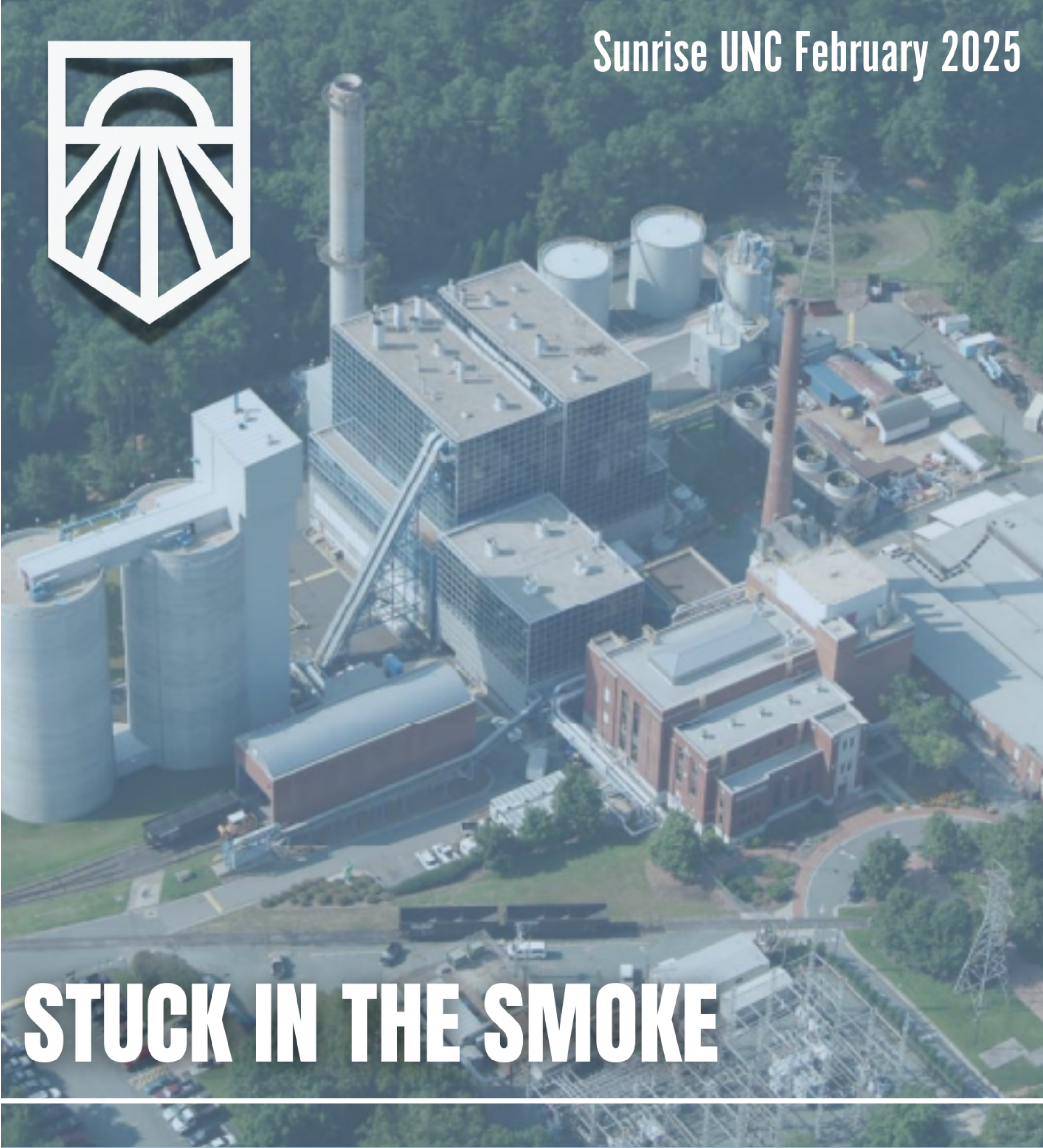
Sunrise UNC February 2025



STUCK IN THE SMOKE

UNC's Coal Plant and Solutions for a Green Transition

This report was authored and edited by members of the Sunrise UNC Research Team.

Sunrise UNC is a hub of the Sunrise Movement, a movement of young people fighting to stop the climate crisis and win a Green New Deal. We are dedicated to combating climate change by holding UNC accountable for its environmental and social impacts and educating the UNC community about institutional issues.

Directed by Victoria Plant, with contributions from Aaratrik Springer, Ally Hudson, Amaria Gonzales, Aurelio Bazzano-Zeldin, Evan Paces-Wiles, Graham Mellon, Izzy Lynn, Kabir Zota-Stull, Megan Mullaney, Sophia Kerov, and Nikki Rubiano

Contact Information:
Website: sunriseunc.org
Instagram: @sunriseunc
Email: sunriseunc@gmail.com

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Executive summary

For over a century, UNC has operated a coal plant next to its campus, relocating from its original site, built in 1920, to its current location on Cameron Avenue in 1940. The plant was placed next to two of Chapel Hill's historically black neighborhoods, Pine Hill and Tin Top, which was an act of environmental racism. As of 2021, these neighborhoods continue to have higher numbers of minority residents compared to the rest of Orange County (Pequeño, 2021). While the plant is important to generate steam to power the campus, the surrounding community and students have been suffering the consequences of its air pollution for decades. Even as UNC transitions to a fossil fuel mix that is less coal-intensive and more reliant on natural gas, these pollutants are still harmful to human health and contribute to the climate crisis. Not only is this a local environmental injustice, but the coal ash that the cogeneration facility produces is sent across state lines to another predominantly black community in South Boston, Virginia (McLaughlin & Pell, 2022). This is a disgrace and an embarrassment as UNC aims to be a leading academic institution committed to serving the public.

Despite University claims, it is not only possible but imperative that this plant be transitioned to a clean alternative to coal. Currently, administrative officials hope to transition to another dangerous solid fuel source, specifically plastic waste pellets made by Convergen, but we join the Chapel Hill-Carrboro community in asserting that the burning of these pellets will likely emit dangerous levels of PFAs. To maintain the steam infrastructure that heats all the campus buildings, our team found few easy options for the replacement of the coal plant. The options we found included solar thermal, geothermal, electrode boilers, an SMR, large-scale heat pumps, thermal salts, and hydrogen. Not all of these will be touched on in this report, but our team hopes to dive deeper into long-term solutions in the future. The most feasible option we found in terms of speed of implementation was electrode boilers, which could be phased in to replace the coal and natural gas-powered boilers currently being used. Because these boilers rely on electricity to generate steam, we also included a section on the role renewable energy could play in supplementing the increased electricity demand. The last section touches on funding and the potential help federal funds from the Inflation Reduction Act (IRA) could provide. While the pace of the energy transition depends on the availability of funding for clean and renewable projects, we argue that the university has these funds and should be taking immediate action. Overall, the purpose of this report is to lay out the negative effects of the coal plant, explore solutions, advocate for research and a timely replacement, and provide an educational resource for interested parties.

