Annual kWh Savings for Lighting Retrofit

Measure					*Annual Gross kWh Savings*	
	Existing Wattage	*Efficient Wattage*	*Hours*	*WHFe*	*Ex Ante*	*TRM-Calculated Ex Post*
Building A						
RF - Fluorescent Delamping	33.7	0	4439	1.25	684	748
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	184	49	4439	1.25	352	1,498
RF - Commercial LED Exit Signs	40	2	8766	1.25	230	416
TOS/NC/RF - LED Bulbs and Fixtures	203	18.6	4903	1	214	1,808
TOS/NC/RF - LED Bulbs and Fixtures	1100	116.8	4903	1	21,484	24,103
TOS/NC/RF - LED Bulbs and Fixtures	361.4	116.8	4903	1	5,256	7,196
TOS/NC/RF - LED Bulbs and Fixtures	361.4	116.8	4903	1	1,524	3,598
Building B						
TOS/NC/RF - LED Bulbs and Fixtures	233	116.8	4439	1.25	2,268	2,579
TOS/NC/RF - LED Bulbs and Fixtures	115	52.5	4903	1	1,577	1,532
TOS/NC/RF - LED Bulbs and Fixtures	295	116.8	4903	1	1,752	1,747
TOS/NC/RF - LED Bulbs and Fixtures	78	18.6	4903	1	2,365	2,621
Total					37,706	47,847

Annual kWh Savings for EC Motors

Measure					*Annual Gross kWh Savings*	
	Measure Type	*Temp*	*Building Type*	*Number of Motors*	*Ex Ante*	*TRM-Calculated Ex Post*
ECMs	Walk-in	Cooler	Restaurant	4	1,604	1,432
ECMs	Walk-in	Freezer	Restaurant	2	802	1,244
Total					2,406	2,676

Annual Therms Savings for High Efficiency Spray Valves

Measure				*Annual Gross Therms Savings*	
	Program Type	*Heating fuel*	*Application*	*Ex Ante*	*TRM-Calculated Ex Post*
High Efficiency Pre-Rinse Spray Valve	RF	Gas	Large institutional establishments with cafeteria	472	541
Total				472	541

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Standard	Fluorescent Delamping	684	748	109%	0.12	8,228
	T8 Fixture and Lamps	352	1,498	426%	0.23	8,629
	LED Bulbs and Fixtures	36,456	45,185	123%	0.00	439,255
	LED Exit Signs	214	416	195%	0.03	6,662
	ECMs	2,406	2,676	111%	0.20	40,140
Total		***40,112***	***50,523***	***126%***	***0.58***	***502,914***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Standard	High Efficiency Pre-Rinse Spray Valve	472	541	115%	2,705
Total		***472***	***541***	***115%***	***2,705***

The 126% verified electric realization rate is due to the ex ante using weighted savings values from the TRM. Whereas, the ex post used TRM savings values specific to the temperatures of the as-built walk-ins. The weighted values assume 80% walk-in cooler and 20% freezer ECMs. This project involved 33% freezer, which resulted in a higher realization rate because ECMs installed on freezers save more. For the T12 delamping measure the ex ante savings estimate used 171 kWh per lamp removed while the ex post utilized the TRM calculation of 187 kWh per lamp removed. The ex ante savings estimate for high performance and reduced wattage T8 fixtures and lamps assumed a savings of 176 kWh per fixture while the ex post TRM calculation utilized 749 kWh per fixture. For the Commercial LED exit signs the ex ante savings estimate allowed for 230 kWh of savings while the TRM savings is 416 kWh per exit sign. For the new LED fixtures and lamps measure the ex ante savings estimate ranged from 107 kWh to 4,297 kWh per fixture while the ex post savings analysis utilizing the TRM resulted in a savings range of 291 kWh to 4,821 kWh.

The 115% verified natural gas realization rate is due to the ex ante analysis using TRM example calculations and default days of use assumption. The ex post analysis used the actual day of use in the TRM calculations. The increase in days of use resulted in more realized savings.

Name S-13

Executive Summary

Application S-13 received standard incentives from Illinois DCEO for installation of VFDs on pumps and fans at their facility. The electric realization rate for this project is 75%.

Project Description

The customer installed the following VFDs:

- (4) 7.5 Hp HVAC Supply/Return Fans
- (4) 10 Hp HVAC Supply/Return Fans
- (2) 15 Hp HVAC Supply/Return Fans
- (2) 10 Hp HVAC Hot Water Pumps
- (1) 25 Hp HVAC Chilled Water Pump
- (2) 40 Hp HVAC Chilled Water Pumps

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verity the installed equipment, ADM field staff documented equipment nameplates.

Standard Incentives

Energy savings for the VFDs were calculated according to the Illinois TRM Version 2.0.

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = kWconnected * Hours * ESF$$

Where:

kWConnected = kW of equipment is calculated using motor efficiency.

(HP * .746 kw/hp* load factor)/motor efficiency

Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.

ESF = Energy savings factor varies by VFD application.

Application	ESF
Hot Water Pump	0.482
Chilled Water Pump	0.432
Constant Volume Fan	0.535
Air Foil/inlet Guide Vanes	0.227
Forward Curved Fan, with discharge dampers	0.179
Forward Curved Inlet Guide Vanes	0.092

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWconnected * DSF$$

Where:

DSF = Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Application	DSF
Hot Water Pump	0
Chilled Water Pump	0.299
Constant Volume Fan	0.348
Air Foil/inlet Guide Vanes	0.13
Forward Curved Fan, with discharge dampers	0.136
Forward Curved Inlet Guide Vanes	0.03
Custom Process	custom

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for VFDs on Pumps

Measure	*Application*	*Program Type*	*Type*	*HP*	*Building Type*	*Annual Gross kWh Savings*	
						Ex Ante	*TRM-Calculated* *Ex Post*
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	7.5 HP	School (K-12)	4,611	1,909
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	7.5 HP	School (K-12)	4,611	1,909
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	7.5 HP	School (K-12)	4,611	1,909
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	7.5 HP	School (K-12)	4,611	1,909
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	10 HP	School (K-12)	6,148	2,543
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	10 HP	School (K-12)	6,148	2,543
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	10 HP	School (K-12)	6,148	2,543
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	10 HP	School (K-12)	6,148	2,543
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	15 HP	School (K-12)	9,222	3,817
Variable Speed Drives for HVAC	Forward Curved Fan, with discharge dampers	RF	HVAC	15 HP	School (K-12)	9,222	3,817
Variable Speed Drives for HVAC	Hot Water Pump	RF	HVAC	10 HP	School (K-12)	6,148	6,849
Variable Speed Drives for HVAC	Hot Water Pump	RF	HVAC	10 HP	School (K-12)	6,148	6,849
Variable Speed Drives for HVAC	Chilled Water Pump	RF	HVAC	25 HP	School (K-12)	15,370	15,268
Variable Speed Drives for HVAC	Chilled Water Pump	RF	HVAC	40 HP	School (K-12)	24,592	24,429
Variable Speed Drives	Chilled Water Pump	RF	HVAC	40 HP	School	24,592	24,429

Measure	Application	Program Type	Type	HP	Building Type	Annual Gross kWh Savings	
						Ex Ante	TRM-Calculated Ex Post
for HVAC					(K-12)		
Total						138,329	103,266

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings	
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh	Ex Post Peak kW Reduction
Standard	Variable Speed Drives for HVAC	138,329	103,266	75%	28.92	1,548,995	28.92
Total		***138,329***	***103,266***	***75%***	***28.92***	***1548,995***	***28.92***

This 75% electric realization rate can be attributed to all of the VFDs being rebated as controlling chilled water pumps. This is an incorrect method as the VFDs where installed on air handler fans and hot water pumps. The greatest impact on savings comes from the air handler fan VFDs as they have an energy savings factor of 0.092 while the chilled water pumps have an energy savings factor of 0.432.

Name S-14

Executive Summary

Application S-14 received standard incentives from Illinois DCEO for installing high-efficiency boilers in their facility. The natural gas realization rate is 62%.

Project Description

The customer installed (3) new Fulton boilers, each with 2,000 MBH input and 92.5% efficiency to replace (4) Burnham cast iron, forced draft boilers.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified that the equipment was installed and operational by documenting unit nameplates and interviewing facility staff.

Standard Incentives

ADM estimated energy savings according to the Errata Corrected Illinois TRM Version 3.0, Section 4.4.10 High Efficiency Boiler.

NATURAL GAS ENERGY SAVINGS

ΔTherms = EFLH * Capacity * (EfficiencyRating(actual) - EfficiencyRating(base)) / EfficiencyRating(base)/100,000

Where:

EFLH	= Equivalent Full Load Hours for heating (see table)
Capacity	= Nominal Heating Capacity Boiler Size (btuh)
	= custom Boiler input capacity in Btu/hr
EfficiencyRating(base)	= Baseline Boiler Efficiency Rating, dependent on year and boiler type. Baseline efficiency values by boiler type and capacity are found in the Definition of Baseline Equipment Section
EfficiencyRating(actual)	= Efficient Boiler Efficiency Rating use actual value

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual Therms Savings for High Efficiency Boilers

Measure	*Measure Metrics*						*Annual Gross Therms Savings*		
	Program Type	*Qty*	*Boiler btuh*	*Base Boiler type*	*Boiler Efficiency*	*Zone*	*Ex Ante*	*TRM-Calculated Ex Post*	*TRM-Calculated (Errata Corrected) Ex Post*
High Efficiency Boiler	RF	3	2,000,000	Hot Water <300,000 Btu/h < June 1, 2013	92.5%	1 (Rockford)	14,580	9,831	9,094
Total							14,580	9,831	9,094

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Standard	High Efficiency Boiler	14,580	9,094	62%	181,875
Total		***14,580***	***9,094***	***62%***	***181,875***

The ex ante savings estimate is calculated using a deemed savings of 2.43 therms per efficient boiler kBtuh for schools, but the assumptions applied to this savings value are unknown. The Illinois TRM Version 3.0 utilizes an EFLH value based on an Elementary School building type in the Rockford climate zone and applies an ex post savings of 1.52 therms per kBtuh, resulting in a realization rate of 62%.

Name S-15, C-4

Executive Summary

Application S-15, C-4 received Standard and Custom incentives from Illinois - DCEO for retrofitting lighting and received standard and custom incentives for installing unitary AC units, beverage machine controls, and demand control ventilation at three of their facilities. The electric realization rate for this project is 62%. The natural gas realization rate is 27%.

