



Programme Area: Carbon Capture and Storage

Project: Network Modelling

Title: Modelling of Carbon Capture & Storage: Project Definition Study - Request for Proposal

Context:

A scoping study to identify the requirements for the project subsequently procured by the ETI to develop a CCS system modelling toolkit.

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Request for Proposals (RfP)



Title of Services for which Proposals are Requested:

Modelling of Carbon Capture & Storage: Project Definition Study

Request Issue Date:

10 December 2009

Closing Date:

Proposals must be received before 5pm on 18 December 2009

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1. Introduction to the Energy Technologies Institute

The Energy Technologies Institute LLP (the ETI) is a private organisation formed as an innovative Limited Liability Partnership between international industrial energy companies and the UK government.

Our mission is to accelerate the development, demonstration and eventual commercial deployment of a focused portfolio of energy technologies, which will increase energy efficiency, reduce greenhouse gas emissions and help achieve energy and climate change goals.

We will do this by leveraging the skills, capabilities and market access routes of our members, working with other organisations worldwide, to take the most challenging large-scale energy projects to full system demonstration, thus bridging the gulf between laboratory proven technologies and full scale commercially tested systems. Our projects will also develop knowledge, skills and supply-chains, and will inform the development of regulation, standards and policy. Hence we aim to overcome major barriers, de-risk the future development and shorten the lead times to market for secure, affordable, low-carbon energy systems for power, heat and transport.

Our portfolio includes programmes in areas such as Wind, Marine, Distributed Energy, Transport, Energy Networks and Carbon Capture & Storage.

Further information can be found on our web-site at www.energytechnologies.co.uk

2. Context for Proposed Study

Given the required speed of roll-out, cost and complexity of the future CCS infrastructure in the UK, modelling will play a crucial role in ensuring a practical, cost effective and robust network of assets. Modelling can potentially support decisions at a range of Business Levels:

- i. **Strategic Planning.** Decisions are required on issues such as siting of power stations, selection of station/capture type, network layout, use of storage assets etc. In all cases a view needs to be taken on what the 'ultimate' system might look like and how it would develop. OEMs need to understand such issues for strategic marketing/product development purposes.
- ii. **System 'Front End' Design.** This will inform decisions on more detailed aspects of design such as pipeline sizing & routing, initial specifications for compression requirements, front end design of power plant.
- iii. **System Detailed Design.** This will inform design and selection of the components of the network (eg power stations, pipes, compressor stations, storage sites), and understanding of how they are best interconnected.
- iv. **System Operation and Maintenance.** It is critical to understand how the system will operate once built, both under steady state conditions and dynamically as a result of load following, planned and unplanned outages of assets etc. Operators within the system need to understand how the CCS system will impact on the key objective of 'keeping the lights on' and how the constraints imposed by the electrical system will impact the CCS chain's operability.

To support business decisions, a number of modelling levels can be identified:

- Level 0:** Enabling models (eg CO₂ phase behaviour)
- Level 1:** Modelling of individual assets (eg power plant with capture; single length of pipeline, compressor station, storage site) to design and optimise performance of each asset;
- Level 2:** Modelling of partial systems to understand different operating & maintenance scenarios ('events'). Whilst being 'partial' in the context of a complex CCS network, such models would cover the full chain from power station through a pipeline to a storage site;
- Level 3:** Steady-state, whole-network techno-economic modelling to optimise system design and roll-out of the network.
- Level 4:** Energy System modelling (eg MARKAL, ESMe)

A review of ETI Member interests has been completed to identify priority business and modelling level needs. From this review it has been concluded that the current CCS priority for the ETI is for models of partial (but full-chain) CCS systems to develop understanding of and support business decisions around the operation and maintenance of assets (eg power stations, compressor stations) within the system (ie Business Level (iv) / Modelling Level 2)

The ETI now wishes to commission a short study to produce a specification for a technology development project to produce a validated modelling toolkit to meet this business need.

3. Business Requirements for an ETI CCS System Modelling Toolkit

The primary requirement is for a validated model, or series of models, which will enable CCS asset owners (eg power stations, compressor stations, storage site operators) to be able to undertake rapid 'what if' simulations of the operation of a CCS system for a variety of system designs and operating scenarios, to improve understanding of the operating requirements and constraints. The model would be required to simulate changes in operating conditions, so ideally would have some degree of dynamic capability, although simulation of multiple steady states to achieve this would be acceptable.

