Coalbed Methane and Coal Seam Gas Capability Method Statement
With operating offices in Kuala Lumpur, Brisbane, Perth and Bucharest, representative offices in Oman, India and Indonesia, LEAP Energy is an international subsurface consulting and technology delivery group with over sixty staff and associates. Our projects are taking us throughout South-East Asia, Australia, the Middle-East and Europe.

LEAP Energy provides subsurface consulting and software technology development services for the oil and gas industry. In particular, we provide expertise in difficult hydrocarbon recovery, fractured and complex reservoirs, enhanced oil recovery. In particular, we have developed, unconventional resources (coal-bed methane, shale gas, geothermal) and integrated field studies,

- We have developed expertise in reservoir modelling of geologically complex settings, where full integration of seismic, static and dynamic data is essential.
- We have provided consulting services to both IOCs and NOCs,
- We believe we have uniquely integrated these three key fundamental value drivers into our company, and thereby provide our CLIENT with a positive differentiator from our competition. Our size allows us to give our full attention to all problems faced by our clients,
- As a company, we have a considerable South-Asian heartland expertise, our team of consulting staff has a wide and international experience in coalbed methane plays around the world. Our expertise covers the areas of due diligence, asset reviews, exploration and appraisal support, field development planning, technology selection and trialing, economics and commercial evaluations.

- Our company has been deeply involved with the field development planning optimization for one of the flagship projects of Queensland's Gladstone LNG. A total of ~7000 mandays have been deployed to date on this project, working on a combined total acreage of over 20,000 sq km. Detailed field development plans have been prepared for 4 fields, and technology assessment & conceptual development plans for another 25 assets as part of the client portfolio.
Recognising the specificity of CBM plays

- Coalbed methane fields are resource plays. Resource play are generally developed in a continuous manner, over a number of years, and require a manufacturing-like approach to drilling, completing and tie-in of new wells. As a result, economies of scale over a large number of repetitive, standardised concepts are more attractive than a well-by-well designer approach to developmental activities. That said, opportunities for continuous improvement and optimisation do exist, and can be applied to successive ‘generations’ of wells and associated developmental activities. To that effect, capturing learnings from early wells is essential, and investing in technology trials has often proven valuable.

- Recognising the above, one can apply the traditional E&P maturation phasing to field development, bearing in mind the need to conduct a number of iterations between Concept Select and Operate, as the development area increases. It must be understood, and integrated in the decision making, that a residual uncertainty exists at the end of the first iteration of Concept Select.

Field development planning workflow

- We have developed a consistent workflow for the optimisation of CBM fields. This workflow integrates the reservoir characterisation, static and dynamic modelling, production forecasting, technology mapping and techno-economic optimisation. In our experience, this assessment needs to be very carefully and systematically conducted under uncertainty.
Exploration/ Appraisal and Sweet-spotting

- Potential development areas based on surface factors are identified within the most favorable envelope of net coal thickness/ permeability and gas content.

CONCEPT SELECT – KEY DECISION

Best practices developed through our experience and according to published literature, suggest that workflow and tools should focus on:

- Integrating geological models, production forecasting and (proxy) economical screening capabilities
- Ensuring that the key uncertainties are assessed, and their impact on decisions are quantified

A number of associated outcomes follow from the Concept Select optimisation workflow, such as:

- Decision mapping for future technology trials and appraisal
- High-grading areas of increasing potential
- Defining economic limits and economic sensitivities

The key decisions can be broken down into four high-level elements:

- **Well Technology**
  This includes well trajectory, completion design including both coal-face completion and artificial lift system. In CBM reservoirs, particular care must be given to interburden management as well as the gas deliverability maximisation,

- **Spacing and reservoir drainage plan**
  Both surface and subsurface spacing need to be assessed, including the use of pads for drilling and production facilities concentration,

- **Sectorisation**
  This is fundamental to the macro-level optimisation of CBM plays, and should be used to define areas of incrementally higher unit cost (or other metric).

- **Development Intensity**
  Drilling pace vs. production facilities phasing are the final aspect of “concept select”, at the highest level. Both sectorisation and development intensity will impact the facilities design and phasing.
- We integrate technology, spacing and sector definition in one iteration, conducted using our proprietary tools and workflows. We can use a proxy-economic model to ensure the preservation of commercial sensitivities (if required by the CLIENT), but we are able to create an effective comparative economical model to select the range of optimum concepts.