Project Description

The customer installed and retrofitted the following :

Building A

- (24) HID High Bay fixtures with (24) 4' 6LT8 fixtures in the Gym
- (6) HID High Bay fixtures with (6) 4' 4LT8 fixtures in the Gym
- Installation of fixture mounted Occupancy Sensors

Building B:

- (8) HID fixtures with (8) 4' 4LT8 fixtures in the Multipurpose Room
- Installation of fixture mounted Occupancy Sensors

Building C:

- (8) HID fixtures with (8) 4' 4lT8 fixtures in the Gym/Multipurpose Room
- Installation of fixture mounted Occupancy Sensors

The participant installed (4) beverage machine controllers, and (4) 5 Ton Carrier package A/C units at three separate schools. The customer also installed demand control ventilation (DCV) sensors and controls on HVAC units serving each of the three schools. The new controls are designed to regulate the amount of outside air being supplied, dependent upon the occupancy levels within the classroom. DCV results in energy savings by reducing the amount of unnecessary outdoor air that needs to be conditioned by the HVAC system.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours.

Standard Incentives

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM section 4.5.3 and 4.5.10 were used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * \ Hours * WHF_e * ISR$$

where

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
WHF_e	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * \ WHF_d * CF * ISR$$

Where:

WHFd	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

For the lighting controls, TRM section 4.5.10 was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kWcontrolled * \ Hours * ESF * \ WHF_e$$

Where:

kWcontroled	= total lighting load connected to the control in kilowatts
ESF	= Energy Savings Factor
WHFe	= waste heat factor to account for cooling energy savings

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = kWcontrolled * \ WHF_d * (CFbaseline - CFos)$$

Where:

WHFd	= heat factor to account for cooling demand savings
CFbaseline	= Baseline Summer Peak Coincidence Factor
CFos	= Retrofit Summer Peak Coincidence Factor

ADM estimated energy savings resulting from the beverage machine controls using the Illinois TRM Version 2.0, Section 4.6.2 provided the following formula for electric energy savings:

ELECTRIC ENERGY SAVINGS

ΔkWh = WATTSbase / 1000 * HOURS * ESF

Where:

WATTSbase	= connected W of the controlled equipment; see table below for default values by connected equipment type:
1000	= conversion factor (W/kW)
HOURS	= operating hours of the connected equipment; assumed that the equipment operates 24 hours per day, 365.25 days per year
	= 8766
ESF	= Energy Savings Factor; represents the percent reduction in annual kWh consumption of the equipment controlled

ELECTRIC ENERGY SAVINGS

ADM estimated energy savings resulting from the new unitary air conditioners using the Illinois TRM Version 2.0, Section 4.4.14 provided the following formula for electric energy savings:

For units with cooling capacities less than 65 kBtu/h:

$$\Delta kWH = (kBtu/h) * [(1/SEERbase) - (1/SEERee)] * EFLH$$

For units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta kWH = (kBtu/h) * [(1/EERbase) - (1/EERee)] * EFLH$$

Where:

kBtu/h	= capacity of the cooling equipment actually installed in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).
SEERbase	= Seasonal Energy Efficiency Ratio of the baseline equipment; see table
SEERee	= Seasonal Energy Efficiency Ratio of the energy efficient equipment (actually installed).
EERbase	= Energy Efficiency Ratio of the baseline equipment; see table above for default values. Since IECC 2006 does not provide EER requirements for air-cooled air conditioners < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1
EERee	= Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EERee is unknown, assume the following conversion from SEER to EER: EER≈SEER/1.1.
	= Actual installed
EFLH	= cooling equivalent full load hours; see table

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW_{SSP} = (kBtu/h * (1/EERbase - 1/EERee)) * CF_{SSP}

Where:

CF_{SSP}	= Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)
	= 91.3%

Custom Incentives

ADM estimated energy savings according to the Illinois TRM Version 3.0, Section 4.4.19 Demand Control Ventilation.

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = \frac{SqFt}{1000} * SF$$

Where,

SqFt = *Actual square footage of conditioned spaced controlled*

SF = *Therms savings factor based on building type and weather zone*

ELECTRIC ENERGY SAVINGS

ADM estimated energy savings according to the Illinois TRM Version 3.0, Section 4.4.19 Demand Control Ventilation.

$$\Delta kWh = \frac{SqFt}{1000} * SF$$

Where,

SqFt = *Actual square footage of conditioned spaced controlled*

SF = *kWh savings factor based on building type and weather zone*

Measure-level Gross Savings Results

Standard Incentives

The table shown below presents the verified gross savings for measures that received standard incentives.

Annual kWh Savings for Lighting Retrofit

Measure					*Annual Gross kWh Savings*	
	Existing Wattage	*Efficient Wattage*	*Hours*	*WHFe*	*Ex Ante*	*TRM-Calculated Ex Post*
Building A RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	455	206	4311	1.23	28,761	31,688
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	295	146	4311	1.23	4,422	4,740
Building B RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	295	146	2422	1.21	3,259	3,493
Building C RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	295	146	2422	1.21	3,259	3,493
Total					39,701	43,415

Annual kWh Savings for Lighting Controls

Measure					*Annual Gross kWh Savings*	
	kW Controlled	*Hours*	*ESF*	*WHFd*	*Ex Ante*	*TRM-Calculated* *Ex Post*
Building A RF - Occupancy Sensor Lighting Controls	6,492	4311	0.3	0.74	14,114	10,327
Building B RF - Occupancy Sensor Lighting Controls	1,232	2422	0.3	1.33	1,480	1.083
Building C RF - Occupancy Sensor Lighting Controls	1,232	2422	0.3	1.33	1,480	1.083
Total					17,074	12,494

Annual kWh Savings for Beverage Machine Controls

Measure	*Measure Metrics*			*Annual Gross kWh Savings*	
	Program Type	*Equipment type*	*Qty*	*Ex Ante*	*TRM-Calculated* *Ex Post*
Beverage and Snack Machine Controls	RF	Refrigerated Beverage Vending Machines	2	3,226	3,226
Beverage and Snack Machine Controls	RF	Refrigerated Beverage Vending Machines	1	1,613	1,613
Beverage and Snack Machine Controls	RF	Refrigerated Beverage Vending Machines	1	1,613	1,613
Total				6,452	6,452

Annual kWh Savings for High Efficiency HVAC Unit

Measure	Measure Metrics								Annual Gross kWh Savings	
	Program Type	Equipment type	Subcategory or rating Condition	Qty	New Cooling Capacity (kbtu/h)	SEER of Efficient Equipment	Zone	Electric Resistance Heat?	Ex Ante	TRM-Calculated Ex Post
Single-Package and Split System Unitary Air Conditioners	TOS	Air conditioners, Air cooled	Single Package	2	57.5	15.2	3 (Springfield)	FALSE	496	649
Single-Package and Split System Unitary Air Conditioners	TOS	Air conditioners, Air cooled	Single Package	2	57.5	15.2	3 (Springfield)	FALSE	496	649
Total									992	1,298

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual Therms Savings for DCV

Measure	Measure Metrics				Annual Gross Therm Savings	
	Program Type	Building Type	Zone	Conditioned Space (Sq. Ft.)	Ex Ante	ADM Calculated Ex Post
DCV	TOS	High School	3 (Springfield)	24,955	5,000	1,348
Total					5,000	1,348

Annual kWh Savings for DCV

Measure	Measure Metrics				Annual Gross kWh Savings	
	Program Type	Building Type	Zone	Conditioned Space (Sq. Ft.)	Ex Ante	ADM Calculated Ex Post
DCV	TOS	High School	3 (Springfield)	24,955	20,956	16,470
DCV	TOS	Elementary	3	23,410	59,698	15,732

Measure	Measure Metrics				Annual Gross kWh Savings	
	Program Type	Building Type	Zone	Conditioned Space (Sq. Ft.)	Ex Ante	ADM Calculated Ex Post
DCV	TOS	Elementary	(Springfield) 3 (Springfield)	18,875	30,324	12,684
Total					110,978	44,886

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh
Standard	T8 Fixtures and Lamps	39,701	43,415	109%	1.82	651,225
	Occupancy Controls	17,074	12,494	73%	0.53	99,948
	Beverage and Snack Machine Controls	6,452	6,452	100%	0.00	48,388
	High Eff. HVAC	992	1,298	131%	1.30	19,474
Subtotal		*64,219*	*63,659*	*99%*	*3.65*	*819,035*
Custom	DCV	110,978	44,886	40%	0.00	448,858
Subtotal		*110,978*	*44,886*	*40%*	*0.00*	*448,858*
Total		***175,197***	***108,545***	***62%***	***3.65***	***1,267,893***

Verified Natural Gas Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings			Lifetime Gross Savings
		Ex Ante Therms	Ex Post Therms	Realization Rate	Ex Post Therms
Custom	DCV	5,000	1,348	27%	13,476
Total		***5,000***	***1,348***	***27%***	***13,476***

The overall electric realization rate is 62%. For the lighting retrofit (4.5.3), the realization rate is high because the ex ante savings estimate applied a savings of 2.15 kWh per connected watt reduced (ranging between 184.25 kWh to 1,198.38 kWh per fixture in savings), while the ex post

savings used the TRM savings of 197.52 kWh to 1,320.33 kWh per fixture. The high realization is due to the difference between TRM assumptions of baseline and as-built fixture wattages versus ex ante baseline and as-built fixture wattages. For the occupancy sensor (4.5.10), the realization rate is low because the ex ante savings estimate was based on a prescriptive value of 1 per connected watt, while the ex post savings follows the TRM calculation for occupancy sensors.

The HVAC portion of the project which produced a 27% natural gas and 44% electric realization rates can be attributed to an overestimation in the DCV savings in the ex ante calculations. By reviewing the submitted calculations, it appears that the ex ante calculations did not include heating and cooling system efficiencies. The reported ex ante savings are actually the thermal energy saved and not the electrical or gas energy savings.

Name S-16

Executive Summary

Application S-16 received Standard incentives from Illinois-DCEO for retrofitting the lighting in their facility. The realization rate for this project is 611%.

Project Description

The customer retrofitted the following (71) HPS fixtures with (71) LED fixtures in the main campus lobby.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours

Standard Incentives

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM section 4.5.4 was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * \ Hours * WHF_e * ISR$$

Where:

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
WHF_e	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * \ WHF_d * CF * ISR$$

Where:

WHFd	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

For the lighting controls, TRM section 4.5.10 was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kWcontrolled * \ Hours * ESF * \ WHF_e$$

Where:

kWcontroled = total lighting load connected to the control in kilowatts

ESF = Energy Savings Factor

WHFe = waste heat factor to account for cooling energy savings

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = kWcontrolled * WHF_d * (CFbaseline - CFos)$$

Where:

WHFd = heat factor to account for cooling demand savings

CFbaseline = Baseline Summer Peak Coincidence Factor

CFos = Retrofit Summer Peak Coincidence Factor

Measure-level Gross Savings Results

Standard Incentives

The table shown below presents the verified gross savings for measures that received standard incentives.

