RESEARCH DEVELOPMENT AND DEMONSTRATION NEEDS OF THE OIL AND GAS INDUSTRY

VOLUME II

Industry Survey Appendix

A REPORT OF THE NATIONAL PETROLEUM COUNCIL • AUGUST 1995

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A REPORT OF THE NATIONAL PETROLEUM COUNCIL • AUGUST 1995

W. W. Allen, Chair, Committee on Research and Development Needs

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The National Petroleum Council is a federal advisory committee to the Secretary of Energy.

The sole purpose of the National Petroleum Council is to advise, inform, and make recommendations to the Secretary of Energy on any matter requested by the Secretary relating to oil and natural gas or to the oil and gas industries.

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APPENDIX D

NPC'S 1995 SURVEY OF RESEARCH AND DEVELOPMENT NEEDS

PART I

SURVEY QUESTIONNAIRE

National Petroleum Council

1995 Survey of
The U.S. Natural Gas and Oil
Research & Development Needs

Please return this survey by *Wednesday, March 15* to:

Benjamin A. Oliver, Jr.
National Petroleum Council
1625 K Street, N.W.
Washington, D.C. 20006-1604

SURVEY COMPLETED BY:

Company: _____

Contact Name: _____

Contact Title: _____

Telephone: _____

FAX: _____

SEE PAGE TWO FOR PURPOSE AND INSTRUCTIONS

NPC 1995 Survey of
The U.S. Natural Gas and Oil R&D Needs
- Purpose and Instructions -

The National Petroleum Council (NPC) has agreed to conduct a study for the Secretary of the Department of Energy (DOE) to determine the research, development, and demonstration needs of the oil and natural gas industry. The study will identify short- and long-term technology needs — both upstream and downstream — and consider the role that DOE* programs and National Laboratories — as well as other public and private labs — might have in meeting these needs.

In connection with the study, this survey of technology needs is designed to:

- Identify specific technology needs, the expected business impact and timing of needed advancements, as well as the willingness to collaborate to advance these technologies (Survey Questions 1-11). One purpose of the survey is to identify issues that favor or disfavor technical collaborations among the natural gas and oil industry, DOE, the National Laboratories, and other public and private labs.
- Identify what impediments to achieving your company-wide business needs might be overcome by improved technologies (Survey Question 12).
- Provide a profile of survey respondents (Survey Questions 13-22). This information will be used to describe the types of companies represented by the survey responses and to analyze the survey responses by company type, business segment, etc.

In NPC's published report, survey responses will NOT be identified with individual companies.

Company Response: We would like to receive just one survey document from each company. But we also would like the responses to be *company responses* and to be based on input from executives or high-level managers responsible for the particular business or technology segments. Technology needs questions are grouped under the following areas of company activities:

- Exploration
- Development
- Drilling and Completion
- Production
- Deepwater Offshore
- Arctic Region Activities
- Oil Processing and Refining
- Gas Processing
- Gas Gathering
- Gas Storage
- Environmental and Regulatory

Assistance: If you have any questions about these instructions or the survey document, please call Benjamin A. Oliver, Jr. at the National Petroleum Council, (202) 393-6100.

*There are two ways to work with DOE, with the first being via collaboration with one or more of the nine National Laboratories — Argonne, Brookhaven, INEL, Lawrence-Berkeley, Lawrence-Livermore, Los Alamos, Oak Ridge, Pacific Northwest and Sandia — which the survey refers to as *National Labs*. The second option, which the survey refers to as *DOE,* is a cost-sharing arrangement with one or more of the following —

- Morgantown Energy Technology Center (METC) for most natural gas projects
- Pittsburgh Energy Technology Center (PETC) for some natural gas projects
- Bartlesville Project Office (BPO)/National Institute for Petroleum and Energy Research (NIPER) for oil projects
- Metarie Site Office (MSO) for natural gas- and oil-related environmental projects (upstream and downstream)
- Rocky Mountain Oilfield Testing Center (RMOTC) for field testing oil- and gas-related tools and techniques

Please provide a copy of this page to each person who completes a portion of the survey.

Q.1) EXPLORATION

Complete this page if your company participates in EXPLORATION. If your company does NOT do exploration, please check this box ☐ and go to page 5.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means that the chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Exploration Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	C)...By end of 1999?: High	C)...By end of 1999?: Moderate	C)...By end of 1999?: Low	D)...Between 1999 and 2010?: High	D)...Between 1999 and 2010?: Moderate	D)...Between 1999 and 2010?: Low	E) Willing to collaborate: Yes	E) Willing to collaborate: No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
1) 3D Basin modeling															
2) Risk assessment methods															
3) High-resolution seismic depth imaging															
4) Specialized seismic processing															
5) Sequence stratigraphy techniques															
6) Workstation seismic modeling															
7) Geochemical analysis															
8) Airborne/satellite remote sensing															
9) Fault seal analysis															
10) Multi-component seismic techniques															
11) 3D Paleostructural restoration															
12) Amplitude versus offset (AVO) in 3D															
13) 3D Visualization tools															
14) Advanced seismic acquisition															
15) Geographic information systems															
16) Geophysical fracture-detection methods															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.1) (Con't.) EXPLORATION	Impact			Timeframe		Likelihood of Commercial Availability						Willingness to Collaborate			
17) Are there other exploration *technological advances or completely new innovations* that you feel are important to the success of companies engaged in exploration? Please check *Yes* or *No*. __ Yes If *Yes*, please list each additional exploration technology below and answer Questions A through G for each added technology. __ No If *No*, please go to next page.	A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* mea s your company would need this technological advance or innovation by the end of 1999 - *Long term* means your company would need this technological advance or innovation between 1999 and 2010		Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75% - *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%						E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*. If *Yes*, Enter in #F) codes of organizations your company would collaborate with: D DOE* N National Labs O Oil and/or gas companies R Research institutes S USGS and state surveys T Trade associations U Universities V Vendors/service companies X Other Y All of above If *No*, Please explain why in #G) using one of the following codes: C Confidential/proprietary concerns I Intellectual property concerns N No benefit expected R Technology perceived as too risky X Other — Please explain in space below. You may continue comment on back of form if needed.			
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:						
Exploration Technology Needs	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
18)															
19)															
20)															
21)															
22)															
23)															

*Cost sharing/demonstration projects — see page 2.

For EXPLORATION technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.2) DEVELOPMENT

Complete this page if your company participates in DEVELOPMENT. If your company does NOT do development, please check this box ☐ and go to page 9.

Reservoir Characterization Technology Needs	Impact: A) What *impact* would advances in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			Timeframe: B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* means your company would need *advances* to this technology by the end of 1999 - *Long term* means your company would need *advances* to this technology between 1999 and 2010		Likelihood of Commercial Availability: Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75% - *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%						Willingness to Collaborate: E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*. If *Yes*, Enter in #F) codes of organizations your company would collaborate with: D DOE* N National Labs O Oil and/or gas companies R Research institutes S USGS and state surveys T Trade associations U Universities V Vendors/service companies X Other Y All of above If *No*, Please explain why in #G) using one of the following codes: C Confidential/proprietary concerns I Intellectual property concerns N No benefit expected R Technology perceived as too risky X Other — Please explain in space below. You may continue comment on back of form if needed.			
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:						
	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
1) Advanced reservoir analog models															
2) Computer-based 3D geological modeling															
3) Development-scale seismic applications															
4) Tracers (biologic/chemical/ radioactive)															
5) Core analysis/imaging															
6) Geostatistical reservoir descriptions															
7) Outcrop analog studies															
8) Fluid-rock interaction															
9) Rock physics															
10) Cross-well geophysical imaging															
11) Advanced attribute processing															
12) Seismic/log/core calibration															
13) Cuttings analysis															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.2) (Con't.) DEVELOPMENT

Complete this page if your company participates in DEVELOPMENT. If your company does NOT do development, please go to page 9.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Formation Evaluation/ Well Logging Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness E): Yes	Willingness E): No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X.* If *X*, i.e., *other*, specify reason.
14) Reservoir property identification															
15) Through casing logging															
16) Deep investigation techniques															
17) High resolution borehole imaging logs															
18) Specialized core analysis															
19) Characterization of rock wettability															
20) Permeability logging techniques															
21) Tracer techniques															
22) CT scanning and NMR imaging															
23) Formation water chemistry															
24) Fluid sampling and analysis															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.2) (Con't.) DEVELOPMENT

Complete this page if your company participates in DEVELOPMENT. If your company does NOT do development, please go to page 9.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999?

For each technology, check one of the following:

D)...Between 1999 and 2010?

For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
D DOE*
N National Labs
O Oil and/or gas companies
R Research institutes
S USGS and state surveys
T Trade associations
U Universities
V Vendors/service companies
X Other
Y All of above

If *No*, Please explain why in #G) using one of the following codes:
C Confidential/proprietary concerns
I Intellectual property concerns
N No benefit expected
R Technology perceived as too risky
X Other — Please explain in space below. You may continue comment on back of form if needed.

Reservoir Management Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness E): Yes	Willingness E): No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X.* If *X*, i.e., *other*, specify reason.
25) Advanced reservoir simulation modeling															
26) Workstation single well simulations															
27) Procedures for data scale-up															
28) Expert systems applications															
29) Time lapse seismic imaging															
30) Advanced monitoring of EOR processes															
31) Advanced well testing and interpretation															
32) Material balance applications															
33) Decision and risk analysis															
34) Expendable well bore instrumentation															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.2) (Con't.) DEVELOPMENT	Impact			Timeframe		Likelihood of Commercial Availability						Willingness to Collaborate			
35) Are there other development *technological advances or completely new innovations* that you feel are important to the success of companies engaged in development? Please check *Yes* or *No*. __ Yes If *Yes*, please list each additional development technology below and answer Questions A through G for each added technology. __ No If *No*, please go to next page.	A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* means your company would need this technological advance or innovation by the end of 1999 - *Long term* means your company would need this technological advance or innovation between 1999 and 2010		Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75% - *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%						E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*. If *Yes*, Enter in #F) codes of organizations your company would collaborate with: D DOE* N National Labs O Oil and/or gas companies R Research institutes S USGS and state surveys T Trade associations U Universities V Vendors/service companies X Other Y All of above		If *No*, Please explain why in #G) using one of the following codes: C Confidential/proprietary concerns I Intellectual property concerns N No benefit expected R Technology perceived as too risky X Other — Please explain in space below. You may continue comment on back of form if needed.	
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:						
Development Technology Needs	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X.* If *X*, i.e., *other*, specify reason.
36)															
37)															
38)															
39)															
40)															
41)															

*Cost sharing/demonstration projects — see page 2.

For DEVELOPMENT technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.3) DRILLING AND COMPLETION

Complete this page if your company participates in DRILLING AND COMPLETION. If your company does NOT do drilling and completion, please check this box ☐ and go to page 11.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Drilling and Completion Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness to Collaborate: Yes	Willingness to Collaborate: No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
1) Horizontal well bore applications															
2) Drilling fluid design															
3) Advanced fracture techniques															
4) Cementing															
5) Perforating and well bore cleanup															
6) Well productivity															
7) Multilateral technology															
8) Innovative bit and tubular technology															
9) Slim hole drilling															
10) Under balanced drilling															
11) Measurements while drilling															
12) Coiled tubing drilling															
13) Unconventional drilling technology															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.3) (Con't.) DRILLING AND COMPLETION

14) Are there other drilling and completion *technological advances or completely new innovations* you feel are important to the success of companies engaged in drilling and completion? Please check *Yes* or *No*.

__ Yes If *Yes*, please list each additional drilling and completion technology below and answer Questions A through G for each added technology.

__ No If *No*, please go to next page.

Drilling and Completion Technology Needs	Impact: A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			Timeframe: B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* means your company would need this technological advance or innovation by the end of 1999 - *Long term* means your company would need this technological advance or innovation between 1999 and 2010		Likelihood of Commercial Availability: Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75% - *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%						Willingness to Collaborate: E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.			
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:					F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X.* If *X*, i.e., *other*, specify reason.
	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No		
15)															
16)															
17)															
18)															
19)															
20)															

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
D DOE*
N National Labs
O Oil and/or gas companies
R Research institutes
S USGS and state surveys
T Trade associations
U Universities
V Vendors/service companies
X Other
Y All of above

If *No*, Please explain why in #G) using one of the following codes:
C Confidential/proprietary concerns
I Intellectual property concerns
N No benefit expected
R Technology perceived as too risky
X Other — Please explain in space below. You may continue comment on back of form if needed.

*Cost sharing/demonstration projects — see page 2.

For DRILLING AND COMPLETION technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.4) PRODUCTION

Complete this page if your company participates in PRODUCTION. If your company does NOT do production, please check this box ☐ and go to page 14.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No.*

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
D DOE*
N National Labs
O Oil and/or gas companies
R Research institutes
S USGS and state surveys
T Trade associations
U Universities
V Vendors/service companies
X Other
Y All of above

If *No*, Please explain why in #G) using one of the following codes:
C Confidential/proprietary concerns
I Intellectual property concerns
N No benefit expected
R Technology perceived as too risky
X Other — Please explain in space below. You may continue comment on back of form if needed.

Production Processes Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	C)...By end of 1999? For each technology, check one of the following: High	C): Moderate	C): Low	D)...Between 1999 and 2010? For each technology, check one of the following: High	D): Moderate	D): Low	E) Yes	E) No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X.* If *X*, i.e., *other*, specify reason.
1) Injection water treatment															
2) Produced water treatment															
3) Corrosion control															
4) Scaling inhibitors															
5) Paraffin control/removal															
6) Oil/water/gas/separation															
7) Beam pump analysis															
8) Gas lift analysis															
9) Submersible pump analysis															
10) Rod/tubing wear evaluation															
11) Stimulation techniques															
12) Gas compression techniques															
13) Recompletion techniques															
14) Remote control and data analysis															
15) Compact processing on offshore platforms															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.4) (Con't.) PRODUCTION

Complete this page if your company participates in PRODUCTION. If your company does NOT do production, please go to page 14.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations yonr company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Advanced Recovery Processes Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C): High	Likelihood C): Moderate	Likelihood C): Low	Likelihood D): High	Likelihood D): Moderate	Likelihood D): Low	Willingness: Yes	Willingness: No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X.* If *X*, i.e., *other*, specify reason.
16) Modification of reservoir fluid mobilities															
17) Miscible contact/displacement															
18) Viscosity reduction of heavy oils															
19) In situ generation of foams/ emulsions															
20) Thickeners for CO_2 floods															
21) Microbial EOR processes															
22) High-velocity gas flow modeling															
23) Thermal processes															
24) Combustion processes															
25) Near well bore stimulation															
26) New directional drilling															
27) Advanced recovery of natural gas															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.4) (Con't.) PRODUCTION

28) Are there other production *technological advances or completely new innovations* that you feel are important to the success of companies engaged in production? Please check *Yes* or *No*.

__ Yes If *Yes*, please list each additional production technology below and answer Questions A through G for each added technology.

__ No If *No*, please go to next page.

Production Technology Needs	Impact: A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			Timeframe: B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* means your company would need this technological advance or innovation by the end of 1999 - *Long term* means your company would need this technological advance or innovation between 1999 and 2010		Likelihood of Commercial Availability: Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75% - *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%						Willingness to Collaborate: E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*. If *Yes*, Enter in #F) codes of organizations your company would collaborate with: D DOE* N National Labs O Oil and/or gas companies R Research institutes S USGS and state surveys T Trade associations U Universities V Vendors/service companies X Other Y All of above			If *No*, Please explain why in #G) using one of the following codes: C Confidential/proprietary concerns I Intellectual property concerns N No benefit expected R Technology perceived as too risky X Other — Please explain in space below. You may continue comment on back of form if needed.
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:						
	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
29)															
30)															
31)															
32)															
33)															
34)															

*Cost sharing/demonstration projects — see page 2.

For PRODUCTION technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.5) DEEPWATER OFFSHORE

Complete this page if your company participates in DEEPWATER OFFSHORE activities. If your company does NOT do deepwater offshore activities, please check this box ☐ and go to page 16.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Deepwater Offshore Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness E): Yes	Willingness E): No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X.* If *X*, i.e., *other*, specify reason.
1) Produced fluid disposal															
2) Extended reach drilling or production															
3) Extended reach control systems															
4) High pressure systems															
5) Flowlines															
6) Flow metering															
7) Subsea equipment															
8) External corrosion protection															
9) Risers															
10) ROV systems															
11) Drilling															
12) Workover															
13) Water/gas injection															
14) Hydrate prevention															
15) Multi-phase pumps															
16) Structures															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.5) (Con't.) DEEPWATER OFFSHORE

17) Are there other deepwater offshore *technological advances or completely new innovations* that you feel are important to the success of companies engaged in deepwater offshore activities? Please check *Yes* or *No.*

__ Yes If *Yes,* please list each additional deepwater offshore technology below and answer Questions A through G for each added technology.

__ No If *No,* please go to next page.

Deepwater Offshore Technology Needs	Impact: A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			Timeframe: B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* means your company would need this technological advance or innovation by the end of 1999 - *Long term* means your company would need this technological advance or innovation between 1999 and 2010		Likelihood of Commercial Availability: Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75% - *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%						Willingness to Collaborate: E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No.* If *Yes,* Enter in #F) codes of organizations your company would collaborate with: D DOE* N National Labs O Oil and/or gas companies R Research institutes S USGS and state surveys T Trade associations U Universities V Vendors/service companies X Other Y All of above			If *No,* Please explain why in #G) using one of the following codes: C Confidential/proprietary concerns I Intellectual property concerns N No benefit expected R Technology perceived as too risky X Other — Please explain in space below. You may continue comment on back of form if needed.
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:						
	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No	F) If *Yes,* list codes of organizations your company would collaborate with.	G) If *No,* why not? List code, i.e., *C, I, N, R, or X.* If *X,* i.e., *other,* specify reason.
18)															
19)															
20)															
21)															
22)															
23)															

*Cost sharing/demonstration projects — see page 2.

For DEEPWATER OFFSHORE technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.6) ARCTIC REGION ACTIVITIES

Complete this page if your company participates in ARCTIC REGION ACTIVITIES. If your company does NOT do arctic region activities, please check this box ☐ and go to page 18.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Arctic Region Activities Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness E): Yes	Willingness E): No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X.* If *X*, i.e., *other*, specify reason.
1) Transportation															
2) Exploration															
3) Development															
4) Drilling															
5) Production															
6) Deepwater offshore activities															
7) Mobil ice															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.6) (Con't.) ARCTIC REGION ACTIVITIES

8) Are there other arctic region *technological advances or completely new innovations* that you feel are important to the success of companies engaged in arctic region activities? Please check *Yes* or *No*.

__ Yes If *Yes*, please list each additional arctic region technology below and answer Questions A through G for each added technology.

__ No If *No*, please go to next page.

Arctic Region Activities Technology Needs	Impact: A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			Timeframe: B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* means your company would need this technological advance or innovation by the end of 1999 - *Long term* means your company would need this technological advance or innovation between 1999 and 2010		Likelihood of Commercial Availability: Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75% - *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%						Willingness to Collaborate: E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*. If *Yes*, Enter in #F) codes of organizations your company would collaborate with: D DOE* N National Labs O Oil and/or gas companies R Research institutes S USGS and state surveys T Trade associations U Universities V Vendors/service companies X Other Y All of above If *No*, Please explain why in #G) using one of the following codes: C Confidential/proprietary concerns I Intellectual property concerns N No benefit expected R Technology perceived as too risky X Other — Please explain in space below. You may continue comment on back of form if needed.			
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:						
	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
9)															
10)															
11)															
12)															
13)															
14)															

*Cost sharing/demonstration projects — see page 2.

For ARCTIC REGION ACTIVITIES technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.7) OIL PROCESSING AND REFINING

Complete this page if your company participates in PROCESSING AND REFINING of OIL. If your company does NOT do processing and refining of oil, please check this box ☐ and go to page 21.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No.*

If *Yes,* Enter in #F) codes of organizations your company would collaborate with:
D DOE*
N National Labs
O Oil and/or gas companies
R Research institutes
S USGS and state surveys
T Trade associations
U Universities
V Vendors/service companies
X Other
Y All of above

If *No,* Please explain why in #G) using one of the following codes:
C Confidential/proprietary concerns
I Intellectual property concerns
N No benefit expected
R Technology perceived as too risky
X Other — Please explain in space below. You may continue comment on back of form if needed.

Operations/Safety Technologies Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	C)...By end of 1999? For each technology, check one of the following: High	C): Moderate	C): Low	D)...Between 1999 and 2010? For each technology, check one of the following: High	D): Moderate	D): Low	E) Yes	E) No	F) If *Yes,* list codes of organizations your company would collaborate with.	G) If *No,* why not? List code, i.e., *C, I, N, R, or X.* If *X,* i.e., *other,* specify reason.
1) Catalysts with improved selectivities, yields, lifetimes															
2) Hydrogen production and recovery															
3) Plant and process reliability															
4) Unconventional process technology															
5) New materials of construction															
6) Reactor engineering and modeling															
7) Catalyst manufacturing technology															
8) Risk assessment methodology															
9) Solid acid catalysts															
10) Alternatives to olefin alkylation process															
11) Techniques for integration of environmental solutions into process and plant design															
12) Improved on-line NDE inspection technology															
13) Predicting useful remaining lifetimes of aging equipment															
14) Robotics for safety applications															
15) Worker safety systems															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.7) (Con't.) OIL PROCESSING AND REFINING

Complete this page if your company participates in PROCESSING AND REFINING of OIL. If your company does NOT do processing and refining of oil, please go to page 21.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- ***High*** **means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.**
- ***Moderate*** **... moderate impact**
- ***Low*** **... low impact**

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- ***Short term*** **means your company would need *advances* to this technology by the end of 1999**
- ***Long term*** **means your company would need *advances* to this technology between 1999 and 2010**

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- ***High*** **likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%**
- ***Moderate*** **likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%**
- ***Low*** **likelihood means chance of the technological advance becoming commercially useful is less than 25%**

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- **D DOE***
- **N National Labs**
- **O Oil and/or gas companies**
- **R Research institutes**
- **S USGS and state surveys**
- **T Trade associations**
- **U Universities**
- **V Vendors/service companies**
- **X Other**
- **Y All of above**

If *No*, Please explain why in #G) using one of the following codes:
- **C Confidential/proprietary concerns**
- **I Intellectual property concerns**
- **N No benefit expected**
- **R Technology perceived as too risky**
- **X Other — Please explain in space below. You may continue comment on back of form if needed.**

Energy Efficiency/Feedstocks/ Information Systems/Product Requirements Technologies Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness E): Yes	Willingness E): No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
16) Energy efficiency of processes															
17) Energy efficiency of equipment															
18) Energy efficiency of separations															
19) Separations technologies															
20) Determining chemical composition of crudes, refinery intermediates and products															
21) New approaches to refining heavy feeds															
22) Processing synthetic fuels															
23) Conversion of methane to liquid fuels															
24) Relating chemical compositions to process and product performance															
25) Advanced computational modeling of processes/reactions															
26) Advanced control and information systems															
27) Performance characteristics of new hydrocarbon fuel compositions															
28) Environmental characteristics of new hydrocarbon fuel compositions															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.7) (Con't.) OIL PROCESSING AND REFINING

29) Are there other oil processing/refining *technological advances or completely new innovations* you feel are important to the success of companies engaged in oil processing/refining? Please check *Yes* or *No*.

__ Yes If *Yes*, please list each oil processing or refining technology below and answer Questions A through G for each added technology.

__ No If *No*, please go to next page.

Oil Processing and Refining Technologies Needs	Impact: A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			Timeframe: B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* means your company would need this technological advance or innovation by the end of 1999 - *Long term* means your company would need this technological advance or innovation between 1999 and 2010		Likelihood of Commercial Availability: Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75% - *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%						Willingness to Collaborate: E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.			
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:					F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No		
30)															
31)															
32)															
33)															
34)															
35)															

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
D DOE*
N National Labs
O Oil and/or gas companies
R Research institutes
S USGS and state surveys
T Trade associations
U Universities
V Vendors/service companies
X Other
Y All of above

If *No*, Please explain why in #G) using one of the following codes:
C Confidential/proprietary concerns
I Intellectual property concerns
N No benefit expected
R Technology perceived as too risky
X Other — Please explain in space below. You may continue comment on back of form if needed.

*Cost sharing/demonstration projects — see page 2.

For OIL PROCESSING AND REFINING technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.8) GAS PROCESSING

Complete this page if your company participates in PROCESSING of GAS. If your company does NOT process gas, please check this box ☐ and go to page 23.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Gas Processing Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness to Collaborate: Yes	Willingness to Collaborate: No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
1) Gas dehydration															
2) Acid gas removal															
3) H_2S scavenger technology															
4) Natural gas liquid separation															
5) Nitrogen separation															
6) Trace constituent (arsenic, Hg, etc.) removal															
7) Sulfur recovery															
8) Separation of high concentrations of impurities (nitrogen, CO_2, H_2S . . .)															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.8) (Con't.)
GAS PROCESSING

9) Are there other gas processing *technological advances or completely new innovations* you feel are important to the success of companies engaged in gas processing? Please check *Yes* or *No.*

__ Yes If *Yes,* please list each gas processing technology below and answer Questions A through G for each added technology.

__ No If *No,* please go to next page.

Impact

A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need this technological advance or innovation by the end of 1999
- *Long term* means your company would need this technological advance or innovation between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?*
- *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75%
- *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No.*

If *Yes,* Enter in #F) codes of organizations your company would collaborate with:
D DOE*
N National Labs
O Oil and/or gas companies
R Research institutes
S USGS and state surveys
T Trade associations
U Universities
V Vendors/service companies
X Other
Y All of above

If *No,* Please explain why in #G) using one of the following codes:
C Confidential/proprietary concerns
I Intellectual property concerns
N No benefit expected
R Technology perceived as too risky
X Other — Please explain in space below. You may continue comment on back of form if needed.

Gas Processing Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness to Collaborate: Yes	Willingness to Collaborate: No	F) If *Yes,* list codes of organizations your company would collaborate with.	G) If *No,* why not? List code, i.e., *C, I, N, R, or X.* If *X,* i.e., *other,* specify reason.
10)															
11)															
12)															
13)															
14)															
15)															

*Cost sharing/demonstration projects — see page 2.

For GAS PROCESSING technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.9) GAS GATHERING

Complete this page if your company participates in GATHERING of GAS. If your company does NOT do gas gathering, please check this box ☐ and go to page 25.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Gas Gathering Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness to Collaborate: Yes	Willingness to Collaborate: No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
1) Compression															
2) Leak detection															
3) Plastic pipe (higher pressure rating)															
4) High pressure measurement															
5) Multi-phase metering															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.9) (Con't.)
GAS GATHERING

6) Are there other gas gathering *technological advances or completely new innovations* you feel are important to the success of companies engaged in gas gathering? Please check *Yes* or *No.*

__ Yes If *Yes,* please list each gas gathering technology below and answer Questions A through G for each added technology.

__ No If *No,* please go to next page.

Impact

A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need this technological advance or innovation by the end of 1999
- *Long term* means your company would need this technological advance or innovation between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?*
- *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75%
- *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No.*

If *Yes,* Enter in #F) codes of organizations your company would collaborate with:
D DOE*
N National Labs
O Oil and/or gas companies
R Research institutes
S USGS and state surveys
T Trade associations
U Universities
V Vendors/service companies
X Other
Y All of above

If *No,* Please explain why in #G) using one of the following codes:
C Confidential/proprietary concerns
I Intellectual property concerns
N No benefit expected
R Technology perceived as too risky
X Other — Please explain in space below. You may continue comment on back of form if needed.

Gas Gathering Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C): High	Likelihood C): Moderate	Likelihood C): Low	Likelihood D): High	Likelihood D): Moderate	Likelihood D): Low	Willingness: Yes	Willingness: No	F) If *Yes,* list codes of organizations your company would collaborate with.	G) If *No,* why not? List code, i.e., *C, I, N, R, or X.* If *X,* i.e., *other,* specify reason.
7)															
8)															
9)															
10)															
11)															
12)															

*Cost sharing/demonstration projects — see page 2.

For GAS GATHERING technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.10) GAS STORAGE

Complete this page if your company participates in GAS STORAGE. If your company does NOT do gas storage, please check this box ☐ and go to page 27.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Gas Storage Technology Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C)...By end of 1999?: High	Likelihood C)...By end of 1999?: Moderate	Likelihood C)...By end of 1999?: Low	Likelihood D)...Between 1999 and 2010?: High	Likelihood D)...Between 1999 and 2010?: Moderate	Likelihood D)...Between 1999 and 2010?: Low	Willingness E): Yes	Willingness E): No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
1) Well deliverability restoration															
2) Leak detection and mitigation															
3) Reservoir management															
4) Gas migration control															
5) Base gas minimization techniques															
6) Inert base gas research															
7) Unconventional development techniques															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.10) (Con't.)
GAS STORAGE

8) Are there other gas storage *technological advances or completely new innovations* you feel are important to the success of companies engaged in gas storage? Please check *Yes* or *No*.

__ Yes If *Yes*, please list each gas storage technology below and answer Questions A through G for each added technology.

__ No If *No*, please go to next page.

Gas Storage Technology Needs	Impact: A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following: - *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc. - *Moderate* ... moderate impact - *Low* ... low impact			Timeframe: B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following: - *Short term* means your company would need this technological advance or innovation by the end of 1999 - *Long term* means your company would need this technological advance or innovation between 1999 and 2010		Likelihood of Commercial Availability: Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?* - *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75% - *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75% - *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%						Willingness to Collaborate: E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.			
						C)...By end of 1999? For each technology, check one of the following:			D)...Between 1999 and 2010? For each technology, check one of the following:					F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
	High	Moderate	Low	Short term	Long term	High	Moderate	Low	High	Moderate	Low	Yes	No		
9)															
10)															
11)															
12)															
13)															
14)															

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
D DOE*
N National Labs
O Oil and/or gas companies
R Research institutes
S USGS and state surveys
T Trade associations
U Universities
V Vendors/service companies
X Other
Y All of above

If *No*, Please explain why in #G) using one of the following codes:
C Confidential/proprietary concerns
I Intellectual property concerns
N No benefit expected
R Technology perceived as too risky
X Other — Please explain in space below. You may continue comment on back of form if needed.

*Cost sharing/demonstration projects — see page 2.

For GAS STORAGE technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

Q.11) ENVIRONMENTAL AND REGULATORY

Complete this page regarding ENVIRONMENTAL/ REGULATORY technologies.

Impact

A) What *impact* would advances in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider *advances* to this technology to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need *advances* to this technology by the end of 1999
- *Long term* means your company would need *advances* to this technology between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that advances to this *technology will be commercially useful...By the end of 1999...Between 1999 and 2010?*

- *High* likelihood means that the chance of the technological advance becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of the technological advance becoming commercially useful is 25% to 75%
- *Low* likelihood means chance of the technological advance becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No*.

If *Yes*, Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No*, Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Environmental/Regulatory Technologies Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood C): High	Likelihood C): Moderate	Likelihood C): Low	Likelihood D): High	Likelihood D): Moderate	Likelihood D): Low	Willingness: Yes	Willingness: No	F) If *Yes*, list codes of organizations your company would collaborate with.	G) If *No*, why not? List code, i.e., *C, I, N, R, or X*. If *X*, i.e., *other*, specify reason.
1) Disposal methods for drilling fluids															
2) Treatment/disposal of produced fluids															
3) Screening procedures — injection wells															
4) Risk and reclamation analysis of disposal methods															
5) Leak detection															
6) Hydrological modeling															
7) Compliance with CAAA stationary source issue															
8) Advanced computation models to predict air pollutant dispersion/transformation/fate															
9) Model transport and remediation of contaminants in groundwater and soils															
10) Effluent and emission monitoring, minimization and control															
11) Recycling of waste/byproduct streams															
12) Remediation technology															
13) Catalyst recycling															
14) Provide scientific basis for risk-based regulation															
15) NORM disposal															

*Cost sharing/demonstration projects — see page 2.

Survey instructions may be found on page 2.

Q.11 (Con't.)

ENVIRONMENTAL AND REGULATORY

16) Are there other environmental and regulatory *technological advances or completely new innovations* you feel are important to the success of companies participating in the oil/gas industry? Please check *Yes* or *No.*

__ Yes If *Yes,* please list each environmental and regulatory technology below and answer Questions A through G for each added technology.

__ No If *No,* please go to next page.

Impact

A) What *impact* would advances or innovations in this technology have on your company? For each technology, check one of the following:
- *High* means the technological advance or innovation would have a *major impact* on your company's performance in terms of cost reduction, gains in domestic production, efficiency, etc.
- *Moderate* ... moderate impact
- *Low* ... low impact

Timeframe

B) Do you consider the technological *advance or innovation* to be a short-term or long-term need? For each technology, check one or both of the following:
- *Short term* means your company would need this technological advance or innovation by the end of 1999
- *Long term* means your company would need this technological advance or innovation between 1999 and 2010

Likelihood of Commercial Availability

Given what you see as the pace of development today among all organizations developing technology, i.e., business as usual, what is the *likelihood* that this *technological advance or innovation will be commercially useful...By the end of 1999...Between 1999 and 2010?*
- *High* likelihood means that the chance of this technology becoming commercially useful is greater than 75%
- *Moderate* likelihood means that the chance of this technology becoming commercially useful is 25% to 75%
- *Low* likelihood means that the chance of this technology becoming commercially useful is less than 25%

C)...By end of 1999? For each technology, check one of the following:

D)...Between 1999 and 2010? For each technology, check one of the following:

Willingness to Collaborate

E) Is your company willing to collaborate to advance this technology? For each technology, check *Yes* or *No.*

If *Yes,* Enter in #F) codes of organizations your company would collaborate with:
- D DOE*
- N National Labs
- O Oil and/or gas companies
- R Research institutes
- S USGS and state surveys
- T Trade associations
- U Universities
- V Vendors/service companies
- X Other
- Y All of above

If *No,* Please explain why in #G) using one of the following codes:
- C Confidential/proprietary concerns
- I Intellectual property concerns
- N No benefit expected
- R Technology perceived as too risky
- X Other — Please explain in space below. You may continue comment on back of form if needed.

Environmental and Regulatory Technologies Needs	Impact: High	Impact: Moderate	Impact: Low	Timeframe: Short term	Timeframe: Long term	Likelihood of Commercial Availability — C)...By end of 1999?: High	C): Moderate	C): Low	D)...Between 1999 and 2010?: High	D): Moderate	D): Low	Willingness to Collaborate: Yes	No	F) If *Yes,* list codes of organizations your company would collaborate with.	G) If *No,* why not? List code, i.e., *C, I, N, R, or X.* If *X,* i.e., *other,* specify reason.
17)															
18)															
19)															
20)															
21)															
22)															

*Cost sharing/demonstration projects — see page 2.

For ENVIRONMENTAL AND REGULATORY technologies, please print appropriate contact name and telephone number, if different than on page one.

Name: _____

Telephone: _____

Survey instructions may be found on page 2.

12) In broad general terms, please describe the **barriers** and **problems** that might prevent you from accomplishing your corporate business needs and which might be met by an **emerging technological solution.** (If more space is needed, you may continue comment on the back of the form.)_____

_____

_____

_____

_____

The following questions will be used to help us understand R&D spending trends in the industry.

13A.1) Approximately what were **1994 R&D expenditures** for your organization as reported in your annual statement or 10-K? Please enter figure in millions of dollars in column A of matrix below.

13A.2) Similarly, what were **1990 R&D expenditures** for your organization? Please enter figure in millions of dollars in column A of matrix below.

13A.3) What do you project your organization's **1998 R&D expenditures** to be? <<Estimate in millions of 1998 dollars.>> Please put estimate in column A of matrix below.

13B.1-3) Approximately what **percent** of these **1994** R&D expenditures do you estimate are related primarily to **oil** R&D projects? Similarly, what percent would you estimate for **1990**? For **1998**? Please enter estimated percentages in column B of matrix below.

13C.1-3) Approximately what **percent** of these **1994** R&D expenditures are related primarily to **gas** R&D projects? Similarly, what percent would you estimate for **1990**? For **1998**? Please enter estimated percentages in column C of matrix below.

13D.1-3) Approximately what **percent** of these **1994** R&D expenditures are related to R&D projects applicable to **both oil and gas**? Similarly, what percent would you estimate for **1990**? For **1998**? Please enter estimated percentages in column D of matrix below.

	Annual R&D Expenditures			
Year	A) $ (Millions)	B) % primarily oil	C) % primarily gas	D) % both oil and gas
1994				
1990				
1998				

14) Do you currently do any ***technology collaborations*** in conjunction with the **National Labs** and/or with **DOE**? (See page 2 for definition.) Please check one option below.

_____ (B) Collaborate with **both** the DOE and National Labs
_____ (D) Collaborate with **DOE**
_____ (N) Collaborate with **National Labs**
_____ (Z) Do not collaborate with either

Survey instructions may be found on page 2.

15A) Are you **willing to collaborate** with the following organizations regarding R&D? For each organization type, please check *Yes* or *No* in section A of the matrix below.

15B) For those organizations you would collaborate with regarding R&D, what is your **preference** regarding **collaboration**? In column B of the matrix below, please enter a **"1"** for the type of organization with which you would **most prefer** to work, **"2"** for the type of organization you would prefer to work with **second most**, etc.

15C) If you would **not collaborate** with an organization, please explain why in column C of the following matrix.

Organization	A) Willingness to Collaborate. Please check *Yes* or *No*		B) Rank preference regarding collaboration	C) If not willing to collaborate, please explain.
	Yes	No		
DOE*				
National Labs				
Oil and/or gas companies				
Research institutes				
USGS and state surveys				
Trade associations				
Universities				
Vendors/service companies				

*Cost sharing/demonstration projects — see page 2.

15D) If you prefer to work with **other** organizations, please specify the type of organization:

_____

15E) If you anticipate **any problems in collaborating** with any of these organizations (even for organizations for which you marked *Yes*), please explain which organizations and issues that would need to be resolved. (If you need additional space, you may continue on the back of the form.)_____

_____

_____

_____

Survey instructions may be found on page 2.

The following questions will be used to help us analyze the data.

16) Please describe whether your company is categorized as an **integrated gas** and/or **oil company**, a large or small **independent producer**, an **independent refiner**, or **service company**. Please check the one category below that best describes your company:

_____ (A) Integrated gas company
_____ (B) Integrated oil company
_____ (C) Integrated oil and gas company
_____ (D) Large independent producer
_____ (E) Small independent producer
_____ (F) Independent refiner
_____ (G) Service company

17) Please describe whether your company participates in the **natural gas** industry, the **oil** industry, or **both**. Please check one of the following:

_____ (A) Gas
_____ (B) Oil
_____ (C) Both oil and gas

18) Please identify which **business segments** your company participates in. Please check all that are appropriate:

_____ (A) Exploration
_____ (B) Drilling
_____ (C) Well completion
_____ (D) Production
_____ (E) Transportation
_____ (F) Offshore facility
_____ (G) Storage
_____ (H) Gas treating
_____ (I) Refining
_____ (J) Other (Please explain: _____)

19) What, approximately, were your company's **1994 gross sales** world-wide? (Please round to millions of dollars, i.e., $8,300,000 becomes 8.3)

_____ ***($ millions 1994)***

20) Approximately how many people were **employed** world-wide by your company as of the **end of 1994?**

_____ ***(# employees 1994)***

21) What, approximately, were your company's **U.S. oil reserves** as of the **end of 1994?** Similarly, what were your company's **worldwide oil reserves** at the end of 1994?

_____ (millions of barrels — **U.S.**)
_____ (millions of barrels — **worldwide**)

22) What, approximately, were your company's **U.S. gas reserves** as of the **end of 1994?** Similarly, what were your company's **worldwide gas reserves** at the end of 1994?

_____ (trillions of cubic feet — **U.S.**)
_____ (trillions of cubic feet — **worldwide**)

Survey instructions may be found on page 2.

PART II

SURVEY RESULTS

Major Companies* that Responded to the NPC Survey of Research and Development Needs

Company
Amoco Exploration & Production Technology
Anadarko Petroleum Corporation
ARCO Exploration and Production Technology
Ashland Oil, Incorporated
Chevron
Conoco, Incorporated
Exxon
Fina, Incorporated
Kerr-McGee Corporation
Marathon Oil Company
Occidental Petroleum Company
Phillips Petroleum Company
Shell Oil Company
Sun Company, Incorporated
Texaco, Incorporated
Union Pacific Resources Company
Unocal Corporation

* For the purposes of this study, a major company is one which is part of the Department of Energy's Financial Reporting System. All but two of the above companies also qualify as major companies by the IRS' definition.

Other Integrated Oil and Gas Companies that Responded to the NPC Survey of Research and Development Needs

Company
BHP Petroleum Americas Incorporated
Columbia Gas System
Consolidated Natural Gas
ENSERCH Corporation
Equitable Resources
Flying J Incorporated
Murphy Oil Corporation
Panhandle Eastern Corporation
Sonat, Incorporated
Southern California Gas Company
Tenneco
The Williams Companies

Independent Companies that Responded to the NPC Survey of Research and Development Needs

Company

Alcorn Exploration
Armstrong Energy Corporation
Axem Resources Incorporated
Badger Oil Corporation
Ballard and Associates, Incorporated
Celsius Energy Company, an Affiliate of Questar Corporation
CMS Nomeco Oil and Gas Company
Coulson Oil Company, Incorporated
Crown Central Petroleum Corporation
Devon Energy Corporation (Nevada)
Diamond Shamrock
Enervest Management Company, L.C.
Forest Oil Corporation
Gunn Oil Company
Julander Energy Company
Lynx Petroleum Consultants, Inc.
Meridian Oil Incorporated
Mesa Incorporated
Mitchell Energy Corporation
National Cooperative Refinery Association
Newfield Exploration Company
Osyka Producing Company, Incorporated
Parker and Parsley Petroleum Company
Parker and Parsley Petroleum USA, Incorporated
Pitts Oil Company/Dallas Production, Inc.
Sanchez-O'Brien Oil and Gas
Seagull Energy Corporation
Seneca Resources
Southwest Research Institute
Taylor Energy Company
Tesoro Petroleum
The Louisiana Land and Exploration Company
Tosco Corporation
Total Petroleum, Incorporated
True Oil Company
Union Texas Petroleum
Ward Petroleum Corporation
Washington Gas
Winn Exploration, Incorporated
Yates Petroleum Company

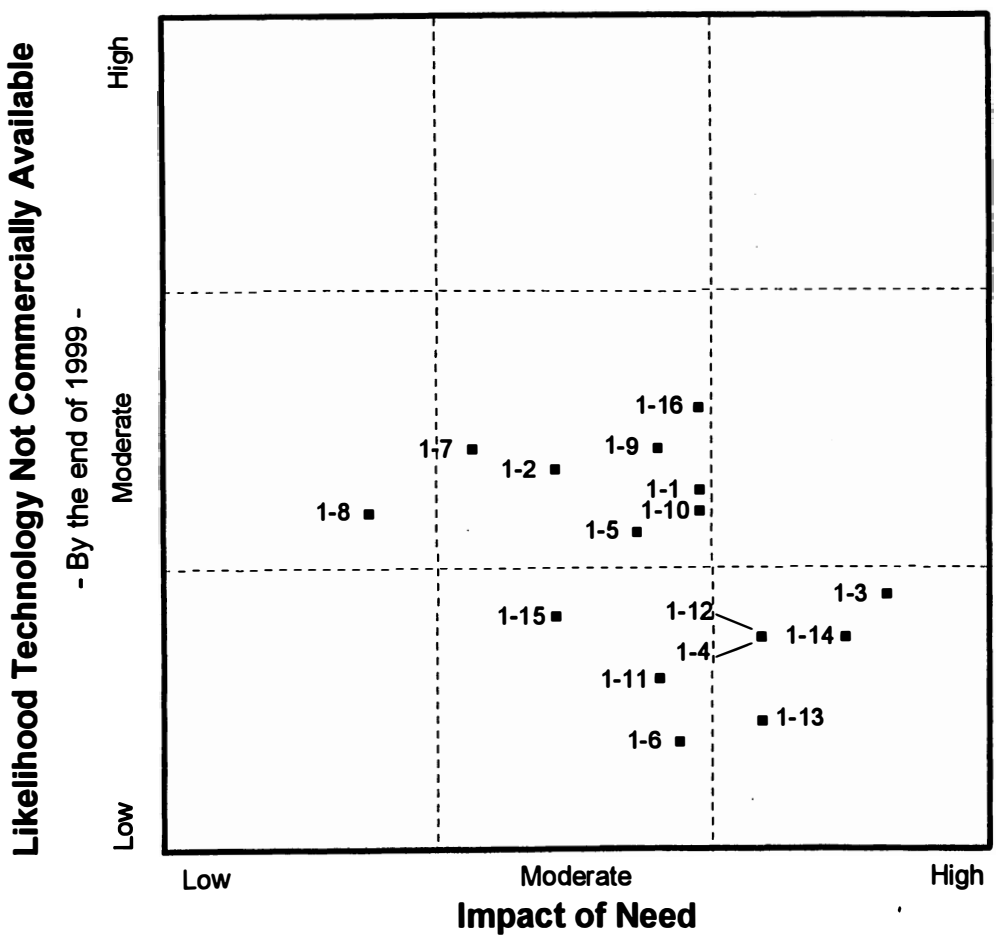
Service Companies that Responded to the NPC Survey of Research and Development Needs

Company
Axelson, Incorporated
Baker Hughes, Incorporated
Barold Drilling Fluids
Copestone, Incorporated
Dresser Oilfield Valve Division
Dresser-Rand Company
Flournoy Drilling Company
Halliburton Energy Services
Ingersoll-Dresser Pump Company
Lone Star Steel Company
Parker Drilling Company
Premier Enterprises, Incorporated
Rowan Companies, Incorporated
Schlumberger
Security DBS
Sperry-Sun Drilling Services
Sperry-Sun Drilling Services, a Dresser Industries Incorporated Company
The M.W. Kellogg Company
Western Atlas International Incorporated
Wheatley Canada, Limited, A Dresser Industries Incorporated Company

Identification of Short-term R, D&D Targets

- Exploration -

- all respondents -

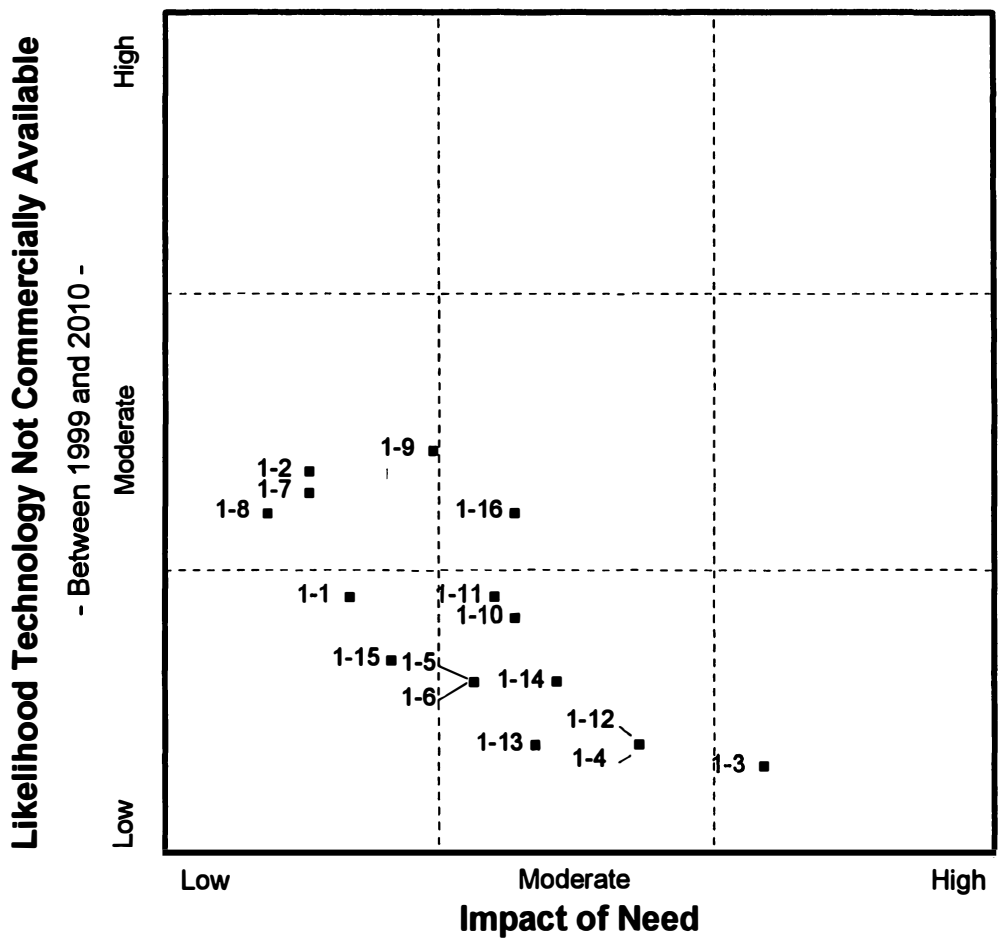


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	3.6	2.7	30
1-2	Risk assessment methods	2.9	2.8	34
1-3	High-resolution seismic depth imaging	4.5	2.2	51
1-4	Specialized seismic processing	3.9	2.0	47
1-5	Sequence stratigraphy techniques	3.3	2.5	42
1-6	Workstation seismic modeling	3.5	1.5	51
1-7	Geochemical analysis	2.5	2.9	30
1-8	Airborne/satellite remote sensing	2.0	2.6	21
1-9	Fault seal analysis	3.4	2.9	37
1-10	Multi-component seismic techniques	3.6	2.6	32
1-11	3D Paleostructural restoration	3.4	1.8	33
1-12	Amplitude versus offset (AVO) in 3D	3.9	2.0	52
1-13	3D Visualization tools	3.9	1.6	45
1-14	Advanced seismic acquisition	4.3	2.0	46
1-15	Geographic information systems	2.9	2.1	29
1-16	Geophysical fracture-detection methods	3.6	3.1	37

Identification of Long-term R, D&D Targets

- Exploration -

- all respondents -

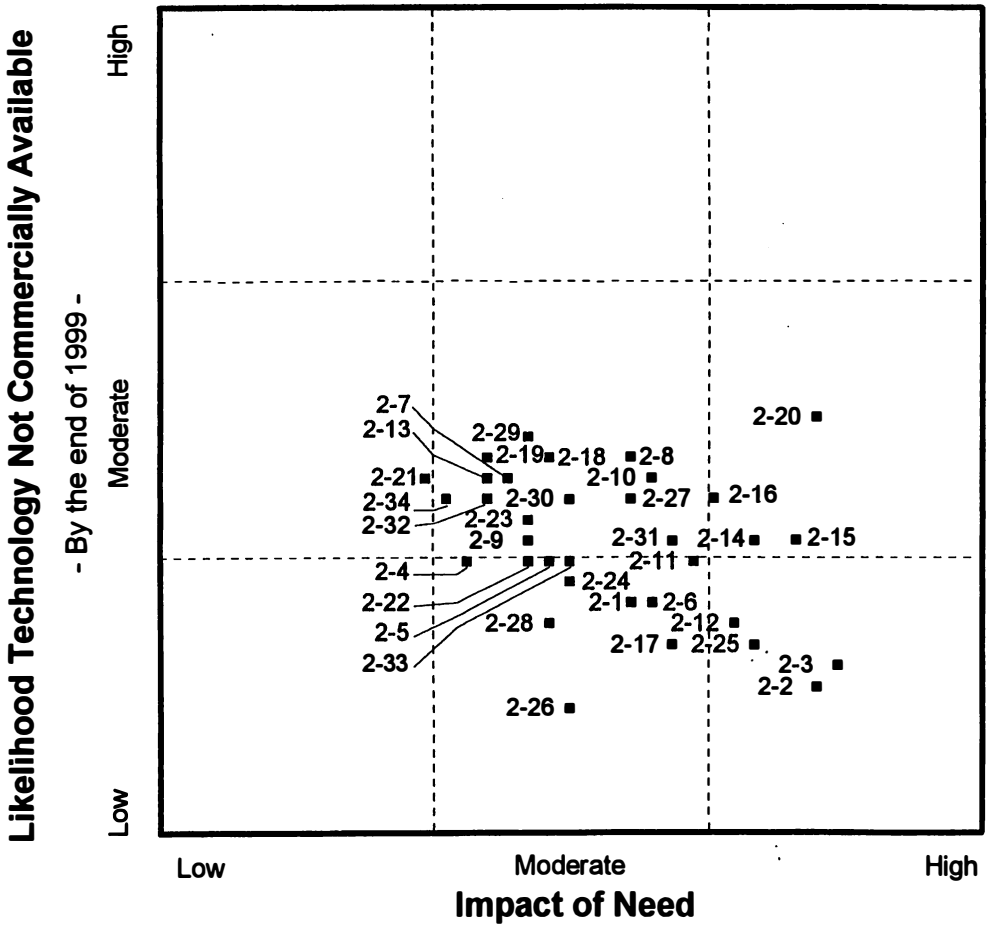


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	1.9	2.2	31
1-2	Risk assessment methods	1.7	2.8	27
1-3	High-resolution seismic depth imaging	3.9	1.4	27
1-4	Specialized seismic processing	3.3	1.5	28
1-5	Sequence stratigraphy techniques	2.5	1.8	29
1-6	Workstation seismic modeling	2.5	1.8	15
1-7	Geochemical analysis	1.7	2.7	31
1-8	Airborne/satellite remote sensing	1.5	2.6	39
1-9	Fault seal analysis	2.3	2.9	32
1-10	Multi-component seismic techniques	2.7	2.1	37
1-11	3D Paleostructural restoration	2.6	2.2	34
1-12	Amplitude versus offset (AVO) in 3D	3.3	1.5	15
1-13	3D Visualization tools	2.8	1.5	22
1-14	Advanced seismic acquisition	2.9	1.8	26
1-15	Geographic information systems	2.1	1.9	35
1-16	Geophysical fracture-detection methods	2.7	2.6	33

Identification of Short-term R, D&D Targets

- Development -

- all respondents -

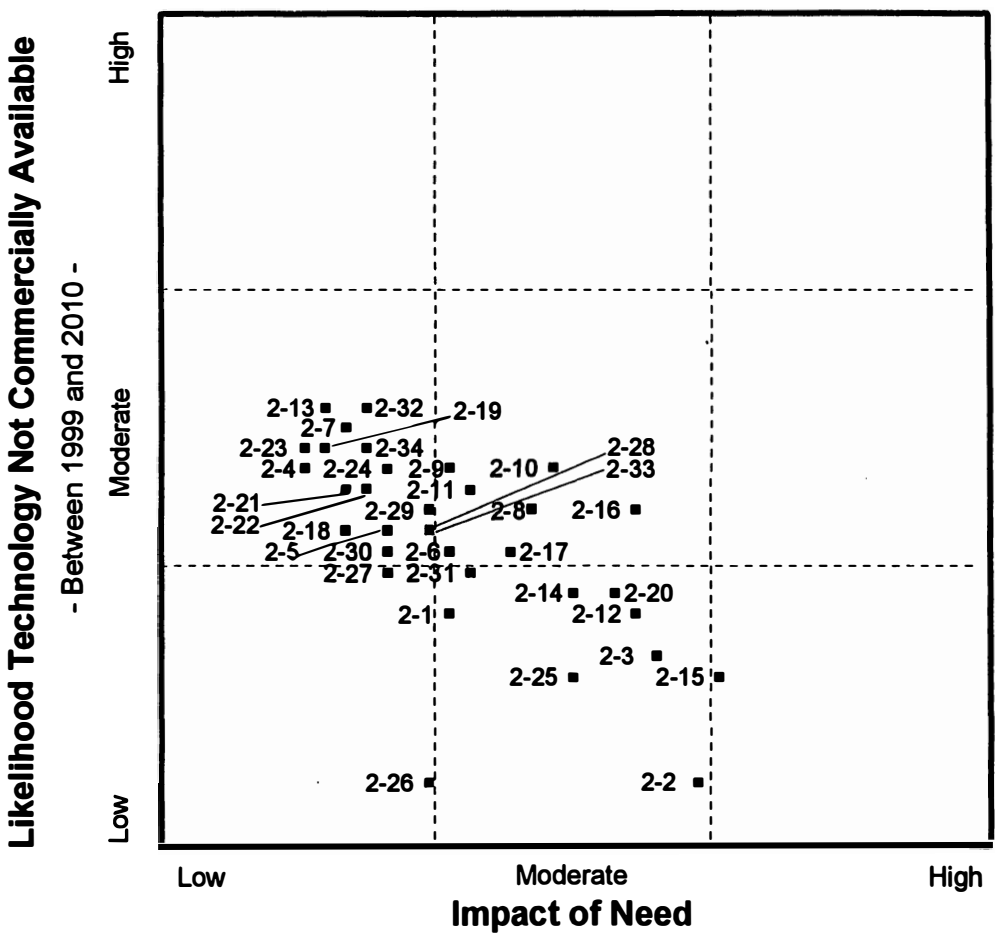


		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	3.3	2.1	32
2-2	Computer-based 3-D geological modeling	4.2	1.7	45
2-3	Development-scale seismic applications	4.3	1.8	43
2-4	Tracers (biologic/chemical/radioactive)	2.5	2.3	24
2-5	Core analysis/imaging	2.9	2.3	35
2-6	Geostatistical reservoir descriptions	3.4	2.1	36
2-7	Outcrop analog studies	2.7	2.7	24
2-8	Fluid-rock interaction	3.3	2.8	39
2-9	Rock physics	2.8	2.4	30
2-10	Cross-well geophysical imaging	3.4	2.7	32
2-11	Advanced attribute processing	3.6	2.3	34
2-12	Seismic/log/core calibration	3.8	2.0	48
2-13	Cuttings analysis	2.6	2.7	28
2-14	Reservoir property identification	3.9	2.4	44
2-15	Through casing logging	4.1	2.4	50
2-16	Deep investigation techniques	3.7	2.6	42
2-17	High resolution borehole imaging logs	3.5	1.9	41
2-18	Specialized core analysis	2.9	2.8	29
2-19	Characterization of rock wettability	2.6	2.8	26
2-20	Permeability logging techniques	4.2	3.0	46
2-21	Tracer techniques	2.3	2.7	23
2-22	CT scanning and NMR imaging	2.8	2.3	24
2-23	Formation water chemistry	2.8	2.5	25
2-24	Fluid sampling and analysis	3.0	2.2	31
2-25	Advanced reservoir simulation modeling	3.9	1.9	43
2-26	Workstation single well simulations	3.0	1.6	37
2-27	Procedures for data scale-up	3.3	2.6	28
2-28	Expert systems applications	2.9	2.0	20
2-29	Time lapse seismic imaging	2.8	2.9	22
2-30	Advanced monitoring of EOR processes	3.0	2.6	24
2-31	Advanced well testing and interpretation	3.5	2.4	38
2-32	Material balance applications	2.6	2.6	28
2-33	Decision and risk analysis	3.0	2.3	31
2-34	Expendable well bore instrumentation	2.4	2.6	20

Identification of Long-term R, D&D Targets

- Development -

- all respondents -

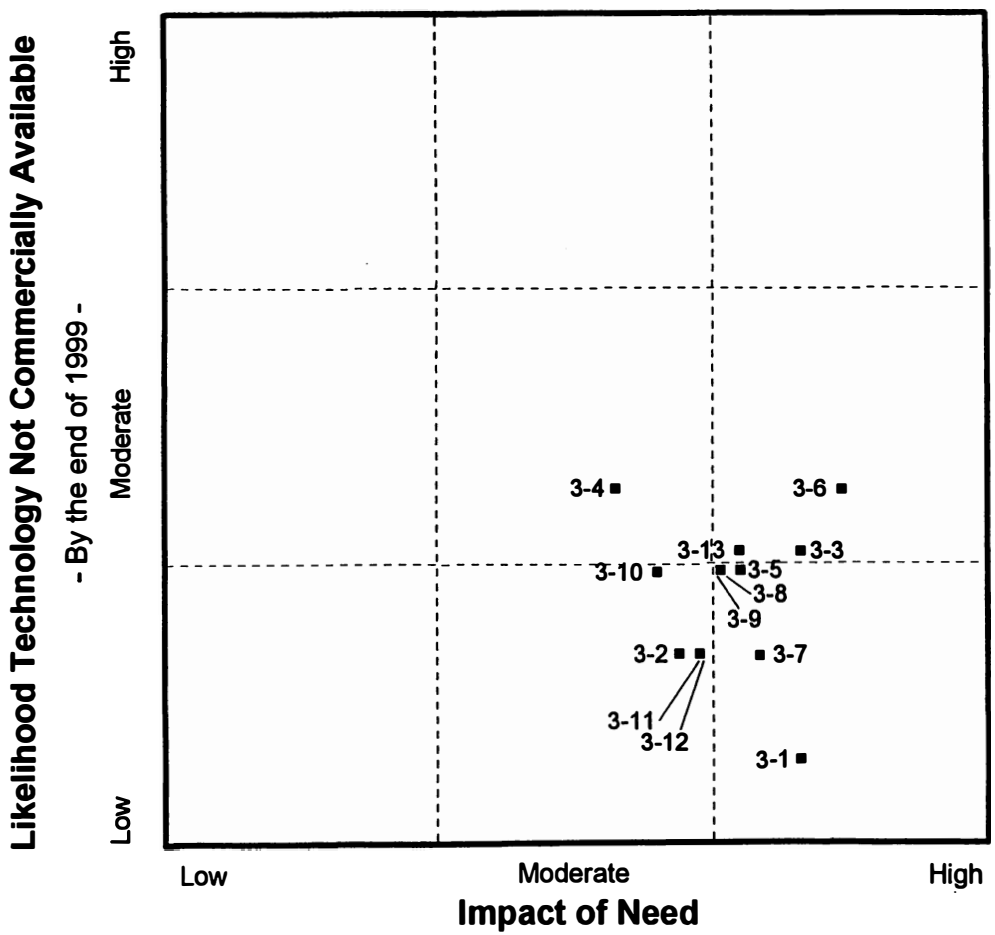


		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	2.4	2.1	30
2-2	Computer-based 3-D geological modeling	3.6	1.3	24
2-3	Development-scale seismic applications	3.4	1.9	28
2-4	Tracers (biologic/chemical/radioactive)	1.7	2.8	39
2-5	Core analysis/imaging	2.1	2.5	27
2-6	Geostatistical reservoir descriptions	2.4	2.4	34
2-7	Outcrop analog studies	1.9	3.0	36
2-8	Fluid-rock interaction	2.8	2.6	28
2-9	Rock physics	2.4	2.8	42
2-10	Cross-well geophysical imaging	2.9	2.8	36
2-11	Advanced attribute processing	2.5	2.7	31
2-12	Seismic/log/core calibration	3.3	2.1	22
2-13	Cuttings analysis	1.8	3.1	32
2-14	Reservoir property identification	3.0	2.2	27
2-15	Through casing logging	3.7	1.8	22
2-16	Deep investigation techniques	3.3	2.6	28
2-17	High resolution borehole imaging logs	2.7	2.4	25
2-18	Specialized core analysis	1.9	2.5	33
2-19	Characterization of rock wettability	1.8	2.9	38
2-20	Permeability logging techniques	3.2	2.2	26
2-21	Tracer techniques	1.9	2.7	44
2-22	CT scanning and NMR imaging	2.0	2.7	37
2-23	Formation water chemistry	1.7	2.9	37
2-24	Fluid sampling and analysis	2.1	2.8	32
2-25	Advanced reservoir simulation modeling	3.0	1.8	29
2-26	Workstation single well simulations	2.3	1.3	29
2-27	Procedures for data scale-up	2.1	2.3	38
2-28	Expert systems applications	2.3	2.5	40
2-29	Time lapse seismic imaging	2.3	2.6	44
2-30	Advanced monitoring of EOR processes	2.1	2.4	41
2-31	Advanced well testing and interpretation	2.5	2.3	31
2-32	Material balance applications	2.0	3.1	33
2-33	Decision and risk analysis	2.3	2.5	30
2-34	Expendable well bore instrumentation	2.0	2.9	40

