CTHSS

CONNECTICUT TECHNICAL HIGH SCHOOL SYSTEM

Energy Use Profile & Recommendations for Energy and Cost Savings

System Overview Report

Utilizing the
U.S. Environmental Protection Agency's
ENERGY STAR® Portfolio Manager™

Institute for Sustainable Energy
At Eastern Connecticut State University

energize CONNECTICUT

December 2014

Prepared by the Institute for Sustainable Energy at Eastern Connecticut State University

The Institute for Sustainable Energy
at Eastern Connecticut State University

At Eastern Connecticut State University

Created in 2001, the Institute for Sustainable Energy (ISE) works to support the sustainability and renewable energy goals of the State of Connecticut. Through involvement with public policy, educational programs, energy solutions, energy information, and workforce development, ISE has proven to be a valuable resource for K-12 schools, colleges, universities, municipalities, commercial entities, non-profits and organizations looking to increase energy efficiency and optimize savings.

The Institute is funded and supported by the Connecticut Energy Efficiency Fund (CEEF) and works in strong collaboration with the Fund's Energize Connecticut programs to implement comprehensive, cost-effective energy efficiency programs and initiatives to reduce energy use throughout Connecticut. In 2014, CEEF funding supported the Institute's work in performing energy benchmarking, conducting walkthrough surveys, and identifying preliminary energy savings opportunities at 15 schools in the Connecticut Technical High School System. The results of this work include this report and follow-up meetings and assistance on implementing a set of comprehensive energy savings measures for the entire technical high school system and continuous improvements toward strategic energy management.

ISE has employed over 100 undergraduate student interns, many of whom have gone on to careers in sustainability across the state. The combination of student interns and a dedicated full-time staff makes the Institute a unique sustainability and energy efficiency resource in the State University system.

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REPORT OVERVIEW

This report is an overview of the results from the benchmarking and walkthrough analysis of multiple technical high school facilities. In March 2014, the Connecticut Technical High School System (CTHSS) requested assistance from the Institute for Sustainable Energy in evaluating the overall efficiency of their facilities and identifying opportunities for strategic implementation of energy retrofit projects on a system-wide basis. Walkthroughs of the 15 CTHSS facilities not currently undergoing renovations were performed by ISE staff during the summer and fall of 2014, along with cooperation from the CTHSS Building Maintenance Supervisors, staff and faculty members.

The benchmarking analysis performed by ISE is designed to improve the understanding of the overall energy efficiency and consumption rates of the facility, and to provide a baseline for tracking energy consumption and carbon emissions in order to encourage environmentally sound energy management practices. The benchmarking reports of the individual schools can provide direction for targeting both the school's operations & maintenance and capital improvement funds, and aid the process for applying for financing, grants and incentives. By identifying the energy-intensity of the facility, they also assesses the need for improved operation and maintenance procedures. This report is intended to be an overview of the system as a whole, and provide a view of the entire system so that decisions can be made about project implementation on a large scale, encompassing multiple schools and multiple technologies.

The comparative energy consumption and benchmark scores for the buildings were calculated with data collected from energy bills and from information provided by CTHSS. The schools were measured against the benchmarks set for K-12 facilities within the U.S. Environmental Protection Agency's (EPA) ENERGY STAR™ Portfolio Manager software and the Department of Energy's Energy Information Service. It should be noted that ENERGY STAR does not have a separate category for technical high schools, which typically use more energy than K12 schools because of energy use in shops (HVAC, electrical, carpentry, automotive), culinary arts kitchens, etc. Although, the CTHSS benchmark scores should not be compared directly to other conventional K12 schools, the scores are useful in comparing relative energy performance among the CTHSS schools and in setting targets to improve the performance of these buildings. The benchmark scores for the CTHSS can be utilized as an aid in the further assessment of the energy management practices at the CTHSS sites and to maximize the energy and economic efficiency of the facility while making it more environmentally sound.

This report was compiled for the Connecticut Technical High School System by the Institute for Sustainable Energy. Mimi Cedrone, Energy Technical Specialist at the Institute for Sustainable Energy, was the project lead and technical support was provided by ISE consultant William Leahy. The purpose of the report is to help the system administrators and Building Maintenance Supervisors better understand how energy is utilized in their facilities and to address potential changes that could be made in the building in order to increase efficiency.

ISE wishes to thank Peter Morrin, Chief of Engineering Services at CTHSS, for his help and guidance throughout all stages of this project and Assistant Superintendent Jeffrey Wihbey and Superintendent Nivea Torres for their strong support and leadership.

PROJECT SCOPE & BACKGROUND

In March 2014, the CTHSS Central Office requested that ISE perform benchmarking and walkthroughs for several of the technical high schools, after ISE had provided Platt Tech with these services. The following table serves to outline which schools were included in the project, the Building Maintenance Supervisor (BMS) and key contact at the school, the date the walkthrough was performed, and the ISE staff members who were present at each walkthrough:

School	Building Maintenance Supervisor	Walkthrough Date	ISE Personnel
Abbott Technical High School	Dave Sheehan	6/23/14	Mimi, Adam, Bill, Laura, Stephanie, Ying
Bristol Technical Education Center	Tom Gray	8/18/14	Adam, Bill, Trevor
Bullard-Havens Technical High School	Ed West	8/19/14	Mimi, Adam, Bill, Stephanie, Trevor
Cheney Technical High School	Fabian Amuso	6/30/14	Mimi, Adam, Bill, Trevor, Tyler
Connecticut Aero Tech	Fabian Amuso	8/21/14	Mimi, Adam, Trevor
Goodwin Technical High School	Dave Meehl	6/27/14	Mimi, Adam, Bill, Stephanie, Trevor, Ying, Kyle
Grasso Technical High School	Peter Dyer	7/29/14	Mimi, Adam, Bill, Lynn
Kaynor Technical High School	Kurt Karpavich	6/26/14	Mimi, Bill, Trevor
Norwich Technical High School	Martin Charette	8/14/14	Mimi, Adam, Bill, Trevor, Ying, Laura
Platt Technical High School	Steve McMahon	9/18/13	Mimi, Bill
Prince Technical High School	Jonathan Scott	5/22/14	Mimi, Adam, Bill
Stratford School for Aviation Maintenance Technicians	Ed West	8/19/14	Mimi, Adam, Bill, Stephanie, Trevor
Vinal Technical High School	Mike Boudreau	8/15/14	Mimi, Adam, Bill, Stephanie, Trevor, Lynn
Windham Technical High School	Rich Balogh	7/31/14	Mimi, Bill, Trevor, Lynn, Dustin, Kyle
Wolcott Technical High School	Joe Carey	7/23/14	Mimi, Adam, Trevor

