CLEAN ENERGY MASTER PLAN
SUNY ONEONTA

APRIL 14, 2021 – FINAL

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SUNY ONEONTA

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Prepared for: SUNY Oneonta

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FOREWARD

The Clean Energy Master Plan (CEMP) for SUNY College at Oneonta will create a framework for a financially sustainable energy program that focuses on energy-intensity reduction goals, which supports meeting the carbon-reduction goals of the campus, and provides reliable low-carbon and resilient energy sources that enable and enhance the campus mission.

The CEMP includes a pathway and a long-term commitment to carbon neutrality, as well as assesses the costs and benefits of various pathways in the context of the College's overall financial commitments and campus needs, while optimizing capital resources. The CEMP will be used to help inform the next Facilities Master Plan, which begins in 2021. This will include an overarching set of principles for how the College approaches energy, as well as recommended options to be fully integrated during the Campus Master Plan efforts.

EXECUTIVE SUMMARY

Purpose

The State University of New York College at Oneonta (SUNY Oneonta) is a Reforming the Energy Vision (REV) Campus Challenge Partner under the New York State Energy Research and Development Authority (NYSERDA) REV Campus Challenge Technical Assistance for Roadmaps program (REV Campus Challenge). NYSERDA co-funded the development of this Clean Energy Master Plan (CEMP), which creates a vision for low carbon and renewable technologies and operational strategies to reduce fossil fuel use/dependency, increase electrification of utility operations, and maintain resiliency and reliability.

Energy and Climate Drivers

SUNY Oneonta is subject to New York State Mandates and SUNY System Administration and State University Construction Fund (SUCF) Directives associated with energy and carbon (*i.e.*, greenhouse gases (GHG)) reduction targets that include the following:

New York State Mandate	Goals
Executive Order 166 (EO 166)	Reduce GHG emissions (from 1990 levels): • 40% by 2030 • 80% by 2050
New Efficiency New York	• 2025 statewide energy efficiency target of 185 trillion British thermal units (TBtu) of site energy savings
The Climate Leadership and Community Protection Act (CLCPA)	• Carbon free electricity system by 2040 • Reduce GHG 85% below 1990 levels by 2050

SUNY and SUCF Directives/Drivers	Goals
SUCF Directive 1B-2	• Commitment to clean energy • Deep energy retrofits on existing buildings • Net zero carbon new buildings
SUNY Clean Energy Roadmap	• Guidelines to help accelerate progress towards NYS's goal to reduce GHG 40% by 2030

Greenhouse Gas Emissions Trend

Greenhouse gas emissions from SUNY Oneonta are derived from a variety of energy fuel types. From Figure 1 below, 72% of the campus energy use is from fossil fuels, and the remaining 28% is from electricity. Approximately 65% of the total energy use is from natural gas and 4% is from No. 2 fuel oil. These are the primary fuel sources for heating and are the opportunity areas for broader energy efficiency and decarbonization considerations through fossil fuel reduction.

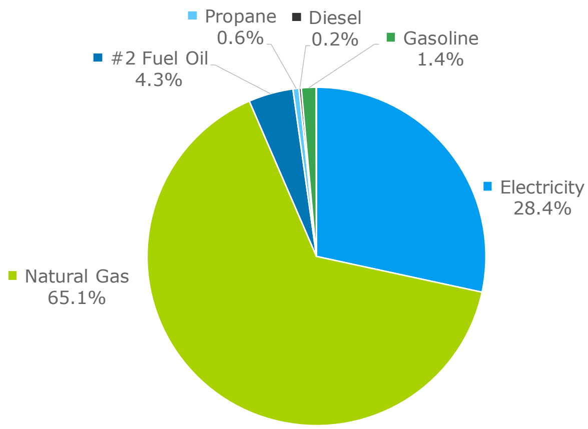

Figure 1. SUNY Oneonta Energy Use by Fuel Type (CY 2019)

As shown in Figure 2, GHG emissions have reduced 37% since 1990 despite an increase in building space, operating hours, and student enrollment.

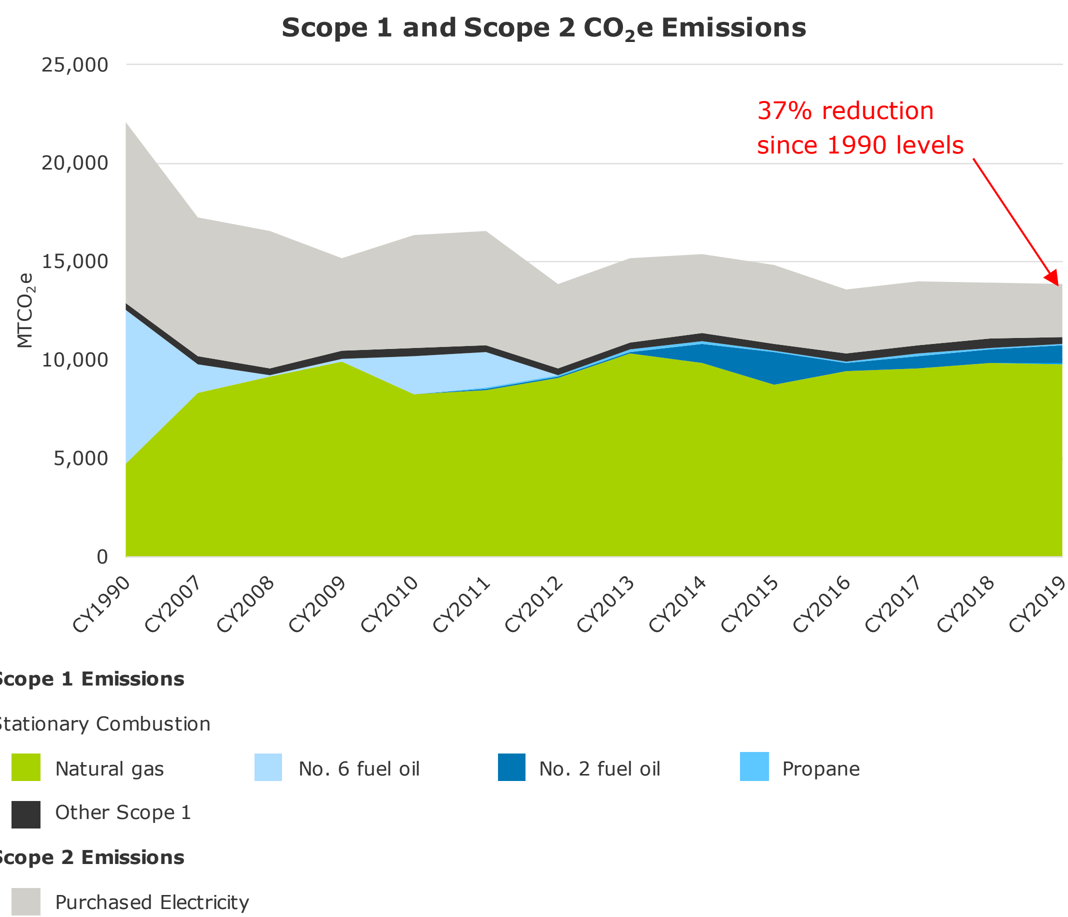

Figure 2. SUNY Oneonta GHG Emissions Trend Since Calendar Year 1990

Clean Energy Master Plan

The CEMP process allowed for critical discussion of key mandates and drivers, coupled with strategic thinking of clean energy options to create a vision of the most economically viable low carbon and renewable technologies and operational strategies to reduce fossil fuel use/dependency, increase electrification, and maintain resiliency and reliability.

Developing the CEMP included assessing energy sources, energy use, potential energy conservation measures (ECM), clean energy options, and institutional factors through a process of facilitated stakeholder engagement. An assessment of existing conditions through American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Level 1 walkthroughs, followed by ASHRAE targeted audits (Final Report, June 2020) and a high-level feasibility energy modeling and scenario planning assessment (November 2020), contributed to the vision of a low carbon campus.

Through aligning campus priorities with vision and goals of EO166, SUNY's Clean Energy Master Plan, the CLCPA, and SUCF directive 1B-2, the actions to reduce energy usage, increase energy efficiency, and decrease operating costs include five strategic areas – ***Energy Efficiency, Resiliency, Renewable Energy, Stewardship, and Engagement***.

ENERGY EFFICIENCY

Energy efficiency and conservation measures often involve capital expenditures that have short to moderate payback periods and are focused on driving near term reductions in GHG emissions and EUI, sometimes referred to as "low hanging fruit". Energy efficiency can also consider infrastructure renewal under major building renovations or gut rehabilitations that will follow the performance goals of SUCF Directive 1B-2.

RESILIENCY

Defining resiliency is unique to each campus. Resiliency for SUNY Oneonta is the desire to decarbonize by reducing fossil fuel use and increase renewables and electrification. This would be a long-term horizon transition, coupled with necessary building renovations, to utilize low carbon energy supplies, energy storage, and a dependable alternative to the interruptible gas supply.

RENEWABLE ENERGY

Renewable energy centers on SUNY Oneonta's desire to achieve GHG reductions by decreasing fossil fuel use and increasing electrification of campus operations that would utilize renewable electricity, along with potential use of biomass where economically feasible.

STEWARDSHIP

Stewardship focuses on the human capital and physical capital needs of managing energy systems to achieve and maintain peak performance.

ENGAGEMENT

Engagement focuses on how SUNY Oneonta integrates energy and sustainability into the cultural fabric of the college, as well as facilitating collaboration and idea sharing with peers and in the community.

Table 1 provides a high-level summary of the planned actions within the five strategic areas and the expected reduction of GHG emissions and site EUI.

Table 1. Energy Roadmap | Strategic Focus Areas

ENERGY EFFICIENCY	RESILIENCY	RENEWABLE ENERGY	STEWARDSHIP	ENGAGEMENT
Low Cost/No Cost Measures	Transition to Low Temperature Hot Water	Large Scale Solar Power Purchase Agreement	Campus Energy Manager	Energy Conservation Awareness and Behavioral Change
Energy Conservation Measures	Low Carbon Energy Supply • Backup and Peak Generation • Geothermal • Heat Pumps • Thermal Energy Storage	2.5 MW Solar PV on Collins Property	Retro-commissioning	Integration with Curriculum, Research, and Workforce Development
Building Renovations	Integration with Facilities Master Plan (FMP)	EV & Fleet Transition	Preventative Maintenance Focus	Campus Sustainability Coordinator
Deep Energy Retrofits	Regional Energy Issues	Biofuel	Advanced Metering and Data Analysis	President's Advisory Council on Sustainability
Net Zero Carbon New Buildings			Workforce Development	
% Contribution to GHG Reduction				
16.7%	**52.6%**	**20.5%**	**3.3%**	**6.8%**
% Contribution to Total Site kBtu/GSF Reduction				
46.6%	**34.9%**	**0.0%**	**7.7%**	**10.8%**

The fundamental basis for establishing a low carbon campus is transitioning the district heating network from a mix of steam and medium temperature hot water (MTW) to low temperature hot water (LTW) and moving to 100% renewable sources for electricity, while a shift to all renewable electricity and energy efficiency measures are essential to reaching the campus' targets. Figure 3 below summarizes the current situation of a steam/MTW-based campus district energy network and the vision of a future low carbon energy supply.

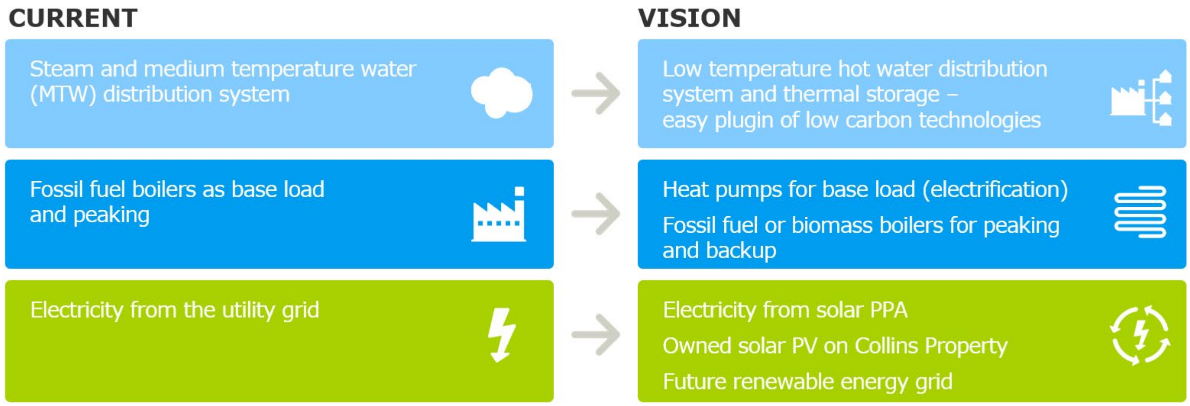

Figure 3. SUNY Oneonta District Energy Network – Current Versus Vision

To help establish the vision of a future low carbon energy supply, energy modeling and scenario planning was completed to provide quantitative information and path forward considerations. Figure 4 represents the scenarios that aligned SUNY Oneonta's priorities with NYS mandates and SUNY's goals/directives.

