

BEFORE THE ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE PETITION)
TO ADOPT NEW REGULATIONS)
WITHIN 20.2 NMAC,) EIB No. 8-19 (R)
STATEWIDE AIR QUALITY REGULATIONS, TO)
REQUIRE GREENHOUSE GAS EMISSIONS REDUCTIONS)
NEW ENERGY ECONOMY, INC. PETITIONER)

REBUTTAL TESTIMONY OF GEORGE PERIDAS

My name is George Peridas and I will be rebutting the testimony of Douglas B. Price regarding the limited options for reducing or eliminating CO2 emissions from natural gas processing and oil refining. I am currently employed by Natural Resources Defense Council (NRDC) as a Scientist with NRDC’s Climate Center as summarized in Rebuttal Exhibit R42. My education and experience are described in detail in Rebuttal Exhibit R43.

Mr. Price’s testimony regarding the oil refining and natural gas processing side paints an incomplete picture about the available opportunities for emissions reductions, and their potential for positive economic impact for the industry. My testimony is intended to address Mr. Price’s claims and those of Darren Smith, regarding limitations to available technologies. There has been a lot of work done in reducing refinery emissions by the oil and gas industry that New Mexico Oil and Gas Association (NMOGA) experts fail to address, including at least one project that sequesters carbon that Devon Energy Corporation, itself, owns and operates¹.

Direct Reduction at Natural Gas Processing Plants

According to the DOE-EIA, CO2 emissions from natural gas processing in the U.S. amounted to 29.9 million metric tons in 2008, of which 20.8 are from CO2 in the gas, and the remaining 9.1 were due to flaring as reflected in Exhibit R44. These processing plants

¹ The Beaver Creek field in Wyoming.

incorporate CO₂ separation units, which produce pure CO₂ streams that are usually vented. The high purity of these streams makes them prime candidates for geologic sequestration and enhanced oil recovery at very little additional cost, since the CO₂ capture is already taking place for other commercial reasons. In New Mexico, there are currently projects that could directly reduce their CO₂ venting in this way. For example, the CO₂ in the enhanced coal bed methane production in Northeast NM has climbed from less than 8% CO₂ to greater than 12%. There is one particular plant (Val Verde) that has 50 mmcfpd (1 mm tons per year) of vent. While this is a good sized volume, it may not be enough for a new pipeline to the Permian Basin, but could be collected and connected to the Cortez line which passes only a few miles distant. There are a couple of other smaller gas plants in Northeast NM that might offer some decent volumes as well.

Natural gas processing plants strip the CO₂ that is naturally contained in produced natural gas (which can be as high as 65% in some cases) in order to get it to commercial pipeline and sales specifications (typically 2-4% CO₂ by volume). In other states, such as Wyoming, CO₂ from such plants (by Exxon) is being used for enhanced oil recovery (by Anadarko and others, including Devon).

New Mexico is no stranger to using or transporting this carbon dioxide, which is considered a valuable commodity in the oilfield and sells for respectable prices. Ironically, CO₂ is mined from sites where it occurs naturally in the subsurface to be used for enhanced oil recovery. One such production “dome” is in New Mexico itself – Bravo Dome. There is also the project McElmo Dome to Permian Basin Project. These are two large, dedicated pipelines that transport CO₂ from Colorado directly through New Mexico to supply CO₂ to oilfields in the Permian Basin. See attached Exhibit R45. The State of New Mexico and the industry, therefore,

are perfectly positioned and capable of expanding their CO₂ supplies from anthropogenic sources, transporting it and sequestering it in oilfields, with appropriate monitoring, reporting, verification and accounting regulations. New Mexico is already part of a large-scale enhanced oil recovery operation and infrastructure, which could develop further and aid in the sequestration of CO₂, and there is already at least one demonstration project in the area. See attached Exhibit R46.

