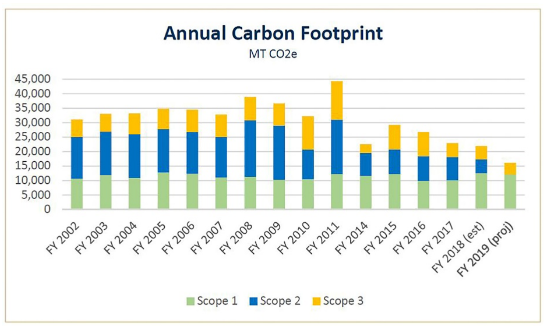
ENERGY ROADMAP

ITHACA COLLEGE

JULY 2019



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Energy Roadmap

Prepared for:
Ithaca College

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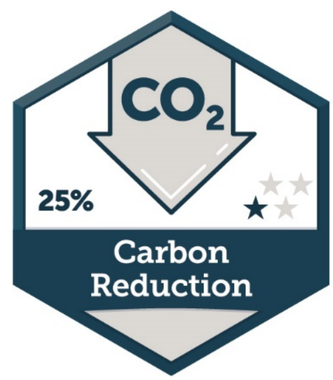
1. GUIDING PRINCIPLE, PURPOSE, AND APPROACH

1.1 GUIDING PRINCIPLE

The Ithaca College (IC) Energy Roadmap (Roadmap) will guide energy and greenhouse gas (GHG) reduction actions over a 10-year period that are realistic, implementable, and cost effective, which will position IC to achieve short-term and long-term energy goals. The Roadmap achieves energy reductions through energy efficiency, infrastructure renewal, renewable energy, stewardship of physical assets, and engagement of the campus community to promote energy conservation and impact behavioral change. The Climate Action Plan Reassessment Team is also working to complete their review of an expedited climate neutrality goal. This Roadmap helps inform that analysis and can assist the college in determining the true financial and environmental impact.

1.2 PURPOSE

The New York State Energy Research and Development Authority (NYSERDA) Reforming the Energy Vision (REV) Campus Challenge Technical Assistance for Roadmaps (REV Campus Challenge) supports REV Campus Challenge members by providing the means for campuses to evaluate existing energy-related conditions on campus and establish an Energy Roadmap (Roadmap) for managing changing campus energy needs. While Ithaca College (IC) is designated as a Leader within the REV Campus Challenge, IC has also taken other public actions that demonstrate a commitment to energy conservation and environmental sustainability which include the following:



- Achieving a STARS Silver rated under AASHE (Association for the Advancement of Sustainability in Higher Education) https://stars.aashe.org/institutions/ithaca-college-ny/report/
- Committing to carbon neutrality and climate resiliency through Second Nature's Climate Commitment (http://secondnature.org/what-we-do/climate-leadership/) with interim greenhouse gas (GHG) emissions reduction goals of:
  - 25% by 2015 (2007 baseline year)
  - 50% by 2025, and
  - 100% by 2050 or sooner (*i.e.*, 2030)
- Committing to purchase 100% renewable electricity since February 2018
- Recipient of the Stage 2 NYSERDA / NYPA Geothermal Clean Energy Challenge grant for CNS / Park Communications / Williams Hall

IC has developed this Roadmap to support the above initiatives and identify energy efficiency and sustainability measures, and the associated energy and GHG emissions reductions across the campus.

1.3 APPROACH

The Roadmap is a compilation of actions to reduce energy usage and GHG emissions, increase energy efficiency, and decrease operating costs. The Roadmap approach was a collaborative process of stakeholder engagement that allowed for recognizing key issues, strategic thinking of best practices, and identifying potential implementation strategies. Engagement and thought leadership was provided by Office of Energy Management and Sustainability, Office of Facilities, and the Climate Action Plan Reassessment Team. Considerations that have shaped the development of IC's Roadmap include:

1. Near-term and Long-term Planning Horizons
   a. Energy and GHG reductions towards achieving 2025 and 2030 targets

   b. Energy savings strategies that reflect campus priorities: Energy Efficiency, Resiliency, Renewable Energy, Stewardship, and Engagement
   c. Financing and contracting to implement the plan within a 10-year timeframe.

2. Energy Reductions through Infrastructure Renewal and Stewardship of Physical Assets
   a. Capital planning and modernization of campus buildings in conjunction with the 2015 Campus Master Plan and upcoming Strategic Master Plan (SMP)
   b. Addressing critical/deferred maintenance in conjunction with annual capital planning
   c. Establishing regular retro-commissioning and continuous commissioning programs, while also working towards O&M practices centered in preventative and predictive maintenance.

2. ASSESS – EXISTING CONDITIONS AND OPPORTUNITIES

The Roadmap process started with an assessment of existing conditions and opportunities to understand the broad picture of "where are we now" relative to the campus energy program. The following key steps contributed to the development of the Roadmap.

1. Greenhouse Gas Inventory
   Established a baseline against which future energy and GHG reductions can be measured and evaluated the potential impact of completed energy projects on energy consumption and GHG emissions.

2. Gap Analysis
   Reviewed the 2009 Climate Action Plan, 2012 FlexTech energy audits by CHA, and Ithaca College's 2015 Campus Master Plan; interviewed facilities personnel to understand what has/has not been implemented since 2012 and to gain an understanding of building and process energy system characteristics and operation and maintenance (O&M) practices; conducted a campus walk-through to better understand the current operational conditions and energy efficiency opportunities.

3. Campus Stakeholder Engagement
   Conducted facilitated strategy meetings to discuss task efforts/results and to help foster consensus amongst the IC stakeholders on key institutional targets and actions related to campus climate and energy goals, and inform the process of Roadmap creation.

4. Energy Roadmap
   Developed a Roadmap to achieve the energy and carbon reduction targets through energy efficiency, infrastructure renewal, and facility stewardship.

2.1 ITHACA COLLEGE ANNUAL ENERGY USAGE, EUI AND GREENHOUSE GAS EMISSIONS

IC recently completed a GHG inventory for fiscal years (FY) 2015-2017. A summary of the Scope 1, 2 and 3 emissions is provided below in Table 1. GHG emissions associated with stationary combustion and purchased electricity are based on the site natural gas use and site electricity use, respectively.

Table 1. Ithaca College Summary of GHG Emissions

GHG Emission Source	FY15 ($MTCO_2e$)	FY16 ($MTCO_2e$)	FY17 ($MTCO_2e$)
Scope 1			
Stationary Source Combustion	11,369	9,183	9,338
Mobile Sources	652	542	514
Scope 2			
Purchased Electricity Consumption	6,405	6,340	6,033
Scope 3			
Total Commuting	5,032	5,032	5,032
Faculty/staff commuting	3,019	3,019	3,019
Student commuting	2,013	2,013	2,013
Directly Financed Outsourced Air Travel[a]	2,843	2,843	2,843
Total Scope 3 Emissions[b]:	7,875	7,875	7,875
Total GHG Emissions:	*26,301*	*23,940*	*23,760*

Notes:

(a) GHG emissions were obtained from Version 9.1 of *University of New Hampshire's Campus Carbon Calculator*.

(b) Total Scope 3 Emissions were calculated for FY17 and are considered representative of Scope 3 activities in FY15 and FY16 and, therefore, FY17 has been used as a respresentative proxy.

As shown in Table 1, the GHG emissions associated with stationary source combustion and electricity consumption have decreased since FY 2015. This is associated with a reduction in natural gas and electricity consumption, as well as an increase in electricity purchased from a 2.9 megawatt (MW) solar farm located in Geneva, NY, approximately 40 miles from campus. This is further discussed in Section 2.2.3 below. Scope 3 emissions were only estimated for FY 2017 and, therefore, to evaluate the 2015-2017 trend in total GHG emissions (of Scopes 1, 2, and 3), FY 2017 Scope 3 emissions were used as a representative proxy for FYs 2015 and 2016.

2.2 EXISTING CONDITIONS AND OPPORTUNITIES

The Roadmap was informed by several energy-related studies completed for IC.

- Energy assessments completed by CHA in 2012 under the NYSERDA FlexTech Program
- Energy study of the Center for Natural Sciences (CNS) building completed by GreenerU in February 2018 under the NYSERDA FlexTech Program
- Job Complex Heating Water Study completed by Murphy Consulting Engineering in September 2017
- IC participation in the NYSERDA / NYPA Stage 2 Geothermal Clean Energy Challenge which is evaluating the economic feasibility for a regional ground source heat pump plant for CNS / Park Communications / Williams Hall.

These studies served as the basis for establishing existing conditions and identifying and categorizing energy conservation measures (ECMs) that have been implemented since the studies were completed, are in the process of being implemented, are no longer being considered, or could be implemented in the future to reduce source EUI and GHG emissions. Energy savings and capital costs for in-process and potential future ECMs were derived from the studies, but adjusted as needed to account for current conditions and utility rates. Further, energy savings calculations and implementation costs presented in the studies were reviewed by OBG for reasonableness and updated when other methodologies or assumptions could be applied to improve estimated savings and cost for the measure. Updated methodologies and assumptions applied for each measure are described in a supporting notes and backup calculations document that is bundled separately from this document. Additional ECMs identified by OBG through the walk-through survey and conversations with facilities personnel were evaluated to provide rough order of magnitude savings and capital costs.

Table 2 lists campus buildings along with building size, year built, primary function, and level of Leadership in Energy and Environmental Design (LEED) certification achieved, when applicable. Previous energy studies completed for each building and referenced for the Roadmap are indicated as well.