Annual kWh Savings for Lighting Retrofit

Measure					*Annual Gross kWh Savings*	
	Existing Wattage	*Efficient Wattage*	*Hours*	*WHFe*	*Ex Ante*	*TRM-Calculated Ex Post*
TOS/NC/RF - LED Bulbs and Fixtures	144	18.6	3540	1.14	5,877	35,931
Total					5,877	35,931

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Standard	4.5.4	5,877	35,931	611%	7.48	355,246
Total		***5,877***	***35,931***	***611%***	***7.48***	***355,246***

The project level realization rate 611%. The ex post savings analysis utilized the TRM savings calculations. The high realization is due to the baseline wattage default value is higher than the TRM nominal data table for baseline wattages.

Name S-17

Executive Summary

Application S-17 received standard incentives from Illinois DCEO for installing lighting and high-efficiency boilers and an air-cooled chiller at their facility. The natural gas realization rate is 135% and the electric realization rate is 104%.

Project Description

The customer replaced T8 fluorescent lighting with T5 fluorescent lighting, which reduced the connected load by 16,016 Watts. The customer also installed occupancy sensors to control fixtures accounting for a load of 16,072 Watts.

The customer installed (2) Aerco Benchmark 2.0 Low NOx boilers, each with 2,000 MBH input to replace (2) Kewanee steam, fire-tube boilers. The customer also added a chilled water system and installed a Trane CGAM, 80 ton, air-cooled chiller.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified that the equipment was installed and operational by documenting unit nameplates and interviewing facility staff.

Standard Incentives

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit, TRM Section 4.5.12 was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * \ Hours * WHF_e * ISR$$

Where:

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
WHF_e	= waste heat factor to account for cooling energy savings
ISR	=In service rate = % of units rebated that get installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * \ WHF_d * CF * ISR$$

Where:

WHFd	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

For the lighting controls, TRM section 4.5.10 was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kWcontrolled * Hours * ESF * WHF_e$$

Where:

kWcontroled	= total lighting load connected to the control in kilowatts
ESF	= Energy Savings Factor
WHFe	= waste heat factor to account for cooling energy savings

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = kWcontrolled * WHF_d * (CFbaseline - CFos)$$

Where:

WHFd	= heat factor to account for cooling demand savings
CFbaseline	= Baseline Summer Peak Coincidence Factor
CFos	= Retrofit Summer Peak Coincidence Factor

ADM estimated energy savings for the boilers according to the Errata Corrected Illinois TRM Version 3.0, Section 4.4.10 High Efficiency Boiler.

NATURAL GAS ENERGY SAVINGS

ΔTherms = EFLH * Capacity * (EfficiencyRating(actual) - EfficiencyRating(base))/EfficiencyRating(base) / 100,000

Where:

EFLH	= Equivalent Full Load Hours for heating (see table)
Capacity	= Nominal Heating Capacity Boiler Size (btuh)
	= custom Boiler input capacity in Btu/hr
EfficiencyRating(base)	= Baseline Boiler Efficiency Rating, dependent on year and boiler type. Baseline efficiency values by boiler type and capacity are found in the Definition of Baseline Equipment Section
EfficiencyRating(actual)	= Efficent Boiler Efficiency Rating use actual value

ADM estimated energy savings for the new chiller according to the Errata Corrected Illinois TRM Version 3.0, Section 4.4.6 Electric Chiller.

ELECTRIC ENERGY SAVINGS

ΔkWH = TONS * ((12/IPLVbase) – (12/IPLVee))* EFLH

Where:

TONS	= chiller nominal cooling capacity in tons (note: 1 ton = 12,000 Btu/h)

12	= conversion factor to express Integrated Part Load Value (IPLV) EER in terms of kW per ton
IPLVbase	= efficiency of baseline equipment expressed as Integrated Part Load Value EER. Dependent on chiller type.
IPLVee	= efficiency of high efficiency equipment expressed as Integrated Part Load Value EER
EFLH	= equivalent full load hours dependent on location

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for Lighting Retrofit

Measure					*Annual Gross kWh Savings*	
	Existing Wattage	*Efficient Wattage*	*Hours*	*WHFe*	*Ex Ante*	*TRM-Calculated Ex Post*
T5 Fixtures and Lamps	128	56	2,422	1.21	36,715	36,715
T5 Fixtures and Lamps	64	56	2,422	1.21	10,222	10,222
Total					46,937	46,937

Annual kWh Savings for Lighting Controls

Measure					*Annual Gross kWh Savings*	
	kW Controlled	*Hours*	*ESF*	*WHFd*	*Ex Ante*	*TRM-Calculated Ex Post*
Occupancy Sensor Lighting Controls	16,072	2,422	0.41	1.33	19,311	19,311
Total					19,311	19,311

Annual Therms Savings for High Efficiency Boilers

Measure	Measure Metrics						Annual Gross Therms Savings		
	Program Type	Qty	Boiler btuh	Base Boiler Type	Boiler AFUE	Zone	Ex Ante	TRM-Calculated Ex Post	TRM-Calculated (Errata Corrected) Ex Post
High Efficiency Boiler	RF	2	2,000,000	Steam - all except natural draft >2,500,000 Btu/h	93.5%	2 (Chicago)	4,200	6,596	5,670
Total							4,200	6,596	5,670

Annual kWh Savings for the High Efficiency Chiller

Measure	Measure Metrics							Annual Gross Savings		
	Qty	Chiller Size (tons)	Chiller Type	Zone	Building Type	As-Built IPLV EER	Baseline IPLV EER	Ex Ante kWh	TRM-Calculated Ex Post kWh	TRM-Calculated (Errata Corrected) Ex Post
Electric Chiller	1	80	Air Cooled	2 (Chicago)	Elementary School	15.6	12	2,710	20,496	5,448
Total								2,710	20,496	5,448

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Natural Gas Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings			Lifetime Gross Savings
		Ex Ante Therms	Ex Post Therms	Realization Rate	Ex Post Therms
Standard	High Efficiency Boiler	4,200	5,670	135%	113,400
Total		***4,200***	***5,670***	***135%***	***113,400***

The ex ante savings estimate for the boilers is calculated using a deemed savings of 2.43 therms per efficient boiler kBtuh for schools, but the assumptions applied to this savings value are unknown. The Illinois TRM Version 3.0 utilizes an EFLH value based on an Elementary School building type in the Chicago climate zone and applies an ex post savings of 1.42 therms per kBtuh, resulting in a realization rate of 135%.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Standard	T5 Fixtures and Lamps	46,937	46,937	100%	4.69	704,052
	Lighting Controls	19,311	19,311	100%	1.93	154,491
	Electric Chiller	2,710	5,448	201%	18.62	108,967
Total		***68,958***	***71,696***	***104%***	***25.24***	***967,510***

For the lighting retrofit and lighting controls, the realization rate is 100%.

The ex ante savings estimate for the chiller is calculated using a deemed savings of 127.4 kWh per efficient chiller ton for schools, but the assumptions applied to this savings value are unknown. The Illinois TRM Version 3.0 utilizes an EFLH value based on the building type in the Chicago climate, resulting in a realization rate of 53%.

The electric realization rate is 104%.

Name C-5

Executive Summary

Application C-5 received Custom incentives from Illinois - DCEO for retrofitting lighting in their facility. The realization rate for this project is 191%.

Project Description

The customer retrofitted the following (105) Halogen 250w lamps with (105) LED 19w lamps in the ballroom area.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment installation, baseline and post-retrofit connected load, and placed one photo-sensor logger at the site (from 07/30/2014 to 11/10/2014) to monitor lighting operation. These data were used to calculate energy savings.

Custom Incentives

For the lighting retrofit, ADM used a custom calculation to estimate savings.

ELECTRIC ENERGY SAVINGS

$$kWh_{savings} = \sum_{Area} \left[HCIF \times t \times \left(N_{base} \times W_{base} - N_{as-built} \times W_{as-built} \right) / 1000 \right]$$

Where:

$kWh_{savings}$	= Annual energy savings
N	= Number of fixtures
W	= Wattage of each fixture
t	= Lighting operating hours
HCIF	= HVAC interactive factor

Measure-level Gross Savings Results

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual kWh Savings for Lighting Retrofit

Measure					*Annual Gross kWh Savings*	
	Existing Wattage	*Efficient Wattage*	*Hours*	*Heating Cooling Interaction Factor*	*Ex Ante*	*ADM Calculated Ex Post*
Halogen to LED	250	19	2,448	1.17	36,375	69,472
Total					36,375	69,472

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Ex Post Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Custom	Lighting Retrofit	36,375	69,472	191%	16.81	981,243
Total		***36,375***	***69,472***	***191%***	***16.81***	***981,243***

The project-level realization rate is 191%. The realization rate is high because the ex post hours of operation verified during the M&V site visit (2,448) are greater than those used to perform ex ante savings estimate (1,500). In addition, the ex post savings analysis included an HCIF for a University in the Springfield region (1.17), while the ex ante savings estimate did not account for HVAC interactive effects.

Name C-6

Executive Summary

Application C-6 received custom incentives from Illinois DCEO for sealing HVAC air leaks. The electric realization rate for this project is 97%, and the natural gas realization rate is 103%.

Project Description

The customer sealed HVAC air leaks. The rooftop HVAC units had to be remounted and sealed. There were large leaks around the bases of the units.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified that the repairs had been made. To verify the energy savings for the repairs, ADM field staff documented equipment nameplates and spec sheets.

Custom Incentives

Energy savings were calculated using engineering equations and temperature bin analysis.

Local TMY3 weather data was used to generate 2 degree temperature bins. The bins range from -10°F to 100°F. The cooling electric energy savings were calculated using heat transfer saved, cooling operating hours, and cooling system efficiency. Operating hours were calculated using a utilization factor and the number of hours in each temperature bin. The utilization factor was determined using the ratio of total cooling runtime hours to total system runtime hours. See Electric Energy Savings calculations.

Gas heating energy savings were found using the same method. Gas heating energy savings were calculated using heat transfer saved, heating system operating hours, and heating system efficiency.

Energy savings were realized from the amount of conditioned air that was no longer being lost.

