IDEA Innovation Award – DePauw University

1. Project/Program Title

DePauw University's Campus Energy Management Project (CEMP)

2. Name and Location of District Energy System or Project

DePauw University
313 S Locust St.
Greencastle, Indiana
46135
USA

3. Name of System Owner

Warren Whitesell, Associate Vice President for Facilities Management

4. Name, relationship to the project/program, address, phone number & email of the person submitting the application

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5. Executive Summary – In 700 words or less, summarize the project /program, demonstrating the key aspects of what was done and the overall benefits. (currently 682 words)

DePauw's Campus Energy Management Project (CEMP) is a district energy network global reengineering project that included upgrades to heating and cooling networks, as well as main assets from the cooling and boiler plants. Leveraging the deferred maintenance budget within an energy efficiency approach, the team dug 5,000 feet of trenches across the campus without impacting indoor conditions or daily activities. Rather than simply replacing rusty and leaking piping, DePauw seized the opportunity to implement a global and transformative project – one that could achieve several desired outcomes.

DePauw's initial needs were to:

1. Eliminate issues with aging heating and cooling infrastructures

2. Reduce operating costs

3. Provide the foundation for a net-zero campus

4. Plan for future campus expansion with a scalable infrastructure

The campus's main heating and cooling networks were old with heavily rusted sections. A complete reengineering of the campus assets enabled an ambitious steam-to-hot water conversion of the entire heating network, where humidification loads were separated from the main district loop and supplied locally with two new steam boilers. The previous 35 psi steam network gave way to a highly efficient, variable flow hot water

network ranging from 145F to 180F in supply temperature. The new networks are now connected in injection with the existing building/satellite loops. Two-way valves and variable speed drives pumps enable significant modulation and energy efficiency for both district networks. This measure has resulted in reduced energy waste, reduced greenhouse gas emissions, and utility savings.

Partnering with a design-build performance contracting partnering firm, DePauw's facilities department assessed different alternative materials to replace the old metal pipes. A comprehensive cost-benefit analysis over the life cycle of the assets took into consideration the pipe costs, mechanical work, trench excavation and remediation, and construction logistics. The main piping options included traditional steel pipes, thin-walled steel and pre-insulated or on-site insulated pipes, and various plastic alternatives. The following pipes were selected:

- 12,400 feet of crossed-linked polyethylene piping with mechanical coupling for the new hot water heating network
- 10,400 feet of high-density polyethylene piping for the new chilled water network

The flexible piping allowed for a simplified design, resulting in no expansion loop, faster and cheaper installation, and no concerns about long-term rust issues. Rather than excavating the entire layout across the campus -- which would cause massive disruption -- the project was broken down into phases. The piping was shallow, with only two feet between the surface and top of the pipe to reduce installation costs and increase installation speed. Digging, installation and remediation were completed between June and early September 2019, an outstanding accomplishment in regards to timing.

The two cooling plants were upgraded during winter 2019-2020, including the decommissioning of five chillers and three cooling towers, which were replaced by two new chillers (650 tons and 800 tons) and two cooling towers, all equipped with VFDs.

In the central heating plant, four obsolete pneumatic controlled steam boilers were decommissioned during summer 2020 and replaced with five new DDC controlled hot water boilers. Four of them are cast iron near condensing boilers, and one of them is a condensing boiler for the shoulder and summer period. The boiler capacity totals 35MMbtu/h output. Headers were upgraded and oversized to account for future campus expansion plans and increased capacity. There are only three primary pumps with variable frequency drives that circulate the hot water loop to the boilers and the building. Only two are required for peak demand. This measure simplified the installation and reduced costs, with fewer pumps to maintain.

"The project will not fix everything, but the things we touch should be bullet proof."
– Warren Whitesell, VP of Facilities

The project achieved:

Annual Natural Gas Reduction	Annual Electricity Reduction	Annual Electricity Demand Reduction	Annual Water Reduction
53,141 MMBtu	7.599,000 kWh	14,721 kW	1,294,700 pi3

Other benefits include:

- Smart asset renewal, successfully leveraging the deferred maintenance budget within a self-financed performance contracting approach
- More preventive maintenance than reactive maintenance
- 8,353 metric tons of eCO_2 of avoided GHG emissions annually
- Increased cooling and heating capacity for future campus expansion

- Pneumatic controls upgraded to DDC and control sequences upgraded for optimized operations

6. In 300 words or less, explain how the project/program is innovative and unique. (currently 299)

There is no comparable North American campus-wide energy district retrofit that has favored plastic pipes. With its CEMP, DePauw has ventured where no other campus has yet, thanks to its partnership with a design-build firm who was contractually accountable to meet expected outcomes.

