center for ENERGY STUDIES
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ENERGY DIALOGUES

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Introduction

On April 21, 2022, Energy Dialogues and the Center for Energy Studies (CES) at Rice University's Baker Institute for Public Policy hosted the Houston Energy Dialogues (HED) for the sixth consecutive year. Co-sponsors of the event included Shell, the American Petroleum Institute, and Chart Industries. This was the second year the HED was held in person since the COVID-19 pandemic.

As in previous years, the event provided a platform for representatives from academia, industry, environmental groups, and government, including regulatory bodies, to take part in an in-depth conversation about the energy landscape. Consisting of two panels and two roundtables, the 2022 HED focused on four topics under the central theme of energy transitions: (1) Houston's potential to become a low-carbon hub; (2) the low-carbon future of the U.S. and the role of hydrogen hubs; (3) the role of natural gas in the global energy transition; and (4) energy market resilience and domestic and global infrastructure needs.

The 2022 HED was held under the Chatham House Rule. As such, the dialogues are summarized in this report without attribution to participants.

(1) **Panel 1: U.S. Gulf Coast — Is Houston the Ideal Location for a Low-carbon Hub?** The first panel stressed the importance of leveraging existing assets and resources in the Gulf Coast region while reducing long-term CO_2 emissions and increasing community involvement. With a unique entrepreneurial environment for financing and scaling new technologies, Houston possesses tremendous potential for incubating innovative solutions. The panel recommended that Houston utilize federal grants and create informative campaigns about the region's potential as a hub to accelerate the required deployment of low-carbon technologies.

(2) **Roundtable 1: The Low-carbon Future of the U.S. and the Role of Hydrogen Hubs.** Among the various low-carbon technologies, hydrogen is central to energy solutions that could be key to unlocking a low-carbon future. Participants agreed that the Gulf Coast and Houston have the assets, infrastructure, and resource advantages to develop a hydrogen hub, although they raised concerns about potential environmental and community impacts as well as water usage. They also highlighted a need for verifiable nature-based solutions.

(3) **Panel 2: The Role of Gas in the World's Decarbonization Journey.** Natural gas is critical to ensuring grid resiliency as intermittent renewable energy sources increase in power generation. Indeed, the panel noted that natural gas is currently the most readily available alternative for regions that want to reduce their dependence on coal. There was ample discussion about the need for additional transport infrastructure in the U.S. to allow the country to exploit its full potential as a liquefied natural gas (LNG) exporter, especially to countries in Europe who are at the mercy of Russia for supplies.

(4) **Roundtable 2: Defining and Building Resilience in Energy Markets — Infrastructure Needs in the U.S. and Globally.** Given the evolution of the energy mix and greater renewable energy penetration, participants deliberated on market resiliency and capital adequacy, as well as the resiliency of the electric grid.

Regarding grid resiliency, participants agreed that a more decentralized generation system, which some are advocating, would require additional grid infrastructure. At the same time, a consistent regulatory and policy environment is pivotal to preparing the world for a just and sustainable transition.

Panel 1: U.S. Gulf Coast — Is Houston the Ideal Location for a Low-carbon Hub?

Three Domains to Drive Energy Transitions in Houston: Technologies, Industry, and Value Chains

The first panel opened with a discussion on how Houston and the Gulf Coast region can develop a low-carbon hub and take a leading role in energy transitions. To reach these goals, Houston is focusing on three critical domains. First, it aims to create an environment to jump-start four pillars of decarbonization technology: carbon capture, utilization and storage (CCUS), hydrogen, plastics recycling, and energy storage. Houston can build these pillars by leveraging its comparative advantages to bring together stakeholders across industry, policy, and elsewhere. Indeed, the existence of legacy energy infrastructures, a large industrial complex, significant port facilities, and an unparalleled human capital depth in engineering, the subsurface, commercial decision-making, and logistics and supply chain management all portend a tremendous advantage for the region.

