

Gulf Hydrogen Workshop 2021

November 14, 2021 | Rosewood, Abu Dhabi | UAE



Moving Hydrogen from the Screen to the Field: *What Will a Successful Consortium Look Like?*

Knowledge Partners





Unlocking Unrealized Potential

The development of the Hydrogen ecosystem has been slow. Much of that comes down to policy and funding. While industry and financial players are keen to invest, they require clarity on policy direction before they will commit. Progress requires planning and coordination among governments, industry and investors to ensure that hydrogen-related projects warrant the investment that they require.

Hydrogen holds tremendous promise as both a source of clean energy and a way to decarbonize hard-to-abate industries, yet current production methods rely almost entirely on coal and natural gas. Therein lies a paradox: Before hydrogen can contribute to a cleaner world, first we must clean up production. To decarbonize the global economy and meet climate targets, the world needs a clean molecule. Hydrogen is that molecule. It's versatile, reactive, storable, transportable, clean-burning and can be produced with low or zero emissions. With the right level of investments, hydrogen could meet 24% of global energy needs by 2050, putting the world on course for a 1.5-degree scenario.

What's special about hydrogen is that it's very versatile. It's a store of energy, it can link energy chains—it's

really an enabler that can improve energy system efficiency and extend the use of modern technologies. Hydrogen is already widely used in some industries. Several technologies available today enable hydrogen to produce, store, move and use energy. While hydrogen remains one of the most viable alternatives for a range of applications, scaling up existing technologies to deliver competitive low-carbon solutions requires around \$280 billion worth of investment and \$150 billion worth of subsidies by 2030.

Hydrogen requires an entire ecosystem. It's not enough for policymakers to incentivize production, you also need to be able to transport and store hydrogen. We must step back and ask whether we're making the right investments in industrial ports, storage infrastructure, fuel-cell technology and more. There are various angles that need to be thought about in a very holistic manner. Putting the proper supply infrastructure in place by 2050, for instance, would require \$11 trillion worth of investment. That spans everything from boosting electrolyser capacity and building large-scale supply and distribution networks to advancing fuel-cell technology and installing refueling stations.

PREVIOUS GI WORKSHOPS



Rules & Format

The Chatham House Rule will be invoked at the meeting to encourage openness and the sharing of information: When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.

OPEN MIC: Following the Welcome Note and problem statement by the moderator and featured speakers, the breakout session discussion structure will follow an Open Floor format whereby all participants will be encouraged to proactively engage in the free-flowing conversation and not wait to be called upon to speak.

COME PREPARED WITH RECOMMENDATIONS: All Participants will be encouraged to come to the table with “Recommended Strategies” in answer to the Session’s Critical Question.

In SESSION A:

SHORTLISTING 5 RECOMMENDATIONS

The 1 Hour Session will be broken into 3 parts:

- Commentary from facilitators
- Open mic with recommendations put forward
- Voting on recorded recommendations with final shortlist of 5

In SESSION B:

SHORTLISTING FROM 5 TO 3 RECOMMENDATIONS

The 1 Hour Session will be broken into 3 parts:

- Commentary from facilitators on shortlist of 5
- Author of each of the 5 shortlisted recommendations will get 5 minutes to promote & defend their recommendation
- Voting on Recommendations to reduce Shortlist to 3

