



BUILDINGENERGY NYC

OCTOBER 15, 2015 AT TKP NEW YORK CONFERENCE CENTER

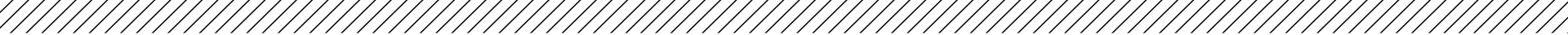
AIA Provider: **Northeast Sustainable Energy Association**

Provider Number: G338

Making Money By Saving Energy

Jon Hettinger

October 15, 2015



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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Rockefeller Center

Tuning The Rock ...
A Path Towards Improved
Energy Efficiency



TISHMAN SPEYER



Course Description

Provide an overview of the energy-savings investments completed at Rockefeller Center.

Discuss the approach and findings resulting from the recently completed Energy Audit and Retro-Commissioning program

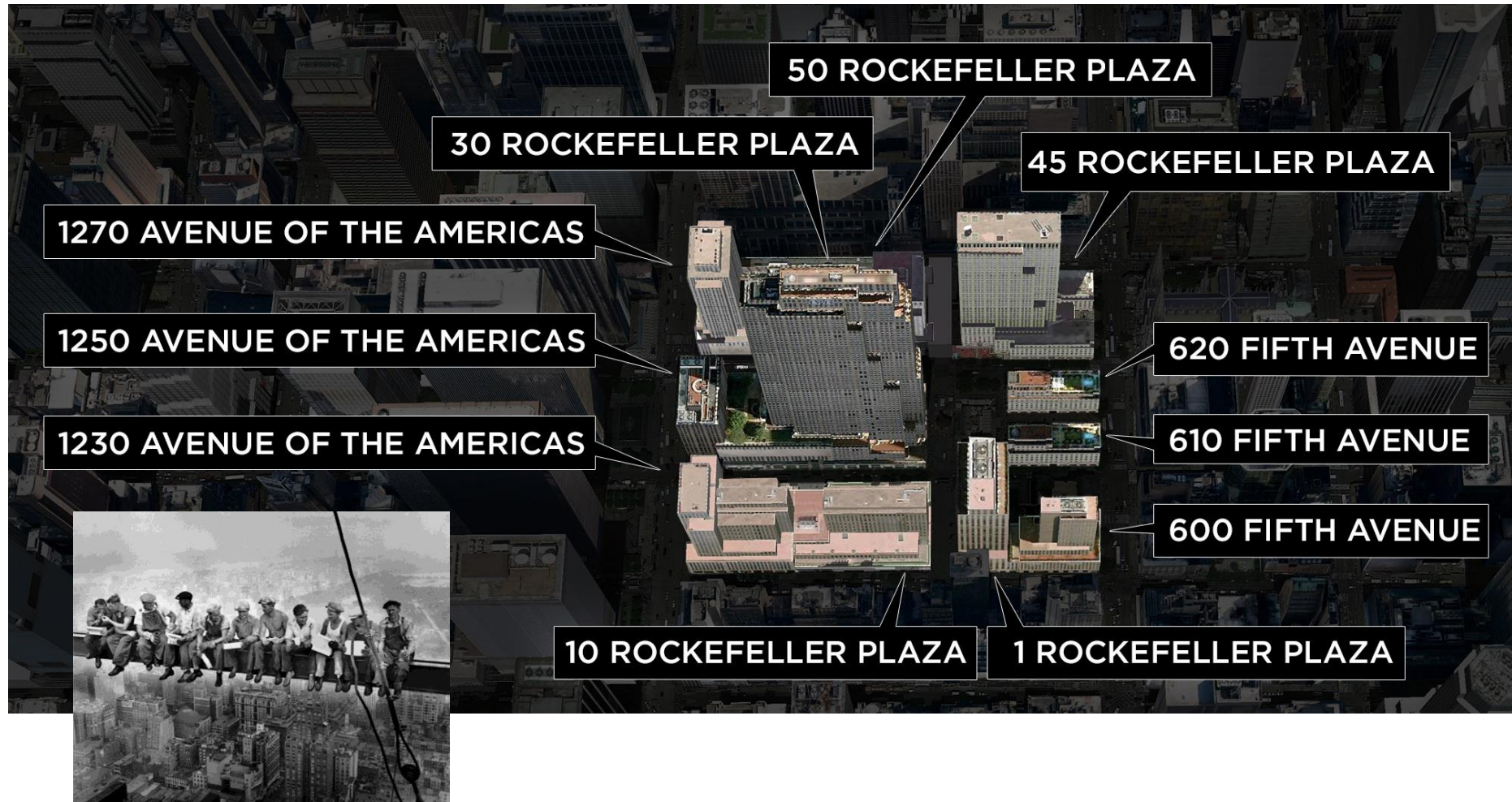
Discuss programs and initiatives moving forward.

Learning Objectives

At the end of the this course, participants will be able to:

1. Consider energy conservation measures for their facilities
2. Understand requirements of Local Law 87 and how it benefits them
3. Look for No or Low Cost Energy Savings Opportunities
4. Discuss the steps for ECM implementation

Overview of Rockefeller Center



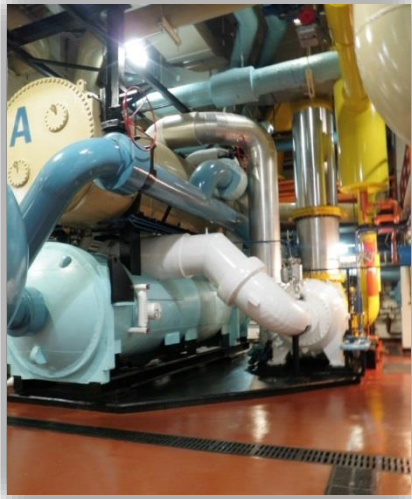
Overview of Rockefeller Center

	1 ROCKEFELLER PLAZA	10 ROCKEFELLER PLAZA	30 ROCKEFELLER PLAZA	45 ROCKEFELLER PLAZA	50 ROCKEFELLER PLAZA	1230 AVENUE OF THE AMERICAS	1270 AVENUE OF THE AMERICAS	600 FIFTH AVENUE	610 FIFTH AVENUE	620 FIFTH AVENUE	TOTAL
BUILDING NUMBER	5	11	1, 9	6	7	8, 14	10	17	2	3	
YEAR BUILT	1939	1939	1933	1939	1939	1940; 1955	1939	1949	1939	1939	
SQUARE FEET	359,526	600,291	3,099,304	1,256,160	528,830	755,253	529,342	449,313	142,451	144,060	7,864,530
FLOORS	37	23	68	42	20	24	34	31	11	9	299
GENERAL HOURS OF OPERATION	8AM-6PM	8AM-6PM	8AM-6PM	8AM-6PM	8AM-6PM	8AM-6PM	8AM-6PM	8AM-6PM	8AM-6PM	8AM-6PM	
NUMBER OF OCCUPANTS	1,287	754	7,308	2,897	850	1,699	1,036	814	550	362	17,557
ENERGY STAR RATING (AS OF REPORT ISSUE DATE)	63	55	25	35	60	55	63	49	16	3	

Rock Center's Foundation

- Twenty (20) electrical accounts, including TOD for Central CHW plant.
- Ten (10) Steam accounts.
- Energy use meters and dashboard, providing daily trends, out-of-range advisories and alarms

