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NORTHEAST ENERGY EFFICIENCY PARTNERSHIPS
FACILITATING PARTNERSHIPS TO ADVANCE ENERGY EFFICIENCY



Incremental Cost Study Phase Four (ICS4)

Final Presentation

June 5, 2015 Webinar

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Today's Presentation



- » **Brief discussion of the ICS4 process**
- » **The ICS4 Measures: Key Findings and Takeaways**
- » **Demonstration: Summary Workbook of all ICS measures from ICS1 -ICS4**
- » **Q & A/Discussion**



Incremental Cost Study Overview



- Developed incremental costs for 29+ measures and studied others that were dropped
- Today reporting on Phase 4 study results (6 measures)

<u>Phases</u>	<u>Budget</u>
Phase 1: 2010	\$400,000
Phase 2 2011-12	\$370,000
Phase 3 2012-13	\$160,000
Phase 4 2014	<u>\$207,000</u>
Total	\$1,137,000

Study Sponsors (15)

- » BGE
- » Berkshire Gas
- » Columbia Gas
- » DC SEU
- » Efficiency VT
- » Eversource
- » First Energy
- » National Grid
- » New England Gas
- » NYPA
- » NYSERDA
- » PEPCO
- » SMECO
- » United Illuminating
- » Vermont Gas



Why Study Incremental Cost?



Defined:

Incremental cost = (E measure material cost + E measure installation cost) - (baseline equipment material cost + baseline equipment installation cost)

Use:

- » Estimate potential cost-effectiveness
- » Help set incentive levels
- » Inform program design: set baselines, other program aspect
- » Serve as a metric to help track market change

Consideration:

- » Not much info initially available
- » CAPUC just developed IC for 62 measures last year
- » Limited shelf life due to baseline, technology and market changes
- » Expensive to conduct (that's why collaboration made sense)



Markets in ICS Region (Defined by R.S. Means)



Markets

1. Northern NE: ME, NH, VT
2. Central NE: MA, RI, most CT
3. NE City- Boston, Providence
4. Metro NY - NYC, LI, SW CT
5. NY UPstate
6. Mid-Atlantic

Cost
Factors
2015



Market	Market Code	Market Territory	Cost Factor
Northern New England	1	ME, VT, NH	0.85
Central/Southern New England	2	MA , RI, most CT	1.06
New England City	3	Boston, Providence	1.13
Metro New York	4	NYC, metro suburbs Southwest CT	1.29
Upstate New York	5	Albany, Buffalo, Rochester, balance of the state	1
Mid-Atlantic	6	MD, DE, DC	0.95
Base Cost Factor (BCF)*	-	-	1

ICS4 Products



- » Characterizations for all study measures
- » Open workbooks for all measures showing data, calculations, market factors, etc.
- » ICS4 Project Report
- » Summary Workbook of all ICS measures from ICS1 - ICS4
- » These measures can be found at:
<http://www.neep.org/initiatives/emv-forum>



With Limited Resources Measure Selections are Critical



In Phase 3, measures were scored and prioritized based on following criteria:

Cost Stability	Codes and Standards Stability
Incentives Currently Offered by PAs	
Contribution to Portfolio Savings	Level of Specificity

Phase 4: revisited the list, with input from PA Technical Advisors, NEEP consultants and Navigant staff to develop the next measure set.

Characterizations developed by Navigant with NEEP and PA input and review.



