Data Center Waste Heat Recovery: Designing Digital Infrastructure for Community Benefit

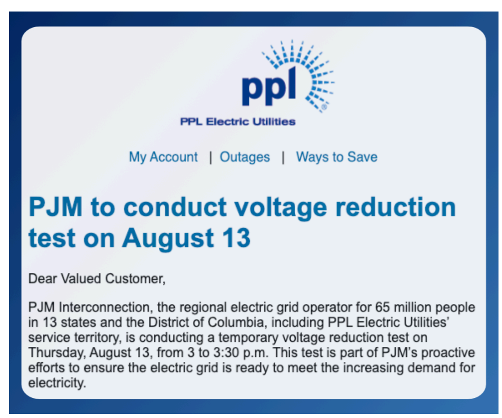
By: Lawrence Eighmy, James Hayes, and Jason Dietterick

Recent advances in Artificial Intelligence (AI) have motivated the fastest expansion of data center capacity in history, raising public concern about land allocation, water usage, and strain on the electrical grid. However, large-scale data centers are not new; they have been the infrastructural backbone of cloud computing since the 1990s. Each of these facilities converts nearly all of the electricity it consumes into heat, the overwhelming majority of which is released into the atmosphere through cooling towers or condenser fans. The consequence is the creation of heat islands: distinct areas of increased temperature leading to higher energy consumption, air pollutants, and greenhouse gases, as well as impaired water quality.

In response, a growing number of institutions and municipalities are reframing the data center conversation around a different question: what if that heat became a resource rather than a waste stream? Some universities, and even entire cities, are already acting on this idea, offering a waste heat recovery blueprint for facility owners, developers, and communities to follow as data centers move into new neighborhoods.

Why Data Centers are Fueling Local Opposition

The International Energy Agency projects global data center electricity consumption will roughly double by 2030, growing nearly four times faster than any other electricity end use. While this increase is expected to represent only about 3% of total global electricity consumption in 2030, grid operators are already showing concern that demand will exceed supply. PPL Electric Utilities notified customers that PJM Interconnection—which manages the power grid for 65 million people across 13 states and the District of Columbia— would conduct a temporary voltage reduction test on August 13, 2026. Days earlier, PJM confirmed it was reviewing new reliability requirements for large loads after nearly 4,000 megawatts of data center capacity tripped offline during a grid fault in Virginia, the largest such event in their history.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PJM to conduct voltage reduction test on August 13

Dear Valued Customer,

PJM Interconnection, the regional electric grid operator for 65 million people in 13 states and the District of Columbia, including PPL Electric Utilities' service territory, is conducting a temporary voltage reduction test on Thursday, August 13, from 3 to 3:30 p.m. This test is part of PJM's proactive efforts to ensure the electric grid is ready to meet the increasing demand for electricity.

All this is occurring amid public concern regarding the impact of new digital infrastructure developments on regional grid stability. In Upper Macungie, PA, residents recently rallied against Air Products' proposed 2.6 million square foot data center, fearing that the immense power demands would drive up their household utility bills. Their concerns are backed by broader data. Based on a review of PJM's own forecasts, the Natural Resources Defence Council estimates that by 2028, the average family in the region will pay an extra $70 per month for electricity due to rapid data center expansion.

Waste heat recovery does not address these concerns. It cannot reduce a facility's water consumption, land footprint, or total draw on the grid PJM is already straining to serve. However, a data center that converts waste heat into a usable resource is a materially different proposition than one offering jobs and tax revenue alone. Instead of an operating cost and environmental liability, waste heat becomes a benefit for the host community. Paired with a shift toward cleanly powered computing (namely, the push for data centers to be fueled by small modular nuclear reactors), it points toward a version of growth where digital infrastructure expansion and a community's decarbonization goals move in the same direction rather than against each other.

How Data Center Waste Heat Recovery Works

No matter how efficient the data center, nearly all the electricity it consumes eventually leaves the building as heat. In fact, there is close to a one-to-one relationship between IT load and heat rejection. Recovering it works in three steps. First, the data center's cooling system captures waste heat by warming water or refrigerant as it passes near the servers. Next, the warmed water runs through a heat exchanger, transferring its heat into a separate water loop. This water is then piped to a thermal host (the building or network that will use the heat) where a final heat exchanger warms the host's own water or air.

Historically, temperature quality has complicated this process. Traditional air-cooled server rooms produce lukewarm heat (77 to 95 degrees Fahrenheit), which is too cool to feed a building's hot water or steam heating system directly. A heat pump is needed to raise the temperature to a useful range for thermal hosts, which adds cost and consumes additional electricity. However, the rise of liquid-cooled and direct-to-chip cooling for AI and other high-performance computing hardware is changing this equation. These systems reject heat at higher, more usable temperatures than traditional air cooling, materially improving the economics of waste heat recovery.

None of the equipment involved is new either. Heat pumps, heat exchangers, and district heating networks have moved industrial waste heat from power plants and factories into neighboring buildings for decades, long before data centers existed at today's growing scale. While the heat source is novel, the strategy is proven, and the projects below show how this is already being put into practice.

