



SCRIBE REPORT

Attendance: 204 delegates over the two days, from 16 countries, and 57 organizations

March 5th (Tuesday) 2024

Short welcoming notes by Abdullah Almutairi (Symposium Chair, Manager Production and Projects – GAS, KOC), Peter Jensen (Executive Co-Chair, ETSA Contract Manager- Jurassic Gas, Shell), and Waleed Refaay (Executive Director AEP), set the stage for two days power-charged discussions and an open dialogue among industry experts, researchers, and practitioners.

Opening Keynotes: The powerful opening session at the Kuwait Hydrogen Symposium was moderated by Mr. Nader Sultan, Senior Energy Expert, and featured Ms. Ameena Rajab Saleh -Deputy CEO (Gas & Environment), Kuwait Oil Company, and Dr. Martha Crawford, Operating Partner at Macquarie, Asset Management, USA. Their keynotes irradiated the vast potential and innovative strategies in the hydrogen sector, emphasizing its transformative potential in achieving a sustainable energy future, a low-carbon economy, and the need for consistent collaborative efforts.

Ameena Rajab Saleh highlighted Kuwait's strategy towards net zero emissions in the Oil & Gas Sector in 2050 and achieving net zero emissions across all other sectors by 2060, where KOC has already set the road map to reducing carbon products with the implementation of renewable energy sources. Securing sufficient CO₂ storage facilities is required to support commercially scaled-up H₂ production and this is in the KOC's priority plans, observing pre-production and post-production cycles to minimize emissions, the carbon capture accumulation, and effectively capturing it.

Dr. Martha Crawford focused on Hydrogen's role in decarbonizing the global Energy Mix – roadmaps, measures, and actions. Starting with an intro to the hydrogen rainbow, she explained what are the policy measures in the US to stimulate supply, scaling, reducing costs. The evolving market demand requires a series of tough adjustments and fast actions, putting regulatory pressure, determining new financing channels, and bridging the gap between VC & PE.

Perspective for Kuwait:

- a) KFAS White paper – from measures into actions, Defining scale – national versus regional
- b) Hydrogen domestic market – Power sector decarbonization; Blue H₂ as a clean feedstock or energy vector
- c) Export market opportunities – Blue Methanol, and Blue Ammonia, for their large volume in terms of shipping.

Regional GCC Plenary Session: Successful Progress, Implementations & Business Models

Speakers:

Shahid Hasan – Fellow Utilities & Renewables KAPSARC

Dr. Sausan Al-Riyami – Director Oman Hydrogen Center

George Beretsos - Chief Commercial Officer GulfCryo

Pradeep Handa - General Manager Foreign Corporate, Oil and Trade Finance Group, National Bank of Kuwait

Challenges in developing a hydrogen economy in the GCC region: GCC countries are known for their low fossil fuel production, and solar energy deployed for the renewables, all components leading to a low-cost decarbonization. For example, the UAE targets 1.4 Mt from Hydrogen by 2031 and Qatar 1.2 Mt by 2026. Hard-to-abate industries are the most primed to explore the use of low-carbon hydrogen, however, H₂ is more expensive than currently used conventional fuels, both in the MENA region and globally. Hydrogen deployment will require concrete and urgent actions on multiple fronts. To incentivize investments in large-scale low-carbon hydrogen production, demand-side policies will be required alongside the business models.

Hydrogen Economy in Oman: Green H₂ production ambition for the Sultanate of Oman in 2030-2050 (Mtpa), includes 1-1.5 Mil by 2030 and 7.5-8.5 Mil by 2050. Three areas with 50,000+ km² have been identified already – Dhofar, Al-Jazir and Duqm. The Ministry of Oil & Minerals will play the key role in developing national policies and regulations, HYDROM is tasked with building the strategy masterplan, ICV, and auctions, while GH₂ projects deployment will be a shared effort between OQ and international developers such as Shell, BP, CIP, Samsung, ENGIE, PTTEP, etc.