Table 2. Ithaca College Building Summary

Building Name	Building No.	Total GSF	Year Built	Stories	Building Function	LEED Certification	Notes
Administration Annex	-	10,890	1965	-	Administrative		1
Alumni Hall	116	17,554	1989	3	Administrative		1
A&E Center	126	180,553	2011	2	Fitness	Gold	
Bogart Hall	7/Q7	30,748	1961	4	Residence		
Boothroyd Hall	30/D30	15,925	1983	3	Residence		
C.B. Ford Observatory	119	742	1997	1	Academic		
Center for Health Sciences (CHS)	118	92,000	1999	5	Academic		1
Center for Natural Sciences (CNS)	117	125,000	1991	4	Academic		2
Ceracche Center	114	24,119	1968	2	Academic		1

Building Name	Building No.	Total GSF	Year Built	Stories	Building Function	LEED Certification	Notes
Circle Apts (110, 111, 120, 121, 130, 131, 150, 160)	-	136,589	1990	2	Residence		
Circle Apts (170, 171, 175, 180, 181, 185, 190, 341, 351)	-	123,634	2003	2	Residence		
Circle Apts (211, 230, 10, 12, 141, 151, 30)	-	85,834	2012	2	Residence		
Clarke Hall	8/Q8	23,132	1961	3	Residence		
Classroom Link	124	-	-	1	Academic	Gold	
Dillingham Center	101	78,746	1968	3	Academic		1
East Tower	11/E1	77,880	1964	16	Residence		1
Eastman Hall	10/Q10	23,132	1961	3	Residence		
Egbert Hall (Campus Center)	108	37,363	1960	4	Administrative		
Emerson	31/D31	63,315	1989	3	Residence		1
Facilities Grounds and Shops	F-3	4,800	1972	1	Service		1
Facility Administration Office Building	F-1	4,909	1975	3	Administrative		1
Facility Maintenance Service and Warehouse	F-2	22,000	1983	2	Service		1
Fitness Center	120	42,333	1999	2	Fitness		1
Friends Hall (Job Complex)	103	19,476	1965	3	Academic		1,3
Gannett Center	109	86,529	1965	5	Library		1
Garden Apartment 25	25/G25	15,350	1970	5	Residence		
Garden Apartment 26	26/G26	25,856	1970	5	Residence		
Garden Apartment 27	27/G27	30,976	1970	6	Residence		
Garden Apartment 28	28/G28	30,976	1970	6	Residence		
Garden Apartment 29	29/G29	11,520	1970	1	Residence		
Hammond Health Center	107	17,190	1961	3	Service		1
Hill Center	111	92,158	1963	2	Academic		
Hilliard Hall	2/Q2	23,132	1960	3	Residence		
Holmes Hall	5/Q5	23,132	1960	3	Residence		
Hood Hall	1/Q1	23,132	1960	3	Residence		
Job Hall (Job Complex)	102	27,221	1965	3	Administrative		1,3
Landon Hall	6/Q6	30,748	1961	4	Residence		
Lyon Hall	9/Q9	27,480	1961	4	Residence		

Building Name	Building No.	Total GSF	Year Built	Stories	Building Function	LEED Certification	Notes
Muller Chapel	112	5,973	1976	2	Service		1
Muller Faculty Center (Job Complex)	105	26,449	1965	4	Administrative		1,3
Park Center for Business and Sustainability	123	81,762	1953	4	Academic	Platinum	1
Park Communications	115	34,007	1988	3	Academic		
Peggy Ryan Williams (PRW)	125	58,200	2008	4	Administrative	Platinum	1
Phillips Hall (Campus Center)	108/DH1	53,620	1960	4	Administrative		
Public Safety & General Services	122	23,000	1953	3	Service		1
Rowland Hall	3/Q3	27,480	1960	3	Residence		
Smiddy Hall	113	35,628	1982	5	Academic		1
Tallcott Hall	4/Q4	23,132	1960	3	Residence		
Terrace 1	13/T1	11,070	1966	2	Residence		1
Terrace 2	14/T2	12,465	1966	2	Residence		1
Terrace 3	15/T3	17,616	1966	4	Residence		
Terrace 4	16/T4	13,560	1966	4	Residence		
Terrace 5	17/T5	11,826	1966	4	Residence		
Terrace 6	18/T6	17,352	1966	4	Residence		
Terrace 7	19/T7	19,188	1966	4	Residence		
Terrace 8	20/T8	15,204	1966	4	Residence		
Terrace 9	21/T9	17,586	1966	4	Residence		
Terrace 10	22/T10	17,340	1966	4	Residence		
Terrace 11	23/T11	17,586	1966	4	Residence		
Terrace 12	24/T12	17,478	1966	4	Residence		
Terrace 13	24-a/T13	-	-	-	Residence		
Terrace Dining Hall	113/DH3	44,842	1966	2	Dining		
Textor Hall (Job Complex)	104	11,938	1965	2	Academic		1,3
Towers Dining Hall	112/DH2	22,582	1964	2	Dining		
West Tower	12/W1	77,880	1964	16	Residence		1
Whalen Music Center	110	141,753	-	5	Academic		1
Williams Hall	106	71,057	1963	6	Academic		

Notes:
1. NYSERDA FlexTech Study, CHA, 2012
2. Ithaca College – Center for Natural Sciences (CNS) Technical Assistance Study, GreenerU, February 14, 2018
3. Job Complex Heating Water Study, Murphy Consulting Engineering, September 2017

Table 3 summarizes primary observations and opportunities in five strategic areas: energy efficiency, resiliency, renewable energy, stewardship, and engagement. Further detailed discussion of these areas immediately follows the table.

Table 3. Existing Conditions and Opportunities

ASSESS: *Existing Conditions and Opportunities*		
	Existing Conditions	**Opportunities**
ENERGY EFFICIENCY		
HVAC Systems	▪ Many types of HVAC systems exist on campus including VAV, constant volume single zone (CVSZ), dual duct, and dual deck multi-zone; unitary HVAC equipment is limited ▪ VFDs installed on many fans and pumps ▪ Geothermal heat pump system serves Peggy Ryan Williams (PRW)	▪ Ongoing initiative to install VFDs and NEMA premium efficiency motors on fans and pumps ▪ Synchronous belts on AHU fans ▪ Convert CVSZ systems to single zone VAV ▪ Convert dual duct systems to VAV (*e.g.,* Gannett Center)
Chillers	▪ Approximately 40% of campus is mechanically cooled primarily by water-cooled chillers ▪ Constant speed centrifugal chillers are prevalent but variable speed chillers have been installed	▪ Replace constant speed water-cooled chillers near end of life or subject to R-22 phase out with high-efficiency variable speed chillers; consider frictionless magnetic bearing chillers ▪ Allow cooling tower water temperature to float for peak chiller operating efficiencies
Boilers and DHW	▪ Ongoing boiler replacement initiative with condensing boilers as many boilers approaching end of life in 1 to 10 years ▪ Dillingham and Gannett Center served by new condensing hot water boilers ▪ Circle Apartment boilers being replaced with condensing boilers and indirect domestic water heaters	▪ Continue boiler replacement initiative ▪ Consideration of Ambient Temperature Loop system for the Campus Center buildings that extracts and rejects thermal energy. Feasibility currently being assessed by Greener U in collaboration with Integral Group.
Building Automation System	▪ Day Automation/Andover Controls BAS ▪ Prevalence of legacy pneumatic controls (25+ years old) ▪ Limited control and energy management capabilities	▪ Convert legacy pneumatic controls to DDC ▪ Implement or expand energy management capabilities; DCV, occupancy based controls, etc. ▪ Consider Real Time Energy Management (RTEM) program through NYSERDA PON 3689 ▪ Future system upgrade/migration to new platform
Interior Lighting	▪ Fluorescent fixtures predominant ▪ Limited automatic controls ▪ Campus LED penetration ~15 to 20% ▪ Phase 1 of CNS lighting project currently underway	▪ Install LED fixtures and advanced controls; specify on-board sensors
Exterior Lighting	▪ Upgraded approximately 40% of exterior lighting to LED (wall packs and parking lots) ▪ Metal halide and high-pressure sodium fixtures still exist; limited controls	▪ LED fixtures and advanced controls
Laboratories	▪ VAV supply and exhaust system in CNS	▪ Controls upgrades on laboratory and non-laboratory HVAC systems ▪ Laboratory ventilation optimization ▪ Laboratory exhaust air heat recovery
Kitchens	▪ VFDs installed on kitchen exhaust and MUA systems for DCV	▪ Upgrade refrigeration evaporator fan motors and controls ▪ Purchase high efficiency cooking equipment when time for replacement

ASSESS: *Existing Conditions and Opportunities*		
	Existing Conditions	**Opportunities**
Building Envelope	▪ Single pane windows and uninsulated walls ▪ Upgrading to double glazed windows	▪ Continue window replacement projects; specify high performance glazing ▪ Specify additional roof insulation levels above minimum code requirements when replacing roofs
Building Level Submetering	▪ Thirty-nine buildings metered for electric interval data ▪ One building (A&E Center) metered for natural gas	▪ Additional building level natural gas metering ▪ Consider deep sub-metering within individual buildings; leverage NYSERDA RTEM Program ▪ Water metering program recently underway ▪ Energy management software with dashboards to monitor and manage key performance indicators
RESILIENCY		
Critical Utilities Services	▪ Emergency power standby generation added to Campus Center in 2017 so facility can serve as a place of refuge ▪ Routine emergency generator upgrades ▪ Regular electrical service upgrades to improve reliability and address key components of the campus' master plan to convert to 12.47 kV electrical distribution ▪ Secondary service upgrades to the Towers included provisions to easily connect emergency generators in the event of a utility failure ▪ IT actions have included redundant incoming fiber, backup data centers, cloud storage usage, enhanced UPS equipment, and adding emergency generators ▪ Aging campus water infrastructure will likely need upgrades	▪ Underground utility upgrades needed over next 15 years, which can be timed with building and site upgrades where applicable ▪ Potential for IT to have a more strategic role in the overall campus governance structure
Infrastructure Renewal	▪ Ongoing initiative to replace boilers, chillers, and other HVAC equipment and systems at end of life ▪ Ongoing initiative to replace old single pane windows with double glazed windows	▪ Continual implementation of these initiatives ▪ Additional IT infrastructure enhancements to further increase cloud hosting solutions, more energy efficient data centers, facilitate business continuity, and disaster recovery.
RENEWABLE ENERGY		
Solar PV	▪ 2.9 MW solar farm, providing 10% of annual electricity ▪ 100% Green-e certified renewable energy purchase since February 2018 ▪ Roof-top solar PV being considered ▪ Currently participating in New York State public/private campus solar consortium known as New York Higher Education Large Scale Renewable Energy (NY HE LSRE)	▪ Roof-top solar PV being considered ▪ Continued participation in NY HE LSRE to see if its value can be fully realized and implemented
Geothermal Heat Pumps	▪ GHP system providing 50% of the heating and cooling capacity in PRW ▪ Participation in NYSERDA Geothermal Challenge	▪ Consideration of GHP systems in buildings addressed by NYSERDA Geothermal Challenge ▪ Potential new county-wide "Green Building Code" requirement for no new fossil fuel powered systems
Solar Thermal	▪ Does not exist on campus	▪ Potential for domestic water heating in future residential renovation projects