The Stone House Group's perspective: A data center's waste heat is only as valuable as the site chosen to receive it. Our sustainable design consulting team helps facility owners and developers evaluate the viability of heat recovery opportunities early, and our building sciences team validates this potential through design review during technical commissioning. With strategic site selection, a promising concept becomes a high-performing system working to benefit the host community.

Waste Heat Recovery Examples: Proof the Model Works

Data center waste heat recovery programs are already up and running around the world, with impressive results.

The University at Buffalo is combining its new 10,000 square-foot Empire AI supercomputing center with a decade-spanning overhaul of its North Campus energy system. Two 30-inch neutral-temperature water pipes will carry waste heat from the supercomputer to the University's Baker Chilled Water Plant, where it will be redistributed across campus buildings alongside a new network of geothermal wells. The initiative is part of a $68 million state-backed clean energy master plan that is expected to cut the North Campus carbon footprint by 30%: a clear illustration of how a computing facility can advance an entire institution's decarbonization effort.

Across the Atlantic, Danish utility Fjernvarme Fyn built a dedicated heat pump to capture waste heat from Meta's ~538,000 square-foot hyperscale data center in Odense. The pump recovers roughly 215,000 megawatt-hours of heat annually and feeds it directly into the city's utility network. It heats more than 12,000 homes as of 2023, lessens the city's reliance on coal, and moves Fjernvarme Fyn closer to its goal of providing 100% renewable energy by 2030.

In Sweden, Stockholm's Open District Heating program lets data centers, supermarkets, and other heat-generating businesses sell their surplus heat directly to the city's district heating network. Not only does this convert a facility's cooling bill into a revenue stream, but also enables heating and cooling plants to operate more efficiently. Initial costs are split between parties: the business invests in the heat pumps and the utility invests in the pipe connections. More than 30 data centers are now connected to this open market, and one H&M-built facility alone is projected to supply heating for roughly 2,500 apartments at full load.

Together, these projects show that waste heat recovery is a responsible design choice available to data centers willing to work with community partners.

Designing Digital Infrastructure for Responsible Heat Reuse

Facility owners and their engineering partners who want to take advantage of this opportunity should evaluate several factors early in a project's planning phase, well before final mechanical design:

- **Cooling technology selection:** Liquid or direct-to-chip cooling delivers heat that is comparatively more usable than heat produced by traditional air cooling.
- **Proximity to a thermal host:** The economics of heat recovery are dramatically improved when a university, hospital, multifamily development, or municipal district heating

network is located near a data center.

- **Delivery temperature match:** The host building's age and heating system type are noteworthy constraints in site selection. If a heat pump is needed, it will work less efficiently to transfer heat to a facility running on older steam or high-temperature systems than newer buildings utilizing lower-temperature heating technologies. It will also cost more to build.
- **Seasonal load balance:** Data centers generate heat year-round, while most building heating demand is seasonal. Successful projects plan for an off-season use of the heat; domestic hot water, absorption cooling, aquaculture, or thermal storage ensure the recovered energy always has a purpose.
- **Community-benefit structuring:** Jurisdictions increasingly expect development plans to holistically integrate into their neighborhoods. Community-benefit agreements tie development approval to clean power sourcing, noise mitigation, local employment support, and direct community investment (and in Pennsylvania, they will be required for data centers per a recent executive order).
- **Standardization and rigorous benchmarking:** Before a site can effectively warm its neighbors, it must first optimize its core performance metrics. Benchmarking candidate sites against the ISO/IEC 30134 framework ensures energy efficiency, renewable sourcing, water usage, and cooling performance are aligned with the Energy Reuse Factor (ERF): the auditable, minimum-standard performance measure for community-scale sustainability partnerships.

A data center is not an inherently bad neighbor, extracting resources solely for its own financial gain; numerous case studies show how data centers can positively contribute to a community's energy resilience. The developers and institutions who incorporate waste heat recovery into their site selection and mechanical design will be the pioneers of computing's sustainable future, but the most promising plan can still fail if its delivery temperature, load profile, or utility infrastructure cannot realistically support a heat recovery connection. The Stone House Group's sustainable design consulting team—supported by Certified Data Center Environmental and Sustainability Specialists, Professional Engineers, Certified Energy Managers, and Renewable Energy Professionals—evaluates these variables early, before a site is chosen or a mechanical system is designed. Our building sciences team carries that technical scrutiny through to commissioning, verifying that the heat recovery system performs as intended.

This is a prime example of Building Stewardship: the facilities management philosophy that The Stone House Group has been practicing for over 25 years. Our expertise in building sciences, energy management, operations, and sustainability allows us a 360-degree view of what it takes to construct facilities that achieve their financial goals while strengthening their communities. If your organization is considering a new data center site, or reconsidering the mechanical systems in an existing one, we welcome the opportunity to discuss how waste heat recovery and other such technologies could benefit your mission.