Identification of Short-term R, D&D Targets

- Drilling and Completion -

- all respondents -

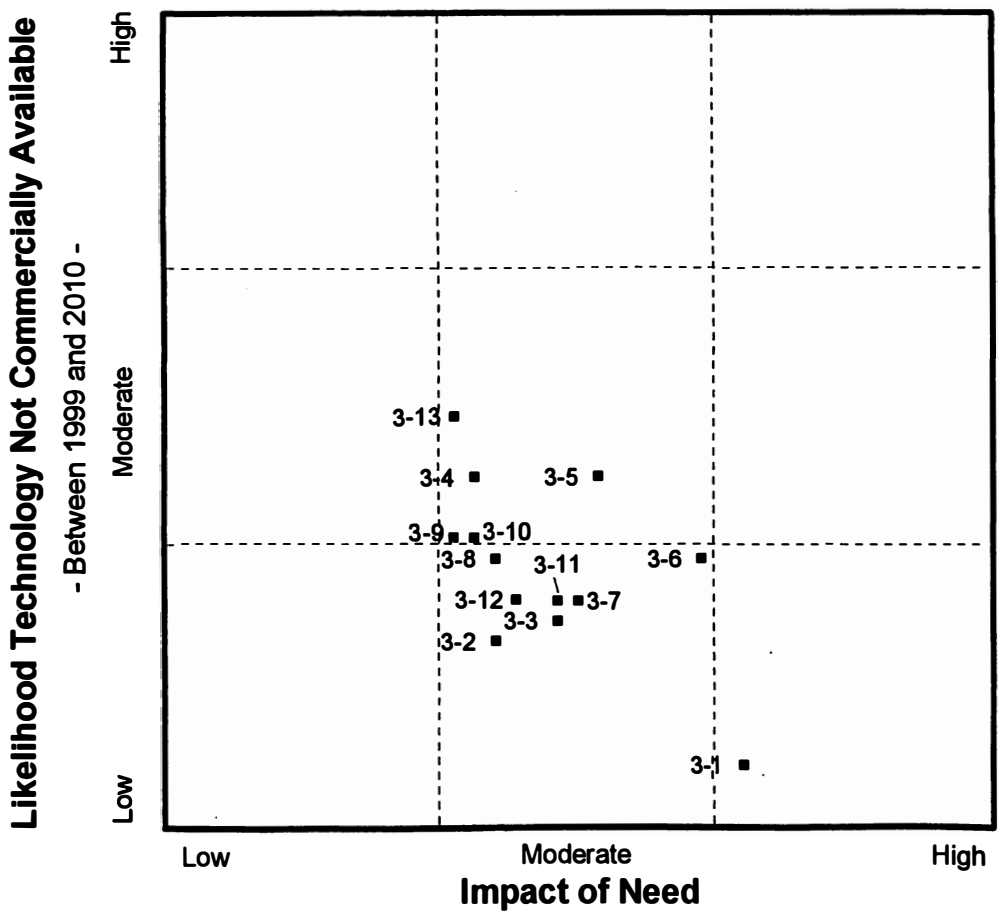


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	4.1	1.4	56
3-2	Drilling fluid design	3.5	1.9	45
3-3	Advanced fracture techniques	4.1	2.4	49
3-4	Cementing	3.2	2.7	42
3-5	Perforating and well bore cleanup	3.8	2.3	48
3-6	Well productivity	4.3	2.7	47
3-7	Multilateral technology	3.9	1.9	36
3-8	Innovative bit and tubular technology	3.7	2.3	42
3-9	Slim hole drilling	3.7	2.3	39
3-10	Under balanced drilling	3.4	2.3	30
3-11	Measurements while drilling	3.6	1.9	46
3-12	Coiled tubing drilling	3.6	1.9	39
3-13	Unconventional drilling technology	3.8	2.4	25

Identification of Long-term R, D&D Targets

- Drilling and Completion -

- all respondents -

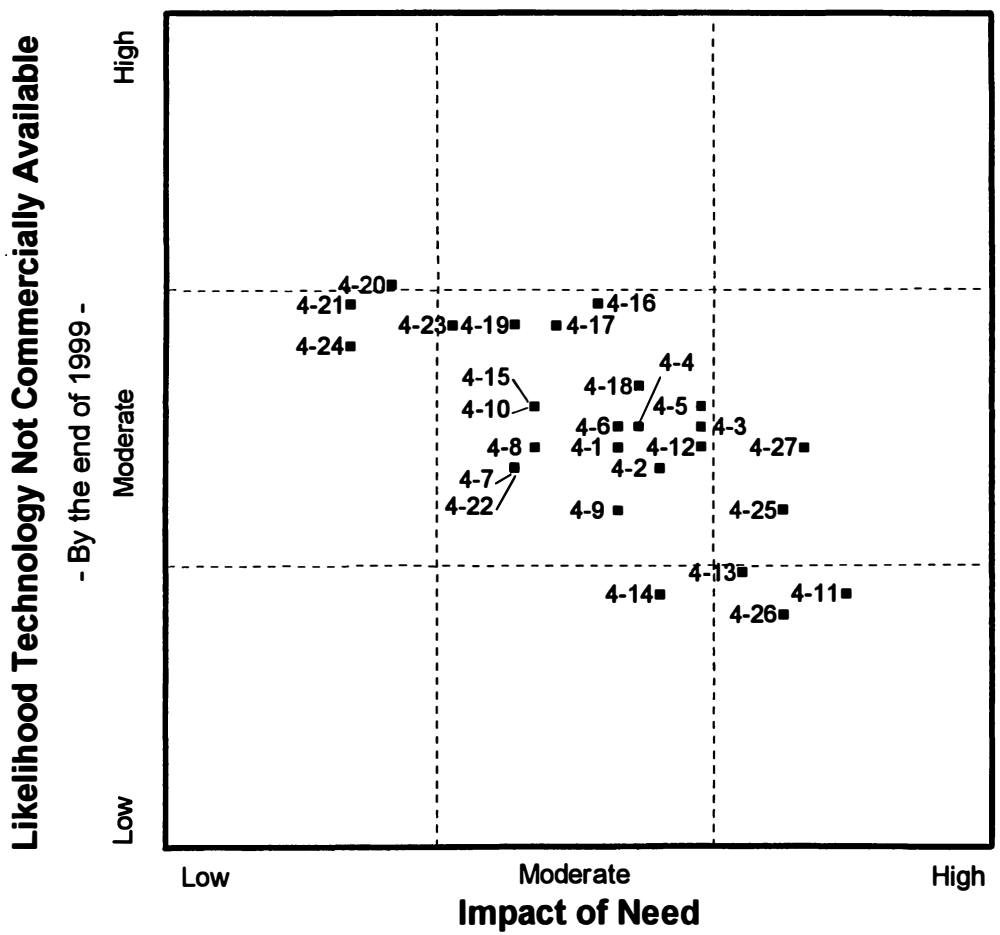


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	3.8	1.3	26
3-2	Drilling fluid design	2.6	1.9	32
3-3	Advanced fracture techniques	2.9	2.0	25
3-4	Cementing	2.5	2.7	32
3-5	Perforating and well bore cleanup	3.1	2.7	24
3-6	Well productivity	3.6	2.3	28
3-7	Multilateral technology	3.0	2.1	36
3-8	Innovative bit and tubular technology	2.6	2.3	32
3-9	Slim hole drilling	2.4	2.4	38
3-10	Under balanced drilling	2.5	2.4	40
3-11	Measurements while drilling	2.9	2.1	28
3-12	Coiled tubing drilling	2.7	2.1	36
3-13	Unconventional drilling technology	2.4	3.0	47

Identification of Short-term R, D&D Targets

- Production -

- all respondents -

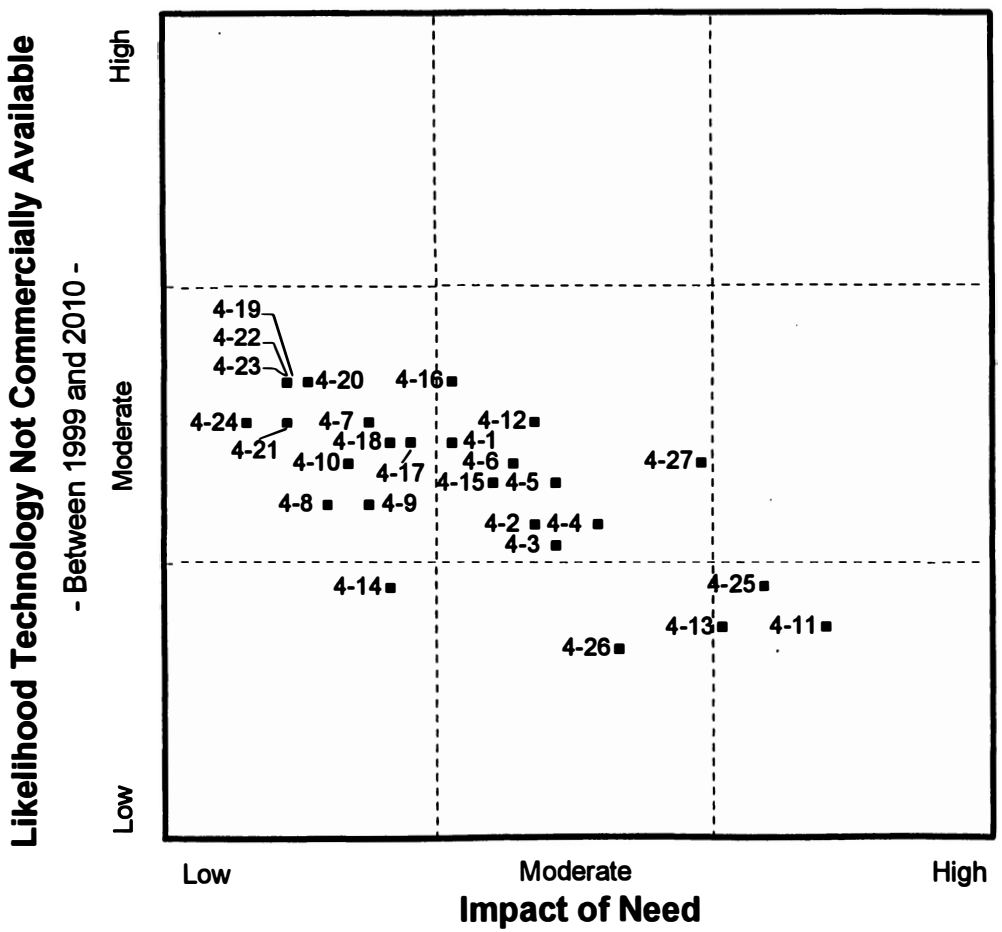


		Impact	Likeli-hood	n =
4-1	Injection water treatment	3.2	2.9	37
4-2	Produced water treatment	3.4	2.8	43
4-3	Corrosion control	3.6	3.0	48
4-4	Scaling inhibitors	3.3	3.0	51
4-5	Paraffin control/removal	3.6	3.1	48
4-6	Oil/water/gas/separation	3.2	3.0	37
4-7	Beam pump analysis	2.7	2.8	35
4-8	Gas lift analysis	2.8	2.9	33
4-9	Submersible pump analysis	3.2	2.6	35
4-10	Rod/tubing wear evaluation	2.8	3.1	38
4-11	Stimulation techniques	4.3	2.2	53
4-12	Gas compression techniques	3.6	2.9	39
4-13	Recompletion techniques	3.8	2.3	50
4-14	Remote control and data analysis	3.4	2.2	39
4-15	Compact processing on offshore platforms	2.8	3.1	25
4-16	Modification of reservoir fluid mobilities	3.1	3.6	30
4-17	Miscible contact/displacement	2.9	3.5	25
4-18	Viscosity reduction of heavy oils	3.3	3.2	24
4-19	In situ generation of foams/emulsions	2.7	3.5	20
4-20	Thickeners for CO_2 floods	2.1	3.7	18
4-21	Microbial EOR processes	1.9	3.6	14
4-22	High-velocity gas flow modeling	2.7	2.8	23
4-23	Thermal processes	2.4	3.5	22
4-24	Combustion processes	1.9	3.4	18
4-25	Near well bore stimulation	4.0	2.6	49
4-26	New directional drilling	4.0	2.1	43
4-27	Advanced recovery of natural gas	4.1	2.9	39

Identification of Long-term R, D&D Targets

- Production -

- all respondents -

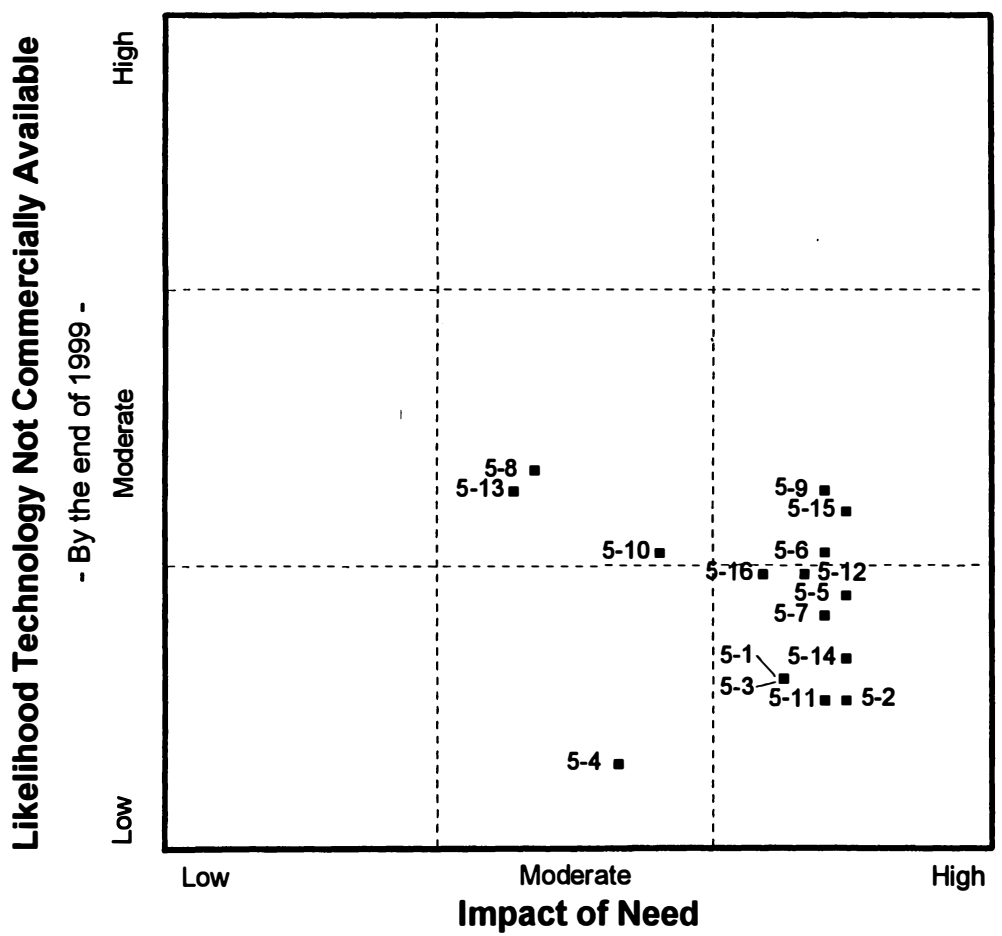


		Impact	Likeli-hood	n =
4-1	Injection water treatment	2.4	2.9	35
4-2	Produced water treatment	2.8	2.5	29
4-3	Corrosion control	2.9	2.4	25
4-4	Scaling inhibitors	3.1	2.5	22
4-5	Paraffin control/removal	2.9	2.7	24
4-6	Oil/water/gas/separation	2.7	2.8	34
4-7	Beam pump analysis	2.0	3.0	27
4-8	Gas lift analysis	1.8	2.6	32
4-9	Submersible pump analysis	2.0	2.6	27
4-10	Rod/tubing wear evaluation	1.9	2.8	27
4-11	Stimulation techniques	4.2	2.0	21
4-12	Gas compression techniques	2.8	3.0	30
4-13	Recompletion techniques	3.7	2.0	18
4-14	Remote control and data analysis	2.1	2.2	31
4-15	Compact processing on offshore platforms	2.6	2.7	36
4-16	Modification of reservoir fluid mobilities	2.4	3.2	34
4-17	Miscible contact/displacement	2.2	2.9	38
4-18	Viscosity reduction of heavy oils	2.1	2.9	37
4-19	In situ generation of foams/emulsions	1.6	3.2	37
4-20	Thickeners for CO_2 floods	1.7	3.2	39
4-21	Microbial EOR processes	1.6	3.0	40
4-22	High-velocity gas flow modeling	1.6	3.2	34
4-23	Thermal processes	1.6	3.2	36
4-24	Combustion processes	1.4	3.0	37
4-25	Near well bore stimulation	3.9	2.2	19
4-26	New directional drilling	3.2	1.9	23
4-27	Advanced recovery of natural gas	3.6	2.8	28

Identification of Short-term R, D&D Targets

- Deepwater Offshore -

- all respondents -

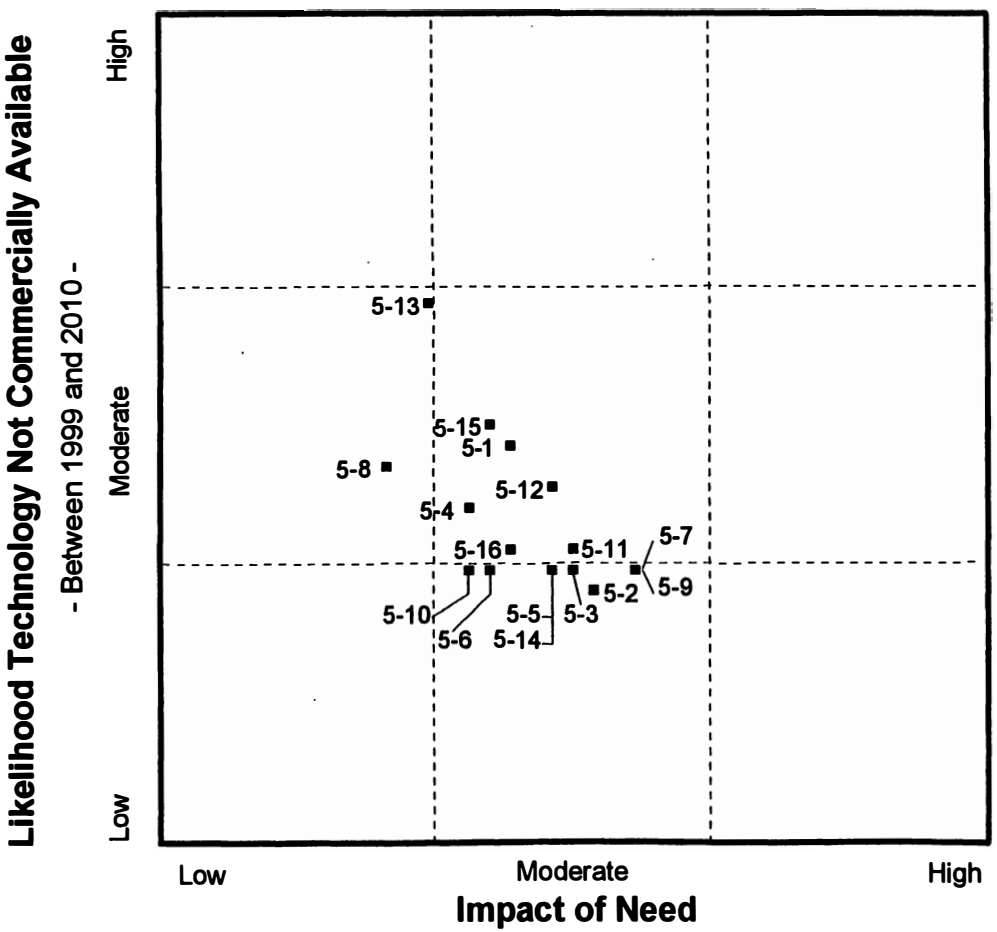


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	4.0	1.8	10
5-2	Extended reach drilling or production	4.3	1.7	20
5-3	Extended reach control systems	4.0	1.8	12
5-4	High pressure systems	3.2	1.4	9
5-5	Flowlines	4.3	2.2	12
5-6	Flow metering	4.2	2.4	13
5-7	Subsea equipment	4.2	2.1	15
5-8	External corrosion protection	2.8	2.8	10
5-9	Risers	4.2	2.7	14
5-10	ROV systems	3.4	2.4	10
5-11	Drilling	4.2	1.7	20
5-12	Workover	4.1	2.3	11
5-13	Water/gas injection	2.7	2.7	6
5-14	Hydrate prevention	4.3	1.9	11
5-15	Multi-phase pumps	4.3	2.6	11
5-16	Structures	3.9	2.3	11

Identification of Long-term R, D&D Targets

- Deepwater Offshore -

- all respondents -

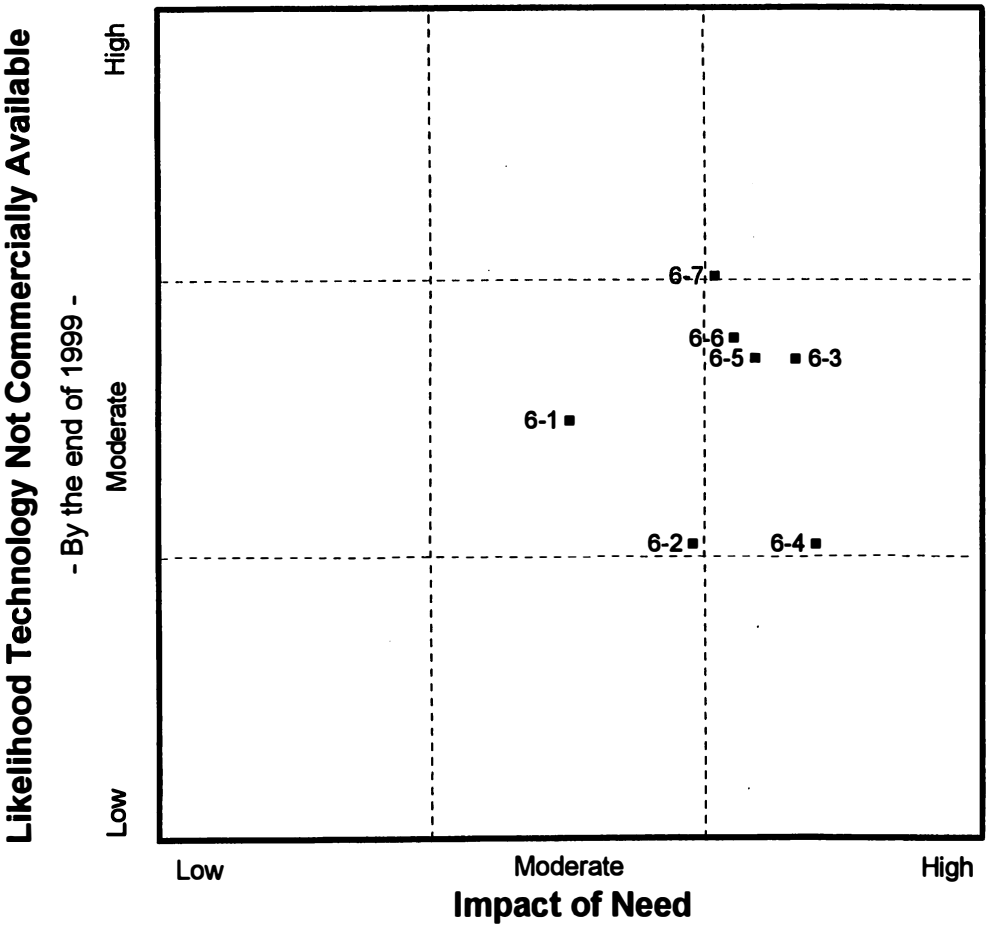


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	2.7	2.9	17
5-2	Extended reach drilling or production	3.1	2.2	13
5-3	Extended reach control systems	3.0	2.3	15
5-4	High pressure systems	2.5	2.6	15
5-5	Flowlines	2.9	2.3	15
5-6	Flow metering	2.6	2.3	15
5-7	Subsea equipment	3.3	2.3	15
5-8	External corrosion protection	2.1	2.8	12
5-9	Risers	3.3	2.3	12
5-10	ROV systems	2.5	2.3	15
5-11	Drilling	3.0	2.4	13
5-12	Workover	2.9	2.7	18
5-13	Water/gas injection	2.3	3.6	18
5-14	Hydrate prevention	2.9	2.3	16
5-15	Multi-phase pumps	2.6	3.0	14
5-16	Structures	2.7	2.4	14

Identification of Short-term R, D&D Targets

- Arctic Region Activities -

- all respondents -

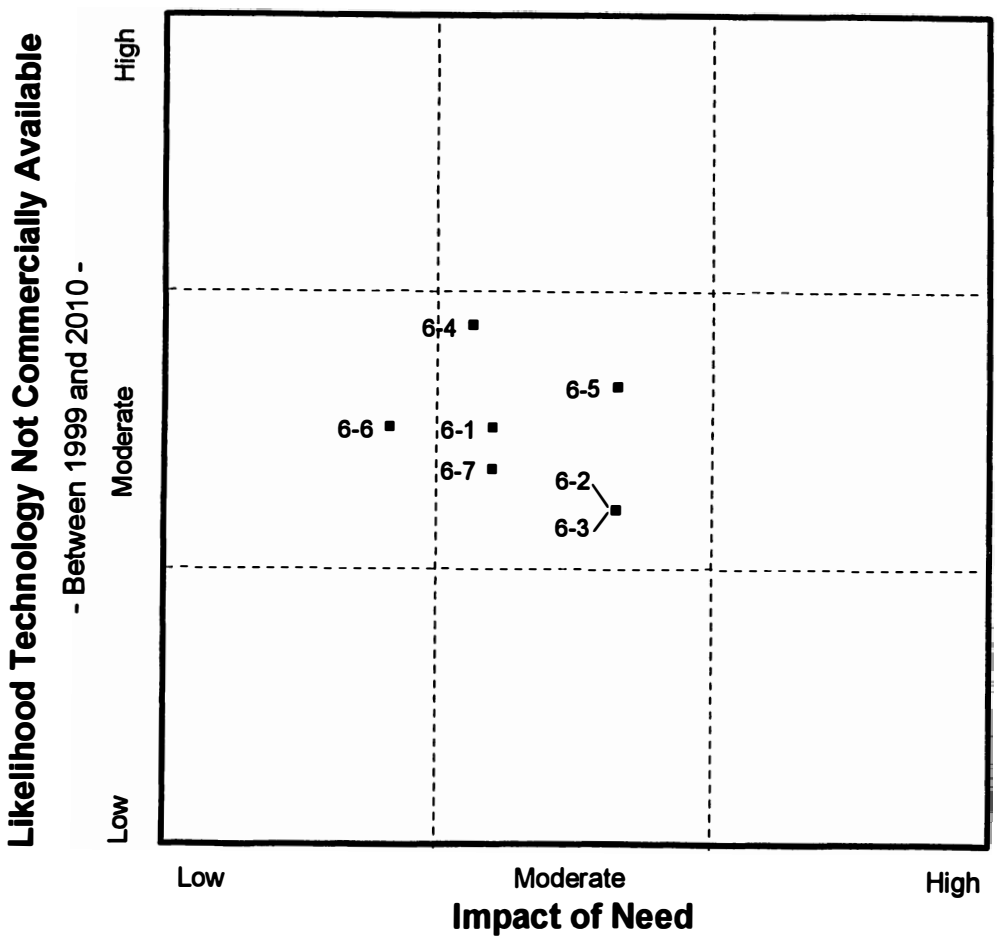


		Impact	Likeli-hood	n =
6-1	Transportation	3.0	3.0	7
6-2	Exploration	3.6	2.4	7
6-3	Development	4.1	3.3	7
6-4	Drilling	4.2	2.4	10
6-5	Production	3.9	3.3	7
6-6	Deepwater offshore activities	3.8	3.4	5
6-7	Mobile ice	3.7	3.7	6

Identification of Long-term R, D&D Targets

- Arctic Region Activities -

- all respondents -

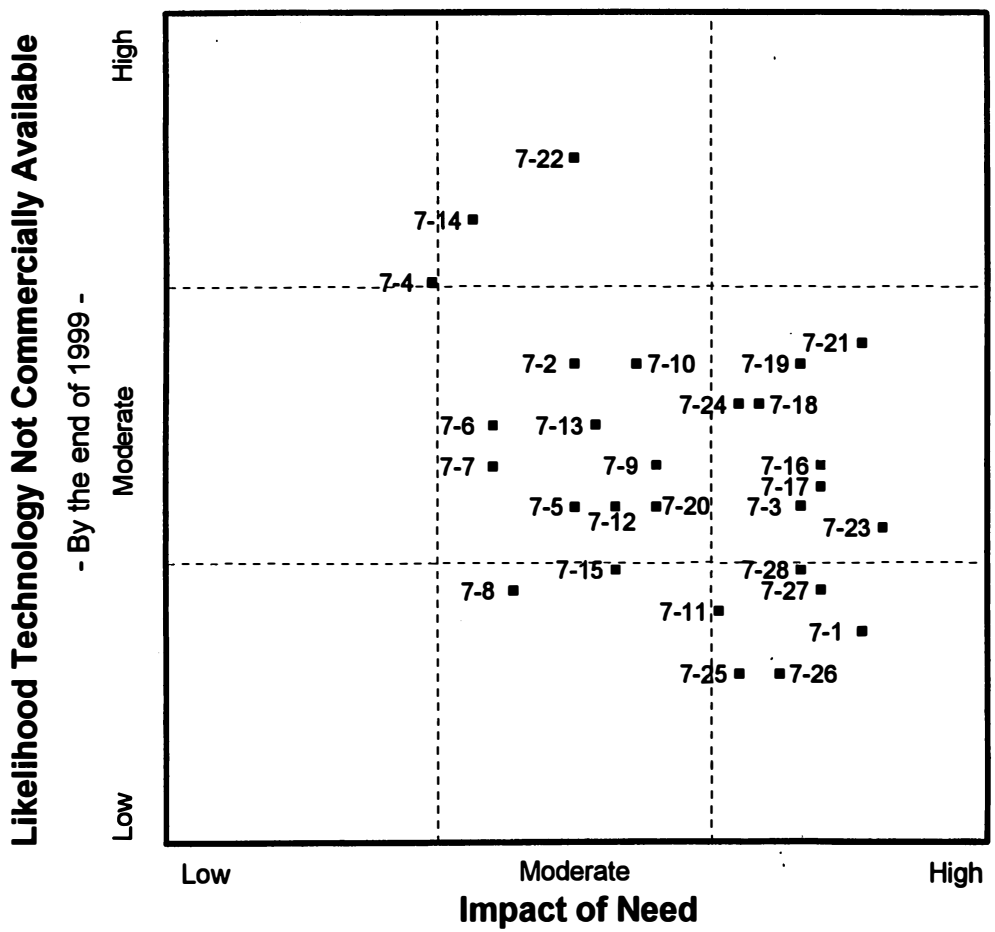


		Impact	Likeli-hood	n =
6-1	Transportation	2.6	3.0	10
6-2	Exploration	3.2	2.6	11
6-3	Development	3.2	2.6	9
6-4	Drilling	2.5	3.5	12
6-5	Production	3.2	3.2	11
6-6	Deepwater offshore activities	2.1	3.0	10
6-7	Mobile ice	2.6	2.8	10

Identification of Short-term R, D&D Targets

- Oil Processing and Refining -

- all respondents -

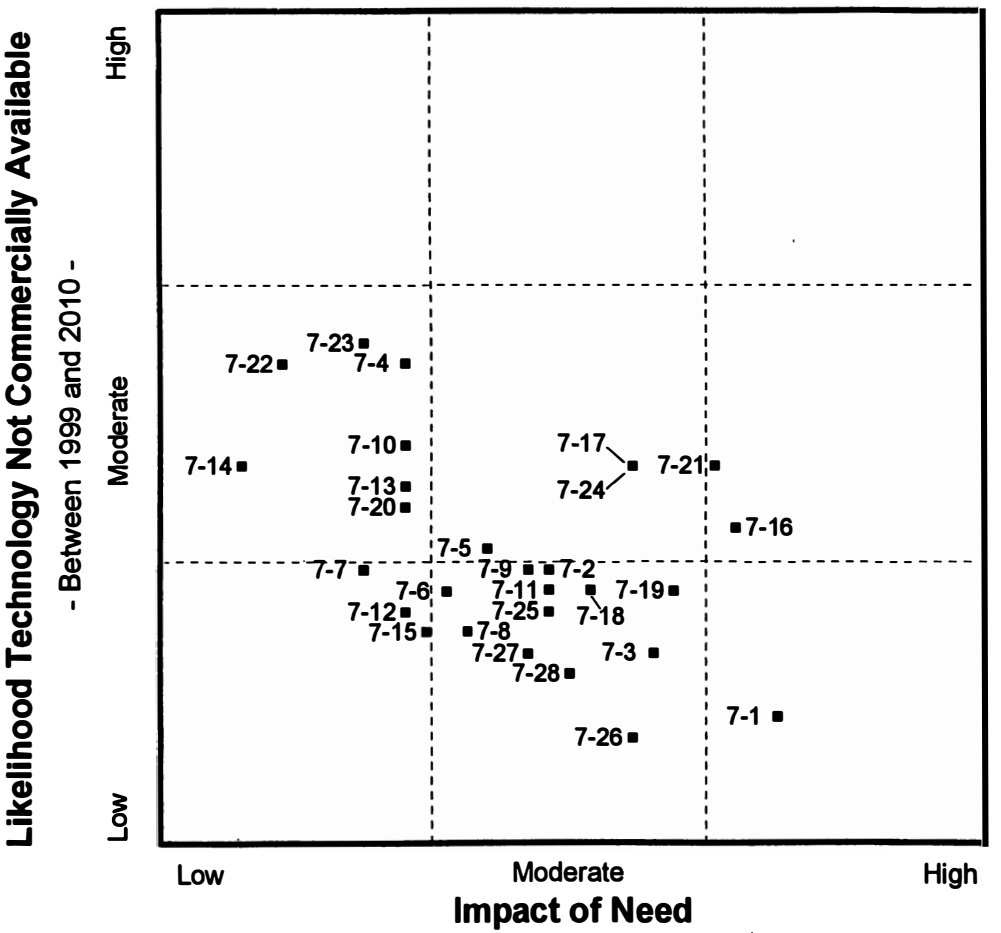


		Impact	Likeli-hood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	4.4	2.0	22
7-2	Hydrogen production and recovery	3.0	3.3	16
7-3	Plant and process reliability	4.1	2.6	19
7-4	Unconventional process technology	2.3	3.7	3
7-5	New materials of construction	3.0	2.6	5
7-6	Reactor engineering and modeling	2.6	3.0	10
7-7	Catalyst manufacturing technology	2.6	2.8	10
7-8	Risk assessment methodology	2.7	2.2	21
7-9	Solid acid catalysts	3.4	2.8	9
7-10	Alternatives to olefin alkylation process	3.3	3.3	8
7-11	Techniques for integration of environmental solutions into process and plant design	3.7	2.1	17
7-12	Improved on-line NDE inspection technology	3.2	2.6	17
7-13	Predicting useful remaining lifetimes of aging equipment	3.1	3.0	16
7-14	Robotics for safety applications	2.5	4.0	4
7-15	Worker safety systems	3.2	2.3	21
7-16	Energy efficiency of processes	4.2	2.8	21
7-17	Energy efficiency of equipment	4.2	2.7	19
7-18	Energy efficiency of separations	3.9	3.1	18
7-19	Separations technologies	4.1	3.3	14
7-20	Determining chemical composition of crudes, refinery intermediates, and products	3.4	2.6	14
7-21	New approaches to refining heavy feeds	4.4	3.4	10
7-22	Processing synthetic fuels	3.0	4.3	3
7-23	Conversion of methane to liquid fuels	4.5	2.5	4
7-24	Relating chemical compositions to process and product performance	3.8	3.1	15
7-25	Advanced computational modeling of processes/reactions	3.8	1.8	15
7-26	Advanced control and information systems	4.0	1.8	20
7-27	Performance characteristics of new hydrocarbon fuel compositions	4.2	2.2	10
7-28	Environmental characteristics of new hydrocarbon fuel compositions	4.1	2.3	14

Identification of Long-term R, D&D Targets

- Oil Processing and Refining -

- all respondents -

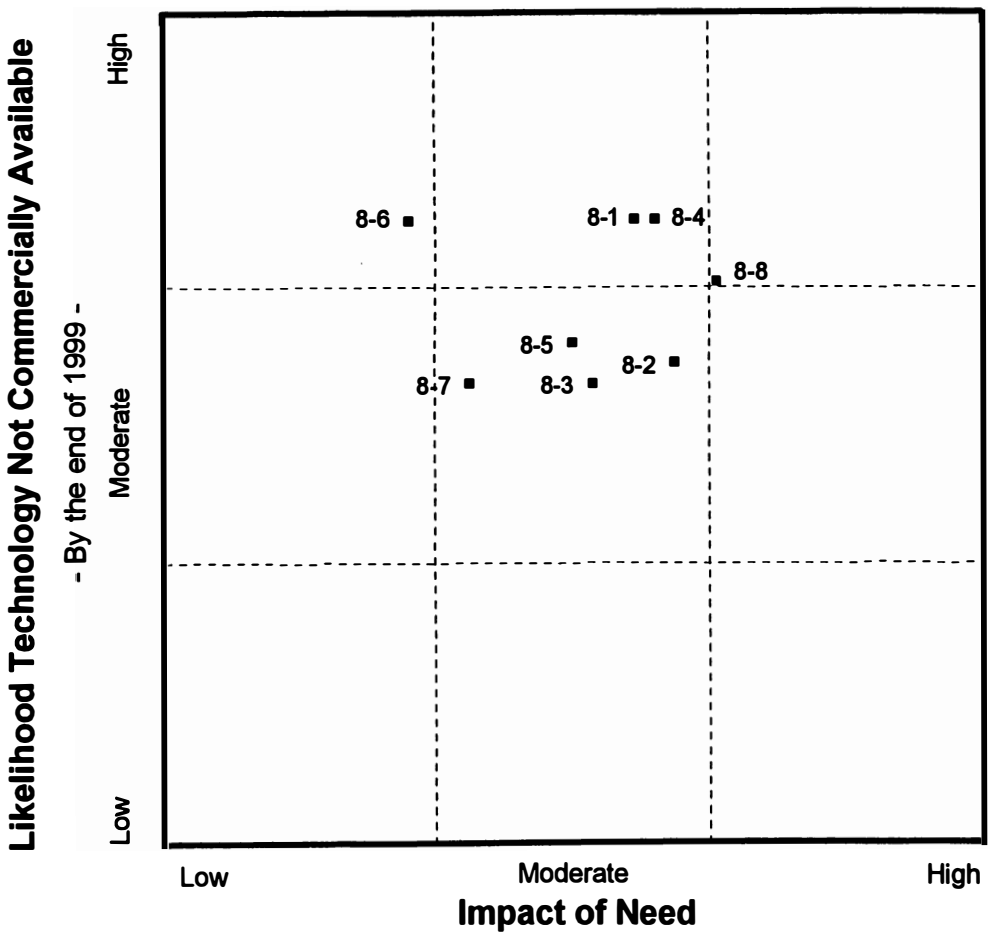


		Impact	Likeli-hood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	4.0	1.6	14
7-2	Hydrogen production and recovery	2.9	2.3	19
7-3	Plant and process reliability	3.4	1.9	17
7-4	Unconventional process technology	2.2	3.3	24
7-5	New materials of construction	2.6	2.4	25
7-6	Reactor engineering and modeling	2.4	2.2	20
7-7	Catalyst manufacturing technology	2.0	2.3	20
7-8	Risk assessment methodology	2.5	2.0	14
7-9	Solid acid catalysts	2.8	2.3	20
7-10	Alternatives to olefin alkylation process	2.2	2.9	22
7-11	Techniques for integration of environmental solutions into process and plant design	2.9	2.2	18
7-12	Improved on-line NDE inspection technology	2.2	2.1	13
7-13	Predicting useful remaining lifetimes of aging equipment	2.2	2.7	13
7-14	Robotics for safety applications	1.4	2.8	20
7-15	Worker safety systems	2.3	2.0	12
7-16	Energy efficiency of processes	3.8	2.5	15
7-17	Energy efficiency of equipment	3.3	2.8	16
7-18	Energy efficiency of separations	3.1	2.2	18
7-19	Separations technologies	3.5	2.2	21
7-20	Determining chemical composition of crudes, refinery intermediates, and products	2.2	2.6	16
7-21	New approaches to refining heavy feeds	3.7	2.8	21
7-22	Processing synthetic fuels	1.6	3.3	24
7-23	Conversion of methane to liquid fuels	2.0	3.4	25
7-24	Relating chemical compositions to process and product performance	3.3	2.8	16
7-25	Advanced computational modeling of processes/reactions	2.9	2.1	17
7-26	Advanced control and information systems	3.3	1.5	13
7-27	Performance characteristics of new hydrocarbon fuel compositions	2.8	1.9	18
7-28	Environmental characteristics of new hydrocarbon fuel compositions	3.0	1.8	16

Identification of Short-term R, D&D Targets

- Gas Processing -

- all respondents -

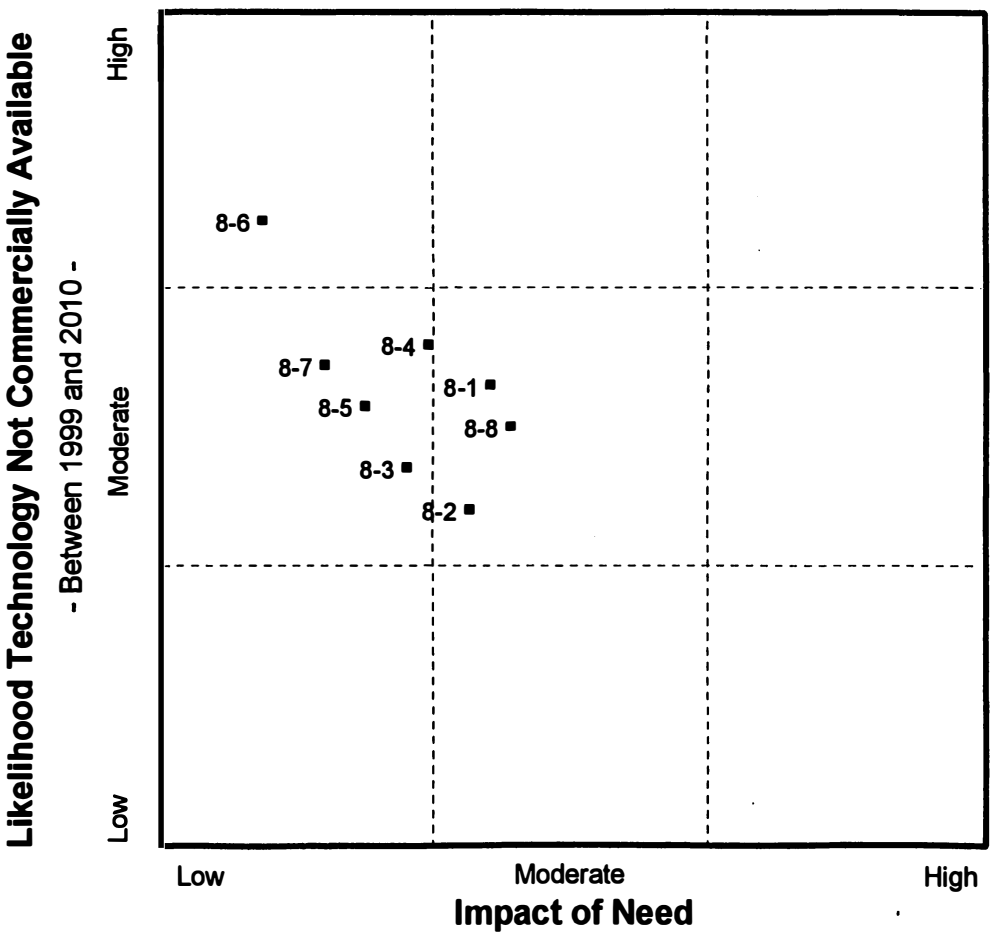


		Impact	Likeli-hood	n =
8-1	Gas dehydration	3.3	4.0	21
8-2	Acid gas removal	3.5	3.3	25
8-3	H_2S scavenger technology	3.1	3.2	23
8-4	Natural gas liquid separation	3.4	4.0	18
8-5	Nitrogen separation	3.0	3.4	17
8-6	Trace constituent (arsenic, Hg, etc.) removal	2.2	4.0	10
8-7	Sulfur recovery	2.5	3.2	13
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	3.7	3.7	23

Identification of Long-term R, D&D Targets

- Gas Processing-

- all respondents -

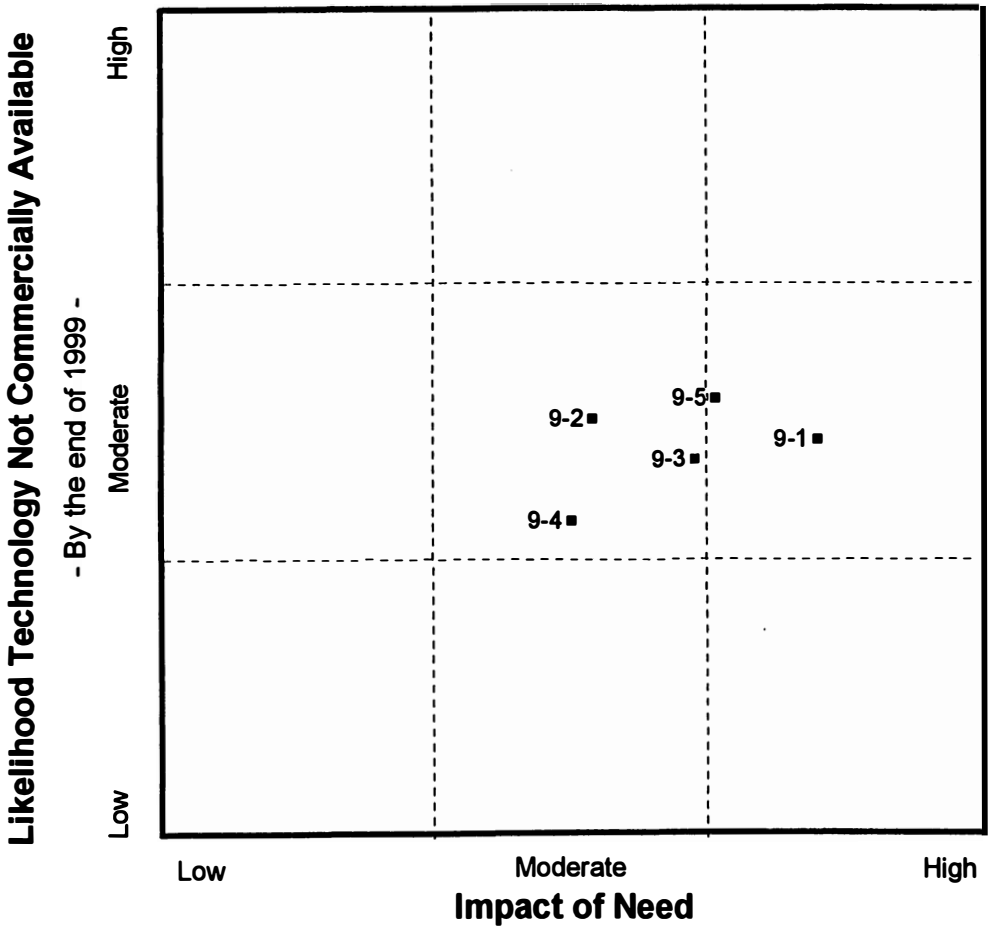


		Impact	Likeli-hood	n =
8-1	Gas dehydration	2.6	3.2	26
8-2	Acid gas removal	2.5	2.6	18
8-3	H_2S scavenger technology	2.2	2.8	22
8-4	Natural gas liquid separation	2.3	3.4	27
8-5	Nitrogen separation	2.0	3.1	24
8-6	Trace constituent (arsenic, Hg, etc.) removal	1.5	4.0	27
8-7	Sulfur recovery	1.8	3.3	26
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	2.7	3.0	21

Identification of Short-term R, D&D Targets

- Gas Gathering -

- all respondents -

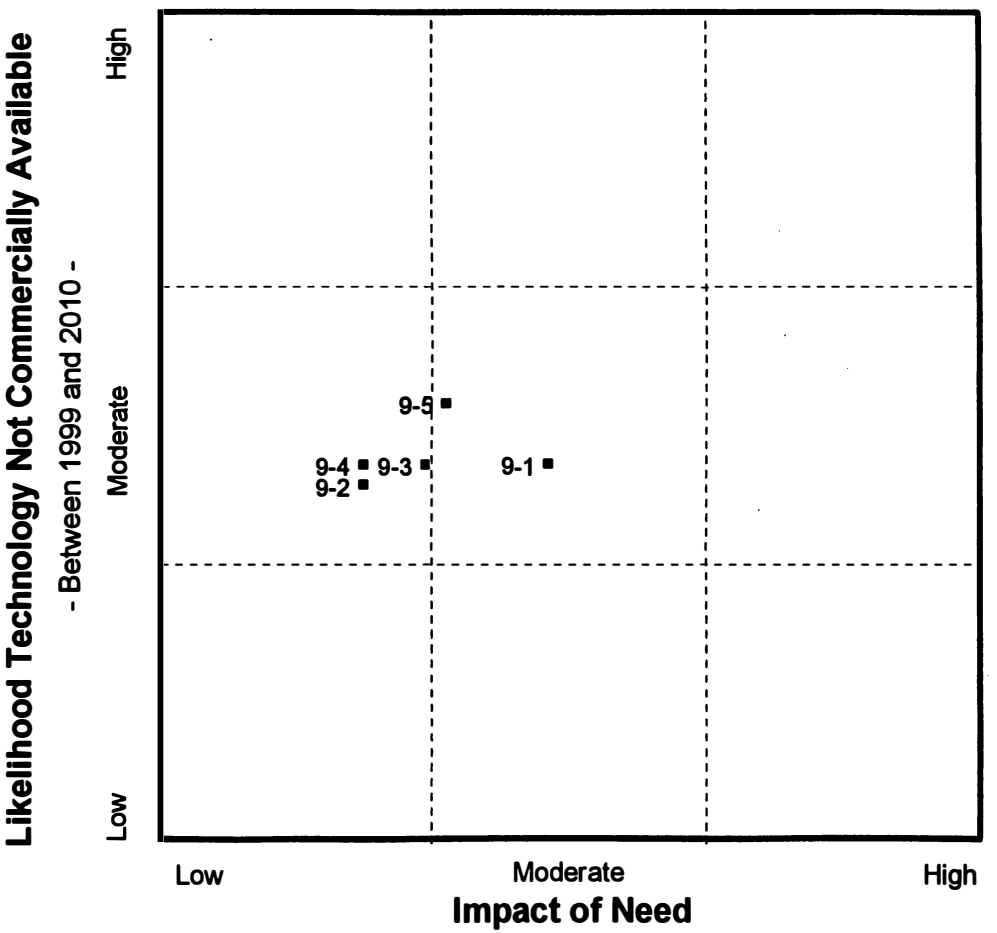


		Impact	Likeli-hood	n =
9-1	Compression	4.2	2.9	30
9-2	Leak detection	3.1	3.0	23
9-3	Plastic pipe (higher pressure rating)	3.6	2.8	20
9-4	High pressure measurement	3.0	2.5	13
9-5	Multi-phase metering	3.7	3.1	19

Identification of Long-term R, D&D Targets

- Gas Gathering -

- all respondents -

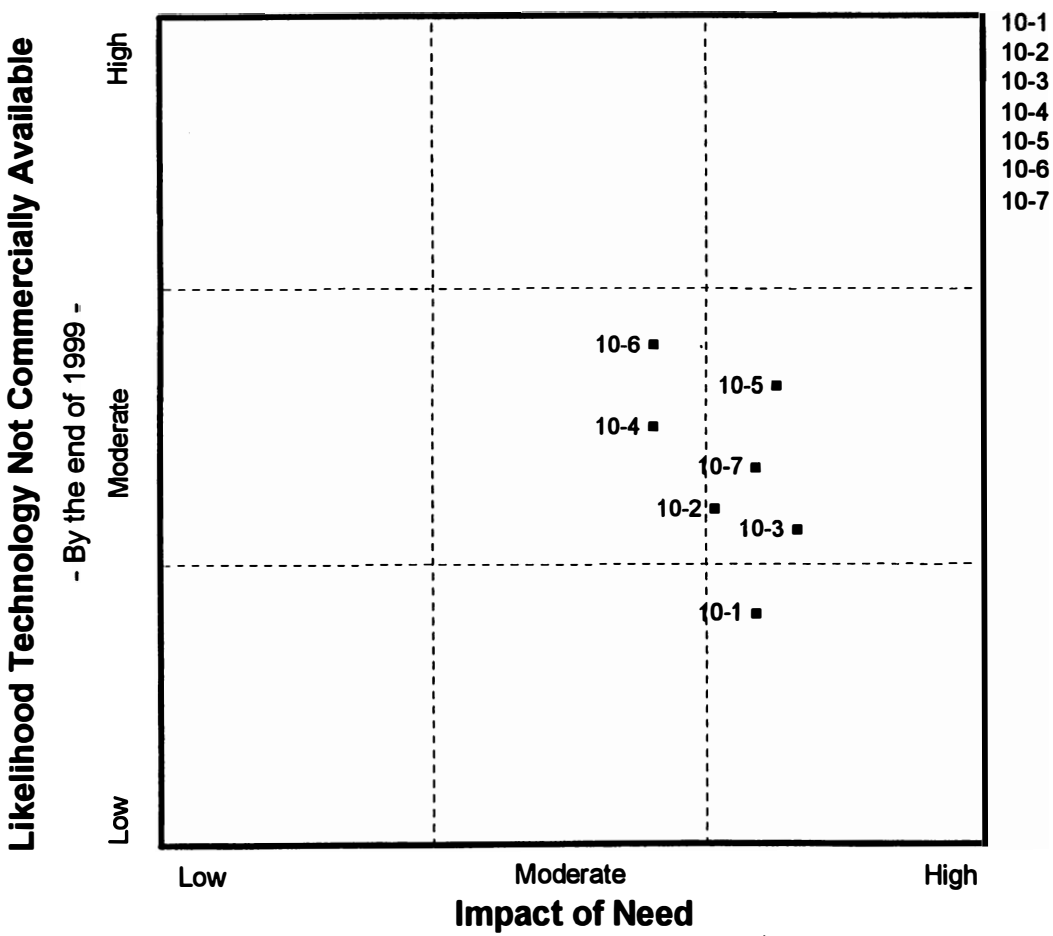


		Impact	Likeli-hood	n =
9-1	Compression	2.9	2.8	19
9-2	Leak detection	2.0	2.7	18
9-3	Plastic pipe (higher pressure rating)	2.3	2.8	19
9-4	High pressure measurement	2.0	2.8	28
9-5	Multi-phase metering	2.4	3.1	24

Identification of Short-term R, D&D Targets

- Gas Storage -

- all respondents -

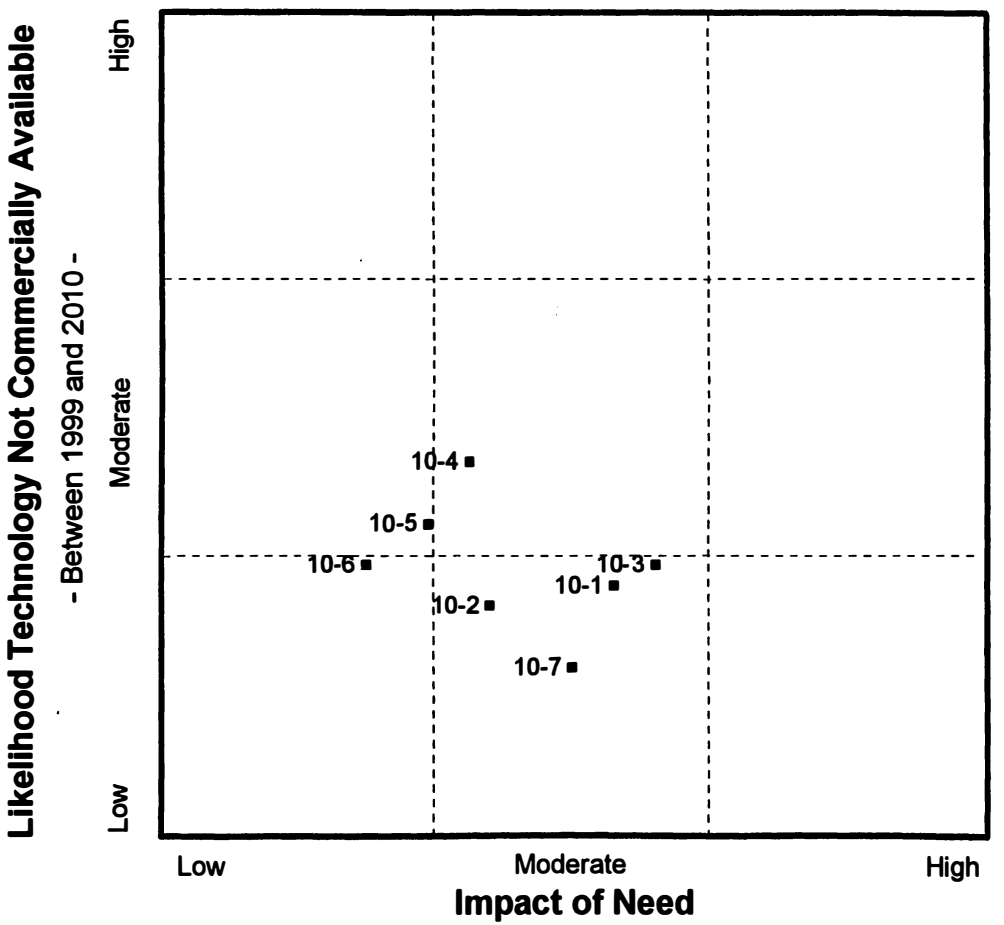


		Impact	Likeli-hood	n =
10-1	Well deliverability restoration	3.9	2.1	13
10-2	Leak detection and mitigation	3.7	2.6	9
10-3	Reservoir management	4.1	2.5	11
10-4	Gas migration control	3.4	3.0	9
10-5	Base gas minimization techniques	4.0	3.2	9
10-6	Inert base gas research	3.4	3.4	5
10-7	Unconventional development techniques	3.9	2.8	9

Identification of Long-term R, D&D Targets

- Gas Storage -

- all respondents -

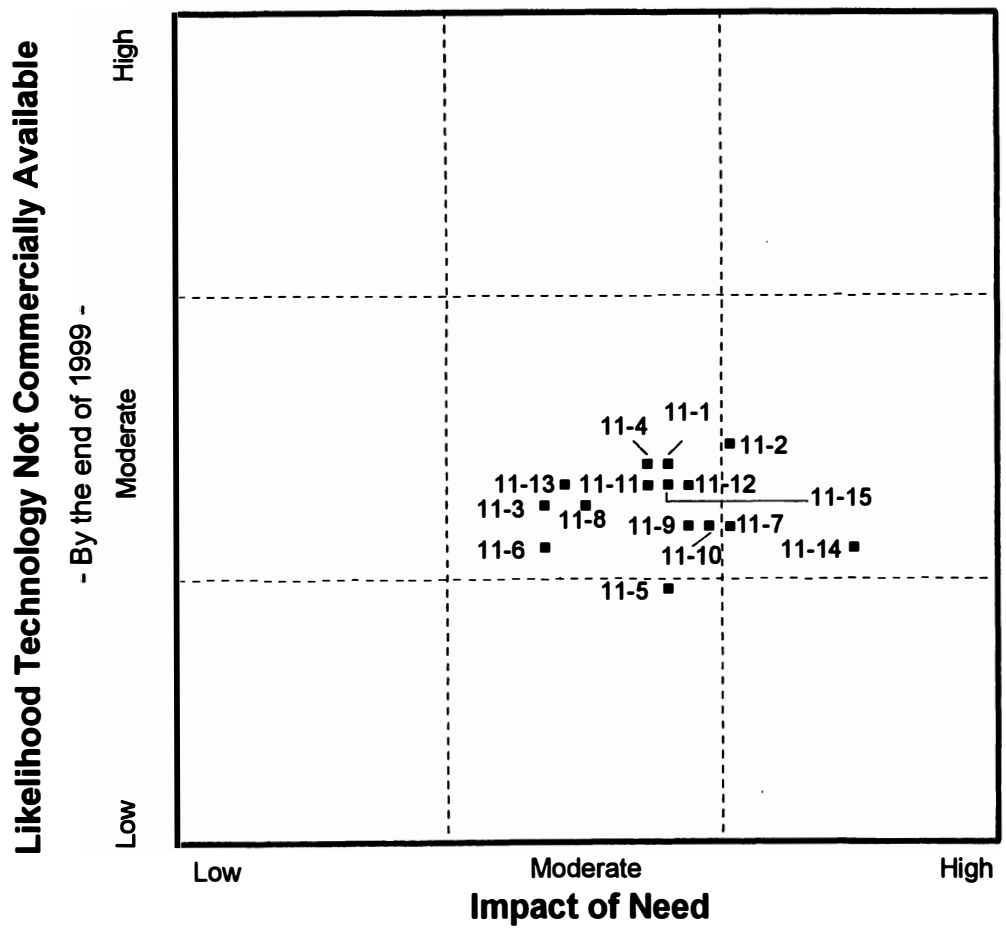


		Impact	Likelihood	n =
10-1	Well deliverability restoration	3.2	2.2	10
10-2	Leak detection and mitigation	2.6	2.1	11
10-3	Reservoir management	3.4	2.3	9
10-4	Gas migration control	2.5	2.8	12
10-5	Base gas minimization techniques	2.3	2.5	8
10-6	Inert base gas research	2.0	2.3	14
10-7	Unconventional development techniques	3.0	1.8	12

Identification of Short-term R, D&D Targets

-Environmental and Regulatory -

- all respondents -

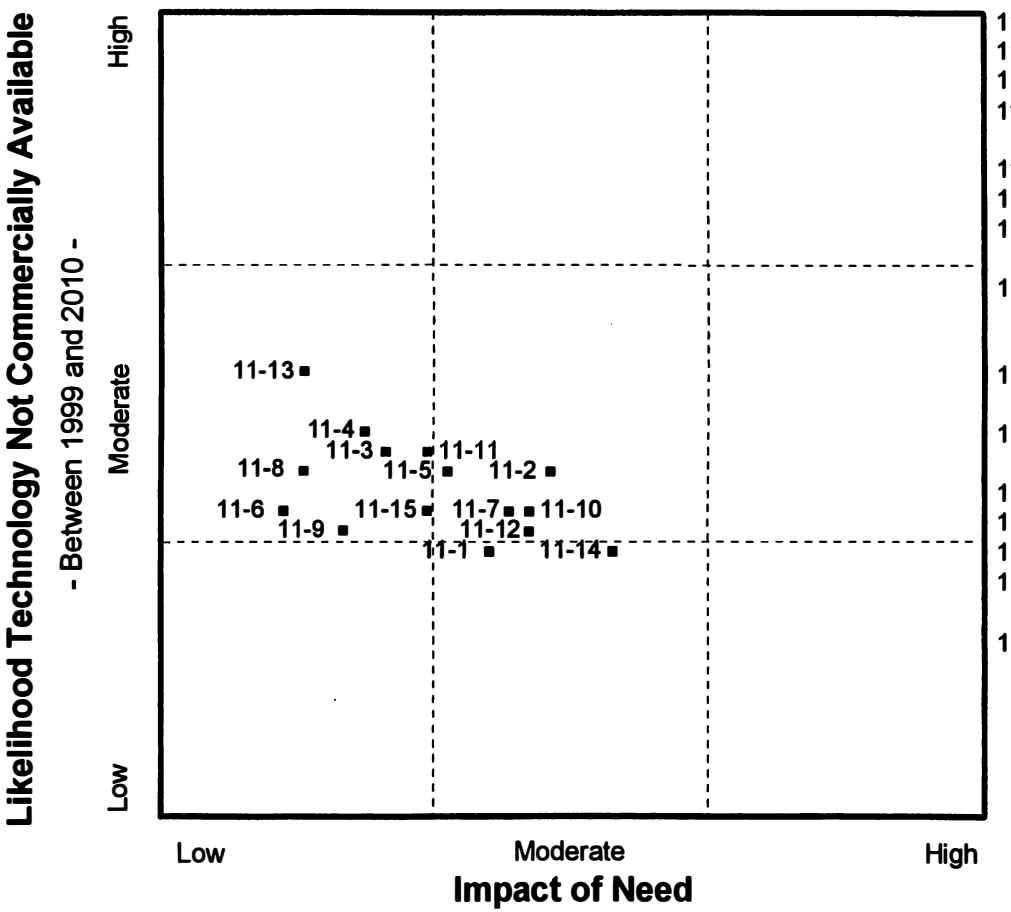


		Impact	Likeli-hood	n =
11-1	Disposal methods for drilling fluids	3.4	2.8	46
11-2	Treatment and disposal of produced fluids	3.7	2.9	43
11-3	Screening procedures for injection wells	2.8	2.6	27
11-4	Risk and reclamation analysis of disposal methods	3.3	2.8	41
11-5	Leak detection	3.4	2.2	40
11-6	Hydrological modeling	2.8	2.4	19
11-7	Compliance with CAAA stationary source issue	3.7	2.5	48
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	3.0	2.6	28
11-9	Model transport and remediation of contaminants in ground water and soils	3.5	2.5	31
11-10	Effluent and emission monitoring, minimization, and control	3.6	2.5	43
11-11	Recycling of waste and byproduct streams	3.3	2.7	29
11-12	Remediation technology	3.5	2.7	39
11-13	Catalyst recycling	2.9	2.7	19
11-14	Provide scientific basis for risk-based regulation	4.3	2.4	49
11-15	NORM disposal	3.4	2.7	44

