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November 22, 2019
TESTIMONY of MR. GREG KENNEDY
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before the
U.S. House of Representatives Committee on Science, Space, and Technology

Hearing to receive testimony on CCUS

Chairwoman Johnson, Ranking Member Lucas, members of the Committee, I am honored to appear today to testify on the issue of carbon capture, utilization and storage and, what we can do as a Country, using market forces and public-private partnerships, to reduce greenhouse gas emissions.

My name is Greg Kennedy, and I'm a Senior Project Director of Asset Management for NRG Energy, Inc., a large, publicly traded competitive power company. My role is to serve as the asset manager for the Petra Nova project and in that capacity, also serve as the President of Petra Nova Parish Holdings and its subsidiary companies. Currently, I also serve as the President of TCV Pipeline, LLC, the entity that owns the 81-mile CO_2 transportation pipeline between the Petra Nova project and the West Ranch oilfield.

What does it mean to be a competitive power company in the electricity sector? It means that NRG is not a rate-regulated utility and, therefore, does not have captive ratepayers from whom we can recover costs or a guaranteed rate of return on the capital that we invest. We have to earn our customers. And our shareholders – not our customers – bear the risks associated with the power plants and other projects that we build and operate and the investments that we make to support those plants, including our investment in the Petra Nova project.

Our company is proud to be a leader in acting to reduce carbon emissions – even in the absence of a comprehensive, federal approach. We have embarked on that effort by establishing science-based greenhouse gas emission reduction targets to reduce our carbon emissions 50% by 2025 and net zero by 2050. We provide granular and public disclosure of our progress towards meeting those targets. And we are making the business decisions that are required to meet those targets in a way that provides consumers with the affordable, reliable and increasingly cleaner electricity they want while generating a return for our shareholders.

I am pleased to be here today sharing not only what we have done as a company, but what we believe the federal government can do as well, to facilitate broader participation – from energy companies and consumers alike – in the actions that are needed to reduce carbon emissions. This morning, I will focus my testimony specifically on carbon capture, utilization and storage and NRG's experience with Petra Nova. I will be providing some background on Petra Nova,

discussing the lessons we have learned, underscoring the importance of public-private partnerships, and sharing a few policy ideas.

I. Background on Petra Nova

Petra Nova captures carbon dioxide from NRG's WA Parish power plant, which is located southwest of Houston, Texas. The Parish plant has ten coal-fueled and natural gas-fueled units and has a total capacity of 3,653 MW, which makes it one of the largest power plants in the Country. Petra Nova uses an amine-based post-combustion technology to capture 90% of the carbon dioxide from a 240 MW equivalent slipstream of flue gas from Unit 8, a coal-fired unit. The captured carbon dioxide is then dried, cooled, compressed and transported 81 miles via pipeline to the West Ranch oilfield where it is injected to enhance oil recovery and ultimately sequestered in the subsurface geology of the field.

To help finance and achieve the technological goals of the project, NRG partnered with JX Nippon—a global oil and gas company—in a 50/50 joint venture. Additionally, Petra Nova formed a joint venture with Hilcorp Energy, a privately held oil and gas exploration company, to leverage the untapped potential of the mature West Ranch oilfield. Given Petra Nova's ownership in the oilfield, oil revenues, not the sale of CO_2, are necessary to service the project's debt and fund going forward costs.

Petra Nova would not exist without its partnership with the U.S. Department of Energy, which provided a $190 million cost-shared grant to defray the approximately $1 billion price tag for the Petra Nova partners' investment in the carbon capture facility and their share of the oilfield improvements.

Petra Nova became operational on December 29, 2016. I am very proud of the development of the project, which resulted in the system coming online, on budget and on schedule. Since starting operations, the plant has captured 3,700,000 tons of carbon dioxide used for enhanced oil recovery providing the dual benefit of removing CO_2 from the atmosphere while boosting the production of domestic oil and the United States' goal of energy independence.

In 2017, Petra Nova received recognition as both the Project of the Year and the Coal-Fired Project of the Year, awarded by Power Engineering. Overall, the project represents an accomplishment for cleaner energy today and a proven vision for how we can enhance sustainable coal-powered technology for the future. This achievement has captured interest from all over the world as we and the Department of Energy have hosted hundreds of visitors each year from both industry and government, including members from both the U.S House of Representatives and Senate.

II. Technical and Economic Advancements in Commercial Scale CCUS

As with any first-of-a-kind effort, we have learned several lessons from Petra Nova. Specifically, we have gained a valuable and more detailed understanding of the challenges presented by

scaling up carbon capture to commercial scale; the impact of location-specific considerations, such as the effects of ambient temperatures; and the costs – both capital and operating costs – along with options to reduce or manage both.

Petra Nova is the only U.S. facility capturing CO_2 in large quantities (over 1 million tons per year) from a fossil-fueled power plant. In the United States, small-scale pilot projects have been more typical. As you would expect, an increase in scale necessitates technical solutions to accommodate unique design challenges. Working with our technology provider, Mitsubishi Heavy Industries America, we have encountered and solved for a variety of challenges.

