AGSO

2nd Petroleum Research & Development Priorities Workshop

Hyatt Hotel Canberra
February 15, 1999

P.E. Williamson and D.J. Wright

AGSO Record 1999/29

In collaboration with

APCRC AUSTRALIAN PETROLEUM COOPERATIVE RESEARCH CENTRE

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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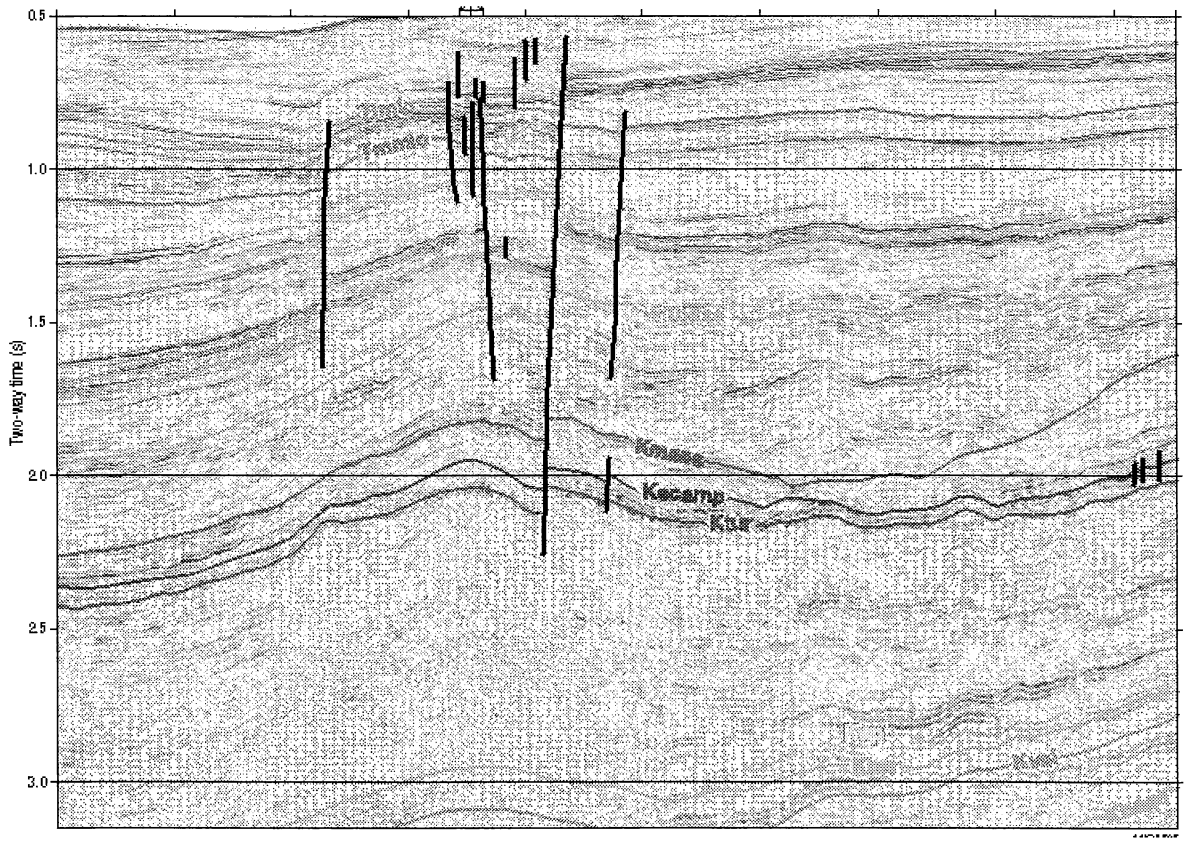

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Foreword

These are challenging times for the Australian petroleum industry as it deals with low oil prices. It is therefore appropriate that this workshop, convened by the Australian Geological Survey Organisation (AGSO) in collaboration with the Australian Petroleum Cooperative Research Centre (APCRC) and the industry, helps to outline a range of petroleum research and development options for the benefit of policy makers, the petroleum industry, and research providers.

AGSO is a professionally independent bureau of the Department of Industry, Science and Resources (DISR). AGSO now includes functions which provide advice to policy areas on technical aspects of the mineral and petroleum industries. These functions were relocated from the former Bureau of Resource Sciences (BRS). In this role, AGSO acts at the interface between science and policy. AGSO was thus well suited to coordinate the analysis of petroleum R&D priorities.

The first workshop on Petroleum R&D Priorities held in July 1998 was under the auspices of some AGSO functions then located in the Bureau of Resource Sciences. The factors, which the government and industry attendees believed were important to the future research needs of the upstream petroleum industry, were outlined, and key issues and questions were identified. That workshop, which had a stronger policy focus, succeeded in outlining the broad range of research but did not look to assign priorities.

This second Petroleum R&D Priorities workshop, held in collaboration with the APCRC, completed the task begun in the first workshop. The second workshop was designed to challenge conventional assumptions using a scenario-based method to develop the priorities. A wider range of participants included more representatives from the research community and industry.

The aim of the workshop was to define Petroleum R & D Priorities in a way that would provide useful inputs for planning in industry, government, research and academia. A set of simple scenarios addressed high/low oil price, high/low prospectivity and high/low effect of international agreements. These scenarios were assessed in terms of the implications for key research areas defined with the help of attendees prior to the workshop. The workshop enabled participation both by scientists involved in research and by industry and government workers who use the results of research for decision making. It is the first time that such a broad high level group has been brought together in Australia to address priorities for petroleum R&D across a number of organisations.

The workshop was designed to be strategic rather than an operational, and to provide a broad vision which was qualitative in nature. It aimed to examine key decisions, not to predict the future. In doing this it sought to ensure petroleum R&D priorities will reflect current and emerging needs of the Australian petroleum industry, government and the research community. The petroleum sector encompasses groups with different objectives and time frames for research needs and petroleum industry companies have different exploration and production portfolios. The industry is also notably subject to rapid price

changes, revised perceptions of prospectivity, and the effects of international agreements, so that no single set of R&D priorities provides a useful planning tool.

The results provided a broad insight into strategies for R&D under different scenarios. For example, in the "Lowdown world" scenario where petroleum prices were low, regional studies were expected to be carried out only by government, and R&D for industry was predicted to focus on cost reduction technologies. The results can be interpreted to also provide information on deficits in important areas of R&D expertise, and areas where training may be required. Results and interpretations from the scenario outcomes tables can also provide insights from the high/low prospectivity scenarios and from the high/low affect of international agreements scenarios.

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1. Uncertainty Factor Analysis Chart 11

1. Introduction

Dr Neil Williams, Executive Director of AGSO, opened the second Petroleum R & D Priorities Workshop at the Hyatt Hotel Canberra on February 15 1999. The workshop was attended by 36 senior representatives from industry, the Australian Petroleum Production and Exploration Association, Commonwealth and State governments, CSIRO, the Australian Petroleum Cooperative Research Centre (APCRC), the Office of Parliamentary Secretary, Mr Warren Entsch, and four Universities. The facilitator was Mr Michael Gill of Organisation Performance Consultants. The workshop was coordinated by Dr Paul Williamson and Denis Wright of the Petroleum Advice Program of AGSO, and co-sponsored by APCRC.

1.1 Preliminary Workshop

The first step in the process of defining priorities was a preliminary workshop with a smaller group - the first Workshop on Research and Development Priorities in the Petroleum Industry, held at the Hyatt Hotel Canberra on July 31 1998. This workshop, held under the auspices of the Bureau of Resource Sciences (BRS), focussed mainly on policy priorities from a government perspective. That workshop established general classes of needed research but did not aim to set priorities. The general areas of needed petroleum R&D were identified as: adaptation of overseas technologies and R&D; emerging technologies; exploration plays; production; environment; petroleum transportation and storage; local problems and projects; increasing efficiency; international obligations; market/social; economic; and alternative energy. The proceedings of the first workshop have been summarised in a previous report (Reference 1).

1.2 Second Workshop

Following the transfer of the petroleum advice function from BRS to AGSO in October 1998, the second Workshop was convened by AGSO with co-sponsorship from APCRC. There was little overlap in attendees at the two workshops, with the second workshop focussing more on the research community and the industry, rather than government. Attendees are listed in Section 2. The workshop recognised that, apart from the benefits to Australian petroleum industry of the research sector, there was an overseas market for Australian petroleum research. This second workshop reassessed and then outlined R&D priorities within a list of research disciplinary decisions arising from the first workshop. The workshop established and reported on R&D priorities for various plausible future scenarios.

1.3 Research Areas

The research areas listed cover most of the areas indexed in Petroleum Abstracts. These are:

Geochemistry
Geology
Geophysics
Drilling
Well Logging
Well Completion and Servicing
Production of Oil and Gas
Reservoir Engineering and Recovery Methods
Pipelining, Shipping and Storage
Ecology and Pollution
Alternate Fuels and Energy Sources
Supplemental Technology

To assist in arriving at a list of R&D classes to be prioritised against the scenarios, attendees were asked prior to the workshop to indicate their involvement, knowledge of, and importance of R&D classes in a list of 187 research areas. The 13 replies (some representing the views of an organisation of group of respondents) were used to rank the importance of, involvement in and knowledge of the areas as assessed by those participants who responded and to identify additional areas of interest. The results of the survey are in Appendices 1 and 2.

Following receipt of the replies to this survey, a number of areas (interoperability of software, process engineering including remote natural gas, gas to liquids, gas processing and cleaning, marinisation of process equipment, technology of gas conversion, knowledge management, risk analysis and risk comparison across projects/opportunities) were added to the list, and the total number of items in the list was condensed to arrive a list of 28 R&D classes for scenario analysis.

1.4 Structure of Workshop

The petroleum industries are notably subject to change as oil prices and perceptions of prospectivity change. Governmental and environmental issues also come into play. These factors can impact differently on different companies and the extent of the impact can vary with time. A single view of the future is therefore unlikely to reveal the kinds of research, which are needed. Therefore, as in the first workshop, a scenario planning approach was used which assessed the need for R&D against high and low effects from the above factors.

An initial exercise ascertained degrees of certainty among the participants (Appendix 3) about research priorities. This was followed by a session identifying the main factors from the first workshop and adding additional factors, and considering key questions. These are shown in Section 3. It was clear that there are two distinct sets of priorities: *marketing and development* for gas, and *exploration* for oil, reflecting the relative abundance of gas resources and scarcity of oil resources at present. The factors are shown in Figure 1.

