

DELAWARE TECHNICAL & COMMUNITY COLLEGE

Sustainable Energy Management Plan

Office of the President Executive Summary



January 2011



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Mailing Address:

John Byrne
Director
Center for Energy and Environmental Policy
University of Delaware
Newark, DE 19716-7381

Email: jbbyrne@udel.edu
Telephone: (302) 831-8405
Telefax: (302) 831-3098
Website: <http://ceep.udel.edu>

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Research Team

Jeremiah Couey (Ph.D., CEEP; prior degrees in mechanical engineering)
Daniel Kasper (Ph.D., CEEP; prior degrees in environmental science & geography)
Colin Manasse (Ph.D., CEEP; prior degrees in energy & environmental policy)
Xilin Zhang (Ph.D., CEEP; prior degrees in electrical engineering)
Peleg Kremer (Ph.D., CEEP; prior degrees in mechanical engineering)
Vasan Srinivasan Chandrasekaran (Ph.D., engineering; prior degrees in mechanical engineering)
Zachary Schafer (MEEP, CEEP; prior degrees in economics, history & international relations)
Zach Sharpless (Mechanical Engineering Technology, DTCC)

Advisors

John Byrne (Ph.D., Distinguished Professor of Energy and Climate Policy, Director of CEEP)
Lado Kurdgelashvili (Ph.D., CEEP Policy Fellow)

Acknowledgements

Delaware Technical & Community College

Gerard McNesby, Vice President for Finance

Stanton and Wilmington Campuses

Mark T. Brainard, Assistant Campus Director
John A. Fogelgren, Jr., Director of Administrative Services
Eddie Cunningham, Assistant Director of Administrative Services
John E. Szotkiewicz, Superintendent of Buildings & Grounds

Owens Campus at Georgetown

George Booth, Assistant Director of Administrative Services
William R. Beauchamp, Superintendent of Buildings & Grounds

Terry Campus at Dover

William Ayers, Director of Administrative Services
John A. Schaible, Chief of Public Safety

TABLE OF CONTENTS

| | |
|---|----|
| Executive Summary | 1 |
| Selection Criteria..... | 3 |
| Projected Energy & Emission Trends | 3 |
| College and Campus-by-Campus Energy and Emissions Inventories | 5 |
| College Energy Savings & Emissions Reduction Potential..... | 8 |
| Summary | 14 |

LIST OF TABLES

| | |
|---|----|
| TABLE 1: Executive Summary of Actions in the SEMP | 3 |
| TABLE 2: Total Energy Use and CO ₂ Emissions for Each Campus | 7 |
| TABLE 3: Summary of Campus Action Plans | 11 |

LIST OF FIGURES

| | |
|---|----|
| Figure 1: BAU and SEMP Energy Use Trends..... | 5 |
| Figure 2: Planning for Change..... | 5 |
| Figure 3: Energy Inventory by Campus | 6 |
| Figure 4: Total College Emissions and Campus-by-Campus Breakdown..... | 7 |
| Figure 5: Average Payback Period for All Campus Projects | 9 |
| Figure 6: Average Cost of CO ₂ Abatement for All Campus Projects | 10 |
| Figure 7: Energy Reduction Potential for All Campus Projects..... | 10 |

Executive Summary

The Sustainable Energy Management Plan (SEMP) developed for Delaware Technical & Community College (DTCC) enables the institution to reduce its vulnerability to rising energy costs while contributing to international efforts to avert climate change. With this Plan, DTCC joins a growing number of educational institutions taking action to concretely support the shift to a green energy economy. The Plan reinforces the commitment of DTCC's leadership to train the workforce for the new economy by having each campus serve as a green energy learning laboratory.

The SEMP is based on an Energy Use Inventory prepared for each campus location (Stanton, Wilmington, Georgetown and Dover). Separate campus reports were produced that specify energy consumption characteristics for the four campuses, along with Action Plans targeting projects available within a 10-year timeframe that recognize the distinct features of the campuses. This Executive Summary provides an overview of each campus energy assessment and cost-saving opportunities. Major findings and a summary of the campus action plans are discussed below.

We are pleased to report that DTCC is a leader in the community college network for energy sustainability. Only 108 campuses of the 1,177 public and independent community colleges have established robust action plans to manage their energy systems and reduce their climate impact.¹ Among these, only 18 institutions have plans that approximate DTCC's commitment to a 20% or more reduction in fossil energy use and greenhouse gas emissions over the next ten years. Thus, the Delaware Technical & Community College is at the forefront of the green campus movement in the United States, ranking among the top 1%.

The major findings of the SEMP are as follows:

1. The SEMP recommends that the College adopt a goal of reducing conventional energy use by 20% from its projected 2020 level and, correspondingly, lower its CO₂ emissions by 20%.

¹ See The American College & University Presidents' Climate Commitment - Reporting Institutions for an updated listing of commitments, inventories, and action plans. Available at: <http://acupcc.aashe.org/>

2. Adoption of the 10-year goal by the College will result in estimated annual energy bill savings of nearly \$600,000.
3. DTCC adoption of the SEMP will place it among the top 1% of community colleges in the country and at the forefront of the green campus movement in the United States.
4. Leadership by the College in this critical area will enhance its role of helping Delaware and the Mid-Atlantic region to transition to sustainable energy future. Indeed, DTCC's efforts are essential to the realization of a regional green economy.

