

UNCONVENTIONAL OIL AND GAS RESEARCH FUND PROPOSAL

This recommendation was designed to strengthen research on the impacts of unconventional oil and gas development and use – and to ensure that the resulting knowledge is used for the improvement of regulations and best practices.

The Roundtable started with a set of assumptions regarding the relative lack of shale gas research given the size of the need, the perception that some research already underway or completed is biased, and the existence of gaps between research and the information needs of policymakers. During the summer and fall of 2012, the Roundtable validated these assumptions through a higher education survey, a literature and media review, and stakeholder outreach and interviews.

While exploring the assumptions, the Roundtable also investigated potential models for overcoming barriers to improved and expanded shale gas research activity. The Health Effects Institute (HEI), a nonpartisan research organization that has supported balanced air quality research for more than 30 years, was identified as the most relevant model that could address the particular challenges of shale gas research. Several discussions were held with HEI, including multiple visits by its senior leadership team to Pittsburgh.

Based on its work and deliberations, the Roundtable believes that substantial benefit can be secured through the creation of a scientifically rigorous, third-party entity with diverse funding streams that can support unconventional oil and gas research to inform sound regulatory and legislative decision making. This proposal describes the recommended characteristics of the research fund, suggests that the region continue to rely on the counsel of HEI in the replication of its model, and outlines a preliminary high-level implementation strategy.

SHALE GAS RESEARCH NEEDS: VALIDATING THE ROUNDTABLE'S ASSUMPTIONS

Shale gas development is complex and multi-faceted, with economic, environmental, public health, social, and technological components. Robust and trustworthy research should be one of the critical ingredients in decision making by the state and federal governments and other important stakeholders. Southwestern Pennsylvania is particularly well-suited to answer the call for additional research given its number of higher education institutions with active interest in shale gas and with relevant capabilities.

The Roundtable made three assumptions about the nature and adequacy of ongoing shale gas research:

1. While substantial research has been completed or is underway, the amount of research activity on shale gas is lacking relative to the knowledge needs of policymakers and the public. Further, this mismatch between needs and actual research is likely due to a dearth of funding.

2. Research that has been completed or is underway often is perceived as biased due to the funding source or review processes used.
3. Research has not been well aligned with the information or timing needs of regulatory staff, elected decision makers, or other civic leaders.

The Roundtable endeavored to validate these assumptions by using various tools and approaches, including a higher education survey, interviews with key government policymakers, outreach to relevant stakeholders, and media/literature reviews.

Existing Research Efforts – The Roundtable designed and distributed a research survey to university and college presidents in August 2012. The surveyed institutions included all colleges and universities in the 10-county Southwestern Pennsylvania region along with other institutions, such as Cornell University, West Virginia University, Ohio State University, Pennsylvania State University, the University of Pennsylvania, and Virginia Tech. The survey was designed to gauge the level of ongoing shale gas research, identify barriers to increased research, and capture potential untapped research capabilities. The survey questions and a summary of responses are included in [Appendix B](#).

Fifty-two faculty and staff members from 18 higher education institutions (out of 37 institutions surveyed) responded to the survey. The results indicate the following:

- Substantial and relevant research is ongoing, but capabilities are under-utilized; multiple important shale areas may not be receiving adequate attention.
- Research collaboration among universities inside and outside the region has occurred, and such partnerships are likely to increase.
- Most research by Pennsylvania institutions has focused on Pennsylvania; however, multi-state research that reflects the broader extents of the Marcellus and Utica formations is increasing.
- Two large research barriers are the availability of and access to accurate data and difficulties in forming effective partnerships with industry and government.
- The largest challenge to previously completed research and to enhancing future research is the overall lack of funding support. Respondents are concerned about accepting funds directly from industry or other shale gas stakeholder groups.
- Research results are increasingly being prepared for peer-reviewed publication.
- The emphasis has not been on sharing research outcomes with the public or with decision makers, though this has begun to shift more recently.
- Diverse faculty beyond the traditional engineering and public health disciplines are interested in shale gas research.

