# A conversation: Sustainability and utility master planning on campus

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For the past 10 years, this column has focused on the impact of building sustainability programs, such as the U.S. Green Building Council's LEED rating system, on district energy. When the column first began, LEED was the primary issue discussed as district energy system owners and operators were concerned about how district energy would be treated in the pursuit of a LEED rating for a connected building.

At the same time, university leaders were beginning to make promises with regard to sustainability, related to energy use and/or carbon footprint, and to set future dates associated with those promises. Those target dates were well into the future – at least beyond the retirement dates of the leaders who were making them. Each day, however, they grow closer, and current campus leaders are having to seriously look at paths to reach difficult promises made. To do so, they are commissioning campus utility master plans that holistically attempt to find solutions to these problems.

To give us a glimpse into what challenges and solutions campus leaders are finding through the master-planning process, I sat down to talk with Andy Jones, the principal in charge of utility master planning at RMF Engineering Inc. Andy has been an infrastructure utility master planner for the past 24 years. He has been involved in planning utility systems on over 100 campuses. In doing so he has helped several district energy owners and campus leaders develop approaches to meet their sustainability goals and reduce their carbon footprint.

**Tim Griffin:** ***Andy, you have spent your career focused solely on assessing and planning for the growth of district cooling, heating and electrical systems within municipalities and on campuses across North America. How did you manage to start and stay in such a unique niche?***

**Andy Jones:** I was lucky enough that RMF had a recruitment booth at the University of Maryland, Baltimore County, my alma mater. They hired me as a summer intern. Like most engineers in our industry, I did not really understand the heating, ventilation and air-conditioning industry at the time. However, I was looking for an opportunity where I could grow as an engineer and make a difference. As an intern, I joined RMF's utility master-planning group and have spent my career focused only on this task.

Immediately the work we did intrigued me as we were developing complicated, big-picture analysis that helped important organizations make wise decisions on how to allocate millions of dollars in capital. The opportunity to dive into an organization's growth plans, understand its goals and then develop options to support its future utility systems was fascinating to me. The planning was not just dedicated to heating, or cooling or electric. I needed to have a thorough understanding of the entire utility system and how those services may interact with one another.

Spending my career on this niche has equipped me to respond to whatever growth challenges an organization faces. Now, after almost a quarter-century in the industry, I have never sized a duct or laid out a mechanical room. You would not want me involved in design details. The entirety of my career has been focused on the forest, not the trees.

Many campus electrical distribution systems are reaching the end of their useful life.

**TG:** ***I have seen everyone from privately owned and operated district energy companies, and Fortune 500 companies, to public and private colleges and universities make various commitments to sustainability; yet their commitments and the wording of those commitments vary. What are you seeing as the main types of commitments being made, and what do each of them mean?***

**AJ:** Good question. There are three primary commitments I am seeing various entities make, and each one is usually accompanied with a target date for completion, anywhere from 2030 to 2050. The first commitment is a carbon reduction goal. This is usually set as a 25 percent to 50 percent reduction in carbon emissions over a given baseline year. I have seen the baselines be as early as 2000. The goal can be met in multiple ways, such as reducing energy use on campus through low-hanging-fruit projects (lighting upgrades, building controls, fuel conversions) and/or purchasing carbon offsets where you are paying for carbon reductions created by others. Generally, this type of sustainability goal is the easiest to achieve.

Next is the goal of carbon neutrality, which involves the same methods as carbon reduction except that instead of targeting a decrease in carbon emissions compared to a previous year, the end goal is reaching net-zero emissions on campus. This is a tougher, more expensive goal to achieve than a carbon reduction goal as you generally have to pursue more expensive technologies to lower campus emissions – such as the combustion of renewable energy instead of fossil fuels and the installation of more energy-efficient heating and cooling equipment. In addition, all the carbon emissions that cannot be eliminated through these methods must be negated with the purchase of carbon offsets. In other words, you must pay for someone else's carbon emissions reductions to negate your carbon emissions. This can be expensive. I have seen several campuses set targets for carbon neutrality in the 2025-2030 range, which is not very far away.

The third goal, which is by far the most challenging to achieve, is net-zero emissions. Unlike carbon neutrality, the intent of this goal is to reduce total carbon emissions on campus to zero without the help of purchasing carbon offsets. This means zero combustion of natural gas or fuel oil on campus. Generally, to accomplish this goal, a campus or district energy system must combust only renewable fuels or move toward electric-only utilities. At that point, the electricity consumed must be generated from wind, hydro and/or solar power sources, either on-site or remote to the site. Remote sites can be in another state as well. The key difference between carbon neutrality and net-zero emissions is you can still combust fossil fuels and achieve carbon neutrality, but you cannot achieve net zero. As a result, campuses that are pursuing a net-zero emissions goal are having to take a strategic look at their systems holistically.

