Review of Project Proposed for CSLF Recognition: Al Reyadah CCUS Project (Phase I: Emirates Steel)

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Projects Interaction & Review Team (PIRT)
Al Reyadah is a pioneering initiative and a knowledge hub for Abu Dhabi in CCUS technology, and it is a working platform for future CCUS projects.
Al Reyadah Combating Global Warming & Abu Dhabi’s Sustainability

COP21’s Paris Climate Agreement
Aims to reduce global warming to less than 2°C

Environmental

CO2 EOR helping ADNOC Reservoirs Gas Availability & Sustainability

EOR helping Strategic Gas Demand

Commitment to Abu Dhabi 30% Clean Energy

CCS Global & Regional Leadership

Abu Dhabi Clean Power

Al Reyadah

Abu Dhabi Government

Increased oil Recovery + Domestic Gas Availability

Gas Liberation & Enhanced Oil Recovery (EOR)

CO2 Injection

EOR

CO2 Capture & Transportation Projects

Regulatory Framework?
Project Objective

1) Reduce Carbon Footprint of Abu Dhabi

2) Enhance Oil Recovery in Subsurface Reservoirs

3) Liberates critically important Natural Gas used in Oil fields for Pressure Maintenance

4) Operate a Commercially Self-Sustaining CCUS Facility which Captures Flue Gas CO2 from a Steel Plant, processes to the required Specification, Pressurizes and delivers to Oil fields for Injection for CO2-EOR
Current UAE Business “Challenges”

• Oil Production Sustainability
  – EOR to build Increase & sustain oil production, add reserves

• Hydrocarbon Gas Supply
  – Growth in HC gas demand is expected to increase to meet Abu Dhabi Power Sector:

• High GHG (CO2) Emissions
  – Low Carbon Power (CCS) is key strategy to reduce UAE’s greenhouse gases whilst continuing to meet the country’s growing energy demands

Mitigation: CO2-EOR
Al Reyadah Background

- UAE per capita has a high CO2 generation rates, linked to need of industries and domestic use
- Has a hydrocarbon Industry which requires Enhanced Oil Recovery (EOR)
- What if we can link these two?
- Various studies undertaken to link CO2 producers (sources) and CO2 users for EOR (sinks)
- Emirates Steel facility identified as an ideal choice for a 1st project, given availability of CO2 and proximity to the ADNOC oil fields
- Al Reyadah (Abu Dhabi Carbon Capture Company), Middle East’s first specialized company focused on exploring and developing commercial-scale CCUS projects was launched
Al Reyadah: ME’s 1st Company mandated to develop Commercial Scale CCUS Projects

Enhance Oil/Gas Production with CO2-EOR, while extending Abu Dhabi’s Oil Fields Life

Liberate Natural Gas for Power Generation

Contribute to Reducing UAE’s Carbon Emissions
Project Timeline

- **Nov-2013**: EPC Contract awarded to Dodsal Group to build the facilities & 43km pipeline to ADCO fields
- **Jul-2014**: Construction commenced in Mussafah, Abu Dhabi
- **Nov-2014**: Formally unveiled Al-Reyadah: Abu Dhabi Carbon Capture Company
- **Nov-2016**: Al Reyadah Launch - 1st CO2 at ADNOC fields
- **Apr-2010**: FEED completed
- **Nov-2011**: Successfully completed CO2 pilot injection project at Rumaitha field
- **Jan-2012**: Abu Dhabi CCUS project announced

<table>
<thead>
<tr>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
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<tr>
<td>H1</td>
<td>H2</td>
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<td>H2</td>
<td>H1</td>
</tr>
<tr>
<td>EPC Award</td>
<td>Engineering &amp; Procurement</td>
<td>Construction</td>
<td>Commissioning</td>
<td>Operation / Stabilization</td>
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Al Reyadah Mandate

Al Reyadah is a new ADNOC OPCO specialized in CO2 Supply

Mandate:

- To manage the CO2 supply to both ADNOC’s Onshore & Offshore assets for CO2-EOR requirements
- Create a CO2 Network & Hub in order to achieve flexibility between CO2 Supply and Injection requirements “like GASCO supplying HC Gas”
- Share learning from a pool of strategic technical advisors from an array of various specialists and scientists including; US DoE, GASCO R&D, ADNOC R&D, Masdar Institute, PI, Khalifa University, and various other technical institutes, organizations and major Oil/Gas Companies & Service Providers

Vision:

To maximize profitability by a robust CO2 Master Plan to ensure ADNOC’s OPCOs CO2 EOR Pilots & Development Plans Commitments while contributing Sales Gas to the Government’s future energy and reducing Carbon Footprint.

Mission:

Efficiently provide OPCOs the required CO2 volumes in a timely manner and at the right location with optimized new technologies and CO2 price
Al Reyadah Location
CO2 Dehydration & Compression Facility
Project Technical Overview

Al Reyadah Carbon Capture Usage and Storage (CCUS)

1. Up to 800,000 tons of CO₂ captured from Emirates Steel manufacturing complex
2. CO₂ transferred to Al Reyadah plant for compression & dehydration
3. Metered and exported through a 43km buried pipeline for Enhanced Oil Recovery to ADNOC’s NEB (Al Rumaitha) and Bab onshore oilfields

- World’s 1st fully commercial CO₂ Capture from Iron & Steel Industry. Middle East’s 1st Commercial Scale Carbon Capture Project
- A commercially self-sustaining project with No Governmental Subsidies
- Start-up of the project is completed and stabilization underway
- Working towards multiple industrial scale CCUS projects and CO₂ pipeline network aimed at reducing the carbon footprint in line with ADNOC’s 2030 Strategy and Abu Dhabi Vision 2030
Generic Steel Making Flowsheet