Identification of Long-term R, D&D Targets

-Environmental and Regulatory -

- all respondents -

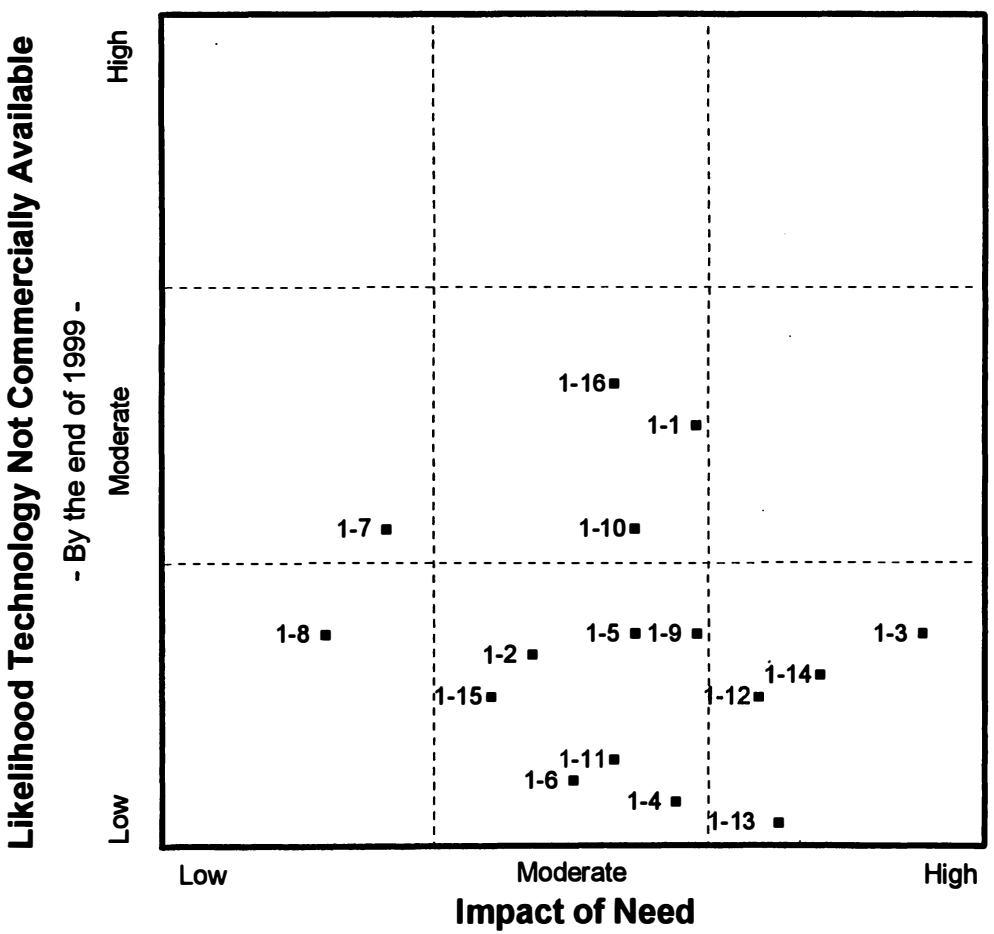


		Impact	Likeli-hood	n =
11-1	Disposal methods for drilling fluids	2.6	2.3	29
11-2	Treatment and disposal of produced fluids	2.9	2.7	30
11-3	Screening procedures for injection wells	2.1	2.8	38
11-4	Risk and reclamation analysis of disposal methods	2.0	2.9	28
11-5	Leak detection	2.4	2.7	37
11-6	Hydrological modeling	1.6	2.5	48
11-7	Compliance with CAAA stationary source issue	2.7	2.5	30
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	1.7	2.7	43
11-9	Model transport and remediation of contaminants in ground water and soils	1.9	2.4	41
11-10	Effluent and emission monitoring, minimization, and control	2.8	2.5	35
11-11	Recycling of waste and byproduct streams	2.3	2.8	43
11-12	Remediation technology	2.8	2.4	41
11-13	Catalyst recycling	1.7	3.2	49
11-14	Provide scientific basis for risk-based regulation	3.2	2.3	35
11-15	NORM disposal	2.3	2.5	27

Identification of Short-term R, D&D Targets

- Exploration -

- majors -

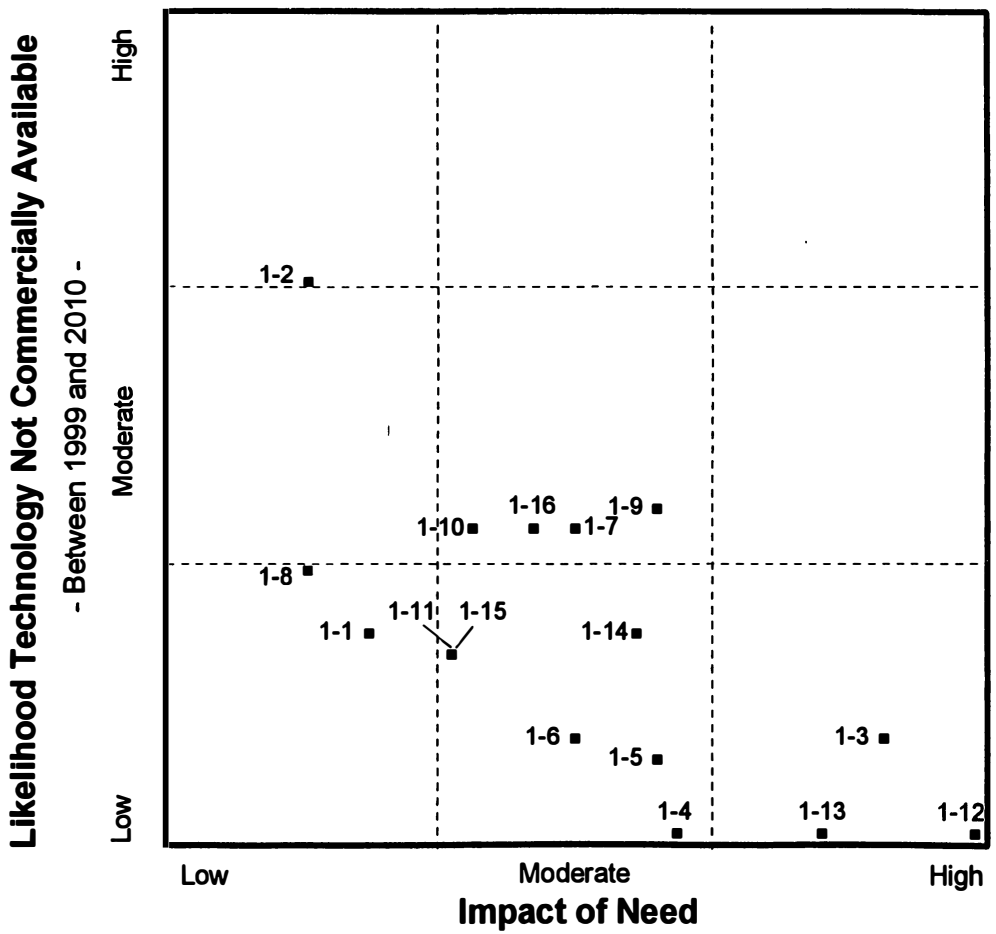


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	3.6	3.0	10
1-2	Risk assessment methods	2.8	1.9	11
1-3	High-resolution seismic depth imaging	4.7	2.0	14
1-4	Specialized seismic processing	3.5	1.2	12
1-5	Sequence stratigraphy techniques	3.3	2.0	14
1-6	Workstation seismic modeling	3.0	1.3	14
1-7	Geochemical analysis	2.1	2.5	13
1-8	Airborne/satellite remote sensing	1.8	2.0	8
1-9	Fault seal analysis	3.6	2.0	14
1-10	Multi-component seismic techniques	3.3	2.5	8
1-11	3D Paleostructural restoration	3.2	1.4	11
1-12	Amplitude versus offset (AVO) in 3D	3.9	1.7	15
1-13	3D Visualization tools	4.0	1.1	14
1-14	Advanced seismic acquisition	4.2	1.8	12
1-15	Geographic information systems	2.6	1.7	9
1-16	Geophysical fracture-detection methods	3.2	3.2	11

Identification of Long-term R, D&D Targets

- Exploration -

- majors -

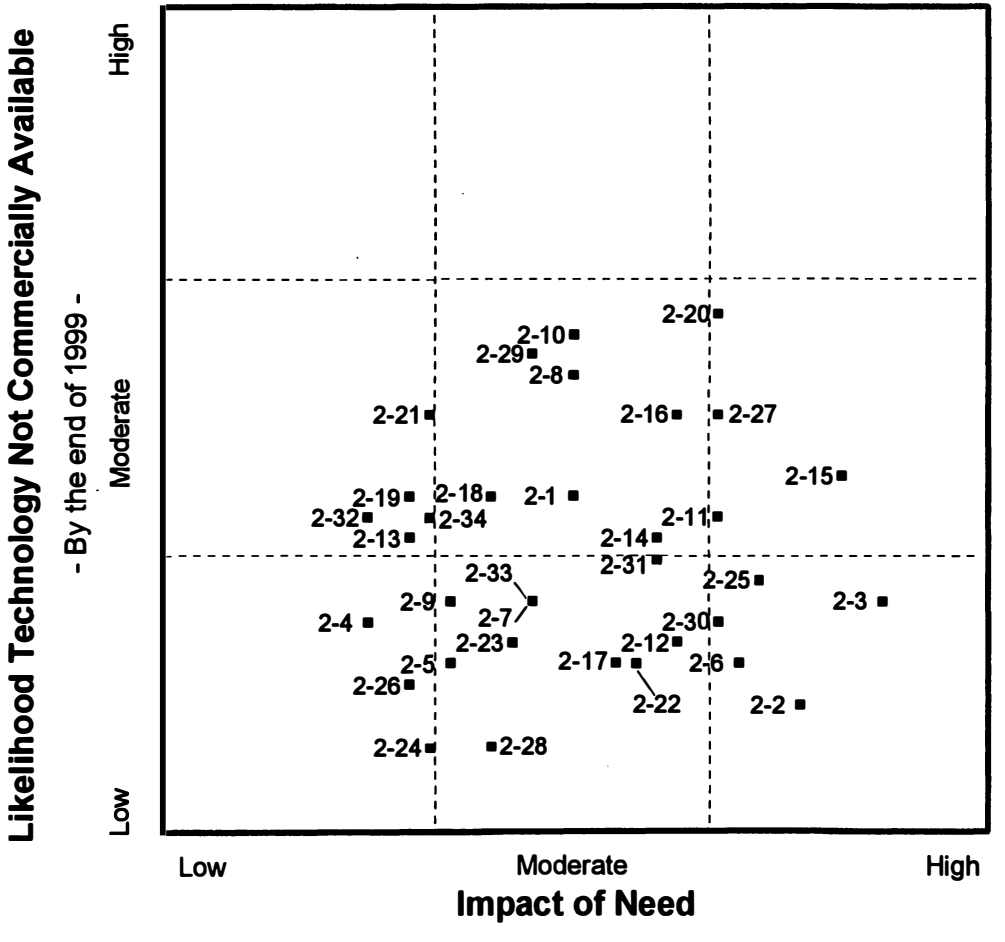


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	2.0	2.0	6
1-2	Risk assessment methods	1.7	3.7	3
1-3	High-resolution seismic depth imaging	4.5	1.5	8
1-4	Specialized seismic processing	3.5	1.0	8
1-5	Sequence stratigraphy techniques	3.4	1.4	5
1-6	Workstation seismic modeling	3.0	1.5	4
1-7	Geochemical analysis	3.0	2.5	4
1-8	Airborne/satellite remote sensing	1.7	2.3	9
1-9	Fault seal analysis	3.4	2.6	5
1-10	Multi-component seismic techniques	2.5	2.5	12
1-11	3D Paleostructural restoration	2.4	1.9	7
1-12	Amplitude versus offset (AVO) in 3D	5.0	1.0	1
1-13	3D Visualization tools	4.2	1.0	5
1-14	Advanced seismic acquisition	3.3	2.0	6
1-15	Geographic information systems	2.4	1.9	7
1-16	Geophysical fracture-detection methods	2.8	2.5	8

Identification of Short-term R, D&D Targets

- Development -

- majors -

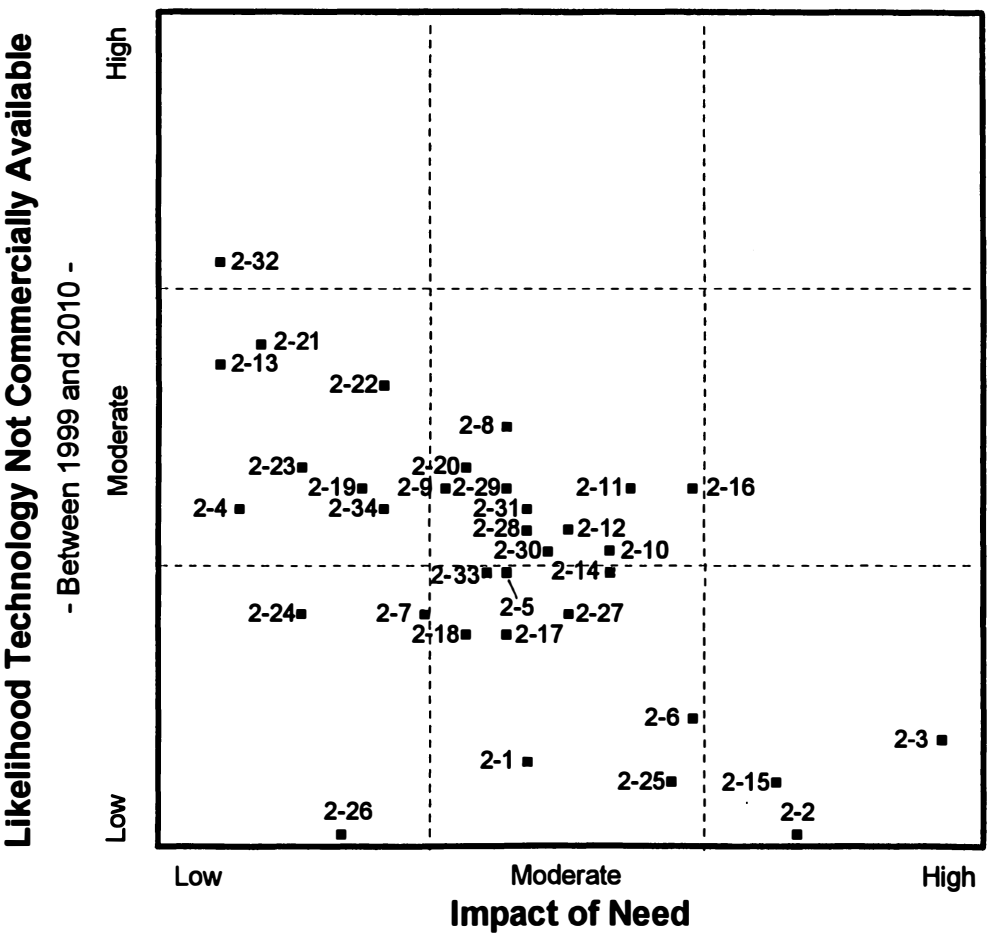


		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	3.0	2.6	9
2-2	Computer-based 3-D geological modeling	4.1	1.6	13
2-3	Development-scale seismic applications	4.5	2.1	13
2-4	Tracers (biologic/chemical/radioactive)	2.0	2.0	8
2-5	Core analysis/imaging	2.4	1.8	10
2-6	Geostatistical reservoir descriptions	3.8	1.8	12
2-7	Outcrop analog studies	2.8	2.1	9
2-8	Fluid-rock interaction	3.0	3.2	12
2-9	Rock physics	2.4	2.1	7
2-10	Cross-well geophysical imaging	3.0	3.4	9
2-11	Advanced attribute processing	3.7	2.5	12
2-12	Seismic/log/core calibration	3.5	1.9	13
2-13	Cuttings analysis	2.2	2.4	10
2-14	Reservoir property identification	3.4	2.4	10
2-15	Through casing logging	4.3	2.7	14
2-16	Deep investigation techniques	3.5	3.0	11
2-17	High resolution borehole imaging logs	3.2	1.8	12
2-18	Specialized core analysis	2.6	2.6	9
2-19	Characterization of rock wettability	2.2	2.6	5
2-20	Permeability logging techniques	3.7	3.5	11
2-21	Tracer techniques	2.3	3.0	8
2-22	CT scanning and NMR imaging	3.3	1.8	8
2-23	Formation water chemistry	2.7	1.9	7
2-24	Fluid sampling and analysis	2.3	1.4	9
2-25	Advanced reservoir simulation modeling	3.9	2.2	13
2-26	Workstation single well simulations	2.2	1.7	12
2-27	Procedures for data scale-up	3.7	3.0	12
2-28	Expert systems applications	2.6	1.4	5
2-29	Time lapse seismic imaging	2.8	3.3	8
2-30	Advanced monitoring of EOR processes	3.7	2.0	6
2-31	Advanced well testing and interpretation	3.4	2.3	11
2-32	Material balance applications	2.0	2.5	8
2-33	Decision and risk analysis	2.8	2.1	9
2-34	Expendable well bore instrumentation	2.3	2.5	8

Identification of Long-term R, D&D Targets

- Development -

- majors -

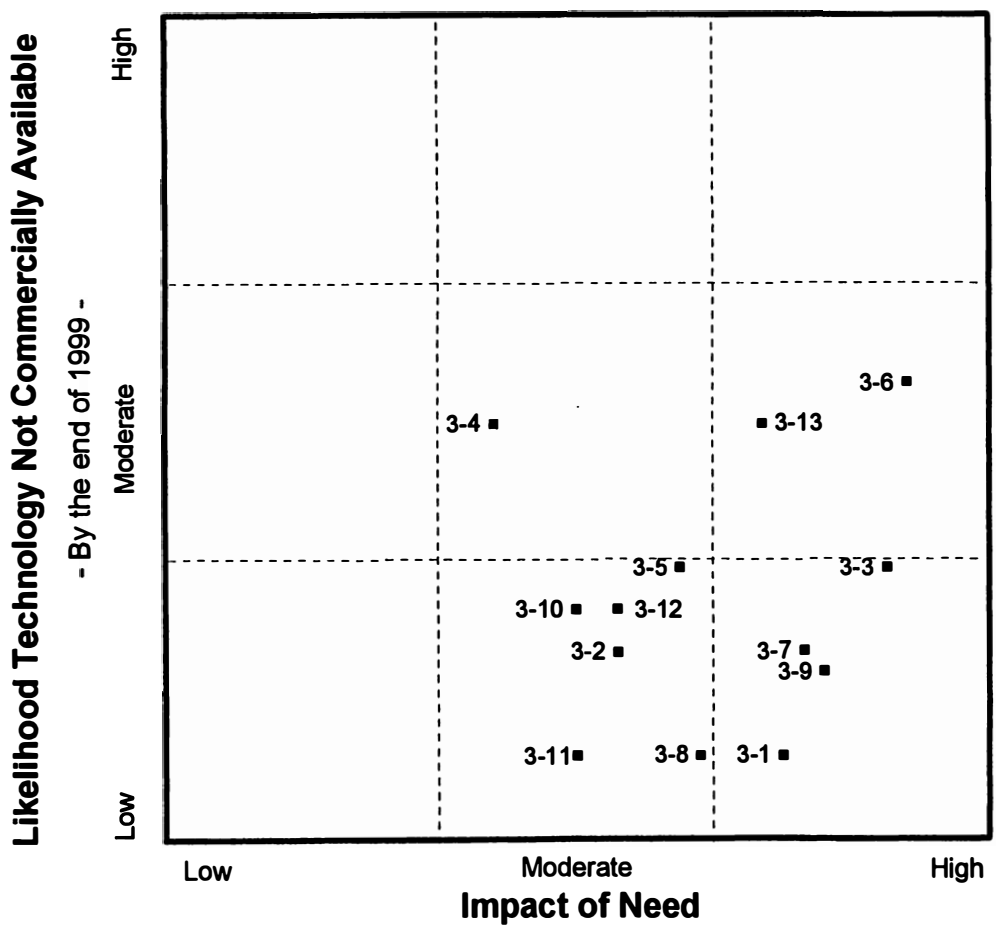


		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	2.8	1.4	9
2-2	Computer-based 3-D geological modeling	4.1	1.0	7
2-3	Development-scale seismic applications	4.8	1.5	8
2-4	Tracers (biologic/chemical/radioactive)	1.4	2.6	9
2-5	Core analysis/imaging	2.7	2.3	6
2-6	Geostatistical reservoir descriptions	3.6	1.6	7
2-7	Outcrop analog studies	2.3	2.1	9
2-8	Fluid-rock interaction	2.7	3.0	6
2-9	Rock physics	2.4	2.7	13
2-10	Cross-well geophysical imaging	3.2	2.4	10
2-11	Advanced attribute processing	3.3	2.7	7
2-12	Seismic/log/core calibration	3.0	2.5	4
2-13	Cuttings analysis	1.3	3.3	6
2-14	Reservoir property identification	3.2	2.3	9
2-15	Through casing logging	4.0	1.3	6
2-16	Deep investigation techniques	3.6	2.7	7
2-17	High resolution borehole imaging logs	2.7	2.0	6
2-18	Specialized core analysis	2.5	2.0	10
2-19	Characterization of rock wettability	2.0	2.7	12
2-20	Permeability logging techniques	2.5	2.8	8
2-21	Tracer techniques	1.5	3.4	11
2-22	CT scanning and NMR imaging	2.1	3.2	9
2-23	Formation water chemistry	1.7	2.8	10
2-24	Fluid sampling and analysis	1.7	2.1	9
2-25	Advanced reservoir simulation modeling	3.5	1.3	8
2-26	Workstation single well simulations	1.9	1.0	7
2-27	Procedures for data scale-up	3.0	2.1	9
2-28	Expert systems applications	2.8	2.5	13
2-29	Time lapse seismic imaging	2.7	2.7	12
2-30	Advanced monitoring of EOR processes	2.9	2.4	14
2-31	Advanced well testing and interpretation	2.8	2.6	9
2-32	Material balance applications	1.3	3.8	8
2-33	Decision and risk analysis	2.6	2.3	9
2-34	Expendable well bore instrumentation	2.1	2.6	11

Identification of Short-term R, D&D Targets

- Drilling and Completion -

- majors -

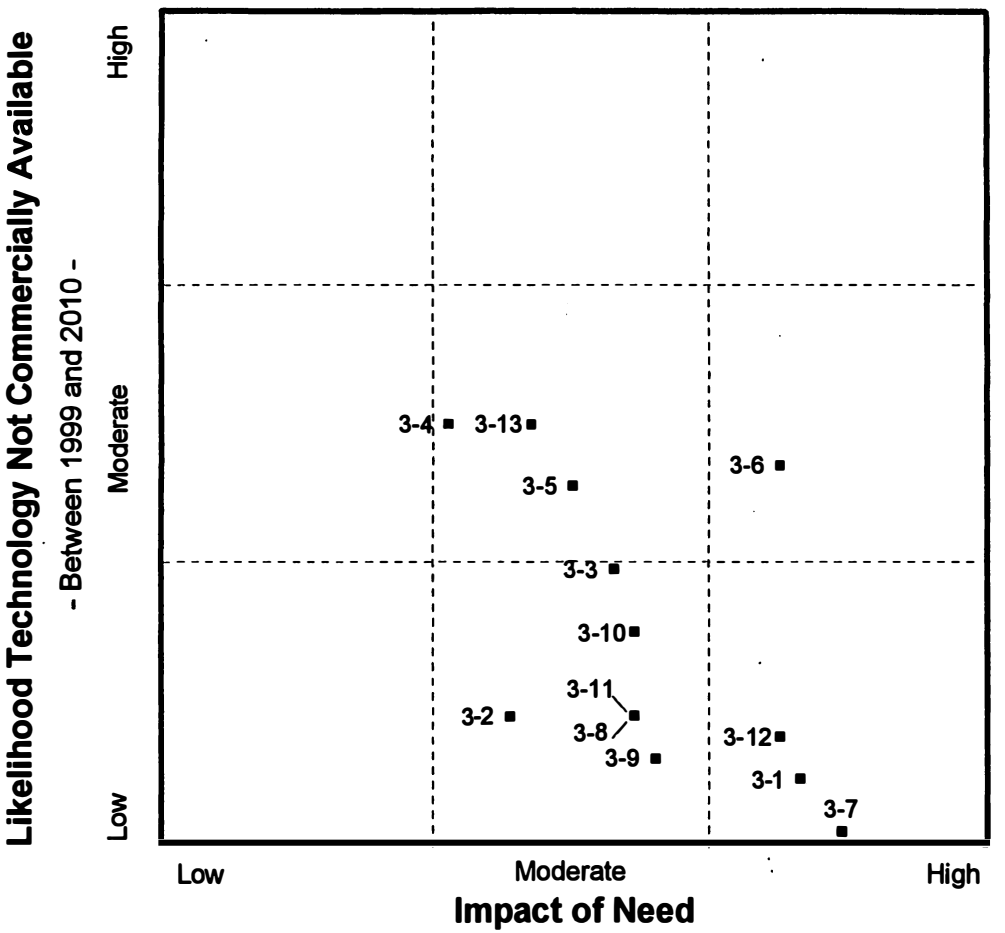


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	4.0	1.4	14
3-2	Drilling fluid design	3.2	1.9	11
3-3	Advanced fracture techniques	4.5	2.3	11
3-4	Cementing	2.6	3.0	11
3-5	Perforating and well bore cleanup	3.5	2.3	12
3-6	Well productivity	4.6	3.2	10
3-7	Multilateral technology	4.1	1.9	13
3-8	Innovative bit and tubular technology	3.6	1.4	10
3-9	Slim hole drilling	4.2	1.8	12
3-10	Under balanced drilling	3.0	2.1	11
3-11	Measurements while drilling	3.0	1.4	9
3-12	Coiled tubing drilling	3.2	2.1	11
3-13	Unconventional drilling technology	3.9	3.0	7

Identification of Long-term R, D&D Targets

- Drilling and Completion -

- majors -

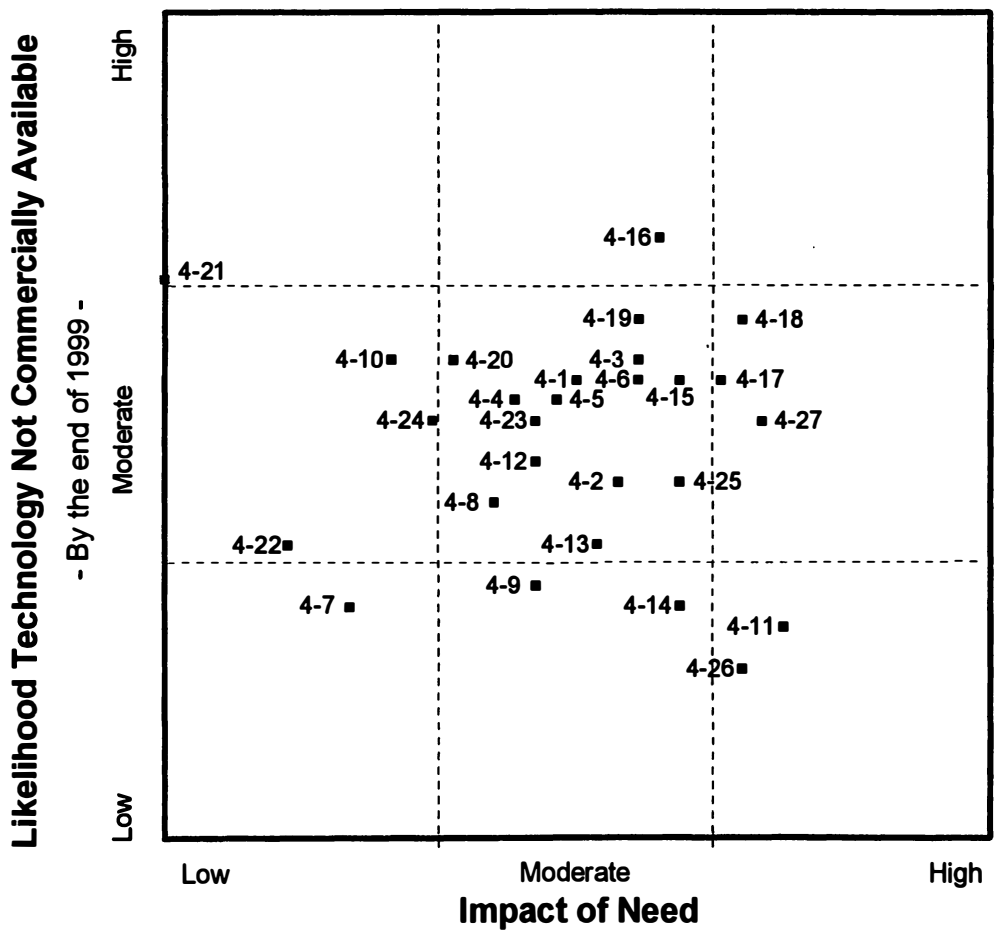


		Impact	Likelihood	n =
3-1	Horizontal well bore applications	4.1	1.3	7
3-2	Drilling fluid design	2.7	1.6	7
3-3	Advanced fracture techniques	3.2	2.3	9
3-4	Cementing	2.4	3.0	7
3-5	Perforating and well bore cleanup	3.0	2.7	6
3-6	Well productivity	4.0	2.8	10
3-7	Multilateral technology	4.3	1.0	7
3-8	Innovative bit and tubular technology	3.3	1.6	7
3-9	Slim hole drilling	3.4	1.4	9
3-10	Under balanced drilling	3.3	2.0	8
3-11	Measurements while drilling	3.3	1.6	7
3-12	Coiled tubing drilling	4.0	1.5	8
3-13	Unconventional drilling technology	2.8	3.0	12

Identification of Short-term R, D&D Targets

- Production -

- majors -

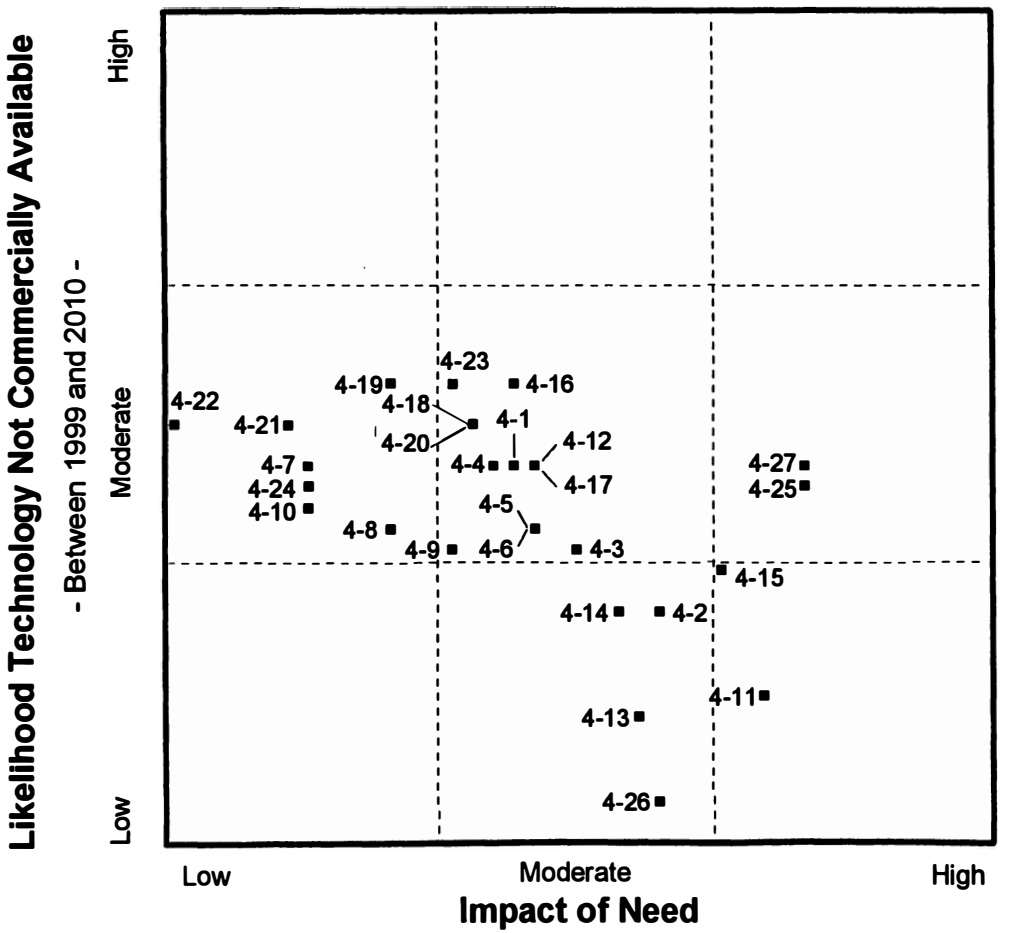


		Impact	Likeli-hood	n =
4-1	Injection water treatment	3.0	3.2	11
4-2	Produced water treatment	3.2	2.7	13
4-3	Corrosion control	3.3	3.3	14
4-4	Scaling inhibitors	2.7	3.1	14
4-5	Paraffin control/removal	2.9	3.1	14
4-6	Oil/water/gas/separation	3.3	3.2	12
4-7	Beam pump analysis	1.9	2.1	9
4-8	Gas lift analysis	2.6	2.6	10
4-9	Submersible pump analysis	2.8	2.2	10
4-10	Rod/tubing wear evaluation	2.1	3.3	13
4-11	Stimulation techniques	4.0	2.0	14
4-12	Gas compression techniques	2.8	2.8	11
4-13	Recompletion techniques	3.1	2.4	14
4-14	Remote control and data analysis	3.5	2.1	13
4-15	Compact processing on offshore platforms	3.5	3.2	11
4-16	Modification of reservoir fluid mobilities	3.4	3.9	9
4-17	Miscible contact/displacement	3.7	3.2	9
4-18	Viscosity reduction of heavy oils	3.8	3.5	8
4-19	In situ generation of foams/emulsions	3.3	3.5	8
4-20	Thickeners for CO_2 floods	2.4	3.3	7
4-21	Microbial EOR processes	1.0	3.7	3
4-22	High-velocity gas flow modeling	1.6	2.4	7
4-23	Thermal processes	2.8	3.0	9
4-24	Combustion processes	2.3	3.0	6
4-25	Near well bore stimulation	3.5	2.7	15
4-26	New directional drilling	3.8	1.8	13
4-27	Advanced recovery of natural gas	3.9	3.0	13

Identification of Long-term R, D&D Targets

- Production -

- majors -

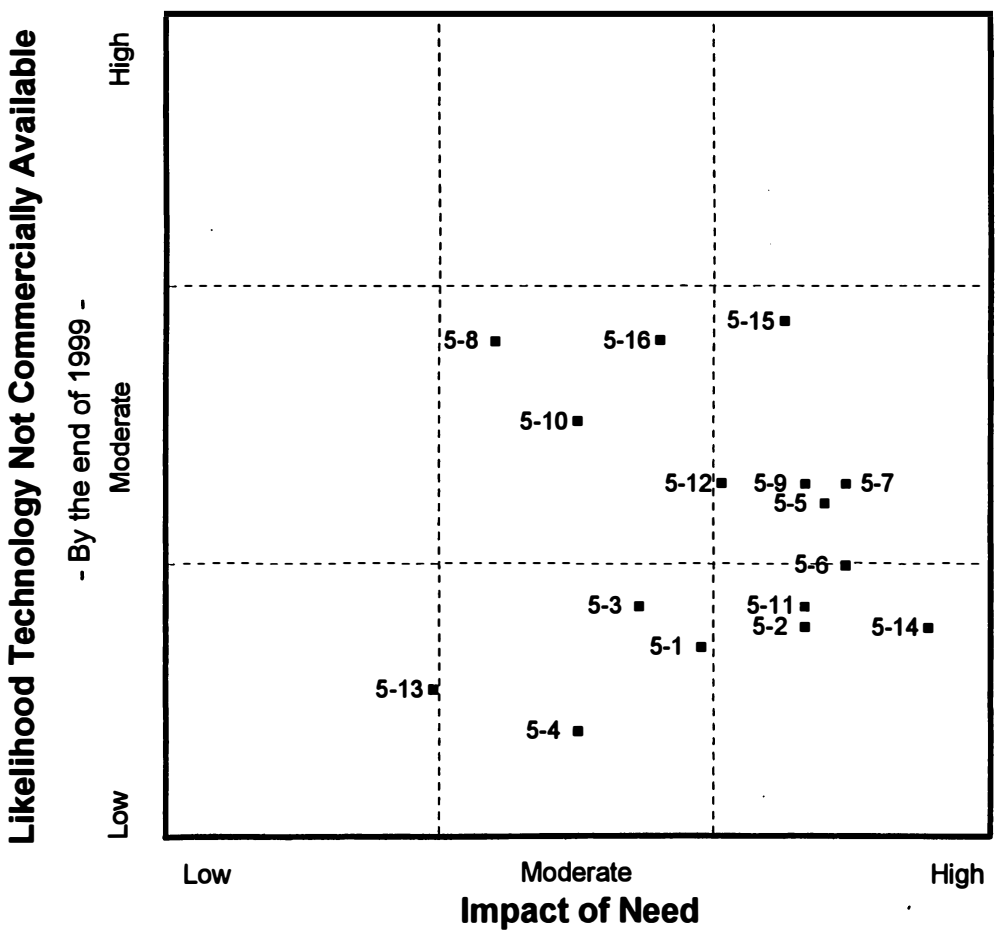


		Impact	Likeli-hood	n =
4-1	Injection water treatment	2.7	2.8	13
4-2	Produced water treatment	3.4	2.1	11
4-3	Corrosion control	3.0	2.4	10
4-4	Scaling inhibitors	2.6	2.8	9
4-5	Paraffin control/removal	2.8	2.5	8
4-6	Oil/water/gas/separation	2.8	2.5	12
4-7	Beam pump analysis	1.7	2.8	9
4-8	Gas lift analysis	2.1	2.5	11
4-9	Submersible pump analysis	2.4	2.4	10
4-10	Rod/tubing wear evaluation	1.7	2.6	9
4-11	Stimulation techniques	3.9	1.7	9
4-12	Gas compression techniques	2.8	2.8	11
4-13	Recompletion techniques	3.3	1.6	7
4-14	Remote control and data analysis	3.2	2.1	11
4-15	Compact processing on offshore platforms	3.7	2.3	12
4-16	Modification of reservoir fluid mobilities	2.7	3.2	12
4-17	Miscible contact/displacement	2.8	2.8	13
4-18	Viscosity reduction of heavy oils	2.5	3.0	12
4-19	In situ generation of foams/emulsions	2.1	3.2	11
4-20	Thickeners for CO_2 floods	2.5	3.0	11
4-21	Microbial EOR processes	1.6	3.0	14
4-22	High-velocity gas flow modeling	1.0	3.0	10
4-23	Thermal processes	2.4	3.2	10
4-24	Combustion processes	1.7	2.7	12
4-25	Near well bore stimulation	4.1	2.7	7
4-26	New directional drilling	3.4	1.2	9
4-27	Advanced recovery of natural gas	4.1	2.8	9

Identification of Short-term R, D&D Targets

- Deepwater Offshore -

- majors -

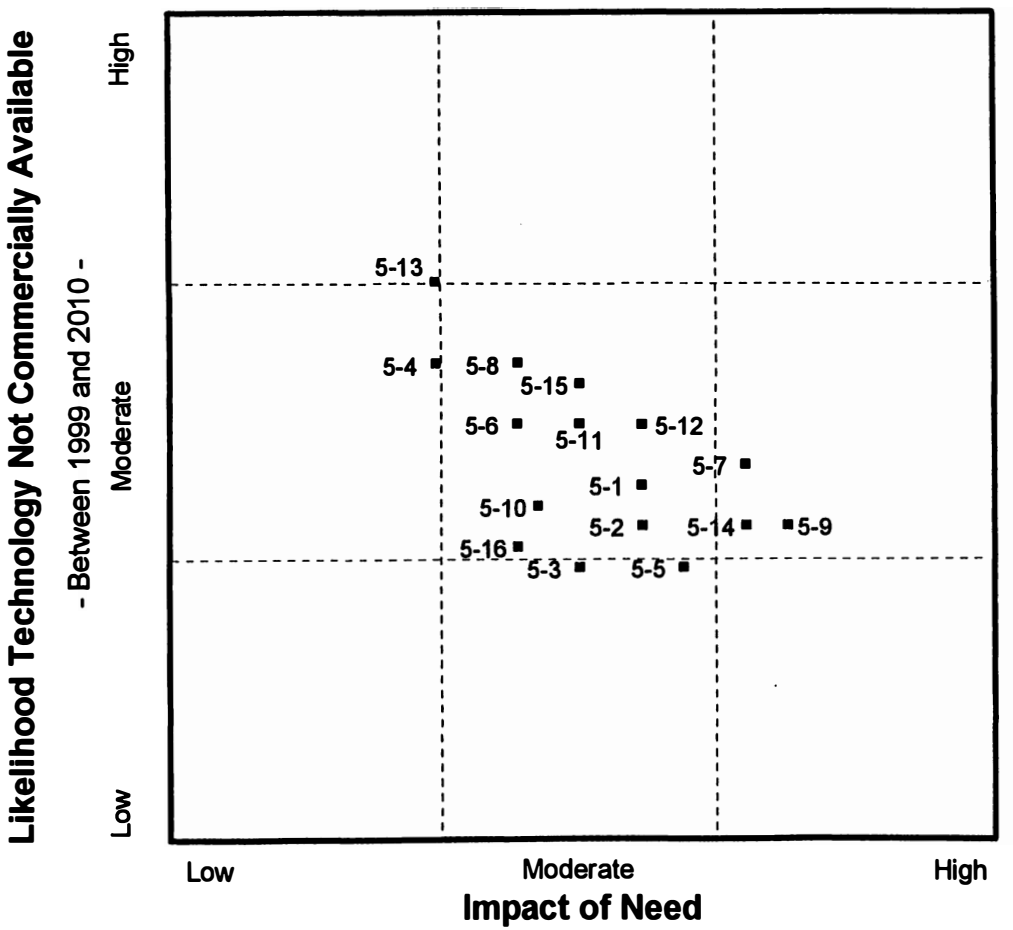


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	3.6	1.9	7
5-2	Extended reach drilling or production	4.1	2.0	10
5-3	Extended reach control systems	3.3	2.1	7
5-4	High pressure systems	3.0	1.5	4
5-5	Flowlines	4.2	2.6	5
5-6	Flow metering	4.3	2.3	6
5-7	Subsea equipment	4.3	2.7	6
5-8	External corrosion protection	2.6	3.4	5
5-9	Risers	4.1	2.7	7
5-10	ROV systems	3.0	3.0	5
5-11	Drilling	4.1	2.1	9
5-12	Workover	3.7	2.7	6
5-13	Water/gas injection	2.3	1.7	3
5-14	Hydrate prevention	4.7	2.0	6
5-15	Multi-phase pumps	4.0	3.5	4
5-16	Structures	3.4	3.4	5

Identification of Long-term R, D&D Targets

- Deepwater Offshore -

- majors -

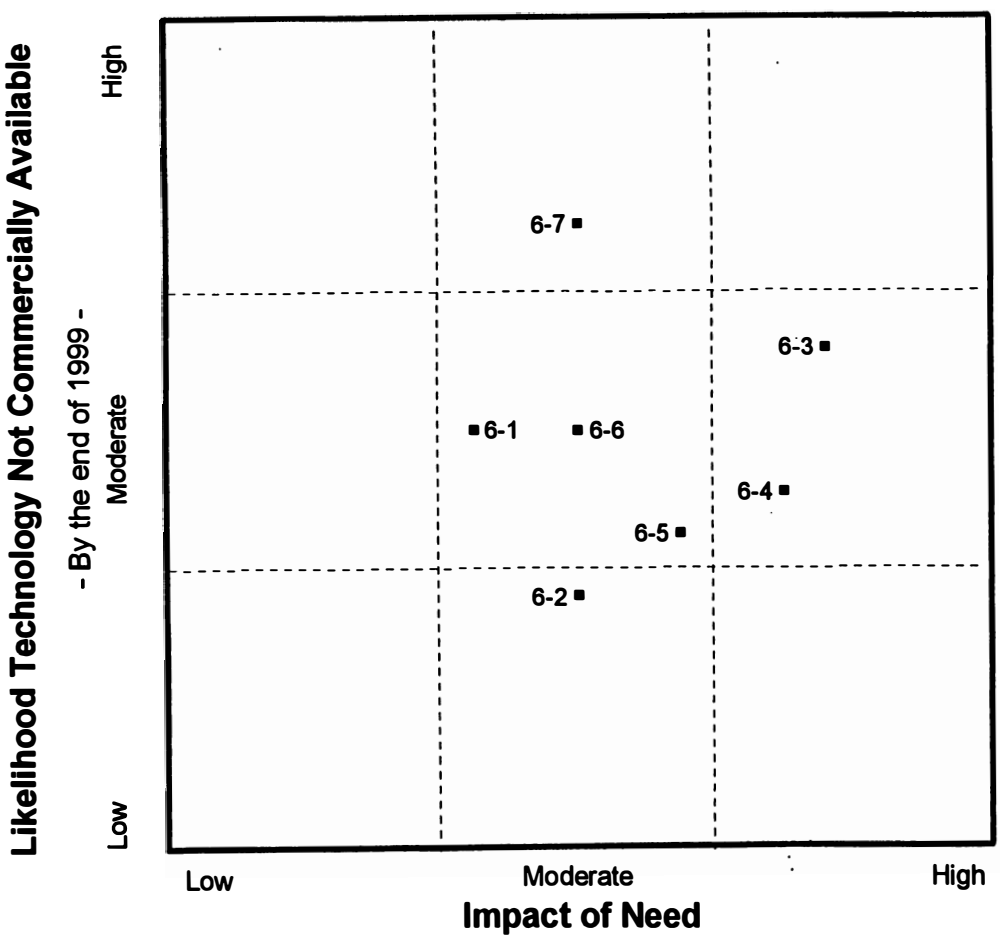


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	3.3	2.7	6
5-2	Extended reach drilling or production	3.3	2.5	4
5-3	Extended reach control systems	3.0	2.3	6
5-4	High pressure systems	2.3	3.3	8
5-5	Flowlines	3.5	2.3	8
5-6	Flow metering	2.7	3.0	6
5-7	Subsea equipment	3.8	2.8	8
5-8	External corrosion protection	2.7	3.3	6
5-9	Risers	4.0	2.5	8
5-10	ROV systems	2.8	2.6	9
5-11	Drilling	3.0	3.0	4
5-12	Workover	3.3	3.0	8
5-13	Water/gas injection	2.3	3.7	9
5-14	Hydrate prevention	3.8	2.5	8
5-15	Multi-phase pumps	3.0	3.2	9
5-16	Structures	2.7	2.4	7

Identification of Short-term R, D&D Targets

- Arctic Region Activities -

- majors -

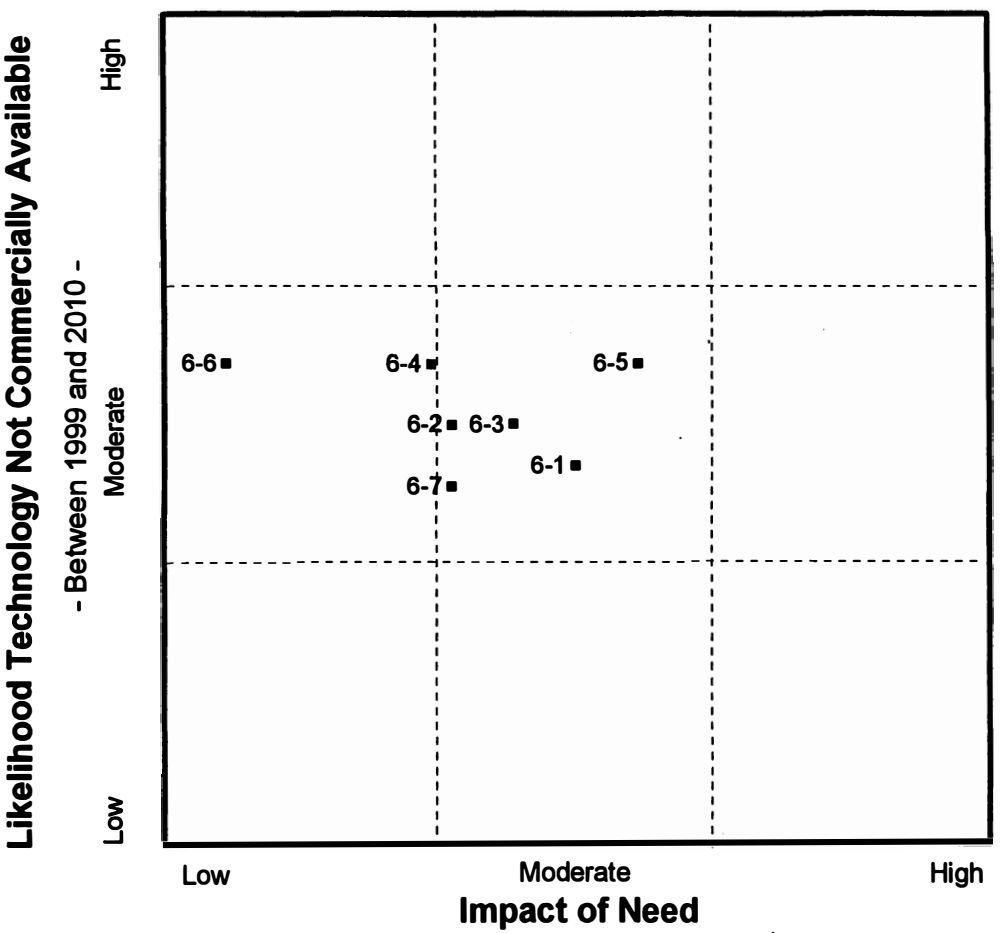


		Impact	Likeli-hood	n =
6-1	Transportation	2.5	3.0	4
6-2	Exploration	3.0	2.2	5
6-3	Development	4.2	3.4	5
6-4	Drilling	4.0	2.7	6
6-5	Production	3.5	2.5	4
6-6	Deepwater offshore activities	3.0	3.0	2
6-7	Mobile ice	3.0	4.0	4

Identification of Long-term R, D&D Targets

- Arctic Region Activities -

- majors -

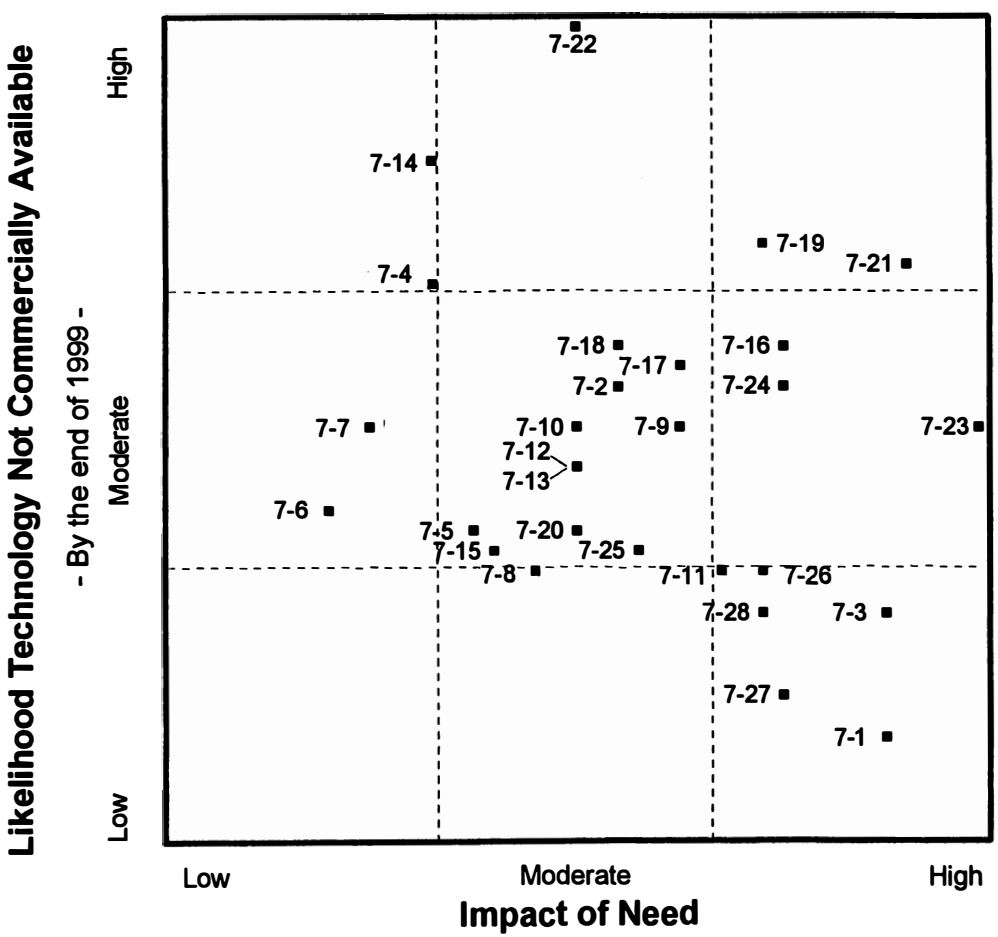


		Impact	Likeli-hood	n =
6-1	Transportation	3.0	2.8	8
6-2	Exploration	2.4	3.0	7
6-3	Development	2.7	3.0	7
6-4	Drilling	2.3	3.3	6
6-5	Production	3.3	3.3	7
6-6	Deepwater offshore activities	1.3	3.3	7
6-7	Mobile ice	2.4	2.7	7

Identification of Short-term R, D&D Targets

- Oil Processing and Refining -

- majors -

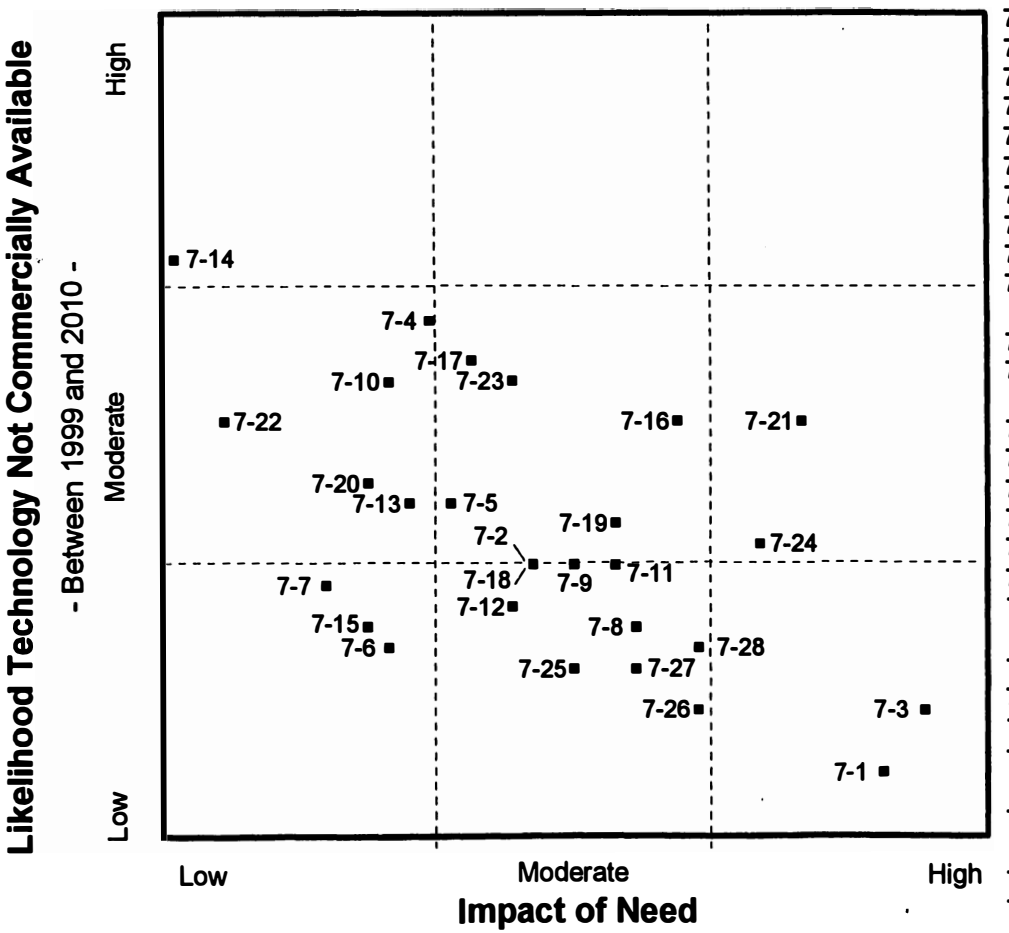


		Impact	Likeli-hood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	4.5	1.5	11
7-2	Hydrogen production and recovery	3.2	3.2	10
7-3	Plant and process reliability	4.5	2.1	11
7-4	Unconventional process technology	2.3	3.7	3
7-5	New materials of construction	2.5	2.5	4
7-6	Reactor engineering and modeling	1.8	2.6	5
7-7	Catalyst manufacturing technology	2.0	3.0	6
7-8	Risk assessment methodology	2.8	2.3	12
7-9	Solid acid catalysts	3.5	3.0	4
7-10	Alternatives to olefin alkylation process	3.0	3.0	3
7-11	Techniques for integration of environmental solutions into process and plant design	3.7	2.3	9
7-12	Improved on-line NDE inspection technology	3.0	2.8	8
7-13	Predicting useful remaining lifetimes of aging equipment	3.0	2.8	9
7-14	Robotics for safety applications	2.3	4.3	3
7-15	Worker safety systems	2.6	2.4	10
7-16	Energy efficiency of processes	4.0	3.4	10
7-17	Energy efficiency of equipment	3.5	3.3	8
7-18	Energy efficiency of separations	3.2	3.4	10
7-19	Separations technologies	3.9	3.9	7
7-20	Determining chemical composition of crudes, refinery intermediates, and products	3.0	2.5	8
7-21	New approaches to refining heavy feeds	4.6	3.8	5
7-22	Processing synthetic fuels	3.0	5.0	1
7-23	Conversion of methane to liquid fuels	5.0	3.0	2
7-24	Relating chemical compositions to process and product performance	4.0	3.2	10
7-25	Advanced computational modeling of processes/reactions	3.3	2.4	7
7-26	Advanced control and information systems	3.9	2.3	11
7-27	Performance characteristics of new hydrocarbon fuel compositions	4.0	1.7	6
7-28	Environmental characteristics of new hydrocarbon fuel compositions	3.9	2.1	9

Identification of Long-term R, D&D Targets

- Oil Processing and Refining -

- majors -

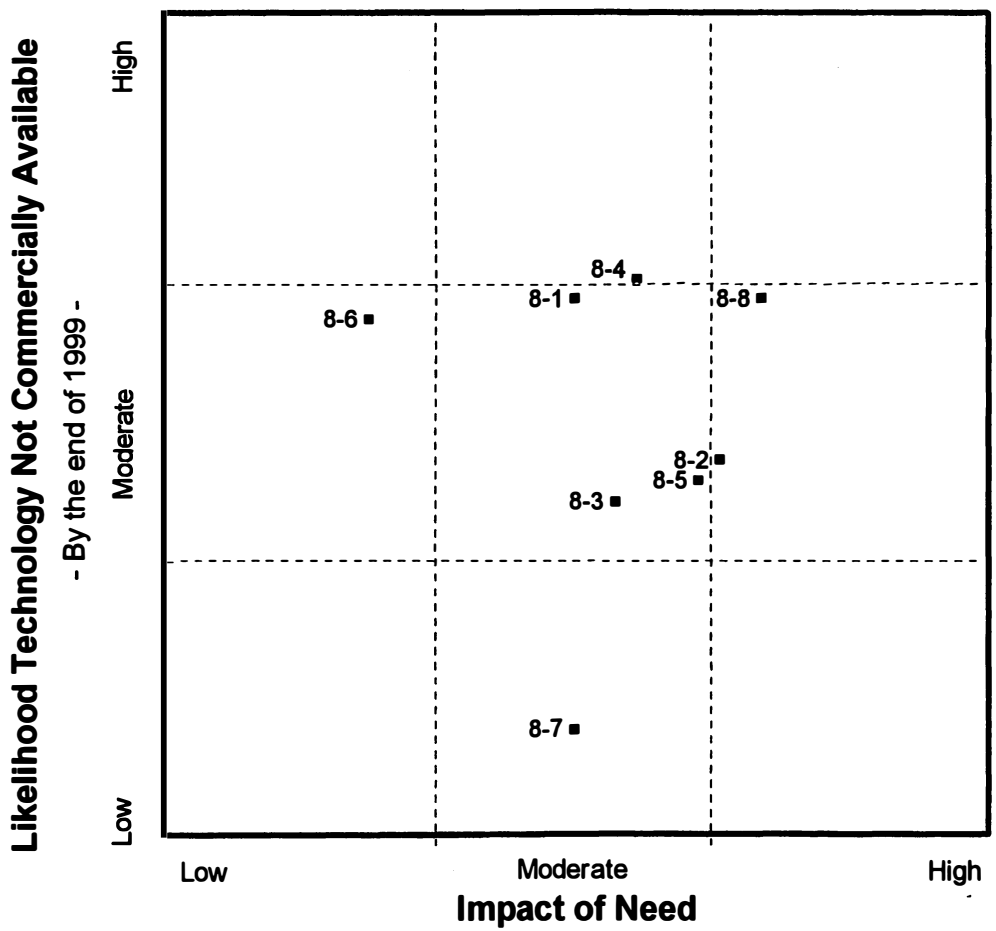


		Impact	Likeli-hood	n =
7-1	Catalysts with improved selectivities, yeilds, lifetimes	4.5	1.3	8
7-2	Hydrogen production and recovery	2.8	2.3	9
7-3	Plant and process reliability	4.7	1.6	7
7-4	Unconventional process technology	2.3	3.5	11
7-5	New materials of construction	2.4	2.6	10
7-6	Reactor engineering and modeling	2.1	1.9	11
7-7	Catalyst manufacturing technology	1.8	2.2	10
7-8	Risk assessment methodology	3.3	2.0	6
7-9	Solid acid catalysts	3.0	2.3	11
7-10	Alternatives to olefin alkylation process	2.1	3.2	11
7-11	Techniques for integration of environmental solutions into process and plant design	3.2	2.3	9
7-12	Improved on-line NDE inspection technology	2.7	2.1	7
7-13	Predicting useful remaining lifetimes of aging equipment	2.2	2.6	5
7-14	Robotics for safety applications	1.0	3.8	8
7-15	Worker safety systems	2.0	2.0	6
7-16	Energy efficiency of processes	3.5	3.0	8
7-17	Energy efficiency of equipment	2.5	3.3	8
7-18	Energy efficiency of separations	2.8	2.3	9
7-19	Separations technologies	3.2	2.5	12
7-20	Determining chemical composition of crudes, refinery intermediates, and products	2.0	2.7	7
7-21	New approaches to refining heavy feeds	4.1	3.0	11
7-22	Processing synthetic fuels	1.3	3.0	12
7-23	Conversion of methane to liquid fuels	2.7	3.2	12
7-24	Relating chemical compositions to process and product performance	3.9	2.4	7
7-25	Advanced computational modeling of processes/reactions	3.0	1.8	10
7-26	Advanced control and information systems	3.6	1.6	7
7-27	Performance characteristics of new hydrocarbon fuel compositions	3.3	1.8	8
7-28	Environmental characteristics of new hydrocarbon fuel compositions	3.6	1.9	7