The key questions were the foundations for the eight scenarios listed in Section 4, which were derived from the twelve scenarios in the first workshop. Groups of four to six people worked on each of the eight scenarios. Under their particular scenario, the participants in each group then assessed the following, for each research area:

1. Applicable time frame	3,5,10 years
2. Importance of research area	Low, Medium, High
3. Main clients	Local industry, government, overseas industry
4. Impact	Oil industry, gas industry, both
5. Availability of research skills in Australia	Yes, no, unsure
6. Achievability of research	Yes, no, unsure
7. Impact of research	Low, medium, high

These results for each scenario/group are given in Section 5, and the reasons behind the results as outlined by group representatives are given in Section 6. Conclusions from the workshop are given in Section 7.

What was attempted during the second workshop was very ambitious and little reporting of results was possible on the day. Consequently, conclusions and the summary for this report were written afterwards and drafts of the report were commented on by attendees.

This report is intended to help guide the research community, academia, industry and government to identify needed research, research capabilities and the necessary skills base.

2. Workshop Attendees

Elinor Alexander
Senior Petroleum Geologist
Department of Primary Industries and Resources
South Australia

Professor Robert Alexander
Professor of Petroleum &Environmental Organic Geochemistry
Curtin University of Technology

Guy Allinson
Senior Fellow
School of Petroleum Engineering
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Anita Andrew
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Peter Cochrane
Deputy Executive Director
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Dr Kevin Dodds
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Phil Domaschenz
Maine and Conservation Section
Marine Group
Environment Australia

Paul Everingham
Advisor to the Parliamentary Secretary
The Hon Warren Entsch MP

Parliamentary Secretary to the
Minister for Industry, Science and Resources (Commonwealth)

Dr Clinton Foster
Petroleum Research Group Leader & Senior Principal Research Scientist
Research Palynology
Australian Geological Survey Organisation

Dr Arie Geertsema
Manager
Gas Processing
CSIRO Division of Petroleum Resources

Michael Gill **(facilitator)**
Organisation Performance Consultants

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University of Adelaide

Professor Robert Kagi
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Dr John Kaldi
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University of Adelaide

Geoff King
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Dr Mark Knackstedt
QE11 Fellow
Applied Maths
Research School of Physical Sciences
Australian National University

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Australian Geological Survey Organisation

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Professor Val Pinczewski
Director
School of Petroleum Engineering
University of New South Wales

Dr Trevor Powell
Deputy Executive Director
Australian Geological Survey Organisation

Kees Van Gelder
Teamleader
Technology & Technical Services - NDST
Woodside Energy Ltd

Dr Larry Wakefield
Manager
Exploration Portfolio and Knowledge
Shell (Development) Australia Ltd

Dr Tony Weir
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Denis Wright
Chief Petroleum Engineer
Petroleum Resources Program
Australian Geological Survey Organisation

Motoyoshi Yamanaka
Inpex Alpha Ltd

Marko Zagar
Departmental Liaison Officer
Office of the Hon Warren Entsch MP
Parliamentary Secretary to the
Minister for Industry, Science and Resources (Commonwealth)

3. Key Questions And Factors Affecting Future Petroleum R&D

3.1 Key Questions

The following key questions were presented as a summary of those derived at the first workshop on 31 July 1998. A brief review of the APPEA planning workshop of the week prior to this workshop was also given as relevant. The aim was to help provide a context in examining the scenarios and petroleum R & D priorities. The key questions were:

- How do we maximise the overall benefit to Australia of its petroleum resources (and researchers)?
- How and where do we discover and produce new resources?
- How do we attract the needed investment?
- How can we achieve and demonstrate sound local and regional environmental management?
- Should we put more R&D into greenhouse emissions from E&P?
- What will be the distribution of research between government and industry?
- Should more R&D be applied to Australia's non-conventional energy resources?
- What is Australia's place in the world petroleum R&D effort?
- How will the policy framework for R&D respond to new scientific and economic knowledge?

3.2 Informal Report on the APPEA Planning Workshop

Adrian Williams who had attended the APPEA workshop described their key issues:

- Cost cutting is top of the agenda in the short term but also consistent with long term trends.
- Australia's oil resource outlook is decreasing but demand remains strong.
- Gas is resource rich but market poor; need to increase demand and add value.
- Government regulations.
- Greenhouse is a significant issue but our ability to impact it seems low.
- Technology development offers most potential and is most within our grasp to manage.

Peter Cochrane of APPEA added the following points in relation to the APPEA Workshop:

- Industry skills basis in decline because of intense cost pressures.
- Industry re-alignment with no room for small players.
- Multinationals are big gas players and direct their R&D in that direction
- Cost is absolutely everything.

ABARE's views expressed at the APPEA Workshop were reported as:

- Asian growth will start to recover in two years especially in China.
- Growth in Asia will then be rapid and greater than for OECD.
- We need to think about whom we collaborate with.
- The real price of oil has remained flat for 15 years.
-

3.3 Key Factors

These are shown in Figure 1. Factors added in the second workshop are shown in bold. The axes represent impact and uncertainty. The figure therefore comprises four areas:
Area A / Major Influence Area (high impact, high uncertainty),
Area B / Trend Area (low uncertainty, high impact),
Area C / Things to Monitor (high uncertainty, low impact)
Area D / Context Area (low uncertainty, low impact)

FIGURE 1:
UNCERTAINTY FACTOR ANALYSIS CHART

*Note: elements in **bold***
have been added in Workshop 2

4. Scenarios

The following scenarios were derived from twelve used in the previous workshop (Reference 1). They each incorporate one or more of the previous scenarios. In each case the flip (positive scenario) is followed by a corresponding flop (negative scenario). Each group of four to six participants considered one scenario.

SCENARIO A-Black-golden World
(High Oil and Gas prices)

- **Middle East supplies quarantined**
- **Resurgence in World Economies**
- **High demand and high price for oil and gas**
- **Petroleum remains dominant energy source**
- **High levels of E & P**
- **High levels of R & D?**
- **It's a black-gold rush!**

SCENARIO B -Lowdown World
(Low Oil and Gas prices)

- **World currency crisis increases**
- **Static to decreasing demand and low price for oil and gas**
- **Competition from alternative energy sources heightens**
- **Supply sustained**
- **Low level of E&P**
- **Reduced level of R&D**
- **How low can you go?**

SCENARIO C -Sunshine Land
(High Prospectivity & Production)

- **Australia highly regarded as exploration arena**
- **Vibrant industry**
- **Stable and positive fiscal regimes**
- **Skilled staff required for industry and R&D**
- **New technologies are accessible**
- **Strong government and industry support for R&D?**
- **High levels of R&D expertise**
- **Good access to resources**
- **Let's make hay**

SCENARIO D-Squeeze Land
(Low Prospectivity & Production)

- **Poor access to exploration acreage**
- **Australia poorly regarded as exploration area**
- **Declining industry**
- **Unstable and unfavourable fiscal regimes**
- **Poor access to new technologies**
- **Weak government and industry support for R&D**
- **Low levels of R&D expenditure**
- **R&D declines along with skills base**
- **Are you finding it a little difficult to breathe?**

SCENARIO E-Window on the World
(High R&D on international agreements and environmental issues)

- **Effective and manageable international agreements**
- **Positive contribution from international infrastructure**
- **Production and use environmentally acceptable**
- **High government and industry support for R&D**
- **Greenhouse targets met**
- **Effective Emissions Trading system**
- **Gas industry plays large role in greenhouse response**
- **Good access to acreage**
- **Community supports industry**
- **Citizens of the world unite!**

SCENARIO F -Solo Land
(Low R&D on international agreements and environmental issues)

- **No regrets and no global perspective**
- **Ineffective Emissions Trading System - unstable energy economies**
- **Poor access to international infrastructure**
- **Greenhouse targets not met**
- **Gas industry plays little role in greenhouse response**
- **Production and use not environmentally acceptable**
- **Poor access to acreage**
- **Low government and industry support for the relevant R&D**
- **Community hostile to industry**
- **I want to be alone!**

5. Scenario Outcomes

The results of each group's responses for its scenario to the list of research areas are given in this section. For Scenario D (Squeeze Land), two responses, one for oil and one for gas, were given.

Nomenclature in responses is as follows:

	Applicable time frame	**Importance of research area**	**Main client**	**Industries affected**	**Availability of research skills in australia**	**Achievability**	**Impact of research**
Abbreviation	3/5/10	L/M/H	L/G/O	O/G/B	Y/N/U	Y/N/U	L/M/H
Meaning	3/5/10 years from present	Low/ medium/ high	Local industry/ government/ overseas industry	Oil/gas/both	Yes/no/ unsure	Yes/no/unsure	Low/ medium/ high

	A: Black Gold	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
1	BASIN STUDIES/ BASIN ANALYSIS including basin analysis, petroleum systems, controls on trap integrity, petroleum potential	10	H	LG	B	Y			
2	PETROLOGY AND BIOSTRATIGRAPHY	10	H	LG	B	U			
3	FIELD ASSESSMENT including prospect appraisal	10	M	L	B	Y			
4	RESERVOIR GEOLOGY including core analysis, production geology	10	M	L	B	Y			
5	ORGANIC GEOCHEMISTRY including airborne laser fluorescence, fluid inclusion, characterisation of oils	10	H	L	B	Y			
6	GEOTECHNICS including geomechanics, rock mechanics	10	M	L	B	Y			
7	GEOPHYSICS including geophysical instrumentation, seismic acquisition, interpretation, physical modelling, 3D/3Component, seismic while drilling, pore pressure prediction, attributes studies	10	H	A	B	Y			
8	PETROPHYSICS including borehole physics, formation evaluation, nuclear magnetic resonance (NMR), wireline logging	10	H	LG	B	U			U= some
9	FIELD DEVELOPMENT including deepwater field development, low API gravity oil field development, small field development	10	H	L	B	U			
10	APPLIED MECHANICS including materials strength	10	H	L	B	U			
11	DRILLING including complex well geometry, directional drilling, horizontal well technology, lost circulation	10	H	L	B	U			
12	WELL ENGINEERING including well completions, well testing, wellbore integrity, smart well completions	5	H	L	B	U			
13	RESERVOIR ENGINEERING PRINCIPLES including microscale modelling, fluid flow in porous media	5	H	L	B	U			
14	RESERVOIR MANAGEMENT including reservoir monitoring, 4D seismic, reservoir heterogeneities, gas storage	10	H	L	B	U			
15	PHASE BEHAVIOUR including PVT analysis, gas hydrates	10	M	LG	B	U			
16	RESERVOIR DESCRIPTION including reservoir simulation, reservoir visualisation	10	H	L	B	U			
17	ENHANCED OIL RECOVERY (EOR) including CO2 injection, miscible flooding, petroleum microbiology	10	M	LG	B	U			
18	PRODUCTION ENGINEERING including corrosion assessment, production fluids handling (water separation and cleanup), subsea technology - design and performance, multiphase flow, pipelines	10	H	L	B	U			
19	ALTERNATIVE ENERGY including coal bed methane, geothermal energy	10	H	LG	B	Y			

	A: Black Gold	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
20	ENVIRONMENTAL IMPACT ASSESSMENT including environmental auditing, environmental site characterisation, remediation	10	H	LG	B	Y			
21	ENVIRONMENTAL STUDIES including marine and onshore studies	10	H	LG	B	Y			
22	GREENHOUSE EFFECT AND MITIGATION	10	M	LG	B	U			
23	PROBABILISTIC ANALYSIS including geostatistics, risk analysis and risk comparison across projects/opportunities	10	M	LG	B	U			
24	ENERGY ECONOMICS including exploration economics	10	H	LG	B	Y			
25	MARKET/SOCIAL RESEARCH	10	M	LG	B	Y			
26	INTEROPERABILITY OF SOFTWARE	5	H	A	B	U			
27	PROCESS ENGINEERING including remote natural gas, gas to liquids, gas processing and cleaning, marinisation of process equip. and technology, techno-economics of gas conversion	10	M	L	B	Y			
28	KNOWLEDGE MANAGEMENT	10	H	A	B	Y			

	B: Lowdown world	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	

Note 1: Scenario incompatibility! Remove competition from alternative energy sources.
Note 2: Unsure = some current expertise available, but the future is the question.