Hydrogen as a Key Molecule for Energy Evolution and Sustainability: Kuwait can play a leading regional role towards carbon neutrality initially as a blue and eventually as a GH₂ provider. Its downstream industry can be the “Decarbonization Champion” and create value chain integration. Industrial Hydrogen Hubs and common network infrastructure will contribute to a local H₂ ecosystem and develop new export-oriented industries such as blue methanol & ammonia, synthetic fuels, and other low carbon H₂/CO₂ derivatives. Key enablers are: a. Activation of local demand, b. The national regulatory framework, c. Partnerships on national, regional, and international levels, d. Commercialization of existing and emerging technologies, e. Incentives for capital investments and De-Risk Management.

Kuwait Government Action Plan Carbon Neutrality from 2024-2027: To develop innovative approaches for renewable energy and scaling up investments in Hydrogen production, we must start with evaluating the current market trends, technological advancements, policy support, risk assessment (including Technical, Regulatory, and Market Risks), and mitigation (Diversification, Due diligence, and Strategic partnerships). Financial models are: a. Loans based on future cash flows and assets as collateral; b. Raising capital via debt instruments; c. Investing in start-ups; d. Loans to companies for capital expenditure; e. Mezzanine financing & securitization, f. Funding & insurance to support the underlying funding requirements; g. Banks participate in PPPs in collaboration with the Government & other stakeholders.

Session 1: Fireside Chat Session: Kuwait Hydrogen ascent, key issues, and critical perspective
Presented by: Lynn Ammar – Partner – Cleary Gottlieb Steen & Hamilton, and **Olivia Azadegan** – Independent Advisor in Energy and Climate Policy

The UN’s roadmap sets out milestones the world must reach to achieve net-zero emissions by 2050. Global non-profits can contribute to reaching those goals from an economic and social point of view, influencing the technological and policy changes needed. A major point to be considered is the growing demand for electrification and how we should utilize hydrogen to bridge the gap. A public framework approach is needed to implement emissions reduction and the voice of society does matter. The government’s role is evolving regulations, and incentives, and building infrastructure with the assistance of private-public partnerships, including developing the right policy mechanisms and

grants to stimulate hydrogen production. There is no uniform approach to resolving the immediate challenges, for example, in Europe subsidies were created, while in the US they created taxes.

Kuwait possesses a unique combination of resources to scale up both blue and green hydrogen production, combined with an NOC which is already driving it from outlook to actions, presenting a strong signal for market investments. In addition, the oil sector in Kuwait possesses a strong track record in ammonia production, an emerging hydrogen carrier and potentially an energy vector in its own right, and is spreading with carbon capture, storage, and utilization (CCUS), the pre-requisite for successful “blue” hydrogen production.

Session 2: Hydrogen Potential Markets & Technology

Speakers:

Dr. Ali H. Abdulrahim - Research Scientist, Energy and Building Research Center, KISR

Justin Schaeffer - Licensing Technology Manager Gasification & Blue Hydrogen, Shell

Bassem Zaher ELKADRI - Director of Industry Value Advisory - SAP

The presentations covered a broad spectrum related to the symposium title. It is now widely acknowledged that hydrogen is a very integral component in any organization’s strategy aiming for carbon neutrality. The session included presentations on:

- 1) **Clean hydrogen solutions** for the Kuwait Power sector by KISR
- 2) **The production of decarbonized hydrogen** by Shell
- 3) **Digital capabilities and certification process** for green hydrogen by SAP

The power sector in Kuwait is one of the most GHG emission sectors and requires innovative technologies to achieve the overall target of net zero GHG emissions. The KISR presentation very well emphasized the need for hydrogen in the power sector and the hydrogen roadmap for Kuwait. It is very clear that hydrogen production now requires to be low-carbon intensive and cost-effective.

The blue hydrogen production through POx technology, as described by Shell, can be the right step towards hydrogen in the next decade. Further, the regulators and users must be confident that the green hydrogen that is produced and used, is in point of fact, a green one.

The green certification process as presented by SAP is a forward step to bring that confidence. Further, the whole digital product passport for hydrogen will assist the organization in planning and tracking hydrogen production and its carbon footprint.

