CO_2 Storage Resource Catalogue

Cycle 3 Report

March 2022

Amounts of CO_2

Stored
0 Gigatonnes

Commercial
0 Gigatonnes

Sub-commercial
0.8 Gigatonnes

Undiscovered
17 Gigatonnes

Appendix D : Middle East & North Africa

Kuwait
Oman
Qatar
Saudi Arabia
UAE

Contents

Change record for STOR-SW-RP-0001-A01/Appendix-D

All changes at A02 revision or above must be detailed.

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Important notice

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1.0 Kuwait

1.1.1 Summary

Kuwait was assessed during Cycle 3. The CSRC has identified a CO_2 storage resource for Kuwait as follows:

Classification	CO_2 storage resource (Gt) Project and no project	CO_2 storage resource (Gt) Project specified only
Stored	0.00	0.00
Capacity	0.00	0.00
Sub-Commercial	0.00	0.00
Undiscovered	0.44	0.00
Aggregated*	0.44	0.00

* The aggregated resource represents the summed storage resource across all maturity classes and as such should not be viewed as representative of the potential of the country.

Table 1-1: Storage resource classification summary for Kuwait.

- Kuwait has one site in the CSRC: 1 saline aquifer (Undiscovered; 0.440 Gt).
- The identified site in Kuwait is classed as “Undiscovered: Inaccessible” due to the lack of CCS regulatory framework for the country.
- There currently are no defined CCS projects in Kuwait.

1.1.2 Evaluation History

Subsurface geologic data in Kuwait is highly restricted and no comprehensive evaluations of the CO_2 storage potential of Kuwait have been completed. Kuwait's proven crude oil reserves exceed 100 billion barrels [1]. This suggests significant unassessed geologic storage likely exists in Kuwait's depleted oil and gas fields and saline aquifers.

1.1.3 Resource Review

1.1.3.1 Major Projects

No CCS project announcements have been made for Kuwait.

1.1.3.2 Depleted Oil & Gas Fields

Kuwait is a prolific hydrocarbon producing country, but its resources for the geologic storage of CO_2 have not been characterized. Its world-class oil and gas resources suggest significant potential for geologic storage of CO_2.

1.1.3.3 Saline Aquifers

One study, by Neele et al. [2], surveyed the CO_2 storage potential in Kuwait and determined the optimal storage site in the country to be the Kra Al-Maru trend. The Kra Al-Maru trend is approximately 320 km^2 and comprises three suitable Cretaceous sandstone reservoirs (Wara Fm., Burgain Fm., and Zubair Fm.). Reservoir thicknesses, porosities, or permeabilities were not provided in the Neele et al. evaluation, but the authors report the formations span "several hundred meters" in thickness, at depths between 2000 and 3000 m with "good to excellent reservoir quality." The regional containment unit is the Ahmadi Formation – a shale unit ranging in thickness from 52 to 128 m. Static and dynamic 3D geologic models were developed for the site, but no details on the modelling were published, apart from the total storage resource of 440 $MtCO_2$ (over the assumed 40 year life of the capture facilities).

1.1.4 Regulatory Framework

Kuwait has not developed a CCS-specific regulatory or legal framework and has not been evaluated in the GCCSI CCS Readiness analysis.

1.1.5 Issues for the Assessment

Very little subsurface data is publicly available for Kuwait, so although the CO_2 storage potential in the country is likely high (implied by its extensive oil and gas resources), the total CO_2 storage picture remains unclear. The Neele et al. [2] evaluation which is assessed here is problematic because very little information is published on their storage modelling work. While their evaluation appears to have been robust with a 3D geologic model and dynamic simulation, no reservoir, well, or injection data were provided. Importantly, it is unknown how their storage resources are partitioned amongst the three reservoir intervals in the Kra Al-Maru trend.

Additionally, some amount of containment risk for future projects exists in the study area, as the authors note the CO_2 is expected to encounter two legacy wells. Well locations and a detailed map of the study area were not provided.

As a result of the low maturity of the resource estimation, only a single value is provided for the assessed resource and has been recorded as the 'Mid-Range' estimate of resource potential. As future studies are planned in Kuwait, effort needs to be made to move towards generating probabilistic resource evaluations.

1.1.6 Future Updates

1.1.6.1 Future Updates for Evaluators

A comprehensive, country-wide assessment of Kuwait's geologic storage resources is required for both saline reservoirs and depleted oil and gas fields. While the Neele et al. [2] publication did conduct a country-wide screening, they focused solely on identifying the optimal storage site, rather than completing a comprehensive storage evaluation. In order to fully understand the CO_2 storage resources of the country, all possible sites need to be characterized and assessed.

