SUSTAINABLE AND COMPETITIVE ENERGY SUPPLY:

THE ROLE OF EFFICIENCY AND INNOVATION

AN **INTERNATIONAL ENERGY FORUM** PUBLICATION 28 February 2019

KEY IEF DIALOGUE INSIGHTS

Riyadh, Saudi Arabia | 28 February 2019

EVENT BRIEF ON THE 5TH IEF-KAPSARC THOUGHT LEADERS' ROUNDTABLE

TABLE OF CONTENTS

Contents

1 KEY FINDINGS

1. The main energy outlook scenarios of the IEA, OPEC, and other stakeholders show that the world is not on track to meet globally shared goals.[1] Governments are developing long-term energy and climate goals to reshape energy markets in consultation with the energy industry.

2. The two main pathways that can make energy markets more reliable, productive, and resilient to global challenges at an acceptable cost to societies are 1) innovation to reduce greenhouse gas and particulate matter emissions, and 2) improvements in efficiency to more effectively supply growing energy demand.

3. Policies and innovation have focused on integrating renewable energy with great success, especially in the power sector. However, the stellar rise of renewables does not change the world's reliance on hydrocarbons, where innovation and efficiency gains can still have a significant impact.

4. Not all hydrocarbon producers are equal emitters, but the environmental footprint of the entire industry supply chain can be reduced through innovation and efficiency gains.

5. Oil and gas production can be made more efficient and sustainable by deploying renewable energy sources in power generation for hydrocarbon production, including water treatment, reinjection, and other processes.

6. The ability to market premium fuels and energy sources with higher carbon efficiency and lower greenhouse gas emissions will sharpen oil producers' competitiveness and reinforce their business models.

7. Apart from limiting flaring and stopping methane and other leakages in the industry, innovations aimed at extracting value from emissions can also create a productive cycle between industry and government objectives and can help economies move toward a circular carbon model over the long-term.

8. Hydrogen can help turn the weaknesses of renewable and hydrocarbon technologies into

strengths by solving renewable intermittency and decarbonising fossil fuels. Hydrogen is obtained from renewables through electrolysis or from fossil fuels through steam methane reforming (SMR), oxidation, and other processes that capture carbon dioxide (CO2) for reinjection to enhance oil recovery or storage. It provides a zero-carbon energy carrier that makes energy systems more sustainable and secure.

9. A full system approach allows societies to build on existing infrastructure and integrate available energy technologies to better enable resources and related waste and emissions to be turned into usable energy and products. This improves the energy sector's ability to adapt to the challenges and opportunities presented by modern energy security and climate policies.

10. Digitalisation, big data, and artificial intelligence further enhance industry performance by leveraging new interconnected information technologies that enrich management capabilities and specifically reduce operating and maintenance costs. This allows the industry to navigate a more uncertain market environment with greater agility and speed.

11. Dialogue on efficiency and innovation agendas will allow industry and governments to better maintain transparent and predictable policy and investment climates.

12. Governments must provide clarity on policy mechanisms and constructively engage the hydrocarbon industry through dialogue to encourage investment at the scale required.

2. EVENT BACKGROUND

The International Energy Forum (IEF) and the King Abdullah Petroleum Studies and Research Center (KAPSARC) jointly hosted the Fifth IEF-KAPSARC Thought Leaders' Roundtable at the IEF Headquarters in Riyadh. The event was organised in response to calls from IEF ministers to pool efforts to accelerate innovation and efficiency gains across the energy sector spectrum. This also involves leveraging the IEF Energy Efficiency Knowledge Sharing Framework in collaboration with relevant organisations and global governance platforms.

3. OVERVIEW

Discussions focused on the opportunities for enhancing efficiency in the oil and gas value chain, the technology options available, the economic viability of such methods, the investments needed, and the impact on demand and supply. The event was structured in four sessions that focused on:

1. Efficiency drivers and gains in hydrocarbon supply chains.
   What are the economic imperatives and constraints that energy markets currently face, and how do efficiency gains improve future operations?

2. Integrating low-carbon energy technologies upstream and midstream.
   Which parts of the hydrocarbon value chain could be made less carbon intensive, and how could new technologies, including carbon capture utilisation and storage (CCUS), renewables and hydrogen contribute to operational sustainability?

3. Innovations in energy systems.
   How can new technologies help optimise synergies between supply chains and industrial clusters, and what policy interventions could help their implementation?

4. The evolution of the oil and gas business model.
   Where will investment in efficiency gains and emission reductions impact industry performance and competitiveness most, and what does this mean for future business models?