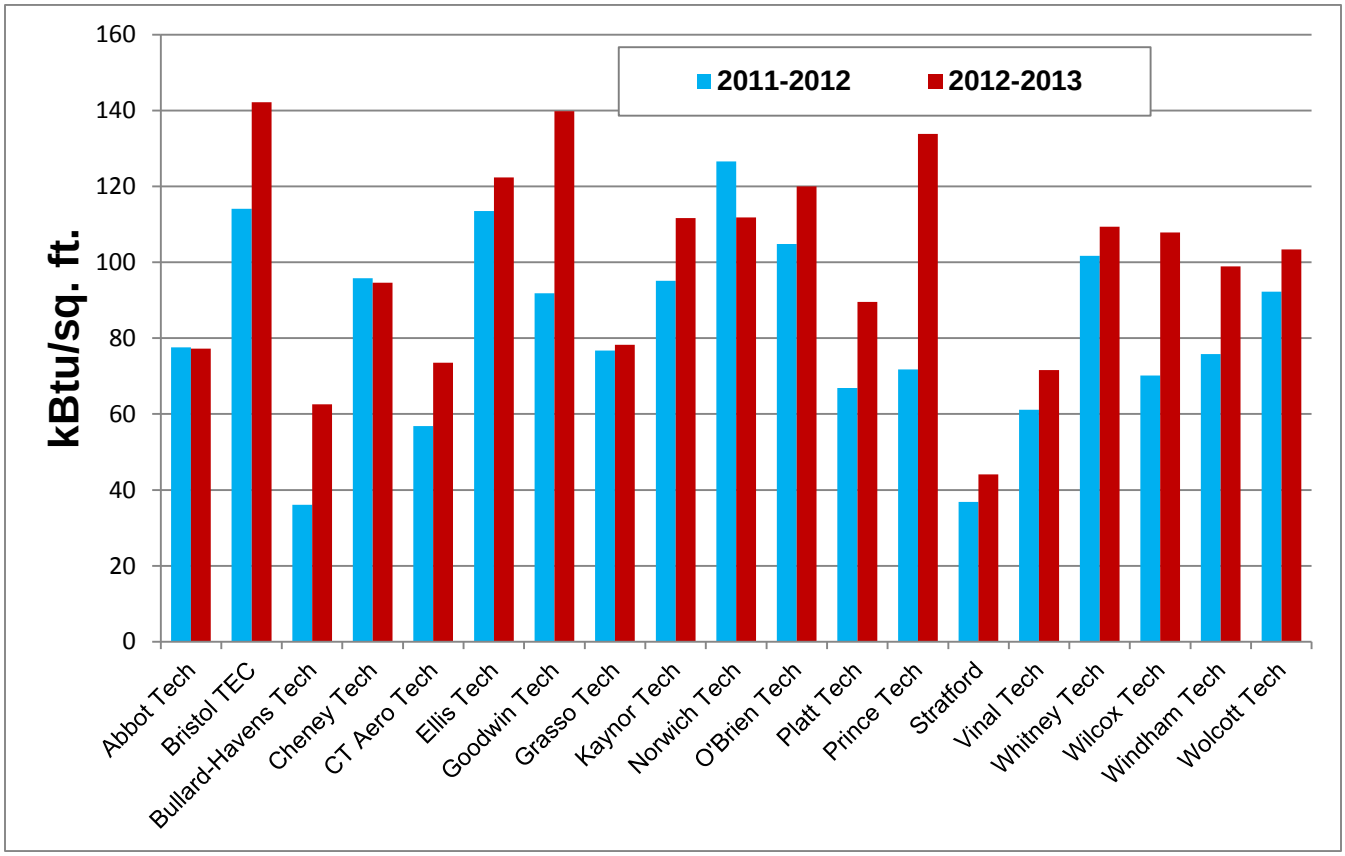
The CTHSS provided ISE with information pertinent to performing benchmarking for the schools, including two years' worth of energy data, and the following building demographic information:

School	Year Built	Sq. Feet	Notes
Abbott Technical High School 21 Hayestown Ave. Danbury 06810	1953	191,262	
Bristol Technical Education Center 431 Minor Street Bristol 06010	1982	49,873	*Scheduled to receive major additions and renovation projects soon
Bullard-Havens Tech High School 500 Palisade Avenue Bridgeport 06610	1952	267,212	
Cheney Technical High School 791 W. Middle Turnpike Manchester 06040	1962	185,095	
Connecticut Aero Tech Brainard Airport 500 Lindbergh Drive Hartford, CT, 06114	2009	30,821	
Goodwin Technical High School 735 Slater Road New Britain 06053	1962	255,441	
Grasso Technical High School 189 Fort Hill Road Groton 06340	1977	212,949	*Scheduled to receive major additions and renovation projects soon
Kaynor Technical High School 43 Tompkins Street Waterbury 06708	1953	220,944	
Norwich Technical High School 7 Mahan Drive Norwich 06360	2009	200,009	
Platt Technical High School 600 Orange Avenue Milford 06461	1974	221,320	*Scheduled to receive major additions and renovation projects soon
Prince Technical High School 401 Flatbush Avenue Hartford 06106	1961	315,335	
Stratford School for Aviation Maintenance Technicians Great Meadow Road Stratford 06615	1987	45,959	*Scheduled to receive major additions and renovation projects soon
Vinal Technical High School 60 Daniels Street Middletown 06457	1962	199,296	*Will be replaced with new building in near future
Windham Technical High School 210 Birch Street Willimantic 06226	1956	172,979	*Will be replaced with new building in near future
Wolcott Technical High School 75 Oliver Street Torrington 06790	1957	151,858	*Will be replaced with new building in near future

SYSTEM BENCHMARING RESULTS

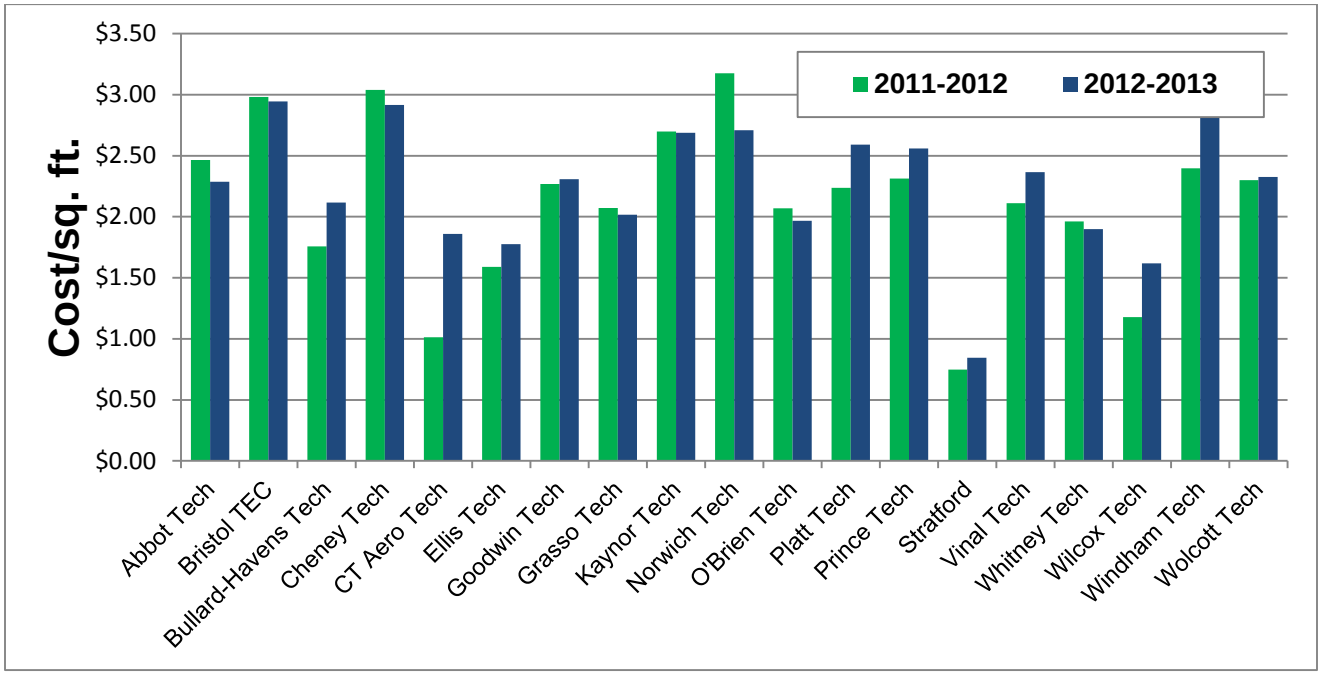
As a reminder, CTHSS schools were benchmarked as K12 schools in ENERGY STAR Portfolio Manager, since receiving an ENERGY STAR score is currently unavailable for technical schools. Although, the CTHSS benchmark scores should not be compared directly to other conventional K12 schools, the scores are useful in comparing relative energy performance among the CTHSS schools and in setting targets to improve the performance of these buildings.

