

MassCEC Low Income Retrofit Programs: Heat Pumps and Solar

March 15, 2019





Our Mission: Grow the state's clean energy industry

INVEST

Invest in programs that increase renewable energy adoption by residents, businesses and communities.

CONNECT

Connect employers, job seekers, students, communities and investors to the clean energy industry.

INNOVATE

Help to spur innovation through infrastructure, funding and technology development support.

\$900,000- MassSave LEAN Program (Low Income Energy Assistance Network)

67 homes weatherized and retrofitted from electric resistance heat to mini-splits

- Conclusion: cost-effective measure
- Now LEAN covers mini-split retrofits free for multi-family affordable buildings
- MassSave LEAN has since retrofitted 440 homes/apartments spending over \$2.9 million





Lessons Learned

- Effective customer education and regular services (filter cleaning, annual tune ups) are required for ASHP's to operate properly

Over 2,300 Low and Moderate Income Customers

5-6 kw System	\$20,000
30% Principal Reduction	-\$6,000
30% Federal Tax Credit	-\$6,000
<u>State Tax Credit</u>	<u>-\$1,000</u>
	\$7,000

Typically a 4-5 Year Payback when
include SMART incentives



2017 Affordable Clean Residential Energy Program

Solar Plus Whole House ASHP <60% SMI Focus on Oil and Propane Retrofits ~30 Homes

- Solar screening straightforward
- Whole House ASHP's are more complex
- Houses over 2000 sf require more than 4-5 heads, becoming prohibitively expensive
- There is no cookie cutter design
- Exploring air to water heat pump retrofits for future projects



2017 Affordable Clean Residential Energy Program

- Averaging \$18-20,000
- One condenser, line sets routed through branch box and 4-5 heads
- Associated costs add an additional \$3-5,000
- Existing forced air furnaces with ductwork can be converted for around \$12-14,000
- Contractor network has not yet fully embraced the concept of whole house ASHP conversion



Solar Access – Affordable Home Heating

- Energy Futures Group
- Bruce Harley Energy Consulting
- Center for EcoTechnology
- Girard Heating and Air Conditioning
- Sunbug Solar
- UMass Five College Credit Union
- Integrated Building & Design



Program Concept

- Low to moderate income customers (60-80% median income)
- Solar PV + ductless mini-split heat pumps
- Positive cash flow from day one
- Guaranteed energy savings



Heat pumps

Mitsubishi Hyper Heat: 12,000 – 18,000 Bth/hr

- One or two single head systems per project
- Designed to offset 30-90% of existing heating
- \$6,000 - \$12,000 installed cost

Incentives

- (Mass CEC rebate: \$1000-\$2000)
- Mass Save rebate: \$300-\$600
- Mitsubishi rebate: \$200-\$400

Financing

- Mass Save HEAT Loan: 0% interest



Solar PV

LG or REC panels: 5 – 15 kW

- Roof mounted or ground mounted
- Designed to provide 100% of electricity including heat pump
- \$25,000 - \$45,000 installed cost

Incentives

- Mass Solar Loan Income Based Loan Support: 30%
- Federal tax credit: 30%
- State tax credit: \$1000

Financing

- Mass Solar Loan:
currently 4.5% interest



Cash Flow

Month	Loan Payment	Energy Savings	SMART	Cash Flow
1	-\$105	\$0	\$0	-\$105
2	-\$105	\$0	\$0	-\$105
3	-\$105	\$0	\$0	-\$105
4	-\$105	\$0	\$0	-\$105
5	-\$378	\$164	\$74	-\$140
6	-\$378	\$164	\$74	-\$140
7	-\$378	\$164	\$74	-\$140
8	-\$378	\$164	\$74	-\$140
9	-\$378	\$164	\$74	-\$140

Installation

Operation

Cash Flow Problems

- Loan payments start right away even though there are no energy savings or incentives yet
- Can take multiple years to claim the full tax credit
- Customers in this income range can't afford negative cash flow
- Lender may not qualify customer for loan to begin with



Cash Flow Solutions

- Apply all rebates, incentives, and tax credits to the loan principal
- Re-amortize loan to reduce payment amount
- Pay all of the loan cost until energy savings are experienced
- Subsidize loan payments to achieve positive cash flow during the first year
- If needed, reduce loan principal even further to achieve positive cash flow after the first year



Cash Flow

Month	Loan Payment	Energy Savings	SRECs	Cash Flow	Solar Access
1	-\$105	\$0	\$0	-\$105	\$105
2	-\$105	\$0	\$0	-\$105	\$105
3	-\$105	\$0	\$0	-\$105	\$105
4	-\$105	\$0	\$0	-\$105	\$105
5	-\$378	\$164	\$74	-\$140	\$140
6	-\$378	\$164	\$74	-\$140	\$140
7	-\$268	\$164	\$74	-\$30	\$30
8	-\$268	\$164	\$74	-\$30	\$30
9	-\$208	\$164	\$74	+\$30	

Installation

Waiting for incentives

After IBLs

After Tax Credit

Marketing

Who are we looking for?

