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Behind the Thermostat – The Layered Landscapes of Campus Heating Infrastructure

> There are two spiritual dangers in not owning a farm. One is the danger of supposing that breakfast comes from the grocery, and the other that heat comes from the furnace.[1] – Aldo Leopold

It is a brisk November morning, and I am comfortably sitting at my desk in a T-shirt in a building without a furnace. The idea of 'room temperature' seems like a constant, steadfast feature of buildings no matter where I am on campus. I think the existence of heating infrastructure is something everyone acknowledges in the back of their mind, but it is hardly a matter of daily consideration. Years of planning, history, technology, and infrastructure all hide behind the thermostat. Yet, the signs are all around us: clouds of condensation billowing from the chimneys of the Charter Street and Walnut Street plants, alien-like lattices melted in the snow from steam tunnels underground, the folklore of Tunnel Bob, and the noticeable drafts in the Humanities building reminding us of air ventilation exchanges. How did campus and our society get to be like this? How are we so ignorant and unappreciative of the infrastructure that makes 'room temperature' a standard metric? There is a great amount of history to centralized heating on this campus.

Forests and Furnaces: The Early Period of Centralized Heating

With the ashes of the old Science Hall still cooling after a destructive fire in 1884, university officials were considering how to prevent future fires beyond using fireproof construction materials.[2] The new Science Hall introduced a steel frame design that changed the nature of fire-resistant buildings, but the building that was constructed next to it more fundamentally altered the future of campus infrastructure. Prior to a centralized heating system, individual buildings operated their own hand-stoked furnaces using either coal, wood, or biomass.[3] The labor of wood harvesting or coal transportation kept campus habitable in the Wisconsin winter and was as much a part of the campus landscape as were receding tree lines of forests or the depths of a coal mine. This feature of campus geography – wide-spread and daily interactions with fuel sources – shifted with the construction of the first auxiliary building intended solely to provide heat.

As an increasing number of campus buildings became connected to a singular energy source, the repetitive offerings of fuel to a furnace faded into toggling with a thermostat. The first heating plant on campus (what is now Radio Hall) was constructed in 1885 and served the campus in its heat-generating capacity from 1893 to 1908.[4] This building offered a centralized location for the cluster of buildings around the Bascom Hill drumlin and the buildings at its base, making it cheaper and more efficient to heat the campus. As the university expanded, it became clear to campus officials and engineers that this facility was inadequate. The construction of the Red Gym risked pushing the heating plant past its capacity, so the university tasked Storm Bull, a professor of steam engineering, with expanding the plant though the addition of a 70 ft. south wing with a new chimney and six new boilers.[5] With the expansion, it was possible for the first time in 1898 to connect all the buildings on the north and east parts of campus by steam tunnels.[6] Yet, even with its expansion, the plant was not connected to and did not have sufficient capacity for the growing agricultural school on the western part of campus, which led the school to erect an additional small heating plant for the agricultural campus in 1899.[7]

Demand for a large, centralized heating plant on campus arose in the early years of the century as both the facilities at Radio Hall and the Agricultural station required increasing maintenance and their byproducts affected research. George Comstock, director of the observatories, complained that the nearby heating station on the agricultural campus caused thermal and visual disruptions to astronomical observation and was a vocal advocate for connecting all campus buildings to a central station.[8] Research played a major role in the development of the campus' heating infrastructure as laboratories need precise and constant temperature controls. To remedy Comstock's concerns and accommodate increasing enrollment, the university built what is now called the Old Heating Plant on the corner of Bruen (now Orchard) and University Avenue in 1908.[9] The largest boiler from Radio Hall accompanied four new boilers to the new plant, which along with upgrades in future boilers and insulation technology led to a reduction in the heating cost per square foot by over 30 percent from 1906 to 1914.[10]

The Old Heating Plant and the Ten Thousand Student Chimney

The plant faced new types of challenges early on from an ambitious architectural design to situations over supplying and storing enormous amounts of fuel. Delays plagued the construction as builders struggled with relatively novel technologies like structural steel framework, reinforced concrete, and the scale of the 250-foot chimney, which was the tallest structure in Madison at the time.[11] Situated on a constructed rail spur from the tracks a block away, the plant unloaded train cars of coal onsite, which saved the university over 50 cents per ton of coal in transportation costs compared to the previous plants. This was not a nominal number, as the university consumed over 20,000 tons of coal in 1923.[12]