For example, maintaining the proper temperatures in the process is critical for the amine to capture and subsequently release the CO_2. The use of amines to capture CO_2 has been well proven in other applications; however, the large scale of the Petra Nova project combined with the previously mentioned high ambient conditions created the need for numerous large heat exchangers, both plate-and-frame and shell-and-tube designs, to properly control temperatures inside the process. While both styles of heat exchangers have been used successfully for many years in industrial applications and in the presence of amines, the projects designers had to work diligently to ensure the long-term viability of the exchangers while providing the needed cooling capacity.

Additionally, information gathered from operating projects can assist engineers in understanding how advanced solvents and sorbents will perform over time. For example, understanding their rate of degradation and the impact on both the carbon capture system components and process efficiency can provide valuable insights for the next generation of carbon capture.

The project has also generated valuable information that could be useful to the committee and future developers, given Petra Nova's location on the Gulf Coast, ambient conditions, the use of Powder River Basin coal, and the geology for enhanced oil recovery unique to the Gulf Coast.

At the West Ranch oilfield, we are gaining experience regarding how an EOR flood performs by tracking and evaluating information such as the amount of gas required to produce a barrel oil (commonly called the gas-to-oil ratio); the pressure needed for the CO_2 to properly mix with the oil (called minimum miscibility pressure or MMP); the proper spacing for injection and production wells; the timing to alternate between injecting water and CO_2 and the amounts for each (a process called "water-alternating-gas" or WAG); the impact of unique reservoir characteristics; and the balance between capital and operating expenditures and production. An example of a specific R&D effort at West Ranch is the partnership between the oilfield partners and Japanese companies to pilot new membrane technologies to remove methane from recycled CO_2 and to determine if it can be deployed at commercial scale.

We would expect that for CCUS to be commercially successful in the future, it will be important for power generators to partner with oil companies in the form of a "fence line" sale of CO_2. The likelihood of producers and consumers of CO_2 to transact under such terms will improve as greater economies are realized to lower the cost of delivered CO_2.

III. The Role of Partnerships

We are fortunate to have partnered with the federal government to further the science and economics of CCUS. In terms of technical expertise and financial support, it is certain that without public-private partnerships for large-scale applications of developing technologies, projects like Petra Nova don't happen.

We hope that the Country proliferates CCUS projects, and that Petra Nova can provide a foundational piece of the knowledge required to do so. But we think there is more the government can do, and more that the DOE can do, to recognize the importance of remaining a partner. So, I'd like to pivot from policy and commercials lessons learned to a handful of new or additional ideas that we believe the committee should consider as it considers funding for ongoing research and development for CCUS.

IV. Policy Concepts.

Consistent with doing more to sustain partnerships between the federal government and the private sector for projects like Petra Nova, I would like to offer some policy ideas as the committee contemplates building upon the important policies of carbon reduction.

One option for ongoing support of projects like Petra Nova would be to amend the underlying authorities for the Department of Energy's Loan Programs Office to allow them to refinance debt associated with projects that are subject to a public-private partnership. Such a change would recognize that as technologies are proven at commercial scale, they become less risky. Improving the financing terms and conditions tied to project debt could provide a shot in the arm to projects that are not only working to demonstrate technologies but also to prove that they can operate profitably. This is particularly important in a state like Texas, which has a very competitive electricity market, and for companies like NRG that have no captive ratepayers from whom costs can be recovered or rates of return that are oftentimes guaranteed by public service commissions in other markets.

We encourage the committee to position the federal government as a more active partner in making projects work, from both an engineering and business perspective. Strengthening these public-private partnerships is critical, because if a commercial-scale demonstration is not also commercially viable, no one will build more of them.

One way to strengthen these partnerships would be on-going collaboration between the DOE's R&D efforts, technology providers, and potential project investors to work through technology challenges. By processing a 240 MW equivalent slip stream of flue gas, Petra Nova was a 10X scale-up of a post-combustion demonstration project in Alabama. This scale-up required an 8,000-horse power flue gas fan to draw flue gas from the host coal unit, a 300-foot tall absorber tower, a 26,000-horse power compressor, and 17 plate and frame heat exchangers, some of which are the largest frames made by our suppliers. Future projects will likely be a further scale-

up in size and whether this results in larger equipment or multiple trains of similar size equipment, this will likely create new challenges to keep costs down.

Lastly, I would encourage members of this committee to collaborate with your colleagues at the tax-writing committees to ensure that the 45Q tax credits are implemented in a way that both recognizes the existence of an already operational facility like Petra Nova and provides flexibility in how eligibility for and receipt of the credit can be kept flexible.

V. Conclusion

In summary, several items are needed for "at-scale" CCUS: (a) technological advancements to drive capital and operating costs lower, (b) alignment between CCUS and EOR operators to sell CO_2 at competitive prices, and (c) flexible mechanisms to access to 45Q tax credits. Parallel to your efforts in looking at the technological challenges, we also support the current efforts of other Government agencies in looking at improving access to 45Q tax credits.

We applaud the committee for remaining engaged not only on the challenge of carbon reduction but also on advancing the programmatic authorities needed to demonstrate technologies capable of solving that challenge. At NRG, we are committed to being a part of that solution, we thank you – again – for the opportunity to appear this morning, and I am happy to respond to any questions that the committee may have.