How to read this report

This report begins by laying out how the energy systems at UNC function. We briefly describe the infrastructure and then dive into the problems that the co-generation plant has caused. Next, we transition to describing solutions and alternatives to coal, such as plastic pellets and electrode boilers. We encourage readers to first get a basic grasp on why the university claims it needs coal to produce steam (you can find this in the first two sections) before jumping around to different sections that interest you. Some sections are more technical or math-based but are important to understanding how we came to our conclusions. We hope this paper provides greater clarity to the coal plant issue and ultimately leads to its closure.

Targets

Our university's administration is overseen by the Board of Governors, which governs the UNC system and appoints 8 of the 15 members of the UNC-Chapel Hill Board of Trustees. 6 members of the Board of Trustees are appointed by the NC General Assembly, and the Student Body President is also a member. The Board of Trustees and the Board of Governors oversee our university's Chancellor, Lee Roberts, and Provost Chris Clemons. The Chancellor has complete executive authority, while one of the roles of the Provost is to manage funding (University administrative structure, 2024; UNC Board of Trustees, 2025). Within the university administration, Michael Piehler is the Chief Sustainability Officer to the Chancellor. He is also the director of The Institute for the Environment, which houses Sustainable Carolina and the Carolina Sustainability Council. These bodies have the authority to work on projects that will decarbonize the university. Sustainable Carolina tracks university emissions and presented their yearly findings at the Energy Transition Town Hall this past fall.

The people who sit in these positions of power know what it would take to shut down the coal plant and implement a zero-carbon solution. These people control what gets studied and what gets funded. More research needs to be done on these targets to determine who makes the decisions to appropriate various amounts of money and who allows major projects to proceed. Ultimately, all are responsible for taking action on this front, and the system is designed for them to work together on major university decisions. UNC has the funds but lacks the willpower to act. Thus, Sunrise UNC will continue to demand that our administrators put real effort into solving this problem, promptly decide on a zero-carbon solution, and most importantly, allocate the required funds.

How the Coal Plant Works

The cogeneration plant at 575 West Cameron Avenue generates about 90% steam and 10% electricity, which composes around 13% of the university's total electricity supply. UNC receives about 87% of its electricity from Duke Energy (Elliot, 2023). This means the main purpose of the plant is to supply our campus with steam energy, and electricity production is a bonus. The plant combusts coal and natural gas to produce steam, which then passes through three superheaters to reach the necessary temperature for distribution. From there, the steam enters a network of pipes (see Figure 3) that deliver it to campus buildings in order to provide "heating, distillation, humidification, sterilization of equipment, and cooling." The steam distribution system serves over two hundred buildings on campus as well as UNC hospitals (Elliot, 2023). For these reasons, alternatives must meet these same energy demands.

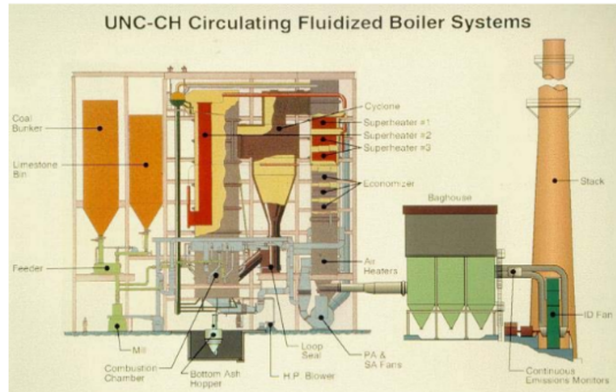

Figure 1: How the coal plant produces steam

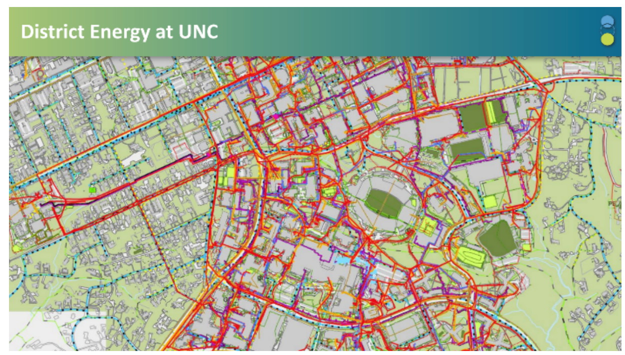

Figure 3: The network of pipes delivering steam energy across campus (provided by Sustainable Carolina)

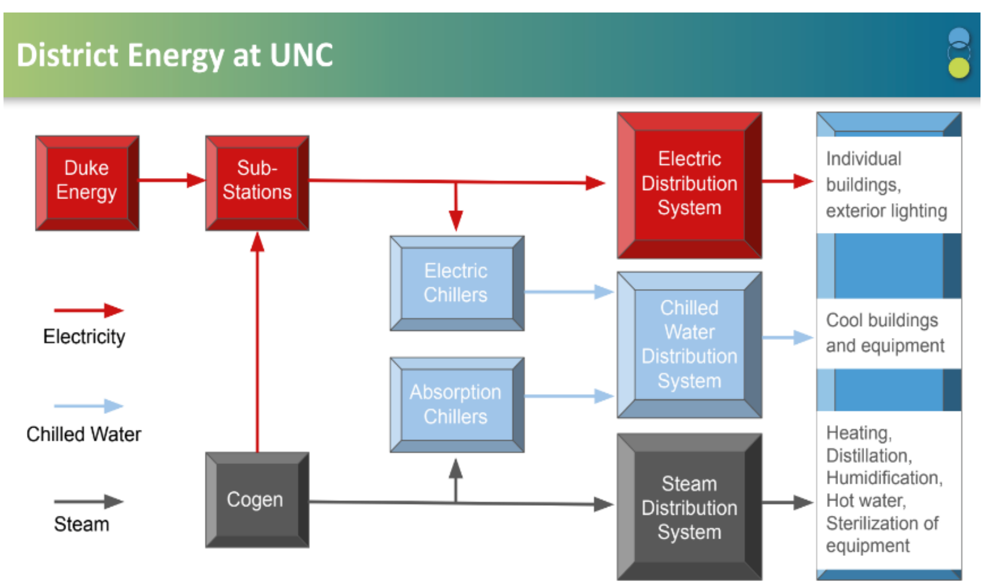

Figure 2: This image (provided by Sustainable Carolina at the Energy Transition Town Hall) shows how district energy works at Carolina. District energy is an efficient and cost-effective way to heat/cool buildings across communities. The red boxes show the flow of electricity and the grey shows the flow of the steam.