Within the proposed ETI Project, which would have a maximum duration of 2 years, such models would initially be built and validated for a single CCS chain (ie source – pipe – storage site), but the Project would need to extend the capability to multiple sources, pipelines and sinks. At the end of project, working modelling tools should be delivered, capable of being used by modelling experts within ETI Member companies on actual CCS systems of interest to them.

4. Study Objectives

The overall objective of the study is to produce a specification for a potential ETI modelling project, which will provide the core of a request for proposals for such a project. The study should involve extensive consultation ETI members with key experience in the appropriate area.

The specific objectives of the study are:

1. To produce a provisional list of the components to be incorporated into the model and level of complexity required (and reasonably achievable) in the model (eg maximum number of sources and storage units; degree of branching of pipeline(s)). To produce an initial list of the operational and maintenance 'events' which the model would be expected to describe.
2. To review currently available modelling approaches and tools which may be suitable for use or development within the toolkit, and critical gaps in model infrastructure, components and underlying 'Level 0' models.
3. To identify potential project participants and their potential contribution to a project to deliver a modelling toolkit to meet the needs of ETI stakeholders, and to propose a specification and outline plan for the project.

5. Programme of Work for Proposed Study

In undertaking the study, the Contractor will be expected to demonstrate that they have consulted extensively with ETI and ETI members with key experience in the appropriate area, and with other key industry stakeholders (the Respondent should indicate who it proposes to contact as part of the study).

5.1. Task 1: Define Functionality of Required Models

The contractor shall produce a provisional list of the components which would need to be incorporated into the model. A provisional list of events which the model would need to describe shall be produced (eg rapid increase/decrease in energy demand; loss of a storage site; component failure etc).

5.2. Task 2: Review of Modelling Tools and Approaches

The contractor shall undertake a brief review of modelling tools and approaches currently available or in development which are suitable, or could be readily developed, to meet the business requirements set out in Section 2, including the requirement to deliver a working model within 2 years. The following should be considered:

- The genre of modelling which is most appropriate (eg discrete event modelling, deterministic modelling etc);
- The extent to which dynamic effects should (and could realistically) be incorporated into the model, or whether a 'multiple steady state' approach should be taken;
- Treatment of CO₂ phase behaviour within and between model components (eg is it critical to be able to model phase changes in a component and/or include multiphase capability or can a simpler approach be adopted);
- Level of modelling of individual assets (eg should a power station with CCS be treated as a single component, several integrated smaller components or in a more complex way);

- Approaches to pipeline models;
- Available modelling infrastructures which may be suitable (from open platforms such as Excel to commercial tools, eg G-Proms, Flowmaster);
- Availability of suitable performance data for the various assets and approach to model validation.

From this review, potential modelling approaches should be identified and recommendations made on the most promising approaches. Any key gaps which would need to be addressed within an ETI project should be identified.

5.3. Task 3: Identify Potential Participants and Produce Scope

The contractor shall identify the skill sets required to deliver the project and potential project participants (academic and industrial) which could provide this, in the UK and elsewhere. Note that it is anticipated that the project would directly involve potential end users of the models developed.

The contractor shall produce an outline scope for the project, suitable as a basis for a Request for Proposals to be issued by the ETI.

5.4. Project Deliverables

- Interim review meeting with the ETI
- Draft report, including:
 - Provisional list of components to be included in the models (categorised into 'essential' and 'optional')
 - Provisional list of events to be modelled
 - Review of modelling approaches and recommendations, based on the business requirements for the modelling tool kit
 - Potential sources of data and approach to validation
 - List of potential project participants, identifying their potential contribution to a future project
 - Outline scope for an ETI modelling project, including an indication of likely cost and key risks
- Presentation of the results to the ETI and its advisers
- Final report incorporating comments from the ETI

6. Request for Proposals: Process and Terms

6.1. Content and Format of Proposals

Interested organisations are requested to submit a short Proposal covering the scope as described above. The Proposal shall be arranged according to the structure detailed in Appendix A and shall include all the information listed therein.

The Proposal must be written in a succinct manner and must not include imprecise statements, generalities or repeated information. The Proposal must be easily readable with appropriate font sizes, margins, etc, **and shall not exceed a maximum of 6 pages.**

The Proposal shall be submitted electronically, in both PDF and Microsoft Word formats.