ECMs – Central Refrigeration Plant



- Dual compressor chiller for improved off-peak efficiency
- Re-piped evaporators on two 4,000T chillers from two-pass to single-pass flow (capacity recovery at off-peak conditions)



Central Plant Refrigeration Machine Statistics		
Type	Quantity	Tons
Electric Centrifugal	3	2,500 - 4,000
Steam Turbine Centr	1	4,000
Ice Plant	1	1,300

ECMs – Central Refrigeration Plant

- Two 1,250 ton Plate Heat Exchangers - “Free Cooling” during colder weather
- VFDs on Cooling Tower fans (also for improved temperature control)
- VFDs on CHW pumps - vary based on load



Central Plant Cooling Towers	
Building	Quantity (Cells)
1/9	10
11	7



Energy Cost Savings Measure – Ice Storage Plant

- 41 tanks yielding 8,200 ton-hours of storage
- Ice produced at nights and “burned” during on-peak to lower our daytime peak electrical demand by approx. 1,000 kW
- TOD electric rates yield further savings



ECM – Fountain Heating

Heat contained within collected Con Ed Steam condensate used as heat source instead of steam directly



ECM – Garage HVAC

- Heat contained within collected Con Ed Steam condensate used as heat source for warming garage ventilation air
- Fan speed control based on measured CO concentration during off-peak periods



ECM - Window Replacement

- 15,550 single-pane windows from the 1930's
- Phased replacement, performed as leases roll or in close coordination with current tenants



ECM - Window Replacement

- New Double-pane thermally insulated windows
- Mock-ups to determine glass type and finish to match existing appearance
- Estimated \$350 annual energy savings per window