ASSESS: *Existing Conditions and Opportunities*		
	Existing Conditions	**Opportunities**
STEWARDSHIP		
Office of Energy Management & Sustainability	▪ Established roles include Director, as well as Campus Sustainability Coordinator	▪ Implementation of Energy Roadmap ▪ Collaboration with campus community
Sustainability	▪ Participation in AASHE STARS, Second Nature, Sierra Cool Schools, and Princeton Green Review reporting ▪ New construction is designed to achieve LEED Silver certification at a minimum	▪ Perform targeted energy audits annually to continually address energy efficiency opportunities
Retro-commissioning (RCx)	▪ RCx of A&E Center is underway ▪ CNS energy audit complete with a list of potential projects under consideration	▪ Make RCx and ongoing commissioning (Cx) an integral part of the College's O&M program
Workforce Training	▪ Aging workforce like many other campuses ▪ Potential for institutional knowledge loss in the next 5 to 10 years from the trade crafts and supervisors	▪ Considering developing future front-line supervisors ▪ Document and record existing institutional knowledge ▪ Train staff in the RCx process ▪ Potential to leverage NYSERDA PON 3715 – Workforce Training: Building Operations & Maintenance
Energy Policies and Guidelines	▪ Campus Space Temperature Guidelines ▪ Guidelines for space heaters ▪ Managed print services group is investigating opportunities to reduce the impact of printing on campus	▪ Complete performance driven facility guidelines ▪ Complete and/or develop program and policy changes that support reduced emission behaviors ▪ Establish commuter reduction goals, along with policies and programs to support reduced business travel ▪ Establish Vehicle Purchase and Operation Standards to Reduce Fuel Consumption ▪ Expand Data Inventory of Energy Using Systems
Maintenance Strategy	▪ Computerized Maintenance Management System (CMMS); SchoolDude platform ▪ Developed Deferred Maintenance Plan	▪ Continuous development of preventative and predictive maintenance program
2015 Campus Master Plan	▪ Many of the original campus buildings exceed 50 years of age ▪ Significant deficiencies exist in Open Labs and Assembly & Exhibit Space ▪ The Campus Center is overcrowded ▪ There are challenges with indoor circulation ▪ Sightlines reported that IC requires $175M in deferred maintenance over a 10-year period to address deficiencies	▪ Increase the density of buildings and activity in the campus core ▪ Integrate stewardship into all campus environmental planning, design, construction & policies ▪ Connect landscape, stewardship, facilities and curriculum ▪ Incorporate environmental site design as it relates to stormwater management ▪ Expand use of deciduous canopy trees ▪ Preserve and improve access to Ithaca College Natural Lands ▪ Make the South Hill campus easier to use in all four seasons ▪ Seek "indoor/outdoor places" when making connections between buildings ▪ Create parallel warm/cold and indoor/outdoor circulation routes

ASSESS: *Existing Conditions and Opportunities*		
	Existing Conditions	Opportunities
Natural Lands	▪ Ithaca College Natural Lands (ICNL) is 560 acres of forest that surrounds the campus. ICNL provides outdoor classrooms, research field sites, a forest resource bank, and recreational opportunities for Ithaca College and the local community.	▪ Future ICNL Sequestration Study led by IC Faculty Researchers. This activity could result in an additional source of carbon offsets.
Compost Program	▪ IC has been composting dining hall food scraps since 1993. The IC facilities group takes the scraps to Cayuga Compost.	▪ Continued participation in the Composting Program which yields carbon offsets for carbon dioxide equivalent (CO_2e) not released to the atmosphere.
ENGAGEMENT		
Campus-Wide Overview	▪ NYSERDA REV Campus Challenge *Leader* ▪ STARS Silver rated under AASHE ▪ Second Nature, Sierra Cool Schools, and Princeton Green Review participation and reporting ▪ Engagement with New York Coalition of Sustainability in Higher Education (NYCSHE) and New York APPA (NYAPPA) ▪ U.S. EPA Green Power Partners	▪ Potential partnerships in the IC community to further expand long-term composting program ▪ Investigate future opportunities to partner with faculty and students to more fully appreciate and understand the total supply cycle and its environmental impact
Student and Community Engagement	▪ Orientation program that fosters engagement with incoming students ▪ First-Year Residential Experience (FYRE) and South Hill Energy Reduction Program (SHERP) ▪ Eco Rep and Office of Energy Management and Sustainability (OEMS) Intern programs. ▪ Facilitation efforts to highlight the importance of personal choices ▪ Ongoing educational and research activities focused on sustainability and GHG reductions ▪ Ithaca College Seminar (ICSM) presentations to further engage and inform students	▪ Continued focus on promoting energy conversation awareness to impact behavioral change ▪ Increase opportunities to connect with more students and the greater Ithaca Community ▪ Staples Sustainability Funding – consider additional ways to facilitate educational opportunities and internships in partnership with IC's five schools ▪ Future ICNL Sequestration Study led by IC Faculty Researchers ▪ Sustainability Literacy – consider partnering with others to expand upon the trial assessment program ▪ United Nations Conference of the Parties - leverage current United Nations Non-Government Observer status to provide opportunities for students, faculty, and staff to engage with the international community

2.2.1 Energy Efficiency

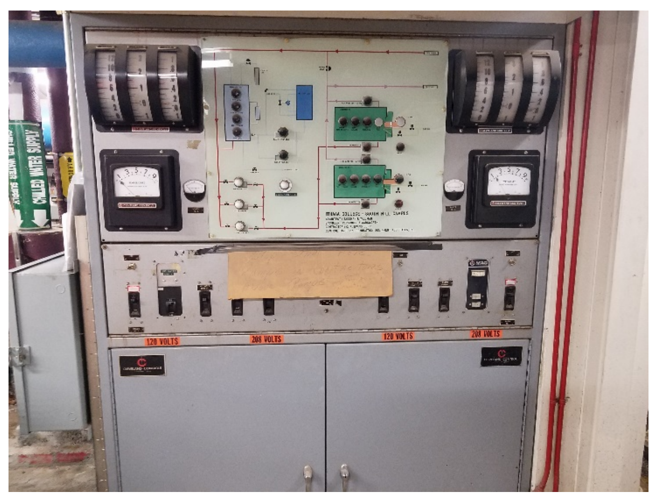
Most campus buildings were originally constructed in the 1960s and 1970s. While IC has renovated and upgraded buildings over time, many buildings still contain original HVAC systems and equipment or equipment that has been previously replaced but is now at the end of its useful life (*e.g.,* chillers and boilers). Since the CHA energy studies were completed in 2012, many energy improvement projects have been implemented including interior and exterior lighting upgrades, building automation system (BAS) integration and upgrade to direct digital control (DDC), various HVAC initiatives such as chiller and boiler replacement, air handling unit replacement, and installation of variable frequency drives on fans and pumps, as well as replacement of original single pane windows with double glazed windows.

An overview of existing conditions gleaned from previous studies, interviews with IC staff, and observations made by OBG during the walk-through survey are summarized below along with opportunities to further improve energy efficiency. Facilities personnel provided a status update of measures considered in the CHA studies as part of a gap analysis process to identify buildings where specific measures have been implemented since the studies were completed, are in the process of being implemented, are no longer being considered, or could be implemented in the future to reduce source EUI and GHG emissions.

HVAC and Controls

- Many types of HVAC systems exist across the campus including variable air volume (VAV), constant volume single zone, dual duct, and dual deck multi-zone. A geothermal heat pump (GHP) system serves Peggy Ryan Williams (PRW). Installation of GHP systems is being considered elsewhere on campus.
- A pneumatically controlled, constant volume dual duct HVAC system serves Gannett Center. This system dates to the original 1965 building construction. Dual duct systems are outdated and inefficient, and should be considered for conversion to or replacement with variable air volume (VAV) systems as part of a gut rehabilitation or major renovation. Dual duct VAV terminal boxes are available that can replace existing constant volume dual duct mixing boxes to maintain space temperature at setpoint. Fan volume control at the air handling units would be provided by variable frequency drives that modulate fan speed in response to duct static pressure.
- Condensing hot water boilers (approximately 94% rated efficiency) have been installed in several buildings as part of an ongoing initiative to replace old, inefficient boilers and boilers near end of useful life.
  - Dillingham and Gannett Center were removed from the Job Complex high temperature hot water (HTHW) boiler plant in 2016 when dedicated Patterson Kelley condensing boilers were installed in each building. Replacing the original two (2) 10,000 MBH HTHW boilers serving the Job Complex with downsized condensing boilers sized for the current heating load is being considered based on recommendations in the 2017 boiler plant study, which calls for four (4) 4,000 MBH Patterson Kelley condensing boilers.
  - Boilers serving the Circle Apartments are being replaced with Lochinvar condensing hot water boilers. The College is in the process of installing new boilers in six apartments. This project includes the installation of 80-gallon indirect domestic water heaters fed by the new boilers, and is expected to be implemented across three phases over the next 5 years.
  - Return water temperature entering condensing boilers should be below about 130°F for full condensing and highest thermal efficiency.