BF - Blast Furnace; DR - Direct Reduction; DRI - Direct Reduced Iron; EAF - Electric Arc Furnace; BOF - Basic Oxygen Furnace; OHF - Open Hearth Furnace
Iron Making – A CO2 Intensive Process

70% - 80% CO2
Al Reyadah CO2 Source:

HYL / Energiron DRI Process
Direct Reduced Iron (DRI) Process

**Process Objective:** Capture 800 KT/Y byproduct CO₂ emitted from ES DRI plants and deliver it to ADNOC Oil Fields for use in EOR

**CO₂ is generated by Process of Direct Reduced Iron (DRI)**

- **In-situ Reforming**
  - CH₄ + H₂O → CO + 3H₂
  - CH₄ + CO₂ → 2CO + 2H₂

- **Reduction**
  - Fe₂O₃ + 3CO → 2Fe + 3CO₂
  - Fe₂O₃ + 3H₂ → 2Fe + 3H₂O

- Methane Gas is reformed to a H₂ & CO Syn Gas

- Iron Ore (Fe₂O₃) is reduced to Iron (Fe) in reactor, producing CO₂ & H₂O waste

- CO₂ is removed via a traditional MEA Amine Absorption System

- CO₂ rich waste stream (>99% dry) is available for the CCS Project

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**CO2 Capture Technology**

**Conventional Amine** Solvent based Absorption/Regeneration System remains the preferred Technology for CO2 Capture

CO2 rich gas is absorbed in an Ammine absorber (MDEA) (Methyl Di Ethanol Amine)

CO2 which is desorbed from the rich amine is cooled and sent for dehydration and compression

CO2 absorbed rich amine is regenerated in a Desorber at 110 Deg. C bottom temperature

CO2 for Utilization and Sequestration

CO2 Rich Gas

CO2 Lean Gas

Steam
Process Overview

Feed CO2 (0.5 bar)

Emirates Steel

1

2

LP Compressor
(Integrally geared 6-Stage Centrifugal (0 – 41 barg))

Dehydration Package
(Reduce water content to 20lb/MMSCF)

HP Compressor
Reciprocating 2 Stage Compressor (35 - 238 barg)

Mass Flow Meter
(0.8 Million TPA or 41.5 MMSCFD)

Pig Launcher & Pipeline
8" X65 API5L Carbon Steel Buried Pipeline

Product CO2
(98% min purity)
CO2 Compression Facility - Layout

- Future Expansion
- Compression Shed
- Utilities
- Control Room
- Electrical Sub-station
- Transfer Lines
CO2 Transmission Pipeline - Location

8” X65 API5L carbon steel buried pipeline designed for 245barg with Telecoms, SCADA, CCTV & Leak Detection running over buried fibre optics

Rumaitha Metering Station: Custody Mass Transfer Meter (Coriolis Meter), complete with Gas Chromatograph and Moisture Analyser
Construction Highlights

- No Lost Time Incident (LTI) during the entire project. Over 4.6 million man-hours without an LTI
- Approx. 80kms of piping at a weight of 270 Tonnes
- 800 Tonnes of Rebar and Structural Steel
- 7000 m³ of Concrete poured
- 260km of Electrical and Instrument Cable installed
- 42kms of Transmission Pipeline
- The Control Room and Administration Building is Pearl 2 rated for Green Building Energy Conservation
- The LP Compressor – an Integral 6 Stage Centrifugal Compressor is one of the largest ever manufactured by Ingersoll Rand
Construction of CO2 Pipeline

- 8” X65 API5L Carbon Steel buried pipeline designed for 245 barg
- 2 Block Valve Stations for emergency venting of CO2 in case of pipeline leak
- Remote isolation and maintenance blowdown facilities
- Pipeline Safety: Telecoms, SCADA, CCTV and Leak Detection running over buried fibre optics

CCS Facility
Mussafah Section

Rumaitha Section
3D Model of the Facility
Abu Dhabi CCUS Project is Al Reyadah’s Phase-I (CO2 Source: Emirates Steel) of an integrated CCUS network linking industrial emitters with oil fields. Overall CCUS network is expected to multiply over 20 folds as a result of establishing the CCUS economic sector.
Al Reyadah - Abu Dhabi Carbon Carbon Capture Company
Phase-I: Emirates Steel - Highlights & Summary

- **World’s 1st fully Commercial CO2 Capture Project from Steel Industry** (Emirates Steel)
- **Captures 800,000 T of CO2** at Emirate Steel, compresses & dehydrates and **Transports through a 43 km Pipeline** for injection into ADNOC oil wells for CO2-EOR
- Operates **Highest Pressure (240 bar) CO2 Pipeline in the World**
- **Combats Climate Change** by eliminating CO2 equivalent to 170,000 cars’ emission
- **Commercially Self-Sustaining** project with **no Governmental Subsidies**
- **Working towards Multiple Industrial scale CCUS Projects & CO2 Pipeline Network/Hub** aimed at reducing the carbon footprint in line with Abu Dhabi vision 2030
- **Driven by the requirement to Capture CO2 from Multiple Industries** & the high potential availability of CO2 storage
- **Current CO2 Supply Potential: 1.6 Bscfd** (ADNOC group & industrial sources in Abu Dhabi which is expected to increase due to the expected increase in sour gas production and the new expected power plants)
Thank You