2015 Interim Assessment of UConn's Climate Action Plan

This report summarizes background related to UConn's Climate Action Plan (CAP) commitment to a carbon-neutral campus, then reviews progress made since the CAP was approved in 2010 and reaffirmed by President Herbst in 2012. In the attached tables, we've used data derived from past experience to estimate greenhouse gas (GHG) emissions reductions to be achieved from ongoing and potential projects. We've also used energy models and emissions factors to estimate anticipated GHG increases from planned capital improvements and the addition of fuel-burning equipment. If reliable cost data is available for projects, it is cited in order to recommend the most effective ways to meet or exceed our interim carbon reduction goals.

As the University advances through the first year of the 10-year, $1.5 billion, Next Gen CT capital improvement program, new construction and expanded enrollment at the main campus are likely to increase demand factors and corresponding GHG emissions. In fact, energy models for projects already in design or construction show that this will happen as new buildings come on-line over the next few years.[1] On the other hand, the potential impact of Next Gen growth on UConn's carbon footprint has also served as a catalyst for the kind of innovation, focus and teamwork needed to achieve our goals. With the CAP's initial interim milestone (2020) fast-approaching, and informed by the first five years of implementation measures, it has become necessary to review and update our carbon reduction strategies.

Senior administrators and staff from several operational departments have been meeting regularly since February 2015 to prepare this report (see full list of participants below). In a collaborative effort among Facilities Operations, PAES and OEP, our objective has been to identify, assess and advance potential projects and other actions needed to achieve steady progress toward the CAP's interim carbon reduction targets. Specifically, the effort has focused on what will be needed to achieve at least 20% reductions from our 2007 baseline by 2020 and 30% reductions by 2025. In turn, this process will help ensure UConn's responsible growth and better align the CAP with:

- New academic and master plans,
- Public policy and regulatory trends,
- Emerging best practices among peer institutions, and
- State-of-the-art technologies for clean and efficient energy and transportation.

Ultimately, this process for reviewing progress with the CAP will help UConn achieve its aspirational carbon-reduction targets and advance its national and international reputation as a leader in environmental stewardship and campus sustainability.

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[1] See Figure 1, attached, which shows estimated increases in GHG emissions from recently completed and proposed new construction projects. Previous projections for the impacts of proposed buildings presented in February 2015 were estimated using a conservative energy model based on peak design load. Since that time, energy modeling conducted as part of the LEED certification process for planned buildings was available. As a result substantial reductions in the impact of new construction projections were achieved by using a more accurate LEED energy model.

CAP Interim Assessment Group Participants

Mike Jednak, Associate Vice President, Facilities Operations & Building Services (FOBS)
Stan Nolan, Director, Utility Operations & Energy Management
Logan Trimble, Executive Director, FOBS
Lynn Hallarin, Director, Business Services Center, FOBS
Matt Cohen, Energy Services, Project & Program Specialist
Laura Cruickshank, University Master Planner and Chief Architect
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UConn's Climate Leadership Commitment – the ACUPCC

In 2008, President Michael Hogan signed the American College & University Presidents' Climate Commitment (ACUPCC), committing UConn to a carbon-neutral main campus (including the Depot) by 2050. The CT DEP (now known as the Department of Energy and Environmental Protection or DEEP) was a major proponent and then-DEP Commissioner Gina McCarthy (now US EPA Administrator) keynoted UConn's signing ceremony. More than 700 college and university presidents or chancellors signed on to the ACUPCC.

Pursuant to this commitment, in 2010, UConn adopted a CAP with ideas advanced through a series of workgroup and task force meetings that included faculty, staff and students. With the baseline year of 2007 established by the ACUPCC, UConn's CAP contained more than 200 goals and strategies for reducing emissions. The pace of reductions needed to achieve carbon neutrality was estimated at roughly 2% a year.

Action items focused sharply on energy, because UConn's annual GHG inventories have consistently shown that the use of fossil fuels to power, heat and cool campus buildings accounts for more than 80% of our carbon footprint. The CAP also included goals and strategies for reducing emissions through certain transportation measures and for improving sustainability-related outreach and academic programs.

In 2012, President Susan Herbst reaffirmed UConn's commitment to carbon neutrality and the CAP. Again, DEEP was a major proponent and participant in the signing ceremony. More recently, Governor Malloy formed the CT Climate Change Council and challenged all state agencies to achieve a minimum 80% GHG reduction goal by 2050.

President Herbst also approved the addition of a Climate Adaptation section to the CAP. This section encourages UConn's role in helping communities build resiliency to the effects of climate change (e.g., more frequent and severe storms and flooding from sea level rise). In January 2014, following extensive damage in CT from two 100-year storms, one 50-year storm, and a record-setting blizzard over a three-year period, UConn partnered with DEEP, EPA and other government agencies to establish the Connecticut Institute for Resiliency and Climate Adaptation (CIRCA) at Avery Point. Speakers at the dedication ceremony included Governor Malloy, several members of CT's Congressional delegation and state legislature, and EPA Region I Administrator.

Leading by Example – Early Progress through Energy Efficiency (2010 – 2013)

From 2010 to 2013, UConn made substantial progress in reducing GHG emissions, primarily through two robust efficiency programs at many of our most energy-intensive buildings. Collectively, retro-commissioning (RCx) of 19 buildings and retrofitted lighting, with motion or occupancy sensors, in 115 buildings reduced corresponding GHG emissions at the main campus by 12%, or 18,000 tons per year (TPY), while saving $2.2 million in annual energy costs.

This immediate progress in developing and implementing our CAP was a key factor in UConn's rapid rise to #1 in green campus rankings, such as the Sierra Club's Cool Schools (2013) and the GreenMetric World University (2012-13) surveys. UConn seemed well on its way to achieving and surpassing the interim CAP milestone of 20% reductions by 2020 (See Figure 2, attached).

Recent Challenges

However, by 2012-2013, the reductions achieved were offset somewhat by increased energy demand from new buildings that were constructed and opened in that timeframe (e.g., Laurel, Oak, Storrs Hall addition) and the continued operation of older, less efficient buildings previously scheduled for demolition (e.g., Arjona and Montieth).