The following chart shows the kBtu per sq. ft. for each of the schools, or the Energy Utilization Index (EUI). Using EUI is an accepted method of comparing similar buildings buildings to one another. The chart shows EUI from the baseline period (2011-2012) as well as the most current year of energy data used for benchmarking (2012-2013).

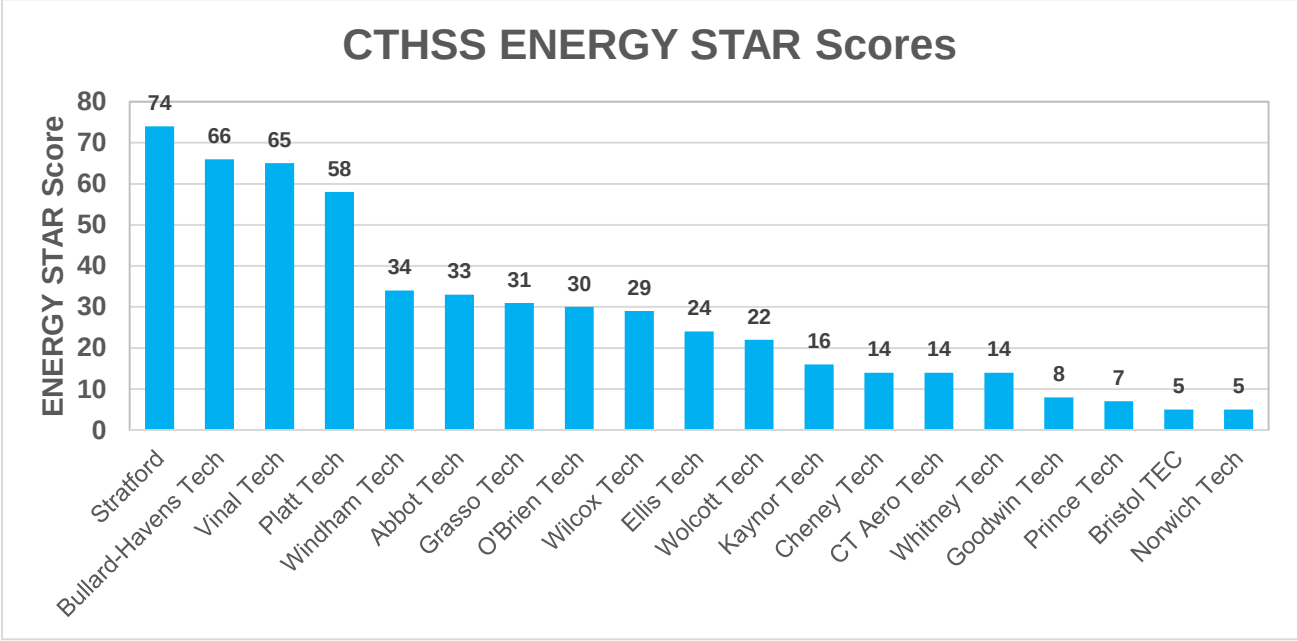


As seen from the graph, there seems to be a general trend among the schools of EUI increasing from the baseline to the current year. This could be due to a number of factors, like more extreme weather, both hot and cold, increased school use, decreasing equipment efficiency, etc. Please note that the large jump in EUI for Prince Tech is due to incomplete natural gas bills from the baseline year and should not be regarded as an unusually huge increase in energy use.

The following chart shows the cost per sq. ft. for each of the schools from the baseline period (2011-2012) as well as from the most current year of energy data used for benchmarking (2012-2013).



There seems to be a general trend of some increasing cost per sq. ft. from the baseline to the current year, while many schools remain about the same and some decrease slightly.



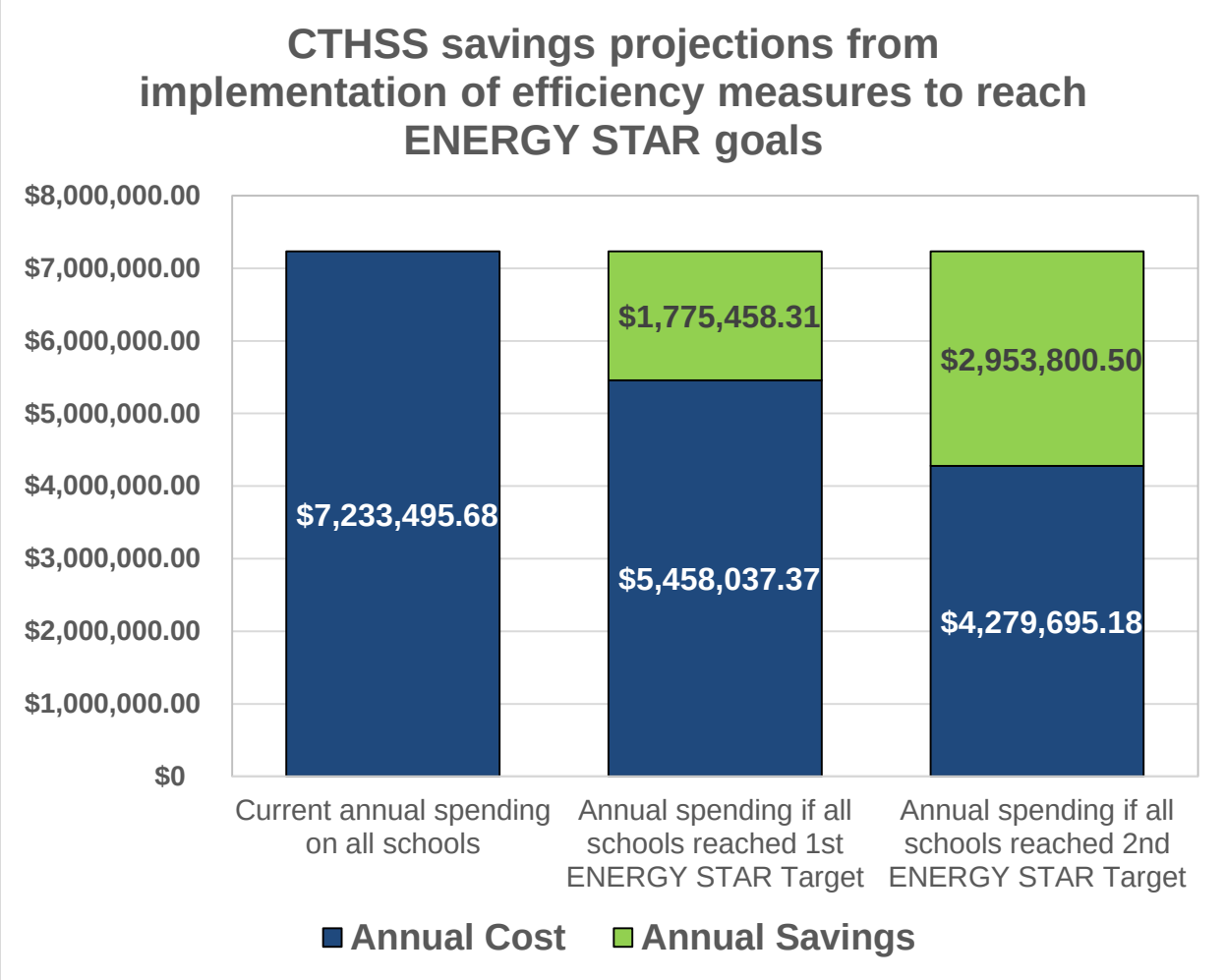
The above graph shows the schools listed in order of ENERGY STAR Score, from most efficient (Stratford) to least efficient (Bristol & Norwich).