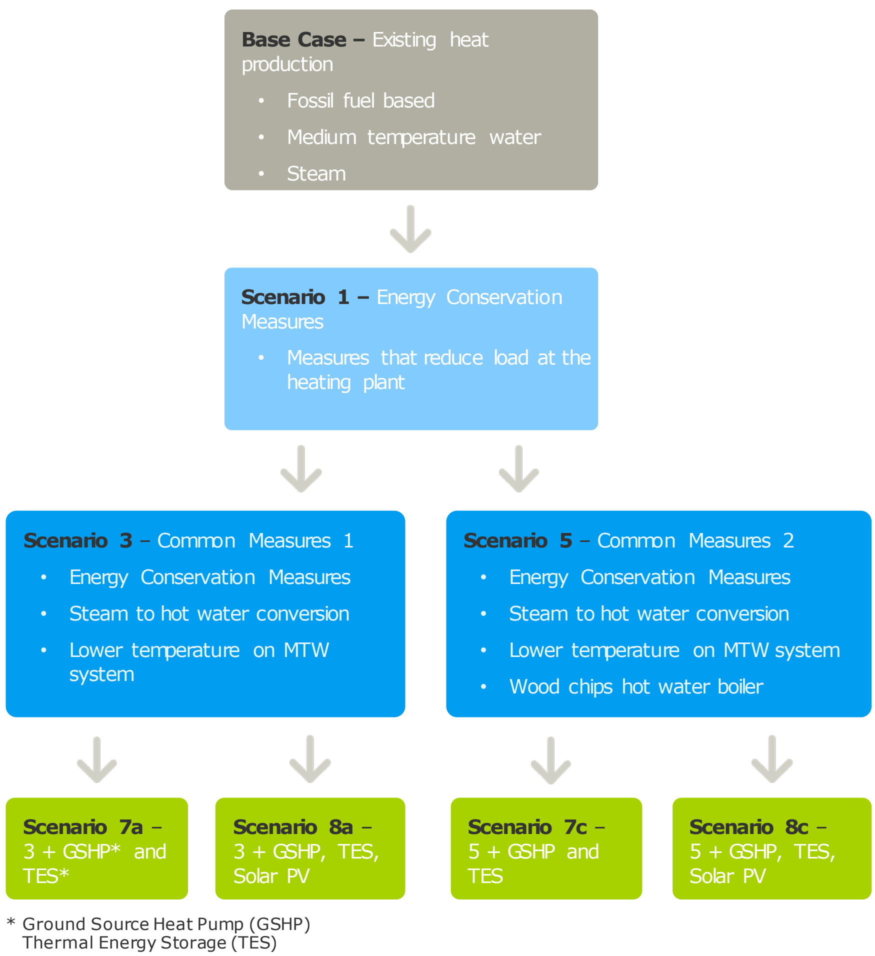

Figure 4. Clean Energy Scenarios Evaluated

Figure 5 provides a comparison of project costs in net present value (NPV) and associated GHG emissions from the scenarios. The yellow diamonds show the present value for each of the scenarios in million US Dollars. Costs (capital expenditures, operating and maintenance expenditures) are accounted for in each year over a 20-year period. The emissions from the base case (2018) without renewable electricity (gray column) are compared to scenario alternatives without renewable electricity (blue columns) and with renewable electricity (green column), which align with the CLCPA commitment to a carbon free electric grid by 2040, as well as SUNY Oneonta's participation in the New York Higher Education Large-Scale Renewable Energy (NY HE LSRE) consortium or another potential power purchase agreement (PPA) option.

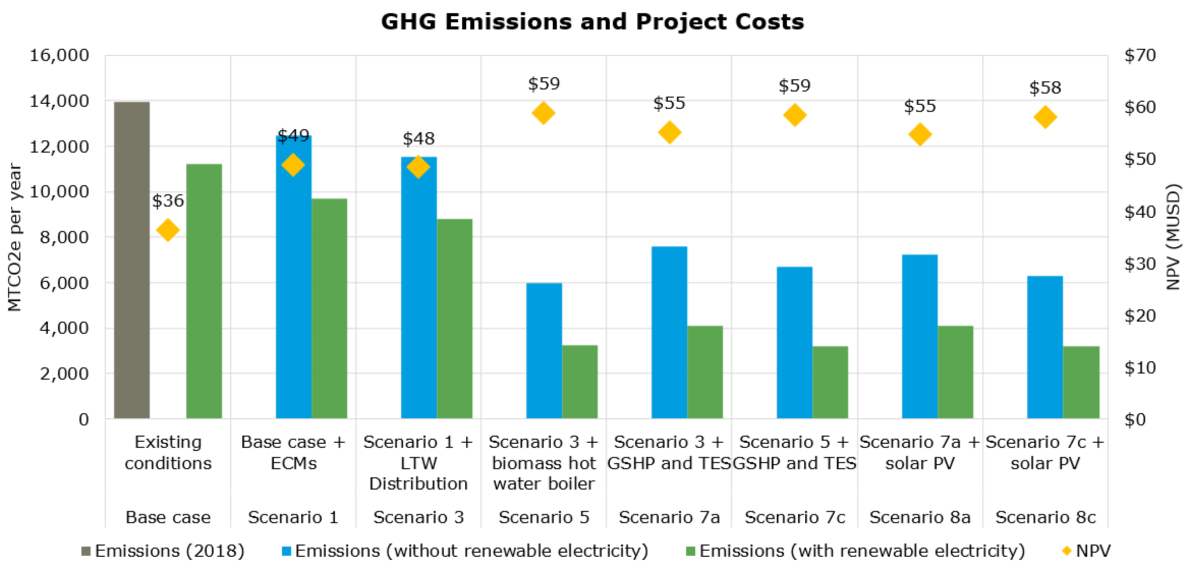

Figure 5. Low Carbon Energy Scenarios Comparison

While a final scenario has not be selected by SUNY Oneonta, the results of this effort provide a roadmap for near-term actions and a decision-making framework for the long-term vision to meet or exceed NYS energy efficiency and GHG reduction mandates and set a path for carbon neutrality.

Establishing the LTW network will have challenges and will require careful consideration to maintain building heating throughout the project period. It may be necessary in early project phases to have both the new low temperature hot water network in operation together with the existing steam and MTW networks. Figure 6 provides a proposed phasing plan to transition steam and MTW to low temperature that aims for a pragmatic timeframe.

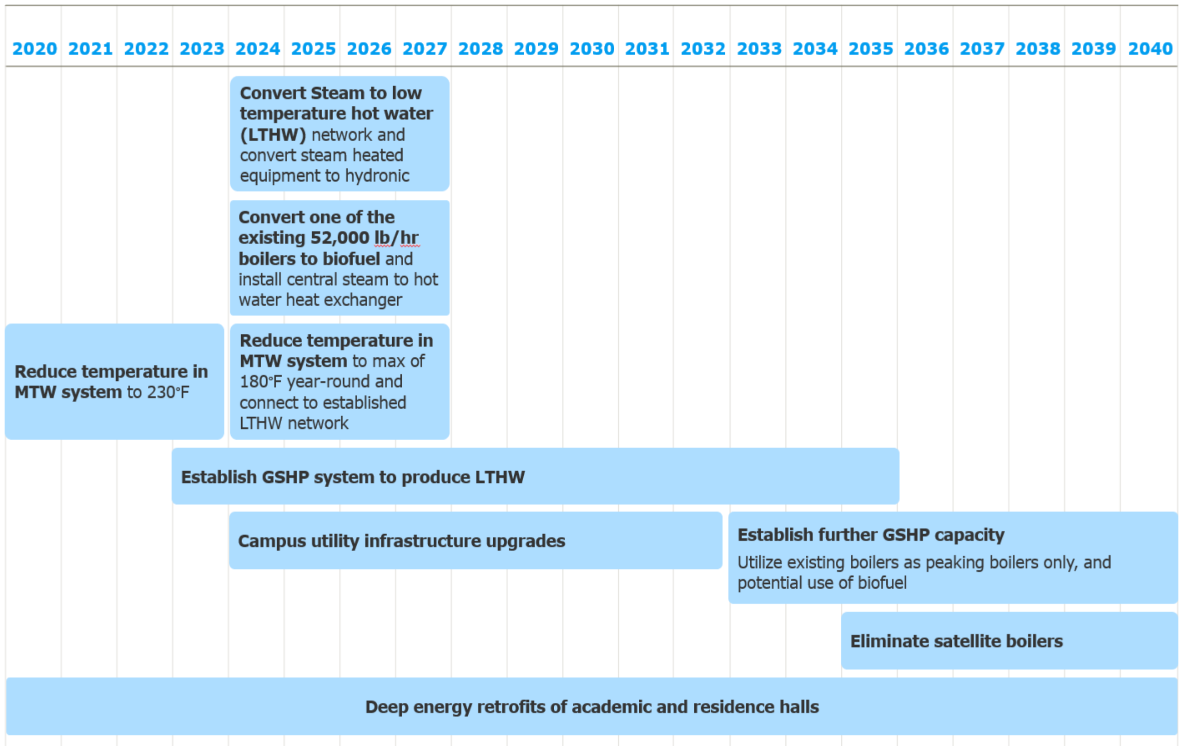

Figure 6. Proposed Steam to Low Temperature Hot Water Phasing Plan

Greenhouse Gas Emissions and Energy Use Intensity Reduction Impact

The combination of ECMs identified from the energy assessment with the clean energy scenarios has the potential to reduce the GHG emissions below the 80% reduction target set forth by EO 166, as shown in Figure 7. Additionally, the campus has the potential to reduce the site energy use intensity (EUI) to an estimated 70 kilo (1,000) British thermal units per gross square feet (kBtu/GSF) over the next 25 years, as shown in Figure 8.

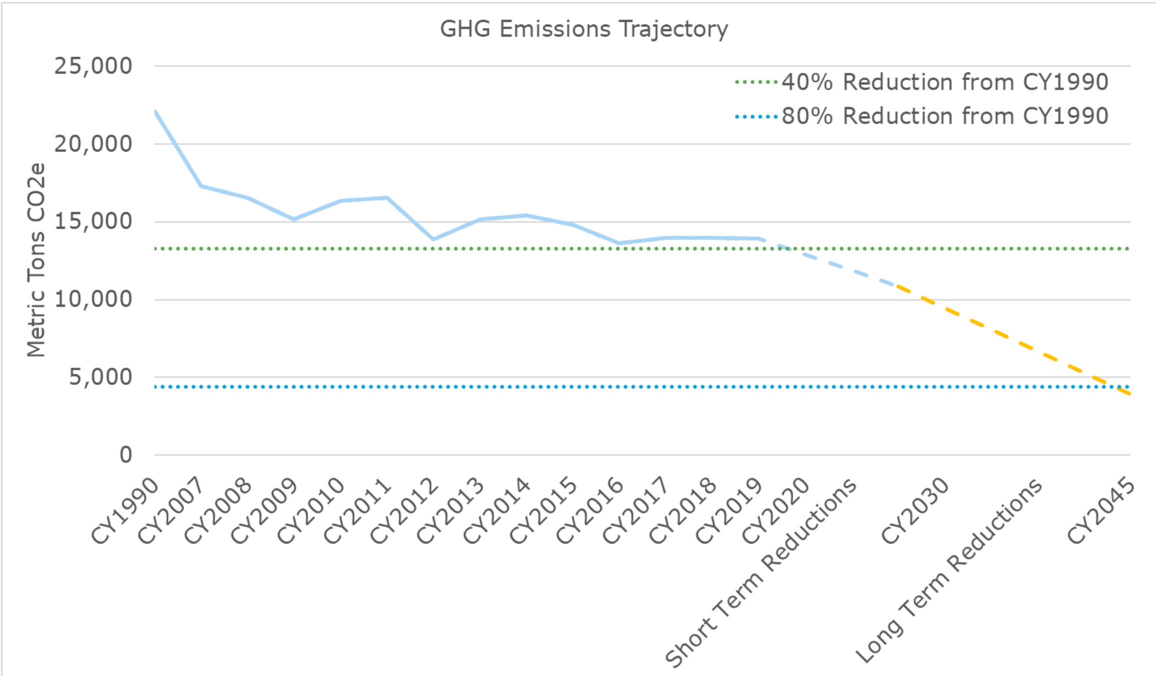

Figure 7. GHG Emissions Trajectory

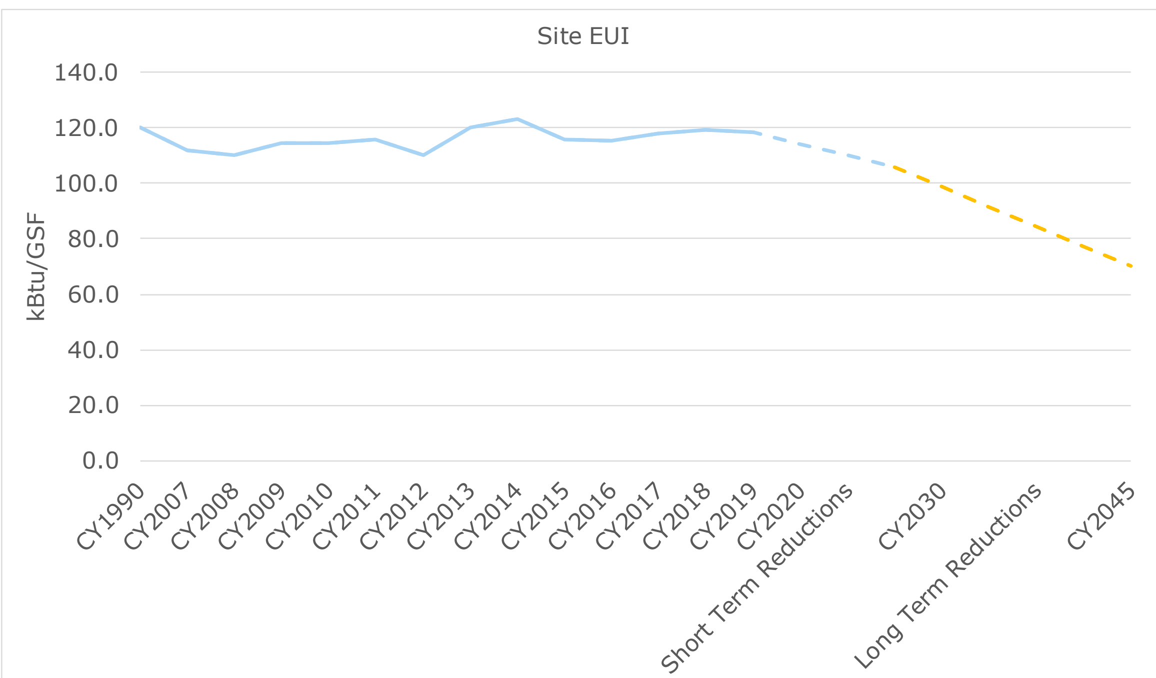

Figure 8. Site Energy Use Intensity Trajectory

Next Steps
The CEMP will guide actions over a 20-year horizon and establishes SUNY Oneonta's desire and commitment to be a leader of energy and sustainability within SUNY. Energy reductions are achieved through ***decreasing fossil fuel use, establishing a platform for electrification and clean energy supply technologies, using renewable energy, completing building upgrades, stewardship of physical assets, and engaging campus stakeholders.***

SUNY Oneonta began a new Facilities Master Plan (FMP) process in Q1 2021. SUNY Oneonta will integrate the CEMP and upcoming FMP to complement capital planning and modernization of campus buildings including critical maintenance and SUCF Directive 1B-2. As a result, the CEMP will be amended following the completion of the FMP in order to create further alignment between these two important campus planning documents.