The plant consists of a 32 MW steam turbine, two 2 MW diesel generators, one 250,000 lb./hr. gas-fired packaged boiler, and two new 250,000 lb./hr. circulating fluidized bed boilers added to the structure in 2019. The boilers have a 50,385-ton cooling capacity with 19 electric and 5 absorption chillers (SE CHP, n.d.). Relatively, this is a small power plant. The gas fired packaged boiler burns natural gas and the flames heat water in the boiler to create steam (EPCB, 2024). The fluidized bed boilers produce steam by burning fuel in a bed of particles. (Crawford, 2012). Combustion air, which is air that is pushed through the circulating bed of particles, causes the particles to move like a liquid at high velocities and move throughout the entire combustion zone of the boiler (Crawford, 2012; Breeze, 2014). The movement of the fuel-particle mixture produces hot water or steam.

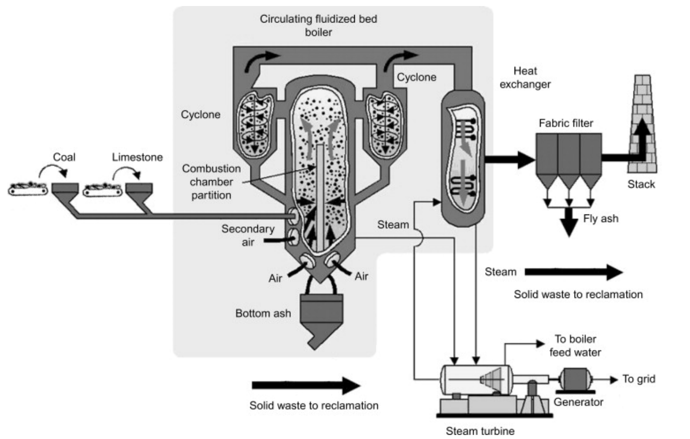

Figure 4: Diagram of circulating fluidized boiler from Breeze, 2014; this system is how most coal plants are used to create electricity.

Once the hot steam or water is produced it is sent to the steam distribution system, the 32 MW steam turbine, or the chillers (Miller, 2011; U.S. DOE, 2017). When hot steam is sent to the steam turbine, pressure is captured from the expanding steam, which turns the turbine shaft connected to a generator, producing electricity (GE Vernova, n.d.). For the most part though, the steam is taken to the steam distribution system or the chillers. The chillers cool the water which is sent through the chilled water distribution system (composed of about 22 miles of pipes) that cools various buildings and equipment on campus (Sechrist, 2020; Elliot, 2023).

The 2 MW diesel generators create power in a similar way to a turbine and are typically used as back up electricity in case there is an outage (Paden, 2023). Along with having the West Cameron Avenue cogeneration plant, UNC also has the Manning Steam plant, four chilled water plants, three electric substations, and backup generators at key locations (Sechrist, 2020).

There are several alternatives to burning coal and natural gas to produce steam, as mentioned before, and after examining the infrastructure, we concluded the solution only has to be able to consistently generate steam. The following section will outline the University's arguments for why they can't implement any solutions that fit this criterion.

UNC's Claims

The University of North Carolina at Chapel Hill states that its cogeneration facility maintains "superior environmental performance" and that the facility is necessary to generate steam and electricity for University operations (Energy Services, n.d.). The University cites financial, practical, and legal arguments against various clean energy solutions. This report will examine the evidence of tangible harm caused by the cogeneration facility and possible solutions for replacing coal as an energy source, but first, UNC's claims about energy production should be identified. In order to understand how we can fix this problem and what challenges we must address, we must understand why UNC is still operating a coal plant in 2025.

UNC's most accessible statements on addressing the climate crisis come from their 2021 Climate Action Plan, found on the Sustainable Carolina website (2021). The University committed to addressing the climate crisis in 2007 and established intentions to reach carbon neutrality by 2040 (after failing to go coal-free by 2020). To accomplish this, the University is prioritizing efforts that seem to be the most feasible given current technology, geography, infrastructure, and the accessibility of capital. In other words, they fund many small projects rather than the coal plant's closure. UNC also prioritizes environmental projects that are "highly visible and draw attention to the effort" (Sustainable Carolina, 2021). This statement indicates great dedication to image. This focus could discourage projects with risk and thus limit the pursuit of innovative, green solutions. Finally, the University must comply with North Carolina law, which does not allow customers to purchase electricity, such as solar energy, from unregulated third-party providers (NC Sustainable Energy Association, n.d.). These regulations mostly limit the University's options for obtaining electricity to Duke Energy's grid.

According to a 2019 issue of the Daily Tar Heel, the University's environmental goals are primarily restrained by lack of funding. The University was, and presumably is, still paying for the coal plant, and didn't want their financial investments to go to waste by abandoning the plant entirely (Quam, 2019). Financial concern is the reason given for not abandoning coal by 2020, and it is a real consideration in switching to green energy as this is a pattern demonstrated by utilities across the country. Throughout this report, we touch on the financial feasibility of the energy options presented.

Overall, the University of North Carolina is hesitant to embrace a transition away from coal mostly because of the perceived cost and the lack of will to solve the problem. This report hopes to demonstrate that those concerns are not compelling enough obstacles to justify the environmental and human health concerns of keeping the current system.

Air Pollution

The UNC cogeneration plant, like coal plants across the country, has deleterious effects on the air quality around it and contributes to health crises. Studies have found that even small amounts of VOCs, nitrogen oxides, sulfur dioxide, ozone, and other pollutants exacerbate cardiovascular disease, asthma, COPD, increase the risk of having a cardiovascular or cerebrovascular event, and increase the total hospitalizations in an area (American Lung Association, n.d.). All of these air pollutants are products of coal combustion. An increase of just 10 micrograms of fine particulate/m3 is associated with an 8 to 18% increase in cardiovascular mortality, an 8% increase in lung cancer mortality, and 6% general mortality (Kravchenko, 2021).