1.1.6.2 Future CSRC Cycles

Updates to this Cycle 3 assessment should be completed if additional studies on Kuwait's storage resources become available.

2.0 Oman

2.1.1 Summary

Oman was assessed during Cycle 3. The CSRC has identified a CO_2 storage resource for Oman as follows:

Classification	CO_2 storage resource (Gt) Project and no project	CO_2 storage resource (Gt) Project specified only
Stored	0.00	0.00
Capacity	0.00	0.00
Sub-Commercial	0.00	0.00
Undiscovered	0.00	0.00
Aggregated*	0.00	0.00

* The aggregated resource represents the summed storage resource across all maturity classes and as such should not be viewed as representative of the potential of the country.

Table 2-1: Storage resource classification summary for Oman.

- Oman has zero sites in the CSRC database

2.1.2 Evaluation History

Oman was reviewed during Cycle 3 [3]. Although Oman is a prolific hydrocarbon producing country, its resources for the geologic storage of CO_2 have not yet been characterized in the public domain. Its world-class oil and gas resources suggest significant potential for geologic storage of CO_2 does exist and should form the subject of any future evaluation effort.

2.1.3 Regulatory Framework

Oman has not developed CCS-specific regulatory or legal frameworks and has not been evaluated in the GCCSI CCS Readiness Index.

2.1.4 Future Updates

2.1.4.1 Future Updates for Evaluators

A comprehensive, country-wide assessment of Oman's geologic storage resources is required for both saline reservoirs and depleted oil and gas fields.

2.1.4.2 Future CSRC Cycles

Updates to the Cycle 3 assessment should be completed if studies on Oman's CO_2 storage resources become available.

3.0 Qatar

3.1.1 Summary

Qatar was assessed during Cycle 3. The CSRC has identified a CO_2 storage resource for Qatar as follows:

Classification	CO_2 storage resource (Gt) Project and no project	CO_2 storage resource (Gt) Project specified only
Stored	0.00	0.00
Capacity	0.00	0.00
Sub-Commercial	0.01	0.01
Undiscovered	0.22	0.216
Aggregated*	0.23	0.225

* The aggregated resource represents the summed storage resource across all maturity classes and as such should not be viewed as representative of the potential of the country.

Table 4-1: Storage resource classification summary for Qatar.

- Qatar has one site in the CSRC: 1 saline aquifer (Discovered/Undiscovered; 0.225 Gt).
- The discovered portion of the identified site in Qatar is classed as "Sub-Commercial: Inaccessible" and the remainder of the site is classed as "Undiscovered: Inaccessible" due to the lack of a CCS regulatory framework for the country.
- There are currently three defined CCS projects in Qatar (Qatar LNG CCS, Qatar Fuel Additive Company CCS, North Field East Project).

3.1.2 Evaluation History

Subsurface geologic data in Qatar is highly restricted and no comprehensive evaluations of its CO_2 storage potential have been completed. The world's largest non-associated gas field (> 900 TCF [4]) is located in Qatar, in addition to other substantial oil and gas resources. Significant unassessed geologic storage likely exists in depleted oil and gas fields as well as saline aquifers.

3.1.3 Resource Review

3.1.3.1 Major Projects

- In February of 2021, Qatar Petroleum announced a final investment decision of 28 billion dollars for development of the North Field East Project (NFE), which will be the world's largest LNG project. The project will comprise 4 LNG trains with a carbon capture and storage system to be integrated with the existing Ras Laffan (Qatar LNG) CCS project [5].
- Qatar Fuel Additive Company currently captures 0.2 Mtpa at its methanol refinery [6].
- The Ras Laffan LNG CCS facility has been operational since 2020. Its initial capture rate is 2.1 Mtpa, but is projected to grow to 5 Mtpa by 2025 [6].

3.1.3.2 Depleted Oil & Gas Fields

Qatar is a prolific hydrocarbon producing country, but its resources for the geologic storage of CO_2 have not been characterized. Its world-class oil and gas resources suggest significant potential for geologic storage of CO_2 exists.