Structure

SUNDAY, NOVEMBER 14, 2021, 8:00AM - 2:00PM

NETWORKING BREAKFAST

PLENARY SESSION

STREAM 1: ADVANCING HYDROGEN PARTNERSHIPS

STREAM 2: DEEPENING COLLABORATIVE HYDROGEN

SESSION A
Shortlist Top 5 Recommendations

SESSION A
Shortlist Top 5 Recommendations

COFFEE BREAK

SESSION B
Top 5 Recommendations Shortlisted to 3

SESSION B
Top 5 Recommendations Shortlisted to 3

WORKING LUNCH
POLL SURVEY on TOP 3 RECOMMENDATIONS IN EACH STREAM

Final Declaration of Recommendation & Closing Comments

About



Abu Dhabi National Oil Company (ADNOC) is one of the world's leading energy producers and a primary catalyst for the growth and diversification of the Abu Dhabi economy. With a production capacity of more than 3.5 million barrels of oil per day and 10.5 billion cubic feet of natural gas per day, we operate across the entire hydrocarbon value chain. We have a network of fully-integrated businesses for exploration, production, storage, refining, and trading, as well as the development of a wide range of petrochemical products. Founded in 1971, ADNOC has been responsible for harnessing the UAE's energy resources by meeting the demands of an ever-changing energy market and ultimately transforming our nation. Since our foundation, we have worked tirelessly to honor the legacy of the UAE's founding father by thinking creatively, challenging convention, and striving for excellence in all that we do. Our work plays a crucial role in Abu Dhabi's global emergence. We have enabled our people to realize their remarkable potential, helped create thousands of jobs, driven economic growth, and invested in education and research for the future. Our diverse family comprises more than fifty thousand people who originate from the UAE and beyond, with over 100 different nationalities represented across the company. Backed by their unique perspectives and wide-ranging skillsets, our people share a collective responsibility to accelerate progress, both here in the UAE and across the globe. With an ambitious outlook for the future, we continue to look for innovative ways to maximize the value of our resources, while applying the latest technology, developing mutually-beneficial partnerships, and driving In-Country Value. Together, we are committed to sustaining our positive impact in the communities where we operate and the Abu Dhabi economy for generations to come.



Uniper is a German energy company based in Dusseldorf that generates, trades and markets energy on a large scale. Uniper also procures, stores, transports and supplies commodities such as natural gas, LNG, IMO compliant fuels and other energy related products. We have power generation installed capacity of more than 34GW in Europe and 11GW in Russia. We are active in more than 40 countries and have around 11,500 employees worldwide. Uniper's global commodity trading business sits at the heart of our power and gas portfolio. It optimizes and dispatches our generation assets, guides our gas midstream business, and manages risk. We are Europe's largest Midstream gas company and have a significant and growing merchant LNG business with a portfolio of 9mtpa and which last year traded over 200 cargoes.

Uniper Global Commodities (UGC):

Uniper has been present and active in the Middle East, based in Dubai, since 2007, where as Uniper Global Commodities, we have developed business in commodities such as LNG, IMO compliant fuels, power, gas, freight and energy services and more recently, as Uniper makes it commitment to the 'Energy Transition', in hydrogen.



Mashreq Bank is One of the UAE's best performing banks for five decades, Mashreq is a leading financial institution with an expanding footprint across the Middle East. We have international offices in Europe, Asia, Africa and the US, and a strong presence in the financial capitals of the world. As the oldest bank in the UAE, our journey can be traced back to humble beginnings in 1967, followed by periods of rapid growth and strategic expansion. Throughout our history, Mashreq has differentiated itself by pioneering new-to-market concepts and launching unique products and services. Our innovative approach sets us truly apart. It also continues to win us numerous awards and accolades in all the fields of banking we operate in – Digital, Corporate, Retail, International, Treasury and Islamic, and across the multiple banking channels we deploy – mobile, digital, online, traditional and telephony.



The internationally top-ranked Khalifa University of Science and Technology is the one university in the UAE with the research and academic programs that address the entire range of strategic, scientific and industrial challenges facing the UAE's knowledge economy transformation and our rapidly evolving world. Its world-class faculty and state-of-the-art research facilities provide an unparalleled learning experience to students from the UAE and around the world. The university brings together the best in science, engineering and medicine in the UAE, to offer specialized degrees that can take promising high school graduates all the way to top-rated doctorate degree holders.



The Global Alliance Powerfuels was initiated by the German Energy Agency (dena) together with 16 renowned corporate partners as founding members. The strategic objective of the Alliance is to foster the development of a global market for powerfuels. The Alliance has three main goals: Raise awareness and acceptance of powerfuels as missing link to reach global climate targets; Support the further enhancement of regulatory frameworks with a first focus on Europe as demand region; Stimulate project development to globally enable production capacities on industrial scale, thus increasing cost competitiveness with fossil fuels.



