Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

1. What is the size of the area of interest (AOI)?
   * It is anticipated that the AOI will cover the full extent of the Bunter aquifer that is hydraulically connected to the UK sector including onshore and non-UK waters as far as necessary to capture the boundaries of the pressure connected system.
2. Where is the area of interest located? Does this study cover the entire Bunter Fm in the SNS? Please provide a map of the study AOI.
   * The AOI is specifically the extent of the Bunter Sandstone Fm in the Southern North Sea, south of the Mid-North Sea High and North of the London-Brabant Massif.
3. Are the regional sub-surface maps of main stratigraphic units (basement to surface including main aquifers and aquitards) available to define model geometries?
   * Regional depth grids will be provided by NSTA as follows (these cover the UKCS only):
     1. Seabed, Top Balder, Base Paleocene, Base Upper Cretaceous, Base Lower Cretaceous, Base Upper Jurassic, Base Middle Jurassic, Base Lower Jurassic, Base Triassic, Base Rotliegend, Base Zechstein. Additional surfaces can be provided where necessary.
4. Will interpretation of faults be provided along with interpreted subsurface maps?
   * First order faults will be provided.
5. Will these maps and faults be based on 2D-seismic, 3D-seismic or a combination of both? If maps are provided, will the seismic data these maps are based on also be provided?
   * Both grids and faults are based on publicly available 2D & 3D seismic data (i.e. the Megamerge and 2D lines which can be accessed on the NDR).
6. Is there a facies model available to be used in the study (in particular of the bunter sandstone aquifer and aquitards of the overburden (digital GDE Maps, digital facies model, property model of Vshale, porosity or similar?))
   * Please reference public domain materials to determine representative Bunter facies models that should be incorporated. Proprietary materials will also be made available to supplement certain scenarios.
7. How many wells with pressure data are available for calibration of the Bunter SSt and overburden pressure in the AOI?
   * There are approximately 600 wells with available pressure data across entire stratigraphic interval of which ~30 in the Bunter.
8. How many wells have porosity/permeability data of the bunter sandstone Fm?
   * ~50 core derived porosities and permeabilities are available in the Bunter. Some supplementary well log derived porosities and permeabilities are available.
9. What is the requirement for the format of the report? Is a detailed power point set of slides sufficient?
   * A detailed, written report describing the approach, assumptions, methodology and results is preferred. An accompanying set of slides could act as an appendix of results.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

1. I have extensive experience with reservoir scale modelling of regional pressure distribution, which needs a static model to start with. Should NSTA provide the static model of BSF? If yes, which format? Is it with PETREL, TNAV or other types? If not, I suppose NSTA has the fundamental data to generate static model.

Building a static geological model is one way to help meet the requirements of the project. The input data anticipated to be required are available from the NSTA (if needed) or can be sourced publicly.  The preferred platform used to construct the model should be recommended in the submitted proposal. The ITT stipulates only that the output be universally accessible (i.e. can be output in ASCII format for example)

1. As for the simulations, which simulator NSTA perform. We have academic license for PETREL, ECLIPSE, CMG and TNAV in Aberdeen. While, we could also go for the open source code, called OPM or MRST.

The NSTA has not stated that there is a requirement to use a specific platform to build the model. Please base your application on the platform that you would recommend and also be mindful of the objectives outlined in the tender document (ITT).

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

I would also like to put forward some clarifications to help with the submission of the tender:

1. Will the NSTA provide access to the data required for the project, seismic and well data?

The NSTA will provide as a minimum:

* Regional depth grids will be provided by NSTA as follows (these cover the UKCS only): Seabed, Top Balder, Base Paleocene, Base Upper Cretaceous, Base Lower Cretaceous, Base Upper Jurassic, Base Middle Jurassic, Base Lower Jurassic, Base Triassic, Base Rotliegend, Base Zechstein.
* First order faults.
* Both grids and faults are based on publicly available 2D & 3D seismic data (i.e. the Megamerge and 2D lines which can be accessed on the NDR).
* Well data: pressure, porosities, permeabilities.

