

**AN ANALYSIS OF THE INSTITUTIONAL CHALLENGES  
TO COMMERCIALIZATION AND DEPLOYMENT OF IGCC  
TECHNOLOGY IN THE U.S. ELECTRIC INDUSTRY:  
Recommended Policy, Regulatory, Executive and Legislative Initiatives**

**Final Report  
Volume 2-Appendicies**

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**U.S. Department of Energy  
National Energy Technology Laboratory  
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National Association of Regulatory Utility Commissioners**

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# **Appendix A**

## **Instructions and Survey Instrument**

### **INSTRUCTIONS**

#### **MEMORANDUM**

DATE: February 18, 2003  
TO: Recipient List  
FROM: Dr. John N. O'Brien  
SUBJECT: SURVEY-Institutional Barriers to Rapid Commercialization and Deployment of Coal Gasification in the Electric Power Industry

#### **INTRODUCTION**

We are conducting a study jointly sponsored by DOE/NETL and NARUC. The objective of this study is to outline recommendations for policy, regulatory and legislative initiatives on both the federal and state levels to facilitate the near-term commercialization and deployment of coal gasification technology in the US power industry. Coal gasification technology allows electric power to be generated from a range of coal grades without producing significant solid, liquid or gaseous pollutants or wastes. Further, with the substantial supply of coal in the US, estimated to be at least 275 years at today's consumption levels, and the long-term price stability of the coal market, utilizing this technology for electric generation will provide essential economic, environmental and strategic benefits.

The US government has invested hundreds of millions of dollars in research and demonstration projects on coal gasification technology. As a result of those efforts, the application of coal gasification technology to electric power generation is no longer technologically speculative. Production of electric power from coal gasification has been successfully demonstrated in a number of significant operating projects in both the US and abroad. However, institutional (i.e., non-technical) barriers to its rapid commercialization and deployment in the U.S. still exist. Except for demonstration projects, no commercial coal gasification power plants are currently under construction in the U.S. or in near term planning. Accordingly, new policy initiatives must be developed and implemented to ensure that the economic, strategic and environmental benefits of this technology are realized. Given the substantial benefits of using coal to generate electric power at a very low level of environmental impact and at stable low coal prices, the commercialization and deployment of coal gasification in the U.S. electric power sector should be a critical policy objective of the federal and state governments.

An important task in our study is to identify and rank the most significant institutional barriers to rapidly commercializing and deploying coal gasification technology in the power industry. We plan to accomplish this using the following survey instrument that is being distributed to a group of approximately 140 experts and stakeholders in industry, government and research institutions.

We have developed the attached list of factors that appear to be barriers to commercialization and deployment. The list includes legal/regulatory, environmental, financial, economic, cultural, and technological factors. It was developed based on a comprehensive review of the technical and policy literature and discussions with experts in key areas. In addition, we received direct comments on the list of candidate barriers from approximately a dozen experts and institutional

stakeholders and we subsequently revised the list of barriers and finalized the attached survey instrument.

## **INSTRUCTIONS**

The survey provides a short statement for each barrier and we request that you rank each of them on a five-point scale ranging from “very low significance” to “very high significance” as a barrier to rapid commercialization and deployment of IGCC technology. ***Bear in mind that we are particularly interested in the significance of these barriers in the near-term, meaning between now and 2010. We want to rank these barriers in terms of how they represent significant barriers to rapid commercialization and deployment of IGCC technology in the U.S. electric power industry.***

There is also a check box, (*No Opinion*), if you feel that you are not qualified to provide a ranking of any particular barrier.

This is not meant to be a scientifically precise survey, but rather a means of collecting opinions from a group of informed individuals about the relative importance of various institutional barriers. Participation in this survey is completely voluntary.

The survey is designed to be completed electronically and should not require a significant amount of time to complete. However, we thank you in advance for the time it takes to contribute to this survey. The results of the survey will be presented in the final report as population data and individual responses will be kept confidential.

***Please go through the survey and put an “x” in the appropriate box for each barrier. Once the survey is completed along with any comments, please save the document and check “reply all” to the email you received this survey in, attach the completed survey instrument and send. We would appreciate it if you can return this survey instrument by February 26<sup>th</sup> so that it can be included in an interim report. However, if you reply before March 14<sup>th</sup> your input will be reflected in the final report.***

In addition, since the objective of the study is to make recommendations for initiatives to remove the significant barriers, feel free to suggest initiatives or recommend documents and other resources that we can access.

If you have any questions or comments do not hesitate to call me at (516) 431-5447. Thank you in advance for your participation in this study.

Sincerely,

John O'Brien, Ph.D.  
PO Box 277  
Point Lookout, NY 11569

## ELECTRONIC SURVEY FORM

**Name:**

**Title:**

**Company:**

**Phone:**

### A. Legal/Regulatory

Please rank the following **legal/regulatory barriers** on a score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe). Please place an **X** in the box provided.

	Barriers not viewed as being severe		Barriers viewed as being extremely severe			
	1	2	3	4	5	No Opinion
1. Lack of regulatory stability and predictability (General uncertainty regarding the critical rules including those governing electricity markets, power plant emissions and power plant siting.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Uncertainty regarding state siting processes (Failure of states to act promptly on siting applications and/or to modify unworkable siting processes)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Degree of restructuring of retail electric markets (Disparity among states regarding retail competition, with a few states having deregulated their retail markets, others having taken tentative steps toward competition, and most others having not deregulated)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Lack of preapproved design features (With the absence of standardized design for IGCC) power plants, each project must go through a full regulatory review, creating the prospect for substantial design modifications, protracted certification proceedings and increased capital costs)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Transition to competitive wholesale electric markets (With wholesale electric markets in a state of flux, power plant developers face uncertainty regarding future prices and market rules)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Regulation uncertainty (The uncertainty that the state and federal governments potential choice to reregulate the generation sector in the electric power industry)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Uncertainty regarding wholesale transmission rules (The heated controversy concerning the Standard Market Design proposed by Federal Energy Regulatory Commission (FERC) is a major factor contributing to the uncertainty developers face regarding future wholesale prices and market rules)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- 8. Potential antitrust problems under PUHCA
- 9. Potential regulation of byproducts
- 10. Limitations on capacity and coproduction
- 11. Lack of preference treatment (e.g. preference hydropower)
- 12. Problems with interconnection policies
- 13. Advent of demand response programs

14. Are there any additional barriers that should be mentioned? Please list them in the space below or in an attachment.

## B. Environmental

Please rank the following **environmental barriers** on a score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe). Please place an **X** in the box provided.

	Barriers not viewed as being severe			Barriers viewed as being extremely severe		No Opinion
	1	2	3	4	5	
1. Lack of certainty on regulation of emissions (Uncertainty regarding federal and state laws and regulations governing the following emissions creates the prospect for substantial design modifications, protracted certification proceedings and increased capital costs)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1a. CO2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1b. NOx	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1c. SOx	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1d. Mercury	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1e. Particulates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1f. New Source Review	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1g. Potential multi-pollutant aggregating rules	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1h. Use of non-hazardous and hazardous waste to cofire	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Problems with permitting process (Treating and IGCC facility as a natural gas plant instead of a coal plant for air emissions permits)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Best Available Control Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Gasifier permitting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Land use requirements versus Natural Gas Combustion Turbine (NGCT)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Water use requirements versus NGCT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Lack of verification technologies for CO2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Selective Catalytic Reduction (SCR) applications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Are there any additional barriers that should be mentioned? Please list them in the space below or in an attachment						

### C. Financial

Please rank the following **financial barriers** on a score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe). Please place an **X** in the box provided.

	Barriers not viewed as being severe			Barriers viewed as being extremely severe		No Opinion
	1	2	3	4	5	
1. Higher non-fuel operating cost than NGCT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Higher capital cost than NGCT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Confusion on capital versus operating costs (As compared to conventional coal combustion technologies)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Uncertainty of tax credits and qualification	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Formula for tax credits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Lack of hedging tools	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. General lack of project finance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. General lack of developmental investment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Lack of adequate Power Purchase Agreements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Long construction lead times	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Poor counterparty creditworthiness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Inability to accelerate depreciation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Uncertainty in accounting rules	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Inability to guarantee performance (Weak licensor guarantees)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Lack of turnkey vendors ( EPC companies are unwilling to “wrap” guarantees)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. Potential for new excise or other taxes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Securing adequate feedstocks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Ownership uncertainty (The uncertainty pertaining to the structural changes in the generation industry and what entities will own major power plants in the future)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Lack of market for CO2 credits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

20. Doubts concerning commercial viability of IGCC  
(Doubts concerning the stand alone ability of IGCC to be competitive without subsidies)

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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21. Lack of hydrogen economy

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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22. Uncertain export-import bank participation

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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23. Uncertain value of byproducts from coproduction

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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24. High licensing fees

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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25. Potential for withdrawal of tax credits

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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26. History of problematic construction and slow start

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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27. Potential Carbon Tax

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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28. Lack of credit for biomass cofiring

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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29. Increased risk due to higher up front development costs  
(Front end engineering design costs are much higher for IGCC than for NGCT)

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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30. Are there any additional barriers that should be mentioned? ? Please list them in the space below or in an attachment.



**D. Economic**

Please rank the following **economic barriers** on a score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe). Please place an **X** in the box provided.

	Barriers not viewed as being severe			Barriers viewed as being extremely severe		No Opinion
	1	2	3	4	5	
1. General economic downturn	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Uncertain life cycle costs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Uncertain fuel costs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Failure to consider volatility of natural gas prices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Uncertain coal transportation costs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Lack of Investor Owned Utility financial strength	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Uncertainty regarding future demand growth	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Uncertainty regarding future fuel prices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Lack of baseload demand	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Inability of IGCC to ramp generation quickly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Failure to socialize external benefits (Failure to reward investment for societal being realized through utilization of IGCC in the power industry, e.g.: lower emissions, stable Electric costs, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Are there any additional barriers that should be mentioned? Please list them in the space below or in an attachment.						