NATURAL GAS ENERGY SAVINGS

$$\Delta\text{Therms} = Q_{saved} * \text{Utilization Factor} * \text{Bin Hours} * / (\text{Heating Efficiency} * 100{,}000)$$

Where:

Q_{saved}	= Amount of heat transfer saved
	= 1.08 * cfm * (ΔT)
1.08	= a constant for sensible heat equations
cfm	= quantity of air flow being lost
ΔT	= Design Supply Air Temp (SAT) – Mixed Air Temp (MAT)
Utilization Factor	= Ratio of building operating hours per week to total hours in a week
Bin Hours	= Hours in each temperature bin
Heating Efficiency	= Efficiency of the heating equipment

100,000	= BTUs to Therms conversion

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = Q_{saved} / 12{,}000 * 12 / \text{Cooling EER} * \text{Utilization Factor} * \text{Bin Hours}$$

Where:

Q_{saved}	= Amount of heat transfer saved
	= 1.08 * cfm * (ΔT)
1.08	= a constant for sensible heat equations
cfm	= quantity of air flow being lost
ΔT	= Design Supply Air Temp (SAT) – Mixed Air Temp (MAT)
Utilization Factor	= Ratio of building operating hours per week to total hours in a week
Bin Hours	= Hours in each temperature bin
Cooling EER	= Cooling Energy Efficiency Ratio
12	= EER to kW/ton Conversion

SUMMER COINCIDENT PEAK DEMAND SAVINGS

Summer peak demand savings were calculated similar to the electric energy savings methodology. The differences being that the operating hours and utilization factor were removed, and an average peak mixed air temperature was determined. It is assumed that the system would have been operating for a full hour during the peak.

$$\Delta kW = Q_{saved} / 12{,}000 * 12 / \text{Cooling EER}$$

Measure-level Gross Savings Results

Custom Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for HVAC Air Leak Repairs

Measure	*Annual Gross kWh Savings*	
	Ex Ante	*ADM Calculated Ex Post*
HVAC Air Leak Repairs	9,455	9,119
Total	9,455	9,119

Annual Therms Savings for HVAC Air Leak Repairs

Measure	*Annual Gross Therms Savings*	
	Ex Ante	*ADM Calculated Ex Post*
HVAC Air Leak Repairs	818	845
Total	818	845

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Custom	HVAC Air Leak Repairs	9,445	9,119	96%	8.7	27,357[14]
Total		***9,445***	***9,119***	***96%***	***8.7***	***27,357***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Custom	HVAC Air Leak Repairs	818	845	103%	2,532
Total		***818***	***845***	***103%***	***2,532***

The 96% verified electric realization rate is due to differences in weather data. The ex ante did not use TMY3 weather data. The TMY3 weather data did not have quite as high of temperatures.

The 103% verified natural gas realization rate is due to the use of TMY3 weather data. The TMY3 weather data had some lower temperatures.

[14] Lifetime savings were calculated using the remaining useful life of the measure. In this case, the expected useful life (EUL) of 15 years came from IL TRM. The remaining useful life was calculated by subtracting the age of the existing HVAC equipment from the EUL.

Name S-18, C-8

Executive Summary

Application S-18, C-8 received standard incentives from Illinois DCEO for retrofitting lighting in three of their buildings, and they received custom incentives for making chilled water system modifications, the addition of VFDs to hot water pumps, and the addition of thermostatic controls to a supply and exhaust fan in one building. The electric realization rate for this project is 29%.

Project Description

The customer installed or retrofitted the following:

Building 1:

- (88) 4' 2LT12 fixtures with (88) 4' 2LT8 fixtures
- (67) Incandescent lamps with (67) CFL lamps
- (13,402) T8 lamps with (13,402) high performance T8 lamps
- (6) 3' 2LT12 fixtures with (6) 3' 2LT8 fixtures
- (9) Incandescent Exit Signs with (9) LED Exit Signs
- Installation of Occupancy Sensors

Building 2:

- (9) Incandescent lamps with (9) CFL lamps
- (7) 4' 2LT12 fixtures with (7) 4' 2LT8 fixtures
- (1) 4' 4LT12 fixture with (1) 4' 4LT8 fixture
- (7,016) T8 lamps with (7,016) high performance T8 lamps
- (18) Incandescent Exit Signs with (18) LED Exit Signs
- Installation of Occupancy Sensors

Building 3:

- Installation of Occupancy Sensors

The customer received incentives for three projects based on an RCx study. Project one involved the replacement of two existing chillers with two new high efficiency air cooled chillers with free cooling capabilities, increasing the chilled water setpoint from 39°F to 42°F, and the conversion of approximately 200 tons of DX process load cooling to chilled water by the addition of a new chiller water loop. The second project involves the installation of four VFDs on how water pumps serving the building's VAV reheat loop. The final projects involved the addition of thermostatic controls on a supply and exhaust fan serving a mechanical room which original operated 24/7. The addition of the controls will allow the fans to cycle on/off based on the cooling needs of the room.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verity the installed equipment, ADM field staff documented equipment nameplates.

Standard Incentives

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM sections 4.5.1, 4.5.3, 4.5.5, and 4.5.10 were used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * \ Hours * WHF_e * ISR$$

Where:

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
WHF_e	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * \ WHF_d * CF * ISR$$

Where:

WHFd	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

For the lighting controls, TRM section 4.5.10 was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kWcontrolled * \ Hours * ESF * \ WHF_e$$

Where:

kWcontroled	= total lighting load connected to the control in kilowatts
ESF	= Energy Savings Factor
WHFe	= waste heat factor to account for cooling energy savings

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = kWcontrolled * \ WHF_d * (CFbaseline - CFos)$$

Where:

WHFd	= heat factor to account for cooling demand savings

CFbaseline = Baseline Summer Peak Coincidence Factor

CFos = Retrofit Summer Peak Coincidence Factor

Custom Incentives

ELECTRIC ENERGY SAVINGS

Annual savings for the pair of chillers and economizer feature was calculated through the use of a temperature bin analysis informed by a prototypical eQuest Hospital model. In order to maximize the certainty of the analysis, the referenced prototypical eQuest model was configured to use two air cooled reciprocating chillers instead of the original three water cooled chiller configuration. The model was then run using TMY3 weather for the Chicago, IL area to determine the typical Part Load Ratios (PLRs) for the rebated chillers. The annual load profile were then determined by calculating the average PLRs for five degree temperature bins and multiplying by the total capacity of the chillers. The savings for the increase in chiller efficiency for each bin was calculated by using the following formula:

$$kWh_{Savings} = Tons \times (kW/ton_{base} - kW/ton_{ee}) \times Hrs$$

Where:

kWhsavings = Annual cooling energy savings

Tons = Cooling Capacity, Tons

kW/tonbase = Integrated Part Load Value of baseline chiller

kW/tonee = Integrated Part Load Value of the newly installed systems

Hrs = Annual hours of operation

The savings for the free cooling abilities of the new chillers was also calculated use a five degree temperature bin analysis informed by the same eQuest model. Baseline energy consumption was calculated for each bin using the derived load profile and the efficiency of the new chillers. The as-built consumption was calculated by assuming that the free cooling option would reduce the cooling load on the chillers starting at an ambient temperature of 43.4 ^{o}F based upon manufacture chiller curves, in which the remaining required mechanical cooling tonnage was multiplied by the efficiency of the as-built chillers. The annual energy savings is the difference baseline and as-built energy consumption.

Annual energy savings for the thermostatic controls on the mechanical room supply and exhaust fans was calculated through the use of the following equation in which fan hours were informed by the prototypical eQuest model:

$$kWh_{Savings} = \frac{Hp \times .746 \times LF \times (Hrs_{base} - Hrs_{as-built})}{Eff}$$

Where:

kWhsavings = Annual cooling energy savings

Hp = Rated horsepower of the fan motor

LF = Assumed load factor of the fan, 0.75

Hrs_{base} = Baseline hours of operation

$Hrs_{as\text{-}built}$ = As-Built hours of operation

Eff = Fan motor efficiency

Energy savings for the VFDs were calculated according to the Illinois TRM Version 2.0.

$$\Delta kWH = kWconnected * Hours * ESF$$

Where:

kWConnected = kW of equipment is calculated using motor efficiency.

(HP * .746 kw/hp* load factor)/motor efficiency

Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.

ESF = Energy savings factor varies by VFD application.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWconnected * DSF$$

Where:

DSF = Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Measure-level Gross Savings Results

Standard Incentives

The table shown below presents the verified gross savings for measures that received standard incentives.

Annual kWh Savings for Lighting Retrofit

Measure					*Annual Gross kWh Savings*	
	Existing Wattage	*Efficient Wattage*	*Hours*	*WHFe*	*Ex Ante*	*TRM-Calculated Ex Post*
Building 1						
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	82	49	3540	1.14	11,251	11,719
Commercial Energy Star Standard CFL			3540	1.14	6,523	4,534
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	32	25	3540	1.14	259,635	339
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	59	49	3540	1.14	-	234,993
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	114	94	3540	1.14	-	35,190
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	88	49	3540	1.14	575	944
RF - Commercial LED Exit Signs	35	2	8766	1.14	1,889	2,968
Building 2						
Commercial Energy Star Standard CFL			3540	1.14	876	609
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	82	49	3540	1.14	1,151	932
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	164	94	3540	1.14	-	282
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	32	25	3540	1.14	135,900	56
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	59	49	3540	1.14	-	119,777
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	88	72	3540	1.14	-	6,070
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	114	94	3540	1.14	-	16,062
RF - Commercial LED Exit Signs	35	2	8766	1.14	3,777	5,936
Total					421,578	440,412

Annual kWh Savings for Lighting Controls

Measure					*Annual Gross kWh Savings*	
	kW Controlled	*Hours*	*ESF*	*WHFd*	*Ex Ante*	*TRM-Calculated Ex Post*
Building 3 RF - Occupancy Sensor Lighting Controls	7,976	3,500	0.41	1.5	13,197	13,197
Building 1 RF - Occupancy Sensor Lighting Controls	45,791	3,500	0.41	1.5	75,766	75,766
Building 2 RF - Occupancy Sensor Lighting Controls	10,338	3,500	0.41	1.5	17,105	17,105
Total					106,068	106,068

Custom Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for High Efficiency Chillers