The following charts show the energy and demographic data behind the previous graphs:

	Sq. Ft.	Year Built	Total kBtu		kBtu/sq. ft.	
			2011-2012	2012-2013	2011-2012	2012-2013
Abbot Tech	191,262	1953	14,837,233	14,765,521	77.6	77.2
Bristol TEC	49,873	1982	5,690,098	7,090,817	114.1	142.2
Bullard-Havens Tech	267,212	1952	9,646,936	16,712,205	36.1	62.5
Cheney Tech	185,095	1962	17,722,960	17,511,348	95.8	94.6
CT Aero Tech	30,821	2009	1,752,100	2,267,217	56.8	73.6
Ellis Tech	165,983	1959	18,835,188	20,304,030	113.5	122.3
Goodwin Tech	255,441	1962	23,450,670	35,710,459	91.8	139.8
Grasso Tech	212,949	1977	16,338,980	16,667,122	76.7	78.3
Kaynor Tech	220,944	1953	21,020,798	24,674,716	95.1	111.7
Norwich Tech	200,009	2009	25,322,047	22,367,146	126.6	111.8
O'Brien Tech	124,834	1968	13,088,397	14,976,793	104.8	120.0
Platt Tech	221,320	1974	14,801,109	19,823,839	66.9	89.6
Prince Tech	315,335	1961	22,632,623	42,189,264	71.8	133.8
Stratford	45,959	1987	1,694,400	2,026,679	36.9	44.1
Vinal Tech	199,296	1962	12,187,961	14,259,658	61.2	71.6
Whitney Tech	178,763	1956	18,179,035	19,543,231	101.7	109.3
Wilcox Tech	178,428	1961	12,523,959	19,240,200	70.2	107.8
Windham Tech	172,979	1956	13,117,579	17,101,974	75.8	98.9
Wolcott Tech	151,858	1957	14,003,438	15,700,191	92.2	103.4
Wright Tech						

	Annual Cost		Cost/sq. ft.		Energy Star Score
	2011-2012	2012-2013	2011/2012	2012/2013	
Abbot Tech	$ 471,248.47	$ 437,481.36	$ 2.46	$ 2.29	33
Bristol TEC	$ 148,674.52	$ 146,941.34	$ 2.98	$ 2.95	5
Bullard-Havens Tech	$ 469,705.84	$ 565,403.80	$ 1.76	$ 2.12	66
Cheney Tech	$ 562,490.95	$ 539,750.06	$ 3.04	$ 2.92	14
CT Aero Tech	$ 31,237.33	$ 57,320.13	$ 1.01	$ 1.86	14
Ellis Tech	$ 263,681.71	$ 294,614.67	$ 1.59	$ 1.77	24
Goodwin Tech	$ 579,431.08	$ 589,215.05	$ 2.27	$ 2.31	8
Grasso Tech	$ 441,159.45	$ 429,574.80	$ 2.07	$ 2.02	31
Kaynor Tech	$ 596,032.95	$ 593,648.27	$ 2.70	$ 2.69	16
Norwich Tech	$ 635,188.79	$ 541,880.81	$ 3.18	$ 2.71	5
O'Brien Tech	$ 258,183.62	$ 245,695.60	$ 2.07	$ 1.97	30
Platt Tech	$ 494,989.11	$ 573,478.40	$ 2.24	$ 2.59	58
Prince Tech	$ 729,128.02	$ 807,071.86	$ 2.31	$ 2.56	7
Stratford	$ 34,358.02	$ 38,806.53	$ 0.75	$ 0.84	74
Vinal Tech	$ 420,662.87	$ 471,372.39	$ 2.11	$ 2.37	65
Whitney Tech	$ 350,677.50	$ 339,680.66	$ 1.96	$ 1.90	14
Wilcox Tech	$ 210,082.44	$ 288,788.67	$ 1.18	$ 1.62	29
Windham Tech	$ 414,666.75	$ 493,077.18	$ 2.40	$ 2.85	34
Wolcott Tech	$ 349,345.31	$ 353,172.50	$ 2.30	$ 2.33	22
Wright Tech	$ -	$ -			

The following graph shows the potential cost savings the CTHSS could realize by implementing energy efficiency projects and practices in order to reach energy goals and reduce fuel consumption. In this case, the goal of ENERGY STAR target scores has been used to calculate savings. Again, the score itself means little in terms of actual ENERGY STAR rating, but still serves as a benchmark for the schools to be compared as a system, as well as compare themselves to a baseline year of efficiency.

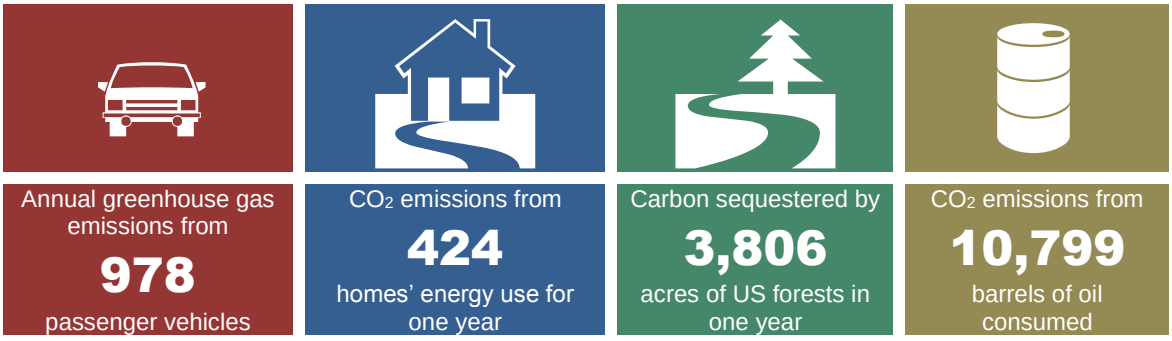


As seen from the graph, the CTHSS is currently spending about $7,300,000 annually for utilities at all of the schools. In each of the individual reports, the schools were given two levels of ENERGY STAR target scores based on their current score. In the case of most of the schools, these goals were 50 and 75. In the case of Stratford, Bullard and Vinal, these targets were 75 and 90, due to having high scores already. The purpose of this was to get an idea of the kind of savings that the system could benefit from if goals are set. In this case, if each of the schools reached its first target score, the system would save almost $2 million annually on energy costs. If the schools all reached their second target score, the system would save nearly $3 million on energy every year.