The NSTA will provide as much of the data as possible for the model build but would welcome integration of additional data types if recommended and available.

1. If the seismic is available will the seismic be interpreted, depth converted, and surveys merged?
   * The publicly available (via the NDR) 3D megamerge volume has been used to derive all depth converted surfaces that will be provided (see above).
2. If a database is available will this be shared with Three60energy?
   * All data that the NSTA can share that is necessary to complete the project will be shared with the successful applicant.
3. Do the NSTA recommend preferred wells for use in the model?
   * The NSTA has not prescribed a preferred wells list but rather would encourage a representative spread of wells and those with relevant data to be used.
4. Do the NSTA have a literature inventory for reference?
   * The NSTA will not provide a library of reference but can and will happily discuss specific papers to focus on or integrate as part of the project.
5. In addition to the clarifications below we would like to ask if a model has been completed previously for the Bunter Fm?
   * There is no existing model for the Bunter Sandstone Fm.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

* Will the CO2 stored database be available to the contractor to use (access and download)?

The NSTA expects all relevant public domain data sources to be considered as part of the project.

* Will the contractor get access to the license application documents for the 14 license stores in questions?

The NSTA will be able to provide access to information from the licence documentation where relevant and necessary.

* What other data will NSTA provide as input? Regional maps, consolidated Bunter wells database etc.

Regional depth grids will be provided by NSTA as follows (these cover the UKCS only): Seabed, Top Balder, Base Paleocene, Base Upper Cretaceous, Base Lower Cretaceous, Base Upper Jurassic, Base Middle Jurassic, Base Lower Jurassic, Base Triassic, Base Rotliegend, Base Zechstein.

First order faults.

Both grids and faults are based on publicly available 2D & 3D seismic data (i.e. the Megamerge and 2D lines which can be accessed on the NDR).

Well data: pressure, porosities, permeabilities.

The NSTA will provide as much of the data as possible for the model build. Where respondents identify data or information that can be supplied as part of a solution, the NSTA will take this into consideration (in line with the criteria included in the ITT) during our assessment.

* Should we consider only 14 stores operating or additional stores coming into play in the future?

The NSTA wishes to consider a wide range of scenarios and expect that would include consideration of future additional storage potential in the Bunter.

* Are the injection profiles explicit in the bid documentation or will the NSTA provide ranges (by license)?

The NSTA will work with the successful bidder to ensure appropriate injectivity and pressure input assumptions are used. These will likely include technical material from licence development plans where necessary.

* Is brine production to limit over-pressurisation encouraged?

The model is intended to test multiple future regional “aquifer scale” scenarios and the NSTA would welcome input to determine the likely requirement for brine production in certain areas.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

1. Can we confirm that the study is looking at pressure distribution and variation and is not looking at trapping styles or thermal effects.

* The NSTA confirms that the study is focussed on pressure distribution and variation. There is no intention to look at trapping styles or well scale thermal effects of injecting CO2.

1. Will the NSTA be supplying any data or previous studies on the Bunter?

* The NSTA will provide as much of the data as possible for the model build but would welcome integration of additional data types if recommended and available. The NSTA will provide as a minimum:

1. Regional depth grids will be provided by NSTA as follows (these cover the UKCS only): Seabed, Top Balder, Base Paleocene, Base Upper Cretaceous, Base Lower Cretaceous, Base Upper Jurassic, Base Middle Jurassic, Base Lower Jurassic, Base Triassic, Base Rotliegend, Base Zechstein
2. First order faults
3. Both grids and faults are based on publicly available 2D & 3D seismic data (i.e. the Megamerge and 2D lines which can be accessed on the NDR)
4. Well data: pressure, porosities, permeabilities
5. Other data may need to be compiled during the project.
6. Would the study look at the just the currently licenced areas, the regional Bunter area of the UKSNS or all areas currently described in CO2Store as having potential Bunter storage?