3.1.3.3 Saline Aquifers

One evaluation, by Ahmed and Nasrabadi [4], has characterized the storage potential of the Aruma saline aquifer in Qatar. The aquifer is a granular limestone averaging 130 m in thickness over an area of 1985 km^2. These authors published well data for four new deep wells in the Aruma aquifer, but data for the existing 11 wells in the evaluation area were not provided. The Ahmed and Nasrabadi [4] evaluation tests two CO_2 development plans: one model comprising 8 injectors and one model comprising 6 injectors with 2 brine producers. The 6-injector model did not exceed the overburden fracture pressure and was able to inject 225 $MtCO_2$ into the formation.

3.1.4 Regulatory Framework

Qatar has not developed CCS-specific regulatory or legal frameworks and has not been evaluated in the GCCSI CCS Readiness analysis.

3.1.5 Issues for the Assessment

Very little subsurface data is publicly available for Qatar, so although the CO_2 storage potential in the country is likely high (implied by its extensive oil and gas resources), the total CO_2 storage picture remains unclear. The Ahmed and Nasrabadi study [4] assessed here is problematic because their model includes reservoir depths of 300-400 m, which is well above the generally accepted 800 m threshold depth for dense phase geologic storage of CO_2.

While the current storage assessment appears robust with a 3D geocellular model and dynamic simulation, some amount of containment risk for future projects exists in the study area due to the 15 legacy wells.

Pressure data from the wells was not provided. The simulation model calculated an assumed initial pressure based on a hydrostatic pressure gradient. Porosity and permeability data were averaged for the CSRC database with values ranging from 11% - 16% and 2263mD - 4187mD, respectively.

As a result of the low maturity of the resource estimation, only a single value is provided for the assessed resource. This has been recorded as the 'Mid-Range' estimate of resource potential. As future studies are planned in the region, an effort needs to be made to move towards generating probabilistic resource evaluations.

3.1.6 Future Updates

3.1.6.1 Future Updates for Evaluators

A comprehensive, country-wide assessment of Qatar's geologic storage resources is required for both saline reservoirs and depleted oil and gas fields. Future studies should focus on storage resources at suitable depths (exceeding 800 m) for geologic storage of CO_2.

3.1.6.2 Future CSRS Cycles

Updates to this Cycle 3 assessment should be completed if additional studies on Qatar's storage resources become available.

4.0 Saudi Arabia

4.1.1 Summary

Saudi Arabia was assessed during Cycle 3. The CSRC has identified a CO_2 storage resource for Saudi Arabia as follows:

Classification	CO_2 storage resource (Gt) Project and no project	CO_2 storage resource (Gt) Project specified only
Stored	0.00	0.00
Capacity	0.00	0.00
Sub-Commercial	0.742	0.00
Undiscovered	0.00	0.00
Aggregated*	0.742	0.00

* The aggregated resource represents the summed storage resource across all maturity classes and as such should not be viewed as representative of the potential of the country.

Table 5-1: Storage resource classification summary for Saudi Arabia.

- Saudi Arabia has one site in the CSRC: 1 oil field (Discovered: Inaccessible; 0.742 Gt).
- The identified site in Saudi Arabia is classed as "Discovered: Inaccessible" due to the lack of a CCS-specific regulatory framework for the country.
- Saudi Arabia currently has one defined project – the Uthmaniyah CO_2-EOR demonstration project (0.8 Mtpa) [7].

4.1.2 Evaluation History

Subsurface geologic data in Saudi Arabia is highly restricted. Several publications have noted the highly suitable geologic storage resources in the country, yet the majority of storage resource characterization to-date has been high-level and regional in scope [8], [9]. Saudi Arabia's proven crude oil reserves exceed 260 billion barrels [1]. This tremendous volume of oil resources suggests significant unassessed geologic storage for CO_2 likely exists in Saudi Arabia's depleted oil and gas fields and saline aquifers.

Several authors have developed geologic models of geologic formations in Saudi Arabia. Issautier et al. [10] conducted a detailed outcrop-based sequence stratigraphic analysis of the Late Triassic Minjur sandstone. The authors constructed a geologic model from their outcrop analysis and estimated a theoretical 20 km x 20 km x 80 m Minjur sandstone reservoir could hold a mass of 30.5 $MtCO_2$. Khan et al. [11] studied the geomechanical response to CO_2 injection in Saudi Arabia's Cretaceous Biyadh sandstone. While their study did not focus on storage resources, their model estimated a theoretical 8 km^2 Biyadh sandstone reservoir could hold a mass of approximately 5 $MtCO_2$. These theoretical resource calculations could be useful in future quantitative subsurface CO_2 storage resource evaluations.