The 5th IEF-KAPSARC Thought Leaders' Roundtable noted that the fastest and easiest way to reduce emissions is to make hydrocarbon supply chains more competitive and sustainable through further innovation. The Roundtable participants highlighted carbon efficiency and industry restructuring as ways to unlock synergies that reduce costs and capture value. Discussions focused on the role of carbon capture use and storage (CCUS) and other technologies, including digitalisation in detecting fugitive emissions, developing premium fuels and more efficient energy conversion processes. The discussion also covered the re-emergence of hydrogen derived from hydrocarbons, renewables, and other sources that enable successful energy system transformations. Panelists also highlighted the importance of cohesive government-industry partnerships in formulating and advancing consistent innovation agendas

that mobilize investment, broaden public acceptance, and create consensus. Innovation and efficiency efforts by governments, industry, and research centres to reduce costs and emissions have shifted from the demand side to the supply side. Producers of low carbon intensity resources with low production costs have an advantage over producers of carbon and emission intensive sources with higher productions costs.[2] Market players continue to invest in innovation and efficiency gains to better respond to growing demand for competitive and more sustainable energy supplies in a world energy market increasingly geared toward reducing greenhouse gas emissions and other environmental impacts.

4. CHANGING DEMANDS ON THE OIL AND GAS INDUSTRY

Roundtable thought leaders noted that the energy community, including the oil and gas industry, must find viable pathways to remove emissions from the energy system while maintaining the momentum of global economic growth which fuels prosperity. Changing market dynamics and long-term energy and environmental policies compel both governments and industry to sharpen their focus on enhancing efficiency and innovation to make energy supplies more competitive and sustainable. The oil and gas industry is an innovation leader and is focused on efficiency gains to remain competitive. To stay viable in the low oil price environment, driven by the unconventional oil and gas revolution, the industry has stepped up the deployment of new technologies and has improved its productivity. To reliably serve future energy and climate requirements and maintain trust and credibility with governments and consumers, the industry is increasingly focused on making energy supplies more sustainable.

Major oil and gas companies collaborate to support the Paris Agreement goals through the Oil and Gas Climate Initiative (OGCI) by exploring low carbon solutions and enabling a circular carbon model via engagements, policies, investments and deployment.[3] OGCI aims to catalyse and scale greenhouse gas reduction by focusing on CCUS, energy efficiency, and nature-based solutions. The OGCI has established an investment fund valued at more than $1 billion to invest in technologies and solutions to lower the carbon footprint of the energy and industrial sectors by reducing methane leakages and CO2 emissions, and recycling CO2 through CCUS. Panelists noted that a holistic approach to the Sustainable Development Goals (UN 2015) is essential. Negative emissions are needed in order to ensure reliable, affordable, and clean energy to meet

growing demand. A circular carbon economy can help to accelerate the reduction of net greenhouse gas emissions.

5. CARBON CAPTURE USE AND STORAGE

CCUS can play a central role in efforts to make energy supply chains more sustainable. International Panel on Climate Change scenarios provide a 50% chance of staying below the 2-degrees Celsius global warming threshold include the use of bioenergy combined with carbon capture and storage (CCS) to produce negative emissions. CCUS provides 14% of the cumulative emission reductions needed in the period to 2060, amounting to around 120 gigatonnes (Gt) of CO2 (GtCO2).[4]

Though CCUS technologies are available, they remain costly and complex to deploy technically and have encountered public resistance. Few policies are in place to give an incentive to invest in CCUS. Therefore, it has not been deployed on a mass scale. Failure to move forward would, however, considerably increase the cost of limiting global warming to the threshold agreed under the Paris Agreement. This cost and the public's resistance to CCUS can be overcome by focusing on the additional benefits that CCUS can offer relative to other technologies while using existing infrastructure. Blue hydrogen production generates carbon which can be used for enhanced oil recovery (EOR). Blue hydrogen and green hydrogen produced from renewable resources together provide zero carbon electricity baseload, and transport fuel, and industry feedstock. This system of blue and green hydrogen reduces the cost of intermittent renewable energy solutions, the carbon intensity of energy consumption beyond the power sector and helps to alleviate the cost burden that stranded assets may impose on societies.

Policy and regulatory risk and financial hurdles further hamper the deployment of CCUS at scale. Only a limited number of countries have clear long-term policies and regulations in place to incentivise investment in CCUS. Unclear legal and regulatory regimes increase the risk-reward ratio, limiting the mobilisation of private sector funds. Liabilities associated with long-term storage, mismatching investment horizons and CO2 supply considerations, including price volatility in carbon credit markets, all negatively affect the long-term viability of CCUS projects.

Collaboration among policy networks, public-private partnerships and producer and consumer

countries on CCUS and nature-based solutions can accelerate CCUS deployment globally. This collaboration could include sharing CO2 storage data to standardise methodologies and protocols, demonstrating projects to showcase business models, and collaborative research and development projects.

6. HYDROGEN

Roundtable thought leaders discussed the renewed interest in hydrogen to make energy supplies more sustainable and to address energy security and climate challenges. In addition to accelerating the deployment of CCUS, hydrogen technologies can help:

- **Resource rich countries navigate energy transition pathways by providing a mechanism that can decarbonise hydrocarbons in combination with CCUS over the long-term.**
  Declines in oil and gas demand in the transport or power generation sectors can be offset by an increase in demand for hydrogen from fuel cell vehicles, hydrogen generated power and as a feedstock in industry.