## E. Cultural

Please rank the following **cultural barriers** on a score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe). Please place an **X** in the box provided.

	Barriers not viewed as being severe			Barriers viewed as being extremely severe		No Opinion
	1	2	3	4	5	
1. Poor perception of coal among:						
1a. General population	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1b. Informed population	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1c. Institutional stakeholders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1d. Regulators	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1e. Plant developers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The nuclear power plant debacle (The push to develop nuclear power plants resulted in very financial difficulties that developers wish to avoid)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Historic poor perception	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Lack of appreciation for coproduction capabilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Lack of appreciation of ancillary services capabilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Oil and Coal companies' avoidance of regulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Lack of appreciation of need for fuel diversity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Lack of appreciation of need for energy independence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Problems in California and Northwest	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Enron	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Failure of some IGCC projects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Lack of appreciation for societal benefits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Plant operators' lack of familiarity with IGCC (Distrust of chemical plants versus conventional boilers)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

14. Are there any additional barriers that should be mentioned? Please list them in the space below or in an attachment.

## F. Technological

Please rank the following **technological barriers** on a score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe). Please place an **X** in the box provided.

	Barriers not viewed as being severe			Barriers viewed as being extremely severe		
	1	2	3	4	5	No Opinion
1. Uncertain CO2 sequestration technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Lack of hydrogen transport plans	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Lack of syngas transport (Inability to site gasifiers remotely from the generation block due to poor economics of syngas transport)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Skepticism regarding IGCC technology generally	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Skepticism regarding membrane air separation technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Skepticism regarding ceramic filter gas cleanup technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Skepticism regarding optimal gasifier technology generally (There are several competing gasifier designs and there is no clear leading technology)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Chance of low plant availability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Slow development of fuel cell technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Lack of long term IGCC operating experience	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Uncertain feedstock injection technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Are there any additional barriers that should be mentioned? Please list them in the space below or in an attachment.						

# APPENDIX B ANALYSIS OF SURVEY RESULTS

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<b>Table B.1 - Legal/Regulatory Items</b>							
Mean Score and Distribution Based on a Score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe)							
	<i>Mean</i>	<i>Distribution</i>					
		1	2	3	4	5	No Opinion
1. Lack of regulatory stability and predictability (General uncertainty regarding the critical rules including those governing electricity markets, power plant emissions and power plant siting.)	3.74	1	6	12	12	15	2
5. Transition to competitive wholesale electric markets (With wholesale electric markets in a state of flux, power plant developers face uncertainty regarding future prices and market rules)	3.74	0	7	7	18	10	6
6. Regulation uncertainty (The uncertainty that the state and federal governments potential choice to reregulate the generation sector in the electric power industry)	3.46	0	10	12	9	10	7
4. Lack of pre-approved design features (With the absence of standardized design for IGCC) power plants, each project must go through a full regulatory review, creating the prospect for substantial design modifications, protracted certification proceedings and increased capital costs)	3.25	1	15	6	16	6	4
3. Degree of restructuring of retail electric markets (Disparity among states regarding retail competition, with a few states having deregulated their retail markets, others having taken tentative steps toward competition, and most others having not deregulated)	3.23	2	10	11	11	6	8
7. Uncertainty regarding wholesale transmission rules (The heated controversy concerning the Standard Market Design proposed by Federal Energy Regulatory Commission (FERC) is a major factor contributing to the uncertainty developers face regarding future wholesale prices and market rules)	3.19	2	9	11	10	5	11
2. Uncertainty regarding state siting processes (Failure of states to act promptly on siting applications and/or to modify unworkable siting processes)	2.86	6	13	10	9	5	5
11. Lack of preference treatment (e.g. preference hydropower)	2.83	8	11	7	8	6	8
9. Potential regulation of byproducts	2.28	10	18	4	7	1	8
10. Limitations on capacity and coproduction	2.22	15	10	10	4	2	7
12. Problems with interconnection policies	2.20	8	15	9	3	0	13
8. Potential antitrust problems under PUHCA	1.89	8	15	3	1	0	21
13. Advent of demand response programs	1.76	14	9	5	1	0	19

