

# **Climate Neutral Campus Energy Alternatives Report**

Appendix E: Energy Conservation Initiatives (ECIs)  
2016 Summary Report



**Cornell University – Ithaca**

**Energy Conservation Initiative (ECI) Performance Report  
FY 2016**

**Prepared by: Cornell University  
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July 2016**

**Executive Summary**

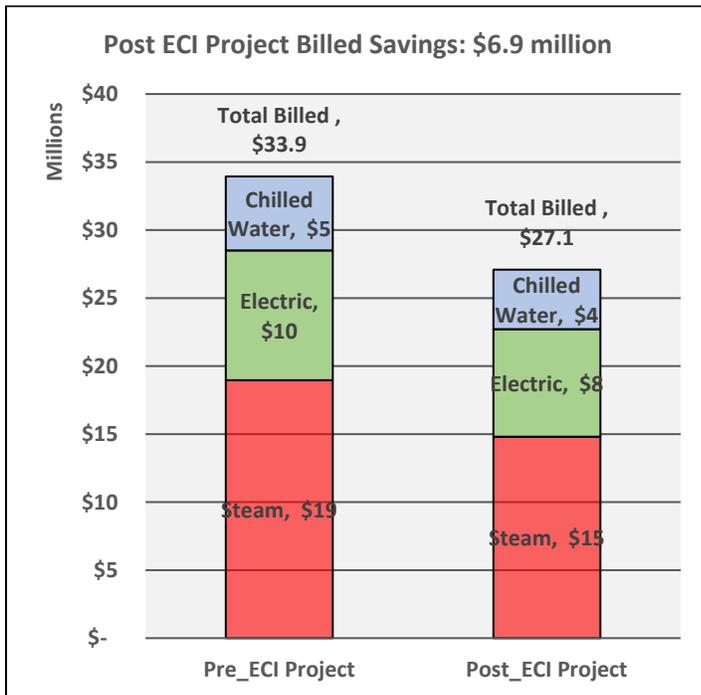
As part of the facilities initiatives of the Administrative Streamlining Program (ASP), energy conservation was specifically targeted as an opportunity for long-term savings. The purpose of the Energy Conservation



Initiative (ECI) is a comprehensive 5-year “demand” side project to cost effectively reduce energy use in buildings and improve operations in response to the university’s need to reduce expenses. ECI will also reduce associated greenhouse gas impacts as prescribed in the Trustee-approved Climate Action Plan completed as part of the Presidents Climate Commitment.

ECI saves 60+ facilities \$6.9 million in annual billed energy, an impressive 20% reduction. The project achieved significant energy savings: (1) 20,000,000 kwh of electric, (2) 139,000 klbs of steam and (3) 5.4 million ton-hrs of chilled water. At the completion of the ECI project the university’s carbon inventory has been reduced by over 14,000 metric tons. The project achieved a 5 year simple payback and exceeds the project target (7 year billed rate payback).

ECI Project Savings	% Reduction from FY 2011	% FY 2017 Total Campus Usage
Steam: 139,000 klbs	22%	16%
Chilled Water: 5,370,000 ton-hrs	20%	12%
Electric: 20,000,000 kwh	17%	10%



## Project Description

The ECI project included over 60 projects and cost approximately \$33 million. The project consists of four phases: (1) energy studies, (2) evaluation and design, (3) installation/construction and (4) continuous



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commissioning. The project team created for ECI included dedicated Cornell technical and program staff, focused energy studies, lean engineering, controls standardization, a single at risk prime contractor, third party commissioning, and owner continuous commissioning. All buildings were analyzed using extensive existing meter data (real time and historical monthly) and benchmarking within Cornell.

The project focused heavily on demand controlled ventilation in laboratories, office/teaching, and dining air systems. Energy saving measures included: (1) extensive replacement/installation of building controls management systems; (2) using occupancy based air change, carbon dioxide sensing and setpoint controls; (2) schedule, cooking hood usage and temperature based controls; and (3) constant volume to VAV conversions, and major re-commissioning of existing building systems.