The panelists also highlighted the entrepreneurial environment boasted by the city and the region, which has been developing energy-focused technologies for decades, many of which can be applied to innovate and deploy new solutions critical for decarbonization. This presents a unique opportunity for federal funding through initiatives such as the U.S. Department of Energy (DOE) programs to spur the development of low-carbon hubs. When combined with the region's comparative advantages, the probability of Houston becoming a leader in low-carbon hub solutions is very high.

The second domain for Houston is to develop into an innovation hub with a vibrant start-up community to bring new technologies to market in the energy sector. Indeed, the city hosts key innovation labs — the Ion and Greentown Labs — that can help the "energy capital of the world" evolve and capture new opportunities availed by energy transitions. This includes technologies such as renewables, battery manufacturing, hydrogen, biofuels, and energy transition-focused innovations in general.

The third domain is to develop and provide critical human capital support for energy transitions across value chains. This includes developing the necessary supply chain expertise — that is inherent to the oil and gas sector — for expansion of new energy enterprises. Existing energy sources will remain in the mix for a long time as the energy industry works to meet the world's current and future energy needs. A collaborative environment will allow the knowledge that helped build Houston into the "energy capital of the world" to facilitate growth in new arenas, some of which will help reduce the greenhouse gas (GHG) footprints of incumbent energy sources. Indeed, the emphasis on

energy security that reemerged in the wake of the war in Ukraine and the growing needs for energy in developing countries dictate a need to reduce GHG emissions along existing energy supply chains, even as new technologies emerge.

Through the course of the conversation, the panelists also discussed various concerns related to new and emerging technologies. These included but were not limited to: (i) the GHG emissions and water requirements along the supply chains of emerging blue and green hydrogen technologies, respectively, and (ii) the costs of CCUS and the evolution of policy incentives to support deployment. The panelists emphasized a need for measurement, monitoring, and verification of supply chains to identify and abate emissions, as well as an assessment of water resource availability. They also highlighted various proposals to bring greater fiscal support to CCUS technologies.

It was emphasized that investment is critical, as Houston will likely be the center of decision-making that drives energy transitions. Thus, the regional economy must remain attractive to banks, private equity firms, and other providers of capital. Hence, the region must better communicate regional initiatives to reduce emissions, including activities such as methane reduction and the electrification of offshore operations. Specifically, the region must make clear that it has thoughtfully embarked on the journey to a lower GHG future.

Community Engagement from the Start Is Key

Efforts to transform the energy industry in the region will require significant infrastructure investment. Currently, Port Houston is taking steps to decarbonize by electrifying more of its operations, building partnerships with industry focused on deploying new technologies, and re-examining freight movements in and around port facilities to increase efficiency. In addition, Port Houston is planning a significant expansion and deepening of the ship channel to allow more freight movement through the region. This could bring an estimated 600,000 jobs to the region, but it also raises concerns about community impact as well as public health and environmental impacts. Thus, staying engaged with local communities is critical to finding the correct balance of all these considerations.

To that end, the panelists reiterated the need for the industry to engage with communities early on. Notably, they stressed that the industry has an opportunity to shape an energy transition that engages actively with communities *before* projects are developed. For example, it can address concerns such as employment opportunities, any new infrastructure footprint, and various plans for new investments.

“Fence-line” communities, particularly those that have been negatively impacted by construction and operation of new industrial facilities, are key stakeholders for industry engagement. For example, the fence-line communities in Port Arthur — a central area for industrial activities and an ideal testing ground for new technologies — have historically experienced adverse impacts due to ongoing health issues connected with surrounding industrial operations. Moreover, the region is plagued by high unemployment and low

economic standing. As a result, these communities can feel disenfranchised and overlooked by the industries in their immediate vicinity, which makes engagement of the utmost importance.

A complete understanding of any project's impact on local communities is essential. Thus, to promote social resilience and create an environment for a just transition, the panelists agreed that industry must pursue solutions with communities from the very beginning. If done properly, Houston has the potential to play a leading role in energy transitions across multiple dimensions, including social and environmental justice.