- Income 60-80% state median income
- Homeowner
- Eligible for Mass Save incentives (served by an Investor-Owned Utility)
- Pays federal income tax
- Good site for solar
- Ideally oil or propane heating
- Ideally central or western Massachusetts



Marketing

What worked!

- Targeted Facebook / Instagram ads (at first)
- Community events
- Community partners
- UMass Five credit union outreach to customers



What didn't!

- Direct mail to income eligible electric customers
- Newspaper articles

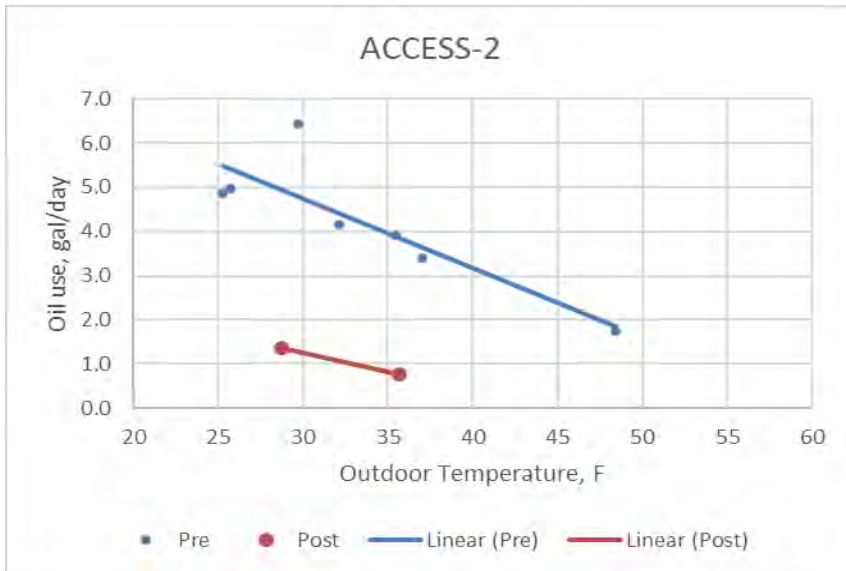


Results So Far



Site 2:

- Original heat: oil hydronic baseboard
- 3.0 tons ASHP installed (1 outdoor, 3 indoor)
- Boiler used for back up, supplemental heating
- ASHP frequently used for cooling
- Installed 1/2018; monitoring began 4/2018
- Installed cost (before incentives): \$36,165



Heating only	PRE-retrofit	POST-retrofit	Savings
Oil (gal/year)	817	202	615
Electric (kWh/year)		6318	-6318
Total Heating Costs	\$ 2,410	\$ 1,986	\$ 424
Implied Seasonal COP			2.7



ENERGY FUTURES GROUP

energyfuturesgroup.com

Pump It Up: Retrofitting Homes through Weatherization, PV and Heat Pumps

NESEA BUILDING ENERGY BOSTON 2019 CONFERENCE

Richard Faesy

March 15, 2019

About Energy Futures Group

Vermont-based clean energy consulting firm established in 2010

Areas of Expertise

- Energy Efficiency & Renewable Energy
- Program Design
- Policy Development
- Expert Witness Testimony
- Building Codes
- Evaluation
- Cost-Effectiveness

Range of Clients

- Government Agencies
- Advocates
- Regulators
- Utilities

Clients in 39 states and provinces plus regional, national and international organizations.