The upgraded control systems required development of a laboratory risk-banding program by EH&S to safely lower air change minimums. In addition, ECI included various lighting upgrades. High maintenance intensive/inefficient metal halide lights were replaced with LED in high bay spaces. Re-lamping of general building space lighting (1.5 million GSF) with LED direct replacements provided notable savings (50%). Poorly insulated steam piping was insulated throughout campus. Old (1950s) legacy controls for plant growth chambers were upgraded to modern state of the art controls specific for greenhouse/plant research. The project utilized Cornell's Lake Source Cooling (Campus's renewable district cooling system) and steam regenerated dessicant dehumidification to eliminate refrigeration based dehumidification.

A unique aspect of the project is maintaining the energy reductions during each building's life. An Energy Conservation Controls Team (ECCT), consisting of ten Cornell staff continuously commission and re-commission all of campus (150 buildings, 13.8 million gross square feet of central utility connected space). The ECCT group uses the new/upgraded controls for better data trending and analysis to assist in their recommissioning effort. In 2015, the ECCT received IPP Cornerstone Award for Effectiveness and Improvement.

All ECI projects are defined from energy studies and are based on a maximum of a seven year billed cost payback. ECI projects addressed significant planned maintenance issues (over \$15 million or half of the total cost) and improve comfort and safety while significantly reducing routine maintenance tickets.

Cornell ECI Team:

W.S. (Lanny) Joyce, PE, CEM	Project Executive
Mark Howe, PE, CEM	Project Program Manager
Darlene Hackworth	Project Contracts Manager
Lou Damiani	Project Coordinator
David Frostclapp	Project Energy Analyst

## Energy Conservation Initiative Savings



ECI savings are calculated by comparing the baseline of 2011 actuals versus the FY 2017 budget by commodity for those metered facilities with a project. Weather factors need to be considered for an accurate analysis. The key weather factors are:

*(1) heating degree days (65F less the average daily temp) which strongly correlates with steam consumption and*

*(2) enthalpy-hours, (based on temperature and relative humidity) which strongly correlates with chilled water consumption.*

The actual weather parameters for FY 2011 are comparable to the “forecast” weather parameters for FY 2017 and thus enable a “weather neutral” analysis. FY 2016 actuals are also provided in the detailed tables; however, are not adjusted for weather impacts.

Annual savings at FY 2016 billed rates are approximately \$6.9 million (Table 1). The % savings across commodities is consistent, averaging 20%. Facility detail is provided via Tables 3 thru 5.

**Table 1: Financial Summary**

@ FY16 Billed Rates	Steam	Electric	Chilled Water	Total Billed
Pre_ECI Project	\$18,965,570	\$9,542,678	\$5,437,575	\$33,945,823
Post_ECI Project	\$14,804,387	\$7,910,071	\$4,373,602	\$27,088,060
Savings	\$4,161,183	\$1,632,607	\$1,063,973	\$6,857,763
% Savings	22%	17%	20%	20%

**Table 2: Consumption Summary**

Consumption Units	Steam klb	Electric kwh	Chilled Water ton-hr
Pre_ECI Project	634,300	117,810,840	27,462,500
Post_ECI Project	495,130	97,655,200	22,088,900
Savings	139,170	20,155,640	5,373,600
% Savings	22%	17%	20%