1	BASIN STUDIES/ BASIN ANALYSIS including basin analysis, petroleum systems, controls on trap integrity, petroleum potential	10	L	G	B	Y	Y	L	
2	PETROLOGY AND BIOSTRATIGRAPHY **(reservoir)**	3	M	L	B	U	Y	M	
3	FIELD ASSESSMENT including prospect appraisal **(exploration)**	10	L	G	B	Y	Y	L	
4	RESERVOIR GEOLOGY including core analysis, production geology	3	M	L	B	U	Y	H	
5	ORGANIC GEOCHEMISTRY including airborne laser fluorescence, fluid inclusion, characterisation of oils etc **(reservoir)**	3	M	L	B	Y	Y	M	
6	GEOTECHNICS including geomechanics, rock mechanics **(reservoir)**	5	L	L	B	Y	Y	L	
7	GEOPHYSICS including geophysical instrumentation, seismic acquisition, interpretation, physical modelling, 3D/3Component, seismic while drilling, pore pressure prediction, attributes studies	3	H	L	B	N	U	H	
8	PETROPHYSICS including borehole physics, formation evaluation, nuclear magnetic resonance (NMR), wireline logging	3	H	L	B	N	Y	M	
9	FIELD DEVELOPMENT including deepwater field development, low API gravity oil field development, small field development	10	L	L	O	U	Y	L	
10	APPLIED MECHANICS including materials strength	10	L	A	B	Y	Y	L	
11	DRILLING including complex well geometry, directional drilling, horizontal well technology, lost circulation	3	H	L	B	U	Y	H	
12	WELL ENGINEERING including well completions, well testing, wellbore integrity, smart well completions	3	H	L	B	U	U	H	
13	RESERVOIR ENGINEERING PRINCIPLES including microscale modelling, fluid flow in porous media	5	H	A	O	Y	Y	H	
14	RESERVOIR MANAGEMENT including reservoir monitoring, 4D seismic, reservoir heterogeneities, gas storage	3	H	A	B	U	U	H	
15	PHASE BEHAVIOUR including PVT analysis, gas hydrates **(Hydrates as problem, not resource)**	3	H	A	G	Y	Y	H	
16	RESERVOIR DESCRIPTION including reservoir simulation, reservoir visualisation	3	H	A	B	N	U	H	

	B: Lowdown world	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
17	ENHANCED OIL RECOVERY (EOR) including CO2 injection, miscible flooding, petroleum microbiology	10	L	A	O	U	Y	L	
18	PRODUCTION ENGINEERING including corrosion assessment, production fluids handling (water separation and cleanup), subsea technology - design and performance, multiphase flow, pipelines	3	H	L	B	U	U	H	
19	ALTERNATIVE ENERGY including coal bed methane, geothermal energy	10	L	A	B	U	Y	L	
20	ENVIRONMENTAL IMPACT ASSESSMENT including environmental auditing, environmental site characterisation, remediation	3	M	A	B	Y	Y	M	
21	ENVIRONMENTAL STUDIES including marine and onshore studies	10	L	A	B	Y	Y	L	
22	GREENHOUSE EFFECT AND MITIGATION	10	L	A	G	N	U	L	
23	PROBABILISTIC ANALYSIS including geostatistics, risk analysis and risk comparison across projects/opportunities	3	H	A	B	U	U	H	
24	ENERGY ECONOMICS including exploration economics	10	L	A	B	N	Y	M	
25	MARKET/SOCIAL RESEARCH	10	L	A	B	U	Y	L	
26	INTEROPERABILITY OF SOFTWARE	3	H	A	B	N	U	M	
27	PROCESS ENGINEERING including remote natural gas, gas to liquids, gas processing and cleaning, marinisation of process equip. and technology techno-economics of gas conversion	10	L	A	B	Y	N	L	
28	KNOWLEDGE MANAGEMENT	3	M	A	B	U	Y	M	

	C: Sunshine land	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
1	BASIN STUDIES/ BASIN ANALYSIS including basin analysis, petroleum systems, controls on trap integrity, petroleum potential	10	H	A	B	Y	Y	H	
2	PETROLOGY AND BIOSTRATIGRAPHY	10	H	A	B	Y	Y	H	
3	FIELD ASSESSMENT including prospect appraisal	10	H	A	B	Y	Y	H	
4	RESERVOIR GEOLOGY including core analysis, production geology	10	H	A	B	Y	Y	H	
5	ORGANIC GEOCHEMISTRY including airborne laser fluorescence, fluid inclusion, characterisation of oils	10	H	A	B	Y	Y	H	
6	GEOTECHNICS including geomechanics, rock mechanics	10	H	A	B	Y	Y	H	
7	GEOPHYSICS including geophysical instrumentation, seismic acquisition, interpretation, physical modelling, 3D/3Component, seismic while drilling, pore pressure prediction, attributes studies	10	H	A	B	Y	Y	H	
8	PETROPHYSICS including borehole physics, formation evaluation, nuclear magnetic resonance (NMR), wireline logging	10	H	A	B	Y	Y	H	
9	FIELD DEVELOPMENT including deepwater field development, low API gravity oil field development, small field development	10	H	A	B	Y	Y	H	
10	APPLIED MECHANICS including materials strength	10	L	L	B	U	Y	L	
11	DRILLING including complex well geometry, directional drilling, horizontal well technology, lost circulation	10	H	A	B	Y	Y	H	
12	WELL ENGINEERING including well completions, well testing, wellbore integrity, smart well completions	10	H	A	B	Y	Y	H	
13	RESERVOIR ENGINEERING PRINCIPLES including microscale modelling, fluid flow in porous media	10	H	A	B	Y	Y	H	
14	RESERVOIR MANAGEMENT including reservoir monitoring, 4D seismic, reservoir heterogeneities, gas storage	10	H	A	B	Y	Y	H	
15	PHASE BEHAVIOUR including PVT analysis, gas hydrates	10	H	A	B	Y	Y	H	
16	RESERVOIR DESCRIPTION including reservoir simulation, reservoir visualisation	10	H	A	B	Y	Y	H	
17	ENHANCED OIL RECOVERY (EOR) including CO2 injection, miscible flooding, petroleum microbiology	10	H	A	B	Y	Y	H	
18	PRODUCTION ENGINEERING including corrosion assessment, production fluids handling (water separation and cleanup), subsea technology - design and performance, multiphase flow, pipelines	10	H	A	B	Y	Y	H	
19	ALTERNATIVE ENERGY including coal bed methane, geothermal energy	10	M	A	B	Y	Y	H	

	C: Sunshine land	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
20	ENVIRONMENTAL IMPACT ASSESSMENT including environmental auditing, environmental site characterisation, remediation	10	H	A	B	Y	Y	H	
21	ENVIRONMENTAL STUDIES including marine and onshore studies	10	H	A	B	Y	Y	H	
22	GREENHOUSE EFFECT AND MITIGATION	10	H	A	B	Y	Y	H	
23	PROBABILISTIC ANALYSIS including geostatistics, risk analysis and risk comparison across projects/opportunities	10	H	A	B	Y	Y	H	
24	ENERGY ECONOMICS including exploration economics	10	H	A	B	Y	Y	H	
25	MARKET/SOCIAL RESEARCH	10	H	A	B	Y	Y	H	
26	INTEROPERABILITY OF SOFTWARE	10	L	A	B	Y	Y	L	
27	PROCESS ENGINEERING including remote natural gas, gas to liquids, gas processing and cleaning, marinisation of process equip. and technology techno-economics of gas conversion	10	H	A	B	Y	Y	H	
28	KNOWLEDGE MANAGEMENT	10	H	A	B	Y	Y	H	

	D: Squeeze land Oil	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
Oil: Prospectivity For Oil									
1	BASIN STUDIES/ BASIN ANALYSIS including basin analysis, petroleum systems, controls on trap integrity, petroleum potential	3	H	A	O	Y	H		
2	PETROLOGY AND BIOSTRATIGRAPHY	5	L	A	O	Y	H		
3	FIELD ASSESSMENT including prospect appraisal	5	L	A	O	Y	H		
4	RESERVOIR GEOLOGY including core analysis, production geology	5	L	A	O	Y	H		
5	ORGANIC GEOCHEMISTRY including airborne laser fluorescence, fluid inclusion, characterisation of oils	3	H	A	O	Y	M		
6	GEOTECHNICS including geomechanics, rock mechanics	3	H	L	O	Y	M		
7	GEOPHYSICS including geophysical instrumentation, seismic acquisition, interpretation, physical modelling, 3D/3Component, seismic while drilling, pore pressure prediction, attributes studies	3	H	L	O	Y	M		
8	PETROPHYSICS including borehole physics, formation evaluation, nuclear magnetic resonance (NMR), wireline logging								
9	FIELD DEVELOPMENT including deepwater field development, low API gravity oil field development, small field development	10	L	A	O	N	H		
10	APPLIED MECHANICS including materials strength								
11	DRILLING including complex well geometry, directional drilling, horizontal well technology, lost circulation	3	H	L	O	Y	H		
12	WELL ENGINEERING including well completions, well testing, wellbore integrity, smart well completions								
13	RESERVOIR ENGINEERING PRINCIPLES including microscale modelling, fluid flow in porous media								
14	RESERVOIR MANAGEMENT including reservoir monitoring, 4D seismic, reservoir heterogeneities, gas storage	3	H	L	O	Y	H		
15	PHASE BEHAVIOUR including PVT analysis, gas hydrates								
16	RESERVOIR DESCRIPTION including reservoir simulation, reservoir visualisation	3	H	L	O	Y	M		
17	ENHANCED OIL RECOVERY (EOR) including CO2 injection, miscible flooding, petroleum microbiology								
18	PRODUCTION ENGINEERING including corrosion assessment, production fluids handling (water separation and cleanup), subsea technology - design and performance, multiphase flow, pipelines								

