

Tight Gas, Shale Gas and Coal Bed Methane

(Output from ITF Technology Challenge Workshop)

A Collaborative Approach to Investment in Technology

The Industry Technology Facilitator (ITF) is a not for profit organisation owned by, and with access to funds from major oil and gas operating and service companies that comprise its membership. ITF has an impressive track record in delivering finance to help develop new initiatives for oil and gas technologies from early stage joint industry projects (JIPs) through to field trials and commercialisation. Since 1999, ITF has supported more than 150 projects worth in excess of £45 million in funding. ITF's key objectives are to identify technology needs, foster innovation and facilitate the development and implementation of new technologies.

A fundamental element of ITF's role as an internationally recognised champion for facilitating research, development and deployment of technology innovation within the upstream oil and gas industry is to engage with key industry sources. ITF uses a proven process, working in collaborative participation with both its Members and industry to identify technology needs and potential solutions.

The ITF process, illustrated below as a step-by-step course of actions, endeavours to bridge the gap between the industry's large global players and development community with the ultimate aim of implementing new technology solutions:

- STEP 1** - Understand and Identify Technology Needs
- STEP 2** - Engage the Development Community / Invite Proposals
- STEP 3** - Evaluate Proposal Submissions
- STEP 4** - Secure Funding
- STEP 5** - Assist the Launch of JIPs
- STEP 6** - Facilitate the Implementation of Technologies

ITF has contractual confidentiality arrangements with all its Members and will enter into a parallel agreement with all developers submitting proposal applications. Proposals will be submitted to our Members only for the purpose for which they are provided, i.e. assessment for funding support and implementation.

Proposals submitted under this Technology Challenge Program will be reviewed for financial sponsorship by **all ITF Members** therefore this is an excellent opportunity to gain access to a global audience in seeking support for your technology. The focus of all ITF themes is to identify technologies which bring clear benefits to sponsors but which require assistance in **research, development, and / or field trial**.

For details of ITF's full Portfolio of Members, please visit our Website - www.oil-itf.com

Background to the Theme

This Call for Proposals is the collective output of an ITF workshop held in Amsterdam on the 18th of March 2010.

The workshop included an intensive, facilitated session which brought together ITF Members, Operators, Service Companies, Small and Medium-sized Enterprises and research and academic players. The output of these discussions has formed the basis of this Call for Proposals.

Programme Timeline

Each ITF Theme follows a nine month timeline from the Technology Challenge Workshop to Programme Completion. The following list of tasks describes the key milestones and their associated date:

Technology Challenge Workshop	March 2010
Call for Proposals Issued	May 2010
<i>Deadline for Receipt of Proposals</i>	<i>5 July 2010</i>
Publish to Members for Review	August 2010
Member Review and Voting	August 2010
Technical Clarification Meeting	September 2010
Members finalise commitment to sponsor	December 2010
Programme Complete	December 2010

An Open Invitation to Global Technology Developers

This document aims to stimulate high quality proposals from global development expertise which meet the specific requirements for Tight Gas, Shale Gas and Coal Bed Methane (CBM). ITF and its Members will jointly assess all submitted proposals and our Members will potentially fund those proposals of greatest interest.

ITF and its Members will not prescribe specific technology solutions, but instead use the output gathered from the Theme Day to stimulate innovative proposals that offer potential solutions to identified needs. Key technology drivers, as identified by ITF Members, are the desire to produce fields in a more cost effective and efficient manner.

This is an open invitation to any organisation seeking sponsorship for innovative technologies in the oil and gas industry to submit proposals for research, development, and / or field trial in the following areas, associated with the identified needs of the ITF Tight Gas, Shale Gas and CBM theme:

- **Well Design/Drilling Efficiency**
- **Improved Stimulation**
- **Sweet Spots**
- **Reservoir Modelling & Simulation**
- **Reservoir Analysis**
- **Recovery Mechanisms (Understand Production Mechanisms)**

It is recognised that much work is being undertaken in these areas and that many valuable developments are being worked on around the world. The purpose of this call is to add to this body of work by challenging the development community to think beyond the current limits and propose projects which will significantly improve the industry's understanding of these unconventional resources.

The list of detailed technology challenges are identified within each area that are of explicit interest to ITF Members in the 'Specific Technology Requirements' below. This information highlights key elements required but allows for innovation and flexibility in interpreting the most appropriate technical solutions.

The method for submitting a proposal is described later in this document but you can also learn how to submit a proposal by going to our website www.oil-itf.com

Specific Technology Requirements

(Any submitted proposal **must** address one or more of the following identified requirements)

WELL DESIGN / DRILLING EFFICIENCY

Background:

For well design it is important to compare productivity versus the total well cost.

From an economic perspective there is an emphasis on standardisation of drilling activities such as utilising a batch drilling or 'manufacturing' approach. This is particularly the case for onshore developments where a high well density is required to adequately drain the reservoir. Operational cost efficiencies are important and the focus is on deriving more value and not solely on cost reduction.

Requirements:

- The reservoir characteristics are required as input – 'where to aim'.
- Consider a hypothetical 'best & worst' cost analysis.
- What lessons can be learned from geothermal wells?