Agenda

NYSERDA's Hudson Valley Heat Pump

Vermont's Zero Energy Now Program

EFG's Office Building



NYSERDA's Hudson Valley Heat Pump Program

- EFG leads, with Bruce Harley and Integral Building & Design
- Project Objectives
 - Install air-source heat pumps in 20 homes
 - Measure and demonstrate savings
 - Increase awareness, understanding and among customers, contractors, and public
 - Provide resources for NYSERDA to better promote heat pump benefits over time

NYSERDA's Hudson Valley Heat Pump Program

- Participants and services
 - Single family, year round homes
 - Variety of projects: solar/no solar; heating displacement vs. replacement; single- vs. multi-head
 - Discounts on installation of Mitsubishi systems
 - Free online monitoring of heat pumps
 - Expert support of design and installation



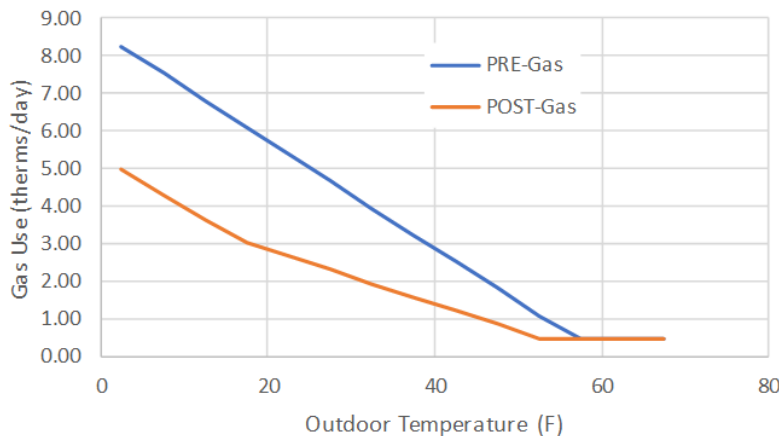
NYSERDA HVHPP Case Study – Early Results



Site 1:

- 1500 sq. ft.
- Original heat: gas boiler with hydronic baseboard
- 1.5 ton ASHP installed: 1 to 1 single zone
- Boiler used for back up, supplemental heating
- ASHP not used for cooling
- Installed in late 2017; monitoring began 12/17
- Installed cost (after incentives): \$5238

EFG-1



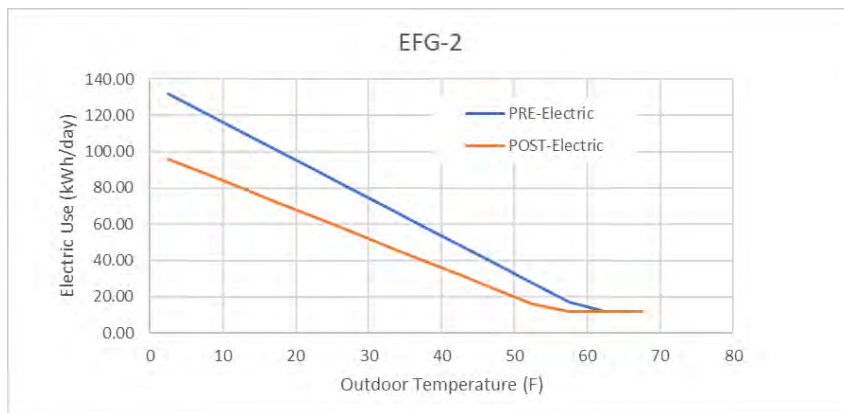
<i>Heating Only</i>	PRE-Retrofit	POST-Retrofit	Savings
Gas (therms/yr)	852.7	445.5	407.2
HP Electric (kWh/yr)		4,016	(4,016)
Total Heating Costs	\$ 565	\$ 697	\$ (132)
Implied Seasonal COP			2.3

NYSERDA HVHPP Case Study – Early Results



Site 2:

- 2,000 sq. ft.
- Original heat: electric baseboard
- 2.5 tons ASHP: 1 outdoor *multi*, 2 indoor zones
- Existing electric used for supplemental heating
- ASHP frequently used for cooling
- Installed 11/14/2017; monitoring began 1/2018



Heating Only	PRE-Retrofit	POST-Retrofit	Savings
Electric (kWh/yr)	13,273.0	9,343.7	3,929.3
		-	-
Total Heating Costs	\$ 1,991	\$ 1,402	\$ 589
Implied Seasonal COP			1.8

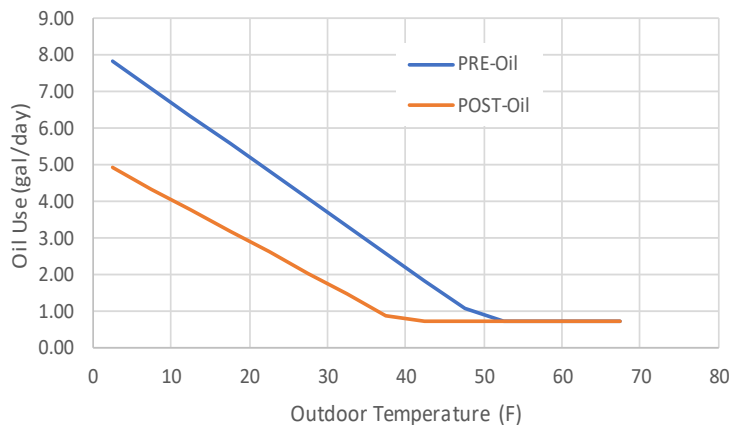
NYSERDA HVHPP Case Study – Early Results