Houston's Outlook for 2050 and What Can Be Done Now

Regarding the region's outlook for 2050, the panelists shared multiple thoughts. Panelists envisioned developments such as

- the region leading technological breakthroughs in energy storage, material science, and plastic recycling;
- increased consumer awareness and creative, intelligent, solution-seeking communities that lead demand-side movements that lower GHG emissions;
- a growing importance of nature-based solutions that emphasize the value of ecosystem services and promote resilience; and
- increasing community focus on local resources, including greater reliance on microgrids and distributed generation for electric power needs.

The panelists also emphasized that much of the region's future prosperity will depend on how it transitions its existing oil and gas legacy to a more environmentally favorable platform for existing and new energy industry participants to thrive. Incubators such as the Ion District, which counts Greentown Labs as one of its residents, are ideal for fostering collaboration between experienced workers, who understand the challenges involved with existing infrastructure, and enthusiastic young talent, who are eager to make the industry cleaner and more efficient.

Roundtable 1: The Low-carbon Future of the U.S. and the Role of Hydrogen Hubs and CCUS

Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis of Hydrogen: Flexibility, Economics, and Infrastructure

During this roundtable discussion, participants focused on hydrogen applications in transport, heavy industry, and energy storage, as well as the United States' potential to become a hydrogen exporter given increasing interest abroad. Panelists noted that hydrogen's potential as a clean and cost-effective alternative will highly depend on the production technologies deployed along the full supply chains for each. Today, natural gas is the most common feedstock for hydrogen production through steam methane reduction. But this technology results in CO_2 emissions, so it must be paired with CCUS (so-called "blue" hydrogen) to be considered low-carbon.

Participants highlighted that hydrogen's strength is its flexibility. Among other things, hydrogen has industrial applications: It can accommodate electric grid resilience as an energy storage vehicle when paired with renewables to make "green" hydrogen, it can be used in the transportation sector in fuel cells, and it can be used to make ammonia. Given the various potential uses of hydrogen, its potential for growth is not demand-limited.

However, capital and production costs along with lead times for development were the primary concerns noted by participants that could limit hydrogen market expansion. Participants shared concerns that other competing, low-carbon technologies could gain a cost advantage before hydrogen can adequately scale into its various potential end-uses. Thus, there is an inherent risk that long-term investments in the hydrogen value chain will not bear a sufficient return to capital expended.

There was also discussion of commercial terms in various hydrogen applications, such as those for ammonia offtake. Specifically, some participants raised the idea that long-term offtake commitments would be needed to support investment in hydrogen infrastructure because such contractual commitments are bankable, which is important for financing. This argument was made with an analogy to LNG. Counter to that point, it was also argued that market liquidity would abate the need for long-dated contracts, particularly as scale is achieved. This could happen much more quickly than what has been seen with LNG, given the scale of capital outlay to enter the hydrogen market is not as significant (lumpy) as the requirements to develop LNG liquefaction capacity. So, the evolution of the market will depend on the capital intensity of production and investors' risk appetite.

Participants also commented on the market structure for hydrogen. Any market structure that does not emphasize transparency and competition could limit participation and place a ceiling on growth.

Finally, concerns were raised about the ability to develop hydrogen infrastructure, especially pipelines. Permitting and siting issues, as well as public opposition to infrastructure, could delay and/or altogether inhibit the development of a hydrogen economy. Addressing these challenges will be crucial for the development of a hydrogen hub on the Gulf Coast.

CCUS and CO_2: Carbon-to-value is Key

Participants observed that further technological breakthroughs in CCUS are required to overcome cost hurdles for investment. In that light, it was also noted that creating a value proposition for CO_2, thus turning it into a potential source of revenue rather than a cost, would alter the investment calculus for any carbon removal technology.

Innovative collaborations between governments, industry, and universities are driving the search for carbon-to-value propositions. With emerging technological advances, much innovation is focused on synthetic fuels and other opportunities to leverage CO_2 in previously unimagined ways.

Participants shared that, much like in the case of shale, once a carbon-to-value proposition appears, it will change the landscape entirely because CO_2, and carbon more generally, would become an intermediate input into other products. This would provide additional value for existing infrastructure that could support new and evolving CO_2-use technologies. Regions like Texas will have a distinct advantage with existing infrastructure ready to capture value once it is demonstrated.