The recommended SEMP goal of a 20% greener energy² mix by 2020 is ambitious. While it applies only to campus buildings (transportation, landscaping, waste management and water use were not considered), the Plan will require significant actions by the College to reduce the direct burning of fossil fuels (mainly, natural gas and heating oil) and to lower its electricity consumption. Direct burning of fossil fuels in 2008-09 released 2,692 metric tons of CO₂ (MTCO₂), while indirect emissions traceable to campus building electricity use accounted for 84% of total College building releases – 14,039 MTCO₂. The Plan includes a detailed menu of actions to meet the 20% target. Because the cost of some is modest and economic benefits accrue quickly (e.g., many pay back their costs through energy bill savings in less than three years), the SEMP proposes a three-year action plan to capture “the low-hanging fruit.” Changes in capital equipment that have long-term benefits but high initial costs are scheduled for completion through a 10-year plan. Table 1 summarizes the range of actions in the SEMP.

² The report includes energy conservation, improvements in energy efficiency and the use of onsite renewable energy generation in the term “green energy.” Reduced consumption is estimated on the basis of the trend in current energy use. Onsite renewable energy generation is credited with the reduction in CO₂ emissions corresponding to the trend in emissions of CO₂ per 15Wh of the regional grid, PJM. EIA data are at: http://tonto.eia.doe.gov/state/SEP_MoreEnviron.cfm, PJM data on fuel mix are at: <http://www.pjm-eis.com/documents/documents.html>, and the trend in PJM emissions reductions is at: <http://www.pjm.com/documents/~media/documents/reports/co2-emissions-report.ashx>

TABLE 1
Executive Summary of Actions in the SEMP

| Action* | Action Plan Phase | Initial Cost to Del Tech | Annual Savings | Annual Energy Savings (mmBTU) | Annual CO2 Savings (MT) | Average Payback Year** |
|----------------------------------|-------------------|--------------------------|------------------|-------------------------------|-------------------------|------------------------|
| Chiller Free Cooling (S,G) | 3-year | \$125,000 | \$102,983 | 3,195 | 543 | 1.2 |
| Vending m/c energy management | 3-year | \$7,200 | \$4,228 | 131 | 22 | 1.7 |
| Gym & Cafeteria Lighting (S,G,D) | 3-year | \$46,809 | \$24,680 | 766 | 130 | 2.1 |
| Parking Garage Lighting (W) | 3-year | \$42,572 | \$14,781 | 459 | 78 | 3.0 |
| Photovoltaic Solar Panels | 3-year | \$0.09-0.13/kWh | \$105,666 | 11,998 | 2,040 | 3.0 |
| HVAC Replacement (G,D) | 3 & 10-year | \$25,000 | \$35,198 | 1,092 | 186 | 2.7 |
| General Lighting Efficiency | 3 & 10-year | \$797,518 | \$141,967 | 4,404 | 749 | 5.4 |
| Boiler Replacement (W,G) | 3 & 10-year | \$70,000 | \$88,051 | 3,025 | 498 | 4.1 |
| Boiler Oxygen Control (S,D) | 10-year | \$40,000 | \$9,901 | 794 | 42 | 4.1 |
| Reduce Unnecessary Reheating (W) | 10-year | \$50,000 | \$10,352 | 940 | 50 | 4.5 |
| VSD Cooling Towers (W) | 10-year | \$107,400 | \$21,418 | 664 | 113 | 4.8 |
| Reduce Overcooling (W) | 10-year | \$70,000 | \$13,823 | 429 | 73 | 4.8 |
| Exterior HVAC Ductwork (S,G) | 10-year | \$29,956 | \$2,995 | 267 | 14 | 4.9 |
| Summed Total | -- | \$1,411,454 | \$576,044 | 28,164 | 4,537 | -- |

* Projects that are only available on specific campuses are labeled using the first letter of the campus location (i.e., S = Stanton, W = Wilmington, G = Georgetown, & D = Dover).

** Average Payback Year denotes the average of simple paybacks for the menu of Actions listed in the table.

*** In the case of PV, Annual Savings denotes the average annual savings over the 25-year life of the solar power equipment.

Selection Criteria

Multiple energy uses in College buildings were considered for the SEMP and, accordingly, each campus action plan reflects options that are tailored to a location's needs and opportunities. Actions that could showcase the College's leadership in research, technological innovation, and policy creativity are given special attention. Criteria for project selection included the initial cost, payback period, effectiveness in reducing energy use, environmental sustainability and reduced CO₂ emissions.

Projected Energy & Emission Trends

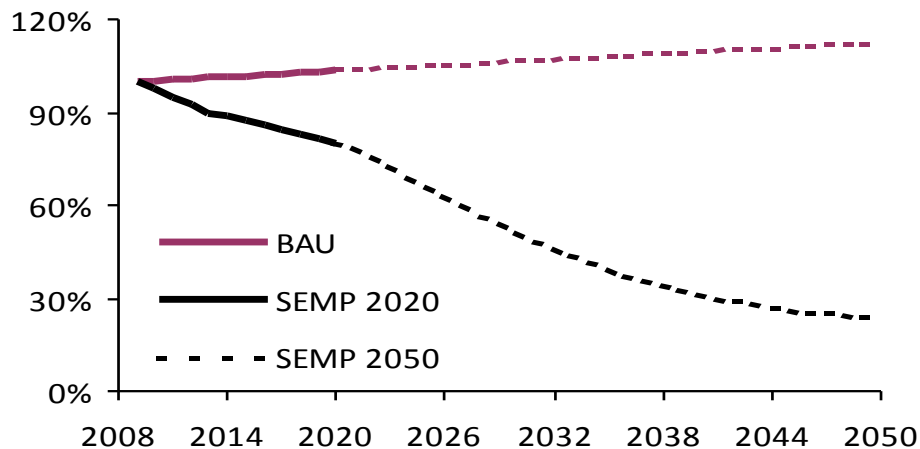
In evaluating energy trends for the College, a business-as-usual (BAU) estimate is made using FY 2009 as the baseline period. Projecting a 10-year or longer trajectory for all four campuses is fraught with uncertainties and complications. The purpose of the BAU is not to estimate yearly use, but to capture the trend in College energy and emissions if there are no changes from past practice. Obviously, change will occur – new buildings will be added and renovations will occur. These cannot be reflected in the BAU trend because they are unknown.