But still, the project team had to do their homework to choose the best value and most reliable solution. In most similar projects, the distribution piping would simply have been replaced with a like-for-like replacement. This project shows that – using innovative techniques – it is possible to rethink solutions based on the organization's desired outcomes and future needs. From pipe size and material selection, to optimal campus network layout, to duration of installation, to validating the most reliable welding/connection techniques, there were many unknown risks that we had to mitigate by conducting our own research and validation process.

More time was spent designing the optimal new network layout to supply both the existing buildings and support future expansion plans.

Beyond the technical aspects, the integrated business model made such a global project possible. The design-build firm enabled both design engineers and construction managers to be involved at all phases of the project, working closely with our facilities and faculty departments to maximize the project value, reducing disruptions and solve inevitable issues. This was crucial for such a complex project, where the best laid plans could go wrong and require immediate action.

Despite being highly innovative, this project is replicable in any other organization, as it is developed and implemented around results that are most important for the organization. The accountability and engagement level resulting from contractually guaranteed results favors a better collaboration between all stakeholders from the start, well into performance monitoring and fine-tuning. This maximizes the chance that the expected results will be met or exceeded.

7. With supporting data, demonstrate the improved energy efficiency benefit offered by the project/program, in 250 words or less. (currently 172)

DePauw selected a design-build partner to design and manage all phases of the project. This firm conducted a campus-wide energy audit inspired by ASHRAE's Level 1, 2 and 3 audit requirements. Although the project was motivated by asset renewal needs, an important energy conservation aspect was included. Accountability to achieve ambitious results favored creative and innovative solutions. This started at the building level, where all steam needs were either:

1. entirely converted to hot water, in the case of one building heating system,
2. removed from the district heating loop, with dedicated, local steam boilers – as performed in two other buildings.

	Adjusted reference year (according to cooling/heating degree-days)	03/20-02/21 performance year	Reduction	% of target achieved
Electricity Consumption	27,637,035 kWh	20,038,035 kWh	7,599,000 kWh (28.81%)	147%
Natural Gas	131,389 MMBTU	78,248 MMBTU	53,141 MMBTU (40.5%)	100%
GHG emissions	27,447 MT eCO2	19,094 MT eCO2	8,353 MT eCO2 (30.4%)	113%

Note: 100% of the electricity savings are monitored. 50% of the natural gas savings are monitored, and the other half is forecasted.

8. With supporting data and graphics, explain the financial advantages of this project / program in 250 words or less. (currently 173)

The design-build firm guaranteed the total project cost, financial incentives and annual utility savings.

During its first year of performance follow-up, the project has generated $990,694.18 in annual savings (utilities and maintenance combined). This is 30% higher than what was contractually guaranteed by the design-build firm (as shown in the table below).

Another major financial advantage of this project relates to how it addressed asset renewal and deferred maintenance issues of the campus buildings. By focusing on reducing demand through building-level improvements, we were able to address asset renewal issues while reengineering more efficient heating and cooling networks – all the while properly sizing new heating and cooling equipment. As a result, this project leveraged asset renewal and deferred maintenance budgets. These budgets were used in a more strategic way than they otherwise would have been, to improve the building systems overall, instead of merely replacing aging equipment one-for-one.

Total Project Investment	$ 14.8M
Guaranteed Incentives	$ 273K
Deferred Maintenance Budget Injected	$ 8.4M
Guaranteed Annual Utility Savings	$ 697,200
Guaranteed Annual Maintenance Savings	$ 67,800
Payback Period	7.6 years

9. In 250 words or less, please provide any additional information about the project/program (What challenges did you face? What plans do you have for the future? How did your customer base or community react?, etc.) currently 247

Any high to low-temperature hot water conversion project is complex. The CEMP was implemented in a live environment, and careful implementation planning was required to minimize disruption. This was especially true during the campus-wide network upgrade, with trenches dug across streets and walkways. The trench work was segmented into eight steps to minimize impacts and take advantage of the least busy times of the summer in each area of the campus. In a similar fashion, the cooling plant upgrades were implemented the following winter, when cooling demand was minimal, and the central heating plant boiler upgrades were performed during the following summer (2020).