RET = Retrofit
 NC = New Construction
 ROB = Replace on Burnout

ICS4 Measures Studied



Measure	Sector	Fuel	Application	Cost Type	Measure Cost Shelf Life
VFD Air Compressors - multiple tiers and types	Com	electric			Stable
Evaporator Fan Controls	Com	electric	RET	Full	Moderate
Infrared Heaters (low and high intensity)	Com	gas	RET, ROB, NC	INC, Full	Moderate
Kitchen Equipment - Fryers	Com	gas	NC, ROB	INC	Stable
Kitchen Equipment - Convection Ovens	Com	gas	NC, ROB	INC	Stable
Refrigeration. Anti-sweat Heater Controls	Com	electric	RET	Full	Moderate
Dropped Measures					
Variable Refrigerant Flow Multisplit AC Systems	Com	electric	RET, NC	Full, INC	
Furnaces 225-500 kBh	Com	natural gas	ROB	INC	

Why These Measures were Dropped



- » Variable Refrigerant Flow Cooling
 - Multiple baseline scenarios (we examined three)
 - Limited prescriptive opportunities and few projects, most custom

- » Large Gas Furnaces (>225 kBH)
 - Measure offered by multiple program administrators but few projects found
 - Interviews indicated these units superseded by unitary heaters
 - Only one manufacturer currently making units at program efficiencies

VFD Air Compressors



- Used in a variety of industrial and commercial applications at various horsepower.
- Offered by most program sponsors with varying program requirements.

Baseline: Changed from modulating compressor without a VFD or Load/No Load controls. Modeled with Load/No load (essentially on/off) and modulating compressors as baseline.

Market Issues:

- Interviews strongly supported baseline shift.
- Also found that buyers of efficient (VFD) compressors more likely to buy ancillary control and system performance equipment, (e.g. as Low-Pressure Drop Filters and Cycling Refrigerated Air Dryers) than buyers of baseline units.

Program Design Implications:

- Consider Phase out of Load/No load units
- Shift measure baselines (<40HP)
- Consider incentives for ancillary equipment to bolster efficient unit purchase.

VFD - Base Cost Factor



VFD Air Compressors Base Cost Factor - Incremental

Size Category (horsepower)	Incremental Base Cost Factor - BCF (\$/Unit)	
	VFD (\$)	VFD (\$/HP)
15	\$5,585.09	\$372.34
30	\$4,766.01	\$158.87
45	\$3,946.92	\$87.71
60	\$3,127.84	\$52.13
75	\$2,308.76	\$30.78

Commercial Kitchen Fryers - Gas



- About 50% of the overall market is in fast food and chain restaurants.
- Purchases are typically ROB.
- Used equipment accounts for estimated 50% of equipment purchases

Baseline: ENERGY STAR standard is easy for manufacturers to achieve.

Market*: Interviews suggest manufacture of non-ENERGY STAR units is rapidly diminishing. Market appears to be saturated with ENERGY STAR units.

Program Design Implications:

- Consider higher tier energy requirements for incentives.
- Consider early replacement for existing units.
- Consider promoting higher ENERGY STAR Standards

*2014 CA CPUC study cost results differed by 1%

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Kitchen Fryers - Base Cost Factor



Table 10. Commercial Kitchen Fryers Base Cost Factor –Incremental

Equipment Description	Incremental Base Cost Factor - BCF (\$/Unit)		
	Incremental Cost (\$/Unit)	Incremental Cost (\$/lb of Shortening Capacity)	Incremental Cost (\$/kBtu)
Commercial Kitchen Fryer	\$2,580.03	\$34.12	\$24.79

Commercial Kitchen Convection Ovens - Gas



- Similar market environment to commercial kitchen fryers.
- Fast food franchises are substantial participants in efficiency programs.

Negative Incremental Costs Found*:

- ENERGY STAR standards considered relatively low and easily attained - market is moving toward all ENERGY STAR units.
- Most high end units are non-qualifying. Durability is the driver, not energy efficiency, unlike other premium products (e.g. Central AC).

Program Design Implications:

- Consider higher tier energy requirements for incentives.
- Consider early replacement for existing units.
- Consider promoting higher ENERGY STAR Standards

*2014 CA PUC Study found comparable negative incremental cost results.

Convection Ovens - Base Cost Factor



Table 12. Commercial Kitchen Convection Ovens Base Cost Factor – Incremental

Equipment Description	Incremental Base Cost Factor - BCF (\$/Oven Cavity)
Commercial Gas Convection Oven	-\$1,790.61

Refrigeration Anti-Sweat Heater Controls



- Installed on reach-in cooler/freezer doors to turn off door heaters when not necessary to prevent condensation.
- Variety of programs offered by many PAs.