	D: Squeeze land Oil	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
18 A	DECOMMISSIONING	5	M	LG	O	N	M		
19	ALTERNATIVE ENERGY including coal bed methane, geothermal energy								
20	ENVIRONMENTAL IMPACT ASSESSMENT including environmental auditing, environmental site characterisation, remediation								
21	ENVIRONMENTAL STUDIES including marine and onshore studies								
22	GREENHOUSE EFFECT AND MITIGATION								
23	PROBABILISTIC ANALYSIS including geostatistics, risk analysis and risk comparison across projects/opportunities								
24	ENERGY ECONOMICS including exploration economics								
25	MARKET/SOCIAL RESEARCH								
26	INTEROPERABILITY OF SOFTWARE								
27	PROCESS ENGINEERING including remote natural gas, gas to liquids, gas processing and cleaning, marinisation of process equip. and technology techno-economics of gas conversion								
28	KNOWLEDGE MANAGEMENT	5	H	A	O	Y	M		

	D: Squeeze land Gas	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	

Gas: Gas Production/Transport etc

1	BASIN STUDIES/ BASIN ANALYSIS including basin analysis, petroleum systems, controls on trap integrity, petroleum potential								
2	PETROLOGY AND BIOSTRATIGRAPHY								
3	FIELD ASSESSMENT including prospect appraisal								
4	RESERVOIR GEOLOGY including core analysis, production geology								
5	ORGANIC GEOCHEMISTRY including airborne laser fluorescence, fluid inclusion, characterisation of oils								
6	GEOTECHNICS including geomechanics, rock mechanics								
7	GEOPHYSICS including geophysical instrumentation, seismic acquisition, interpretation, physical modelling, 3D/3Component, seismic while drilling, pore pressure prediction, attributes studies								
8	PETROPHYSICS including borehole physics, formation evaluation, nuclear magnetic resonance (NMR), wireline logging								
9	FIELD DEVELOPMENT including deepwater field development, low API gravity oil field development, small field development								
10	APPLIED MECHANICS including materials strength								
11	DRILLING including complex well geometry, directional drilling, horizontal well technology, lost circulation	3	H	L	G	Y	H		
12	WELL ENGINEERING including well completions, well testing, wellbore integrity, smart well completions	3	H	L	G	Y	H		
13	RESERVOIR ENGINEERING PRINCIPLES including microscale modelling, fluid flow in porous media								
14	RESERVOIR MANAGEMENT including reservoir monitoring, 4D seismic, reservoir heterogeneities, gas storage								
15	PHASE BEHAVIOUR including PVT analysis, gas hydrates								
16	RESERVOIR DESCRIPTION including reservoir simulation, reservoir visualisation								
17	ENHANCED OIL RECOVERY (EOR) including CO2 injection, miscible flooding, petroleum microbiology								
18	PRODUCTION ENGINEERING including corrosion assessment, production fluids handling (water separation and cleanup), subsea technology - design and performance, multiphase flow, pipelines	5	M	LG	G	Y	M		

	D: Squeeze land Gas	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
18 A	DECOMMISSIONING								
19	ALTERNATIVE ENERGY including coal bed methane, geothermal energy								
20	ENVIRONMENTAL IMPACT ASSESSMENT including environmental auditing, environmental site characterisation, remediation								
21	ENVIRONMENTAL STUDIES including marine and onshore studies								
22	GREENHOUSE EFFECT AND MITIGATION								
23	PROBABILISTIC ANALYSIS including geostatistics, risk analysis and risk comparison across projects/opportunities								
24	ENERGY ECONOMICS including exploration economics								
25	MARKET/SOCIAL RESEARCH	3	H	LG	G	Y			
26	INTEROPERABILITY OF SOFTWARE								
27	PROCESS ENGINEERING including remote natural gas, gas to liquids, gas processing and cleaning, marinisation of process equip. and technology, techno-economics of gas conversion	3	H	LG	G	N	M/L		
28	KNOWLEDGE MANAGEMENT	5	H	A	O	Y	M		

	E: Window on the World	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	

Note 1:The items not marked/scored below have not been addressed specifically in this scenario
Note 2: Impact: all marked items were selected to be those having impact high for this scenario

1	BASIN STUDIES/ BASIN ANALYSIS including basin analysis, petroleum systems, controls on trap integrity, petroleum potential	3510	M	A	B	Y	Y	H	
2	PETROLOGY AND BIOSTRATIGRAPHY								
3	FIELD ASSESSMENT including prospect appraisal								
4	RESERVOIR GEOLOGY including core analysis, production geology								
5	ORGANIC GEOCHEMISTRY including airborne laser fluorescence, fluid inclusion, characterisation of oils								
6	GEOTECHNICS including geomechanics, rock mechanics								
7	GEOPHYSICS including geophysical instrumentation, seismic acquisition, interpretation, physical modelling, 3D/3Component, seismic while drilling, pore pressure prediction, attributes studies								
8	PETROPHYSICS including borehole physics, formation evaluation, nuclear magnetic resonance (NMR), wireline logging								
9	FIELD DEVELOPMENT including deepwater field development, low API gravity oil field development, small field development								
10	APPLIED MECHANICS including materials strength								
11	DRILLING including complex well geometry, directional drilling, horizontal well technology, lost circulation (environmental research)	3510	H	A	B	Y	Y	H	
12	WELL ENGINEERING including well completions, well testing, wellbore integrity, smart well completions								
13	RESERVOIR ENGINEERING PRINCIPLES including microscale modelling, fluid flow in porous media								
14	RESERVOIR MANAGEMENT including reservoir monitoring, 4D seismic, reservoir heterogeneities, gas storage								
15	PHASE BEHAVIOUR including PVT analysis, gas hydrates								
16	RESERVOIR DESCRIPTION including reservoir simulation, reservoir visualisation								
17	ENHANCED OIL RECOVERY (EOR) including CO2 injection, miscible flooding, petroleum microbiology	3510	H	A	O	Y	Y	H	

	E: Window on the World	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
18	PRODUCTION ENGINEERING including corrosion assessment, production fluids handling (water separation and cleanup), subsea technology - design and performance, multiphase flow, pipelines	3510	H	A	B	N	Y	H	
19	ALTERNATIVE ENERGY including coal bed methane, geothermal energy								
20	ENVIRONMENTAL IMPACT ASSESSMENT including environmental auditing, environmental site characterisation, remediation	3510	H	A	B	Y	Y	H	
21	ENVIRONMENTAL STUDIES including marine and onshore studies	3510	H	A	B	Y	Y	H	
22	GREENHOUSE EFFECT AND MITIGATION	3510	H	A	B	Y	Y	H	
23	PROBABILISTIC ANALYSIS including geostatistics, environmental risk analysis and risk comparison across projects/opportunities	3510	H	A	B	Y	Y	H	
24	ENERGY ECONOMICS including exploration economics								
25	MARKET/SOCIAL RESEARCH	3510	H	A	B	Y	Y	H	
26	INTEROPERABILITY OF SOFTWARE								
27	PROCESS ENGINEERING including remote natural gas, gas to liquids, gas processing and cleaning, marinisation of process equip. and technology techno-economics of gas conversion	3510	H	A	B	Y	Y	H	
28	KNOWLEDGE MANAGEMENT	3510	H	A	B	Y	Y	H	

	F: Solo Land	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	

All achievabilities unsure because research run down. Similarly impacts unlikely to be high (recorded as M-M). Production important, but not exploration.

1	BASIN STUDIES/ BASIN ANALYSIS including basin analysis, petroleum systems, controls on trap integrity, petroleum potential		L			YU	U		
2	PETROLOGY AND BIOSTRATIGRAPHY		L			U	U		
3	FIELD ASSESSMENT including prospect appraisal		M	A	B	Y	U	M	
4	RESERVOIR GEOLOGY including core analysis, production geology		M	A	B	Y	U	M	
5	ORGANIC GEOCHEMISTRY including airborne laser fluorescence, fluid inclusion, characterisation of oils		L				U		
6	GEOTECHNICS including geomechanics, rock mechanics		M	L			U	M	
7	GEOPHYSICS including geophysical instrumentation, seismic acquisition, interpretation, physical modelling, 3D/3Component, seismic while drilling, pore pressure prediction, attributes studies		M	L	B	Y	U	M	
8	PETROPHYSICS including borehole physics, formation evaluation, nuclear magnetic resonance (NMR), wireline logging		M	A	B	Y	U	M	
9	FIELD DEVELOPMENT including deepwater field development, low API gravity oil field development, small field development		L			Y	U		
10	APPLIED MECHANICS including materials strength		M	L	B	Y	U	M	
11	DRILLING including complex well geometry, directional drilling, horizontal well technology, lost circulation		M	L	B	Y	U	M	
12	WELL ENGINEERING including well completions, well testing, wellbore integrity, smart well completions		M	L	B	Y	U	M	
13	RESERVOIR ENGINEERING PRINCIPLES including microscale modelling, fluid flow in porous media		M	L	B	Y	U	M	
14	RESERVOIR MANAGEMENT including reservoir monitoring, 4D seismic, reservoir heterogeneities, gas storage		M	L	B	Y	U	M	
15	PHASE BEHAVIOUR including PVT analysis, gas hydrates		M	L	B	Y	U	M	
16	RESERVOIR DESCRIPTION including reservoir simulation, reservoir visualisation		LM	L	B	Y	U	M	
17	ENHANCED OIL RECOVERY (EOR) including CO2 injection, miscible flooding, petroleum microbiology		M	L	B	Y	U	M	
18	PRODUCTION ENGINEERING including corrosion assessment, production fluids handling (water separation and cleanup), subsea technology - design and performance, multiphase flow, pipelines		M	L	B	Y	U	M	
19	ALTERNATIVE ENERGY including coal bed methane, geothermal energy		L			U	U		

	F: Solo Land	Applicable time frame	Importance of research area	Main client	Industries affected	Availability of research skills in Australia	Achievab -ility	Impact of research	Note
		3/ 5/ 10 years from present	Low/ Medium/ High	Local Industry/ Government/ Overseas Industry	Oil/ Gas/ Both	Yes/ No/ Unsure	Yes/ No/ Unsure	Low/ Medium/ High	
20	ENVIRONMENTAL IMPACT ASSESSMENT including environmental auditing, environmental site characterisation, remediation		L			U	U		
21	ENVIRONMENTAL STUDIES including marine and onshore studies		L			U	U		
22	GREENHOUSE EFFECT AND MITIGATION		L			U	U		
23	PROBABILISTIC ANALYSIS including geostatistics, risk analysis and risk comparison across projects/opportunities		L			U	U		
24	ENERGY ECONOMICS including exploration economics		L			N	U		
25	MARKET/SOCIAL RESEARCH		H	A	B	Y	U	H	
26	INTEROPERABILITY OF SOFTWARE		L			U	U		
27	PROCESS ENGINEERING including remote natural gas, gas to liquids, gas processing and cleaning, marinisation of process equip. and technology techno-economics of gas conversion		L			U	U		
28	KNOWLEDGE MANAGEMENT	10	H	A	B	N	L	M	

6. Comments On Scenario Outcomes

For Scenario (A) (Black Gold) with **high oil prices** the favoured R & D classes emphasised access to the resource. Thus exploration, drilling and production technologies were favoured along with knowledge management. The client for this research was seen to be mainly local. Environmental research was undertaken for both industry and government along with precompetitive geoscience by government to encourage exploration. The high oil prices encouraged R&D into alternative energy sources. The oil and gas industries were considered to be affected in similar ways. Much of the needed research skill was thought to be available in Australia, although for the high-tech end of production technologies there was some uncertainty.

