SHOWCASE PROJECT: FORD MOTOR COMPANY: DEARBORN RESEARCH AND ENGINEERING CAMPUS CENTRAL ENERGY PLANT

SOLUTION OVERVIEW

BETTER PROJECT WINNER 2020 The new Central Energy Plant (CEP) at Ford's Dearborn Research and Engineering Center delivers significant energy and water savings while supporting the modernization and future expansion of a 900-acre campus. The new plant was completed at the end of 2019 and is projected to achieve a 50% reduction in campus office space energy and water use. The CEP provides the capacity to add thousands of employees to the campus and features a mix of technologies, including combined heat and power, thermal energy storage, and heat recovery chillers. An innovative project delivery model was critical to the project's success and included partnerships with engineering firms and the local utility, DTE Energy. The plant serves both process and building loads using a combination of grid-sourced and distributed energy systems that were scaled to optimize cost and efficiency.

The Ford and DTE Energy team set out to design and build a new central energy plant that would replace an older steam powerhouse that was at the end of its useful life and multiple in-building chillers. Ford defined a range of high-performance sustainability objectives to accompany the modernization of the plant, including:

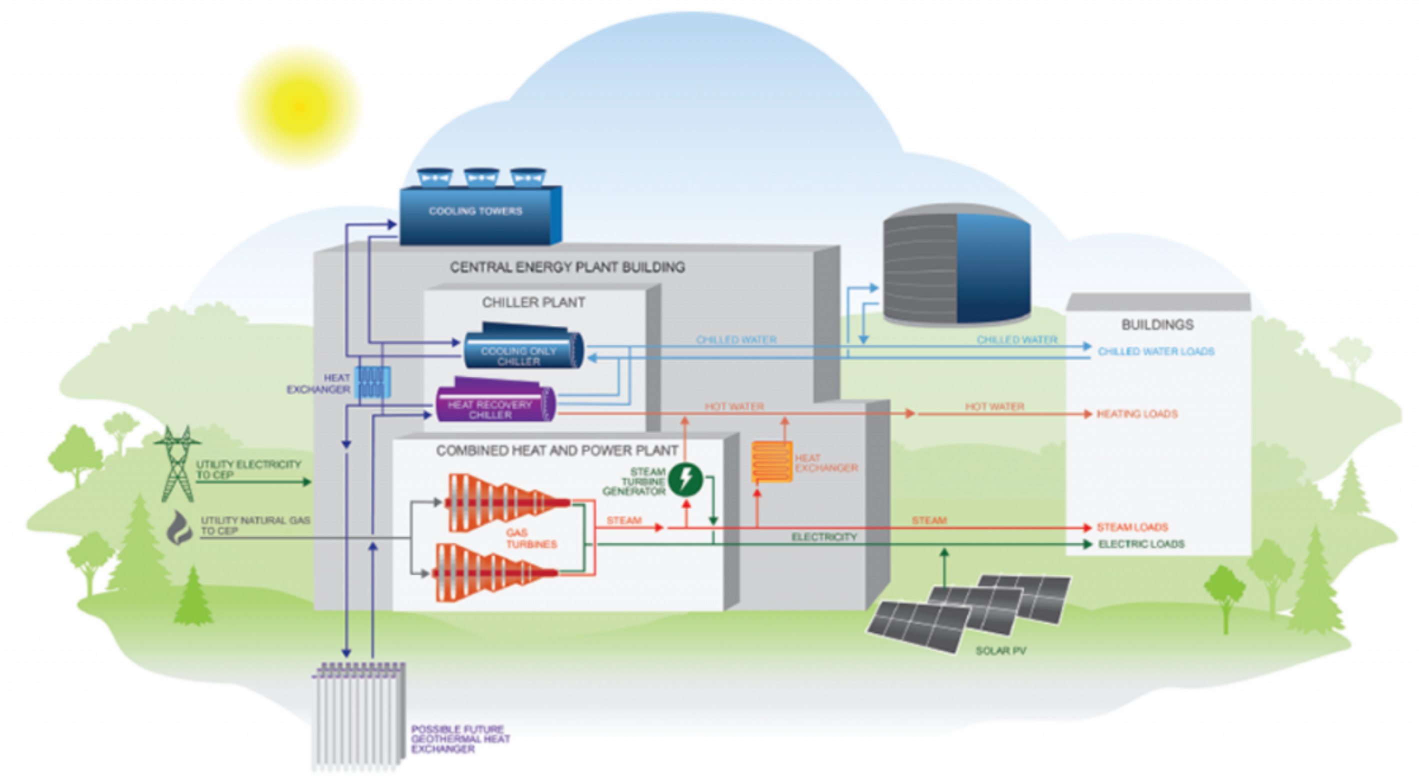
- 50% reduction in carbon footprint,
- 50% reduction in water use,
- 60% improvement in chilled water production efficiency, and
- 100% of space heating provided from recovered waste heat or geothermal energy sources.