Gulf Intelligence (GI) is the leading strategic consulting group in the Middle East focused on the international energy & natural resources industry. The Dubai-based firm uses more than 10 years of operational experience in the region to offer trusted, fully compliant, and strategic advice. The GI consultancy provides expert and hands-on assistance to international clients looking for opportunities or seeking solutions in the Arab Gulf, as well as supporting national energy stakeholders expand their global engagement.

Recent Workshops

Gulf Intelligence has produced more than 50 workshops to bring together industry, academia and government to deliver tangible intelligence and recommendations to address issues of critical importance.

Recent projects include:

- *Oman Energy Master Plan 2040*
- *Oil Markets Workshop: How Should the Middle East Leverage IMO 2020 to Create a Fujairah Oil Products Benchmark?*
- *Middle East LNG Workshop: Navigate Rise in LNG Spot Trading During Era of Glut?*



Discussion between Participants at the Gulf LNG Workshop in Abu Dhabi



H.E. Salim Al Afi, Undersecretary, Ministry of Oil & Gas, at the Oman Energy Master Plan Industry Workshop



Participants at The Gulf Intelligence Oil Markets Workshop discussing the future Outlook for a Middle East Oil Products Benchmark



Participants casting their recommendation votes at the Gulf LNG Workshop in Dubai

HYDROGEN

State of Play in the GCC?



H₂
Hydrogen

May 2021



Consultancy
Intelligence
Publishing

KEY DEFINITIONS:

- **Grey Hydrogen:** Grey hydrogen is the shade produced with fossil fuels (i.e. hydrogen produced from methane using steam methane reforming (SMR) or coal gasification). The use of grey hydrogen entails substantial CO₂ emissions, which makes these hydrogen technologies unsuitable for a route toward net-zero emissions.¹
- **Blue Hydrogen:** Blue hydrogen is when natural gas is split into hydrogen and CO₂ either by Steam Methane Reforming (SMR) or Auto Thermal Reforming (ATR), but the CO₂ is captured and then stored. As the greenhouse gasses are captured, this mitigates the environmental impacts on the planet. During early stages of the energy transition, the use of blue hydrogen could facilitate the growth of a hydrogen market. Around three-quarters of hydrogen is currently produced from natural gas. Retrofitting with CCS would allow the continued use of existing assets while still achieving lower GHG emissions.²
- **Turquoise Hydrogen:** It combines the use of natural gas as feedstock with no CO₂ production. Through the process of pyrolysis, the carbon in the methane becomes solid carbon black. A market for carbon black already exists, which provides an additional revenue stream. Carbon black can be more easily stored than gaseous CO₂.²
- **Green Hydrogen:** Among the different shades of hydrogen, hydrogen produced from renewable energy – is the most suitable one for a fully sustainable energy transition. The most established technology options for producing green hydrogen is water electrolysis fueled by renewable electricity. Green hydrogen production through electrolysis is consistent with the net zero routes, allows the exploitation of synergies from sector coupling, thus decreasing technology costs and providing flexibility to the power system. Technological improvement is decreasing the cost of production of green hydrogen. For these reasons, green hydrogen from water electrolysis has been gaining increased interest.⁴
- **Carbon Capture, Utilization, and Storage (CCUS):** Carbon Capture, Utilization, and Storage (CCUS) encompasses methods and technologies to remove CO₂ from the flue gas and from the atmosphere, followed by recycling the CO₂ for utilization and determining safe and permanent storage options. Despite the adoption of alternative energy sources and energy efficient systems to reduce the rate of CO₂ emissions, the cumulative amount of CO₂ in the atmosphere needs to be reduced to limit the detrimental impacts of climate change. Therefore, regardless of the deployment of clean and efficient energy solutions, CCUS technologies need to be implemented.⁵
- **Net Zero Emissions:** ‘Net zero emissions’ refers to achieving an overall balance between greenhouse gas emissions produced and greenhouse gas emissions taken out of the atmosphere.⁶
- **The Paris Agreement:** The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on December 12th 2015 and entered into force on November 4th 2016. Its goal is to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century. The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.⁷

Executive Summary

Growing appetite for an increasingly diversified energy mix in Gulf Cooperation Council (GCC) nations is opening a coveted window of opportunity for the region to safeguard its leading role on the global energy stage – and hydrogen plays a central role in the 21st century.