In Scenario (B) (Low Down) with **low oil prices** the favoured R & D classes were cost reduction technologies in exploration and production. Regional studies were done only by government presumably to seek to further stimulate exploration. Cost reduction technologies were oriented towards seismic, log analysis, drilling and production technologies and software inter operability. While much of the client base was local industry, engineering and reservoir oriented R&D was also exported. The favoured areas of R&D were invariably those considered to be of high impact. R&D skills were thought to be locally available except for seismic, well logging and reservoir description. The former two presumably were retained in the service industries.

In Scenario C (Sunshine Land) with **high prospectivity** for oil and gas E&P, R&D associated with E&P was considered to have high importance. The client for the research was assumed to be both local and overseas. R&D included associated environmental R&D and greenhouse. Alternative energy oriented R&D was considered less important. Interoperability of software was considered a less important area of R&D, presumably because high profitability reduced the emphasis on efficiency in those areas. Clearly R&D was assumed to be important and was well supported, local capabilities were maintained at high levels and R&D was also exported. Oil and gas industries were thought to be affected in similar ways.

For Scenario D (Squeeze Land) with **low prospectivity,** oil and gas industries were considered to be affected differently. R &D for **oil** was short to medium term, and aimed at discovering and producing oil. Reducing costs was considered important. Favoured R&D included seismic and drilling and production technologies. The interest in R&D was constricted away from these areas. Platform decommissioning was an area of interest. The research base for these areas was normally considered to be present except for decommissioning and field development. The areas for R&D were seen to be high to medium impact. The client base was local except for regional studies. Government was considered to have an interest in R&D into decommissioning. Knowledge management was a favoured area presumably because of its ability to lower costs and assist in discoveries.

For the **gas** case short to medium term production oriented R&D was favoured. R&D was favoured which potentially provided new markets for gas, such as process engineering including gas to liquids and marinisation of processing equipment. Market/social research was considered important. Clients were considered to be local and government with export potential for knowledge management. The R&D base and the skills available were contracting. Only high to medium impact R&D was undertaken.

For Scenario E (Window on the World) had **high levels of R&D relating to international agreements** and locally well regarded oil and gas industries. Research to explore and develop were considered of medium to high importance. Enhanced production, greenhouse and environmentally oriented studies, market/social research and knowledge management were also favoured. The client for the R&D was seen as industry (both local and overseas) and government.

R&D related to both the oil and gas industries. The research base was considered available locally except for production engineering. Significant R&D in the favoured areas was considered achievable and of high impact.

For Scenario F (Solo Land) **international agreements were not met** and industry was poorly regarded locally. Exploration and production oriented R&D was seen to be of low to medium importance, with the highest level of importance assigned to immediate production needs, market/social research and knowledge management. The client for R&D was dominantly local industry, with government and overseas industries as clients for monitoring R&D such as prospect appraisal, reservoir geology and well logging, and also market/social research and knowledge management. R&D were considered to relate to both oil and gas. Research capability was considered generally present except possibly in greenhouse and environmental areas. It was considered unavailable in the important knowledge management areas. The group was unsure if significant results were achievable via the R&D effort, and its impact was considered medium except for market/social research

There were several high priority areas favoured in several scenarios. Those with no "low" ratings under any scenarios comprised knowledge management, production engineering, geophysics, petrophysics, field development, drilling, well engineering, reservoir engineering principles, reservoir management and phase behaviour. These were clearly seen as "core" or basic areas where research was needed in several scenarios.

7. Conclusions

This, the second Petroleum R&D Priorities Workshop, was conducted as a priority setting exercise to assist government, academia and the petroleum upstream industry in Australia and for the Australian upstream petroleum research sector. The first workshop held on July 31 1998 sought to define the broad range of needed petroleum R&D. A consultative scenario planning approach was used with input from industry, research providers and government. The results of the workshops are not intended to advocate a single direction for future research, as too many uncertainties exist in the economic, prospectivity and governmental framework to predict future events with any certainty.

The results of the scenario planning part of the second workshop show how some aspects of the "futures" depicted already exist. For example, in less well explored parts of Australia there are few wells, projectivity is considered low and the scenario "Squeeze Land " already applies to some extent. Similarly, the scenario for low oil prices has been active in early 1999, although the price is increasing towards mid 1999, incorporating some aspects of "Low Down". With restrictions on funding, the research focus must be sharper. There is also a spectrum of views on current conditions. Different companies (for example, service vs operating companies, or onshore vs offshore operators), may be in different scenarios at the same time. Companies with existing gas contracts would have a different outlook from gas explorers which do not have contracts. Research areas seen as important under several scenarios included knowledge management, production engineering, geophysics, petrophysics, field development, drilling, well engineering, reservoir engineering principles, reservoir management and phase behaviour.

As the workshop included many players from the geological side of the petroleum industry, and engineering and economic players were less well represented, the results may be skewed towards a geological view of the future. In general, participants felt that the scenario method worked well in assisting them to get away from conventional views.

AGSO and APCRC thank all the participants in the workshops and trusts that the results will benefit both the petroleum industry in Australia and the Australian petroleum research sector.

7. Acknowledgments

This workshop and its predecessor were facilitated by Michael Gill of Organisation Performance Consultants. Thanks are also due to Dr Peter Cook of APCRC for addressing the workshop and assisting in its planning, and to Janet Matthews and Julie Allais of BRS and to Sue Butt and Karen Thompson of AGSO for assistance in the administration and in recording the proceedings of the workshop.

8. References

1. *Petroleum R&D Priorities Workshop, Hyatt Hotel Canberra, 31 July 1998* Bureau of Resource Sciences, Canberra.

APPENDICES

Appendix 1
Results of survey of research areas

(Conducted prior to Workshop)

Areas were ranked from 1 (low) to 5 (high). Results are averages of responses received (ie. not weighted by number of persons contributing to a single response). Results under 2 are shown in italics; over 3 are shown underlined; and over 4 are in bold and underlined.

		KNOWLEDGE	INVOLVEMENT	IMPORTANCE
		average	average	average
1	BASIN STUDIES/ BASIN ANALYSIS	3.5	2.9	**4.4**
2	basin analysis	3.6	3.0	**4.7**
3	basin modelling	3.2	2.6	**4.4**
4	relative sea level curves	2.9	2.3	3.3
5	petroleum systems	3.6	2.9	**4.1**
6	basement structure	2.9	2.4	3.6
7	controls on trap integrity	3.5	3.0	**4.3**
8	petroleum potential	3.2	2.8	**4.1**
9	bathymetry	2.2	2.2	2.9
10	REMOTE SENSING	2.4	*1.9*	3.7
11	BIOSTRATIGRAPHY	2.4	2.0	3.0
12	FIELD ASSESSMENT	2.6	2.0	3.3
13	prospect appraisal	2.6	2.0	2.6
14	GEOPHYSICS	3.4	3.5	**4.7**
15	2D seismic	3.2	2.5	3.1
16	3D seismic	2.9	2.8	**4.3**
17	4D seismic	2.3	2.2	3.9
18	computational seismology	2.5	2.2	3.7
19	geophysical instrumentation	*1.8*	*1.8*	3.1
20	seismic acquisition	2.8	2.5	3.7
21	seismic interpretation	3.3	3.2	**4.6**
22	seismic processing	2.9	3.1	**4.6**
23	potential field methods	3.7	3.0	2.3
24	GEOLOGY	3.8	3.3	**4.2**
25	coal bed methane	2.2	*1.6*	2.7
26	core analysis	3.2	3.0	3.6
27	diagenesis	2.5	2.3	3.0
28	geochemistry	3.1	2.7	3.6
29	outcrop studies	3.0	2.0	3.4
30	petrology	2.9	2.0	3.4
31	reservoir geology	2.8	2.0	**4.1**
32	OPERATIONS SUPPORT	*1.9*	*1.3*	2.4
33	ORGANIC GEOCHEMISTRY	3.1	2.1	3.8
34	chemistry	2.4	*1.9*	2.8
35	chemistry of crude oil	2.8	*1.9*	2.9
36	well chemistry	*1.4*	*1.4*	3.1
37	oil fluorescence spectra	2.4	2.0	3.6

	Results (continued)	KNOWLEDGE	INVOLVEMENT	IMPORTANCE
		average	average	average
38	airborne laser fluorescence	2.7	2.0	3.5
39	fluid inclusion	2.3	*1.9*	3.3
40	characterisation of oils	2.6	2.1	3.9
41	source rock potential	2.9	2.0	3.8
42	FIELD DEVELOPMENT	2.5	*1.5*	**4.0**
43	deepwater field development	2.3	2.2	**4.0**
44	HP/HT field development	*1.5*	*1.3*	3.4
45	low API gravity oil field development	*1.3*	*1.1*	3.2
46	small field development	*1.8*	*1.3*	3.4
47	APPLIED MECHANICS	*1.6*	*1.0*	2.8
48	asset integrity management	*1.6*	*1.3*	3.1
49	materials for downhole HP/HT service	*1.6*	*1.2*	3.0
50	materials strength	*1.9*	*1.2*	2.9
51	structural strength	*1.6*	*1.2*	3.1
52	DRILLING	*1.9*	*1.4*	**4.2**
53	advanced drilling design	2.0	*1.4*	**4.0**
54	advanced drilling technologies	*1.8*	*1.1*	**4.0**
55	cementing	*1.5*	*1.0*	3.2
56	coiled tubing technology	*1.8*	*1.4*	3.5
57	complex well geometry	*1.6*	*1.0*	3.8
58	cuttings transport in horizontal and inclined well bores	*1.5*	*1.1*	3.4
59	directional drilling	*1.8*	*1.5*	**4.0**
60	drill bit development	*1.4*	*1.0*	3.4
61	drilling and completing fluids	*1.8*	*1.4*	3.7
62	drilling engineering	*1.5*	*1.1*	3.4
63	drilling fluids	2.1	*1.5*	3.7
64	extended reach drilling	*1.9*	*1.4*	**4.3**
65	horizontal well technology	2.2	*1.8*	**4.3**
66	lost circulation	*1.4*	*1.0*	3.0
67	multilateral/ multibranch wells	2.0	*1.3*	**4.0**
68	underbalanced drilling	*1.6*	*1.0*	3.4
69	WELL ENGINEERING	*1.5*	*1.4*	**4.0**
70	well completions	*1.9*	*1.6*	**4.2**
71	well control	*1.6*	*1.3*	**4.0**
72	well testing	*1.6*	*1.4*	**4.0**
73	well testing and control	*1.6*	*1.3*	**4.0**
74	wellbore engineering	*1.6*	*1.3*	**4.0**
75	wellbore integrity	*1.9*	*1.6*	**4.0**
76	well productivity enhancements	*1.4*	*1.4*	**4.0**
77	scale prevention	*1.3*	*1.3*	3.4
78	PETROPHYSICS	2.4	*1.9*	**4.3**
79	borehole physics	2.4	*1.9*	**4.0**
80	formation evaluation	2.6	*1.9*	3.8
81	logging-while-drilling (LWD)	2.1	*1.4*	3.7