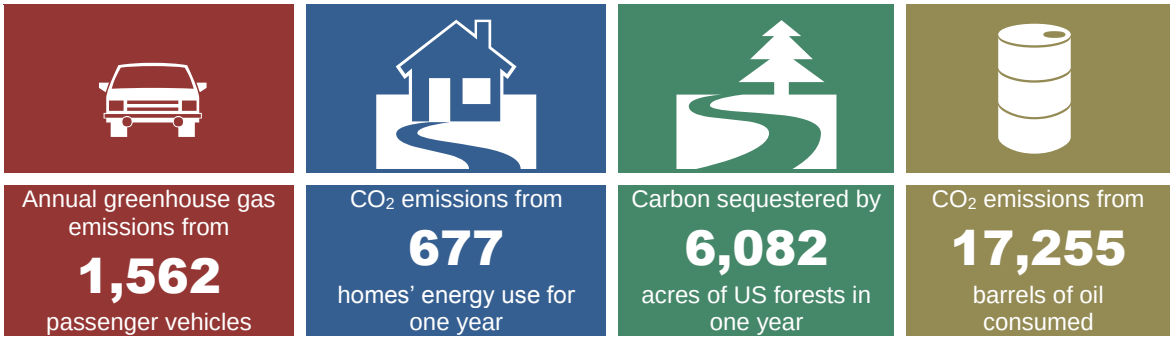
GREENHOUSE GAS EMISSIONS DATA

The total current emissions for CTHSS were **17,498.3 MtC0$_2$e**. "Carbon dioxide equivalent" is a standardized method of comparing emissions from various greenhouse gases based on the global warming potential specific to each gas.

If the system's energy performance is improved to achieve an ENERGY STAR score **50 (or 75 in 3 cases)**, the system's corresponding greenhouse gas emissions would be reduced by **4,643.5 MtCO$_2$e**, for an annual total of **12,854.8 MtCO$_2$e**. This reduction of **4,643.5 MtCO$_2$e** is equivalent to:



If the system's energy performance is improved to achieve an ENERGY STAR score of **75 (or 90 in 3 cases)**, the system's corresponding greenhouse gas emissions would be reduced by **7,419.5 MtCO$_2$e**, for an annual total of **10,078.8 MtCO$_2$e**. This reduction of **7,419.5 MtCO$_2$e** is equivalent to:



These numbers represent total emissions for the school, both direct and indirect emissions. Direct emissions are the combustion of fossil fuels at the site and indirect emissions are created at the power plant for purchased electricity.

In order to get equivalencies of GHG emissions (MtCO2e) the EPA's Green House Gas Equivalencies Calculator was used. The methodologies for the equivalencies can be found from the link here: http://www.epa.gov/cleanenergy/energy-resources/calculator.html

The following chart shows an overview of the greenhouse gas emissions reduction data for each school:

	Current Annual Total GHG Emissions (MtCO2e)	Amt. Reduction needed for ENERGY STAR Score of 50 (MtCO2e)	% Reduction needed of total for ENERGY STAR Score of 50	Amt. Reduction needed for ENERGY STAR Score of 75 (MtCO2e)	% Reduction needed of total for ENERGY STAR Score of 75
Abbott	1,051.5	146.0	13.88%	343.2	32.64%
Bristol TEC	457.1	175.8	38.46%	237.1	51.87%
Cheney	1,273.7	386.4	30.34%	580.3	45.56%
CT Aero Tech	158.6	47.1	29.70%	71.5	45.08%
Goodwin	2,273.2	838.3	36.88%	1,151.3	50.65%
Grasso	1,257.6	196.0	15.59%	427.2	33.97%
Kaynor	1,719.9	481.7	28.01%	751.4	43.69%
Norwich	1,610.4	660.2	41.00%	867.2	53.85%
Prince	2,813.4	1,082.3	38.47%	1,459.3	51.87%
Windham	1,342.9	177.6	13.23%	431.8	32.15%
Wolcott	1,037.7	232.2	22.38%	407.5	39.27%
	Total	**For score of 75**	**Score of 75**	**For Score of 90**	**Score of 90**
Bullard-Havens	1,219.7	105.4	8.64%	335.7	27.52%
Stratford	125.9	4.6	3.65%	29.6	23.51%
Vinal	1,156.7	109.9	9.50%	326.4	28.22%

ENERGY CONSERVATION MEASURES

Energy Conservation Measure (ECM)	
Building Automation System (BAS)	The Building Automation Systems at the CTHSS are generally old and outdated and have not functioned properly for some time. In many cases, critical building systems are not a part of the BAS, preventing the Building Maintenance Supervisors (BMS) from being able to effectively monitor building systems and manage energy use in the building. Many schools are still using pneumatic or partly pneumatic systems. The schools should all have their existing systems evaluated and upgraded to Direct Digital Control with a graphic user interface that allows the BMS to easily track and control energy use. All building systems should be added to the BAS to ensure maximum building control.
	Many of the schools have moisture problems in the building caused by negative pressure and lack of control on exhaust equipment, where monitoring and controlling of rooftop exhaust fans and radiant perimeter heating units is needed. Time clock and calendar scheduling to control the larger exhaust fan systems should be added to the BAS at each school, along with monitoring of total building static pressure and controlling make-up air units to ensure positive or neutral pressure.
	In many of the schools, hot water is constantly being made and circulated throughout the buildings regardless of the lack of need for it. This should be controlled by the BAS, and point of use hot water should be investigated for applications where it may be appropriate.
	The Building Maintenance Supervisors at all of the schools do not currently receive monthly energy or water bills. As a result, they are unable to quickly respond to changes in building energy and water use. We recommend that the school integrate the ability to read energy data into the capabilities of the BAS at each school in order to more effectively manage energy use in the buildings.
	Across the system, access to the BAS at each school is restricted to the computer workstation in the Building Maintenance Supervisor's office. Wireless access to the system using a laptop or tablet would give them the capability to diagnose issues and make adjustments to set points in the mechanical rooms, on rooftop units and in major lighting systems from anywhere in the buildings.