While bulk shipments by rail presented clear economic advantages, the dependency upon regular shipments from distant coal seams made the university susceptible to accidents, fluctuations in the market, or labor disputes. For example, the total cost of heating rose by $22 million (40 percent) in the 1910-11 year due to a labor strike in the Illinois coal fields, requiring the university to purchase much of its needed coal from the Milwaukee dock at a higher rate.

Coincidentally in the same year, the coal in the storage bins caught fire, resulting not only in a significant loss of coal, but demanded a costly firefighter response lasting several weeks.[13]

A decade later, the heating plant became entangled in a regional rail shortage which brought action from the Interstate Commerce Commission (ICC). George B. McGinty, an ICC official, noted in a service order that, "because of a shortage of equipment and congestion of traffic, which continue to exist upon the [railroad] lines… east of the Mississippi River" the ICC determined that the inability to transport coal to government operations required "immediate action."[14] In the service order, the ICC declared that, effective September 19, 1920, common carriers by railroad be available to serve public institutions so that they "may be kept supplied for current use but not for storage, exchange, or sale."[15] University officials, who were authorized by the order to assign cars to coal mines, promptly requested "four open top cars to be furnished each calendar day, exclusive of Sunday, commencing October 1, 1920" from the Illinois Central Railroad to meet the heating plant's daily appetite for 125 tons of coal.[16] This did not mean that the University was forbidden from using previously stored coal, though. A memorandum noted that the campus held 6,000 tons of coal at Camp Randall, but that the coal had to be moved inefficiently by cars and that the bins outside the heating plant were nearly empty.[17]

Although the ICC's order was only in effect for about a month, this situation demonstrated the necessity of planning and organization needed to make a centralized heating network reliable. Part of this planning involved a thoughtfully engineered tunnel system to pipe the steam across campus and back to the heating plant while creating alternate routes in case of a rupture or for maintenance. This system did not come cheap, however. Each foot of tunnel costed around $20-50 (1923 prices).[18] In 1923, there were over two miles of walkable main heating lines with 6x6 ft. or 7x7 ft. cross sections and over a mile of branch conduits connect to buildings in smaller concrete encasings.[19] Not only did the system of steam tunnels allow for easy expansion and connection, but the heating plant itself was designed to expand. The 250-foot smokestack that towered over campus was dubbed the “10,000 student chimney” as it was designed to accommodate the fast-approaching enrollment of that many students.[20] But, instead of expanding the plant as originally anticipated, the school kept upgrading the boiler systems to higher-output models and installed efficiency-improving measures like water softeners to prevent pipe scaling (mineral buildup), condensation return to send back higher temperature water, and basic insulation of pipes and water tanks.[21] Despite the gains in efficiency and output, it was clear the Old Heating Plant would soon be insufficient for the post-war boom in enrollment.

The efficiencies and blessings of a large, central plant were also its shortcomings. As buildings were designed without furnaces and expensive research labs needed constant temperatures, the hallmarks of campus research (and the integrity of indoor plumbing) rested on several boilers in a single building. Failure was not an option (and thankfully never happened). High-tech industrial boilers required specific fuel sources, so the University’s expansion extended far beyond the campus; it was tied to the political economics of extraction landscapes outside the state, deep into southern Illinois coal fields. These connections of distant landscapes to the campus landscape became contentious issues for the next generation of heating plants on campus. Especially with the rise of the environmental movement and the energy crisis in the 1970s, the political economy and geography of fuel sources shaped future heating plants in ways not seen before.

