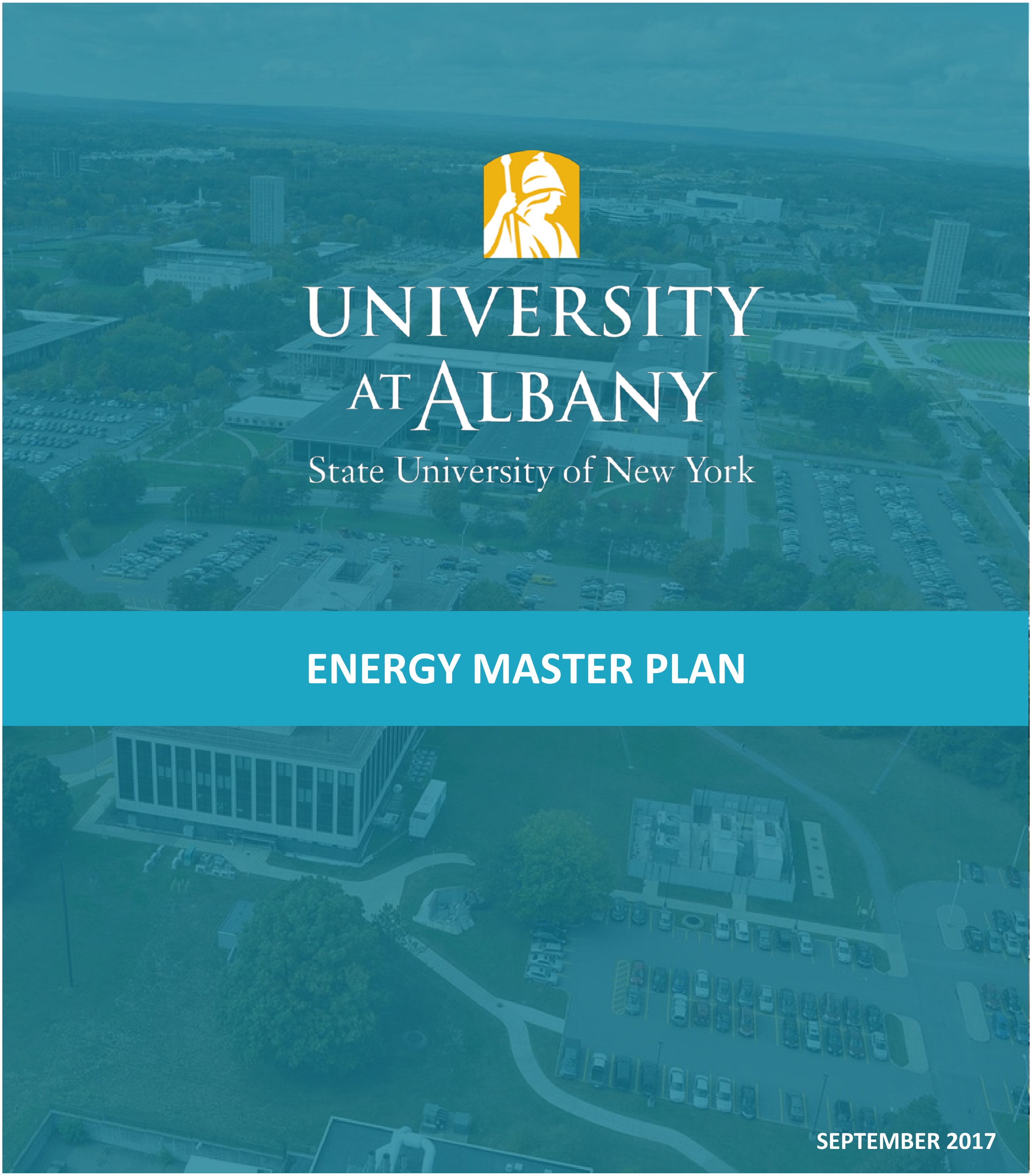

UNIVERSITY AT ALBANY

State University of New York

ENERGY MASTER PLAN

SEPTEMBER 2017

OBG

A 10-year planning horizon that is realistic, implementable, and cost effective

Incorporating resiliency to maintain reliable, flexible, and affordable facility operations

Achieving energy reductions through energy efficiency, infrastructure renewal, and stewardship of physical assets centered in preventative and predictive maintenance

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ACKNOWLEDGEMENTS

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1. PURPOSE, PRINCIPLES, & COMMITMENT

1.1 PURPOSE

University at Albany (UAlbany) has developed an Energy Master Plan (EMP) for its Uptown and Downtown campuses in response to ***BUILD SMART NY***, New York Governor Andrew Cuomo's program for aggressively pursuing energy efficiency in New York State government buildings, while advancing economic growth, environmental protection, and energy security in New York State (NYS). Executive Order 88 (EO 88) is the centerpiece of Build Smart NY and mandates reducing statewide energy use (building source energy use intensity (EUI)) by 20% by the year 2020 compared to the baseline year of 2010. EUI is commonly measured in thousands of Btu (kBtu) per gross square foot of building area. EO 88 aims to accomplish this goal through energy analysis, benchmarking, energy assessments, and implementation of campus-wide EMP.

1.2 GUIDING PRINCIPLES AND APPROACH

The EMP is a roadmap of actions to reduce energy usage, increase energy efficiency, and decrease operating costs for UAlbany. Equally important, the EMP supports UAlbany's capital plan for asset renewal, reliability, and resiliency, which collectively enables UAlbany to address campus stewardship and environmental sustainability in a pragmatic and cost-effective manner.

The EMP approach was a deliberate and collaborative process that allowed for discovery of key issues, strategic thinking of best practices, and creative implementation strategies for identified opportunities. Engagement and thought leadership from the Office of Facilities Management, including Campus Planning, Architecture Engineering & Construction Management, Physical Plant, and Energy Management, were critical to producing an EMP that could be accepted, financed, and implemented.

Three principles have shaped the development of UAlbany's EMP:

1. A Plan that is Realistic, Implementable, and Flexible
    a. Long-term plan with two important horizons. Energy reductions to *Meet EO 88* and *Beyond EO 88*
    b. Energy savings strategies that reflect campus priorities: Energy Efficiency, Resiliency, Renewable Energy, and Optimized Operations & Maintenance
    c. Cost effective financing and contracting to implement the plan within a 10-year timeframe
2. Achieving Energy Reductions through Infrastructure Renewal and Stewardship of Physical Assets
    a. Capital planning and modernization of campus buildings
    b. Addressing deferred maintenance
    c. Establishing O&M practices centered in preventative and predictive maintenance, rather than reactive maintenance
    d. Tied to the Facilities Master Plan (Perkins & Will, 2012)
3. Resiliency Planning for the Future
    a. Manage potential utility supply disruptions and price volatility to maintain reliable, flexible, and affordable facility operations
    b. Incorporate technologies such as CHP, renewable energy, and demand response management to achieve deep energy savings
    c. Tied to UAlbany's Climate Action Plan and Sustainability Initiatives

1.3 UALBANY COMMITMENTS TO SUSTAINABILITY

Outside of EO 88 requirements to reduce energy use intensity, UAlbany has taken other public actions that demonstrate our commitment to energy conservation and environmental sustainability. UAlbany is a STARS Gold rated higher education institution under AASHE (Association for the Advancement of Sustainability in Higher Education) **https://stars.aashe.org/institutions/university-at-albany-ny/report/2016-01-15/**

