Jupiter Oxygen Corporation
Dave Johnston Power Plant Unit 2

CARBON CAPTURE UTILIZATION & STORAGE PROJECT

FRONT END ENGINEERING DESIGN STUDY

EXECUTIVE SUMMARY

July 2021

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Jupiter Oxygen Corporation (JOC) is proposing the installation of their patented fossil fuel combustion technology in conjunction with carbon dioxide (CO_2) capture at PacifiCorp's Dave Johnston Unit 2 (DJ2), a 112-MW coal-fired unit located in Glenrock, Wyoming (the "Project"). JOC's patented technology uses a high flame temperature design to combust coal in a high purity (>95%) oxygen environment in place of ambient air. This process known as "oxy-combustion" eliminates airborne nitrogen from the combustion process. Nitrogen, which represents the majority of ambient air, uses energy during combustion, reducing the overall efficiency of the combustion process and the amount of energy available to make steam. Oxy-combustion yields far fewer pollutants, less overall emissions, and simplifies the CO_2 capture process by producing a higher CO_2 concentration in the resulting flue gas. For the proposed CO_2 capture utilization and storage (CCUS) retrofit at DJ2, the highly concentrated CO_2 flue gas will be treated and compressed to deliver a suitable CO_2 stream to a nearby oil field for enhanced oil recovery (EOR) and/or geologic storage.

The Project is designed to capture 97% of the CO_2 emitted from the DJ2 boiler that will be purified, compressed, and sold to nearby oil fields under a long-term CO_2-offtake agreement. The Project will utilize §45Q tax credits to further enhance funding and economic considerations. The retrofitted boiler design will also provide the ability to run on air-firing for periods when the CO_2 purification unit (CPU), CO_2 pipeline, and/or oil field is offline. An added benefit of the Project is that post-retrofit nitrogen oxide (NOx) emissions will be significantly reduced without the need for post-combustion NOx emissions controls such as selective catalytic reduction (SCR). Water captured from the flue gas within the direct contact cooler polishing scrubber (DCCPS) and introduced into the cooling water cycle reduces the need for makeup water taken from the North Platte River. As DJ2 only has an existing electrostatic precipitator (ESP) for particulate matter (PM) control and activated carbon injection (ACI) for mercury control, implementation of oxy-combustion CCUS with an integrated wet flue gas desulfurization (WFGD)/DCCPS would significantly reduce the DJ2 emissions. Oxy-combustion technology is uniquely qualified to be implemented at DJ2 compared to post-combustion CCUS technology which has been proven to be uneconomical for units of comparable size to DJ2.

This report and the appendices document the Phase II Front-End-Engineering-Design (FEED) Study for the Project, which is a continuation of the Phase I Feasibility Study completed in May 2019. The FEED Study documents the preliminary engineering and design of the various process and balance-of-plant (BOP) components, which are the basis of the Project cost estimate and schedule development. The results of the FEED Study validate the Project's technical viability. Phase III of the Project, currently scheduled to begin Q4 of 2021, will include detailed engineering, permitting, procurement, and construction as laid out in the Project schedule.

The Project will consist of the following major process equipment: an air separation unit (ASU) to generate oxygen for the combustion process, replacement of the existing DJ2 burners to support oxy-combustion, replacement of the existing forced draft (FD) fans with flue gas recirculation (FGR) fans, a waste heat recovery heat exchanger to increase plant efficiency by introducing waste heat into the steam cycle, an induced draft (ID) booster fan, an integrated WFGD/DCCPS for sulfur dioxide (SO_2) removal, flue gas cooling, and moisture control, a CPU booster fan, a flue gas filter for fine particulate matter (PM) removal, a CPU for flue gas purification, a CO_2 compressor to condition and transport the purified CO_2 to the oil field and/or geologic storage facility, water treatment for the supply of process water to the WFGD/DCCPS and a new cooling tower. The overall process schematic for the DJ2 retrofit, identifying new and modified equipment, is shown in Figure ES-1. A 3D rendering of the new equipment integrated at DJ2 is depicted in Figure ES-2.