The Modern Era: Charter Street Heating Plant

The explosion of post-GI Bill enrollment exacerbated the limitations on what was already an aging heating plant nearing half a century of service, and campus officials were looking into alternative options for campus heating. Determining that a new plant was needed, they settled on a city block encircled by Charter, Mills, Dayton, and two rail lines. Located two blocks southeast of the Old Heating Plant, this location provided the same benefits of rail transportation and allowed for easier connection to the steam mains near the old plant. The University briefly flirted with the atomic idealism of the 1950s and considered the seemingly magical use of a mere few dozen pounds of uranium to replace tens of thousands of tons of coal, but their ambitions did not last long as the usual concerns over safety and waste disposal steered them toward more conventional options.[22]

Although the engineers settled on using coal, the land at the site for the future plant was not owned by the University, which limited the amount of money they could spend on a new plant (as the land owners needed to be compensated under eminent domain). Luckily, an industrial salvage company helped them save about $1 million by purchasing a relatively new heating plant from an abandoned automobile factory in Detroit.[23] By the winter of 1959, the Charter Street Heating Plant was carrying the full load of the campus and, like previous plants, was built with the intent to expand and improve technology.

Part of this upgraded facility besides the higher quantity and quality of the boilers was its ability to burn a mixture of fuels from coal, natural gas, and fuel oil – something that played an important role for environmental regulations in the future. The University was committed to keeping the plant continually supplied, so a constant 70-day supply of coal rested next to the plant in a 21,000-ton pile as a buffer for delays in shipments. A similar safeguard in the form of a half-million-gallon fuel oil tank was built underground across the street. While the coal pile was a visible part of the landscape and frequently contributed to air quality complaints, students were far removed from the networks making such a convenient nuisance possible. This heating plant reached even deeper into coal country through purchasing from western Kentucky mines and having the coal shipped by barge up the Mississippi to a rail depot at Prairie du Chien.[24]

Conversely, the underground fuel oil tanks were not part of the daily visible landscape of campus, except for times of refueling and the danger it posed as a giant pit during its construction. A large hole over 20 feet deep and 100 feet long was left vacant from Fall of 1973 to Summer of 1974 with only a flimsy snow face guarding the sheer drop off that hugged the sidewalk. Rightly upset, citizens were shocked at safety officials' dismissive attitude after one individual died and another was injured after their cars fell into the pit which dropped off right at the sidewalk.[25]

Except for these moments of transition or during legal and political battles yet to come, the daily effort put into maintaining this network of interconnecting landscapes of labor, capital, and the environment often went unnoticed to the campus community. Internal engineering reports in the 1980s describe the extensive repairs needed to parts of the tunnel network like the conduit pipes due to corrosion from salty runoff from winter roads.[26] A newspaper feature article of the same time gestures at the 40 plus employees necessary to run the Charter Street Plant, some of who removed coal ash from the boilers by hand, and the 20 or so mechanics and steam fitters who work in various building units across campus.[27] It is important to remember that a centralized heating system is just as much about individual buildings receiving and using the steam as it is about the heating plant itself.

Some of this labor demand has since diminished with the increasing automation and digitization of processes, but technology requires upkeep itself and can create its own unique challenges. Many organizations worldwide feared a global failure of certain software at the turn of the millennium due to potentially faulty computer code, a situation which became known as

Y2K. Likewise, the University put a considerable amount of time and planning for Y2K. The physical plant had 20 staff on site that night and reminded other departments to make sure all systems were Y2K compliant so that the computerized systems would not potentially malfunction and cause disruptions of service as widely feared.[28] Nevertheless, changes in technology are not the only transitions that affected the physical plant's operations.

Shifts in public opinion, federal laws, and the rise of the environmental movement shaped the future of the Charter Street facility. Many state and federal environmental laws, especially regarding air quality, were formulated in the 1970s and 1980s. The Wisconsin Department of Natural Resources (DNR) sent UW-Madison a notice in 1983 that the plant was in violation of air opacity limits. The school responded in two ways. First, they started blending their fuel mixture with higher quantities of natural gas which, although it made the emissions cleaner, raised the annual fuel bill by $2 million. Second, they constructed a several-million-dollar device called a baghouse which acted like a sophisticated vacuum cleaner and sat over the boilers in order to remove fine particulate matter that contributed to the air pollution problem. By constructing the baghouse, the University planned on returning to 100 percent coal by 1989 while still meeting the DNR requirements.[29] Interestingly, the power demand for the baghouse created a moment of concern over the electric substation's capacity, so power loads were shifted and redistributed across campus – a reminder of the overlap between different utilities.[30]

