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

Overview and Results of the NYSERDA Supported Pilot

November 8, 2018
Program Initiative Team

NYSERDA

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

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

1. Intro to Teams
2. Technology + Pilot Overview
3. Findings + Feedback
4. Recommendations
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.
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

- **Provide contractor and customer webinar trainings**
  - 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)

What: $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

- **Pre-Qualification**
  - Customer submits application to Affiliate
  - Affiliate and Transformative Wave vet project for eligibility

- **Application Submission**
  - After confirming eligibility, Transformative Wave and Energy Solutions approve project.

- **Installation**
  - Customer works with Affiliate to install project.

- **Commissioning and Verification**
  - Transformative Wave conducts commissioning and verification activities.
  - 3rd party Measurement and Verification occurs for select sites

- **Incentive Delivery**
  - Energy Solutions, on behalf of NYSERDA, approves project and issues incentive to contractor.

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

Average time from installation to incentive delivery was **1 month**.
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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
Deployment Summary – Building and RTU characteristics

- Unit age ranged from 1 – 19 years
  - Average – 11 years
- RTU size ranged from 3-20 tons
  - 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

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

- The eIQ 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.

Simple Payback = Initial investment/annual net cash flow

Savings to Investment Ratio =

\[
\text{Savings to Investment Ratio} = \frac{\text{Total present value of all future cash flows}}{\text{Initial investment}}
\]

*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.
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

![Total Deployment Sales](chart)

- 83% (3 contractors) - Contractors with previous sales training/experience selling intelligent controls
- 17% (2 contractors) - New contractors
Customer decisions are driven by a wide range of energy and non-energy impacts.

What are the most common or valuable benefits to customers?

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

- Participating Contractor #2

#1 by far is **comfort** and **noise**. 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 **energy savings is secondary for them**. There is a huge benefit beyond energy to the right customer.

- Participating Contractor #1
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 customers who fit the application criteria (larger, single-zone RTUs, no existing BMS, no other HVAC equipment).

- Participating contractor #1

It is a part of our overall business. It is used as standalone offering, 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 beginning to rely on CATALYST fault detection more. We're hopeful that this will support our maintenance business more.

- Participating contractor
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Recommendation:

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

Verified Savings

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

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

Workforce education and training **overcome** adoption barriers.
Recommendation:

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.