Also, by 2012, we had begun to see an impact from an increasing number of curtailment days – cold winter days when Connecticut Natural Gas (CNG) curtailed our gas supply (pursuant to provisions of our interruptible rate contract) because of increased residential customer demand and capacity constraints in the region's limited natural gas transmission pipelines. On these days, UConn was required to substitute the use of natural gas with more carbon-intensive oil at our Central Utility Plant (CUP), adding approximately 500 tons of GHG per curtailment day to UConn's annual inventory. In 2013 and 2014, UConn averaged 12 curtailment days. This past winter, the number climbed to 30 days. However, CNG has recently assured UConn that regional transmission capacity problems will be resolved by the end of 2017, making curtailment a non-factor to UConn's GHG inventory by the 2020 interim milestone.

More significantly, in 2013, state policy-makers enacted Next Gen CT, calling for $1.5 billion in STEM-related capital improvements, along with an increase in enrollment of 5,000 students, at our main campus. While this investment in UConn will drive state economic development, it has the potential to significantly increase the University's carbon emissions as its physical plant grows.

Despite ambitious goals and strategies for green buildings spelled out and approved in the new Campus Master Plan, such as a proposed upgrade in UConn's policy from LEED Silver to LEED Gold for all new construction and Net Zero Growth (in energy and water consumption), these strategies have not yet been adopted and operationalized as UConn policies, guidelines or procedures. Thus, they have not been significant factors in the design of the first two Next Gen buildings: NESB and STEM Residence Hall, nor the UConn-owned Tech Park building, the IPB. The Honors Residence Hall is still early in design but appears to be on a similar track.

Consequently, when these four buildings are constructed and operating by 2018, together they could add as much as 7,000 tons of GHG emissions per year to UConn's carbon footprint, negating more than a third of the aforementioned energy and GHG emissions reductions achieved from 2010-2013 (see Figure 2, attached). Without new or accelerated carbon mitigation strategies to offset increases from these capital improvements, including the addition of generators, chillers and other fuel-burning equipment, UConn would not achieve its 20% reduction target by 2020.

Closing the Gap – Additional CAP Projects and Opportunities

When the preceding was discussed at a meeting with the CFO/EVP and senior administrators for Infrastructure and Strategic Planning, Facilities, PAES and OEP, it was agreed that:

- President Herbst's commitment per the ACUPCC to our Climate Action Plan and a carbon-neutral campus should be maintained as a matter of compliance and policy.
- Our CAP goals are aspirational and intended to inspire and motivate innovative action for sustainable growth – all of which are important components of UConn's reputation as a highly-ranked campus sustainability leader.
- In turn, this green campus leadership has become significant to the UConn brand for attracting and retaining the best students and faculty, building corporate partnerships, competing for research dollars, and ensuring state and local officials of our commitment to responsible growth through NextGen CT and beyond.
- We resolved to develop this report with recommended actions, projects and studies needed to fulfill UConn's CAP commitments.

This planning process has been deliberate, collaborative, and focused. As a result, the group has generated additional awareness and momentum for the CAP and new ideas for carbon mitigation strategies. Group discussions have also spurred immediate action to operationalize green building principles, conduct feasibility studies for clean energy alternatives, and expedite and expand ongoing energy conservation measures.

Attached are three summary tables showing estimated GHG reductions, costs per ton of reduction, and payback period from: 1) Potential Projects (Table 1), 2) Completed Projects (Table 2) and 3) Ongoing/Proposed Projects (Table 3). Appendix A, Table A-2 includes more detailed comments and status reports about the Potential Projects identified in Table 1.

As of the date of this report, additional study is needed to complete the cost/benefit analysis that will help guide the selection of GHG mitigation strategies. For example, one such study, the Utility Framework Plan, will provide cost/benefit data for at least seven of the 15 Potential Project ideas raised. This study is currently in the contractor procurement phase. Ultimately, projects will be selected and advanced largely based on their operational priority, respective GHG reduction potential, cost per ton of GHG reduced (corresponding kwh or MMBTU of energy saved), and length of payback period.

Recommendations for Achieving the 20% by 2020 CAP Milestone

The group considered the factors listed above, and assessed the relative momentum of various Potential Projects currently in conceptual, planning or even partial implementation phases. Then, comparing estimates for each project's anticipated GHG reductions, cost and payback period (where available), the group recommends advancing the following strategies for achieving the 20% GHG reductions (30,500 TPY) by the 2020 interim milestone:

1. After completing implementation of ESCO Phase 1 in 2016-17, complete implementation of ESCO Phase 2 by 2020 (-5000 TPY)
2. Accelerate re-lamping of all campus buildings and exterior/parking lot lighting to LED bulbs, so that the retrofits occur over the next three or four years (-10,000 TPY)
3. Install and begin operating a 1.4 MW fuel cell CHP Plant by 2020 (e.g., at Putnam) (-1,000 TPY)

Based on current projections for increases and reductions in GHG emissions, implementation of these three strategies from the list of Potential Projects would exceed the 2020 emissions target by 0.65% or 1,000 TPY (See Figure 2, attached). Table A-1 (Appendix A) presents an overview of projects that result in GHG increases and reductions, and how the above recommendations would achieve the 2020 target. Figure 3 presents the proposed energy projects recommended to achieve the 20% reduction target by 2020.

The group further recommends that we continue to meet periodically over the next year, in order to monitor and evaluate progress with these recommendations, continue planning efforts for the 2025 interim milestone, and update information about Ongoing and Potential Projects. We will especially monitor the Utility Framework Plan and other studies that will inform our recommendations with cost/benefit data points currently listed as "TBD" in the project tables of this report.

Tables

University of Connecticut

Table 1

Potential Energy Projects to Achieve Energy Savings and Reduce Greenhouse Gas Emissions