On top of a solid implementation plan, careful attention was given to the communication plan, including:

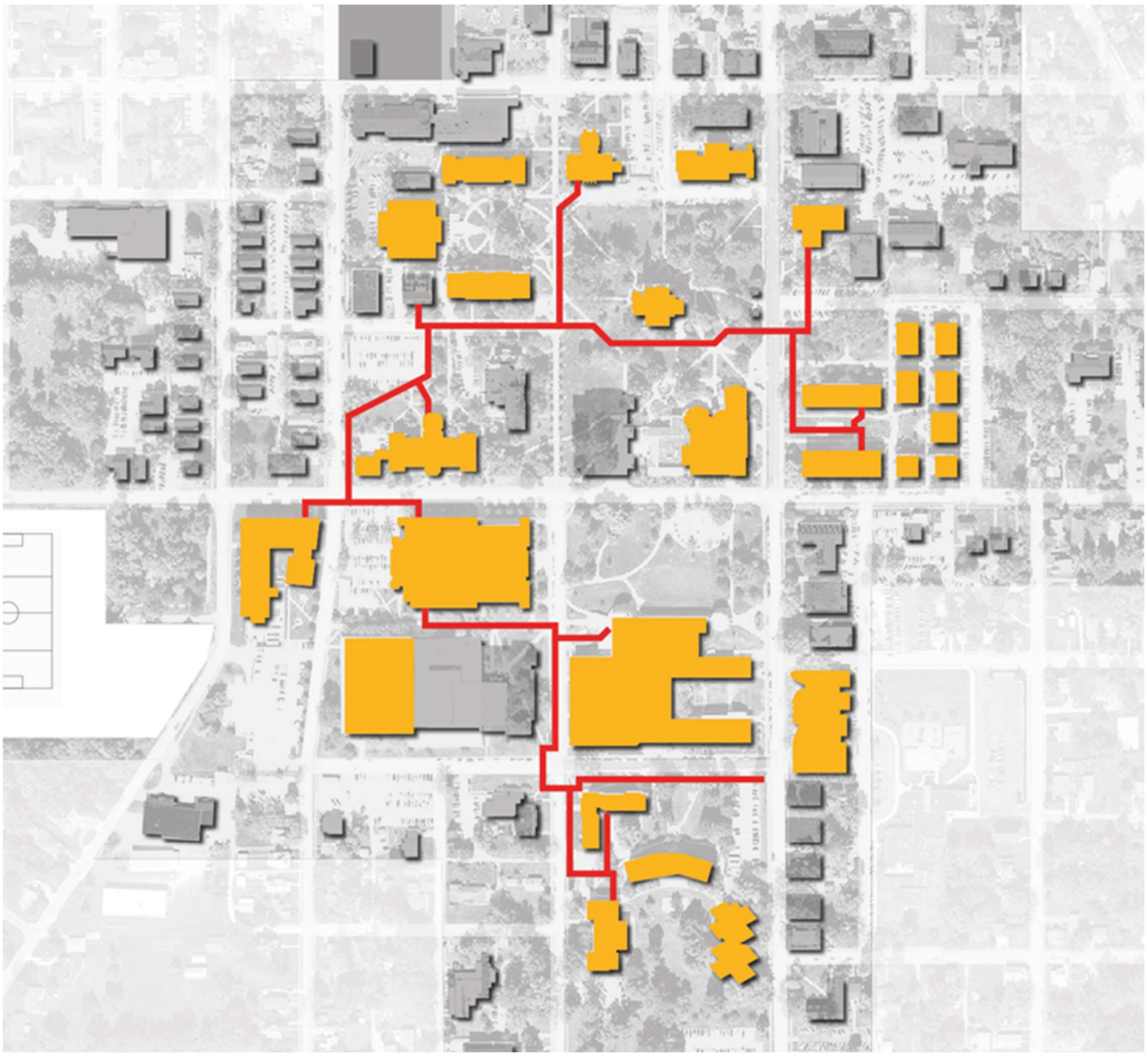
- Project presentations to:
  - the campus facility management and custodial teams
  - the city's security and fire department

    - the campus environmental committee
- Postcard to inform neighbors about the project timeline and benefits
- Explanation sheet for freshmen students arriving on campus
- Small yard signs planted over a week before the major work got started
- Four 5x8” banners and six 5x20” banners fixed on security fences to inform to pedestrians and drivers

Thanks to these communication efforts, the community experiencing the heavy work during summer 2019 had a favorable opinion of the project.

The CEMP has enabled DePauw to move past outdated infrastructures and look forward to a bright, energy efficient, more environmentally conscious future – one that will include expansion plans and be better supported by the new networks.