Orange County has a similar cancer rate to the rest of North Carolina, one of the top 10 states by total cancer incidence, with 470 cases per 100,000 people. Orange County reports 375 cases of lung cancer per year, according to the North Carolina Central Cancer Registry (2022). With VOCs being known carcinogens, this is likely in part due to the presence of the coal plant. In addition, the cogeneration plant is located next to Chapel Hill neighborhoods, exposing hundreds of people, including children and students, to these harmful pollutants. Evidence also shows that early exposure to even marginally elevated concentrations of ozone and particulate matter makes children more susceptible to asthma and other lung conditions later (Jornal de Pediatra, 2021).

To reduce emissions and pollution, UNC's Cogeneration plant has moved to burning 60% natural gas and 40% coal and reducing total coal use by 67%. Even with UNC's claimed 54% reduction in coal use since 2007 (Sustainable Carolina, 2022), they still burn around 4000 tons of coal per year (Sierra Club, n.d.), resulting in 127 tons of NOx, 16 tons of particulate matter, 182 tons of SO2, 3 tons of VOCs, 59 tons of CO, and 11 tons of H2SO4 (Zeman, J. et al, 2021). All of these pollutants are detrimental to human health and the environment.

According to air quality data from the EPA, the Chapel Hill area has had almost 300 days in the past 10 years with a PM2.5 greater than 50 mg/m3, a level that the EPA deems a moderate risk (EPA AQS, n.d.). Though it is difficult to say exactly how much air pollution is from the coal, it is undoubtedly having an effect. The study done in part by SEAC will shed light on this sometime next year, comparing air quality from homes right next to the Cogeneration plant and homes some distance away. Even so, there is no reason to wait, as the continued operation of the cogeneration plant puts all of us at risk. If UNC wants to protect the health of its students and the surrounding community, it must halt the coal plant's operations as soon as possible.

Coal Ash Pollution

This section explains the deposition of coal ash in the areas immediately surrounding the UNC coal plant and its consequences on local populations and the environment. We argue that the existence and transportation of coal ash near the Bolin Creek Greenway and Chapel Hill Police Department create an unacceptable hazard. Additionally, UNC continues to produce coal ash and offload it onto another community, which is deplorable behavior for a university to engage in. The many harms of coal ash demand urgent action to protect Chapel Hill residents and other communities from lasting damage.

From around ten years in the mid-1960s to the early 1970s, the site surrounding 828 Martin Luther King Jr. Boulevard in Chapel Hill, North Carolina, was utilized as a borrow site, where clean soil was dug up and exported. This hole was later filled by construction debris and coal combustion products (CCPs), which include fly ash and boiler slag. The Town of Chapel Hill bought the property in the 1970s, and coal ash was first discovered on the site in 2013 (Town of Chapel Hill, 2024). While exposure from soil contact and vapor intrusion was deemed highly unlikely by soil samplers, repeated stream and well sampling found elevated levels of dangerous heavy metals such as arsenic, barium, manganese, and cobalt. The site is located less than a mile from downtown Chapel Hill and sits a mere half-mile from apartment complexes such as Union, Millcreek, and Stratford Hills. The Chapel Hill Police Department headquarters currently rests on this site, and the volatility of the coal ash prevents renovations from occurring within the aging building. Bolin Creek, a local waterway, sits on this site along with a prevalent greenway that connects to downtown Chapel Hill.

Elevated levels of coal ash negatively affect the environment in two ways. First, the atmospheric mobility of fly ash increases its area of impact. Furthermore, the presence of minerals such as copper, arsenic, and selenium within the ash creates leachate, a harmful liquid composed of heavy metals that contaminates both soil and water (Munawer, 2018). As coal ash leaks into groundwater, it negatively affects fish and plant growth.

Human health is affected by the presence of coal ash through two primary ways. First, the prevalence of ash in groundwater and drinking water creates a substantial risk of ingestion, which is amplified by the creek's proximity to crucial water reservoirs. Bolin Creek is officially listed as a WS-V water source. WS-V water sources are protected as sites that sit upstream and drain to Class WS-IV waters, or waters used by industry to supply their employees with drinking water (Brownfields Assessment Report, 2022). Bolin Creek sits approximately six miles upstream of Jordan Lake, a massive watershed that provides drinking water to over 700,000 people in the Triangle area (Jordan Lake

One Water, 2022). Furthermore, the prevalence of coal ash in an environment creates added health risks through increased exposure to particulate matter, which may result in DNA mutation, epigenetic effects, and cancer and other cardiovascular diseases (Munawer, 2018).

A large, often-discussed issue within the local community is whether and how to remove this toxic coal ash. Digging up and replacing the coal ash poses numerous problems to the Town of Chapel Hill and surrounding communities. If this coal ash was dug up, the question would be: what do we do with it? UNC's continued use of coal at its cogeneration plant on Cameron Avenue amplifies the issue of coal ash. Currently, 20,000 tons of coal ash per year is hauled to an unlined pit near the town of South Boston, Virginia, creating a major environmental injustice. This is the equivalent of 1 ton of coal ash per year per undergraduate student (Ross, 2022). South Boston contains 8,000 people and is 60% Black, with a median household income of $40,087, about half of that of Chapel Hill and far below the national median household income (McLaughlin & Pell, 2022). In return, UNC gives around $30,000 per year to the town of South Boston.

It is clear that the University is offloading its environmental impacts to underrepresented and impoverished communities for a relatively shallow fee. If the Town of Chapel Hill were to dig up the coal ash in our community, they would need to present a just alternative to polluting another, less fortunate neighborhood. Solutions to coal ash include transporting the ash to lined surface impoundments and lagoons far away from vulnerable communities or important wildlife areas. Furthermore, this solution could also be feasible for solving the question of disposal for the coal ash that the University continues to produce through the Cameron Avenue coal plant.

Convergen Pellets

Introduction

To transition away from coal, UNC is planning to test newly engineered fuel pellets, produced by Convergen Energy, at the Cameron Avenue Cogeneration Facility (University of North Carolina at Chapel Hill, 2024b). As of July 2024, the university has applied for a modification to their Title V Air Quality Permit. UNC wants a one-year testing period to combust the fuel pellets in Boiler 6 and Boiler 7. According to the permit application, "The University expects to start the Project during the summer of 2025" (University of North Carolina at Chapel Hill, 2024a). Although ending coal use is critical and urgent, the pellets pose several concerns and are ultimately not a long-term sustainable solution to meet UNC's energy needs.