The storage resources assessed in this cycle for Saudi Arabia were published in a presentation by Salas et al. [12]. These authors built dynamic 3D models of the Permian Unayzah Formation and estimated 741.47 Mt CO_2 could be stored (employing the US DOE methodology). Very little information was provided for their work, but the

presentation describes facies models and indicates subsurface well control, and thus could be classified as discovered resources in the CSRC.

4.1.3 Resource Review

4.1.3.1 Major Projects

- The Uthmaniyah CO_2-EOR project captures 0.8 Mtpa CO_2 from the Hawiyah Natural Gas Liquids processing facility and transports it 85 km for storage and enhanced oil recovery in the Uthmaniyah oil field [7].
- Saudi Aramco and Hyundai Heavy Industry Holdings signed a Memorandum of Understanding in March 2021 for development of blue hydrogen in South Korea [13]. Ships will bring liquified petroleum gas from Saudi Arabia to South Korea for blue hydrogen production and the captured CO_2 will be shipped back to Saudi Arabia for enhanced oil recovery.

4.1.3.2 Depleted Oil & Gas Fields

Saudi Arabia is a prolific hydrocarbon-producing country and features the world's largest onshore oil field (Ghawar field). Its geologic storage resources for CO_2, however, have not been adequately characterized. Salas et al. [12] have estimated 741.47 $MtCO_2$ are present for one site in the Unayzah Formation; however, many more world-class oil and gas resources exist beyond this site, suggesting significant additional storage potential beyond what Salas et al. [12] have published.

4.1.3.3 Saline Aquifers

Saudi Arabia's geology is highly suitable for geologic storage of CO_2 [8], [9], but country-wide characterization of its saline aquifer storage resources has not been completed.

4.1.4 Regulatory Framework

While Saudi Arabia has allowed state-owned enterprises to utilize CCS for enhanced oil recovery operations, the government has yet to establish a CCS-specific regulatory or legal framework which would encourage private investment in CCS projects.

4.1.5 Issues for the Assessment

Very little subsurface data is publicly available for Saudi Arabia, so although the CO_2 storage potential in the country is likely high (suggested by its extensive oil and gas resources), the total CO_2 storage picture remains unclear.

The resources assessed in this cycle provided very little information about storage sites, well control, and formation parameters. We've included the resources as Discovered: inaccessible, but significantly more information is needed to mature these resources toward commerciality. Additional published geologic models of Saudi Arabian geologic formations reviewed in this Cycle are not valid subsurface models (i.e. they are either outcrop models or strictly theoretical block-models). As such, these data cannot be included in the CSRC.

4.1.6 Future Updates

4.1.6.1 Future Updates for Evaluators

A comprehensive, country-wide evaluation of Saudi Arabia's geologic storage resources is required for both its saline reservoirs and depleted oil and gas fields. Geologic models should be built for valid subsurface reservoir segments

utilizing well- and seismic- data to constrain model dimensions and stratigraphic architecture. In order to fully understand the CO_2 storage resources of the country, all possible sites need to be characterized and assessed.

4.1.6.2 Future CSRC Cycles

Updates to this Cycle 3 assessment should be completed if additional evaluations of Saudi Arabia's storage resources become available.

5.0 United Arab Emirates

5.1.1 Summary

The United Arab Emirates (UAE) was assessed during Cycle 3. The CSRC has identified a CO_2 storage resource for the UAE as follows:

Classification	CO_2 storage resource (Gt) Project and no project	CO_2 storage resource (Gt) Project specified only
Stored	0.00	0.00
Capacity	0.00	0.00
Sub-Commercial	0.00	0.00
Undiscovered	16.70	5.91
Aggregated*	16.70	5.91

* The aggregated resource represents the summed storage resource across all maturity classes and as such should not be viewed as representative of the potential of the country.

Table 6-1: Storage resource classification summary for UAE.

- There are currently 4 sites all within one basin (Rub al Khali) in the UAE.
- Two of the sites are considered to be projects.
- All sites are saline aquifers.
- There are no operating CCS projects active in the UAE.
- The UAE government has recognized the need for CCS to reduce the countries emissions, Tsai 2014.