- Develop cost effective steerable systems. In coal bed methane, accurate well placement is required as the producing zone is often much thinner than a conventional reservoir.
- Improve ways to hit 'sweet spots' within the reservoir
- Application of managed pressure drilling
- The rock typing approach should drive the required engineering processes.
- Alternative fracturing/perforating methods and technologies are requested
- Consider alternative approaches to well architecture.
 - For example creating a tree-like drainage network in small footprint wells (maximise the surface area of the wellbore exposed to the reservoir). Look to nature for inspiration.
- Optimised safety factors
- Novel slimhole drilling technology
- How to make multi-laterals more cost effective?
- Alternative wellbore construction methods including, but not limited to:
 - Non-drilling
 - Impact
 - Ultrasonics
 - Autonomous drilling systems (e.g. similar to the existing Badger system)
 - High voltage drilling

IMPROVED STIMULATION

Background:

Stimulation technologies (particularly in Shale Gas and Tight Gas sands) are required to 'create' the reservoir. In Shale Gas reserves the source rock is effectively the reservoir/play.

Requirements:

- Reduce formation damage related to fracture treatments. It is important to know where the fracturing fluid is going within the subsurface and understand the associated formation damage effects.
- Particularly in tight gas there is a need for description and quantification of 'fines migration' as this is an impairment mechanism.
- Investigate water-free fracturing fluids (e.g. foam fracs)
- Investigate new methods to reduce the cost of stimulation
- Investigate self-propped fracturing – what are the thermal effects?
- Tools and methods to effectively monitor the size and geometry of fractures
- Approaches to optimise the fracture with horizontal well development
- Investigate alternative fracturing techniques which will target sweet spots within the reservoir
- Link geomechanics to the fracture design and consider the stress field
- Understand fracture growth and improve the ability to model this.
- How do we effectively describe the placed fracture's properties?
- There is a need to predict individual zonal production from multiple downhole and commingled intervals
- Use geomechanics to improve predictability, understand brittleness and the behaviour of soft shales.
- Improved understanding of fracture geometry in shales taking into account the geomechanical parameters
- How can the effective stimulated area be increased?
- Completion systems for stimulation. Some new technologies are already in use such as multi-stage stimulation, swell packers and others which are much faster than previous methods. Other innovative stimulation systems are requested.

SWEET SPOTS

Background:

Because of the heterogeneity of the subsurface, within low permeability reservoirs there will be areas of higher permeability/connectivity – 'sweet spots'. Identification of these on a macro scale is of great importance in accessing these reserves, through optimum well and perforation placement. It is recognized that not all plays are the same.

Important questions for the field developer arise such as: where to focus drilling activity when the areal extent of the potential reservoir is great and where should appraisal activity start? Research or technology that can help address these questions is invited.

Requirements:

- There is a need to identify and describe sweet spots through the use of geophysical or other measurement techniques.

- What are the parameters that create a regional sweet spot?
- There is a need to accurately describe sweet spots and the role that diagenesis plays in the process.
- Drilling activity should be focussed where the wells are likely to produce at the best initial rate – how to identify the best locations?
- How can we discern what is pay versus non-pay?
- What controls sweet spots and their distribution within the subsurface? Recognising that the controls are likely to differ according to the unconventional gas resource type: Tight Gas, Shale Gas & Coal Bed Methane
- For shale gas, porosity and brittleness of the rock should be considered.
- If working with core samples - what technology, tools and processes can be utilised to identify sweet spots?

RESERVOIR MODELLING & SIMULATION

Background:

Previously the industry has adapted conventional models and simulation methods to unconventional gas reservoirs, however it is now recognized that this may not be the most appropriate approach.

In order to address the Reservoir Modelling & Simulation challenge effectively it is likely that proposed solutions will require collaboration between organisations with complementary modelling & simulation skills. It is recognised that the size and integrated nature of this challenge may exceed the capabilities of any one organisation, so ITF wishes to encourage collaboration between organisations and between projects where possible.

Requirements:

- Improved understanding of the impact of upscaling and the incorporation of heterogeneity
- Models that consider multi-scales.
- There is a need to link different model types using different component algorithms to create representative detailed simulation models.
- Models need to incorporate the geomechanics of the reservoir
- Include the characteristics of the reservoir and pressure and temperature
- Improve reservoir-specific modelling
- Include the fundamental behaviour in nanopores
- Develop methodologies for rock typing and reservoir typing
- Type models are required for tight and shale gas reservoirs, in particular what are the building blocks – the big groupings (the logical groupings)?
- A better view of the reservoir response is required
- What is happening in the near wellbore (adopt a similar approach to the SBED model developed for tidal reservoirs)?
- Models need to consider the detail at the pore scale, the reservoir response and the pressure decline
- Any model developed requires detailed input – ‘the building bricks’ components such as: pore simulation, geomechanics, field data, matrix features
- The challenge includes ways of capturing the heterogeneity properly and incorporating this into the model. Models tend to go towards an average – in this situation we need to avoid this and capture the real heterogeneity and do detailed analysis on it.

- Is the upscaling mechanism adequately capturing the detail?