**Figure B.1--Legal/Regulatory Items--Mean Scores**

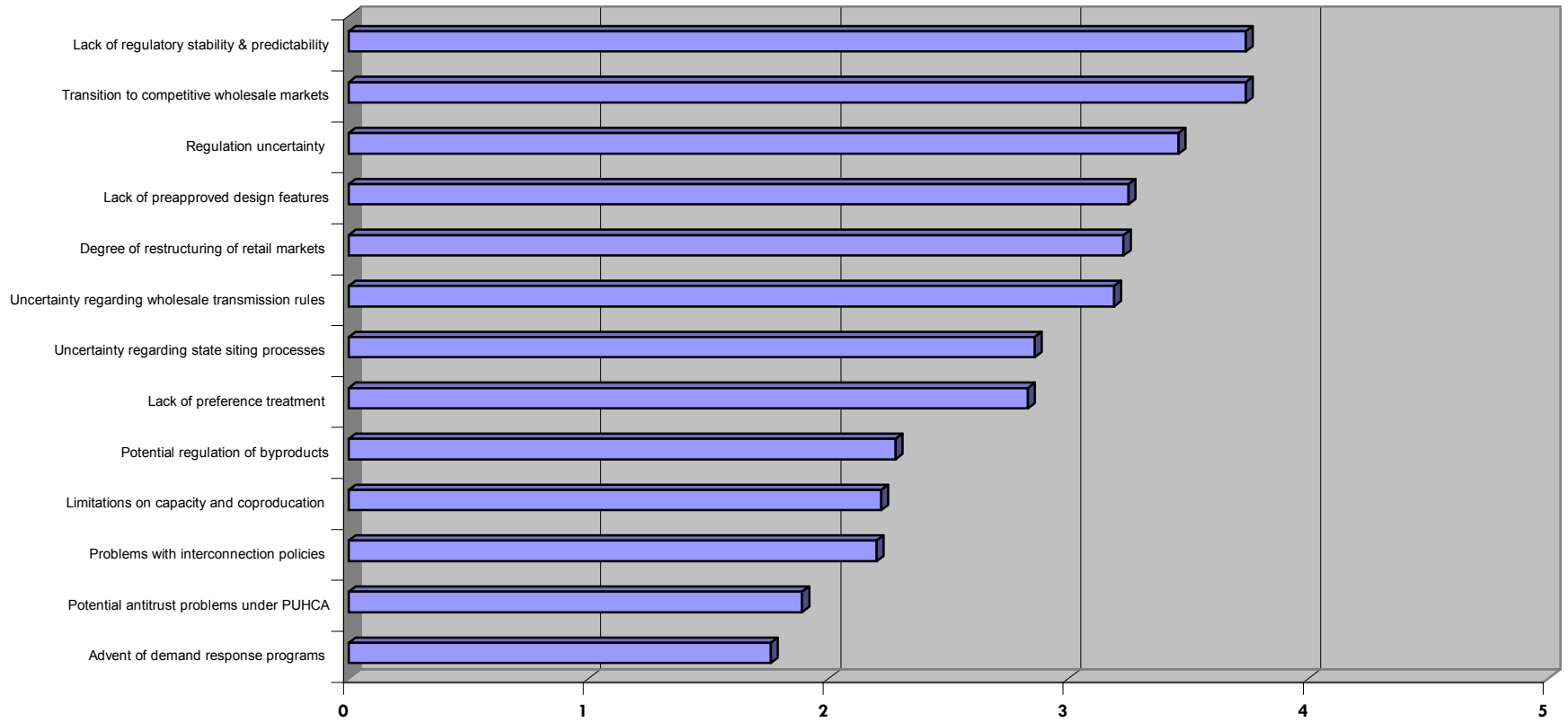


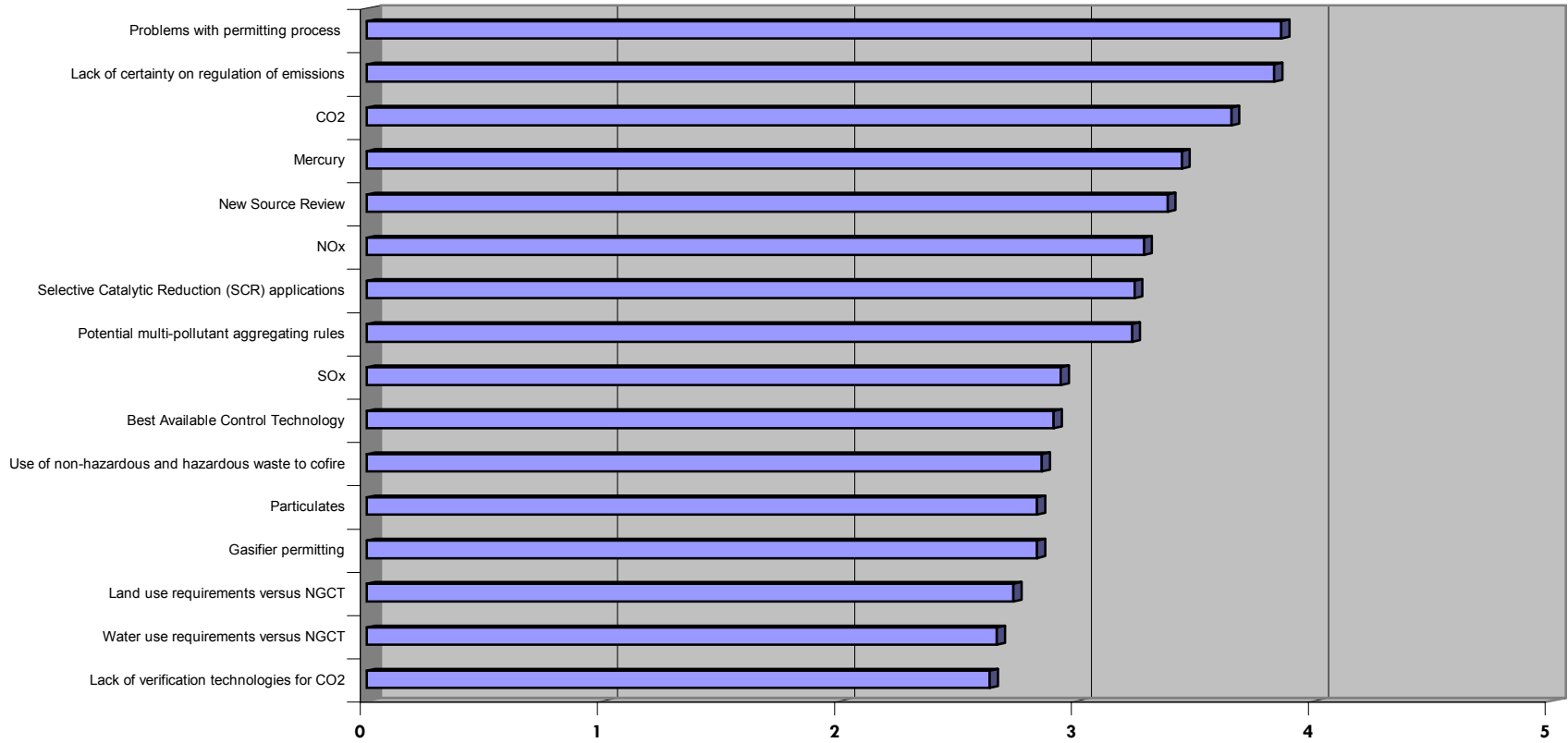
Table B.2--Respondent Comments on Legal/Regulatory Items

- *IGCC is a low marginal cost, high capacity capital cost technology. The current unregulated markets do not value this type of capacity. Long-term capacity has little value today where there is a surplus of merchant energy. This must be resolved if IGCC or other coal power plants are to be funded.*
- *Uncertainties regarding federal regulations concerning multi-pollutant control (particularly mercury and carbon dioxide) are impacting decisions regarding use of coal-based technologies such as gasification. Regulations need to recognize and reward IGCC's inherent environmental advantages over other coal-based power generation technologies. Regulations should control how much of our limited domestic natural gas supplies can be allocated to power generation.*
- *Recognition of the capability of gasification technology to provide hydrogen fuel for the automobile Industry from a coal resource base. Clearly this is a technology that can provide a fuel base for a hydrogen industry that is not driven by oil prices. Therefore all of the above barriers must be addressed to enhance this strategic initiative for our country.*
- *Continuing life-extension of old, inefficient, paid-off coal units with higher emissions and much lower costs than new coal units due to their lack of capital charges.*
- *Best Available Control Technology ("BACT") re-openers such as were imposed on Polk and Pioneer facilities are severe disincentives that come under the regulatory uncertainty category.*
- *There is a general barrier to building any new generation facilities where long-term cost recovery is a concern. Stranded cost recovery is an issue for regulated states, and non-regulated states will need to have long-term contracts in place with strong, creditworthy counter- parties.*
- *Legal and regulatory issues have been a consistent barrier to IGCC development for the last decade. Potential users have been reluctant to select a high capital cost technology, and enter a potentially deregulated market with high fixed costs. Legal and regulatory uncertainty pushes users to a risk-averse position, and IGCC is perceived (rightly or wrongly) as high risk.*

<b>Table B.3 - Environmental Items</b>							
Mean Score and Distribution Based on a Score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe)							
	<i>Mean</i>	<b>Distribution</b>					
		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>No Opinion</b>
2. Problems with permitting process (Treating an IGCC facility as a natural gas plant instead of a coal plant air emissions permits)	3.86	0	4	13	12	15	4
1. Lack of certainty on regulation of emissions	3.83	1	6	7	12	15	7
1a. CO <sub>2</sub>	3.65	4	9	4	11	18	2
1d. Mercury	3.44	2	11	8	13	11	3
1f. New Source Review	3.38	3	9	7	10	10	9
1b. NO <sub>x</sub>	3.28	1	12	13	13	7	2
8. Selective Catalytic Reduction (SCR) applications	3.24	5	8	8	12	8	7
1g. Potential multi-pollutant aggregating rules	3.23	3	9	11	8	8	9
1c. Sox	2.93	3	16	11	13	3	2
3. Best Available Control Technology	2.90	7	8	12	8	5	8
1h. Use of non-hazardous and hazardous waste to cofire	2.85	8	11	7	7	7	8
1e. Particulates	2.83	7	15	8	11	5	2
4. Gasifier permitting	2.83	5	10	14	9	2	8
5. Land use requirements versus Natural Gas Combustion Turbine (NGCT)	2.73	4	15	10	10	1	8
6. Water use requirements versus NGCT	2.66	5	16	15	5	3	4
7. Lack of verification technologies for CO <sub>2</sub>	2.63	8	16	4	9	4	7



**Figure B.2-- Environmental Items - Mean Scores**

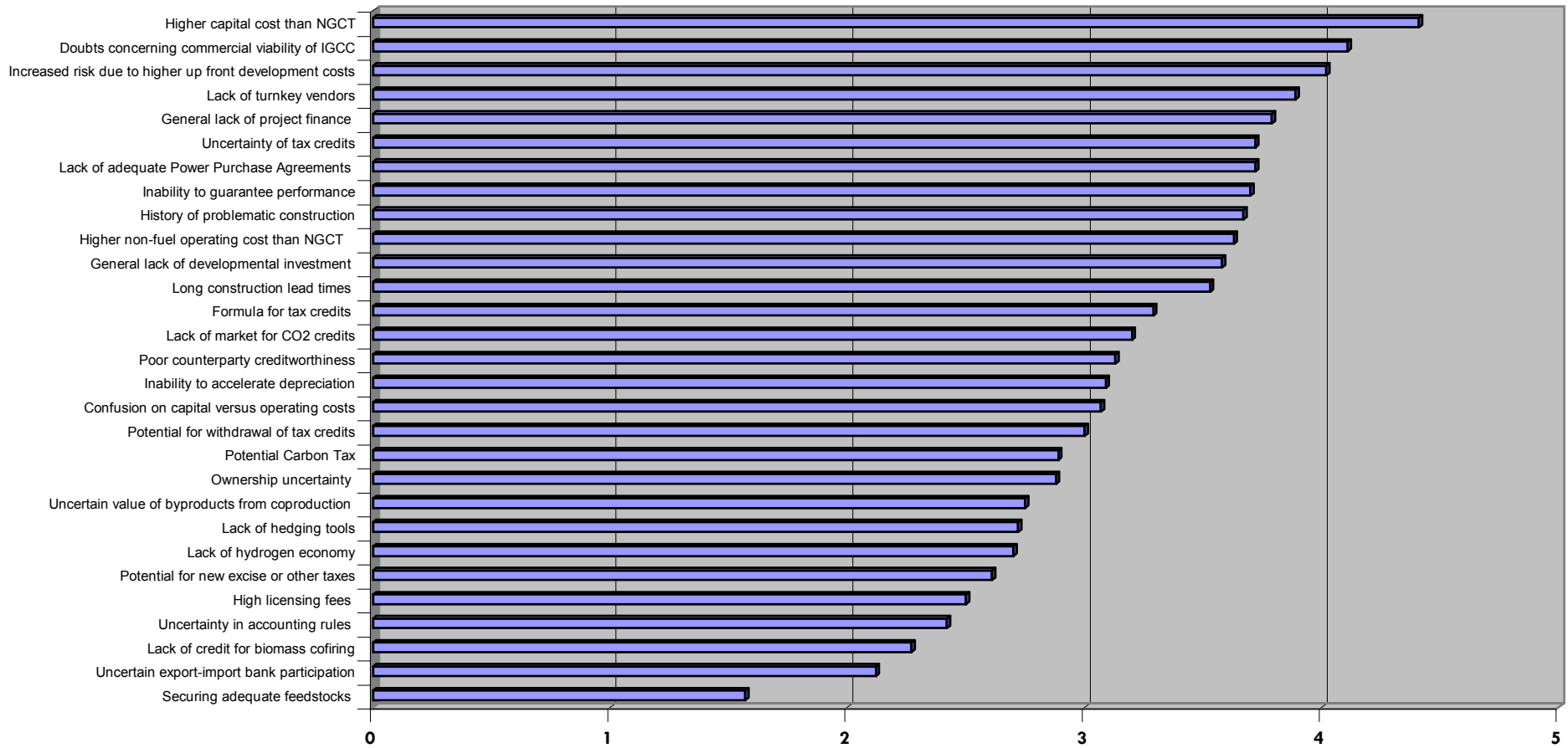


#### **Table B.4--Respondent Comments on Environmental Items**

- *IGCC must be permitted as a coal plant not a NGCC plant. Forcing IGCC to meet NG standards sets up an impossible barrier that permits PC coal plants with higher emissions to be built instead. The regs must value the benefits of IGCC over PC plants not NGCC plants.*
- *Allowing pulverized coal plants to have higher emission limits than IGCC provides less incentive for utilities to change from traditional coal technology.*
- *Lack of recognition of gasification's proven capability for relatively inexpensive and high-level removal of volatile mercury from its syngas product.*
- *Continuing life extensions "forever" of "grand-fathered" "big dirties."*
- *Negative coal posture even for IGCC, i.e., Wisconsin etc. No credit for aggregate lowest emissions.*
- *A definite barrier has been the treatment of IGCC in the permitting process as comparable to NGCC. As long as IGCC is compared to alternate clean coal technologies, it will get a fair shake.*
- *IGCC has inherent advantages over other coal technologies in terms of mercury and particulate emissions as well as carbon dioxide capture. Greater certainty of regulation of these emissions will benefit IGCC. The decision to define BACT as saturation without SCR (15 ppm nitrogen oxides) at the Polk Power Station has hopefully removed a potential barrier regarding nitrogen oxides regulation.*