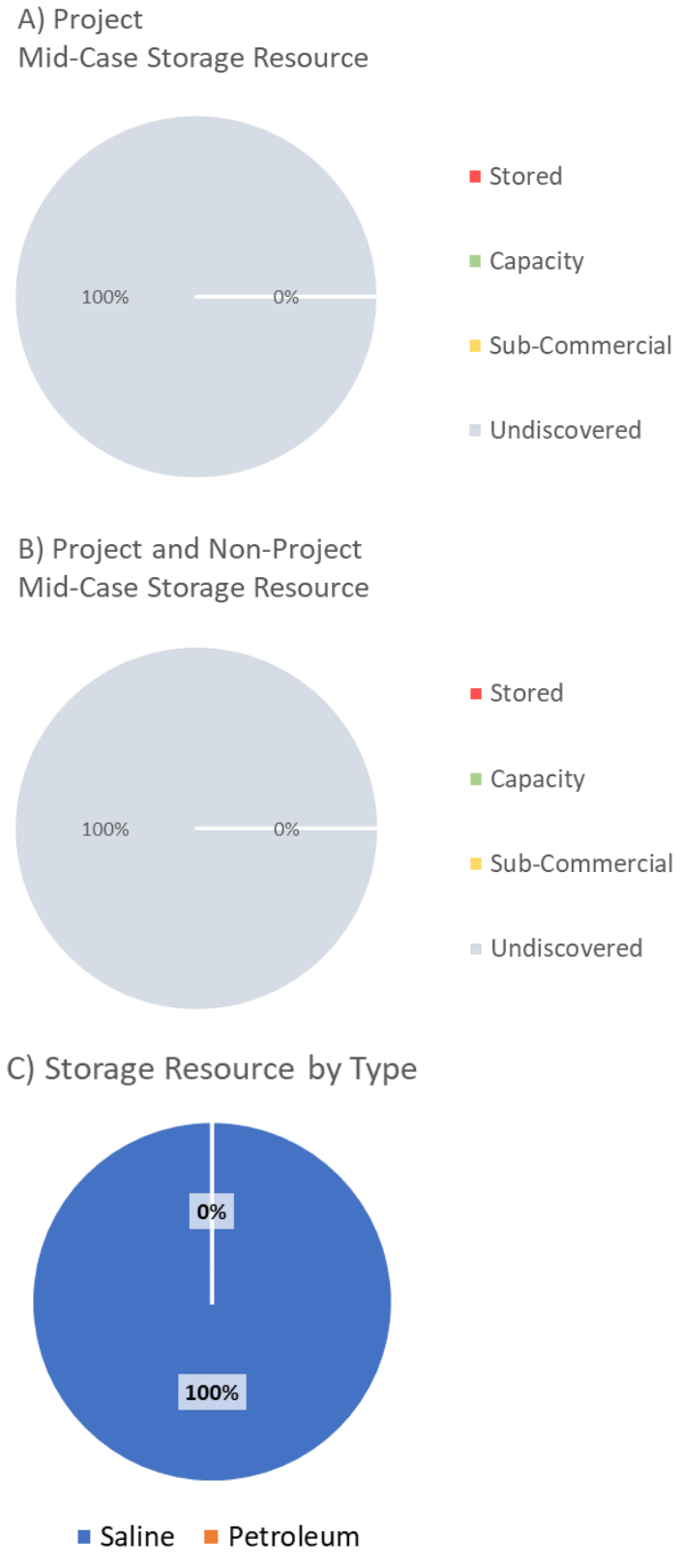

Figure 6-1: a) Spread of storage resource in UAE sites (4) across SRMS classifications, where a project has been specified. b) Spread of storage resource in all UAE sites across SRMS classifications; both project specified and not. c) Split of UAE storage resource between saline aquifers and hydrocarbon fields, both project specified and not.