	Results (continued)	KNOWLEDGE	INVOLVEMENT	IMPORTANCE
		average	average	average
82	magnetic resonance imaging for petrophysical applications	2.9	2.1	**4.0**
83	measurement-while-drilling (MWD)	2.3	*1.6*	3.4
84	nuclear magnetic resonance (NMR)	2.8	2.1	3.7
85	surface data logging	2.3	*1.5*	3.3
86	wireline logging	3.1	*1.9*	3.7
87	RESERVOIR ENGINEERING	2.3	*1.8*	**4.6**
88	artificial lift	2.1	*1.3*	3.2
89	depressurisation	*1.6*	*1.0*	3.2
90	groundwater	2.5	2.0	3.5
91	H2S reduction and control	*1.7*	*1.0*	2.6
92	H2S removal	*1.8*	*1.0*	2.6
93	heavy oil recovery	*1.3*	*1.0*	2.5
94	high pressure/high temperature (HP/HT) reservoir engineering	*1.6*	*1.4*	3.7
95	microscale modelling	*1.9*	*1.6*	3.0
96	multiphase flow in fractures	*1.9*	*1.3*	3.4
97	PVT (pressure, volume and temperature) testing	2.0	*1.3*	3.6
98	reservoir heterogeneities	2.6	2.4	**4.2**
99	reservoir management	2.0	*1.3*	**4.0**
100	reservoir monitoring	2.3	*1.4*	3.8
101	reservoir performance	2.5	*1.5*	3.8
102	reservoir sweep improvements	2.0	*1.0*	3.8
103	reservoir testing	2.0	*1.1*	3.6
104	reservoir uncertainty	2.1	*1.6*	**4.2**
105	subsurface downhole technology	2.1	*1.4*	**4.0**
106	subsurface reservoir characterisation	2.9	2.6	**4.6**
107	gas storage	2.0	*1.3*	3.4
108	fluid flow in porous media	2.5	2.0	**4.0**
109	conformance control	2.3	*1.6*	3.4
110	PHASE BEHAVIOUR	2.3	*1.1*	3.6
111	hydrates	2.0	*1.1*	3.1
112	phase behaviour	2.3	*1.0*	3.6
113	phase behaviour and gas hydrates	*1.9*	*1.0*	3.4
114	phase behaviour of petroleum fluids	2.5	*1.3*	3.8
115	RESERVOIR DESCRIPTION	2.6	*1.6*	**4.4**
116	integrated reservoir studies	2.6	*1.6*	**4.2**
117	performance modelling	2.1	*1.1*	3.8
118	reservoir modelling	2.6	*1.6*	**4.0**
119	reservoir simulation	2.8	2.0	**4.0**
120	reservoir studies	2.4	*1.4*	**4.0**
121	reservoir visualisation	2.6	2.3	**4.4**
122	SUBSURFACE IMAGING	2.6	2.4	**4.4**
123	graphical user interface reservoir displays	*1.8*	*1.5*	3.7
124	subsurface characterisation	2.2	*1.9*	**4.0**
125	RESERVOIR STIMULATION	*1.5*	*1.3*	3.3

	Results (continued)	KNOWLEDGE	INVOLVEMENT	IMPORTANCE
		average	average	average
126	formation damage/stimulation	*1.7*	*1.3*	**4.0**
127	fracture stimulation	*1.7*	*1.2*	3.6
128	IMPROVED OIL RECOVERY (IOR)	2.0	*1.3*	**4.5**
129	improved reservoir exploitation	2.6	2.0	**4.6**
130	ENHANCED OIL RECOVERY (EOR)	*1.9*	*1.4*	3.7
131	CO2 injection	*1.7*	*1.4*	3.6
132	foam	*1.6*	*1.0*	3.3
133	gas injection	2.1	*1.8*	3.5
134	gel foam development for near-well and deep penetration applications	*1.1*	*1.0*	3.2
135	gels	*1.1*	*1.0*	3.2
136	in situ combustion	*1.1*	*1.0*	2.7
137	miscible flooding	2.1	*1.5*	3.7
138	petroleum microbiology	*1.1*	*1.0*	2.8
139	steam injection	*1.5*	*1.1*	2.7
140	Surfactants	*1.9*	*1.3*	3.2
141	thermal oil recovery	*1.3*	*1.0*	2.7
142	PRODUCTION ENGINEERING	*1.7*	*1.0*	3.5
143	multi phase flow	2.4	2.0	3.4
144	corrosion assessment	*1.8*	*1.3*	3.0
145	fluid flow separation	2.1	*1.3*	3.4
146	fluid management and transportation	*1.9*	*1.0*	2.5
147	pigging	*1.9*	*1.1*	2.6
148	produced solids handling	*1.4*	*1.0*	2.8
149	production	*1.6*	*1.0*	2.6
150	production fluids handling (water separation and cleanup)	*1.9*	*1.4*	3.4
151	production technology	*1.6*	*1.1*	3.1
152	pumping and boosting	*1.9*	*1.4*	3.3
153	facility optimisation	2.0	*1.4*	**4.4**
154	subsea technology - design and performance	2.1	*1.5*	**4.4**
155	oilfield chemicals	*1.8*	*1.0*	2.3
156	PROCESS ENGINEERING	2.3	*1.3*	3.0
157	GEOTECHNICS	*1.9*	*1.1*	3.0
158	computational geomechanics	*1.6*	*1.1*	3.0
159	geomechanics	*1.5*	*1.3*	3.2
160	hydraulic fracture diagnostics	*1.4*	*1.0*	3.0
161	rock mechanical testing	*1.6*	*1.0*	3.0
162	rock mechanics	*1.6*	*1.1*	3.0
163	GEOTHERMAL ENERGY	*1.3*	*1.0*	2.3
164	geothermal drilling	*1.1*	*1.0*	3.0
165	geothermal reservoir engineering	*1.1*	*1.0*	3.1
166	ALTERNATIVE ENERGY	2.1	*1.1*	**4.0**
167	ENVIRONMENTAL IMPACT ASSESSMENT	2.1	*1.3*	3.7

	Results (continued)	KNOWLEDGE	INVOLVEMENT	IMPORTANCE
		average	average	average
168	bioremediation of environmental contamination	*1.6*	*1.0*	3.0
169	environmental auditing	*1.4*	*1.1*	3.5
170	environmental remediation	*1.6*	*1.1*	3.4
171	environmental site characterisation	*1.5*	*1.1*	3.0
172	environmental studies	*1.9*	*1.6*	3.5
173	environmental studies - marine	*1.8*	*1.6*	3.4
174	environmental technology	*1.8*	*1.4*	3.3
175	nuclear waste isolation	*1.6*	*1.0*	2.6
176	oil spill remediation	2.0	*1.2*	3.5
177	shallow subsurface pollution	*1.6*	*1.1*	3.3
178	GREENHOUSE EFFECT	*1.9*	*1.9*	3.7
179	PROBABILISTIC ANALYSIS	2.6	*1.4*	3.7
180	geostatistics	2.0	*1.4*	3.5
181	probabilistic escalation modelling	*1.7*	*1.0*	3.0
182	risk evaluation	2.4	*1.3*	**4.0**
183	risk management	2.3	*1.3*	**4.2**
184	ENERGY ECONOMICS	2.1	*1.3*	2.6
185	reservoir economics	2.4	*1.2*	3.0
186	exploration economics	2.3	*1.3*	2.6
187	GREENHOUSE EFFECT	*1.4*	*1.3*	3.0
188	MARKET/SOCIAL RESEARCH	*1.4*	*1.3*	2.4

Appendix 2
Ranking of research areas

(From survey conducted prior to Workshop)

1. Results ranked by **knowledge of research area**

Areas were ranked from 1(low) to 5(high). Results are averages of responses received (ie. not weighted by number of persons contributing to a single response).

		KNOWLEDGE
		average
24	GEOLOGY	3.8
23	potential field methods	3.7
2	basin analysis	3.6
5	petroleum systems	3.6
1	BASIN STUDIES/ BASIN ANALYSIS	3.5
7	controls on trap integrity	3.5
14	GEOPHYSICS	3.4
21	seismic interpretation	3.3
3	basin modelling	3.2
8	petroleum potential	3.2
15	2D seismic	3.2
26	core analysis	3.2
28	geochemistry	3.1
33	ORGANIC GEOCHEMISTRY	3.1
86	wireline logging	3.1
29	outcrop studies	3
4	relative sea level curves	2.9
6	basement structure	2.9
16	3D seismic	2.9
22	seismic processing	2.9
30	petrology	2.9
41	source rock potential	2.9
82	magnetic resonance imaging for petrophysical applications	2.9
106	subsurface reservoir characterisation	2.9
20	seismic acquisition	2.8
31	reservoir geology	2.8
35	chemistry of crude oil	2.8
84	nuclear magnetic resonance (NMR)	2.8
119	reservoir simulation	2.8
38	airborne laser fluorescence	2.7
12	FIELD ASSESSMENT	2.6
13	prospect appraisal	2.6
40	characterisation of oils	2.6
80	formation evaluation	2.6
98	reservoir heterogeneities	2.6
115	RESERVOIR DESCRIPTION	2.6
116	integrated reservoir studies	2.6
118	reservoir modelling	2.6
121	reservoir visualisation	2.6
122	SUBSURFACE IMAGING	2.6
129	improved reservoir exploitation	2.6
179	PROBABILISTIC ANALYSIS	2.6