1. PURPOSE, DRIVERS AND APPROACH

1.1 Purpose

The New York State Energy Research and Development Authority (NYSERDA) Reforming the Energy Vision (REV) Campus Challenge Technical Assistance for Roadmaps program (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 for managing changing campus energy needs. As a State University of New York (SUNY) institution and REV Campus Challenge member, SUNY Oneonta is committed to the goals of the REV Campus Challenge through the development of this NYSERDA co-funded Clean Energy Master Plan (CEMP), along with assisting other colleges and universities in this process through collaboration and sharing best practices and lessons learned.

1.2 Energy and Climate Drivers

SUNY Oneonta is subject to New York State Mandates and SUNY System Administration and State University Construction Fund (SUCF) Directives associated with energy and carbon (*i.e.*, greenhouse gases (GHG)) reduction targets that include the following:

New York State Mandate	Goals
Executive Order 166 (EO 166)	Reduce GHG emissions (from 1990 levels): • 40% by 2030 • 80% by 2050
New Efficiency New York	• 2025 statewide energy efficiency target of 185 trillion British thermal units (TBtu) of site energy savings
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SUNY and SUCF Directives/Drivers	Goals
SUCF Directive 1B-2	• Commitment to clean energy • Deep energy retrofits on existing buildings • Net zero carbon new buildings
SUNY Clean Energy Roadmap	• Guidelines to help accelerate progress towards NYS's goal to reduce GHG 40% by 2030

1.3 Approach and Guiding Principles

The CEMP development approach was a deliberate and collaborative process of stakeholder engagement that allowed for critical discussion of key institutional goals and targets, strategic thinking of clean energy options and best practices, and establishing strategies to implement the CEMP. Engagement and thought leadership from SUNY Oneonta Office of Facilities, Safety, and Physical Plant (OFSPP) were critical to aligning campus priorities with SUNY's Clean Energy Roadmap ambitious goals. Key stakeholder engagement meetings conducted during the development of the CEMP are summarized below in Table 2. Guiding principles that have influenced SUNY Oneonta's campus priorities in strategic focus areas of Energy Efficiency, Resiliency, Renewable Energy, Stewardship, and Engagement (described in Section 3) include:

1. Create a CEMP that provides a roadmap for near-term actions and a decision-making framework for the long-term vision to meet or exceed NYS energy efficiency and GHG reduction mandates and set a path for carbon neutrality.
2. Identify the most economically viable clean energy (low carbon and renewable) technologies and operational strategies to reduce fossil fuel use/dependency, increase electrification, and provide increased resiliency and reliability.
3. Integrate the CEMP and upcoming Facilities Master Plan (FMP) (2021-2022) to complement capital planning and modernization of campus buildings including critical maintenance and SUCF Directive 1B-2.
4. Incorporate campus operations with curriculum, research, and workforce development.

Table 2. Key Stakeholder Engagement Meetings

Date	Audience	Purpose
October 2018	OFSPP	Kickoff meeting to share overview of the CEMP process, seek input on energy and GHG reduction goals, and discuss key milestones
January 2019	OFSPP	Discuss preliminary energy-use analysis (PEA) results and initial walk-through survey findings
September 2019	OFSPP	Discuss results and findings of the ASHRAE Targeted Audits
January 2020	OFSPP	Discuss results of hydraulic modeling, and energy modeling and scenario planning
March 2020	OFSPP	Discuss updated results of energy modeling and scenario planning
May 2020	President's Executive Council	Share overview of the CEMP process and the vision of a low carbon campus to help meet energy and GHG goals

2. ASSESS – EXISTING CONDITIONS AND OPPORTUNITIES

The CEMP process initiated with an October 2018 kickoff meeting with the CEMP Implementation Team and SUCF to discuss existing conditions and opportunities and the broad picture of "where are we now" relative to the campus energy program. An assessment of existing conditions through American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Level 1 walkthroughs, followed by ASHRAE targeted audits (June 2020) and a high-level feasibility energy modeling and scenario planning assessment (November 2020), aided in developing a roadmap towards envisioning a low carbon campus. SUNY Oneonta's longstanding actions around energy and sustainability are presented in Figure 9.

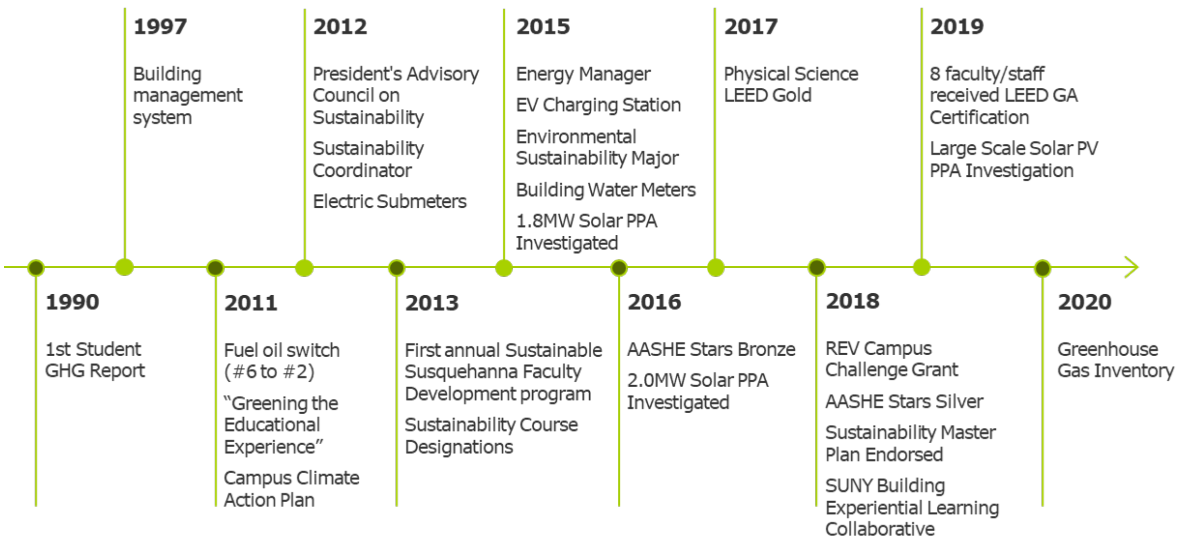

Figure 9. Recent History of Energy and Sustainability Actions at SUNY Oneonta

2.1 Greenhouse Gas Emissions and Energy Use Intensity

Greenhouse gas emissions from SUNY Oneonta are derived from a variety of energy fuel types. From Figure 10 below, 72% of the campus energy use is from fossil fuels, and the remaining 28% is from electricity. Approximately 65% of the total energy use is from natural gas and 4% is from No. 2 fuel oil. These are the primary fuel sources for space heating and domestic hot water heating and are the opportunity areas for broader energy efficiency and decarbonization considerations through fossil fuel reduction. Propane (used for heating at Cooperstown Biological Field Station (BFS)), diesel, gasoline, and kerosene account for about 3% of the total energy use.

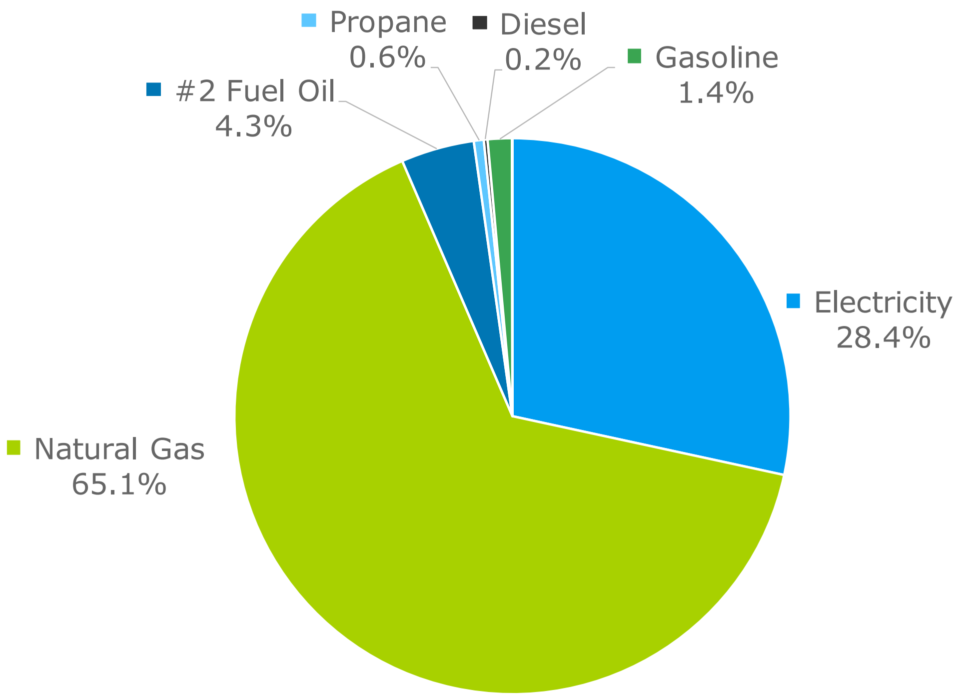

Figure 10. SUNY Oneonta Energy Use by Fuel Type (CY 2019)

Figure 11 below summarizes the GHG emissions (Scope 1 and Scope 2 sources) trend from calendar year (CY) 1990 through CY2019, where CY1990 is being considered the baseline year for GHG emissions in this CEMP. The values represent SUNY Oneonta facilities and properties including the main campus and Cooperstown BFS.

Scope 1 emissions are direct emissions from sources owned and controlled by SUNY Oneonta (*e.g.*, district steam boilers, building hot water boilers, vehicle fleet) and Scope 2 emissions are indirect emissions from sources that are owned or operated by SUNY Oneonta, but whose products are directly linked to on campus energy inputs (*e.g.*, purchased electricity).

GHG emissions have reduced 37% since 1990 despite a 250,000 gross square feet (GSF) increase in building space, buildings staying open longer, and a 16% increase in student enrollment. The campus has reduced GHG emissions by 20% since CY2007, not only from the grid becoming cleaner over time, but also by switching the backup heating plant fuel from No. 6 fuel oil to No. 2 fuel oil.

Figure 12 provides a graphical representation of energy use intensity (EUI) over the same time period. EUI is estimated based on site energy data and total SUNY Oneonta building property gross square footage. The overall trend (which is not weather normalized) has remained relatively constant.

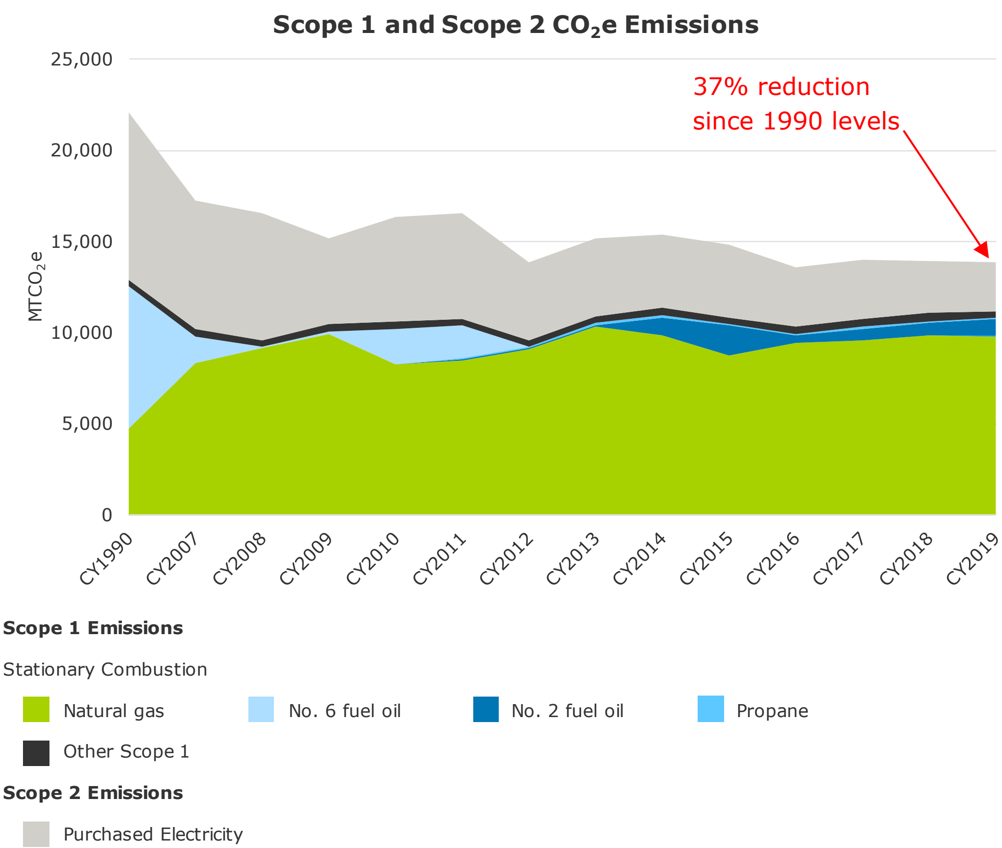

Figure 11. SUNY Oneonta GHG Emissions Trend Since Calendar Year 1990

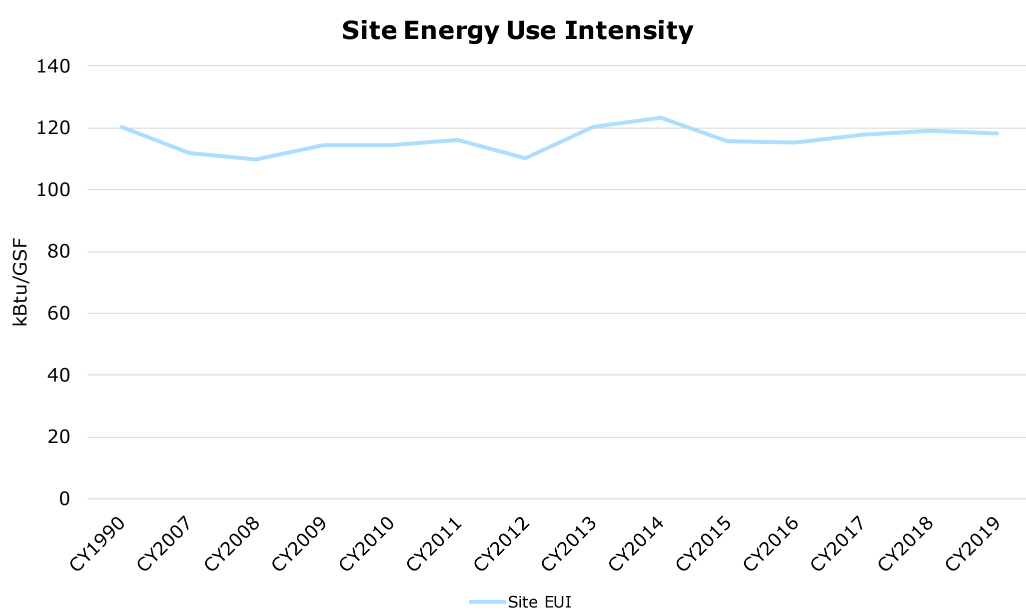

Figure 12. SUNY Oneonta Energy Use Intensity Trend Since Calendar Year 1990

2.2 Existing Conditions and Opportunities

Developing the CEMP included assessing energy sources, energy use, potential energy conservation measures (ECM), clean energy options, and institutional factors through a process of facilitated stakeholder engagement. Through aligning campus priorities with vision and goals of EO166, SUNY's Clean Energy Master Plan, the CLCPA, and SUCF directive 1B-2, the actions to reduce energy usage, increase energy efficiency, and decrease operating costs include five strategic areas – ***Energy Efficiency, Resiliency, Renewable Energy, Stewardship, and Engagement***. Table 3 through Table 6 summarize the primary observations and opportunities in those five strategic focus areas.

