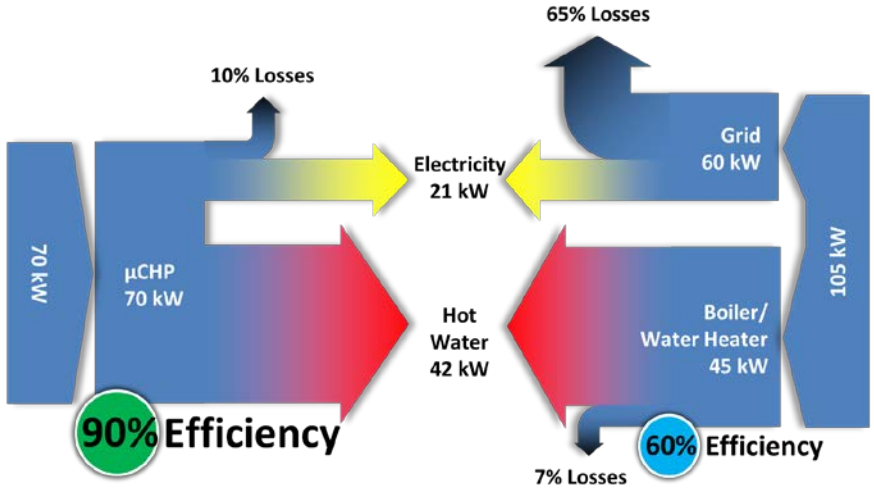
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

ORNL – Systems Technology Research and Development Support

Evaporator Fan Motors

Wireless Thermostatic Radiator Valves



Micro Combined Heat and Power

Oak Ridge National Laboratory

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Project Summary

Timeline:

Start date: FY15

Planned end date: FY20

Key Milestones (insert 2-3 key milestones and dates)

1. Final report, QM Power; 30 April 2018
2. Final report, AO Smith; 31 March 2019
3. Final report, Steven Winter Associates; 30 September 2020

Budget:

Total Project $ to Date:

- DOE: $729k
- Cost Share: $1,980k

Total Project $:

- DOE: $1,317k
- Cost Share: $3,000k

Key Partners:

A.O. Smith QM Power

Steven Winter Associates

Project Outcome:

Understand technical and cost performance through in situ testing of energy-efficient HVAC&R technologies:

- Micro Combined Heat & Power, wireless radiator valve and Q-Sync motor
- Measured energy savings from demonstration projects led by ORNL
- Design, code review and installation considerations required for successful implementation
- Training, operations and maintenance aspects for continued operation and energy savings

Demonstrations support the HVAC, WH & Appliance Sub-Program MYPP 2020 goal to enable technologies that can reduce primary HVAC Energy Use Intensity (EUI) by 60% and water heating EUI by 25%.

Team – Micro CHP

AO Smith: System design and fabrication, securing sites, point of contact with code officials and installing contractors, instruct site staff on operation of the system.

Oak Ridge National Laboratory: Measurement and verification process development and implementation, data acquisition and analysis, final reporting.

Yanmar: Prime mover development (engine supplier and engine controls)

Briggs & Stratton: Prime mover development (engine supplier and engine controls)

MicroCogen Partners: Consulting, identification of sites

Challenge – Micro CHP

The Problem:

- 400,000 commercial buildings in North America have high hot water demand
  - Candidates for thermally-led micro Combined Heat & Power systems
- Lack of information available to consumers about small (under 50kW) CHP systems
  - System performance
  - Regulatory, installation, payback and ease of system operation

Project Goal:

- Demonstrate that microCHP systems can be:
  - Installed cost-effectively (under 3 year payback)
  - With no complex operation or maintenance required

Benefit:

- Understand technical and regulatory barriers for applications of microCHP systems
- Energy savings in terms of source energy
  - 90% efficiency with uCHP versus only 60% with conventional water heating

Approach – Micro CHP

- Identify necessary site characteristics for a water heating system of this size, with necessary electrical interconnection and safety provisions.
- Meter natural gas usage, electric power production and hot water generation.
  - Accurately characterize the energy savings potential for a real building installation
    - Pre-retrofit performance with existing water heating equipment
    - Post-retrofit performance with micro CHP
  - Clearly show what performance benefits and energy savings can be provided by a uCHP system.
  - Overcome barriers to installation.
- Identify start-to-finish (from design to operation and decommissioning) issues associated with successfully implementing a uCHP system as a retrofit to an existing commercial water heating system.
- Inform future product improvements.