Track record

The timeline regarding the pellets is vague; UNC has a history of pushing timelines backwards and breaking promises. In 2010, UNC promised to stop burning coal by 2020, but never followed through. Now, UNC is aiming to "be emission-neutral—but not coal-free—by the year 2040" (Pequeño, 2021). UNC also has a history of failure surrounding similar alternative fuel sources. The university tested wood pellets in 2010 and 2011 before abandoning the project (Triangle Blog Blog, 2024).

Composition

The pellets are composed of "non-recyclable feedstock materials provided by local manufacturing facilities" in the State of Michigan (University of North Carolina at Chapel Hill, 2024a). Materials include paper sludge, packaging, and corrugated containers (Wagner & Grubb, 2024). The lack of certainty regarding the many chemicals that compose the pellets is a concern when understanding and testing potential risks of burning them as fuel. According to UNC's project proposal, the EPA considers the engineered fuel pellets Non-Hazardous Secondary Materials and not solid waste (University of North Carolina at Chapel Hill, 2024a). As the EPA and NC DEQ start classifying various PFAS (chemicals in these pellets) as hazardous air pollutants, we seriously question whether these engineered pellets should be considered Non-Hazardous. The proposal also claims the fuel pellets are "an ultra-low carbon fuel that [has] been deemed a 100% renewable fuel source in states such as Michigan" (University of North Carolina at Chapel Hill, 2024a, p. 3). As the currently stated sources of the pellets are not renewable and would have to travel a long distance to Chapel Hill, this seems to be a very misleading statement.

Benefits and drawbacks

In some ways, fuel pellets represent an improvement over burning coal. The fuel pellets have a heating value comparable to coal (University of North Carolina at Chapel Hill, 2024a), and UNC projects a decrease in certain pollutants, such as "particulate matter, fluorides and sulfuric acid mist," including a large reduction in sulfur dioxide (Wagner & Grubb, 2024). Comparing the increase in NOx and the big decrease in SO_2, this seems to be a net positive. In terms of greenhouse gases, UNC projects a moderate decrease from the equivalent of 189,758 tons of CO_2e per year to 166,886 tons when switching to pellets. These changes can be seen in the table below provided by the NC DEQ.

Annual Emissions (tons/year)		
Pollutant	**Current Baseline**	**Potential Changes**
NOx	127	+22
PM/PM_{10}/$PM_{2.5}$	16	-8
SO_2	182	-118
VOC	3	+9
CO	59	+16
Sulfuric Acid	11	-7
Greenhouse Gases (CO_2e)	189,758	-22,871

Figure 5: Projections for Boilers 6 and 7 emissions completely replacing coal with engineered pellets, based on data from UNC.

However, this moderate decrease in GHGs isn't enough to contend with the climate crisis. Despite UNC's claims that the fuel pellets are "ultra-low carbon" (University of North Carolina at Chapel Hill, 2024b), their own modeling projects suggest that switching to fuel pellets would only marginally lower emissions. Based on our calculations, the reduction in greenhouse gases would be about a 6% decrease in total university emissions (22,871/365,554=0.06; from 2024 sustainability report). Furthermore, UNC's modeling suggests that certain key pollutants would increase when transitioning from coal to fuel pellets, projecting a rise in nitrogen oxides, carbon monoxide, and volatile organic compounds (Wagner & Grubb, 2024). **The risks that these changes in pollutants pose to human health do not outweigh the benefits of decreasing GHG emissions.**

The pellets also include varying PFAS, or forever chemicals (University of North Carolina at Chapel Hill, 2024a). According to UNC's project proposal, the concentration of PFAS is "negligible" (University of North Carolina at Chapel Hill, 2024a, p. 4). The public hearing notification claims "the facility would not emit more than 1.2 pounds of PFAS per year" (Taylor, 2024). However, PFAS are harmful, even in very small quantities (The Associated Press, 2022). The EPA measures their concentration in parts per trillion, so 1.2 pounds is quite significant. Furthermore, their categorization remains contentious. For example, North Carolina recently petitioned the EPA to designate several PFAS as Hazardous Air Pollutants (Martin, 2024). In addition, North Carolina has long struggled with the consequences of PFAS, such as the contamination along the Haw River (Ross, 2019). Many citizens are rightfully concerned, as seen in the recent public hearing, about the potential adverse health effects that PFAs could cause in our community.

Other than the permit application, which is a dense legal document, UNC has provided little information available on the fuel pellets. The public's input on alternative fuel solutions has been disregarded, despite considerable public concern regarding both the use of coal and the introduction of fuel pellets (Wagner & Grubb, 2024). Kym Meyer, a Southern Environmental Law Center senior attorney, said, "We do appreciate that the university's trying to reduce its carbon emissions, but this just doesn't seem like the way to do that" (Wagner & Grubb, 2024).

In spite of serious drawbacks to fuel pellets, UNC remains committed to pursuing this particular alternative to burning coal. One likely reason UNC is pursuing fuel pellets is the fact that they can be burned in the existing cogeneration plant with minor adjustments (University of North Carolina at Chapel Hill, 2024b). The lack of infrastructure upfitting likely means a low upfront cost to transition. Additionally, they claim to require burning solid fuel to produce steam. According to UNC: "To meet the campus steam demand, and to maintain the necessary high levels of reliability and resilience, Carolina needs to have multiple fuel options and be able to store fuel on site" (University of North Carolina at Chapel Hill, 2024b). This isn't necessarily true, rather, it is an easy excuse that is used to justify delaying the inevitable transition to a zero-carbon energy source.

Recycling

Convergen Energy claims that the materials used for their pellets would otherwise end up in landfills (University of North Carolina at Chapel Hill, 2024a). With that being said, the degree to which the feedstock materials could be recycled is more complex. A Comparative Lifecycle Assessment commissioned by Convergen Energy considers chemical recycling as a proposed alternate scenario, specifically pyrolysis of plastic to PE (Zeman et al., 2021). According to the Assessment, both "proposed and baseline scenarios for the fuel pellet solution result in higher absolute impacts" (p. 35) for global warming potential than chemical recycling. Although both plastic-to-plastic and plastic-to-fuel technologies are still being developed, some research suggests that plastic-to-plastic "consistently offers GHG [greenhouse gases] emissions benefits regardless of region or functional unit" (Das et al., 2022, p. 85).