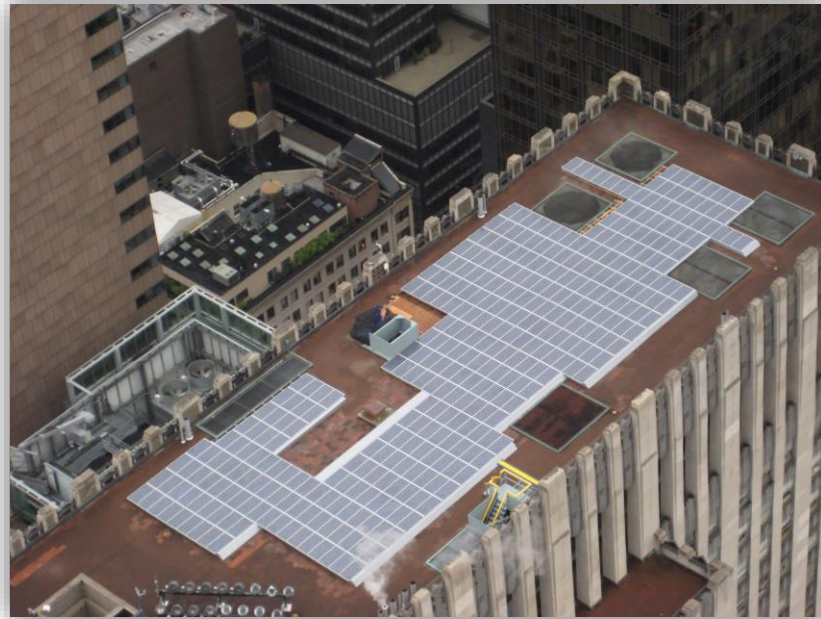


ECM – Convector Replacement



ECM – Solar Panels at 45 Rock

- 363 GE panels
- 60 kW of peak power



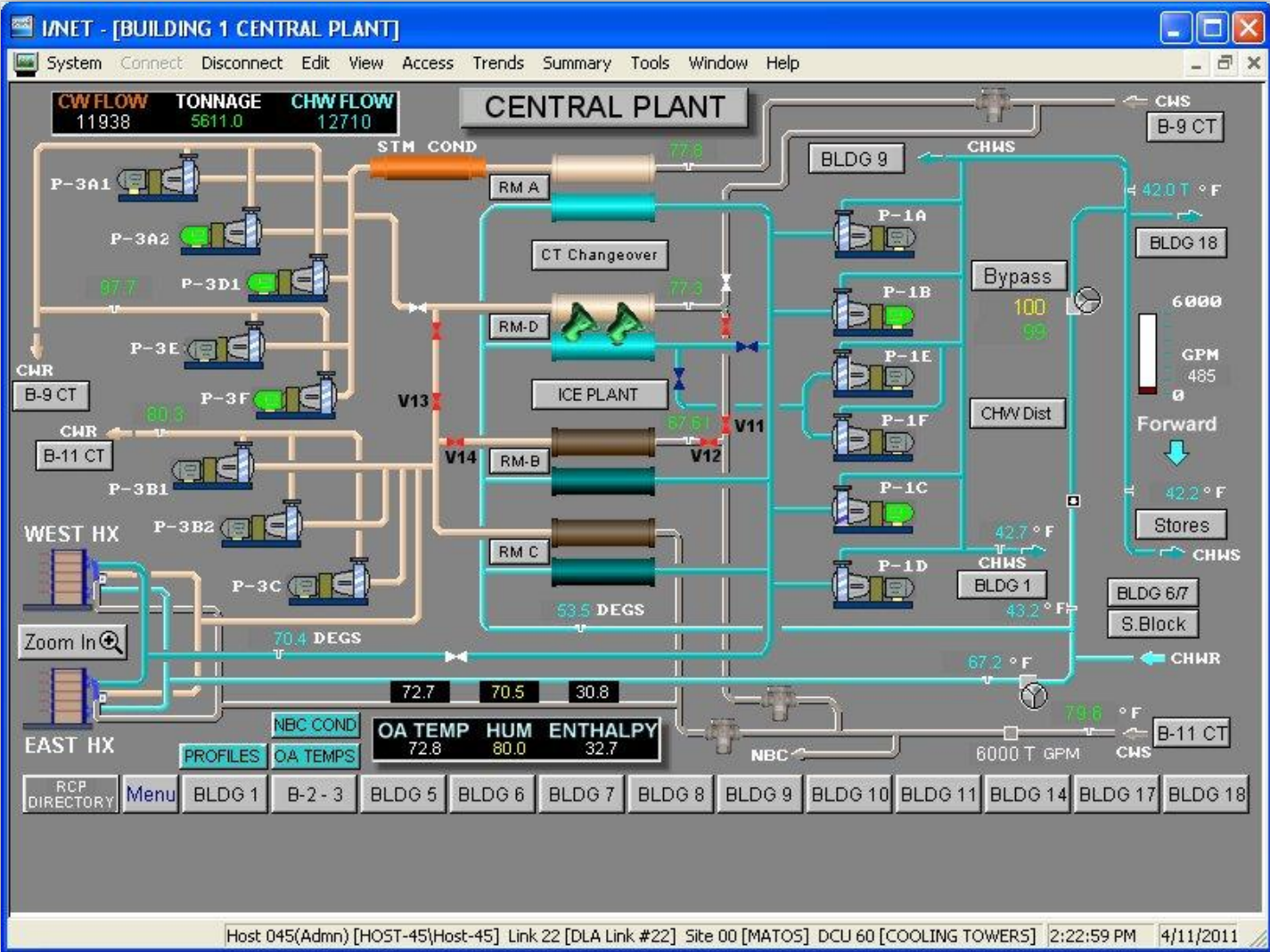
ECM – Continuous Systems Monitoring

Central Plant Control Center



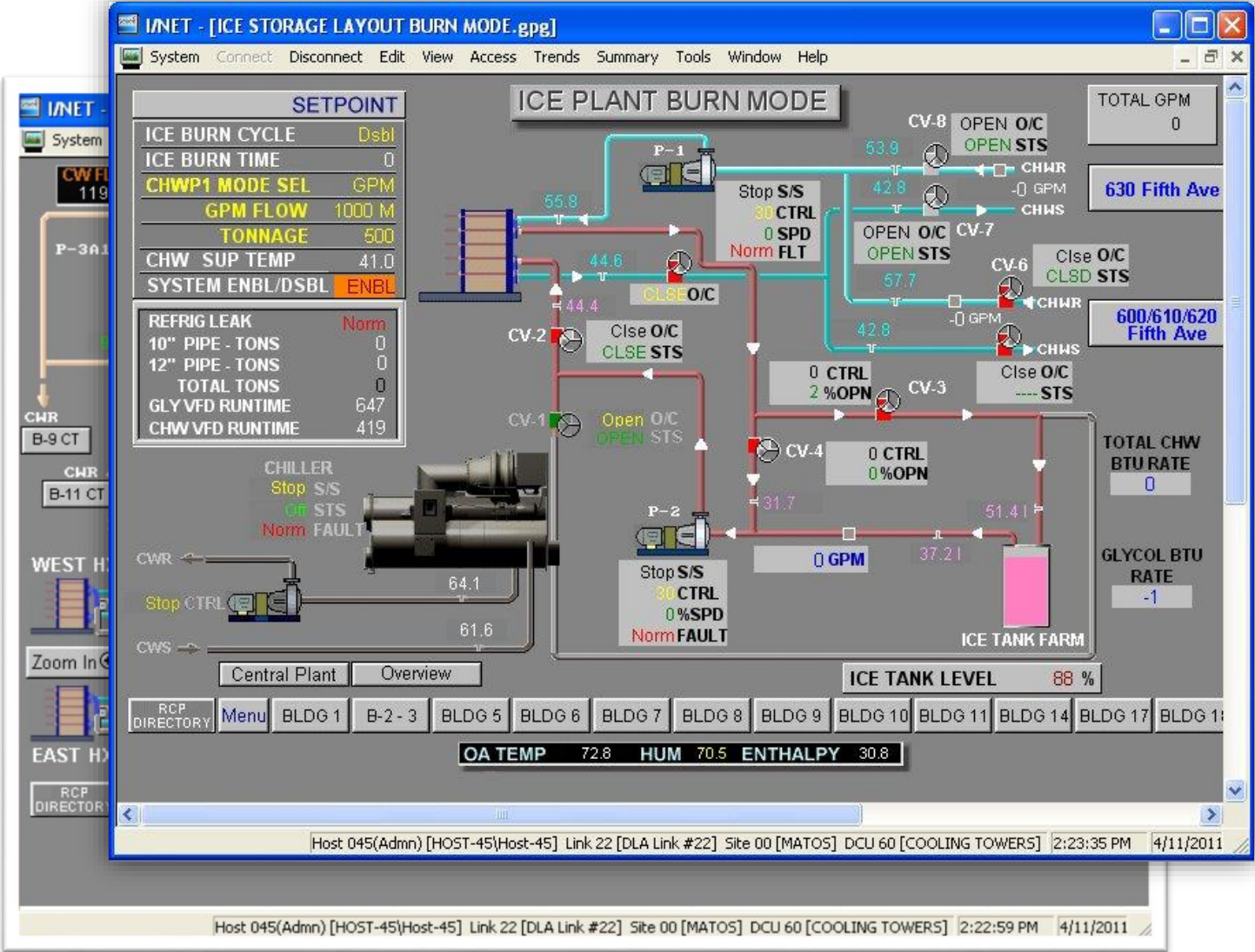
ECM – Continuous Systems Monitoring

Central Plant Overview Screen



ECM – Continuous Systems Monitoring

Ice Plant Operations



ECM – Continuous Systems Monitoring

Building by Building Temperature and CHW Usage

RC Global Page **CENTRAL PLANT CHW DISTRIBUTION** **CP Menu**

BUILDING	CHW FLOW	TEMPERATURE		CHW FLOW	TEMPERATURE		Gals/Ton	TON RATE	CONSUMPTION		
		SUPPLY	RETURN		SUPPLY	RETURN			DAILY TONS	MONTHLY TONS	
BUILDING 8	531	41.2	58.9	583	43.5	58.9	1.6	372	3270	29208	
BUILDING 14	905	40.6	55.9	979	41.6	55.9	1.7	624	4337	21128	
BUILDING 11	493	40.8	58.5	478	43.0	58.5	1.5	315	2110	15117	
BUILDING 5	714	41.1	54.8	900	42.1	54.8	1.9	474	2771	18829	
BUILDING 17	552	40.4	55.4	589	44.6	55.4	2.2	283	1586	3219	
BUILDING 2	416	41.2	56	118	45.7	59.8	1.7	72	301	949	
BUILDING 3				295	44.6	58.1	1.8	166	933	6475	
KENNETH KOLE STORE	33 A	44.6	53.1	25	46.1	55.6	2.8	12	90	1389	
BUILDING 6	4	48.1	49.5	0	54.5	51.0	0.0	0	2056	72163	
BUILDING 7				0	42.5	55.7	0.0	0	601	18651	
BUILDING 10	1226	41.6	50.9	814	43.9	58.8	1.7	527	3580	42661	
BUILDING 18				413	43.8	61.6	1.3	286	1712	26434	
BUILDING 1	A-RISER	2170	40.7	51.5	11-CT OUTSIDE AIR CONDITIONS		2.2	974	9831	119232	
	B-RISER	1038	40.4	51.0	72.79 °	71 %	30.9 ENT	2.2	473	3497	22834
	C-RISER	1363	40.8	52.8	AVG OUTSIDE AIR CONDITIONS		2.1	666	3918	23858	
BUILDING 9	Conc Retail	1078	40.9	52.5	74.80 °	63 %	30.8 ENT	2.0	521	6611	83922
BUILDING 9	Conc Retail	369	40.8	50.8			2.3	154	1956	43567	
CHLR PLANT	974 Fwrd	11991	41.3	52.1				15: 30	4 / 11 / 2011		

Host 045(Admin) [HOST-45|Host-45] Link 22 [DLA Link #22] Site 00 [MATOS] DCU 60 [COOLING TOWERS] 3:31:12 PM 4/11/2011

ECM – System Advisories

Central AHU Summary Screen

INET - [Bldg 6 HVAC System Matrix.gpg]