Old Air Handler



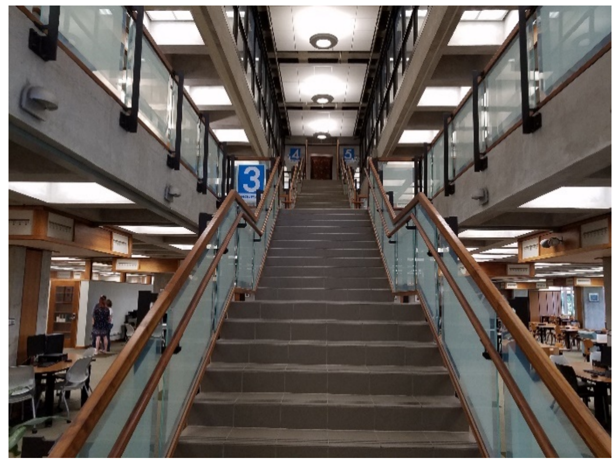
Job Boiler Control Panel

- Approximately 40% of the campus is mechanically cooled primarily by water-cooled chillers.
  - There is an ongoing initiative to replace old, inefficient constant speed chillers near the end of their useful life with new variable speed chillers. For example, a Daikin magnetic bearing chiller was recently installed in Williams Hall and York variable speed water-cooled centrifugal chillers have been installed in other buildings.
  - Chillers that use refrigerant R-22 are also candidates for replacement, as the refrigerant is subject to phase out on January 1, 2020. After that date, R-22 can no longer be manufactured or imported into the U.S.
  - Opportunities exist to replace existing chillers with high efficiency machines sized for current cooling loads (*e.g.,* Alumni Hall, CHS, CNS, Emerson Hall, Fitness Center, Job Complex, and Park Communications). New chillers should be selected to exceed the minimum full- and part-load (IPLV) performance requirements stipulated by the state energy code.
  - Most residence halls are not cooled; however, the College would like to install mechanical cooling systems in select dorms to accommodate summer programs. The Circle Apartments and Garden Apartment 29 have mini-split air conditioning units; Emerson has two Trane chillers; and Garden Apartment 25 has air-source heat pumps.
  - The campus should review the sequence of operation for cooling tower water temperature control. Chiller entering condenser water temperature should be allowed to float to a minimum temperature recommended by the manufacturer as ambient wet bulb conditions allow. This is critical to achieving peak chiller operating efficiencies, particularly on variable speed chillers operating at part load. Although the cooling tower fan would operate at higher speeds and power levels to maintain lower temperature water, this measure would improve chiller performance and result in net energy savings.
- The campus Day Automation/Andover Controls BAS provides monitoring, DDC, and energy management of HVAC systems.
  - All buildings are on the BAS, but some have very few input/output (I/O) points with limited control and energy management capabilities.
  - Pneumatic control devices are still prevalent across the campus (*e.g.,* damper and valve actuators). Pneumatic thermostats for space temperature control also exist in some buildings. Pneumatic controls are being phased out and converted to full DDC as buildings are upgraded. Replacement parts for the legacy pneumatic controls are becoming costlier with less available inventory.
  - Opportunities exist to implement or expand energy management capabilities of the BAS such as VAV system discharge air temperature and duct static pressure reset, differential pressure reset on variable speed pumping systems, heating hot water supply temperature reset, chilled water temperature reset, and condenser water temperature reset.
  - Demand controlled ventilation (DCV) has been implemented on some systems, but should be further considered particularly on single zone air handling systems that serve assembly areas such as lecture halls, auditoriums, gymnasiums, and dining halls.
  - Occupancy based controls can be installed on HVAC systems to allow for automatic setback of space temperature setpoints in unoccupied zones during normal occupied mode periods. Occupancy sensors have been installed in some VAV zones on campus to provide occupied mode setback through the BAS.
  - Expanding the BAS would increase the ability of facilities staff to diagnose and improve HVAC system operation across more of the campus through data visualization and analytics.
- The campus has made good progress installing variable frequency drives (VFDs) on cooling tower fans, air handling unit fans, and pumps (chilled water and hot water).
  - Opportunities exist to install VFDs on additional fans and pumps. For example, the College should determine if any multi-zone variable air volume (VAV) systems with inlet guide vanes for fan volume control still exist. If so, these systems would be ideal candidates for VFDs.

   - Constant volume single zone (CVSZ) systems can be converted to single zone VAV (SZVAV) by installing VFDs on the air handling unit fans and applying a temperature based control scheme to modulate airflow as heating and cooling loads change.
- Standard efficiency fan and pump motors are replaced on a regular basis with NEMA premium efficiency motors.
- Synchronized belts have been installed on approximately 17 air handling units to eliminate slippage and increase fan drive efficiency.

Interior Lighting

- Interior lighting is predominantly fluorescent throughout the campus; T8 fixtures are most prevalent, but some T5 linear fluorescent fixtures exist along with T12 fixtures in mechanical rooms. Interior HID fixtures are very limited.
- Upgrades to light-emitting diode (LED) are made as budget permits; estimated at 15 to 20% LED penetration campus wide. A proposal to upgrade lighting in CNS to LED is under consideration. This project includes retrofitting linear fluorescent fixtures with LED tubes and drivers, retaining the existing fixture housing and lens.



Gannett Library Lighting Upgrade

- Many campus buildings have limited or no automatic lighting controls. The installation of occupancy sensors appears to be building specific and based on the code requirements at the time of building construction or the most recent renovation in the building. Opportunities exist to install occupancy or vacancy sensors to automatically switch off fixtures when people are not present.
- Daylight harvesting control is limited primarily to LEED certified buildings.
- LED lighting with on-board sensing for daylight accommodation and occupancy/vacancy is recommended to provide real-time energy tuning. Implementation of onboard sensing technologies eliminates the need to install remote ceiling or wall mounted sensors or a head end control system. Onboard sensors will dim, or turn off, luminaires when enough light is available in the space and will turn off luminaires on the condition of vacancy. An additional benefit of on-board sensing is that the luminaire and the control device are of the same manufacturer and covered under a single warranty.
- Use of LED "replacement lamp style" (like TLED) should be assessed before implementing. There are several considerations for educational areas such as the directionality of the replacement lamps may not work effectively with existing luminaire reflector arrangements and can cause significant glare, uniformity problems, and over/under illumination conditions that are not in alignment with recommended practice nor conducive to student performance. Additionally, the life and efficiencies of LED luminaires are twice those realized by existing luminaires with TLED replacement lamps, maximizing energy reductions while reducing life cycle maintenance costs. Given the cost effectiveness of new LED luminaires with integral sensing technologies, taken with the improved efficiencies and life cycle benefits, replacement lamps may have limitations as a recommendation for permanent implementations.
- In spaces with high ceilings, suspended luminaires are recommended to move the luminaires closer to the area needing the light. Classroom luminaire layouts should be redesigned to accommodate use of personal electronic devices and projection. Dimming drivers and onboard sensors should be specified and "dim to off" capable to ensure effectiveness for daylight accommodation and vacancy performance.

- Opportunities exist for LED lighting upgrades and additional controls for daylighting, and bi-level occupancy controls for corridors and common areas in residence halls, where lighting fixtures typically operate continuously. If LED lighting is installed in dormitory rooms, the health impacts from elevated levels of blue light on a person's circadian rhythm should be considered.

Exterior Lighting

- Exterior lighting is being replaced gradually (and regularly) by LED technologies; estimated at 40% penetration (*e.g.,* wall packs and parking lot lighting).

- It is estimated that converting exterior lighting fixtures to LED equivalents could save approximately 950 kWh annually for a 250-Watt HID fixture and 1,500 kWh for a 400-Watt fixture, resulting in a 75% reduction in annual energy use. The campus should consider requirements to increase lighting output as part of the upgrade to comply with applicable standards (*e.g.,* to meet exterior illumination requirements for safety).

Building Envelope

- Approximately 13 campus buildings have single pane windows; East and West Towers were both recently upgraded to double glazed windows. Existing single pane windows should be replaced with high performance windows that exceed the minimum prescriptive requirements of ASHRAE Standard 90.1-2013 (and the current state energy code or code in place at the time of design) for U-factor and Solar Heat Gain Coefficient (SHGC). In addition to improved thermal and solar performance, air leakage and drafts would drop dramatically and occupant comfort would improve.

- The roofs on several residence halls have been replaced over the past 5 to 10 years. For any roof replacement project, consideration should be given to installing rigid roof deck insulation such as extruded polystyrene or polyisocyanurate at a thickness that exceeds the minimum prescriptive requirements of the energy code for R-value. Also, an ENERGY STAR rated cool roof membrane with a high solar reflectance index (SRI) and a high emissivity should be considered to further reduce summer heat gains, especially in buildings that are mechanically cooled.

- Buildings constructed prior to the introduction of energy codes likely have little to no exterior wall insulation. An Exterior Insulation and Finish System (EIFS) or rainscreen cladding system are options that could be considered on these buildings, especially when adding insulation to the interior of the wall is impractical, but these systems would change the building façade and aesthetic.

New generator for Peggy Ryan Williams and Dillingham

Laboratories

- The Center for Natural Sciences (CNS) laboratory building has been evaluated for energy efficiency improvements by GreenerU. A VAV supply and exhaust system serves laboratory space, but the laboratory air handling unit does not have an exhaust air heat recovery system to precondition outside air. The GreenerU study addresses the installation of a glycol runaround heat recovery loop to transfer heat between the laboratory exhaust air and outside air streams. Other opportunities identified in the study include control optimization on both laboratory and non-laboratory HVAC systems, lab ventilation optimization, lab freezer management, and LED lighting upgrades. These measures are addressed in the Roadmap as ECM-11 through ECM-16.

Kitchens and Dining Facilities

- Some energy efficiency improvements have been made to these facilities. For example, variable speed controls are installed on kitchen hood exhaust and makeup air systems to provide demand controlled ventilation. Other potential measures include:
  - Replace walk-in cooler and freezer evaporator motors with electronically commutated (EC) motors and fans with high efficiency blades. Evaporator controllers are also available to vary fan speed (through EC motors) in response to the refrigeration load.
  - Purchase higher efficiency cooking equipment when it is time for replacement.

Natatorium

- The natatorium in the A&E Center uses chilled water for space dehumidification and hot water for reheat. An exhaust air heat recovery system does not exist. Opportunities to improve the efficiency of the natatorium energy systems exist, but requires further study.

Other Energy Systems

- Campus data centers have Liebert computer room air conditioning (CRAC) units with direct expansion (DX) cooling and free cooling capability via a glycol dry cooler.

Building Level Sub-metering

- Electric interval meters are installed on 39 buildings, allowing IC to analyze buildings or areas on an individual basis, making it easier to manage how energy is used.
- One building, the A&E Center, is metered for natural gas. Installing additional building level gas metering will allow IC to track building level energy use and proactively address energy performance issues.
- A Water Metering Program is being implemented to better understand water use of the individual campus buildings. After meters are installed, a gap analysis is planned that will compare the sum of individual buildings water use versus the main campus water meter.
- Equipment level deep sub-metering within the buildings does not exist.

2.2.2 Resiliency

Resiliency considerations for the Roadmap center around the campus' ability to maintain safe, clean, and reliable energy sources in the face of an aging New York State energy grid infrastructure, extreme weather events, potential power outages, and system security needs. The campus should also consider reviewing plans to safely shelter students on campus during an emergency in order to proactively prepare for the unexpected.

Critical Utilities Services

- In 2017, emergency power standby generation was added to the Campus Center to utilize the facility as a place of refuge for students and faculty/staff during a power outage event on campus. The generator backs up the most critical systems for the facility, including the cafeteria, boilers, HVAC, elevators, and lighting/fire alarm systems. The data center is also backed by its own, independent emergency generator.
- In 2018, a new emergency generator was installed to provide business continuity and critical emergency services to Peggy Ryan Williams and Dillingham.
- In 2016, a medium-voltage service upgrade project included the replacement of an existing 'A2' 4,800-V feeder from the substation to the Towers Complex and the 'B2' 4,800-V feeder from the substation to the Terraces Dining Hall portion of campus. The project also included the replacement of a 4,800-V pad-mount sectionalizing switchgear at Terraces Dining Hall and the replacement of three pad-mount transformers. The upgrades will increase the reliability of the campus by repairing splices in manholes and replacing sections of duct bank that were deteriorating and prone to failure. These upgrades are also key components to the campus' master plans in the coming years to convert the campus to 12.47-kV electrical distribution.