6.2. Acceptance, Review and Selection of Proposals

Proposals will be reviewed and judged primarily against the criteria listed below.

- Completeness of information content, structure and quality of Proposal (against areas listed in Appendix A)
- Compliance with technical specification (i.e. Sections 5 of this RfP)
- Availability of suitable resources to undertake the study
- Knowledge, skills and experience against the following criteria:
 - Record and ability in quality, timely and on-budget delivery of technical studies
 - Knowledge of CCS technologies and previous experience of working with industrial participants in the CCS chain
 - Knowledge of a broad range of modelling techniques relevant to the full CCS chain or network and model architectures capable of encompassing technology models in a common framework.
 - Experience of developing modelling codes for industrial use.
- Value for money
- Willingness to accept ETI standard terms and conditions for the services
- Speed of delivery (the work must be delivered within 3 months, but faster delivery will be favoured).

The ETI at its discretion may request further information in order to assess a Proposal, and may reject any Proposal which does not provide sufficient information.

This RfP is not an agreement to purchase goods or services, and the ETI is not bound to enter into a Contract with any Respondent. All decisions made by the ETI relating to the acceptance, review and selection or otherwise of Proposals are final. The ETI will be under no obligation to explain or justify any such decisions at any time.

6.3. Estimated Time-Frames

The deadline for receipt of proposals by the ETI is as stated on the front cover of this Request for Proposal. Subject to contract, the ETI intends starting the study in January 2010 with duration of approximately 2-3 months. Since the work is urgent, it is desirable that the contractor undertakes the work in the shortest possible period, subject to being able to meet the required quality criteria.

7. Price and Payment

This Project will be paid on a fixed price basis. Payments will be made against defined Payment Milestones, subject to ETI acceptance of a Milestone Completion Report. It is anticipated that the project will have a single Payment Milestone, based on delivery and acceptance of all deliverables as set out in Section 5.4.

Appendix A – Content and Format of Proposals

The Proposal shall be arranged according to the structure defined below and shall explicitly include all the information listed.

1. Executive Summary [maximum ½ page]

A summary of the Proposal, describing briefly:

- The organisation(s) undertaking the work
- Summary of the technical approach and **key** deliverables
- Confirmation of compliance with the Specification detailed in the Request for Proposals and/or brief summary of **key** exceptions/deviations
- Total Project cost and duration.

2. Project Objectives [maximum ½ page]

The overall Project objectives will be as specified in the Request for Proposals. The Respondent may provide subsidiary objectives if it thinks this is appropriate. The Respondent should also describe any Critical Success Factors which either characterise a successful Project outcome or which are required to facilitate a successful Project outcome.

3. Background to Proposed Participant(s) [maximum 1 page]

The Respondent should provide a brief description of each of the proposed Participant organisations, including any major Subcontractors:

- Key skills, knowledge, experience and previous track record in the area (technical, commercial and project management, including any UK-specific issues such as technology applicability to UK systems, UK industry practice, UK market/industry knowledge, etc)
- Key staff members involved (including a designated Project Manager), with the amount of each individual's time which will be dedicated to the Project, and detailing their experience – with CVs included in an Appendix (maximum 2 pages per individual)
- Alternate resources available to be deployed in the event that the above key members become unavailable
- Relevant quality, health, safety and environment management systems.

If the Project is to be undertaken by a group of organisations (whether as a Consortium or as Subcontractors), a table should also be provided to identify which Participant(s) is/are proposed to satisfy each of the specific criteria (skills, experience, etc) listed in the 'Criteria for Review and Selection of Proposals' section of the Request for Proposals.

4. Programme of Work [maximum 3 pages]

The Respondent should expand upon the scope of work set out in the Request for Proposals, identifying specifically how it proposes to address the tasks. A time schedule should be included, identifying key activities and dates.

5. Statement of Compliance [maximum ½ page]

The Respondent shall provide a statement that the Proposal is fully compliant with the Specification and all other aspects of the Request for Proposals, or shall state clearly any exceptions, deviations, alternative approaches or additions to the required Specification, with justification. ***Note that in the absence of any specifically-stated deviation in this section of the Proposal, in the case of any subsequent dispute, the ETI's specification will take precedence over the Proposal.***

This statement should specifically include compliance with the ETI Standard Terms and Conditions, as set out in Appendix B.