* The AOI should cover the full extent of the Bunter aquifer that is hydraulically connected to the UK sector. This should include offshore and into non-UK waters as far as necessary to capture the boundaries of the pressure connected system. This will therefore include the licenced areas and the extent of the Bunter Sandstone Fm in the Southern North Sea, south of the Mid-North Sea High and North of the London-Brabant Massif.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

Can you clarify what data will be made available to the successful tenderer please? Will at least the following be made available?

* Well log data (LAS)
* Core data (LAS/ASCII/SCAL reports)
* Geological Reports (PDF)
* Surfaces, Faults & maybe Seismic data (in a Petrel model)
* Pressure Data/Well test, RE data

And what other data/information will be made available?

The NSTA will provide as a minimum:

* Regional depth grids will be provided by NSTA as follows (these cover the UKCS only): Seabed, Top Balder, Base Paleocene, Base Upper Cretaceous, Base Lower Cretaceous, Base Upper Jurassic, Base Middle Jurassic, Base Lower Jurassic, Base Triassic, Base Rotliegend, Base Zechstein.
* First order faults.
* Both grids and faults are based on publicly available 2D & 3D seismic data (i.e. the Megamerge and 2D lines which can be accessed on the NDR).
* Well data: porosities, permeabilities, pressure, salinity, temperature and conventional core analysis where possible or it can be sourced publicly.  The NSTA welcome the integration of additional data where recommended.

The input data anticipated to be required are available from the NSTA (if needed) or can be sourced publicly. Where respondents identify data or information that can be supplied as part of a solution, the NSTA will take this into consideration (in line with the criteria included in the ITT) during our assessment.

The NSTA will be able to provide information from proprietary geological reports and will happily discuss publicly available published literature to focus on or integrate as part of the project.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

Please could you clarify whether there is any existing database held by the NSTA you anticipate being used or whether you anticipate any data base generation to be part of the project work.

The NSTA will provide as much of the data as possible for the model build but would welcome integration of additional data types if recommended and available.

The NSTA will provide as a minimum:

* Regional depth grids will be provided by NSTA as follows (these cover the UKCS only): Seabed, Top Balder, Base Paleocene, Base Upper Cretaceous, Base Lower Cretaceous, Base Upper Jurassic, Base Middle Jurassic, Base Lower Jurassic, Base Triassic, Base Rotliegend, Base Zechstein
* First order faults
* Both grids and faults are based on publicly available 2D & 3D seismic data (i.e. the Megamerge and 2D lines which can be accessed on the NDR)
* Well data: pressure, porosities, permeabilities
* Other data may need to be compiled during the project.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

* Does the NSTA have a preferred area of interest? We are presuming a model that covers the entire Bunter over the SNS is not required.
  + The project aims to understand subsurface inter-dependencies of proposed CO2 storage sites across the SNS. It is anticipated that the AOI will cover the full extent of the Bunter aquifer that is hydraulically connected to the UK sector including onshore and non-UK waters as far as necessary to capture the boundaries of the pressure connected system.
* The ITT discussed CO2 injection, rate of injection and pressure communication, connectivity but does not directly ask for a dynamic model. Is it assumed therefore that a dynamic model is expected for this project?
  + Building a dynamic geological model that could be used to test future injection scenarios is one way that the project requirements could be met but the NSTA will consider alternative solutions – in line with the assessment criteria provided in the ITT - if they are offered.
* Will the NSTA provide any data, or is it expected that publicly available data (NSTA, NDR, BGS, etc) be used as input to the project?
  + The input data anticipated to be required are available from the NSTA (if needed) or can be sourced publicly. Where respondents identify data or information that can be supplied as part of a solution, the NSTA will take this into consideration (in line with the criteria included in the ITT) during our assessment.
* Is it expected that operator development plans are used (and therefore to be supplied to the contractor by the NSTA) for the injection rate and injection volume assumptions, or are these assumptions to be proposed by the project?
  + The NSTA will work with the successful bidder (during the project) to ensure appropriate input assumptions are used. These will likely include material from licence development plans.
* We assume that for this project no hydrocarbons will be modelled within the BSF, can the NSTA please confirm this assumption is aligned with their expectations.
  + It is anticipated that hydrocarbons will not be modelled within the BSF but would welcome further conversation around this with successful bidder.
* Do the NSTA want this to be an independent piece of work or will the NSTA be open to inputs from the operators with CCUS licences in the selected AOI?
  + The NSTA expects this to be an independent piece of work and input from operators with CS licences (out with licence documentation) will not be sought at this time.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