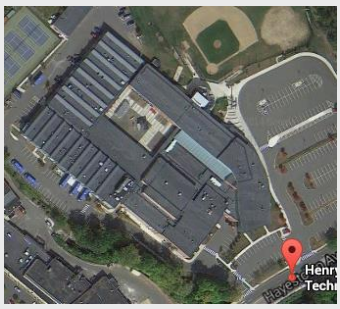
HVAC	Though the majority of the schools in the system use natural gas, the three schools that still use fuel oil should look into becoming a part of the state's expanding natural gas infrastructure if not hooked up at all, or converting completely to natural gas if both gas and oil are still used. (More info below). This applies to Bullard-Havens, Vinal and Windham.
Lighting	There are opportunities to replace lighting with more efficient fixtures at every school, which would save the system a great deal of money in electricity costs, as well as in maintenance costs. More energy efficient bulbs last longer and do not need to be changed as often. Additionally, newer bulbs can give the same amount of light output with fewer watts, reducing the electricity load without compromising proper lighting levels. Major general system-wide recommendations from walkthroughs are: • Replace all T-12 lighting in shops with T-8 or T-5 fluorescent fixtures • In gymnasiums with mercury vapor/metal halide lighting, convert to T-5 high bay fixtures • Convert all exterior pole and security lighting to LED • Many classrooms are over lit throughout the system, consider de-lamping or reconfiguration so that excess wattage is not being wasted
Building Envelope	Most of the schools should install weather stripping and caulking where energy is being wasted through poor air sealing. Many of the schools on the walkthrough had doors and windows open to the outside with large gaps for air to escape through. Weather stripping is a relatively simple and inexpensive measure that will help to increase the efficiency of the buildings.
Culinary	On the majority of the walkthroughs, existing natural gas equipment was operating with constant, uncontrolled pilot lights, even during the summer when no one was using the kitchens. Natural gas use can be reduced significantly by replacing the pilot lights with electronic igniting equipment. The Department of Energy reports that each pilot consumes approximately 0.5 cubic feet of natural gas per hour or over 4,000 cubic feet per year.

	The exhaust hoods in the cafeteria and culinary teaching area kitchens in the schools are very inefficient compared to equipment available today. They lack fan motor speed controls, which would save significant energy by idling fans when operating in non-cooking conditions and varying the fan speed based on the temperature and amount of particulates in the exhaust during cooking conditions. This would reduce the energy used by the fan motor up to 90% as well as reduce the need to heat or cool make-up air to replace exhausted conditioned air, saving up to 50% of losses from excess exhausting. In addition, systems for providing make-up air to replace the conditioned air being exhausted should be designed and installed, since there were many schools that were exhausting lots of air without bringing any fresh air back into the space.
	Nearly all kitchen refrigerators and freezers seen on the walkthroughs over the summer were operating while mostly empty, even if there were multiple units side by side. Refrigerators and freezers should be consolidated so that units are not operating while mostly empty. They should also be retrofitted with controls in order to maximize operation efficiency. In summer, refrigerator and freezer use should be minimized to help reduce electric consumption when classes are not in session.
	Commercial cooking is one of the most energy-intensive operations at the schools, and nearly all of them have some kind of culinary program. Some of the cooking equipment could be cost-effectively replaced with modern, energy efficient natural gas and electric equipment. ENERGY STAR estimates that new equipment on the market is approximately 35% more energy efficient than the aging kitchen equipment currently in the schools.
Renewable Energy	The system has plenty of available roof space for large solar PV systems, which could be installed through the use of a Power Purchase Agreement (more info below).

Other	The school system has an excellent opportunity to involve its students in the process of making the buildings more energy efficient. The unique nature of the technical high school system means that the students are learning about a variety of trades, many of which are directly impacted by the principles of energy efficiency and conservation. The entire system, should take advantage of the opportunities to teach students real-world skills about the process of increasing building efficiency, using their own schools as learning laboratories. This is an excellent change to educate the future working generation on principles of energy use, efficiency, conservation and environmental sustainability as it relates to not just their specific trade, but to larger issues like climate change, and to help prepare them for a changing workforce.
	As part of strategic energy management, facility and maintenance personnel should be involved in ongoing professional development and training to remain up to date on best practices for operations and maintenance, as well as standards for performance of lighting and HVAC equipment.

SOLAR POWER PURCHASE AGREEMENTS

Aerial view of CTHSS roofs:



Aerial view of Abbott Tech.

Aerial view of Bristol TEC.

Aerial view of Bullard-Havens Tech.


Aerial view of Cheney Tech.


Aerial view of CT Aero Tech.

Aerial view of Goodwin Tech.


Aerial view of Grasso Tech.


Aerial view of Kaynor Tech.

Aerial view of Norwich Tech.

Aerial view of Prince Tech.


Aerial view of Stratford.

Aerial view of Vinal Tech.


Aerial view of Windham Tech.

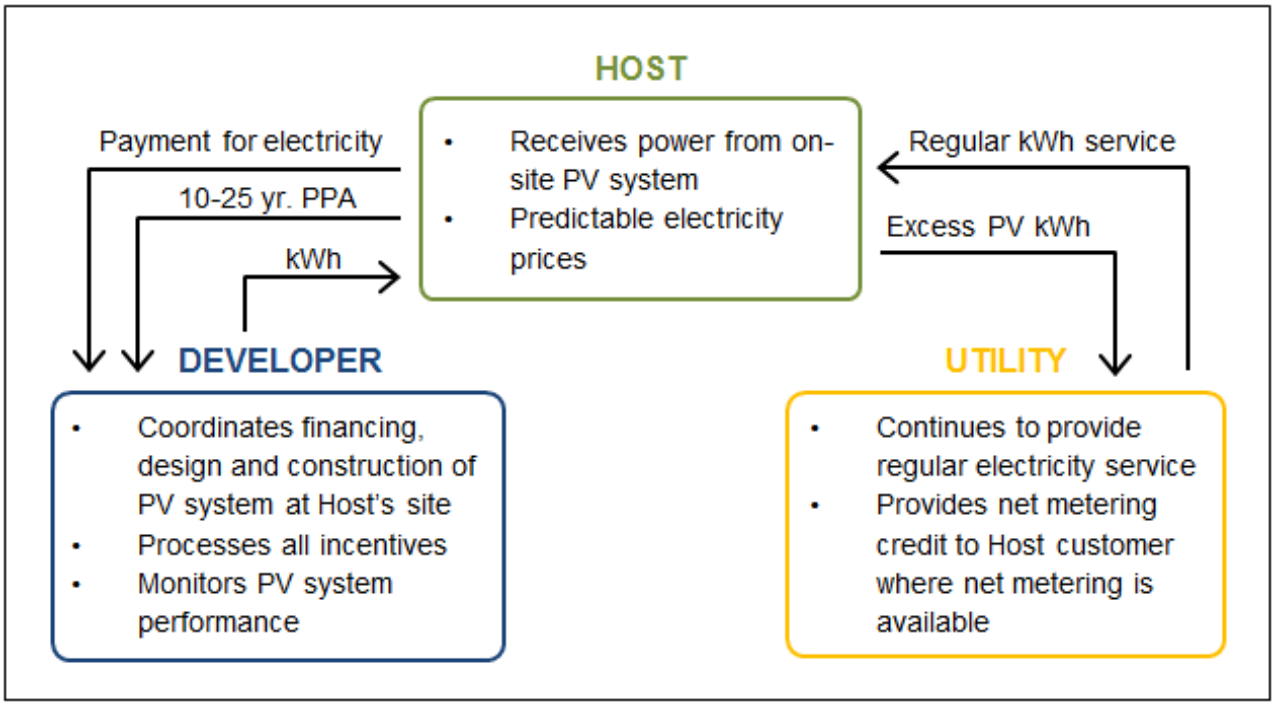
Aerial view of Wolcott Tech.