RESERVOIR ANALYSIS

Background:

Power generation has specific requirements such as sustainable volumes at a predictable rate and of known quality/purity. There may be a disconnect because of these issues between the gas supplier and the power generator, in particular the volumes and time scales are different in each industry sector.

Requirements:

- Gas shales are often not strictly shales in the geological sense. What is the likely influence on gas composition and recovery?
- What role does thermal maturity play in gas composition/quality?
- There is a need to quantify the recoverable volumes and their location and more accurately predict the well performance and decline over time.

RECOVERY MECHANISMS (UNDERSTAND PRODUCTION MECHANISMS)

Background:

There is a need to improve the ultimate recovery and understand the physics of flow and storage.

Possible workflow required:

Sweet Spot Identification → Reservoir Characterisation (rock physics & modelling) → Recovery Mechanism → Reservoir Modelling and Simulation → Optimised Development Plan → Drilling

It is likely that activities in this workflow will have feedback to other activities e.g. drilling will have links to the activity on the recovery mechanism and the optimized development plan will link back to reservoir modeling and simulation

Requirements:

- Where and how is the gas stored?
- How does the gas and water move?
- Improved ways of forecasting production rates and the ultimate recovery are requested.
- What is the physics of gas flow in shale gas reservoirs?
- What drives flow and well recovery?
- In shales and tight gas reservoirs there is a need for description and spatial prediction of microporosity as this is a key control on gas mobility.
- There is a need to predict the well decline curve – what is driving the decline?
- It is likely that novel decline curve methods are required to predict the performance as shale gas behaves differently.
- What are the gas release mechanisms?
- Fracture design should consider the influence of the fracture on the decline

curve.

- What type of shale shows what kind of well response? Where possible this should be linked back to a 'type' shale.
- How do the many length/volume scales interact during production? There is clearly something operating in addition to matrix pores. Fundamental understanding underpins all other predictions and impacts field scale prediction
- There is a need to understand the fundamentals in order to design treatments and operations that can improve recovery.
- There is a need to consider multiple scales and have a clear appreciation of the end use when approaching this area.

WATER MANAGEMENT

Requirements for Produced Water for Coal Bed Methane (CBM):

- There is a need for rapid removal and treatment methods for produced water, the volumes are likely to be high with early onset during production.
- How can the water be removed faster? (For example through the use of downhole pumps or eductors?)
- Economical achievement of specifications for disposal and treatment through processes such as (but not limited to):
 - Evaporation
 - Reverse Osmosis
 - Solids Removal
- Options for turning the cost associated with handling produced water into profit by utilising the by-products (e.g. salt, fresh water)

Requirements for Fracture Treatment Water for Shale & Tight Gas:

- Smaller water volumes are involved than with CBM operations.
- There is a need to source the water to start with.
- When the water comes back to surface and if the quality is worse, can it be treated and re-used? How bad can the water quality be?
- Options for disposal should be considered – Reverse Osmosis, evaporation / condensation
- Fracturing fluids are required which have a wide compatibility with different brines from fresh to high salinity
- More flexible fluid chemistries are required
- Consideration should be given to solids removal and environmental profile.

Process for Submitting a Proposal

1. Register Interest with ITF

Register your interest as early as possible by sending an email to Colin Sanderson at c.sanderson@oil-itf.com

2. Visit the ITF Website - www.oil-itf.com

On the ITF Home page, click on the "How to Submit a Proposal" button or follow [this link](#) to access all the information required to submit a proposal.

3. Read the 'Project Application Guidance' Document

This document is available to view or download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website. Reading this document prior to submitting a proposal is essential. If you require further clarification or are unsure if your proposal is suitable for submission, please call ITF (ITF Contact Information appears later).

4. Download and Complete the 'Project Application Form'

This form is available to download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website.

5. Download and Complete the 'Project Presentation Template'

This template is available to download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website.

6. Email the Completed 'Project Application Form' and 'Project Presentation Template' to ITF

Email the Completed 'Project Application Form' in Microsoft Word format (not PDF) and the 'Project Presentation Template' in Microsoft PowerPoint format (not PDF) to Colin Sanderson at c.sanderson@oil-itf.com by the 5th July 2010. Proposals received after this date may not be processed.

Qualifying Technologies

In order to qualify for potential sponsorship, technologies submitted in response to this Call for Proposals must:

- be applicable to at least one of the identified requirements
- be novel or innovative
- demonstrate a clear business case for support
- have a clear and demonstrable path to commercialisation and implementation

Note: Proposals submitted to any other ITF Call in the past nine months or any previously unsuccessful applications should not be resubmitted without first consulting ITF (contact information provided later in this document).

Qualifying Organisations

Proposals are invited from any organisation including SME's, academia, research institutions, large organisations, consortiums or alliances. Proposals may be submitted by a national or international organisation, and equal opportunities will be extended to all proposers. Please keep in mind however that should your proposal be taken forward, you will be required to participate in meetings and make presentations to interested parties in the UK and in the English language (teleconference and video conference are acceptable).

ITF Contact Information

If you would like to discuss any matters related to this call or any other issue related to ITF, please contact any of the following people:

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