- Secondary service entrance replacement includes the installation of a 3,000-Amp switchboard for Towers Complex and three 1,200-Amp switchboards for interior electrical distribution to the east and west Towers. Design provisions were included to easily connect a portable generator to power the Towers Complex in the event of a utility failure. Terraces Dining secondary service replacement includes new secondary feeders, the replacement of an aging lighting control system, and the relocation of the medium-voltage switchgear from the building interior to the building exterior due to safety concerns.
- Considering the campus age, it is anticipated that underground utilities (*e.g.,* water, sewer, natural gas) improvements will be needed over the next 15 years. These improvements should be considered in relation to and in support of the Strategic Master Plan. Additional water conservation and reclamation options should be considered to help the campus more fully minimize water waste.
- Information Technology (IT) actions recently added redundant incoming fiber, backup data centers, cloud storage use, and enhanced UPS equipment and emergency generators. They are also investigating improvements to make the varied computer labs more efficient by increasing the overall utilization and more efficient equipment.

Terrace Dining Hall - medium voltage service upgrade

Infrastructure Renewal

- There is an ongoing initiative to replace old, inefficient constant speed chillers near end of useful life with new variable speed chillers.
- Condensing hot water boilers have been installed in several buildings as part of an ongoing initiative to replace old, inefficient boilers and boilers near end of useful life.
- Replacement of HVAC equipment in existing buildings may require relocating building occupants during construction. Space planning for relocated occupants and other building functions would be addressed as part of campus facility master planning.
- Comprehensive upgrades to building HVAC systems would be prioritized in conjunction with overall building renovations based on annual capital funding availability.

2.2.3 Renewable Energy

Renewable and alternative energy technologies such as solar photovoltaic (PV) power generation and ground source heat pump (GSHP) systems can contribute to reducing the campus energy use and GHG emissions.

Solar farm in Geneva, NY

- In February 2018, IC began purchasing 100 percent of the college's electricity from Green-e certified national wind farms. This action will offset about 25% of IC's total GHG emissions per year. IC's current contract for wind-generated electricity runs through December 2020 and, barring unforeseen changes or availability, IC plans that future contracts will also be for exclusively renewable sources. The Geneva, NY solar array electricity is being considered as an option to offset the college's "Scope 3" emissions, which include carbon emissions associated with faculty/staff/student commuting, and directly financed outsourced air travel.
- In December 2016, Solar Liberty conducted a solar PV assessment for the Athletics Center, Emerson Hall, Hammond Health Center, Peggy Ryan Williams, and the Warehouse. Hammond Health Center is being considered by IC for solar PV as that building will undergo a future roof replacement, thus a more rational decision is to install solar PV in conjunction with the roof replacement. The other buildings are expected to receive roof replacements in approximately 10 years and may be good candidates for additional solar PV.
- IC has a 25-year virtual net metering agreement with Greenwood Energy for a 2.9 megawatt (MW) solar farm located in Geneva, NY, approximately 40 miles from campus. The project achieved commercial operation in November 2016 and generates approximately 3.4 million kilowatt-hours per year of electricity, or roughly 10% of IC's annual electricity since November 2016.
- Since the fall of 2017, IC has been actively participating in the New York Higher Education Large Scale Renewable Energy Consortium (NY HE LSRE), a coalition of 20 plus public and private institutions looking to develop large scale renewable sites within the NYISO region to further facilitate their varied environmental goals and green-house gas reduction commitments. IC is actively engaged with the consortium and has an employee on the Steering Committee. A 2020 date has been established as a target for this action to become fully realized and implemented.
- The Peggy Ryan Williams Center opened in Fall 2009 and has a ground source geothermal system that provides the building's heating and cooling capacity.
- IC is participating in the NYSERDA Geothermal Clean Energy Challenge. A NYSERDA study (December 2018) was completed to evaluate the technical and economic viability of a Campus Center Regional Ground Source Heat Pump (GSHP) Plant, which considers replacing aging HVAC infrastructure for approximately 15% of the campus with geothermal. Transformer upgrades are expected to be necessary should a regional GSHP plant move forward.
- Residential buildings may present opportunities to utilize solar thermal domestic water heating and the feasibility of this technology can be evaluated as part of future renovation projects.

2.2.4 Stewardship

Stewardship is being facilitated through many example actions and programs at IC such as:

- IC has an Office of Energy Management and Sustainability that focuses on supporting institution-wide, eco-centric projects initiated across the Ithaca College campus and strives to integrate sustainability into the institution, academics, culture, and operations. Actions and efforts are driven by the Director of Energy Management & Sustainability and the Campus Sustainability Coordinator. The development of this Energy Roadmap is a key action by this Office in helping reducing campus energy use and operating costs, increasing energy awareness, and improving operations and maintenance of building systems.
- On an annual basis following the May commencement, IC performs scheduled testing of its high voltage distribution systems.
- IC expects to develop an updated Electrical Master Plan in the near future. This would consider expansion of 12.47 kW cabling across campus and gradual elimination of the 4,800-Volt system.
- IC has developed a Deferred Maintenance plan that includes a Building Condition Index (BCI) to help prioritize capital improvements.

- IC utilizes SchoolDude (a Computerized Maintenance Management System) to track and manage assets throughout their lifecycle, which helps increase staff efficiency, provide a tool to proactively maintain equipment, maintain data integrity, and streamline communication.
- The IC policy manual states that interior building temperature set points are 69-71°F for the heating season (generally November through April) and 74-76°F for the cooling season (generally May through October). This is an environmentally responsible policy that meets applicable New York State building codes and OSHA guidelines as well as helps the college reduce its energy consumption.
- The use of portable space heaters is prohibited except where it is determined by the Office of Facilities that the building HVAC system cannot maintain the college approved temperature set point range. The Office of Facilities will provide a space heater if it is determined that one is needed. This policy better allows the Office of Facilities to determine what HVAC systems need upgrading and will reduce the excessive electrical load and potential safety hazards created by unregulated space heaters.
- New construction strives to meet Leadership in Energy and Environmental Design (LEED) Silver, or equivalent, at a minimum. The most recent phase of building construction included the A&E Center (2011) and Classroom Link both achieving LEED Gold, and the Peggy Ryan Williams Center (2009) and Park Center for Business and Sustainability achieving LEED Platinum (2008).
- IC will continue to improve building scheduling such as further enhancements to HVAC operating schedules to align with building occupancy and possibly establishing a Holiday Temperature Setback Program.
- IC is considering developing performance driven facility guidelines that are influenced by LEED for Building Operations and Maintenance (O+M), further submetering, and total cost of ownership tracking.
- IC plans to continue promotion and deployment of electric vehicle charging stations on campus.
- NYSERDA has regular program offerings that IC could consider participating in. An example is NYSERDA PON 3715 - Workforce Training: Building Operations & Maintenance which seeks to reduce energy use, associated carbon emissions, and building operations costs by enhancing the skills of operations and maintenance staff and managers through on-site training and training tools.
- IC plans to perform targeted energy audits annually to continually assess and address energy efficiency opportunities.
- IC is performing a retro-commissioning (RCx) study/energy audit for the A&E Center. RCx is considered an important strategy for maintaining efficient operation of building energy systems and achieving recurring energy savings. IC desires to establish regular RCx and continuous commissioning programs, while also working towards O&M practices centered in preventative and predictive maintenance.

  RCx can include the development or revision of documentation, such as system manuals, that describe the building operating sequences and can serve as a basis for training the technicians who operate and service the building. When performed correctly, RCx can provide significant benefits such as:

  - Improved energy performance (6% median savings achieved per LBNL Study cited below)
  - Improved equipment performance
  - Increased asset value
  - Improved thermal comfort and indoor air quality

  According to the newest (2018) research from Lawrence Berkeley National Laboratory (LBNL) and the Building Commissioning Association (BCxA), building commissioning remains a cost-effective way to improve building operations and reduce energy use. The 2018 study (https://www.energy.gov/eere/buildings/articles/new-doe-research-strengthens-business-case-building-commissioning) is an update to the 2009 LBNL study entitled "Building Commissioning – A Golden

Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions" and now includes nearly 1,500 new construction commissioning and RCx projects. Of the 684 RCx projects, 112 are higher education buildings.

Larger buildings with HVAC systems that are less than 20 years old, and those that have DDC control systems, are generally good candidates for RCx. Small buildings and those with pneumatic controls often lack the type of sensors and controls necessary to implement the type of diagnostics and functional testing that can lead to significant performance improvements. Buildings with HVAC systems older than 20 years are approaching the end of their useful design life and would most likely benefit from a more extensive HVAC renovation or system replacement, although performing RCx in these building can be beneficial if upgrades need to be deferred; additionally, RCx could help identify deficiencies that inform the energy and economic analysis of larger capital-intensive projects and selection of the most viable solutions. Buildings with very simple HVAC infrastructure and control strategies also do not benefit as much. It would be more beneficial to upgrade the HVAC systems of such buildings to include energy saving features such as economizers and VFDs, and commission the systems as part of the upgrade project.

2.2.5 Engagement

Engagement is being facilitated through many example actions and programs at IC such as:

Campus-Wide Overview

- Becoming a NYSERDA REV Campus Challenge *Leader* and striving to invest in clean energy projects, embrace clean energy curricula, and engage further in the Ithaca community.
- Achieving a STARS Silver rating under AASHE.
- Actively engaged with the New York Coalition of Sustainability in Higher Education (NYCSHE) and New York APPA (NYAPPA) where best practices in energy efficiency and conservation are regular shared and promoted.
- Annual participation and reporting with Second Nature, Sierra Cool Schools, and Princeton Green Review.
- Being members of the U.S. EPA Green Power Partners to help achieve Clean Air Act requirements by reducing the pollution and the corresponding negative health and environmental impacts associated with conventional electricity use.
- Continue to support and grow the long-term composting program on campus, and look for potential partnerships in the IC community to further expand its benefits.
- While IC continues to closely track and monitor the waste and recycling streams, investigate future opportunities to partner with faculty and students to more fully appreciate and understand the total supply cycle. This will help identify ways to reduce excessive packaging, plastics, Styrofoam, and other items that negatively impact the environment.

Student and Community Engagement

- Orientation Program – Continue to foster engagement opportunities with incoming students and their families as they begin their IC journey.
- First-Year Residential Experience (FYRE) and South Hill Energy Reduction Program (SHERP).
- Active student engagement and participation through the Eco Rep and OEMS Intern programs.
  - For the past two years IC has hired 15 students and sponsored at least one academic credit intern every year.
  - Increase opportunities to connect with more students and the greater Ithaca Community.
  - IC continues the recent trend to hire engaged students to work on special projects, events, research projects, and engagement.