- In particular, when looking at the selection of spacing, the following analysis is generated, for each technology. This workflow can be entirely conducted within DOT,CBM™, or replicated using other commercial tools in conjunction with Excel-based solutions.

- Dynamic forecasting is conducted at different well spacing, for the identified ‘do-able’ technologies – that pre-selection of technology is done using industry-proven metrics, and using our wide experience of CBM provinces (notably: USA, Canada, Australia, China).

- For a given technology, well spacing selection is conducted using alternative Value-Metrics, which are economic (or proxy-economic) criteria. These can vary depending on the strategic drivers of the client but optimisation curves such as shown below can be generated.

Our proposed workflow

Set up dynamic models
Map or Distribution based
Run alternative technologies
Run alternative spacing
Compute Value Metrics
Selection

Technology concept (completion/deviation)
Spacing
Sectorisation

Alternative technologies tested
Combined selection of spacing and technology

Dev
Fracc’ed
1.0 km spacing

Figure 4: Concept Select workflow using dynamic modelling and value-metric screening

Figure 5: Spacing Optimisation, CBM fields

Economical analysis – underpinning the selection of technology and spacing

Figure 7: Combined Well Technology selection

FIGURE 7: Combined Well Technology selection
Sectorisation: high grading of development areas

Key to economic optimisation is the assessment of development sectors, which can be defined as areas of consistent geological and structural settings, development concepts (well technology primarily) and economics (or value-metrics) indicators. They should also correspond to incremental sizes of development units, such as nodal gathering and compression stations, and processing plants. Land access, reserves categories are non-technical factors that may influence the definition of these sectors.

Full field forecasting: definition of possible production scenarios

The final stage of the evaluation is to construct a number of realistic scenarios for the full field forecast – broken down by sector or development area, and using the selected technology and well spacing. The main degree of freedom that is left to optimise is the development pace; that means how many rigs are used to drill the development wells, and the associated production build that ensues.

Application of resource maturation

Uncertainty can be also assessed by nesting this workflow over a number of subsurface realisations. The areas of higher certainty (more constrained and attractive value metrics are high-graded),
PRODUCTION FORECASTING
- Generate rapid full-field, static model based forecasts
- Advanced material balance production forecasting, multi-well and multi-layer
- Fast numerical scheme for transient production behaviour
- Perform uncertainty and variability assessments
- Forecast alternative well & completion concepts, with a comprehensive constraints handling capability

FIELD DEVELOPMENT PLANNING OPTIMISATION
- Forecast alternative drilling schedule, well technology and spacing concepts
- Automated type curve generation
- Identify optimum drilling and completion concepts
- Support decision under uncertainty

ECONOMIC EVALUATION
- Perform field and sector economic evaluation using a variety of pre-defined and user-defined indicators
- Detailed and scalable complexity of cost templates.
- Development concept ranking for Field Development Planning decisions

WELL TECHNOLOGY SELECTION
- Rapidly create well plans using an automated well trajectory building tool
- Automated Computation of well technology costs across the field

DATA ANALYSIS
- Develop property models using powerful data fitting functionalities
- Perform advanced statistical data analysis, correlations and analogue benchmarking
- Generate stochastic simulation for probabilistic volume assessment

REPORTING
- Easy export of data, text, figures, tables and maps in most recognized formats
- Drag’n’drop functionality for copying data and graphics to MS Office applications

MAPPING and VISUALISATION
- Visualise, edit and generate maps of reservoir properties
- Perform upscaling and downscaling
- Automated visualisation of reservoir simulation outcomes for high-grading analysis
- GIS functionality and map overlay capability

PRODUCTION HISTORY MATCHING
- Match pilot well production with multiple solutions
- Generate matching parameter ranges for reservoir characterisation input
- Finite-Elements numerical and Material-balance
- Multiple global search algorithm including evolutionary stochastic methods

All features are packaged in a user-friendly interface allowing easy navigation through the modules, easy export of outputs, integration with other applications and advanced 2D and 3D graphics

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