Propose Implementation plan of Methane to Methanol technology to reduce GHG emissions

Prepared for

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Executive summary

Background

The UAE has committed to a comprehensive long-term plan focused on green energy transformation as part of its national strategy to tackle climate change. The country has set ambitious targets, including a 25% reduction in carbon emissions by 2030 and achieving zero emissions by 2050, ensuring sustainable growth for its energy sector.

As a key player in this effort, PetroChina, acting as the asset leader for ADNOC's NEB, plays a critical role in advancing sustainable research and development. Under the 2022 NEB performance contract, the team has actively pursued on-site testing and promotion of carbon reduction technologies, laying the groundwork for continued research in 2023 and beyond.

On an international scale, carbon reduction technologies are rapidly evolving, offering diverse solutions. After accumulating preliminary experience and exploring various technologies, PetroChina is focused on selecting the optimal technology that aligns with NEB's specific carbon reduction needs. In 2023, PetroChina led an international project to assess the latest carbon reduction innovations, proposing several candidates for application in ADNOC fields. Among these, methane-to-methanol conversion for flaring gas reduction was identified as a high-potential pilot technology.

To implement methane-to-methanol technology in NEB oilfields, comprehensive planning is required, especially for its application in carbon reduction at the Central Processing Plant (CPP). Collaborating with international experts, the project team is working on a detailed implementation plan that will offer the technical support needed for NEB's flaring gas reduction efforts, ensuring the project aligns with UAE's green energy goals.

Work Scope

The primary objective of the **KPI-3.2** initiative is to develop and propose an implementation plan for methane-to-methanol (M2M) technology aimed at reducing greenhouse gas emissions at ADNOC's oil and gas operations. The scope of work focuses on exploring, piloting, and evaluating the feasibility of this technology within ADNOC's NEB (North East Bab) asset.

The work scope includes the following key tasks:

1) **M2M Technologies Study**:
   - Analyze the current state of M2M technologies, including both traditional and emerging methods, with a focus on reducing methane emissions.
   - Review market implementation cases to understand practical applications of the technology.

2) **Technology Feasibility Study:**
   - Conduct a detailed assessment of the feasibility of implementing M2M technology in the NEB asset, taking into account gas supply, infrastructure, and environmental benefits.

3) **Pilot Site Selection:**
   - Identify a suitable pilot site within the NEB asset for testing the technology, considering infrastructure and gas flow requirements.
   - Analyze gas flow and processing capabilities to ensure alignment with the pilot project objectives.

4) **Economic and Risk Analysis:**
   - Perform an economic assessment and risk analysis to evaluate the cost-effectiveness and potential challenges of implementing the M2M technology.

5) **Technology Proposal and Vendor Screening:**
   - Propose the most suitable M2M technology solution by screening feasible vendors or service companies.

6) **Pilot Implementation Plan:**
   - Develop a comprehensive pilot implementation plan, including equipment preparation, transportation, deployment schedule, and health, safety, and environmental (HSE) risk assessments.
   - Identify gaps in implementation and propose solutions for continuous improvement.

7) **Final Business Case Development:**
   - Build a final business case outlining the economic, environmental, and operational benefits of the M2M pilot project.

- Present the business case to ADNOC for review and approval.

Throughout 2024, milestones will be set and progress will be tracked, with deliverables expected in **Q3 2024**, including the pilot project plan and final implementation proposal.

Execution status of the project

The joint team had conducted 7 joint weekly and biweekly meetings, presented 7 milestone reports. PetroChina team had performed multiple vendors' visiting and investigations. and one final PPT and word report. These meetings served as valuable platforms for knowledge exchange and collaboration between the research team and the CNPC representatives. By engaging in these discussions, the team gained insights from the vendors and CNPC asset lead team's expertise, enabling a deeper understanding of the project's scope and requirements.

Table 0.1 Summary of meetings and major activities.

	Date	Location	Tasks	Participants
1	2024-3-2	Teams	Methanol tech status and M2M on well site feasibility discussion with Qinghua Uniersity	Jijun Miao, Wei Yu, Tiejun Wang(Qinghua)
2	2024-5-6	Teams	ADNOC KPI3.2 Kickoff meeting	Nasser, Eisa Abulla, Hamoud Abdulbari, Pierre, Jigar, Ahmed, Essa, James Rodgerson, Jijun Miao, Du Wei
3	2024-5-23	Abu Dhabi	SEG CCUS workshop and ADNOC On shore visiting	Jijun Miao, Du Wei, Chenji Wei, Nasser
4	2024-5-25	Yingchuan,China	Visit Lanzhou Petrochemical Co. PetroChina, discuss the M2M joint study	Jijun Miao, Pengfei Li
5	2024-5-27	Teams	Updating and clarifying meeting with ADNOC	Nasser, Awais, Faisal Azza, Shalkha, Yougal, Jigar, Ahmed, Essa, Du Wei, Jijun Miao
6	2024-6-29	Shanghai, China	Shanghai Electro Co. for green methanol case	Zhang Xingning, Jijun Miao, Guozheng Chi
6	2024-7-20	Daqing, China	Daqing PetroChemical Research Institute, PetroChina.	Jiang Wei, Weizhong Wang, Jijun Miao, Zhong Ma
7	2024-8-6	Teams	Key Milestone to conclude M2M is not feasible for NEB CPP	Nasser, Jigar, Ahmed, Essa, Jijun Miao, Wei Du
…	…	…	…	…
8	2024-8-8	Chendu, China	Visit Huaxi petrochemical S&T Lmd for substitute flaring gas reduction	Jijun Miao, Ma Zhong, Hou Shijie
9	2024-8-13	Suining, China	Suining Natural Gas Central Processing Plant visiting	Jijun Miao, Haotian Zhang, Jie Cao, Yu Zhao
10	2024-8-19	Teams	Membrane Gas Holder introduction	Nasser, Jigar, Ahmed, Essa, Du Wei, Cunqi Jia
11	2024-9-6	Teams	Progress meeting with Asset regarding MGH	Nasser, Jigar, Ahmed, Essa, Du Wei, Cunqi Jia
12	2024-9-20	Teams	Milestone meeting with Asset to review implementation of MGH	Nasser, Jigar, Awais, Du Wei, Jijun Miao