Instead of forecasting the unknown, a BAU trend analysis enables the College to evaluate the impacts of what it can know and affect, namely, the actions it can plan which will measurably change the institution's future use. The BAU case serves this purpose – the College can gauge the impact of its planned actions.

The BAU estimate shown in Figure 1 aggregates the energy use estimates for the four campuses. Over the 10-year horizon, the SEMP anticipates progress toward the College-wide goal of greater than 10% within three years followed by additional reduction actions that combine to produce at least a 20% reduction in energy use and carbon emissions by 2020. After 2020, the College will need to plan for continued actions in order to contribute fully to a proposed national commitment, announced by President Obama³ on April 22, 2009 of a reduction in carbon emissions by 2050 of at least 80% from current levels. The projection to 2050 of the SEMP in Figure 1, illustrates the process of greening DTCC's energy mix and possibly, its transportation, water use and waste management strategies.

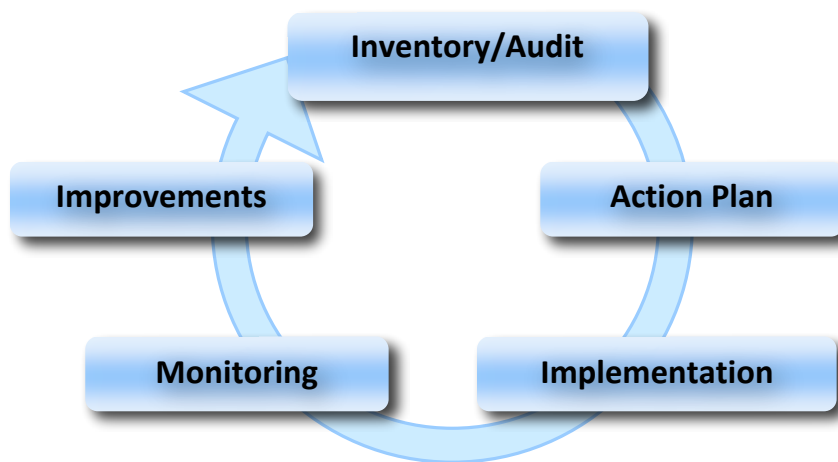
³ http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-in-Newton-IA/

Figure 1: BAU and SEMP Energy Use Trends



The SEMP should be treated as a “living document,” continuously updated to reflect new opportunities and new technology. It can both remind the College community of the challenge of being a sustainable leader and the Plan can also attract the creativity and commitments of faculty, staff and students to design and practice a sustainable future for the institution and the region.