Site 3:

- 2,000 sq. ft.
- Original heat: oil boiler with hydronic baseboard
- 3.0 tons ASHP: 1 outdoor multi, 3 indoor zones
- Boiler used for back up, supplemental heating
- ASHP frequently used for cooling
- Installed 1/19/2018; monitoring began 4/2018
- Installed cost (after incentives): \$11,450

EFG-3



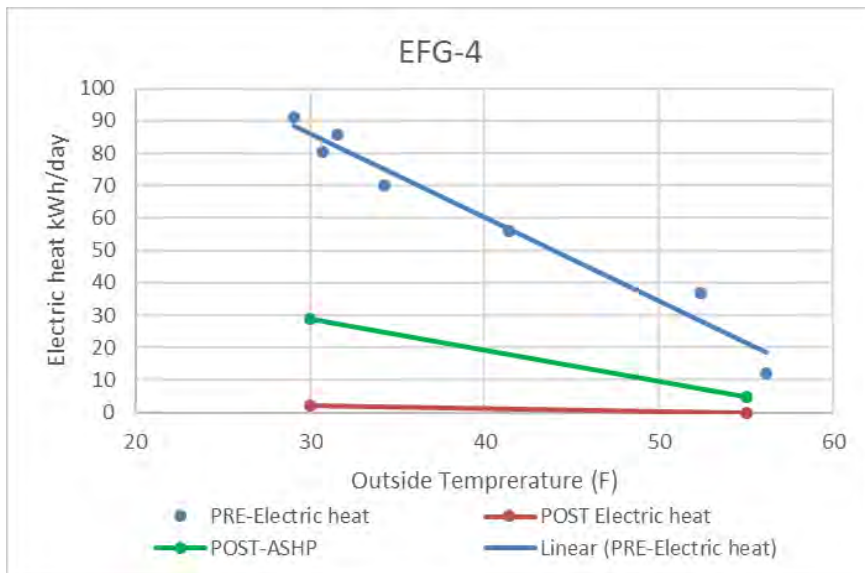
<i>Heating Only</i>	PRE-Retrofit	POST-Retrofit	Savings
Oil (gal/yr)	745.5	412.2	333.3
HP Electric (kWh/yr)		4,489	(4,489)
Total Heating Costs	\$ 1,854	\$ 1,474	\$ 380
Implied Seasonal COP			2.5

NYSERDA HVHPP Case Study – Early Results



Site 4:

- 1600 sq. ft.
- Original heat: electric baseboard
- 1.25 ton ASHP installed: 1 to 1 single zone
- Existing electric used for supplemental heating
- ASHP not used for cooling
- Installed 12/20/2017; monitoring began Jan'18
- Installed cost (after incentives): \$4499



<i>Heating only</i>	PRE-retrofit	POST-retrofit	Savings
Resistance (kWh/year)	13374	309	13065
ASHP (kWh/year)		5026	-5026
Total Heating Costs	\$ 2,407	\$ 960	\$ 1,447
Implied Seasonal COP			2.7
Implied COP including resistance			2.5