6. Project Payment [maximum ½ page]

The Respondent should provide a figure for the total fixed contract value. To enable the ETI to assess value for money, the Respondent should provide the total number of person-days to be spent in undertaking the project (including for Subcontractors if appropriate).

Travel will be chargeable extra at cost plus 10%, according to the ETI's travel policy (available on request).

Appendix B – ETI Terms and Conditions of Contract

RESEARCH SERVICES CONTRACT (ETI OWNS ALL ARISING IP) Summary of Terms Single/Prime Contractor

Introduction

The following represents a summary of the key contractual terms which the ETI would expect to be included in the Research Services Contract for a project under which the ETI owns all arising IP. This summary relates to projects to carried out by a single contractor, the Contractor, which may have specific named parts of the scope subcontracted.

Structure

1. The Contractor will manage the project. Where there are other subcontractors, they shall be represented in dealings with the ETI by the Contractor, who shall be responsible for managing communication between the ETI and any subcontractors. This role includes providing notices of meetings and other activities to the ETI, reviewing and commenting on project reports (as required under the project). The Contractor will be responsible and administer payment for all of its subcontractors.

Project Management

2. The Contractor will appoint a project manager for the day-to-day management of the project. The ETI will appoint a programme manager to act on behalf of the ETI with regards to the project.
3. The Contractor must fulfil various reporting obligations. The requirements for reports will depend upon the nature of the project, the deliverables under it and the duration of the project but are likely to include monthly reports and a final report. Each report must address a specified list of topics required by the ETI.

Finance

4. ETI will pay a fixed price against a single milestones for the work done under the project. Acceptance of milestones will be determined by the ETI, where appropriate, against agreed acceptance criteria. Any increase in costs in carrying out the project over and above the agreed contractual amounts will only be payable by the ETI when such charges are agreed in accordance with the contractual variation control procedure.

5. Costs are payable in Sterling and ETI will pay valid invoices within 30 days of receipt of invoice following acceptance of a milestone.
6. The ETI reserves the right to require the return of funding in certain circumstances (such as in the event of corruption or fraud, overpayment, costs incurred in respect of unapproved project changes and failure to comply with State Aid obligations).

Confidentiality

7. Restrictions on disclosure of any other party's confidential information will apply. Any publication of results (if appropriate) will be subject to the confidentiality provisions in the agreement.

Audits and Records

8. ETI will require the right to audit the project, the Contractor and the named subcontractors during the project and, in certain circumstances, up to 7 years from the end of the project on financial or technical grounds.
9. Any parties involved in the project will be required to maintain the majority of project records for a minimum of 10 years from the project end date and for potentially more than 20 years where the records relate to registered intellectual property rights. The Contractor shall require no less obligations from its key subcontractors.

Sub-contracting

10. Sub-contracting is not permitted without consent, except for agreed known subcontractors included at signing.

Variation

11. Any variations to the project must be made via the variation control procedure.

Liability

12. The liability provisions relating to the Contractor will be tailored on a case-by-case basis but are likely to be capped at the amounts payable under the project (except in the case of IP infringement claims, certain third party claims or other liabilities which cannot be limited or excluded by law. For these claims, no cap will apply). Recovery of indirect, consequential etc. damages will usually be excluded.

Termination and Suspension

13. The ETI reserves the right to terminate the agreement in certain circumstances (such as breach by the Contractor (which shall include a breach by a subcontractor), insolvency, change of control of a Contractor etc.). The ETI also reserves the right to terminate the agreement unilaterally upon giving a (to be agreed) period of notice to the Contractor. Upon termination, the ETI will pay the eligible costs incurred by the Contractor up to the date of termination.
14. The ETI will reserve the right to suspend the project in certain defined circumstances.

Intellectual Property

15. All arising IP from the project will be owned by the ETI. The Contractor and any subcontractors will, to the extent required, be required to assign all relevant arising IP to the ETI.
16. The Contractor and any subcontractors will be required to licence their background IP: (i) to the other parties involved in the project on a royalty free basis where required for the purposes of the project; (ii) to the ETI or sub-licensees of the ETI, where required for the use or exploitation of the arising IP.