Baseline: No control installed - full measure cost.

Market Analysis Issues:

- Largest programs have negotiated prices with program implementers, not the same as market prices.
- Some controls have considerably greater functionality and are also considerably more expensive but not possible to disaggregate costs of greater capabilities.

Program Design Issues: Costs and Savings differ for freezers and coolers but programs provide same incentives for both. Closer examination may suggest separate prescriptive or custom approaches.

Anti-Sweat Heater Controls - Base Cost Factor



**Table 14. Refrigeration Anti-Sweat Door Heater Control Base Cost Factor
- Full Costs**

Unit	Base Cost Factor (\$/Unit) *
Door Heater Controller	\$1,266.11
Cooler Door	\$126.61
Freezer Door	\$281.36

Note: This measure includes Full Equipment and Labor Costs.

*Note 2: For this measure cost/"unit", the unit is defined in each row, e.g. \$/door heater controller, etc.

Refrigeration Evaporator Fan Controls



- Installed in walk-in coolers or freezers to turn off or reduce the speed of evaporator fans when the compressor is not running.
- Variety of PA prescriptive and custom offerings.

Baseline: No control installed - full measure cost.

Market Issues:

- Efficient measures consists of two control types.
- Market is moving to more complex controls with greater energy management capabilities beyond controlling fans.
- Like Anti-Sweat heater controls, larger PA programs appear to have negotiated pricing with implementers that includes additional costs.

Program Design Issues:

- More active promotion to increase participation
- Research to assess impact of increasingly complex controls, possibly split off simple fan controllers from more complex systems in programs.

Evaporator Fan Control - Base Cost Factor



Table 16. Refrigeration Evaporator Fan Controls Base Cost Factor – Full Costs

Equipment Description	Base Cost Factor - BCF (\$/control)
Evaporator Fan Control	\$562.69

Table 17. Refrigeration Management Controls Cost Range – Full Cost

Equipment Description	Installed Cost Range (\$/control)
Multifunctional Refrigeration Management Control	Low \$500 – High \$1,700

Commercial InfraRed Heaters - Gas



- Low intensity, vented heaters - warehouses, industrial
- High intensity, unvented - loading docks , well-ventilated locations

Baseline: Commercial gas unit heater. InfraRed heaters have no efficiency standards.

Negative Incremental Costs for High Intensity Units across the board.

Program Design Implication: High intensity units should not be incentivized.

InfraRed Gas Heaters - Base Cost Factor



Table 18. InfraRed Heaters Base Cost Factor - Incremental

	Incremental Base Cost Factor - BCF (\$/unit)	
	High Intensity	Low Intensity
Up to 50,000 BTUh	-\$294	\$470
> 50,000 BTUh up to 150,000 BTUh	-\$278	\$422
> 150,000 BTUh up to 175,000 BTUh	-\$264	\$380
Greater than 175,000 BTUh	-\$255	\$353

ICS Phases 1-4 Summary Workbook



Summary of cost data analysis for variable frequency drives. Regional adjustment factors are applied to base cost factor costs. Regional adjustment factors were developed using RSMMeans City Cost Indexes based on weighted average of division category.

Variable Frequency Drives			
Data Vintage	2012		
Does this measure have incremental labor cost (Yes/No)?	No		
Return to Measure Index			
Base Cost Factor Results:			
		Base Cost Factor (\$/Unit)	
Size (HP)	Equipment Cost	Labor Cost	Total Installed Cost
5	\$1,115	\$1,135	\$2,250
15	\$2,183	\$1,135	\$3,318
25	\$3,250	\$1,135	\$4,386
50	\$5,438	\$1,135	\$6,573
75	\$7,397	\$1,135	\$8,532
100	\$8,848	n/a	n/a
200	\$15,301	n/a	n/a
Results by Market:			

Navigation bar: Unitary AC - README | Unitary AC - Results | VFD - README | VFD - Results | Res Air Sealing - README | Res Air ...