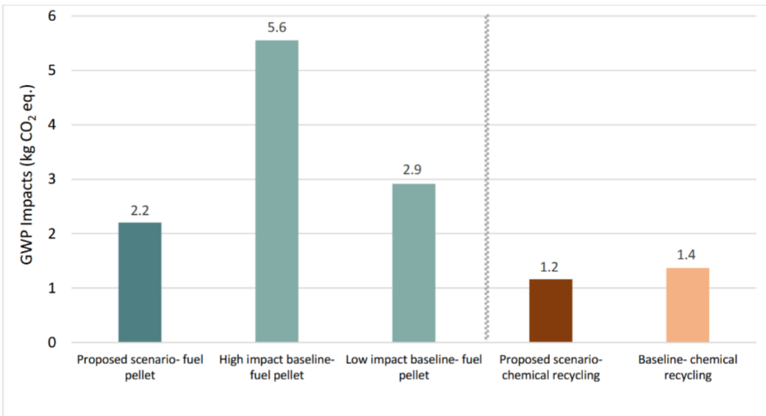

Figure 6: Ratio of GWP impacts in proposed vs baseline scenarios for Convergen Energy

Conclusion

Based on all available evidence, Convergen Energy fuel pellets are a poor option for the University's transition away from coal. Despite promising only a marginal reduction in global warming impact, the fuel pellets have a projected increase in several key pollutants and contain dangerous PFAs. It is crucial to invest in techniques for reducing and recycling paper and plastic industrial byproducts rather than burning them as fuel. Ultimately, UNC's promotion of Convergen Energy fuel pellets is greenwashing and distracts from long-term solutions for clean and renewable energy.

Electrode Boilers

Electrode boilers are a high-quality option for providing clean steam generation for campus buildings while utilizing the existing infrastructure. Electrode boilers use electricity to produce hot water or steam for industrial and district heating applications. They operate by passing an electric current through water, using submerged metal electrodes. When voltage is applied, the current flows through the electrodes, generating heat due to the water's resistance. This heat causes the water to boil, producing steam (Ivanov, 2024). There are various configurations of this process, including inner tank boilers, jet-type steam boilers, and electrode-shielded boilers (Noviok et al, 2023). Electrode boilers are versatile and can meet large-scale heating needs, such as those in educational institutions. "[Electrode boilers] are usually installed as peak load units, similar to oil or gas boilers" (Noviok et al, 2023). Electrode boilers are compact, durable, and require minimal maintenance or supervision (Wallace, 2007).

Electrode boilers have been used in Europe for **over 70 years**, often using surplus electricity from the grid for heating (Wallace, 2007). For a project at Carolina, connecting these boilers to Duke Energy's grid could provide a cleaner energy source. Duke Energy supplies electricity that is 54% clean (nuclear, hydro, and solar) and 84% non-coal (Elliot, 2023), in contrast to the campus's current coal plant, which uses a mix of 40% coal and 60% natural gas—neither of which are clean energy sources. Transitioning to powering our boilers with Duke's grid would represent a significant environmental upgrade.

The coal and natural gas used in the cogeneration facility will be about 2 (*Equation 2)* times more efficient than the electricity generated from the grid. Cogeneration facilities are efficient and will power at 65-75% efficiency in total production (U.S. Department of Energy). Duke generates electricity from coal at 9,000 BTUs/kWh (Belews Creek Steam Station, 2024), and the electrode boiler requires 293kWh/million BTUs of steam, which is nearly 100% efficient (Harfst, 2016), producing ≅37.9% efficiency *(Equation 1)*. Currently, replacements of boilers with electrode ones would decrease the universities' coal use by ≅10.5% *(Equation 3)* and natural gas use by ≅10.3% *(Equation 4)*. Although this is not fully clean, it will get less carbon-intensive over time until Duke Energy phases out coal and becomes 70% clean in 2035 (Duke Energy, 2024). **In 2035, carbon production for the university will be down 44.8% if the**

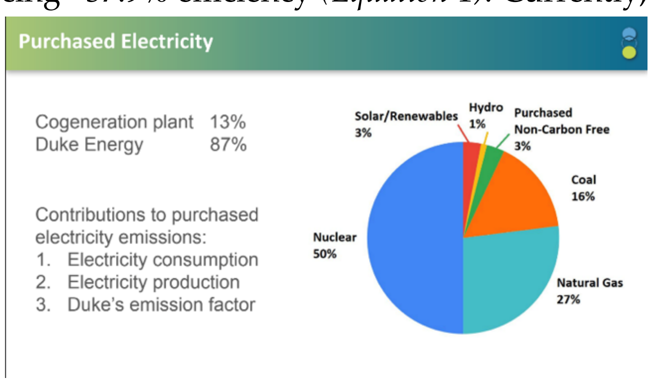

Figure 7: UNC's purchased electricity provided by Sustainable Carolina. The pie chart shows Duke Energy's electricity portfolio.

electrode boilers are implemented and Duke Energy continues to decarbonize (*Equation 5).* Additionally, the university could invest in other renewable energy projects to provide the electricity electric boilers need.

Equation 1: $\frac{1kWh}{9{,}000BTU\ Coal} * \frac{1{,}000{,}000\ BTU\ Steam}{293kWh} * 100\%\ Boiler\ efficency = 37.9\%$ Energy efficiency from Duke Grid to steam

Equation 2: **≅70%** cogen efficiency ÷ **37.9%** efficiency from duke energy =**1.84** times more efficient

** Using 70% as an average estimate of cogen efficiency

Equation 3: **40%** coal used cogen **- (1.84 x 16%** coal use duke energy*(Figure 7*) = **10.56%** decrease in coal use

**1.84 multiplied because the cogeneration system is ≅1.84 times more efficient

Equation 4: **60%** natural gas used cogen **- (≅1.84 x 27%** natural gas use duke energy(Figure 7) = **≅10.32%** decrease in natural gas use

Equation 5: **100%** carbon sourced energy cogen **- (≅1.84 x 30%** carbon sourced duke energy) = **≅44.8%** decrease in carbon sourced energy by 2035

**30% because Duke Energy will be 70% clean in 2035

The operation and capital cost of the electrode boilers may have financial implications. However, it is the university's responsibility to investigate financing as we have little information on the university's budget and current expenditures. Even if the costs are high, the negative externality of carbon cost on climate, the negative effects of the coal plant, and the long-term viability of electrode boilers should be considered.