System Connect Disconnect Edit View Access Trends Summary Tools Window Help

630 Fifth Avenue

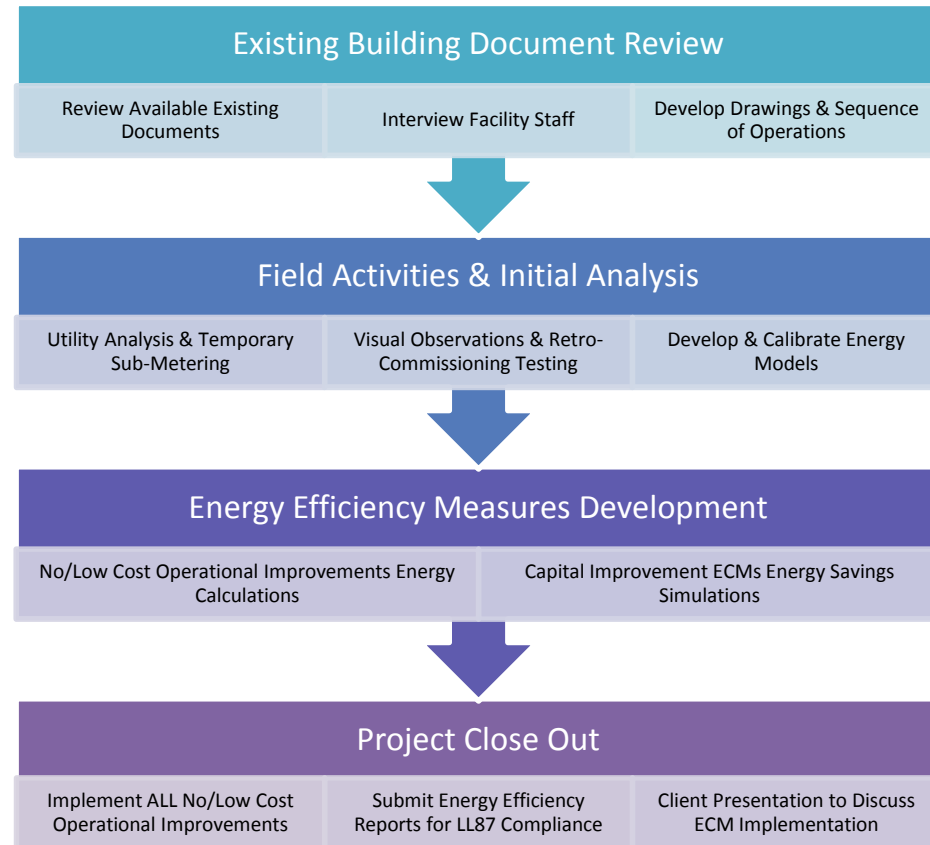
Air Handler	S/S	Static Pressure Setpoint	Static Pressure 1/3	Supply VFD Control	Supply VFD Status	Return VFD Control	Return VFD Status	Return Temp	Mixed Air Setpoint	Mixed Air Temp	Preheat/Reheat Setpoint	Preheat/Reheat Temp	Supply Setpoint	Supply Temp	Valves Preheat	Valves CHW	Dampers Control	Dampers Fresh%	
ACS-40W	Strt	3.0	3.0	74	74	64	62	73.6	55.0	55.2	68.9	68.5	57.5	55.2	61	0	84	89	
ACS-40E	Strt	2.0	2.0	60	62	68	73	74.2	54.2	54.8	68.1	68.0	56.9	56.3	55	0	100	90	
ACS-37S	Strt	2.7	2.7	69	72	59	64	71.9	58.3	59.4	70.0	69.1	59.2	58.4	60	0	72	75	
ACS-36N	Strt	1.2	1.3	73	70	62	58	73.0	57.1	56.7		58.9	62.1	56.3		0	74	80	
ACS-39W	Strt	2.0	2.0	64	59	55	50	73.0	57.1	57.0		56.4	62.1	57.3		0	76	78	
ACS-34S	Strt	1.2	1.2	77	79	66	67	71.9	59.0	58.8		62.3	62.0	58.7		0	48	48	
ACS-33N	Strt	1.2	0.0	64	63	54	51	70.0 T	63.9	63.8		64.9	66.9	62.8		0	47	36	
ACS-32S	Strt	1.5	1.5	62	56	53	46	74.1	53.4	57.3		58.0	59.1	59.9	57.3	0	0	100	78
ACS-31N	Strt	1.2	1.3	64	68	55	60	72.0 T	62.2	62.3		68.5	77.1	66.9	62.4	0	0	42	50
ACS-30S	Strt	1.2	1.3	72	70	61	57	71.5 T	63.2	63.1		69.5	69.0	68.5	62.0	9	0	49	44
ACS-28S	Strt	1.5	1.5	56	54	50	45	74.7	54.4	55.1		60.3	57.7	54.1		0	100	88	
ACS-27N	Strt	1.3	1.3	59	50	54	47	71.0 T	62.3	62.3		72.0	71.2	61.7	61.8	48	0	73	79
ACS-26N	Strt	1.5	1.5	63	63	54	53	73.1	57.0	56.7		67.5	68.2	61.2	56.4	4	0	51	80
ACS-24N	Strt	1.2	1.3	66	60	56	56	71.0 T	64.2	63.4		73.4	73.2	70.2	64.2	49	0	25	41
ACS-24S	Strt	1.5	1.3	74	74	63	61	71.0 T	63.9	64.2		69.8	71.3	67.5	64.6	0	0	32	37
ACS-22S	Strt	1.5	1.5	64	59	55	50	71.8	57.3	57.4		68.4	68.6	61.5	58.5	15	0	64	75
ACS-21N	Strt	1.5	1.5	55	60	47	52	73.3	59.2	58.4		67.4	67.2	61.8	56.2	41	0	58	62
ACS-20N	Strt			STRT	ON	STRT	ON	71.0	60.6	61.0		70.3	68.6	66.3	61.4	44	0	56	54
ACS-20S	Strt			STRT	ON	STRT	ON	70.0 T	62.2	61.5		71.3	70.9	65.4	60.4	42	0	49	49
ACS-19S	Strt	1.2	1.2	69	68	58	57	71.5	59.7	59.4		55.0	59.6	65.0	59.9	0 M	0	29	64
ACS-17N	Strt	2.5	2.5	78	78	66	67	74.3	54.4	59.2		67.0	67.7	59.1	59.3	26	0	100	70
ACS-17S	Strt	1.2	1.2	70	65	59	55	71.0 T	60.5	60.8		69.7	67.6	66.9	61.1	41	0	45	55
ACS-16N	Strt	1.5	1.5	62	67	53	59	72.0	58.8	56.6		65.0	63.4	64.8	57.9	0 M	0	93	79
ACS-15N	Strt	1.2	1.2	70	66	59	54	70.0 T	66.5	66.3		70.4	71.2	67.9	66.9	10	0	1	21
ACS-15S	Strt	1.3	1.3	58	64	49	57	71.0 T	64.2	63.9		72.6	73.9	65.9	64.4	11	0	55	38
ACS-14S	Strt			STRT	ON	STRT	ON	71.0 T	64.5	64.1		52.5	63.6	66.5	57.9	0	0	50	54
ACS-12N	Strt	3.0	3.0	70	69	59	58	71.7	56.4	56.5		59.6	64.6	55.9		0	100	79	
ACS-12S	Strt	2.0	1.9	63	63	54	54	73.4	54.7	55.2		59.1	61.1	55.5		0	88	88	
ACS-10S	Strt	0.2	0.3	86	92	78	76	73.0 T	63.5	63.4		62	61.0	64.5	61.7	14	0	78	62
ACS-09S	Strt	2.0	2.0	71	66	61	50	73.1	58.3	59.7			61.2	58.6		0	47	65	
ACS-08N	Strt	1.5	1.5	66	68	56	60	72.5	55.9	56.3		70.4	69.0	59.0	55.6	27	0	100	82
ACS-08N	Strt	1.5	1.5	62	63	53	53	72.5	59.1	63.6				66.1	63.0		0	100	62
ACS-06S	Strt	1.0	1.0	83	80	70	65	72.1	61.7	61.5		60.0	64.6	68.9	61.2	0	0	44	54
ACS-05N	Strt	1.2	0.4	67	63	63	58	75.8	52.0	58.4			60.6	58.7	57.8		21	100	100
ACS-05W	Strt	1.5	0.3	59	53	50	45	74.4	54.8	56.7			57.5	57.0	54.5		0	100	81
ACS-05S	Strt	1.2	0.0	61	61	52	51	74.4	54.8	55.4			59.4	56.6	54.7		0	100	100
ACS-04S	Strt	1.0	1.0	45	38	38	30	73.6	56.3	56.3		70.0	69.9	61.2	55.3	2	0	85	82
ACS-SB9	STOP M			Stop	Off	Stop	Off	83.5	60.1	80.2			79.6	50.0	82.4	0	0 M	0	10
ACS-SB8	Strt			STRT	ON				0.0	53.5		54.8	56.2	62.0	62.0	0	0		
ACS-SB7	Strt			STRT	ON	STRT	ON	76.8	68.0	67.7		58.2	66.0	78.9	75.5	0	0	41	39
ACS-SB6	Strt			STRT	ON	STRT	ON	71.4	59.6	59.6		52.5	58.5	61.9	61.6	0	0	69	63
ACS-SB5	Strt			STRT	ON	STRT	ON	71.5	65.1	64.8		57.4	64.9	70.1	69.6	0	0	33	35
ACS-SB4	Strt			STRT	ON	STRT	ON	73.0	59.6	59.6		54.4	61.2	60.5	60.9	0	0	29	66
ACS-SB3	Strt			STRT	ON	STRT	ON	72.7	60.7	60.5		54.9	60.3	62.4	64.4	0	0	19	20