Proposed Project	Potential Benefits to Evaluate	Estimated GHG Reduction (tons)	Average Net Costs/Ton of Reduction	Average Pay Back (Years)
Select steam to hot water conversion (Long Term Project, 2020-2025)	Reduced operating and maintenance costs Energy savings by converting from steam heat to hot water heat Hot water piping has a lower thermal loss (-25%) than do steam/condensate pipes and traps, with a good economic payback Hot water systems are closed loop requiring no makeup water during normal operation	TBD, Framework Study	TBD, Framework Study	TBD, Framework Study
Smart Grid – Power Factor (Short Term Project, 2015-2020)	Reduce total operation and maintenance costs Decrease voltage drop Improve power system stability and power quality	600 (based on C2E2 Study)	TBD, Framework Study	2 years
Smart Grid – Voltage Regulation (CVR) (Short Term)	Reduced voltage at substation and building locations by 2 to 5% can result in similar overall energy savings with limited capital costs Software is installed on existing monitoring system to optimize the electricity system Software sets voltage set points with local control at building locations to regulate usage	800 to 2,000 (assumes voltage regulation for 50% of UConn electricity use)	TBD, Framework Study	2 years
Geothermal (Long Term)	Decreased reliance on fossil fuels resulting in reduced GHG emissions Increased energy efficiency for heating and cooling Less maintenance than conventional fossil fuel systems	Up to 2,300*	TBD, Framework Study	TBD, Framework Study
Fuel Cells (Short Term)	Reduce electrical and thermal base loads otherwise generated at the CUP Not a combustion source. Therefore, minimal NOx emissions and reduced GHG emissions. Unit would not require air quality permitting.	950**	TBD, Framework Study	TBD, Framework Study
On-site Solar (Long Term)	No up-front capital costs to install solar equipment through 15 to 20 year PPA Project-specific installations Up to 500 kW of solar installations (~ 5 acres located over parking lots, garages and also land-based arrays) would reduce GHG emissions	780 (various installations up to 500 kW)	TBD, Framework Study	TBD, Framework Study

* - Specific estimates will be developed based on information obtained from the Framework Study. However, based on information obtained from a geothermal feasibility study conducted for Wesleyan University for a 340,000 square foot project similar to the type of installation proposed for UConn, GHG reductions could be up to 2,300 tons.

** - Projected greenhouse gas reduction estimate is for one 1.4 MW installation.

Table 1 (con't)
Potential Energy Projects to Achieve Energy Savings and Reduce Greenhouse Gas Emissions

Proposed Project	Potential Benefits to Evaluate	Estimated GHG Reduction (tons)	Average Net Costs/Ton of Reduction	Average Pay Back (Years)
Off-site Solar (or Wind) Power through PPA (Long Term)	No up-front capital costs to install solar equipment but increased operational costs	TBD, Framework Study	TBD, Framework Study	TBD, Framework Study
	Solar developer owns or leases land. No UConn land ownership or lease required. Proximity to campus preferred but not needed for off-site installation with virtual net metering (VNM)			
	Stable long-term electric costs at signing of 15 to 20 year PPA			
	1 - 4 MW solar installation (10 – 40 acres) would reduce GHG emissions			
Chiller/Cooling Equipment Installation refrigerant options (Long Term)	Low pressure units (vs. mid- to high-pressure) reduce leakage, minimizing emissions from refrigerants	1,200	TBD	TBD
	Utilize lower Global Warming Potential (GWP) refrigerants (e.g., R-123) to minimize emissions			
	Convert units using high-GWP refrigerants to lowest feasible GWP			
	Develop leak detection and repair/replacement program to minimize refrigerant leakage			
Purchase of Carbon Offsets (As Needed)	Low cost carbon offsets are available for as little as $0.85 per ton to minimize impact of new projects (up to 5,000 tons as needed).	5,000	0.85	NA
LEED Gold Plus (Short Term)	Modify policy from LEED Silver to LEED Gold	TBD	TBD	TBD
	Enhance policy by adding requirement to obtain additional energy credits beyond minimum prerequisites			
Replacement of old equipment (Long Term)	Eliminate the use of older less efficient equipment resulting in less energy use	TBD	TBD	TBD
	Use of newer equipment may reduce the number of units needed to achieve the same purpose			
Renovation of existing buildings (Short/Long Term)	Reduce energy use intensity (EUI) of older, less efficient buildings	1,150	TBD	TBD
	Improvement of building controls to reduce energy costs			

Table 1 (con't)
Potential Energy Projects to Achieve Energy Savings and Reduce Greenhouse Gas Emissions

Proposed Project	Potential Benefits to Evaluate	Estimated GHG Reduction (tons)	Average Net Costs/Ton of Reduction	Average Pay Back (Years)
Demolition of existing buildings (Short/Long Term)	Eliminate older, less efficient buildings with high EUI	2,000	TBD	TBD
	Replace older buildings with newer less energy intensive buildings			
Implement Traffic Demand Management strategies (Long Term)	Reduce vehicle miles travelled for commuters	3,200	TBD, Traffic Study	TBD, Traffic Study
	Increased on-line and/or off-site courses resulting in reduced building occupancy levels at Storrs minimizing the need for additional building space.			
Expansion of Compost Facility (Short Term)	Allow for the processing of 80% of all animal organic waste	1,200	$330	NA
	Increase the amount of carbon offsets by reducing methane emissions from agricultural waste through aerobic decomposition/composting			

Table 2
Completed Energy Projects Achieving Energy Savings and Greenhouse Gas Emissions Reductions
2010 - 2015

Completed Project	Estimated GHG Reduction (tons)	Average Net Costs/Ton of Reduction	Average Pay Back (Years)
Retro-Commissioning (19 Buildings in 2 Phases)	12,693	$303	2.5 years
Re-lamping (115 Buildings, Parking Lot 8 and Lot F, Sherman Field)	5,318	$477	5 years
Other ECM's (25 Buildings)	661	$486	3.5 years
North Eagleville Road Area Repair/Replacement Phase I	166	$15,000	

Note:
Retro-Commissioning, Re-lamping and other ECM’s energy savings and greenhouse gas data obtained from EverSource through Letters of Agreement (LOA) for each project verifying the savings. This is part of the Master Service Agreement UConn has with EverSource to reduce energy consumption by 10 percent in the next 3 years. Greenhouse gas reductions for the North Eagleville Road Area Repair/Replacement Phase I project were estimated based on the current condition of the steam and condensate lines and how much mass losses would be reduced as a result of the completion of this project. Phase I project costs reflect the replacement of the steam and condensate lines only and does not include other project costs.