The school administration should consider installing Solar Photovoltaic (PV) systems on the roofs of the CTHSS facilities. Nearly all of them have the adequate space and lack of shading to support big systems, which when looked at as a whole add up to a potentially very large amount of solar power. These systems have the added benefit of being able to be used as demonstration systems and training centers for the students, and to provide stabilization against electric price increases. The systems can be installed using a Power Purchase Agreement, which requires no up-front cash, with the schools purchasing the output of the PV arrays at a rate indexed below the local utility charge.

SPPAs are financial instruments specifically designed to promote renewable energy development in the form of solar. Simply put, an SPPA is an arrangement in which a third-party developer owns, operates and maintains a solar array, and the customer agrees to host the system on their property and purchase the electric output of the system from the provider for a predetermined period. This allows the customer access to a stable source of renewable energy, as well as the ability to use the system as a teaching tool, while the third-party receives financial benefits including green power tax credits. This arrangement allows the customer the benefits of renewable power without the barriers of high up-front cost, worries about maintenance and a difficult design and permitting process. Many schools, both K-12 and higher education, use SPPAs as a way of installing solar arrays on their campuses.

Benefits & Challenges of Solar Power Purchase Agreements	
Benefits for host customer:	Challenges for host customer:
• No upfront capital cost. • Predictable energy pricing. • No system performance or operating risk. • Projects can be cash flow positive from day one. • Visibly demonstrable environmental commitment. • Potential to make claims about being solar powered (if associated RECs are retained). • Potential reduction in carbon footprint (once system is paid for.) • Support for local economy and job creation.	• More complex negotiations and potentially higher transaction costs than buying PV system outright. • Ongoing administrative costs of paying separate electricity invoices, and allowing access to equipment by maintenance personnel. • The SPPA will be owned by a special purpose entity that may have limited liability and limited assets, and the special purpose entity may change over time.

Above table: http://www.epa.gov/greenpower/buygp/solarpower.htm.



Above Figure: http://www.seia.org/research-resources/solar-power-purchase-agreements.

LIGHTING DISPOSAL

Lighting upgrades often involve the replacement of compact fluorescent tubes that contain mercury. Lighting products containing mercury that are removed from technical high schools may not be disposed in the solid waste stream and require proper handling and disposal through an authorized lamp recycling company. In addition, older fluorescent light ballasts contain PCBs (polychlorinated biphenyls). If a school was built prior to 1979 and has not had a complete lighting retrofit, retrofitting to high efficiency bulbs will reduce energy use and costs and eliminate the possibility of exposure to leaking PCBs.

The CT Department of Administrative Services has a contract for "retrieval, disposal and recycling services for lamps, ballasts and items containing mercury," including ballasts containing PCBs. This contract may be used by the CT Technical High School System. The vendor services under this contract include the supply of appropriate collection containers with packaging and labeling, waste retrieval and pick up, transportation, recycling and disposal that complies with permitting, manifest, and reporting requirements required by federal and Connecticut hazardous waste regulations. The contract, DAS contract #14PSX0039, can be found at http://www.biznet.ct.gov/SCP_Search/ContractDetail.aspx?ID=13673

NATURAL GAS

The 2013 Comprehensive Energy Strategy for Connecticut establishes a broad goal of achieving cheaper, cleaner, and more reliable energy for Connecticut. The recommendations for energy savings measures in this report align directly with the State's promotion of energy efficiency as a primary strategy to achieve this goal. Another key element of the 2013 Comprehensive Energy Strategy for Connecticut, which has been further endorsed through legislation, is to expand natural gas infrastructure to provide residents and businesses access to an energy choice that is lower-cost, less-polluting, and domestically available. The Connecticut Technical High School System should explore opportunities for natural gas connections to schools that currently heat with fuel oil. In addition to the lower cost of natural gas, Energize Connecticut has rebates and low interest financing for certain high efficiency natural gas equipment.

Vinal Tech, Bullard-Havens Tech and Windham Tech should explore opportunities for connecting to natural gas. The appropriate contact person to assist the school with natural gas connection and use is:

Peter Casarella
Yankee Gas Services Company
Office: (860) 779-4605
Email: casarpf@nu.com

NEXT STEPS: SAVING ENERGY & COSTS WITH STRATEGIC ENERGY MANAGEMENT

The total square footage for the 19 Connecticut technical high schools (not including Wright Tech which is new construction) is just under 3.4 million square feet. The total annual energy spend for these 19 schools for fiscal year 2013 was approximately $7.2 million, an average of $2.11 per square foot.
The average benchmarking score for the Connecticut Technical High School System is 28. However, as noted previously, this benchmarking score is based on a comparison of Connecticut's technical high schools to a large national data set of conventional K12 schools. Because of the higher energy use by technical high schools, benchmarking comparisons should only be made within the CTTHS system to determine the energy performance of these schools relative to each other. Nonetheless, there are significant opportunities for the technical high schools to save energy and money by improving the energy performance of these buildings. By increasing the system average school performance to an Energy Star rating of 50 (or 75 in a few cases), the system could save $1,775,460 annually. These wasted energy dollars can be used to reduce tight operating budgets and to finance energy retrofits throughout the system. The goal should be to work

towards "strategic energy management," which means continuous improvement in the way energy is used within each school and across the Connecticut Technical High School System. Strategic energy management includes improvements to operations and maintenance (O&M) as well as equipment upgrades that will achieve on-going, persistent energy savings over time. This approach moves away from single "one-off" equipment replacement towards setting long-term energy goals, tracking and monitoring energy use (which can be done through the Portfolio Manager accounts that ISE has established for each school), and realizing and quantifying savings from O&M improvements and from energy retrofits. By managing energy more strategically across the system, the schools will benefit from energy and cost savings, improved performance of building systems, reduced deferred maintenance, increased building comfort and learning environment for students and staff, and additional opportunities for Building Management Supervisors to control energy use.

Connecticut's new **Energy Savings Performance Contracting (ESPC) Program** provides a tremendous opportunity for CTHSS to achieve deep, comprehensive, system-wide energy upgrades with no upfront capital costs. ESPC combines a variety of energy savings measures across multiple buildings into one large project, in which the vendor guarantees future energy savings which will cover the cost of implementing the energy measures. Designed to minimize risk for state agencies and municipalities, Connecticut's program includes:

- 13 pre-qualified vendors (Qualified Energy Services Providers) on contract with the Department of Administrative Services,
- A full set of ESPC contract documents that have been pre-approved by the Attorney General,
- Technical support on the analysis of energy savings measures and opportunities from the Department of Energy and Environmental Protection (DEEP) and engineering firms with funding support from the CT Energy Efficiency Fund, and
- Technical support on financing from the Connecticut Green Bank.