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Campus-Wide Air Handling Unit Statistics		
Building	Quantity	Max CFM
1/9	71	66,000
2	8	31,000
3	8	31,000
5	30	45,000
6	71	48,292
7	28	41,000
8/14	32	79,300
10	17	41,400
11	23	75,400
17	23	29,235

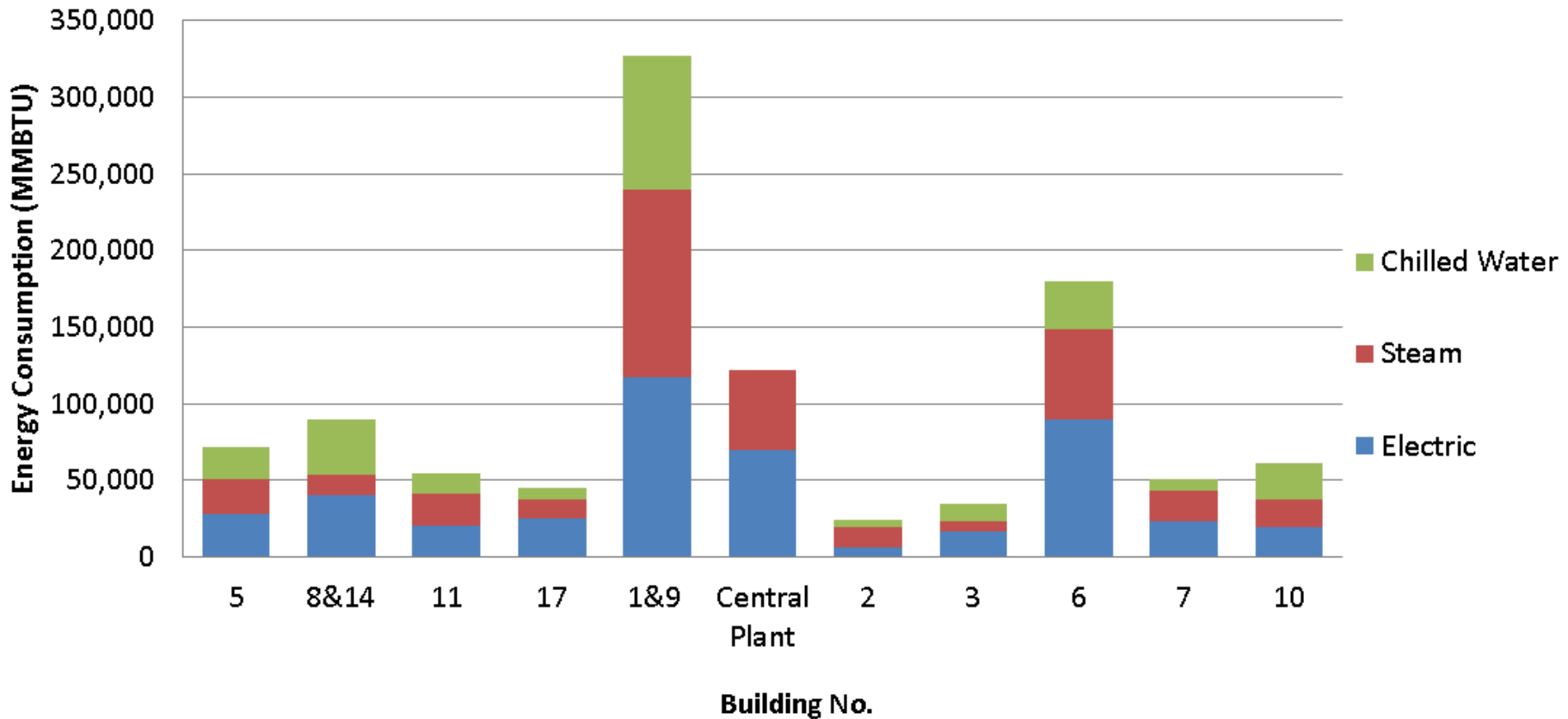
Early Compliance with NYC LL87

- AKF performed the following to achieve a comprehensive understanding of the buildings' system operations:
 - Document review & facility discussions
 - Utility Analysis and Temporary Metering
 - Energy Model Development & Calibration
 - Retro-Commissioning Functional Testing & TAB Measurements