5.1.2 Resource Statement

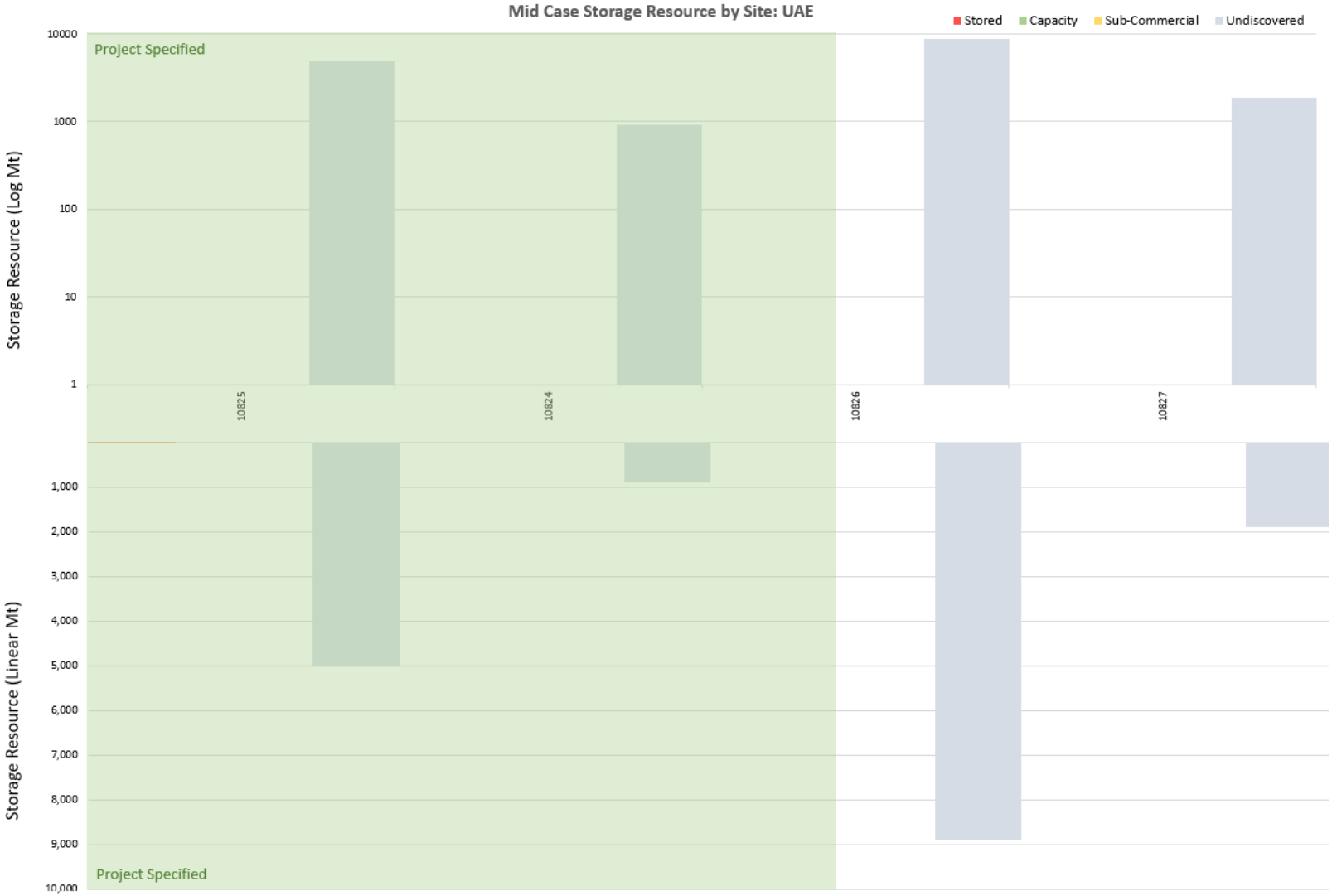

Figure 6-2: Storage resource summary for UAE compiled in the CSRC. Graph above is log scale and graph below is linear. Green box highlights sites where a project has been specified.

5.1.3 Evaluation History

There are three sources presenting potential resources for the UAE: Ajayi et al 2016 [14], Ajayi et al 2019 [15], and Khan et al 2019 [16]. All three provide information on the Lower Cretaceous Shuaiba Aquifer, but only Ajayi et al 2019 [15] expands this to include the Simsima, Umm Er Radhuma and Dammam aquifers. These three sit in the same AOI as Shuaiba but shallower in the stratigraphy (Upper Cretaceous, Palaeocene & Eocene respectively). Ajayi et al 2016 [14] and Ajayi et al 2019 [15] are linked studies and both are co-authored by Abu Dhabi National Oil Company which hints to their source of funding.

The earliest publication [14] initiates with site selection taking into account salt domes, abandoned oil and gas fields, and shallow and deep aquifers. The following criteria were considered during site selection: long-term storage capacity, permeability, sealing efficiency, closure and leakage conditions, risks (distance from cities), costs (distance from source) and available knowledge of reservoir continuity. Here the Shuaiba aquifer was identified as having the best potential for storing CO_2, subsequently a large static geological model was created using well and seismic data. This model was then split up into downsized sector models in order to run dynamic simulations.

Ajayi 2019 [15] started by calculating a volumetric resource (from static models) for the Simsima, Umm Er Radhuman, Dammam and the Shuiaba aquifers. Out of these four, the Simsima and Shuiaba were chosen for dynamic simulation due to their favourable depth and reservoir properties. The simulations were run using GEM to account for buoyant trapping, solubility trapping and residual/ capillary trapping over 100 years of injection and 4000 years shut in. The end resource for the Shuaiba aquifer was the same as that presented in Ajayi 2016 [14]. However, in the 2019 paper, more information was given on well locations and well data allowing a portion of this site to have discovered status under the SRMS.