Temperature			*Hours*	*Tonnage*		*Baseline kW*		*As-Built kW*		*kWh Savings*	
High	*Low*	*Average*		*Chiller 1*	*Chiller 2*	*Chiller 1*	*Chiller 2*	*Chiller 1*	*Chiller 2*	*Chiller 1*	*Chiller 2*
95	90	92.5	27	160.15	160.15	150.54	150.54	142.53	142.53	216	216
90	85	87.5	160	142.64	124.22	134.08	116.77	126.95	110.56	1,141	994
85	80	82.5	335	136.50	97.72	128.31	91.86	121.49	86.97	2,286	1,637
80	75	77.5	493	141.65	50.76	133.15	47.71	126.07	45.18	3,492	1,251
75	70	72.5	668	137.82	21.20	129.55	19.93	122.66	18.87	4,603	708
70	65	67.5	768	114.07	5.99	107.22	5.63	101.52	5.33	4,380	230
65	60	62.5	692	71.14	9.45	66.87	8.88	63.31	8.41	2,461	327
60	55	57.5	686	44.49	3.27	41.82	3.07	39.59	2.91	1,526	112
55	50	52.5	651	35.69	0.42	33.55	0.39	31.77	0.37	1,162	14
50	45	47.5	544	34.74	0.00	32.66	0.00	30.92	0.00	945	0
45	40	42.5	596	35.43	0.00	33.31	0.00	31.54	0.00	1,056	0
40	35	37.5	642	36.02	0.51	33.86	0.48	32.05	0.45	1,156	16
35	30	32.5	832	33.84	0.13	31.81	0.12	30.12	0.12	1,408	5
30	25	27.5	552	31.20	0.00	29.32	0.00	27.76	0.00	861	0
25	20	22.5	320	33.84	0.00	31.81	0.00	30.12	0.00	542	0
20	15	17.5	344	26.92	0.00	25.30	0.00	23.96	0.00	463	0
15	10	12.5	162	29.42	0.00	27.65	0.00	26.18	0.00	238	0
10	5	7.5	125	26.43	0.00	24.84	0.00	23.52	0.00	165	0
5	0	2.5	84	9.67	0.00	9.09	0.00	8.61	0.00	41	0
0	-5	-2.5	54	0.00	0.00	0.00	0.00	0.00	0.00	0	0
-5	-10	-7.5	25	0.00	0.00	0.00	0.00	0.00	0.00	0	0
Total kWh Savings										33,653	

Annual kWh Savings for Chiller Free Cooling

Temperature			*Hours*	*Baseline Tonnage*		*As-Built Tonnage*		*kWh Savings*	
High	*Low*	*Average*		*Chiller 1*	*Chiller 2*	*Chiller 1*	*Chiller 2*	*Chiller 1*	*Chiller 2*
95	90	92.5	27	160.15	160.15	160.15	160.15	0	0
90	85	87.5	160	142.64	124.22	142.64	124.22	0	0
85	80	82.5	335	136.50	97.72	136.50	97.72	0	0
80	75	77.5	493	141.65	50.76	141.65	50.76	0	0
75	70	72.5	668	137.82	21.20	137.82	21.20	0	0
70	65	67.5	768	114.07	5.99	114.07	5.99	0	0
65	60	62.5	692	71.14	9.45	71.14	9.45	0	0
60	55	57.5	686	44.49	3.27	44.49	3.27	0	0
55	50	52.5	651	35.69	0.42	35.69	0.42	0	0
50	45	47.5	544	34.74	0.00	34.74	0.00	0	0
45	40	42.5	596	35.43	0.00	17.29	0.00	9,623	0
40	35	37.5	642	36.02	0.51	0.00	0.00	20,579	289
35	30	32.5	832	33.84	0.13	0.00	0.00	25,061	96
30	25	27.5	552	31.20	0.00	0.00	0.00	15,325	0
25	20	22.5	320	33.84	0.00	0.00	0.00	9,639	0
20	15	17.5	344	26.92	0.00	0.00	0.00	8,241	0
15	10	12.5	162	29.42	0.00	0.00	0.00	4,241	0
10	5	7.5	125	26.43	0.00	0.00	0.00	2,940	0
5	0	2.5	84	9.67	0.00	0.00	0.00	723	0
0	-5	-2.5	54	0.00	0.00	0.00	0.00	0	0
-5	-10	-7.5	25	0.00	0.00	0.00	0.00	0	0
Total kWh Savings								96,757	

Annual kWh Savings for Thermostatic Controls

Measure						*Annual Gross kWh Savings*	
	Fan	*HP*	*Eff*	*Baseline Hours*	*As-Built Hours*	*Ex Ante*	*ADM Calculated Ex Post*
Thermostatic Controls	*S-13*	*50*	*93.0%*	*8,760*	*6,579*	*94,600*	*65,606*
Thermostatic Controls	E-12	25	91.7%	*8,760*	*6,579*	47,300	*33,268*
Total						141,900	*98,874*

Annual kWh Savings for VFDs

Measure						*Annual Gross kWh Savings*	
	Application	*Program Type*	*Type*	*HP*	*Building Type*	*Ex-Ante*	*ADM Calculated Ex Post*
Variable Speed Drives for HVAC	Hot Water Pump	RF	HVAC	3 Hp	College/ University	61,225	3,912
Total						61,225	3,912

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Standard	Compact Fluorescent Lamp	7,501	5,143	69%	1.47	26,322
	T8 Fixtures and Lamps	408,512	426,365	104%	88.75	6,286,797
	LED Exit Signs	5,666	8,904	157%	0.75	142,464
	Occupancy Controls	106,068	106,068	100%	22.08	848,543
Subtotal		*527,646*	*546,480*	*104%*	*113.04*	*7,304,126*
Custom	Chilled Water Modifications	1,953,400	130,410	7%	5.25	1,956,151
	HW Pump VFDs	61,225	3,912	6%	0.00	58,682
	Thermostatic Controls	141,900	98,874	70%	11.29	1,483,108
Subtotal		*2,156,525*	*233,196*	*11%*	*16.54*	*3,497,942*
Total		***2,684,171***	***779,676***	***29%***	***129.58***	***10,802,068***

For the standard incentive projects, the realization rate is 104%. The realization rate is slightly high because the ex ante savings estimate for the LED Exit Signs (210 kWh per fixture) was lower than the ex post savings analysis which utilized the TRM calculation (330 kWh per fixture). The measure for T8 lamps had the ex ante savings estimate (41 kWh – 128 kWh per lamp) slightly lower than the ex post TRM calculations (43 kWh – 157 kWh per lamp). For the CFL measure the ex ant savings estimate (73 kWh – 97 kWh per lamp) was higher than the TRM

calculation (51 kWh – 68 kWh per lamp). The ex ante estimate for the Occupancy Sensors was highly accurate.

For the custom incentive project, the 11% electric realization rate can be attributed to the facility not completing all of the claimed measures during the time of ADM's M&V visit. One of largest contributors was part of the chilled water modification measure; in which 200 tons of process load were to be tied into the chilled water system and the original DX units decommissioned. During the M&V visit, ADM was informed that this measure had not been completed and had been postponed. Due to this, no savings were attributed to the chilled water re-piping and only savings for the efficiency increase with the new chillers was given. Also as part of the chilled water modification measure the chilled water set point was to be raised from 39°F to 42°F. During the M&V visit, ADM obtained the chilled water setpoint from the BMS system and discovered it was set at 29°F and the second chiller was sequenced to come on when the chilled water temperature rose above 33°F. Due to the chilled water temperature setpoint being lower than originally claimed the energy consumption would be technically higher; therefore, zero savings was attributed to this measure.

The 6% realization rate for the hot water pump VFDs is due to the ex-ante claiming the installation of four VFDs. However, during the site visit, ADM was informed the scope of the project had been changed to only a single VFD being installed on hot water pump P-30, which only has a 3 Hp motor.

The project level realization rate is 29%

Name C-9, C-10, C-11, & C-12

Executive Summary

Applications C-9, C-10, C-11, & C-12 received custom incentives from Illinois DCEO for renovations to their existing HVAC equipment and controls. The electric realization rate for this project is 620%, and the natural gas realization rate is 176%.

Project Description

The applicant made various renovations to their existing HVAC systems and controls under the (4) project reviewed in this report. The installed energy efficiency measures are as follows:

Project Number	***Description of Measures***
C-9	Replace existing boilers with new, high efficiency, units. New boilers are also installed with advanced controls to optimize combustion efficiency.
C-10	Existing unit heaters (used primarily in classrooms) throughout the facility were replaced with VRF system – now allowing for cooling where there previously was none. In addition, ERVs were added to condition the outside air for each VRF system.
C-11	The packaged rooftop unit (RTU-1) serving the library was replaced with a new, high efficiency, unit with DCV controls
C-12	DCV controls were retrofitted onto the existing air handler serving the north gym (AHU-1).

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified that the equipment and controls were installed and operational. To verify the energy savings for the measures, ADM field staff documented equipment nameplates, construction documents, and mechanical schedules. ADM staff also reviewed the new building energy management system to identify control inputs, set-points, and operations.

Custom Incentives

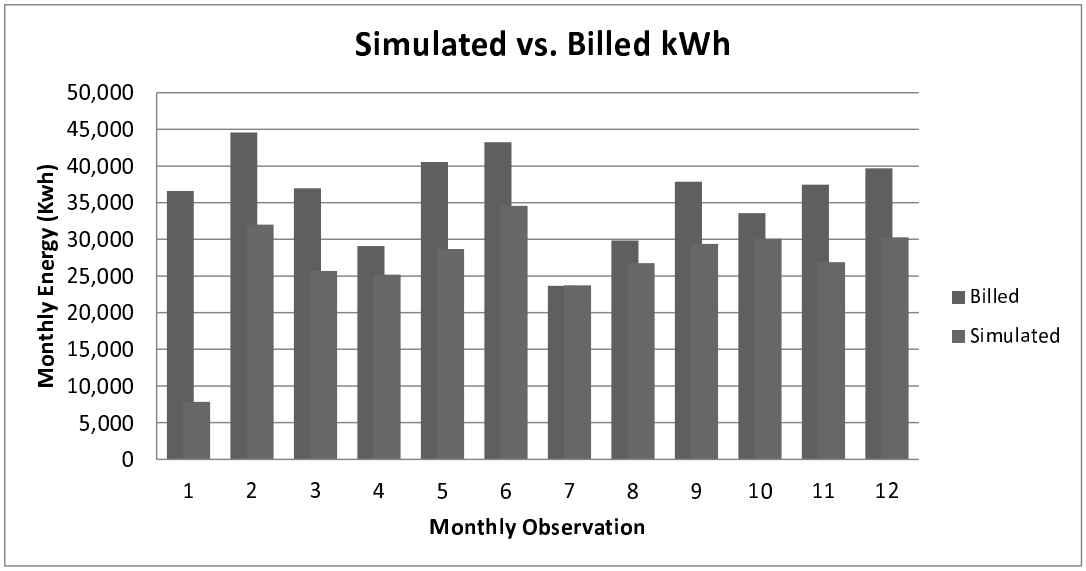
Energy savings were calculated using IPMVP Option D. ADM developed several building energy models of school – each representing the measures installed for a particular project (including one model which represented baseline conditions). In all, six models were developed:

Number	***Model Name***	***Model Description***
0	Calibrated Baseline	Represents baseline conditions. Simulated using real weather data from NOAA and calibrated to facility billing history (see graphs below)
1	Typical Baseline	Same as above, but simulated with TMY3 weather data to represent 'Typical' annual energy performance. Note that one

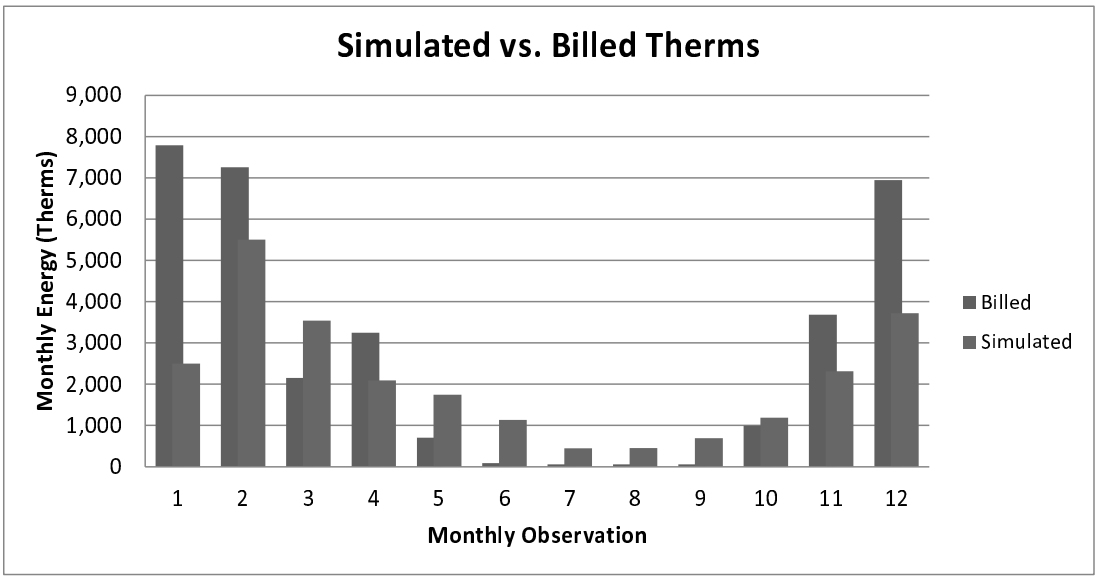
		key addition was made to this model. The unit heaters serving the classrooms and south auditorium were replaced with a Water Loop Heat Pump System. The reason for this is discussed later in this section.
2	C-12	Measures implemented in *Project C-12* (DCV controls on AHU-1) were added to the *Typical baseline*. The difference between the annual energy performance predicted by this model and the model above (Model #1) are the ex post impacts for this project.
3	C-11	Measures implemented in *Project C-11* (replacement of RTU-1) were added to Model # 2. The difference between the annual energy performance predicted by this model and the model above (Model #2) are the ex post impacts for this project.
4	C-10	Measures implemented in *C-10* (Addition of ERVs and VRF systems) were added to Model #3. The difference between the annual energy performance predicted by this model and the model above (Model #3) are the ex post impacts for this project.
5	C-12	Measures implemented in *C-12* (Replacement of boilers and boiler controls) were added to Model #4. The difference between the annual energy performance predicted by this model and the model above (Model #4) are the ex post impacts for this project.

To ensure that the modeled results are grounded in real-world facility energy performance, ADM calibrated the baseline model (Model #0 in the list above) to actual facility billing history. A custom weather file was created using historical weather data, downloaded from NOAA, for the Chicago Midway area. The results of this calibration effort can be seen below:

2014 Monthly kWh Calibration



2014 Monthly Therms Calibration



A special note should be made regarding the billed and simulated values for the month of January. The billing data available to ADM for the month of January happened to include a significant portion of energy use from the previous December – thus the simulated results for that month are not comparable to the corresponding billing data. This is the only month for which this is the case.

It is also noted in the table of models (at the beginning of this section) that the baseline unit heaters were replaced with Water Loop Heat Pumps to represent the *Typical Baseline* conditions for these projects. This is on account of the VRF system installed in Project C-10. With the addition of VRF these spaced now have the ability to provide cooling were there previously was

none. While the addition of cooling does represent an increase in electrical loads, the facility installed cooling to improve the conditions for those spaces and chose to install an inherently efficient HVAC technology to do so. Thus, this particular portion of Project C-10 is considered new construction in nature and an appropriate baseline was determined via the IECC 2009 building energy code to which this project was permitted – a minimally compliant Water Loop Heat Pump system.

Energy impacts for each project were simulated using the models described above and used TMY3 weather data for the region to normalize savings for yearly variations in weather. The typical year annual savings is the difference between the two models' annual consumption and can be seen below:

Simulated Annual Electric Energy Consumption for each Model [kWh]

End Use	Model 1 [kWh]	Model 2 [kWh]	Model 3 [kWh]	Model 4 [kWh]	Model 5 [kWh]
Lighting	198,378.52	198,378.52	198,378.52	198,378.52	198,378.52
Task lighting	0.00	0.00	0.00	0.00	0.00
Miscellaneous equipment	86,307.58	86,307.58	86,307.58	86,307.58	86,307.58
Heating	96,767.14	97,296.14	97,280.39	123.81	123.81
Cooling	179,752.96	178,187.41	175,121.86	112,491.74	112,491.74
Heat rejection	2,964.58	2,964.74	2,964.59	0.00	0.00
Auxiliary (pumps)	134,505.84	134,539.58	134,502.87	49,532.03	49,532.03
Vent fan	96,091.72	96,119.24	96,082.80	226,521.38	226,521.38
Refrigeration systems	0.00	0.00	0.00	0.00	0.00
Supplemental heat pump	0.00	0.00	0.00	0.00	0.00
Domestic hot water	0.00	0.00	0.00	0.00	0.00
Exterior to the building	50.30	50.30	50.30	50.30	50.30
Total end-use energy	**794,818.66**	**793,843.54**	**790,688.98**	**673,405.32**	**673,405.32**

Simulated Annual Electric Energy Consumption for each Model [kW]

End Use	Model 1 [kW]	Model 2 [kW]	Model 3 [kW]	Model 4 [kW]	Model 5 [kW]
Lighting	21.06	21.06	21.06	21.06	21.06
Task lighting	0.00	0.00	0.00	0.00	0.00
Miscellaneous equipment	14.22	14.22	14.22	14.22	14.22
Heating	0.99	0.99	0.99	0.00	0.00
Cooling	88.50	86.20	84.07	47.45	47.45
Heat rejection	1.88	1.88	1.88	0.00	0.00
Auxiliary (pumps)	15.67	15.67	15.67	5.91	5.91
Vent fan	11.42	11.42	11.43	27.76	27.76
Refrigeration systems	0.00	0.00	0.00	0.00	0.00
Supplemental heat pump	0.00	0.00	0.00	0.00	0.00
Domestic hot water	0.00	0.00	0.00	0.00	0.00
Exterior to the building	0.00	0.00	0.00	0.00	0.00
Total end-use energy	**153.75**	**151.45**	**149.33**	**116.40**	**116.40**

Simulated Annual Gas Energy Consumption for each Model [Therms]

End Use	Model 1 [Therms]	Model 2 [Therms]	Model 3 [Therms]	Model 4 [Therms]	Model 5 [Therms]
Lighting	0.00	0.00	0.00	0.00	0.00
Task lighting	0.00	0.00	0.00	0.00	0.00
Miscellaneous equipment	4,456.65	4,456.65	4,456.65	4,456.65	4,456.65
Heating	30,764.37	20,708.41	17,610.88	6,330.43	4,627.76
Cooling	0.00	0.00	0.00	0.00	0.00
Heat rejection	0.00	0.00	0.00	0.00	0.00
Auxiliary (pumps)	0.00	0.00	0.00	0.00	0.00
Vent fan	0.00	0.00	0.00	0.00	0.00
Refrigeration systems	0.00	0.00	0.00	0.00	0.00

Supplemental heat pump	0.00	0.00	0.00	0.00	0.00
Domestic hot water	3,139.87	3,137.96	3,137.96	3,137.86	3,137.86
Exterior to the building	0.00	0.00	0.00	0.00	0.00
Total end-use energy	**38,360.89**	**28,303.02**	**25,205.49**	**13,924.94**	**12,222.27**

Measure-level Gross Savings Results

Custom Incentives

The tables shown below present the verified gross savings for measures that received Custom incentives.

Annual kWh Savings for Project Renovations

Measure	*Annual Gross kWh Savings*	
	Ex Ante	*ADM Calculated Ex Post*
C-9: Boiler System and Controls Upgrade	-	-
C-10: Install Energy Recovery Ventilators (Add VRF)	-	117,284
C-11: Replace LRC RTU and Controls	17,698	3,155
C-12: Install DCV on Auditorium AHU	1,878	975
Total	19,576	121,413

Annual Therms Savings for Project Renovations

Measure	*Annual Gross Therms Savings*	
	Ex Ante	*ADM Calculated Ex Post*
C-9: Boiler System and Controls Upgrade	10,416	1,703
C-10: Install Energy Recovery Ventilators (Add VRF)	3,330	11,281
C-11: Replace LRC RTU and Controls	894	3,098
C-12: Install DCV on Auditorium AHU	235	10,058
Total	14,875	26,139

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*[15]
Custom	C-9: Boiler System and Controls Upgrade	-	-	N/A	0.00	0
Custom	C-10: Install Energy Recovery Ventilators (Add VRF)	-	117,284	N/A	32.92	1,759,255
Custom	C-11: Replace LRC RTU and Controls	17,698	3,155	18%	2.13	47,318
Custom	C-12: Install DCV on Auditorium AHU	1,878	975	52%	2.30	12,189
Total		**19,576**	**121,413**	***620%***	***37.4***	***1,058,775***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Custom	C-9: Boiler System and Controls Upgrade	10,416	1,702.67	16%	34,053
Custom	C-10: Install Energy Recovery Ventilators (Add VRF)	3,330	11,280.55	339%	169,208
Custom	C-11: Replace LRC RTU and Controls	894	3,097.53	346%	46,463
Custom	C-12: Install DCV on Auditorium AHU	235	10,057.87	4,280%	125,723
Total		**14,875**	**26,139**	**176%**	**375,448**

The verified electric and gas impacts are higher than the ex ante estimates (620% and 176% realization rates for electric and gas respectively). One large reason for this is because rebate C-10, which included the addition of the VRF system, did not attempt to claim the energy savings resulting from the VRF systems. Additional variation between the ex-ante and ex post electric impacts (affecting all measures) is present due to differences in the methods used to calculate ex

[15] The lifetime savings were calculated by multiplying typical first year savings by the expected useful life found in California DEER Effective Useful Life worksheets: *DEER2014-EUL-table-update_2014-02-05.xlsx*

ante and ex post impacts. The ex ante impact were calculated using deemed savings estimates and an un-calibrated Trane Trace model. The ex post used calibrated eQuest simulation.