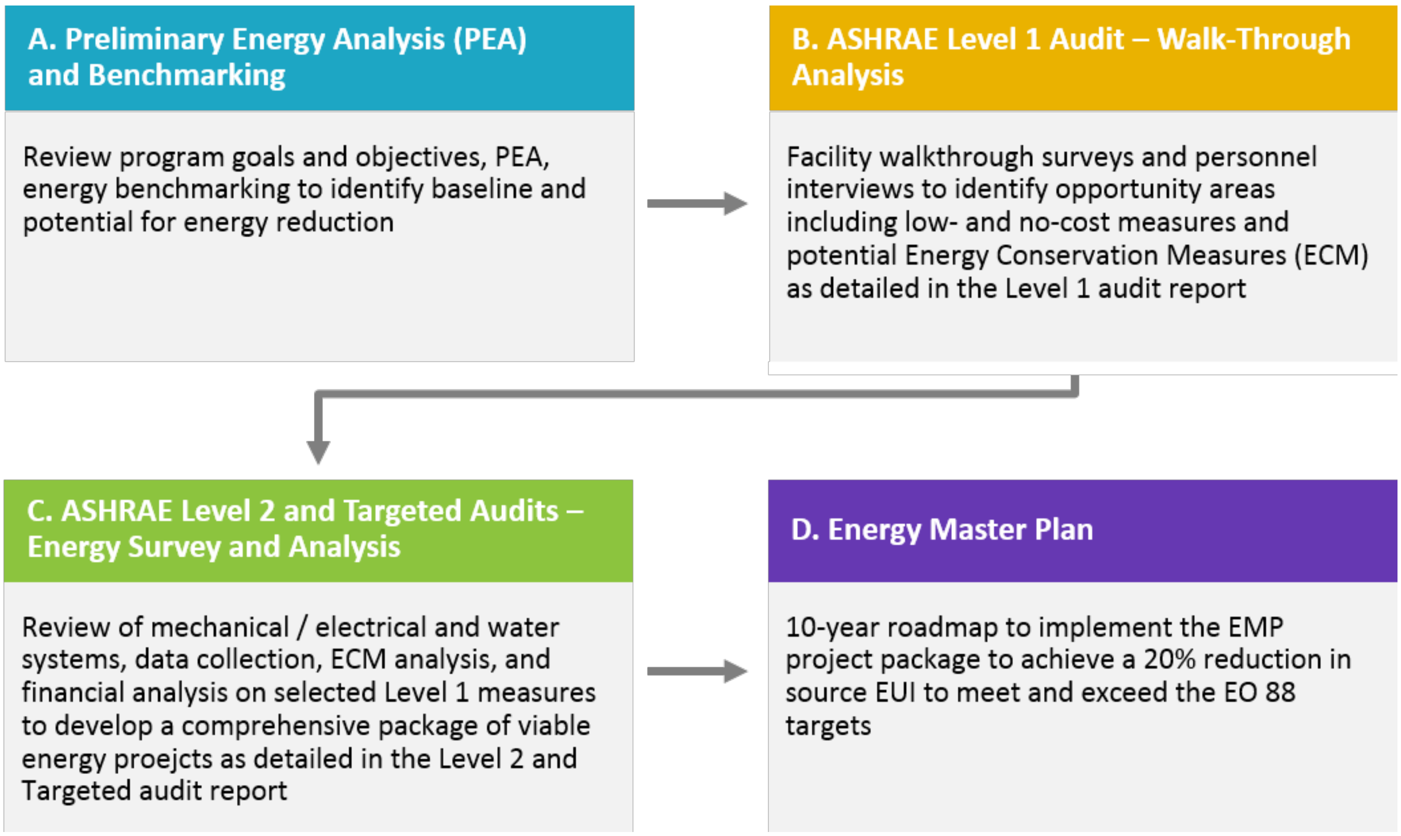
UAlbany has also committed to carbon neutrality and climate resiliency through Second Nature's Climate Commitment (**http://secondnature.org/what-we-do/climate-leadership/**).

Throughout the development of the EMP, stakeholders were engaged to provide input, perspective, review, opinion, and consensus on energy projects planned over the next 10 years. The UAlbany community can be inspired that this plan demonstrates our commitment to our facilities, our constituents who use those facilities, and to the planet.

http://www.UAlbanyphotos.com/Campus/Fall-on-campus/i-hsR9zr8

2. ASSESS – EXISTING CONDITIONS AND OPPORTUNTIES

The EMP started with an assessment of existing conditions and opportunities to understand the broad picture of "where are we now" relative to our energy program. The illustration below depicts the key steps that led to the development of the EMP.



UAlbany approached the development of the EMP project in two phases. Phase 1 included a Preliminary Energy Analysis (PEA), benchmarking, and an American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Level 1 Energy Audit. The results of those collective efforts were summarized in an ASHRAE Level 1 Energy Audit Report issued on April 17, 2014. During Phase 1, over (70) buildings, along with the central heating and cooling plant, were assessed for potential energy efficiency improvement opportunities. Field observations of buildings and systems, and review of historical energy data trends identified (30) energy conversation measures (ECMs) that warranted further analysis under Phase 2.

Phase 2 included ASHRAE Level 2 Energy Audits and Targeted Audits of the (30) measures, which included detailed information about existing conditions, recommended actions, project purpose, estimated energy savings, estimated project costs, and implementation considerations. The results of the Level 2 and Target Audits were summarized in a ASHRAE Level 2 Energy Audit report issued on January 5, 2017. This effort was a critical step for UAlbany's discussion and creation of a 10-year Energy Master Plan.

2.1 UALBANY ANNUAL ENERGY USAGE AND EUI

EO 88 mandates a 20 percent reduction in the source EUI of New York state buildings by 2020, compared to the baseline year of 2010. Table 1 below provides a year over year summary of UAlbany's EUI from state fiscal year (SFY) 2010-2011 (baseline) through 2015-2016. Annual EUI reductions have been varied over the past six years, but the total energy use on campus has remained constant even with 8.5% increase in square footage and growth in academic programs. This is attributed to UAlbany's proactive approach in undertaking energy projects and actions over the past 10 years including:

- Mechanical System Upgrades at Life Science Research Building, University Library, Performing Arts Center, Humanities, Alumni Quad, and Downtown academic campus
- Lighting and Lighting Control System Upgrades at University Library, Science Library, Fine Arts, SEFCU Arena, Downtown academic buildings, and exterior roadway, parking lots and pedestrian pathway lighting
- Various building automation system upgrades and installation of new electric, chilled water, and high temperature hot water meters
- High levels of energy efficiency and inclusion of renewable energy systems in new construction projects to meet UAlbany's High Performance Design Guidelines

Table 1. UAlbany Annual Energy and EUI Summary

Year	Floor Area (GSF)[1]	Elec (MWH)[2]	NG (DKTHM)[2]	No. 2 Fuel Oil (Mgal)[2]	No. 4 Fuel Oil (Mgal)[2]	Propane (gal)[2]	Water/Sewer (Mgal)[2]	Source Energy (kBtu/yr.)[3]	Source EUI[3] (Kbtu/SF-yr.)	Source EUI Reduction (% of Baseline)
2010-2011	**5,045,254**	**69,980**	**465,269**	**114.4**	**13.67**	**-**	**232,881**	**1,302,595,448**	**258.2**	**Baseline Value**
2011-2012	5,045,254	72,283	428,547	29.0	-	1,003	181,122	1,276,569,833	253.0	**2.0%**
2012-2013	5,352,907	73,155	453,423	12.4	-	3,720	209,719	1,310,485,231	244.8	**5.5%**
2013-2014	5,474,508	75,238	525,962	8.0	-	5,734	217,246	1,409,743,225	257.5	**0.3%**
2014-2015	5,474,508	73,106	495,304	152.5	-	3,053	198,738	1,373,251,106	250.8	**2.9%**
2015-2016	5,474,508	72,978	445,988	65.2	-	974	195,045	1,307,783,782	238.9	**8.1%**

Notes:

[1]Building GSF values from UAlbany Physical Space Inventory (PSI).

[2]Energy and water consumption obtained from EnergyCAP for the period from April 1 to March 31.

[3]Source energy and source EUI (Energy Use Intensity) values have been calculated using conversion factors in Build Smart NY Guidelines. EUI values presented herein are not normalized for weather and non-weather factors that may impact energy usage.