Ford Hall – Full renovation expected to occur from spring 2023 through summer 2024; building envelope, high efficiency HVAC systems, solar thermal domestic water; and designed to achieve SUNY goals for Deep Energy Retrofits (DER)

Table 3. Energy Efficiency - Existing Conditions and Opportunities

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
ENERGY EFFICIENCY Energy efficiency and conservation measures often involve capital expenditures that have short to moderate payback periods and are focused on driving near term reductions in GHG emissions and EUI, sometimes referred to as "low hanging fruit". Energy efficiency can also consider infrastructure renewal under major building renovations or gut rehabilitations that will follow the performance goals of SUCF Directive 1B-2.		

Main Campus	• Numerous small LED conversion projects recently completed
	  ○ Fluorescent fixtures are still the predominant
		• ECMs studied as part of the CEMP development:
		  ○ Interior LED lighting upgrades
		  ○ Building automation system (BAS) control enhancements

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
	technology for interior lighting • Exterior lighting upgraded to LED • Heating for majority of buildings provided by district heating plant • De-centralized cooling provided by air-cooled and water-cooled chillers or direct expansion cooling • Implementation of the FMP (2013-2023) has resulted in improved electrical, HVAC, and thermal performance through building renovations	○ Kitchen demand-controlled ventilation (DCV) ○ Chilled water and hot water pump variable frequency drives (VFDs) ○ Convert constant volume single zone systems to single zone variable air volume (VAV) systems ○ Carbon dioxide (CO_2)-based demand-controlled ventilation for high occupancy areas ○ Steam and medium temperature water (MTW) distribution pipe insulation
Cooperstown Biological Field Station	• Propane-fired hot water condensing boilers • Air-cooled chiller with R-22 refrigerant • Variable laboratory supply and exhaust	• BAS control enhancements • Interior LED lighting upgrades
Building Level Sub-metering	• Campus sub-metering for water and electricity in all buildings	• Potential for building level thermal sub-metering • Further deep sub-metering within individual buildings at a system level • Potential to leverage NYSERDA's Real-Time Energy Manager (RTEM) Program

Alumni Hall – Full renovation is expected to occur from summer 2021 through summer 2023; geothermal field planned in the parking lot for a ground source heat pump system designed for heating and cooling

Table 4. Resiliency - Existing Conditions and Opportunities

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
RESILIENCY Defining resiliency is unique to each campus. Resiliency for SUNY Oneonta is the desire to decarbonize by reducing fossil fuel use and increase renewables and electrification. This would be a long-term horizon transition, coupled with necessary building renovations, to utilize low carbon energy supplies, energy storage, and a dependable alternative to the interruptible gas supply.		

District Energy Network	• SUNY Oneonta operates steam and MTW distribution networks. Approximately 28% of buildings on campus are connected to the steam distribution and 54% of buildings are connected to the MTW distribution. The remaining 19% have de-centralized heating systems (*e.g.* satellite boilers).
	• Steam distribution serves
	  ○ Alumni Hall
	  ○ Chase PE
	  ○ Golding
	  ○ Human Ecology
	  ○ Lee
	  ○ Littell
	  ○ Morris Complex
	  ○ Physical Science
	  ○ Science 1
	  ○ Tobey
	  ○ Wilber
		• Transition from steam and MTW to a low temperature hot water (LTW) distribution network that would:
		  ○ Enable a platform for low carbon/renewable energy supplies such as geothermal, thermal energy storage, and heat pumps
		  ○ Provide flexibility towards general technology developments
		  ○ Align with SUCF Directive 1B-2 for deep energy retrofits and energy efficiency
		  ○ Become more energy independent and better manage utility costs
		  ○ Potential for biomass or bio-oil boiler to replace natural gas consumption
		  ○ Help meet or exceed GHG mandates

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
	• MTW distribution serves ○ Alumni Field House ○ Blodgett ○ Curtis ○ Fine Arts ○ Ford ○ Grant ○ Hays ○ Hulbert ○ Huntington ○ IRC ○ Macduff ○ Matteson ○ Mills ○ Milne Library ○ Netzer ○ Schumacher ○ Sherman ○ Wilsbach • Antiquated heating plant controls that are no longer supported by manufacturer	• SUNY Oneonta desires to decarbonize by reducing fossil fuel use and increase renewables and electrification. This would be a long-term horizon transition and would be coupled with necessary building renovations to utilize low carbon energy supplies. As an interim transition step, low pressure steam would be needed for the Heating Plant and Morris Complex, until the buildings are renovated • Replace antiquated and unsupported heating plant controls with a new control system that would support the heating plants operation for the next 10 to 15 years
Geothermal	• Alumni Hall will have a geothermal well field to provide 100 tons of cooling capacity and 1 million British thermal units per hour (MMBtu/hr) of heating capacity • Water-to-water heat pumps will provide chilled water and hot water to dedicated outdoor air system, fan coil units, and chilled beams in Alumni Hall	• Preparing fit up for eventually tying this geothermal well field to the future district LTW loop with central heat pump operation
De-centralized cooling	• Numerous chillers with R-22 refrigerant	• Replace R-22 chillers with high-efficiency chillers with more environmentally friendly refrigerant • Alternatively, centralized supply of cooling from district heat pumps should be evaluated
Facilities Master Plan	• A new FMP process will take place from 2021-2022	• Integration of the FMP with CEMP to align the vision, projects, and implementation phasing of both documents

Collins Property: North of campus; potential location for strategic consideration of renewable energy systems such as solar PV, solar thermal, wind, or carbon sequestration

Table 5. Renewable Energy - Existing Conditions and Opportunities

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
RENEWABLE ENERGY Renewable energy centers on SUNY Oneonta's desire to achieve GHG reductions by decreasing fossil fuel use and increasing electrification of campus operations that would utilize renewable electricity, along with potential use of biomass where economically feasible.		
Offsite Large-Scale Solar PV	• Participating in New York Higher Education Large Scale Renewable Energy (NY HE LSRE), a large-scale solar consortium of New York State public and private campuses. Price estimates and detailed analysis were completed during 2020.	• A near-term 10-year plus agreement to purchase electricity generated by large scale solar PV farms in NYS
Campus Solar PV	• No solar PV exists on campus • Two investigations into solar PV (1.8 MW and 2.0 MW) • NYPA assessment of 2.5 MW and 5.0 MW arrays at the Collins property	• Collins property has been identified as a potential location for a large-scale on campus solar PV array • To be further investigated during the FMP process in 2021 • Through the CLCPA, NYS is committed to reducing GHG gas emissions 85% by 2050 (from 1990 levels) and having a carbon free electric grid by 2040. In this case, the electric grid is expected to be incrementally cleaner each year towards those goals, thus impacting SUNY Oneonta's annual GHG emissions


Physical Science II Building - Air Handling Unit #2

Table 6. Stewardship - Existing Conditions and Opportunities

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
STEWARDSHIP Stewardship focuses on the human capital and physical capital needs of managing energy systems to achieve and maintain peak performance.		
Campus Energy Management	• Campus Energy Manager established in 2015	• Implementation of short-term and long-term actions within the CEMP
Workforce Training	• Established workforce and potential for institutional knowledge loss in the next 5 to 10 years from the trade crafts and supervisors due to retirement and/or career transition	• Potential participation in NYSERDA PON 3715 – Workforce Training: Building Operations & Maintenance for energy management and human capital development through On-the-Job-Training (OTJT) • Continued development of tools and skill sets that are required to make the program sustainable, New York Energy Manager (NYEM), along with integrating new training initiatives within standard business procedures and merge training into the campus culture to support operations and maintenance • Continued documentation and recording of existing institutional knowledge

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
Preventive Maintenance Focus	• Preventive Maintenance Software – Equipment inventory, preventative maintenance (PM), and work order management are currently through TMI	• Continuous development of preventative and predictive maintenance program
Advanced Metering and Data Analysis	• Campus sub-metering for water and electricity in all buildings • CopperTree Analytics platform installed in newly renovated Huntington Hall for continuous commissioning and fault detection	• Potential for system level submetering, and connection/integration cloud-based analytics platforms like NYEM and RTEM • Potentially expand the CopperTree platform to more buildings

Retro-commissioning (RCx)	• 2018 RCx study by Guth-DeConzo of
	  ○ Chase PE
	  ○ Fine Arts
	  ○ Human Ecology
	  ○ IRC
	  ○ Science 1
	  ○ Wilber Hall
		• Make RCx and ongoing commissioning Cx an integral part of the College’s O&M program

Sustainability Standards	• 2011 Climate Action Plan (CAP) updated in 2012 • Campus Sustainability Coordinator established in 2012 • President’s Advisory Council on Sustainability established in 2012 • 2018 Sustainability Master Plan	• Update CAP to align with EO166, CLCPA, and SUNY Clean Energy Roadmap goals • Decide if CAP and CEMP should be merged or maintained as separate plans
Energy Policies and Guidelines	• Building Temperature Policy	• Enforcement of guidelines • Complete and/or develop program and policy changes that support reduced emission behaviors
Forest Management and Sequestration	• Collins property exists with some forest lands	• Collins property could be assessed for potential carbon sequestration management in offsetting a portion of SUNY Oneonta’s GHG emissions towards NYS mandates and campus neutrality goals

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
Planning Documents	• A new FMP process will take place from 2021-2022	• Integration of the CEMP and FMP • SUCF and capital fund critical maintenance plans and projects

Student engagement in tree planting

Table 7. Engagement Existing Conditions and Opportunities

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
ENGAGEMENT Engagement focuses on how SUNY Oneonta integrates energy and sustainability into the cultural fabric of the college, as well as facilitating collaboration and idea sharing with peers and in the community.		
SUNY Oneonta-Wide Overview	• NYSERDA REV Campus Challenge Leader • Achieved AASHE STARS Silver in 2018	• Committed to attaining AASHE STARS Gold • Continued focus on promoting energy conversation awareness to impact behavioral change

ASSESS: Existing Conditions and Opportunities		
	Existing Conditions	**Opportunities**
Curriculum and Student Engagement	• 2011 Climate Action Plan • AASHE STARS reports • Environmental Sustainability major introduced in 2015 • "Greening the Educational Experience" • A two-tier sustainability designation program that has courses designated as including sustainability themes in half of the College's departments • An annual faculty development program that helps faculty integrate sustainability into existing or new courses • Sustainability events are hosted throughout the academic year including a week-long celebration around Earth Day, and Green Dragon Week. • Student internships in the Office of Sustainability • Green Building Design courses are offered in the Environmental Sustainability Department through SUNY PIF Green Energy Workforce Development funding	• Including energy and green building curriculum within the Environmental Sustainability major or related majors • A sustainability graduation requirement could be considered • Continue funding of SUNY PIF Green Energy Workforce Development program
Outreach and Community Engagement	• Sharing lessons learned and best practices through existing and new channels • Engagement with New York Coalition of Sustainability in Higher Education (NYCSHE) and the SUNY Sustainability Coalition • Participation in NYSERDA REV Workshops • Members of the Otsego County Energy Task Force	• Share Oneonta story with commercial and industrial businesses within Otsego County. • Help promote economic development opportunities in the area

3. ACT – CLEAN ENERGY MASTER PLAN

The CEMP process allowed for critical discussion of key mandates and drivers, coupled with strategic thinking of clean energy options to create a vision of the most economically viable low carbon and renewable technologies and operational strategies to reduce fossil fuel use/dependency, increase electrification, and provide increased resiliency and reliability. Table 8 below provides a high-level summary of the planned actions within the five strategic areas of ***Energy Efficiency, Resiliency, Renewable Energy, Stewardship, and Engagement*** and the expected reduction of GHG emissions and site EUI.