Figure 2: Planning for Change

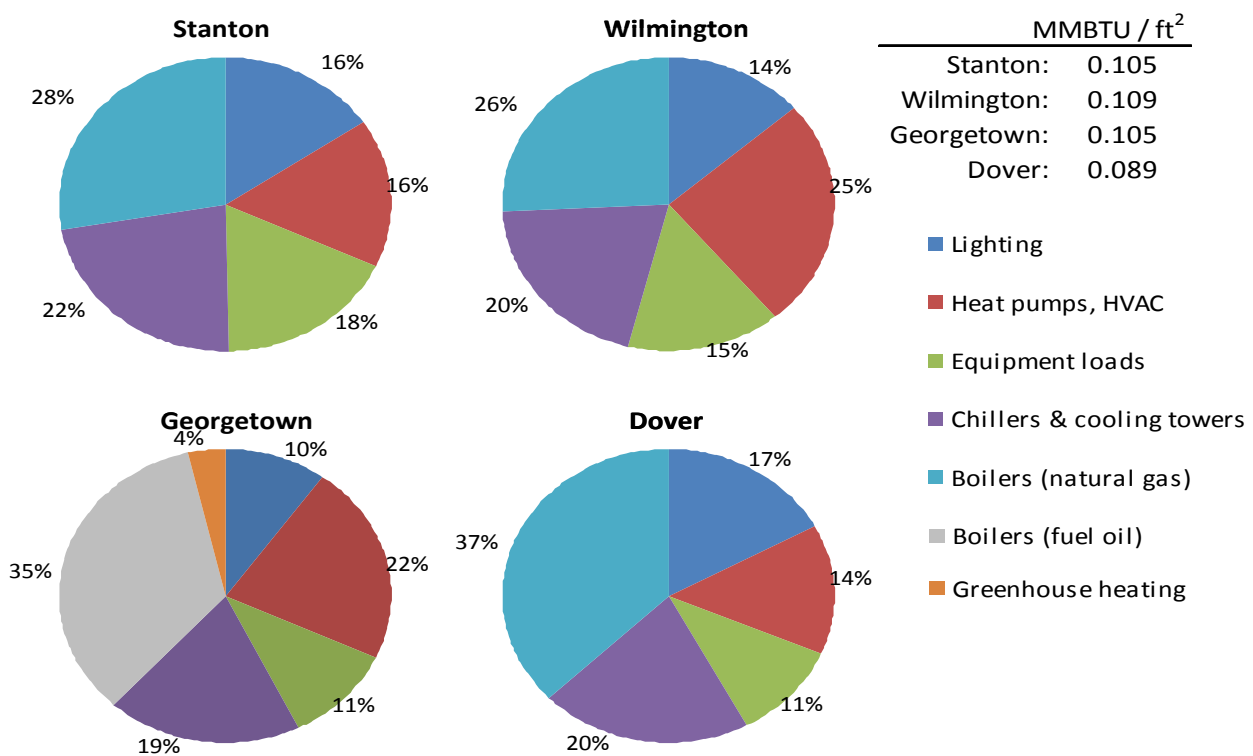


College and Campus-by-Campus Energy and Emissions Inventories

The energy and emissions inventories completed under the SEMP begin at the campus level. Activities vary from campus to campus and knowledge of energy end uses must take this into account. For instance, heavy machinery like mills, lathes and welding equipment can use much more

energy compared to building space dedicated to classroom instruction. Figure 3 presents the results of the energy end use inventories of the four campuses.⁴ The estimated energy intensity for each campus is nearly equivalent – approximately 0.1 mmBTU/ft² for each campus. As a metric for performance, this value is consistent with average building performance for schools generally⁵ and is equivalent to the national average for buildings of comparable size as reported by the U.S. Energy Information Administration (EIA) in 2003.⁶

Figure 3: Energy Inventory by Campus



For carbon dioxide emissions, each campus has a similar breakdown to the one seen in the energy profiles, where variation from campus to campus is chiefly due to enrollment difference, and the size

⁴ All buildings of the four campuses were audited using methods developed by the U.S. Department of Energy for its Industrial Assessment Center program. See http://www1.eere.energy.gov/industry/bestpractices/about_iac.html, and http://iac.rutgers.edu/manual_industrial.php. Graduate students from CEEP and the College of Engineering of the University of Delaware were joined by DTCC students and staff in conducting the audits.

⁵ For example, see Figure 2.2 Energy Use Index for Building Type, pg 16 in *Handbook of Energy Audits, 7th Edition* by Albert Thumann, William J. Younger

⁶ See building floorspace 200,001 to 500,000 in "Table E2A. Major Fuel Consumption (Btu) Intensities by End Use for All Buildings, 2003" available from the EIA at: http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set19/2003pdf/e02a.pdf

of the campus building stock. Some variation is also due to different equipment in use. For this reason, savings opportunities and the scale of impact of technologies will differ for each campus.

Aggregating the emissions for the entire College, the direct burning of fossil fuels resulted in 2,692 metric tons (MT) of carbon dioxide emitted per year, while indirect emissions from using electricity resulted in 14,039 MTCO₂ per year, or 84% of the College total of 16,731 MTCO₂ in fiscal year 2009 (Figure 4 and Table 2).