Most countries within the GCC enjoy vast industrial capacity thanks to well-established energy value chains, geographical advantages, and rising local and export energy demand. All these drivers are spurring the region's hydrogen growth ambitions, both at home and abroad.

Partnerships are a central part of this strategy. The UAE is eyeing partners from South Korea, Japan, India, and Germany. And locally, ADNOC and Masdar are playing influential roles via a series of hydrogen agreements. Plus, ADNOC's existing infrastructure and commercial-scale Capture, Utilization and Storage (CCUS) capabilities should help it become a major player in the blue hydrogen market. In Saudi Arabia, Aramco recently signed a Memorandum of Understanding (MoU) with Japan's ENEOS to develop a new hydrogen and ammonia supply chain. Oman's strategic green hydrogen project HYPOR[®] Duqm has signed a cooperation agreement with energy giant Uniper. Under the cooperation for Oman's biggest hydrogen project, Uniper will be joining the project team to provide engineering services and negotiate an exclusive offtake agreement of green ammonia.

But there is still much work to do – hydrogen's regional journey has only really just started. The region must develop enabling and supportive policies that attract investments, launch more pilot projects, and craft more robust national strategies and commitments to give investors much-needed goalposts. All of these factors – and more – are vital to scaling up an industry that many are referring to as the 'new oil of the 21st century'.

More details about how the GCC is flexing its hydrogen plans so far this year are detailed in this report. We track the many milestones achieved in what has been a very proactive five months – and we expect many more to come.

300,000 tons
is the amount of hydrogen ADNOC currently produces a year – it plans to reach more than 500,000 tons in the near future.

Source: ADNOC

20.5 kg/hr
of hydrogen at 1.25MWe of peak power can be produced by the first industrial-scale, solar-powered green hydrogen facility in MENA launched in collaboration with Siemens Energy, Dubai Electricity and Water Authority (DEWA), and Expo 2020 Dubai.

Source: Siemens Energy

\$11trn
is the estimated potential of the hydrogen market globally. It's expected to generate \$2.5trn in direct revenues and \$11trn of associated infrastructure by 2050 as its production is set to increase six-fold.

Source: Bank of America Securities

\$2/kg
is the benchmark cost of green hydrogen that a scaled up industry could deliver in 2030, with \$1/kg in many parts of the world by 2050.

Source: BNEF

ADNOC to Build World-Scale Blue Ammonia Project

Date: May 24, 2021



PROJECT BRIEF

ADNOC will advance a world-scale “blue” ammonia production facility in Ruwais, Abu Dhabi, in the UAE. ADNOC is an early pioneer in the emerging hydrogen market, driving the UAE’s leadership in creating local and international hydrogen value chains, while contributing to economic growth and diversification in the UAE. The facility, which has moved to the design phase, will be developed at the new TA’ZIZ industrial ecosystem and chemicals hub in Ruwais.

Blue ammonia is made from nitrogen and “blue” hydrogen derived from natural gas feedstocks, with the carbon dioxide by-product from hydrogen production captured and stored. Ammonia can be used as a low-carbon fuel across a wide range of industrial applications, including transportation, power generation and industries including steel, cement and fertilizer production. The facility’s capacity will be 1,000 kilotons per annum.