Table 3

Proposed Energy Projects to Achieve Energy Savings and Greenhouse Gas Emissions Reductions

Projections

Proposed Project	Estimated GHG Reduction (tons)	Average Net Costs/Ton of Reduction	Average Pay Back (Years)
North Eagleville Road Area Infrastructure Project - Phase II	539	$3,700	22 years
Status: To be completed by December 2015.			
Retro-Commissioning Phase 3 (Projects related to the ROME HALL Bldg, MUSIC ORCHESTRA Bldg and MUSIC LIBRARY Bldg)	850	$340	3.5 years
Status: Investigation phase complete. Implementation phase to start in Summer 2015 and should be completed in one year. Projects assumed to be completed in the 2015-2020 time period.			
South Campus Chiller Improvements	220	$440	3 years
Status: To be completed by June 2015.			
Retro-Commissioning Phase 4 (Improvements to chilled water entrance to several campus buildings)	188	$530	3.5 years
Status: Survey phase complete. Investigation phase to start in Summer 2015 and should be completed in one year. Projects assumed to be completed in the 2015-2020 time period.			
Re-Lamping (All campus buildings not covered under ESCO phases)	6,387	$430	4 years
Status: On-going in-house projects headed by Steve Werth. Projects assumed to be completed in the 2015-2020 time period.			
Other ECMs (All campus buildings not covered under ESCO phases)	889	$905	6 years
Status: On-going in-house projects. Projects assumed to be completed in the 2015-2020 time period.			
ESCO Phase I (Assumes various improvements to approximately 1 million square feet of buildings and the replacement of 1,500 linear feet of steam and condensate lines)	4,800	$2,100	≤ 15 years
Status: ConEdison will start investment grade audit in Summer 2015 and should be completed in one year. Projects assumed to be completed in the 2015-2020 time period.			
Re-lamping (LED re-lamping 115 completed projects presented in Table 2)	3,560		
Status: TBD. Projects assumed to be completed in the 2015-2020 time period.			

Table 3 (con't)

Proposed Energy Projects to Achieve Energy Savings and Greenhouse Gas Emissions Reductions

Projections

Proposed Project	**Estimated GHG Reduction (tons)**	**Average Net Costs/Ton of Reduction**	**Average Pay Back (Years)**
Martha Washington Outdoor Lighting Replacement (1,000 LED lights)	240		
Status: On-going in-house projects headed by Steve Werth. Projects assumed to be completed in the 2015-2020 time period.			
Replacement of Outdoor Lighting for Student and Employee Parking Lots (LED lights. TBD)	1,865	$60	5 years
Status: On-going in-house projects headed by Steve Werth. Projects assumed to be completed in the 2015-2020 time period.			
ESCO Phase II (Assumed similar effort to ESCO Phase I)	4,800	$2,100	≤ 15 years
Status: TBD. Projects assumed to be completed in the 2015-2020 time period.			
ESCO Phase III (Assumed similar effort to ESCO Phase I)	4,800	$2,100	≤ 15 years
Status: TBD. Projects assumed to be completed in the 2020-2025 time period.			
25% Conversion of Light Duty Vehicles to Hybrid or Electric	190		
Status: To date, approximately 10 percent of the existing fleet has been converted to hybrid or electric vehicles. Conversion assumed to be completed in the 2020-2025 time period.			

Note:

The projections presented in this table are based on the most current information available. As a project progresses and more detailed information is available, projections may be adjusted to reflect any updated information. Projections for the North Eagleville Road Area Repair/Replacement Phase II project were estimated based on the current condition of the steam and condensate lines and how much mass losses would be reduced as a result of the completion of this project. Phase II project costs reflect the replacement of the steam and condensate lines only and does not include other project costs. Projections for Retro-Commissioning Phase 3 and Re-lamping and Other ECMs projects are based on energy savings and cost factors (factor/sq.ft.) developed using information from completed projects for similar building types. Projections for Retro-Commissioning Phase 4 based on information contained in the Survey Phase Report. Projections for the ESCO projects based on energy savings and cost factors for similar building types and the reduction in mass losses as a result of the steam and condensate line replacement. Net costs of each ESCO phase is estimated to be $10 million. In order to obtain funding for the ESCO projects, the average pay back must not be greater than 15 years. Beyond the re-lamping building projects, UConn is also in the process of replacing lighting outside of buildings including parking areas, garages, outdoor lighting and bus stops. Once more information is available on these types of projections, projections will be added to this table.

Figures

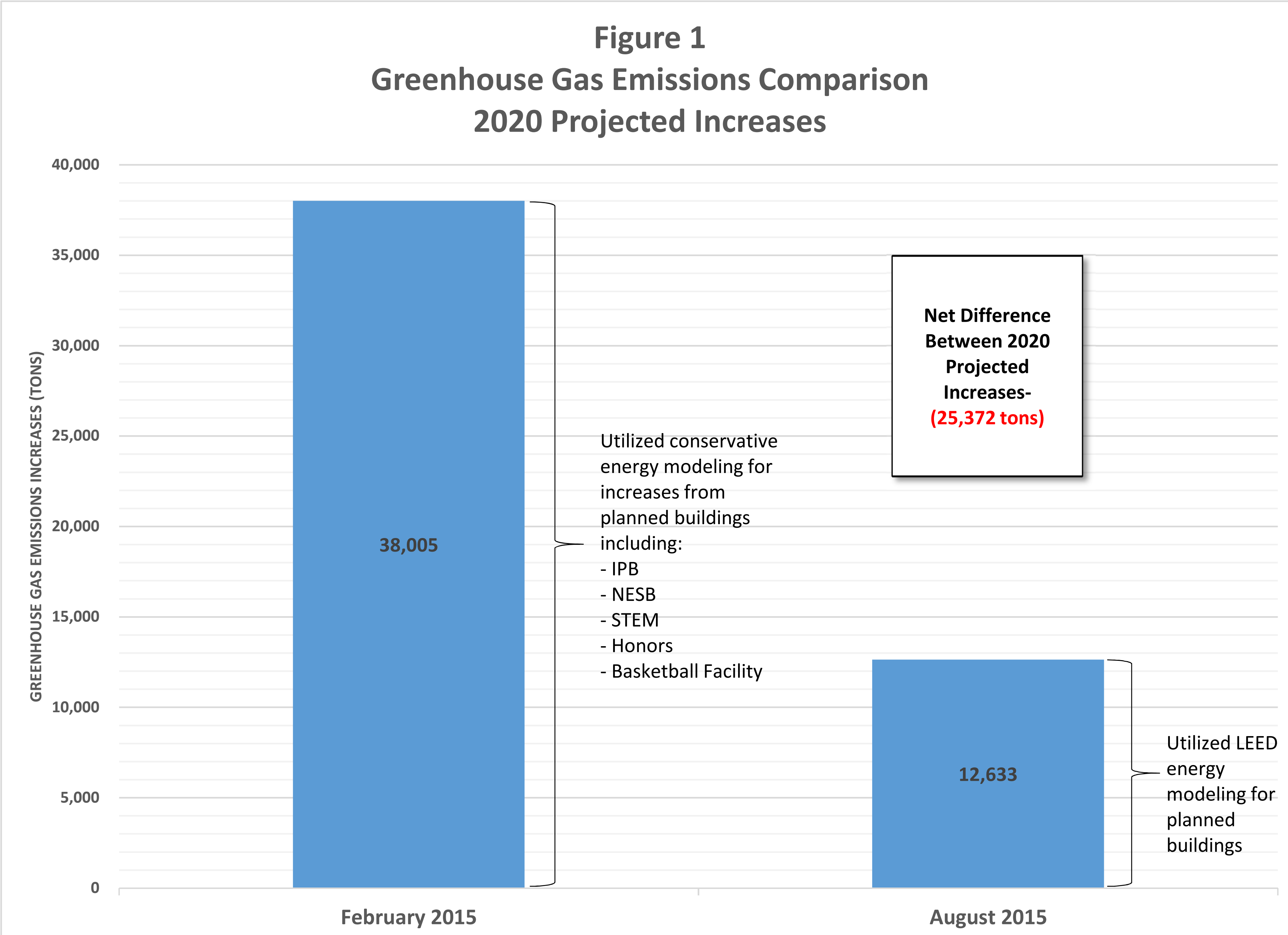
Figure 1
Greenhouse Gas Emissions Comparison
2020 Projected Increases
GREENHOUSE GAS EMISSIONS INCREASES (TONS)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
38,005
Utilized conservative energy modeling for increases from planned buildings including:
- IPB
- NESB
- STEM
- Honors
- Basketball Facility
Net Difference Between 2020 Projected Increases- (25,372 tons)
12,633
Utilized LEED energy modeling for planned buildings
February 2015
August 2015