- IC is helping facilitate the importance of personal choices through:
  - Providing illustrative bills for College Circle Apartment residents for peer comparative purposes and behavioral change influence.
  - Organizing campus residence hall energy competition.
  - Continuing the monthly themed Student Leadership Institute (SLI) presentations and special events, which are designed to help students develop and refine personal leadership skills.
  - Considering options to improve building sub-metering for natural gas and water combined with a true energy dashboard that is available to the entire campus community.
  - Implementing a Green Space Certification Program in conjunction with the Eco Reps and Residential Life.
- Ithaca College Seminar Series – Continue developing and delivering ICSM presentations to further engage and inform students.
- IC is considering conducting a Natural Lands Carbon Sequestration Study as part of a forest characterization curriculum research project to help the college more fully understand the true carbon benefit of the natural lands. This activity could result in an additional source of carbon offsets.

Integrative Core Curriculum (ICC) Quest 2018

ICC Eco Reps

- Staples Sustainability Funding – consider additional ways to facilitate educational opportunities and internships in partnership with IC's five schools.
- Sustainability Literacy – consider partnering with others to expand upon the trial assessment program that was rolled out during the Fall 2018 semester.
- United Nations Conference of the Parties - leverage current United Nations Non-Government Observer status to provide opportunities for students, faculty, and staff to engage with the international community.

3. ACT - ENERGY ROADMAP

The Roadmap process helped IC to align campus planning priorities, energy efficiency, and critical maintenance within a 10-year capital planning horizon to address campus stewardship along with energy and carbon reduction goals. The actions to reduce energy usage, increase energy efficiency, and decrease operating costs includes five strategic areas – ***Energy Efficiency, Resiliency, Renewable Energy, Stewardship, and Engagement***. Table 4 below provides a high-level summary of the planned actions within the five strategic areas and the GHG reduction impact.

Table 4. Energy Roadmap | Strategic Areas

ACT: *Energy Roadmap | Strategic Areas*				
ENERGY EFFICIENCY	**RESILIENCY**	**RENEWABLE ENERGY**	**STEWARDSHIP**	**ENGAGEMENT**
Low Cost/No Cost Measures	Transformer Replacement	100% Green-e certified renewable energy purchase	Campus Energy Manager	Energy Conservation Awareness and Behavioral Change
Energy Conservation Measures	Emergency Generator Upgrades	Solar PV	Retro-Commissioning	IC Natural Lands Study
Infrastructure Renewal	Geothermal Heat Pumps	Solar Thermal	Deferred Maintenance Plan	
			Updated Electrical Master Plan	
			Advanced Metering and Data Analytics	
			Workforce Development	
			IC Natural Lands Sequestration	
			Compost Program	
Approximate % Contribution to Annual GHG Reduction				
27%	11%	40%	16%	6%

3.1 SUMMARY OF ENERGY PROJECTS

The ECMs identified for the Roadmap were assessed and prioritized based on a 10-year outlook. Table 5 below includes energy efficiency and infrastructure renewal projects being considered for implementation, the estimated percent GHG reduction from 2017, and the estimated implementation timeframe. The measures reflect the campus' priorities in physical asset renewal, cost savings, capital outlay, and GHG reductions. It is noted that interactive effects between measures were not considered apart from the lighting ECMs. Energy savings for installing occupancy sensors and daylighting controls were calculated using LED lighting as the baseline condition. Also, total savings listed in the table do not account for interaction; actual savings could be lower depending on which combination of measures are ultimately implemented.

Additionally, reductions in campus energy use can also be achieved through changes in occupant behavior, increased energy awareness, improved operation and maintenance practices, and through the implementation of policies to institutionalize best energy practices at little or no additional cost. As described in sections 2.2.4 and 2.2.5 above, IC is already effecting changes in this area by engaging faculty and students, building awareness, and developing educational programs and purchasing policies.

Table 5. Energy Roadmap | Summary of Potential Energy Efficiency/Conservation Measures

ECM No.	Potential Energy Efficiency/Conservation Measure	Buildings Affected	Annual Electrical Savings (kWh/yr)	Annual Natural Gas Savings (therms/yr)	Annual Energy Cost Savings ($/yr)	Estimated Capital Cost	Simple Payback Period (years)	Annual GHG Reduction (MTCO2e)	Cost per MTCO2e Reduction	Percent GHG Reduction from FY17 Scope 1, 2 & 3 Emissions	Percent GHG Reduction from FY17 Scope 1 & 2 Emissions	Estimated Implementation Timeframe from Year 0 (years)	Notes
	Energy Efficiency												
ECM-1A	**Boiler Replacements**	Job Complex (Job Hall, Friends Hall, Textor Hall, Muller Faculty Center)	0	21,667	$11,939	$2,773,000	232.3	115	$24,102	0.5%	0.7%	1	2
ECM-1B	**Boiler Replacements**	CNS, Emerson, Garden Apts., Hammond HC, Public Safety, Williams	0	64,872	$35,744	$2,898,173	81.1	344	$8,413	1.4%	2.2%	5	1,2
ECM-1C	**Boiler Replacements**	Terraces	0	19,815	$10,918	$1,158,382	106.1	105	$11,009	0.4%	0.7%	2	2
ECM-1D	**Boiler/Water Heater Replacements**	Circle Apts. - 10 +/- per year	0	20,105	$11,078	$1,634,068	147.5	107	$15,306	0.4%	0.7%	1-5	2
ECM-1E	**Boiler Replacements - Quad**	Bogart, Clarke, Eastman, Hilliard, Holmes, Hood, Landon, Lyons, Rowland, Tallcott, Boothroyd	0	20,032	$11,038	$1,307,052	118.4	106	$12,288	0.4%	0.7%	3	2
ECM-1F	**Boiler Replacements**	Park Center for B&S, Park Communications	0	7,576	$4,174	$870,918	208.6	40	$21,649	0.2%	0.3%	7	2
ECM-2A	**Chiller Replacements**	Alumni, Emerson, Job	157,417	0	$10,075	$1,467,207	145.6	30	$49,600	0.1%	0.2%	2	2
ECM-2B	**Chiller Replacements**	CHS, CNS, Fitness Center	256,512	0	$16,304	$2,197,225	134.8	48	$45,583	0.2%	0.3%	5	2
ECM-3A	**Window Replacements**	East Tower - completed summer 2018	3,586	12,834	$16,305	$356,458	21.9	69	$5,179	0.3%	0.4%	0	2
ECM-3B	**Window Replacements**	Boothroyd, Emerson	29,151	13,058	$9,061	$400,431	44.2	75	$5,352	0.3%	0.5%	3	1,2
ECM-3C	**Window Replacements - Quad**	Bogart, Clarke, Eastman, Hilliard, Holmes, Hood, Landon, Lyons, Rowland, Tallcott	0	42,063	$23,177	$1,289,869	55.7	223	$5,775	0.9%	1.4%	3	2
ECM-4	**Roof Insulation (incremental cost at end of life replacement)**	Boothroyd, Emerson, Hammond HC	968	1,554	$918	$22,827	24.9	8.4	$2,707	0.0%	0.1%	8	2
ECM-5A	**Controls Upgrade to DDC**	Boothroyd, Gannett, Muller FC, Park Communications	114,028	11,021	$13,370	$903,552	67.6	80	$11,302	0.3%	0.5%	3	2
ECM-5B	**Controls Upgrade to DDC - Quad**	Bogart, Clarke, Eastman, Hilliard, Holmes, Hood, Landon, Lyons, Rowland, Tallcott	56,915	4,400	$6,067	$371,886	61.3	34	$10,919	0.1%	0.2%	3	2
ECM-6	**Motor Upgrades**	CHS, Gannett, Job, Smiddy, Whalen	17,270	0	$1,105	$15,048	13.6	3.2	$4,637	0.0%	0.0%	4	1
ECM-7A	**Variable Frequency Drives on AHU Fans**	Fitness Center, Friends	202,300	0	$12,947	$97,267	7.5	38	$2,559	0.2%	0.2%	5	1
ECM-7B	**Variable Frequency Drives on AHU Fans (includes DCV)**	Textor	33,400	0	$2,138	$31,579	14.8	6.3	$5,031	0.0%	0.0%	1	1
ECM-8	**Variable Frequency Drives on CHW and HW Pumps**	CHS, Dillingham, Fitness Center, Smiddy, Whalen	101,640	0	$6,505	$158,519	24.4	19	$8,300	0.1%	0.1%	4	1
ECM-9	**Synchronous Belts on AHU Fans**	CHS, Dillingham, Fitness Center, Gannett, Muller FC, Park Center for B&S, PRW	52,959	0	$3,389	$42,731	12.6	10.0	$4,294	0.0%	0.1%	2	1
ECM-10	**Lighting Fixture Retrofit/Replacement (LED with On Board Sensors) - 75% of Building GSF**	Admin. Annex, Alumni, A&E Center, Boothroyd, Campus Center, Ceracche Center, CHS, Circle Apts., Dillingham, Emerson, Facility Admin., Facilities G&S, Facility Maintenance, Fitness Center, Ford Obs., Gannett, Garden Apts., Hill Center, Hammond HC, Job Complex, Muller Chapel, Park Communications, Public Safety, PRW, Quad, Smiddy, Terraces, Terrace Dining, Towers, Towers Dining, Whalen, Williams	3,748,558	0	$239,908	$6,474,148	27.0	704	$9,191	3.0%	4.4%	0-10	1,2

