System Performance Best Practices

Pennsylvania State Health, Milton S. Hershey Medical Center – Hershey, PA

Climate Zone	5A
Cooling Degree Days	1448
Heating Degree Days	4428
ISO	PJM
Local Utility	PPL electric

System Profile

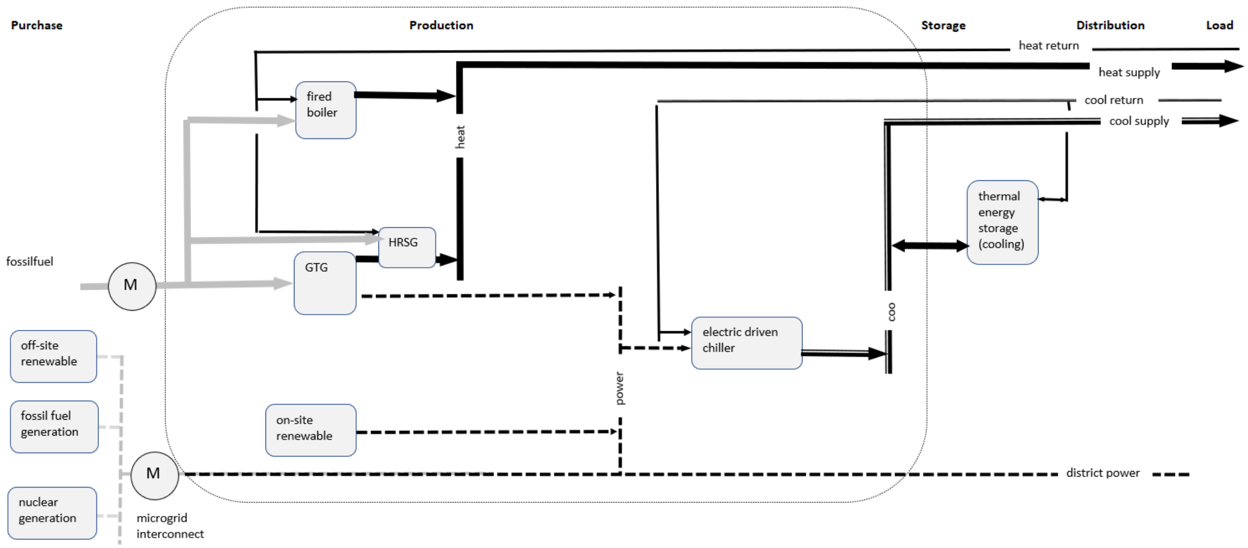
Penn State Health Milton S. Hershey Medical Center is a 550 acre, 548 bed medical school and hospital campus located in Hershey Pennsylvania. The campus includes two hospitals, five institutes, and the Penn State College of Medicine, includes a Level-One Trauma Center, and serves over 1.2 million patients annually. Since 2009, the utilities team has undertaken a comprehensive energy system upgrade to improve reliability and resiliency (critical for a major hospital and research facility) and decrease the overall cost and carbon emissions of the campus. These upgrades have included a major chilled water optimization project and implementation of CHP. Annual energy consumption is about 112,000,000 kWh of electricity and 573,000 MMBtu of natural gas.

The 8 MW natural gas fired CHP system is based on one combustion gas turbine generator and one heat recovery steam generator with duct firing capability to supply 90,000 lb/hr of steam, most of which is used for climate control, cooking, hot water generation, and sterilization of medical equipment. The CUP provides an additional 180,000 pph of district heating using three boilers. Three chiller plants serve 2.6 million square feet of building space. The central plant uses 8 chillers, and two satellite plants use 2 chillers each, for a combined total of 13,300 tons of cooling. The campus is also equipped with a 1.4-million-gallon TES tank.

System Capacity

CHP capacity	7.5 MW
District Heating (steam)	180,000 lbs/hr
District Cooling (chilled water)	14,200 tons
Chilled Tank Volume	1.4 million gallons

System Single Line Diagram



To view this graphic in a web browser, visit this site:

[Penn State Health Milton S. Hershey Medical Center - International District Energy Association]

System Performance

1. **System Efficiency**
   - District Cooling (kW/ton): improved from .83 to .68
   - CHP efficiency improved from 45% to 80%
2. **System Reliability and Availability**
   - No data
3. **TES Reducing Peak Demand**
   - 1,624,040 kWh peak reduction from 1.4-million-gallon TES tank
4. **Improved CHW system delta T**
   - Before improvements: 10 degrees F, after improvements: 15 degrees F