2.2 EXISTING CONDITIONS AND OPPORTUNITIES

The collective efforts of Phases 1 and 2 are summarized in . Provided therein are the primary observations and opportunities in four energy areas important to UAlbany: energy efficiency, resiliency, renewable energy, and stewardship. Further detailed discussion of these areas immediately follows the table.

Table 2. Existing Conditions and Opportunities

ASSESS: *Existing Conditions and Opportunities*

ENERGY EFFICENCY

Dual Duct HVAC Systems
- Outdated and inefficient
- VAV upgrade potential

HTHW
System distribution improvement Opportunities

Chilled Water
Advanced controls optimization and variable primary pumping opportunities

Interior Lighting
- Fluorescent fixtures, limited controls
- LED fixtures and advanced controls opportunities

Building Automation System
- Multiple independent platforms
- Legacy equipment
- Proprietary network communication protocols
- Supervisory integrated control system opportunity

Interior Lighting
- Metal halide, high pressure sodium, limited controls
- LED fixtures and advanced controls opportunities

Building Level Submetering
- Buildings metered for electric interval data
- Chilled water meters at academic buildings
- Building level HTHW metering opportunity

Laboratories
- Constant volume hoods operating 24/7
- Oversized and uncontrolled support utility systems
- Hood retrofits and control upgrade opportunities

Kitchens
- Continuous operation of exhaust and supply fans
- Once through condenser cooling
- Water and energy reduction opportunities

Building Envelope
Single pane windows and uninsulated walls

Water
- Low flow fixture opportunity
- Additional metering needs

RESILIENCY

Critical Utilities Services
- Substation upgrade
- Two new electrical feeders planned to provide redundancy and future growth capacity
- Natural gas supply availability

Distributed Energy Resources (DER)
- Microgrid potential
- Combined Heat and Power (CHP) Feasibility Study completed
- Demand response and generation capacity

Infrastructure Renewal
- 50+ years old original mechanical systems beyond end of useful life
- Disruption to normal operations during system repair / replacement
- Prioritizing deferred maintenance based on funding availability

RENEWABLE ENERGY

Solar PV
- 49.8 kW at Social Sciences
- 27.5 kW at Campus Center West Addition
- 1.7 MW project proposed for Academic Podium

Geothermal Heat Pumps
- Existing Liberty Terrace apartments
- New ETEC Building

Solar Thermal
Potential for domestic water heating in future residential renovation projects

STEWARDSHIP

Campus Energy Officer
Well established role and function

Office of Sustainability
Responsible for education and engagement

Continuous Commissioning (CCx) and Existing Building Commissioning (EBCx)
- Services currently outsourced
- Instrumentation, Controls and Commissioning (ICC) shop established in 2016

Energy Policies and Guidelines
- High Performance Building Guidelines
- Space Temperature Setpoint Policy
- Winter Intersession Energy Initiative policy
- Air Handling Unit Scheduling Policy

2012 Facility Master Plan
- Uptown and Downtown Campus plans
- New construction and renovation considerations
- Provides guidance to the EMP process

Maintenance Strategy
- Assetworks AiM platform for Computerized Maintenance Management System (CMMS)
- Continuous development of preventative and predictive program

The ASHRAE Level 2 audit efforts identified four strategic areas with 32% in combined potential energy savings to achieve and exceed the EO 88 target. The impact of these strategies on the UAlbany site and source energy consumption is presented in Table 3 below. It is noted that Table 3 summarizes the source energy reduction opportunity potential, while Table 5 in the Energy Master Plan Program section identifies the impact to source energy reduction from a subset of specific projects that UAlbany plans to implement to meet EO88 targets.

Table 3. EMP Savings Strategy Summary

	Electrical (kWh/yr.)	Natural Gas (therm/yr.)	Source Energy (kBtu/yr.)	Percentage of Baseline Source Energy[4]
2010-2011 UAlbany Baseline[1]	69,979,850	4,652,685	1,302,595,448	100%
Estimated Energy Savings				
Energy Efficiency	9,280,000	1,250,000	236,590,000	18%
Resiliency[2]	36,500,000	(2,760,000)	126,850,000	10%
Renewable Energy	1,970,000	0	22,450,000	2%
Stewardship[3]	1,400,000	90,000	25,690,000	2%
Total[5]	**49,150,000**	**(1,420,000)**	**411,580,000**	**32%**

Notes:
[1] Represents updated campus metrics for April 2010 – March 2011 not included in original EO 88 reporting.
[2] CHP savings based on a 4.6 MW gas combustion turbine generator with exhaust heat recovery.
[3] Conservative O&M savings estimate of approximately 2%.
[4] Conversion factors for site to source energy are taken from the EO 88 Guidelines.
[5] Rolled-up energy savings do not account for increases or decreases resulting from measure interactions.

2.2.1 Energy Efficiency

The Uptown Campus includes many buildings that were constructed in the 1960's, while the Downtown Campus buildings were constructed in early 1900's through 1929. While UAlbany has renovated and upgraded some of these buildings, most of the buildings still contain original HVAC systems and equipment. General observations of the existing conditions based on the Phase I on-site assessment activities are summarized below.

Uptown Campus Residence Halls

- Original building HVAC systems are at the end of their effective useful life.
- Buildings with original mechanical systems and single pane glazing were observed with many open windows during heating season leading to energy waste as well as occupant discomfort. Buildings with renovated mechanical systems (improved zone controls) and dual pane thermal glazing were observed with fewer open windows than buildings without similar renovations.
- In buildings that have not been renovated, limited heating zone control results in wide swings in space temperatures and poor occupant comfort.
- Lighting in corridors and common area is on 24 hours per day, 7 days per week with no provisions for varying light levels with changing occupancy schedules and ambient lighting conditions.

Uptown Campus Academic Podium Buildings

- Most buildings have single pane exterior window glazing.
- Original dual duct HVAC system relies upon simultaneous heating and cooling of hot deck and cold deck air streams during much of the year. High pressure supply air fans consume excessive motor energy and ductwork is prone to excessive air leakage. Hot water heating terminal equipment lacks zone control valves. Original pneumatic controls are obsolete.

- Laboratory hood supply and exhaust fans in science buildings (except LSRB) operate continuously at constant volume with little or no duty cycling based on occupancy or actual lab hood requirements.
- Supplemental laboratory support equipment including chillers, air compressors, and steam generators appear to be oversized and operate uncontrolled.
- Lighting has been upgraded to T8 fluorescent fixtures, but opportunities exist for light-emitting diode (LED) lighting upgrades and additional controls for daylighting, and bi-level occupancy controls for corridors and common areas.
- Lighting levels and wattage in areas served by “palm frond” light fixtures appear to exceed recommended maximum lighting standards.

Uptown Campus Athletic Facilities

- Athletic field lighting operating schedules include many hours with limited usage.
- Interior lighting is mostly T12 and metal halide.
- The new stadium has a variable refrigerant volume (VRV) cooling system that has been in operation since the fall of 2013. Campus facilities staff is observing the performance of this newer cooling technology to see if it may have applicability elsewhere on campus.

Uptown Campus Central Utility Plant

- The central chillers and High Temperature Hot Water (HTHW) generators serving the Uptown Campus present several opportunities where energy could be more effectively utilized.
- The HTHW distribution piping can be modified to reduce flow restriction and the associated dynamic head losses that can reduce pumping energy required at the heating plant.
- UAlbany is investigating chilled water energy efficiency opportunities, including variable primary pumping and advanced optimization controls, as part of an upgrade to the chiller plant infrastructure and controls.

Uptown Campus Building Automation System (BAS)

- The building automation system (BAS) currently consists of separate systems for building automation, central plant controls and energy monitoring. The existing systems utilize legacy controllers and proprietary platforms that require the campus to maintain expensive annual service contracts for system maintenance.
- Existing setup is not conducive to advanced data analytics that can allow for optimized and proactive operation, demand response load shedding, and integrated alarm management. The campus is investigating a supervisory integrated control system and BacNet open protocol network controls to address these issues.