Session 3: Risks and Opportunities

Speakers:

Wa’el Almazeedi – Chief Executive Officer – AVANCE Labs

Dr. Michael Tsang – Chief Carbon & Sustainability Accounting Officer AVANCE Labs

Attribute Tracking and Certification as a Risk Management Tool to Enable Hydrogen Trade:

Acknowledging the milestones included: a. Public research done; b. Advisory committees in Kuwait & KSA; c. Thought Leadership; d. Corporate (Accreditation by I-Track Standard Foundation, Hydrogen Passport, Engagement with WTO) and Case study (1st Pilot project – GulfCryo, UAE).

The paradigm shifts to a demand-driven value chain, consumers set price & quality, the value is equitably distributed across the supply chain, and energy attributes for all energy sources are tracked and certified. Hydrogen is the key, but it comes with a bunch of challenges too, which can be classified

into several major categories: Industry challenges; Project bankability, Market response, and Regulatory response. Several industrial countries are already applying consumption-based regulations and cross-border adjustments that will stimulate trade, nevertheless, those are not enough and the road ahead will be a long one.

The I-TRACK Ecosystem is a proven success already, and the principles of attribute certification are Ex-post; Fact-based; Independent; Transparent; Agnostic; Non-biased; Inclusive, and Conflict-free.

GulfCryo pilot project included the I-TRACK (HX) Code on GulfCryo's H2, developing a preliminary certificate and incorporating:

- 1) Screening-level product-level GHG study (i.e. LCA) for H2
- 2) Demonstrate stacking of I-REC (E) certificates and I-TRACK (HX) Certificates;
- 3) Regulatory and third-party 'Labels' are generated
- 4) Net-Zero Benchmark Analysis based on the Avance methodology

Session 4: Hydrogen Infrastructure, Transportation and Exports

Speakers:

Eng. Wael Moati - Gas Industry Expert - OAPEC

Dr. Suleiman M. Suleiman – Associate Research Scientist Energy Efficiency - KISR

Challenges and opportunities of hydrogen transport and key projects in the Arab Region: Identifying the H2 value chain: Production - Storage - Transportation - End users' applications. The current Hydrogen market is huge and growing fast, therefore resolving the challenges of H2 storage and transportation is vital. The partway will include conversion, transportation, re-conversion, and purification, which will require different methodologies for CGH2, LH2, MH3, and MCH.

Examples of mega projects in GCC with remarkable progress are:

- For Green H2 with awarded contracts - NEOM Project (1.2 mt/y of green NH3), KSA, starts up in 2026 and Oman Green NH3 in Duqm (1.2 mt/y of green ammonia: 2 phases), starts up in mid-2025
- For Blue H2 with awarded EPC Contracts - Qatar Blue Ammonia Project (1.2 Mt/y of blue ammonia) starts up in 2026, Taziz Blue Ammonia Project (1 Mt/y of blue ammonia) – UAE, starts up in 2025, Al Jubail Blue hydrogen (153 kt/y of blue H2), KSA, starts up 2025

The Role of Existing Energy Infrastructure for Developing Hydrogen economy, and where we are now, and where we should be? An in-depth review of the main components of hydrogen transportation and hydrogen compression challenge was presented, along with several case studies in recalibration requirements for existing booster stations, electrical energy storage (Green H2) challenges, and limitations, and what are the potential H2 economy scenarios in front of us.

Blue hydrogen will dominate for many years to come until seawater electrolysis becomes feasible. Natural gas will continue to be transported using existing pipeline infrastructure. Conversion from natural gas to hydrogen will remain the most economical near/or at the Power plants, avoiding most of the complex and costly hydrogen transport infrastructure. H2 compression in existing centrifugal compressors will play an important role in the energy transition till H2 reaches 20% in the blended gas mix.

Takeaways from Day 1: Hydrogen is nothing new. We have done it for many years and the technologies are there to produce it, however, the scale is not there yet. We are producing very little today, henceforward to reach the milestones of 2030 and 2050, we need to go quicker, consistently, and resourcefully. No one can make it happen alone, therefore, establishing partnerships and collaboration, creating H2 market space and business models, is vital, while continuing to improve the technology and drive down costs.

March 6th (Wednesday) 2024

Session 5: Panel Discussion “CCUS Challenges & Opportunities”, moderated by Peter Jensen (Executive Co-Chair, ETSA Contract Manager- Jurassic Gas, Shell). An engaging discussion explored the complicated realm of Carbon Capture, Utilization, and Storage (CCUS), unpacking multi-layered challenges presented through the entire value chain.