**TG:** ***Do you have a feel for the percentage of campuses pursuing each of these three goals?***

**AJ:** We just completed a survey of universities in five states across the southeastern United States. From respondents in that region, 56 percent have made carbon reduction commitments, 44 percent have set carbon neutrality goals, and only 6 percent have made a future commitment to net-zero emissions.

**TG:** ***How are you seeing the push toward these goals impact decision making?***

**AJ:** That has certainly evolved over time. Twenty-plus years ago the focus was always on providing energy solutions that involved the lowest lifecycle costs. As entities first began setting carbon reduction goals, there were plenty of energy reduction directions to proceed in that also provided good returns on investment. Switching from older, inefficient lighting to fluorescent and then to LED lights provided an annual reduction in energy costs that usually offset the initial investment over a reasonable period. In addition, investments in combined heat and power systems resulted in the ability to reduce fuel input in power production significantly over inefficient electric utility grids. So traditional methods aimed at developing energy-efficient systems met both the carbon reduction goals and provided a good return on investment.

**TG:** ***I work with district energy owners who must "sell" the benefits of district energy to customers. Sometimes the customers are separate organizations that pay for heating and cooling utilities just as they would pay for electric utilities from the power company; and sometimes the customers are different departments in the same organization such as on a government, health care or university campus. District energy can provide many benefits to any end user. How have you seen customers evolve in what benefits they are looking for from district energy?***

**AJ:** There is more emphasis on reducing energy use and emissions, and this includes how the client's utilities are generated. They are asking to understand the carbon emissions for the heating and cooling supplied to their campus. We have even recently seen campuses that are planning to add efficient CHP systems run into resistance from various stakeholders who may not understand the efficiency advantages of the technology. Instead, they only want systems that do not use fossil fuel.

**TG:** ***What's the biggest change you have seen over the years in the way campuses approach the utility master-planning process?***

**AJ:** Traditionally, clients want to understand how they can reduce energy use and carbon emissions for the campus but limit the master plan to just evaluating the plants and generation equipment. This, unfortunately, will significantly limit their ability to achieve their overall goals. Yes, the generation equipment, especially the heating equipment, consumes the fuel that drives the energy use and carbon emissions. However, the building heating and cooling equipment determines what flexibility is available to change the operations of the generation equipment.

For instance, there can be efficiency advantages to lowering the temperature of the heating water in a campus district system. However, each of a campus's individual building heating systems requires certain temperatures of heating hot water from the district heating system to meet space heating requirements, process heating loads, domestic water heating needs and even prevent Legionella. So, the evaluation of the buildings on campus is becoming much more important to help develop a complete picture of what options are available in moving toward your campus sustainability goals.

This requires more time than an older, traditional master plan but is required to meet the needs of most clients today. The low-hanging fruit, in terms of energy savings, has mostly been harvested. To move significantly toward energy reduction and greenhouse gas emissions reduction, you must look at the whole picture, which includes energy at the source, energy as it is converted in a district energy system, energy as it is distributed and energy as it is consumed in the buildings themselves. Today, we are starting to see some campus leaders understand this and begin to approach their utility master planning this way.

**TG:** ***What ticking time bombs do you see on college and university campuses?***

**AJ:** That is a great question. There is certainly a growing list of deferred maintenance items that cannot be ignored forever. However, I do see some systems where the need to address deferred maintenance is becoming critical. In our survey of college and university district energy system operators throughout the southeastern U.S., we found that of all their underground thermal and electric systems, the overall electric system is the oldest – and its reliability is a growing concern. This is not surprising. Most campuses made major investments in their electrical distribution systems in the sixties and seventies in response to a surge in students from the boomer generation. These systems, whose life was estimated at 50 years, have exceeded that. In addition, they are carrying loads they were never designed to accommodate. As a result, partial and full campus electrical outages are starting to occur, which threaten not only the institution's ability to carry out its educational mission but can impact valuable research.