Accusations of Bias – Reviews of media coverage indicate a significant number of bias accusations in shale gas research. The results of high-profile projects at a number of higher education institutions nationally and in Pennsylvania have been labeled as biased due to being supported or initiated by a particular sector. Research conducted by some industry trade associations and environmental organizations also has been criticized in this regard. The Roundtable is not in a position to evaluate the validity of bias claims or to rule on the scientific rigor of research studies. However, the presence of

numerous bias storylines in the national and regional media does substantiate the perceived bias concern in the second assumption.

The Intersection of Research and Policy/Regulation/Best Practices – Governor Tom Corbett’s Marcellus Shale Advisory Commission recognized the potential value of state government support for various types of shale gas research in its final report recommendations 9.2.37 and 9.4.11:

9.2.37

The Department of Health should work in partnership with the Commonwealth’s graduate schools of public health and other appropriate medical institutions to better protect and enhance the public health interests of citizens, such as through the establishment of the population-based health registry and curriculum development.

9.4.11

Academic research efforts across the Commonwealth, including initiatives such as SAFER (Shale Alliance for Energy Research), the Ben Franklin Technology Partners’ Shale Gas Innovation and Commercialization Center and others, should be marshaled to focus academic-supported efforts on needs such as research and development, business start-up incubation and seed-capital start-up assistance.

Based on a presidential Executive Order in April 2012, the federal government established the Interagency Steering Committee consisting of the U.S. Environmental Protection Agency (EPA), Department of Energy (DOE), and Department of Interior (DOI) to determine collective unconventional oil and gas research priorities. Their resulting memorandum of understanding explains the partnership:

The DOE, DOI, and EPA will identify research priorities and collaborate to sponsor research that improves our understanding of the impacts of developing our Nation’s unconventional oil and gas resources and ensure the safe and prudent development of these resources. Through enhanced cooperation, the Agencies will maximize the quality and relevance of this research, enhance synergies between the Agencies’ areas of expertise, and eliminate redundancy.

In January 2013, it was announced that the U.S. Department of Health and Human Services was joining the steering committee as an informal advisory member. The Interagency Steering Committee is expected to release its federal research plan for public comment in 2013. The Roundtable engaged, as appropriate, in the interagency process and anticipates interest from the federal level in additional shale gas research efforts in this region.

Through multiple conversations with elected officials and legislative/executive/regulatory staff at the state and federal government levels, the Roundtable secured additional beneficial perspectives about research needs and the use of shale gas research. Interviewees expressed general support for additional research but also shared four specific concerns:

- While public health and environmental impacts need to be investigated, many fear heavy-handed research methods in shale gas development areas. Several interviewees expressed a

strong desire for populations living in shale gas areas, particularly rural populations, to be treated with dignity and respect and not as “test subjects.” Research methodologies will require careful attention.

- Researchers need to place particular emphasis on sharing research findings with policymakers and on the accurate translation and explanation of research outcomes, particularly on technical projects. A frequently cited example was a study on underground fluid migration pathways. Interviewees noted that the research conclusions appeared to vary depending on the newspaper reporting on them.
- Multiple research efforts are getting underway, and efforts should be made to avoid duplication. For this reason, the Roundtable will continue to engage with possible collaborators. The research fund is not designed to supplant or control other existing efforts but rather to complement and strengthen them. In particular, the Roundtable believes there will be synergies with the innovative technology research conducted by the National Energy Technology Laboratory and its Regional University Alliance.
- Elected officials expressed frustration about the lack of scientific guidance on the issues they have examined. However, they also recognized the difficulty of peer-reviewed rigorous research that aligns with legislative schedules. Several interviewees suggested that research will be more appropriately aimed at regulatory decision makers in the short-term while strategic longer-term research investments could impact legislative actions. Interviewees also suggested that research could help to inform the efforts of non-governmental organizations that are focused on developing and improving best practices.