Environmentalists were far from relenting their attacks on the heating plant, though, and a lawsuit from the Sierra Club ended the era of coal on campus. The lawsuit started in 2006 when the Sierra Club claimed that numerous repairs and upgrades of the plant violated parts of the federal Clean Air Act. This required old technology to be phased out rather than undergo significant repairs. Skipping over the intricacies of the case and the law, the result was that the federal district judge sided with the Sierra Club, leaving the University and the state to find a new source of fuel for the heating plant.[31] Community and student activists grabbed onto the controversy created by the lawsuit and delivered two stockings to the Chancellor's Office: one filled with coal, and the other filled with postcards complaining about the plant.[32]

The decision about how to remodel the heating plant became a political issue that went all the way to the governor's desk. Former Governor Jim Doyle's administration wanted to use biomass like leftover farm waste and switchgrass as fuel. This option would diversify fuel sources (many of which would be in-state) but cost about $80 million more than the natural gas option chosen by the incoming Governor Walker.[33] The Charter Street Plant now burns exclusively natural gas (except for fuel oil during gas shortages) and has committed itself to a distant resource historically volatile in price. As the gas is delivered by Madison Gas and Electric, the ability to store months of fuel at a time as previous plants did is no longer an option. Our campus landscape no longer includes coal dust and daily deliveries by rail, but we are now tied beneath the ground to a national system of gas extraction and transportation.

The Walnut Street Plant: A New Generation of Steam and Controversy

Just as the Charter Street Plant was built to meet the heating and cooling needs of the rapidly expanding main campus, the University constructed the West Campus Heating Plant (also called the Walnut Street Plant) in 1972 to accommodate the heating and cooling needs of the new Medical Sciences complex, as well as provide a backup to the rest of campus. Built after the enactment of numerous pollution laws, the boilers in this plant used natural gas from its start.[34] It faithfully served campus until like all the other plants on campus, it was time to upgrade.

However, the Walnut Street Plant did not go through just a regular upgrade. Through a heated process of public hearings and legislative hearings, the expansion became a joint public-private project between the state and Madison Gas and Electric (MG&E). Together, the $190 million project would create a "co-generation" plant or "co-gen" where MG&E would operate an electrical power plant and UW would use the extra heat and steam to heat and cool its buildings. Investors received a guaranteed 12.1 percent rate of return, and both sides produce what they need at higher efficiencies than either could by themselves.[35] This was also an opportunity to make an incinerator to burn low-level radioactive and medical waste to save the school money on landfill costs. The result was a doubling in height of the smokestack to better disperse the toxic emissions[36]. Besides NIMBY-style concerns over noise, vibration, and air pollution, community members were concerned about the project's impact on Lake Mendota. Early estimates raised alarm at evaporation losses topping 800,000 gallons a day due to condensation and leakage.[37] Such concern brought satirical rebukes in local papers with headlines such as "Hey, why not drain the lakes and develop the land?"[38] The plant is operating smoothly today, and the real estate market has not yet claimed the lake.

Conclusion: The Steam Around Us

Significant effort and planning has gone into making 'room temperature' an invisible part of our daily experience. Yet, with roughly three quarters of campus' energy use coming from HVAC (heating ventilation and air conditioning), our daily actions are anything but invisible to the world around us.[39] Whether turning up the thermostat or leaving a window open, we impact economies, environments, and human lives in both local and distant landscapes. Bringing in fresh air to campus buildings means polluting air elsewhere. Heat no longer comes from the tree in the nearby woods, but neither does it come from the thermostat. Becoming a major institution with a research focus would not have been possible without the increasing magnitude of central heating infrastructure or the reach into other interconnected geographic, economic, and political landscapes. In seeking to better understand our role in a community larger than our campus, it is essential to reflect upon the history that connects us all to the air we breathe.