The project will build on the UAE’s position as a major producer and reserves holder of natural gas and leadership in Carbon Capture Utilization and Storage (CCUS). CCUS is the use of advanced technology to prevent CO₂ from entering the atmosphere after it is expended as a by-product of industrial processes. ADNOC today operates, Al Reyadah, the world’s first fully commercial CO₂ facility for the iron and steel industry, and the first commercial-scale carbon capture, utilization, and storage facility in the Middle East. Each year, Al Reyadah captures up to 800,000 tons of CO₂ from local UAE steel production.

PROJECT SOUNDINGS

H.E. Dr Sultan Al-Jaber, UAE’s Minister of Industry and Advanced Technology & Group CEO of ADNOC

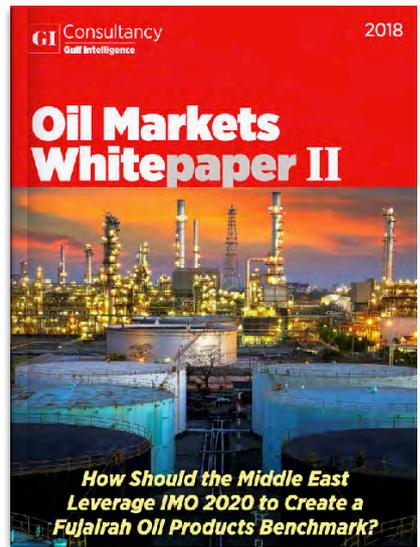
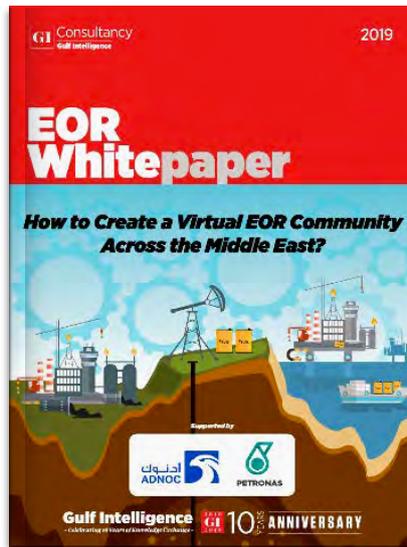
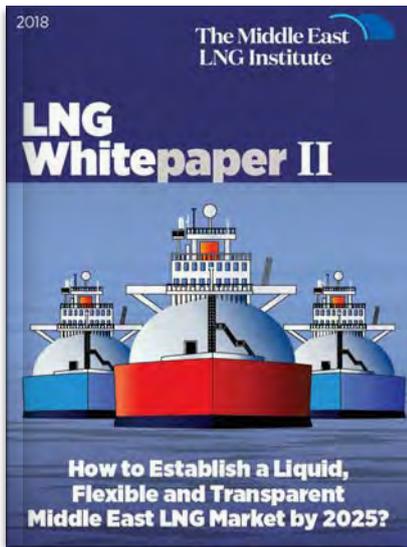
“This is a significant milestone in the development of our blue hydrogen and ammonia business, building on the UAE’s strong position as a producer of competitive, low carbon natural gas and our leadership role in carbon capture and underground storage. As we collectively navigate the global energy transition, we believe hydrogen, and its carrier fuels such as ammonia, offer promise and potential as zero carbon energy sources.”

BACKGROUND READING

ADNOC: <https://www.adnoc.ae/en/news-and-media/press-releases/2021/adnoc-to-build-world-scale-blue-ammonia-project>

The Post-Workshop Whitepaper

Gulf Intelligence will harvest the content from the workshop into a Gulf Downstream Workshop Whitepaper, which will be distributed to the relevant and wider stakeholders.



Whitepaper

STREAM 1
Top Three Recommendations

1. Create a joint Industry and Academia regional Center of Excellence to share EOR knowledge across the GCC and standardize where applicable

50% - 70%
Consensus of industrial EOR & EOR practitioners across the region

4% - 8%
EOR Recovery Rates
Based on current EOR Recovery Rates
Average Recovery Rates

Building for success & Center would be shared by
IOC, manufacturers such as ADNOC, PSC, BOC and Academics. First steps would be to build a database and repository to identify communication the strategic capabilities and use such data to explain EOR recovery. Many plants existing across the region and these should be categorized into two (1, 2, 3, 4) and if for example, to determine quantifiable measurable capabilities to be assessed. One point to be agreed. There are various recovery challenges, energy recovery have been identified, a portfolio of EOR concepts that will serve the region. For example, those which address heavy or light oil.

