

# PETRA NOVA - THE FUTURE CAPTURED

AMID INCREASING CONCERNS OVER CLIMATE CHANGE AND GLOBAL WARMING AROUND THE WORLD, THE PETRA NOVA CARBON CAPTURE AND STORAGE/SEQUESTRATION (CCS) PROJECT ACHIEVED FINANCIAL CLOSE ON AUGUST 1 2014 FOR WHAT WILL BE, WHEN COMPLETED, THE WORLD'S LARGEST IMPLEMENTATION OF POST-COMBUSTION CARBON CAPTURE TECHNOLOGY ON AN EXISTING COAL-FIRED POWER PLANT.

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CCS projects consist of capturing waste carbon dioxide (CO<sub>2</sub>) from large point sources and transporting it to a storage site (often in an underground geological formation or deep in the ocean) and depositing it where it will remain outside of the atmosphere. The Petra Nova project is sponsored by NRG Energy Inc and JX Nippon Oil & Gas Exploration of Japan and will seek to remove CO<sub>2</sub> emitted from a coal-fired power unit at NRG's WA Parish facility at Fort Bend County, Texas, US and inject the captured CO<sub>2</sub> into an oilfield as part of an enhanced oil recovery (EOR) operation.

The project, when completed, is expected to be the world's largest implementation of post-combustion carbon-capture technology on an existing coal-fired power plant. It is unique in that it will reduce CO<sub>2</sub> emission at a coal-fired power plant while utilising the captured CO<sub>2</sub> to boost oil production at a nearby legacy oilfield. The project is expected to capture at least 90% of the CO<sub>2</sub> (or approximately 1.6m tons of CO<sub>2</sub> annually) emitted from a flue gas stream (equivalent to 240MW in size) of a 650MW coal-fired generating unit at NRG's WA Parish facility – the largest fossil-fueled generation facility in the US.

The captured CO<sub>2</sub> will be transported via an 82-mile pipeline to a nearby oilfield where it will be injected into the ground as part of an EOR operation, where it is expected to boost oil production from approximately 500 barrels per day to approximately 15,000 barrels per day. The project creates an innovative "win-win" outcome in that the project will help to reduce carbon emission (which is harmful to the environment) at a key generation facility while displacing oil that the US may otherwise have to import.

The Petra Nova project is one of the CCS projects to request a grant under the US Department of Energy's "Clean Coal Power Initiative" programme and it will be the first commercial-scale post-combustion carbon capture project in the US. Its success will demonstrate the commercial feasibility of retrofitting an existing coal-fired power plant with a commercial-scale carbon capture system and encourage more financing of similar projects in the US and around the world.

CCS projects are often hampered by large capital costs with insufficient revenue support but the Petra Nova project is noteworthy in that by structuring and combining an EOR component as part of the overall project (and taking a direct interest in the EOR operations), it creates additional revenue sources (such as the oil sales proceeds, in addition to the CO<sub>2</sub> sales) to support and improve the economic feasibility of the project.

Amid increasing concerns over climate change and global warming and under increasingly stricter emission standards, the project also provides a crucial potential path forward for coal-fired power plants (one of the largest emitters of CO<sub>2</sub> in the world and which are expected to remain a substantial part of the energy portfolio in the US and internationally) to continue energy production while meeting higher environmental standards.

## Project summary

The Petra Nova project consists of (a) retrofitting an existing power plant at NRG's WA Parish facility, and (b) the construction of (i) a 78MW natural gas-fired cogeneration facility that will supply electricity and steam to the CCS facility, (ii) the CCS facility, (iii) an 82-mile CO<sub>2</sub> pipeline, and (iv) related infrastructure and modification of the West Ranch oilfield in Jackson County, Texas for EOR operations.

The project initially pursued smaller-scale CCS plans at the WA Parish facility but later expanded to its current form to accommodate the need for larger volumes of CO<sub>2</sub> required for the EOR operations. Total cost of the project is approximately US\$1bn. Around 45MW of electricity to be generated by the 78MW

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cogeneration facility will be prioritised for the operation of the CCS facility with remaining mega-watts to be sold into the grid to create additional cashflow to support the project. While the operation of the 78MW cogeneration facility will give rise to some carbon emission, the project is still expected to result in significant net carbon reduction (approximately 815,000 tons of carbon per year).

#### **CCS component**

There are different types of CCS technology available and the Petra Nova project will use a CO<sub>2</sub> recovery technology called the KM-CDR process that is jointly developed by Mitsubishi Heavy Industries and the Kansai Electric Power Company of Japan, which has the largest and longest running CCS technology research programme in the world. According to Business Wire, Mitsubishi Heavy Industries leads the CCS industry globally with a record of having installed 10 natural gas-fired CO<sub>2</sub> capture facilities currently in operation, plus one under construction, for chemical plant applications<sup>1</sup>.