Identification of Short-term R, D&D Targets

- Gas Processing -

- majors -

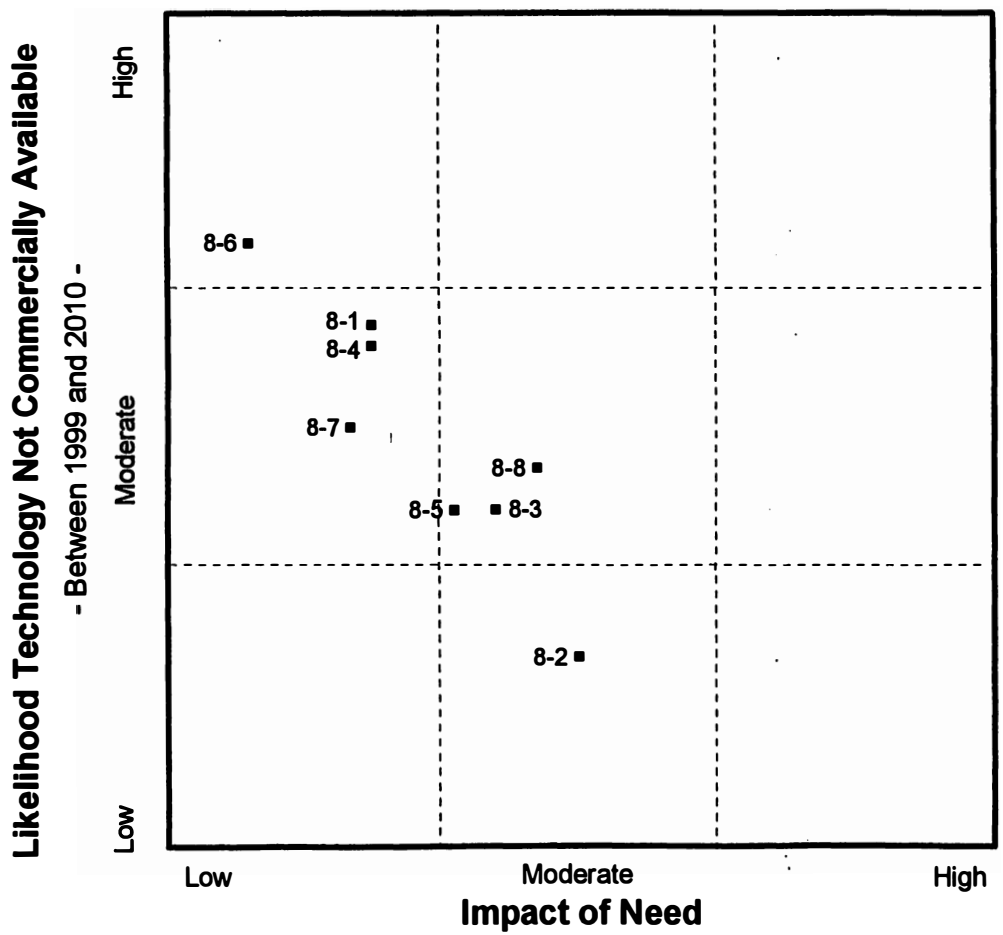


		Impact	Likeli-hood	n =
8-1	Gas dehydration	3.0	3.6	7
8-2	Acid gas removal	3.7	2.8	9
8-3	H_2S scavenger technology	3.2	2.6	9
8-4	Natural gas liquid separation	3.3	3.7	6
8-5	Nitrogen separation	3.6	2.7	7
8-6	Trace constituent (arsenic, Hg, etc.) removal	2.0	3.5	4
8-7	Sulfur recovery	3.0	1.5	4
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	3.9	3.6	9

Identification of Long-term R, D&D Targets

- Gas Processing -

- majors -

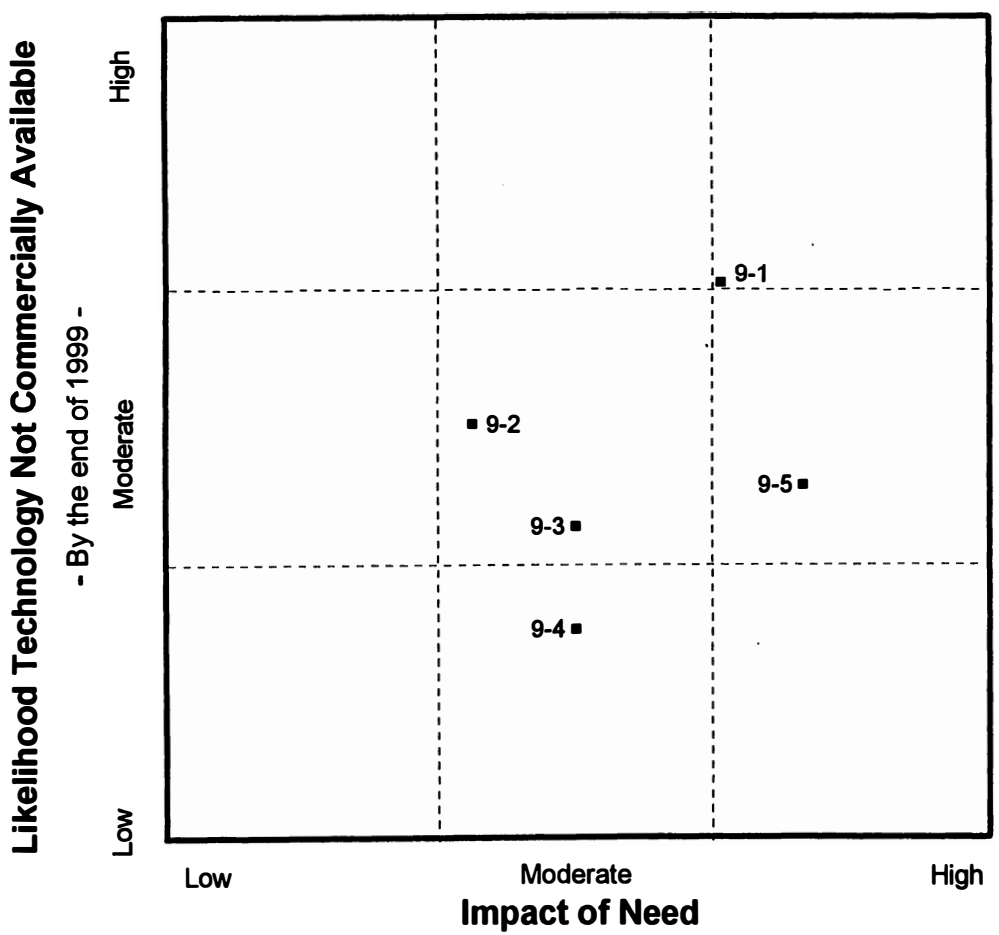


		Impact	Likelihood	n =
8-1	Gas dehydration	2.0	3.5	8
8-2	Acid gas removal	3.0	1.9	7
8-3	H_2S scavenger technology	2.6	2.6	9
8-4	Natural gas liquid separation	2.0	3.4	10
8-5	Nitrogen separation	2.4	2.6	10
8-6	Trace constituent (arsenic, Hg, etc.) removal	1.4	3.9	11
8-7	Sulfur recovery	1.9	3.0	11
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	2.8	2.8	8

Identification of Short-term R, D&D Targets

- Gas Gathering -

- majors -

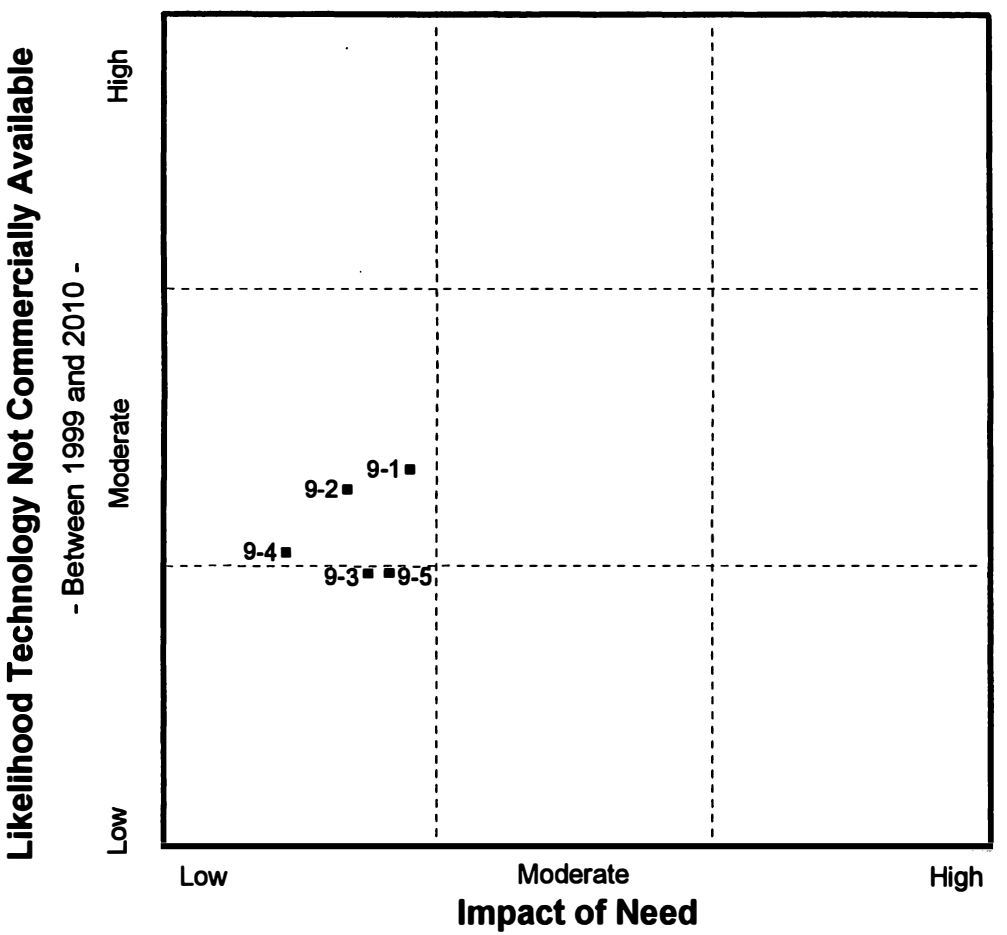


		Impact	Likeli-hood	n =
9-1	Compression	3.7	3.7	6
9-2	Leak detection	2.5	3.0	8
9-3	Plastic pipe (higher pressure rating)	3.0	2.5	8
9-4	High pressure measurement	3.0	2.0	2
9-5	Multi-phase metering	4.1	2.7	7

Identification of Long-term R, D&D Targets

- Gas Gathering -

- majors -

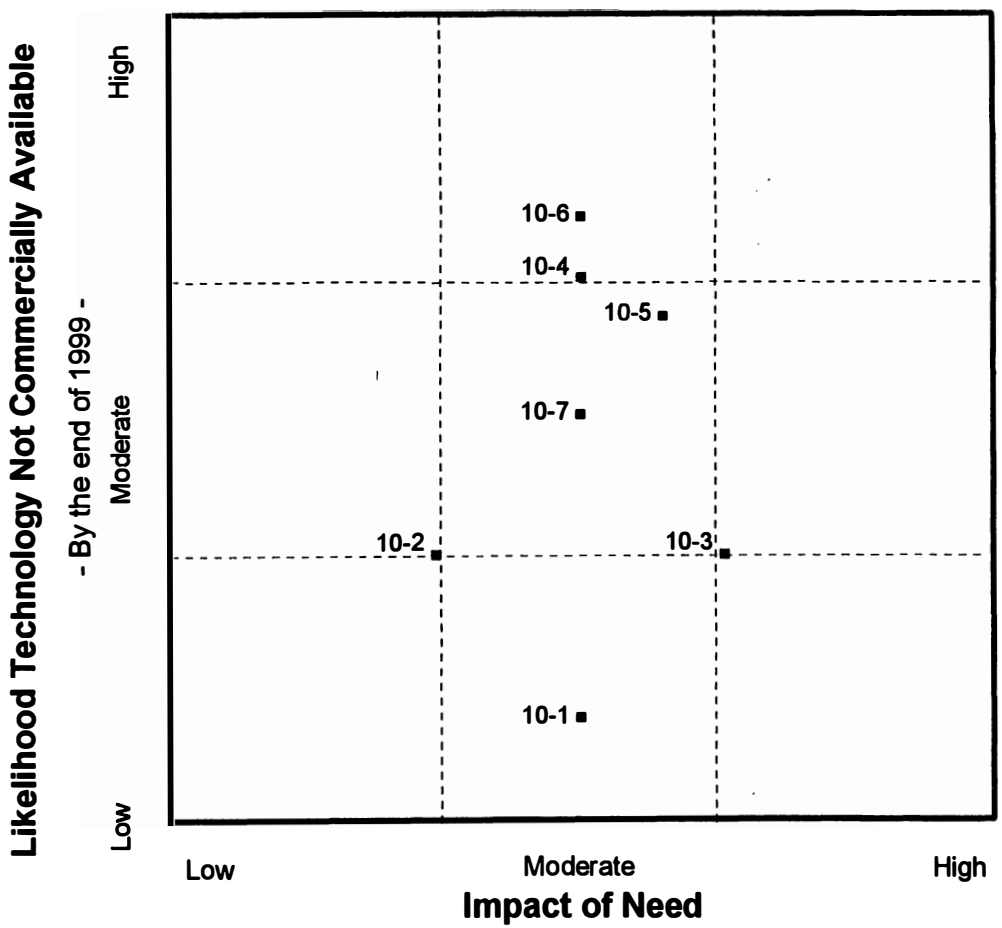


		Impact	Likeli-hood	n =
9-1	Compression	2.2	2.8	10
9-2	Leak detection	1.9	2.7	7
9-3	Plastic pipe (higher pressure rating)	2.0	2.3	6
9-4	High pressure measurement	1.6	2.4	13
9-5	Multi-phase metering	2.1	2.3	9

Identification of Short-term R, D&D Targets

- Gas Storage -

- majors -

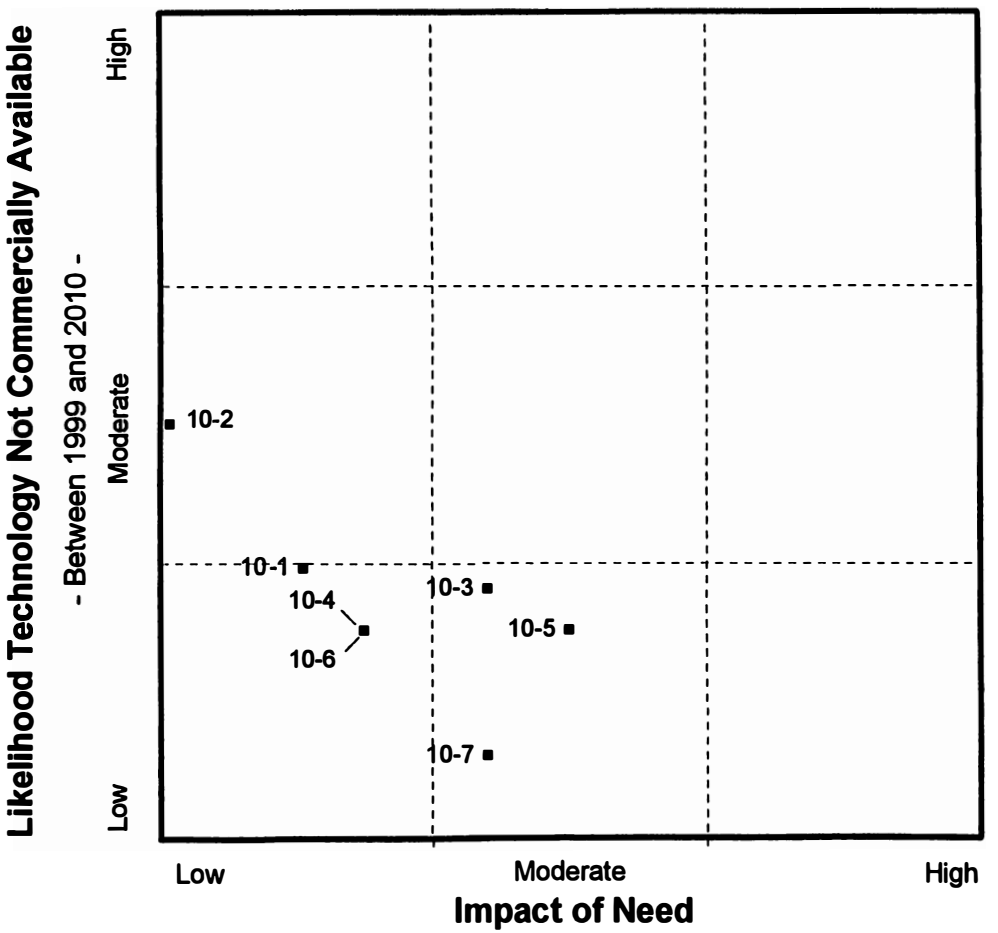


		Impact	Likeli-hood	n =
10-1	Well deliverability restoration	3.0	1.5	4
10-2	Leak detection and mitigation	2.3	2.3	3
10-3	Reservoir management	3.7	2.3	3
10-4	Gas migration control	3.0	3.7	3
10-5	Base gas minimization techniques	3.4	3.5	4
10-6	Inert base gas research	3.0	4.0	2
10-7	Unconventional development techniques	3.0	3.0	3

Identification of Long-term R, D&D Targets

- Gas Storage -

- majors -

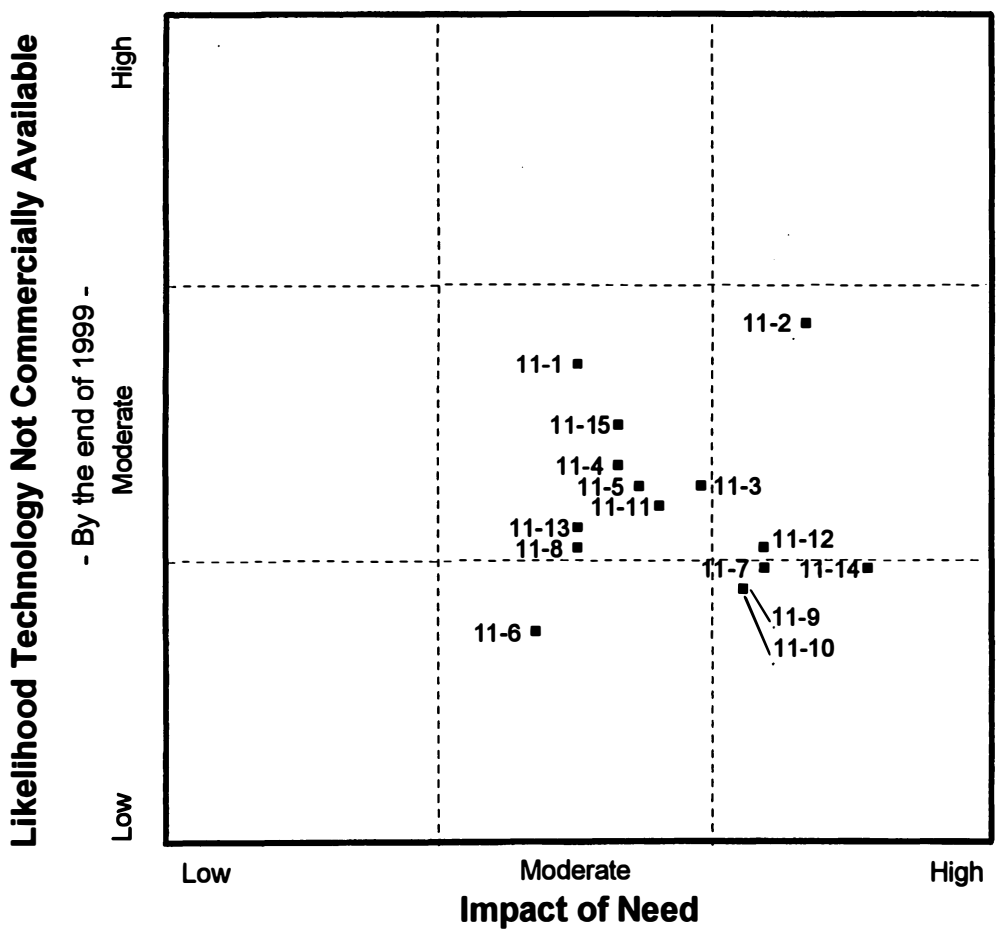


		Impact	Likeli-hood	n =
10-1	Well deliverability restoration	1.7	2.3	3
10-2	Leak detection and mitigation	1.0	3.0	3
10-3	Reservoir management	2.6	2.2	5
10-4	Gas migration control	2.0	2.0	4
10-5	Base gas minimization techniques	3.0	2.0	2
10-6	Inert base gas research	2.0	2.0	4
10-7	Unconventional development techniques	2.6	1.4	5

Identification of Short-term R, D&D Targets

- Environmental and Regulatory -

- majors -

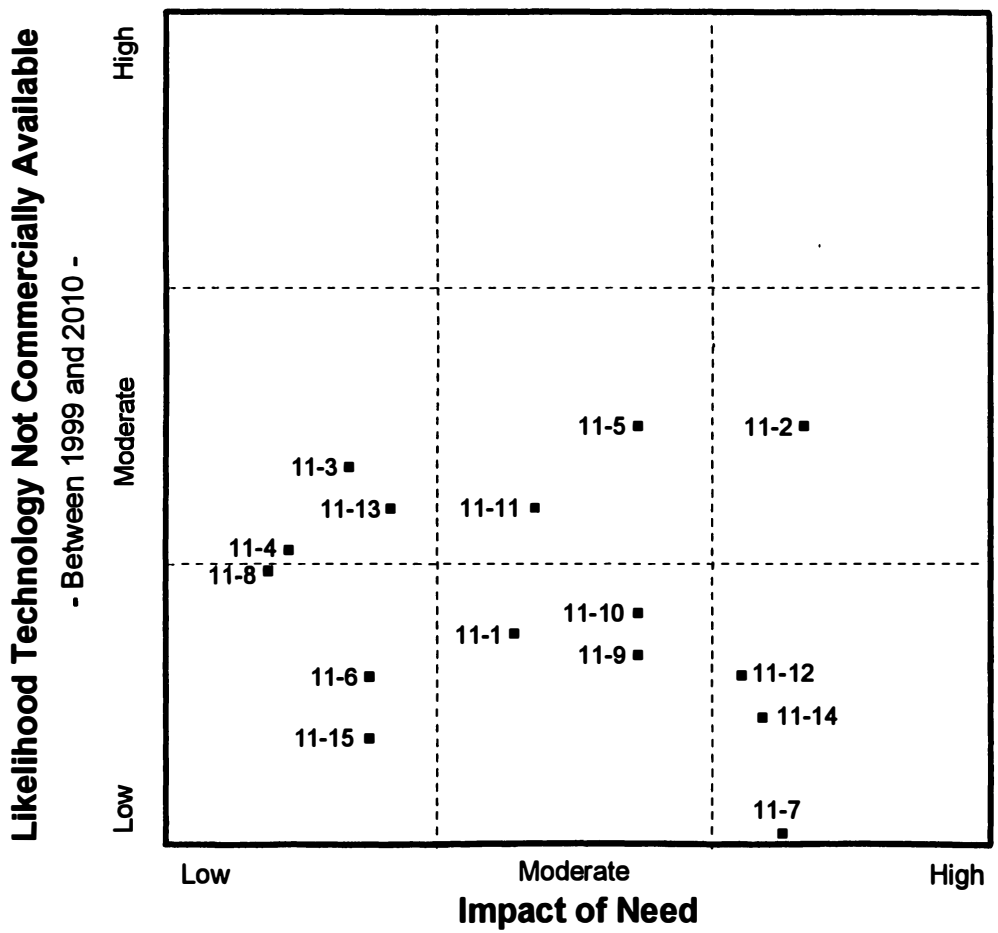


		Impact	Likeli-hood	n =
11-1	Disposal methods for drilling fluids	3.0	3.3	12
11-2	Treatment and disposal of produced fluids	4.1	3.5	11
11-3	Screening procedures for injection wells	3.6	2.7	7
11-4	Risk and reclamation analysis of disposal methods	3.2	2.8	12
11-5	Leak detection	3.3	2.7	12
11-6	Hydrological modeling	2.8	2.0	8
11-7	Compliance with CAAA stationary source issue	3.9	2.3	16
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	3.0	2.4	10
11-9	Model transport and remediation of contaminants in ground water and soils	3.8	2.2	12
11-10	Effluent and emission monitoring, minimization, and control	3.8	2.2	12
11-11	Recycling of waste and byproduct streams	3.4	2.6	10
11-12	Remediation technology	3.9	2.4	13
11-13	Catalyst recycling	3.0	2.5	8
11-14	Provide scientific basis for risk-based regulation	4.4	2.3	14
11-15	NORM disposal	3.2	3.0	13

Identification of Long-term R, D&D Targets

- Environmental and Regulatory -

- majors -

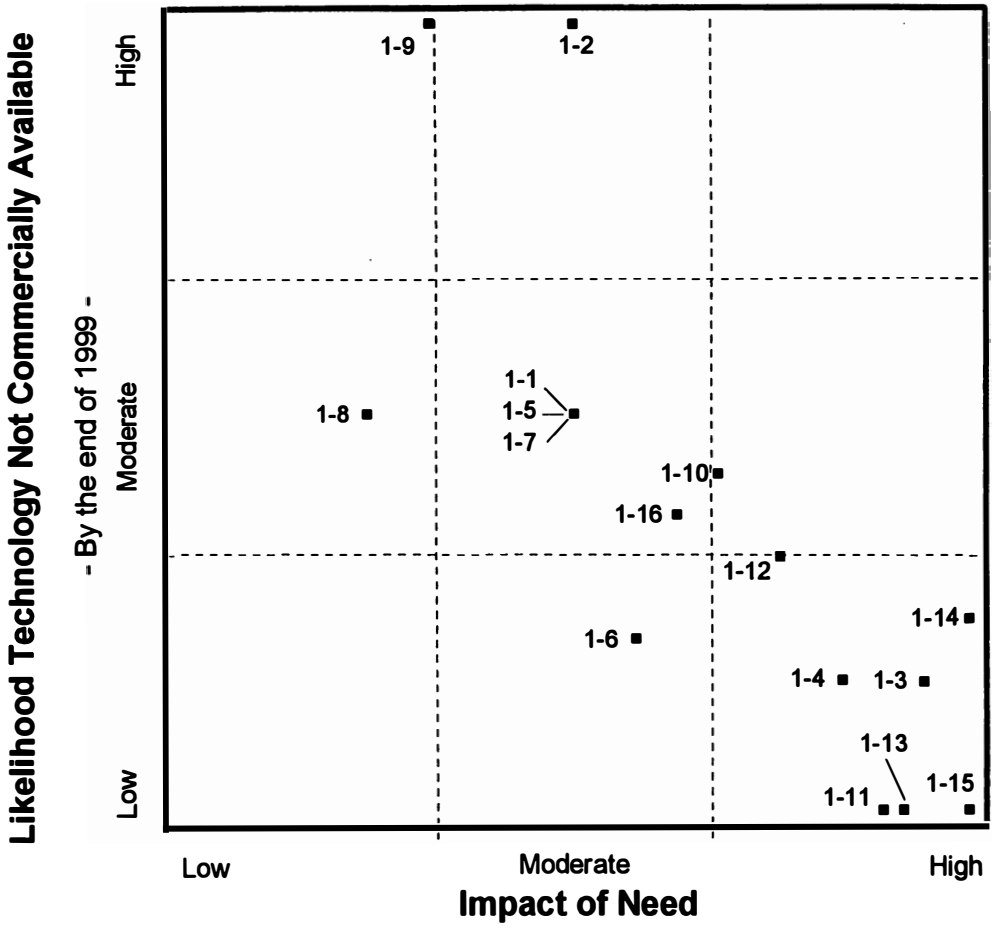


		Impact	Likell-hood	n =
11-1	Disposal methods for drilling fluids	2.7	2.0	6
11-2	Treatment and disposal of produced fluids	4.1	3.0	7
11-3	Screening procedures for injection wells	1.9	2.8	10
11-4	Risk and reclamation analysis of disposal methods	1.6	2.4	7
11-5	Leak detection	3.3	3.0	7
11-6	Hydrological modeling	2.0	1.8	10
11-7	Compliance with CAAA stationary source issue	4.0	1.0	4
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	1.5	2.3	8
11-9	Model transport and remediation of contaminants in ground water and soils	3.3	1.9	7
11-10	Effluent and emission monitoring, minimization, and control	3.3	2.1	7
11-11	Recycling of waste and byproduct streams	2.8	2.6	10
11-12	Remediation technology	3.8	1.8	8
11-13	Catalyst recycling	2.1	2.6	11
11-14	Provide scientific basis for risk-based regulation	3.9	1.6	7
11-15	NORM disposal	2.0	1.5	4

Identification of Short-term R, D&D Targets

- Exploration -

-integrated gas or oil -

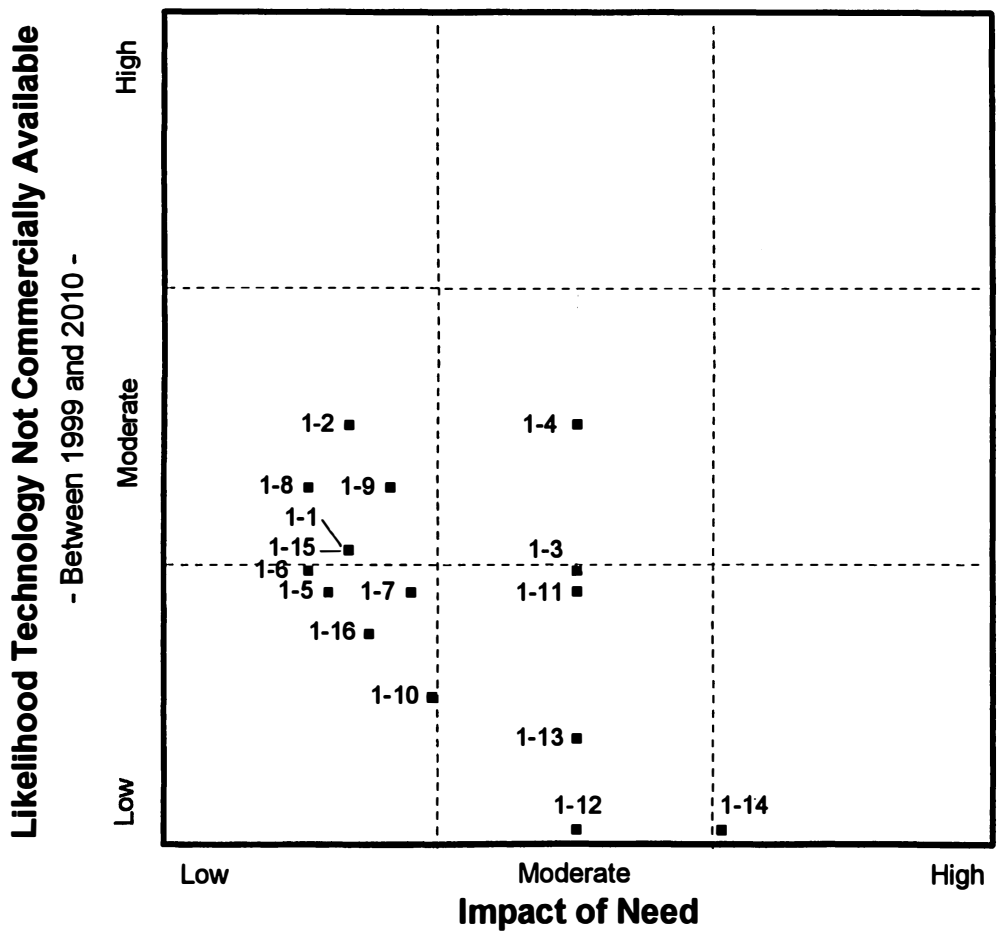


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	3.0	3.0	1
1-2	Risk assessment methods	3.0	5.0	3
1-3	High-resolution seismic depth imaging	4.7	1.7	6
1-4	Specialized seismic processing	4.3	1.7	6
1-5	Sequence stratigraphy techniques	3.0	3.0	4
1-6	Workstation seismic modeling	3.3	1.9	7
1-7	Geochemical analysis	3.0	3.0	4
1-8	Airborne/satellite remote sensing	2.0	3.0	2
1-9	Fault seal analysis	2.3	5.0	3
1-10	Multi-component seismic techniques	3.7	2.7	6
1-11	3D Paleostructural restoration	4.5	1.0	4
1-12	Amplitude versus offset (AVO) in 3D	4.0	2.3	8
1-13	3D Visualization tools	4.6	1.0	5
1-14	Advanced seismic acquisition	5.0	2.0	6
1-15	Geographic information systems	5.0	1.0	1
1-16	Geophysical fracture-detection methods	3.5	2.5	4

Identification of Long-term R, D&D Targets

- Exploration -

-integrated gas or oil -

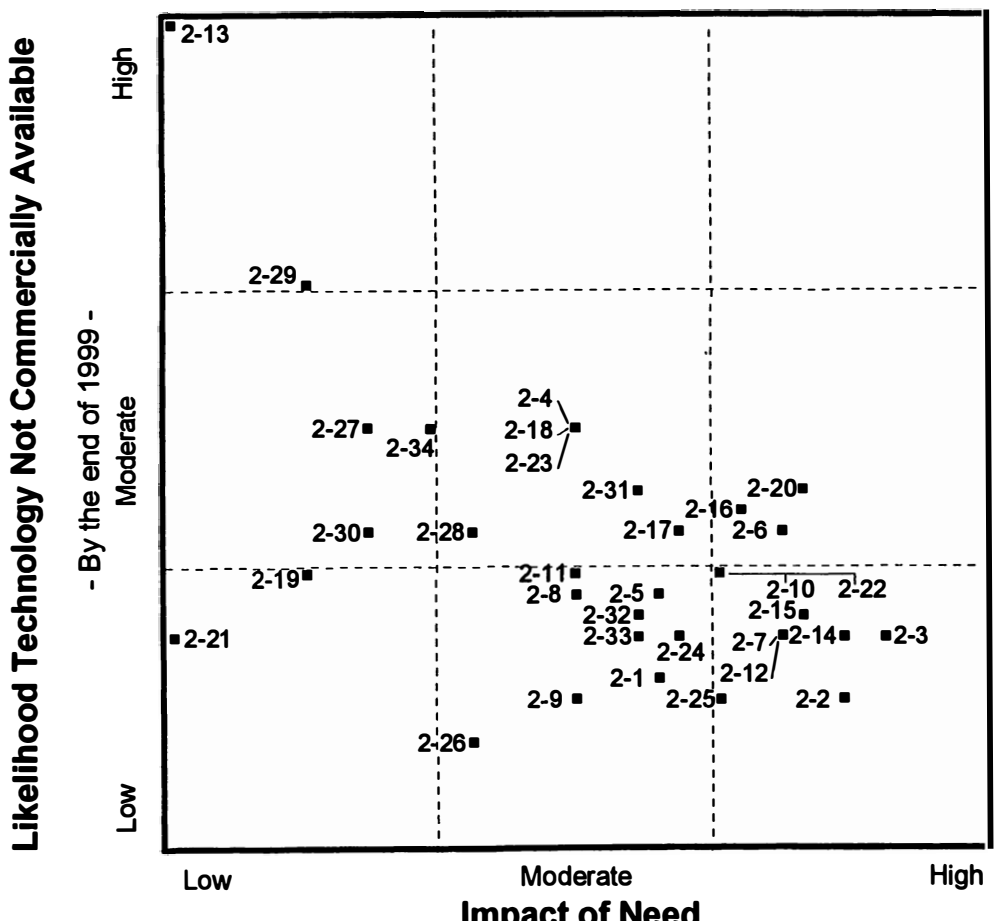


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	1.9	2.4	7
1-2	Risk assessment methods	1.9	3.0	7
1-3	High-resolution seismic depth imaging	3.0	2.3	3
1-4	Specialized seismic processing	3.0	3.0	3
1-5	Sequence stratigraphy techniques	1.8	2.2	5
1-6	Workstation seismic modeling	1.7	2.3	3
1-7	Geochemical analysis	2.2	2.2	5
1-8	Airborne/satellite remote sensing	1.7	2.7	6
1-9	Fault seal analysis	2.1	2.7	7
1-10	Multi-component seismic techniques	2.3	1.7	3
1-11	3D Paleostructural restoration	3.0	2.2	5
1-12	Amplitude versus offset (AVO) in 3D	3.0	1.0	1
1-13	3D Visualization tools	3.0	1.5	4
1-14	Advanced seismic acquisition	3.7	1.0	3
1-15	Geographic information systems	1.9	2.4	7
1-16	Geophysical fracture-detection methods	2.0	2.0	4

Identification of Short-term R, D&D Targets

- Development -

-integrated gas or oil -

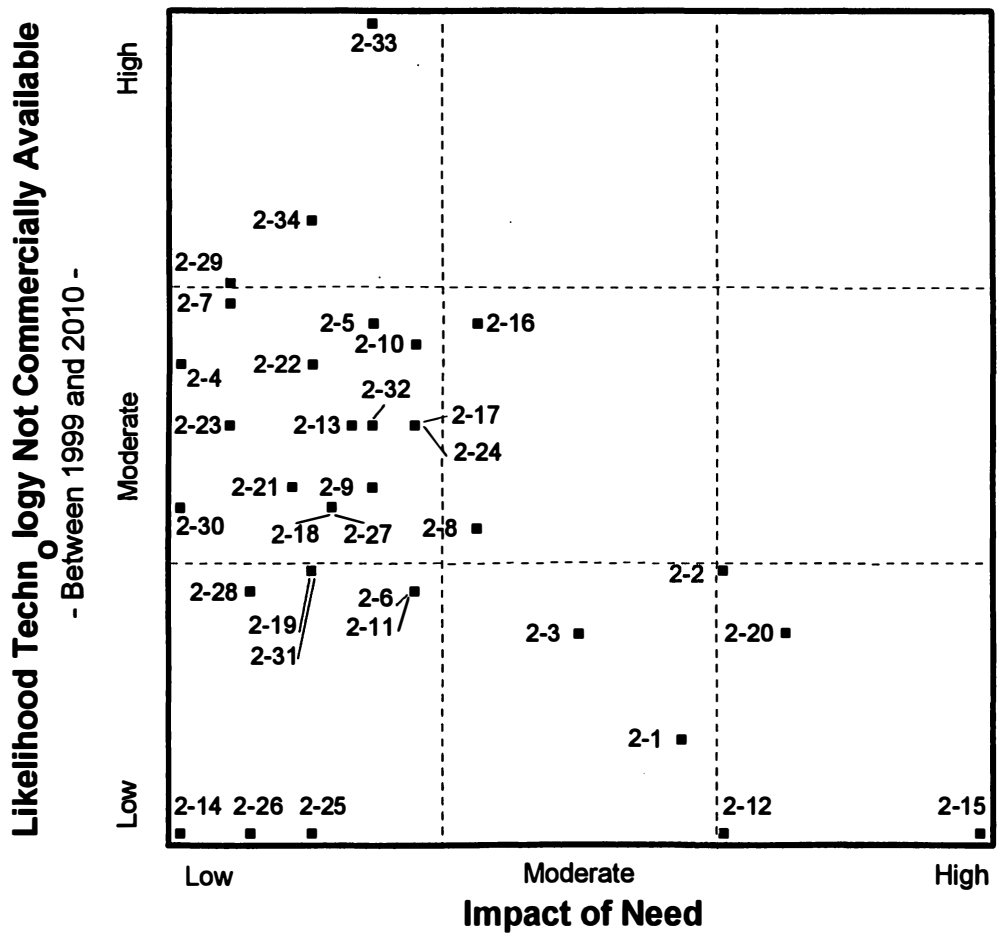


		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	3.4	1.8	5
2-2	Computer-based 3-D geological modeling	4.3	1.7	6
2-3	Development-scale seismic applications	4.5	2.0	4
2-4	Tracers (biologic/chemical/radioactive)	3.0	3.0	2
2-5	Core analysis/imaging	3.4	2.2	5
2-6	Geostatistical reservoir descriptions	4.0	2.5	4
2-7	Outcrop analog studies	4.0	2.0	2
2-8	Fluid-rock interaction	3.0	2.2	5
2-9	Rock physics	3.0	1.7	3
2-10	Cross-well geophysical imaging	3.7	2.3	3
2-11	Advanced attribute processing	3.0	2.3	3
2-12	Seismic/log/core calibration	4.0	2.0	6
2-13	Cuttings analysis	1.0	5.0	1
2-14	Reservoir property identification	4.3	2.0	8
2-15	Through casing logging	4.1	2.1	7
2-16	Deep investigation techniques	3.8	2.6	5
2-17	High resolution borehole imaging logs	3.5	2.5	4
2-18	Specialized core analysis	3.0	3.0	4
2-19	Characterization of rock wettability	1.7	2.3	3
2-20	Permeability logging techniques	4.1	2.7	7
2-21	Tracer techniques	1.0	2.0	2
2-22	CT scanning and NMR imaging	3.7	2.3	3
2-23	Formation water chemistry	3.0	3.0	3
2-24	Fluid sampling and analysis	3.5	2.0	4
2-25	Advanced reservoir simulation modeling	3.7	1.7	6
2-26	Workstation single well simulations	2.5	1.5	4
2-27	Procedures for data scale-up	2.0	3.0	4
2-28	Expert systems applications	2.5	2.5	4
2-29	Time lapse seismic imaging	1.7	3.7	3
2-30	Advanced monitoring of EOR processes	2.0	2.5	4
2-31	Advanced well testing and interpretation	3.3	2.7	6
2-32	Material balance applications	3.3	2.1	7
2-33	Decision and risk analysis	3.3	2.0	6
2-34	Expendable well bore instrumentation	2.3	3.0	3

Identification of Long-term R, D&D Targets

- Development -

-integrated gas or oil -

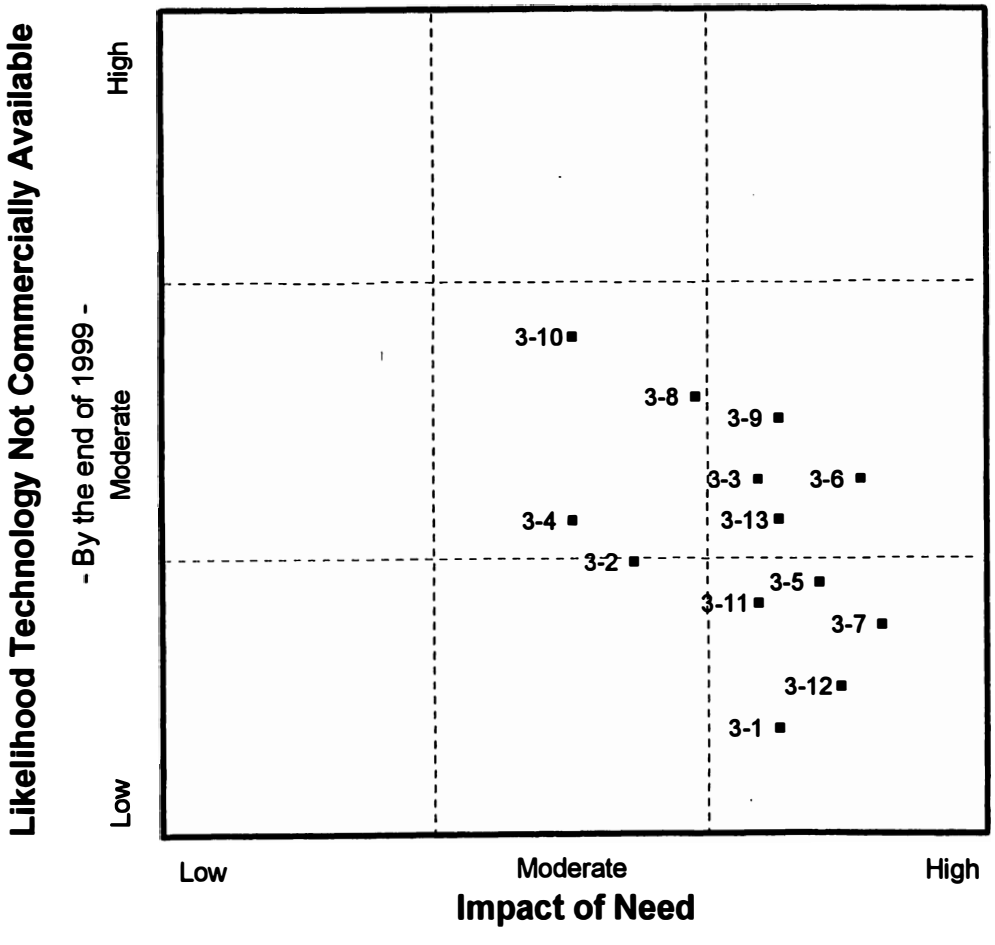


		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	3.5	1.5	4
2-2	Computer-based 3-D geological modeling	3.7	2.3	3
2-3	Development-scale seismic applications	3.0	2.0	4
2-4	Tracers (biologic/chemical/radioactive)	1.0	3.3	6
2-5	Core analysis/imaging	2.0	3.5	4
2-6	Geostatistical reservoir descriptions	2.2	2.2	5
2-7	Outcrop analog studies	1.3	3.6	7
2-8	Fluid-rock interaction	2.5	2.5	4
2-9	Rock physics	2.0	2.7	6
2-10	Cross-well geophysical imaging	2.2	3.4	5
2-11	Advanced attribute processing	2.2	2.2	5
2-12	Seismic/log/core calibration	3.7	1.0	3
2-13	Cuttings analysis	1.9	3.0	7
2-14	Reservoir property identification	1.0	1.0	1
2-15	Through casing logging	5.0	1.0	1
2-16	Deep investigation techniques	2.5	3.5	4
2-17	High resolution borehole imaging logs	2.2	3.0	5
2-18	Specialized core analysis	1.8	2.6	5
2-19	Characterization of rock wettability	1.7	2.3	6
2-20	Permeability logging techniques	4.0	2.0	2
2-21	Tracer techniques	1.6	2.7	7
2-22	CT scanning and NMR imaging	1.7	3.3	6
2-23	Formation water chemistry	1.3	3.0	6
2-24	Fluid sampling and analysis	2.2	3.0	5
2-25	Advanced reservoir simulation modeling	1.7	1.0	3
2-26	Workstation single well simulations	1.4	1.0	5
2-27	Procedures for data scale-up	1.8	2.6	5
2-28	Expert systems applications	1.4	2.2	5
2-29	Time lapse seismic imaging	1.3	3.7	6
2-30	Advanced monitoring of EOR processes	1.0	2.6	5
2-31	Advanced well testing and interpretation	1.7	2.3	3
2-32	Material balance applications	2.0	3.0	2
2-33	Decision and risk analysis	2.0	5.0	2
2-34	Expendable well bore instrumentation	1.7	4.0	6

Identification of Short-term R, D&D Targets

- Drilling and Completion -

-integrated gas or oil -

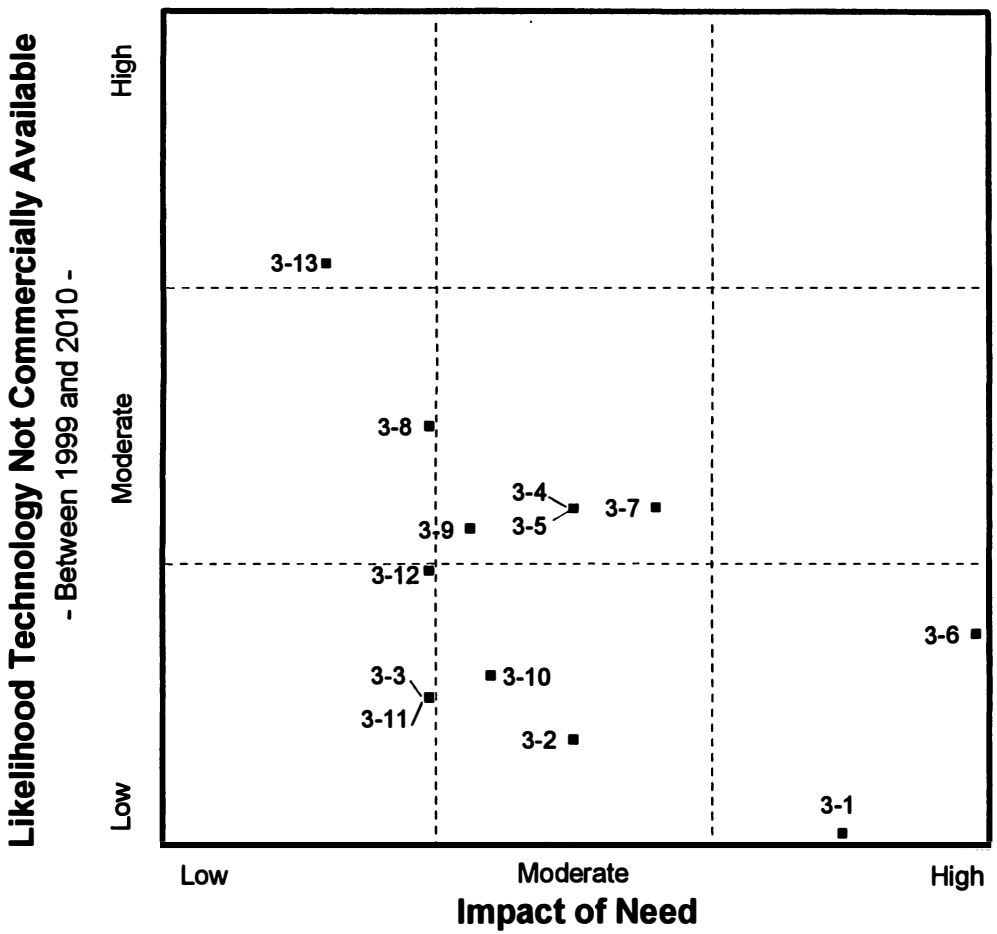


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	4.0	1.5	8
3-2	Drilling fluid design	3.3	2.3	6
3-3	Advanced fracture techniques	3.9	2.7	7
3-4	Cementing	3.0	2.5	4
3-5	Perforating and well bore cleanup	4.2	2.2	5
3-6	Well productivity	4.4	2.7	7
3-7	Multilateral technology	4.5	2.0	4
3-8	Innovative bit and tubular technology	3.6	3.1	7
3-9	Slim hole drilling	4.0	3.0	6
3-10	Under balanced drilling	3.0	3.4	5
3-11	Measurements while drilling	3.9	2.1	7
3-12	Coiled tubing drilling	4.3	1.7	6
3-13	Unconventional drilling technology	4.0	2.5	4

Identification of Long-term R, D&D Targets

- Drilling and Completion -

-integrated gas or oil -

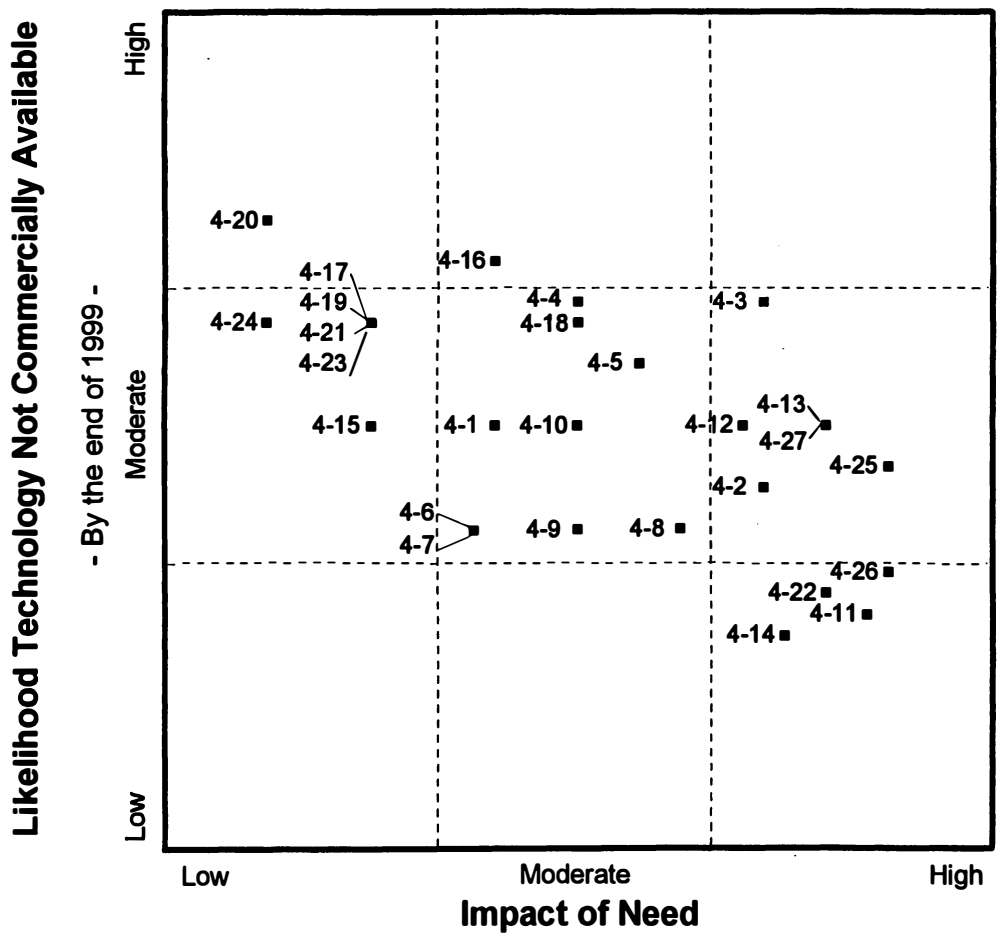


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	4.3	1.0	3
3-2	Drilling fluid design	3.0	1.5	4
3-3	Advanced fracture techniques	2.3	1.7	3
3-4	Cementing	3.0	2.6	5
3-5	Perforating and well bore cleanup	3.0	2.6	5
3-6	Well productivity	5.0	2.0	2
3-7	Multilateral technology	3.4	2.6	5
3-8	Innovative bit and tubular technology	2.3	3.0	3
3-9	Slim hole drilling	2.5	2.5	4
3-10	Under balanced drilling	2.6	1.8	5
3-11	Measurements while drilling	2.3	1.7	3
3-12	Coiled tubing drilling	2.3	2.3	3
3-13	Unconventional drilling technology	1.8	3.8	5

Identification of Short-term R, D&D Targets

- Production -

- integrated gas or oil -

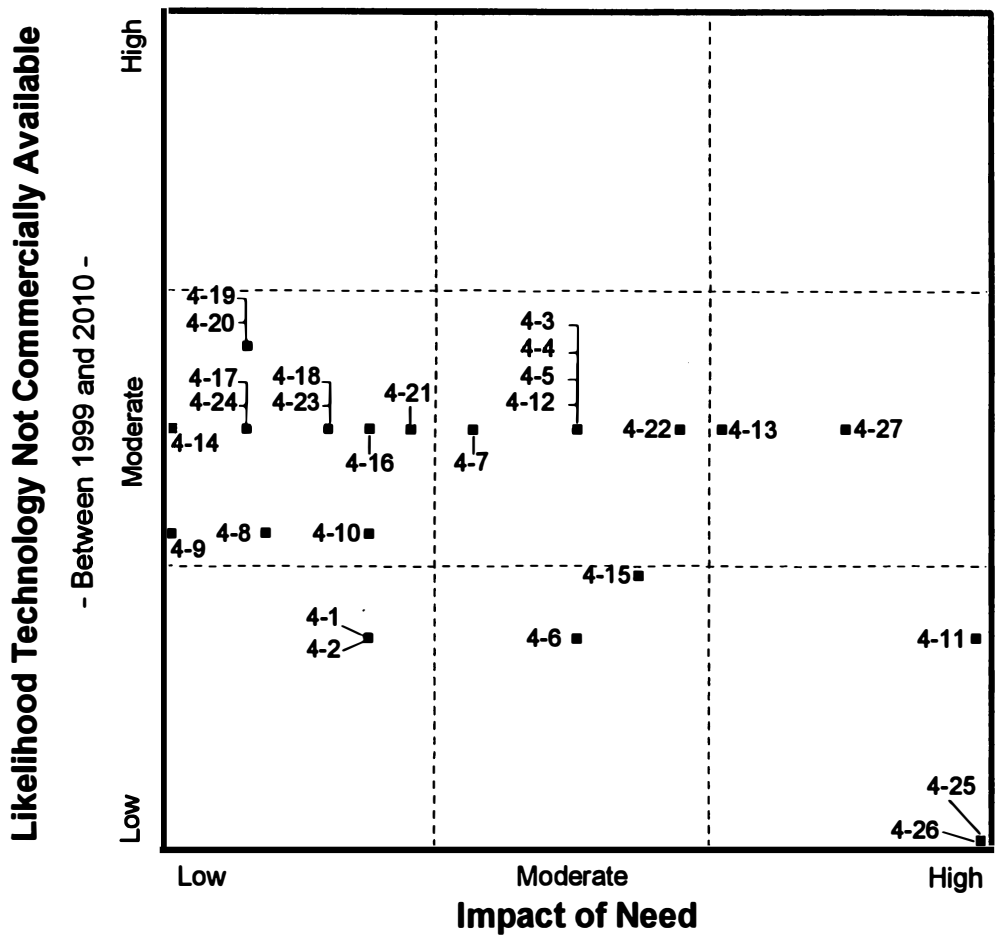


		Impact	Likeli-hood	n =
4-1	Injection water treatment	2.6	3.0	5
4-2	Produced water treatment	3.9	2.7	7
4-3	Corrosion control	3.9	3.6	7
4-4	Scaling inhibitors	3.0	3.6	7
4-5	Paraffin control/removal	3.3	3.3	7
4-6	Oil/water/gas/separation	2.5	2.5	4
4-7	Beam pump analysis	2.5	2.5	4
4-8	Gas lift analysis	3.5	2.5	4
4-9	Submersible pump analysis	3.0	2.5	4
4-10	Rod/tubing wear evaluation	3.0	3.0	4
4-11	Stimulation techniques	4.4	2.1	7
4-12	Gas compression techniques	3.8	3.0	5
4-13	Recompletion techniques	4.2	3.0	5
4-14	Remote control and data analysis	4.0	2.0	6
4-15	Compact processing on offshore platforms	2.0	3.0	2
4-16	Modification of reservoir fluid mobilities	2.6	3.8	5
4-17	Miscible contact/displacement	2.0	3.5	4
4-18	Viscosity reduction of heavy oils	3.0	3.5	4
4-19	In situ generation of foams/emulsions	2.0	3.5	4
4-20	Thickeners for CO_2 floods	1.5	4.0	4
4-21	Microbial EOR processes	2.0	3.5	4
4-22	High-velocity gas flow modeling	4.2	2.2	5
4-23	Thermal processes	2.0	3.5	4
4-24	Combustion processes	1.5	3.5	4
4-25	Near well bore stimulation	4.5	2.8	8
4-26	New directional drilling	4.5	2.3	8
4-27	Advanced recovery of natural gas	4.2	3.0	5

Identification of Long-term R, D&D Targets

- Production -

- integrated gas or oil -

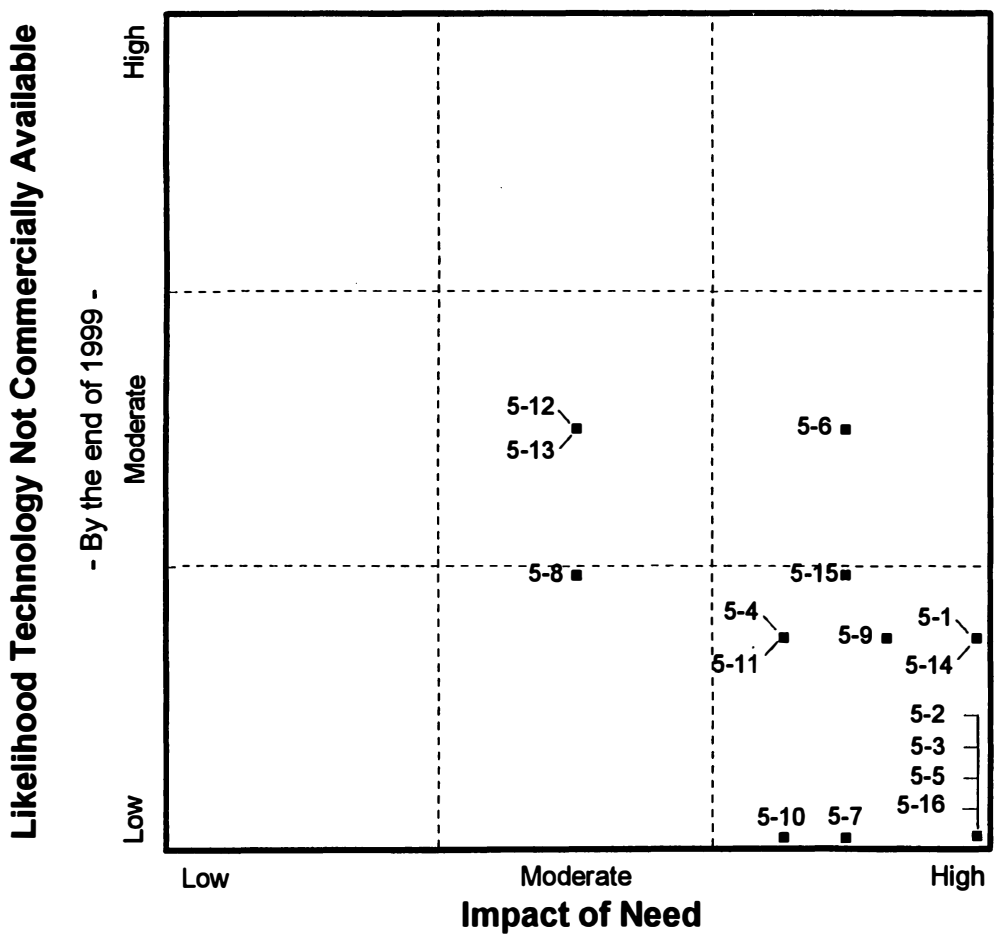


		Impact	Likeli-hood	n =
4-1	Injection water treatment	2.0	2.0	4
4-2	Produced water treatment	2.0	2.0	2
4-3	Corrosion control	3.0	3.0	1
4-4	Scaling inhibitors	3.0	3.0	1
4-5	Paraffin control/removal	3.0	3.0	1
4-6	Oil/water/gas/separation	3.0	2.0	4
4-7	Beam pump analysis	2.5	3.0	4
4-8	Gas lift analysis	1.5	2.5	4
4-9	Submersible pump analysis	1.0	2.5	4
4-10	Rod/tubing wear evaluation	2.0	2.5	4
4-11	Stimulation techniques	5.0	2.0	2
4-12	Gas compression techniques	3.0	3.0	3
4-13	Recompletion techniques	3.7	3.0	3
4-14	Remote control and data analysis	1.0	3.0	2
4-15	Compact processing on offshore platforms	3.3	2.3	6
4-16	Modification of reservoir fluid mobilities	2.0	3.0	4
4-17	Miscible contact/displacement	1.4	3.0	5
4-18	Viscosity reduction of heavy oils	1.8	3.0	5
4-19	In situ generation of foams/emulsions	1.4	3.4	5
4-20	Thickeners for CO_2 floods	1.4	3.4	5
4-21	Microbial EOR processes	2.2	3.0	5
4-22	High-velocity gas flow modeling	3.5	3.0	4
4-23	Thermal processes	1.8	3.0	5
4-24	Combustion processes	1.4	3.0	5
4-25	Near well bore stimulation	5.0	1.0	1
4-26	New directional drilling	5.0	1.0	1
4-27	Advanced recovery of natural gas	4.3	3.0	3