Table 8. Energy Roadmap | Strategic Focus Areas

ENERGY EFFICIENCY	RESILIENCY	RENEWABLE ENERGY	STEWARDSHIP	ENGAGEMENT
Low Cost/No Cost Measures	Transition to Low Temperature Hot Water	Large Scale Solar Power Purchase Agreement	Campus Energy Manager	Energy Conservation Awareness and Behavioral Change
Energy Conservation Measures	Low Carbon Energy Supply • Backup and Peak Generation • Geothermal • Heat Pumps • Thermal Energy Storage	2.5 MW Solar PV on Collins Property	Retro-commissioning	Integration with Curriculum, Research, and Workforce Development
Building Renovations	Integration with Facilities Master Plan (FMP)	EV & Fleet Transition	Preventative Maintenance Focus	Campus Sustainability Coordinator
Deep Energy Retrofits	Regional Energy Issues	Biofuel	Advanced Metering and Data Analysis	President's Advisory Council on Sustainability
Net Zero Carbon New Buildings			Workforce Development	
% Contribution to GHG Reduction				
16.7%	**52.6%**	**20.5%**	**3.3%**	**6.8%**
% Contribution to Total Site kBtu/GSF Reduction				
46.6%	**34.9%**	**0.0%**	**7.7%**	**10.8%**

3.1 Basis for a Low Carbon Transition

The fundamental basis for establishing a low carbon campus is transitioning the district heating network from a mix of steam and MTW to low temperature hot water. Figure 13 below summarizes the current situation of a steam/MTW-based campus district energy network and the vision of a future low carbon energy supply. This conversion has the following attributes:

- Allows the use of existing assets to maximum extent practical during the transition period
- Enables a flexible system where low carbon technologies can be incorporated over time – a plug and play approach, while providing provisions for future developments of heating and cooling technology developments
- Allows the use of existing assets to extent practical during the transition period
- Integrates with building improvements tied to FMP

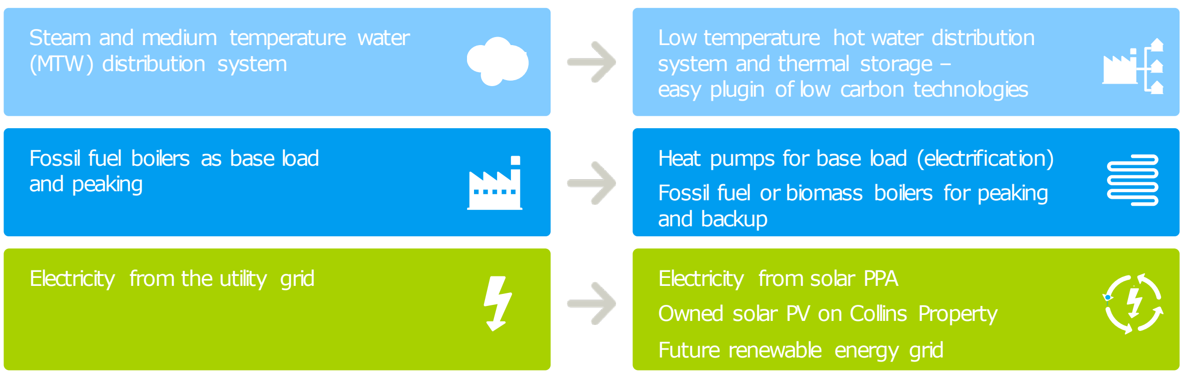

Figure 13. SUNY Oneonta District Energy Network – Current Versus Vision

Figure 14 details the existing distribution network, which has three MTW lines (North, East, and West) and two steam lines (South and West). The West MTW line serves Hulbert Hall and is fed from the West Steam line via a medium pressure steam to MTW heat exchanger located in Human Ecology.

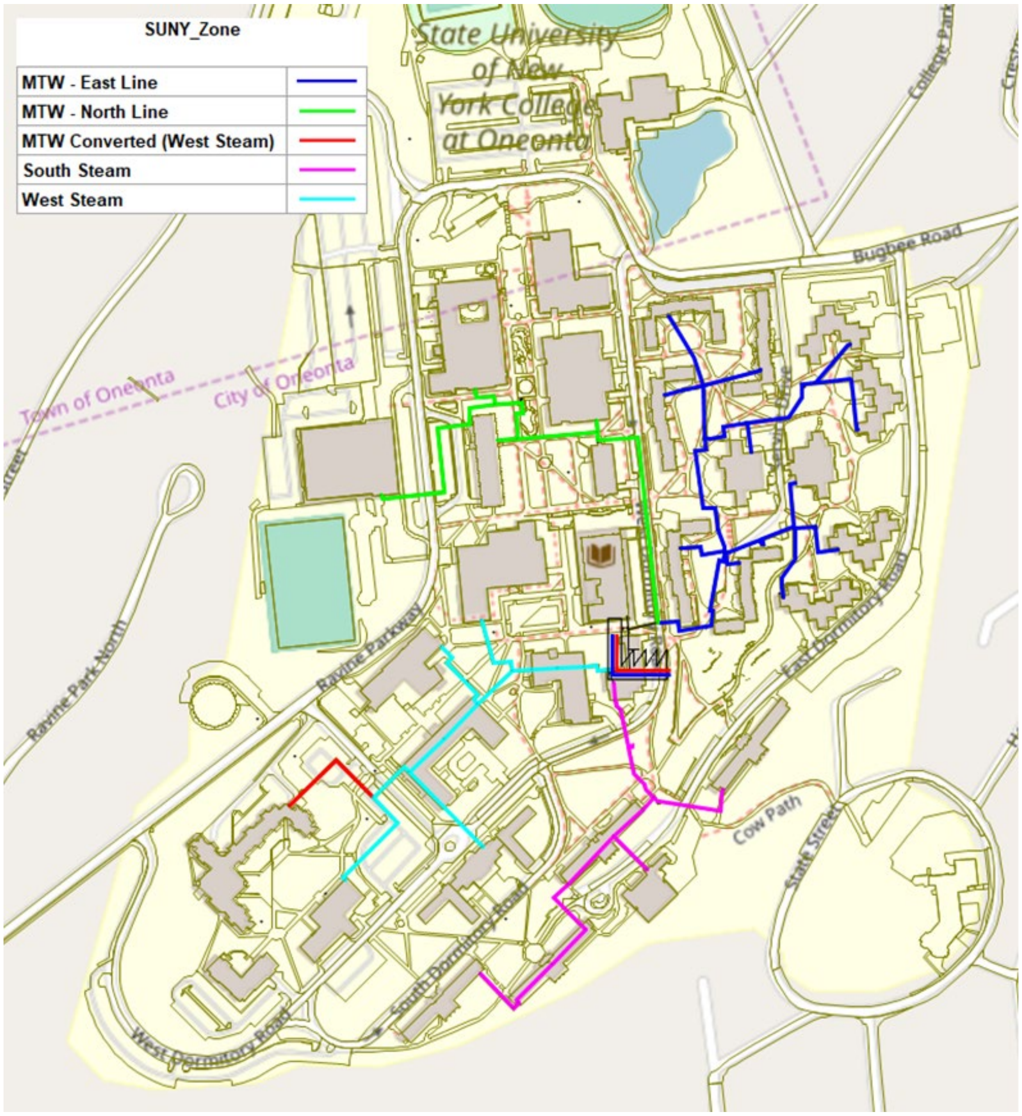

Figure 14. Existing Distribution Network

3.2 Energy Modeling and Scenario Planning

To help establish the vision of a future low carbon energy supply, a feasibility study of energy demand and supply scenarios was completed to provide quantitative information and path forward considerations. The existing conditions (*i.e.*, Base Case) were compared to fourteen scenarios that included integrated variations of measures and technologies such as energy conservation measures, steam and MTW to low temperature hot water conversion, ground source heat pumps (GSHP), thermal energy storage (TES), biomass, bio-oil, and solar PV. The results are summarized in an Energy Scenario Planning Report (November 2020) that can be referenced for specific details.

A stakeholder engagement meeting was held on May 14, 2020 with the SUNY Oneonta CEMP committee and SUNY Oneonta Administration to share the energy modeling and scenario planning results and discuss current and future district energy aspects. Figure 15 represents the six scenarios (3, 5, 7a, 8a, 7c, and 8c) that aligned SUNY Oneonta's priorities with NYS mandates and SUNY's goals/directives.

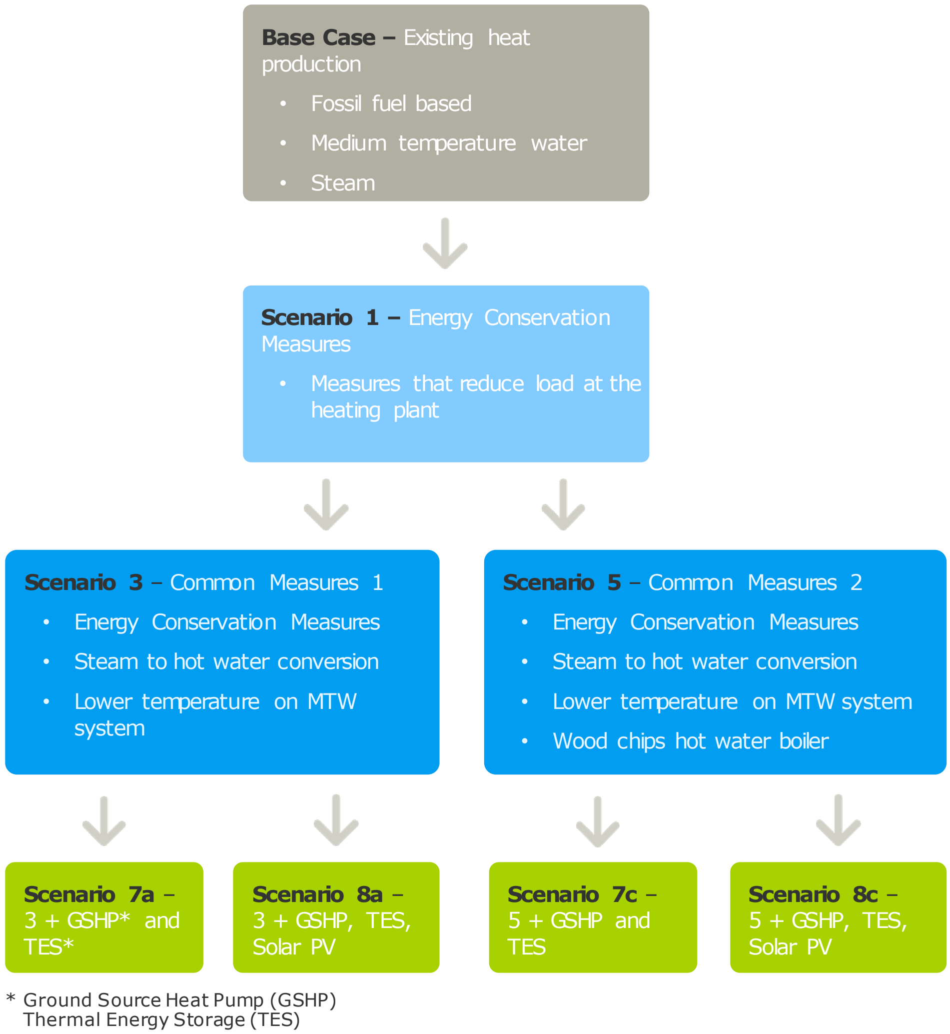

Figure 15. Clean Energy Scenarios Evaluated

Scenarios 3 and 5 are common measures, with Scenario 5 including the introduction of a biomass (wood chip) hot water boiler into the boiler plant. Of those common measures, ECMs around campus have been and will continue to be implemented. While emissions for biomass and bio-oil are similar, biomass appeared more favorable to the campus because it is a more cost-effective fuel than bio-oil. This analysis assumes biomass and bio-oil have limited GHG emissions given their consideration as renewable energy sources. However, there are regular ongoing discussions about the sustainability of using biomass (*e.g.* wood pellets or wood chips) and bio-oil.

Scenarios 7a and 7c include a central GSHP system, and a low temperature hot water network is envisioned that would include thermal energy storage. A final location of the wells has not been determined at this time, but several possible locations have been identified, as shown below in Figure 16 and Table 9.

Figure 16. Location of Wells for the GSHP System

Table 9. Potential Capacity from GSHP System

Area	Description	Area (SF)	Est no. of wells	Cooling Capacity (ton)	Heating Capacity (kBtu/hr)
01	Area planned for 24 wells next to Denison Hall (No. 10) and Tobey Hall (No. 41). Area approx. 328 x 131 feet	43,034	111	217	3,700
02	Area next to Hulbert Hall (No. 20). Approximately 98 x 229 feet	22,400	58	113	1,933
03	Parking lot in front of building 32	25,820	66	129	2,200
04	Parking lot at Alumni Field House (98 x 656)	64,300	166	325	5,533
05	Parking lot next to Human Ecology (No 21). Area: 147 x 164 ft	24,100	62	121	2,067
06	Parking lot next to tennis courts and building 27	59,171	152	297	5,067
Total		**238,825**	**615**	**1,202**	**20,500**

Scenarios 8a and 8c include the addition of a 2.5 MW solar PV array. The Collins property has been identified as a potential location for solar PV. A mixed use of the Collins property has been discussed, including solar PV, solar thermal, recreational use, and a portion as a carbon sequestration wood lot.

3.3 Scenario Planning – Economic Results and Discussion

Figure 17 provides a comparison of project costs in net present value (NPV) and associated GHG emissions from the scenarios. By developing a low temperature hot water loop for district heating and establishing a platform for low carbon technologies, it will be possible to lower emissions considerably. The total costs over the 20-year evaluation period are higher than in the existing conditions (base case) when moving toward low carbon emission technologies. This is primarily due to low natural gas prices. However, SUNY Oneonta has resiliency and reliability concerns related to the region's natural gas capacity constraints and pipeline condition that results in New York State Electric & Gas (NYSEG) interruptions during the heating season.

The yellow diamonds show the present value for each of the scenarios in million US Dollars. Costs (capital expenditures, operating and maintenance expenditures) are accounted for in each year over a 20-year period. The emissions from the base case (2018) without renewable electricity (gray column) are compared to scenario alternatives without renewable electricity (blue columns) and with renewable electricity (green column), which align with the CLCPA commitment to a carbon free electric grid by 2040, as well as SUNY Oneonta's participation in the NY HE LSRE consortium or another potential power purchase agreement (PPA) option.