Vermont's Zero Energy Now



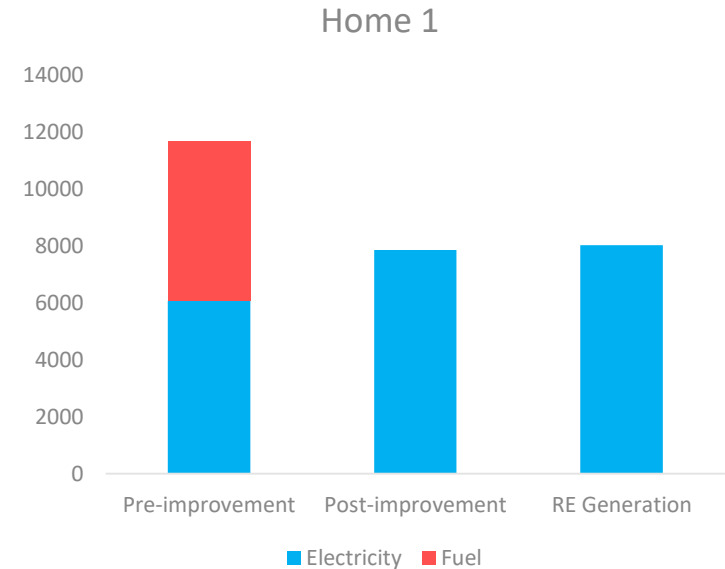
- Piloted by the Building Performance Professionals Association (BPPA) in 2016 – 2017
 - Designed and implemented by EFG
 - Green Mountain Power's Community Energy and Economic Development (CEED) Fund grant of ~\$700k
 - Developed the working model for coordinating contractors to address:
 - Weatherization
 - Solar PV
 - Renewable heating (heat pumps and wood heating)
 - Including quality and energy savings guarantee
 - 2016 – 22 projects
 - 2017 - additional 13 homes as “Solar Bonus” program
- BPPA is now restructuring **Zero Energy Now** with Efficiency Vermont for statewide rollout

Average Summary Results

Results (Modeled)	Zero Energy Now (19 of the 22 projects; 2016)
Savings (MMBtu / year)	~90 MMBtu
Savings (% Total Energy)	79%
Cost Savings (\$/year)	\$3,583
Project Cost	\$41,209
Return on Investment	9%

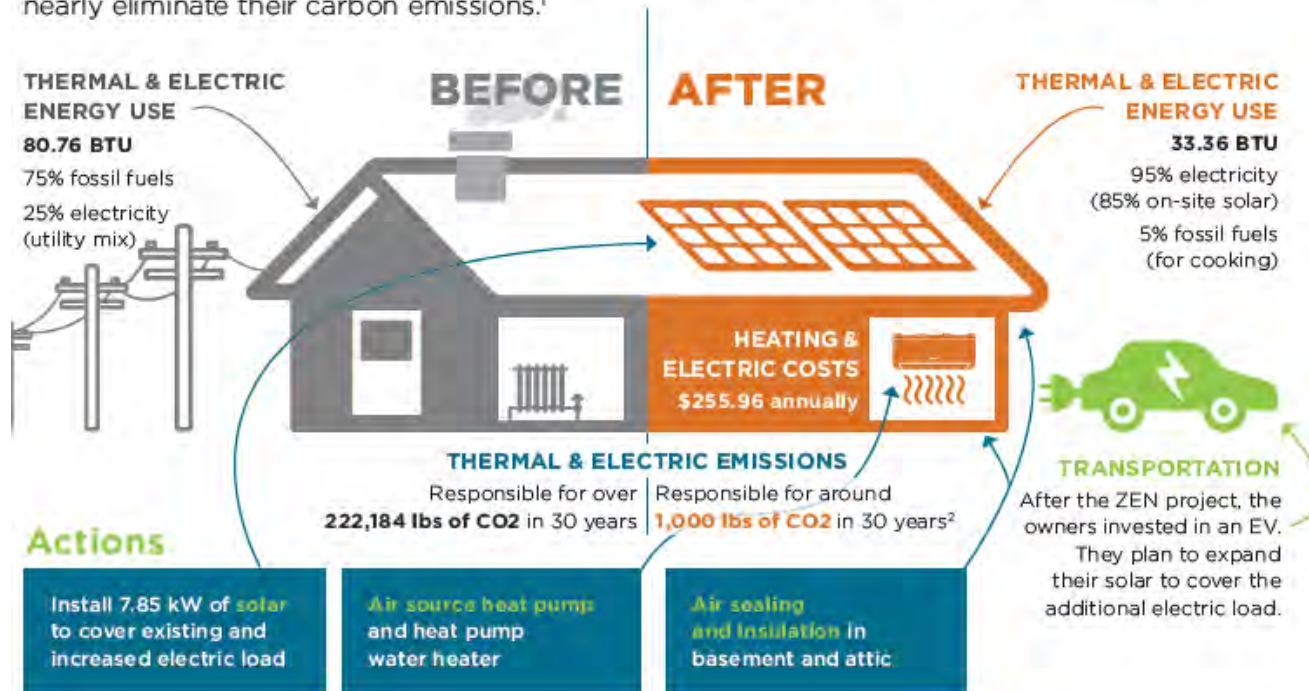


Vermont 1950's Ranch House Case Study



How Vermonters benefit: a case study

Let's take a look at a real 1950 ranch house in Jericho, Vermont. The homeowners, one recently retired from the Vermont Air National Guard and one a bookkeeper at a local school district, recently completed a Zero Energy Now (ZEN) project to get their home off fossil fuels and nearly eliminate their carbon emissions.¹