**Table 3: Electricity**



Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized" Savings	Actuals FY2016
1001 Barton Hall	936,800	(200,000)	857,200	(79,600)	755,200
1008 Ives Hall East	1,149,800	(73,900)	877,100	(272,700)	832,520
1009 Ives Hall	1,548,700	(90,906)	1,204,700	(344,000)	1,155,200
1018 Biotechnology	5,277,700	(251,000)	4,561,700	(716,000)	4,812,840
1019 Biological Science Complex	3,866,400	(620,100)	3,628,300	(238,100)	3,927,280
1027 Mann Library	4,356,800	(96,972)	2,745,100	(1,611,700)	2,860,705
1028B Bradfield Hall	4,736,800	(53,100)	4,389,300	(347,500)	4,331,200
1028E Emerson Hall	shared meter with 1028B	(73,700)			
1045A Kenneth Post Lab	874,200	(70,100)	402,900	(471,300)	428,741
1060A Tower Rd East Yellow Gh 1060A	1,235,600	(70,100)	840,100	(395,500)	841,200
1061A Tower Rd East Blue Gh 1061A	438,000	(70,100)	385,600	(52,400)	394,320
1062 Riley-Robb Hall	1,648,600	(2,500)	1,162,300	(486,300)	1,189,320
1068B Guterman Bioclimatic Lab	3,145,000	(1,191,200)	2,873,000	(272,000)	3,363,200
1076 Boyce Thompson Institute	4,779,000	(23,700)	4,128,900	(650,100)	4,279,500
1080 Kennedy & Roberts Complex	1,571,000	(119,500)	1,352,200	(218,800)	1,417,760
1081 Comstock Hall-Academic II	2,409,200	(365,000)	1,882,000	(527,200)	1,990,440
1140 Vet Research Tower	3,370,200	(140,000)	3,111,900	(258,300)	3,032,040
1150C Schurman Hall	1,149,900	(91,600)	1,405,600	255,700	1,567,280
1163 Vet Education Center	669,800	(98,700)	594,200	(75,600)	424,960
1164 Vet Medical Center	11,016,800	(1,732,500)	8,243,100	(2,773,700)	9,040,800
1902 Love Lab - Plant Breeding	224,700	(43,400)	212,100	(12,600)	204,280
1905 Muenscher Laboratory	113,100	(50,100)	137,000	23,900	117,360
2000 Duffield Hall	7,955,900	(890,900)	6,803,100	(1,152,800)	7,364,000
2001 Morrill Hall	320,100	(22,000)	292,300	(27,800)	292,160



Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized" Savings	Actuals FY2016
2007 Olive Tjaden Hall	654,400	(13,000)	363,800	(290,600)	407,700
2010 Uris Library	1,016,100	(51,000)	940,000	(76,100)	864,480
2019 Baker Laboratory	3,060,400	(333,200)	3,140,600	80,200	2,618,793
2020 Willard Straight Hall	1,241,600	(55,200)	1,159,600	(82,000)	1,184,000
2032 Savage Hall	1,952,500	(300,000)	932,900	(1,019,600)	964,640
2033 Statler Hall & Auditorium	2,263,200	(368,000)	2,217,600	(45,600)	2,424,480
2033A Statler Hotel	2,700,000	(432,000)	2,287,000	(413,000)	2,270,400
2037K Kimball Hall	1,502,900	(91,000)	1,659,200	156,300	1,700,560
2042 Carpenter Hall	583,700	(46,000)	450,800	(132,900)	475,520
2047 Olin Library	1,988,300	(78,100)	1,626,100	(362,200)	1,547,043
2047A Kroch, Carl A Library	1,538,100	(551,000)	802,400	(735,700)	789,440
2049 Snee Hall Geological Science	1,195,200	(153,714)	1,167,200	(28,000)	1,120,800
2070 Bard Hall	1,131,900	(91,000)	749,500	(382,400)	902,640
2081 Malott Hall	862,500	(41,700)	706,900	(155,600)	662,146
2083 Olin Chemistry Research Wing	2,700,200	(486,100)	1,902,200	(798,000)	2,120,660
2086 Johnson Museum Of Art	986,400	(100,100)	890,300	(96,100)	908,010
2087 Uris Hall	2,642,000	(78,000)	2,078,100	(563,900)	1,963,600
2088 The Cornell Store	586,700	(170,000)	555,300	(31,400)	585,547
2610 Grumman Squash Courts	284,100	(40,000)	182,800	(101,300)	116,480
2611 Teagle Hall	856,600	(108,338)	804,300	(52,300)	790,800
2613 Lynah Rink	1,253,400	(437,400)	1,182,900	(70,500)	1,163,800
2616 Helen Newman Hall	808,800	(53,000)	892,900	84,100	840,420
2631 Bartels Hall	1,699,900	(350,000)	1,569,600	(130,300)	1,526,459
2638 Friedman Wrestling Center	115,900	(30,000)	102,400	(13,500)	96,320



Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized" Savings	Actuals FY2016
3009 Balch Hall	952,900	(57,900)	763,000	(189,900)	749,400
3010B Maple Ave 120	1,034,300	(23,000)	710,600	(323,700)	715,600
3031 Alice H. Cook House	746,600	(145,182)	736,900	(9,700)	750,240
3032 Carl Becker House	1,783,600	(850,800)	1,347,900	(435,700)	1,448,160
3033 Hans Bethe House	1,212,400	(647,400)	1,080,400	(132,000)	1,206,400
3034 William T. Keeton House	1,187,300	(116,900)	1,117,800	(69,500)	1,068,480
3035 Flora Rose House	915,100	(106,100)	913,800	(1,300)	884,400
3126 Noyes Lodge - Beebe Lake	190,500	(24,000)	141,100	(49,400)	139,840
3204 Robert J & Helen Appel Commons	1,459,000	(475,000)	1,148,500	(310,500)	1,173,840
3212 Robert Purcell Community Ctr	3,049,200	(1,219,900)	1,776,000	(1,273,200)	1,715,840
MULTI Growth Chambers 1		(1,299,000)			
1165 East Campus Research Facility	2,569,000	ECCT	2,066,900	(502,100)	2,507,000
2002 White Hall	384,240	ECCT	301,400	(82,840)	316,400
2014 Rockefeller Hall	630,080	ECCT	535,100	(94,980)	501,440
1018 Biotechnology	5,277,720	ECCT	4,561,700	(716,020)	4,812,840
<b>Total kwh</b>	<b>117,810,840</b>	<b>(15,864,113)</b>	<b>97,655,200</b>	<b>(20,155,640)</b>	<b>100,656,924</b>
<b>Electric billed</b>	<b>\$9,542,678</b>	<b>(\$1,284,993)</b>	<b>\$7,910,071</b>	<b>(\$1,632,607)</b>	<b>\$8,153,211</b>
			<b>% Reduction</b>	<b>17%</b>	
			<b>Savings metric tons CO2</b>	<b>(8,264)</b>	

**Table 4: Steam**



Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized Savings"	Actuals_2016
1007 ILR Conference Center Complex	2,490	(770)	2,070	(420)	1,570
1009 Ives Hall	10,370	(4,620)	5,420	(4,950)	4,770
1018 Biotechnology	25,950	(2,300)	20,680	(5,270)	18,630
1019E Dale R Corson Bio Science Wing	13,160	(2,340)	11,860	(1,300)	12,330
1027 Mann Library	28,340	(470)	10,590	(17,750)	11,420
1028B Bradfield Hall	21,960	(1,400)	26,870	4,910	26,290
1028E Emerson Hall	7,510	(4,610)	5,370	(2,140)	4,750
1045A Kenneth Post Lab	5,890	(210)	4,230	(1,660)	3,780
1062 Riley-Robb Hall	10,510	(2,780)	8,300	(2,210)	7,470
1068B Guterman Bioclimatic Lab	24,320	(3,280)	16,070	(8,250)	12,740
1076 Boyce Thompson Institute	11,420	(1,380)	9,650	(1,770)	7,420
1080 Kennedy & Roberts Complex	7,300	(1,360)	5,650	(1,650)	4,830
1081 Comstock Hall-Academic II	11,580	(1,900)	6,310	(5,270)	5,940
1140 Vet Research Tower	16,420	(3,300)	13,510	(2,910)	11,820
1150C Schurman Hall	22,990	(1,690)	20,120	(2,870)	17,340
1163 Vet Education Center	4,190	(290)	3,090	(1,100)	1,630
1164 Vet Medical Center	54,900	(8,750)	41,230	(13,670)	38,600
2000 Duffield Hall	30,350	(9,130)	27,140	(3,210)	23,380
2007 Olive Tjaden Hall	5,950	(780)	4,950	(1,000)	4,620
2010 Uris Library	3,700	(760)	3,630	(70)	3,300
2014 Rockefeller Hall	5,690	(680)	3,090	(2,600)	2,690
2015 Foundry	800	(200)	780	(20)	850
2019 Baker Laboratory	31,950	(9,820)	20,030	(11,920)	15,470
2020 Willard Straight Hall	9,960	(1,260)	10,520	560	12,350



Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized Savings"	Actuals_2016
2032 Savage Hall	7,260	(2,000)	3,800	(3,460)	3,190
	18,840		4,180	(14,660)	4,190
2033 Statler Hall & Auditorium	-	(4,400)	13,850	13,850	12,130
2037K Kimball Hall	8,660	(1,970)	8,230	(430)	8,580
2042 Carpenter Hall	2,370	(520)	1,830	(540)	1,760
2047 Olin Library	12,730	(6,600)	8,140	(4,590)	7,590
2047A Kroch, Carl A Library	5,780	(2,000)	2,880	(2,900)	2,860
2049 Snee Hall	5,330	(1,600)	3,780	(1,550)	3,320
2070 Bard Hall	8,720	(1,010)	6,820	(1,900)	6,820
2081 Malott Hall	4,820	(930)	3,400	(1,420)	3,230
2083 Olin Chemistry Research Wing	24,030	(12,200)	10,690	(13,340)	13,280
2086 Johnson Museum Of Art	9,790	(3,850)	10,650	860	9,580
2087 Uris Hall	23,060	(3,980)	17,490	(5,570)	17,230
2088 The Cornell Store	370	(790)	660	290	690
2613 Lynah Rink	5,050	(2,220)	5,200	150	4,200
3009 Balch Hall	11,300	(430)	9,530	(1,770)	9,490
3031 Alice H. Cook House	4,380	(1,410)	4,490	110	3,940
3032 Carl Becker House	11,180	(4,950)	9,060	(2,120)	8,460
3033 Hans Bethe House	6,810	(1,670)	6,600	(210)	5,690
3034 William T. Keeton House	6,380	(860)	4,370	(2,010)	4,400
3035 Flora Rose House	4,100	(1,250)	4,210	110	3,580
3126 Noyes Lodge - Beebe Lake	640	(110)	360	(280)	260
3204 Robert J & Helen Appel Commons	3,950	(2,000)	3,230	(720)	2,740
3212 Robert Purcell Community Ctr	33,570	(2,900)	36,280	2,710	29,580



Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized Savings"	Actuals_2016
1165 East Campus Research Facility	13,420	ECCT	8,310	(5,110)	8,010
2002 White Hall	2,420	ECCT	2,160	(260)	1,770
2014 Rockefeller Hall	5,690	ECCT	3,090	(2,600)	2,690
1018 Biotechnology	25,950	ECCT	20,680	(5,270)	18,630
<b>Total klb</b>	<b>634,300</b>	<b>(123,730)</b>	<b>495,130</b>	<b>(139,170)</b>	<b>451,880</b>
<b>Steam Billed</b>	<b>\$18,965,570</b>	<b>(\$3,699,527)</b>	<b>\$14,804,387</b>	<b>(\$4,161,183)</b>	<b>\$13,511,212</b>
			<b>% Reduction</b>	<b>22%</b>	
			<b>Savings metric tons CO2</b>	<b>(5,706)</b>	