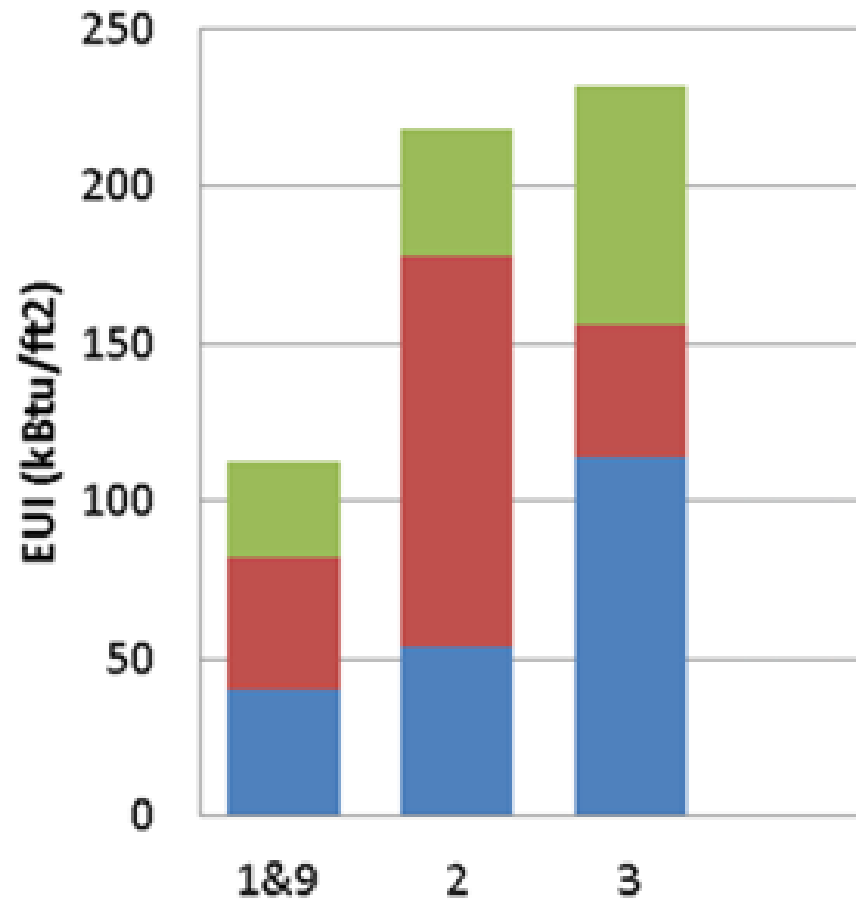
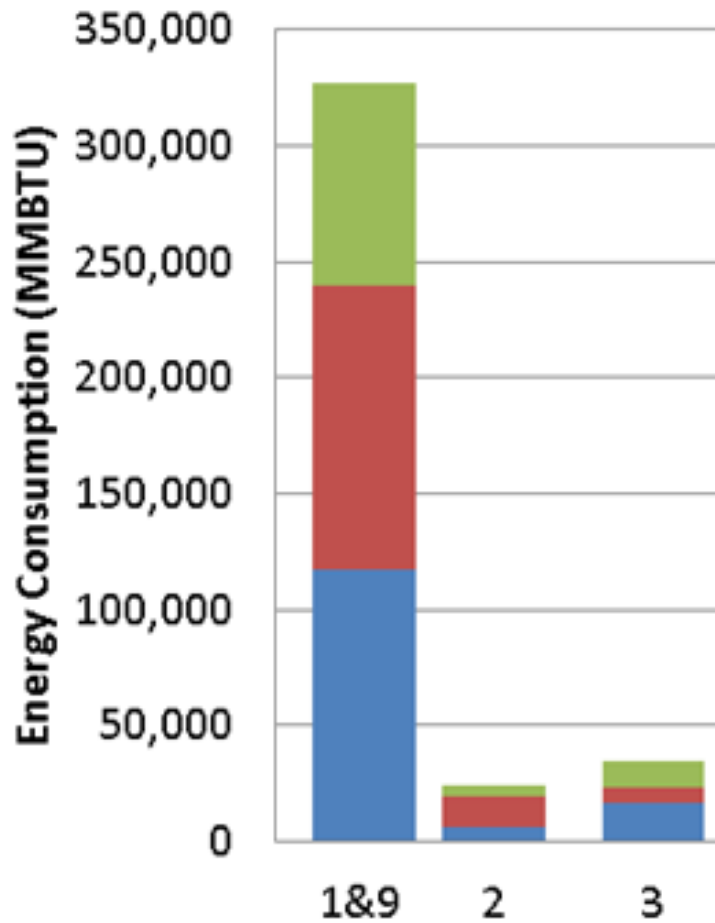


Energy Audit – Utility Analysis

Energy Consumption per Building



Energy Consumption vs. Energy Use Intensity



Understanding the Energy Use

We identified a number of “parasitic loads” on the electrical and steam systems. The following summarizes major parasitic loads identified during the project:

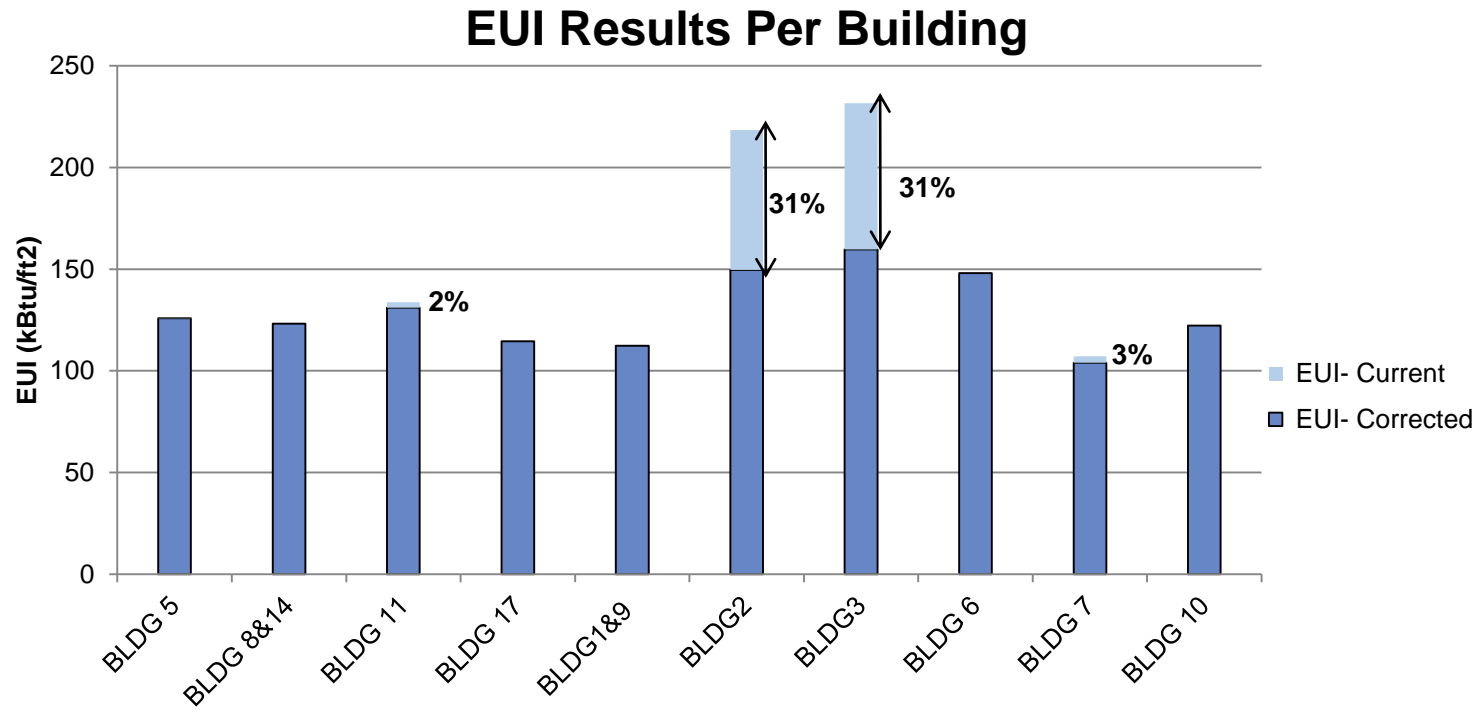
Building No.	Load Type	Load Details	Annual Estimated Load
3	Electric	Serves the following miscellaneous loads at Rockefeller Center: <ul style="list-style-type: none">• Fountain pumps,• Loading dock and concourse lighting,• Tenants• Loading dock Equipment	2,130,000 kWh
2	Steam	Plaza Restaurants	6,402 Mlbs
7	Electric	Serves 50 Rock Cooling Towers that provide condenser water to 50 Rock, 45 Rock and the central Ice Plant	440,000 kWh
11	Electric	Serves 10 Rock Cooling Towers that provide condenser water to the Central Plant	300,000 kWh

Notes:

- 1) Building No. 2 & 3's loads were estimated from equipment information, operational hours, and utility bill review.
- 2) Building No. 7 & 11's loads were temporarily sub-metered to establish loads.