<b>Table B.5--Financial Items</b>								
Mean Score and Distribution Based on a Score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe)								
		<b>Mean</b>	<b>Distribution</b>					<b>No Opinion</b>
			<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	
Q31	2. Higher capital cost than NGCT	4.41	0	2	6	9	29	2
Q49	20. Doubts concerning commercial viability of IGCC (Doubts concerning the stand alone ability of IGCC to be competitive without subsidies)	4.11	1	4	4	17	20	2
Q58	29. Increased risk due to higher up front development costs (Front end engineering design costs are much higher for IGCC than for NGCT)	4.02	1	2	9	16	17	3
Q44	15. Lack of turnkey vendors ( EPC companies are unwilling to "wrap guarantees")	3.89	2	3	10	13	17	3
Q36	7. General lack of project finance	3.79	1	6	8	13	14	6
Q33	4. Uncertainty of tax credits and qualification	3.72	0	6	10	12	11	9
Q38	9. Lack of adequate Power Purchase Agreements	3.72	3	5	6	11	14	9
Q43	14. Inability to guarantee performance (Weak licensor guarantees)	3.70	3	5	9	11	15	5
Q55	26. History of problematic construction and slow start	3.67	2	7	7	17	12	3
Q30	1. Higher non-fuel operating cost than NGCT	3.63	2	6	12	13	13	2
Q37	8. General lack of developmental investment	3.58	1	11	7	10	14	5
Q39	10. Long construction lead times	3.53	1	7	13	18	8	1
Q34	5. Formula for tax credits	3.29	2	9	7	11	6	13
Q48	19. Lack of market for CO2 credits	3.20	4	10	10	13	7	4
Q40	11. Poor counterparty creditworthiness	3.13	0	9	13	7	3	16
Q41	12. Inability to accelerate depreciation	3.09	2	6	15	7	3	15
Q32	3. Confusion on capital versus operating costs (As compared to conventional coal combustion technologies)	3.07	4	12	8	11	6	7
Q54	25. Potential for withdrawal of tax credits	3.00	1	13	10	7	4	13
Q56	27. Potential Carbon Tax	2.89	6	14	9	9	6	4
Q47	18. Ownership uncertainty (The uncertainty pertaining to the structural changes in the generation industry and what entities will own major power plants in the future)	2.88	6	13	7	8	6	9
Q52	23. Uncertain value of byproducts from coproduction	2.75	5	18	8	9	4	4
Q35	6. Lack of hedging tools	2.72	1	13	10	3	2	19
Q50	21. Lack of hydrogen economy	2.70	12	10	7	9	6	4
Q45	16. Potential for new excise or other taxes	2.61	4	14	9	3	3	15
Q53	24. High licensing fees	2.50	10	15	5	5	5	8
Q42	13. Uncertainty in accounting rules	2.42	3	16	9	2	1	17
Q57	28. Lack of credit for biomass cofiring	2.27	12	17	9	3	3	4
Q51	22. Uncertain export-import bank participation	2.12	10	6	8	1	1	22
Q46	17. Securing adequate feedstocks	1.57	24	17	2	0	1	4

### Figure B.3--Financial Items - Mean Scores



## Table B.6--Respondent Comments on Financial Items

- *A major barrier in the lending community is the lack of long-term commercial experience with IGCC fired on solid fuels. More plants need to be built and operated successfully before lenders will take much risk.*
- *Because IGCC is not as mature as other coal-based power generation technologies, it has a near-term capital cost disadvantage. Preferential incentives can help IGCC reach parity until it has more time to mature as a technology and benefit from the learning curve of multiple commercial plants.*
- *Lack of incentives to encourage larger commercial-scale IGCC facilities ( $\geq$  500 MW size).*
- *Perception of higher capital costs and lower availability for IGCC than supercritical PC boilers.*
- *EPC issue of Risk is very serious – You cannot buy an IGCC today you must grow one.*
- *In our evaluation of technologies, the greatest concern for a gasification plant today was lack of the technology providers guaranteeing operational performance including availability of the gasifier and the lack of capital cost guarantees. Without those two items, the projects are not financable. The technology providers have to stand behind the technology or put risk money to offset this. Alternatively, we have to go through another round of DOE funding to show the commercial viability of such a project.*
- *If a customer wanted to buy an IGCC plant, who does he go to get one? One of the major impediments to the growth of IGCC has been the lack of a single entity serving as a single point for sourcing an entire IGCC plant. There is no single face to the customer. Conventional coal plants benefit from being a single source. With IGCC it's "some assembly required". In fact, there's a lot of assembly required. The go-to-market strategy is basically to start by paying for a study, then hiring an EPC to come up with a lump-sum price and a performance wrap. This might work if process risk could be adequately covered by the provider of the gasification technology. But there isn't enough financial benefit for the gasification licensor to take on any more liability than the value of the license. The EPC has to provide the contingency at a high cost or risk and no one is willing to take that on in the current financial environment. The only potential customers are those that are visionary, see the value of fuel diversity and have significant financial and technical resources to pull an IGCC project off.*

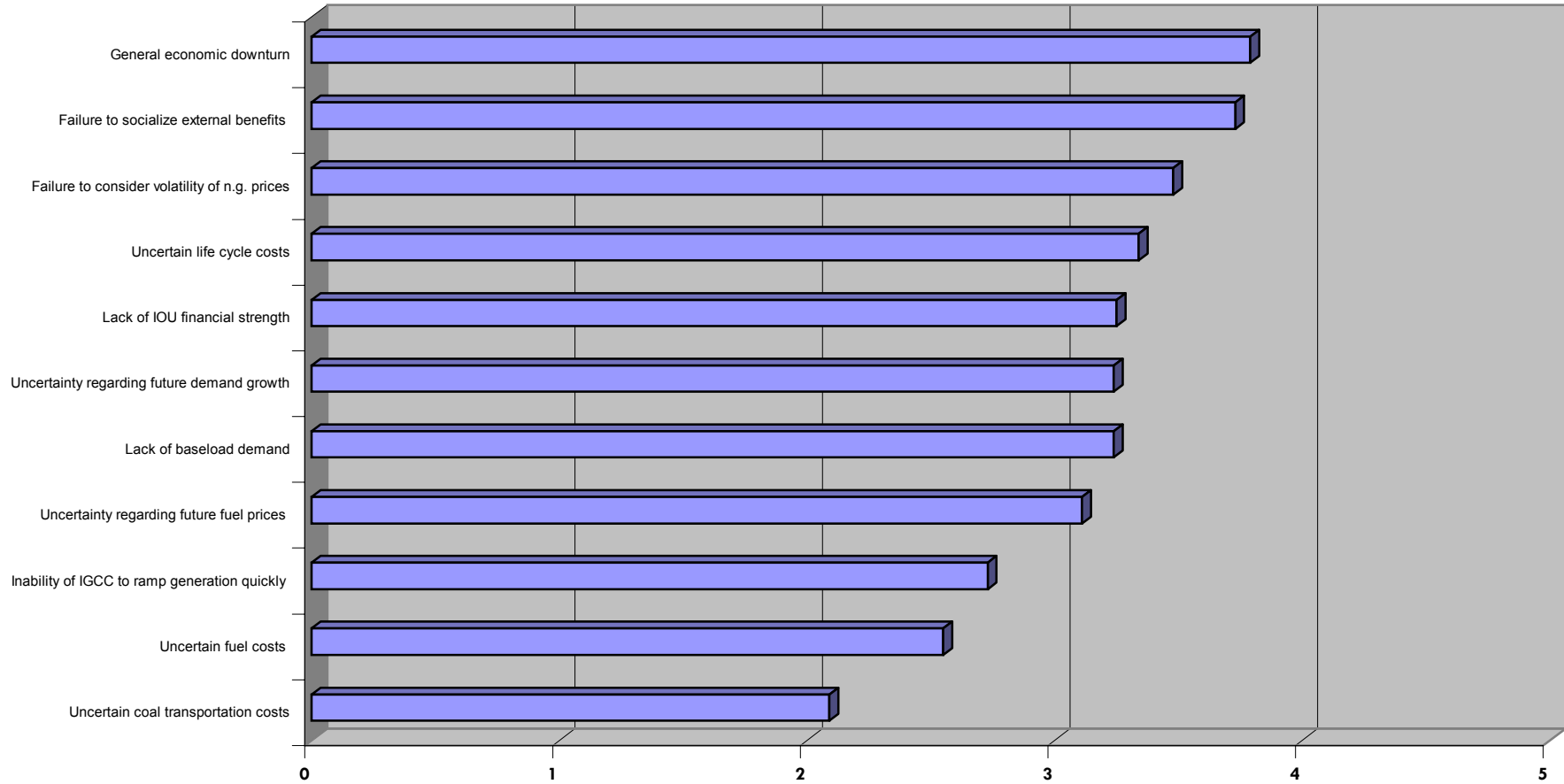
- *With respect to carbon dioxide credits, but especially with respect to fuel cells and/or a hydrogen economy – nobody is expecting these before 2010, probably not before 2015. It has no impact on planning for current projects.*
- *There appears to be a tendency for EPC providers and owners to drive costs upward in the form of risk and contingency costs in an effort to cover the perceived EPC risks.*
- *The cost of electricity from IGCC is too high.*
- *A greater effort needs to be made with “Wall Street” to educate it about IGCCs. Wall Street thinks IGCCs are still very experimental. This is not correct; some types are, some aren’t. There just aren’t a lot of IGCCs out there yet. It doesn’t mean that a turnkey IGCC cannot be built. Wall Street needs to give a greater comfort level regarding the reliability of IGCC installations.*
- *Government-backed loan guarantees might assure lenders that they are protected in the unlikely event of catastrophic project technical problems. With these guarantees the bank may not require a total wrap, allowing for the first set of projects to move forward.*
- *Lack of sufficient tax credits to inspire investment.*