The CCS technology for the project uses a solvent called KS-1, which is specially formulated for low cost and low energy-consuming CO<sub>2</sub> absorption and desorption processes. During the carbon capture process, a portion of the flue gas, which has already been treated to reduce nitrogen oxides (NOx) and sulfur dioxide (SO<sub>2</sub>), from the WA Parish unit will be diverted from the existing stack to the CO<sub>2</sub> capture system, where it will be cooled (as the absorption of CO<sub>2</sub> is favored at lower temperatures) and for further SO<sub>2</sub> removal.

The treated flue gas will then be routed to an absorber, where, through chemical reaction, the CO<sub>2</sub> in the flue gas will be captured by the solvent and the carbon-free clean flue gas (which is expected to be among the cleanest fossil fuel emission in the world) is then released into the atmosphere. The CO<sub>2</sub> rich solvent stream is then separated from the CO<sub>2</sub> using low-pressure steam and the CO<sub>2</sub>-stripped solvent will be recycled to be used for further carbon capture processes.

The captured CO<sub>2</sub> is then compressed and transported via an 82-mile pipeline to the West Ranch oilfield, where it will be injected into the ground for EOR operations. The project represents the first time that such CCS technology has been sold/licensed on a project-finance basis.

The construction of the CCS facility itself will be undertaken by a consortium consisting of The Industrial Company and Mitsubishi Heavy Industries Americas Inc. The CCS facility will be located next to the coal-fired power unit that will provide the flue gas at NRG's WA Parish facility. Construction began in September 2014 and is expected to take approximately two years, with commercial operation targeted in late 2016.

#### **EOR component**

CO<sub>2</sub> injection is a proven technique in tertiary oil recovery and was reportedly first used in large

scale in Scurry Country, Texas in 1972. Generally, EOR operation involves the injection of gas or solvents into the oil reservoir to change the character of the crude oil, usually to lower its viscosity, or resistance to flow. In the case of CO<sub>2</sub>, typically, the CO<sub>2</sub> dissolves in the oil, reducing its viscosity and enabling more oil to flow to the well bore for recovery.

Such processes make it possible to recover oil that could not otherwise be recovered during the primary and secondary phases of oil production. Typically, primary and secondary production technology can produce 20%–40% of the “original oil in place”, yet if a field is amenable to EOR, a total of 30%–60% of the original oil in place can be recovered.

Historically, EOR operations that use CO<sub>2</sub> mostly use “natural” CO<sub>2</sub> produced from underground reservoirs; however, as CO<sub>2</sub>-EOR operations expand to locations where naturally occurring reservoirs are not available (and as existing reservoirs are being depleted), anthropogenic CO<sub>2</sub> from industrial applications such as natural gas processing plants or ammonia fertiliser or ethanol production plants can be used.

The Petra Nova project is pioneering as it is capable of supplying a large quantity of CO<sub>2</sub> for EOR operations along the Gulf Coast, a region of the US that, unlike the Permian Basin of West Texas and eastern New Mexico, does not have ready access to large quantities of CO<sub>2</sub>.

As noted above, coupling the EOR operation with the CCS process ensures the economic feasibility of the project. Unlike other CCS projects that sometimes rely on sales of CO<sub>2</sub> as the main source of revenue and where project sponsors often do not have an interest in the downstream EOR operation, NRG and JX Japan jointly own, through a project company, 50% of the West Ranch oilfield and will be able to benefit directly from the sale proceeds of the oil recovered from the EOR operations.

A portion of the US\$1bn project cost includes the costs of acquiring the project's interest in the West Ranch oilfield. Hilcorp Energy I LP, one of the largest privately-held independent oil and gas exploration and production companies in the US, owns the other 50% interest in the West Ranch oilfield.

The West Ranch oilfield has produced oil continuously through conventional production techniques since 1938 under a series of different owners and, in recent years, production rates have steadily declined. It is currently estimated to hold approximately 60m barrels of recoverable oil from EOR operations.

By injecting CO<sub>2</sub> piped from the WA Parish facility as part of the EOR operation, production at the West Ranch field is expected to increase from 500 barrels per day to approximately 15,000 barrels per day. Under the EOR operation, once the oil reaches the surface, it will enter a recycling facility where it is separated from the CO<sub>2</sub>, which will be re-injected into the wells for additional use.