**TG:** ***Interesting. I typically think of the chilled-water, steam and heating water generation and distribution systems on campus as the primary district energy systems. But the campus underground medium-voltage systems are an integral part of the operations of the district energy system itself and the building energy systems they serve. So, you are finding that these systems may be the weakest link in delivering reliable heating and cooling on campuses, and you are starting to see campus leaders both recognize and focus on upgrading or replacing them. Is the challenge in replacing a campus medium-voltage system primarily a financial one?***

**AJ:** That's a part of it. However, there are two other significant challenges. First, you must plan for replacements on active campuses, which means a lot of construction activity that can interrupt operations. Second, every campus building will require power interruptions to switch to a new system. What we have found is that stakeholders from most campus buildings will insist on receiving temporary power so they have only minimal interruption of service. Yet, this is cost-prohibitive. Therefore, to be successful you must have a huge communication effort so that stakeholders buy into the overall project goal. To be successful, campus leaders must plan carefully in advance; and getting the communication and buy-in right at the stakeholder level is just as important as getting the engineering right.

As global warming has become a bigger issue in society and entities have started to think seriously about how to create systems with zero carbon emissions, master planning has begun to radically shift. Basically, there is an understanding now that fossil fuels can't be utilized if your goal is net zero.

**TG:** ***I began my engineering career many years ago in Tampa, Florida, where I was taught that the only heating systems required were electric strip heaters in terminal boxes. No boilers. I remember thinking that was odd as I understood even then that electric resistance heat was an inefficient way to heat spaces. But I soon learned that the relatively few hours a year where heating was needed in Central Florida did not justify the cost of installing gas-fired heating systems. This certainly changed, however, when I moved back a couple of states to the north. Today, though, I am seeing campuses in New England moving toward electric heating. How is this related to sustainability?***

**AJ:** Generally, people are starting to think with the end goal in mind. If the end goal is net-zero emissions, then the thinking is, I need to move forward in directions that will result in no carbon emissions. The word used today is "decarbonization," and that is what it is all about. How do I create a campus that in the future releases no carbon? First, I must move away from combusting fossil fuel on my campus. Second, I need to find ways to move heat around on campus from where it is not needed to where it is needed. Third, to help to keep the electric usage as small as possible, I must take a hard look at how to reduce building energy consumption. This typically requires addressing the building envelope. Fourth, I need to move toward using only grid-generated electricity as my fuel source.

**TG:** ***There are currently no campuses in North America where all the electricity is produced in the grid from non-carbon-emitting resources. So how does taking this approach achieve the goal of net-zero emissions?***

**AJ:** It is like the philosophy behind all-electric-driven automobiles. If all the electricity used to charge your car comes from an electric grid whose primary fuel source is coal, then this likely will result in more emissions than would a hybrid electric vehicle. However, if the grids in North America continue to move toward greener electricity, meaning a higher percentage of electricity produced from zero-carbon technologies such as wind, solar, hydro and nuclear, then the decision to move toward all-electric cars will reduce emissions. Also, since electric-driven vehicles can be charged at night with off-peak power, a higher percentage of that power from non-carbon-emitting technologies (except for solar) will be available.

 

The same idea applies to decarbonization for a campus. If the grid is moving toward producing a higher percentage of power from non-carbon-generating technologies, then using only electricity as a fuel source will also help progress toward net zero. Even if the grid does not become solely carbon-free, the greater availability of carbon-free power should make purchasing this portion of the power generated by utilities more affordable.

**TG:** ***How about the move away from steam and even 180 degree F heating water toward lower-temperature hot water heating?***

**AJ:** The overall strategy involves moving heat on campus from where it needs to be rejected to places where it can be utilized with the end goal of significantly increasing the overall system efficiency. However, most currently available heat rejection equipment, such as heat recovery chillers, can only reject heat at temperatures as high as 140 F. As a result, some campus leaders are working to lower district heating hot water supply temperature so rejected heat from heat recovery chillers, and other technologies, can be easily transported to where it is needed via the underground heating network.

What drives this strategy is the lack of commercially available equipment that can reject heat at higher hot water supply temperatures. However, the prospect of the country moving toward electric heating is driving the industry to develop equipment that can operate with higher supply temperatures in the future. I look forward to seeing what technology is developed in the next 10 years that addresses some of these challenges.

**TG:** ***If you oversaw a university campus and were faced with all the challenges they see – reliability, limited funding, deferred maintenance, sustainability goals, etc. – how would you want to set your priorities?***

**AJ:** I would be looking at the campus to understand if there were a way to address all these items at one time. For example, instead of trying to convert the entire campus at once to a low-temperature hot water system, do I address a portion of the campus? This portion of the campus can remain connected to the central system with a heat exchanger that converts the steam or high-temperature hot water to low-temperature hot water. Then when funding becomes available, go after another district until I can address the entire campus. This approach takes time, but it defers a large up-front capital investment into the system while making it possible to make sustainability improvements.


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