurants and retail.



Retail

Office



Findings: Contractor education and training plays a significant role in project success

Successful deployment of CATALYST and other ARC technologies at scale requires a dedicated focus on workforce education and training.

- Selling and installing ARC solutions has an initial learning curve and requires dedicated training and experience to successfully integrate this into contractor core competencies.
- Contractors with dedicated training and controls experience accounted for the vast majority of initiative sales



- Contractors with previous sales training/experience selling intelligent controls
- New contractors

Total Deployment Sales

Contractor feedback

Customer decisions are driven by a wide range of energy and non-energy impacts.

What are the most common or valuable benefits to customers?

#1 by far is <u>comfort</u> and <u>noise</u>. We have a church where the pastor wanted a light installed when the system was running because he could not hear the system anymore. The <u>energy savings is secondary for them</u>. There is a huge benefit beyond energy to the right customer.

- Participating Contractor #1

The fact that CATALYST offers <u>a BMS with</u> <u>remote access is a big plus</u>. The trending and analytics capabilities are appreciated.

- Participating Contractor #2



Contractor feedback

Contractors market the CATALYST as a standalone solution but also as an additional service that can be included in larger projects.

Has providing ARC offerings to your customers helped your business? If so, how?

I feel that it is a valuable offering for our <u>customers who fit the application</u> <u>criteria</u> (larger, single-zone RTUs, no existing BMS, no other HVAC equipment).

- Participating contractor #1

It is a part of our overall business. It is <u>used as</u> <u>standalone offering</u>, however we are noticing an increase in the CATALYST being part of an overall larger project. We offer it when it fits.

- Participating contractor #2



Contractor feedback

Customers find continuous benefit from fault detection and contractors continue to provide maintenance support.

Do you have any ongoing maintenance contract with customers? If so, how does the CATALYST's fault detection capabilities support your maintenance business?

> Yes, we are now under contract with some of our customers and are <u>beginning to rely on CATALYST fault detection</u> <u>more</u>. We're hopeful that this will <u>support our maintenance</u> business more.

> > - Participating contractor

Outline





Utility program measures should integrate the CATALYST into their program portfolios as standalone measures or large-scale offerings.



- Monitoring data confirms Transformative Wave's claim of 25-50% energy savings.
- The one site that did not achieve those numbers (they saved 24%) was a church that was primarily concerned with improving maintenance insight and occupant comfort
- Final report will include key details for utility programs such as measure cost, hours of use by mode, and baseline conditions.



Scaling up

- Where possible, utilities should consider moving towards prescriptive offerings to streamline and scale participation
- Monitoring capabilities enable utilities to collect information and refine assumptions over time
- Programs should include a customer data monitoring agreements to enable performance verification over time

Where possible, utilities should make monitoring data a core part of their incentive programs to inform and update energy efficiency measures.



Utility programs should incorporate significant workforce education and training components into programs to ensure increased awareness and uptake for ARCs.





As the number of trained affiliate contractors familiar with the CATALYST and other ARC solutions grows, utilities should consider piloting distributor-based midstream programs of the technology to achieve further scale



Align incentive programs to target **proper point of entry** to achieve increased market adoption.



Next Steps



Interim Report will be sent to all attendees



Final report will incorporate additional monitoring data and site validation results, as well as supplemental information to support utility program measure development



The report will be released June 2019. We will send today's attendees the updated report in June 2019.





Thank You

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Appendix





Energy savings by Season

As predicted, units typically have peak savings during shoulder seasons when units are not running at full output



Figure 7. Electrical (kWh) Savings as Percentage of the Baseline kWh per building Type. The value for each building type is the average across all sites for the specific building type and the chart also includes a line showing the average across all sites.