“Corrected” EUI Results

- Using the results from the temporary metering analysis, the following figure identifies an EUI reduction for Buildings 2, 3, 7, & 11:



Find the No or Low Cost Opportunities

- AKF performed walk-throughs with facility engineers of all mechanical equipment rooms to determine NLC improvements for the base building equipment. The following typical measures were found:

Measure No.	AHU Measure Description
NLC-01	Repair/seal air leaks at an access doors
NLC-02	Repair/seal air leaks throughout ductwork
NLC-03	Repair/replace ductwork insulation
NLC-04	Repair/replace thermal insulation on piping
NLC-05	Repair leaky/faulty valves and/or fittings
NLC-06	Repair/clean damaged/dirty coils
NLC-07	Replace dirty filters
NLC-08	Repair loose fan pulleys and/or belts
NLC-09	Repair noisy fan motors
NLC-10	Repair/replace thermal insulation on an unit casing

Note: Measures in **blue** contributed most to energy savings.

Retro-Commissioning Findings

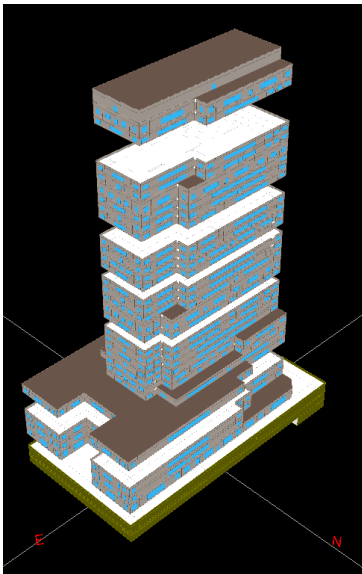
- The following table represents the typical operational improvements identified during functional testing:

Measure No.	Description
RCx-01	Repair/replace a pump's thermal insulation on piping
RCx-02	Repair unit damper(s) for proper normal operation (excess OA)
RCx-03	Repair unit damper(s) for proper economizer operation (lack of OA)
RCx-04	Repair unit damper(s) for proper economizer operation (increased SP)
RCx-05	Repair chilled water valve leaking into coil during non-cooling hours (overcooling)
RCx-06	Repair steam valve to prevent overheating
RCx-07	Repair unit spill air damper(s) for proper economizer operation (increased RF SP)
RCx-08	Recalibrate over-reporting sensor to prevent overheating
RCx-09	Recalibrate under-reporting sensor to prevent overcooling
RCx-10	Repair open RA damper to prevent excessive use of chilled water during economizer mode
RCx-11	Remove blockage from the airway's path to reduce SP
RCx-12	Re-attach SP sensor to fan to allow for variable volume control
RCx-13	Repair an AHU's or fan's loose fan pulleys and/or belts

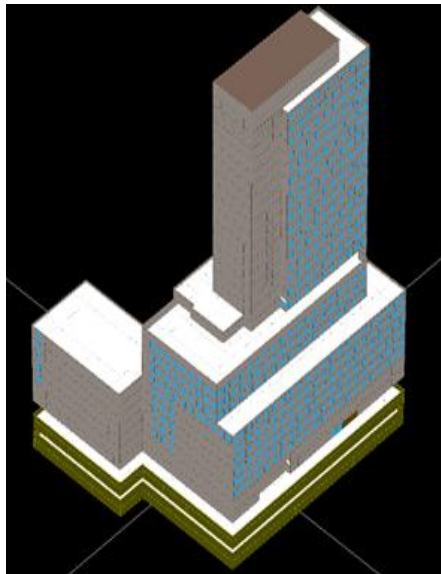
*Note: Measures in **blue** contributed most to energy savings.*

Energy Modeling – Predicting ECM Performance

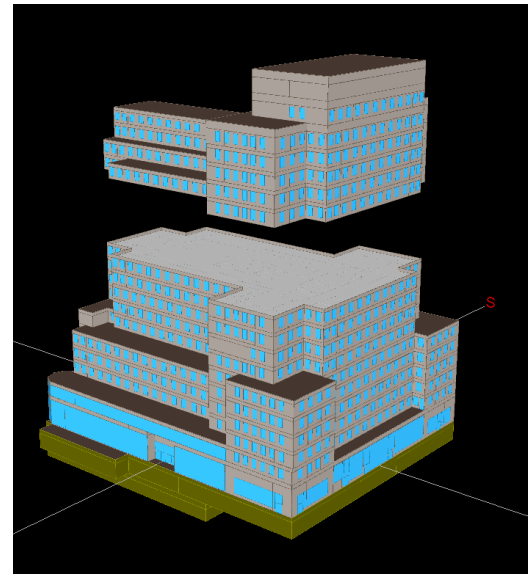
- Developed (6) energy models to identify typical major end-use (lighting, plug loads, fans, pumps. etc) breakdown for Rockefeller Center buildings.
- Calibrated models to be within 5% of annual utility energy consumption and 10% for monthly utility energy consumption.



45 Rock Plaza



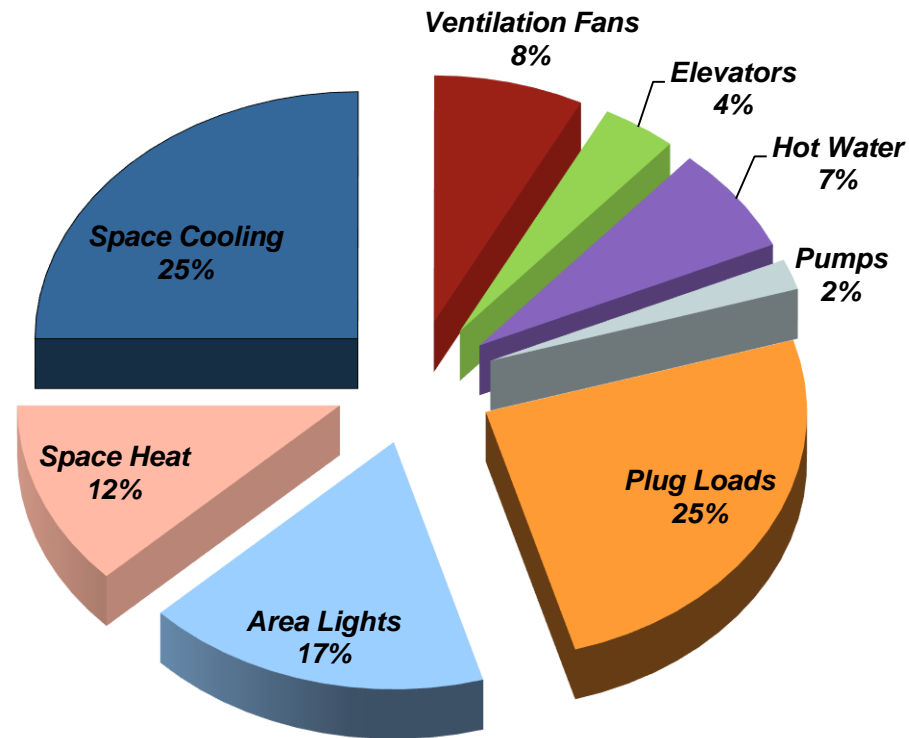
600 5th Avenue



1230 Avenue of the Americas

Modeling Results – End Use Breakdown

- The following represents a typical building's major end-use profiles for Rockefeller Center based on the modeled buildings.