Speakers:

Murali Guntuku – Lead Engineer Design, Production GAS- KOC (presenting on behalf of Abdullah Almutairi)

Siddarth Ramadurai - Senior Advisor Energy Transition - Halliburton

Otmane Benamar – CTO Gas Power Europe, Middle East & Africa, GE Vernova

Dr. Muhammad Muhammadih – VP Large Industry- GulfCryo

Uwe Zwiefelhofer - Managing Director MENA - LINDE

KPC as a leading organization in the energy sector, has announced its 5 main pillars for decarbonizing Kuwait's O&G industry and the way forward. CCUS is one of them and KOC is tasked to lead the CCUS business and achieve the ambitious target of 26 million ton capacity by 2050. Capturing CO2 from low-pressure sources is a major challenge now, while experts are looking into optimized solutions to reduce the footprint and utilities consumption. Starting with water capture, CO2 transportation and pipelines (coupled with dehydration), and utilization – EOR field development, CCUS facilities in West Kuwait, building CCUS hubs, exploring other areas such as North Kuwait, or even cross-border.

NOCs in the region will lead the energy transition countrywide, while the service majors like Halliburton will support their efforts by two main avenues: a. Incubating low carbon solutions in their daily operations, like using less carbonized cementing compounds and electrical fracking; b. Developing technologies and facilities for CCUS, Geothermal, and Solar energy, as part of the sustainable energy mix. With a high degree of confidence, we can say that CCUS technology is already available in the Middle East, however, understanding or using it is not at the level that it needs to be. The financials behind it are that 70% cost goes to capture, 15% to transportation, and 15% to storage. Safety concerns about CO2 leakage or contamination can easily be resolved by using specific software that models gas migration and tracking. CCUS is here to stay, making it bankable and economically worthy is both a challenge and an opportunity.

GE focused on **how CCUS is managed in the Power generation sector**, as we need to produce electricity and meet the demand of the growing population globally, while still providing electricity in a sustainable way and adequate cost. Natural gas is the transition element and will be used broadly to achieve organic growth. Using H2 in turbines is not new for GE, but the purpose has changed, and they are working on both the pre-and post-combustion. Emissions at the backend are very low in CO2 (4%), which makes the process a very expensive one. How to augment the method is key, and some answers will include steam optimization, exhausted gas re-circulating, and recycling.

With decades of regional experience in the CCUS, GulfCryo sees **CO₂ as an opportunity for converting it into value products**, which is not a simple process and requires insightful knowledge about capture technologies, transport, and end-market usages. The concept planning of the future CCUS projects in Kuwait must cover essential subjects through the entire value chain, from sources to sink. Sources will include - identification of CO₂ emitters/ standardized sampling program/ ranking of the sources according to the CO₂ content to high, medium, and low. Capture process to have the right selection of technologies and alignment to the CO₂ specifications (Food, Industrial, CCS grade), and then we move towards conditioning, transportation, and utilization (for CCS w/t 99 % CO₂ and for other applications with 99.99 % CO₂).

Linde is a market leader in developing CO₂ systems and has an impressive investment portfolio of clean energy, including industrial gas production and engineering solutions, with current low-carbon energy projects under development globally, which include a large-scale hub in Saudi Arabia in partnership with Aramco and SCL, Blue H₂ facility in Texas in partnership with ExxonMobil, a similar project in Alberta, CO₂ liquidizing plant in the Netherlands, etc. About 3 years ago GH₂ was the main focus of everyone, but now BH₂ and CCUS have taken the stage and will have a greater market share, as the technology is already available, it is less risky, much cheaper, and has predictable stable results. If we look at the world map of CCUS, the top countries are the US, UK, Norway, and Netherlands, and the reason is that those governments are supporting CCUS financially and pushing legislation forward. The GCC governments need to do the same as soon as possible and catch up with the EU and US. The local NOCs will play a pivotal role, and we predict that the implementation will be very rapid in this region compared to the rest of the world.