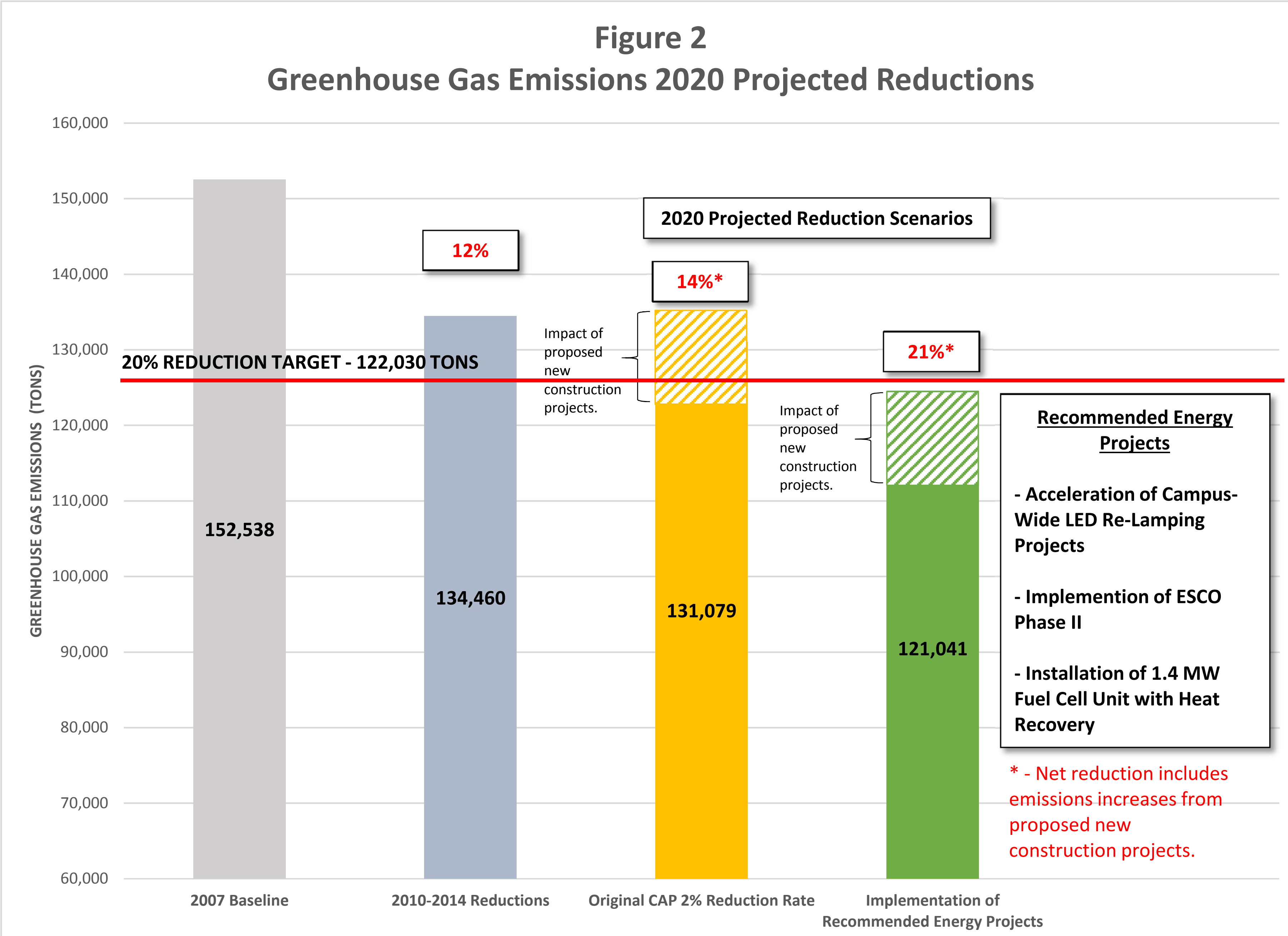

Figure 2
Greenhouse Gas Emissions 2020 Projected Reductions
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
GREENHOUSE GAS EMISSIONS (TONS)
20% REDUCTION TARGET - 122,030 TONS
2020 Projected Reduction Scenarios
12%
14%*
21%*
152,538
134,460
131,079
121,041
Impact of proposed new construction projects.
Impact of proposed new construction projects.
Recommended Energy Projects
- Acceleration of Campus-Wide LED Re-Lamping Projects
- Implemention of ESCO Phase II
- Installation of 1.4 MW Fuel Cell Unit with Heat Recovery
* - Net reduction includes emissions increases from proposed new construction projects.
2007 Baseline
2010-2014 Reductions
Original CAP 2% Reduction Rate
Implementation of Recommended Energy Projects