Downtown Campus Alumni Quad

http://www.UAlbanyphotos.com/Campus/Architecture/Alumni-Quad/i-

- Heating system in Sayles Hall was upgraded with new boilers and controls in 2011.
- Unitary HVAC controls and lack of central BAS in other buildings require manual operation.
- Original slate roofs are in poor condition with excessive air leakage from occupied space to unconditioned attic.
- Most existing windows are single pane.
- Metal halide and high pressure sodium site lighting is in poor condition. UAlbany has started and should continue the process of replacing the exterior fixtures with LED.

Downtown Campus Academic Buildings

- Existing lighting includes fluorescent fixtures with T8 and T12 lamps and minimal occupancy controls.
- Space cooling with older, inefficient window units does not allow for centralized control.
- There is limited building automation outside of Husted Hall.
- Building heating systems are a mix of steam and hot water systems.

Building Level Submetering

- All buildings are sub-metered for electricity and most residential buildings are metered for potable water.
- Academic buildings have chilled water meters but the data is not collected or trended in a consistent manner. The total chilled water supplied to the campus is metered and trended at the central plant.
- High Temperature Hot Water (HTHW) is metered at the plant but building level meters do not exist.
- Installing HTHW meters in all buildings and integrating all meters, including electric, potable water, chilled water and HTHW into one platform will allow UAlbany to track building level source EUI and proactively address energy performance issues.

Kitchens and Dining Facilities

- With the recently completed renovations to State and Indian Quad kitchens and dining facilities, and with Dutch Quad dining coming off line in 2017, only Colonial and Alumni Quad facilities remain to be renovated.
- Energy efficiency improvements should be considered as part of the design of renovations to Colonial and Alumni Quad kitchens and dining halls.
- Sodexo issued a Kitchen Audit Report in January 2016 that identified water, energy, and cost savings recommendations for UAlbany kitchens including:
  - Replace ice machine once-through water cooling with a chilled water loop.
  - Install variable speed hood controls on the Colonial and Alumni kitchen hoods for exhaust and makeup air.
  - Schedule kitchen hood exhaust fans and air handling units OFF during unoccupied hours.
  - Purchase higher efficiency cooking equipment when it is time for replacement.
  - Replace walk-in cooler evaporator motors with electronically commutated motors and fans with high efficiency blades.
  - Retrofit hand spray nozzles with new high efficiency reduced flow models.

Water Conservation

- OBG conducted a water audit for purposes of understanding water allocation usage of residential dormitories, kitchens, and the power plant; benchmarking against peers; and identifying water conservation measures. To reduce water usage on campus, the May 2017 report provided the following recommendations:
  - Install low flow fixtures in residence halls that have not been updated.
  - Continue to monitor the existing building level meters using the BMS to identify excessive increases that need to be further investigated.
  - Replace once through cooling water for domestic water booster pumps in Eastman, Livingston and Stuyvesant towers with variable speed pumping systems similar to Mohawk Tower in Indian Quad.

2.2.2 Resiliency

Resiliency considerations for the EMP 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.

Critical Utilities Services

- The Uptown campus houses nearly 7,000 students, and has a highly reliable electric substation and an ongoing major substation upgrade (with New York State Office of General Services (NYS OGS) that will provide N+2 redundancy and future growth capacity.
- Natural gas supply at the east gate is essential to campus operations. UAlbany regularly considers supply service capacities and believes that it is currently adequate for planned new construction and EMP projects.

Infrastructure Renewal

- Original HVAC systems are beyond the end of their useful life and require extensive upgrades or replacement for continued use of the buildings.
- Replacement of HVAC equipment in existing buildings requires relocating building occupants during construction. Space planning for relocated occupants and other building functions would be addressed as part of long 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.

Distributed Energy Resources

- Combined Heat and Power (CHP) projects can provide dramatic reductions in source energy by eliminating the generation and transmission losses from the utility generating plant while offsetting campus heating and cooling loads by using waste heat from a gas turbine or internal combustion engine generating system.
- The August 2015 study identified a CHP plant with a 4.6 megawatt (MW) gas combustion turbine generator as the preferred CHP prime mover. The CHP plant will provide resiliency benefits through backup power during an outage, as well as contribute significantly to baseline source energy reduction.
- UAlbany is moving forward with 30% design on this project and will continue through 100% design and construction if the project is deemed financially viable and technically feasible.

2.2.3 Renewable Energy

Renewable and alternative energy technologies such as solar photovoltaic (PV) power generation can contribute to reducing the campus source energy use intensity by offsetting utility grid electrical generation inefficiencies and transmission losses.

UAlbany conducted a screening assessment of several candidate sites for solar PV power at the Uptown Campus and identified the Academic Podium roof system as a potential location for a 1.7 MW solar PV array. While the PV array will only reduce source energy by approximately 2.0%, it will help the University work toward its renewable energy goals, generate Renewable Energy Credits (RECS) on campus and satisfy the growing demands from the student population to advance sustainable energy on campus. The University will continue to integrate renewable energy into new construction and major renovation projects, where feasible.

The Liberty Terrace 500 bed apartment-style living complex successfully demonstrated the benefits of a geothermal (or ground source) heat pump HVAC system at UAlbany. Geothermal heating and cooling is also being included in the new ETEC building, which uses modular heat recovery chillers. As future new construction or campus renovations are planned, UAlbany will continue to assess and include geothermal where practical and economically feasible.

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

UAlbany has a dedicated Campus Energy Manager with responsibility to develop, implement, manage and monitor campus energy programs, including the development of the EMP. This role is critical to reducing campus energy use and operating costs, increasing energy awareness, and improving operations & maintenance of building systems. UAlbany also has a well-established Office of Sustainability with responsibility to integrate sustainability into curriculum, operations, research, education and engagement.

UAlbany developed a 10-year Facility Master Plan (FMP) in 2012 to guide future development and renewal of UAlbany's physical environment. One of its guiding principles is to achieve responsibility and stewardship in the management of UAlbany's physical and capital resources. The FMP provided insight on existing conditions, building renovation requirements, and space needs, and the impact of population growth and facilities expansion plans on the potential expansion and upgrade of campus infrastructure systems.

The Office of Facilities Management, supported by the Campus Energy Manager, will continue to facilitate Stewardship through the following actions:

- Establish a supervisory integrated control system to conduct advanced data analytics for optimized and proactive operation, demand response load shedding, and integrated alarm management. Sustain the recently created instrumentation, controls and commissioning (ICC) shop to manage the campus BAS and Electric Power Monitoring System (EPMS) that control and meter HVAC and lighting equipment on campus. Internal staff will reduce the need for outside resources and respond to abnormal conditions by proactively addressing the underlying issues to eliminate comfort complaints and energy waste.
- Follow the High Performance Building Guidelines to achieve high levels of energy and sustainability in all new construction, major renovation and gut rehabilitation projects.
- Continue to assess and implement internal energy use policies and strategies such as building shutdown during winter intersession, Green IT and Sustainable Lab initiatives.
- Utilize AssetWorks (a Computerized Maintenance Management System) to track and manage assets throughout their lifecycle, which will help increase staff efficiency, provide a tool to proactively maintain equipment, maintain data integrity, and streamline communication.
- Refer to the 2012 FMP for insight on planned building renovations, space needs, population growth, and facilities expansion plans that could potentially impact the expansion and upgrade of campus energy and infrastructure systems.
- Invest in workforce development through trainings and certification programs to build a base of highly skilled and knowledgeable facility operators to maintain the energy performance of buildings with newer technologies.

3. ACT – ENERGY MASTER PLAN PROGRAM

The EMP process enabled UAlbany to align campus planning priorities, energy efficiency, and critical maintenance within a 10-year capital planning horizon to address campus stewardship and environmental sustainability in a pragmatic and cost-effective manner. The roadmap of actions to reduce energy usage, increase energy efficiency, and decrease operating costs includes four strategic areas – ***Energy Efficiency, Resiliency, Renewable Energy, and Stewardship***. Table 4 below provides a high-level summary of the planned actions within the four strategic areas, followed by a summary of approved and funded projects, and the expected EUI reduction impact.