Photo 1. The early heating plant for the agricultural campus is visible on the left of Smith Hall. "Horticultural, Dairy and Agricultural Buildings." N.D. UW-Madison Digital Collections http://digicoll.library.wisc.edu/UW/data/images/MmBib/UWCulturalLand/UWCL-A/large/CLP-B0075l.jpg

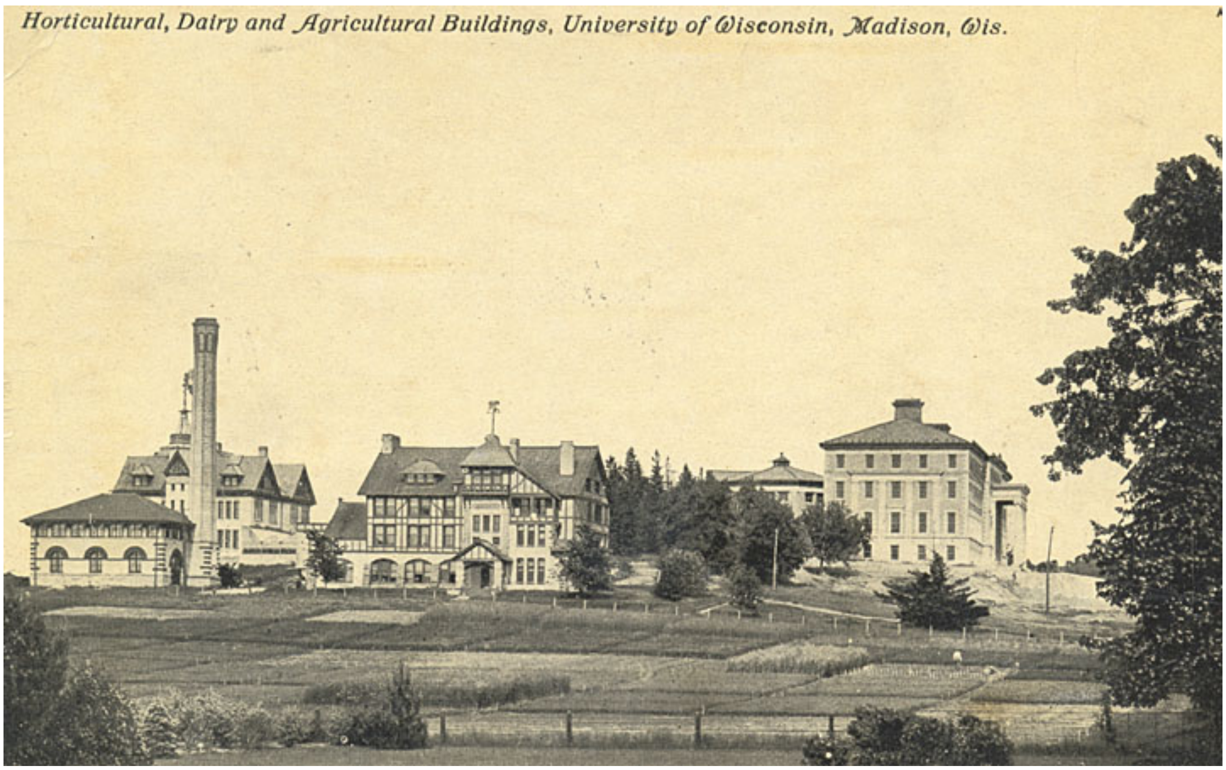

Photo 2. An aerial shot of the Charter Street Plant and the amount of coal it stored along the tracks. Evidence of rail transportation still exist in a small spur on the north side and the extra tracks on the eastern part.

"Heating Plant." N.D. UW-Digital Collections.
http://digicoll.library.wisc.edu/UW/data/images/UWArchives/large/tk090715021.jpg

[1] Aldo Leopold. *A Sand County almanac, and Sketches here and there: illus. by Charles W. Schwartz*. New York, 1950. p. 6
[2] Jim Feldman. *The buildings of the University of Wisconsin.* 1997. The University Archives. http://digital.library.wisc.edu/1711.dl/UW.UWBuildings p. 59
[3] *Ibid.*
[4] *Ibid.*
[5] *Ibid*, p. 60
[6] Gustus Larson and John Novotny, "The University Heating System." *The Wisconsin* Engineer. Volume XXVII, No. 8. May, 1923. http://digital.library.wisc.edu/1711.dl/UW.WIEv27no8 pp. 137-138