Furthermore, the joint weekly and biweekly meetings held with ADNOC played a crucial role in project coordination and progress. These meetings provided an opportunity for effective communication and alignment of objectives between the research team and ADNOC stakeholders. By facilitating regular updates, addressing any concerns, and ensuring clarity in expectations, these meetings ensured a streamlined and collaborative approach to project execution.

After extensive technical research, field evaluations, and economic assessments, it was determined that methane-to-methanol (M2M) technology is neither technically nor economically feasible for the NEB Central Processing Plant (CPP). As a result, the CNPC Asset Leader (AL) team shifted focus toward identifying alternative solutions for addressing the issue of incidental flaring gas at NEB CPP. The new objective became the exploration of alternative technologies

that could enable temporary gas storage during these unplanned flaring events, providing a viable pathway for reducing carbon emissions.

To conclude the project, a final presentation and comprehensive written report were prepared and submitted. The presentation provided a concise overview of the project's key objectives, methodologies, and significant findings, while the written report offered a detailed account of the research process, including thorough analysis, data interpretation, and final conclusions. These deliverables demonstrated the research team's expertise, the value generated by their efforts, and the overall impact of their findings.

Throughout the project, the research team worked closely with both the CNPC asset leadership and ADNOC, engaging in regular meetings, submitting interim reports, and ensuring transparent communication. The final submission of the presentation and report showcased the team's dedication to delivering high-quality research, effectively communicating their results, and ensuring the successful completion of the project’s objectives.

Assessment indicators and their completion status

In alignment with ADNOC's emissions reduction policy for the Abu Dhabi NEB asset group, an analysis and evaluation of the 2022 carbon reduction roadmap was conducted. The feasibility of the proposed implementation plan for 2024 was assessed, including a detailed evaluation of the pilot site and conditions. The alternative flaring reduction technology was identified as the preferred solution. The on-site implementation plans for both methane-to-methanol (M2M) and Membrane Gas Holder (MGH) technologies have been reviewed and are prepared for the next phase of execution.

As part of the project deliverables, both soft and hard copies of all reports, materials, diagrams, and tables were provided for presentations and technical exchanges. Additionally, comprehensive reports and documentation were prepared in English, with both digital and physical copies of the final report submitted. These deliverables offer a thorough overview of the project's analysis, findings, and recommendations, ensuring clear communication and accessibility for all stakeholders.

Table 0.2 Summary of the project tasks.

	Tasks	Achievements	Results
1	M2M technologies study	Accomplished the investigation report	Accomplished
2	Pilot target assessment	Finished the pilot condition evaluation	Accomplished
3	Target Technology Proposal	Proposed a substitute technology of MGH	Accomplished
4	Pilot implementation plan	Proposed the MGH implementation plan	Accomplished
4	Knowledge Sharing	4 times	Accomplished

Conclusion

The project was executed successfully, completing all tasks within the defined scope of work and facilitating key KPI objectives. The formation of an international expert team provided crucial support to CNPC's KPI efforts while delivering substantial value to ADNOC's production evaluation and carbon reduction initiatives. Knowledge-sharing activities throughout the project strengthened ADNOC's confidence in CNPC's technology, earning respect and paving the way for future project opportunities and partnerships.

In optimizing NEB's carbon reduction roadmap, the feasibility of updated technologies was thoroughly evaluated, drawing insights from global case studies. A feasible implementation plan for the methane-to-methanol (M2M) technology was developed to guide pilot projects, supporting technology deployment within the NEB asset team.

The Carbon Reduction roadmap played a pivotal role in informing the 2024 KPI decision-making process at NEB. The project's contribution to carbon reduction efforts demonstrated CNPC's technical capability and innovative approach. Through knowledge sharing and feasibility studies, CNPC garnered approval from NEB members for new task proposals, further enhancing CNPC's visibility and positioning as a technological leader.

The NEB team accepted the feasibility conclusions and the alternative flaring reduction technology proposal. The Membrane Gas Holder (MGH) implementation plan is now poised for potential pilot testing within NEB or other assets. Through this process, CNPC's visibility will increase, and its reputation for technological innovation will continue to grow.