Name C-13

Executive Summary

Application C-13 received custom incentives from Illinois DCEO for retrofitting the existing HVAC system serving their facility. The electric realization rate for this project is 109%, and the natural gas realization rate is 97%.

Project Description

The customer retrofitted the existing HVAC system serving the A.C. Building. The existing system was constant volume and used pneumatic controls. The new system is variable air volume (VAV), with DDC controls.

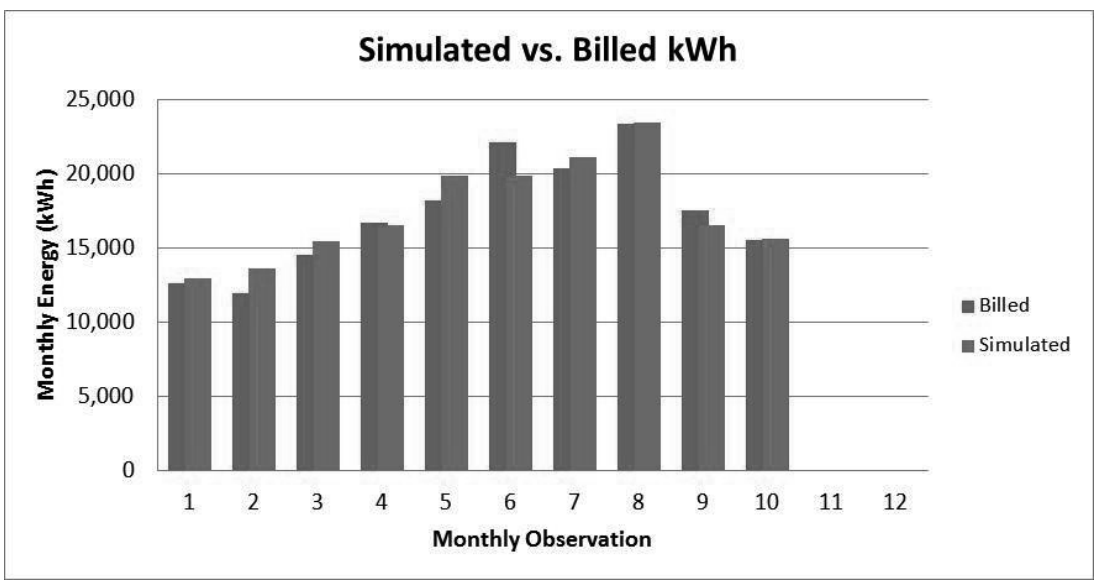
Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified completion of the HVAC retrofit. To verify energy savings for the retrofit, ADM field staff documented equipment nameplates, construction documents, and mechanical schedules.

Custom Incentives

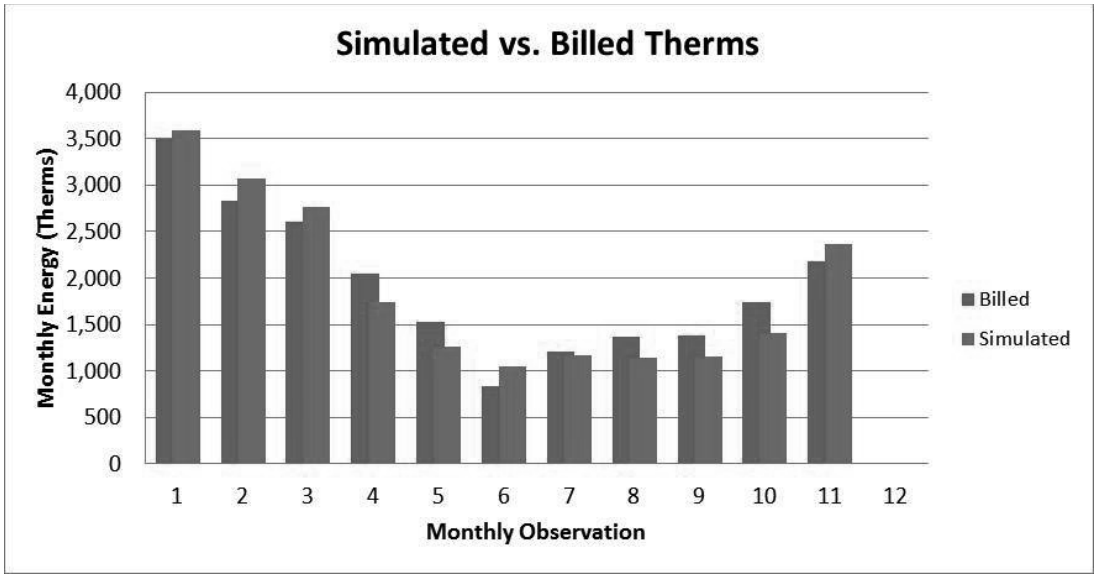
Energy savings were calculated using eQuest modeling of the campus. ADM compiled a model of the as-built facility. Upon completion of the initial model, a custom weather file was created using 2014 NOAA weather data for the Chicago Midway area. Using this weather file and billing data[16] for the facility, ADM was able to ensure that the model's energy load shape matched that of the bills. The result of this calibration effort can be seen below:

2014 Monthly kWh Calibration



[16] Billing data was normalized to building area because the meters serve multiple buildings.

2014 Monthly Therms Calibration



Upon completion of the calibration for the as-built eQuest model, a baseline model was created in which all the above-code measures were removed. Once the baseline model was completed, the baseline and as-built models were run using TMY3 weather data for the region. The typical year annual savings is the difference between the two models' annual consumption and can be seen below:

As-Built Vs. Baseline Annual Energy Consumption

End-Use	*Baseline kWh*	*As-Built kWh*	*Annual kWh Savings*	*Baseline Therms*	*As-Built Therms*	*Annual Therm Savings*
Lighting	*65,999*	*65,999*	*0*	*0*	*0*	*0*
Miscellaneous Equipment	*23,329*	*23,329*	*0*	*0*	*0*	*0*
Heating	*0*	*0*	*0*	*29,121*	*8,446*	*20,674*
Cooling	*75,477*	*40,096*	*35,381*	*0*	*0*	*0*
Heat Rejection	*0*	*0*	*0*	*0*	*0*	*0*
Pumps	*22,361*	*14,227*	*8,135*	*0*	*0*	*0*
Fans	*235,195*	*93,425*	*141,771*	*0*	*0*	*0*
Domestic Hot Water	*0*	*0*	*0*	*1,229*	*1,229*	*0*
Total	**422,362**	**237,076**	**185,286**	**42,623**	**21,948**	**20,675**

Measure-level Gross Savings Results

Custom Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for Above Code Renovations

Measure	*Annual Gross kWh Savings*	
	Ex Ante	*ADM Calculated Ex Post*
HVAC Retrofit	170,274	185,285
Total	170,274	185,285

Annual Therms Savings for Above Code Renovations

Measure	*Annual Gross Therms Savings*	
	Ex Ante	*ADM Calculated Ex Post*
HVAC Retrofit	21,307	20,675
Total	21,307	20,675

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Custom	HVAC Retrofit	170,274	185,285	109%	25.49	2,779,281[17]
Total		***170,274***	***185,285***	***109%***	***25.49***	***2,779,281***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Custom	HVAC Retrofit	21,307	20,675	97%	310,119
Total		***21,307***	***20,675***	***97%***	***310,119***

[17] The lifetime savings were calculated by multiplying typical first year savings by the expected useful life of 15 years. California DEER Effective Useful Life worksheets: EUL_Summary_10-1-08.xls

The 109% verified electric realization rate and 97% verified natural gas realization rate are due to differences in analysis approaches. The ex ante analysis used HVAC system information and engineering calculations. The ex post used calibrated eQuest simulation. The main difference in total realized savings is that the calibrated model accounts for interactive effects of the actual building.

Name S-19, S-20, C-14, & S-21

Executive Summary

Applications S-19, S-20, & S-21 received standard incentives from Illinois DCEO for installation of three high efficiency boilers, VFDs on pumps and AHUs, and a high efficiency tanked water heater. Under application C-14 the facility received a custom incentive to replace the HVAC control system with new DDC controls. The electric realization rate for the combination of projects is 131%, and the natural gas realization rate is 94%.

Project Description

The customer installed (3) new Lochnivar Knight KBN 801 high efficiency boilers. The installed boilers have an efficiency of 94% AFUE. VFDs were installed on 20 motors for the AHUs and hot water pumps. The water heater has been replaced with an A.O. Smith Cyclone Xi tanked water heater. The customer also replaced the aging control system with new DDC controls, including DCV, HW reset, zone temperature setbacks, and static pressure reset.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM field staff documented equipment nameplates.

Standard Incentives

Energy savings were calculated according to the Illinois TRM Versions 2.0 and 3.0 (errata corrected).

For the boiler incentives, TRM Version 3.0, Section 4.4.10 High Efficiency Boiler was used.

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = EFLH * Capacity * ((EffRating_{actual} - EffRating_{base})/EffRating_{base}) / 100{,}000$$

Where:

EFLH	= Equivalent Full Load Hours for heating (see table)
Capacity	= Nominal Heating Input Capacity Boiler Size (btuh)
	= custom Boiler input capacity in Btu/hr
EfficiencyRating(base)	= Baseline Boiler Efficiency Rating, dependent on year and boiler type. Baseline efficiency values by boiler type and capacity are found in the Definition of Baseline Equipment Section
EfficiencyRating(actual)	= Efficent Boiler Efficiency Rating use actual value

For the AHU and hot water pump VFDs, Section 4.4.17 (Version 2.0) Variable Speed Drives for HVAC was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = kWconnected * Hours * ESF$$

Where:

kWConnected = kW of equipment is calculated using motor efficiency.