Khan 2019 [16] also presented a resource study of the Shuaiba aquifer using 2D numerical modelling over 20 years of injection at 0.73Mt/year. This study was also accompanied by an economic assessment using a chemical looping plant with hydrogen reformer as the source of CO_2 to be stored. The final cost of CO_2 storage was estimated at $4.58/ ton. This study does not present a final resource, however, it is calculated at 14.6Mt after 20 years of injection, we know from Ajayi 2019 [15] that the Shuaiba aquifer can store 60 times this.

Published evaluations of potential storage resources in the UAE have focused on the Rub al Khali basin ([15] [14] [16]). Several storage types were considered: salt domes, abandoned oil and gas fields, and shallow and deep aquifers. Four saline aquifers (the Shuaiba, Simsima, Umm Er Radhuma, and Dammam formations) have been identified as having storage potential from these studies, which considered several screening criteria (long-term storage capacity, permeability, sealing efficiency, closure and leakage conditions, distance from cities, distance from source and available knowledge of reservoir continuity). Regional scale, static geological models have been built of each of these reservoirs, and deterministic estimates of storage resource have been calculated. Additional dynamic simulation of the Shuaiba and Simsima ([15]) aquifers provides notional storage development plans under two different injection scenarios.

5.1.4 Resource Review

5.1.4.1 Major Projects

The Abu Dhabi National oil company (ADNOC) has two capture projects currently operating. These are: Abu Dhabi CCS Phase 1 – Pre-combustion capture from the Al Reyadah steel plant in Mussafah (0.8Mt/year), and Abu Dhabi CCS Phase 2 – Post-combustion capture from a gas processing plant (1.9-2.3Mt/year). Both of these capture projects inject their

CO_2 into the same oil field, 43km from the Al Reyadah steel plant. Abu Dhabi CCS Phase 1 is the first and only fully commercial CCS facility for the iron and steel industries globally [17].

5.1.4.2 Depleted Oil & Gas Fields

No CO_2 storage evaluations for depleted petroleum fields were found in the public domain for UAE. Due to the large number of hydrocarbon fields in the country, it is highly likely that some future depleted field storage potential does exist and future assessments of the UAE should attempt to quantify this. Ajayi et al 2016 [14] did consider depleted fields at the site selection and screening stage, but no details of field-based storage resources were provided in the publication.

5.1.4.3 Saline Aquifers

Ajayi et al 2019 [15] identified a total of 15.66 Gt storage resource split across 4 aquifers in the Rub Al Khali basin. The Shuaiba aquifer has been evaluated by two other published studies and appears to be the best candidate for storage. It consists of a large syncline (the Falaha syncline) surrounded by six anticlines that host petroleum fields. The Shuaiba aquifer lies in the Lower Cretaceous which is within the same stratigraphy as the six surrounding petroleum fields, which may provide useful dynamic datasets and proof of a working seal for the Shuaiba formation.

The Simsima aquifer sits above the Shuaiba in the Upper Cretaceous. Ajayi et al [15] used an optimization algorithm to pick suitable injection wells in both aquifers and suggests that 5 vertical wells in each aquifer can be used to inject a total of 5960 Mt over 100 years. Two additional aquifers, the Paleocene Umm Er Radhuma and Eocene Dammam formations, were considered to have less potential for CO_2 storage due to shallow depth and poor reservoir properties. Resources for these were only calculated using the volumetric method. These two aquifers lie in the shallowest stratigraphy of the area of interest. Due to the lack of any CCS specific policy in the UAE, all resources are classed as inaccessible under the SRMS, with a small portion (6%) of the Shuaiba aquifer being discovered, inaccessible (51Mt).

5.1.5 Regulatory Framework

The second UAE NDC – UNFCCC submission (2020) commits the country to reducing emissions by 23.5% by 2030, relative to the business as usual scenario. This NDC specifically mentions that CCUS will be one of the measures used to bring this reduction into effect. The plan is to build on the success of the country's two CCS pilot projects which capture CO_2 from steel and gas processing. As yet though, the country has not published any CCS specific policies or regulations (according to the CCS Readiness Index [18]). Currently all CCS activities are regulated on a case-by-case basis as all projects are operated by the government owned Abu Dhabi National Oil Company (ADNOC). The Masdar institute, Abu Dhabi has published a paper titled: Carbon Capture Regulation for The Steel and Aluminium Industries in the UAE: An Empirical Analysis [19], which could help to lead the way to a more country wide regulation system. Currently, however, all storage resources given in Cycle 3 for UAE sit in the inaccessible category due to this lack of CCS regulation and policy.