Identification of Short-term R, D&D Targets

- Deepwater Offshore -

- integrated gas or oil -

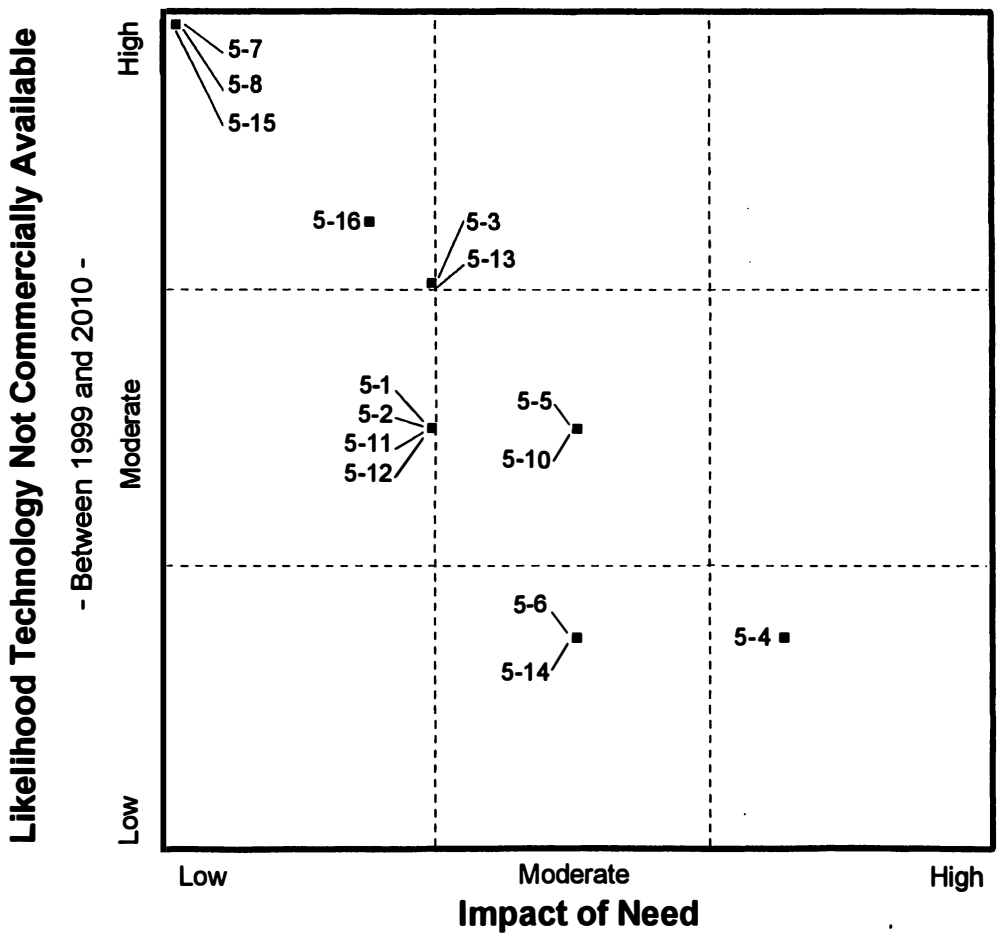


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	5.0	2.0	2
5-2	Extended reach drilling or production	5.0	1.0	1
5-3	Extended reach control systems	5.0	1.0	1
5-4	High pressure systems	4.0	2.0	2
5-5	Flowlines	5.0	1.0	3
5-6	Flow metering	4.3	3.0	3
5-7	Subsea equipment	4.3	1.0	3
5-8	External corrosion protection	3.0	2.3	3
5-9	Risers	4.5	2.0	4
5-10	ROV systems	4.0	1.0	2
5-11	Drilling	4.0	2.0	2
5-12	Workover	3.0	3.0	1
5-13	Water/gas injection	3.0	3.0	1
5-14	Hydrate prevention	5.0	2.0	2
5-15	Multi-phase pumps	4.3	2.3	3
5-16	Structures	5.0	1.0	2

Identification of Long-term R, D&D Targets

- Deepwater Offshore -

- integrated gas or oil -

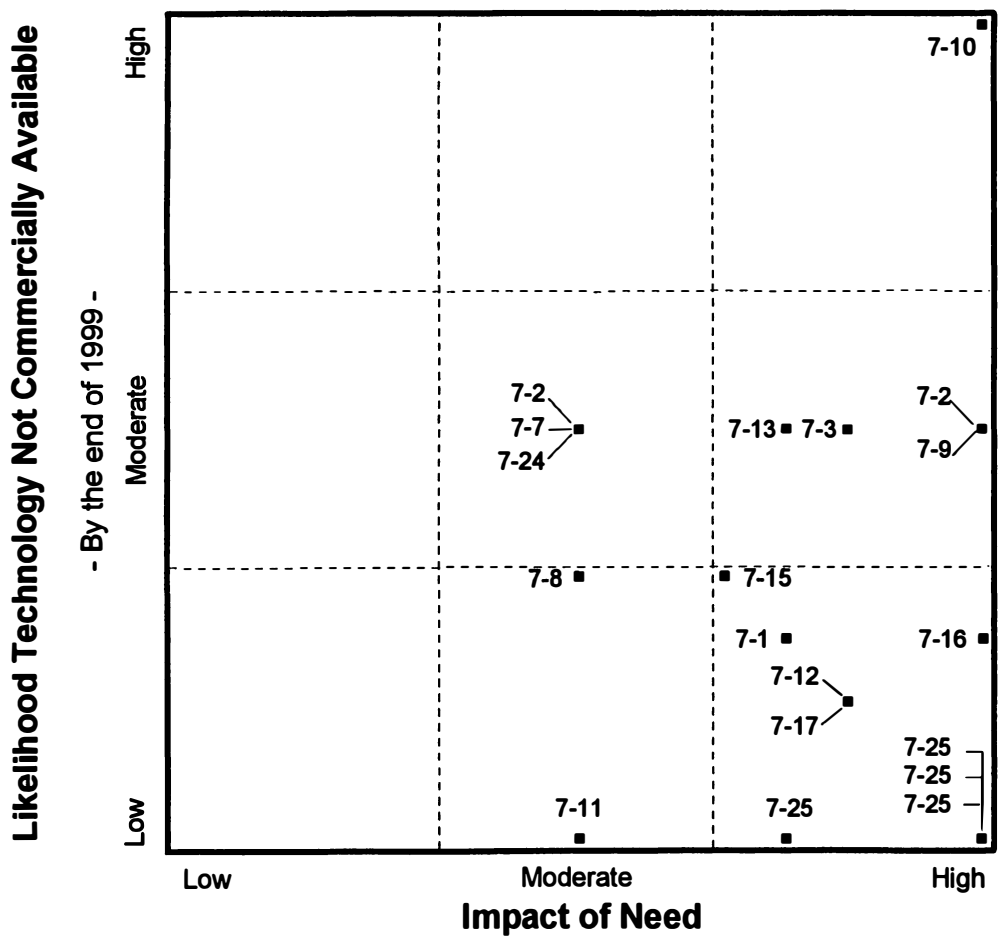


		Impact	Likelihood	n =
5-1	Produced fluid disposal	2.3	3.0	3
5-2	Extended reach drilling or production	2.3	3.0	3
5-3	Extended reach control systems	2.3	3.7	3
5-4	High pressure systems	4.0	2.0	2
5-5	Flowlines	3.0	3.0	2
5-6	Flow metering	3.0	2.0	2
5-7	Subsea equipment	1.0	5.0	1
5-8	External corrosion protection	1.0	5.0	1
5-9	Risers	-	-	-
5-10	ROV systems	3.0	3.0	2
5-11	Drilling	2.3	3.0	3
5-12	Workover	2.3	3.0	3
5-13	Water/gas injection	2.3	3.7	3
5-14	Hydrate prevention	3.0	2.0	2
5-15	Multi-phase pumps	1.0	5.0	1
5-16	Structures	2.0	4.0	2

Identification of Short-term R, D&D Targets

- Oil Processing and Refining -

- integrated gas or oil -

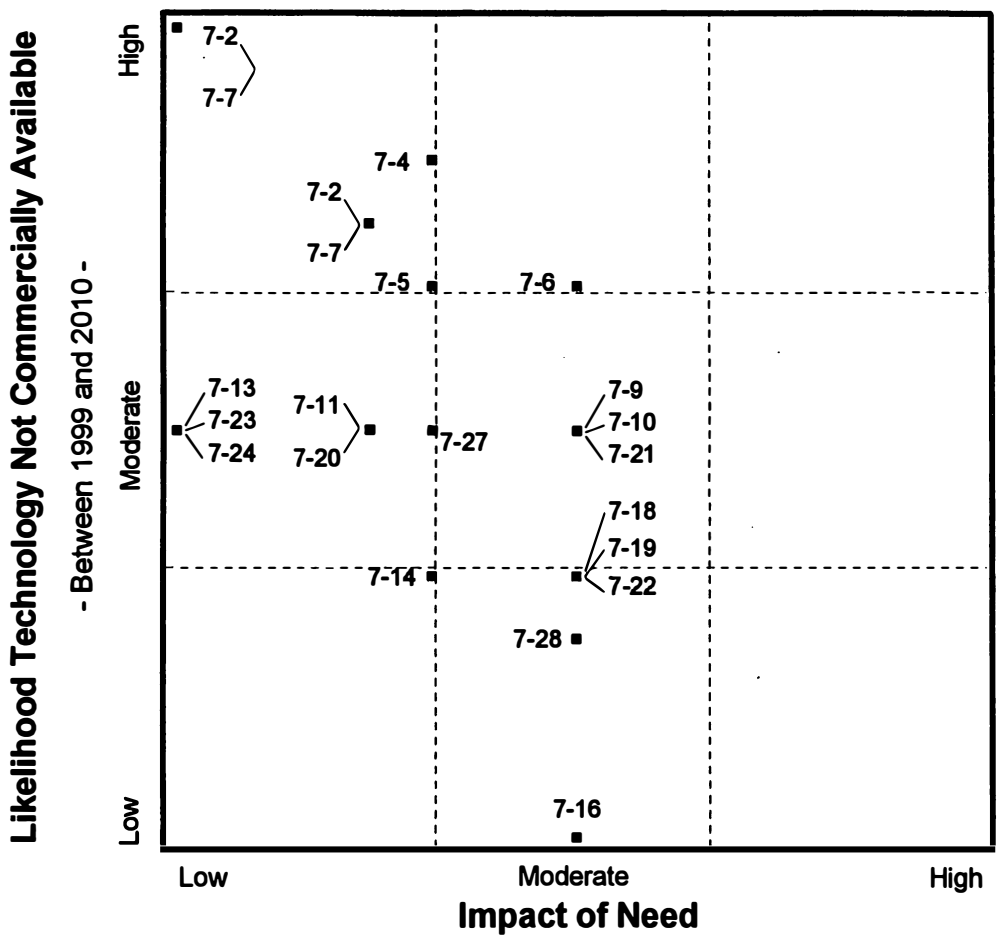


		Impact	Likelihood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	4.0	2.0	2
7-2	Hydrogen production and recovery	3.0	3.0	1
7-3	Plant and process reliability	4.3	3.0	3
7-4	Unconventional process technology	-	-	-
7-5	New materials of construction	-	-	-
7-6	Reactor engineering and modeling	-	-	-
7-7	Catalyst manufacturing technology	3.0	3.0	1
7-8	Risk assessment methodology	3.0	2.3	3
7-9	Solid acid catalysts	5.0	3.0	1
7-10	Alternatives to olefin alkylation process	5.0	5.0	1
7-11	Techniques for integration of environmental solutions into process and plant design	3.0	1.0	1
7-12	Improved on-line NDE inspection technology	4.3	1.7	3
7-13	Predicting useful remaining lifetimes of aging equipment	4.0	3.0	2
7-14	Robotics for safety applications	-	-	-
7-15	Worker safety systems	3.7	2.3	3
7-16	Energy efficiency of processes	5.0	2.0	2
7-17	Energy efficiency of equipment	4.3	1.7	3
7-18	Energy efficiency of separations	-	-	-
7-19	Separations technologies	-	-	-
7-20	Determining chemical composition of crudes, refinery intermediates, and products	5.0	1.0	1
7-21	New approaches to refining heavy feeds	5.0	3.0	1
7-22	Processing synthetic fuels	-	-	-
7-23	Conversion of methane to liquid fuels	-	-	-
7-24	Relating chemical compositions to process and product performance	3.0	3.0	1
7-25	Advanced computational modeling of processes/reactions	4.0	1.0	2
7-26	Advanced control and information systems	5.0	1.0	3
7-27	Performance characteristics of new hydrocarbon fuel compositions	-	-	-
7-28	Environmental characteristics of new hydrocarbon fuel compositions	5.0	1.0	1

Identification of Long-term R, D&D Targets

- Oil Processing and Refining -

- integrated gas or oil -

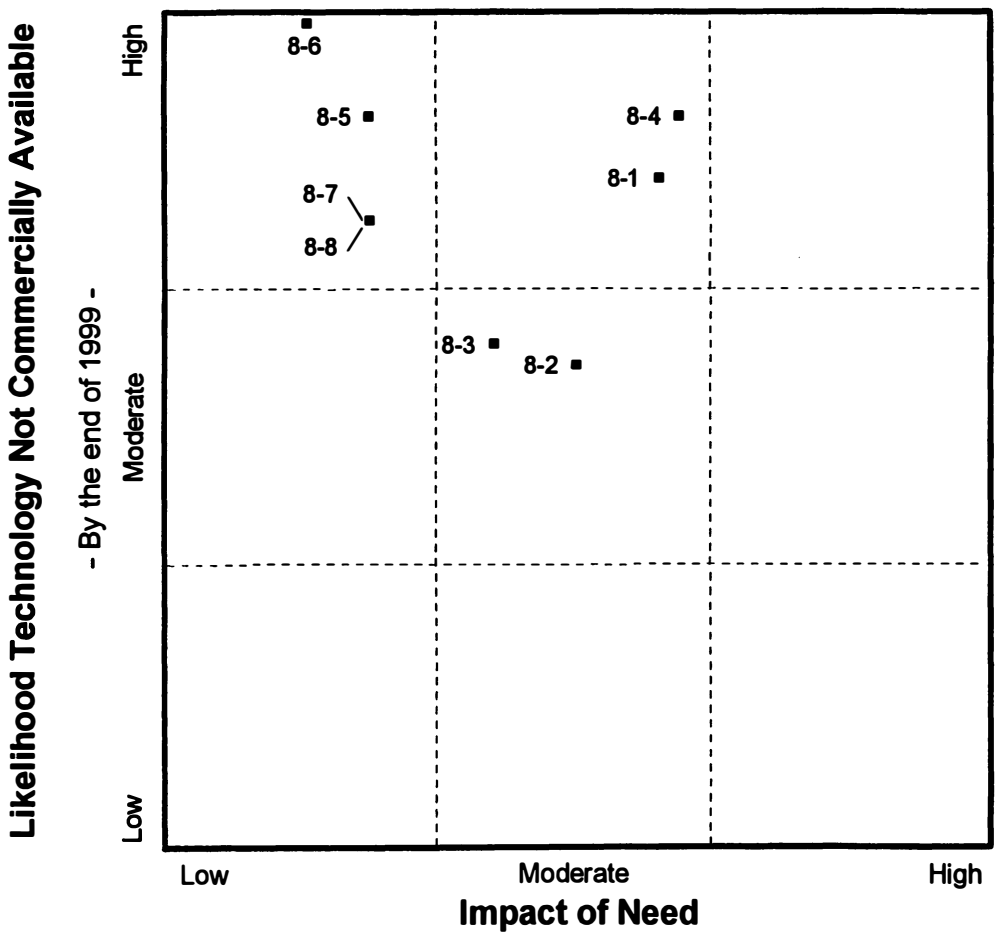


		Impact	Likeli-hood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	1.0	5.0	1
7-2	Hydrogen production and recovery	2.0	4.0	2
7-3	Plant and process reliability	-	-	-
7-4	Unconventional process technology	2.3	4.3	3
7-5	New materials of construction	2.3	3.7	3
7-6	Reactor engineering and modeling	3.0	3.7	3
7-7	Catalyst manufacturing technology	2.0	4.0	2
7-8	Risk assessment methodology	-	-	-
7-9	Solid acid catalysts	3.0	3.0	2
7-10	Alternatives to olefin alkylation process	3.0	3.0	2
7-11	Techniques for integration of environmental solutions into process and plant design	2.0	3.0	2
7-12	Improved on-line NDE inspection technology	-	-	-
7-13	Predicting useful remaining lifetimes of aging equipment	1.0	3.0	1
7-14	Robotics for safety applications	2.3	2.3	3
7-15	Worker safety systems	-	-	-
7-16	Energy efficiency of processes	3.0	1.0	1
7-17	Energy efficiency of equipment	-	-	-
7-18	Energy efficiency of separations	3.0	2.3	3
7-19	Separations technologies	3.0	2.3	3
7-20	Determining chemical composition of crudes, refinery intermediates, and products	2.0	3.0	2
7-21	New approaches to refining heavy feeds	3.0	3.0	2
7-22	Processing synthetic fuels	3.0	2.3	3
7-23	Conversion of methane to liquid fuels	1.0	3.0	3
7-24	Relating chemical compositions to process and product performance	1.0	3.0	2
7-25	Advanced computational modeling of processes/reactions	1.0	5.0	1
7-26	Advanced control and information systems	-	-	-
7-27	Performance characteristics of new hydrocarbon fuel compositions	2.3	3.0	3
7-28	Environmental characteristics of new hydrocarbon fuel compositions	3.0	2.0	2

Identification of Short-term R, D&D Targets

- Gas Processing -

- integrated gas or oil -

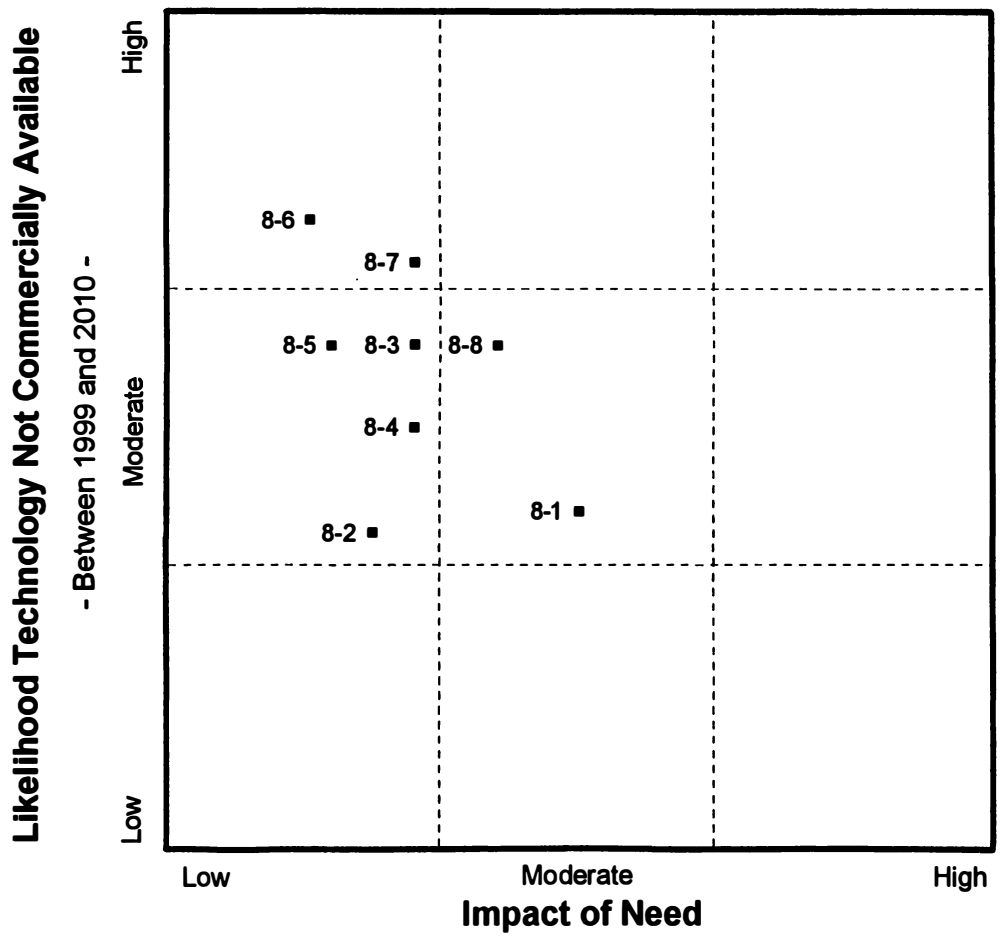


		Impact	Likeli-hood	n =
8-1	Gas dehydration	3.4	4.2	5
8-2	Acid gas removal	3.0	3.3	7
8-3	H_2S scavenger technology	2.6	3.4	5
8-4	Natural gas liquid separation	3.5	4.5	4
8-5	Nitrogen separation	2.0	4.5	4
8-6	Trace constituent (arsenic, Hg, etc.) removal	1.7	5.0	3
8-7	Sulfur recovery	2.0	4.0	4
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	2.0	4.0	4

Identification of Long-term R, D&D Targets

- Gas Processing -

- integrated gas or oil -

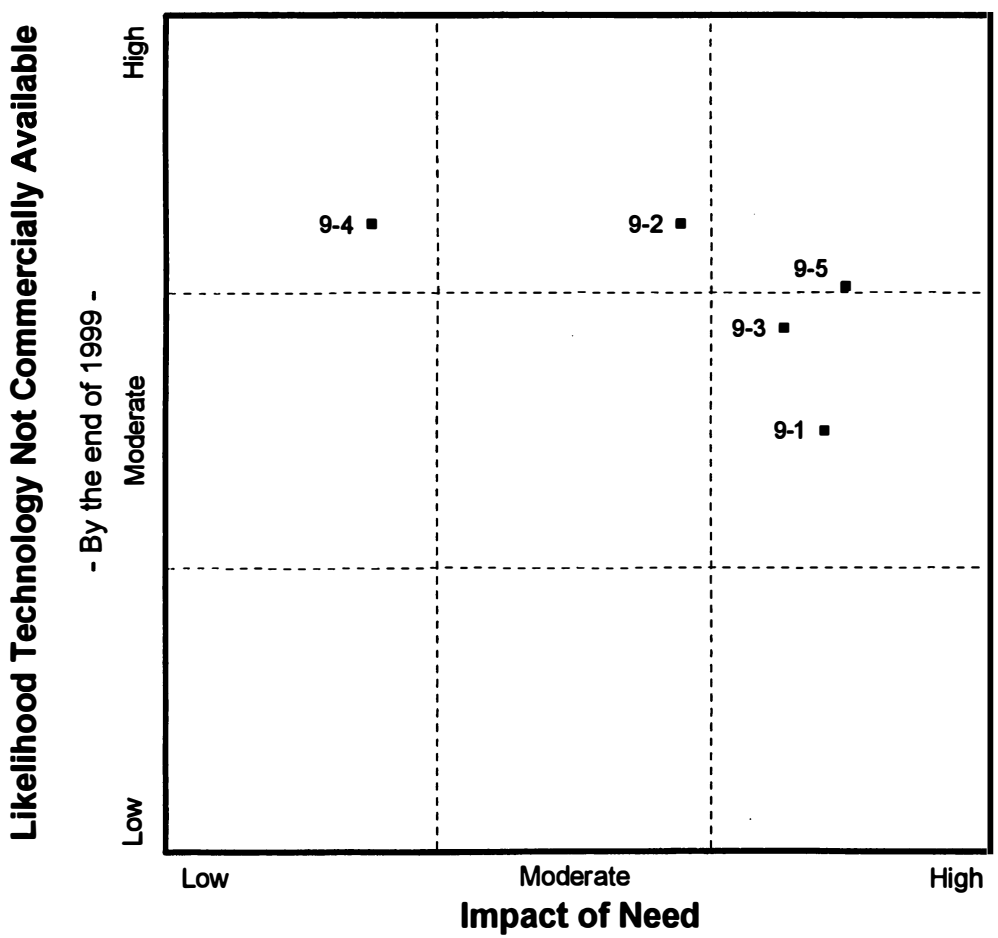


		Impact	Likeli-hood	n =
8-1	Gas dehydration	3.0	2.6	5
8-2	Acid gas removal	2.0	2.5	4
8-3	H_2S scavenger technology	2.2	3.4	5
8-4	Natural gas liquid separation	2.2	3.0	5
8-5	Nitrogen separation	1.8	3.4	5
8-6	Trace constituent (arsenic, Hg, etc.) removal	1.7	4.0	6
8-7	Sulfur recovery	2.2	3.8	5
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	2.6	3.4	5

Identification of Short-term R, D&D Targets

- Gas Gathering -

- integrated gas or oil -

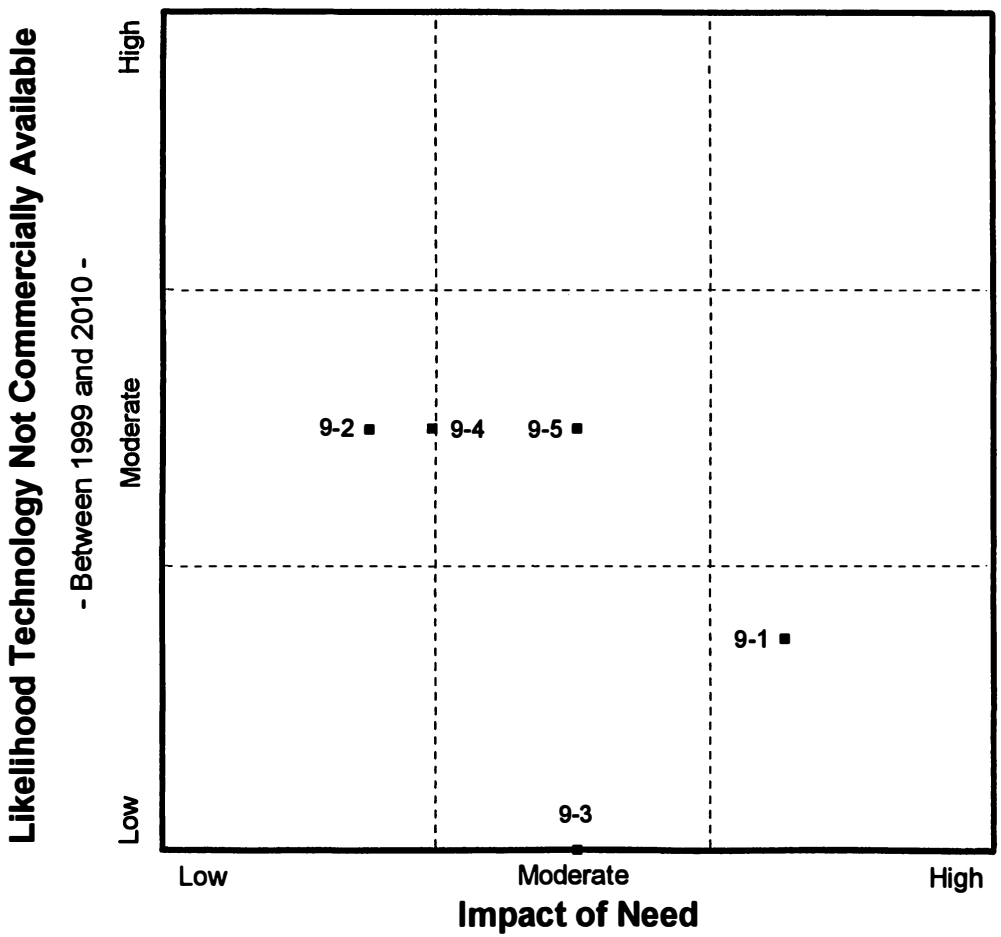


		Impact	Likeli-hood	n =
9-1	Compression	4.2	3.0	5
9-2	Leak detection	3.5	4.0	4
9-3	Plastic pipe (higher pressure rating)	4.0	3.5	4
9-4	High pressure measurement	2.0	4.0	2
9-5	Multi-phase metering	4.3	3.7	3

Identification of Long-term R, D&D Targets

- Gas Gathering -

- integrated gas or oil -

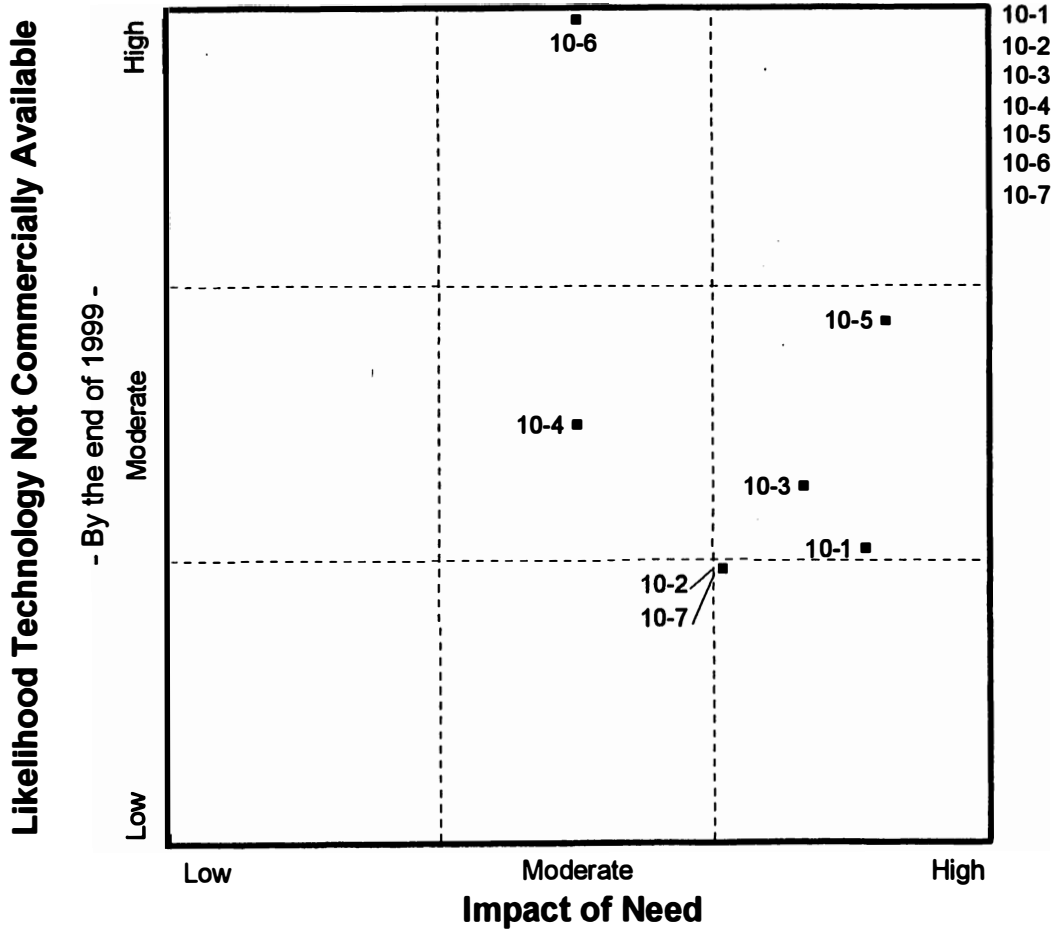


		Impact	Likelihood	n =
9-1	Compression	4.0	2.0	2
9-2	Leak detection	2.0	3.0	2
9-3	Plastic pipe (higher pressure rating)	3.0	1.0	2
9-4	High pressure measurement	2.3	3.0	3
9-5	Multi-phase metering	3.0	3.0	1

Identification of Short-term R, D&D Targets

- Gas Storage -

- integrated gas or oil -

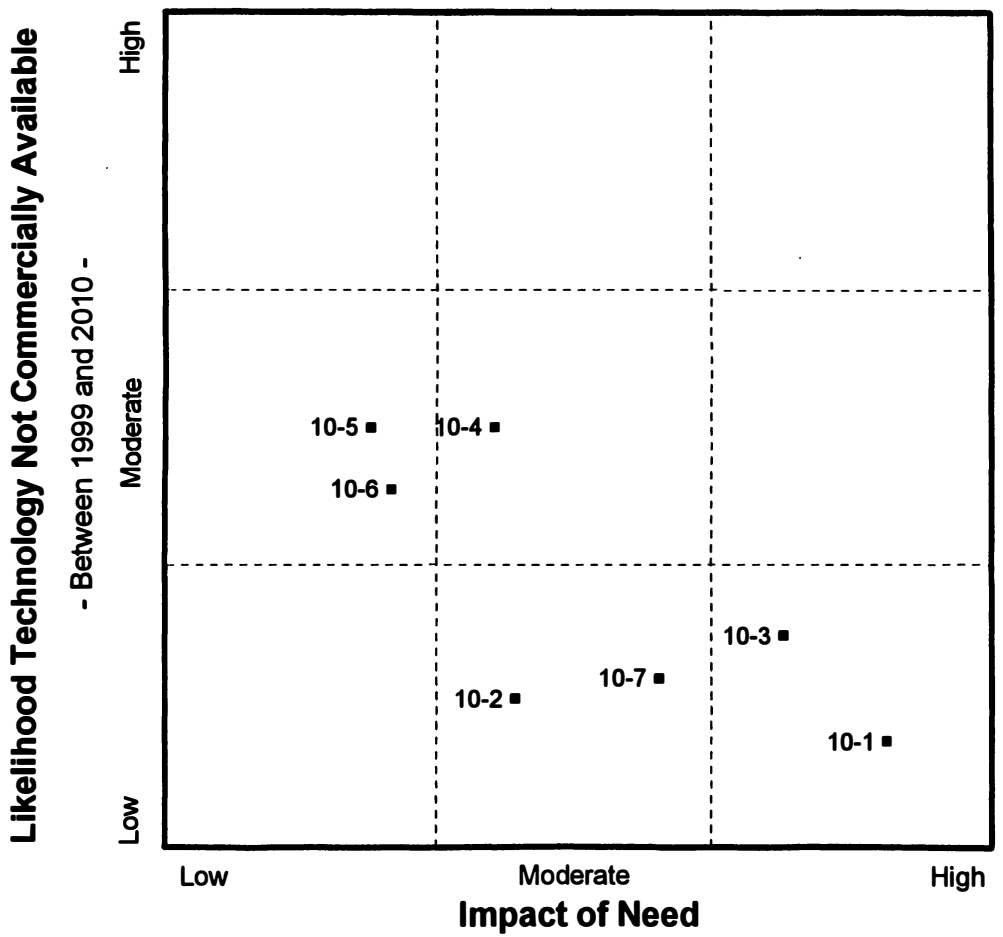


		Impact	Likeli-hood	n =
10-1	Well deliverability restoration	4.4	2.4	7
10-2	Leak detection and mitigation	3.7	2.3	3
10-3	Reservoir management	4.1	2.7	7
10-4	Gas migration control	3.0	3.0	3
10-5	Base gas minimization techniques	4.5	3.5	4
10-6	Inert base gas research	3.0	5.0	1
10-7	Unconventional development techniques	3.7	2.3	3

Identification of Long-term R, D&D Targets

- Gas Storage -

- integrated gas or oil -

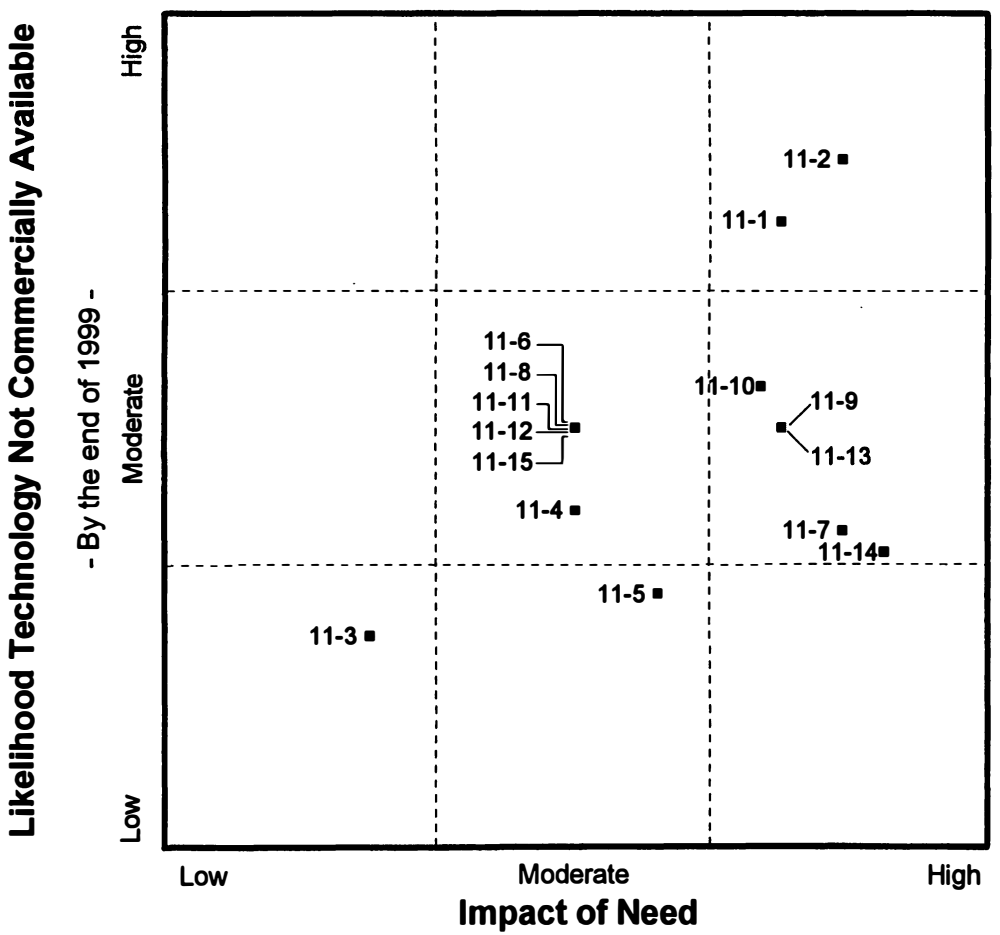


		Impact	Likeli-hood	n =
10-1	Well deliverability restoration	4.5	1.5	4
10-2	Leak detection and mitigation	2.7	1.7	6
10-3	Reservoir management	4.0	2.0	2
10-4	Gas migration control	2.6	3.0	5
10-5	Base gas minimization techniques	2.0	3.0	4
10-6	Inert base gas research	2.1	2.7	7
10-7	Unconventional development techniques	3.4	1.8	5

Identification of Short-term R, D&D Targets

- Environmental and Regulatory -

- integrated gas or oil -

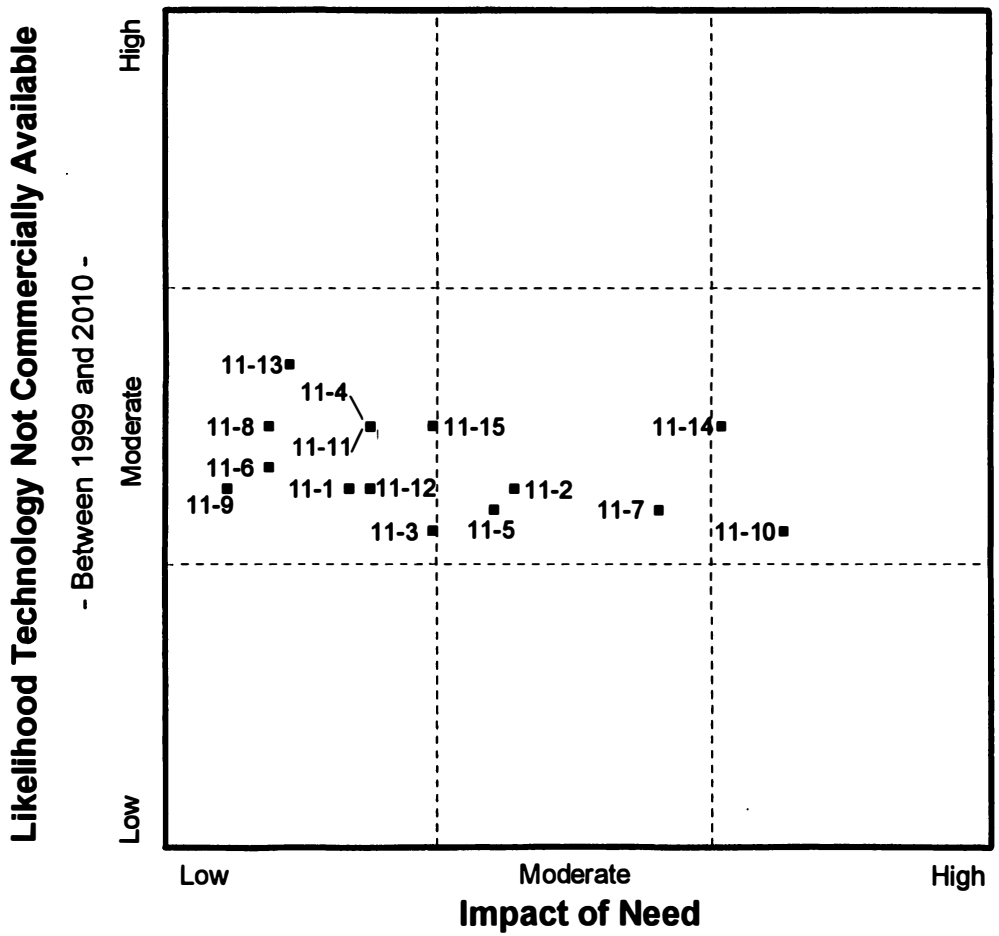


		Impact	Likeli-hood	n =
11-1	Disposal methods for drilling fluids	4.0	4.0	2
11-2	Treatment and disposal of produced fluids	4.3	4.3	3
11-3	Screening procedures for injection wells	2.0	2.0	2
11-4	Risk and reclamation analysis of disposal methods	3.0	2.6	5
11-5	Leak detection	3.4	2.2	5
11-6	Hydrological modeling	3.0	3.0	1
11-7	Compliance with CAAA stationary source issue	4.3	2.5	8
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	3.0	3.0	7
11-9	Model transport and remediation of contaminants in ground water and soils	4.0	3.0	2
11-10	Effluent and emission monitoring, minimization, and control	3.9	3.2	9
11-11	Recycling of waste and byproduct streams	3.0	3.0	6
11-12	Remediation technology	3.0	3.0	5
11-13	Catalyst recycling	4.0	3.0	2
11-14	Provide scientific basis for risk-based regulation	4.5	2.4	8
11-15	NORM disposal	3.0	3.0	7

Identification of Long-term R, D&D Targets

- Environmental and Regulatory -

- integrated gas or oil -

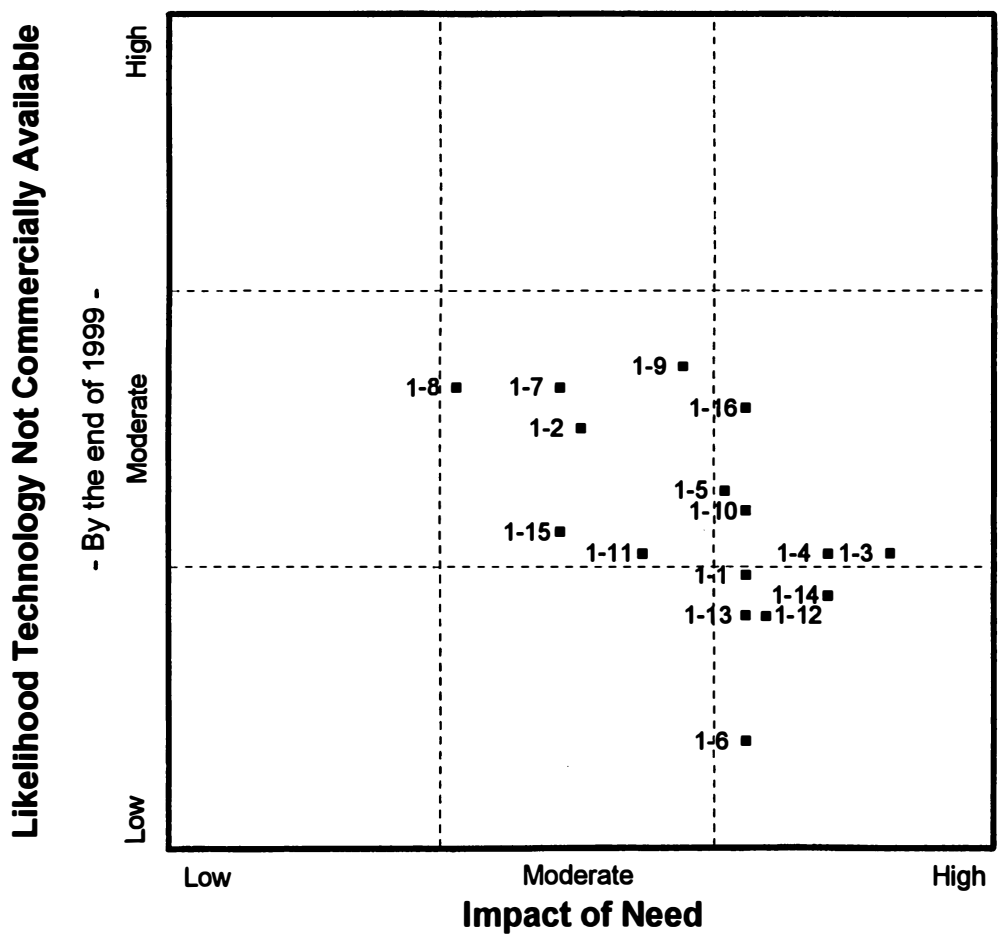


		Impact	Likeli-hood	n =
11-1	Disposal methods for drilling fluids	1.9	2.7	7
11-2	Treatment and disposal of produced fluids	2.7	2.7	7
11-3	Screening procedures for injection wells	2.3	2.5	8
11-4	Risk and reclamation analysis of disposal methods	2.0	3.0	4
11-5	Leak detection	2.6	2.6	5
11-6	Hydrological modeling	1.5	2.8	8
11-7	Compliance with CAAA stationary source issue	3.4	2.6	5
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	1.5	3.0	4
11-9	Model transport and remediation of contaminants in ground water and soils	1.3	2.7	7
11-10	Effluent and emission monitoring, minimization, and control	4.0	2.5	4
11-11	Recycling of waste and byproduct streams	2.0	3.0	4
11-12	Remediation technology	2.0	2.7	6
11-13	Catalyst recycling	1.6	3.3	7
11-14	Provide scientific basis for risk-based regulation	3.7	3.0	6
11-15	NORM disposal	2.3	3.0	3

Identification of Short-term R, D&D Targets

- Exploration -

- independents -

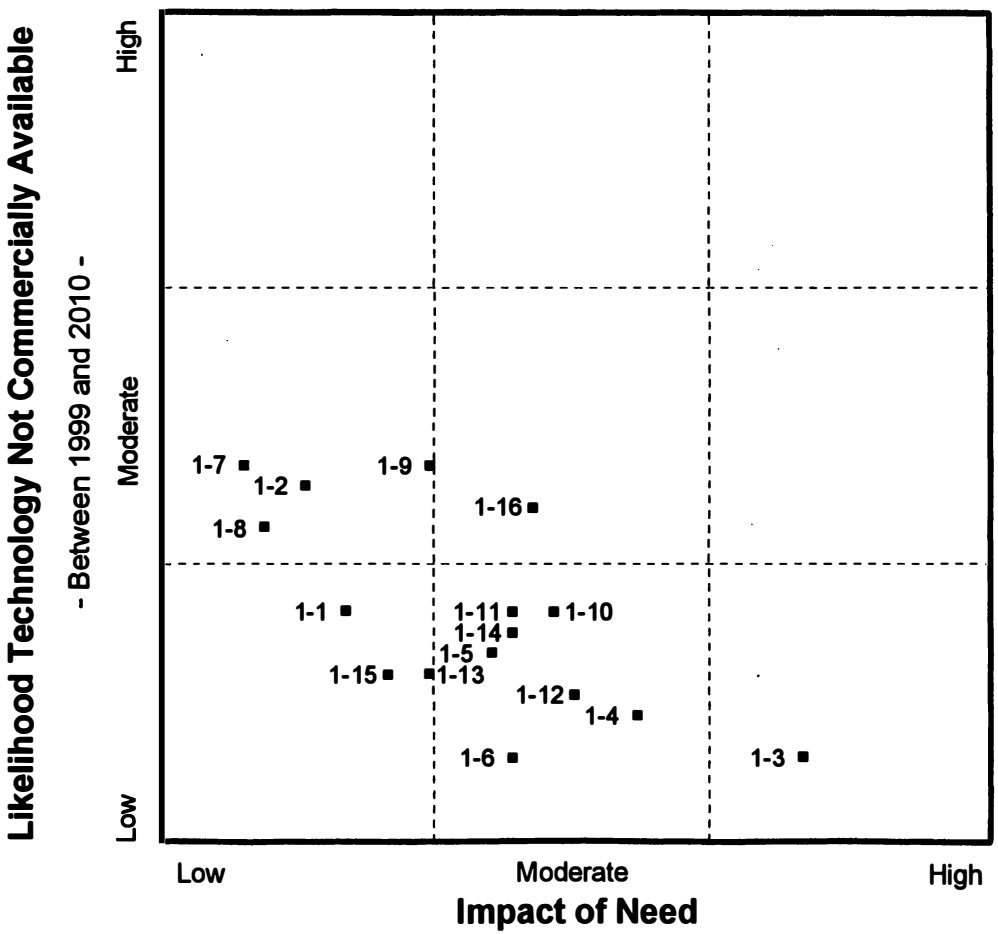


		Impact	Likelihood	n =
1-1	3D Basin modeling	3.8	2.3	17
1-2	Risk assessment methods	3.0	3.0	19
1-3	High-resolution seismic depth imaging	4.5	2.4	28
1-4	Specialized seismic processing	4.2	2.4	24
1-5	Sequence stratigraphy techniques	3.7	2.7	20
1-6	Workstation seismic modeling	3.8	1.5	27
1-7	Geochemical analysis	2.9	3.2	13
1-8	Airborne/satellite remote sensing	2.4	3.2	10
1-9	Fault seal analysis	3.5	3.3	19
1-10	Multi-component seismic techniques	3.8	2.6	18
1-11	3D Paleostructural restoration	3.3	2.4	17
1-12	Amplitude versus offset (AVO) in 3D	3.9	2.1	26
1-13	3D Visualization tools	3.8	2.1	23
1-14	Advanced seismic acquisition	4.2	2.2	26
1-15	Geographic information systems	2.9	2.5	17
1-16	Geophysical fracture-detection methods	3.8	3.1	20

Identification of Long-term R, D&D Targets

- Exploration -

- independents -

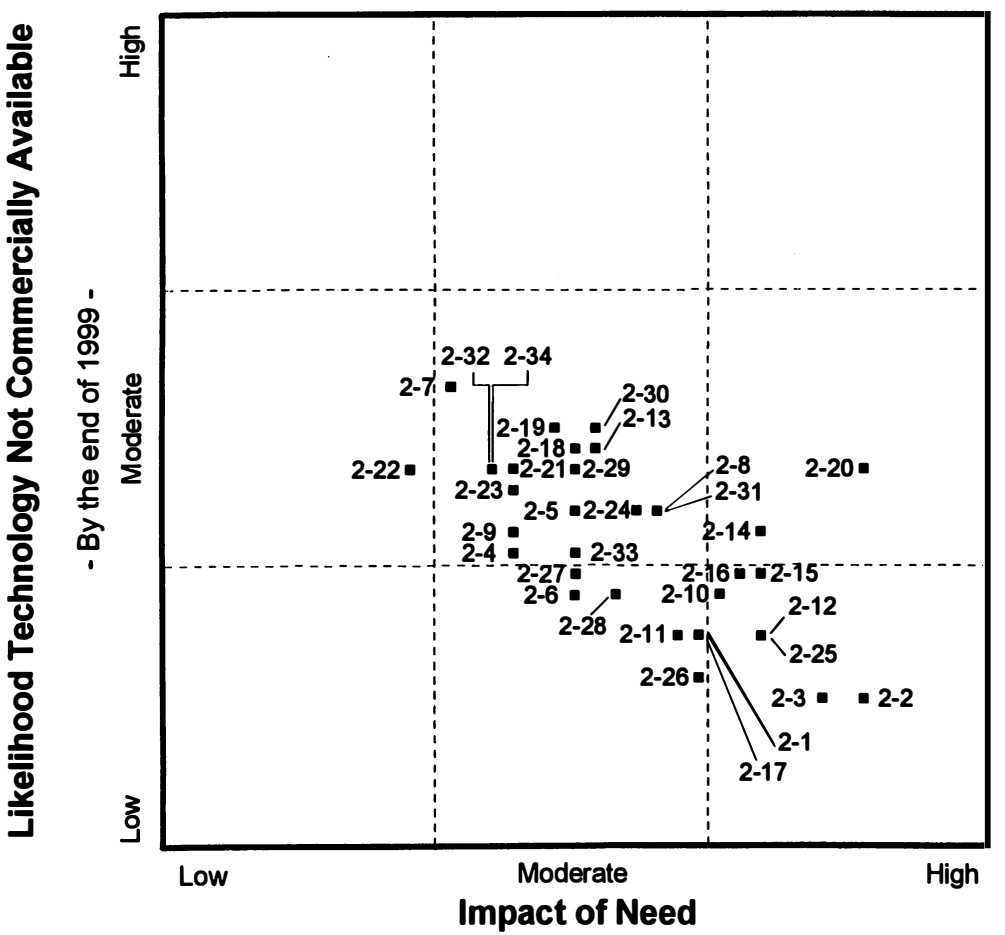


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	1.9	2.1	15
1-2	Risk assessment methods	1.7	2.7	14
1-3	High-resolution seismic depth imaging	4.1	1.4	11
1-4	Specialized seismic processing	3.3	1.6	14
1-5	Sequence stratigraphy techniques	2.6	1.9	18
1-6	Workstation seismic modeling	2.7	1.4	5
1-7	Geochemical analysis	1.4	2.8	18
1-8	Airborne/satellite remote sensing	1.5	2.5	21
1-9	Fault seal analysis	2.3	2.8	16
1-10	Multi-component seismic techniques	2.9	2.1	17
1-11	3D Paleostructural restoration	2.7	2.1	18
1-12	Amplitude versus offset (AVO) in 3D	3.0	1.7	9
1-13	3D Visualization tools	2.3	1.8	10
1-14	Advanced seismic acquisition	2.7	2.0	12
1-15	Geographic information systems	2.1	1.8	17
1-16	Geophysical fracture-detection methods	2.8	2.6	16

Identification of Short-term R, D&D Targets

-Development-

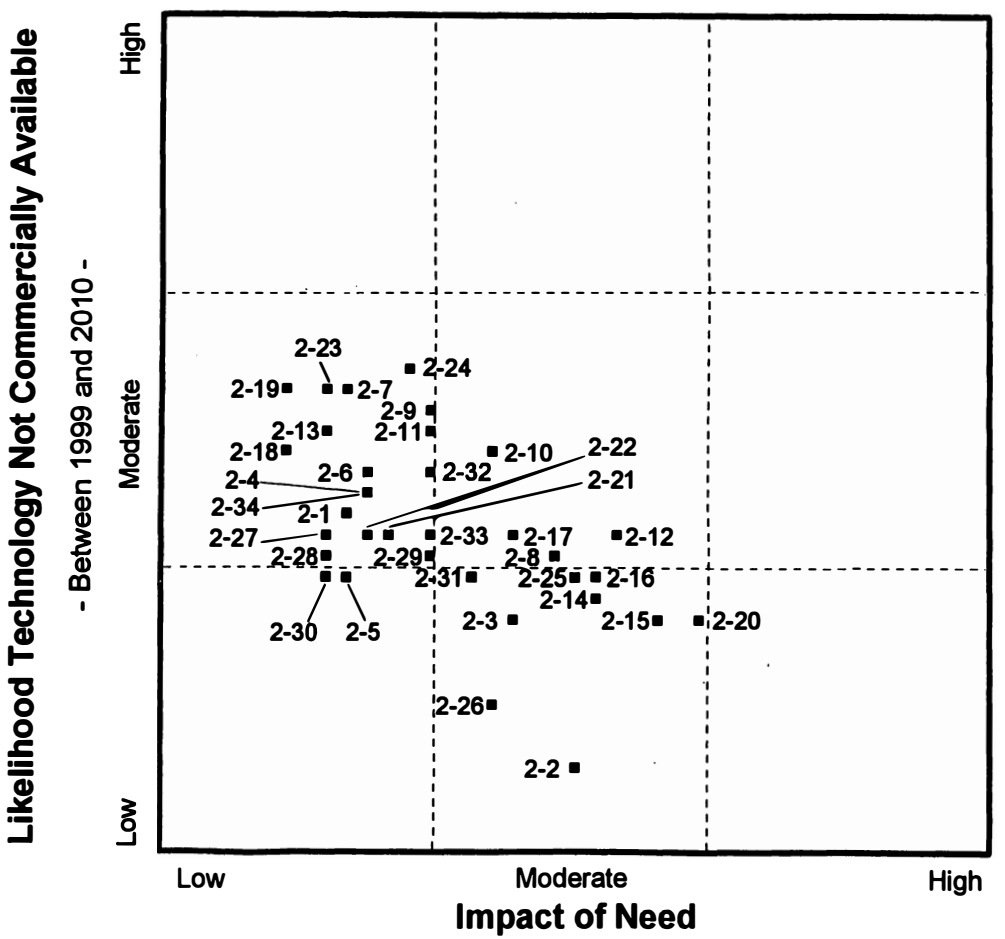
- independents -



		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	3.6	2.0	16
2-2	Computer-based 3-D geological modeling	4.4	1.7	23
2-3	Development-scale seismic applications	4.2	1.7	24
2-4	Tracers (biologic/chemical/radioactive)	2.7	2.4	13
2-5	Core analysis/imaging	3.0	2.6	18
2-6	Geostatistical reservoir descriptions	3.0	2.2	18
2-7	Outcrop analog studies	2.4	3.2	12
2-8	Fluid-rock interaction	3.4	2.6	18
2-9	Rock physics	2.7	2.5	15
2-10	Cross-well geophysical imaging	3.7	2.2	18
2-11	Advanced attribute processing	3.5	2.0	16
2-12	Seismic/log/core calibration	3.9	2.0	25
2-13	Cuttings analysis	3.1	2.9	14
2-14	Reservoir property identification	3.9	2.5	22
2-15	Through casing logging	3.9	2.3	24
2-16	Deep investigation techniques	3.8	2.3	22
2-17	High resolution borehole imaging logs	3.6	2.0	20
2-18	Specialized core analysis	3.0	2.9	14
2-19	Characterization of rock wettability	2.9	3.0	15
2-20	Permeability logging techniques	4.4	2.8	24
2-21	Tracer techniques	2.7	2.8	11
2-22	CT scanning and NMR imaging	2.2	2.8	12
2-23	Formation water chemistry	2.7	2.7	14
2-24	Fluid sampling and analysis	3.3	2.6	15
2-25	Advanced reservoir simulation modeling	3.9	2.0	21
2-26	Workstation single well simulations	3.6	1.8	17
2-27	Procedures for data scale-up	3.0	2.3	8
2-28	Expert systems applications	3.2	2.2	10
2-29	Time lapse seismic imaging	3.0	2.8	8
2-30	Advanced monitoring of EOR processes	3.1	3.0	13
2-31	Advanced well testing and interpretation	3.4	2.6	18
2-32	Material balance applications	2.6	2.8	13
2-33	Decision and risk analysis	3.0	2.4	14
2-34	Expendable well bore instrumentation	2.6	2.8	8

Identification of Long-term R, D&D Targets

-Development-
- independents -

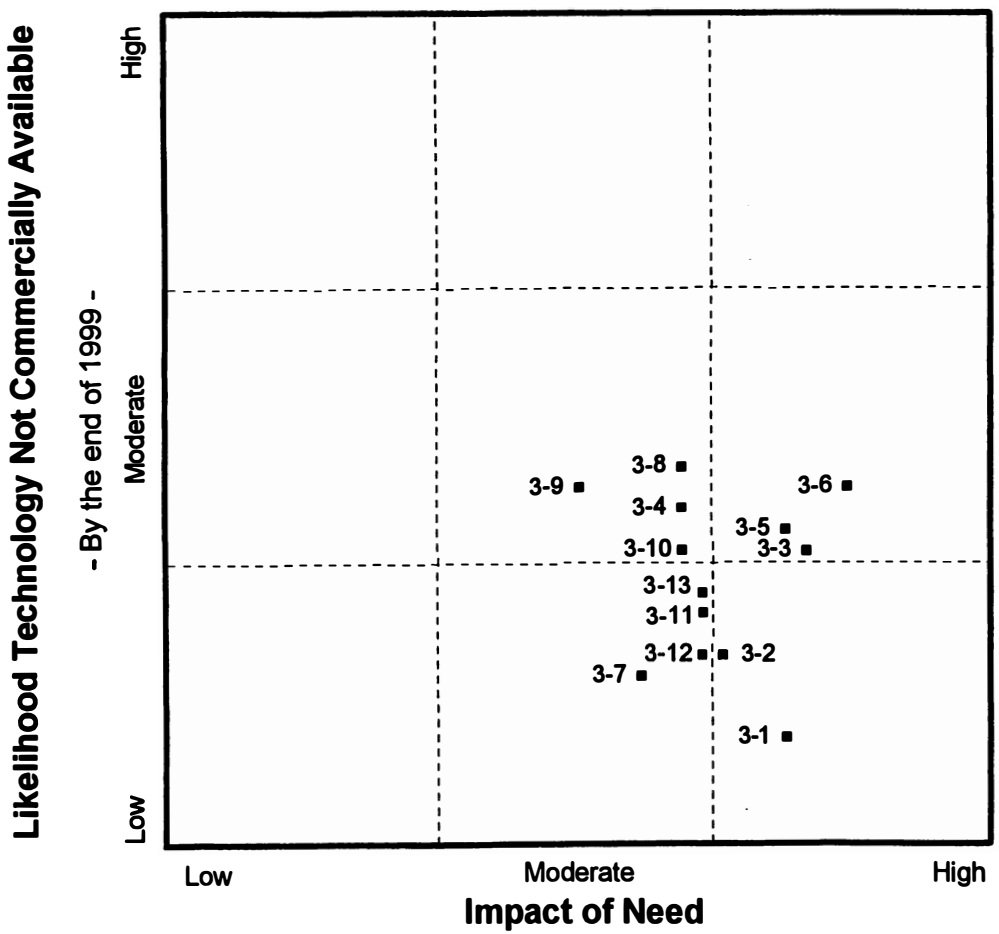


		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	1.9	2.6	16
2-2	Computer-based 3-D geological modeling	3.0	1.4	10
2-3	Development-scale seismic applications	2.7	2.1	11
2-4	Tracers (biologic/chemical/radioactive)	2.0	2.7	21
2-5	Core analysis/imaging	1.9	2.3	15
2-6	Geostatistical reservoir descriptions	2.0	2.8	18
2-7	Outcrop analog studies	1.9	3.2	18
2-8	Fluid-rock interaction	2.9	2.4	17
2-9	Rock physics	2.3	3.1	20
2-10	Cross-well geophysical imaging	2.6	2.9	17
2-11	Advanced attribute processing	2.3	3.0	16
2-12	Seismic/log/core calibration	3.2	2.5	11
2-13	Cuttings analysis	1.8	3.0	18
2-14	Reservoir property identification	3.1	2.2	15
2-15	Through casing logging	3.4	2.1	14
2-16	Deep investigation techniques	3.1	2.3	15
2-17	High resolution borehole imaging logs	2.7	2.5	13
2-18	Specialized core analysis	1.6	2.9	16
2-19	Characterization of rock wettability	1.6	3.2	17
2-20	Permeability logging techniques	3.6	2.1	14
2-21	Tracer techniques	2.1	2.5	22
2-22	CT scanning and NMR imaging	2.0	2.5	19
2-23	Formation water chemistry	1.8	3.2	18
2-24	Fluid sampling and analysis	2.2	3.3	16
2-25	Advanced reservoir simulation modeling	3.0	2.3	15
2-26	Workstation single well simulations	2.6	1.7	15
2-27	Procedures for data scale-up	1.8	2.5	22
2-28	Expert systems applications	1.8	2.4	18
2-29	Time lapse seismic imaging	2.3	2.4	21
2-30	Advanced monitoring of EOR processes	1.8	2.3	19
2-31	Advanced well testing and interpretation	2.5	2.3	16
2-32	Material balance applications	2.3	2.8	19
2-33	Decision and risk analysis	2.3	2.5	16
2-34	Expendable well bore instrumentation	2.0	2.7	20