Spotlight Presentation 1: “CO₂ Utilization and Storage - challenges and solutions”

by Prof. Dr.-ING Mathias Franke - Director of Energy Transition, Fraunhofer Institute for Environmental Safety & Energy Technology

An overview of Fraunhofer as a leading organization for applied research, and field studies for sustainable development and restructuring focusing on the circular economy, carbon management, green hydrogen, and local energy systems. CCUS in the European Union and Germany are gaining momentum by the hour. Sizable climate actions are in place already, with only few to mention: the European Net-Zero Industry Act, the European Emission Trading Directive, the European CCS Directive, the Carbon Dioxide Storage Law, the European Climate Law.

Decarbonization ambitions in the GCC are set at net zero till 2050 for Oman and UAE, and net zero till 2060 for Kuwait, KSA, and Qatar. Opportunities for carbon capture and CO₂ utilization in Kuwait are across all sectors, however, priority will be given to power and water, chemicals, petroleum and petrochemicals, construction, cement production, and transport. The selection criteria for CCUS options will be based on the technology readiness and competitive matrix.

Outlook of Kuwait as a regional CCUS Hub:

- Storage of CO₂ in depleted oil fields
- Investment in CCU R&D at demonstration scale
- Capacity building in CCU
- Adaptation of legal framework and policies
- Business models for capture, transport, storage, and utilization of CO₂

Session 6: Enabling Technology – CCUS and Decarbonization

Speakers:

Siddarth Ramadurai - Senior Advisor Energy Transition, Halliburton

Eng. Abdul Hadi Alajmi - Research & Analytical Director, Equate

Hossam Abdulrasoul Jamal - Team Leader Environment, KPNC

Mohammad Khaled Al Mohsen - Senior Engineer Optimization & Capital Planning, KIPIC

Oliver Hagen-Smith - Chief Technology Officer, KNCC

Eberhart W. Gomez - Commercial Director – Europe, Carbon Clean

CCUS uptake needs to grow 120 times over by 2050 for countries to achieve their net-zero commitments. CCUS has been recognized as an essential and relatively low-risk piece of the decarbonization puzzle, but is the technology moving fast enough to achieve a 1.5° or even 2.0° pathway? The session on enabling technology and industrial decarbonization covered a broad spectrum of topics.

Halliburton experience and Envana Catalyst Emissions Management were presented as tools bridging sustainability and operations by offering a standardized workflow for emissions management. Equate explored sustainable energy efforts in Kuwait, focusing on low-carbon hydrogen production and proposing a national strategy for integration.

Kuwait National Petroleum Company discussed initiatives such as a pre-feasibility study on hydrogen as fuel, carbon capture, and projects optimizing efficiency in hydrogen units.

A notable case study from KIPIC evaluated the viability of low-carbon methanol production at the Al-Zour Refinery. Despite a proactive stance on reducing carbon emissions, the study emphasized the necessity of assessing economic viability and technological maturity before adoption. KIPIC committed to ongoing technology monitoring and a reassessment of economic viability when national climate regulations, including carbon taxation, are established.

The trillion-dollar market potential in industrial decarbonization was underscored, with Carbon Clean recognized as a global leader in carbon capture solutions. The discussion highlighted innovative processes enabling the recycling of captured CO₂ for diverse applications, including fuel production, plastics, food and drinks, building materials, soda ash, agriculture, concrete curing, mineralization, and cement manufacturing.

The session also featured KNCC insights into the application of Elevated Pressure (EP) Carbon Capture, Utilization, and Storage (CCUS) in the vessel industry. DNV, representing the Norwegian Maritime Authority, played a crucial role in developing a regulatory roadmap for alternative Carbon Capture and Storage (CCS) specific to the transport of liquid carbon dioxide (LCO₂) on ships.