The campus currently operates with two 250,000 lb./hr. Circulating Fluidized Bed Boilers and one 250,000 lb./hr. gas-fired boiler (US DOE). The High Voltage Jet Type Steam Boiler from ACME offers a capacity of up to 270,000 lbs. of steam per hour, demonstrating the high capacity of modern electrode boilers (ACME, 2022). To replace the campus's steam generation, three electrode boilers with similar capacity would be sufficient. However, if the university opts for electrode boilers with inner tanks or shielded electrodes, which offer better control and lower maintenance, approximately twelve electrode boilers would be needed to meet the steam production requirements (Noviok et al, 2023). A phased installation approach—replacing one boiler at a time—would ensure continuous operation and minimize disruptions to campus facilities, including critical areas like the hospital.

To conclude, electrode boilers can directly replace the current boilers to generate the steam required for university operations. This could be achieved through a phase-out process replacing boilers one by one, so university operations are not disturbed greatly. The energy would come largely from the Duke Energy electrical grid with potential additional renewable sources generated on campus. The electrical grid wouldn't be completely clean but would pose a great upgrade, decreasing carbon production by 10% from coal use and 10% from natural gas use if done right now, but by 44.8% and coal-free by 2035. The electrode boiler provides a cleaner, long-term replacement to current carbon-generating alternatives.

Other Renewable Energy Sources – Costs and Benefits

Introduction

In addition to using electrode boilers as an alternative for steam generation, there are a variety of other renewable energy sources that the university can use to generate electricity to power these boilers. While alternative energy sources are constantly advancing, we will only focus on two that have shown the most promise in large-scale and commercial uses: solar and wind. UNC has already investigated solar and wind energy projects, funding research in this sector and installing solar arrays on several campus buildings, including parking decks and the Student Union. Other institutions of similar size have already integrated solar panels into their campus electricity generation: one example is Pennsylvania State University, which signed a 25-year contract with Lighthouse BP to provide a 70-megawatt solar farm. This farm will produce 25% of Penn State's needs, an impressive investment that has already saved the university over $14 million to date (Penn State & Lightsource bp, 2020). With the willpower and appropriate funding, UNC too can set an example for similar institutions across the country and provide economic and environmental benefits by continuing to invest in renewable energy sources.

Solar Energy

To produce energy from solar energy, either solar photovoltaic (PV) or solar thermal power is used. Solar thermal systems are used primarily to heat water for district heating and steam generation purposes, which could be directly useful for our district heating system. These systems require significant land but have a high long-term efficiency and lower emissions over the system's lifetime. Photovoltaic arrays can easily be used to generate electricity for many purposes, including lighting, electricity, and appliances. They are efficiently and easily installed on open land, and their costs are rapidly decreasing. To optimally generate electricity for the University, a combination of thermal and photovoltaic arrays could be used to power different sectors of the campus, with most of the arrays being positioned on solar farms near Chapel Hill. In a state with relatively consistent sunlight year-round, the cost of building and maintenance for electricity generated by solar (per million British Thermal Units [MMBtu]) is about $25.13. This can be compared to the costs for steam and chilled water, which are $43.62 and $97.07 per MMBtu, respectively using figures from UNC's 2022-23 Strategic Energy and Water plan. Future improvements in technology will further decrease this price. Solar energy is already shown to be a promising, cost-effective way to generate electricity in households and cities; UNC should be a leader in embracing these technologies and integrating these changes into their plans.

UNC has already begun investments into solar projects on larger scales, showing a greater initiative beyond installations on rooftops and campus buildings. Near the old airport on the proposed site for Carolina North (a planned mixed-use campus and research hub), the University recently finished construction of a solar photovoltaic system. The solar array will generate 376 kW of instantaneous power, enough electricity annually to meet the needs of over 50 average US households (376 kw/1 hr * 4.5 hrs sun/day * 365 days/yr = 617,580 kwh/yr / 10,791 kwh/yr/house= 57 households/yr) (U.S. Energy Information Administration, n.d.). While there have been talks of putting a temporary basketball stadium in this spot, we hope the University makes the right choice in maintaining this solar project. If it stands, this energy will be used to power Carolina North but not any part of the campus south of Franklin Street.

Wind Energy

Energy generated through wind turbines is clean but also intermittent power similar to solar. Whether wind projects pencil out is based on whether there is supportive policy, strong wind resources, or high electricity prices. Onshore wind has comparably similar total costs to solar (about $42 MWh, according to the National Renewable Energy Laboratory 2024 Cost of Wind Energy Review), while often generating more energy per unit of installed capacity. Because it has become so cheap, wind energy has been extremely promising in areas with strong wind resources across the country. Although UNC has published information highlighting the potential for offshore wind farms along the NC coast, the transmission to campus prevents offshore wind from being a feasible option for the university. The problem is similar for onshore wind as North Carolina's best wind resources are located in coastal counties and in the Appalachian mountains (WINDExchange, n.d.). While wind energy presents an intriguing possibility in the future as costs continue to fall, implementation should be left to the utilities. UNC can do its part by pushing Duke Energy to follow the NC Carbon Plan and build wind farms across our state. In doing so, this will lower electricity rates and lower the university's indirect electricity-related emissions.

Conclusion

In summary, solar (PV) is a promising clean option to power UNC's campus, including the electrode boilers if they are phased in. Because of solar's decreasing costs, it has demonstrated its feasibility through university projects, such as the solar array at Carolina North. Wind energy also holds potential, although the logistical challenges make solar energy a more direct solution for UNC. As technology continues to improve, the integration of these renewable sources into UNC's energy infrastructure will reduce operating costs and position the university as a leader in sustainability.

Financing Decarbonization Projects through the Inflation Reduction Act

While the University of North Carolina has addressed concerns about moving away from coal due to technological and financial restrictions, the Inflation Reduction Act (IRA) provides tools for covering clean technology expenses.

What is the Inflation Reduction Act?

In August of 2022, Congress passed the Inflation Reduction Act, more commonly referred to as the IRA. This legislation allocated $369 billion to programs aimed at helping build a cleaner energy economy and combating climate change (U.S. Department of Treasury, 2024). Most of this climate investment is delivered through several environmental tax incentives designed to encourage tax-exempt organizations to complete energy improvement projects.