Identification of Short-term R, D&D Targets

- Drilling and Completion -

- independents -

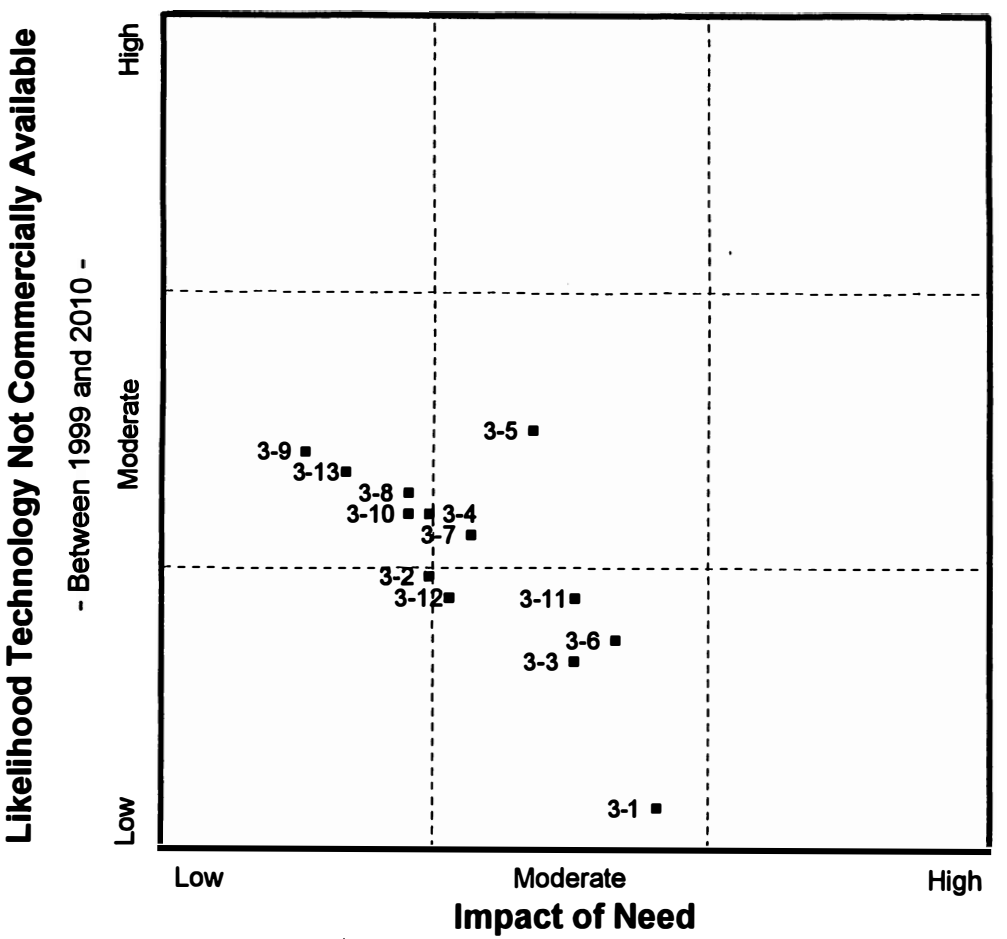


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	4.0	1.5	26
3-2	Drilling fluid design	3.7	1.9	21
3-3	Advanced fracture techniques	4.1	2.4	26
3-4	Cementing	3.5	2.6	21
3-5	Perforating and well bore cleanup	4.0	2.5	24
3-6	Well productivity	4.3	2.7	25
3-7	Multilateral technology	3.3	1.8	13
3-8	Innovative bit and tubular technology	3.5	2.8	18
3-9	Slim hole drilling	3.0	2.7	14
3-10	Under balanced drilling	3.5	2.4	10
3-11	Measurements while drilling	3.6	2.1	23
3-12	Coiled tubing drilling	3.6	1.9	15
3-13	Unconventional drilling technology	3.6	2.2	12

Identification of Long-term R, D&D Targets

- Drilling and Completion -

- independents -

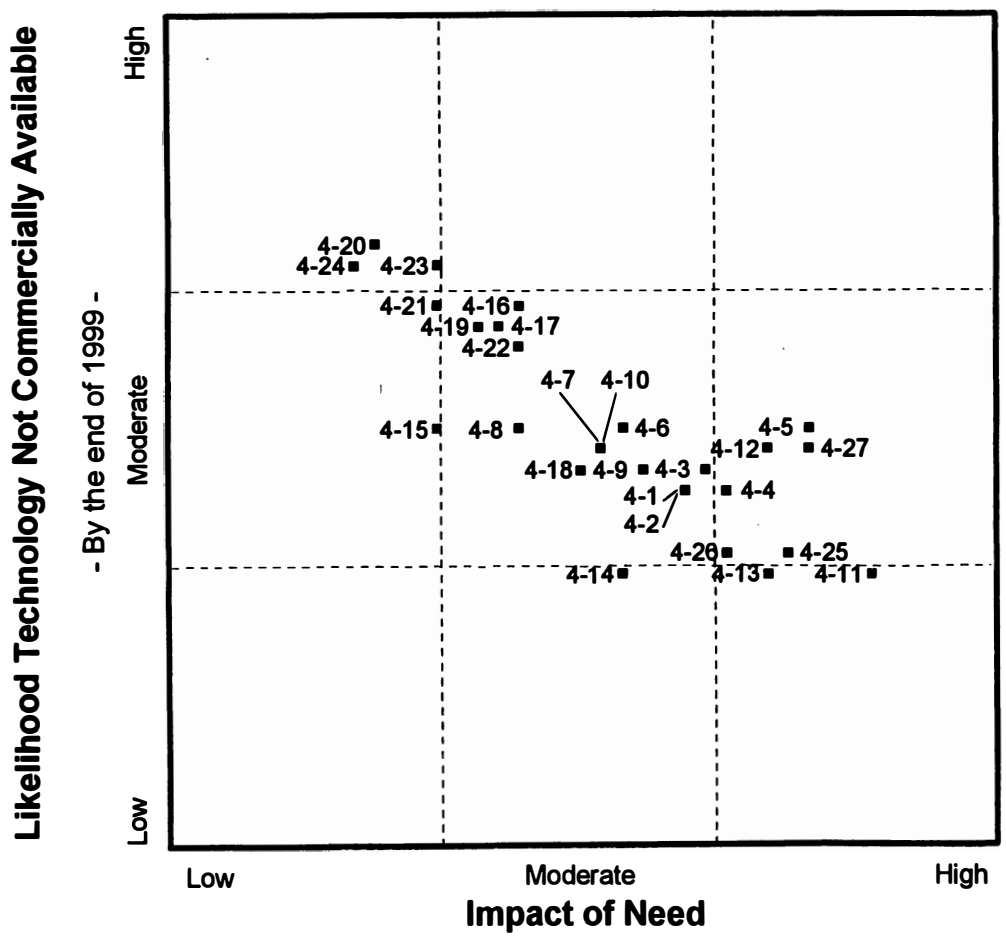


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	3.4	1.2	11
3-2	Drilling fluid design	2.3	2.3	16
3-3	Advanced fracture techniques	3.0	1.9	7
3-4	Cementing	2.3	2.6	15
3-5	Perforating and well bore cleanup	2.8	3.0	9
3-6	Well productivity	3.2	2.0	10
3-7	Multilateral technology	2.5	2.5	19
3-8	Innovative bit and tubular technology	2.2	2.7	18
3-9	Slim hole drilling	1.7	2.9	19
3-10	Under balanced drilling	2.2	2.6	19
3-11	Measurements while drilling	3.0	2.2	13
3-12	Coiled tubing drilling	2.4	2.2	19
3-13	Unconventional drilling technology	1.9	2.8	20

Identification of Short-term R, D&D Targets

- Production -

- independents -

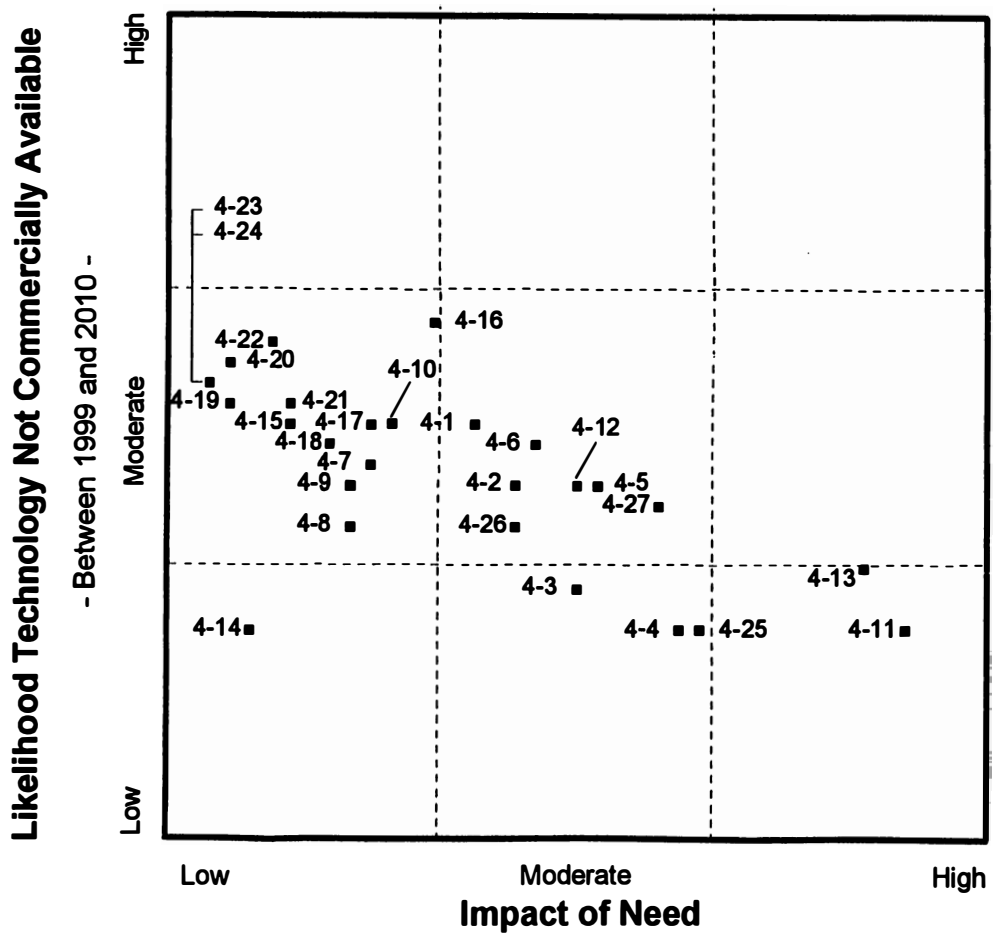


		Impact	Likelihood	n =
4-1	Injection water treatment	3.5	2.7	21
4-2	Produced water treatment	3.5	2.7	22
4-3	Corrosion control	3.6	2.8	25
4-4	Scaling inhibitors	3.7	2.7	27
4-5	Paraffin control/removal	4.1	3.0	25
4-6	Oil/water/gas/separation	3.2	3.0	20
4-7	Beam pump analysis	3.1	2.9	19
4-8	Gas lift analysis	2.7	3.0	17
4-9	Submersible pump analysis	3.3	2.8	18
4-10	Rod/tubing wear evaluation	3.1	2.9	19
4-11	Stimulation techniques	4.4	2.3	29
4-12	Gas compression techniques	3.9	2.9	23
4-13	Recompletion techniques	3.9	2.3	28
4-14	Remote control and data analysis	3.2	2.3	18
4-15	Compact processing on offshore platforms	2.3	3.0	11
4-16	Modification of reservoir fluid mobilities	2.7	3.6	14
4-17	Miscible contact/displacement	2.6	3.5	11
4-18	Viscosity reduction of heavy oils	3.0	2.8	12
4-19	In situ generation of foams/emulsions	2.5	3.5	8
4-20	Thickeners for CO_2 floods	2.0	3.9	7
4-21	Microbial EOR processes	2.3	3.6	7
4-22	High-velocity gas flow modeling	2.7	3.4	11
4-23	Thermal processes	2.3	3.8	8
4-24	Combustion processes	1.9	3.8	8
4-25	Near well bore stimulation	4.0	2.4	24
4-26	New directional drilling	3.7	2.4	19
4-27	Advanced recovery of natural gas	4.1	2.9	20

Identification of Long-term R, D&D Targets

- Production -

- independents -

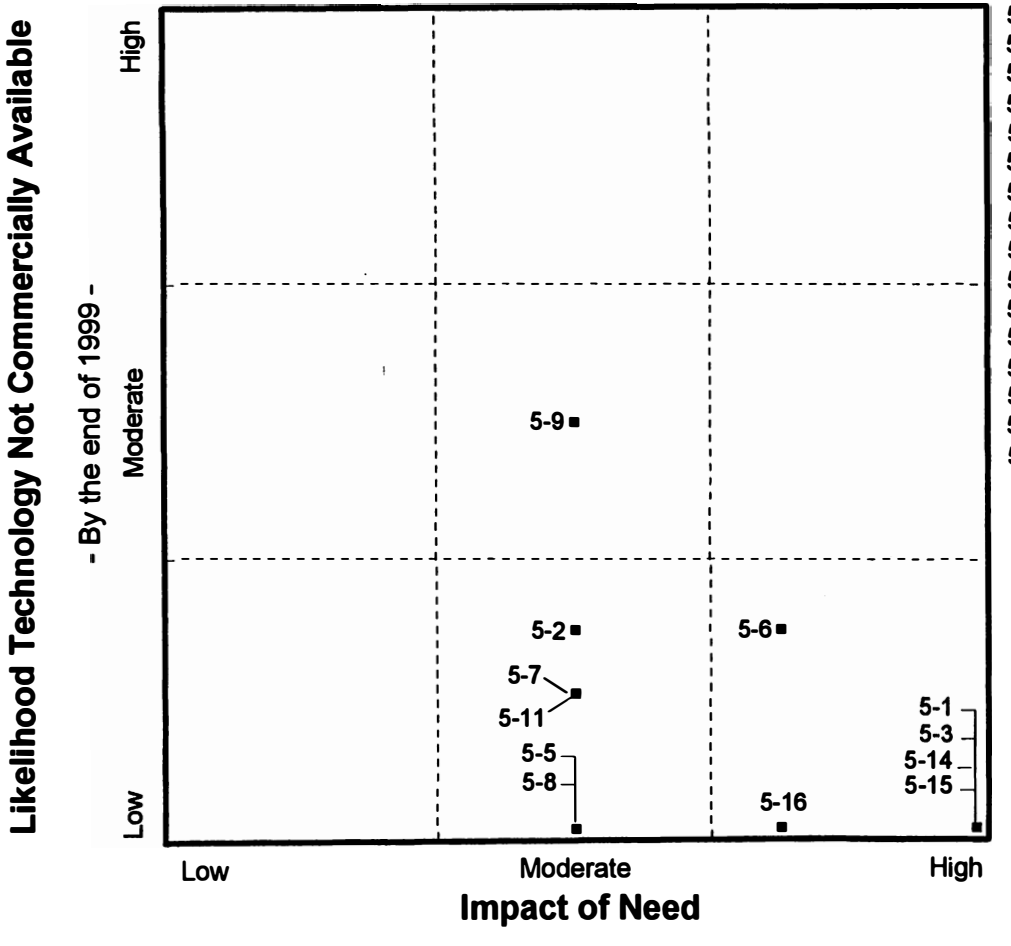


		Impact	Likeli-hood	n =
4-1	Injection water treatment	2.5	3.0	16
4-2	Produced water treatment	2.7	2.7	14
4-3	Corrosion control	3.0	2.2	10
4-4	Scaling inhibitors	3.5	2.0	10
4-5	Paraffin control/removal	3.1	2.7	12
4-6	Oil/water/gas/separation	2.8	2.9	15
4-7	Beam pump analysis	2.0	2.8	12
4-8	Gas lift analysis	1.9	2.5	15
4-9	Submersible pump analysis	1.9	2.7	13
4-10	Rod/tubing wear evaluation	2.1	3.0	13
4-11	Stimulation techniques	4.6	2.0	8
4-12	Gas compression techniques	3.0	2.7	12
4-13	Recompletion techniques	4.4	2.3	6
4-14	Remote control and data analysis	1.4	2.0	14
4-15	Compact processing on offshore platforms	1.6	3.0	17
4-16	Modification of reservoir fluid mobilities	2.3	3.5	17
4-17	Miscible contact/displacement	2.0	3.0	19
4-18	Viscosity reduction of heavy oils	1.8	2.9	19
4-19	In situ generation of foams/emulsions	1.3	3.1	20
4-20	Thickeners for CO_2 foods	1.3	3.3	22
4-21	Microbial EOR processes	1.6	3.1	20
4-22	High-velocity gas flow modeling	1.5	3.4	19
4-23	Thermal processes	1.2	3.2	19
4-24	Combustion processes	1.2	3.2	19
4-25	Near well bore stimulation	3.6	2.0	10
4-26	New directional drilling	2.7	2.5	12
4-27	Advanced recovery of natural gas	3.4	2.6	14

Identification of Short-term R, D&D Targets

- Deepwater Offshore -

- independents -

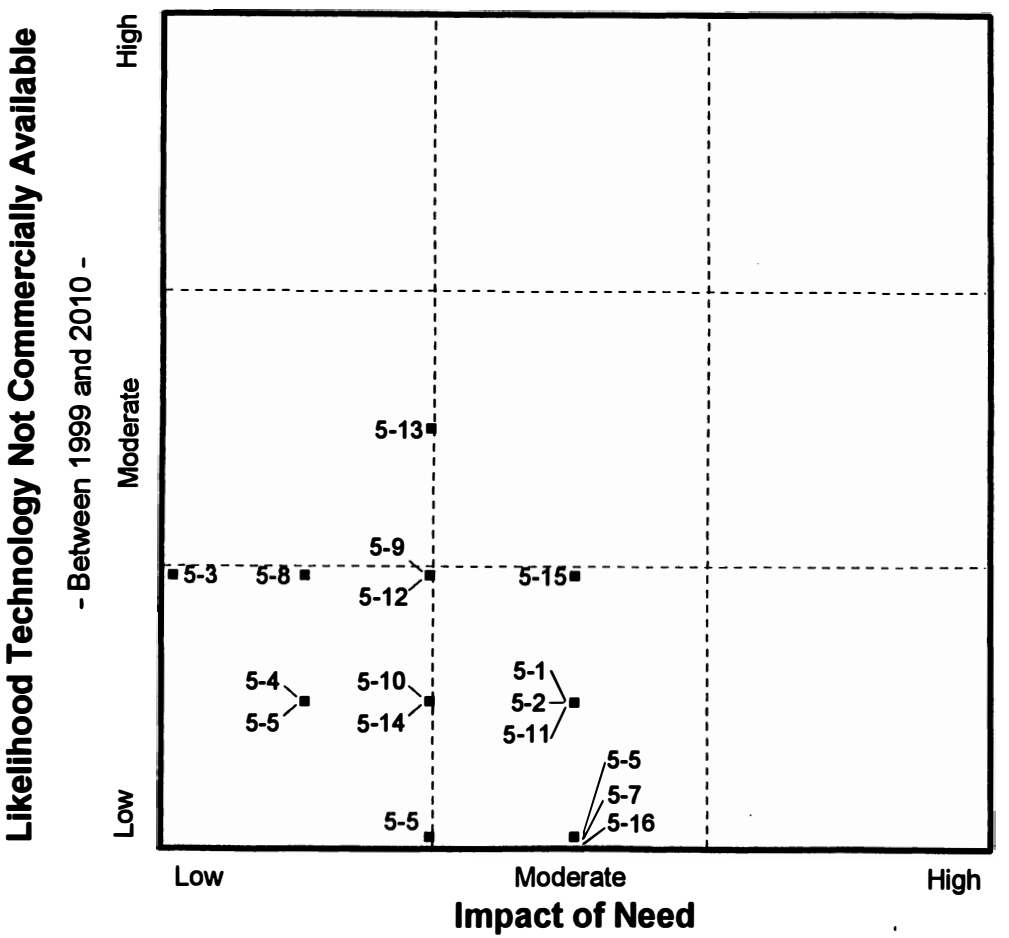


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	5.0	1.0	1
5-2	Extended reach drilling or production	3.0	2.0	3
5-3	Extended reach control systems	5.0	1.0	1
5-4	High pressure systems	-	-	-
5-5	Flowlines	3.0	1.0	1
5-6	Flow metering	4.0	2.0	2
5-7	Subsea equipment	3.0	1.7	3
5-8	External corrosion protection	3.0	1.0	1
5-9	Risers	3.0	3.0	1
5-10	ROV systems	-	-	-
5-11	Drilling	3.0	1.7	3
5-12	Workover	-	-	-
5-13	Water/gas injection	-	-	-
5-14	Hydrate prevention	5.0	1.0	1
5-15	Multi-phase pumps	5.0	1.0	1
5-16	Structures	4.0	1.0	2

Identification of Long-term R, D&D Targets

- Deepwater Offshore -

- independents -

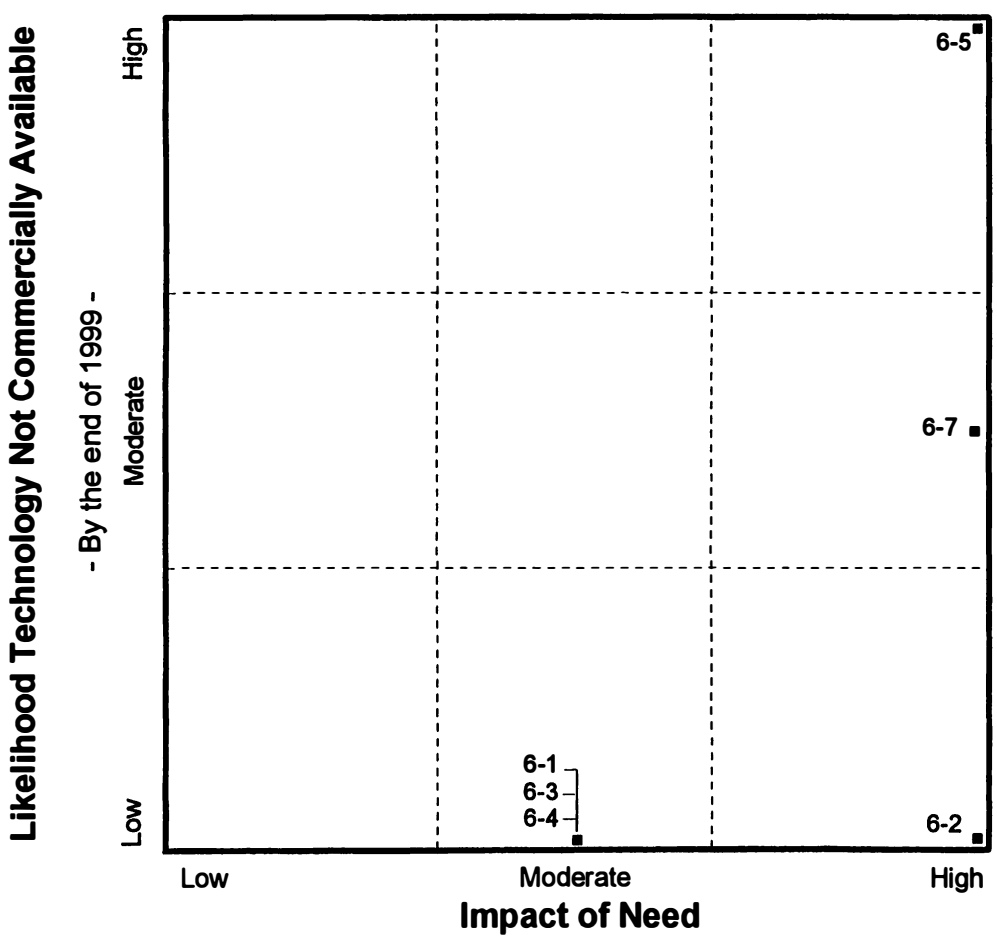


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	3.0	1.7	3
5-2	Extended reach drilling or production	3.0	1.7	3
5-3	Extended reach control systems	2.3	1.0	3
5-4	High pressure systems	1.7	1.7	3
5-5	Flowlines	1.7	1.7	3
5-6	Flow metering	3.0	1.0	2
5-7	Subsea equipment	3.0	1.0	3
5-8	External corrosion protection	1.7	2.3	3
5-9	Risers	2.3	2.3	3
5-10	ROV systems	2.3	1.7	3
5-11	Drilling	3.0	1.7	3
5-12	Workover	2.3	2.3	3
5-13	Water/gas injection	2.3	3.0	3
5-14	Hydrate prevention	2.3	1.7	3
5-15	Multi-phase pumps	3.0	2.3	3
5-16	Structures	3.0	1.0	3

Identification of Short-term R, D&D Targets

- Arctic Region Activities -

- independents -

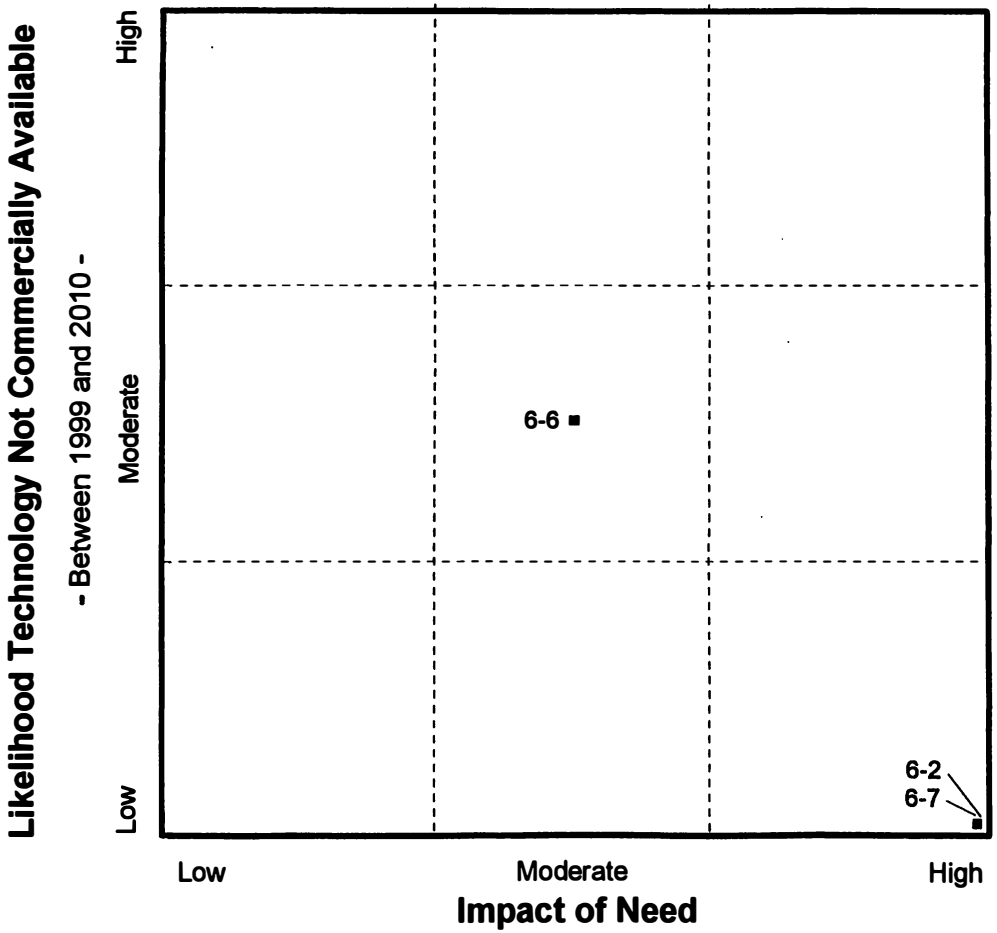


		Impact	Likeli-hood	n =
6-1	Transportation	3.0	1.0	1
6-2	Exploration	5.0	1.0	1
6-3	Development	3.0	1.0	1
6-4	Drilling	3.0	1.0	1
6-5	Production	5.0	5.0	1
6-6	Deepwater offshore activities	-	-	-
6-7	Mobile ice	5.0	3.0	1

Identification of Long- term R, D&D Targets

- Arctic Region Activities -

- independents -

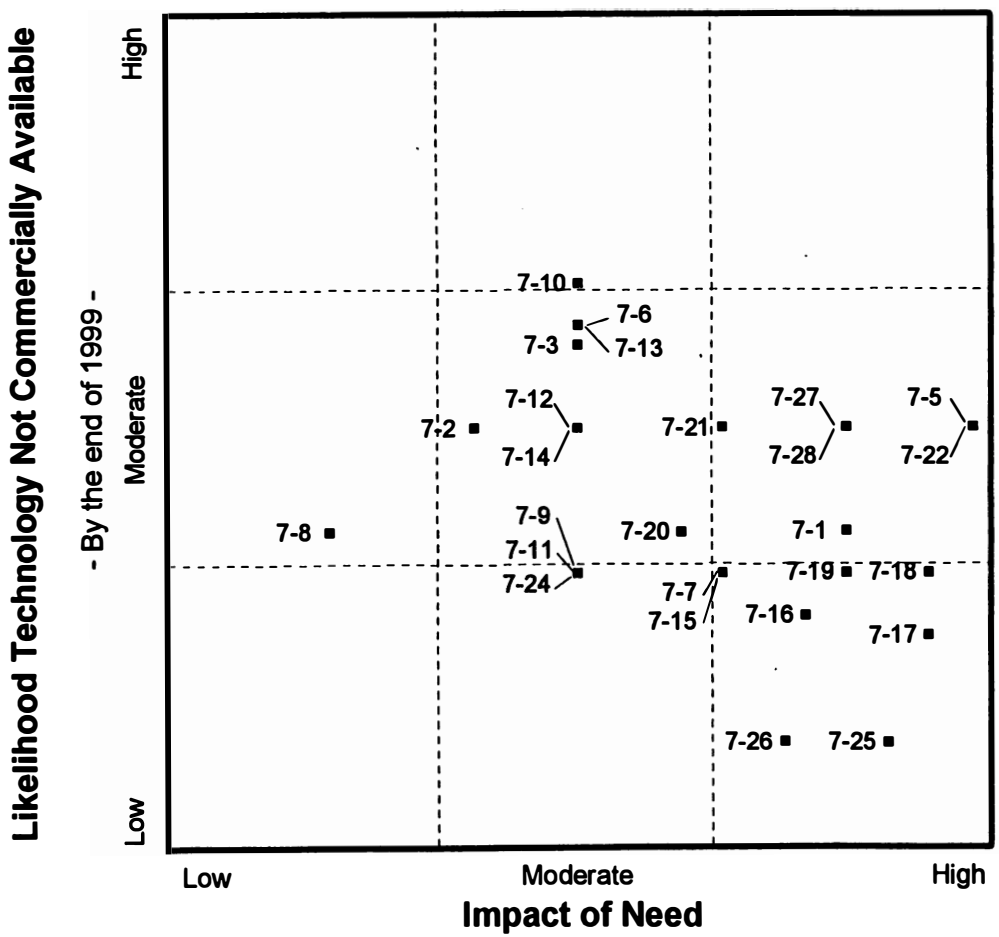


		Impact	Likeli-hood	n =
6-1	Transportation	-	-	-
6-2	Exploration	5.0	1.0	1
6-3	Development	-	-	-
6-4	Drilling	-	-	-
6-5	Production	-	-	-
6-6	Deepwater offshore activities	3.0	3.0	1
6-7	Mobile ice	5.0	1.0	1

Identification of Short-term R, D&D Targets

- Oil Processing and Refining -

- independents -

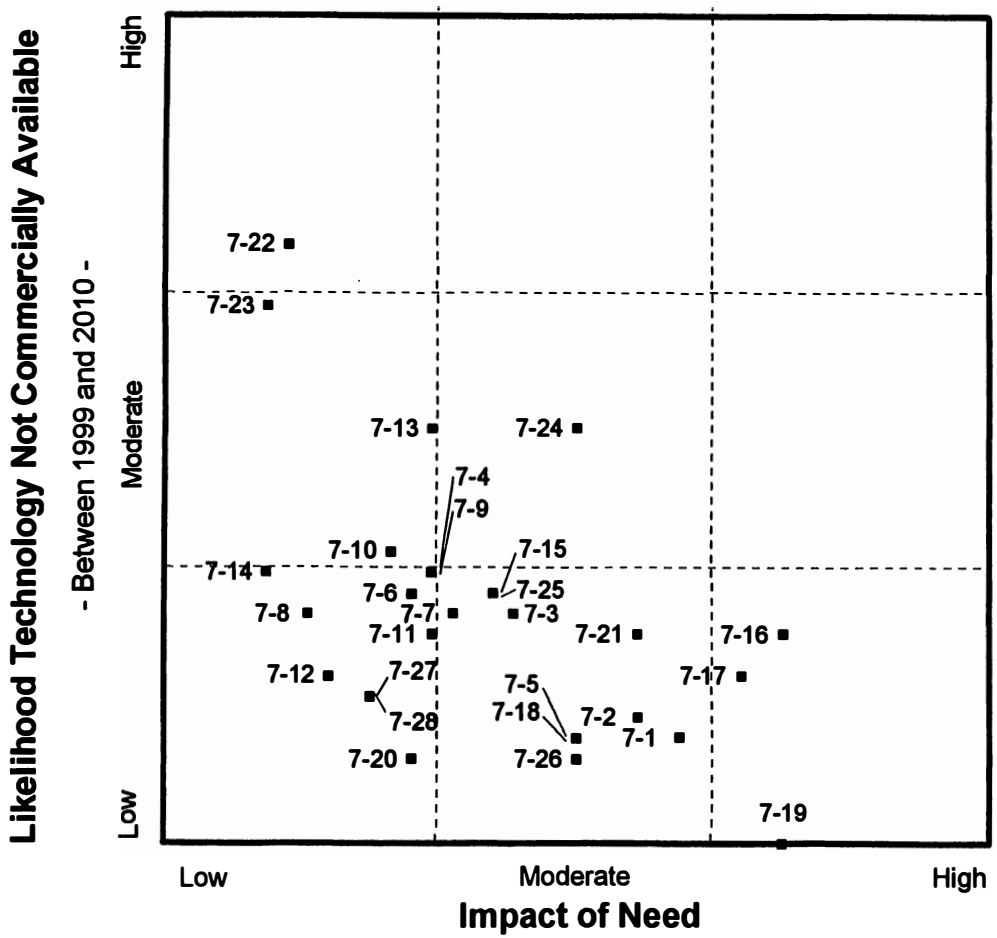


		Impact	Likeli-hood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	4.3	2.5	8
7-2	Hydrogen production and recovery	2.5	3.0	4
7-3	Plant and process reliability	3.0	3.4	5
7-4	Unconventional process technology	-	-	-
7-5	New materials of construction	5.0	3.0	1
7-6	Reactor engineering and modeling	3.0	3.5	4
7-7	Catalyst manufacturing technology	3.7	2.3	3
7-8	Risk assessment methodology	1.8	2.5	4
7-9	Solid acid catalysts	3.0	2.3	3
7-10	Alternatives to olefin alkylation process	3.0	3.7	3
7-11	Techniques for integration of environmental solutions into process and plant design	3.0	2.3	3
7-12	Improved on-line NDE inspection technology	3.0	3.0	5
7-13	Predicting useful remaining lifetimes of aging equipment	3.0	3.5	4
7-14	Robotics for safety applications	3.0	3.0	1
7-15	Worker safety systems	3.7	2.3	6
7-16	Energy efficiency of processes	4.1	2.1	7
7-17	Energy efficiency of equipment	4.7	2.0	6
7-18	Energy efficiency of separations	4.7	2.3	6
7-19	Separations technologies	4.3	2.3	6
7-20	Determining chemical composition of crudes, refinery intermediates, and products	3.5	2.5	4
7-21	New approaches to refining heavy feeds	3.7	3.0	3
7-22	Processing synthetic fuels	5.0	3.0	1
7-23	Conversion of methane to liquid fuels	-	-	-
7-24	Relating chemical compositions to process and product performance	3.0	2.3	3
7-25	Advanced computational modeling of processes/reactions	4.5	1.5	4
7-26	Advanced control and information systems	4.0	1.5	4
7-27	Performance characteristics of new hydrocarbon fuel compositions	4.3	3.0	3
7-28	Environmental characteristics of new hydrocarbon fuel compositions	4.3	3.0	3

Identification of Long-term R, D&D Targets

- Oil Processing and Refining -

- independents -

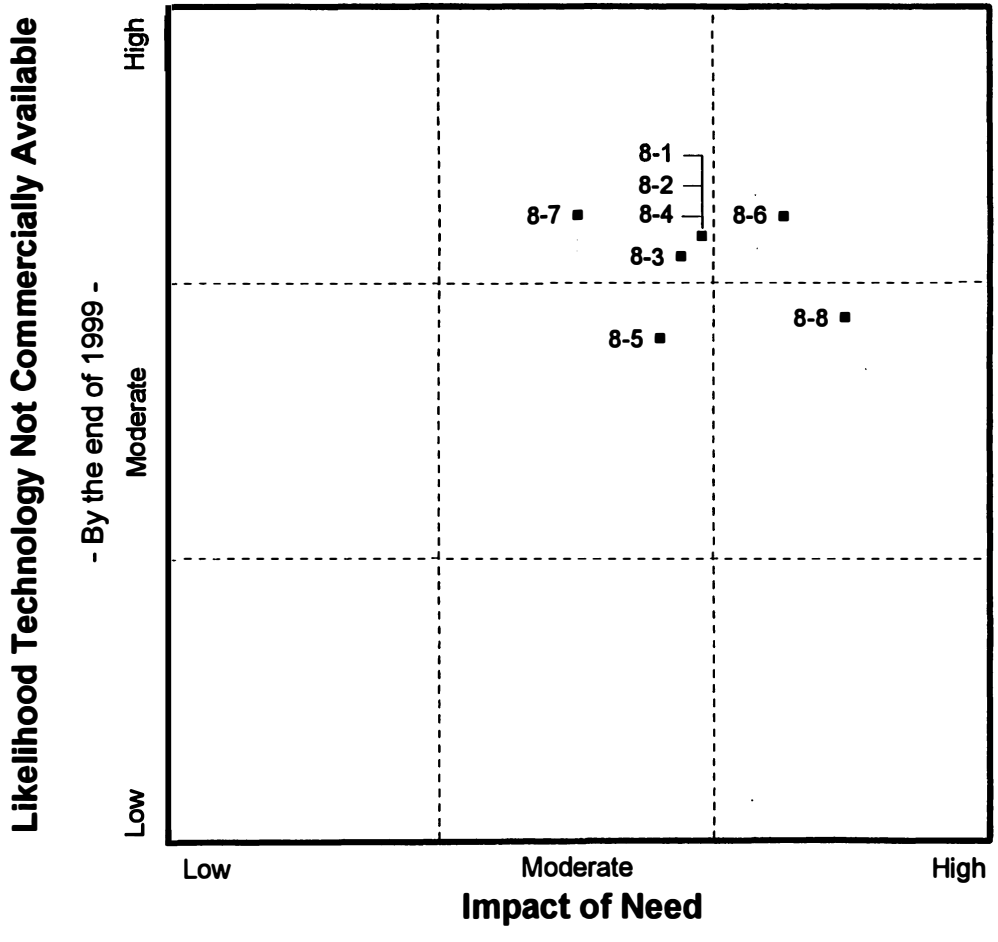


		Impact	Likeli-hood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	3.5	1.5	4
7-2	Hydrogen production and recovery	3.3	1.6	7
7-3	Plant and process reliability	2.7	2.1	7
7-4	Unconventional process technology	2.3	2.3	8
7-5	New materials of construction	3.0	1.5	8
7-6	Reactor engineering and modeling	2.2	2.2	5
7-7	Catalyst manufacturing technology	2.4	2.1	7
7-8	Risk assessment methodology	1.7	2.1	7
7-9	Solid acid catalysts	2.3	2.3	6
7-10	Alternatives to olefin alkylation process	2.1	2.4	7
7-11	Techniques for integration of environmental solutions into process and plant design	2.3	2.0	6
7-12	Improved on-line NDE inspection technology	1.8	1.8	5
7-13	Predicting useful remaining lifetimes of aging equipment	2.3	3.0	6
7-14	Robotics for safety applications	1.5	2.3	8
7-15	Worker safety systems	2.6	2.2	5
7-16	Energy efficiency of processes	4.0	2.0	4
7-17	Energy efficiency of equipment	3.8	1.8	5
7-18	Energy efficiency of separations	3.0	1.5	4
7-19	Separations technologies	4.0	1.0	4
7-20	Determining chemical composition of crudes, refinery intermediates, and products	2.2	1.4	5
7-21	New approaches to refining heavy feeds	3.3	2.0	6
7-22	Processing synthetic fuels	1.6	3.9	7
7-23	Conversion of methane to liquid fuels	1.5	3.6	8
7-24	Relating chemical compositions to process and product performance	3.0	3.0	6
7-25	Advanced computational modeling of processes/reactions	2.6	2.2	5
7-26	Advanced control and information systems	3.0	1.4	5
7-27	Performance characteristics of new hydrocarbon fuel compositions	2.0	1.7	6
7-28	Environmental characteristics of new hydrocarbon fuel compositions	2.0	1.7	6

Identification of Short- term R, D&D Targets

- Gas Processing -

- independents -

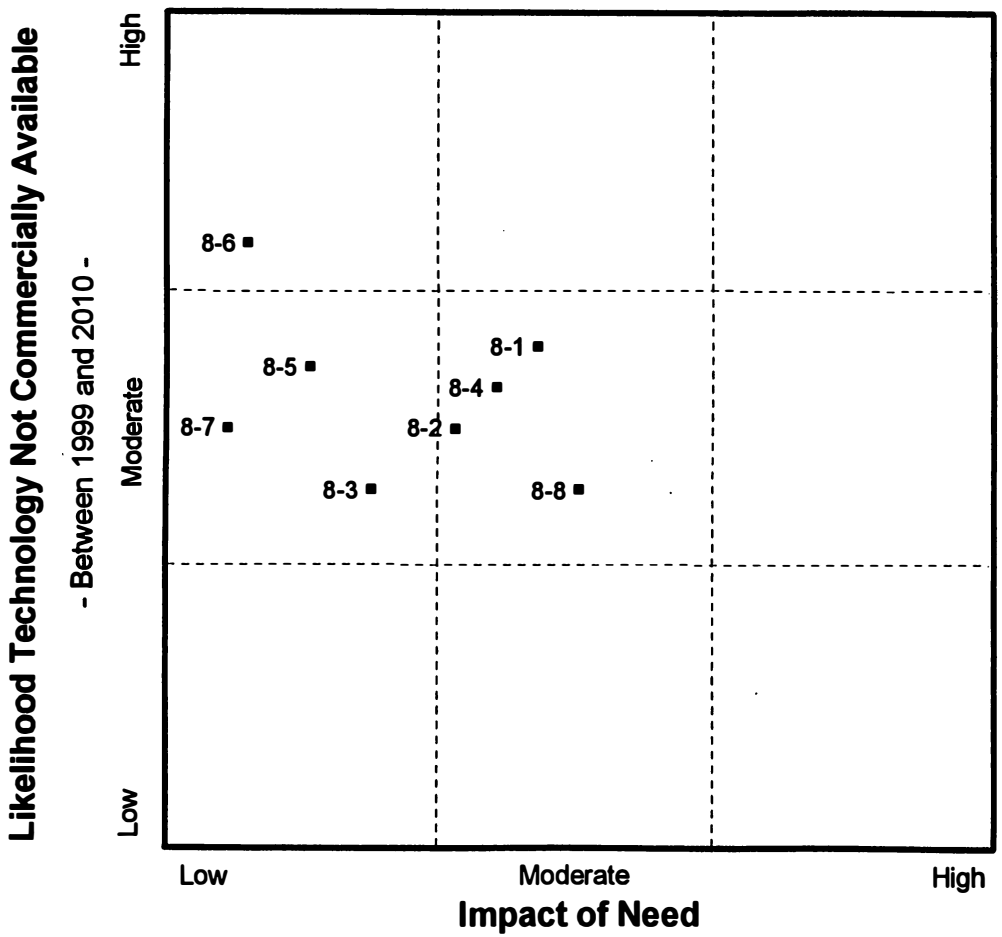


		Impact	Likelihood	n =
8-1	Gas dehydration	3.6	3.9	7
8-2	Acid gas removal	3.6	3.9	7
8-3	H2S scavenger technology	3.5	3.8	8
8-4	Natural gas liquid separation	3.6	3.9	7
8-5	Nitrogen separation	3.4	3.4	5
8-6	Trace constituent (arsenic, Hg, etc.) removal	4.0	4.0	2
8-7	Sulfur recovery	3.0	4.0	4
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	4.3	3.5	8

Identification of Long-term R, D&D Targets

- Gas Processing -

- independents -

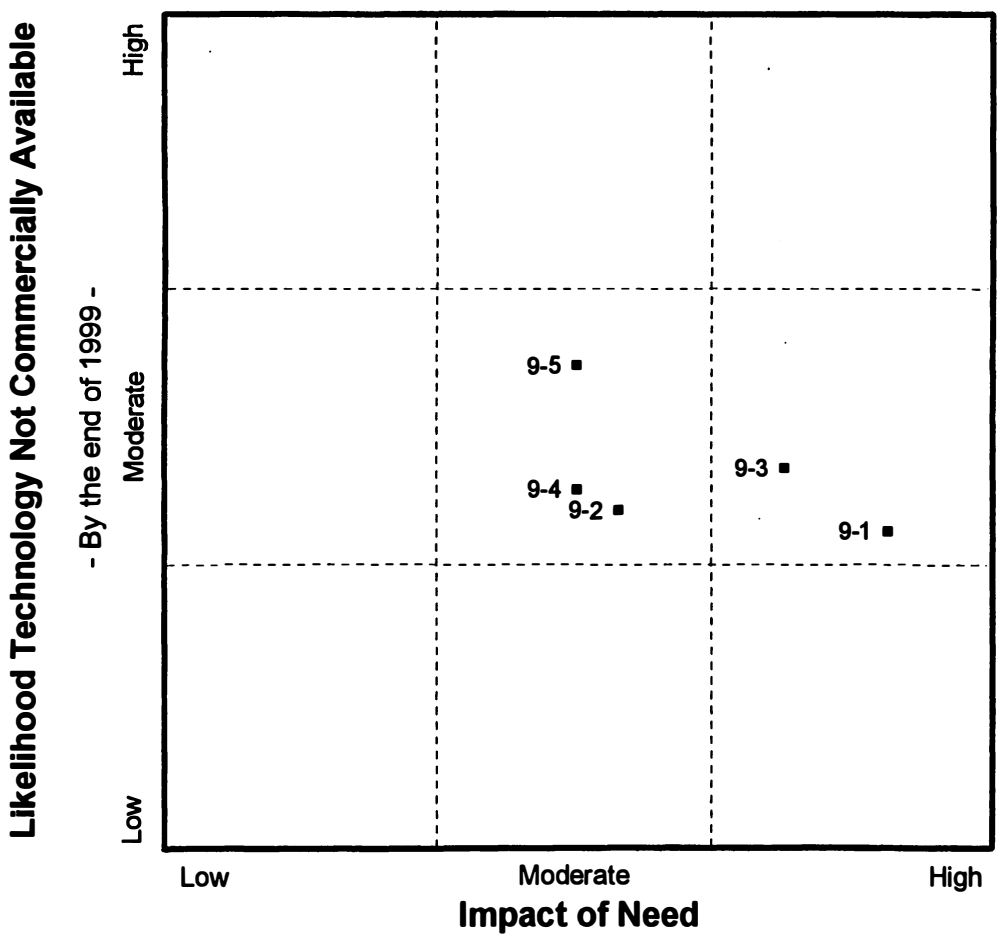


		Impact	Likeli-hood	n =
8-1	Gas dehydration	2.8	3.4	11
8-2	Acid gas removal	2.4	3.0	6
8-3	H2S scavenger technology	2.0	2.7	7
8-4	Natural gas liquid separation	2.6	3.2	10
8-5	Nitrogen separation	1.7	3.3	8
8-6	Trace constituent (arsenic, Hg, etc.) removal	1.4	3.9	9
8-7	Sulfur recovery	1.3	3.0	8
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	3.0	2.7	6

Identification of Short-term R, D&D Targets

- Gas Gathering -

- independents -

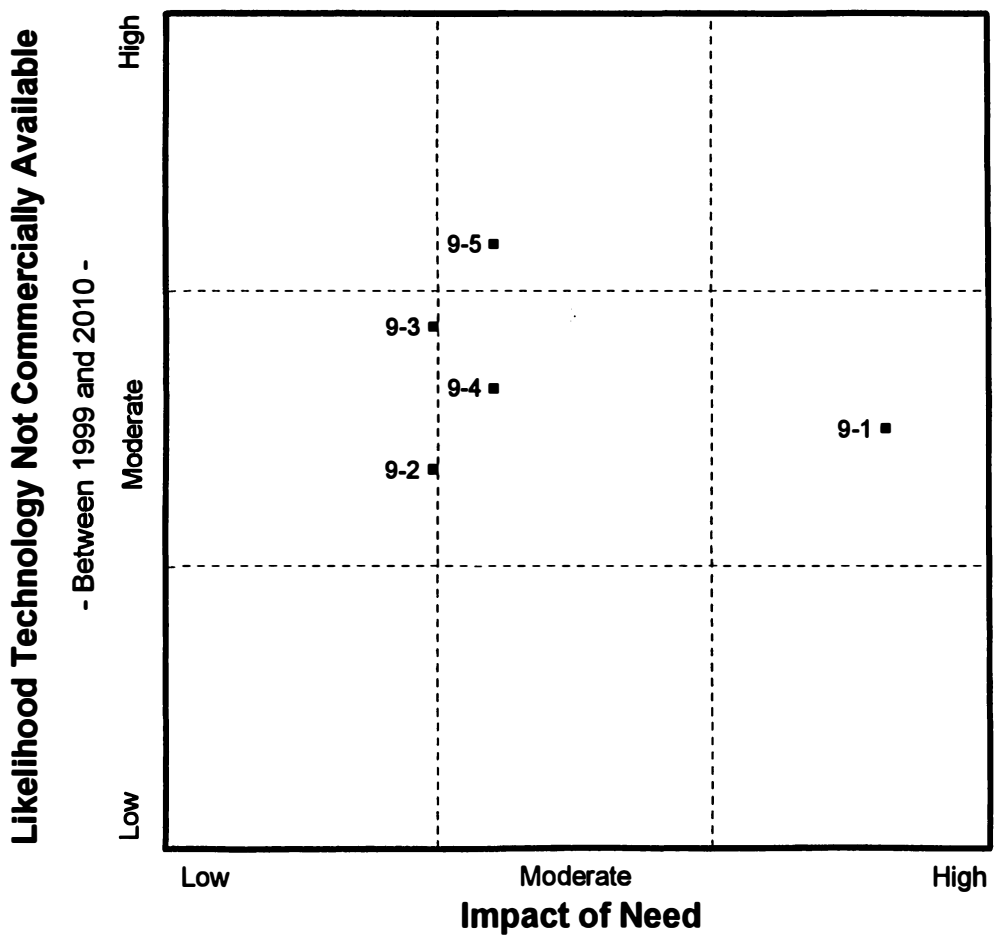


		Impact	Likeli-hood	n =
9-1	Compression	4.5	2.5	16
9-2	Leak detection	3.2	2.6	10
9-3	Plastic pipe (higher pressure rating)	4.0	2.8	8
9-4	High pressure measurement	3.0	2.7	7
9-5	Multi-phase metering	3.0	3.3	8

Identification of Long-term R, D&D Targets

- Gas Gathering -

- independents -

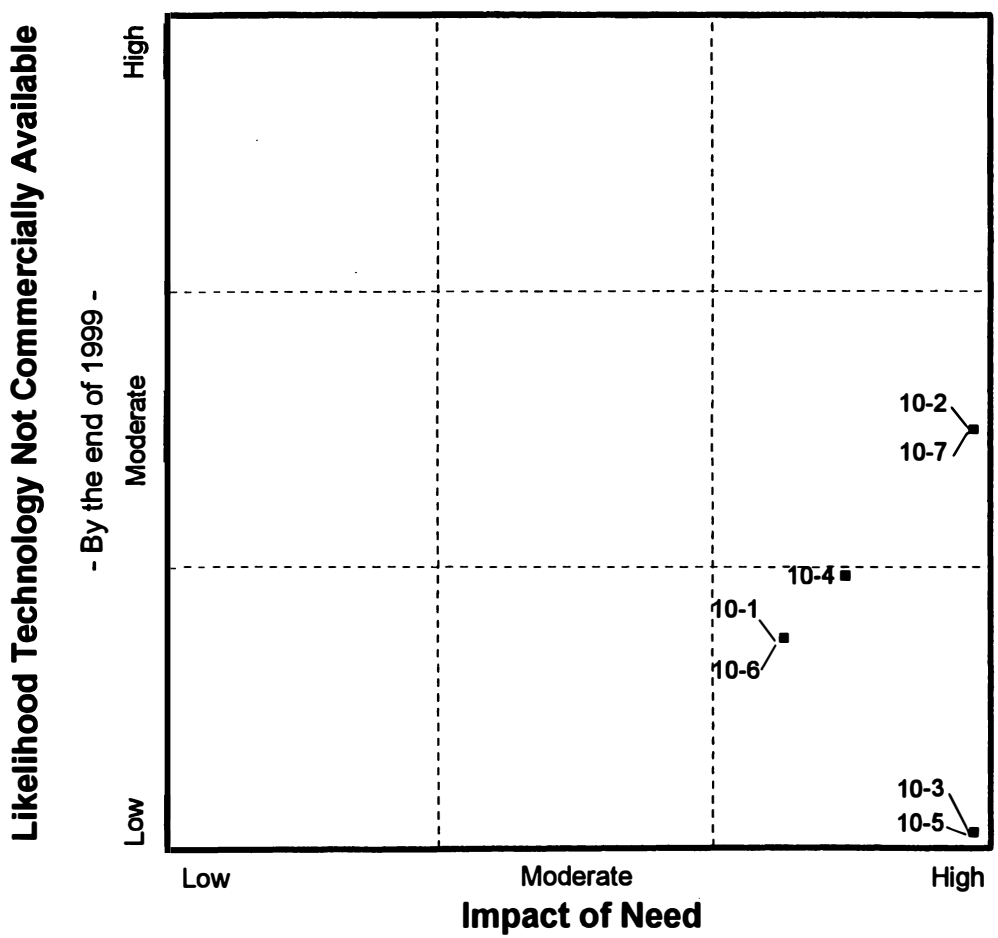


		Impact	Likeli-hood	n =
9-1	Compression	4.5	3.0	4
9-2	Leak detection	2.3	2.8	8
9-3	Plastic pipe (higher pressure rating)	2.3	3.5	8
9-4	High pressure measurement	2.6	3.2	10
9-5	Multi-phase metering	2.6	3.9	11

Identification of Short-term R, D&D Targets

- Gas Storage -

- independents -

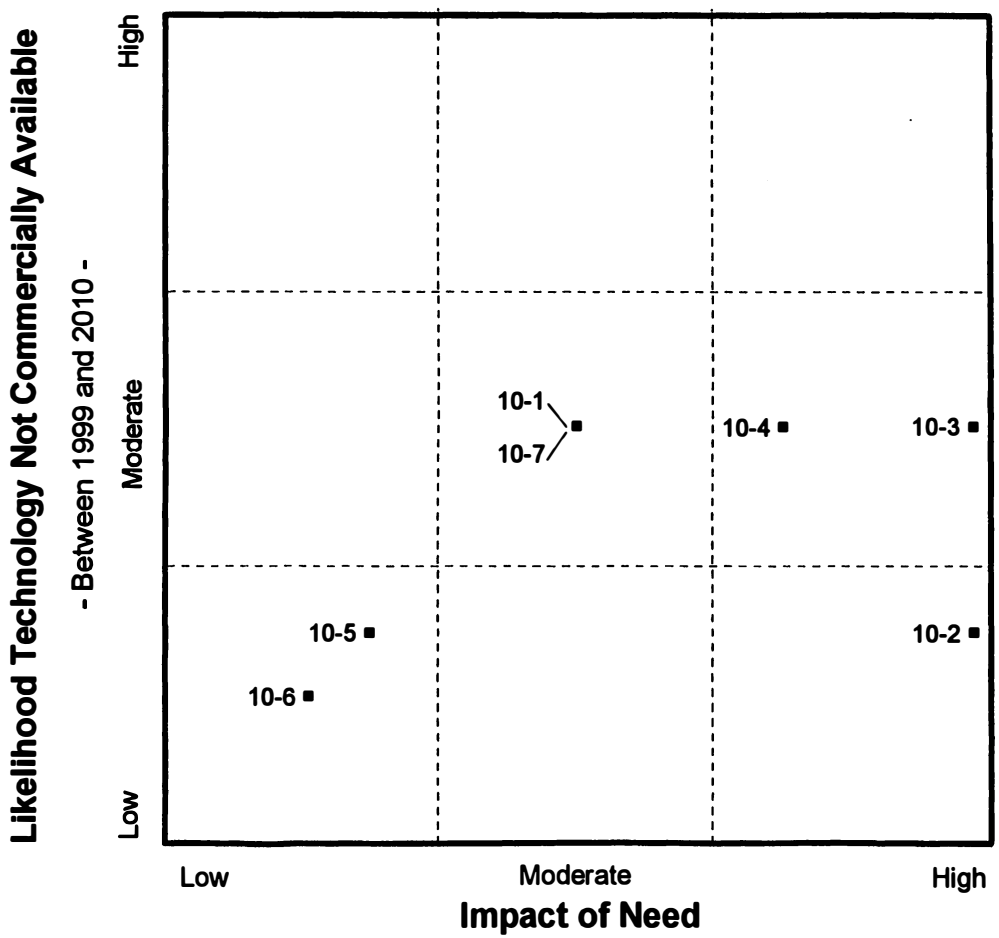


		Impact	Likeli-hood	n =
10-1	Well deliverability restoration	4.0	2.0	2
10-2	Leak detection and mitigation	5.0	3.0	3
10-3	Reservoir management	5.0	1.0	1
10-4	Gas migration control	4.3	2.3	3
10-5	Base gas minimization techniques	5.0	1.0	1
10-6	Inert base gas research	4.0	2.0	2
10-7	Unconventional development techniques	5.0	3.0	3

Identification of Long-term R, D&D Targets

- Gas Storage -

- independents -

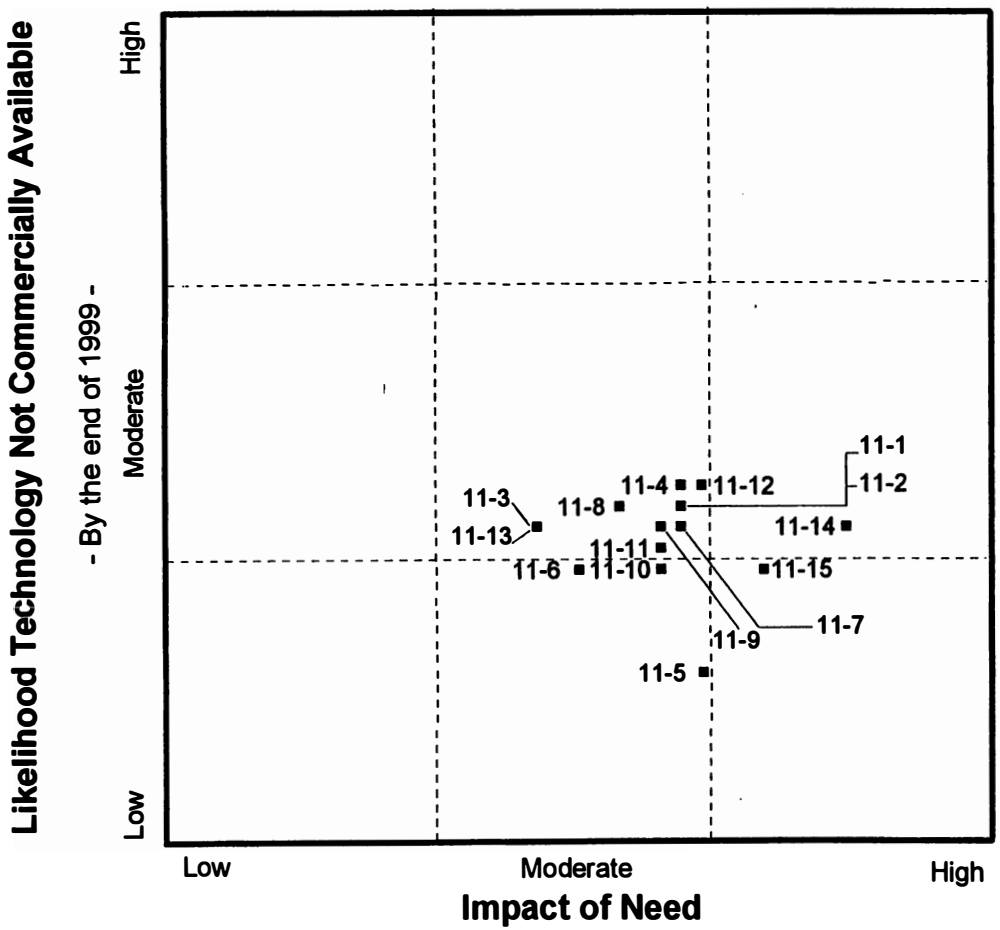


		Impact	Likeli-hood	n =
10-1	Well deliverability restoration	3.0	3.0	3
10-2	Leak detection and mitigation	5.0	2.0	2
10-3	Reservoir management	5.0	3.0	2
10-4	Gas migration control	4.0	3.0	2
10-5	Base gas minimization techniques	2.0	2.0	2
10-6	Inert base gas research	1.7	1.7	3
10-7	Unconventional development techniques	3.0	3.0	2

Identification of Short-term R, D&D Targets

- Environmental and Regulatory -

- independents -

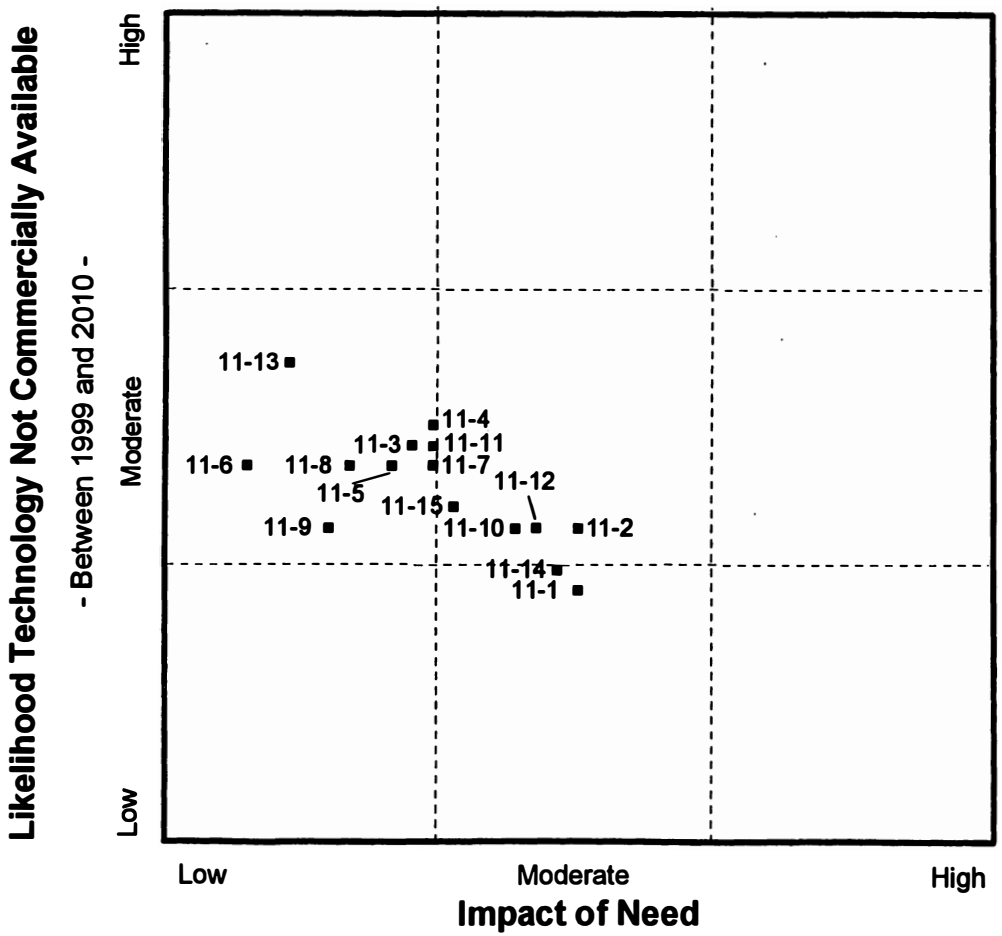


		Impact	Likelihood	n =
11-1	Disposal methods for drilling fluids	3.5	2.6	24
11-2	Treatment and disposal of produced fluids	3.5	2.6	25
11-3	Screening procedures for injection wells	2.8	2.5	16
11-4	Risk and reclamation analysis of disposal methods	3.5	2.7	21
11-5	Leak detection	3.6	1.8	20
11-6	Hydrological modeling	3.0	2.3	9
11-7	Compliance with CAAA stationary source issue	3.5	2.5	21
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	3.2	2.6	10
11-9	Model transport and remediation of contaminants in ground water and soils	3.4	2.5	15
11-10	Effluent and emission monitoring, minimization, and control	3.4	2.3	19
11-11	Recycling of waste and byproduct streams	3.4	2.4	10
11-12	Remediation technology	3.6	2.7	18
11-13	Catalyst recycling	2.8	2.5	8
11-14	Provide scientific basis for risk-based regulation	4.3	2.5	22
11-15	NORM disposal	3.9	2.3	20