[7] Feldman, p. 94
[8] Feldman, p. 111
[9] *Ibid.*
[10] H.J. Thorkelson, "Report of the consulting engineer." *Biennial report of the Board of Regents for the years 1910-11 and 1911-12.* Democrat Printing Company, WI. 1912. p. 335
[11] Feldman, p. 111
[12] Larson and Novotny, p. 137
[13] Thorkelson, *Biennial Report.* pp. 335-336
[14] George McGinty, "Service order No. 16." *Interstate Commerce Commission*. Sep. 15, 1920. UW Archives Box 10 of series 24/1/1. Folder titled "Coal."
[15] *Ibid.*
[16] The University of Wisconsin Business Manager, "Application for priority order." Sept. 29, 1920. A letter from the University to the superintendent of the IL Central Railroad. UW Archives Box 10 of series 24/1/1. Folder titled "Coal."
[17] H.J Thorkelson, "Memorandum of trip to Chicago in regard to coal situation." Oct. 1, 1920. UW Archives Box 10 of series 24/1/1. Folder titled "Coal."
[18] Larson and Novotny, p. 139
[19] *Ibid.*
[20] *Ibid.*
[21] *Ibid.* p. 140
[22] Feldman, pp. 304-305
[23] *Ibid.*
[24] Mary Ellen Bell, "Heat's on: vast system keeps campus cozy." *WI. Week*. Dec. 10, 1986. Page 75 of UW Digital Collection folder "Physical Plant (1962-2001)." http://digital.library.wisc.edu/1711.dl/UW.PhysicalPlant
[25] John Stallard, "UW heating plant hole doesn't concern local safety officials." *The Capital Times*. May 15, 1974. Clipping in UW Archives subject folder "Heating Plant (1952-2004)"
[26] Department of Planning and Construction, "Campus heating plant master plan." April 1986. UW Archives box 141 titled "Campus Planning and Landscape Architecture." p. 19
[27] Bell, "Heat's on."
[28] University Communications, "UW-Madison is Y2K ready." Page 3 of UW Digital Collection folder "Physical Plant (1962-2001)." http://digital.library.wisc.edu/1711.dl/UW.PhysicalPlant
[29] Department of Planning, "Heating master plan." p. 12
[30] *Ibid.* p. 41
[31] Lee Bergquist, "Sierra Club sues DNR for records of state's coal plants." *Milwaukee Journal Sentinel*. Feb. 16, 2010. http://archive.jsonline.com/news/wisconsin/84535062.html
The full text of *Club v. Morgan* (07-C-251-S. (W.D. Wis. Nov. 7, 2007) can be accessed at https://casetext.com/case/club-v-morgan
[32] University Archives holds the two stockings given to the Chancellor in a box titled "Sierra Club anti-Charter St. power plant stockings." Acc. 2012/698.
[33] Dave Zweifel, "Plain talk: seems Walker won't look beyond his nose." *The Capital Times.* Feb. 2, 2011. Accessed clipping in UW Archives subject folder "Heating Plant (1952-2004)"
[34] Feldman, p. 437
[35] Judy Newman, "New power plant at UW-Madison gets initial OK." *Wisconsin State Journal.* Sep. 20, 2003. Accessed clipping in UW Archives subject folder "Heating Plant (1952-2004)"
[36] Mike Ivey, "Smokestack safety hikes cogen cost." *The Capital Times*. June 3, 2004. Accessed clipping in UW Archives subject folder "Heating Plant (1952-2004)"
[37] Mike Ivey, "MGE plant to use lake water hit: new plant to need millions of gallons." *The Capital Times*. Oct. 31, 2002. Accessed clipping in UW Archives subject folder "Heating Plant (1952-2004)"
[38] Ellen Rulseh, "Hey, why not drain the lakes and develop the land?" *The Capital Times*. Oct. 11, 2002. Accessed clipping in UW Archives subject folder "Heating Plant (1952-2004)"
[39] Data from personal correspondence with Professor Cathy Middlecamp who teaches a class on campus sustainability.