**Table B.7--Economic Items**

Mean Score and Distribution Based on a Score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe)

		<b>Mean</b>	<b>Distribution</b>					
			<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>No Opinion</b>
Q59	1. General economic downturn	3.79	2	4	10	17	14	1
Q69	11. Failure to socialize external benefits (Failure to reward investment for societal being realized through utilization of IGCC in the power industry, e.g.: lower emissions, stable electric costs, etc.)	3.73	3	6	8	11	17	3
Q62	4. Failure to consider volatility of natural gas prices	3.48	4	6	12	15	11	0
Q60	2. Uncertain life cycle costs	3.34	2	6	18	16	5	1
Q64	6. Lack of Investor Owned Utility financial strength	3.25	4	9	7	13	7	8
Q65	7. Uncertainty regarding future demand growth	3.24	4	9	12	12	8	3
Q67	9. Lack of baseload demand	3.24	8	8	9	7	14	2
Q66	8. Uncertainty regarding future fuel prices	3.11	5	10	12	11	7	3
Q68	10. Inability of IGCC to ramp generation quickly	2.73	6	12	15	12	0	3
Q61	3. Uncertain fuel costs	2.55	10	15	11	8	3	1
Q63	5. Uncertain coal transportation costs	2.09	16	18	7	5	1	1

**Figure B.4-- Economic Items - Mean Scores**





## **Table B.8--Respondent Comments on Economic Items**

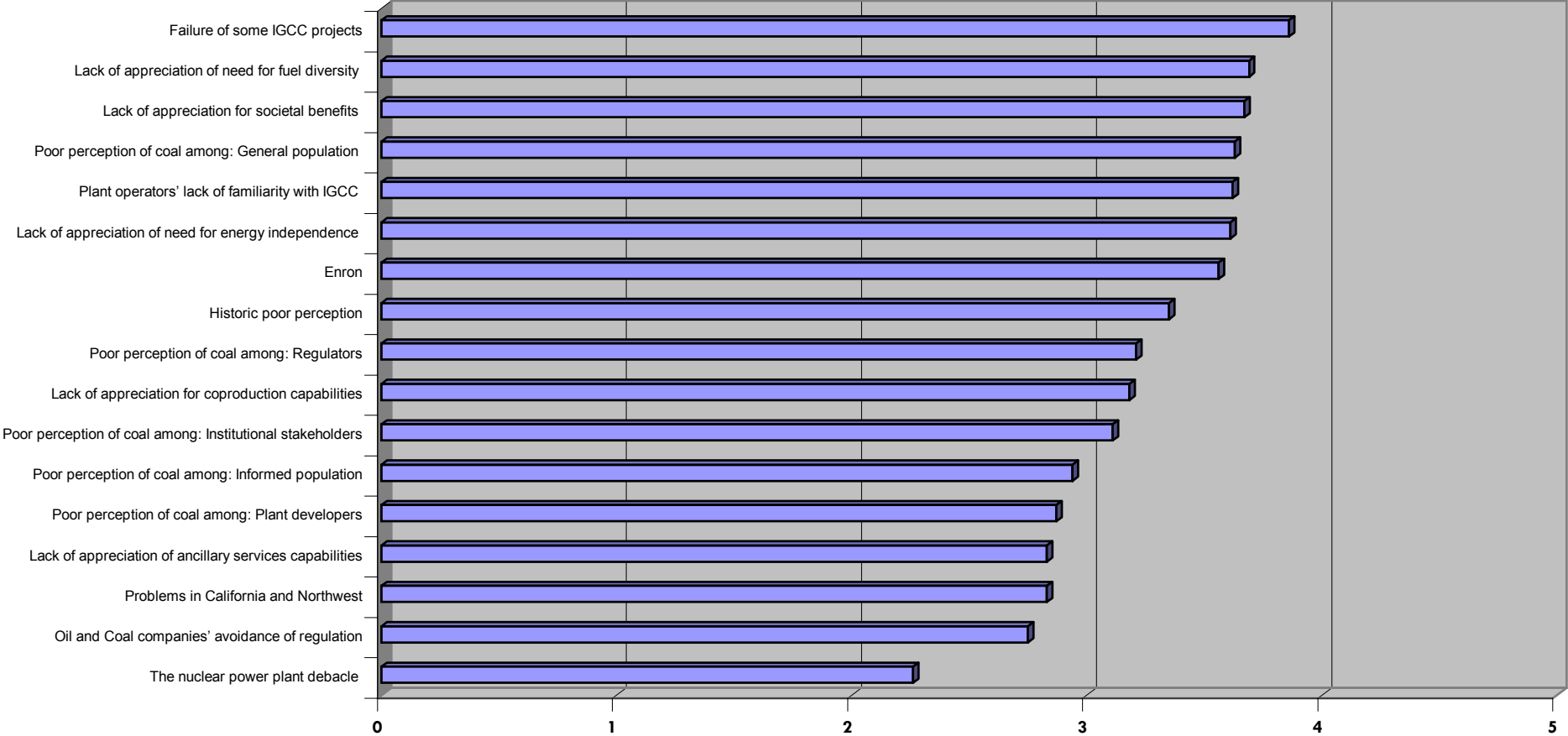
- *Reluctance of Public Utilities to take risks associated to the introduction of new technologies. Lack of incentives to Public Utilities to generate power using domestic fuels and /or efficient, low emission technologies.*
- *The key to implementation is industry who will make decisions based on business principles. All other incentives and considerations do weigh in, but the business case needs to be sound in the long term without artificial (unsustainable) sweeteners. With current conditions, the economics are such that the power generating industry, which is traditionally conservative, does not see its way open to get into gasification (and IGCC) yet. It also is not amenable to the upsides of co- or poly-generation since it does not have an interest in getting into chemicals as joint products. The market will decide.*
- *Lack of long-term reliable operations area concern of lenders.*
- *Lack of confidence in the power market post-Enron.*
- *Failure to recognize the devastating impact of the power sector natural gas demand on other sectors of the economy such as domestic chemical and fertilizer industries.*
- *Failure to recognize the dramatic impact of hydrogen generation for transportation fuels from a coal based economy. Who takes the risk versus who gets the reward.*
- *No new power plants can compete with the ultra- low costs of generation from life extended old coal units that have no capital charges.*
- *The economic downturn has seriously impacted the project financing markets. More equity investment will be required in the near term.*
- *General lack of awareness in the public at-large of coal-based power and its financial benefits to U.S. economy.*
- *The key economic driver in favor of IGCC is the fuel price differential between coal (or other solid fuel) and natural gas. Coal prices have historically been stable and predictable. Natural gas price volatility and the inability to forecast long term prices (or price differentials) has been a significant barrier to IGCC plant development.*

**Table B.9--Cultural Items**

Mean Score and Distribution Based on a Score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe)

		<i>Mean</i>	<i>Distribution</i>					
			<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>No Opinion</b>
Q84	11. Failure of some IGCC projects	3.86	2	4	7	15	15	5
Q80	7. Lack of appreciation of need for fuel diversity	3.69	3	6	6	17	13	3
Q85	12. Lack of appreciation for societal benefits	3.67	3	6	9	12	15	3
Q70	1a. Poor perception of coal among: General population	3.63	3	11	4	13	17	0
Q86	13. Plant operators' lack of familiarity with IGCC (Distrust of chemical plants versus conventional boilers)	3.62	2	7	10	13	13	3
Q81	8. Lack of appreciation of need for energy independence	3.61	6	6	6	10	18	2
Q83	10. Enron	3.56	5	6	6	12	14	5
Q76	3. Historic poor perception	3.35	3	8	12	16	7	2
Q73	1d. Poor perception of coal among: Regulators	3.21	4	10	12	14	7	1
Q77	4. Lack of appreciation for coproduction capabilities	3.18	2	11	15	11	6	3
Q72	1c. Poor perception of coal among: Institutional stakeholders	3.11	4	13	10	12	7	2
Q71	1b. Poor perception of coal among: Informed population	2.94	4	17	10	10	6	1
Q74	1e. Poor perception of coal among: Plant developers	2.87	8	10	11	12	4	3
Q78	5. Lack of appreciation of ancillary services capabilities	2.83	4	15	11	8	4	6
Q82	9. Problems in California and Northwest	2.83	6	10	12	11	2	7
Q79	6. Oil and Coal companies' avoidance of regulation	2.75	5	10	13	5	3	12
Q75	2. The nuclear power plant debacle (The push to develop nuclear power plants resulted in very financial difficulties that developers wish to avoid)	2.26	11	12	11	2	2	10