Figure 4: Total College Emissions and Campus-by-Campus Breakdown

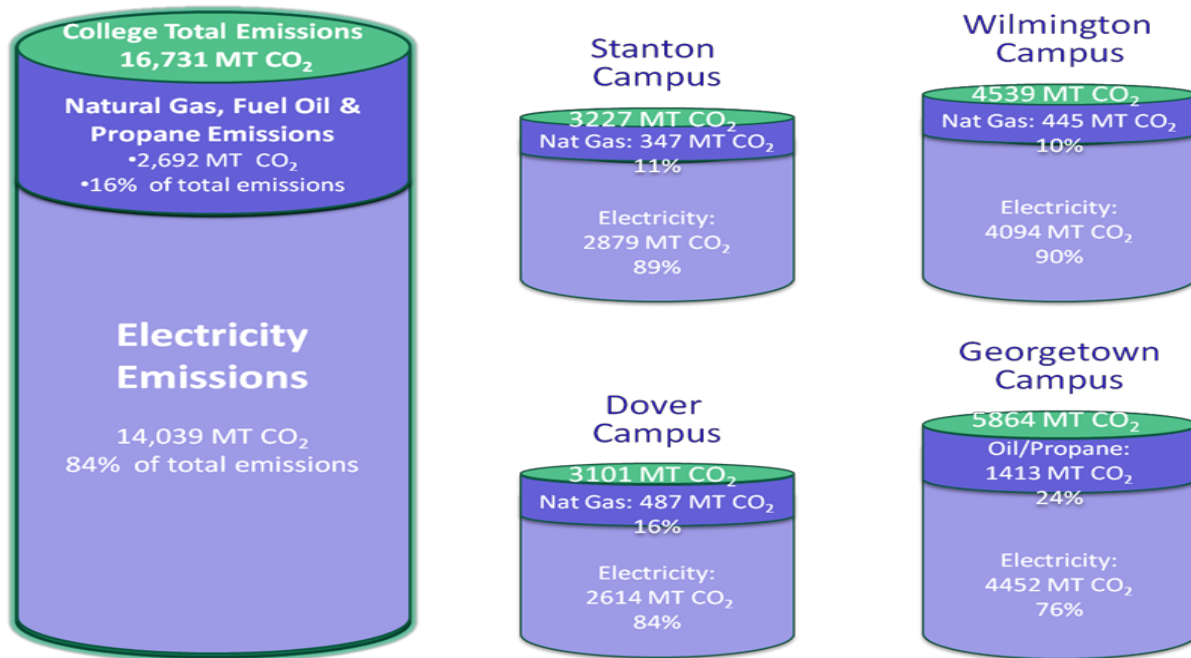


TABLE 2
Total Energy Use and CO₂ Emissions for Each Campus

| Campus | Electricity Consumption (kWh) | Electricity Emissions (MTCO ₂) | Natural Gas, Fuel Oil, Propane Consumption (mcf, gal, gal) | Natural Gas, Fuel Oil, Propane Emissions (MTCO ₂) | Total Emissions (MTCO ₂) |
|-------------|-------------------------------|--|--|---|--------------------------------------|
| Collegewide | 24,204,777 | 14,039 | 23,449 121,547 31,041 | 2,692 | 16,731 |
| Wilmington | 7,058,377 | 4,094 | 8,166 | 445 | 4,539 |

| | | | | | |
|------------|-----------|-------|-------------------|--------------|-------|
| Stanton | 4,964,050 | 2,879 | 6,364 | 347 | 3,227 |
| Dover | 4,507,152 | 2,614 | 8,921 | 487 | 3,101 |
| Georgetown | 7,675,198 | 4,452 | 121,547 31,041 | 1,234 179 | 5,864 |

Using the results of the inventory and building audits, a portfolio of initiatives were developed for each campus that will ultimately result in the College reducing energy consumption, stabilizing power demand, and making a significant reduction in its carbon footprint.

Many of the same initiatives can be implemented throughout all of the campuses, but several projects are unique to one or two campuses. College-wide collaboration will enable economies of scale by sharing knowledge, experience and coordinating implementation. Summing the energy savings available (and estimating the savings from solar power generation under a competitively-bid power purchase agreement⁷), the College could reduce its energy bills by nearly \$600,000 per year (see Table 1, column labeled “Annual Savings”).

College Energy Savings & Emissions Reduction Potential

To illustrate the energy savings reductions potential for the College, the following three figures combine the action plans for all four campuses. In each figure, projects that are only available on specific campuses are labeled using the first letter of the campus location (i.e., S = Stanton, W = Wilmington, G = Georgetown, & D = Dover). Figure 5 shows the average payback period for the combined campus projects.

Savings of more than 25% of the BAU projected energy use by DTCC have been identified, allowing the College to choose options for implementation. As Figure 5 notes, more than 80% of the savings pay back their initial costs in less than five years and 100% have paybacks that are less than six years. The CEEP research team also assessed the value of LED parking lot lighting on the

⁷ Currently, it is cost-effective to secure solar energy through a power purchase agreement in which the College agrees to use its land and roof areas to host solar panels and buying the electricity from the panels at a specified price over a 10- to 20-year period. Under this arrangement, federal tax benefits available only to private companies can be optimized and DTCC can avoid all capital costs. For a detailed discussion of this approach, see CEEP’s study for the City of Newark (2009), available at: <http://ceep.udel.edu>.

Georgetown, Stanton, and Dover campuses. While the payback is currently in excess of 12 years, outside the 10-year timeframe of the SEMP, the team suggests revisiting this option in the near future, as rising electricity prices and continued improvements in this technology may lower the breakeven year considerably in the next four years or so.

Figures 6 and 7 record the net cost to the College of the measures reported in Figure 5. Measures with bars below the horizontal zero-cost line actually save money for the College. That is, the lower energy bills accompanying the implementation more than pay for the cost to implement them. Figure 6 records the cost to reduce College emissions by one ton and Figure 7 indicates the cost per unit of energy saved. The same measure can produce different savings rates. For example, eliminating unnecessary reheating of areas in a building can be accomplished by low-cost building management strategies. Because reheating relies on high-carbon electricity in Wilmington, the impact of the measure on carbon emissions is greater than on energy use. Nonetheless, in both cases, it saves money while improving the College's carbon footprint.

