The Future of New Mexico's Coal-Fired Power Plants: Two Approaches to Carbon Sequestration

Following a global trend away from coal as a source of energy production, by 2020, it was announced that all three of New Mexico's coal-fired power plants (CFPPs) were scheduled for retirement in the near future. Potential new owners of two of those CFPPs – the San Juan Generating Station and the Escalante Power Plant – hope to retrofit the facilities with carbon capture technology to allow for continued electricity generation with a reduced environmental impact.

Because these power plants and captive coal mines have long been economic drivers for the northwest quadrant of the state, the proposals have gained some support as a means of maintaining, or at least minimizing the negative impact on, employment and local tax revenues. At the same time, concerns remain about the efficacy, financial viability, and environmental impact of still-developing carbon capture technology.

Carbon Sequestration: What Is It and How Does It Work?

Carbon sequestration, also called carbon capture or carbon capture, utilization, and storage (CCUS), is the process of capturing and reusing or storing carbon dioxide to prevent its release into the atmosphere. Carbon dioxide may be captured from industrial and energy-related sources, such as steel production and electricity generation, before escaping the facilities and can either be used for commercial purposes or stored. The two main types of sequestration are geologic and biologic; proposals to implement CCUS in New Mexico would use geologic sequestration – the injection of carbon dioxide into deep subsurface rock formations for long-term storage.

Carbon capture systems also fall into one of two technology areas: post-combustion or pre-combustion. In a post-combustion capture system, carbon dioxide is captured from a flue (combustion exhaust) gas generated by burning a carbon-based fuel, such as coal or natural gas. Post-combustion carbon capture is a method of reducing the carbon dioxide emissions of conventional fossil fuel power plants, the source of more than 60 percent of the electricity generated in the United States today.

Pre-combustion carbon capture removes carbon dioxide from fossil fuels to create a synthesis gas ("syngas") that can be converted into a clean energy source. Rather than burning fossil fuels and attempting to separate carbon dioxide from the resulting flue gas, a carbon-based fuel is reacted with steam and oxygen to form syngas, which undergoes a subsequent reaction to produce hydrogen and carbon dioxide. The carbon dioxide is sequestered and the hydrogen can be used as fuel for energy production that produces no greenhouse gas emissions. According to the National Energy Technology Laboratory, pre-combustion carbon capture is typically more efficient than post-combustion capture because the concentration of carbon dioxide produced through the syngas reaction is higher than that of the flue gas generated by fossil fuel combustion.[i]

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PURPOSE OF HEARING: Presentation of key issues surrounding plans for carbon sequestration projects and coal-fired power plants in New Mexico.

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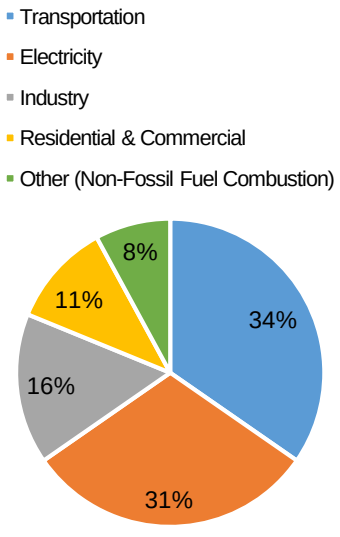
US Carbon Dioxide Emissions, by Economic Sector



Source: US Environmental Protection Agency (2021). Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2019

Potential Benefits and Remaining Challenges. CCUS has the potential to greatly reduce atmospheric carbon dioxide, and the United Nations' Intergovernmental Panel on Climate Change (IPCC) identified it as a necessary component to limiting global temperature increases to 2.7 degrees Fahrenheit by 2100. But large-scale CCUS projects have not yet been attempted, and the cost of implementation, as well as additional research and development that is still needed, may be limiting factors. Analysts at the Institute for Energy Economics and Financial Analysis (IEEFA), an Ohio-based think tank that conducts research on global energy markets and policies, wrote in a recent report that post-combustion carbon capture technology has not yet been proven successful: one of just two CFPP carbon capture projects in the world shut down in 2020 after suffering intractable mechanical problems that caused it to fall short of its carbon capture target by about 17 percent.[ii]