Government Support and the Regulatory Landscape — What Does It Mean for Texas?

Participants agreed that a viable economic opportunity and a supportive regulatory regime are prerequisites for any successful CCUS or hydrogen project. Moreover, it was recognized that fiscal support — through direct subsidies, grants, and/or loan guarantees — are powerful tools in the policy toolkit for enhancing economic value. However, it was also noted that although government funding can help specific projects overcome initial cost barriers, excessive reliance on it could harm the organic development of markets.

Regarding hydrogen, the U.S. DOE has designated funding of $8 billion to support the development of up to four hydrogen hubs in the United States. Participants all recognized that Texas could become one such hub because of its comparative advantages. However, participants also observed that Texas state representatives had not taken a proactive stance on this in Washington. One participant noted that Texas could differentiate itself from other states by focusing on heavy industry and elevating what using hydrogen for industrial sector decarbonization could mean for other sectors such as aviation, shipping, and heavy transportation.

Regarding CCUS, participants recommended revisions to the 45Q tax credit at the time of the HED, including (1) increasing the duration to 20 years and (2) increasing the value to $85 per ton of CO_2 to incentivize innovation and adoption.[1] Doing so, it was argued, would drive greater industry appetite for CCUS solutions. Participants also noted the example of wind and solar energy in making such arguments for CCUS, where government tax support accelerated the wind and solar industries from their infancy.

Several participants underscored a need to improve data collection for adequate enforcement of CO_2-related regulations, such as carbon border adjustments, carbon credits and carbon trading, nature-based offsets, and other potential climate legislation. The absence of accurate assessments of CO_2 emissions makes the value of implementing various CO_2 reduction solutions difficult to evaluate, which ultimately acts as an impediment for investment.

[1] The Inflation Reduction Act, signed into law in August 2022, made important updates to the 45Q tax credit, including an extension to January 2033 for projects to begin construction and an increase of the credit to up to $60/ton of CO_2 used in enhanced oil recovery, and $85/ton of CO_2 in permanent storage. For direct air capture projects, claimants can earn up to $130/ton of utilized CO_2 and $180/ton of CO_2 permanently stored.

Panel 2: The Role of Gas in the World's Decarbonization Journey

In the second panel of the HED, panelists discussed the role of natural gas in energy transitions. There was general agreement that the Texas Gulf Coast will likely remain a critical gas hub, even with a potential shift toward hydrogen. Panelists foresaw a continuing role for natural gas, with or without hydrogen, in energy transitions worldwide. Natural gas presents a lower-carbon alternative to coal for baseload power generation, which is particularly important for developing regions like China and India that are heavily dependent on coal.

Panelists pointed out that natural gas also currently provides an important reliability and balancing function for power markets, particularly where intermittent renewable energy sources are growing. Panelists agreed that this could change in the long run, once other long-duration energy storage options emerge, though no such option is currently available.

Participants noted the growing demand for “certified natural gas,” which is a lower-carbon natural gas with certificates documenting its production origin and methane intensity. Transparency on carbon-intensity information can allow customers to evaluate their willingness to pay potential premiums for natural gas that is certified as “clean.” To this end, participants observed that a neutral, international, and standardized certification body should oversee all methane certificates to accurately quantify the product’s footprint.

Panelists noted energy security as another advantage of natural gas. After Russia invaded Ukraine, the European Union quickly proposed legislative packages to develop LNG import facilities and natural gas transport infrastructure to diversify suppliers. Both actions indicate that Europe is responding to an energy security threat by recognizing its reliance on natural gas to meet energy demands, at least in the near term. Thus, to the extent that natural gas supplies can be certified as clean, they will serve a dual purpose of advancing both lower GHG emissions and energy security.

Panelists stressed that the U.S. could play an important role in certified natural gas exports to the European market. But they also noted that a legal framework enforcing methane emissions reduction and streamlined regulations for siting and permitting natural gas infrastructure — from the wellhead to pipelines to liquefaction — are needed for the U.S. to fulfill its potential for growth.