Table 4. EMP Program | Strategic Areas

ACT: *Energy Master Plan Program*			
ENERGY EFFICENCY	RESILIENCY	RENEWABLE ENERGY	STEWARDSHIP
Low cost / no cost measures Existing building commissioning	**Combined Heat and Power (CHP)**	**Solar PV**	**Advanced Metering and Data Analytics**
ECMs / IR Projects ▪ HVAC upgrades ▪ Controls upgrades ▪ Lighting upgrades ▪ Kitchen equipment improvements	**Infrastructure Renewal**	**Geothermal Heat Pumps**	**Asset Management**
Water conservation		**Solar Thermal**	**Integrated monitoring of utilities and building systems**
			Instrumentation, Controls and Commissioning Shop
			Workforce Development
% Contribution to Total Source kBtu Reduction			
42%	**40%**	**7%**	**11%**

3.1 SUMMARY OF APPROVED AND FUNDED ENERGY PROJECTS

The (30) Energy Conservation Measures (ECMs) developed under the ASHRAE Level 2 and Targeted audits were assessed and prioritized based on a 10-year outlook. UAlbany considered two important planning horizons for energy reductions; *Meeting EO 88* (short-term actions through 2022) and *Beyond EO 88* (long-term actions through 2027). Table 5 below identifies the measures planned for implementation. The measures reflect the campus' priorities in EUI reduction, cost savings, capital outlay, sustainability, and physical asset renewal. Additional selection criteria included end-use satisfaction, level of disruption, and the risk of not doing the project.

Table 5. EMP | Summary of Approved and Funded Energy Projects

UNIVERSITY AT ALBANY
State University of New York

Baseline Information (2010-11)	
Baseline kbtu/yr	1,302,595,448
Baseline sq ft	5,045,254
Baseline EUI	258.2
Baseline Emissions (CO2-eq MT)	52,337
$/kWh (7-Yr Avg)	$0.0808
$/therm (7-Yr Avg)	$0.6686

ECM/TA No.	Recommended ECM	Buildings Affected	Electrical Savings (kWh/yr.)	Natural Gas Savings (therm/yr.)	Energy Cost Savings ($/yr.)	Estimated Project Cost	Backlog, Infrastructure Renewal portion	Net Impact on Utility Budget ($/yr)	Simple Payback Period (yrs)	Source Energy Reduction (kBtu/yr)	Source Energy Reduction (% of 2010)	Emissions reduction (CO2-eq MT)	% CO_2e Reduction	Funding Source
Energy Efficiency														
ECM-12B	Lighting Upgrade - Fine Arts Building	Fine Arts	102,000	0	$8,000	$424,000			53.0	1,200,000	0.1%	53	0.1%	Capital
ECM-12C	Lighting Controls - University Library	University Library	369,000	0	$30,000	$40,000			1.3	4,200,000	0.3%	193	0.4%	Capital
ECM-10C	Incorporate HTHW Distribution System Monitoring	Uptown Campus	0	212,000	$142,000	$660,000		$92,000	4.6	22,200,000	1.7%	1,127	2.2%	Financed
ECM-5	Building HVAC and Controls Upgrades	Campus Wide	205,000	87,000	$75,000	$1,600,000	$960,000	($47,000)	21.3	11,400,000	0.9%	570	1.1%	Financed
ECM-15	LSRB Exhaust Fan Controls-EBCx	LSRB	860,000	0	$69,000	$1,100,000		($15,000)	15.9	9,800,000	0.8%	450	0.9%	Financed
ECM-1B	Demand Controlled Laboratory Ventilation-LSRB Vivarium	LSRB	281,000	16,000	$33,000	$440,000		($600)	13.3	4,900,000	0.4%	232	0.4%	Financed
TA-7	Site Lighting Upgrades - MH to LED	Uptown, Downtown & AQ	1,360,000	0	$110,000	$2,600,000	$2,600,000	($88,000)	23.6	15,500,000	1.2%	711	1.4%	Financed
ECM-12E/F	Lighting Upgrade - Uptown Campus Corridor and Stairway	Arts & Science, Biology, Chemistry, Earth Science, Education, Humanities, Physics and Social Sciences	627,000	0	$51,000	$4,600,000		($300,000)	90.2	7,100,000	0.5%	328	0.6%	Financed
ECM-11	Lighting Upgrade - Athletic Building	SEFCU, Phys Ed, Bubble	629,000	0	$51,000	$1,700,000	$1,700,000	($79,000)	33.3	7,200,000	0.6%	329	0.6%	Financed
ECM-1C	Chemistry AHU upgrade w/VSD/BAS/Exhaust Fan Controls	Chemistry	1,430,000	130,000	$200,000	$1,370,000	$1,370,000	$95,000	10.0	29,900,000	2.3%	1,439	2.7%	Financed
ECM-1	Laboratory (113) Fume Hood Upgrades - Chemistry	Chemistry	0	0	$0	$620,000		($47,000)				0	0.0%	Financed
ECM-3B	Air Handling Unit Upgrade (VSD/BAS Retrofit)-PE (no cooling)	Phys Ed	230,000	50,000	$52,000	$1,500,000	$1,500,000	($62,000)	28.8	7,900,000	0.6%	386	0.7%	Financed
ECM-12A	Lighting Upgrade - Lecture Center	Lecture Center	273,000	0	$22,000	$810,000			36.8	3,100,000	0.2%	143	0.3%	Capital
ECM-3A	VAV HVAC System Retrofit	Lecture Center	560,000	45,000	$75,000	$7,400,000	$7,400,000		98.7	11,100,000	0.9%	532	1.0%	Capital
		Subtotal	**6,930,000**	**540,000**	$920,000	**$24,900,000**	**$15,500,000**	($450,000)	**27.1**	**135,500,000**	**10.4%**	**6,491**	**12.4%**	
Resiliency														
Task 7	4.6 MW Combined Heat and Power Plant incl. Empire Commons on Campus Grid	Uptown Campus	**36,500,000**	(2,760,000)	$1,100,000	**$18,311,000**	**$5,400,000**	($126,000)	**16.6**	**126,850,000**	**9.7%**	**4,417**	**8.4%**	Financed
Renewable														
ECM-20	1.7 MW Solar Photovoltaic Array	Podium Roof	**1,970,000**	**0**	**$159,000**	**$4,320,000**		($171,000)	**27.2**	**22,450,000**	**1.7%**	**1,030**	**2.0%**	Financed/PPA
Stewardship														
ECM-9	HTHW Pump Seal Water Cooling	Power Plant	-4,500	0	-$400	$120,000		($9,600)	-300.0	-100,000	0.0%	-2	0.0%	O&M
TA-9	Kitchen Equipment Efficiency Improvements	SQ, CQ, IQ, AQ	363,000	167,000	$141,000	$360,000		$114,000	2.6	21,600,000	1.7%	1,077	2.1%	O&M
ECM-16	Existing Building Commissioning (EBCx)	University Hall, Arts & Sciences, Science Library, Husted Hall (Downtown Campus)	394,000	76,000	$83,000	$141,000	$85,000	$72,000	1.7	12,400,000	1.0%	607	0.9%	O&M
		Subtotal	**752,500**	**243,000**	**$223,600**	**$621,000**	**$85,000**	**$176,400**	**2.8**	**33,900,000**	**2.6%**	**1,682**	**3.0%**	
		GRAND TOTAL	**46,150,000**	**(1,977,000)**	**$2,400,000**	**$48,150,000**	**$20,985,000**	**($570,000)**	**20.1**	**318,700,000**	**24.5%**	**13,621**	**25.8%**	

Notes

1. Net cash flow represents the annual financial impact to UAlbany for implementing the portfolio of energy measures and considers both estimated utility cost savings and costs for financing the projects over a 15-year term at an interest rate of 1.8%.
2. Backlog infrastructure renewal portion represents the portion of the project that is associated with addressing infrastructure renewal that is inevitable.
3. Based on project implementation negotiations between UAlbany and NYPA, some Estimated Project Cost values have changed since the publishing of the ASHRAE Level 2 Audit Report (January 2017).