The ultimate goal in carbon sequestration technology, and another essential piece of the IPCC's plan to prevent global warming from exceeding 2.7 degrees, is the ability to remove existing atmospheric carbon dioxide from ambient air via a process called direct air capture (DAC). DAC would have a much more significant environmental benefit than either pre- or post-combustion capture, but advancements are needed to make the technology effective and cost-efficient. Furthermore, despite the potential of carbon sequestration technology to mitigate emissions from conventional energy generation and manufacturing sources, the development and implementation of CCUS means a continued reliance on fossil fuels, possibly at the expense of further investment in renewable energy sources.

Key Terms and Acronyms

CFPPs: Coal-fired power plants

Carbon sequestration or capture: the process of capturing and reusing or storing carbon dioxide (CO_2) to prevent it from entering the atmosphere; sometimes abbreviated **CCUS** for carbon capture, utilization, and storage

Post-combustion capture: the removal of CO_2 from the combustion exhaust, or flue, gas produced when fossil fuels are burned

Pre-combustion capture: the removal of CO_2 from fossil fuels through gasification rather than combustion; produces hydrogen, a low-carbon fuel option for transportation, electricity generation, and manufacturing applications, among other traditional uses

Hydrogen: a zero-carbon fuel that can store and deliver usable energy; does not typically exist by itself in nature and must be produced from compounds that contain it, such as coal or natural gas

Blue hydrogen: hydrogen derived from methane through a process called steam-methane reformation, in which high-temperature steam reacts with methane in the presence of a catalyst to produce hydrogen, carbon monoxide, and CO_2, which is removed and sequestered

Green hydrogen: hydrogen produced by using renewable electricity to split water into oxygen and hydrogen (a process called electrolysis)

Continuing with Coal or Heading towards Hydrogen: Two Proposals for Carbon Capture in New Mexico

Post-Combustion Carbon Capture at the San Juan Generating Station. After Public Service Company of New Mexico (PNM) announced its intent to close the San Juan Generating Station (SJGS) in 2019, Enchant Energy Corporation and the City of Farmington announced a partnership to acquire the plant, retrofit it with carbon capture and sequestration technology, and keep it operational as a CFPP. The retirement of SJGS was estimated to result in the loss of more than 1,500 jobs and $53 million in state and local annual tax revenue.[iii] In a 2019 presentation on the proposal, Enchant Energy estimated the retrofit and extended life of SJGS would preserve 458 direct jobs, at least 1,000 indirect jobs, and approximately $8 million annually in local tax revenue.[iv] Continued operation of SJGS as a CFPP is also expected to keep utility rates low and stable.

Enchant's original plan was to begin construction for CCUS capability at SJGS at the beginning of 2021 and have the plant and carbon capture technology operational by January 2023.[v] However, the expected start of construction has been pushed back to mid-2022 at the earliest, and Enchant reports it intends to begin operations at SJGS at that time without CCUS in place. In a recent presentation to the interim Water and Natural Resources Committee, Enchant stated it plans to operate the plant without carbon capture for two and a half years.