Abatement Options for Oil Refineries from Energy Improvements and Industrial Cogeneration

The oil refining industry is the second largest CO₂ emitter in the U.S. industrial sector. The latest EIA estimate of U.S. oil refinery CO₂ emissions were 0.266 Gt in 2008 or about 4.8% of total U.S. CO₂ emissions. This includes indirect CO₂ from electricity which appears to be a much lower portion of the total than for bulk chemicals. Many oil refineries cogenerate most of their electricity needs. In addition, oil refinery electric power requirements are also relatively low per unit of energy or oil processed at only about 25-50 MWe per 100,000 bbl/d of crude oil feedstock.

Relative to European oil refineries, U.S. oil refineries have higher CO₂ emissions due to the processing of heavy crude oils and converting most of the vacuum residue to lighter distillates and petcoke. About 10-12% of the carbon in the crude oil feed ends up as mostly on-site CO₂ emissions and some as solid petcoke. Another roughly 2-3% of carbon (on a crude oil basis) comes from the use of natural gas to supplement refinery byproduct fuel gas for utilities, such as for fire heaters, furnaces, and hydrogen production. This natural gas addition avoids the need to utilize more valuable oil-derived liquids or more capital intensive petcoke for utilities.

The petcoke is generally exported abroad and combusted in large existing coal-fired power plants and cement kilns where it replaces some coal. The high sulfur and low volatility of

fuel grade petcoke generally favors blending with coal. If it had a high enough CO₂ avoidance value, the solid petcoke could be landfilled as secure storage and avoid its combustion to CO₂, which is accompanied by the release of high amounts of sulfur and NO_x. However, this type of carbon credit storage poses baseline issues, and potentially additional issues.

Their large size, location, and high hydrogen utilization of many U.S. oil refineries make them good targets in general for CCS, as we discuss later. The oil industry also has both the chemical process expertise for CO₂ capture and geologic expertise for CO₂ storage that are essential for successful CCS development—skills which are not currently yet established in the electric power industry.

There are many different processes and process configurations in oil refineries. Therefore, it is hard to make general statements about oil refinery CO₂ abatement options. Nevertheless, there are many opportunities for U.S. oil refineries reduce their emissions, starting with efficiency. ExxonMobil's most recent environmental performance report shows a 10 million ton decline from 2007 to 2008 in its CO₂ (equivalent) emissions while its oil production increased.² While about half of the decrease was due to oil/gas flare reductions, the other half was mainly due to improved energy efficiency and cogeneration in mostly its oil refinery and petrochemical operations.

In the U.S., most refinery hydrogen is made from natural gas in Steam Methane Reforming (SMR) designs utilizing pressure swing absorbers (PSAs), without a high purity CO₂ vent.³ One option would be to produce refinery hydrogen through petroleum coke gasification,

² "Reducing Greenhouse Gas Emissions from our Operations," ExxonMobil, January 5, 2010; www.exxonmobil.com/Corporate/energy_climate_ops.aspx.

³ M. Shah, D. Bonaquist, and J. Shine (Praxair), "Attributes of Existing Industrial Sources Part 2. Steam Methane Reformer Plants," A Part of the CEED CO₂ Shortcourse #13 entitled "CO₂ Sourcing for Enhanced Oil Recovery," Midland, Texas, December 6, 2006.

which would produce a pure CO₂ stream that can be captured and sequestered. In addition, there are other, lower capital cost process design options for producing refinery hydrogen from natural gas that can produce a high purity CO₂ vent, even without the need to switch to gasification. Commercial examples include autothermal reformers and heat exchange reformers. Praxair is also currently working on the use of a vacuum pressure swing absorber (VPSA) with cryogenic CO₂ clean-up, thereby creating lower cost CO₂ compression.⁴ This concept is designed to be retrofitted to current SMR designs. VPSA is already commercially used for CO₂ removal.