Technical Best Practices

1. CHP

When it came time for Penn State Health Milton S. Hershey Medical Center to replace its aging electrical infrastructure, the campus took the opportunity to reinforce the overall system's reliability and resiliency by installing a natural gas fired CHP system. Additionally, adding CHP allowed the campus to extend the life of existing boilers, rather than forcing replacement. As the medical center went through the process of integrating CHP, they also found it useful to replace electric gear in the plant to accept the power being generated from the new system. This project was championed by the CFO for its potential resiliency and carbon savings, in addition to the energy savings: it received PEER platinum in 2021.

CHP generates 54% of the campus power and 96% of the steam load, which reduces the annual utility costs, improves resiliency, and lowers overall campus carbon emissions by 83,120 metric tons. CHP provides the campus with $4 million in annual energy savings.

2. Chilled Water Optimization

Starting in 2009, the campus utilities team embarked on a comprehensive energy efficiency plan that culminated in the implementation of a chilled water optimization program. The plant had not been substantially updated since the late 70s, when energy efficiency was less of a concern, so the chilled water system had a relatively low deltaT (8 degree), limiting the capacity of the installed chillers and distribution network. In the winter of 2010, the group instituted an aggressive chilled water distribution preventative maintenance plan, which included strainer cleaning and replacement, valve replacement, and adding analog thermometers at air handler coils. They also replaced chilled water coils in older units with newer coils with higher deltaT splits and sized them appropriately to the load. The also replaced two aging centrifugal chillers with magnetic-bearing centrifugal chillers, each rated to deliver 1,000 tons of cooling. Collectively, pre-optimization efficiency measure is estimated to have reduced the campus's energy intensity by 20%.

Once the mechanical control systems issues were addressed, the medical center moved on to optimization. First, the campus HVAC automation provider, Johnson Controls, installed variable-speed drivers on pumps and fans, fully automating the plant. The medical center then partnered with an energy optimization firm to deploy their optimization platform and relational control software, capable of analyzing HVAC data and identifying opportunities to improve efficiency, making equipment adjustments automatically. The system reviews the fully system (all chillers plus the TES tank) as a single unit and deploys the best combination of technology based on equipment efficiency and cooling demand. Plant control optimization is attributed with electrical energy savings of 3,406,337 kWh/yr, and an electrical demand reduction of 183.7 kW. HMC also realized 4.16 GWh/yr in energy savings, $300,000/yr savings in electrical costs, an electrical demand reduction of 874 kW, and a CO_2 reduction of 3,200 tons/year.

Altogether, the medical center's energy efficiency measures include operation and maintenance, capital equipment replacement overlayed with a plant control optimization program saved million pounds of CO_2 emissions. and 1.4 million gallons of water annually, earning the US Green Building Council's Central PA Forever Green Award.

3. TES for Demand Response

Though Penn State Health Milton S. Hershey Medical Center initially installed its TES tank to take advantage of off-peak energy rates (the Time of Use rate structure has since changed), the tank is now used primarily to participate in PPL's demand response program and prevent disruption in instances where chillers either break down or are taken offline.

Management and Financial Best Practices

1. Budget Process

Prior to the early 2000s, central utilities annual capital budget requests competed with diagnostic and patient care investment needs for medical center funding. The process was revised to separate infrastructure from healthcare allocate adequate infrastructure renewal funding. As a result, the campus utilities became very reactive, leaving the campus prone to faults. The CFO at the time elected to revise the request process so that utilities would request renewal funding based on baseline performance data, which established a pool of money the utilities team could use to make necessary upgrades.

Though Penn State Health Milton S. Hershey Medical Center's early success moving away from reactive utility planning to forward planning was largely championed and enabled by their CFO. In addition to revising the budget request strategy mention above, he was also integral to the eventual adoption of CHP. Because the utilities team has been successful at tracking system data, they've been able to persuade leadership to take more daring risks in utilities improvements.

2. Training

Penn State Health Milton S. Hershey Medical Center largely credits their success in preparing for and implementing the optimization program to their commitment to building their in-house workforce. They have committed to purchasing comprehensive training packages for newly integrated technologies (including cogeneration and solar PV) and reworked how the operators respond to and tolerate fluctuations in the newly automated controls systems. Even still, they run annual tests where the optimization system is disabled so the operators are required to operate the plant manually.