5.1.6 Issues for the Assessment

Ajayi 2019 [15] mentions that a database of 4768 wells was used to create the geo models, but that a lot of them had poor data quality for the aquifers above the Lower Cretaceous stratigraphy. This suggests that the level of published detail is not fully representative of the available data, resulting in a lower maturity classification for the identified storage resource. The stated resources may be able to progress through the SRMS classification if more information can be published.

The two existing carbon storage projects in UAE are EOR pilot projects. These are not included in the CO_2 Storage Resource Catalogue because the SRMS does not include EOR projects.

5.1.7 Future Updates

The resource added in Cycle 3 is solely for saline aquifers. Future assessments should look for any evaluations of depleted field storage resources as well as new evaluations of storage resource in saline aquifers.

6.0 Bibliography

[1] OPEC, “OPEC Annual Statistical Bulletin 56th Edition,” 2021.

[2] F. Neele, V. Vandeweijer, H. Mayyan, S. R. K. Sharma and D. Kamal, “Options for CO2 Sequestration in Kuwait,” Energy Procedia, 2016.

[3] A. Mingjie Chena, “Evaluation of CO2 sequestriation and circulation in fault-bounded thin geothermal reservoirs in North Oman unisn response surface methods.,” Journal of Hydrology, 2021.

[4] T. K. Ahmed and H. Nasrabadi, “Case study on combined CO2 sequestration and low-salinity water production potential in a shallow saline aquifer in Qatar,” J. Environ. Manage., 2012.

[5] Qatar Petroleum, “Qatar Petroleum constructs the world's largest LNG project ever, including substantial CO2 capture & sequestration,” 2021.

[6] Global CCS Institute, “GLOBAL STATUS OF CCS 2020,” Melbourne, 2020.

[7] Global CCS Institute, “Global Status of CCS 2021,” 2021.

[8] H. Liu, B. G. Tellez, T. Atallah and M. Barghouty, “The role of CO2 capture and storage in Saudi Arabia's energy future,” Int. J. Greenh. Gas Control, 2012.

[9] OGCI, “CCUS in Saudi Arabia: The value and oppourtunities for deployment,” 2021.

[10] B. Issautier, Y. M. Le Nindre, S. Viseur, A. Memesh and S. Dini, “Managing clastic reservoir heterogeneity II: Geological modelling and reservoir characterisation of the Minjur Sandstone at the Khashm al Khalta type locality (Central Saudi Arabia),” GeoArabia, 2012.

[11] S. Khan, Y. A. Khulief and A. Al-Shuhail, “Numerical Modeling of the Geomechanical Behavior of Biyadh Reservoir Undergoing CO2 Injection,” Int. J. Geomech, 2017.

[12] S. M. Salas, A. Tasianas, M. Corrales, H. Hoteit and A. Alafifi, “Quantifying Uncertainty through 3D Geological Modeling for Carbon Capture Storage in the Unayzah Formation in Saudi Arabia,” EGU General Assembly, 2021.

[13] HHIH, “HHI Group launches 'Hydrogen Project' with Saudi Aramco,” 2021. [Online]. Available: http://www.hyundai-holdings.com/?p=115&idx=491.

[14] T. Ajayi and A. Jialiang Hu, “Characterization and Quantification of the CO2 Sequestration Potential of a Carbonate Aquifer in Falaha Syncline, Onshore Abu Dhabi,” 2016.

[15] T. Ajayi, “Large scale modeling and assessment of the feasibility of CO2storageonshore Abu Dhabi,” Energy, 2019.

[16] T. S. Khan and N. Mohammed, “NUMERICAL MODELING AND ECONOMIC ASSESSMENT OF CO2STORAGEIN DEEP SALINE AQUIFER BASED IN UAE,” 2019.

[17] SCCS, “Al Reyadah: Project Details,” 2021. [Online]. Available: https://www.geos.ed.ac.uk/sccs/project-info/622.

[18] Global CCS Institute, “CCS Legal and Regulatory Indicator,” 2018.

[19] I.-T. Tsai, “CCS Regulation in Gulf Cooperation Council (GCC): Current Progress & Future Perspectives,” 2014. [Online]. Available: https://iea.blob.core.windows.net/assets/imports/events/3/1.3_Tsai.pdf.