The Campus Central Energy Plant, illustrated in Figure 1, includes a mix of technologies that provide electricity, steam, chilled water, and hot water for campus buildings. The components of the new plant include:

- A combined heat and power (CHP) system that can generate up to 225,000 lbs./hr. steam and 34 MW of electricity.

- A 15,800-ton central chilled water plant with four 3,200-ton chillers, one 1,200-ton heat pump chiller, and one 1,800-ton heat pump chiller with R-1233zd refrigerant.
- A 5.3 Million gallon (40,000 ton/hr.) chilled water energy storage tank to minimize on-peak electrical demand.
- Geothermal-ready infrastructure that includes 200 tons of heating and cooling via a field of vertical shell and tube heat exchangers and piping connections at the plant for the future addition of a 3,000-ton vertical shell and tube heat exchanger.
- Consolidation of 40kv campus electrical service into an upgraded dual-line 120kv utility service line to improve electricity supply reliability.
- Incorporation of emergency diesel generators (30MW) to enable islanding operations.

Figure 1: New central energy plant and distribution to serve Ford's Research and Engineering Campus (Source: MEP Associates LLC)



SECTOR TYPE
Industrial

LOCATION
Dearborn, Michigan

PROJECT SIZE
Plant serves 6.5 million square feet of buildings

SOLUTIONS

Ford implemented the CEP project as part of a Design-Build-Own-Operate-Maintain (DBOOM) contract with DTE Energy Services. DBOOM offers integrated project delivery, external capital, and operational efficiencies whereby Ford assigns expertise, ownership, and performance incentives to the project party that is best suited to address them. Under this agreement, DTE Energy Services will operate and maintain the facility for 30 years while ownership of the non-CHP assets will transfer to Ford after 20 years, and DTE Energy will maintain ownership of all the CHP assets. DTE Energy Services operates the entire plant, including the DTE Electric-owned CHP facility. In this manner, significant external capital could be committed to the project, and operability among electrical generation, the electrical grid, and the thermal network could be optimized.

Another important aspect of designing the new CEP was the use of 3-D modeling and digital twin technology. The 3-D modeling provided highly accurate measurements and all installations were laser measured and matched with the 3-D model to ensure zero to minimal deviations. The digital twin, a virtual representation of the facility and critical pieces of equipment within a system or process, uses sensors to merge live data from its physical counterpart with an interactive visual interface to enhance monitoring and decision-making. This aspect of the design and construction provided data that was incorporated into a Building Information Management system (BIM) to ensure that all systems operated as intended and facilitated maintenance scheduling.

The combined heat and power (CHP) portion of the plant consists of two 15 MW gas turbine units for electricity generation and one 5 MW condensing steam turbine. The system has a combined peak generating capacity of 34 MW. The 15 MW gas turbine units generate 70,000 lbs./hr. of steam when running exhaust gases through a heat recovery steam generator (HRSG) system. An HRSG is attached to each turbine and outfitted with duct burners which when fully fired can boost HRSG output from 70,000 lbs./hr. in turbine exhaust gas mode to approximately 180,000 lbs./hr. in duct firing mode. Each turbine and HRSG assembly are also fitted with bypass exhaust stacks allowing the HRSGs to be bypassed if needed for maintenance and repair purposes. The HRSGs can also be operated independently, which allows maintenance on the turbines while still using and generating steam from the HRSGs.

The central chilled water plant portion of the plant is made up of four 3,200-ton duplex chillers. Two of the chillers are heat pumps that generate both chilled water and hot water concurrently: 38,500 gallons per minute (GPM) of 42-degree chilled water at 70 pounds per square inch gauge (PSIG) is distributed to campus through 42” supply and return pipes and 19,500 GPM of 120-degree water at 85 PSIG is distributed via supply and return pipes. The new cooling towers offer 25% less drift loss than traditional cooling towers, which saves on water and water treatment costs. Future expandability of the plant was carefully considered and integrated into the design and construction. All the original steam and condensate distribution systems around the campus were upgraded with better steam traps to reduce steam losses due to piping issues.

Other key infrastructure for the CEP includes a thermal storage tank. The chilled water piping system is connected to a 5.3-million-gallon thermal energy storage (TES) tank for peak shaving purposes. The TES is designed to supply 5,000 tons/hr. of chilled water for 8 hours from 11:00 am through 7:00 pm when utility rates increase due to peak demand pricing.

OTHER BENEFITS

The DBOOM project development model used for the CEP is an innovative approach that can be applied to other sustainable infrastructure developments. Integrating the specialized knowledge of DTE Energy Services and the experience of the project's contractors into the design and construction process ensured long-term operational and sustainability needs would be met. The CEP project demonstrates how a successful pursuit of environmental goals and financial responsibility will result in a better, more energy-efficient work environment for company employees.

Annual Energy Use

Baseline()
1

Actual()
0.5

Energy Savings

50%

Annual Energy Cost

Baseline()
1

Actual()
0.5

Cost Savings

50%

Plant with Dusk View