**Table 5: Chilled Water**

Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized" Savings	Actuals_2016
1007 ILR Conference Center Complex	100,200	(49,200)	89,400	(10,800)	57,900
1008 Ives Hall East	266,700	(131,400)	121,200	(145,500)	99,700
1009 Ives Hall	492,100	(194,100)	316,700	(175,400)	244,300
1018 Biotechnology	1,443,300	(67,000)	1,251,300	(192,000)	1,133,400
1019 Biological Science Complex	875,500	(78,600)	827,600	(47,900)	822,700
1027 Mann Library	2,169,400	(299,500)	607,000	(1,562,400)	575,900
1028B Bradfield Hall	914,200	(72,500)	876,700	(37,500)	721,600
1028E Emerson Hall	583,600	(12,700)	524,100	(59,500)	433,200
1076 Boyce Thompson Institute	681,800	(67,100)	703,700	21,900	712,200
1080 Kennedy & Roberts Complex	297,700	(2,400)	244,700	(53,000)	219,900
1081 Comstock Hall-Academic II	496,900	(149,900)	323,300	(173,600)	312,100
1140 Vet Research Tower	649,300	(235,200)	698,000	48,700	531,600
1150C Schurman Hall	475,600	(17,600)	377,300	(98,300)	216,300
1150D Basic Science Building	63,300	(1,000)	63,800	500	47,000
1163 Vet Education Center	217,100	(3,500)	130,400	(86,700)	82,300
1164 Vet Medical Center	2,892,600	(348,800)	2,256,300	(636,300)	1,962,600
2000 Duffield Hall	2,168,900	(152,600)	2,045,800	(123,100)	1,959,700
2010 Uris Library	350,500	(70,000)	334,900	(15,600)	265,000
2019 Baker Laboratory	1,449,600	(288,100)	831,500	(618,100)	666,100
2020 Willard Straight Hall	198,900	(46,600)	328,500	129,600	281,200
2032 Savage Hall	288,000	(79,900)	257,000	(31,000)	239,000
2033 Statler Hall & Auditorium	793,200	(166,600)	611,100	(182,100)	664,100
2033A Statler Hotel	572,800	(195,700)	555,000	(17,800)	523,000



Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized" Savings	Actuals_2016
2037K Kimball Hall	363,200	(8,200)	304,000	(59,200)	335,300
2042 Carpenter Hall	170,200	(35,000)	102,200	(68,000)	98,700
2047 Olin Library	542,800	(140,800)	411,500	(131,300)	421,800
2047A Kroch, Carl A Library	847,900	(37,000)	344,100	(503,800)	342,500
2049 Snee Hall Geological Science	305,900	(10,800)	251,600	(54,300)	202,700
2070 Bard Hall	436,500	(8,200)	405,300	(31,200)	377,000
2083 Olin Chemistry Research Wing	832,500	(518,800)	580,700	(251,800)	561,500
2086 Johnson Museum Of Art	585,700	(122,700)	801,500	215,800	671,300
2087 Uris Hall	1,131,100	(236,700)	810,100	(321,000)	910,400
2088 The Cornell Store	116,300	(65,000)	98,700	(17,600)	94,800
2613 Lynah Rink	62,000	(9,400)	59,200	(2,800)	59,200
3031 Alice H. Cook House	111,500	(70,500)	130,400	18,900	129,200
3032 Carl Becker House	378,100	(83,400)	309,900	(68,200)	290,500
3033 Hans Bethe House	200,800	(154,800)	286,100	85,300	194,800
3034 William T. Keeton House	218,100	(94,600)	259,200	41,100	198,200
3035 Flora Rose House	175,900	(67,900)	190,700	14,800	151,600
3204 Robert J & Helen Appel Commons	124,700	(61,700)	256,500	131,800	223,300
1165 East Campus Research Facility	869,000	ECCT	736,100	(132,900)	647,200
2002 White Hall	95,500	ECCT	100,800	5,300	88,700
2014 Rockefeller Hall	10,300	ECCT	23,700	13,400	20,200
1018 Biotechnology	1,443,300	ECCT	1,251,300	(192,000)	1,133,400
<b>Total ton-hrs</b>	<b>27,462,500</b>	<b>(4,455,500)</b>	<b>22,088,900</b>	<b>(5,373,600)</b>	<b>19,923,100</b>
<b>Chilled Water Billed</b>	<b>\$5,437,575</b>	<b>(\$882,189)</b>	<b>\$4,373,602</b>	<b>(\$1,063,973)</b>	<b>\$3,944,774</b>
			<b>% Reduction</b>	<b>20%</b>	



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Facility	Actuals_2011	Totals ECI Savings (Projected)	Budget_2017	"Realized" Savings	Actuals_2016
			Savings metric tons CO2	(177)	