ECM No.	Potential Energy Efficiency/Conservation Measure	Buildings Affected	Annual Electrical Savings (kWh/yr)	Annual Natural Gas Savings (therms/yr)	Annual Energy Cost Savings ($/yr)	Estimated Capital Cost	Simple Payback Period (years)	Annual GHG Reduction (MTCO2e)	Cost per MTCO2e Reduction	Percent GHG Reduction from FY17 Scope 1, 2 & 3 Emissions	Percent GHG Reduction from FY17 Scope 1 & 2 Emissions	Estimated Implementation Timeframe from Year 0 (years)	Notes
ECM-11	**GreenerU CNS Study - LED Lighting & Lighting Controls**	CNS	443,942	0	$28,412	$547,450	19.3	83	$6,562	0.4%	0.5%	1	3
ECM-12	**GreenerU CNS Study - Non-Lab Controls Optimization**	CNS	90,654	13,222	$13,087	$124,836	9.5	87	$1,431	0.4%	0.5%	3	3
ECM-13	**GreenerU CNS Study - Lab Controls Optimization**	CNS	88,694	0	$5,676	$73,974	13.0	17	$4,438	0.1%	0.1%	3	3
ECM-14	**GreenerU CNS Study - Lab Ventilation Optimization (includes heat recovery and DCV)**	CNS	398,915	12,518	$32,428	$514,613	15.9	141	$3,639	0.6%	0.9%	3	3
ECM-15	**GreenerU CNS Study - Lab Exhaust System Optimization**	CNS	333,132	89,862	$70,834	$2,147,940	30.3	540	$3,979	2.3%	3.4%	3	3
ECM-16	**GreenerU CNS Study - Lab Freezer Management**	CNS	8,760	0	$561	$2,000	3.6	1.6	$1,215	0.0%	0.0%	5	3
ECM-17	**Demand Controlled Ventilation - Non-Lab**	CHS, Fitness Center, Public Safety, Whalen	73,688	0	$4,716	$92,010	19.5	14	$6,645	0.1%	0.1%	4	1
ECM-18A	**Convert Dual Duct System to VAV System**	Gannett	102,000	13,550	$13,994	$217,878	15.6	91	$2,391	0.4%	0.6%	10	1
ECM-18B	**Replace Dual Deck System**	Campus Center	87,497	280	$5,754	$331,224	57.6	18	$18,474	0.1%	0.1%	3	2
ECM-19	**Heat Recovery**	Williams	5,011	14,668	$8,403	$156,000	18.6	79	$1,979	0.3%	0.5%	5	2
	SUBTOTAL		**6,406,997**	**383,097**	**$630,025**	**$28,678,263**	**45.5**	**3,238**	**$8,856**	**13.6%**	**20.4%**		
	Resiliency												
ECM-20	**Geothermal Heat Pump (GHP) System**	CNS, Park Communications, Williams	-1,863,781	317,080	$55,429	$2,480,872	44.8	1,328	$1,868	5.6%	8.4%	5	3
	SUBTOTAL		**-1,863,781**	**317,080**	**$55,429**	**$2,480,872**	**44.8**	**1,328**	**$1,868**	**5.6%**	**8.4%**		
	Renewable Energy												
ECM-21A	**Solar PV (29.76 kW DC Array)**	Hammond HC	32,921	0	$2,107	$89,280	42.4	6.2	$14,432	0.03%	0.04%	3	3
ECM-21B	**Solar PV (753 kW DC Array)**	A&E Center, Emerson, PRW, Warehouse	807,157	0	$51,658	$2,753,708	53.3	152	$18,155	0.64%	0.95%	7	3
ECM-22	**Purchase 100% Renewable Electricity**	Campus Wide (began February 2018)	0	0	$0	$102,083	NA	4,748	$21	20.0%	29.9%	0	3
	SUBTOTAL		**840,078**	**0**	**$53,765**	**$2,945,072**	**54.8**	**4,906**	**$600**	**20.6%**	**30.9%**		
	Stewardship												
ECM-23	**Retro-commissioning**	A&E Center, Campus Center, CHS, CNS, Dillingham, Emerson, Fitness Center, Gannett, Hammond HC, Hill Center, Job Complex, Park Center for B&S, Park Communications, PRW, Smiddy	1,052,597	56,418	$98,453	$287,888	2.9	497	$579	2.1%	3.1%	0-5	2
ECM-24	**Natural Lands (sequestration offsets)**	N/A	-----	-----	-----	-----	-----	680	-----	2.9%	4.3%	0	
ECM-24A	**Natural Lands (additional sequestration offsets)**	N/A	-----	-----	-----	-----	-----	680	-----	2.9%	4.3%	2	
ECM-25	**Composting**	Campus Wide	-----	-----	-----	-----	-----	70	-----			0	
	SUBTOTAL		**1,052,597**	**56,418**	**$98,453**	**$287,888**	**2.9**	**1,927**	**$149**	**7.8%**	**11.7%**		

ECM No.	Potential Energy Efficiency/Conservation Measure	Buildings Affected	Annual Electrical Savings (kWh/yr)	Annual Natural Gas Savings (therms/yr)	Annual Energy Cost Savings ($/yr)	Estimated Capital Cost	Simple Payback Period (years)	Annual GHG Reduction (MTCO2e)	Cost per MTCO2e Reduction	Percent GHG Reduction from FY17 Scope 1, 2 & 3 Emissions	Percent GHG Reduction from FY17 Scope 1 & 2 Emissions	Estimated Implementation Timeframe from Year 0 (years)	Notes
	Engagement												
ECM-26	**Energy Conservation Awareness and Behavioral Change**	Campus Wide	1,605,247	87,928	-----	-----	-----	769	-----	3.2%	4.8%	0-5	
	SUBTOTAL		**1,605,247**	**87,928**	-----	-----	-----	**769**	-----	**3.2%**	**4.8%**		
	GRAND TOTAL		**8,041,138**	**844,523**	**$837,672**	**$34,392,094**	**41.1**	**12,168**	**$2,826**	**50.9%**	**76.2%**		

Notes	
1	ECM that was previously identified in the 2012 CEA conducted by CHA and updated with revised methodologies and assumptions, if necessary.
2	ECM that was identified by OBG and was not previously identified in the 2012 CEA conducted by CHA.
3	ECM that was previously identified in a study conducted by an outside party other than the CHA CEA (i.e. Solar Liberty, Greener U, etc.).

FY 2017	Total Electric Consumption	33,331,257	kWh
FY 2017	Total Natural Gas Consumption	1,719,516	therms
FY 2017	Total Electric Cost	$2,137,827	
FY 2017	Total Natural Gas Cost	$946,690	

3.2 FACTORS IMPACTING CAMPUS OPERATIONS AND FUTURE ENERGY USE

The following factors could influence and impact the projects listed in Table 5 relative to campus operations and future energy use:

- The Institutional Strategic Plan that commenced in Fall, 2018
- Campus growth in terms of new buildings, additions, or space consolidation
- Changes in enrollment and residential student body
- Demand for cooling in buildings that do not have it, that have window units, or are already cooled but use of the space is increasing
- Natural lands carbon sequestration study.

Energy conservation measures generally involve capital expenditures that have short to moderate payback periods and are focused on driving near term reductions in EUI, sometimes referred to as "low hanging fruit". Even with a portfolio of completed energy projects and actions, it has become increasingly difficult to achieve additional deep energy savings without making significant capital investments. Careful consideration is required before investing in ECMs that affect systems and controls that are at or near the end of their effective useful life, as is the case with much of the legacy infrastructure at IC. The short-term savings need to be weighed against the long-term cost effectiveness if the buildings they serve are destined for overall renovation in the foreseeable future.

Long Term Infrastructure Renewal – Energy improvements to systems and equipment that have reached the end of their effective life need to address system/equipment replacement to maintain the comfort, health, and safety of building occupants. This requires major renovation and significant capital investment resulting in longer term payback periods than ECM projects. However, in addition to the energy savings, these projects provide the benefits associated with newer systems and infrastructure.

Conversely, a major infrastructure improvement project whose primary purpose is to modernize aging and end-of-life building components, and upgrade or repurpose the space presents a distinct opportunity to incorporate and improve energy efficiency that might otherwise have been deferred. When evaluating the economic impact of improving energy efficiency, an approach that only considers the incremental cost of the energy measures is suggested since the cost of the major renovation is primarily to address infrastructure renewal that is inevitable.

3.3 GREENHOUSE GAS EMISSIONS REDUCTION IMPACT

The business-as-usual GHG emissions trajectory represents the projected GHG emissions from current levels if no actions were taken to reduce energy use. The business-as-usual GHG emissions trajectory was estimated assuming no increase in GSF or energy consumption from current levels through 2030.

Figure 1 below depicts the estimated GHG reduction impact of the energy projects based on planned implementation timeframes, and progress towards the 2025 interim goal of 50% reduction in GHG emissions from 2007 levels. As shown in Figure 1, IC could expect to achieve a 50% reduction in GHG emissions by 2022 from specific impacts of energy efficiency/conservation measures including the purchase of 100% Green-e certified renewable energy electricity, LED lighting improvements, additional ICNL sequestration offsets, and energy conservation awareness and behavioral change.

Implementing the full list of efficiency/conservation measures in Table 5 could potentially result in a 65% reduction in GHG emissions from baseline year 2007 by 2030, not considering the impact of measures that have interactive effects or that are mutually exclusive. The continued purchase of 100% Green-e certified renewable energy is an important commitment to achieve and maintain GHG emissions reductions presented in Table 5. Should IC discontinue this purchase, alternative energy and GHG emissions reduction strategies would need to be evaluated.