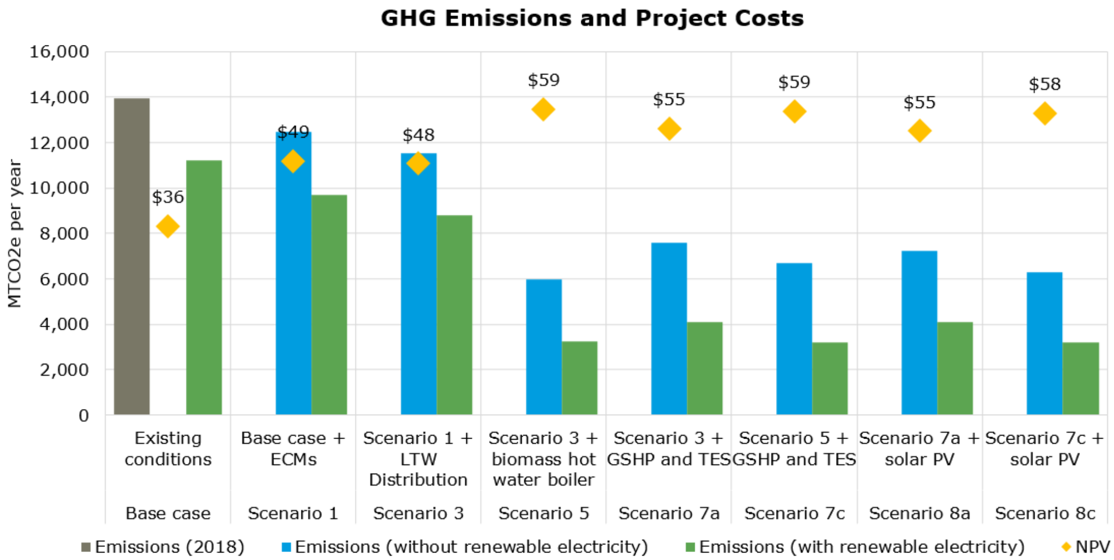

Figure 17. Low Carbon Energy Scenarios Comparison

Capital and operating and maintenance expenditures are accounted for in a 20-year period NPV. The residual value of assets that have a technical lifetime beyond the 20-year period is also considered. The net present value is the lifetime costs assuming a 4.5% discount rate.

NPV costs increase from the existing conditions because costs for energy efficiency measures and conversion of steam buildings to hydronic have been incorporated into the models. The estimated total capital expenditure is approximately $14 million and only considers energy measures associated with heat demand reduction.

Key attributes and the estimated percent carbon reduction for each scenario are summarized in Table 10, below.

Table 10. Low Carbon Energy Scenario Attributes

Scenario	Key Attributes	Estimated Carbon Reduction from Baseline without Renewable Electricity (%)	Estimated Carbon Reduction from Baseline with Renewable Electricity (%)
Base Case	• Existing steam/MTW distribution from heating plant (natural gas/fuel oil) • Natural gas satellite boilers	-	-
1	• Energy efficiency measures that reduce heat demand • Heat demand reduced by 17%	13%	36%
3	• Convert steam and MTW to LTW • MTW reduced to 180°F • Reduces distribution losses • Enables integration of low carbon heating technologies	21%	44%
5	• Biomass boiler offsets fossil fuels at heating plant • Natural gas still used in satellite boilers • NPV increase due to high price of biomass	60%	92%
7a	• GSHP • Significant decrease in fossil fuel emissions • Increase in electric use from electric heat pumps • Natural gas boilers used at heating plant when heat pumps do not have adequate capacity	55%	85%
7c	• GSHP • Increase in electric use from electric heat pumps • Biomass boiler offsets fossil fuels at heating plant, only used when heat pumps do not have adequate capacity	63%	92%
8a	• Same as 7a • 2.5 MW PV array	58%	85%
8c	• Same as 7c • 2.5 MW PV array	66%	92%

While opinions and stances vary, the USEPA treats biogenic CO_2 emissions from the combustion of biomass from managed forests at stationary sources for energy production as carbon neutral[1]. For purposes of developing this CEMP, CO_2 emissions from burning biomass has been assumed to be zero, while the associated carbon dioxide equivalent (CO_2e) constituents of methane (CH_4) and nitrous oxide (N_2O) have been included for estimating GHG emissions.

[1] https://www.epa.gov/air-and-radiation/epas-treatment-biogenic-carbon-dioxide-emissions-stationary-sources-use-forest#:~:text=On%20April%2023%2C%202018%2C%20EPA,energy%20production%20at%20stationary%20sources.

Heat pumps with thermal storage will enable the use of renewable energy expected from the utility grid (over time), or from Oneonta's plans to enter into a large-scale solar power purchase agreement (PPA) and/or install solar PV on campus. Heat pumps (as in Scenarios 7a, 7c, 8a, and 8c) are a good low carbon option. Whether biomass should be combined with heat pump production (as in 7c and 8c) would need further consideration; this will depend on biomass price and availability, as well as the perception of biomass as a low carbon fuel.

Production of district cooling was not part of the scope of the assessment. District cooling can contribute to savings as well as allow additional flexibility (*e.g.*, further increase energy efficiency, require fewer chillers). The additional costs of adding a cooling network when a heating network is already being installed is much less than for a stand-alone cooling network. If heat pumps (additional GSHP or possibly air-source heat pumps) are introduced as part of the low carbon technologies, they will also be able to produce cooling.

When the heat pump/chiller produces hot water and chilled water simultaneously, the combined coefficient of performance (COP)[2] will be approximately 6 to 7 instead of approximately 3.5 when producing hot water alone or 5 when producing chilled water alone. Furthermore, district cooling with thermal storage can reduce costs due to:

- Reduced need for cooling production capacity due to demand diversity and thermal storage to reduce cooling peaks.
- Reduced operation and maintenance cost (fewer, centralized chillers).
- Reduced or eliminate need for cooling towers (heat is utilized).
- Reduced capital expenditures for chillers (economies of scale and lower capacity).

The 2.5 MW solar PV array would require approximately 10 to 15 acres of space, which is available on the Collins property, and would be expected to produce approximately 3,300 MWh per year; about 14% of the approximately 23,750 MWh total annual campus electric energy use.

With the NYS utility grid expected to be carbon neutral within 20 years, the value of the on-site PV option would be diminished over time in terms of GHG goals. The reduction in emissions from installation of solar PV will be approximately 379 metric tons per year in year 1 and 221 metric tons per year in year 10, with no reduction in year 20. However, the behind the meter PV system would reduce energy costs by reducing distribution costs.

3.4 Potential Low Carbon Heating Strategy

Figure 18 is a load duration curve showing the hourly estimated heating load for the main campus central heating system after ECMs are implemented in the buildings. The shaded areas under the curve represent the amount of heat provided by each supply asset. Note this is a potential heating strategy with ground source heat pump systems that was not part of the base energy scenario evaluation, but it provides a conceptual illustration of the potential extent of GSHP that might be practical at SUNY Oneonta. The GSHP well numbers correspond to entries in Table 9.

[2] The coefficient of performance for a heat pump is heat output divided by the electric energy input to drive the heat pump compressors (heat of rejection divided by work of compression; unitless)

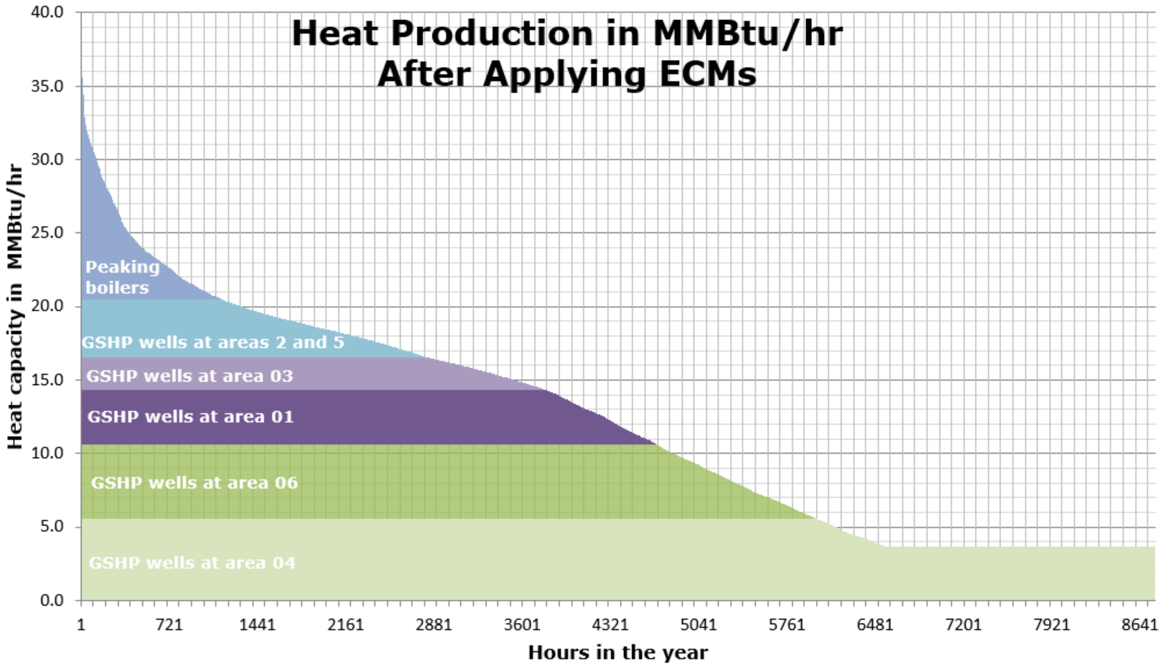

Figure 18. Heat Production for Different Ground Loop Locations

Heat pumps combined with thermal storage enable a connection between the electric grid and the heat demand, but the heat pumps should only be used in combination with a heat storage tank to be able to support the electric grid and should primarily produce hot water during off-peak hours. During peak hours, other technologies should produce heating in the event thermal storage capacities are insufficient. A heat pump system could be combined with other supply technologies (*e.g.* bio-oil or biomass boilers). Bio-oil boilers can be used to operate for only short periods of time during peak heating loads when heat pump capacity cannot sufficiently handle the loads. However, bio-oil market aspects including its maturity, availability, and pricing would need to be evaluated for long-term viability.

For base load purposes, "Wells at area 04" are located at the Alumni Field House parking lot. This location provides the largest potential heating capacity. Figure 18 also suggests other potential locations (*e.g.*, other parking lots, courtyards). Other relevant technologies that could be considered include solar thermal, other heat sources for the heat pumps (*e.g.*, wastewater, air), aquifer thermal energy storage for seasonal storage, and heat recovery chillers. These sources would need further feasibility investigation, but the total production from heat pumps is illustrated at approximately 85-90% of the total annual heating load.

3.5 Proposed Steam and MTW to LTW Phasing Plan

Establishing the low temperature hot water network will have challenges and will require careful consideration to maintain building heating throughout the project period. It may be necessary in early project phases to have both the new low temperature hot water network in operation together with the existing steam and MTW networks. Figure 19 provides a proposed phasing plan to transition steam and MTW to low temperature that aims for a pragmatic timeframe.

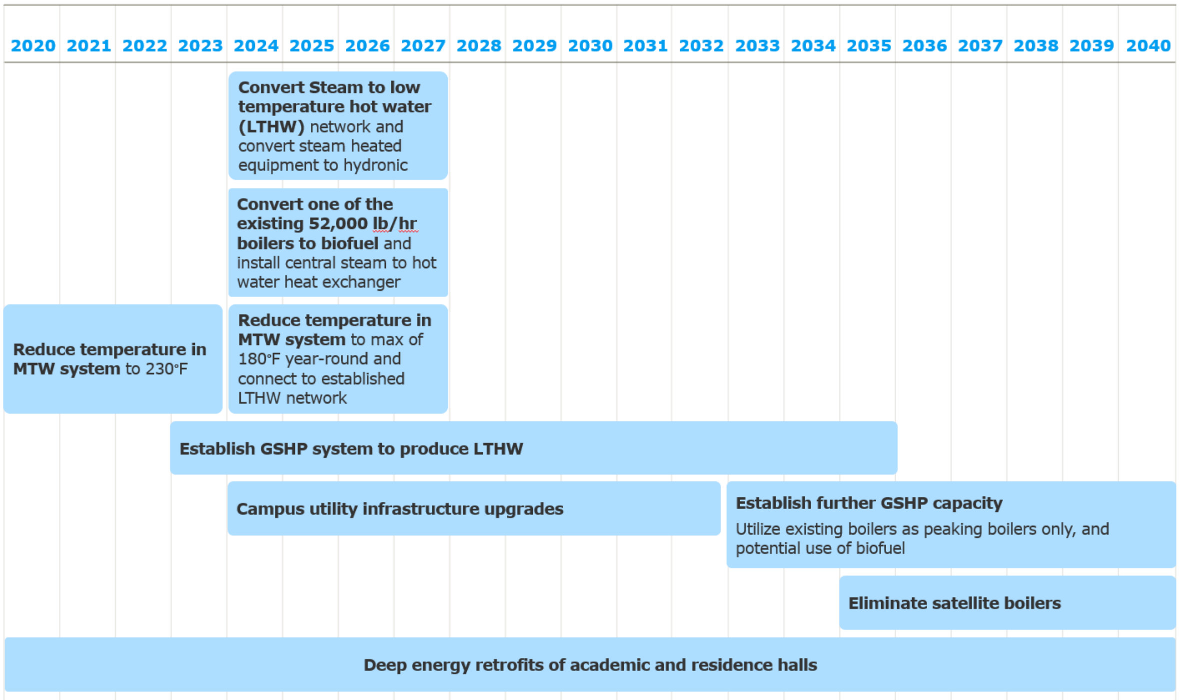

Figure 19. Proposed Steam to Low Temperature Hot Water Phasing Plan

3.6 Summary of Energy Projects

SUNY Oneonta has implemented and continues to implement ECMs. Major renovations to some buildings are also planned and will include deep energy retrofits (*e.g.*, Alumni Hall, Ford Hall). The total efficiency of the energy system can be significantly improved by reducing the required heating supply temperature to the buildings. This will help allow for strategic use of low carbon technologies.

Appendix A presents ECMs that were identified in the Energy Assessment Report (Final June 2020) as a result of this CEMP development process. Major gut renovations that are planned (Alumni Hall, Ford Hall) are also noted and are expected to be further detailed in the FMP. The measures reflect the campus' priorities in physical asset renewal, cost savings, EUI reduction, capital outlay, and GHG reductions. Energy savings subtotals for each of the five strategic focus areas were multiplied by a 0.7 interactive factor to account for potential interaction between measures.

Energy savings were derived from the following utility rates:

- Electricity 0.048 $/kWh
- Natural gas 0.442 $/therm
- Fuel oil 1.909 $/gal
- Propane 1.350 $/gal

Energy conservation measures generally involve capital expenditures that have short to moderate payback periods and are focused on driving near term reductions in GHG emissions and 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. 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. Major building renovations or gut rehabilitations will follow the performance goals of SUCF Directive 1B-2.