Identification of Long-term R, D&D Targets

- Environmental and Regulatory -

- independents -

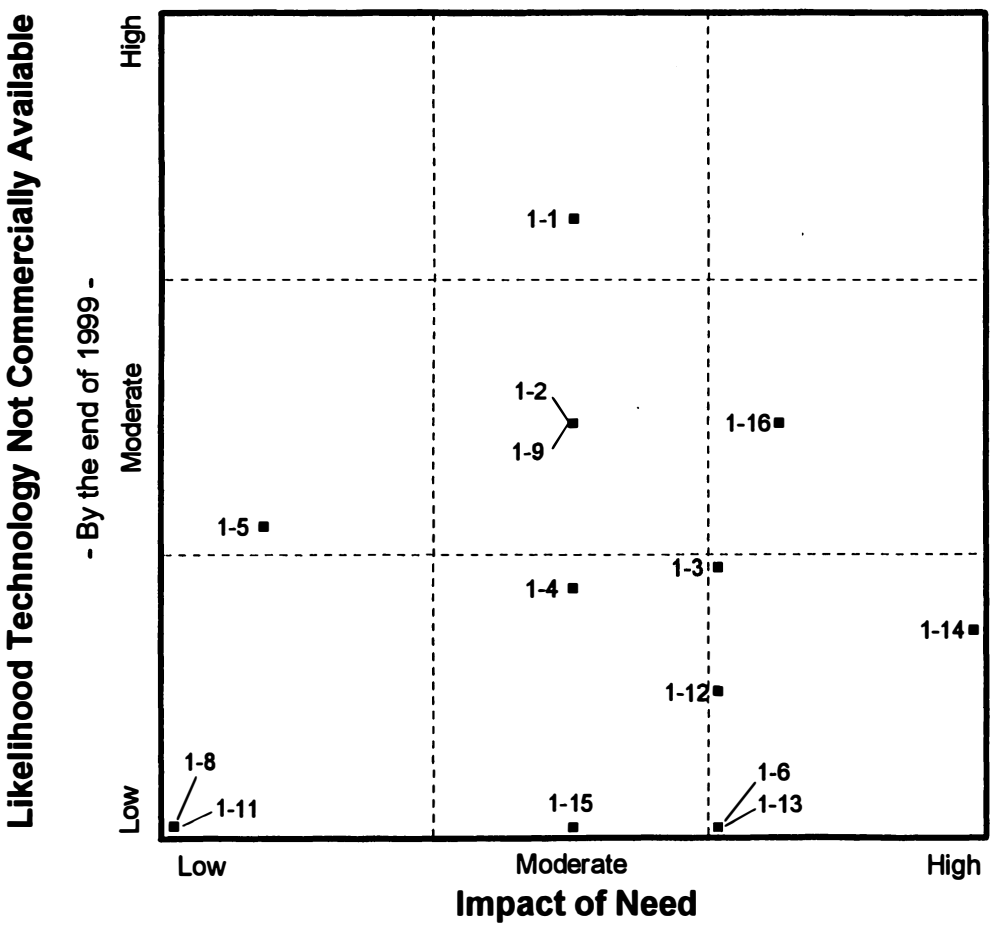


		Impact	Likeli-hood	n =
11-1	Disposal methods for drilling fluids	3.0	2.2	12
11-2	Treatment and disposal of produced fluids	3.0	2.5	11
11-3	Screening procedures for injection wells	2.2	2.9	16
11-4	Risk and reclamation analysis of disposal methods	2.3	3.0	15
11-5	Leak detection	2.1	2.8	20
11-6	Hydrological modeling	1.4	2.8	26
11-7	Compliance with CAAA stationary source issue	2.3	2.8	18
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	1.9	2.8	26
11-9	Model transport and remediation of contaminants in ground water and soils	1.8	2.5	24
11-10	Effluent and emission monitoring, minimization, and control	2.7	2.5	20
11-11	Recycling of waste and byproduct streams	2.3	2.9	27
11-12	Remediation technology	2.8	2.5	23
11-13	Catalyst recycling	1.6	3.3	27
11-14	Provide scientific basis for risk-based regulation	2.9	2.3	19
11-15	NORM disposal	2.4	2.6	17

Identification of Short-term R, D&D Targets

- Exploration -

- service companies -

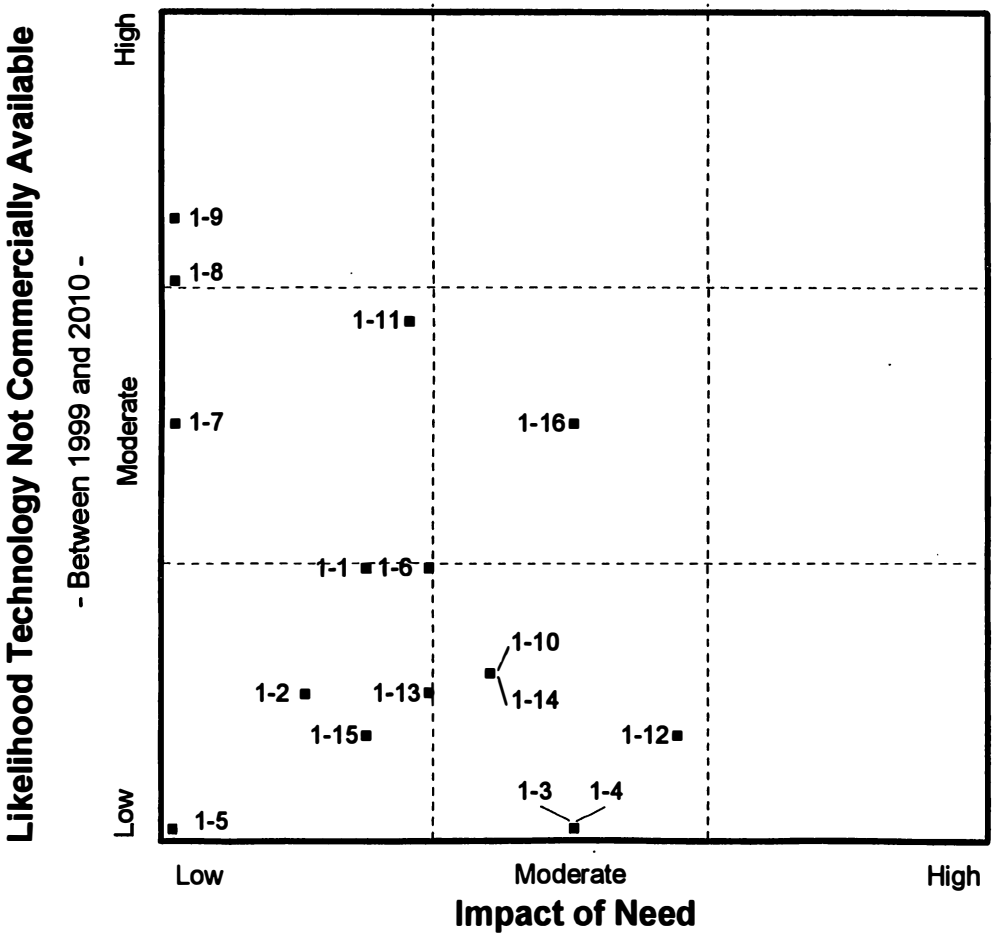


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	3.0	4.0	2
1-2	Risk assessment methods	3.0	3.0	1
1-3	High-resolution seismic depth imaging	3.7	2.3	3
1-4	Specialized seismic processing	3.0	2.2	5
1-5	Sequence stratigraphy techniques	1.5	2.5	4
1-6	Workstation seismic modeling	3.7	1.0	3
1-7	Geochemical analysis	-	-	-
1-8	Airborne/satellite remote sensing	1.0	1.0	1
1-9	Fault seal analysis	3.0	3.0	1
1-10	Multi-component seismic techniques	-	-	-
1-11	3D Paleostructural restoration	1.0	1.0	1
1-12	Amplitude versus offset (AVO) in 3D	3.7	1.7	3
1-13	3D Visualization tools	3.7	1.0	3
1-14	Advanced seismic acquisition	5.0	2.0	2
1-15	Geographic information systems	3.0	1.0	2
1-16	Geophysical fracture-detection methods	4.0	3.0	2

Identification of Long-term R, D&D Targets

- Exploration -

- service companies -

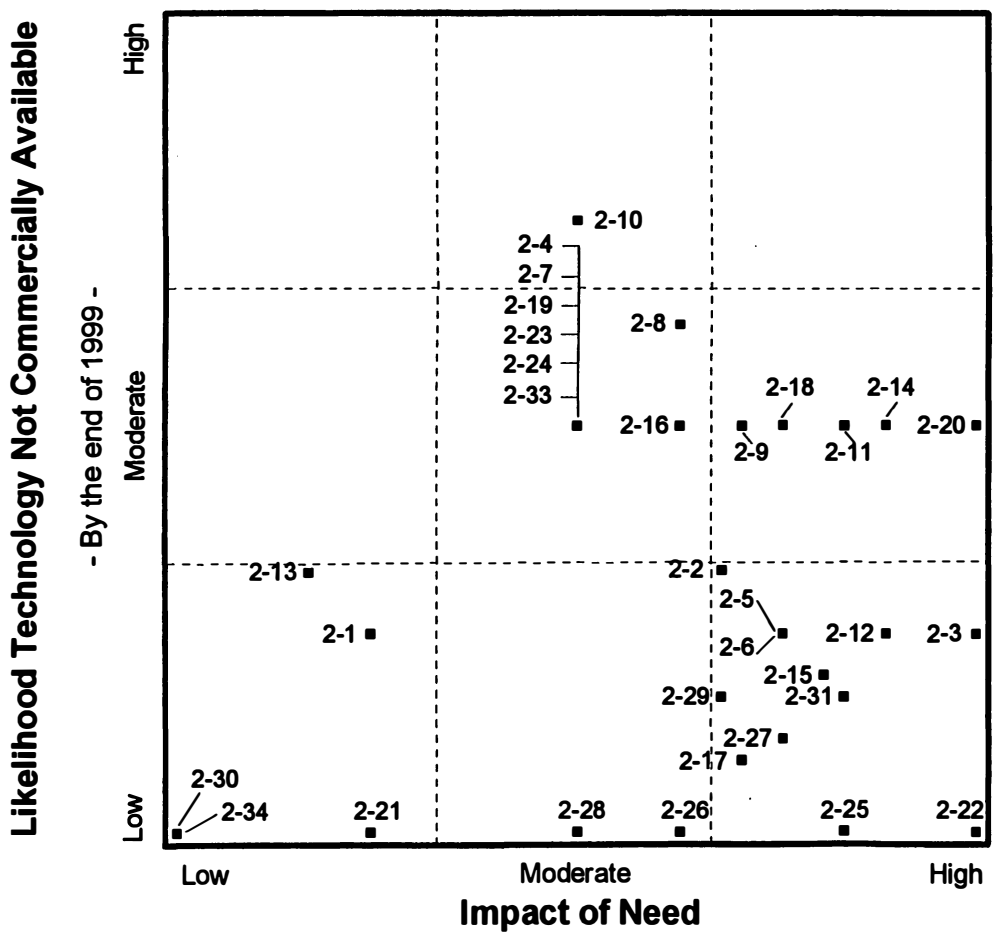


		Impact	Likeli-hood	n =
1-1	3D Basin modeling	2.0	2.3	3
1-2	Risk assessment methods	1.7	1.7	3
1-3	High-resolution seismic depth imaging	3.0	1.0	5
1-4	Specialized seismic processing	3.0	1.0	3
1-5	Sequence stratigraphy techniques	1.0	1.0	1
1-6	Workstation seismic modeling	2.3	2.3	3
1-7	Geochemical analysis	1.0	3.0	4
1-8	Airborne/satellite remote sensing	1.0	3.7	3
1-9	Fault seal analysis	1.0	4.0	4
1-10	Multi-component seismic techniques	2.6	1.8	5
1-11	3D Paleostructural restoration	2.2	3.5	4
1-12	Amplitude versus offset (AVO) in 3D	3.5	1.5	4
1-13	3D Visualization tools	2.3	1.7	3
1-14	Advanced seismic acquisition	2.6	1.8	5
1-15	Geographic information systems	2.0	1.5	4
1-16	Geophysical fracture-detection methods	3.0	3.0	5

Identification of Short-term R, D&D Targets

- Development -

- service companies -

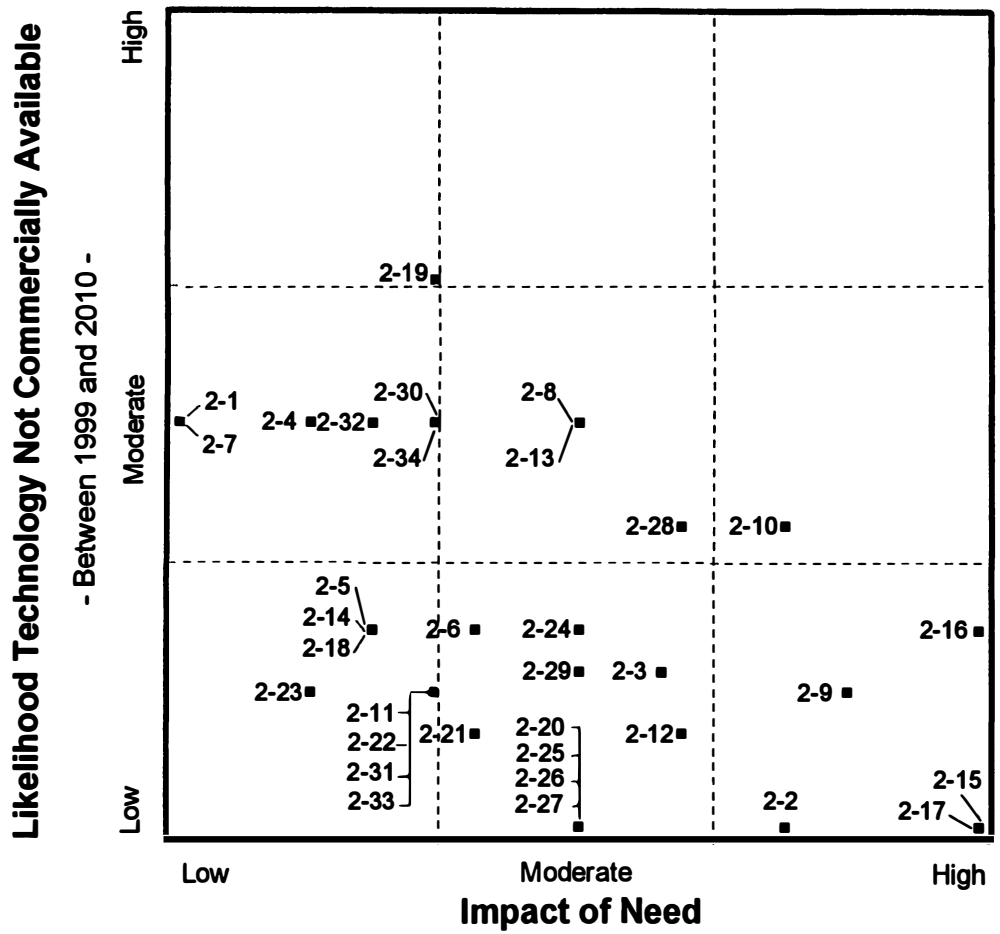


		Impact	Likeli-hood	n =
2-1	Advanced reservoir analog models	2.0	2.0	2
2-2	Computer-based 3-D geological modeling	3.7	2.3	3
2-3	Development-scale seismic applications	5.0	2.0	2
2-4	Tracers (biologic/chemical/radioactive)	3.0	3.0	1
2-5	Core analysis/imaging	4.0	2.0	2
2-6	Geostatistical reservoir descriptions	4.0	2.0	2
2-7	Outcrop analog studies	3.0	3.0	1
2-8	Fluid-rock interaction	3.5	3.5	4
2-9	Rock physics	3.8	3.0	5
2-10	Cross-well geophysical imaging	3.0	4.0	2
2-11	Advanced attribute processing	4.3	3.0	3
2-12	Seismic/log/core calibration	4.5	2.0	4
2-13	Cuttings analysis	1.7	2.3	3
2-14	Reservoir property identification	4.5	3.0	4
2-15	Through casing logging	4.2	1.8	5
2-16	Deep investigation techniques	3.5	3.0	4
2-17	High resolution borehole imaging logs	3.8	1.4	5
2-18	Specialized core analysis	4.0	3.0	2
2-19	Characterization of rock wettability	3.0	3.0	3
2-20	Permeability logging techniques	5.0	3.0	4
2-21	Tracer techniques	2.0	1.0	2
2-22	CT scanning and NMR imaging	5.0	1.0	1
2-23	Formation water chemistry	3.0	3.0	1
2-24	Fluid sampling and analysis	3.0	3.0	3
2-25	Advanced reservoir simulation modeling	4.3	1.0	3
2-26	Workstation single well simulations	3.5	1.0	4
2-27	Procedures for data scale-up	4.0	1.5	4
2-28	Expert systems applications	3.0	1.0	1
2-29	Time lapse seismic imaging	3.7	1.7	3
2-30	Advanced monitoring of EOR processes	1.0	1.0	1
2-31	Advanced well testing and interpretation	4.3	1.7	3
2-32	Material balance applications	-	-	-
2-33	Decision and risk analysis	3.0	3.0	2
2-34	Expendable well bore instrumentation	1.0	1.0	1

Identification of Long-term R, D&D Targets

- Development -

- service companies -

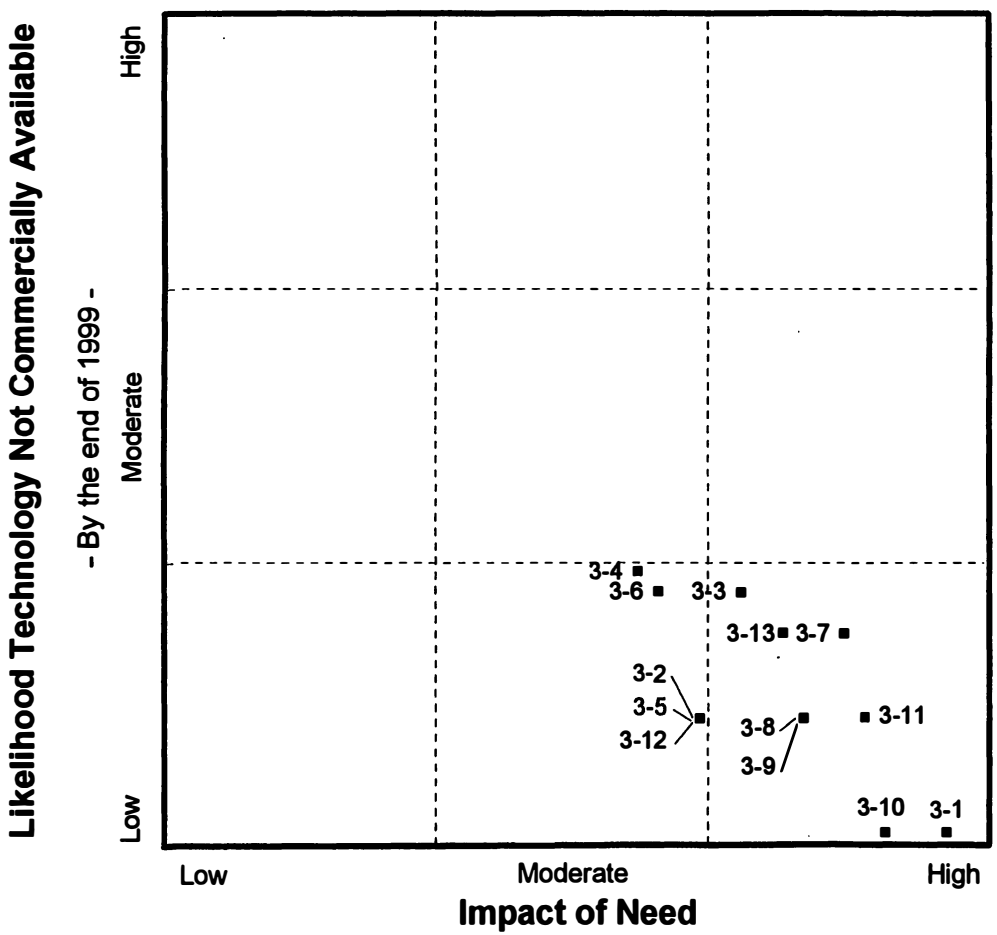


		Impact	Likelihood	n =
2-1	Advanced reservoir analog models	1.0	3.0	1
2-2	Computer-based 3-D geological modeling	4.0	1.0	4
2-3	Development-scale seismic applications	3.4	1.8	5
2-4	Tracers (biologic/chemical/radioactive)	1.7	3.0	3
2-5	Core analysis/imaging	2.0	2.0	2
2-6	Geostatistical reservoir descriptions	2.5	2.0	4
2-7	Outcrop analog studies	1.0	3.0	2
2-8	Fluid-rock interaction	3.0	3.0	1
2-9	Rock physics	4.3	1.7	3
2-10	Cross-well geophysical imaging	4.0	2.5	4
2-11	Advanced attribute processing	2.3	1.7	3
2-12	Seismic/log/core calibration	3.5	1.5	4
2-13	Cuttings analysis	3.0	3.0	1
2-14	Reservoir property identification	2.0	2.0	2
2-15	Through casing logging	5.0	1.0	1
2-16	Deep investigation techniques	5.0	2.0	2
2-17	High resolution borehole imaging logs	5.0	1.0	1
2-18	Specialized core analysis	2.0	2.0	2
2-19	Characterization of rock wettability	2.3	3.7	3
2-20	Permeability logging techniques	3.0	1.0	2
2-21	Tracer techniques	2.5	1.5	4
2-22	CT scanning and NMR imaging	2.3	1.7	3
2-23	Formation water chemistry	1.7	1.7	3
2-24	Fluid sampling and analysis	3.0	2.0	2
2-25	Advanced reservoir simulation modeling	3.0	1.0	3
2-26	Workstation single well simulations	3.0	1.0	2
2-27	Procedures for data scale-up	3.0	1.0	2
2-28	Expert systems applications	3.5	2.5	4
2-29	Time lapse seismic imaging	3.0	1.8	5
2-30	Advanced monitoring of EOR processes	2.3	3.0	3
2-31	Advanced well testing and interpretation	2.3	1.7	3
2-32	Material balance applications	2.0	3.0	4
2-33	Decision and risk analysis	2.3	1.7	3
2-34	Expendable well bore instrumentation	2.3	3.0	3

Identification of Short-term R, D&D Targets

- Drilling and Completion -

- service companies -

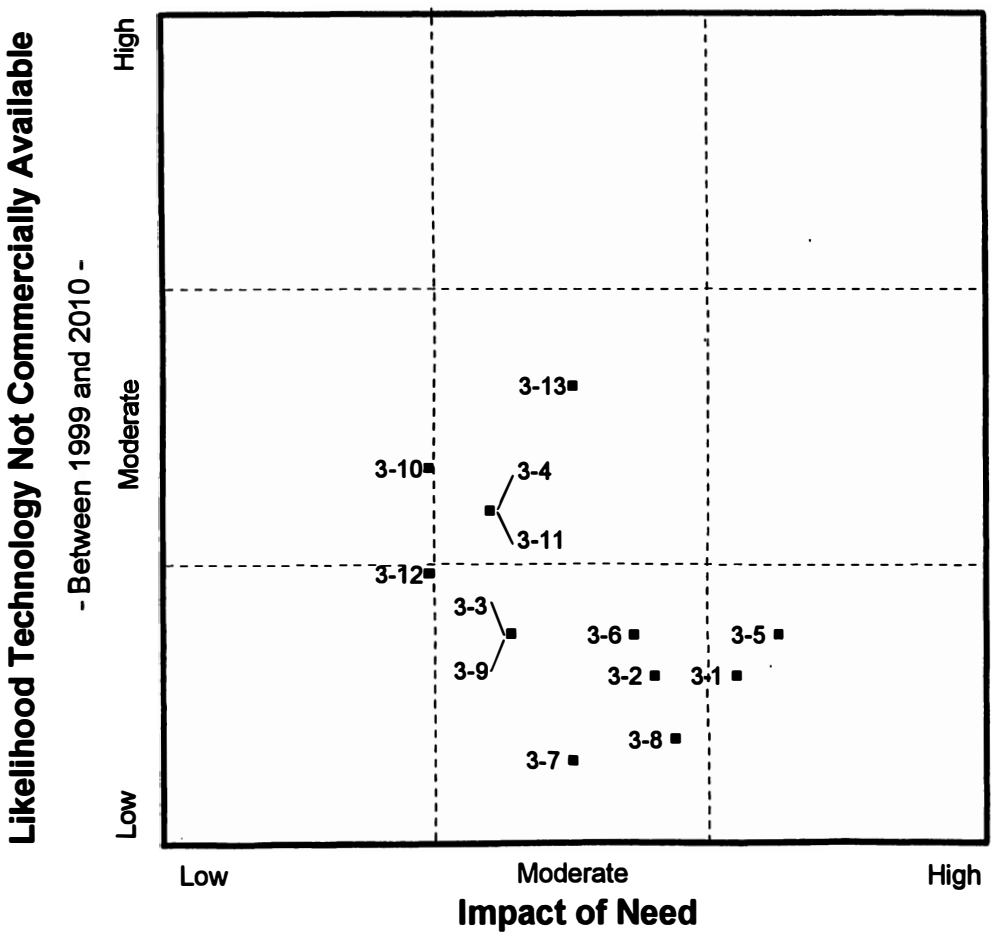


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	4.8	1.0	8
3-2	Drilling fluid design	3.6	1.6	7
3-3	Advanced fracture techniques	3.8	2.2	5
3-4	Cementing	3.3	2.3	6
3-5	Perforating and well bore cleanup	3.6	1.6	7
3-6	Well productivity	3.4	2.2	5
3-7	Multilateral technology	4.3	2.0	6
3-8	Innovative bit and tubular technology	4.1	1.6	7
3-9	Slim hole drilling	4.1	1.6	7
3-10	Under balanced drilling	4.5	1.0	4
3-11	Measurements while drilling	4.4	1.6	7
3-12	Coiled tubing drilling	3.6	1.6	7
3-13	Unconventional drilling technology	4.0	2.0	2

Identification of Long-term R, D&D Targets

- Drilling and Completion -

- service companies -

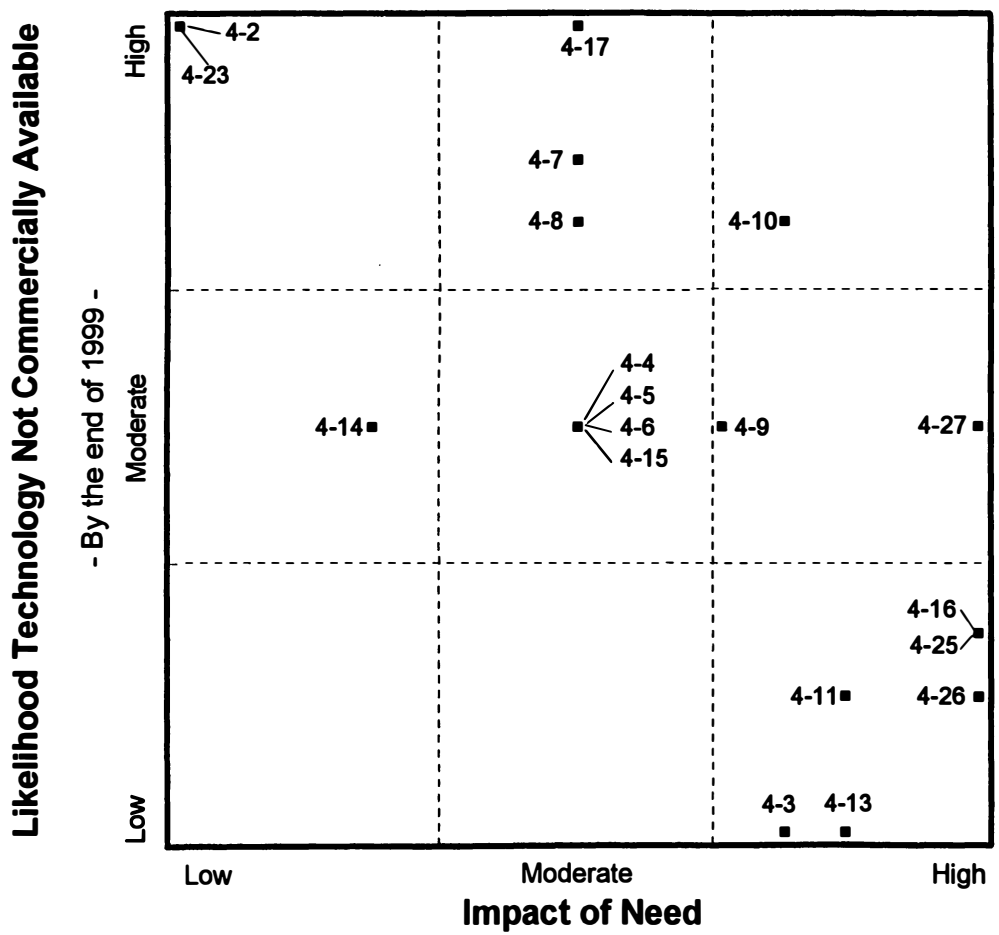


		Impact	Likeli-hood	n =
3-1	Horizontal well bore applications	3.8	1.8	5
3-2	Drilling fluid design	3.4	1.8	5
3-3	Advanced fracture techniques	2.7	2.0	6
3-4	Cementing	2.6	2.6	5
3-5	Perforating and well bore cleanup	4.0	2.0	4
3-6	Well productivity	3.3	2.0	6
3-7	Multilateral technology	3.0	1.4	5
3-8	Innovative bit and tubular technology	3.5	1.5	4
3-9	Slim hole drilling	2.7	2.0	6
3-10	Under balanced drilling	2.3	2.8	8
3-11	Measurements while drilling	2.6	2.6	5
3-12	Coiled tubing drilling	2.3	2.3	6
3-13	Unconventional drilling technology	3.0	3.2	10

Identification of Short-term R, D&D Targets

- Production -

- service companies -

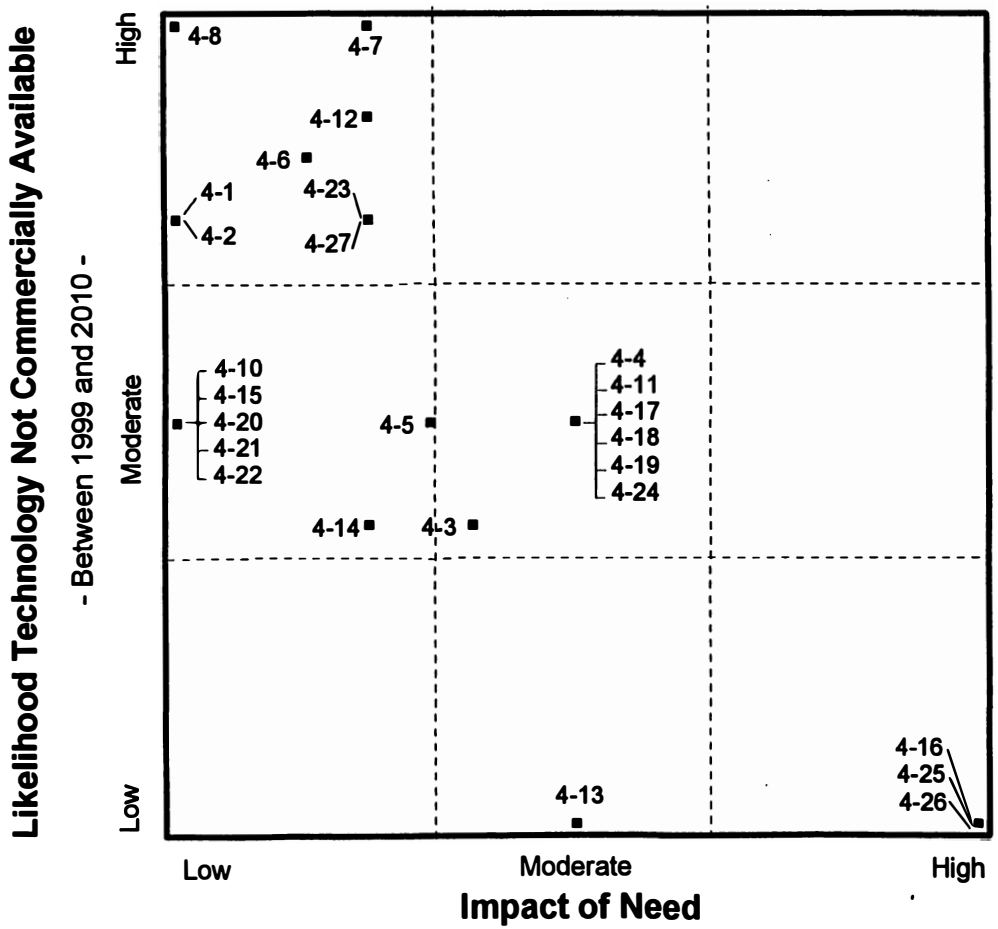


		Impact	Likeli-hood	n =
4-1	Injection water treatment	-	-	-
4-2	Produced water treatment	1.0	5.0	1
4-3	Corrosion control	4.0	1.0	2
4-4	Scaling inhibitors	3.0	3.0	3
4-5	Paraffin control/removal	3.0	3.0	2
4-6	Oil/water/gas/separation	3.0	3.0	1
4-7	Beam pump analysis	3.0	4.3	3
4-8	Gas lift analysis	3.0	4.0	2
4-9	Submersible pump analysis	3.7	3.0	3
4-10	Rod/tubing wear evaluation	4.0	4.0	2
4-11	Stimulation techniques	4.3	1.7	3
4-12	Gas compression techniques	-	-	-
4-13	Recompletion techniques	4.3	1.0	3
4-14	Remote control and data analysis	2.0	3.0	2
4-15	Compact processing on offshore platforms	3.0	3.0	1
4-16	Modification of reservoir fluid mobilities	5.0	2.0	2
4-17	Miscible contact/displacement	3.0	5.0	1
4-18	Viscosity reduction of heavy oils	-	-	-
4-19	In situ generation of foams/emulsions	-	-	-
4-20	Thickeners for CO_2 floods	-	-	-
4-21	Microbial EOR processes	-	-	-
4-22	High-velocity gas flow modeling	-	-	-
4-23	Thermal processes	1.0	5.0	1
4-24	Combustion processes	-	-	-
4-25	Near well bore stimulation	5.0	2.0	2
4-26	New directional drilling	5.0	1.7	3
4-27	Advanced recovery of natural gas	5.0	3.0	1

Identification of Long-term R, D&D Targets

- Production -

- service companies -

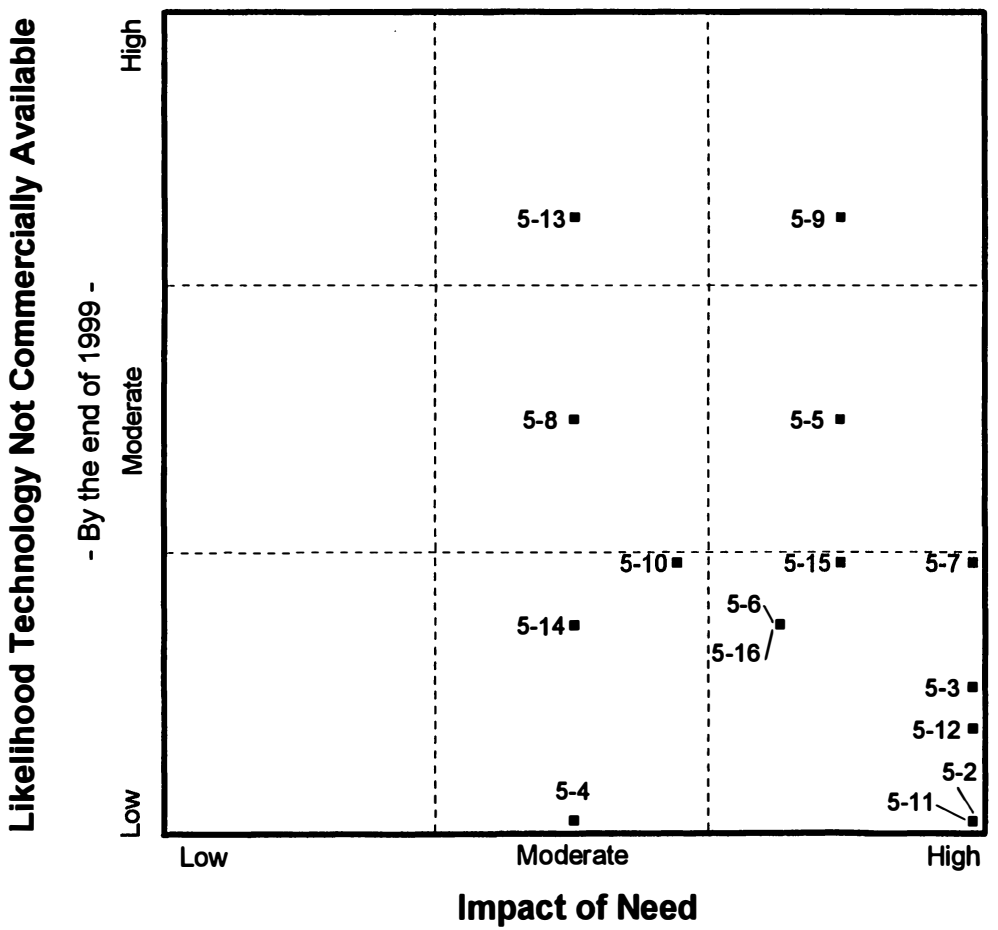


		Impact	Likeli-hood	n =
4-1	Injection water treatment	1.0	4.0	2
4-2	Produced water treatment	1.0	4.0	2
4-3	Corrosion control	2.5	2.5	4
4-4	Scaling inhibitors	3.0	3.0	2
4-5	Paraffin control/removal	2.3	3.0	3
4-6	Oil/water/gas/separation	1.7	4.3	3
4-7	Beam pump analysis	2.0	5.0	2
4-8	Gas lift analysis	1.0	5.0	2
4-9	Submersible pump analysis	-	-	-
4-10	Rod/tubing wear evaluation	1.0	3.0	1
4-11	Stimulation techniques	3.0	3.0	2
4-12	Gas compression techniques	2.0	4.5	4
4-13	Recompletion techniques	3.0	1.0	2
4-14	Remote control and data analysis	2.0	2.5	4
4-15	Compact processing on offshore platforms	1.0	3.0	1
4-16	Modification of reservoir fluid mobilities	5.0	1.0	1
4-17	Miscible contact/displacement	3.0	3.0	1
4-18	Viscosity reduction of heavy oils	3.0	3.0	1
4-19	In situ generation of foams/emulsions	3.0	3.0	1
4-20	Thickeners for CO_2 floods	1.0	3.0	1
4-21	Microbial EOR processes	1.0	3.0	1
4-22	High-velocity gas flow modeling	1.0	3.0	1
4-23	Thermal processes	2.0	4.0	2
4-24	Combustion processes	3.0	3.0	1
4-25	Near well bore stimulation	5.0	1.0	1
4-26	New directional drilling	5.0	1.0	1
4-27	Advanced recovery of natural gas	2.0	4.0	2

Identification of Short-term R, D&D Targets

- Deepwater Offshore -

- service companies -

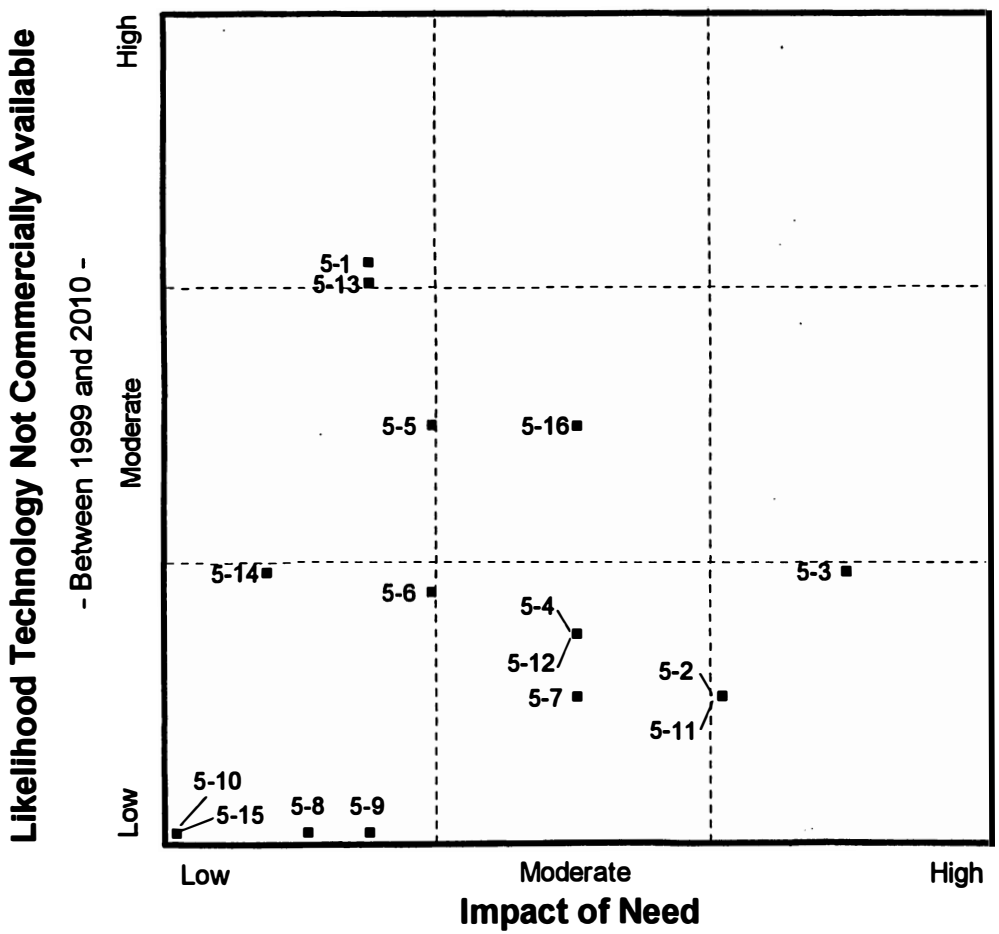


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	-	-	-
5-2	Extended reach drilling or production	5.0	1.0	6
5-3	Extended reach control systems	5.0	1.7	3
5-4	High pressure systems	3.0	1.0	3
5-5	Flowlines	4.3	3.0	3
5-6	Flow metering	4.0	2.0	2
5-7	Subsea equipment	5.0	2.3	3
5-8	External corrosion protection	3.0	3.0	1
5-9	Risers	4.3	4.0	2
5-10	ROV systems	3.5	2.3	3
5-11	Drilling	5.0	1.0	6
5-12	Workover	5.0	1.5	4
5-13	Water/gas injection	3.0	4.0	2
5-14	Hydrate prevention	3.0	2.0	2
5-15	Multi-phase pumps	4.3	2.3	3
5-16	Structures	4.0	2.0	2

Identification of Long-term R, D&D Targets

- Deepwater Offshore -

- service companies -

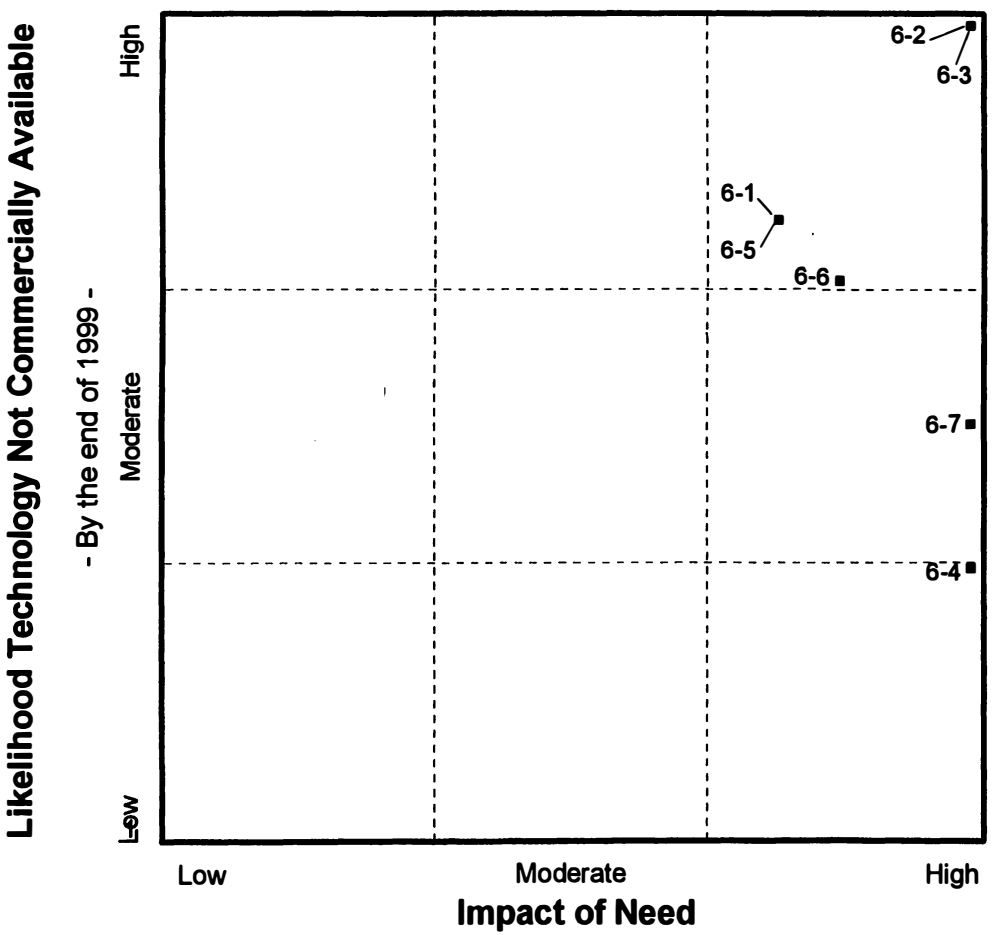


		Impact	Likeli-hood	n =
5-1	Produced fluid disposal	2.0	3.8	5
5-2	Extended reach drilling or production	3.7	1.7	3
5-3	Extended reach control systems	4.3	2.3	3
5-4	High pressure systems	3.0	2.0	2
5-5	Flowlines	2.3	3.0	2
5-6	Flow metering	2.3	2.2	5
5-7	Subsea equipment	3.0	1.7	3
5-8	External corrosion protection	1.7	1.0	2
5-9	Risers	2.0	1.0	1
5-10	ROV systems	1.0	1.0	1
5-11	Drilling	3.7	1.7	3
5-12	Workover	3.0	2.0	4
5-13	Water/gas injection	2.0	3.7	3
5-14	Hydrate prevention	1.5	2.3	3
5-15	Multi-phase pumps	1.0	1.0	1
5-16	Structures	3.0	3.0	2

Identification of Short-term R, D&D Targets

- Arctic Region Activities -

- service companies -

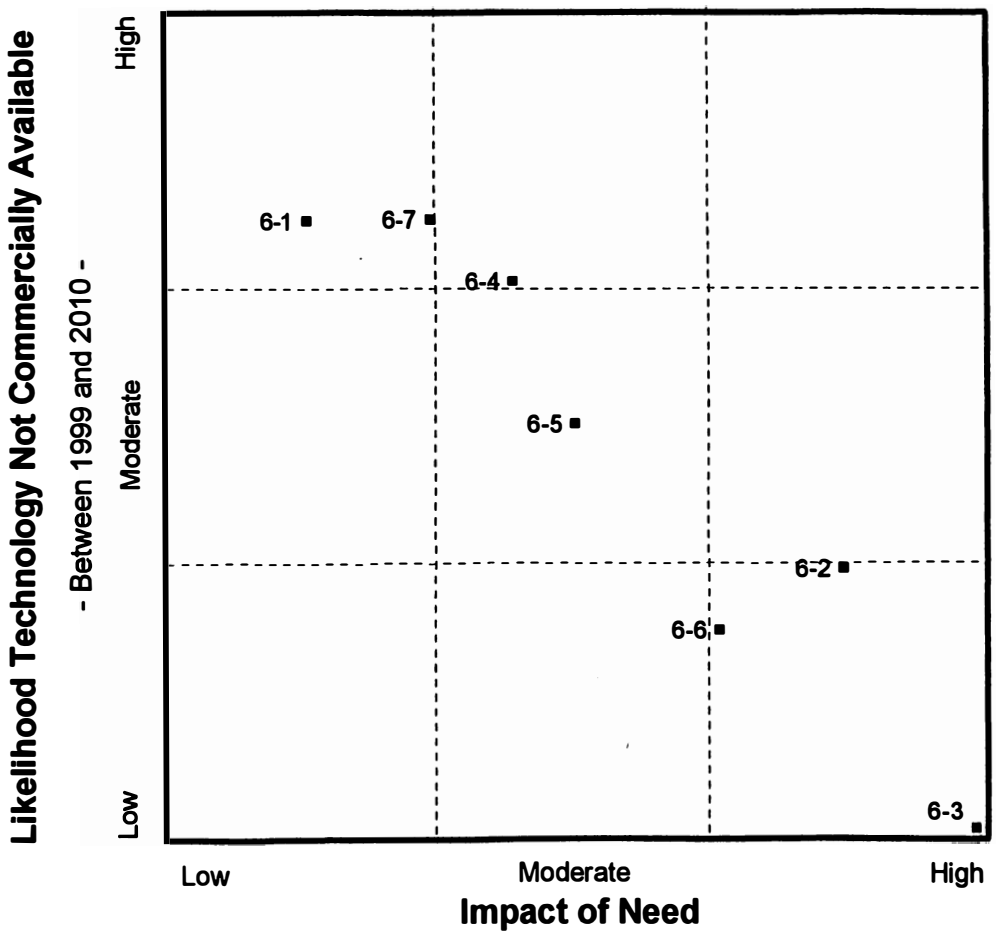


		Impact	Likeli-hood	n =
6-1	Transportation	4.0	4.0	2
6-2	Exploration	5.0	5.0	1
6-3	Development	5.0	5.0	1
6-4	Drilling	5.0	2.3	3
6-5	Production	4.0	4.0	2
6-6	Deepwater offshore activities	4.3	3.7	3
6-7	Mobile ice	5.0	3.0	1

Identification of Long-term R, D&D Targets

- Arctic Region Activities -

- service companies -

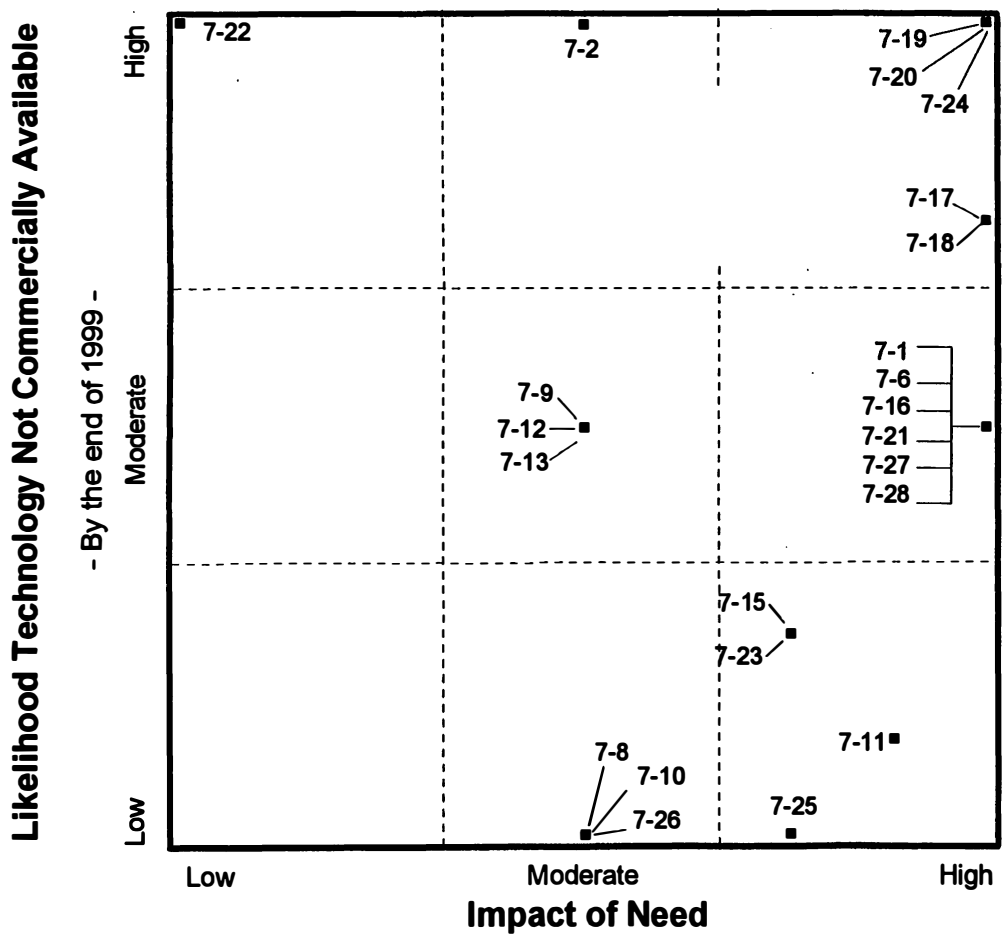


		Impact	Likeli-hood	n =
6-1	Transportation	1.7	4.0	2
6-2	Exploration	4.3	2.3	3
6-3	Development	5.0	1.0	2
6-4	Drilling	2.7	3.7	6
6-5	Production	3.0	3.0	4
6-6	Deepwater offshore activities	3.7	2.0	2
6-7	Mobile ice	2.3	4.0	2

Identification of Short-term R, D&D Targets

- Oil Processing and Refining -

- service companies -

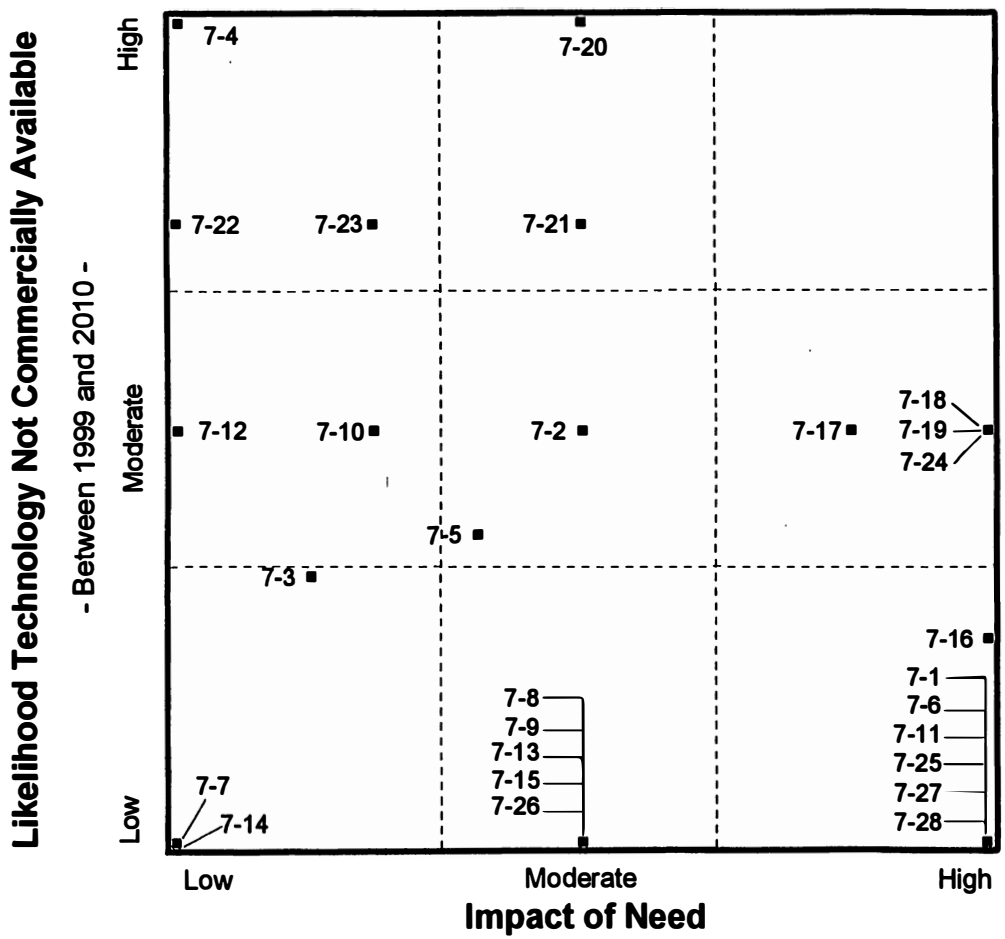


		Impact	Likeli-hood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	5.0	3.0	1
7-2	Hydrogen production and recovery	3.0	5.0	1
7-3	Plant and process reliability	-	-	-
7-4	Unconventional process technology	-	-	-
7-5	New materials of construction	-	-	-
7-6	Reactor engineering and modeling	5.0	3.0	1
7-7	Catalyst manufacturing technology	-	-	-
7-8	Risk assessment methodology	3.0	1.0	2
7-9	Solid acid catalysts	3.0	3.0	1
7-10	Alternatives to olefin alkylation process	3.0	1.0	1
7-11	Techniques for integration of environmental solutions into process and plant design	4.5	1.5	4
7-12	Improved on-line NDE inspection technology	3.0	3.0	1
7-13	Predicting useful remaining lifetimes of aging equipment	3.0	3.0	1
7-14	Robotics for safety applications	-	-	-
7-15	Worker safety systems	4.0	2.0	2
7-16	Energy efficiency of processes	5.0	3.0	2
7-17	Energy efficiency of equipment	5.0	4.0	2
7-18	Energy efficiency of separations	5.0	4.0	2
7-19	Separations technologies	5.0	5.0	1
7-20	Determining chemical composition of crudes, refinery intermediates, and products	5.0	5.0	1
7-21	New approaches to refining heavy feeds	5.0	3.0	1
7-22	Processing synthetic fuels	1.0	5.0	1
7-23	Conversion of methane to liquid fuels	4.0	2.0	2
7-24	Relating chemical compositions to process and product performance	5.0	5.0	1
7-25	Advanced computational modeling of processes/reactions	4.0	1.0	2
7-26	Advanced control and information systems	3.0	1.0	2
7-27	Performance characteristics of new hydrocarbon fuel compositions	5.0	3.0	1
7-28	Environmental characteristics of new hydrocarbon fuel compositions	5.0	3.0	1

Identification of Long-term R, D&D Targets

- Oil Processing and Refining -

- service companies -

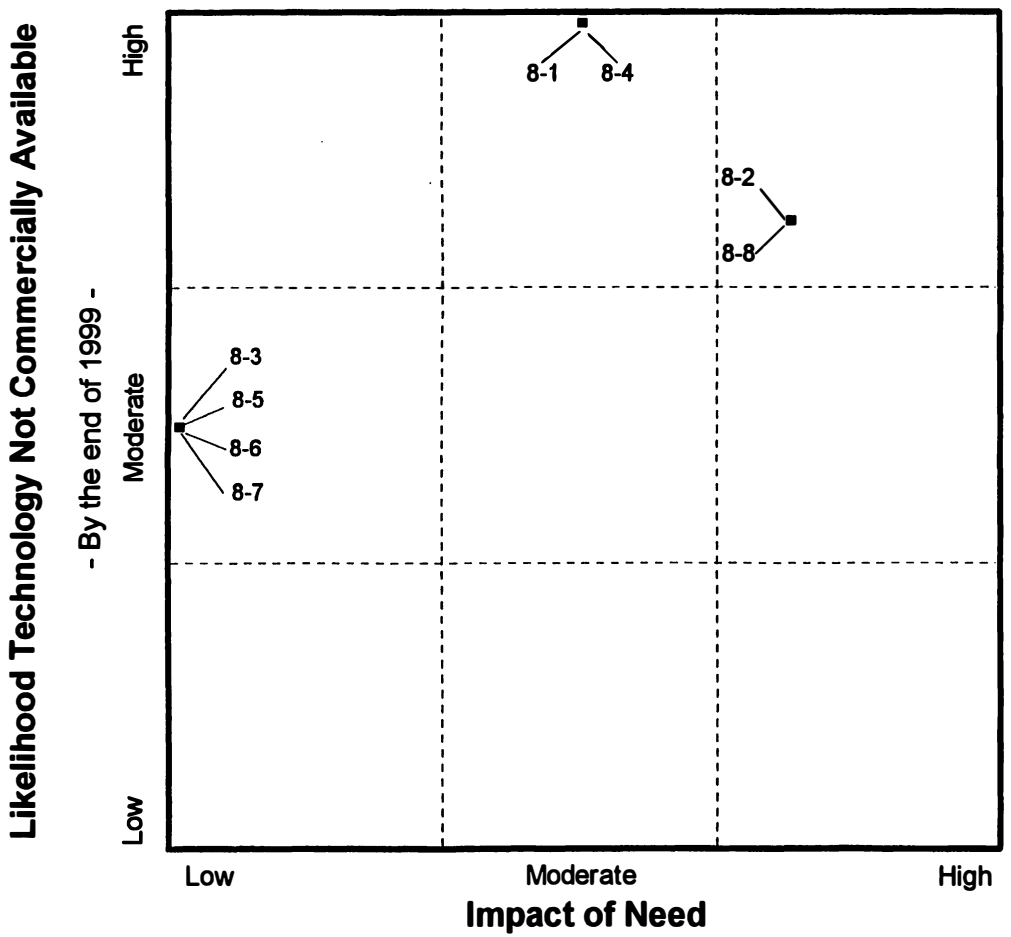


		Impact	Likell-hood	n =
7-1	Catalysts with improved selectivities, yields, lifetimes	5.0	1.0	1
7-2	Hydrogen production and recovery	3.0	3.0	1
7-3	Plant and process reliability	1.7	2.3	3
7-4	Unconventional process technology	1.0	5.0	2
7-5	New materials of construction	2.5	2.5	4
7-6	Reactor engineering and modeling	5.0	1.0	1
7-7	Catalyst manufacturing technology	1.0	1.0	1
7-8	Risk assessment methodology	3.0	1.0	1
7-9	Solid acid catalysts	3.0	1.0	1
7-10	Alternatives to olefin alkylation process	2.0	3.0	2
7-11	Techniques for integration of environmental solutions into process and plant design	5.0	1.0	1
7-12	Improved on-line NDE inspection technology	1.0	3.0	1
7-13	Predicting useful remaining lifetimes of aging equipment	3.0	1.0	1
7-14	Robotics for safety applications	1.0	1.0	1
7-15	Worker safety systems	3.0	1.0	1
7-16	Energy efficiency of processes	5.0	2.0	2
7-17	Energy efficiency of equipment	4.3	3.0	3
7-18	Energy efficiency of separations	5.0	3.0	2
7-19	Separations technologies	5.0	3.0	2
7-20	Determining chemical composition of crudes, refinery intermediates, and products	3.0	5.0	2
7-21	New approaches to refining heavy feeds	3.0	4.0	2
7-22	Processing synthetic fuels	1.0	4.0	2
7-23	Conversion of methane to liquid fuels	2.0	4.0	2
7-24	Relating chemical compositions to process and product performance	5.0	3.0	1
7-25	Advanced computational modeling of processes/reactions	5.0	1.0	1
7-26	Advanced control and information systems	3.0	1.0	1
7-27	Performance characteristics of new hydrocarbon fuel compositions	5.0	1.0	1
7-28	Environmental characteristics of new hydrocarbon fuel compositions	5.0	1.0	1