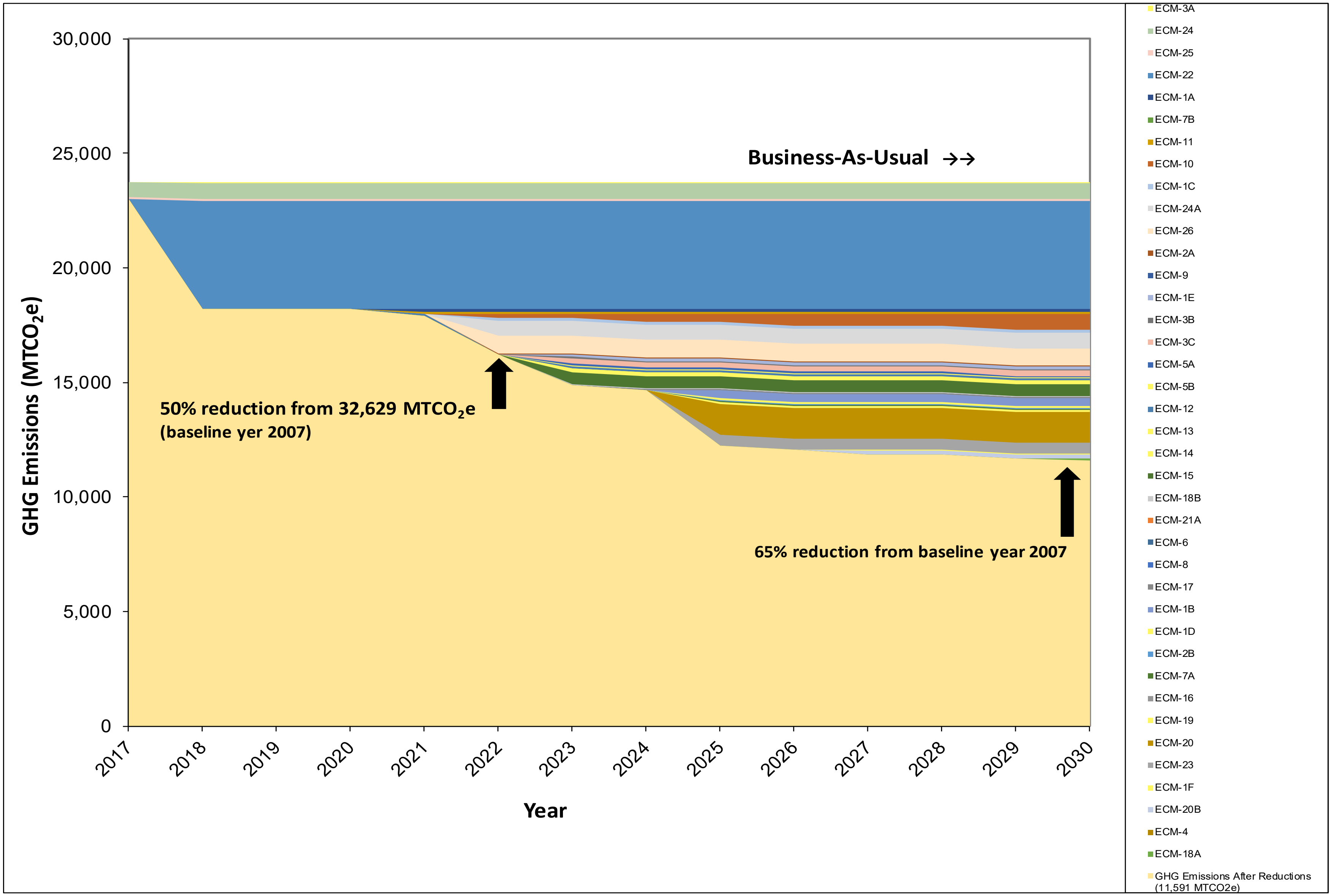


Figure 1. Ithaca College Stabilization Wedge Diagram

4. ACHIEVE – IMPLEMENTATION PLAN

IC's engagement and input were essential to developing a Roadmap that is realistic and implementable in a cost-effective manner while potentially expediting the current 2050 carbon neutrality goal. Table 6 below provides a summary of the three key components that will help IC implement the Roadmap and realize the goals of reducing energy usage, decreasing operating costs, and addressing critical maintenance. A broader discussion of these areas immediately follows Table 6.

Table 6. Roadmap Implementation Plan Summary

ACHIEVE: Implementation Plan

Funding	Implementation Team and Partners	Policies and Procedures
▪ Capital Budget Deferred Maintenance Program ▪ Energy Conservation Account ▪ PAR Program ▪ Energy Performance Contracting ▪ Grants/incentives/rebates	**IC Team** ▪ Athletic Department ▪ CAP Reassessment Team ▪ Dining Services ▪ Energy Management & Sustainability ▪ Faculty ▪ Information Technology ▪ Office of Business and Finance ▪ Office of Facilities ▪ Office of Provost ▪ Office of Public Safety and Emergency Management ▪ Office of Student Engagement and Multicultural Affairs ▪ Procurement ▪ Residential Life ▪ Senior Leadership Team ▪ Strategic Planning Committee ▪ Student Government ▪ Student Body ▪ Other engaged and interested campus partners **Partners** ▪ Greater Ithaca and Tompkins County Communities ▪ NYCSHE ▪ Consultants and Contractors ▪ NYSEG ▪ NYSERDA	▪ New Construction and Renovation Design and Engineering Standards ▪ Energy and Environmental Conservation policies ▪ Education/Engagement to promote behavioral change ▪ Incorporate into the recently started Strategic Planning process ▪ Town of Ithaca Green Building Policy

4.1 FUNDING

The College is reviewing the possibility of expediting the previously approved 2050 climate neutrality date, and will need to carefully consider an acceptable plan and the economic impact. Several options have been discussed within the Climate Action Plan Reassessment Team, including:

- Monetizing the value of carbon and obtaining senior leadership support to include this in financial decisions.
- Establishing a Green Fund that can facilitate energy efficient and carbon reduction projects. The College could also consider providing stipends to faculty to further facilitate the incorporation of sustainability themes in course content.
- Energy performance contracting.
- Continue to take advantage of NYSERDA, NYPA, and other grant funding programs.
- Consider the potential for allowing students to choose a "carbon free" education; a very high-level concept that would need further development through establishing an IC committee to assess.
- Consider developing an internal carbon tax, possibly in alignment with providing the educational schools and large departments a more direct understanding and control of their utility budgets.

While the actual costs for achieving carbon neutrality remain undefined, scientific consensus suggests that limiting climate change requires substantial and sustained reductions in greenhouse gas emissions. The Climate Action Plan Reassessment Team recommends 2030 as a new date for carbon neutrality, though this will require significant support from IC's engaged faculty and students in helping the college more fully appreciate the full cost impact for an earlier date compared to the standard "business as usual" approach.

4.2 IMPLEMENTATION TEAM AND PARTNERS

The College will need to be fully engaged and transparent with the entire IC campus community to achieve the needed support to expedite the current 2050 carbon neutrality goal. IC is fortunate to have many highly interested and engaged supporters and partners throughout the entire community, a number of which are listed in the Table 6. Periodic reports and/or public meetings are considerations to keep persons informed and engaged.

4.3 POLICIES AND PROCEDURES

The College should consider using this Energy Roadmap and the potential for an expedited carbon neutrality goal to help inform the strategic plan. A direct connection to the college's mission, vision, and values are important in sustaining support.

4.4 KEYS TO SUCCESS

Keys to successfully implement the Energy Roadmap include:

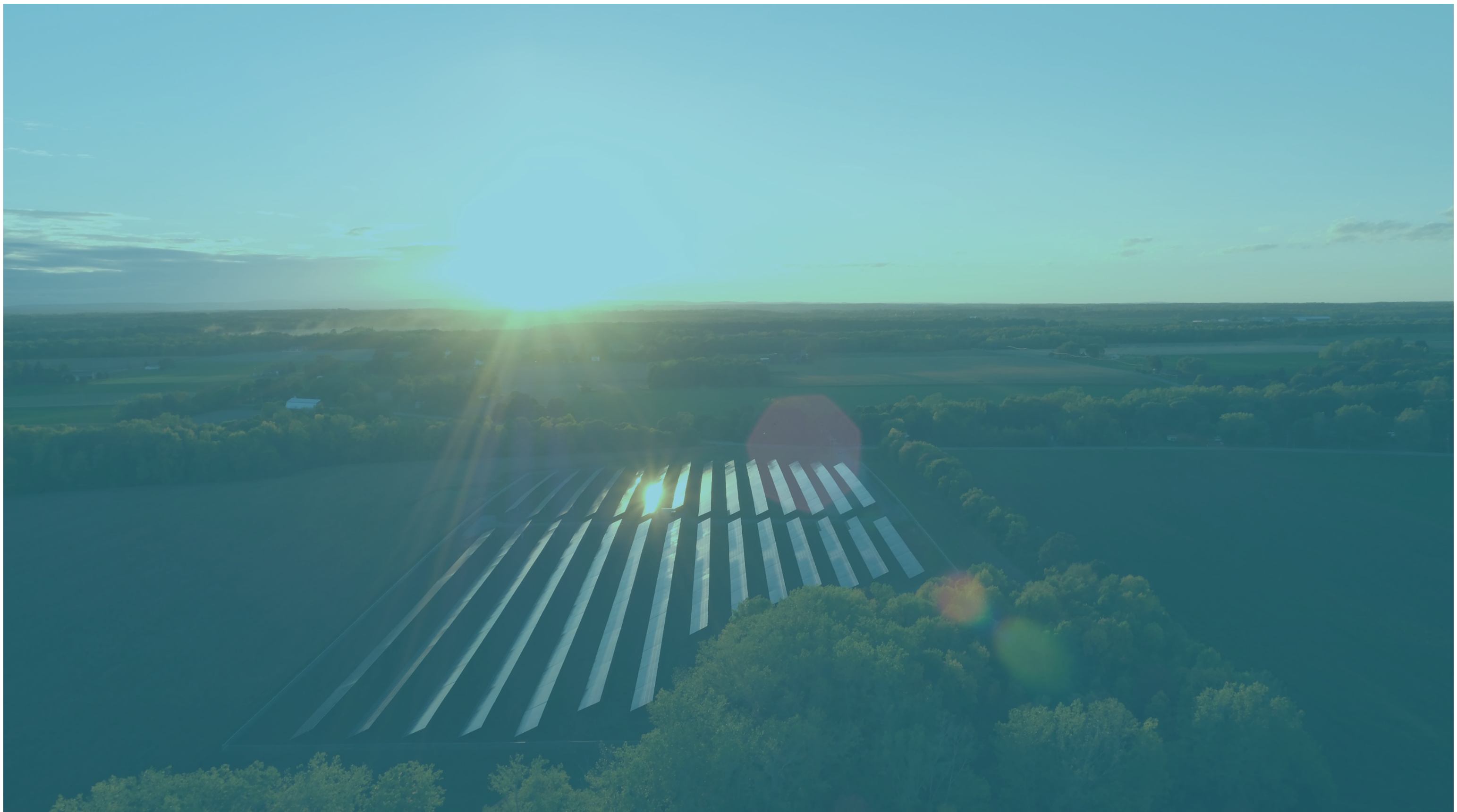
- Help inform and be an integral part of the strategic plan that is being developed.
- Faculty research and student projects focused on the overall impact of a national or internal carbon tax, and the true cost of carbon including viable mitigation strategies.
- Developing an internal Green Fund to more fully consider the economic impact of a "greener" approach versus the traditional "business as usual" approach.
- Periodic Sustainability Progress reports, with a high-level summary dashboard overview that clearly illustrates the critical metrics.
- Consider occasional updates from the senior leadership team during the All College Gatherings and similar public events.

4.5 KEY PERFORMANCE INDICATORS

Key Performance Indicators that can be used to measure progress and impact can include:

- Annual GHG emissions monitored in CO_2e
- Periodic sustainability reports with a high-level dashboard executive overview summary
- Financial impact (*e.g.*, project costs, energy and cost savings, return on investment, annual net cash flow, $/MT$CO_2e$ reduced)
- Dollars invested in infrastructure renewal
- Positive Behavioral Changes / Dashboard
- Potential student learning opportunities
- Operations & maintenance savings
- Student/staff/faculty perception/feedback
- Student Sustainability Assessment on issues related to energy
- Non-energy benefits including improvements in occupant comfort, reliability, and resiliency
- Achievement of sustainability goals
- Participation and recognition with AASHE STARS, Second Nature, NYCSHE, TCCPI, and other engaged organizations and ranking systems.

Jump Start G.R.E.E.N. Tour



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