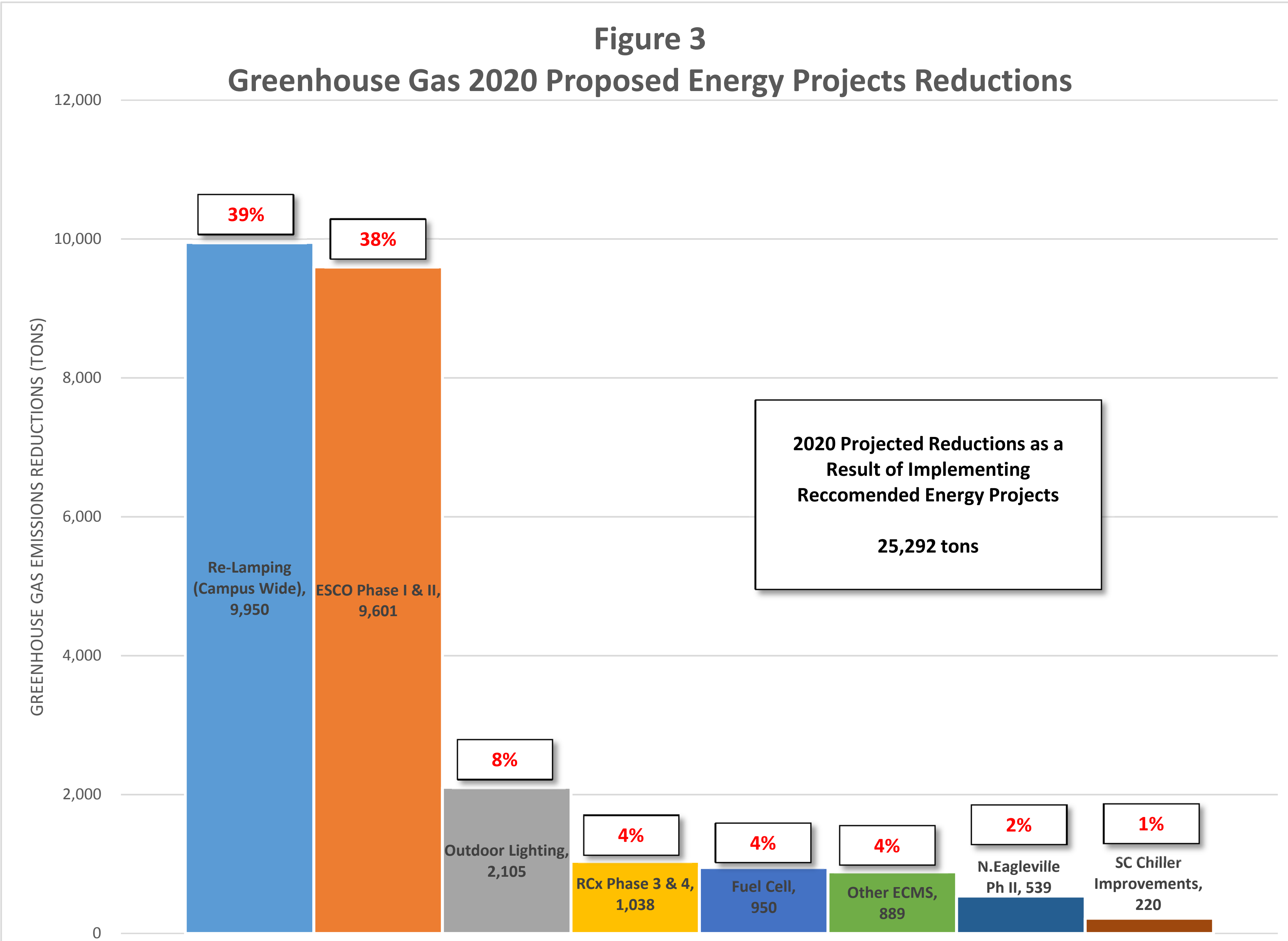

Figure 3
Greenhouse Gas 2020 Proposed Energy Projects Reductions
GREENHOUSE GAS EMISSIONS REDUCTIONS (TONS)
12,000
10,000
8,000
6,000
4,000
2,000
0
39%
38%
8%
4%
4%
4%
2%
1%
Re-Lamping (Campus Wide), 9,950
ESCO Phase I & II, 9,601
Outdoor Lighting, 2,105
RCx Phase 3 & 4, 1,038
Fuel Cell, 950
Other ECMS, 889
N.Eagleville Ph II, 539
SC Chiller Improvements, 220
2020 Projected Reductions as a Result of Implementing Reccomended Energy Projects
25,292 tons

Appendix A

University of Connecticut
Table A-1
Greenhouse Gas Emissions without Achieving Net Zero Growth

Greenhouse Gas Reduction Targets	**2007 Baseline GHG Emissions (Tons):**	**152,538**	
	20% of 2007 Baseline (Tons):	**30,508**	**12,429 needed to achieve 20% by 2020**
	30% of 2007 Baseline (Tons):	**45,761**	**27,683 needed to achieve 30% by 2025**

Summary	**Time Period Emissions (Tons)**		
	2010-2014	**2015 - 2020**	**2020-2025**
Totals (Tons)	**(18,078)**	**(13,419)**	**(4,990)**
Cumulative Totals		**(31,497)**	**(36,488)**
Percent Reduction/Increase	**-11.85%**	**-20.65%**	**-23.92%**
Emission reductions needed to achieve net zero growth (Tons):	**12,633**		