Figure ES-1. Overall Process Schematic

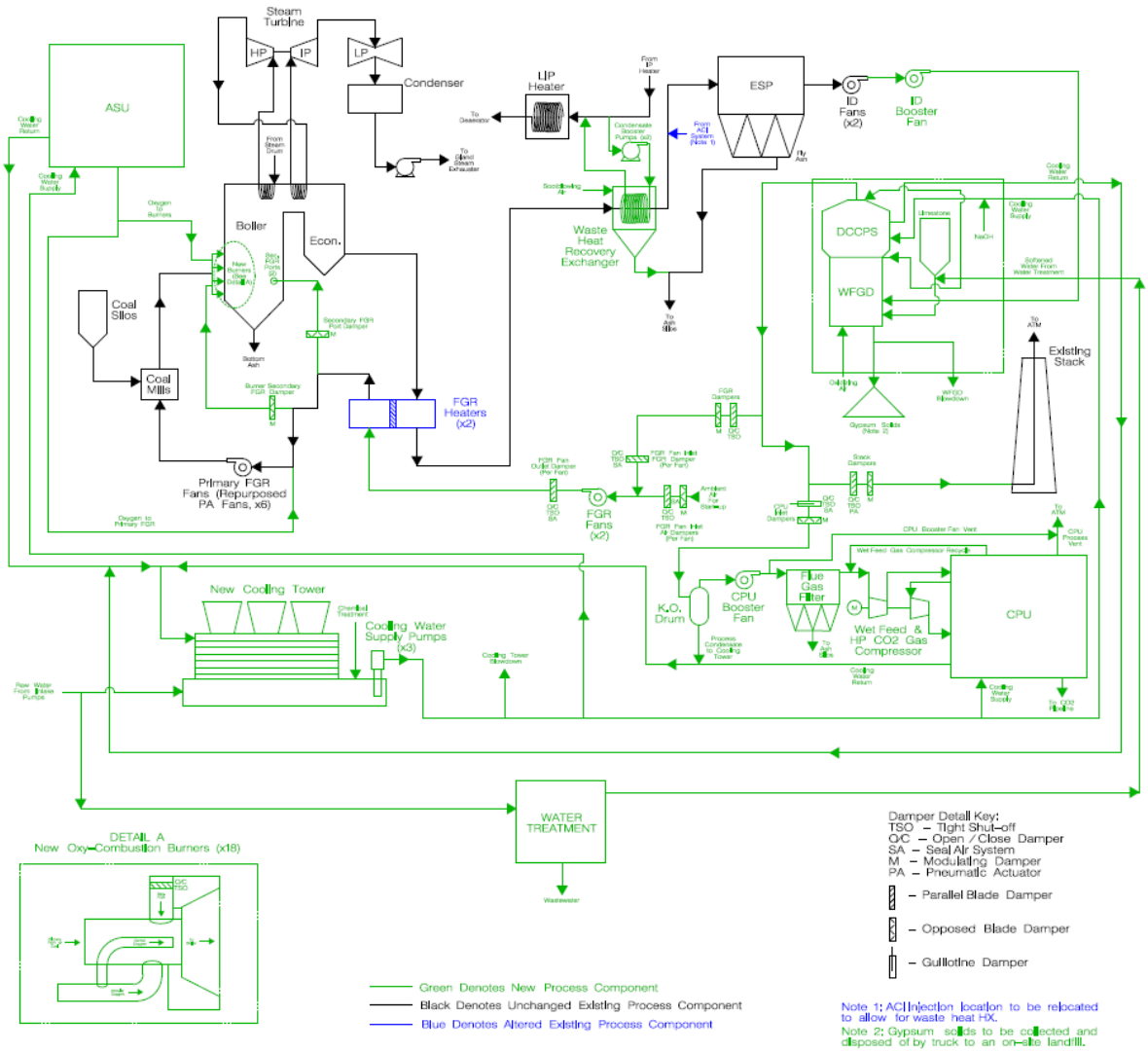
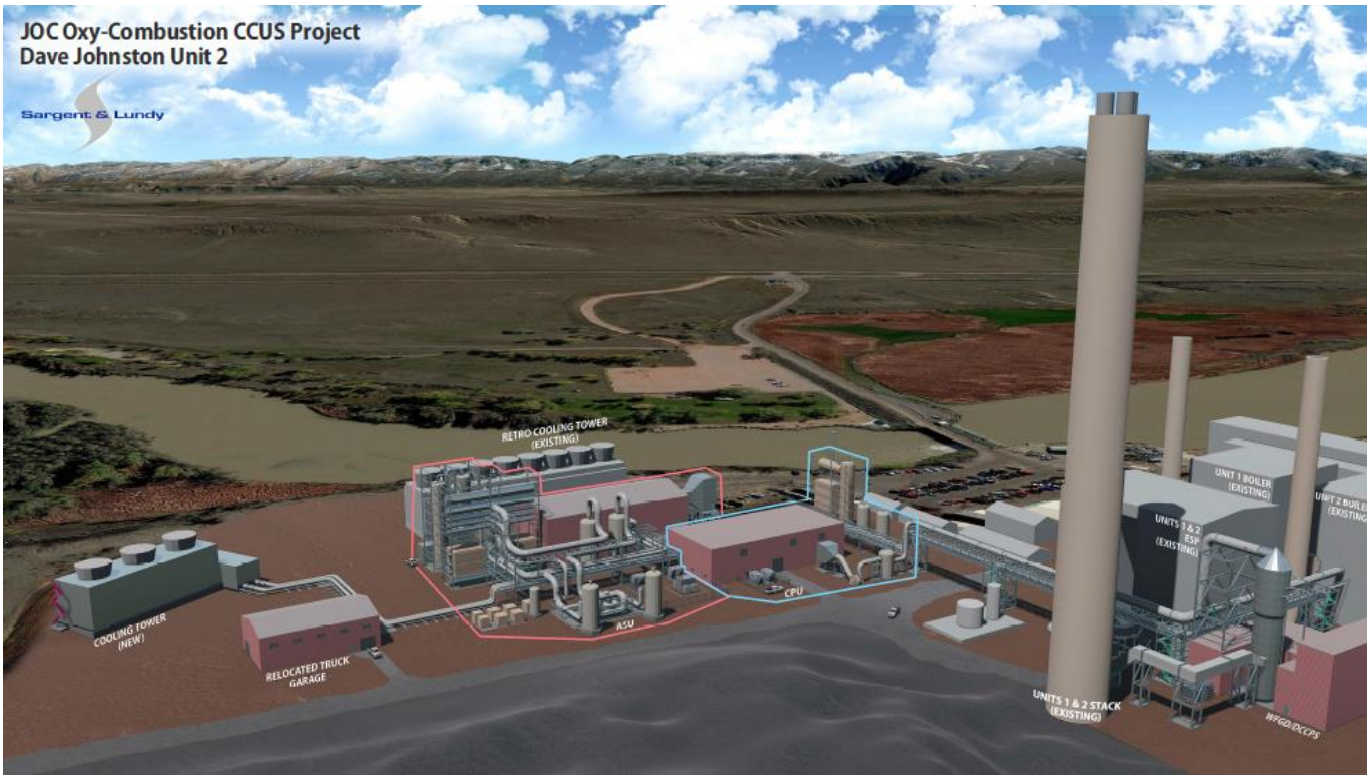