- **Serve as a bridge between energy technologies.**
  Hydrogen produced from renewables through electrolysis can be stored and can provide fuel and
  feedstock beyond transport and power generation, including in the refining and petrochemical sectors. Hydrogen produced from gas through methane-steam reforming in combination with CCUS creates clean energy molecules.

- **Help integrate variable renewable energy sources into hydrocarbon energy supply chains.**
  Renewable energy resources are increasingly providing the energy needed to fuel hydrocarbon production. For example, renewables can provide steam for the reforming process to generate hydrogen from fossil fuels.

- **Make good use of existing infrastructure.**
  Once transformed to ammonia, hydrogen can be transported with relative ease through existing gas pipeline systems. Making use of existing systems and rights of way will provide greater value and resiliency.

However, the cost of producing hydrogen must be reduced significantly to create demand for hydrogen at scale. More international collaboration is needed to accelerate the innovation and deployment of hydrogen technologies to facilitate orderly and cost-effective energy transitions.

7. REDUCING EMISSIONS IN THE OIL AND GAS SECTOR

Participants highlighted that indirect greenhouse gas emissions from oil and gas production, including refining and shipment, amount to around 15% of total energy sector emissions; the remaining 85% is from the energy these segments use. For oil, these amount to about 10% to 30% of total well-to-wheel emissions, and they represent 15% to 40% of total gas system emissions.[5] Most of these emissions in the oil sector relate to methane and CO2 from energy generation and refining. Because of the wide variation in indirect emissions intensity of sources, more than two-thirds of indirect emissions stem from around half of the total production.

The indirect emissions from energy used in the extraction of gas resources is relatively uniform. Most of the indirect emissions in the gas sector are from methane leaks. The gas supply chain contributes 1.5% to 2% of total methane emissions. The agriculture and waste sectors emit the most methane, providing an opportunity for biogas production.

Technologies can help substantially reduce these emissions. One option is replacing inefficient diesel generators; another is using renewable solar energy for steam generation and deploying CCUS in combination with hydrogen production and EOR. Digitalisation can optimise leak detection and help to improve maintenance efficiency. Biogas, synthetic gas derived from waste, and power-to-gas techniques that convert variable renewable energy sources to hydrogen or methane can further reduce indirect emissions and can help to decarbonise the gas sector. Except for biogas, renewable-to-gas technologies are still too costly to be deployed. Collaboration between governments, industry and research centers will be needed to make these green gas technologies viable.

8. DIGITALISATION

The oil and gas industry is exploring digitalisation through various innovations that include digital

oil fields controlled by real-time drilling optimisation centers, analytics-driven predictive maintenance, submersible robots and unmanned aerial vehicles for exploration and inspection. These innovations will reduce transaction costs, increase productivity and optimise the delivery of more reliable, affordable, and sustainable energy in a more interactive dynamic. To ensure digital technologies are integrated smoothly, it is important to engage in dialogue on digital innovation in the energy sector.

Digital transformations in other industries such as logistics and mobility, telecommunications, finance, and retail can inform the energy industry's digitisation. Digitalisation enables more efficient connections between upstream and downstream supply chains.

Digital transformation will also help resource economies to diversify. Digital transformations may require information technology professionals with the skills to manage digitalisation. Cooperation on digitalisation between governments and energy sectors can accelerate digital innovations to make supply chains more competitive and sustainable.

9. PERSPECTIVES ON THE ENERGY FUTURE

In Europe, governments and utilities have focused on support for power-to-gas through hydrogen production from electrolysis. Upstream industries, such as part of the OGCI, meanwhile, are promoting hydrogen in combination with carbon recycling to reduce emissions.

Market stakeholders are exploring large-scale production of CO2-neutral hydrogen. Hydrocarbons and variable renewable resources can be used to produce hydrogen, while CO2 is captured and stored. Hydrogen can be stored to balance supply and demand, or it can be used to generate green electricity and stabilise electricity grids. Hydrogen can also be used in the refining and petrochemical industries to supply hydrogen fueling infrastructure.

New innovative approaches will allow energy market stakeholders to better integrate new energy technologies. They will also ensure that energy supplies continue to meet growing energy demand in accordance with globally agreed goals.

[1] These include the United Nations (UN) Sustainable Development Goals, the Un Paris Agreement goals, the International Maritime Organisation's agreement of 2016, the World Health Organisation's air quality guidelines on ambient air pollution.

[2] This includes heavy oils, shales, deep-water sources, sour and acid gas or production from fields with a high water cut.

[3] The Oil and Gas Climate Initiative is a voluntary CEO-led oil and gas industry initiative that aims to catalyse meaningful actions on climate change. It comprises 13 member companies: BP, Chevron, CNPC, ENI, Equinor, Exxonmobil, Oxy, Pemex, Petrobras, Repsol, Saudi Aramco, Shell, and Total.

[4] Five Keys to Unlock CCS Investment, IEA 2017.

[5] Oil and Gas Innovation, IEA World Energy Outlook 2018.