Project Description		**Time Period Emissions (Tons)**			**Ave. Net Costs/**
		2010-2014	**2015 - 2020**	**2020-2025**	**ton of Reduction**
Completed Projects					
Retro-Commissioning (19 Buildings in 2 Phases)	CL&P Modeling LOA Estimates	(12,693)			$303
Re-lamping (115 Buildings)	CL&P Modeling LOA Estimates	(5,318)			$477
Other ECM's (25 Buildings)	CL&P Modeling LOA Estimates	(661)			$486
North Eagleville Road Area Repair/Replacement Phase I (2014)	Energy Savings (Estimated)	(166)			$15,068
Basketball Facility (2014)	Energy Consumption (LEED Modeling Estimate)	760			
On-going Projects					
Central Utility Plant Steam Chiller Expansion (Complete in 2015)	Energy Consumption (Estimated to generate 20,000 lbs/hr of steam)		4,367		
North Eagleville Road Area Infrastructure Project - Phase II (Complete by December 2015)	Energy Savings (Estimated)		(539)		$3,700
Retro-Commissioning Phase 3 (Implementation Phase in 2015)	Energy Savings (Estimated)		(850)		$340
South Campus Chiller Improvements (Complete by September 2015)	Energy Savings (Estimated)		(220)		$440
Retro-Commissioning Phase 4 (Investigation Phase in 2015)	Energy Savings (Estimated)		(188)		$530
Re-Lamping (All campus buildings not covered under ESCO phases. On-going)	Energy Savings (Estimated)		(6,387)		$430
Other ECMs (All campus buildings not covered under ESCO phases. On-going)	Energy Savings (Estimated)		(889)		$905
ESCO Phase I (7 Science Buildings. Investment Grade Audit phase in 2015)	Energy Savings (Estimated)		(3,924)		
ESCO Phase I (1,500 feet of steam line. Investment Grade Audit phase in 2015)	Energy Savings (Estimated)		(877)		
25% Conversion of Light Duty Vehicles to Hybrid or Electric (On-going)	Energy Savings (Estimated)			(190)	
Proposed Projects					
Re-Lamping (LED re-lamping 115 completed projects. TBD)	Energy Savings (Estimated)		(3,563)		
Martha Washington Outdoor Lighting Replacement (1,000 LED lights. TBD)	Energy Savings (Estimated)		(240)		
Replacement of Outdoor Lighting for Student and Employee Parking Lots (LED lights. TBD)	Energy Savings (Estimated)		(1,865)		$60
1.4 MW Fuel Cell Plant with CHP (Near Putnam Hall. Conceptual design phase.)	Energy Savings (Estimated)		(950)		
ESCO Phase II (Buildings. TBD)	Assumed similar effort as ESCO Phase I		(3,924)		
ESCO Phase II (1,500 feet of steam line. TBD)	Assumed similar effort as ESCO Phase I		(877)		
Main Accumulation Area (Design phase. Construction to start in 2015)	Energy Consumption (Estimated)		365		
STEM Residence Hall (Construction phase. Complete by Fall 2016)	Energy Consumption (LEED Modeling Estimate)		1,467		
	On-Site Generation				
New Engineering and Science Building (Construction start Summer 2015. Complete by Fall 2016)	Energy Consumption (LEED Modeling Estimate)		1,733		
	On-Site Generation				
Innovative Partnership Building (Anticipated completion 2017)	Energy Consumption (LEED Modeling Estimate)		2,320		
	On-Site Generation				
Central Utility Plant New Generator (Design Phase. Anticipated completion 2016)	Energy Consumption (Estimated)		119		
Gurleyville Pump Station New Generator (Design Phase. Anticipated completion 2016)	Energy Consumption (Estimated)		35		
Honors Residence Hall (Design and EIE Phase. Anticipated completion Fall 2018)	Energy Consumption (Estimated)		1,467		
	On-Site Generation				
ESCO Phase III (Buildings. TBD)	Assumed similar effort as ESCO Phase I			(3,924)	
ESCO Phase III (1,500 feet of steam line. TBD)	Assumed similar effort as ESCO Phase I			(877)	

University of Connecticut

Table A-2

Potential Energy Projects to Achieve Energy Savings and Reduce Greenhouse Gas Emissions

<table>
<tr><th>Proposed Project</th><th>Potential Benefits to Evaluate</th><th>Estimated GHG Reduction (tons)</th><th>Average Net Costs/Ton of Reduction</th><th>Average Pay Back (Years)</th></tr>
<tr><td rowspan="4">Select steam to hot water conversion (Long Term Project, 2020-2025)</td><td>Reduced operating and maintenance costs</td><td rowspan="4">TBD, Framework Study</td><td rowspan="4">TBD, Framework Study</td><td rowspan="4">TBD, Framework Study</td></tr>
<tr><td>Energy savings by converting from steam heat to hot water heat</td></tr>
<tr><td>Hot water piping has a lower thermal loss (-25%) than do steam/condensate pipes and traps, with a good economic payback</td></tr>
<tr><td>Hot water systems are closed loop requiring no makeup water during normal operation</td></tr>
<tr><td>Next Steps:</td><td colspan="4">
UConn has had several discussions with facilities/energy management staff from Stanford University on its campus-wide conversion from steam to hot water. UConn has also had discussions with the University of Rochester which has been making a more gradual conversion over the past 10 years and has a 25 MW natural gas-fired cogen facility, comparable to UConn's.
Further research is needed on the pros and cons and relative energy efficiency of this type of conversion. Currently, UConn is beginning a multi-phase, $100 million, ESPC process for replacing or repairing current steam lines, generally in 1,000 to 3,000 ft. sections per phase. The Investment Grade Audit is now underway and should be completed in 6 months.
AECOM is under contract to evaluate the installation of hot water lines for the south campus area to potentially service the proposed Honors Residence Hall. The study needs to be completed 60 days after the initial kick-off meeting. This AECOM study should be complete by the end of 2015. In addition, a feasibility study is being assigned to the Utility Framework consultant for further study. Consultant will provide recommendations on possible options to implement utility replacement strategies including the installation of hot water lines in select locations around campus. The framework study should be completed by the end of 2016.
AECOM is also the lead design engineer for the North Eagleville Road Area Infrastructure Project - Phase III, which will evaluate the potential conversion to hot water for the North Campus Residence Halls.
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Table A-2 (con't)
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Proposed Project	Potential Benefits to Evaluate	Estimated GHG Reduction (tons)	Average Net Costs/Ton of Reduction	Average Pay Back (Years)
Smart Grid – Power Factor (Short Term Project, 2015-2020)	Reduce total operation and maintenance costs Decrease voltage drop Improve power system stability and power quality	600 (based on C2E2 Study)	TBD, Framework Study	2 years
Smart Grid – Voltage Regulation (CVR) (Short Term)	Reduced voltage at substation and building locations by 2 to 5% can result in similar overall energy savings with limited capital costs Software is installed on existing monitoring system to optimize the electricity system Software sets voltage set points with local control at building locations to regulate usage	800 to 2,000 (assumes voltage regulation for 50% of UConn electricity use)	TBD, Framework Study	2 years
Next Steps:	• **UConn has met with a company to discuss the potential use of CVR on the Storrs campus and whether voltage can be controlled at the individual building level to ensure proper functioning of sensitive equipment that may require higher voltage. A similar requirement is part of a CVR project at Virginia Commonwealth University. The Power Factor analysis began as a recommendation from an electrical engineering faculty member and is a more proven method for achieving reductions in energy usage with low risk and lower capital investment.** • **Smart grid feasibility study is being assigned to the Utility Framework consultant for further study. Consultant will provide recommendations on possible options to implement smart grid strategies. The smart grid study should be completed by the end of 2016.**			
Geothermal (Long Term)	Decreased reliance on fossil fuels resulting in reduced GHG emissions Increased energy efficiency for heating and cooling Less maintenance than conventional fossil fuel systems	Up to 2,300*	TBD, Framework Study	TBD, Framework Study
Next Steps:	**Renewable energy feasibility study is being assigned to the Utility Framework consultant for further study. Consultant will provide recommendations on possible renewable energy installations on campus including geothermal. The study should be completed by the end of 2016.**			
Fuel Cells (Short Term)	Reduce electrical and thermal base loads otherwise generated at the CUP Not a combustion source. Therefore, minimal NOx emissions and reduced GHG emissions. Unit would not require air quality permitting.	950**	TBD, Framework Study	TBD, Framework Study
Next Steps:	**Renewable energy feasibility study is being assigned to the Utility Framework consultant for further study. Consultant will provide recommendations on possible renewable energy installations on campus including fuel cell. UConn plans to have a discussion with Central Connecticut State University (CCSU), who has similar 1.4 MW fuel cell installation on their campus, to obtain more detailed information on their fuel cell installation. The study should be completed by the end of 2016.**			