**Figure B.5--Cultural Items - Mean Scores**



### **Table B.10--Respondent Comments on Cultural Items**

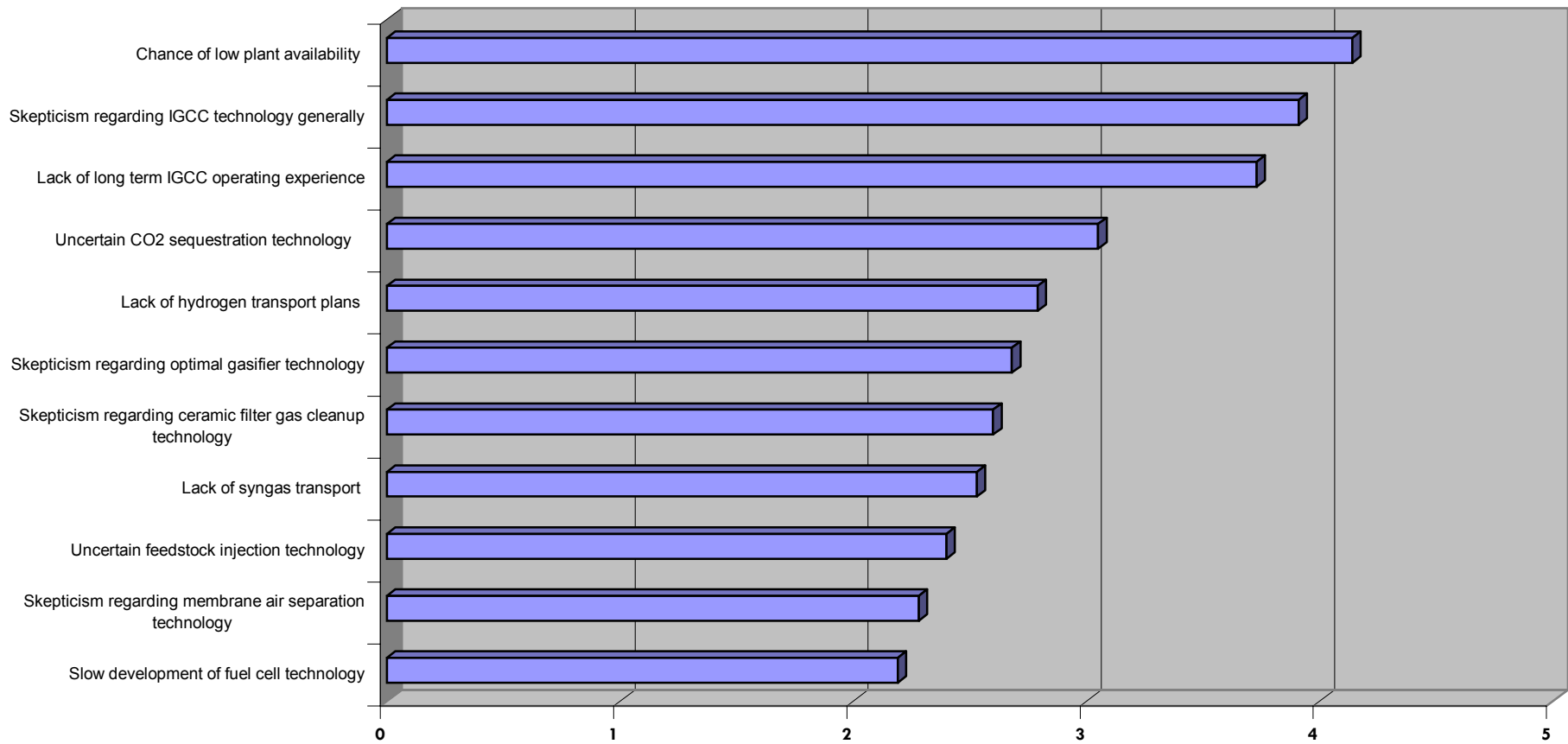
- “NIMBY” effect; Lack of information that an IGCC plant can achieve emissions as low as NGCT or lower
- There is a USA cultural block re “not invented here”, resistance to international experience in gasification.
- Coal handling transportation is generally unpopular with local communities. IGCC faces this issue just like other coal plants.
- General lack of understanding of IGCC technology – its environmental advantages, its ability to address climate change concerns, and its potential for producing hydrogen, clean syngas, and useful chemical byproducts. There is also a lack of understanding of highly successful long-term gasification operations, such as Eastman Chemical Company’s Kingsport, TN, operations (20-years of very high reliability performance).
- Lack of chemical process expertise plus even worse, lack of willingness to hire this essential chemical process expertise. This assures continuing bias against and poor performance of IGCC.
- Most of the cultural barrier mentioned apply to coal generation in general not to gasification. Gasification needs to overcome the economic issues and guarantee issues. The entire coal community needs to attack the cultural issues.
- Poor understanding by public, stakeholders, and regulatory community of recent technological advances and reality.
- An additional cultural barrier that could be considered is the “herd mentality” among power generators. There is general reluctance to do something different than the rest of the market. Conversely, there is a strong drive to follow the direction of others in the industry. Witness the practically irrational stampede to purchase large numbers of NGCC units in the late 1990’s. This “safety in numbers mindset” has been exacerbated by the uncertainty in markets and environmental regulation.

**Table B.11--Technological Items**

Mean Score and Distribution Based on a Score of 1 (Barriers not viewed as being severe) to 5 (Barriers viewed as being extremely severe)

		<i>Mean</i>	<i>Distribution</i>					
			<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>No Opinion</b>
Q94	8. Chance of low plant availability	4.14	0	3	10	8	22	5
Q90	4. Skepticism regarding IGCC technology generally	3.91	1	4	8	16	15	4
Q96	10. Lack of long term IGCC operating experience	3.73	1	9	5	15	14	4
Q87	1. Uncertain CO2 sequestration technology	3.05	5	9	14	11	5	4
Q88	2. Lack of hydrogen transport plans	2.79	6	12	11	11	2	6
Q93	7. Skepticism regarding optimal gasifier technology generally (There are several competing gasifier designs and there is no clear leading technology)	2.68	9	10	12	12	1	4
Q92	6. Skepticism regarding ceramic filter gas cleanup technology	2.60	9	14	8	7	4	6
Q89	3. Lack of syngas transport (Inability to site gasifiers remotely from the generation block due to poor economics of syngas transport)	2.53	7	14	11	7	1	8
Q97	11. Uncertain feedstock injection technology	2.40	10	16	8	5	3	6
Q91	5. Skepticism regarding membrane air separation technology	2.28	10	14	11	5	0	8
Q95	9. Slow development of fuel cell technology	2.19	11	19	7	3	2	6

**Figure B.6-- Technological Items- Mean Scores**



## Table B.12--Respondent Comments on Technological Items

- *Lack of opportunities to build very large (>3000MWe) IGCC plants that would take advantage of economy of scale, repeat business savings, improved availability, etc. One clear additional barrier to IGCC technology in the US is the continued permission for more than 200,000 megawatts (MW) of existing, old coal plants (30+ years) to remain in operation with no sulfur dioxide controls. At the same time, mercury is an uncontrolled emission, and it is plausible to believe that other metals found in coal (cadmium, lead, etc.) are also being emitted out the stack. IGCC technology, if rapidly implemented and supported by the Administration, and financially through tax credits and other means, can begin to address these issues, including allowing for carbon dioxide sequestration in the future.*
- *Our country is rapidly running through new found oil and natural gas fields, draining them at a higher pace than historical. The US transportation industry is now highly dependent on imported oil (60%), and our power industry is now moving in the direction of imported Liquefied Natural Gas (LNG) to fill the needs of our power, chemical, and home heating industries. Currently, more than 50% of our power industry is dependent on coal. This country needs an immediate funded and focused effort to utilize our existing coal resource for power through IGCC, for fuel diversity and to clean up our environment.*
- *Lack of confidence that an IGCC plant can be started up and reach stable operations within a few months. IGCC and PC plants have proven startup records. Lack of CT choices and performance on Low NO<sub>x</sub>, Low S syngas fuels. GE is currently the only supplier of syngas CT's. More choices would be better. Freezing the CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub> rules for coal fired IGCC would help a lot. Driving coal technology to meet NGCC rules creates and impossible. Technical barrier. EPA needs an enlightened view of this issue. Private R&D of gasification has come to a halt. Only DOE is funding R&D and it is not very helpful. Private industry needs more incentives to improve what they now have. Nothing is being done. Tax policy needs to address this very serious problem that will grow in the long run.*
- *Lack of lower cost and higher temperature syngas clean-up technology. Need for longer life refractory linings for gasifiers, or technology to avoid refractory linings altogether in gasifiers. Need for longer feed injector lifetimes in gasifiers. Need for online coal analysis and/or characterization technology. Need for semi-works scale demonstration facilities for advanced gasification technologies and poly-generation.*
- *Uncertainty regarding burner life and its impact on plant availability. Uncertainty as to who makes the money (licensees) versus who takes the operating risks.*

- *Traditional electric utilities lack fundamental background and experience with coproduction of syngas chemicals, gas turbine, effective cogeneration and poly-generation, which are all unique advantages of IGCC over steam boilers.*
- *Most experience with single train no redundancy has led to poor availability but all plants with spare have operated above 95%.*
- *Availability concerns are chief issue. This is baseload electric generating plant and currently running demonstration plants do not have reliability needed to be competitive with other existing coal technology. The gasification suppliers promise high levels of reliability for the next generation of IGCC plants; however, utilities are hesitant to be the test case to prove this to be true. Everyone is waiting for the next guy to take the plunge.*
- *As an industry, we have a lack of leadership in getting our message out. The gasifier technology providers tend to be the stakeholders that try to improve this situation, but fear of antitrust issues and of possibly helping a competitor, significantly hinder their efforts. This has also been hindered by too much salesmanship and no enough cutting to the chase to make projects happen. It has hurt our credibility. With an increase in the number of plants being built, the capital costs will come down, making IGCC more economically viable. Coal fed plant reliability is a big issue that is being addressed with redundant equipment, which drives the costs up. Further, the size of the plants must come down because the large-scale plants typically are oversized for their markets, potentially flooding the markets with products that cannot be absorbed.*
- *Ash disposal options remain few.*
- *Many potential users are concerned with gasifier availability projections in the mid 70 to mid 80 percent range. They fail to appreciate that overall power generation availabilities for IGCC is in the 95 percent range with back up fuel capability. This translates into a plant that has extremely low incremental cost and high capacity factor 80% of the year that can operate as an NGCC plant for 15% of the remaining 20% of the year.*
- *Comments to “transport plans and infrastructure”: The ‘industry’ and government opinion has been that an infrastructure similar to that of natural gas is necessary for the hydrogen economy. NONSENSE. That opinion is extremely short-sighted when technologies are in place that can produce hydrogen on location, meaning in your neighborhood. Hydrogen can be produced cheaply without the expense of natural gas and efforts to overcome pipelines and right-of-way issues. The only hydrogen issue I see is the public willingness to have hydrogen fueling stations on a typical street corner like gasoline stations.*