Footer: 85%

29+ Measure Cost Studies



Measure	Sector	Fuel	Application	Cost Type	Source of Final Results	Measure Cost Shelf Life
Phase 1: Measures September 2011						
1 Air Sealing	Res	Gas/	RET	Full	Phase 1	
2 Air Source Heat Pumps	Res	Electric	RET	Incr	Phase 1	
3 Boilers (300-2,500 kBtu//h)	C&I	Gas	ROB	Incr	Phase 1	
4 Boilers (<300 kBtu/h)	Res	Gas	ROB	Incr	Phase 1	
5 Central Air Conditioning	Res	Electric	ROB	Incr	Phase 1	Medium
6 Combination Heat Hot Water	Res	Gas	ROB/NC	Incr	Phase 2	Frequent
7 Furnace Including ECMs (60-120 kBtu/h)	Res	Gas	ROB	Incr	Phase 1	
8 Indirect Water Heaters (30-65 Gal)	Res	Gas	ROB/NC		Phase 1	
9 Insulation, Attic, Cellulose	Res	Gas	RET	Incr	Phase 2	Stable
10 Lighting Controls	C&I	Electric	RET/NC	Full	Phase 1	
11 On Demand (Tankless) Water Heaters	Res	Gas	ROB	Incr	Phase 2	
12 On Demand (Tankless) Water Heaters (Condensing)	Res	Gas	ROB	Incr	Phase 2	Medium
13 Unitary Air Conditioning	C&I	Electric	ROB/NC		Phase 1	
Phase 2: Measures January 2013						
14 Dual Enthalpy Economizers	C&I	Electric	RET/NC	Incr, Full	Phase 2	Medium
15 Ductless Mini-Splits	Res	Electric	RET/NC	Incr, Full	Phase 2	Frequent
16 ENERGY STAR Ventilation Fans	Res	Electric	ROB/NC	Incr, Full	Phase 2	Medium
17 Prescriptive Chillers	C&I	Electric	ROB	Incr	Phase 2	Medium
18 Variable Frequency Drives	C&I	Electric	RET	Incr	Phase 2	Medium

29+ Measure Cost Studies (continued)



Phase 3: Measures June 2014						
Measure	Sector	Fuel	Application	Cost Type	Source of Final Results	Measure Cost Shelf Life
Air Source Heat Pump	Com	Electric	ROB,NC	Inc	Phase 3	Stable
Heat Pump Water Heater	Res	Electric	ROB,NC	Inc	Phase 3	Stable
LED Refrigeration Case Lighting	Com	Electric	RET	Full*	Phase 3	Frequent
Steam traps	Com	Gas	ROB,NC	Full**	Phase 3	Stable
Unitary AC 65- 135kBh	Com	Electric	ROB,NC	Inc	Phase 3	Medium

Phase 4: Measures June 2015					
Measure	Sector	Fuel	Application	Cost Type	Measure Cost Shelf Life
VFD Air Compressors - multiple tiers and types	Com	electric			Stable
Evaporator Fan Controls	Com	electric	RET	Full	Moderate
Infrared Heaters (low and high intensity)	Com	gas	RET , ROB, NC	INC, Full	Moderate
Kitchen Equipment - Fryers	Com	gas	NC, ROB	INC	Stable
Kitchen Equipment – Convection Ovens	Com	gas	NC, ROB	INC	Stable
Refrigeration. Anti-sweat Heater Controls	Com	electric	RET	Full	Moderate

Questions?



*You want fries
with that?*



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Incremental Cost Study Team



Reports and ICS Reference Sheet can be found at:

[www.neep.org/initiatives/emv-forum/forum-products#EM&V Methods](http://www.neep.org/initiatives/emv-forum/forum-products#EM&V%20Methods)

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