**Questions from subsurface viewpoint:**

1. Is the area of interest a specific field, licence block, etc?
   * It is anticipated that the AOI will cover the full extent of the Bunter aquifer that is hydraulically connected to the UK sector including onshore and non-UK waters as far as necessary to capture the boundaries of the pressure connected system.
2. What is the type and extent of available data for the reservoir characterisation? For example, are the following data sets accessible?
   * Static geological model, i.e. lithological model, facies, porosity, permeability distribution?
   * Building a static geological model is one way to help meet the requirements of the project. The input data anticipated to be required are available from the NSTA (if needed) or can be sourced publicly.
   * Well-log data
   * This information is available from the NSTA (if needed) or can be sourced publicly.
   * PVT data or model
   * This information is available from the NSTA (if needed) or can be sourced publicly.
   * Core data
     1. Routine core analysis - This data can be provided by the NSTA
     2. Special core analysis - The NSTA will not provide this data but would welcome its integration if available.
     3. Gas injection core analysis - The NSTA will not provide this data but would welcome its integration if available.
   * Historical production data
   * The NSTA will not provide this data but would welcome its integration if available.
   * History-matched dynamic reservoir model
   * A history matched model is not a project requirement but building a dynamic geological model to test future scenarios is one way to meet the project requirements. The input data anticipated to be required are available from the NSTA (if needed) or can be sourced publicly.
   * Seismic reflection (or other geophysical) data
   * The NSTA will provide seismic depth grids and major faults (both based on 2D and 3D seismic data from the NDR).
   * Core data (See above).

Other data may need to be compiled during the project.

1. Is there a communication route to collaborate with existing and/or past operators of the field?
   * No, this project will be executed solely with the NSTA
2. Apart from the final report, should the award winner hold other dissemination events such as workshops or conference attendance?
   * It is likely that some follow up meetings and workshops (or conferences) could be required after the delivery of the model results (to be determined as necessary)

**Questions from procurement viewpoint:**

1. What is the legal entity that we will be under contract with, Oil & Gas Authority or North Sea Transition Authority?
   * The North Sea Transition Authority is a business name of the Oil and Gas Authority. Oil and Gas Authority is a limited company registered in England and Wales with registered number 09666504 and VAT registered number 249433979. Our registered office is Sanctuary Buildings, Lower Ground Floor, 20 Great Smith Street, London, SW1P 3BT.
2. Has any early market engagement been held on this opportunity?
   * No.
3. Please confirm if there is opportunity to meet the team prior to the bid deadline or award?
   * We cannot meet with prospective tenderers prior to the closing date of the tender. If we were to meet with one company, we would have to offer the opportunity to all and because of tight timelines for this project we can only meet with any suppliers who are shortlisted.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

What data will be available/provided by the NSTA to conduct the study some examples below that would help:

* Regional surfaces
* Pressures in the Bunter Fm – plus any field pressures overtime.
* Core data is it available for the Bunter – has this been collated ready for analysis?
* Regional Bunter studies the NSTA may have access to e.g. facies maps and distributions etc..
* Company reports e.g. access to CCS applications and studies conducted models and views on aquifer pressures and seal capacity and
* Data regarding expected CO2 injection rates and levels over time to predict pressure increases expected over time etc.

The NSTA will provide as a minimum:

* Regional depth grids will be provided by NSTA as follows (these cover the UKCS only): Seabed, Top Balder, Base Paleocene, Base Upper Cretaceous, Base Lower Cretaceous, Base Upper Jurassic, Base Middle Jurassic, Base Lower Jurassic, Base Triassic, Base Rotliegend, Base Zechstein

* First order faults

* Both grids and faults are based on publicly available 2D & 3D seismic data (i.e. the Megamerge and 2D lines which can be accessed on the NDR)

* Well data: porosities, permeabilities, E&A well pressures, salinity, temperature and conventional core analysis where possible or it can be sourced publicly.  The NSTA welcome the integration of additional data where recommended.