**APPENDIX C**  
**ANALYSIS OF RESPONDENT GROUP DIFFERENTIATION**

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**Table C.1--Analysis of Responses to Legal/Regulatory Items--  
Differentiated by Respondent Groups**

<b>Respondent Groups</b>	<b>Analysis of Results</b>
Government/ Regulatory	Generally, the responses from government and regulatory organizations closely aligned with the aggregate results. This group gave somewhat higher rankings to the lack of regulatory stability and uncertain state siting processes, and somewhat lower rankings to the lack of pre-approved design features.
Energy Companies	Generally, the rankings by the energy companies closely approximated the aggregate results.
Technology/ Engineering	This group's rankings generally followed aggregate results, though it ranked standard market design as somewhat less significant than did the other groups.
Consulting/ Financial	This group ranked uncertainty regarding state siting processes much higher than the aggregate score (4.00 v. 2.86) It also gave above average rankings to uncertainty regarding wholesale market rules, and limitations on capacity and coproduction.

**Table C.2--Responses to Legal/Regulatory Items--Differentiated by Respondent Groups**

		<i>Mean Score by Category</i>				
		Aggregate	Gov't Org	Energy Co.	Tech/Engineering	Consulting/Financial
Q1	1. Lack of regulatory stability and predictability (General uncertainty regarding the critical rules including those governing electricity markets, power plant emissions and power plant siting.)	3.74	3.25	3.83	3.94	4.00
Q2	2. Uncertainty regarding state siting processes (Failure of states to act promptly on siting applications and/or to modify unworkable siting processes)	2.86	2.50	2.73	3.00	4.00
Q3	3. Degree of restructuring of retail electric markets (Disparity among states regarding retail competition, with a few states having deregulated their retail markets, others having taken tentative steps toward competition, and most others having not deregulated)	3.23	3.50	3.40	3.00	3.00
Q4	4. Lack of preapproved design features (With the absence of standardized design for IGCC) power plants, each project must go through a full regulatory review, creating the prospect for substantial design modifications, protracted certification proceedings and increased capital costs)	3.25	3.80	3.17	3.06	3.00
Q5	5. Transition to competitive wholesale electric markets (With wholesale electric markets in a state of flux, power plant developers face uncertainty regarding future prices and market rules)	3.74	3.80	3.83	3.67	3.50
Q6	6. Regulation uncertainty (The uncertainty that the state and federal governments potential choice to reregulate the generation sector in the electric power industry)	3.46	3.56	3.45	3.39	3.67
Q7	7. Uncertainty regarding wholesale transmission rules (The heated controversy concerning the Standard Market Design proposed by Federal Energy Regulatory Commission (FERC) is a major factor contributing to the uncertainty developers face regarding future wholesale prices and market rules)	3.19	3.56	3.20	2.87	3.67
Q8	8. Potential antitrust problems under PUHCA	1.89	2.20	1.71	1.92	1.50
Q9	9. Potential regulation of byproducts	2.28	2.25	2.58	2.13	2.00
Q10	10. Limitations on capacity and coproduction	2.22	1.89	2.25	2.24	3.00
Q11	11. Lack of preference treatment (e.g. preference hydropower)	2.83	2.67	2.82	2.81	3.25
Q12	12. Problems with interconnection policies	2.20	2.38	2.09	2.21	2.00
Q13	13. Advent of demand response programs	1.76	1.63	1.70	2.00	1.00

**Table C.3--Analysis of Responses to Environmental Items--  
Differentiated by Respondent Groups**

<b>Respondent Groups</b>	<b>Analysis of Results</b>
Government/ Regulatory	This group ranked the lack of certainty on regulating emissions slightly lower than the other groups. However, its rankings for regulation of particulates, Best Available Control Technology, and the use of hazardous and non-hazardous wastes to cofire were well above the aggregate scores for these items.
Energy Companies	This group indicated the general lack of certainty regarding regulation of emissions, as well as specific concerns with respect to carbon dioxide and mercury, as being high ranking challenges (mean scores of 4.00-4.17). In contrast, other groups all ranked these items below 4.00. Otherwise, the rankings by the energy companies generally tracked the aggregate scores.
Technology/ Engineering	The technology and engineering companies ranked permitting problems as a major concern (4.11), whereas the other groups all ranked this item below 4.00. Otherwise, this group's rankings generally tracked the aggregate scores.
Consulting/ Financial	This group ranked many items considerably below the aggregate scores. Most notably, it ranked lack of certainty on regulation of emissions as 2.50, compared with the aggregate score of 3.83.

**Table C.4--Responses to Environmental Items--  
Differentiated by Respondent Groups**

		<i>Mean Score by Category</i>				
		Aggregate	Gov't Org	Energy Co.	Tech/Engineering	Consulting/Financial
Q14	1. Lack of certainty on regulation of emissions (Uncertainty regarding federal and state laws and regulations governing the following emissions creates the prospect for substantial design modifications, protracted certification proceedings and increased capital costs)	3.83	3.60	4.09	3.94	2.50
Q15	1a. CO2	3.65	3.64	4.17	3.37	3.50
Q16	1b. NOx	3.28	3.36	3.25	3.32	3.00
Q17	1c. SOx	2.93	3.09	3.00	2.89	2.50
Q18	1d. Mercury	3.44	3.55	4.00	3.22	2.50
Q19	1e. Particulates	2.83	3.45	2.67	2.68	2.25
Q20	1f. New Source Review	3.38	3.50	2.90	3.56	3.67
Q21	1g. Potential multi-pollutant aggregating rules	3.23	3.00	3.50	3.12	3.67
Q22	1h. Use of non-hazardous and hazardous waste to cofire	2.85	3.38	2.73	2.76	2.50
Q23	2. Problems with permitting process (Treating and IGCC facility as a natural gas plant instead of a coal plant air emissions permits)	3.86	3.50	3.83	4.11	3.67
Q24	3. Best Available Control Technology	2.90	3.50	3.00	2.76	2.00
Q25	4. Gasifier permitting	2.83	2.71	3.27	2.72	2.25
Q26	5. Land use requirements versus Natural Gas Combustion Turbine (NGCT)	2.73	2.25	3.00	2.88	2.25
Q27	6. Water use requirements versus NGCT	2.66	2.90	2.75	2.50	2.50
Q28	7. Lack of verification technologies for CO2	2.63	3.22	3.10	2.11	2.50
Q29	8. Selective Catalytic Reduction (SCR) applications	3.24	3.75	3.09	3.11	3.33

**Table C.5--Analysis of Responses to Financial Items--  
Differentiated by Respondent Groups**

Respondent Groups	Analysis of Results
Government/ Regulatory	This group ranked higher capital cost (versus natural gas-fired units), higher non-fuel operating costs, and the lack of a hydrogen economy as more significant challenges than did other respondents. Conversely, it downplayed such items as the lack of purchase power agreements, poor counterparty creditworthiness, lack of project finance, lack of turnkey vendors, and lack of performance guarantees compared with the other groups.
Energy Companies	The energy company respondents viewed higher capital costs and the lack of turnkey vendors as important challenges, ranking both items at 4.25. They regarded the possible withdrawal of tax credits for IGCC plants as a more significant challenge than did other groups.
Technology/ Engineering	The technology and engineering respondents ranked the lack of purchase power agreements considerably higher than the aggregate score (4.40 v. 3.72) It also gave above average rankings to general lack of project finance, lack of developmental investment, long construction lead times, and poor counterparty creditworthiness.
Consulting/ Financial	This group's results differed markedly from the aggregate scores. It ranked several items considerably below the aggregate scores--e.g., higher non-fuel operating costs, lack of developmental investment, lack of turnkey vendors, and ranked several items considerably higher than the other groups--e.g., uncertainty regarding tax credits, inability to accelerate depreciation.