Figure ES-2. Project 3D Rendering



JOC is pursuing project development of commercial-scale CCUS project opportunities domestically and internationally. Wyoming offers a strategic, favorable opportunity given the State of Wyoming's focus on deploying CCUS for the existing coal fleet as a means to address emissions, incrementally increasing oil production and associated revenues, and further enhancing economic development through capital investment and job creation. The Wyoming Governor's office has taken proactive steps to help facilitate commercial-scale CCUS project development through streamlined permitting initiatives, enactment of HB200 and SF159, the Wyoming Pipeline Corridor Initiative, and commitment to enhance energy production. Another key factor is that there is a vital CO_2 off-take market in Wyoming with extensive CO_2–EOR and CO_2 geologic storage expertise and CO_2 transportation infrastructure development being further pursued through the Wyoming Pipeline Corridor Initiative. The Dave Johnston Station, in particular, is in close proximity to CO_2 pipelines that can be used for transportation. These initiatives have garnered positive public perceptions for CCUS technology for the existing coal fleet, potentially allowing for continued coal-fired operations well into the future. For DJ2, this would mean extending the unit life well beyond the current planned shutdown of 2027. Wyoming's CCUS initiatives and strong support for constructing a CCUS project are key drivers for the Project, which will not only benefit PacifiCorp and the state, but many other coal-fired plants domestically and internationally.

The capital cost developed for the Project includes all major components necessary for the implementation of the oxy-combustion and CO_2 capture processes as well as all BOP equipment and plant integration. As many coal-fired power plants are already equipped with FGD systems, the cost summary was provided both with and without the WFGD/DCCPS and associated equipment for cost comparison.

As the Project would include "over the fence" operations for the integration of or dependence upon CO_2 pipelines and oil field and/or geologic storage operations, as well as pursue equity financing via the §45Q tax credits, the Project could be arranged through a variety of partnership deal structures. For the economic analysis, it was assumed that the Project would be arranged such that the utility would maintain ownership of the power unit, the oil field, geologic storage facility, and possibly the CO_2 pipeline would be owned by the CO_2 offtake partner.

The §45Q tax credit treatment, government support, and sales and use tax waivers have a high potential to offset Project costs. Given the presence of motivated CO_2 off takers and the availability of §45Q tax credits, there are a number of plant and operational designs that would allow CO_2 to be sequestered while satisfying the return requirements of investors. Thus, making the Project, arranged in the partnership deal structure outlined above, economically viable.