3.7 Greenhouse Gas Emissions and Energy Use Intensity Reduction Impact

Figure 20 and Figure 21 represent GHG emissions and EUI trajectories, respectively, as a result of the CEMP. For illustration purposes, business-as-usual increases or decreases in campus gross square footage, student enrollment, or energy consumption are not considered. Both figures account for short-term and long-term energy reductions that SUNY Oneonta is anticipated to implement, however are subject to change based on annual campus priorities and plans, available budgets and funding options, and the future FMP recommendations. Short-term and long-term energy reductions are from estimated implementation timeframes summarized in Appendix A. These include energy projects associated with energy efficiency, resiliency, renewable energy, clean energy technologies, stewardship, and engagement.

Short term energy reductions are represented by the blue dashed portion of the trajectory and are anticipated to occur by 2025. As seen in Figure 20, GHG emissions reduce approximately by 3,400 $MTCO_2e$ during the 2020-2025 period. The primary influence is from SUNY Oneonta’s expected participation in NY HE LSRE consortium or other PPA, which offsets about 2,725 $MTCO_2e$ and would allow SUNY Oneonta to meet its 40% reduction goal (baseline CY1990).

Long-term energy reductions are represented by the yellow dashed portion of the trajectory. SUNY Oneonta’s actual progress during the time period of 2025-2045 will be determined predominately by building renovations tied to the FMP, and ultimately by the low carbon campus strategy adopted by SUNY Oneonta.

Figure 21 below illustrates the estimated site EUI reduction impact of short-term and long-term energy projects. Short-term energy projects are estimated to reduce site EUI from 118 to 106 kilo (1,000) British thermal units per gross square feet (kBtu/GSF). Long-term energy projects are estimated to reduce site EUI from 106 to 70 kBtu/GSF, impacted largely by fossil fuel decreases from the implementation of clean energy technologies.

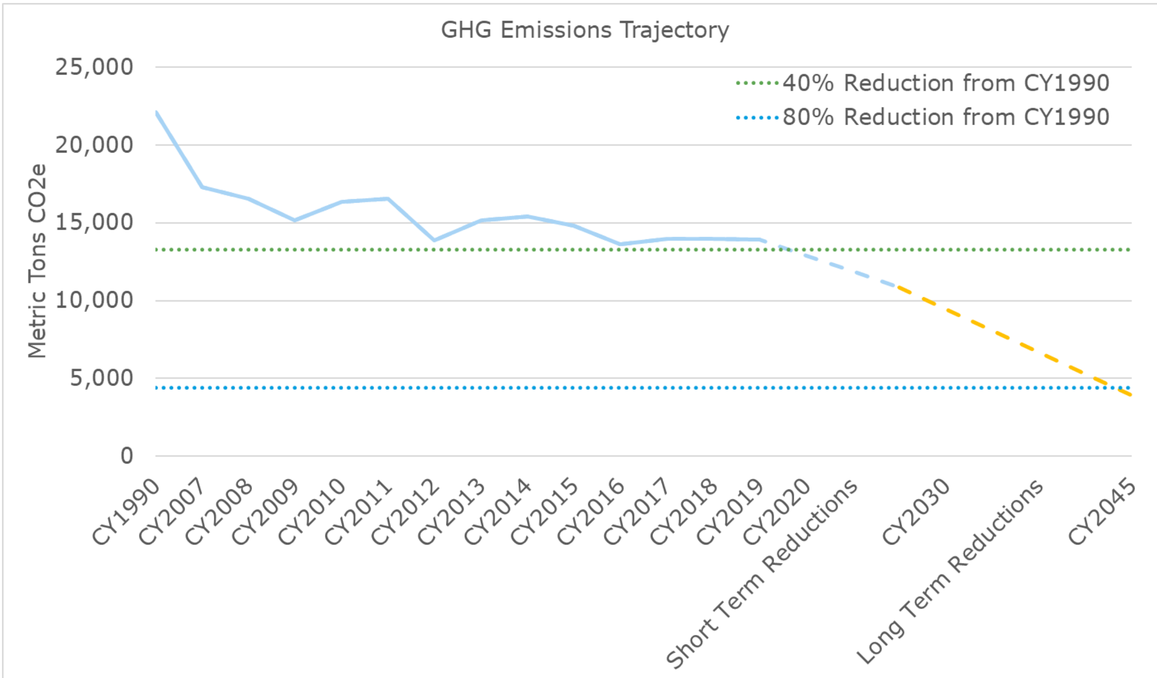

Figure 20. GHG Emissions Trajectory

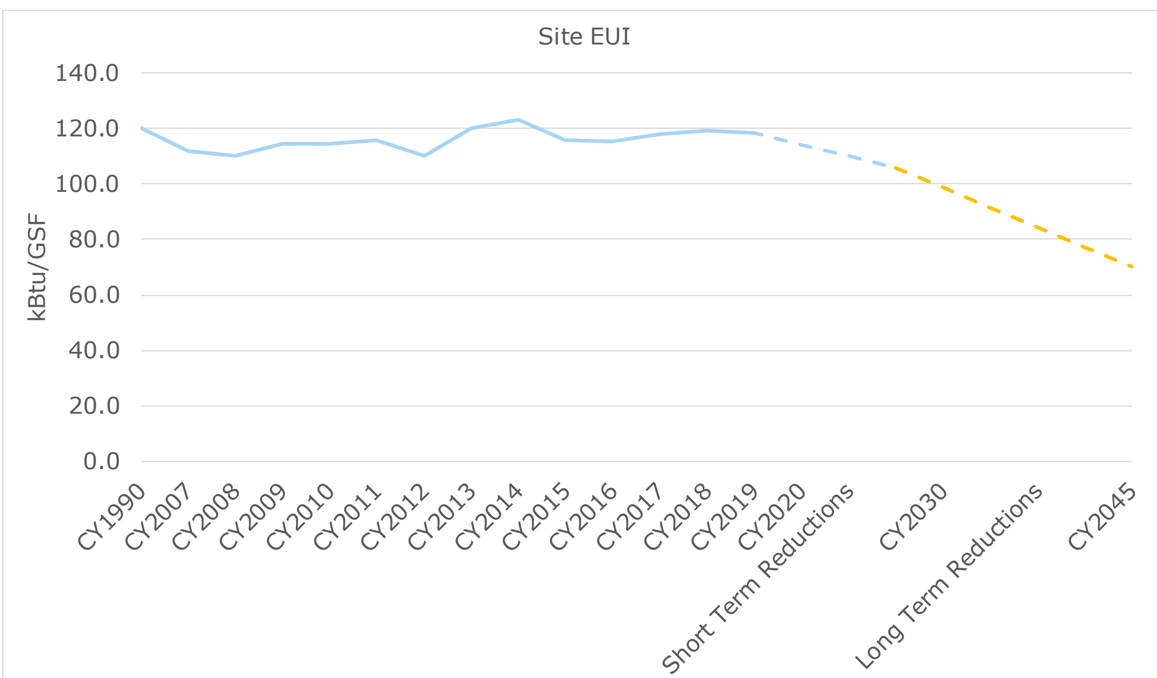

Figure 21. Site Energy Use Intensity Trajectory

3.8 Factors Impacting a Low Carbon Campus Transition

The following factors could influence and impact campus operations, future energy use, and selected energy supply technologies.

- Integration of a future FMP and CEMP will be needed to align the vision, projects, and implementation phasing of both documents.
- Current low utility costs impact on capital project economics and operations and maintenance (O&M) costs.
- Market availability and pricing of biomass or bio-oil as fuel options.
- SUNY Oneonta stakeholder perception of the carbon neutral aspects of biomass or bio-oil.
- Availability of grants or incentives to offset first capital costs. For example, NYSERDA's Ground Source Heat Pump Rebate program or Community Heat Pump Systems (PON 4614).
- Uncertainty of a potential future market tax on carbon or fossil fuels.
- Enrollment changes and associated revenue fluctuations.
- Demand for cooling in buildings that do not have it.

3.9 Summary Considerations and Approach to a Low Carbon Transition

The following key components and considerations shape the roadmap of a low-carbon future at SUNY Oneonta:

1. Maintain buildings on the central supply of heating. Central supply of heating for comfort, as well as for domestic hot water provides several advantages over distributed systems.
2. Convert the steam system to a low temperature hot water system to reduce distribution losses and enable integration of low carbon heating technologies.
3. For the MTW system in the near-term, it is recommended to reduce the temperature in the system to approximately 200°F year around to the practical extent possible while maintaining building humidification needs.
4. Since there are still many years of service life remaining in the steam boilers, it is recommended that a central plant steam to hot water heat exchanger be installed to feed low temperature hot water for campus distribution. Oneonta could consider converting one or two of the existing gas boilers to bio-oil. In future scenarios utilizing electrified heating, bio-oil could be used as a low carbon fuel for peaking and backup.
5. When the low temperature heat network and the peaking and backup production are in place, new low carbon technologies can easily be plugged into the network. Thereby, the supply from ground source heat pumps can gradually be built out. However, from an economic perspective, it would be more economical to install the well fields simultaneously and plan the total size and number of heat pumps based on campus overall needs (rather than several small systems). Oneonta has adequate space available for establishing wells for ground source heat pumps with a heating capacity of approximately 17.6 MMBtu/hr. This is expected to cover approximately 85-90% of the total demand for heat; the long-term heating capacity will depend on the ability to annually balance boreholes thermal loads.
6. With heat pumps, thermal energy storage is recommended. This will enable Oneonta to utilize the electricity in off-peak periods and reduce the use of peaking heat technologies, since the thermal storage would discharge during peak demand periods.

7. It is recommended that campus cooling demand and opportunities for centralized supply be evaluated as well. The same heat pumps which produce heat can produce cooling as well (heat recovery chillers), either as co-production with heating or as separate production. Co-production of heating and cooling will have significantly higher efficiency for the heat pump. The same heat pumps which are utilizing the ground as heat source can be utilized for cooling production and for heat production using other heat sources than the ground. Furthermore, connecting a cooling load to the heat pumps will help balance the annual load of the ground loop, thereby increasing capacity and efficiency of heating and cooling.
8. A potential heating strategy could be the following:
   - Convert the steam system to a low temperature hot water system
   - Convert one of the 52,000 lb/hr boilers to bio-oil and install a central steam to hot water heat exchanger
   - Install ground source heat pumps to supply hot water to the low temperature hot water system
   - Connect the low temperature hot water network (the converted steam system) and the MTW system after the temperature in the MTW system is reduced to a maximum of 180°F year-round.
   - Install additional ground source heat pump capacity
   - Consider potential production from biomass instead of heat pumps
9. Other relevant technologies that could be further investigated are solar thermal, other sources for the heat pumps (*e.g.*, wastewater, air), aquifer thermal energy storage for seasonal storage and heat recovery chillers.

4. ACHIEVE – IMPLEMENTATION PLAN

SUNY Oneonta's engagement and thought leadership were essential to developing a CEMP that captures the campus vision while aligning with goals of SUNY's Clean Energy Master Plan, the CLCPA, and SUCF directive 1B-2. Table 11 below provides a summary of the three key components that will help SUNY Oneonta implement the CEMP and realize the goals of reducing energy usage, increasing energy efficiency, and decreasing operating costs. A broader discussion of these areas immediately follows.

Table 11. Roadmap Implementation Plan Summary

ACHIEVE: Implementation Plan		
Funding	**Implementation Team and Partners**	**Policies and Procedures**
• Alumni • Capital budget, including minor critical maintenance fund • DASNY bonds • Grants/incentives/rebates • Matching funds • NYPA (Performance contract, financing • Operating budget • SUNY Revolving Loan Fund	SUNY Oneonta Team • Administration • CEMP Committee • Facilities Planning • Energy Management	• TMI – to support preventave and predictive maintenance program • Carbon sequestration management • Energy and environmental conservation policies • Education/engagement to promote behavioral change • Facilities Master Plan integration • Key Performance Indicator tracking and performance assessment • SUCF Direction 1B-2 • Workforce Development Program for Building Operations and Maintenance

4.1 Funding

SUNY Oneonta, like many other SUNY campuses, has capital improvement needs outside of energy efficiency, and projects compete for limited available capital funding. SUNY Oneonta will assess availability annually. Many of the ECMs will be funded as part of the campus critical maintenance capital program. In addition, projects may be funded through the following means:

- NYPA low interest financing with debt service from the utility budget
- SUNY Green loans
- Grants and incentives from utility providers (*e.g.*, NYSEG), NYSERDA
- Campus Cash
- Participation in matching funds programs

4.2 Implementation Team

SUNY Oneonta has several contracting mechanisms to implement energy efficiency projects, but the primary mechanism will be through direct campus let, SUCF, NYPA and/or DASNY, who can provide several variations of implementation services for energy projects. SUCF, NYPA, and DASNY also have term consultants under contract who can be utilized for design and construction management.

4.3 Policies and Procedures

The continued demand for more services, including extended building schedules and environmental controls, necessitates the need for careful planning to address the increased demands in a thoughtful and sustainable manner.

SUCF Directive 1B-2 was updated in December 2020. The directive defines and identifies goals for Net Zero Carbon (NZC) new buildings, Deep Energy Retrofits of existing buildings and partial building renovations or system/component replacements to advance SUNY's energy and carbon reduction goals and the CLCPA. The latest version can be found at SUCF's website https://sucf.suny.edu/resources/program-directives.

Education, engagement, and outreach can 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 and carefully thought-out policies and procedures are crucial to ensuring that campus constituents' requests are weighed alongside the needs of the campus and its energy and GHG reduction goals.

4.4 Keys to Success

Keys to successfully implement the Roadmap include:

- Integration with the FMP
- Continued support from senior administration on energy efficiency and sustainability goals
- Availability of SUCF and DASNY funding, as well as NYPA financing at a low 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 buildings and systems
- Establishing a regular CEMP update schedule to assess progress and incorporate adaptive changes resulting from items such as legislation and mandate changes, campus and/or SUNY initiatives, electricity grid progress towards renewable energy, and clean energy technology advancements

4.5 Key Performance Indicators

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

- Annual Greenhouse Gas (GHG) emissions monitored in carbon dioxide equivalent (CO_2e)
- Annual Site EUI
- Financial impact (*e.g.*, project costs, energy, and cost savings, return on investment, annual net cash flow, $/MT$CO_2$e reduced)

- Dollars invested in infrastructure renewal
- Operations & maintenance savings
- Integration in curriculum, research, and work force development programs
- Student/staff/faculty perception/feedback
- Non-energy benefits including improvements in occupant comfort, reliability, and resiliency
- Advancement and achievement of sustainability goals

The CEMP will guide actions over a 20-year horizon that will help SUNY Oneonta position to achieve short-term and long-term energy and carbon reduction goals. These reductions are achieved through energy efficiency, infrastructure renewal, incorporating clean energy supply technologies, renewable energy, building upgrades, stewardship of physical assets, and engaging our campus stakeholders.