18	computational seismology	2.5
27	diagenesis	2.5
42	FIELD DEVELOPMENT	2.5
90	groundwater	2.5
101	reservoir performance	2.5
108	fluid flow in porous media	2.5
114	phase behaviour of petroleum fluids	2.5
10	REMOTE SENSING	2.4
11	BIOSTRATIGRAPHY	2.4
34	chemistry	2.4
37	oil fluorescence spectra	2.4
78	PETROPHYSICS	2.4
79	borehole physics	2.4
120	reservoir studies	2.4
143	multi phase flow	2.4
182	risk evaluation	2.4
185	reservoir economics	2.4
17	4D seismic	2.3
39	fluid inclusion	2.3
43	deepwater field development	2.3
83	measurement-while-drilling (MWD)	2.3
85	surface data logging	2.3
87	RESERVOIR ENGINEERING	2.3
100	reservoir monitoring	2.3
109	conformance control	2.3
110	PHASE BEHAVIOUR	2.3
112	phase behaviour	2.3
156	PROCESS ENGINEERING	2.3
183	risk management	2.3
186	exploration economics	2.3
9	bathymetry	2.2
25	coal bed methane	2.2
65	horizontal well technology	2.2
124	subsurface characterisation	2.2
63	drilling fluids	2.1
81	logging-while-drilling (LWD)	2.1
88	artificial lift	2.1
104	reservoir uncertainty	2.1
105	subsurface downhole technology	2.1
117	performance modelling	2.1
133	gas injection	2.1
137	miscible flooding	2.1
145	fluid flow separation	2.1
154	subsea technology - design and performance	2.1
166	ALTERNATIVE ENERGY	2.1
167	ENVIRONMENTAL IMPACT ASSESSMENT	2.1
184	ENERGY ECONOMICS	2.1
53	advanced drilling design	2
67	multilateral/ multibranch wells	2
97	PVT (pressure, volume and temperature) testing	2
99	reservoir management	2
102	reservoir sweep improvements	2
103	reservoir testing	2

107	gas storage	2
111	hydrates	2
128	IMPROVED OIL RECOVERY (IOR)	2
153	facility optimisation	2
176	oil spill remediation	2
180	geostatistics	2
32	OPERATIONS SUPPORT	*1.9*
50	materials strength	*1.9*
52	DRILLING	*1.9*
64	extended reach drilling	*1.9*
70	well completions	*1.9*
75	wellbore integrity	*1.9*
95	microscale modelling	*1.9*
96	multiphase flow in fractures	*1.9*
113	phase behaviour and gas hydrates	*1.9*
130	ENHANCED OIL RECOVERY (EOR)	*1.9*
140	Surfactants	*1.9*
146	fluid management and transportation	*1.9*
147	pigging	*1.9*
150	production fluids handling (water separation and cleanup)	*1.9*
152	pumping and boosting	*1.9*
157	GEOTECHNICS	*1.9*
172	environmental studies	*1.9*
178	GREENHOUSE EFFECT	*1.9*
19	geophysical instrumentation	*1.8*
46	small field development	*1.8*
54	advanced drilling technologies	*1.8*
56	coiled tubing technology	*1.8*
59	directional drilling	*1.8*
61	drilling and completing fluids	*1.8*
92	H2S removal	*1.8*
123	graphical user interface reservoir displays	*1.8*
144	corrosion assessment	*1.8*
155	oilfield chemicals	*1.8*
173	environmental studies - marine	*1.8*
174	environmental technology	*1.8*
91	H2S reduction and control	*1.7*
126	formation damage/stimulation	*1.7*
127	fracture stimulation	*1.7*
131	CO2 injection	*1.7*
142	PRODUCTION ENGINEERING	*1.7*
181	probabilistic escalation modelling	*1.7*
47	APPLIED MECHANICS	*1.6*
48	asset integrity management	*1.6*
49	materials for downhole HP/HT service	*1.6*
51	structural strength	*1.6*
57	complex well geometry	*1.6*
68	underbalanced drilling	*1.6*
71	well control	*1.6*
72	well testing	*1.6*
73	well testing and control	*1.6*
74	wellbore engineering	*1.6*
89	depressurisation	*1.6*
94	high pressure/high temperature (HP/HT)	*1.6*

	reservoir engineering	
132	foam	*1.6*
149	production	*1.6*
151	production technology	*1.6*
158	computational geomechanics	*1.6*
161	rock mechanical testing	*1.6*
162	rock mechanics	*1.6*
168	bioremediation of environmental contamination	*1.6*
170	environmental remediation	*1.6*
175	nuclear waste isolation	*1.6*
177	shallow subsurface pollution	*1.6*
44	HP/HT field development	*1.5*
55	cementing	*1.5*
58	cuttings transport in horizontal and inclined well bores	*1.5*
62	drilling engineering	*1.5*
69	WELL ENGINEERING	*1.5*
125	RESERVOIR STIMULATION	*1.5*
139	steam injection	*1.5*
159	geomechanics	*1.5*
171	environmental site characterisation	*1.5*
36	well chemistry	*1.4*
60	drill bit development	*1.4*
66	lost circulation	*1.4*
76	well productivity enhancements	*1.4*
148	produced solids handling	*1.4*
160	hydraulic fracture diagnostics	*1.4*
169	environmental auditing	*1.4*
187	GREENHOUSE EFFECT	*1.4*
188	MARKET/SOCIAL RESEARCH	*1.4*
45	low API gravity oil field development	*1.3*
77	scale prevention	*1.3*
93	heavy oil recovery	*1.3*
141	thermal oil recovery	*1.3*
163	GEOTHERMAL ENERGY	*1.3*
134	gel foam development for near-well and deep penetration applications	*1.1*
135	gels	*1.1*
136	in situ combustion	*1.1*
138	petroleum microbiology	*1.1*
164	geothermal drilling	*1.1*
165	geothermal reservoir engineering	*1.1*

2. Results ranked by **involvement in research area**

Results are averages of responses received (ie. not weighted by number of persons contributing to a single response).

		INVOLVEMENT
		average
14	GEOPHYSICS	3.5
24	GEOLOGY	3.3
21	seismic interpretation	3.2
22	seismic processing	3.1
23	potential field methods	3
2	basin analysis	3
7	controls on trap integrity	3
26	core analysis	3
5	petroleum systems	2.9
1	BASIN STUDIES/ BASIN ANALYSIS	2.9
8	petroleum potential	2.8
16	3D seismic	2.8
28	geochemistry	2.7
3	basin modelling	2.6
106	subsurface reservoir characterisation	2.6
15	2D seismic	2.5
20	seismic acquisition	2.5
6	basement structure	2.4
98	reservoir heterogeneities	2.4
122	SUBSURFACE IMAGING	2.4
4	relative sea level curves	2.3
121	reservoir visualisation	2.3
27	diagenesis	2.3
18	computational seismology	2.2
17	4D seismic	2.2
43	deepwater field development	2.2
9	bathymetry	2.2
33	ORGANIC GEOCHEMISTRY	2.1
82	magnetic resonance imaging for petrophysical applications	2.1
84	nuclear magnetic resonance (NMR)	2.1
40	characterisation of oils	2.1
29	outcrop studies	2
30	petrology	2
41	source rock potential	2
31	reservoir geology	2
119	reservoir simulation	2
38	airborne laser fluorescence	2
12	FIELD ASSESSMENT	2
13	prospect appraisal	2
129	improved reservoir exploitation	2
90	groundwater	2
108	fluid flow in porous media	2
11	BIOSTRATIGRAPHY	2
37	oil fluorescence spectra	2
143	multi phase flow	2
86	wireline logging	*1.9*
35	chemistry of crude oil	*1.9*
80	formation evaluation	*1.9*

10	REMOTE SENSING	*1.9*
34	chemistry	*1.9*
78	PETROPHYSICS	*1.9*
79	borehole physics	*1.9*
39	fluid inclusion	*1.9*
124	subsurface characterisation	*1.9*
178	GREENHOUSE EFFECT	*1.9*
87	RESERVOIR ENGINEERING	*1.8*
65	horizontal well technology	*1.8*
133	gas injection	*1.8*
19	geophysical instrumentation	*1.8*
115	RESERVOIR DESCRIPTION	*1.6*
116	integrated reservoir studies	*1.6*
118	reservoir modelling	*1.6*
83	measurement-while-drilling (MWD)	*1.6*
109	conformance control	*1.6*
25	coal bed methane	*1.6*
104	reservoir uncertainty	*1.6*
70	well completions	*1.6*
75	wellbore integrity	*1.6*
95	microscale modelling	*1.6*
172	environmental studies	*1.6*
173	environmental studies - marine	*1.6*
42	FIELD DEVELOPMENT	*1.5*
101	reservoir performance	*1.5*
85	surface data logging	*1.5*
63	drilling fluids	*1.5*
137	miscible flooding	*1.5*
154	subsea technology - design and performance	*1.5*
59	directional drilling	*1.5*
123	graphical user interface reservoir displays	*1.5*
179	PROBABILISTIC ANALYSIS	*1.4*
120	reservoir studies	*1.4*
100	reservoir monitoring	*1.4*
81	logging-while-drilling (LWD)	*1.4*
105	subsurface downhole technology	*1.4*
53	advanced drilling design	*1.4*
153	facility optimisation	*1.4*
180	geostatistics	*1.4*
52	DRILLING	*1.4*
64	extended reach drilling	*1.4*
130	ENHANCED OIL RECOVERY (EOR)	*1.4*
150	production fluids handling (water separation and cleanup)	*1.4*
152	pumping and boosting	*1.4*
56	coiled tubing technology	*1.4*
61	drilling and completing fluids	*1.4*
174	environmental technology	*1.4*
131	CO2 injection	*1.4*
72	well testing	*1.4*
94	high pressure/high temperature (HP/HT) reservoir engineering	*1.4*
69	WELL ENGINEERING	*1.4*
36	well chemistry	*1.4*
76	well productivity enhancements	*1.4*