**Table C.6--Responses to Financial Items -- Differentiated by Respondent Groups**

**A3. Financial Barriers**

		Mean Score by Category				
		Aggregate	Gov't Org.	Energy Co.	Tech/Engineering	Consulting/Financial
Q30	1. Higher non-fuel operating cost than NGCT	3.63	4.18	3.42	3.68	2.50
Q31	2. Higher capital cost than NGCT	4.41	4.64	4.25	4.37	4.50
Q32	3. Confusion on capital versus operating costs (As compared to conventional coal combustion technologies)	3.07	3.33	2.91	2.94	3.50
Q33	4. Uncertainty of tax credits and qualification	3.72	3.60	3.89	3.56	4.25
Q34	5. Formula for tax credits	3.29	3.10	3.56	3.23	3.33
Q35	6. Lack of hedging tools	2.72	2.57	3.00	2.69	2.50
Q36	7. General lack of project finance	3.79	3.22	3.73	4.06	4.00
Q37	8. General lack of developmental investment	3.58	3.20	3.60	3.95	2.75
Q38	9. Lack of adequate Power Purchase Agreements	3.72	2.67	3.45	4.40	4.00
Q39	10. Long construction lead times	3.53	3.58	2.92	3.89	3.50
Q40	11. Poor counterparty creditworthiness	3.13	2.75	2.56	3.53	3.25
Q41	12. Inability to accelerate depreciation	3.09	2.83	3.40	2.87	4.00
Q42	13. Uncertainty in accounting rules	2.42	2.40	3.00	2.00	2.67
Q43	14. Inability to guarantee performance (Weak licensor guarantees)	3.70	3.33	3.58	3.94	3.75
Q44	15. Lack of turnkey vendors ( EPC companies are unwilling to "wrap guarantees)	3.89	3.40	4.25	4.05	3.25
Q45	16. Potential for new excise or other taxes	2.61	2.75	2.71	2.53	2.33
Q46	17. Securing adequate feedstocks	1.57	2.00	1.17	1.61	1.50
Q47	18. Ownership uncertainty	2.88	3.22	3.00	2.71	2.33
Q48	19. Lack of market for CO2 credits	3.20	3.82	2.91	3.21	2.00
Q49	20. Doubts concerning commercial viability of IGCC	4.11	4.18	4.17	4.05	4.00
Q50	21. Lack of hydrogen economy	2.70	3.89	2.50	2.26	2.75
Q51	22. Uncertain export-import bank participation	2.12	2.00	2.13	2.23	1.50
Q52	23. Uncertain value of byproducts from coproduction	2.75	3.30	2.73	2.68	1.75
Q53	24. High licensing fees	2.50	2.86	2.67	2.18	2.75
Q54	25. Potential for withdrawal of tax credits	3.00	3.29	3.44	2.76	2.00
Q55	26. History of problematic construction and slow start	3.67	3.20	4.00	3.63	4.00
Q56	27. Potential Carbon Tax	2.89	2.45	3.25	2.89	3.00
Q57	28. Lack of credit for biomass cofiring	2.27	3.00	2.08	1.94	2.33
Q58	29. Increased risk due to higher up front development costs	4.02	4.00	4.08	4.11	3.50

**Table C.7--Analysis of Responses to Economic Items--  
Differentiated by Respondent Groups**

<b>Respondent Groups</b>	<b>Analysis of Results</b>
Government/ Regulatory	This group gave higher rankings to uncertain fuel costs, uncertain coal transportation costs, and failure to socialize external benefits than did other groups. Conversely, it gave lower rankings to lack of investor owned utility financial strength and the lack of baseload demand.
Energy Companies	The energy companies gave a substantially lower ranking to several items including uncertain fuel costs and uncertain coal transportation costs.
Technology/ Engineering	This group was the only one that ranked the country's economic downturn as a prominent issue (4.06). Otherwise, its responses generally tracked the aggregate scores.
Consulting/ Financial	This group gave a far above average ranking to uncertain fuel costs, and a far below average ranking to lack of baseload demand. Otherwise, its rankings generally tracked the aggregate scores.



**Table C.8--Responses to Economic Items--  
Differentiated by Respondent Groups**

**A4. Economic Barriers**

		Aggregate	Distribution			
			Gov't Org.	Energy Co.	Tech/Engineering	Consulting/Financial
Q59	1. General economic downturn	3.79	3.77	3.42	4.06	3.75
Q60	2. Uncertain life cycle costs	3.34	3.67	3.50	3.11	3.00
Q61	3. Uncertain fuel costs	2.55	3.25	1.92	2.26	3.75
Q62	4. Failure to consider volatility of natural gas prices	3.48	3.46	3.50	3.47	3.50
Q63	5. Uncertain coal transportation costs	2.09	2.58	1.58	2.05	2.25
Q64	6. Lack of Investor Owned Utility financial strength	3.25	2.75	3.25	3.44	3.50
Q65	7. Uncertainty regarding future demand growth	3.24	3.25	3.25	3.29	3.00
Q66	8. Uncertainty regarding future fuel prices	3.11	3.45	2.67	3.11	3.50
Q67	9. Lack of baseload demand	3.24	2.83	3.17	3.72	2.50
Q68	10. Inability of IGCC to ramp generation quickly	2.73	3.40	2.67	2.47	2.50
Q69	11. Failure to socialize external benefits	3.73	4.10	3.25	3.89	3.50

**Table C.9--Analysis of Responses to Cultural Items--  
Differentiated by Respondent Groups**

<b>Respondent Groups</b>	<b>Analysis of Results</b>
Government/ Regulatory	This group ranked three items at 4.00 or higher--lack of appreciation for fuel source diversity, lack of appreciation for the need for energy independence, and lack of appreciation for the need for fuel diversity. In contrast, these items were ranked considerably lower by the other groups.
Energy Companies	This group ranked the historic poor perception of IGCC at 4.08. In contrast, no other group ranked this item above 3.32. Conversely, the energy companies group downplayed the relative importance of items such as the Enron debacle and the lack of appreciation for societal benefits.
Technology/ Engineering	The technology and engineering group was the only one that ranked the failure of some IGCC projects as a major concern (4.11 v. the aggregate score of 3.86). Otherwise, its responses varied only slightly from the aggregate results.
Consulting/ Financial	This group downplayed the significance of many cultural items. On the other hand, it ranked the Enron debacle at 4.67, well above the aggregate score of 3.56 for this item.

**Table C.10--Responses to Cultural Items--  
Differentiated by Respondent Groups**

**A5. Cultural Barriers**

		Aggregate	Mean Score by Category			
			Gov't Org.	Energy Co.	Tech/Engineering	Consulting/Financial
Q70	1a. Poor perception of coal among: General population	3.63	3.85	3.33	3.74	3.25
Q71	1b. Poor perception of coal among: Informed population	2.94	3.00	2.75	3.11	2.50
Q72	1c. Poor perception of coal among: Institutional stakeholders	3.11	3.45	3.33	2.84	2.75
Q73	1d. Poor perception of coal among: Regulators	3.21	2.92	3.25	3.26	3.75
Q74	1e. Poor perception of coal among: Plant developers	2.87	2.64	3.00	2.89	3.00
Q75	2. The nuclear power plant debacle (The push to develop nuclear power plants resulted in very financial difficulties that developers wish to avoid)	2.26	2.78	2.70	1.81	1.67
Q76	3. Historic poor perception	3.35	3.09	4.08	3.32	2.00
Q77	4. Lack of appreciation for coproduction capabilities	3.18	3.50	3.08	3.16	2.75
Q78	5. Lack of appreciation of ancillary services capabilities	2.83	3.10	2.67	2.89	2.25
Q79	6. Oil and Coal companies' avoidance of regulation	2.75	2.50	2.40	3.07	3.00
Q80	7. Lack of appreciation of need for fuel diversity	3.69	4.00	3.25	3.84	3.50
Q81	8. Lack of appreciation of need for energy independence	3.61	4.18	3.33	3.42	3.75
Q82	9. Problems in California and Northwest	2.83	3.10	2.45	2.89	3.00
Q83	10. Enron	3.56	3.73	2.73	3.78	4.67
Q84	11. Failure of some IGCC projects	3.86	3.56	3.82	4.11	3.50
Q85	12. Lack of appreciation for societal benefits	3.67	4.27	2.82	3.79	3.75
Q86	13. Plant operators' lack of familiarity with IGCC (Distrust of chemical plants versus conventional boilers)	3.62	3.40	3.83	3.84	2.50

**Table C.11--Analysis of Responses to Technological Items--  
Differentiated by Respondent Groups**

<b>Respondent Groups</b>	<b>Analysis of Results</b>
Government/ Regulatory	This group generally ranked most of the technological barriers considerably higher than the other respondent groups, particularly carbon dioxide sequestration and the lack of hydrogen transport plans. Conversely, it ranked chance of low plant availability at 3.67, whereas the other groups all ranked this item at 4.00 or higher.
Energy Companies	The rankings by the energy companies did not vary appreciably from the aggregate scores. The energy companies gave somewhat higher rankings to two key items--general skepticism toward IGCC technology and chance of low plant availability.
Technology/ Engineering	This group gave somewhat lower rankings to technological items relative to the aggregate scores, particularly with respect to uncertain CO <sub>2</sub> sequestration and lack of hydrogen transport plans.
Consulting/ Financial	This group's responses generally tracked the aggregate scores, except for two items. They ranked general skepticism toward IGCC and skepticism regarding optimal gasifier technology considerably below the aggregate score.

**Table C.12--Responses to Technological Items -- Differentiated by Respondent Groups**

		Aggregate	Mean Score by Category			
			Gov't Org.	Energy Co.	Tech/Engineering	Consulting/Financial
Q87	1. Uncertain CO2 sequestration technology	3.05	3.78	3.25	2.63	2.75
Q88	2. Lack of hydrogen transport plans	2.79	3.89	2.55	2.39	2.75
Q89	3. Lack of syngas transport (Inability to site gasifiers remotely from the generation block due to poor economics of syngas transport)	2.53	3.13	2.36	2.35	2.50
Q90	4. Skepticism regarding IGCC technology generally	3.91	3.89	4.17	3.89	3.25
Q91	5. Skepticism regarding membrane air separation technology	2.28	3.50	2.25	1.94	2.00
Q92	6. Skepticism regarding ceramic filter gas cleanup technology	2.60	3.14	2.92	2.26	2.25
Q93	7. Skepticism regarding optimal gasifier technology generally (There are several competing gasifier designs and there is no clear leading technology)	2.68	3.22	2.92	2.47	1.75
Q94	8. Chance of low plant availability	4.14	3.67	4.33	4.28	4.00
Q95	9. Slow development of fuel cell technology	2.19	3.25	1.92	1.95	2.00
Q96	10. Lack of long term IGCC operating experience	3.73	3.67	3.58	3.79	4.00
Q97	11. Uncertain feedstock injection technology	2.40	3.00	2.08	2.47	2.00