Energy Efficiency Measures Development

List of Central Plant - Recommended ECMs

FIRST PRIORITY ECM RECOMMENDATIONS	
ECM Description	Simple Payback
Retrofit Existing 4,000 Ton Electric Chiller (RM-B) with New Complete Driveline Including Motor, Compressor, Control Panel, and VFD	~ 5
Retrofit Existing 2,500 Ton Electric Chiller (RM-D) with New Complete Driveline Including Motor, Compressor, Control Panel, and VFD	~ 3
Rebalance Central Plant Chilled Water and Condenser Water Systems	~ 1
Reset Condenser Water Temperature	~ 1
All First Priority ECMs Combined	~ 3

SECOND PRIORITY ECM RECOMMENDATIONS	
PLC Controller on Steam Chiller (RM-A)	~ 4
Trim CW Pump Impellers	~ 4
New 2,500 Ton Chiller	~ 4.5
All Second Priority ECMs Combined	~ 4

Energy Efficiency Measures Development

List of Building - Recommended ECMs

FIRST PRIORITY ECM RECOMMENDATIONS	
ECM Description	Simple
Building Chilled Water System Balancing	< 1
Install floor isolation dampers at supply air duct mains for all multifloor AHUs for 610 and 620 5th Ave.	~ 3
Exterior Lighting – Semi-Replacements	~ 1.5
All First Priority ECMs Combined	~ 1.5

SECOND PRIORITY ECM RECOMMENDATIONS	
Replace 30 Rock Secondary Chilled Water Heat Exchangers	~ 9
Interior Lighting - Full Replacements	~ 5.5
Recalibrate minimum OA requirements at AHUs and H&V units.	~ 4.5
All Second Priority ECMs Combined	~ 5

Energy Efficiency Measures Development

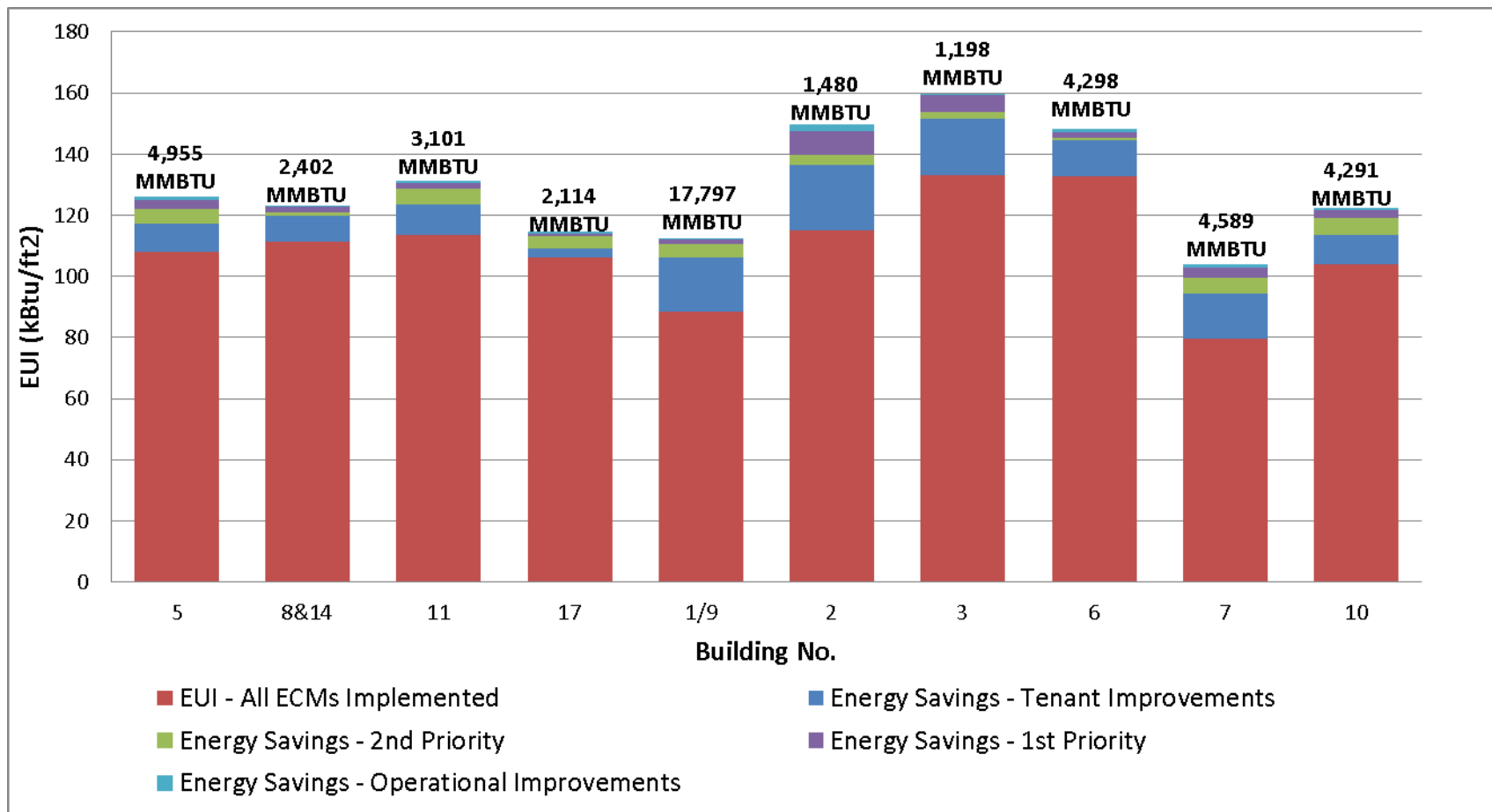
List of Tenant - Recommended ECMs

TENANT RENOVATION ECM RECOMMENDATIONS	
ECM Description	Simple Payback
Convert existing dual duct constant volume air handling systems to variable air volume systems.	~ 3.5
Retrofit existing constant volume air handling systems to variable air volume systems.	~ 15.5
Convert economizer operation from dry bulb to enthalpy-based control.	~ 7.5
Tie Perimeter Heating Controls to Space Thermostats	~ 22
Retrofit existing windows with a new standard performance window ("ClearGlass"). [Low]	~ 14.5
All Tenant Renovation ECMs Combined	~ 19

Energy Efficiency Measures Development

All-in Energy Reduction Findings

- The following figure presents the associated EUI reduction per building if all ECMs and operational improvements were implemented:



Moving Forward - Why Stop Here?

- Implementing Study's Findings
 - Central Plant Improvements
 - LED Exterior Façade Lights
- Investigating Additional Technologies
 - Cogeneration
 - Electric Storage
- Installing Permanent Sub-metering
 - Benchmarking
 - Regular monitoring of utility usage
 - Assess opportunities for Control Sequence Improvements
- Global Initiative – “Tishman Speyer University”
 - Training
 - Best Practices
 - Innovation Task Group



Keys to Success

- Business partners (Con Edison, NYSERDA, consultants and vendors)
- Use proven technology (reliability and competitive pricing)
- Implement systems or strategies that complement primary business focus
- Put information to use!
- Commissioning / retro-commissioning and energy audits

This concludes The American Institute of Architects
Continuing Education Systems Course