Regardless of *future* growth, given the scale of *current* natural gas production and use and the legacy of dedicated infrastructure, panelists concluded that natural gas will play a long-term role, albeit one that varies across regions as energy markets transition.

Roundtable 2: Defining and Building Resilience in Energy Markets — Infrastructure Needs in the U.S. and Globally

Panelists agreed that a stable regulatory environment facilitates smooth transitions by allowing industry players to choose where to allocate resources, capital, and time to develop and execute strategy. This is essential for *market* resiliency. If regulation or the actions of policymakers add uncertainty, market resiliency is compromised. Under these circumstances, firms are unsure about the types of investments to make and at what scale they should be made. Generally, firms already deal with uncertainties around both future demand and cost, so policy and regulatory uncertainty only serves to make decision-making more difficult.

Regarding infrastructure resiliency, participants were concerned about the ability of the Gulf Coast's existing and future infrastructure to withstand hurricanes, tropical storms, and especially storm surges. Beyond the physical damage that could be inflicted and the economic harm that would be caused by infrastructure downtime, participants highlighted the environmental damage that could result from accidental spills or chemical releases.

Participants also discussed strategies to improve overall electricity grid resiliency, including infrastructure hardening and weatherization, decentralized generation, microgrids, and improved communication and coordination between grid operators and utility companies. The issues associated with reliability and the integration of intermittent renewable resources were also raised. This, in general, served to highlight the importance of diversity in generation assets, and, specifically, the role that natural gas has played in the Texas market to support reliability.

Participants emphasized innovation as a potential enabler of resilience, highlighting several interesting new technology pathways including the use of synthetic biology to enable greater microbial uptake of CO_2 in soils and/or develop syn-fuels from captured CO_2, among other things. Emerging innovation pathways — such as CCUS, hydrogen, renewables, and battery storage technologies — were also discussed. They were each identified as important parts of a portfolio of solutions to ensure future resiliency in energy systems, just as they are critical for broad decarbonization.

Participants also underscored that the industry must engage with communities about how new technologies and infrastructures will impact them. This is vital for establishing opportunities for climate and societal resilience and extends to what participants identified as a noticeable generational gap between current and future decision-makers. Several participants noted a tendency among the younger generation to simplify issues into "good versus bad," even when the situation may be much more complex. A key to resiliency lies in collaboration, creativity, and hard work to find solutions, all while giving time for innovative technologies to develop and mature. Hence, education is a critical piece of any resilient future.

Further to societal resiliency, participants agreed that it is critical to increase education and awareness of the material needs and new waste streams accompanying energy transitions. Electronic waste, mining waste, and the carbon intensity of materials needed to support various new technologies are crucial issues for the coming generations to understand. Only then can circular designs be conceived to preemptively solve these potential problems.

Final Remarks

In closing, it was recognized that climate change is a global challenge, but effective solutions must be designed locally. To that end, participants stressed that Houston is a great place to test solutions, establish deep collaborations, and evaluate the effectiveness of various technologies and ideas that could drive desired outcomes and potentially be replicated around the world. As such, Houston will likely play a vital role in developing solutions and building resiliency throughout the global energy transition.

Participants of the 2022 Houston Energy Dialogues stressed that collaboration is more important than ever to ensure that all solutions are considered and deployed in the most advantageous ways possible. Not all problems are created equal, and it is imperative to recognize each solution's net benefit in terms of its environmental, social, and economic impacts. This likely means that natural gas will remain an important part of energy systems as they transition, but only if associated environmental concerns can be transparently and successfully addressed. It also means that a portfolio of technology solutions will emerge. Successful deployment will be conditional on stable market and regulatory settings, as well as community acceptance.

Therefore, participants called for candid and pragmatic assessments of energy transitions to help develop strategies that support long-term resiliency in markets, through regulation and with communities. They underscored that creating a cohesive strategy with all stakeholders will avoid dissonance and alleviate potential hurdles. Moreover, participants stressed the importance of bringing industry and communities together to achieve the scale required for successful energy transitions around the world.