APPENDIX A
ENERGY PROJECTS SUMMARY

State University of New York at Oneonta
REV Campus Challenge - Clean Energy Master Plan

ECM Summary

ECM No.	Potential ECM	Buildings Affected	Annual Electrical Savings (kWh/yr)	Electrical Peak Demand Savings (kW)	Annual Natural Gas Savings (therms/yr)	Annual Fuel Oil Savings (gal/yr)	Annual Propane Savings (gal/yr)	Annual Energy Cost Savings ($/yr)	Estimated Capital Cost	Simple Payback Period (years)	Annual GHG Reduction (MTCO2e)	Cost per MTCO2e Reduction	Campus Source EUI Reduction (kBtu/GSF/yr)	Percent EUI Reduction from CY2019	Estimated Implementation Timeframe from Year 0 (years)	Notes	Include Measure in CEMP?
	Energy Efficiency																
ECM-2	Automated Control of MTW Pump VFDs	Central Heating Plant	81,289	12.9	0	0	0	$3,902	$7,149	1.8	9	$764	0.4	0.2%	0-1	1	Y
ECM-3	Automated Control of Feedwater Pump VFDs	Central Heating Plant	124,480	15.6	0	0	0	$5,975	$22,424	3.8	14	$1,564	0.6	0.3%	0-1	1	Y
ECM-5A	Kitchen Demand Controlled Ventilation (DCV) - Hulbert Hall	Hulbert Hall	12,366	4.9	9,318	350	0	$5,380	$42,900	8.0	55	$782	0.5	0.2%	0-1	1, 2	Y
ECM-5B	Kitchen Demand Controlled Ventilation (DCV) - Mills Hall	Mills Hall	33,045	7.1	8,532	320	0	$5,969	$38,925	6.5	53	$738	0.6	0.3%	0-1	1, 2	Y
ECM-5C	Kitchen Demand Controlled Ventilation (DCV) - Wilsbach Hall	Wilsbach Hall	46,255	6.9	18,337	688	0	$11,638	$35,750	3.1	110	$324	1.1	0.5%	0-1	1, 2	Y
ECM-6	Chilled Water Pump VFD	Human Ecology, Lee Hall, Mills Hall, Science 1, Wilsbach Hall	62,012	8.6	0	0	0	$2,977	$83,680	28.1	7	$11,717	0.3	0.1%	0-1	1	Y
ECM-7	Hot Water Pump VFD	Hulbert Hall, Human Ecology, Wilber Hall	36,797	0.0	0	0	0	$1,766	$239,437	135.6	4	$56,499	0.2	0.1%	0-1	1	Y
ECM-8	Differential Pressure Reset	Alumni Field House, Alumni Hall, Bugbee, Chase PE, Cooperstown BFS, Fine Arts Center, Fitzelle, Higgins, Hulbert, Hunt, IRC, Lee, Mills, Milne Library, MOC, Morris, Bacon, Denison, Netzer, Physical Science, Red Dragon Outfitters, Schumacher, Science 1, Welcome Center, Wilsbach	47,869	21.0	0	0	0	$2,298	$46,292	20.1	6	$8,397	0.2	0.1%	1-2	1	Y
ECM-9	Multizone VAV Static Pressure Reset	Cooperstown BFS, Fitzelle, Human Ecology, Hunt, IRC, Lee, Physical Science, Science 1, Welcome Center	384,762	33.5	0	0	0	$18,469	$25,361	1.4	44	$572	1.9	0.9%	2-3	1	Y
ECM-10	Milne Library VAV Retrofit	Milne Library	831,132	30.4	6,899	259	0	$43,438	$938,774	21.6	135	$6,940	4.3	2.2%	4-5	1	Y
ECM-11A	Constant Volume Single Zone to Single Zone VAV Retrofit	Alumni Hall	42,412	2.8	0	0	0	$2,036	$13,286	6.5	5	$2,720	0.2	0.1%	10-20	1	Y
ECM-11B	Constant Volume Single Zone to Single Zone VAV Retrofit	Chase PE	127,118	6.6	0	0	0	$6,102	$48,796	8.0	15	$3,333	0.6	0.3%	10-20	1	Y
ECM-11C	Constant Volume Single Zone to Single Zone VAV Retrofit	Fine Arts Center	26,365	1.3	0	0	0	$1,266	$9,441	7.5	3	$3,109	0.1	0.1%	10-20	1	Y
ECM-11D	Constant Volume Single Zone to Single Zone VAV Retrofit	IRC	42,412	2.8	0	0	0	$2,036	$1,910	0.9	5	$391	0.2	0.1%	10-20	1	Y
ECM-11E	Constant Volume Single Zone to Single Zone VAV Retrofit	Old Greenhouse, Chem Storage, Old O + M	20,346	0.8	0	0	0	$977	$13,572	13.9	2	$5,792	0.1	0.0%	10-20	1	Y
ECM-12	Demand Controlled Ventilation	Chase PE, Fine Arts Center	279	4.7	14,830	556	0	$7,630	$10,729	1.4	85	$126	0.7	0.3%	2-3	1	Y
ECM-13	Scheduling and Optimum Start - Representative Project	Milne Library	709,725	0.0	17,236	647	0	$42,920	$237,397	5.5	181	$1,315	4.2	2.1%	10-20	1	Y
ECM-14	Occupancy Based HVAC Controls - Representative Project	Netzer Administration	35,120	0.0	2,878	108	0	$3,164	$157,487	49.8	21	$7,665	0.3	0.2%	10-20	1	Y
ECM-15	Energy Recovery	Netzer Administration	-38,921	19.0	11,761	441	0	$4,173	$93,844	22.5	63	$1,491	0.4	0.2%	4-5	1	Y
ECM-16	MTW and Steam Distribution System Thermal Blanket Insulation - Shannon Enterprises	Central Heating Plant, Science 1, Human Ecology, Hulbert, Milne, Chase, Schumacher, IRC, Netzer, Alumni Field House, Fine Arts Center, West Steam Tunnel	0	0.0	59,641	2,238	0	$30,633	$117,167	3.8	342	$343	2.8	1.4%	10-20	1, 3	Y
ECM-18	Science 1 Fume Hood Exhaust Fan VFD	Science 1	77,117	9.0	0	0	0	$3,702	$67,943	18.4	9	$7,650	0.4	0.2%	10-20	1, 4	Y
ECM-19	Steam Turbine to Replace PRV Station	Central Heating Plant	1,056,480	124.0	0	0	0	$50,711	$847,633	16.7	122	$6,966	5.1	2.6%	4-6	1	Y
ECM-20	IRC LED Lighting Retrofit	IRC	136,915	57.7	-1,423	-53	0	$5,841	$362,012	62.0	8	$47,576	0.6	0.3%	5-6	1	Y
ECM-21A	Chase PE Pool LED Tube Lighting Retrofit	Chase PE	10,605	4.8	-110	-4	0	$452	$5,838	12.9	1	$9,902	0.0	0.0%	0	1, 5	Y
ECM-21B	Chase PE Pool LED Fixture Lighting Retrofit	Chase PE	-32,493	-14.7	338	13	0	-$1,386	$80,589	N/A	-2	N/A	-0.1	-0.1%	N/A	1, 5	N
ECM-22	Campus LED Lighting Retrofit	Campus Wide	3,813,369	903.0	-13,815	-473	-205	$175,755	$7,187,276	40.9	359	$20,009	17.7	8.9%	10-20	1	Y
	SUBTOTAL		**5,403,544**	**894.2**	**93,859**	**3,553**	**-144**	**$307,444**	**$7,458,516**	**24.3**	**1,160**	**$6,430**	**30.3**	**15.2%**			
	Resiliency																
ECM-1A	R-22 Chiller Replacement - Cooperstown BFS	Cooperstown BFS	8,538	4.9	0	0	0	$410	$169,098	412.6	1	$171,968	0.0	0.0%	7-8	1	Y
ECM-1B	R-22 Chiller Replacement - Human Ecology	Human Ecology	64,136	37.1	0	0	0	$3,079	$322,108	104.6	7	$43,608	0.3	0.2%	6-7	1	Y
ECM-1C	R-22 Chiller Replacement - IRC	IRC	65,490	55.8	0	0	0	$3,144	$302,088	96.1	8	$40,052	0.3	0.2%	0-1	1	Y
ECM-1D	R-22 Chiller Replacement - Lee Hall	Lee Hall	19,906	25.4	0	0	0	$955	$163,864	171.5	2	$71,477	0.1	0.0%	8-9	1	Y
ECM-1E	R-22 Chiller Replacement - Mills Hall	Mills Hall	21,249	12.7	0	0	0	$1,020	$223,438	219.1	2	$91,303	0.1	0.1%	1-2	1	Y
ECM-1F	R-22 Chiller Replacement - Milne Library	Milne Library	101,895	44.7	0	0	0	$4,891	$595,095	121.7	12	$50,710	0.5	0.2%	0-1	1	Y
ECM-1G	R-22 Chiller Replacement - Netzer Administration	Netzer Administration	65,983	54.6	0	0	0	$3,167	$369,870	116.8	8	$48,672	0.3	0.2%	3-5	1	Y
ECM-1H	R-22 Chiller Replacement - Science 1	Science 1	44,178	1.9	0	0	0	$2,121	$179,966	84.9	5	$35,371	0.2	0.1%	3-4	1	Y
ECM-1I	R-22 Chiller Replacement - Wilsbach Hall	Wilsbach Hall	17,076	19.5	0	0	0	$820	$212,570	259.3	2	$108,089	0.1	0.0%	5-6	1	Y
ECM-23	Heating Plant Controls	Central Heating Plant	0	0.0	0	0	0	$0	$170,000	N/A	0	N/A	0.0	0.0%	0-2		Y
ECM-24	Low Carbon Energy Supply Scenario (Scenario 8a)	Campus	-3,217,429	0.0	1,011,006	0	0	$329,730	$27,688,283	84.0	5,038	$5,496	28.8	14.5%	10-20	6	Y
ECM-27	Alumni Hall Deep Energy Retrofit	Alumni Hall	-35,903	0.0	7,752	595	0	$2,838	$13,992,443	4930.2	43	$322,224	0.2	0.1%	2-5	1, 9	Y

State University of New York at Oneonta
REV Campus Challenge - Clean Energy Master Plan

ECM Summary

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ECM-28	**Ford Hall Deep Energy Retrofit**	Ford Hall	165,654	0.0	14,253	1,057	0	$16,269	$16,910,016	1039.4	106	$159,307	1.5	0.7%	2-3	1, 9	Y
	SUBTOTAL		**-1,875,459**	**179.6**	**723,108**	**1,156**	**0**	**$257,910**	**$42,909,188**	**166.4**	**3,664**	**$11,710**	**22.7**	**11.4%**			
	Renewable Energy																
ECM-25	**Offsite Large Scale Purchased Renewable Energy**	Campus	0	0.0	0	0	0	-$85,084	$0	N/A	2,044	$0	0.00	0.0%	0-5	7	Y
	SUBTOTAL		**0**	**0.0**	**0**	**0**	**0**	**-$59,559**	**$0**	**N/A**	**1,431**	**$0**	**0.00**	**0.0%**			
	Stewardship																
ECM-4A	**Kitchen MAU BAS Adjustments - Hulbert Hall**	Hulbert Hall	85,369	-11.0	-1,444	-54	0	$3,356	$941	0.3	2	$605	0.3	0.2%	0-1	1	Y
ECM-4B	**Kitchen MAU BAS Adjustments - Mills Hall**	Mills Hall	-33,799	-19.6	-2,970	-111	0	-$3,148	$538	N/A	-21	N/A	-0.3	-0.2%	0-1	1	Y
ECM-4C	**Kitchen MAU BAS Adjustments - Wilsbach Hall**	Wilsbach Hall	68,420	36.1	-30,682	-1,151	0	-$12,475	$941	N/A	-168	N/A	-1.1	-0.5%	0-1	1	Y
ECM-17	**Retro-commissioning**	Campus	1,059,447	0.0	66,305	3,687	420	$87,766	$435,315	5.0	517	$842	8.3	4.1%	0-5	1	Y
	SUBTOTAL		**825,606**	**3.9**	**21,847**	**1,659**	**294**	**$52,850**	**$306,415**	**5.8**	**231**	**$1,328**	**5.0**	**2.5%**			
	Engagement																
ECM-26	**Energy Conservation Awareness and Behavioral Change**	Campus	1,181,718	0.0	92,478	4,383	900	$107,180	$0	0.0	681	$0	10.1	5.1%	0-5	8	Y
	SUBTOTAL		**827,203**	**0.0**	**64,734**	**3,068**	**630**	**$75,026**	**$0**	**0.0**	**477**	**$0**	**7.0**	**3.5%**			
	GRAND TOTAL		**5,180,894**	**1,077.7**	**903,548**	**9,436**	**780**	**$633,671**	**$50,674,118**	**80.0**	**6,962**	**$7,278**	**65.2**	**32.7%**			

Notes	
1	Energy savings will be impacted by interactive effects from other measures. These interactive effects were not considered when calculating energy savings.
2	Savings assume ECM-4 is implemented prior to implementing ECM-5.
3	Measure was proposed by Shannon Enterprises on November 11, 2014. Project cost was escalated for this study by 2% per year to 2019.
4	Savings and cost estimates were taken from a Guth-DeConzo Retrocommissioning Scoping Survey dated February 5, 2018. Project cost was escalated for this study by 2% per year to 2019.
5	Measures are mutually exclusive.
6	Savings and project cost estimate represents Scenario 8a from the Ramboll Scenario Planning Feasibility Study Report.
7	Measure assumes 75% of electricity will be purchased through offiste renewable energy, with a 10% increase in purchased electricity costs.
8	Measure assumes a 5% reduction in electricity and natural gas consumption can be achieved through energy conservation awareness and behavioral changes
9	Savings estimated assuming the renovation will comply with SUCF Directive 1B-2. Cost estimate based on past deep energy retrofit projects, assuming $298/GSF.
10	Subtotals are multiplied by a 0.7 interactive factor to account for interaction between measures.