Previously, tax incentive credits existed for renewable energy projects, however, were only beneficial for institutions with tax liabilities to offset (Hu, 2024). This ultimately excluded most public colleges and universities. To address the lack of incentives available, the IRA created a credit delivery mechanism called elective pay, otherwise known as "direct pay". Under direct pay, tax-exempt and governmental entities that do not owe federal income taxes can receive a payment equal to the full value of tax credits for building qualifying clean energy projects. The advantage of elective pay is that applicants are sure to get this payment if they meet the requirements, unlike more competitive grant and loan programs in which applicants may not receive an award. Direct pay provides a new opportunity for colleges and universities to take on decarbonization efforts and implement renewable energy projects on campus.

Eligible Tax Credits Under Direct Pay

The IRA includes about a dozen tax provisions that are eligible for "direct pay" which can be applied to a range of renewable projects. These projects consist of everything from electricity production through solar and wind sources to electric vehicle infrastructure. The IRA's provisions on clean energy focus on either *investment*, which is often more beneficial for smaller-scale projects, or *production*, which is more beneficial for larger-scale projects (Evergreen, n.d.).

Through the §48E Clean Electricity Investment Tax Credit, upfront costs of clean energy infrastructure installations are lowered. As this credit is technology neutral, it is also more flexible in terms of what power facilities it can be applied to, and it covers technologies including solar, geothermal, small wind, and energy storage. This credit covers up to 6% of the project's total value, with the potential to increase to 30% if it generates 1 megawatt-hour or less of clean power and complies with prevailing wage and apprenticeship requirements (U.S Department of Treasury, n.d.).

Through the §48E Clean Electricity Production Tax Credit, credits are provided based on the amount of energy a system produces in kilowatt hours and can be claimed annually for the first ten years that a project operates. Its credit amount starts at 0.55 cents per kilowatt hour and can reach up to 2.75 cents if prevailing wage and apprenticeship requirements are met (U.S Department of Treasury, n.d.). This credit works to incentivize districts to generate as much clean energy as possible through projects including solar, wind, and geothermal facilities, small irrigation, and certain landfill and trash energy facilities.

Additionally, both credits are eligible for location bonuses if projects reside in low-income communities or energy communities, both of which apply to UNC-Chapel Hill. The low-income communities bonus credit program provides a 10% increase on the base investment credit for qualified facilities that have a maximum net output of less than five megawatts. An additional 10% would be added if domestic content requirements are met. This ultimately means that a certain percentage of materials, including steel and iron from an applicable project, would have to be manufactured in the United States (Department of Treasury, n.d.).

Although electrode boiler technology itself is not covered through these credits, there is ample opportunity for UNC to invest in solar or geothermal projects. Geothermal energy infrastructure could be implemented into UNC's plans of Carolina North, a newly planned research and mixed-use campus, or the renovation and possible reconstruction of Dean Smith Center, UNC's multi-purpose arena. While geothermal is not explicitly covered beyond its mention in this section, we hope to research it more in the future.

Implementation of IRA in other Universities

Currently, the University of California at Berkeley is on track to replace its natural gas fueled cogeneration plant which provides approximately 90% of electricity and 100% of the steam needs on campus, in contrast to UNC, where cogeneration only accounts for 13% of electricity (University of California, Berkeley, n.d.). By 2028, the campus plans to have a fully functional clean energy grid that includes a central heating and cooling plant, thermal storage enhanced by geothermal exchange wells, photovoltaic systems, battery storage, and many other renewable sources (Fisher, McGarrahan, & Stoll, 2023). U.C Associate Director of Renewable Energy Sam Schabacker comments that the U.C system has been able to mold its decarbonization planning efforts to benefit from the IRA credits (Hu, 2024). In addition to ambitious U.C systems, Dartmouth College has set out to replace their aging fossil-fueled steam-heating plant with a geo-exchange system (Boutwell, 2024). To fund this transition, Dartmouth representatives are looking closely at how they can take advantage of these credits as their decarbonization program aligns well with the IRA.

What Comes Next

While there may be a risk the new Trump administration could undermine these tax benefits, it is unlikely that they will be fully repealed. These tax credits are protected by statute and cannot be eliminated by executive orders unless Congress overturns the law. This is unlikely as these tax credits have growing bipartisan support and are achieving key bipartisan priorities like restoring manufacturing and jobs and reducing our reliance on foreign energy sources. In addition, 84% of all IRA funds have already been "obligated" or signed off between federal agencies and clean energy companies (Gardner, 2025).

Most IRA tax credits are scheduled to expire in 2032; therefore, it is crucial that we take advantage of this opportunity and advance our climate action plan while there is still time. Identifying the renewable projects, aligning them with the corresponding credits, and devising a clear and specific climate action plan will be crucial in ensuring that we fully leverage the funding provided.

Conclusion

UNC must declare a new plan for the replacement of its coal plant. Not only does this plan need transparent research and financial assessments to guide decision making, but the Chapel Hill-Carrboro community should be involved in the process. Once this plan is made, it should be disclosed to the public, and a timely schedule must be provided in order for community members to keep the University accountable. How UNC plans to deal with the coal ash should be a cornerstone piece of this plan. Its cleanup and containment must be safe and just for Chapel Hill, but also for South Boston, Virginia, the community the university has played an active role in polluting.

In the past, UNC has shared that immediate and timely plans for replacing the coal plant (beyond burning Convergen's dangerous plastic pellets) are not on the board. Our university has declared such plans infeasible, but the only limitation stopping the university from taking these steps is the university itself. Claims of lack of funding are excuses and attempts to delay the inevitable. UNC must put resources and funding towards research on clean, long-term solutions. Electrode boilers are the primary route that we encourage UNC to pursue as it is the fastest option to replace the coal plant. If UNC provided research that suggested another zero emissions alternative is more efficient, cost-effective, or feasible to implement within the next 5-10 years, we would also get behind that proposal.

Continuing to burn coal and natural gas or choosing to greenwash UNC by burning plastic PFA-filled pellets are both bad options. **UNC's inaction opposes all public universities' missions to serve the public as both options will continue to harm the community and students from across the state.** Among the oldest universities in the United States, UNC Chapel Hill should have the prestige, means, and connections to support this transition and serve as the face of environmental activism in our state and nation.

To this end, we demand that UNC stop burning fossil fuels, properly dispose of coal ash instead of dumping it in other communities, and transition to a clean energy source. This means rejecting proposals to burn other harmful materials such as plastic pellets and considering new innovative solutions, including ones that aren't explored in this report. We firmly stand on the side of reducing air pollution to stop contributing to the climate crisis and to promote health and well-being for residents of Chapel Hill.

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