Identification of Short-term R, D&D Targets

- Gas Processing -

- service companies -

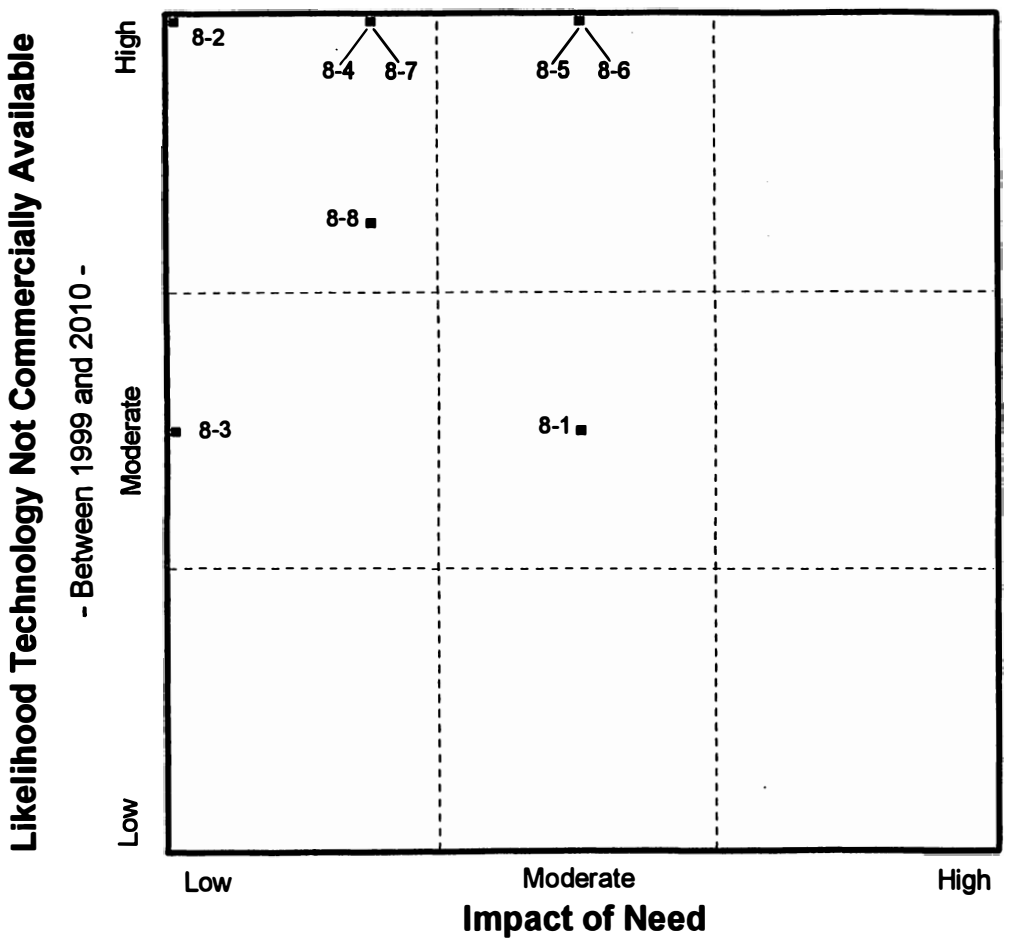


		Impact	Likeli-hood	n =
8-1	Gas dehydration	3.0	5.0	2
8-2	Acid gas removal	4.0	4.0	2
8-3	H_2S scavenger technology	1.0	3.0	1
8-4	Natural gas liquid separation	3.0	5.0	1
8-5	Nitrogen separation	1.0	3.0	1
8-6	Trace constituent (arsenic, Hg, etc.) removal	1.0	3.0	1
8-7	Sulfur recovery	1.0	3.0	1
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	4.0	4.0	2

Identification of Long-term R, D&D Targets

- Gas Processing -

- service companies -

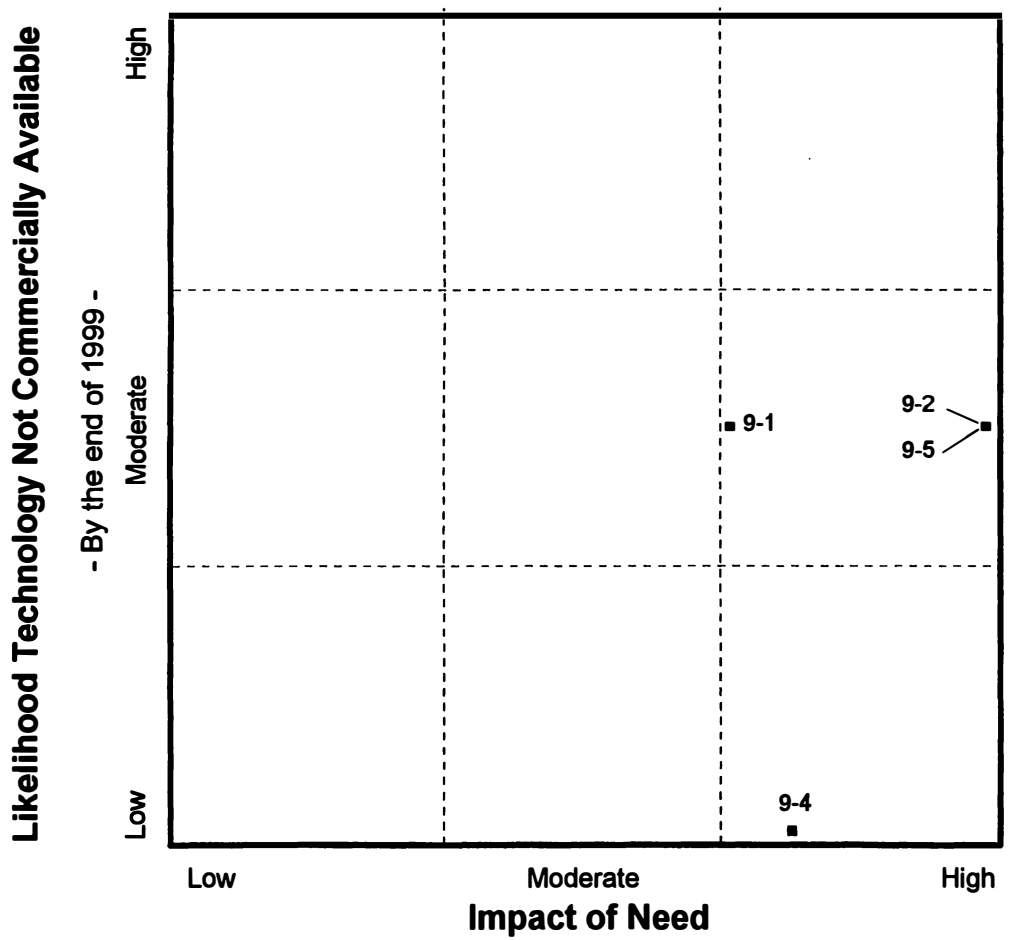


		Impact	Likeli-hood	n =
8-1	Gas dehydration	3.0	3.0	2
8-2	Acid gas removal	1.0	5.0	1
8-3	H_2S scavenger technology	1.0	3.0	1
8-4	Natural gas liquid separation	2.0	5.0	2
8-5	Nitrogen separation	3.0	5.0	1
8-6	Trace constituent (arsenic, Hg, etc.) removal	3.0	5.0	1
8-7	Sulfur recovery	2.0	5.0	2
8-8	Separation of high concentrations of impurities (nitrogen, CO_2, H_2S ...)	2.0	4.0	2

Identification of Short-term R, D&D Targets

- Gas Gathering -

- service companies -

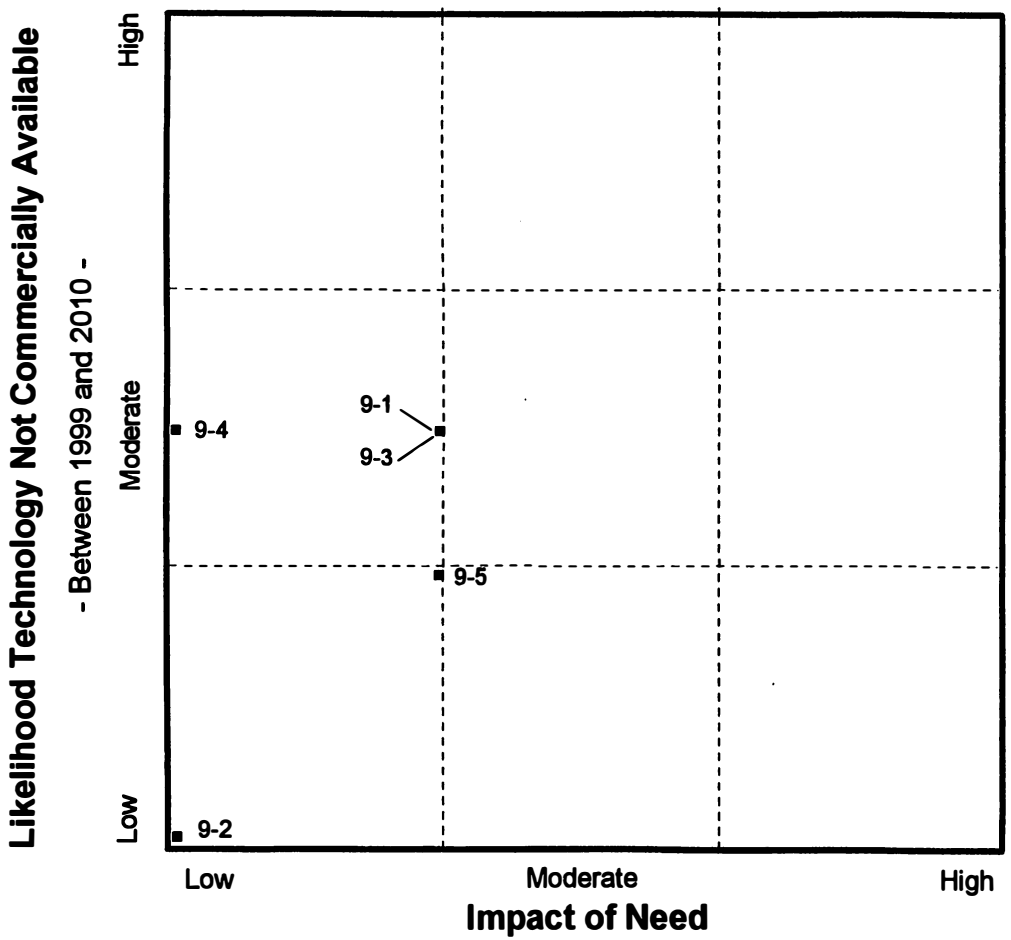


		Impact	Likeli-hood	n =
9-1	Compression	3.7	3.0	3
9-2	Leak detection	5.0	3.0	1
9-3	Plastic pipe (higher pressure rating)	-	-	-
9-4	High pressure measurement	4.0	1.0	2
9-5	Multi-phase metering	5.0	3.0	1

Identification of Long-term R, D&D Targets

- Gas Gathering -

- service companies -

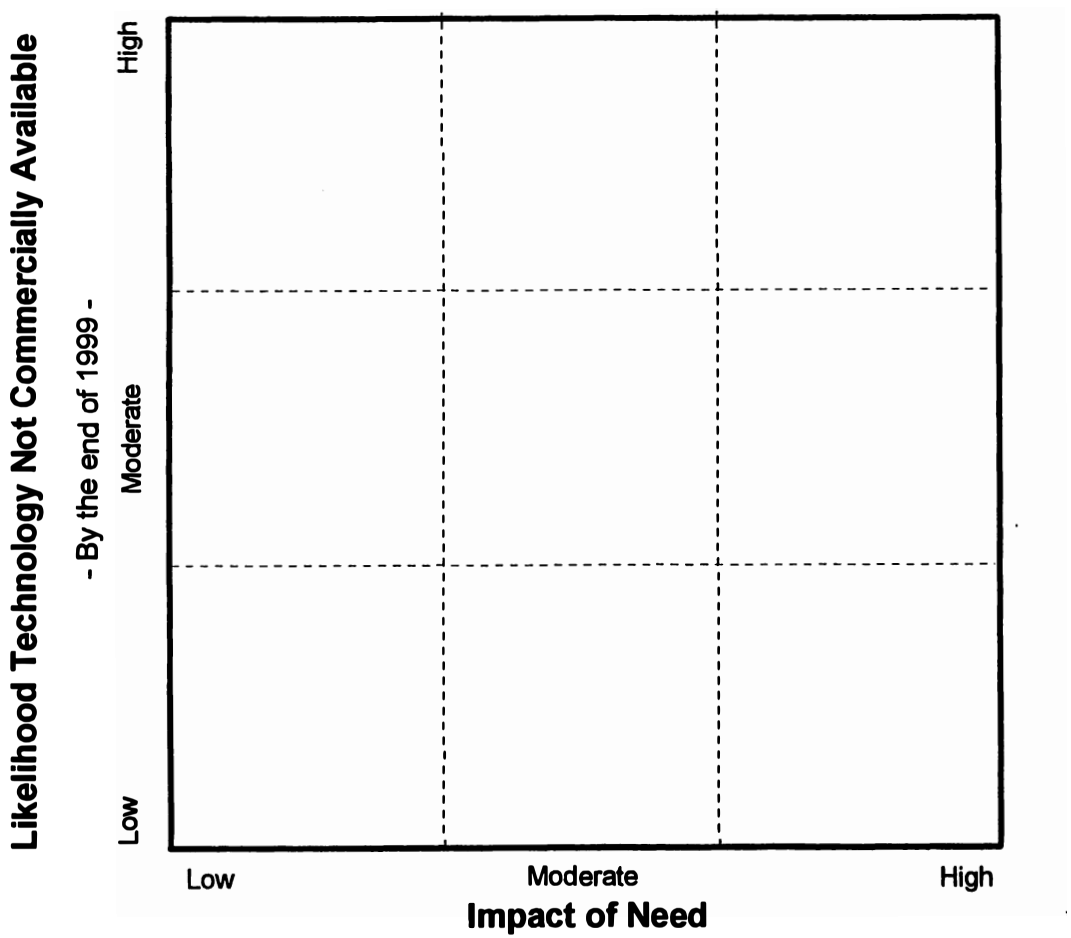


		Impact	Likeli-hood	n =
9-1	Compression	2.3	3.0	3
9-2	Leak detection	1.0	1.0	1
9-3	Plastic pipe (higher pressure rating)	2.3	3.0	3
9-4	High pressure measurement	1.0	3.0	2
9-5	Multi-phase metering	2.3	2.3	3

Identification of Short-term R, D&D Targets

- Gas Storage -

- service companies -



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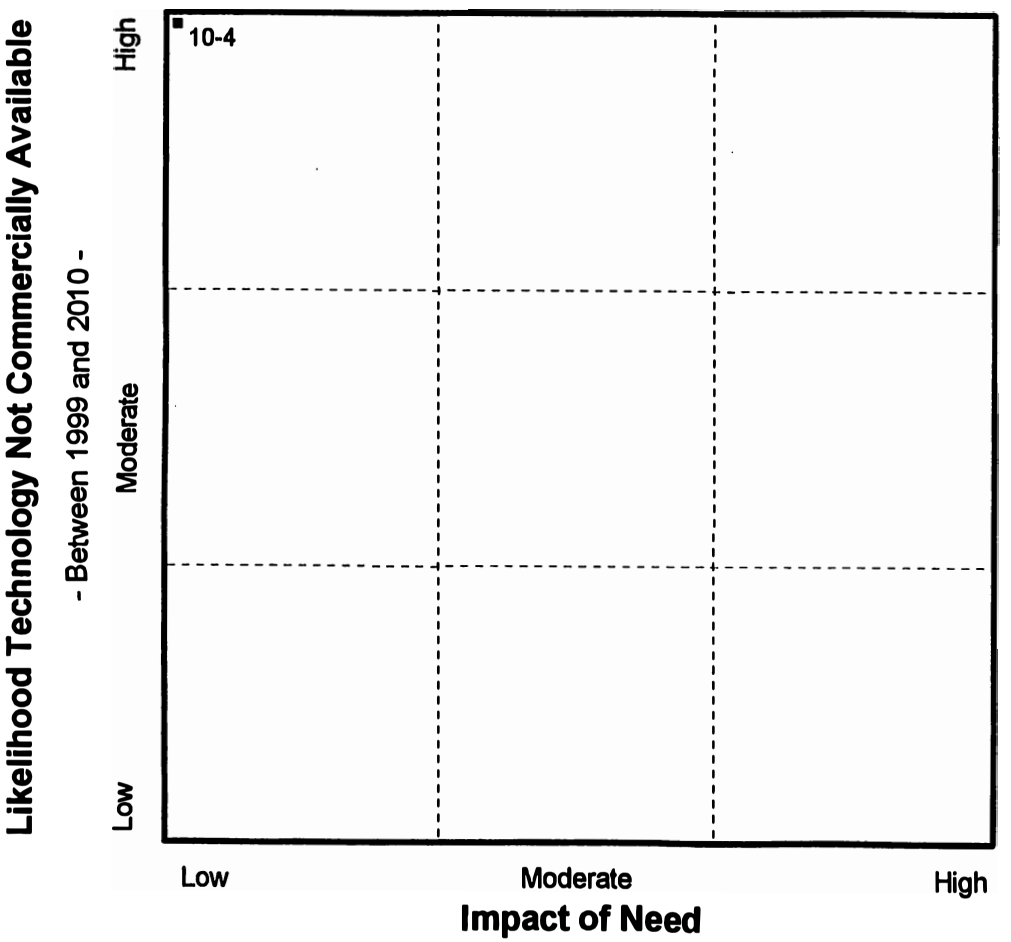
Identification of Long-term R, D&D Targets

- Gas Storage -

- service companies -

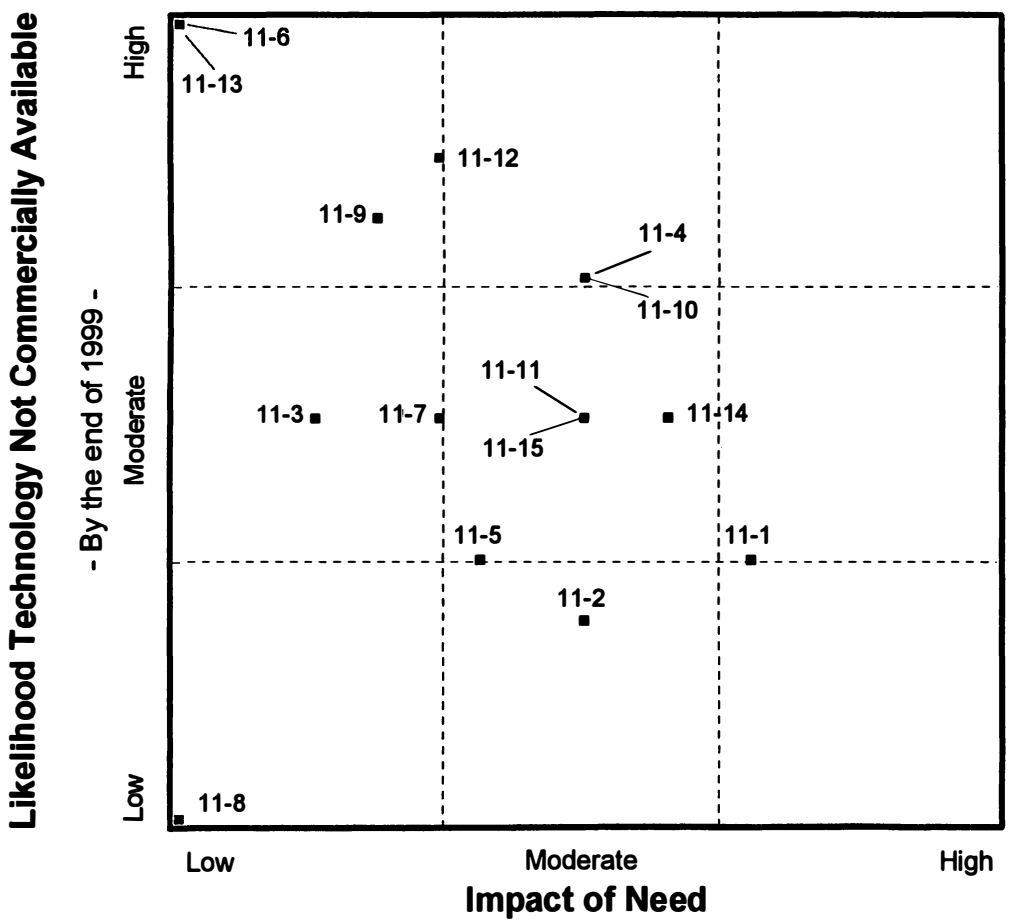


		Impact	Likelihood	n =
10-4	Gas migration control	1.0	5.0	1

Identification of Short-term R, D&D Targets

- Environmental and Regulatory -

- service companies -

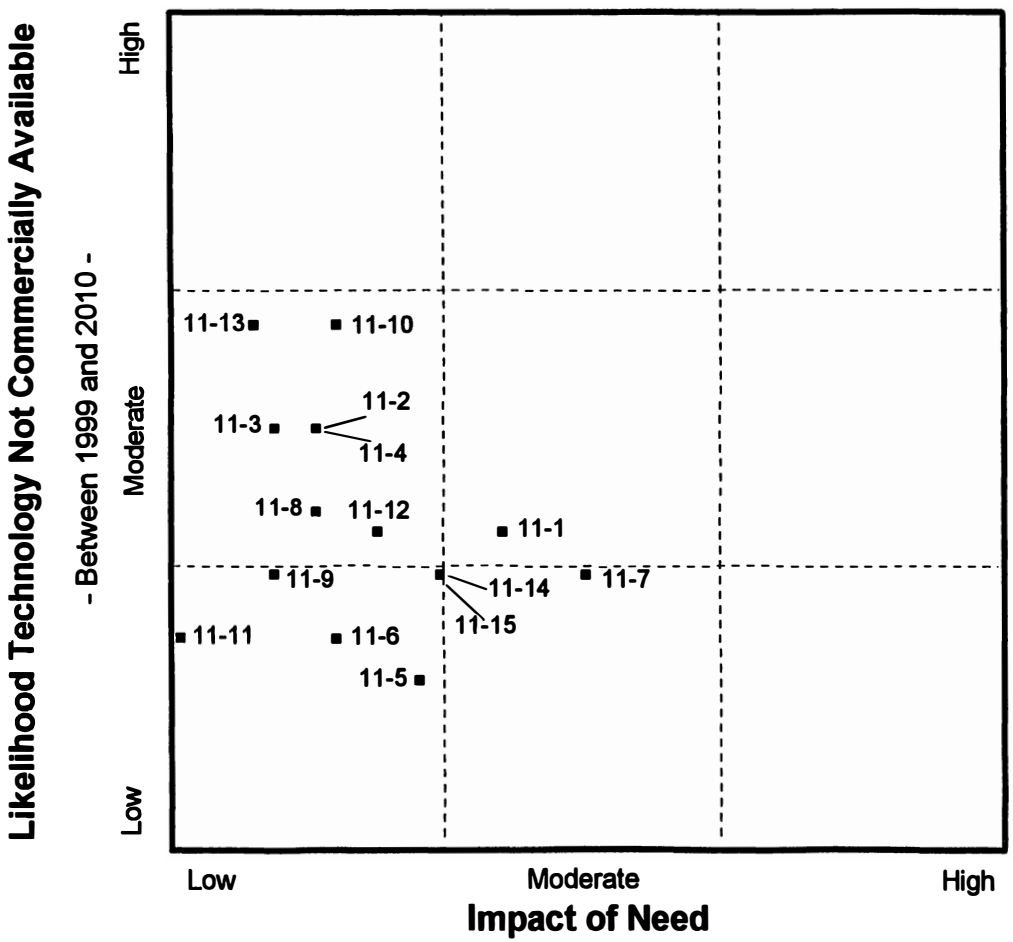


		Impact	Likell-hood	n =
11-1	Disposal methods for drilling fluids	3.8	2.3	8
11-2	Treatment and disposal of produced fluids	3.0	2.0	4
11-3	Screening procedures for injection wells	1.7	3.0	2
11-4	Risk and reclamation analysis of disposal	3.0	3.7	3
11-5	Leak detection	2.5	2.3	3
11-6	Hydrological modeling	1.0	5.0	1
11-7	Compliance with CAAA stationary source	2.3	3.0	3
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	1.0	1.0	1
11-9	Model transport and remediation of contaminants in ground water and soils	2.0	4.0	2
11-10	Effluent and emission monitoring, minimization, and control	3.0	3.7	3
11-11	Recycling of waste and byproduct streams	3.0	3.0	3
11-12	Remediation technology	2.3	4.3	3
11-13	Catalyst recycling	1.0	5.0	1
11-14	Provide scientific basis for risk-based regulation	3.4	3.0	5
11-15	NORM disposal	3.0	3.0	4

Identification of Long-term R, D&D Targets

- Environmental and Regulatory -

- service companies -



		Impact	Likeli-hood	n =
11-1	Disposal methods for drilling fluids	2.6	2.5	4
11-2	Treatment and disposal of produced fluids	1.7	3.0	5
11-3	Screening procedures - injection wells	1.5	3.0	4
11-4	Risk and reclamation analysis of disposal methods	1.7	3.0	2
11-5	Leak detection	2.2	1.8	5
11-6	Hydrological modeling	1.8	2.0	4
11-7	Compliance with CAAA stationary source issue	3.0	2.3	3
11-8	Advanced computation models to predict dispersion, transformation, and fate of air pollutants	1.7	2.6	5
11-9	Model transport and remediation of contaminants in ground water and soils	1.5	2.3	3
11-10	Effluent and emission monitoring, minimization, and control	1.8	3.5	4
11-11	Recycling of waste and byproduct streams	1.0	2.0	2
11-12	Remediation technology	2.0	2.5	4
11-13	Catalyst recycling	1.4	3.5	4
11-14	Provide scientific basis for risk-based regulation	2.3	2.3	3
11-15	NORM disposal	2.3	2.3	3

Q1- Additional EXPLORATION Technologies

Segment	18)	19)	20)	21)	22)	23)
Independent	3-D velocity analysis					
Independent	Higher Seismic resolution through signal decoding					
Independent	Wire line advances	Drilling technology	Remote sensing techniques	Utility Geochem fingerprinting to map migration pathways		
Independent	Magnetic resonance logging					
Independent	Petrophysical Anal (log analysis)					
Integ. Gas/Oil	Gas hydrates					
Integ. Gas/Oil	Petrophysical logging to determine porosity and fluid content					
Integ. Gas/Oil	Economics of seismic data gathering	Environmental impact of drilling				
Integ. Gas/Oil	Gravity gradiometry	Marine magnetotelluric				
Integ. Gas/Oil	Use of existing hazard surveys by MMS for block clearance	Consolidation of data on chemosynthetic communities				
Major	Wellbore core and log characterization	Source Rocks: kinetics and expulsion	Fracture modeling			
Major	Integrating geoscience & engineering data/analysis	Lithology/reservoir-predicting seismic				

Q1- Additional EXPLORATION Technologies

Segment	18)	19)	20)	21)	22)	23)
Major	Regional stress fields and fracture orientation					
Major	Gravity-microstudies	Magnitics				
Major	Through casing resistivity measurements	Salt proximity surveying	MWO depth accuracy	Permeability measurements from logs		
Major	Time lapse 3-D for reservoir management-cheap	Multi-component bottom cables for deepwater	High spatial and vertical 3-D resoltuion for reservoir	Logging tools to detect low resistivity pays		
Major	Seismic imaging below salt					
Major	Sea floor multi seismic					
Service	Simulators for Seismic Borehole Geophysics Systems	Low cost/high bandwidth data transfer/compress	Fluid differentiation by Seismic Indicators	Portable, high energy Seismic source	Light weight, large channel, land Seismic systems	3-D earth model software
Service	Statistical descriptions of clastic sedimentary environment					
Service	Visualizational ahead of drill bit					

Q2 - Additional DEVELOPMENT Technologies

Segment	36)	37)	38)	39)	40)	41)
Independent	Crosswell Seismic modeling	Connectivity mapping	Stochastic modeling of 3-D logs	Fracture connectivity with multiphase data		
Independent	Sand control	Water shut off	Prodn logs for fluid entry profile	Down hole pressure sensors (cheap, durable)	Better cased hole SW tools (logs)	Better shaley sand logs & interpretation
Independent	Advanced new recovery methods	Understanding advanced recovery in fractured reservoirs				
Independent	Integrated production databases					
Independent	Resolution in drilling technology & techniques	Developmental horizontal drilling	Geochemical/remote sensing	Detailed reservoir facies analysis		
Integ. Gas/Oil	Drainage area shape determination	Moveable hydrocarbon measurements	Reservoir heterogeneity characterization			
Major	Polymer gels to shut off water or gas channels	Improved visualization of reservoir modeling results	Improved asphalhene(?) deposition prediction	Improved wax deposition prediction		
Major	Hard copy to digital conv.					
Major	Small diameter NWD-FEWD	Small diameter high temp-NWR				
Major	Fracture orientation					
Major	Coupled 3D geologic and reservoir simulation models	Accurate price forecasting				

Q2 - Additional DEVELOPMENT Technologies

Segment	36)	37)	38)	39)	40)	41)
Major	Production logging high water identification	Fracture characterization				
Major	Advanced integrated workstation software	3-D geological analog	Parallel computing	Higher-speed 3-phase (vapor-liquid-liquid) flash simulation routine (incl. equilihium databases)		
Service	Unstructured grid simulation technique					
Service	Statistical description of areal distribution of clastic facies	More extensive, specific databases				

Q3 - Additional DRILLING & COMPLETION Technologies

Segment	15)	16)	17)	18)	19)	20)
Independent	Gravel pack tech.					
Independent	Drilling systems optimization	Completion systems optimization	Non-newtonian (CFD) hydraulic perf. codes			
Independent	Fluid compatability & chemistry					
Independent	Advanced acid treatments					
Independent	Advanced logging techniques					
Independent	Drill pipe design					
Independent	Improved hole cleaning in horizontal wells	Removal of formation skin due to edregmud in open hole gravel pack completion				
Integ. Gas/Oil	Petrophysical measurements-moveable hydrocarbons and permeability	Reservoir heterogenicity characterization				
Integ. Gas/Oil	(Near bit sensors) Smart drilling systems					
Integ. Gas/Oil	Multiple completion(?)	Frac pack-gravel pack				
Major	Propellant fracturing					
Major	Extender reach drilling					
Major	Cost effective deep water systems	Automated rigs				

Q3 - Additional DRILLING & COMPLETION Technologies

Segment	15)	16)	17)	18)	19)	20)
Major	Ultra-low cost drilling					
Major	Universal fluid-drilling mud which can be activated to act like cement					
Major	Open hole completion design	Formation strength analysis	CBM proppant and fluid design	Frac pack modeling	LCM polymers-low damage	Low skin gravel packing
Major	Extended reach drilling	Well bore (openhole) stability				
Service	Downhole water separation	Evaporative production	Slag/MVD cements	Sputter technology in multilaterals	Closed loop drilling systems	
Service	Seismic while drilling	High temperature downhole drilling systems	Rotary steerable systems	MWD gyro		

Q4 - Additional PRODUCTION Technologies

Segment	29)	30)	31)	32)	33)	34)
Independent	Type of polymer to control water production					
Independent	Production process system optimization	Production system automation	Multiphase wet gas metering			
Independent	Progressive cavity pumps					
Independent	Wellbore multiple zone production					
Independent	Study of shallow H2O sands become charged and corrosive	Control of water influx in horizontal wells				
Integ. Gas/Oil	Environmental/safety					
Integ. Gas/Oil	P/L installation in deep water	P/L recovery and recycling	Control of hydrate formation in H.P. Gas Prod.			
Major	Gas hydrate inhibition	Waste management	Sour water treating			
Major	Multiphase pumping and metering	Continuous water quality monitoring	Remote monitoring and control	Subsea hardware	Energy management	
Major	Integrated prod./invest. optimization					
Major	Unmanned offshore operations control	Advanced floating production systems				
Major	Produced water shut off	Sand production	Water disposal	Waste disposal (tank bottoms)	Vapor recoveries	

Q4 - Additional PRODUCTION Technologies

Segment	29)	30)	31)	32)	33)	34)
Major	Profile modification (esp. on producers; lowcost, variable)	Cable suspended electric submersible pumps				
Service	Evaporative production	Downhole water separation				
Service	Environmental protection					
Service	New wear & corrosion resistant coatings for cylinder ID's					
Service	Rigless workover					

Q5 - Additional DEEPWATER OFFSHORE Technologies

Segment	18)	19)	20)	21)	22)	23)	24)
Independent	Multiphase flow perf. (CFD) codes	Remote control from existing surface facilities					
Integ. Gas/Oil	SPAR Technology	Floating Production System					
Integ. Gas/Oil	Mechanical connection for J-Lay	Reliable pipeline isolation technique w/o water flooding pipeline	Riser splash-zone coating & repair				
Integ. Gas/Oil	Multi-phase flow analysis tools	Poraffin prevention					
Integ. Gas/Oil	Subsea well intervention methods from low cost vessels	Deepwater drilling vessels with subsea completion requirements included in design	Flowline installation vessels in deepwater				
Major	Pipeline installation & repair	Multi-phase metering	Mooring system materials				
Major	New/composite materials						
Major	Produced fluids problems	Regulatory issues	Mooring	Leak detection	Subsea power distribution	Simulation software multiphase	
Major	Extended well testing	Mooring systems	Composite materials	Subsea power	Foundations/anchors		
Major	Loop/eddy forecasting						
Major	Riser less and/or composite riser drilling	Reduced hole size drilling	Mooring systems and designs	Well control	Well testing	Foundations	Shallow water flows

Q5 - Additional DEEPWATER OFFSHORE Technologies

Segment	18)	19)	20)	21)	22)	23)	24)
Major	Subsea oil completions	Paraffin (subsea and flowlines					
Major	Mooring systems	Subsea production control systems	Integrated real time data acquisition systems	Climate/environmental monitoring systems	Novel drilling concepts	Completion equipment	Sea floor multi-component seismic
Service	High flow rates	Slim hole exploration					
Service	Underwater multiphase pumping	Light weight moorings	Pipe lay equipment				
Service	Renewal/biodegradable drilling fluids	Extended reach/non-formatio n damaging drilling fluids	Products to enhance water based drilling fluids				
Service	Remote power (batteries)	Remote power (high freq.)	Pipeline technology	Pipeline lay/inst vessel	Pipeline pigging	Pipeline repair	

Q5 - Additional DEEPWATER OFFSHORE Technologies

Segment	5-25	5-26	5-27	5-28
Independent				
Integ. Gas/Oil				
Integ. Gas/Oil				
Integ. Gas/Oil				
Integ. Gas/Oil				
Major				
Major				
Major				
Major				
Major				
Major				
Major				
Major	Well bore produced fluids sepn	Subsea separation	Subsea multiphase pumping	Subsea power transmissior
Service				
Service				
Service				
Service				

Q6 - Additional ARCTIC REGION Activities Technologies

Segment	9)	10)	11)	12)	13)	14)
Independent	Economic incentives (royalty relief, transportation deductions exemptions to the Jones Act, ect.)					
Major	Icebreaking tankers trafficability	Onshore pipeline permafrost regions	Offshore pipeline & shoreline crossing	Offshore terminal in infested water		
Major	Arctic logistics					
Service	Winter construction	Tanker loading facilities	Ice scouring			
Service	Multi-phase pumps	Water injection				

Q7 - Additional OIL PROCESSING/REFINING Technologies

Segment	30)	31)	32)	33)	34)	35)
Independent	Carbon rejection technology	Sulfur removal processes	Emissions control additives	Waste petrol producation upgrade	Sensors and controls	Contaminate fluids/solids control
Independent	Heavy oil processing					
Major	Alternate HF alkylatron	Catalyst recycling vs landfill	Improved effluent treatment			
Major	High acid					
Major	Processes to refine high sulfur & metal crudes	Process analyzer technology				
Major	Stationary source control of NOx, SOx and VOL					
Service	Biological demetalation	Biological heavy hydrocarbon cracking	Hydrocarbon (oil, gasoline, etc.) powered fuel cells			

Q8 - Additional GAS PROCESSING Technologies

Segment	10)	11)	12)	13)	14)	15)
Independent	Wellhead sulfur remediation	Sour water treatment	Real-time monitoring and automation	Separation efficiency	Energy efficiency	
Independent	Compression	Air emissions	Electronic monitoring and control (plant)	Liquid measurement	Noise abatement	Dynamic simulation
Integ. Gas/Oil	Membrane dehydration					
Integ. Gas/Oil	Hydrocarbon dewpoint reduction (to improve gas marketability by eliminating condensation along transmission system, at points of delivery to LDC's)					
Integ. Gas/Oil	Compressor efficient					
Major	CO2 removal	Liquify natural gas	Gas to liquid	Fire protection	Membrane technology	Small scale LNG liquefaction to utilize remote wells
Major	Instrumentation	Software simulation and gas data management	Environmental remediation soil, ground water & NORM	Air emission control & vapor recovery	Data telemetry	Energy optimization
Major	Membrane separation	(CO2, water cleaning, nat. gas liquids)				
Major	Compact LNG facilities for offshore	Process to convert CH4 into liquids	Oxygen removal			
Major	Mercaptan removal	NOx reduction from equipment (e.g. turbines)	Tail gas treating (from Claus)			

Q8 - Additional GAS PROCESSING Technologies

Segment	10)	11)	12)	13)	14)	15)
Service	Environmental protection					
Service	Natural gas liquifaction					

Q9 - Additional GAS GATHERING Technologies

Segment	7)	8)	9)	10)	11)	12)
Independent	Energy measurement	Wet gas metering	Hydrate control/removal	Pulsation control		
Independent	Air emissions	Electronic flow measurement	Noise abatement	Hydrate inhibition		
Integ. Gas/Oil	N2 rejection	Higher line efficiency in low pressure gathering				
Integ. Gas/Oil	Deepwater offshore rapid life/joining system	Dry diverless pipeline repair system	Limit state pension criteria	Low pressure dehydration		
Integ. Gas/Oil	Less expensive electronic metering					
Major	Fuel/emissions optimization	Very low pressure system models				
Major	Offshore pipeline laying/welding	Pipeline repairs	Pipeline upgrade			
Major	Sampling/analysis of low pressure gas	Streams from wellhead/lease				
Major	Internal pipe inspection	Software (system models)	Low volume/low pressure measurements	Pipe coatings & coating repair on ext.		
Major	Modeling of multiphase flow in networks					
Major	H2S reduction in gathering systems					
Major	Hydrate control					

Q9 - Additional GAS GATHERING Technologies

Segment	7)	8)	9)	10)	11)	12)
Service	Telemetering	Low volume+pressure measurement				

Q10 - Additional GAS STORAGE Technologies

Segment	9)	10)	11)	12)	13)	14)
Independent	Horizontal drilling (modifications)					
Independent	Injection/withdrawal flow metering	Well safety systems	Well monitoring/automation	Compression		
Integ. Gas/Oil	Bedded salt technology	Effect of gas temperature in salt cavern storage				
Integ. Gas/Oil	Surface facility management					
Integ. Gas/Oil	Hi pressure perforating	Operations optimization				
Major	Analysis and management of closure or creep in saltdome caverns					
Major	Through casing logging	Bacterial control				

Q11 - Additional ENVIRONMENTAL AND REGULATORY Technologies

Segment	17)	18)	19)	20)	21)
Independent	Statisitical inventory reconciliation for underground storage tanks				
Independent	Stream line environmental associates of operations on public lands				
Independent	MGP remediation	Risk base standards for MGP sites			
Independent	Closed system drilling				
Independent	Regulatory review				
Independent	Reclaimation technologies				
Independent	Produced water treatment for surface discharge	Low cost vapor recovery systems			
Integ. Gas/Oil	Emissions monitoring/identification				
Integ. Gas/Oil	Wetland mitigation	Endangered species	Cultural resources		
Integ. Gas/Oil	Bioremediation of recalcitrant PAHs	Increased bioremediation rates in subsurface environments	NOx emission reduction technologies	Removal of toxic inorganics from soil	
Integ. Gas/Oil	Hydrostatic test water disposal	Waste minimization and reduction			

Q11 - Additional ENVIRONMENTAL AND REGULATORY Technologies

Segment	17)	18)	19)	20)	21)
Major	Rational methods for estimating the full life cycle costs of environmental management practices				
Major	Oil spill clean up				
Major	Downhole separation of produced water & oil	NORM-containing hardware smelting			
Major	Waste source reduction				
Major	Advanced computation models to predict dispersion/transformation/fate of discharges to marine environment				
Major	Incident prevention	Risk assessment with human & ecological euclpoints	Intrinsic bioremediation	Assess sediment	Scientific assess of petrol contamination
Service	Accurate macro & micro oil spill risk indexes	Government approved risk-based levels of financial responsibility	Computer generated regulatory matrices		
Service	Handling & transfer of hazardous liquids				

Barriers/Problems - Total

Segment	12-2 Code	Barriers/Problems
Independent		Drilling costs, fracture costs, tight sands, fractured shales, formation damage due to inappropriate drilling and completion techniques, ability to track efficacy of stimulation methods, problems with steering and measurement while drilling in horizontal wells-conventional and slim hole; and low impact seismic acquisition.
Independent		The biggest problem for us would be if we could not efficiently and effectively find enough oil and gas reserves to not only replace production but to also grow our company. As technology continues to improve our ability to explore for both conventional and non-conventional reserves, it should help to alleviate the impact of the problem.
Independent		At first indicated "no comment," then went on to say that the government should get out of this process. This is a waste of government money. The government is looking for places to cut spending, and this should be it.
Independent		Since we are a small E&P company, advnaces in new technology are important component for our growth. These emerging solutions provide a window of opportunity for future growth.
Independent		1) Advanced recovery injectants preferentially move through fractures in dual permeability (fractured, low permeability matrix) reservoirs. A huge percentage of our properties are of this type and our company is faced with productive lives of our reservoirs limited to primary production. Any emerging technology which can address secondary/tertiary production in these reservoirs is of our highest priority. It is for this reason that we have collaborated with USDOE on their Class III Oil Research Program and would encourage additional research in this area. We believe additional research in the advanced recovery area to be a critical element in acquiring the large remaining reserves in existing fields. 2) In a broad category, acquiring useful data for more detailed in-site reservoir characterization is a large barrier for field development and recovery. Research on methods such as well to well tomography have been encouraged owed to their high leverage if successful. Research to date has been disappointing but not condemning of the technique. Other techniques should be encouraged as well. 3) Many in industry are critical of collaborative research efforts of the government and industry saying that the past proves that the best ideas come from the industry itself. Many in government are also critical of the collaborations saying that what the projects amount to are subsidies for specific elements of the industry. Neither of these class of critics reflect the actual truth and ignore the increasing need for cooperation between industry and government. A critical industry is best served by an assisting government and we believe the domestic oil and gas industry to be extremely critical to the future of the U.S. We welcome the emphasis of the Federal government in the investigation as represented by this survey. We wish you the best of luck.
Independent		Primary concern is profitability of exploration and development activities. Technologies which could reduce exploration risk, reduce development cost, and/or improve production performance would have the greatest benefit and impact.
Independent		The area that would most benefit us would be waste management of disposal i.e., new technology that would render hazardous waste harmless.
Independent		Historically less than 50% of oil in place is recoverable with present enhancement methods. Technological solutions for increasing that percentage would add significantly to our recoverable reserves. Also, most of the large reserve exploration opportunities remaining in the Western U.S. are in environmentally sensitive areas. Technological solutions for conducting seismic and other evaluation procedures that would provide the necessary data with less environmental disturbance would be helpful.
Independent		The latest technologies seem to be too expensive relative to its benefits.

Barriers/Problems - Total

Segment	12-2 Code	Barriers/Problems
Independent		As a developer of technology and provider of engineering services for the oil and gas industry, our ability to supply this needed resource will be enhanced through emerging technological solutions that: 1) allow more cost-effective analysis of complex process phenomena; i.e, improved computer hardware and software, and models that can be used to optimize performance and reduce capital and operating cost. 2) Improve sensor and instrumentation reliability and operating condition compatibility. Such advances will aid in developing more efficient and reliable processes and machinery, and for use in the next generation of process control and diagnostic systems. 3) Provide R&D needs background information (technology status and industry needs) in a readily available form that can be used to establish priorities for SwRi corporate planning purposes. Electronic information systems, video conferencing, and other emerging technologies that can efficiently communicate industry-wide technological needs to the R&D community will benefit both the developer and end user.
Independent		Cost, access, technical knowledge, people, no R&D, tax incentives, government regulations.
Independent		Improved seismic imaging of potential reservoirs would increase success rates and help achieve reserve addition goals. Improved drilling and production techniques would help control costs.
Independent		We explore for hydrocarbons in the U.S. Gulf of Mexico in areas covered by salt flows. Seismic imaging of sedimentary structures below salt has not been possible in the past. Computational facilities and technical staffs of the National Laboratories can expedite the rapid development of depth imaging techniques to exploit sub-salt resources. Many western U.S. gas fields require fractures to produce. Advances in multi-component seismic, cross-well seismic and improved models of fractured rock for interpretation of seismic observation will help industry exploit this resource.
Independent	1	The oil and gas industry has been forced (for years) to operate as cheaply as they can allowing no room for R&D for most companies. Most companies are operating on shoestring budgets with as few people as they can. The technology that will get wells drilled quicker (cheaper) and refines a barrel of crude cheaper is what is needed.
Independent	1	Lack of money prevents our company from supporting R&D. Small independents spent lots of capital to replace what they produce.
Independent	1	Access to R&D funds.
Independent	100	RB
Independent	100	No comment-none at this time.
Independent	100	RB
Independent	100	Refused to comment.
Independent	100	RB
Independent	100	No response.
Independent	100	RB
Independent	100	No comment.
Independent	1;4	The traditional barrier is economic feasibility, i.e., when the price of commodity is low. There is an economic barrier or a barrier to attempting an elaborate solution. As the price becomes high, there is more of an opportunity to try things. The second barrier is staff availability; there are finite resources now.

Barriers/Problems - Total

Segment	12-2 Code	Barriers/Problems
Independent	2	Since we rely heavily on available processing technology, so long as the technology is in the public domain there are few substantial impediments. There is concern that available technology to meet ever increasing environmental requirements could limit the economic life of refining facilities.
Independent	2	Environmental-the acquisition business is severly hampered by the preoccupation with environmental problems. Both sellers and buyers spend resources and create very little from our efforts.
Independent	2	Excessive environmental regulations.
Independent	2	Barrier-complicated and unworkable environmental government regulations (federal and state).
Independent	2	Most of the challenges occurring in the refining sector of the industry over the last ten years are the result of regulatory compliance from government solutions, not advances from technological solutions. The expenditures for regulatory compliance have encumbered investment strategies of most companies. Expectations are that emerging technology solutions will produce a much better return of investment than has occurred during the period of complying with government solutions. Therefore, unless government changes their posture from command and control of our industry, I firmly believe that government is both a barrier & problem to have adequate funds to invest in & advance with new technologies.
Independent	2;3	Environmental & governmental regulations which might be lessened with advancing technology. A barrier is economics. Some technology is uneconomical under various pricing possibilities.
Independent	2;4	Major problem at this time is the limited profit margin provided by low natural gas prices. Technology can aid in solution by working to reduce costs/improve recoveries of existing reservoirs at limited additional costs. Certain governmental regulations and reporting requirements continue to complicate our business excessively.
Independent	2;4	1) Government regulation, 2) pricing i.e., the price of gas is low and that restricts Natural Gas drilling.
Independent	2;4	1) Well head prices for oil & gas remain low or go lower. 2) Capital continues to stay away from the industry. 3) Regulations increase. 4) Domestic activity continues to decrease.
Independent	2;4	Environmental regulations and economics.
Independent	4	The greatest challenge we face is remaining profitable and competitive in a low-price environment. Technology has proven to be our greatest ally in meeting that challenge. By utilizing technology advancements we are able to keep finding and development costs low, even as new hydrocarbon sources become more scarce. We firmly believe that technological advancements will continue in the future, and we plan to use these advancements in order to remain competitive regardless of weak prices.
Independent	96	Nothing comes to mind-not for LDC Co. It would be different if we were producer or pipeline.
Independent	96	Our company is a small independent oil & gas operator. We have in the past worked with DOE, GRI & BEG and service companies on research & technology projects. We have no detail set budget for R&D--only as specific projects arise.
Independent	?;1;4	For a natural gas producer, high costs coupled with a low gas price make many projects uneconomic. New technological breakthroughs could help in the following areas: 1) seismic technology-lower cost and higher accuracy, 2) drilling technology-lower cost, 3) deep water technology-lower cost, a) completion techniques, b) production techniques, c) transportation techniques, 4) any technology that would enhance the use of more natural gas a) higher demand would result in higher gas prices.

Barriers/Problems - Total

Segment	12-2 Code	Barriers/Problems
Independent	?;6	The primary problems encountered when adopting new or emerging methods involve: 1) training and familiarity of personal in the new methods; 2) normally high costs associated with new designs, e.g., demand on limited equipment; 3) rapid identification of a successful new technology with sufficient examples/analogies for direct implementation.
Integ. Gas/Oil		Deepwater pipeline for off gathering-1,000 meters. Low Btu combustors for gas turbines. More efficient gas compressors. Pollution free mobile engines or clean burning liquid fuels are needed to prevent the demise of the refined products business. Otherwise there will continue to be a strong push to electric cars or other low polluting vehicle fuels.
Integ. Gas/Oil		Our company executes an acquisition/development strategy with limited exploration. Our main technology need prior to the acquisition is improved screening methods for infill potential. Subsequent to an acquisition, technologies which relate to spacing optimization are key, as well as development and operating cost minimization.
Integ. Gas/Oil		The Natural Gas transmission & distribution segment of the business cannot identify any barriers that would be resolved by an emerging technological solution. There could be benefits, but not something at this time.
Integ. Gas/Oil	1	One respondent-Not able to respond-this is a regional office of foreign-based company. Another respondent-Our industry as a whole and our company in particular has reduced staff to a point to where it is difficult to take advantage of new technologies. People only have so much time to work in a day; they do not have time to learn about new technologies so they refine old ones. Instead of investigating a hot new technology, they are digging themselves into a technological rut, say, seismic monitoring. What this means is that new technologies lack champions. A new technology can be introduced but will not be fully utilized until someone in some company demonstrates that it is remarkable. Then others will scramble to catch up. With downsizing, the people who are charged with investigating details of new technologies are wasting time on making their own viewgraphs, maintaining the computer system, changing disk drives, etc. In cutting staff, there is a need to re-distribute skills to the least-cost producer. In general, the oil industry has not done this. Many individuals who should be investigating technologies are doing mundane tasks. The tieback is that if people are doing mundane things and are not ready to adapt technologies, it makes no difference if there is an excellent technology because people are not able to be receptive to it.
Integ. Gas/Oil	100	Refused response.
Integ. Gas/Oil	100	No comment-refused.
Integ. Gas/Oil	100	RB
Integ. Gas/Oil	1;5;6;7	1) New technologies generally require additional funds which are generally hard to come by. 2) Resistence to change even if it is better. 3) New skill sets needed with new technology. 4) Ability to define new technology needs.
Integ. Gas/Oil	2	The environmental impact and regulation of the emissions from combustion process continue to inhibit growth opportunities. Technologies capable of near-zero emissions would be valuable.
Integ. Gas/Oil	?;1;4	At the current time, our company is being impacted by Chapter 11. However, once these proceedings are behind us, we intend to do whatever is necessary to respond to competition in the E&D area to enhance our E&D properties value. Additionally, with energy prices expected to remain flat in real and nominal terms over the remainder of the decade, continued technological improvements will be needed to make the economics of funding and producing hydro-carbon reserves attractive.

Barriers/Problems - Total

Segment	12-2 Code	Barriers/Problems
Major		The major business challenge we face is to improve our profitability in a competitive commodity business which is increasingly constrained by regulations concerning operations and product performance. To meet this challenge, we must continue to reduce our finding and operating costs in all aspects of our business, improve the reliability of our operations and add profitable reserves to our resource base. Technology can help us achieve these goals. We must continue to advance the core technologies of our business such as catalysis, reactor and process engineering, and the basic chemistry of our resource, products and processes. These form the basis for the competitive technological positions of individual companies, particularly in our downstream business. We need to pursue selected collaborations which advance our technology in these areas but which will not jeopardize our relative competitive position. In the upstream areas of our business, most operations are already joint with other companies, and making advances in technology to distinguish one company from another is becoming less important than it is in the downstream business. Technology advances, however, remain vitally important to improve the health of the industry as a whole, and in the upstream these are being accomplished primarily through joint industry projects. In the upstream such advances can reduce the cost of finding and producing oil and make new resource areas, such as deep water and arctic areas, economic. At the same time that we improve our core technologies, we must find ways of adapting and applying supporting technologies which are growing up outside our industry. These technologies have the potential to advance our core technologies and, in conjunction with them, to improve our operations. This task is a particular challenge since these supporting technologies are not those in which we have the strength to make inventions or advance the technology on our own. Indeed, these technologies often form the basis for other industries that act as vendors to our own. Our challenge will be to form effective partnerships to encourage the development of these supporting technologies in ways that will benefit our industry and to find the right ways to use them in our industry. Supporting technologies which will have particular impact in the future are computational and information technologies, advanced control and process monitoring technologies and materials technology. In addition we have a strong interest in encouraging the development of cost effective approaches to meet environmental requirements and less expensive ways of remediating detrimental environmental effects of past activities. In both the downstream and upstream businesses, a key to successful performance is the IMPLEMENTATION of technological advances. In many instances the rapid and successful deployment of a technology can be more important to a company than having made the original invention of the technology.
Major		The technical problem for major oil companies as I see it, is tech transfer. The problem is getting the technology implemented on the field. The key decision maker is the person on the well-site; he must know and understand what we are trying to communicate.
Major		1) Understanding the migration of hydrocarbons during the basin evolution; 2) correctly imaging in structurally complex areas; 3) making realistic economic evaluations of exploration opportunities; 4) understanding how and when faults act as seals and transmission paths.

Barriers/Problems - Total

Segment	12-2 Code	Barriers/Problems
Major		A) Bring more prospects into commercial developments. This will require lower-cost exploration and development drilling and production technology, as well as more effective exploration (pre-and post-drill) methods, including: accurate direct hydrocarbon seismic indicators, improved risk assessments and analysis techniques (visualization, high performance computing, etc.), extended reach and horizontal drilling techniques, slim hole drilling techniques for exploration and delineation, lower-cost workover techniques such as coiled tubing methods, three-phase metering and pumping systems for new fields to use existing facilities, minimum foot print and weight facilities for remote and offshore development, multilateral drilling and advanced fracturing approaches to improve productivity, and productivity enhancements of heavy oil fields, especially shallow Alaska North Slope accumulations. B) Reduce production costs with better well and field management approaches, including: improved water and gas shutoff techniques, better management and use of horizontal wells, improved use of fracturing and matrix stimulation approaches. C) Find methods to make commercial remote and low inherent value gas fields, including: improved conversion technologies for making liquid products from natural gas, and lower-cost infrastructure development for pipelines and road access to fields. D) Information management in a more diverse and complex industry, including: rapid means to exchange large amounts of complex (engineering, seismic, etc.) data worldwide, more effective translation methods due to increasingly international work force, and enhanced analysis speed via application of parallel computing processes. E) Application of improved and lower-cost environmental techniques, including: allow sound exploration and development in more sensitive areas, eliminate more waste before it is created and find better uses for wastes once they are created.
Major		Primary barriers are in reducing drilling costs and improving hydraulic fracturing effectiveness in low permeability, deep reservoirs.
Major		1) Improvement in exploration success must come from cost-effective enhancement of seismic acquisition, imaging through salt and other marking rock formations, and better processing of the acquired data. 2) The cost of dwelling wells is too high, especially deep inshore wells or wells in deep water offshore. 3) Prevention and remedial measures are needed for organic depositions (asphalthenes, waxes, gas hydrates) especially offshore in multiphase nibsco(?) lines. 4) There is a need for cheaper floating production platforms for deepwater development. 5) At present there is often no economic means to transport to market gas from single inshore wells, from small onshore and offshore fields, with fields in remote locations. Development of an economic liquefaction process for small gas flow rates (from single well to just below the economic size of a present LNG plant) is needed. 6) Improved reservoir characterization. 7) Improved ability to meet environmental mandates in a cost effective manner, and based on risk assessment and cost benefit analysis. 8) Improved technologies leading to lower operating costs, like in production operations and refining. 9) Advantages from lighter processing equipment to offshore platforms, both when adding facilities to existing platforms and to reduce overall weight, size and cost of deepwater platforms.
Major		Relatively higher development/operating costs per BOE for CO2 EOR projects. Relatively higher development cost of tight gas. High water handling costs, both offshore and onshore. Cost effective secondary gas recovery.
Major		Any technological solution which lowers our cost or is ahead of our competitors would increase our profitability. Lowering cost for the industry as a whole would benefit all and would increase consumer demand.
Major		Information technology and/or information management: advancements impact culture and organization to such an extent that we often implement very poorly in the form of making the old processes slightly more efficient rather than changing the business process. Most "Field Technologies" require demonstration to be accepted. Demonstration difficult due to well costs.
Major	1	Financial resources insufficient. Research cut to bare bones.
Major	100	RB
Major	100	No comment.

Barriers/Problems - Total

Segment	12-2 Code	Barriers/Problems
Major	2	High environmental costs in all areas-remediation, air and water stationary sources, product quality.
Major	4	In general, world wide oversupply and low prices preclude significant R&D expenditures. High demand and higher prices will drive private enterprise to develop needed technology. Specific areas where technological advances would help include cost-effective drilling improvements and cost-effective deep-water development schemes.
Major	?;1;2	A) UPSTREAM OFFSHORE FACILITIES DESIGN Technology barriers in the area of produced fluids include paraffin prediction, prevention and remediation. More work is needed in deepwater pipeline installation, maintenance and repair. Better multiphase flow software technology is required-including measuring actual multiphase flow paths, development of pumps/meters and development of subsea separation equipment. Improvements in electrical submersible pumps are needed. We would be more involved with the National Labs and other collaborative efforts except for concerns over uncertainty of government funds and (slow) pace. B) DOWNSTREAM ACTIVITIES 1) Costs (both money & time) to remediate sites to a condition suitable for alternate developments. 2) Ability to manufacture and market in an environment of regulations that have a high cost of compliance and little benefit of improved conditions and little probability of paying for improvements. C) EXPLORATION The risk vs expected return for exploring the remaining big potential plays in deepwater is the biggest barrier that might be alleviated by the emerging technologies. Better imaging of these prospects through advanced data acquisition, processing and visualization techniques and other risk reduction methods, i.e., fault seal analysis or even better risk assessment methods will have the biggest impact on our business tech. that significantly reduce the imaging (3D Seismic Acquisition) costs and environment impact could also improve the risk to reward equation and make these plays achievable. D) OFFSHORE PRODUCTION 1) We perceive there is a barrier to the use of new solutions because existing regulations do not encourage the field testing (Pilot Programs) of emerging technologies. 2) The current business environment (lack of sufficient capital) minimizes the resources available for technology development and deployment.
Major	?;1;2	A) UPSTREAM 1) The ability to economically treat water for recycle or surface disposal. 2) The ability to clean drill cuttings when using oil or "near" oil base drilling needs for disposal overboard (in water). 3) The ability to remove sulfur from crude oil and gas economically at very low level residual. Note: The barriers to all these are money and fair/reasonable treatment by the EPA and the Federal regulatory process. B) DOWNSTREAM Refining: Business need is to operate in a profitable manner while meeting the ever-changing regulations. Basic barriers and problems are: 1) Cost of health, safety and environmental systems. 2) Lack of lead time provided by regulatory environment. 3) Need to handle large amounts of data. 4) Crude slate changes. 5) Tightening of product quality specifications. 6) New regulatory requirement on all media and products. Also, technology breakthroughs in catalyst area needed for better sulfur recovery. Decisions in these key areas must be cost effective and based on risk assessment and dynamic system modeling (as opposed to static). C) GAS GATHERING AND PROCESSING Highly competitive environment means company must work more efficiently with fewer persons. Much technology in gas gathering/processing is very well established with the exception of automation technologies (i.e., electronic flow measurement and radio telemetry). As this technology is proven out-we are installing and utilizing. In addition, there have been very few technological advances in areas like acid gas treatment, hydrocarbon separation and pipelines. Amino gas treatment technology has not changed essentially for 70 years plus. The latest in hydrocarbon separation was cryogenic processing which began in the late 60s. While plastic pipe has grown in its use in our industry over the past 25 years, there could still be significant progress made in increasing the pressure ratings of plastic pipe. Another technology that could vastly improve the efficiency of the gas gathering, transmission and distribution sectors would be leak detection. There has been some work in this area, but it hasn't come to much.
Service		Lack of accurate and assimilated data to develop risk-based computer programs (indexes, etc.) to aid in corporate and governmental decision/policy making; lack of accessible clearinghouses/repositories for these data; lack of systematic initiatives to collect and assimilate such data.

Barriers/Problems - Total

Segment	12-2 Code	Barriers/Problems
Service		Aging of our pump technology is a major concern. As processes change the market for this equipment decreases.
Service		A) Resolution limitations in seismic and borehole techniques; B) Limitations in cost reductions achievable with equipment used in field measurement systems without significant reductions in size and weight; C) Limitations in cost effective testing of new techniques/equipment/concepts in the absence of sufficiently robust, cost effective simulators; D) Funding means that fit management's budgetary constraints yet permit sufficiently broadly based R&D to capitalize on emerging technologies.
Service		Government intervention; differentiated new bit types & bottom hole assembly equipment.
Service		Certain petroleum industry operations cause safety and environmental fears and concerns on the part of the public and, indirectly, cause political barriers to be erected preventing further development of domestic oil and gas production. Many of these concerns are not well founded or based on sound science. Merging technologies, effectively applied and communicated, should contribute to the lowering of these barriers.
Service		Tooling issues associated with new materials such as plastics or ceramics.
Service		As a service company, we stay abreast of the challenges that confront our client community. These challenges include increasing environmental regulation, intense competition that calls for impartial productivity, better returns from capital expenditures, etc. Our technology development activities are thus very much market driven and aimed at meeting our clients' requirements. Our goal is to have the appropriate technology on line at the right time. Therefore, technology identification and time to market are the two factors that most significantly impact our corporate business needs.
Service		Access to classified or confidential techniques for metal surface hardening. Evaluation of numerous hardening techniques to identify most efficient one to use. Controlled testing of candidate techniques and conclusive feedback.
Service	1	Access to captial.
Service	100	None that I can think of.
Service	100	Response by corporate office.
Service	100	RB
Service	100	Did not respond after many calls and fax.
Service	2	Barriers would be legislation involving environmental concerns or restrictions to developmental drilling, such as California coast off shore. Also, restrictions on drilling on land, such as Alaska.
Service	2	Emmissions control on plants & compressors.
Service	8	If emerging technological solutions are "subsidized" by the government, there would be very little incentive for private industry to invest their own money in R&D.
Service	96	None.
Service	?;1	1) Financial resources insufficient to address the needs. 2) Majority of the technical development focused on short term needs. 3) Broad technology initiatives to address industry problems such as a) environment, b) deep water technology, etc., requiring pooling of resources.
Service	?;2	The big problem is too much government regulation; we're being hit with a lot of things. For specific technologies, we do need further enhancement of 3-D seismic.
Service	?;2;4	1) Slow down of environmental regulations enforcement: would restrict purchase of capital equipment; 2) general worldwide slow down of business: would limit capital equipment procurement; 3) fall in the price of oil, etc. New, emerging technologies would offset those barriers; e.g. multi-phase pumping would greatly reduce the cost of subsea oil production; subsea water injection, if developed, would do the same.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