Impact – Micro CHP

- MicroCHP system generates hot water for a building ***and*** simultaneously generates electricity
- If uCHP is fully implemented, the energy savings could be as much as 0.54 quads/year of primary energy savings
- This new microCHP system is smaller capacity than units already on the market
  - Serve smaller commercial facilities such as hotels and multifamily housing.
  - Deliver energy savings to market sectors that have historically been unable to cost-effectively install more complicated CHP units
- Manufacturer's goal: Payback of less than three years
  - Without the need for any incentives such as tax credits, grants, etc.
- The performance benefits have been demonstrated at the first test site, with performance exceeding expectations
  - The remaining three sites, each a different type of building occupancy, will provide additional performance data for a variety of settings
  - This will demonstrate the validity of the microCHP technology for the target occupancies (multi-family housing, hotels, restaurants and health care)
- The project has also addressed regulatory issues (plans review by building code officials) with that information used to inform future projects as well as design/installation guidance

Progress – Micro CHP

- Measurement & Verification plans – complete
- Site questionnaire and site selection – complete
- Data acquisition
  - Complete at 1 site; Remaining 3 sites to be instrumented
- Data analysis
  - Preliminary analysis has been conducted for the first test site
  - Data analysis for the three remaining sites to be completed

Remaining Project Work

- Complete baselining and retrofit data acquisition at three remaining sites.
  - Two in WI and one in MN: Dec 31, 2018
- Complete the analysis and final report by March 31, 2019.

Stakeholder Engagement

- Four commercial host sites.
- Presentations to commercial owners/operators via webinar and Better Buildings Summit.
- Report findings to be shared with Better Buildings community and utility stakeholders.

Team – Evaporator Fan Motors

QM Power: Manufacturer of permanent magnet synchronous AC motors for commercial refrigeration applications

Oak Ridge National Laboratory: Measurement and verification process development and implementation, data acquisition and analysis, final reporting

Supermarket Partners:

- Defense Commissary Agency (DeCA)
- HyVee
- Price Chopper
- Shaw's
- Vons
- Wal-Mart
- Whole Foods Market

QM POWER

OAK RIDGE National Laboratory

Challenge – Evaporator Fan Motors

The Problem:

- 16 million evaporator fan motors in commercial refrigeration equipment.
  - Display cases in supermarkets and convenience stores; refrigeration equipment in food service; beverage vending machines, etc.
- Shaded pole, permanent split capacitor (PSC) and electronically commutated (EC) motors currently in use.
- Approximately 61 TBtu per year of primary energy.

Solution:

- Permanent magnet synchronous motors developed by QM Power.
  - Significantly more efficient than current technology.
  - Lower current draw; Increased power factor.

Barrier:

- Motor has just recently been commercialized.
- Lack of performance data on the new motor.
  - Low market penetration

Approach – Evaporator Fan Motors

- Measure power consumption of incumbent fan motors and QM Power's new synchronous motor.
  - Refrigerated display cases; Walk-in coolers/freezer
- Side-by-side energy comparison of synchronous motor and incumbent fan motors.
- Whole-store retrofit – before and after energy comparison.
- Deliver unbiased analysis of energy savings potential.
  - ORNL published reports, presentations at conferences.
  - Encourage market adoption, utility program development.

Impact

- Up to 35% more efficient than EC motors.
- Up to 80% more efficient than shaded-pole motors.
- 37 TBtu/yr energy savings if all motors switched to QM Power synchronous motors.
- Retrofit incentives via National Grid (utility in the Northeast).
- Press coverage and reports: ORNL; San Diego Gas & Electric; E Source; Appliance Design; The Energy Times; Air Conditioning, Heating, Refrigeration News.

Progress – Evaporator Fan Motors

- Project is wrapping up.
- Seven side-by-side comparisons completed.
  - Refrigerated display case evaporator fan motors
  - Walk-in cooler/freezer evaporator fan motors
  - 35% to 80% energy savings
  - 40% increase in power factor
- One whole-store retrofit completed.
  - 185 refrigerated display case motors retrofitted
  - 77 walk-in cooler/freezer motors retrofitted
  - Average motor energy savings: 46%
  - Simple payback: 2.6 years (includes utility incentives)
- Demonstrated long-term reliability through side-by-side comparisons.
- Demonstrated significant energy savings.