3.2 FACTORS IMPACTING CAMPUS OPERATIONS AND FUTURE ENERGY USE

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

- Campus growth in terms of new buildings/space
- New academic programs including the engineering school
- Demand for four-season cooling
- Demand for cooling in residential and athletic facilities
- Growth in enrollment and residential student body

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". While the proactive energy projects and actions summarized previously have resulted in significant decreases in energy usage, 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 UAlbany. 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 needs 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.

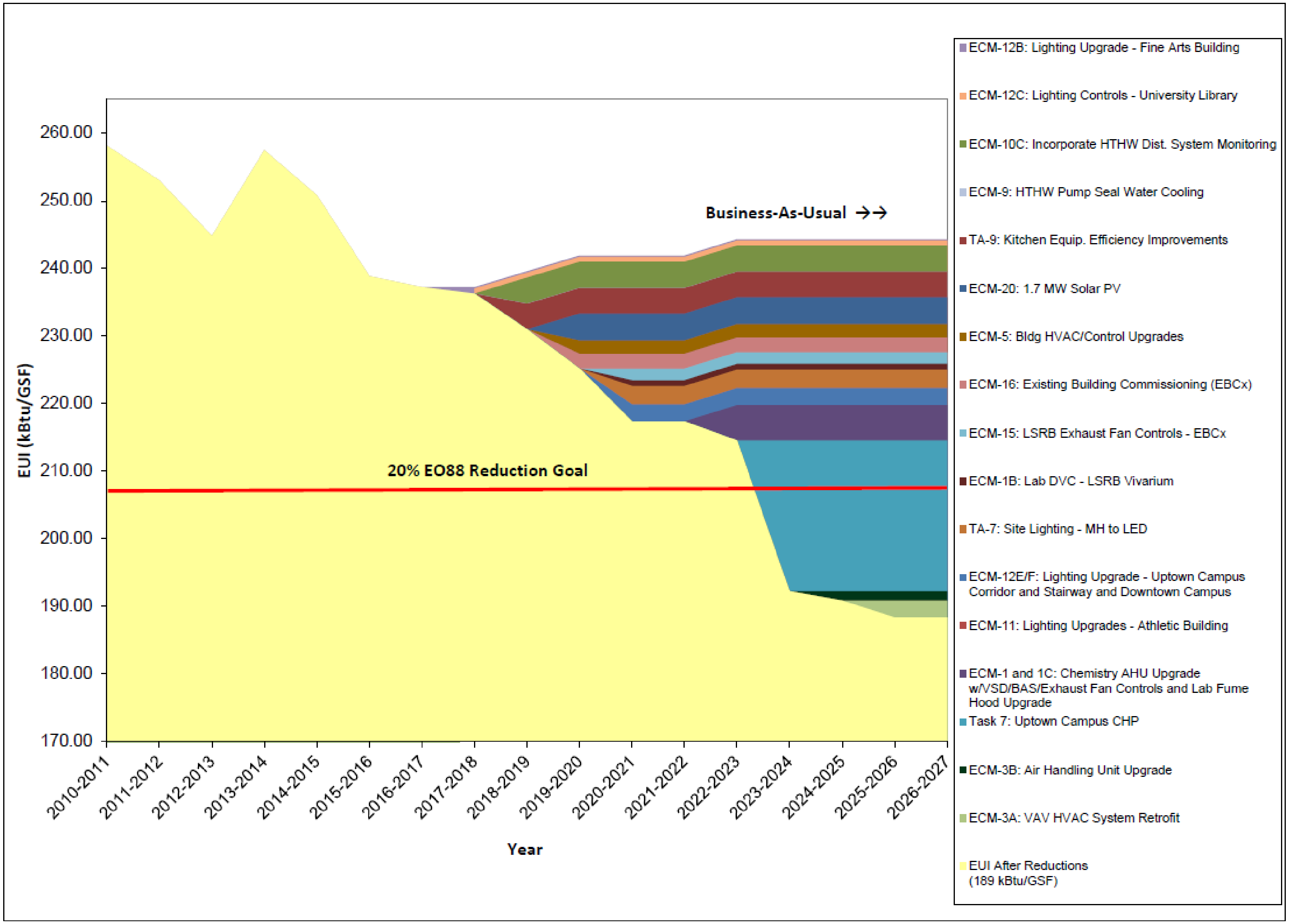
Conversely, a major infrastructure improvement project whose primary purpose is to modernize aging and end-of-life building components, and upgrade or repurpose the space presents a distinct opportunity to incorporate and improve energy efficiency that might otherwise have been deferred.

When considering the economic impact of improving energy efficiency, only the incremental cost of the energy measures should be considered as the cost of the major renovation is primarily to address infrastructure renewal that is inevitable.

3.3 ENERGY USE INTENSITY REDUCTION IMPACT

Figure 1 below depicts the estimated EUI reduction impact of the energy projects based on planned implementation dates. It is noted that the EUI has decreased from 258 kBtu/GSF in SFY 2010-2011 to 237 kBtu/GSF in SFY 2016-2017. The business-as-usual trajectory includes the predicted growth in campus gross square feet and associated projected energy consumption from current levels if no actions were taken to reduce energy use. The gross square feet is projected to increase approximately 4% by 2027, with a corresponding projected 7% increase in energy usage during that same time frame. The EUI under this scenario is projected to increase 2% from SF 2017-2018 through 2019-2020 and another 1% through 2026-27.

Figure 1. UAlbany Stabilization Wedge Diagram: Energy Efficiency Actions through 2027 by Measure



With a source EUI of 258 kBtu/GSF for baseline SFY 2010-2011, UAlbany must reduce annual source EUI by 52 kBtu/GSF to achieve a 20% reduction. As of SFY 2015-2016, UAlbany has successfully implemented energy projects outside of the EMP to reduce its EUI. However, projected campus growth through SFY 2026-27 is estimated to increase business-as-usual campus EUI unless the EMP projects are implemented as planned. The planned energy projects have inherent complexity that require calendar time to advance through the phases of pre-design, design, procurement, and construction. Therefore, UAlbany anticipates achieving the EO 88 EUI reduction target by SFY 2023. Additional energy projects that UAlbany plans to implement over the next 10 years will reduce the annual source EUI further to 189 kBtu/GSF, or approximately 27% from the baseline by 2027. A summary is presented in Table 6 below.

Table 6. Energy Use Intensity Reduction Projection

Year	Campus EUI Business-As Usual	Campus EUI with EMP Implementation	% EUI Reduction from Baseline with EMP Implementation
SFY 2010-11	258.2		
SFY 2015-16	238.9	238.9	7.5%
SFY2019-20	241.9	225.2	12%
SFY2022-23	244.3	190.9	26%
SFY2026-27	244.3	189	27%

Further, it is noted that UAlbany is investigating chilled water energy efficiency opportunities, including variable primary pumping and advanced optimization controls, as part of an upgrade to the chiller plant infrastructure and controls. The project is currently in the design phase, and while energy savings estimates have not been developed to date, a considerable energy reduction is expected from these upgrades.

The CHP project noted in Table 5 provides the single largest EUI reduction of approximately 10%. This project will move to a 30% design phase in 2017-2018 where its economic viability will be assessed before UAlbany determines whether the project will advance to 100% design and implementation. If the CHP project does not advance, UAlbany will re-prioritize additional projects in its place towards the 20% EUI reduction goal.

4. ACHIEVE – IMPLEMENTATION PLAN

UAlbany's engagement and thought leadership throughout the Energy Master Plan process were critical to developing an EMP that is implementable in a realistic and cost-effective manner. Table 7 below provides a summary of the three key components that will allow UAlbany to implement the EMP and realize the goals of reducing energy usage, decreasing operating costs, and addressing critical maintenance. A broader discussion of these areas immediately follows.