Spotlight Presentation 2:

“CO₂ Emissions from Waste to Value, a Commitment to Decarbonize Our Region”, by Elie Adaimy- Group Director Business Development, Technology & Innovation, GulfCryo

An overview of the 1st CCUS project in the region completed in Kuwait a decade ago, and footage of GulfCryo's pioneering experience in carbon-capture technology and projects through the years. Seeing CO₂ from a different angle and understanding its value to generate work opportunities, create national economic growth, and improve quality of life. To support the statement, several case studies in different sectors were presented:

- 1) Decarbonizing concrete industry by precise injection and dosage of captured CO₂ into concrete during mixing, where it mineralizes into calcium-carbonate crystals
- 2) Decarbonizing seawater desalination by putting in use recovered CO₂ for desalted water remineralization
- 3) Developing green agriculture - CO₂ injection by air enrichment or water misting for increasing yield, biomass, and quality of production

In conclusion, the challenges in the region are widely discussed and known already, therefore defining the opportunities and mapping the road ahead is critical:

- CO₂ is not a “waste” but an abundant added-value resource
- CCU is a solution where CCS is not applicable
- Recovered CO₂ key contributor in decarbonizing industries
- CO₂U hubs for further collaboration and technology scale-up
- Stimulate recovered CO₂ commercial demand through green investments and regulations
- Setting carbon price and implementation of Carbon taxation
- Governmental support for R&D and pilot projects in the GCC Region.

Session 7: What will be the business model for Hydrogen and CCUS

Speakers:

Dr. Malek Al-Chalabi - Senior Carbon Pricing Policy Advisor, Shell

Shahid Hasan – Fellow Utilities & Renewables KAPSARC

Hasan Jafar - Engineer Process Operations, Al-Zour-LNGI, KIPIC

Yuri Melnikov - Independent Hydrogen Policy Consultant, UNECE Sustainable Energy Division

Dr. Awwal Bamanga – Ass. Director, Nigerian Maritime Administration & Safety Agency

Despite H₂ and CCUS projects growing exponentially worldwide, the commercial deployment has remained relatively flat in the last decade. Can the emerging business models open the door to new investments, or transform the government-subsidized scenarios into public-private partnerships? The session covered many insightful viewpoints under one roof.

Shell's experience and assessment showed how carbon pricing can stimulate countries to achieve net zero emissions as part of a broader policy framework. With only 25% of global emissions being currently priced, carbon markets and pricing will have an integral role to play in scaling CCUS to a commercially viable size and incentivizing Hydrogen production through a variety of policy options.

KAPSARC's study on business models showed that the key risks that business models need to address are market price risk and volume (or offtake) risk. Potential options for H₂ business modeling can be either producer-led revenue or consumer-led revenue supported. Building a green hydrogen ecosystem will require a targeted approach and a strong policy push to create an initial demand market. Designing a model that reduces price inequality in the short run and provides sufficient revenue certainty through binding off-take contracts is the way forward.

Navigating the Green Horizon: leveraging past success for future sustainability was presented by KIPIC with a detailed assessment of the vital role that legislation, partnerships, ownership, and carbon pricing will play in the selection of Green Business Models. Clear mandates and regulations create a level playing field, ensuring fair competition, as well as adhering to the same industry and environmental standards. Financial support can be in the form of CCS grants and clean energy incentives with favorable loan programs with low interest rates.

Dr. Melnikov presented the pivot role of National Hydrogen Strategies (NHS) for hydrogen deployment and achieving a low-carbon future globally. NHS is a leading document for realizing the country's

ambitious plans, it takes a long time (app 10+ years) to be developed, but then again builds trust and provides long-term transparency. It should cohere with the other strategies of national importance and address country-specific barriers. A total of 52 strategies & roadmaps have been published worldwide, including 4 in the MENA region: Morocco (Jan 2021), Oman (Oct 2022), UAE (Nov 2023) and Algeria (Feb 2024).

Navigating Regulatory Changes: Impacts on the African Bunker presentation highlighted the recent changes in the shipping industry, driven by environmental concerns and sustainability goals. The African bunker market has witnessed shifts in demand, supply dynamics, and infrastructure investments as stakeholders strive to meet evolving compliance requirements and contribute to a greener maritime future. Despite many different developments for reducing shipping emissions, using alternative fuels is and will remain the weightiest solution in the short, medium, and long term.

Short closing remarks were made by Abdullah Almutairi and Peter Jensen, thanking all speakers, moderators, session chairs, and committee members for their hard work and months of planning and preparations. Recommendations have been made for scheduling the next Hydrogen event in Kuwait approximately in a year time.