There are a number of other oil refinery processing modifications that could become commercially viable under a carbon price. After capturing CO₂ from hydrogen production, the second most interesting refinery CCS option is the oxyfuel combustion of existing Fluid Catalytic Cracking (FCC) units. This is generally one of the largest single CO₂ point sources in U.S. refineries due to its maximum gasoline yield. Slight oxygen enrichment of air-blown FCC combustion is already common to increase existing FCC capacity. Total oxyfuel combustion (with required CO₂ recycle) enables greater capacity uprating of existing FCC capacity by replacing all of the nitrogen in air combustions. Petrobras is doing research on this concept in their residual FCC pilot plant in Brazil as part of CCS development.⁵

The immense oil refinery-fired heaters can also be candidates for carbon capture using pre-, post-, or oxyfuel combustion techniques. Each option has its own attributes and promoters. Pre-combustion is discussed above in association with refinery hydrogen manufacturing but it could also be expanded to convert refinery fuel gas to a higher hydrogen content. Oxyfuel combustion avoids the complex chemical processes of pre-combustion techniques, but requires

⁴ "Texas City Industrial CO₂ Capture & Storage Demonstration Project," Praxair, presented at the 7th Enhanced Oil Recovery Carbon Management Workshop, Houston, Texas, December 7, 2009.

⁵ L. deMello, et al (Various), "A Technical and Economical Evaluation of CO₂ Capture from FCC Units," Abstract for GHGT-9; www.sciencedirect.com.

over two times more oxygen, and the large, indirect energy requirement of oxygen production likely eliminates any direct efficiency improvements associated with oxyfuel combustion. Post-combustion processing has the advantage of simple add-on retrofits to any flue gas stream, but unfortunately has a large space requirement for low pressure flue gas scrubbing and also a high energy requirement. Nevertheless, it does have potential for improvements, such as the use of new, less energy intensive ammonia flue gas CO₂ scrubbing processes, which is now in the demonstration and pilot phase. Interestingly, if successful at scale, ammonia scrubbing will also help pre-combustion CCS due to its greater savings in CO₂ compression costs. Pressurized oxyfuel combustion—a variation on conventional oxyfuel combustion—would also help to reduce its CO₂ compression costs.

There are also some innovative ways to increase oil refinery efficiency, which are best deployed with high efficiency cogeneration-based electricity sold to the grid. Specifically, oil refineries have a number of large radiant-fired heaters. The gas turbines can be used to generate electricity with the hot gas turbine exhaust (still containing about 12% oxygen and up to 1,100°F) being effectively used along with some additional fuel to more efficiently heat-up the process fluids in the furnace. This is already being done in at least two European oil refineries and one hydrogen plant in the United States owned by Air Products.^{6,7} Due to the large work of major fired heaters in oil refineries and the high power-to-heat ratio of gas turbines, this non-traditional cogeneration has large power generation potential. This could even be extended to a more radical concept of using all convection fluid heating with only the gas turbine exhaust heat

⁶ R. Peltier (Air Products), "Port Arthur II Integrated Hydrogen/Cogeneration Facility, Port Arthur, Texas," *Power*, September 2007, pp. 2-5.

⁷ "Commercial FBC Projects and Status of Technologies," *The SFA Quarterly Report*, SFA Pacific, Inc., June 1992, pp. 21-41.

and no additional fuel. This option also creates CO2 abatement opportunities in the power generation sector.

Refiners, therefore, do have numerous options to abate emissions.

Captured CO2 from Natural Gas Processing and Oil Refining Can Lead to Additional Oil Production, Job Creation and Economic Growth

Captured CO2 can even lead to additional oil production, job creation and economic growth using our EOR data, as is happening on a big scale in the Permian Basin, next door. The injection of captured CO2 has enabled significant additional production from these fields, and an extension of their life with clear economic and job creation impacts. In fact, this is a clear case in point where CO2 mitigation and economic growth go hand in hand.

This concludes my rebuttal testimony.

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