Remaining Project Work

- Complete final report by 30 April 2018.

Stakeholder Engagement – Fan Motors

- Report results of demonstrations and network with industry leaders:
  - Winter and Summer ASHRAE Conferences
  - Food Marketing Institute Energy & Store Development Conferences
  - Purdue International Refrigeration and Air Conditioning Conferences
- Seek support from refrigeration system OEMs:
  - Hillphoenix, Hussmann
- Demonstration sites from major supermarket chains:
  - HyVee, Price Chopper, Shaw's, Vons, Walmart, Whole Foods Market

Team – Wireless Thermostatic Radiator Valves

Steven Winter Associates, Inc.: Consulting engineering and analysis services; identify, develop, and deploy energy efficient building technologies.

Oak Ridge National Laboratory: Measurement and verification process development and implementation, data acquisition and analysis, final reporting.

Sentient Buildings: Web application development, data analytics for buildings.

conEdison: Large utility with a key role in New York Sate Reforming the Energy Vision (REV) program – changing the way utilities make investments and empower customers to drive efficiency.

E Source: Work with utilities on DSM programs.

Challenge – Radiator Valves

The Problem:

- Multi-tenant and multifamily building heating energy use.
  - Driven by systems that give no feedback to users.
- Few tenants pay for heat (if they do, it's not in a meaningful and rational way).
- Heat is not evenly distributed.
- Average indoor temperature during winter:
  - Northeast: 65˚F
  - New York City: 74˚ F
- Thermal sub-metering under-utilized.
  - Viewed as technically challenging.

Solution:

- Demonstrate that thermal sub-metering can achieve 50% reduction in space heating.
  - Wireless thermostatic radiator valves.
  - Real-time energy monitoring.
  - Consumption-based billing for heat.
    - Address behavioral opportunities with tenants.
    - Allow tenants to control cost of heating (rather than being "baked" into their rent).

Approach – Wireless Radiator Valves

- Identify suitable multi-family buildings utilizing central hot water/steam heat.
- Install wireless thermostatic radiator valves at space heating terminal units.
  - Regulates terminal heat output in response to local temperature.
  - Communicates wirelessly with central Energy Management and Information System (EMIS).
- Utilize smart valve and central boiler plant data to equitably meter thermal output.
  - Develop personnel interface and heat allocation algorithm.
- Develop system to bill tenants for their heating energy use.
  - Develop tenant interface.
  - Measure energy impact due to billing change.

Impact

- 50% savings in heating energy (360 TBtu).
- Improved heat distribution and balancing of heating in each space.
- Tenant control over space temperature.
- Allow tenants to control cost of heating (rather than being “baked” into their rent).

Progress – Radiator Valves

- Project recently started (kick-off on 12 Dec 2017)
- M&V Plan and Site Questionnaire completed
- Currently recruiting sites
  - 261 unit apartment building, built 1987, two-pipe steam with PTAC terminal units
  - 180 unit apartment building, built 1970, two-pipe steam with PTAC terminal units

Remaining Project Work

- Install instrumentation and data acquisition equipment, Summer 2018.
- Begin baseline data collection, Winter 2018/2019.
- Install wireless radiator valves and necessary instrumentation, Summer 2019.
- Develop heat allocation algorithm and tenant interface, Summer 2019.
- Pilot tenant billing for heating energy use, Winter 2019/2020.
- Analysis and final reporting, Summer 2020.

Stakeholder Engagement

- conEdison is actively engaged.
  - Empowering customers with choices on how they manage and consume energy.
- Sentient Buildings
  - Experience with tenant space heating control, well connected to property management companies and building owners.

Thank You

Oak Ridge National Laboratory, A.O. Smith, QM Power, Steven Winter Associates
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REFERENCE SLIDES

Project Budget

Project Budget: $1,317k
Variances: N/A
Cost to Date: $717k
Additional Funding: N/A

Budget History					
FY 2015 – FY 2017 (past)		FY 2018 (current)		FY 2019 – FY 2020 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share$
$717k	$1,980k	$200k	$330k	$400k	$3,000k

Project Plan and Schedule