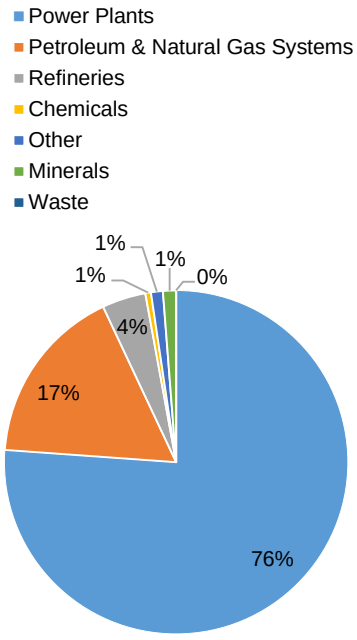
Doubts remain that Enchant will be able to effectively sequester the carbon emissions even when CCUS is implemented. The recently closed Petra Nova plant near Houston, Texas, the only other CFPP carbon capture project in the United States, had a generation capacity of 240 megawatts (MW). At 847 MW generation capacity, SJGS is more than three times the size. Enchant also plans to use the same carbon capture technology from Mitsubishi Heavy Industries America that

was used at Petra Nova. Including the emissions from the combustion turbine needed to power the CCUS systems, Mitsubishi's technology only achieved a carbon capture rate of about 60 percent.[vi]

Additionally, the funding needed to convert the plant, roughly $1.5 billion, has not been fully secured, despite Enchant's expectation to meet that goal by the end of 2020. The company is now applying for loans from the US Department of Energy (DOE) and Department of Agriculture to supplement investor financing that is still being pursued. The IEEFA analysis of Enchant's progress warned that relying on funding from DOE would likely delay the SJGS conversion further, based on the amount of time it took DOE to approve funds for the Petra Nova facility, a much smaller and less expensive project.[vii] The paper also raised the possibility that DOE may not be interested in supporting this type of project, quoting an agency official who recently said, "It's clear that carbon capture may not make economic sense on the remaining existing fleet of coal-fired power plants in the United States," in part because many CFPPs are already within a few years of retirement.

Pre-Combustion Carbon Capture at the Escalante Power Plant. Wholesale power supply cooperative Tri-State Generation and Transmission Association, Inc., announced the retirement of the Escalante Power Plant in 2020. Newpoint Gas, LLC – a multi-fuels processing, conversion, and purification company – partnered with Brooks Energy – a natural gas and helium exploration company – to create Escalante H_2 Power, an initiative to combine pre-combustion carbon capture with geologic sequestration to transform the Escalante CFPP into a hydrogen-fired power plant. Escalante H_2 Power announced its intent to purchase the Escalante plant from Tri-State in April 2021 and plans to convert the natural gas easily accessed from the site into "blue hydrogen."

NM Carbon Dioxide Emissions, by Source



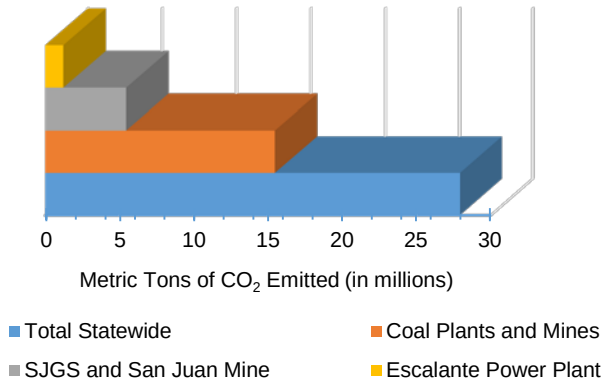
Source: US Environmental Protection Agency (2020). Facility Level Information on Greenhouse Gases

Power plants account for three-quarters of New Mexico's total carbon dioxide (CO_2) emissions. Of the 21.2 million metric tons of CO_2 emitted by power plants in 2019, 73 percent came from CFPPs. Overall, coal plants and mines contribute more than half of the state's total CO_2 emissions. The chart below shows CO_2 emissions from the Escalante and San Juan plants relative to all coal plant/mine emissions, as well as to total CO_2 emissions statewide.