Figure 5: Average Payback Period for All Campus Projects

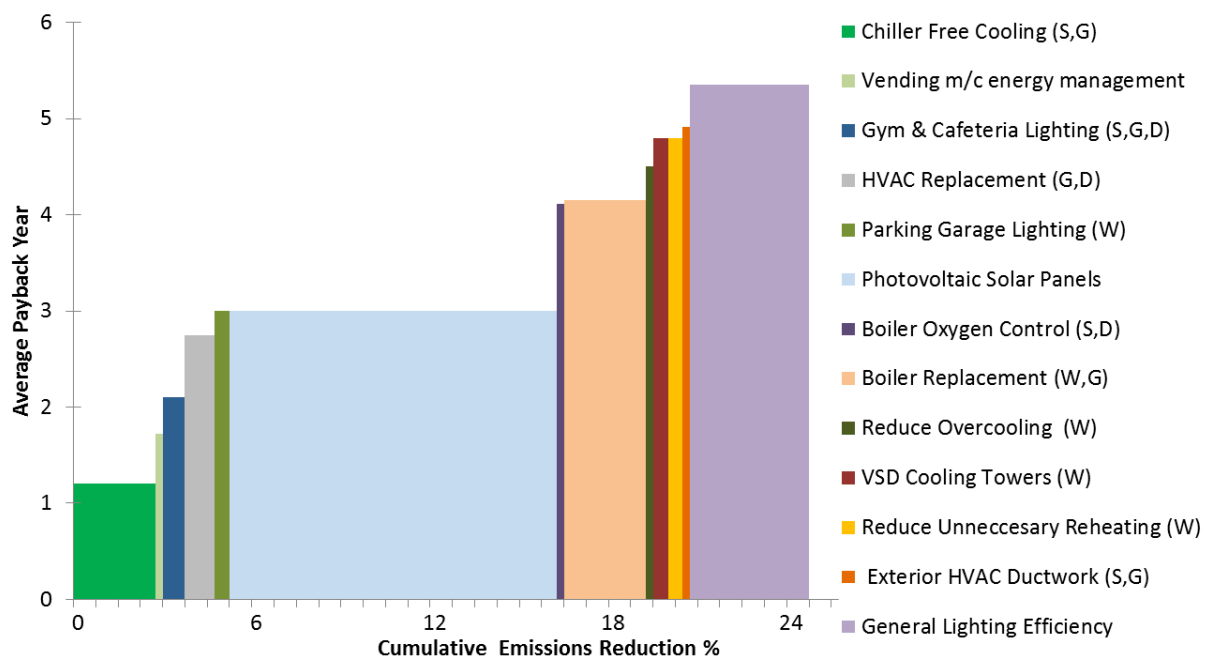


Figure 6: Average Cost of CO₂ Abatement for All Campus Projects

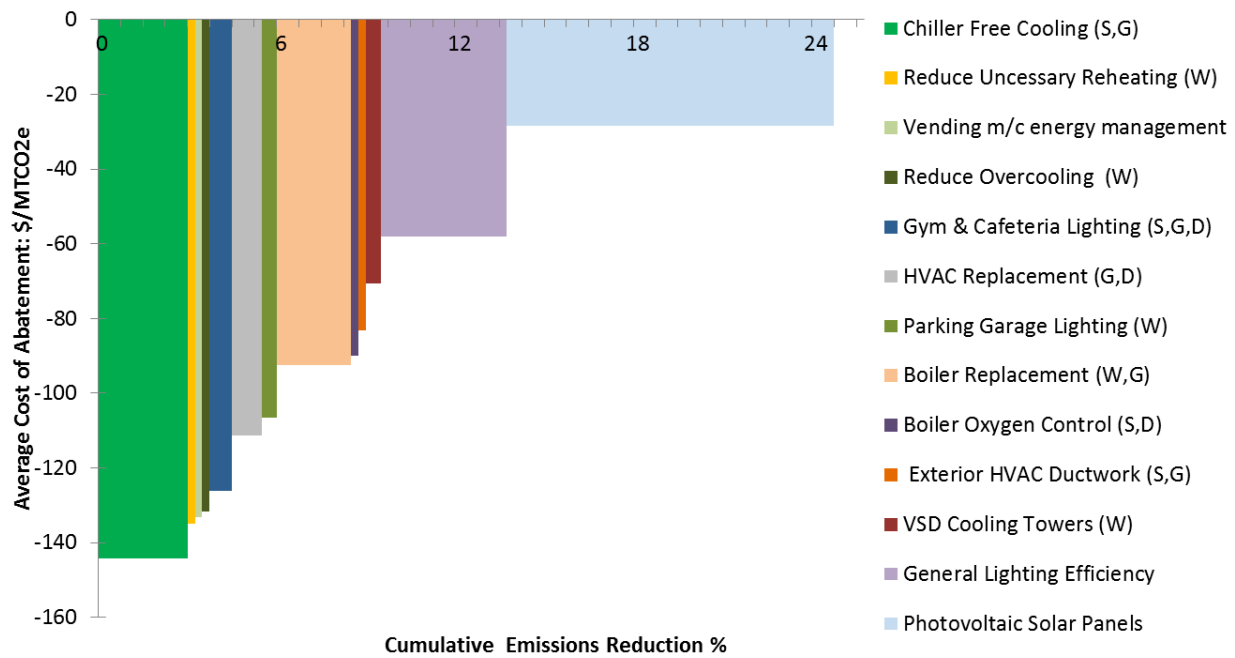


Figure 7: Energy Reduction Potential for All Campus Projects

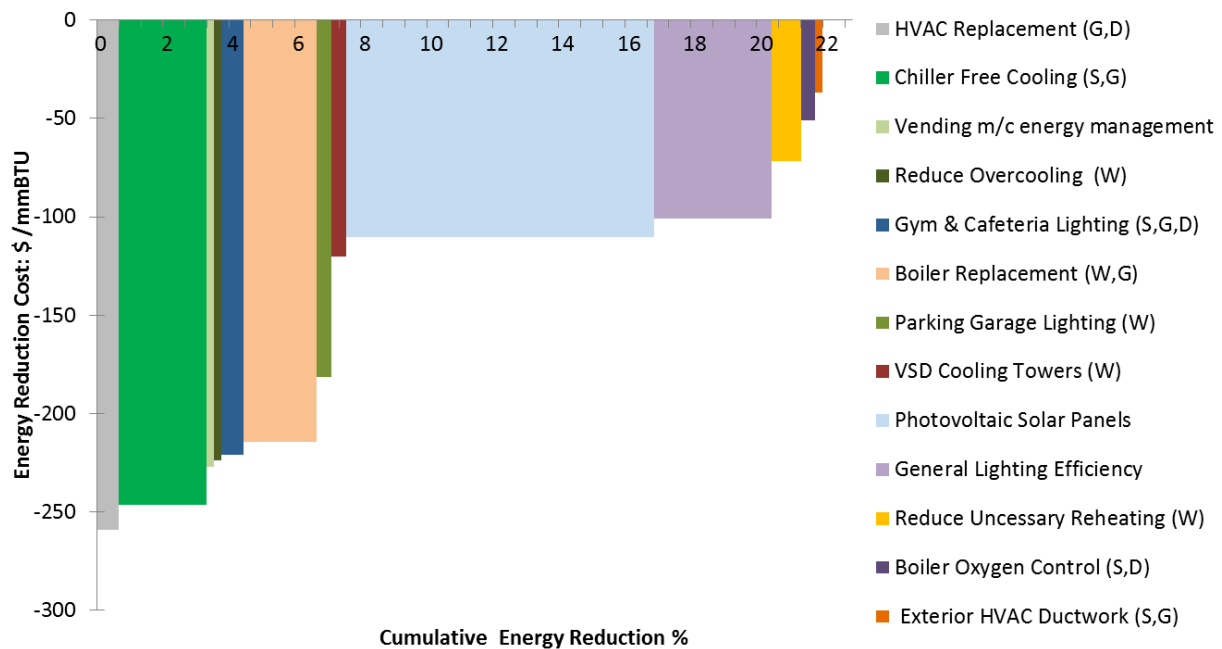


Table 3 summarizes the costs and benefits of each project on each campus. Detailed information is provided in the four campus reports.

TABLE 3
Summary of Campus Action Plans

Wilmington

| Wilmington Action | Action Plan Phase | Initial Cost to Del Tech | Annual Savings | Annual Energy Savings (mmBTU) | Annual CO2 Savings (MT) | Payback Year |
|-------------------------------|-------------------|--------------------------|----------------|-------------------------------|-------------------------|--------------|
| Vending m/c energy management | 3-year | \$2,000 | \$1,349 | 42 | 7 | 1.5 |
| Parking Garage Lighting | 3-year | \$42,572 | \$14,781 | 459 | 78 | 3.0 |
| Photovoltaic Solar Panels | 3-year | \$0.09-0.13/kWh | \$22,632* | 1,941 | 330 | 3.0 |
| Remove Unnecessary Reheating | 10-year | \$50,000 | \$10,352 | 940 | 50 | 4.5 |
| VSD Cooling Towers | 10-year | \$107,400 | \$21,418 | 664 | 113 | 4.8 |
| Reduce Overcooling | 10-year | \$70,000 | \$13,823 | 429 | 73 | 4.8 |
| General Lighting Efficiency | 10-year | \$286,175 | \$38,157 | 1,184 | 201 | 7.0 |
| Boiler Replacement | 10-year | \$70,000 | \$7,697 | 687 | 37 | 8.2 |

* Based on assumed installed capacity of 461 kW and savings per solar kWh of \$0.02.

Stanton

| Stanton Action | Action Plan Phase | Initial Cost to Del Tech | Annual Savings | Annual Energy Savings (mmBTU) | Annual CO2 Savings (MT) | Payback Year |