ESPC projects can result in up to 30% energy savings. From preliminary projections, if it were appropriate to include all 19 of Connecticut's Technical High Schools in an ESPC project, a 15-year project (the maximum ESPC term allowed by CT General Statutes) could result in a $30 million system-wide ESPC project providing a broad portfolio of energy retrofits. Approximately $2 million in annual energy savings would be used to finance the energy retrofits and then accrue directly to CTTHS after the term of the ESPC. Due to planned new construction of some schools, it is unlikely that all 19 schools would be included in a system-wide ESPC, but the example illustrates the ESPC potential.

The Connecticut Green Bank and DEEP are currently exploring the issuance of a Green Bond by the Green Bank to finance a few of the initial ESPC projects in Connecticut, which could include CTHSS. ISE is available to help the CTTHS actively engage with DEEP and the Green Bank to explore this opportunity further and include a system-wide ESPC in the initial Green Bond package. The lead contact people for Connecticut's ESPC program are:

Andrew Brydges, Director, Institutional Programs
Clean Energy Finance and Investment Authority (CEFIA)
845 Brook Street, Rocky Hill, CT 06067
www.ctcleanenergy.com | andrew.brydges@ctcleanenergy.com
860.258.7834

Diane W. Duva, Office Director
Office of Energy Demand
Bureau of Energy and Technology Policy
Connecticut Department of Energy and Environmental Protection
10 Franklin Square, New Britain CT 06051
Phone: 860.827.2756 | Cell: 860.906.7641 | Fax: 860.827.2806
diane.duva@ct.gov | www.energizeCT.com

The State of Connecticut offers an additional broad range of programs and incentives to increase energy efficiency in all sectors. This portfolio of programs and incentives, known as Energize Connecticut (energizect.com), is funded through the CT Energy Efficiency Fund which is funded in large part by Connecticut electricity customers. Energize Connecticut programs provide technical support (energy audits), financing, and pre-qualified vendors to implement energy retrofits. Determining the best combination of programs that will result in comprehensive, ongoing improvements to how these schools use energy will require strong coordination between the systems office, Building Management Supervisors, and Energize Connecticut and utility program leads. ISE is available to help support this coordination as the schools move to implementation of energy measures. The following issues will help determine which combination of programs is most appropriate for the Connecticut technical high schools:

- Can multiple measures be combined in order to obtain deeper, more comprehensive retrofits, possibly through an Energy Savings Performance Contract?
- Can similar measures (e.g., lighting upgrades) in multiple schools be combined into one project?
- How much longer will a particular school be in use by CTTHS? Is the projected payback within the timeframe of CTTHS's planned use of the building?
- Will the school's use change in the near future – e.g., increasing/decreasing hours of use, planned additions or renovations, changes in use or configuration of building space, etc.
- Are any of the recommended energy measures already included in the capital improvement plan for the near future?
- Is there an opportunity to standardize equipment across schools in order to optimize training and purchasing?
- How can CTTHS students be integrated into the energy retrofits as a way of hands-on training?

The following Energize Connecticut programs are most relevant to CTTHS and will likely become important components of the solution for system-wide comprehensive, deep energy improvements. To facilitate next steps on implementation, the program leads for these Energize Connecticut programs have been invited to participate in the December 2014 meeting with ISE and the Connecticut Technical High School System office and Building Maintenance Supervisors.

Small Business Energy Advantage ***(SBEA)***
(http://www.energizect.com/government-municipalities/programs/Small-Business-Energy-Advantage)
Free energy assessment that focuses on lighting, HVAC, and refrigeration systems.
For projects less than $100,000 with a payback of less than 4 years.
No upfront costs. Incentives pay for up to 50% of installed cost. On-bill financing with 0% interest for the remainder.
All state agencies are eligible to participate in SBEA through agreements signed by CL&P, UI, and the Attorney General.
Program contact: 877-WISE-USE (877-947-3873)

Retrocommissioning
(http://www.energizect.com/nonprofits/programs/retro-commissioning)
To optimize building controls, operations, and maintenance.
For schools with an existing building energy management system with trending capability.
Financial incentives available for investigation and implementation stages.
Program contact: 877-WISE-USE (877-947-3873)

Energy Savings Performance Contracting ***(ESPC)***
(http://www.ct.gov/deep/cwp/view.asp?a=4405&Q=513642&deepNav_GID=2121)
Comprehensive portfolio of energy retrofits and O&M improvements.
No up-front costs. Energy measures are paid from future energy savings that are guaranteed by the vendor.
CT has a list of pre-qualified ESPC vendors and a full set on ESPC contract documents that have been pre-approved by the Attorney General. Incentives from other Energy Connecticut programs are incorporated.
Program contact: Andrew Brydges, Clean Energy Finance & Investment Authority, 860-258-7834, Andrew.brydges@ctcleanenergy.com
ESPC@energizect.com

Energy Opportunities
(http://www.energizect.com/government-municipalities/programs/Energy-Opportunities)
Addresses equipment upgrades, including lighting, HVAC, chillers, motors, controls, water heaters and commercial cooking equipment.
Incentives cover 35-40% of installed costs.
Zero-interest and low-interest rate financing.
Program contact: 877-WISE-USE (877-947-3873)

Natural Gas Heating and Water Heating Equipment
(http://www.energizect.com/government-municipalities/programs/Natural-Gas-Heating-Equipment-Rebate)

Addresses new high efficiency natural gas furnaces and boilers and water heaters.
Rebates on per-unit basis.
Program contact: 877-WISE-USE (877-947-3873)

Energy Conscious Blueprint
(http://www.energizect.com/government-municipalities/programs/Energy-Conscious-Blueprint)
For new construction and major renovation.
Financial incentives to offset the cost premium cost of high efficiency electric and natural gas equipment.
Program contact: 877-WISE-USE (877-947-3873)

CT Green LEAF Schools
(http://www.ctgreenschools.org/ctgreenleaf.htm)
In addition to energy improvements to technical high schools buildings, the Connecticut Green LEAF Schools program can help integrate sustainability into technical school curriculum. Over 65 K-12 schools in Connecticut have signed on to this program in which participating schools are supported in working toward three goals: educating students about sustainability and environmental literacy; promoting health and wellness for all students and staff; and reducing the cost and environmental impact of resources used in the school. Schools sign on with a Principal's Letter of Commitment and then complete a school Self-Assessment, and set their own action plan. The program provides assistance in greening the school through workshops and connections to statewide programs. As schools become greener, they may be eligible for state and national recognition. Green LEAF Schools provides yet another resource to help Connecticut's technical high schools with comprehensive sustainability initiatives.

CONCLUSION

ISE has coordinated a meeting at the CTHSS Central Office in Middletown, CT to take place on Tuesday, December 16th, 2014. This meeting will serve to bring together the Building Maintenance Supervisors from the tech schools, as well as CTHSS administrative and financial staff members, and representatives from efficiency programs in the state. ISE will be presenting the key findings of these reports, based on overall CTHSS recommendations gained from benchmarking and the building walkthroughs. The meeting should be a starting point in the formation of an action plan as to how the CTHSS wants to move forward with the implementation of energy efficiency measures and practices that will result in real, significant system-wide savings. ISE looks forward to the opportunity to keep working with the Technical High School System as this project moves forward, and will be available for any further opportunities to continue the work that has been started with these reports.