In order to ensure that the CO<sub>2</sub> remains permanently sequestered underground, the project will, in co-operation with the US Department of Energy and the Bureau of Economic Geology at the University of Texas at Austin, develop a CO<sub>2</sub> monitoring programme to determine whether CO<sub>2</sub> or other fluids are migrating from the production formation in the planned EOR area. Hilcorp Energy Company, as the operator, will lead the process for preparing and modifying the field for EOR purposes and will be responsible for managing the EOR operations and the CO<sub>2</sub> monitoring programme at such field.

**Financing structure**

The total project cost of the project is approximately US\$1bn. The debt portion consists of a US\$250m multi-tranched project financing provided by the Japan Bank for International Cooperation and Mizuho Bank Ltd (in the case of Mizuho, backed by Nippon Export & Investment Insurance). The sponsors will each contribute around US\$300m of equity to fund the remaining project costs.

As noted above, the project also benefits from a US\$167m grant from the United States Department of Energy as part of its Clean Coal Power Initiative Program, a cost-shared collaboration between the US federal government and private industry. The project is the only CCS project sponsored under such program to have reached financial close.

**Conclusion**

There are other similar CCS/EOR projects at planning stages around the world – such as the Dongguan CCS/EOR project in China and the Bow City CCS/EOR project in Alberta, Canada. Similar but smaller than the Petra Nova project, the Boundary Dam CCS/EOR project in Saskatchewan, Canada recently completed construction in the last quarter of 2014. However, unlike the Petra Nova project, the Boundary Dam project will rely solely on sales of CO<sub>2</sub> and SO<sub>2</sub> to offset project costs<sup>2</sup>.

The successful financing of the project marks an important milestone for the CCS

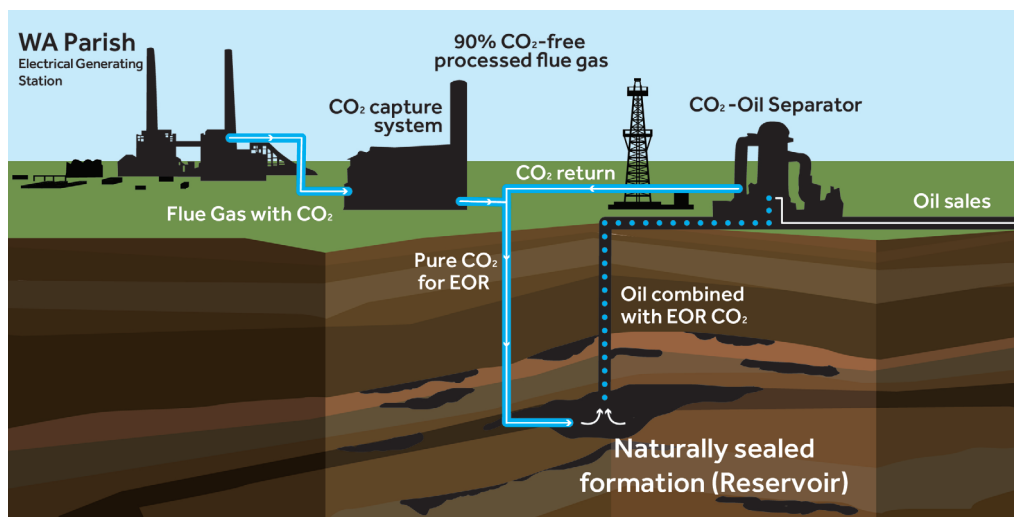
The project’s innovative approach of combining the CCS process with an ownership interest in EOR operations has enormous potential as a model

and the energy industries. If successful, it will demonstrate the commercial feasibility of large-scale post-combustion carbon capture projects and encourage more financial institutions to participate in the financing of similar projects.

The project’s innovative approach of combining the CCS process with an ownership interest in EOR operations has enormous potential as a model for other CCS/EOR projects around the world, especially for projects that are hampered by large capital costs with insufficient revenue streams. Amid increasing concerns over climate change and under stricter emission standards (such as US Environmental Protection Agency’s June 2014 decree regarding new carbon emission standards), the Petra Nova project may also provide an important model for coal-fired power plants on how to continue energy production while meeting stricter environmental standards. ■

**Footnotes**

- 1 – “World’s Largest Post-Combustion Carbon Capture-Enhanced Oil Recovery Project to be built by NRG Energy and JX Nippon Oil & Gas Exploration”, Business Wire, July 15 2014
- 2 – Construction of the Boundary Dam project was driven by federal regulations in Canada that will make coal-fired generation impossible without CCS. Without a similar regulatory regime, the only way the US will see CCS projects built is through CCS-EOR – so long as CCS’s CO<sub>2</sub> is competing with natural CO<sub>2</sub> or industrial CO<sub>2</sub>, it’s quite simply uneconomic without the oil revenues.



The CCS process