Table 7. EMP Implementation Plan Summary

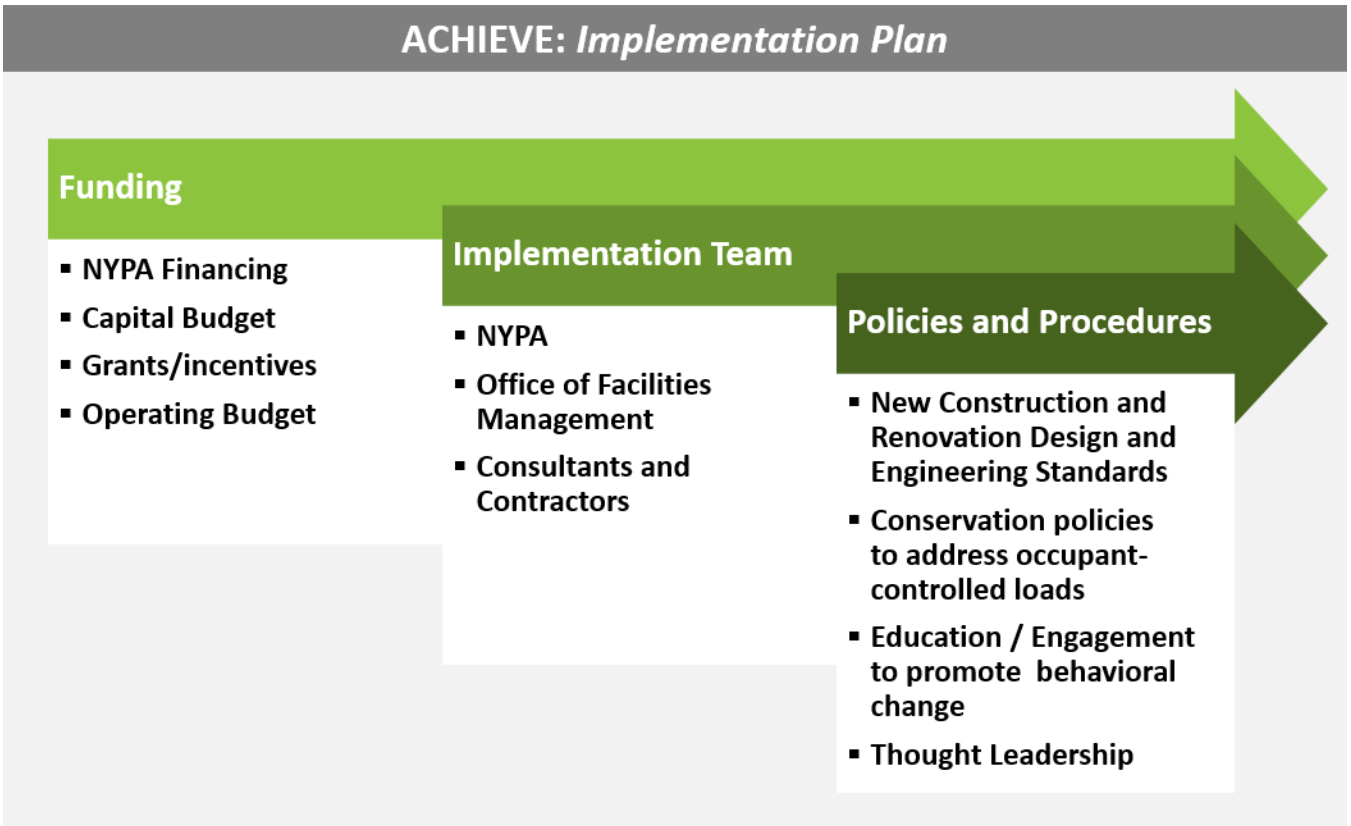
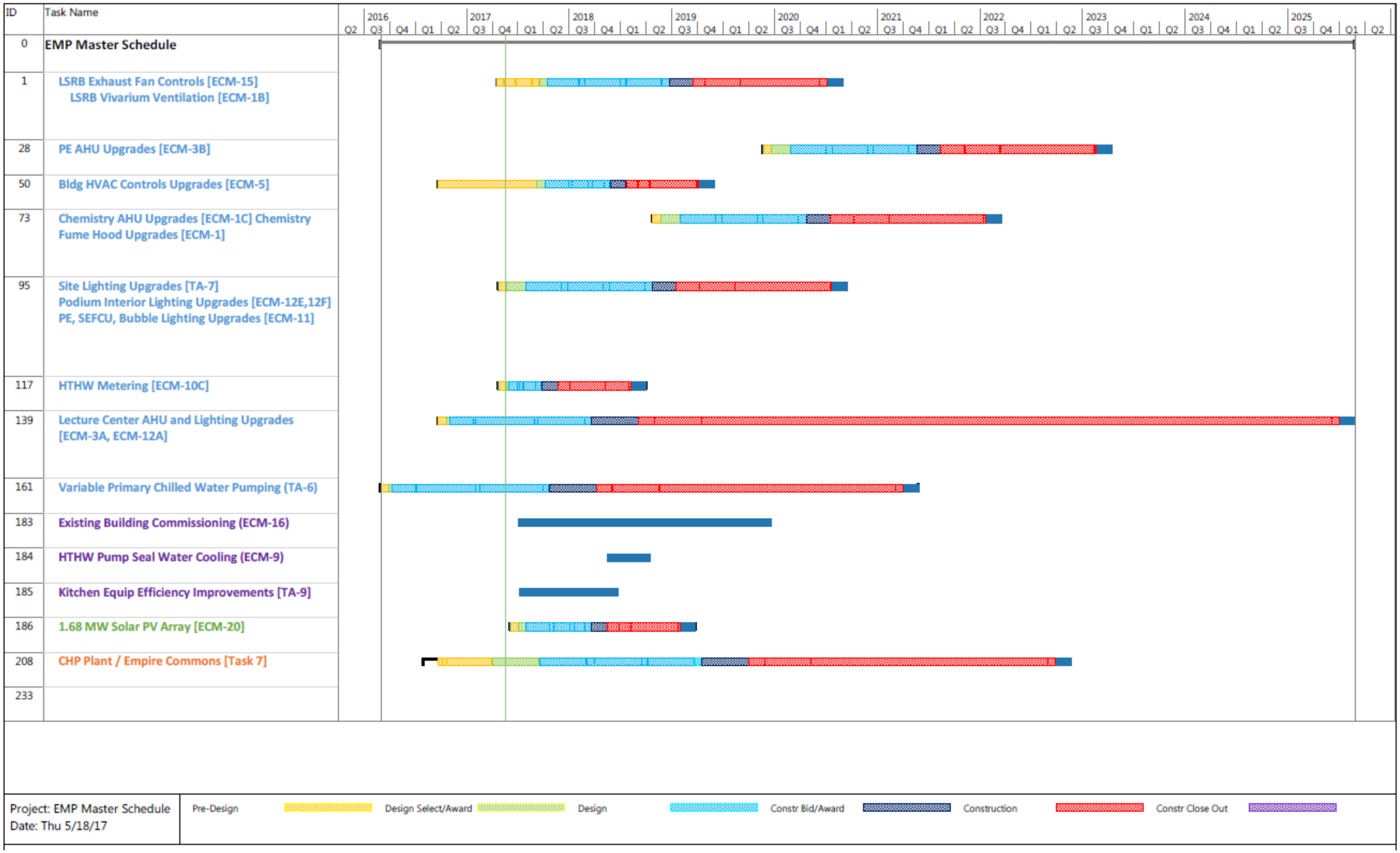


Figure 2 below is a detailed implementation schedule for the energy projects identified in Table 5. The schedule considers the many phases of the project implementation from pre-design to construction close-out. While the majority of projects will be designed before 2020, many will not be fully constructed until after 2020. Implementation considerations will routinely include project funding, occupied buildings logistics, and the need for transitional space.