|-------------------------------|-------------------|--------------------------|----------------|-------------------------------|-------------------------|--------------|
| Chiller Free Cooling | 3-year | \$45,000 | \$33,794 | 1,048 | 178 | 1.3 |
| Vending m/c energy management | 3-year | \$2,200 | \$1,218 | 38 | 6 | 1.8 |
| Gym & Cafeteria Lighting | 3-year | \$35,041 | \$18,529 | 575 | 98 | 1.9 |
| Photovoltaic Solar Panels | 3-year | \$0.09-0.13/kWh | \$8,478* | 1,074 | 183 | 3.0 |
| Exterior HVAC Ductwork | 10-year | \$3,780 | \$703 | 63 | 3 | 4.0 |
| Boiler Oxygen Control | 10-year | \$20,000 | \$3,659 | 238 | 13 | 5.1 |
| General Lighting Efficiency | 10-year | \$245,646 | \$30,350 | 941 | 160 | 7.5 |

* Based on assumed installed capacity of 255 kW and savings per solar kWh of \$0.02.

Dover

| Dover Action | Action Plan Phase | Initial Cost to Del Tech | Annual Savings | Annual Energy Savings (mmBTU) | Annual CO2 Savings (MT) | Payback Year |
|-------------------------------|-------------------|--------------------------|----------------|-------------------------------|-------------------------|--------------|
| Vending m/c energy management | 3-year | \$2,200 | \$1,218 | 38 | 6 | 1.8 |
| Gym & Cafeteria Lighting | 3-year | \$5,492 | \$1,868 | 58 | 10 | 2.9 |
| General Lighting Efficiency | 3-year | \$105,000 | \$34,119 | 1,058 | 180 | 3.0 |
| Photovoltaic Solar Panels | 3-year | \$0.09-0.13/kWh | \$23,272* | 2,948 | 501 | 3.0 |
| Oxygen Control | 10-year | \$20,000 | \$6,242 | 557 | 30 | 3.1 |
| HVAC Replacement | 10-year | \$25,000 | \$4,352 | 135 | 23 | 5.4 |

* Based on assumed installed capacity of 700 kW and savings per solar kWh of \$0.02.