114	phase behaviour of petroleum fluids	*1.3*
182	risk evaluation	*1.3*
156	PROCESS ENGINEERING	*1.3*
183	risk management	*1.3*
186	exploration economics	*1.3*
88	artificial lift	*1.3*
145	fluid flow separation	*1.3*
167	ENVIRONMENTAL IMPACT ASSESSMENT	*1.3*
184	ENERGY ECONOMICS	*1.3*
67	multilateral/ multibranch wells	*1.3*
97	PVT (pressure, volume and temperature) testing	*1.3*
99	reservoir management	*1.3*
107	gas storage	*1.3*
128	IMPROVED OIL RECOVERY (IOR)	*1.3*
32	OPERATIONS SUPPORT	*1.3*
96	multiphase flow in fractures	*1.3*
140	Surfactants	*1.3*
46	small field development	*1.3*
144	corrosion assessment	*1.3*
126	formation damage/stimulation	*1.3*
48	asset integrity management	*1.3*
71	well control	*1.3*
73	well testing and control	*1.3*
74	wellbore engineering	*1.3*
44	HP/HT field development	*1.3*
125	RESERVOIR STIMULATION	*1.3*
159	geomechanics	*1.3*
187	GREENHOUSE EFFECT	*1.3*
188	MARKET/SOCIAL RESEARCH	*1.3*
77	scale prevention	*1.3*
185	reservoir economics	*1.2*
176	oil spill remediation	*1.2*
50	materials strength	*1.2*
127	fracture stimulation	*1.2*
49	materials for downhole HP/HT service	*1.2*
51	structural strength	*1.2*
110	PHASE BEHAVIOUR	*1.1*
117	performance modelling	*1.1*
166	ALTERNATIVE ENERGY	*1.1*
103	reservoir testing	*1.1*
111	hydrates	*1.1*
147	pigging	*1.1*
157	GEOTECHNICS	*1.1*
54	advanced drilling technologies	*1.1*
151	production technology	*1.1*
158	computational geomechanics	*1.1*
162	rock mechanics	*1.1*
170	environmental remediation	*1.1*
177	shallow subsurface pollution	*1.1*
58	cuttings transport in horizontal and inclined well bores	*1.1*
62	drilling engineering	*1.1*
139	steam injection	*1.1*

171	environmental site characterisation	*1.1*
169	environmental auditing	*1.1*
45	low API gravity oil field development	*1.1*
112	phase behaviour	*1*
102	reservoir sweep improvements	*1*
113	phase behaviour and gas hydrates	*1*
146	fluid management and transportation	*1*
92	H2S removal	*1*
155	oilfield chemicals	*1*
91	H2S reduction and control	*1*
142	PRODUCTION ENGINEERING	*1*
181	probabilistic escalation modelling	*1*
47	APPLIED MECHANICS	*1*
57	complex well geometry	*1*
68	underbalanced drilling	*1*
89	depressurisation	*1*
132	foam	*1*
149	production	*1*
161	rock mechanical testing	*1*
168	bioremediation of environmental contamination	*1*
175	nuclear waste isolation	*1*
55	cementing	*1*
60	drill bit development	*1*
66	lost circulation	*1*
148	produced solids handling	*1*
160	hydraulic fracture diagnostics	*1*
93	heavy oil recovery	*1*
141	thermal oil recovery	*1*
163	GEOTHERMAL ENERGY	*1*
134	gel foam development for near-well and deep penetration applications	*1*
135	gels	*1*
136	in situ combustion	*1*
138	petroleum microbiology	*1*
164	geothermal drilling	*1*
165	geothermal reservoir engineering	*1*

3. Results ranked by **importance of research area**

Results are averages of responses received (ie. not weighted by number of persons contributing to a single response).

		IMPORTANCE
14	GEOPHYSICS	4.7
2	basin analysis	4.7
21	seismic interpretation	4.6
22	seismic processing	4.6
106	subsurface reservoir characterisation	4.6
129	improved reservoir exploitation	4.6
87	RESERVOIR ENGINEERING	4.6
128	IMPROVED OIL RECOVERY (IOR)	4.5
1	BASIN STUDIES/ BASIN ANALYSIS	4.4
3	basin modelling	4.4
122	SUBSURFACE IMAGING	4.4
121	reservoir visualisation	4.4
115	RESERVOIR DESCRIPTION	4.4
154	subsea technology - design and performance	4.4
153	facility optimisation	4.4
7	controls on trap integrity	4.3
16	3D seismic	4.3
78	PETROPHYSICS	4.3
65	horizontal well technology	4.3
64	extended reach drilling	4.3
24	GEOLOGY	4.2
98	reservoir heterogeneities	4.2
116	integrated reservoir studies	4.2
104	reservoir uncertainty	4.2
70	well completions	4.2
52	DRILLING	4.2
183	risk management	4.2
5	petroleum systems	4.1
8	petroleum potential	4.1
31	reservoir geology	4.1
43	deepwater field development	4
82	magnetic resonance imaging for petrophysical applications	4
119	reservoir simulation	4
108	fluid flow in porous media	4
79	borehole physics	4
124	subsurface characterisation	4
118	reservoir modelling	4
75	wellbore integrity	4
42	FIELD DEVELOPMENT	4
59	directional drilling	4
120	reservoir studies	4
105	subsurface downhole technology	4
53	advanced drilling design	4
72	well testing	4
69	WELL ENGINEERING	4
76	well productivity enhancements	4
182	risk evaluation	4
67	multilateral/ multibranch wells	4

99	reservoir management	4
126	formation damage/stimulation	4
71	well control	4
73	well testing and control	4
74	wellbore engineering	4
166	ALTERNATIVE ENERGY	4
54	advanced drilling technologies	4
17	4D seismic	3.9
40	characterisation of oils	3.9
33	ORGANIC GEOCHEMISTRY	3.8
41	source rock potential	3.8
80	formation evaluation	3.8
101	reservoir performance	3.8
100	reservoir monitoring	3.8
114	phase behaviour of petroleum fluids	3.8
117	performance modelling	3.8
102	reservoir sweep improvements	3.8
57	complex well geometry	3.8
20	seismic acquisition	3.7
18	computational seismology	3.7
84	nuclear magnetic resonance (NMR)	3.7
86	wireline logging	3.7
10	REMOTE SENSING	3.7
178	GREENHOUSE EFFECT	3.7
63	drilling fluids	3.7
137	miscible flooding	3.7
123	graphical user interface reservoir displays	3.7
179	PROBABILISTIC ANALYSIS	3.7
81	logging-while-drilling (LWD)	3.7
130	ENHANCED OIL RECOVERY (EOR)	3.7
61	drilling and completing fluids	3.7
94	high pressure/high temperature (HP/HT) reservoir engineering	3.7
167	ENVIRONMENTAL IMPACT ASSESSMENT	3.7
26	core analysis	3.6
28	geochemistry	3.6
6	basement structure	3.6
37	oil fluorescence spectra	3.6
131	CO2 injection	3.6
97	PVT (pressure, volume and temperature) testing	3.6
127	fracture stimulation	3.6
110	PHASE BEHAVIOUR	3.6
103	reservoir testing	3.6
112	phase behaviour	3.6
38	airborne laser fluorescence	3.5
90	groundwater	3.5
133	gas injection	3.5
172	environmental studies	3.5
180	geostatistics	3.5
56	coiled tubing technology	3.5
176	oil spill remediation	3.5
169	environmental auditing	3.5
142	PRODUCTION ENGINEERING	3.5

29	outcrop studies	3.4
30	petrology	3.4
143	multi phase flow	3.4
83	measurement-while-drilling (MWD)	3.4
109	conformance control	3.4
173	environmental studies - marine	3.4
150	production fluids handling (water separation and cleanup)	3.4
145	fluid flow separation	3.4
107	gas storage	3.4
96	multiphase flow in fractures	3.4
46	small field development	3.4
44	HP/HT field development	3.4
77	scale prevention	3.4
170	environmental remediation	3.4
58	cuttings transport in horizontal and inclined well bores	3.4
62	drilling engineering	3.4
113	phase behaviour and gas hydrates	3.4
68	underbalanced drilling	3.4
60	drill bit development	3.4
4	relative sea level curves	3.3
12	FIELD ASSESSMENT	3.3
39	fluid inclusion	3.3
85	surface data logging	3.3
152	pumping and boosting	3.3
174	environmental technology	3.3
125	RESERVOIR STIMULATION	3.3
177	shallow subsurface pollution	3.3
132	foam	3.3
88	artificial lift	3.2
140	Surfactants	3.2
159	geomechanics	3.2
45	low API gravity oil field development	3.2
89	depressurisation	3.2
55	cementing	3.2
134	gel foam development for near-well and deep penetration applications	3.2
135	gels	3.2
15	2D seismic	3.1
19	geophysical instrumentation	3.1
36	well chemistry	3.1
48	asset integrity management	3.1
51	structural strength	3.1
111	hydrates	3.1
151	production technology	3.1
165	geothermal reservoir engineering	3.1
27	diagenesis	3
11	BIOSTRATIGRAPHY	3
95	microscale modelling	3
156	PROCESS ENGINEERING	3
144	corrosion assessment	3
187	GREENHOUSE EFFECT	3
185	reservoir economics	3
49	materials for downhole HP/HT service	3

157	GEOTECHNICS	3
158	computational geomechanics	3
162	rock mechanics	3
171	environmental site characterisation	3
181	probabilistic escalation modelling	3
161	rock mechanical testing	3
168	bioremediation of environmental contamination	3
66	lost circulation	3
160	hydraulic fracture diagnostics	3
164	geothermal drilling	3
9	bathymetry	2.9
35	chemistry of crude oil	2.9
50	materials strength	2.9
34	chemistry	2.8
47	APPLIED MECHANICS	2.8
148	produced solids handling	2.8
138	petroleum microbiology	2.8
25	coal bed methane	2.7
139	steam injection	2.7
141	thermal oil recovery	2.7
136	in situ combustion	2.7
13	prospect appraisal	2.6
186	exploration economics	2.6
184	ENERGY ECONOMICS	2.6
147	pigging	2.6
92	H2S removal	2.6
91	H2S reduction and control	2.6
149	production	2.6
175	nuclear waste isolation	2.6
146	fluid management and transportation	2.5
93	heavy oil recovery	2.5
32	OPERATIONS SUPPORT	2.4
188	MARKET/SOCIAL RESEARCH	2.4
23	potential field methods	2.3
155	oilfield chemicals	2.3
163	GEOTHERMAL ENERGY	2.3

Appendix 3
Workshop opening exercise

Exercise – Certainty of current knowledge

In terms of your own decision – making what percentage certainty do you have on your knowledge of key factors for petroleum R&D over the next 10 years?

The group showed a bias towards greater rather than lesser certainty.

People at 80 percent certainty were confident of planning for any given scenario. At 90 per cent people still retained doubts about the effects of the Greenhouse issue on gas exports to Japan and Korea. They would move from 90 to 60 percent certain if a significant unexpected scenario emerged.

People in the range 60 – 70 percent certain said they were optimistic about availability of skilled researchers and access to technology. A move from 70-80 percent certain would occur:

- *If petroleum prices were higher through restriction in supply for example by war;*
- If there was stability of Government policy, more information, knowledge of what importance government will place on investment, and reductions in conflicting signals; and
- If there was more certain knowledge of future trends in oil and gas prices.

People at 50 percent certain said:

- *They could not predict with certainty the future legislative framework.*
- *They considered they would still be uncertain about externalities including those affecting petroleum prices; and*
- There was a continued need to seek to encourage investment.

They would move from 50 to 70 percent certain if there were more regulation on production and less tax.

They could move from 50 to 90 percent certain if government would freeze legislation for 10 years.

Those at 10 percent were too challenged to make predictions as to key factors for the next ten years. They would move to 20 percent if they knew oil prices for the next 10 years.