Figure 2. UAlbany Implementation Schedule



4.1 FUNDING

The projects summarized in Table 5 have an estimated project cost of approximately $48 million. Of that amount, approximately $8.7 million is funded through ongoing or completed capital projects. UAlbany senior administration approved approximately $36 million for implementation of the EMP projects using NYPA financing with a net annual utility budget increase of no more than $500,000 per year for 15 years to fund the project package. This leaves a shortfall of $3 million which will be managed through value engineering and proactive planning and implementation at the individual project level to bring the EMP package within the approved funding limits.

UAlbany, like many other SUNY campuses, has capital improvement needs outside of energy efficiency, and projects compete for limited available capital funding. To ensure a consistent funding stream to implement the EMP, UAlbany engaged the New York Power Authority (NYPA) to provide low-interest financing for most of the EMP projects. NYPA financed project will be paid back from UAlbany's utility budget. Smaller projects that are not financed by NYPA will be implemented using campus cash and operating monies.

UAlbany will assess Capital Budgets from the NYS Governor's Office annually for potential contribution to the EMP goals. Grants and incentives from utility providers, New York State Energy Research and Development Authority (NYSERDA) and Federal agencies will be monitored for potential funding offsets.

4.2 IMPLEMENTATION TEAM

UAlbany has several contracting mechanisms to implement energy efficiency projects, but the primary mechanism will be through NYPA, who will provide turnkey implementation services on many of the EMP projects. NYPA will utilize consultants on term agreement for design and construction management on the projects and will procure construction services through a public bid process. On complex projects, such as CHP, NYPA will procure design services through a solicitation process. Projects that are not implemented by NYPA will be implemented by the campus using in-house resources via design-bid-build process. The EMP approval included the addition of 2.0 FTE to manage the implementation of the projects. UAlbany also has term consultants under contract who can be utilized for design and construction management. Administration of the EMP will be performed by the Campus Energy Officer with support from Architecture Engineering & Construction Management.

4.3 POLICIES AND PROCEDURES

The growth in campus footprint and student enrollment as well as the demand for more services including, extended building schedules, four-season cooling and increased air-conditioning, necessitates the need for careful planning to address the increased demands in a thoughtful and sustainable manner. New construction and major renovation projects provide an excellent opportunity to incorporate the highest levels of energy and sustainability to significantly impact the overall campus EUI. Education, engagement and outreach play an increasingly important role to curb occupant-controlled energy use in buildings, which has seen an increase with the proliferation of connected devices on college campuses. Senior leadership support is crucial to ensure that campus constituents' wish lists are weighed against the backdrop of our commitment to energy use and carbon emissions reductions. Carefully thought-out policies and procedures can ensure that we continue to meet both the needs of the campus and our energy reduction goals.

4.4 KEYS TO SUCCESS

Keys to successfully implement the EMP include:

- Continued support from senior administration on energy efficiency and sustainability goals
- Availability of NYPA financing at a reasonable interest rate to fund the projects

- Adequate administrative and technical resource allocation to manage the design and implementation of the projects
- Investment in campus O&M staff to maintain the energy performance of projects

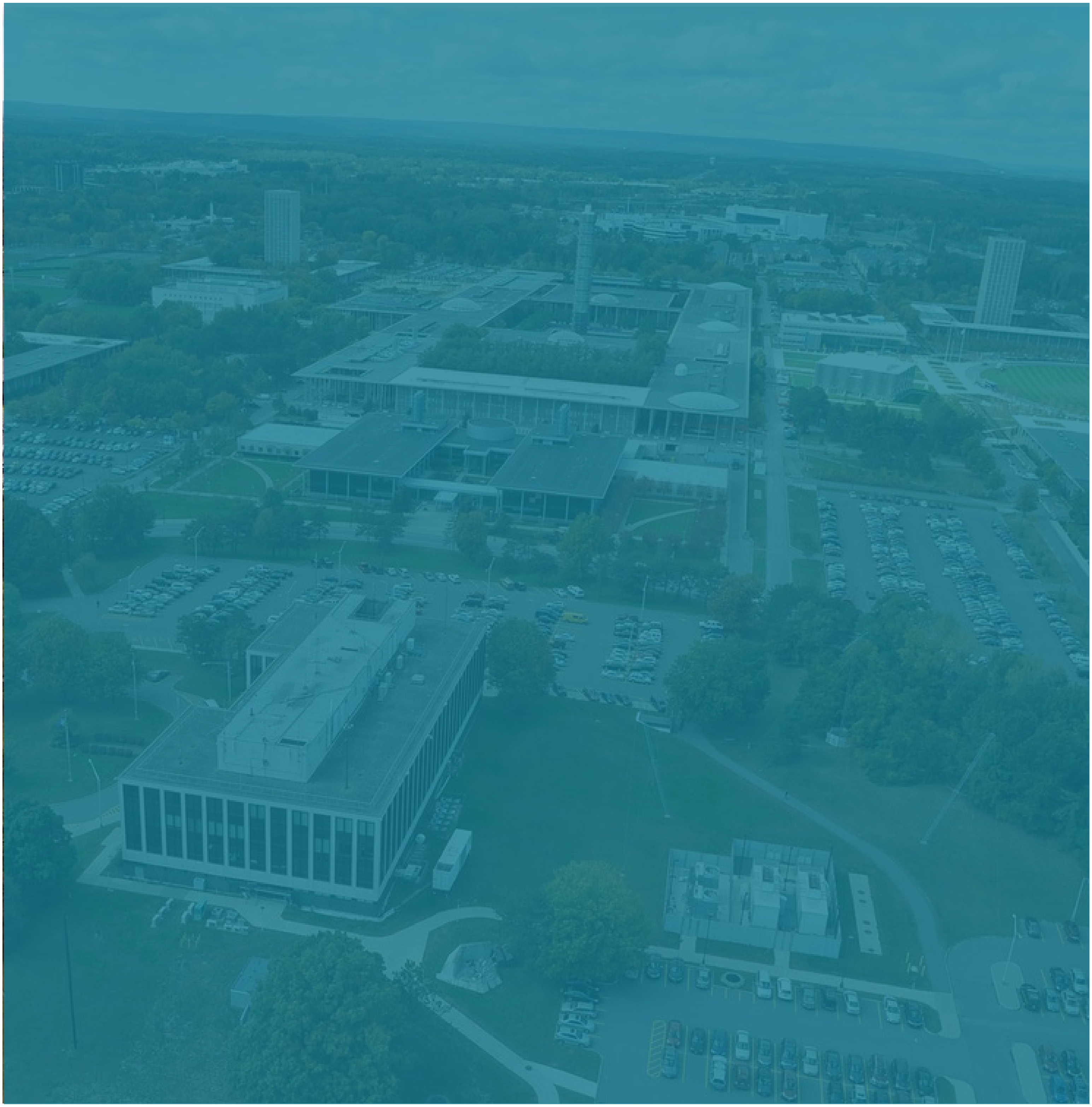
4.5 KEY PERFORMANCE INDICATORS

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

- Annual Source EUI
- Annual Greenhouse Gas (GHG) emissions monitored in Carbon dioxides equivalent (CO_2e)
- Financial impact (*e.g.*, project costs, energy and cost savings, return on investment, annual net cash flow)
- Dollars invested in infrastructure renewal
- Operations & maintenance savings
- Student/staff/faculty perception/feedback
- Non-energy benefits including improvements in occupant comfort, reliability, and resiliency
- Achievement of sustainability goals

4.6 LOOKING AHEAD

The EMP will guide actions over a 10-year period that are realistic, implementable, and cost effective, which position the University to achieve short-term and long-term energy goals. The EMP incorporates resiliency to maintain reliable, flexible, and affordable facility operations, and achieves energy reductions through energy efficiency, infrastructure renewal, renewable energy, and stewardship of physical assets.



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THERE'S A WAY