Georgetown

| Georgetown Action | Action Plan Phase | Initial Cost to Del Tech | Annual Savings | Annual Energy Savings (mmBTU) | Annual CO2 Savings (MT) | Payback Year |
|-------------------------------|-------------------|--------------------------|----------------|-------------------------------|-------------------------|--------------|
| Boiler Replacement | 3-year | \$0 | \$80,354 | 2,338 | 461 | 0.0 |
| HVAC Replacement | 3-year | \$0 | \$30,846 | 957 | 163 | 0.0 |
| Chiller Free Cooling | 3-year | \$80,000 | \$69,189 | 2,146 | 365 | 1.1 |
| Gym & Cafeteria Lighting | 3-year | \$6,276 | \$4,283 | 133 | 23 | 1.5 |
| Vending m/c energy management | 3-year | \$800 | \$443 | 14 | 2 | 1.8 |
| Photovoltaic Solar Panels | 3-year | \$0.09-0.13/kWh | \$51,284* | 6,035 | 1,026 | 3.0 |
| General Lighting Efficiency | 10-year | \$160,697 | \$39,341 | 1,220 | 207 | 3.9 |
| Exterior HVAC Ductwork | 10-year | \$26,176 | \$2,292 | 204 | 11 | 5.8 |

* Based on assumed installed capacity of 1423 kW and savings per solar kWh of \$0.02.

To illustrate how a specific measure creates value for the College community, the case of using solar power on the Stanton campus is used. The Stanton campus has the opportunity to install solar panels (often called photovoltaic or PV panels) on its building(s) to generate electricity. Photovoltaic power utilizes energy from sunlight to create electricity. Since electric generation using this technology is fueled directly by solar energy, no greenhouse gases are emitted. Replacing conventional electricity with solar power has the potential to significantly reduce the College's carbon footprint. An additional benefit of PV power is its low maintenance and operations costs.

The research team explored options for use of this technology on each campus. For the Stanton campus, a detailed survey of building roofs, garages and ground mount locations was conducted to

determine suitable host sites. Financial analyses were also performed using a power purchase agreement (PPA) model involving third-party ownership for at least a part of the technology's useful life.⁸ This model is equivalent to the one developed by CEEP for the University of Delaware and the City of Newark.

The financial basis for this decision is simple: the College will seek, through a competitive bidding process, to purchase power from the solar plant hosted on its campus at a cost equivalent to its current and projected electricity prices. Perhaps, the College might consider paying an initial green premium of 1.0 to 2.0 cents per kWh if the later years of a PPA recover the initially higher costs. Based on a projection of the likely long-term cost of electricity from non-renewable sources, it is expected that College payments for solar electricity will be less than it would cost to purchase grid power in 3-8 years.⁹ Because the College will not initially own the solar plant, it will incur no capital cost.

For the Stanton Campus, the solar electricity generation plan is based on installing a 255kW system located on the "good condition" rooftop surfaces.¹⁰ Total rooftop capacity for the campus based on current model efficiencies is estimated at 800 kW. Installing the 255kW system would enable the Stanton campus to generate 314,679 kWh of energy, or approximately 6% of their annual electricity consumption.

| Initial Cost | Annual Energy Savings | Annual Cost Savings | Payback | Annual CO₂ Savings (Metric Tons) |
|---------------------|------------------------------|----------------------------|----------------|--|
| \$0.09-0.13/kWh* | 314,679 kWh | \$8,478** | ~3 years | 184 |

*Represents a range for an initial PPA price of electricity; the initial price and escalation rate would be negotiated in the PPA contract.

**Based on an assumed installation capacity of 255 kW at the Stanton Campus and savings per solar kWh of \$0.02.

⁸ Third-party ownership is necessary to capture tax benefits available under federal law only to private owners.

⁹ DTCC recently held bids for a solar power purchase agreement that yielded prices per kWh below electricity rates currently paid by the College.

¹⁰ Only rooftop surfaces categorized as in "good condition" are considered. Further potential exists after scheduled rooftop resurfacing and maintenance are performed.

The College is able to install photovoltaic systems at each campus and the combined capacity for all the campuses might be as high as 5 megawatts (MW) based on all proper rooftop areas.¹¹ If this technology is installed by a private company and billed at a lower cost per kWh than future conventional electricity prices, the College reduces its energy costs over the long term (panels have useful lives of 25 years), requires less electricity from the grid (much of which is currently supplied by coal power plants, which have the highest carbon emissions per kWh of electricity supplied), and helps the region to transition to a sustainable future. The equipment also provides an exceptional learning opportunity for faculty and students, both during and after installation.

Summary

The potential for the College to cost-effectively reduce energy demand and generate its own energy in a sustainable manner is substantial. Actions described in the SEMP will serve to strengthen the leadership of Delaware Technical & Community College as a *green learning and doing* model for Delaware and the region. The Plan can be integrated into the College's educational and outreach programs and can become a point-of-departure for the community to innovate new approaches and new knowledge needed to be the challenge of sustainability.

The proposed projects will continue the progress made by the College in reducing energy demand. For example, all campuses have installed high efficiency lighting – changing T-12 fluorescent bulbs to the more efficient T-8 models, using compact fluorescent lamps where available, and upgrading exit signs to ultra-high efficiency light emitting diode lamps.

As an educational institution, DTCC has shown a serious commitment to programs, policies and technology developments that can help its campuses and the wider community to implement more sustainable practices consistent with sustainability education goals. Essential to this process, engagement and involvement of all members of the community is indispensable. Each campus report discusses Green E-Letter or Green Liaison programs that can invite the creativity of faculty,

¹¹ 5 MW includes all rooftop areas permissible for photovoltaic installation; this decreases to 2.8 MW for “good condition” rooftop surfaces at the time of this report.

students and staff to improve and expand upon the SEMP. If Delaware Technical & Community College decision-makers can harness the ideas and energy of its members, the prospects for a sustainable future brighten.