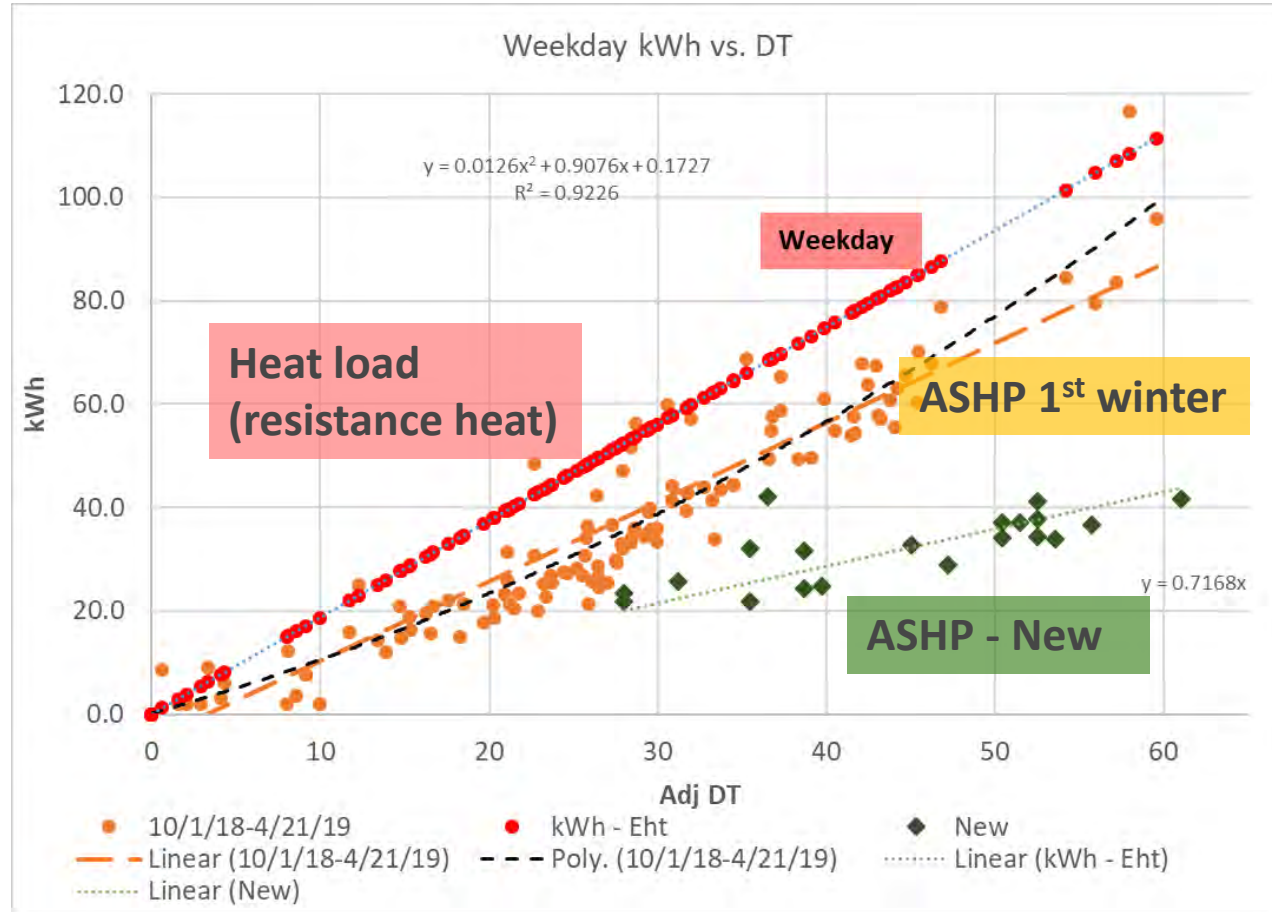
¹ Zero Energy Now (ZEN), Building Performance Professionals Association. Note: The ZEN project only included thermal and electric energy projects, so all cost and emissions figures are only related to those two sectors. ² Extrapolated by EAN based on energy use post-ZEN project.

EFG Office Building Heat Pump Swap-Out

Before:



After:



New installs as of 2/8/19 – 3/7/19

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Zero Energy Now Video (if there's time)

- <https://vimeo.com/197440650>