* - Specific estimates will be developed based on information obtained from the Framework Study. However, based on information obtained from a geothermal feasibility study conducted for Wesleyan University for a similar type of installation proposed for UConn, GHG reductions could be up to 2,300 tons.

** - Projected greenhouse gas reduction estimate is for one 1.4 MW installation.

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Proposed Project	Potential Benefits to Evaluate	Estimated GHG Reduction (tons)	Average Net Costs/Ton of Reduction	Average Pay Back (Years)
On-site Solar (Long Term)	No up-front capital costs to install solar equipment through 15 to 20 year PPA Project-specific installations Up to 500 kW of solar installations (~ 5 acres located over parking lots, garages and also land-based arrays) would reduce GHG emissions	780 (various installations up to 500 kW)	TBD, Framework Study	TBD, Framework Study
Off-site Solar (or Wind) Power through PPA (Long Term)	No up-front capital costs to install solar equipment but increased operational costs Solar developer owns or leases land. No UConn land ownership or lease required. Proximity to campus preferred but not needed for off-site installation with virtual net metering (VNM) Stable long-term electric costs at signing of 15 to 20 year PPA 1 - 4 MW solar installation (10 – 40 acres) would reduce GHG emissions	TBD, Framework Study	TBD, Framework Study	TBD, Framework Study
Next Steps:	**Several meetings have been conducted with solar companies interested in entering into agreements with UConn to install solar on-site through a PPA. Renewable energy feasibility study is being assigned to the Utility Framework consultant for further study. Consultant will provide recommendations on possible renewable energy installations on campus including solar. The study should be completed by the end of 2016.**			
Chiller/Cooling Equipment Installation refrigerant options (Long Term)	Low pressure units (vs. mid- to high-pressure) reduce leakage, minimizing emissions from refrigerants Utilize lower Global Warming Potential (GWP) refrigerants (e.g., R-123) to minimize emissions Convert units using high-GWP refrigerants to lowest feasible GWP Develop leak detection and repair/replacement program to minimize refrigerant leakage	1,200	TBD	TBD
Next Steps:	**Develop design standards to ensure the selection of equipment with the lowest global warming potential possible. Strive to reduce GHG emissions from refrigerant use by 50%. Assess practices for recycling spent or replaced refrigerants.**			
Purchase of Carbon Offsets (As Needed)	Low cost carbon offsets are available for as little as $0.85 per ton to minimize impact of new projects (up to 5,000 tons as needed).	5,000	0.85	NA
Next Steps:	**If needed, develop a process to obtain the carbon offsets until additional reductions can occur through the implementation of energy projects.**			
LEED Gold Plus (Short Term)	Modify policy from LEED Silver to LEED Gold Enhance policy by adding requirement to obtain additional energy credits beyond minimum prerequisites	TBD	TBD	TBD
Next Steps:	**Revise design policy to implement a LEED Gold plus process for new and renovated buildings.**			

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Proposed Project	Potential Benefits to Evaluate	Estimated GHG Reduction (tons)	Average Net Costs/Ton of Reduction	Average Pay Back (Years)
Replacement of old equipment (Long Term)	Eliminate the use of older less efficient equipment resulting in less energy use Use of newer equipment may reduce the number of units needed to achieve the same purpose	TBD	TBD	TBD
Next Steps:	**Compile an inventory of existing equipment and then determine if replacement is a viable option for this equipment.**			
Renovation of existing buildings (Short/Long Term)	Reduce energy use intensity (EUI) of older, less efficient buildings Improvement of building controls to reduce energy costs	1,150	TBD	TBD
Next Steps:	**Evaluate the current EUI of existing buildings. Determine projects that can be completed to reduce EUI for those buildings. Strive to reduce EUI for existing buildings by 25%. Current renovation projects in the short term include Putnam Refectory and Monteith. Long term projects include the Gant Complex.**			
Demolition of existing buildings (Short/Long Term)	Eliminate older, less efficient buildings with high EUI Replace older buildings with newer less energy intensive buildings	2,000	TBD	TBD
Next Steps:	**Master Plan has identified several buildings to be demolished including the Faculty Row Houses (Short Term) and Torrey Life Science (Long Term).**			
Implement Traffic Demand Management strategies (Long Term)	Reduce vehicle miles travelled for commuters Increased on-line and/or off-site courses resulting in reduced building occupancy levels at Storrs reducing building EUI.	3,200	TBD, Traffic Study	TBD, Traffic Study
Next Steps:	**Traffic study is currently being conducted to determine potential areas that may require mitigation to minimize vehicle traffic impacts. Possible Traffic Demand Management strategies will be evaluated. Strive to reduce commuter vehicle miles travelled by 20%.**			
Expansion of Compost Facility (Short Term)	Allow for the processing of 80% of all animal organic waste Increase the amount of carbon offsets by reducing methane emissions from agricultural waste through aerobic decomposition/composting	1,200	$330	NA
Next Steps:	**Discuss with Farm Services to determine if expansion of the compost facility is a viable option.**			