The input data anticipated to be required are available from the NSTA (if needed) or can be sourced publicly. Where respondents identify data or information that can be supplied as part of a solution, the NSTA will take this into consideration (in line with the criteria included in the ITT) during our assessment.

The NSTA will be able to provide information from proprietary geological reports (e.g. Bunter core analysis) and will happily discuss publicly available published literature to focus on or integrate as part of the project.

The NSTA will work with the successful bidder to ensure appropriate injectivity and pressure input assumptions are used. These will likely include target and technical material from licence development plans where necessary.

Tender Name: Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection.

Tender Reference: TRN493-11-2023

1. **Area of Interest** (AOI): What is the size of the study area? How many storage sites are to be included/covered?

The project aims to understand subsurface inter-dependencies of proposed CO2 storage sites across the SNS. It is anticipated that the AOI will cover the full extent of the Bunter aquifer that is hydraulically connected to the UK sector including onshore and non-UK waters as far as necessary to capture the boundaries of the pressure connected system.

1. **Wells:** How many wells will be included in the initial model, and what data will be provided (logs, core, maps, etc.)?

The NSTA has not prescribed a preferred wells list or number of wells but would rather encourage a representative spread of wells and those with relevant data to be used. The input data anticipated to be required are available from the NSTA (if needed) or can be sourced publicly. Where respondents identify data or information that can be supplied as part of a solution, the NSTA will take this into consideration (in line with the criteria included in the ITT) during our assessment.

1. **Structure:** Will seismic interpretation be available, and what level of detail is required for fault mapping/compartmentalization over the study area?

Regional depth grids will be provided by NSTA as follows (these cover the UKCS only): Seabed, Top Balder, Base Paleocene, Base Upper Cretaceous, Base Lower Cretaceous, Base Upper Jurassic, Base Middle Jurassic, Base Lower Jurassic, Base Triassic, Base Rotliegend, Base Zechstein. First order faults will also be provided. Additional surfaces and faults may be available where identified as necessary.

1. **Petrophysical Properties:** Any previous work on property interpretations (well tops, facies, porosity & permeability by facies)?

The NSTA will provide as much of the data as possible for the model build but would welcome integration of additional data types if recommended and available.  Please reference public domain materials to determine representative Bunter facies models that should be incorporated. Proprietary materials will also be made available to supplement certain scenarios.

1. **Connectivity:** Is there information on fault/fracture mapping and the extent of first and second order faults within the AOI, especially their connectivity to seabed/onshore.?

First order faults will be made available by the NSTA and their connectivity to seabed/onshore further discussed upon project initiation.

1. **Boundary:** Does the study area include subcrop edges of the Bunter Formation on the seafloor or onshore within the AOI? Major regional geological risks directly offsetting AOI?

It is anticipated that the study area captures the subcrop edges of the Bunter Sandstone Fm on the seafloor and onshore.

1. **Rock & Fluid Properties:** What information is available for fluid properties (reservoir temperature, pressure, water salinity variations,  water viscosities, rock compressibility, core floods or info on CO2-water real-perm, etc.)

The NSTA will provide access to pressure, salinity, temperature and conventional core analysis where possible or it can be sourced publicly.  The NSTA welcome the integration of additional data where recommended.

1. **Seabed and Onshore Exposure:** Is there any additional overburden information to be considered in this study?

It is anticipated that the necessary detail in the overburden will form part of the model construction captured in the submitted proposal. This might include but not be limited to the seabed outcrop(s) and faults that go to seabed. Well based data in the overburden can also be provided where deemed necessary.

1. **CCS targets:** Are injection targets available for each storage site? Any injectivity & pressure constraints (technical & regulatory constraints) imposed on these licensed storage sites?

The NSTA will work with the successful bidder to ensure appropriate injectivity and pressure input assumptions are used. These will likely include target and technical material from licence development plans where necessary.