10. Please provide 3 to 5 attachments as images, diagrams or photographs in jpeg format with identifying captions.

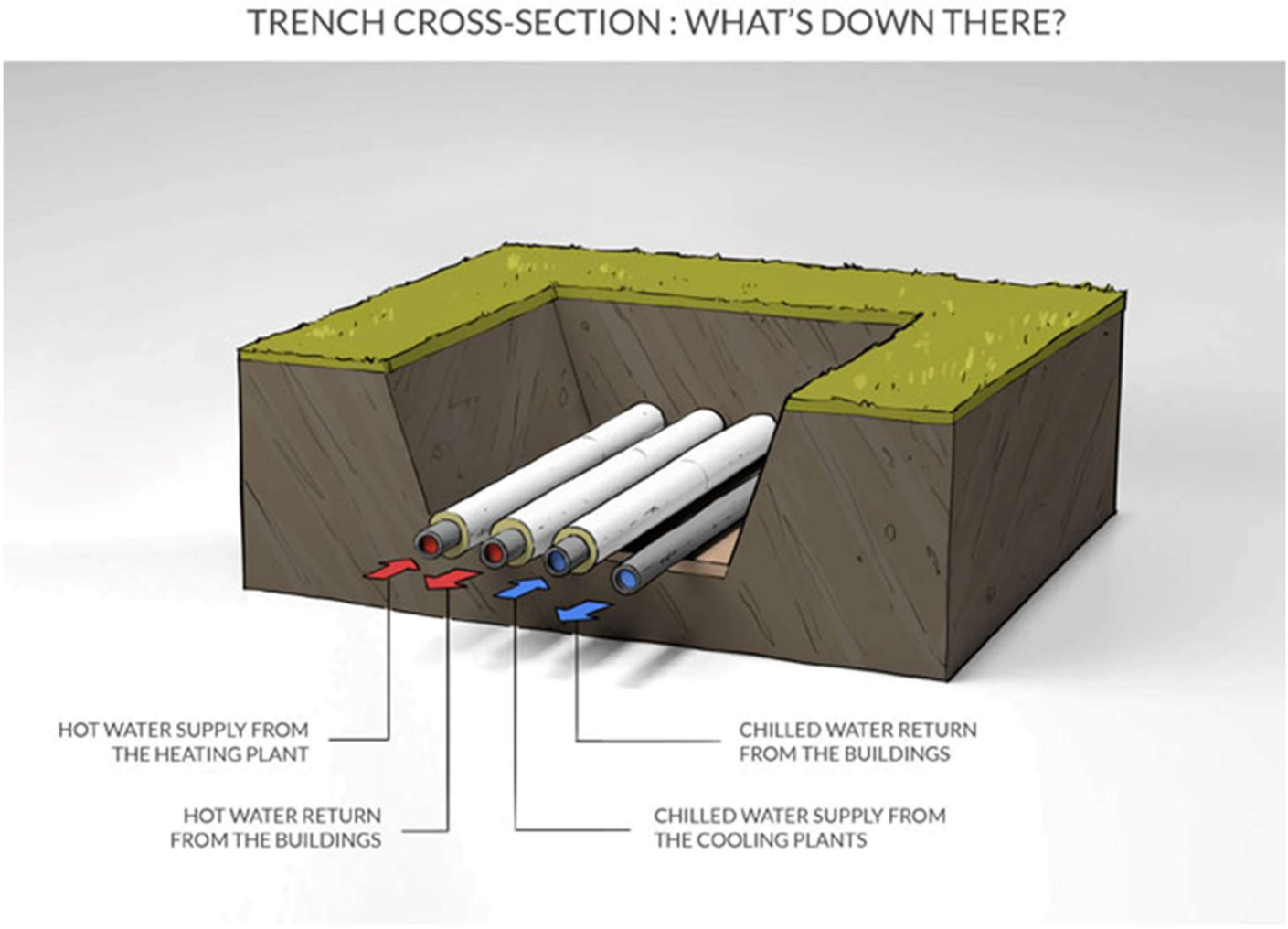


New district heating and cooling trench layout across the campus

The DePauw University campus: one of "The 50 Most Beautiful College Campuses in America," according to Condé Nast Traveler.

An aerial shot of a portion of the trenches dug across the campus during summer 2019.

Flexible piping laid into a trench



Shallow trenching to reduce installation cost: the top of the pipe is two feet from the surface