For a project would also need to be determined. Resources and facilities already available in region should be used.

There are only one or two independent country centers of Excellence for EOR being established in region and that those are still in early stages of being covered and shared. Need to create something for Centre of Excellence at individual country level. First order going to regional level. Suggestion that a virtual Center could also be an option. Is, don't have to be a physical space.

The Gulf

2. Establish the Gulf as a rewarding place to invest in R&D and collaboration

230km
The length of the world's longest oil pipeline in the world (Saudi Arabia to Oman, Saudi Arabia)

Facilities & financial incentives to create value and enable long term investment for EOR. Need to look at increasing financing available for EOR and establishing new private sector investments. Information, in technology needs to be matched with investment in EOR.

Future alternatives in EOR and EOR have no understanding of these and that facilities to raise financing are available. Currently there are no enough facilities to attract more EOR investment. It needs a better regulatory environment. Investors want the opportunity to invest in a global portfolio. Top executive management at IOCs need to be more involved in strategic EOR planning.

3. Gulf EOR Conference Focused on Addressing Strategic & Business Topics

An annual or biennial conference on EOR should be organized, since the time of development.

Whitepaper

WORKSHOP - STREAM 1
What are the Top 3 Steps to Advance EOR Partnerships in the Gulf?

\$140bn
The total investment in the Gulf EOR market in 2020

The global EOR market is expected to cross \$140bn by 2024 (Global Market Insights Inc.) and at a compound annual growth rate of 24%. It is expected to be one of the fastest growing segments within the global oil and gas market (Baker Hughes).

IOCs continue to expand to capture the same growth during this period. The majority of EOR production is under global market review. Some markets are starting to shift, with primary and secondary recovery rates averaging 25%. Achieving tertiary recovery rates requires continued investment in EOR activities and partnerships could be a strong enabler on this path.

Gulf States are developing a number of EOR technologies such as CO2 gas injection, EOR and renewable water-powered thermal EOR. Oman's Mirat project is a successful example of the latter and is expected to deliver the largest peak energy output of any oil field in the world - saving 1.4 trillion Bbls of natural gas and providing a sustainable solution for EOR reuse. How long will other Gulf EOR become a best practice for the Gulf? Has this successful case study been shared with other Gulf States? Expect to see the first country in the region to use its own chemical oil extraction rather than rely on other countries from Gulf parties. Has this been presented as a solution across the Gulf? Surely have shared the EOR Value Chain for adoption to enhance own Gulf partnerships and projects.

Whitepaper

Kuwait became the first country in the region to use its own chemical oil extraction earlier this year, rather than seeking chemicals from third parties. Has this been presented as a solution across the Gulf?

Should Gulf States cooperate on developing bespoke regional EOR solutions?

5%
95%
Yes

Which of the following is the strongest incentive for regional collaboration on developing EOR solutions?

A. Off the shelf solutions not sufficient
B. Custom Bespoke and flexible across the Arabian Peninsula
C. Shared cost and risk of piloting new technology
D. Need to tertiary recovery extraction rates to maintain market share

44%
10%
7%
39%

Although some cooperation is already present amongst IOCs in the region, there is the opportunity for deeper, more structured partnerships which can provide regional investment towards EOR and diverse collaborative alternatives across the industry. Moving Gulf EOR players away from a large approach of working in silos and towards a collaborative energy sector ecosystem.

What are the next steps for developing these partnerships and establishing a region-wide framework that establishes the Gulf as a leader in EOR? Both IOCs and academia have an important role and opportunities - how can this be leveraged to create a world-leading EOR hub in the Gulf? Does the industry need to develop an approach to the lifecycle of its oil fields? How should energy recovery management and EOR investments be addressed?



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