(HP * .746 kw/hp* load factor)/motor efficiency

Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.

ESF = Energy savings factor varies by VFD application.

Application	ESF
Hot Water Pump	0.482
Chilled Water Pump	0.432
Constant Volume Fan	0.535
Air Foil/inlet Guide Vanes	0.227
Forward Curved Fan, with discharge dampers	0.179
Forward Curved Inlet Guide Vanes	0.092

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWconnected * DSF$$

Where:

DSF = Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Application	DSF
Hot Water Pump	0
Chilled Water Pump	0.299
Constant Volume Fan	0.348
Air Foil/inlet Guide Vanes	0.13
Forward Curved Fan, with discharge dampers	0.136
Forward Curved Inlet Guide Vanes	0.03
Custom Process	custom

For the water heater, Section 4.3.1 (Version 2.0) Storage Water Heater was used.

NATURAL GAS ENERGY SAVINGS

Gas, High Efficiency	Gas, Standard
The annual natural gas energy savings from this measure is a deemed value equaling 251[18]	Gas savings depend on building type and are based on measure case energy factor of 0.67 and a heating capacity of 75 MBtuh. These values are averages of qualifying units. Savings values are derived from 2008 DEER Miser, which provides MBtuh gas savings per MBtuh capacity. Savings presented here are per water heater.[19]

Building Type	Energy Savings (therms/unit)
Assembly	185
Education – Primary/Secondary	124
Education – Post Secondary	178
Grocery	191
Health/Medical - Hospital	297
Lodging - Hotel	228
Manufacturing - Light Industrial	140
Office – > 60,000 sq-ft	164
Office – < 60,000 sq-ft	56
Restaurant - FastFood	109
Restaurant – Sit Down	166
Retail	105
Storage	150
Multi-Family	119
Other	148

Custom Incentives

Savings for the DDC controls were broken into separate calculations as the new controls had four main features which included; DCV, HW reset, zone temperature setbacks, and static pressure reset. The savings for the DCV and HW reset features of the DDC controls were calculated using the Illinois TRM Version 3.0.

Section 4.4.19 Demand Control Ventilation

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = \frac{SqFt}{1000} * SF$$

Where:

SqFt = Actual square footage of conditioned spaced controlled

SF =Therms savings factor based on building type and weather zone

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{SqFt}{1000} * SF$$

[18] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011. These deemed values should be compared to PY evaluation and revised as necessary

[19] Gas Storage Water Heater 0.67. Work Paper WPRSGNGDHW106. Resource Solutions Group. December 2010

Where:

SqFt	= Actual square footage of conditioned spaced controlled
SF	= kWh savings factor based on building type and weather zone

Section 4.4.4 Boiler Reset Controls.

NATURAL GAS ENERGY SAVINGS

$$\text{Therm Savings} = \text{Binput} * \text{SF} * \text{EFLH} /(100)$$

Where:

Binput	= Boiler Input Capacity (kBtu/hr)
	= custom
SF	= Savings factor
	= 8% or custom
EFLH	= Equivalent Full Load Hours for heating are provided in section 4.4 HVAC End Use

Savings for the temperature setback control strategy was calculated by using a modified version of the Illinois TRM Version 3.0 Section 4.4.18 Programmable Thermostat. The TRM analysis methodology relies on; heating system capacity, equivalent full load hours, degree of setback and a savings factor. However, it is noted in the TRM that Section 4.4.18 is only applicable for single zone systems. To make the provided savings factor appropriate for the site, ADM used electric and natural gas billing data to create a regression to predict HVAC heating and cooling energy use based on local weather data. Since the savings factor form TRM Section 4.4.18 is reported in a percent savings per degree setback format, TMY3 weather for the area was used to determine annual HVAC kWh and Therm consumption. The following equations were then used to determine annual energy savings.

NATURAL GAS ENERGY SAVINGS

$$\Delta\text{Therms} = (\text{HVAC} * \text{DOS} * \text{SF})$$

Where:

HVAC	= Annual Therm consumption by HVAC system
DOS	= The degrees in Fahrenheit the temperature is setback from the space temperature setpoint (°F). Baseline manual setback should be determined and only the incremental setback due to the programmable thermostat be applied.
SF	= The percent savings per incremental °F setback, Section 4.4.18

ELECTRIC ENERGY SAVINGS

$$\Delta\text{kWh} = (\text{HVAC} * \text{DOS} * \text{SF})$$

Where:

HVAC	= Annual kWh consumption by HVAC system

DOS	= The degrees in Fahrenheit the temperature is setback from the space temperature setpoint (°F). Baseline manual setback should be determined and only the incremental setback due to the programmable thermostat be applied.
SF	= The percent savings per incremental °F setback, Section 4.4.18

Electrical savings for the static pressure reset control was determined using a temperature bin calculation methodology similar to what was used in the ex-ante analysis. The bin analysis is informed by TMY3 weather and corresponding fan hours determined through the use of a prototypical elementary school model. The static pressure reset control strategy assumes that the static pressure will be reset linearly when the outside air is between 82°F and 50°F. The effect that this has on the demand of the air handler's fan is calculated through the use of the fan affinity laws. The following equation was used to calculate individual fan kW demand for a given static pressure.

ELECTRIC ENERGY SAVINGS

$$kW = \left(\frac{SP_N}{SP_o}\right)^{1.25} \times kW_O$$

Where:

SP_N	= The new reset static pressure of the system
SP_O	= The original static pressure of the system
kW_O	= The original kW demand of the air handler's fan at the original static pressure

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for VFDs

Measure	*Measure Metrics*					*Annual Gross kWh Savings*	
	Application	*Program Type*	*Type*	*HP*	*Building Type*	*Ex Ante*	*TRM-Calculated Ex Post*
Variable Speed Drives for HVAC	AHU 1 SF	RF	HVAC	10 HP	School(K-12)		7,602
Variable Speed Drives for HVAC	AHU 1 RF	RF	HVAC	5 HP	School(K-12)		3,807
Variable Speed Drives for HVAC	AHU 2 SF	RF	HVAC	10 HP	School(K-12)		7,602
Variable Speed Drives for HVAC	AHU 2 RF	RF	HVAC	5 HP	School(K-12)		3,807
Variable Speed Drives for HVAC	AHU 3 SF	RF	HVAC	10 HP	School(K-12)		7,602
Variable Speed Drives for HVAC	AHU 3 RF	RF	HVAC	5 HP	School(K-12)		3,807
Variable Speed Drives for HVAC	AHU 4 SF	RF	HVAC	10 HP	School(K-12)		7,602
Variable Speed Drives for HVAC	AHU 4 RF	RF	HVAC	5 HP	School(K-12)		3,807
Variable Speed Drives for HVAC	AHU 5 SF	RF	HVAC	7.5 HP	School(K-12)		5,704
Variable Speed Drives for HVAC	AHU 5 RF	RF	HVAC	3 HP	School(K-12)		2,269
Variable Speed Drives for HVAC	AHU 6 SF	RF	HVAC	5 HP	School(K-12)		3,807
Variable Speed Drives for HVAC	AHU 6 RF	RF	HVAC	3 HP	School(K-12)		2,269
Variable Speed Drives for HVAC	AHU 7 SF	RF	HVAC	10 HP	School(K-12)		7,602
Variable Speed Drives for HVAC	HWP P-EX (1)	RF	HVAC	20 HP	School(K-12)		13,698
Variable Speed Drives for HVAC	HWP P-EX (2)	RF	HVAC	20 HP	School(K-12)		13,698
Total						***79,001***	***94,683***

Annual Therms Savings for High Efficiency Boilers

Measure	*Measure Metrics*				*Annual Gross Therms Savings*		
	Program Type	*Boiler btuh*	*Building Type*	*Efficient Measure*	*Ex Ante*	*TRM-Calculated* *Ex Post*	*TRM-Calculated (Errata Corrected)* *Ex Post*
High Efficiency Boiler	TOS	800,000	Elementary	AFUE 90%	927	933	840
High Efficiency Boiler	TOS	800,000	Elementary	AFUE 90%	927	933	840
High Efficiency Boiler	TOS	800,000	Elementary	AFUE 90%	927	933	840
Total					***2,781***	***2,800***	***2,520***

Annual Therms Savings for Storage Water Heater

Measure	*Measure Metrics*				*Annual Gross Therms Savings*	
	Program Type	*Measure Type*	*Tank Size*	*Building Type*	*Ex Ante*	*TRM-Calculated* *Ex Post*
Storage Water Heater	TOS	Gas,High Efficiency	120 gallons	Medical	124	251
Total					***124***	***251***

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual Therms Savings for DDC

Measure	*Annual Gross Therms Savings*	
	Ex Ante	*ADM Calculated* *Ex Post*
DDC Controls	10,835	10,174
Total	***10,835***	***10,174***

Annual kWh Savings for DDC

Measure	*Annual Gross kWh Savings*	
	Ex Ante	*ADM Calculated Ex Post*
DDC Controls	24,731	41,388
Total	***24,731***	***41,388***

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Standard	VFDs	79,001	94,683	120%	19.87	1,420,238
Subtotal		*79,001*	*94,683*	*120%*	*19.87*	*1,420,238*
Custom	DDC	24,731	41,388	167%	0.00	307,017
Subtotal		*24,731*	*41,388*	*167%*	*0.00*	*307,017*
Total		***103,732***	***136,071***	***131%***	***19.87***	***1,727,255***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Standard	High Efficiency Boiler	2,781	2,520	91%	50,400
Standard	Storage Water Heater	124	251	202%	3,765
Subtotal		*2,905*	*2,771*	*95%*	*54,165*
Custom	DDC	10,835	10,174	94%	71,314
Subtotal		*10,835*	*10,174*	*94%*	*71,314*
Total		***13,740***	***12,945***	***94%***	***125,479***

The 131% verified electric realization rate is due to TRM Version 3.0 using hours and an energy savings factor associated with VSDs for hot water pumps, supply, and return fans. The prescriptive ex ante savings is 270 kWh per horsepower, and is likely based on averages of energy savings factors for pumps and fans. Another contributing factor is the ex-ante calculations incorrectly calculated the impact on fan kW that a reduction in static pressure would cause as they failed to utilize the Affinity Laws, resulting in an underestimation of energy savings.

The 94% verified natural gas realization rate is due to the ex-ante analysis for the temperature setback portion of the DDC controls failing to use a regression to determine annual HVAC energy usage. Instead they assumed that the HVAC used 12% of annual electric consumption and 20% of the heating natural gas consumption.