Blue hydrogen is derived from methane (the primary component of natural gas) through a pre-combustion carbon capture process called steam-methane reformation. In this process, high-temperature steam reacts with methane in the presence of a catalyst to produce hydrogen, carbon monoxide, and carbon dioxide, which is removed and sequestered, leaving hydrogen to be used as fuel. When hydrogen is combusted, it emits only water vapor, and is therefore a zero-emissions source of power generation. The founders of Escalante H_2 believe their hydrogen production technology "has the capacity to merge the low environmental impact of renewable power with the reliable dispatchable power generation of a fossil fueled power plant."[viii]

Hydrogen production via natural gas reforming without the use of carbon capture is an established technology responsible for most of the hydrogen production in the United States. It is also capable of reaching the DOE's cost targets of $2/kilogram (kg) by 2025 and $1/kg by 2030. But DOE's goal is to reduce the cost of hydrogen through net-zero-carbon pathways, and the agency supports research and development of hydrogen production technologies to that effect. Blue hydrogen production at the Escalante Power Plant would not be carbon-neutral due to the production and transportation of natural gas needed for steam-methane reforming. However,

NM Carbon Dioxide Emissions: Coal Breakout



Source: US Environmental Protection Agency (2020). Facility Level Information on Greenhouse Gases Tool.

Escalante H_2 asserts the retrofitted facility will emit a lower volume of greenhouse gases than both the previous CFPP and a conventional natural gas power plant.

The carbon dioxide that would be separated from natural gas at Escalante would either be sequestered underground or used in other manufacturing operations. According to a study published in the academic journal *Sustainable Energy & Fuels*, the climate change impact of this type of hydrogen production that incorporates carbon sequestration is comparable to renewable electricity-based, or "green," hydrogen.[ix] Escalante H_2 intends to eventually transition from blue to green hydrogen production, eliminating the need for natural gas and instead using water electrolysis to create hydrogen.

Conversion of the Escalante Power Plant will include construction of a three-mile pipeline to transport natural gas to the plant and a sequestration well to store the captured carbon in the underground reservoir at the site. Newpoint Gas estimates the hydrogen production facility will take about 18 months to complete, while air quality and sequestration well permitting will require an additional 12 to 18 months. The company projects the creation of approximately 300 construction jobs during the retrofit and retention of up to 110 jobs from the retired CFPP for ongoing operations and maintenance.

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[i] National Energy Technology Laboratory, US Department of Energy. n.d. *Pre-Combustion CO2 Capture.* https://www.netl.doe.gov/coal/carbon-capture/pre-combustion.

[ii] Groom, Nichola. 2020. *Problems plagued U.S. CO2 capture project before shutdown: document.* August 6. https://www.reuters.com/article/us-usa-energy-carbon-capture/problems-plagued-u-s-co2-capture-project-before-shutdown-document-idUSKCN2523K8.

[iii] Chacón, Daniel J. 2021. *Carbon-capture project generates support, skepticism among New Mexico lawmakers.* July 13. https://www.santafenewmexican.com/news/local_news/carbon-capture-project-generates-support-skepticism-among-new-mexico-lawmakers/article_8dfcd960-e3ec-11eb-851d-ef8590cfc5c2.html#tncms-source=login.

[iv] Mandelstam, Peter. 2019. "Carbon Capture Utilization and Storage: Project Summary." *Enchant Energy Presentation.* December 17.

[v] *Ibid.*

[vi] Schlissel, David. 2021. "Where's the Beef? Enchant's San Juan Generating Station CCS Retrofit Remains Behind Schedule, Financially Unviable." Institute for Energy Economics and Financial Analysis.

[vii] *Ibid.*

[viii] Electric Energy Online. 2021. *Clean energy project proposed for retired New Mexico coal-fired power plant.* April 15. https://electricenergyonline.com/article/energy/category/biofuel/83/892891/clean-energy-project-proposed-for-retired-new-mexico-coal-fired-power-plant-.html.

[ix] Antonini, Cristina, Karin Treyer, Anne Streb, Mijndert van der Spek, Christian Bauer, and Marco Mazzotti. 2020. "Hydrogen production from natural gas and biomethane with carbon capture and storage – A techno-environmental analysis." *Sustainable Energy & Fuels.*