Funds originally slated for research investment from the impact fee revenue were ultimately removed from Act 13 due, in part, to the concerns noted above. Recent state legislative proposals include the creation of a shale gas health advisory panel and the redirection of some impact fee revenues to public health research.

Interviewees at both the state and federal levels expressed a desire to stay informed and involved in discussions about improving and increasing shale gas research efforts.

MODEL RESEARCH ORGANIZATIONS

While the above activities were underway, the Roundtable also investigated possible “boundary organization” models to address research needs. Boundary organizations are funding and/or administrative intermediaries that operationally and functionally reside at the intersection of multiple interested constituencies (in this case, the natural gas industry, government, environmental organizations, academia, and the public).

Most potential models proved to be inadequate to overcoming the particular barriers of enhanced shale gas research. For example, the National Water Research Institute, Water Environment Federation, and Electric Power Research Institute fund high-quality respected research in the areas of water supply, water quality, and electric power, respectively. However, their research agendas are largely determined and funded by their industry members, with some augmentation from other funding sources. If these models were used for shale gas research, the bias issue would largely remain.

In other instances, the federal or state governments have supported enhanced use of ongoing research on a given topic. For example, the Decision Center for a Desert City at Arizona State University is funded by the National Science Foundation to support the translation, sharing, and use of significant climate change research that is being conducted at that university. While use of the research is an issue in the shale gas arena, the current level of research probably could not be defined as sufficiently robust and merely in need of distribution.

These models and others were useful for informational purposes, but none provided a comprehensive model framework for shale gas research. The one exception, however, was the Health Effects Institute (HEI) based in Boston. Multiple constituencies suggested HEI as an ideal model for the Roundtable's consideration. The Roundtable researched HEI's structure, history, and activities and conducted several interviews with HEI senior staff. The HEI website provides a succinct overview of the organization (www.healtheffects.org):

HEI is a nonprofit corporation chartered in 1980 as an independent research organization to provide high-quality, impartial, and relevant science on the health effects of air pollution. Typically, HEI receives half of its core funds from the US Environmental Protection Agency and half from the worldwide motor vehicle industry. Other public and private organizations periodically support special projects or certain research programs.

To accomplish its mission, HEI

- Identifies the highest priority areas for health effects research;*
- Funds and oversees the conduct of research projects;*
- Provides intensive independent review of HEI-supported and related research;*
- Integrates HEI's research results with those of other institutions into broader evaluations; and*
- Communicates the results of HEI research and analyses to public and private decision makers.*

To this end, HEI has funded over 250 studies in North America, Europe, and Asia that have produced important research to inform decisions on carbon monoxide, air toxics, nitrogen oxides, diesel exhaust, ozone, particulate matter, and other pollutants. The results of all endeavors have been published in over 200 Research Reports and Special Reports. At the urging of the World Health Organization and countries throughout the world, HEI has extended its international research to help inform air quality decisions in Europe, Asia, and elsewhere.

An independent Board of Directors consists of leaders in science and policy who are committed to the public-private partnership that is central to HEI. The Health Research Committee works with scientific staff to develop the Five-Year Strategic Plan with input from HEI's sponsors and other interested parties, select research projects for funding, and oversee their conduct. The Health Review Committee, which has no role in selecting or overseeing studies, works with staff

to evaluate and interpret the results of funded studies and related research. All project results and HEI Commentaries are widely communicated through HEI's home page, Annual Conferences, publications, and presentations to legislative bodies and public agencies.

A third committee, the Special Committee on Emerging Technologies, advises HEI on new technologies and fuels, and their potential health and environmental impact. Its membership was selected to provide a broad range of technical expertise from government, industry, public interest, and academic organizations.

Examination of this model proved to be useful. In particular, several visits by HEI's senior management team to Pittsburgh were critical to informing the Roundtable and advancing this proposal. During the visits, HEI representatives were able to interact with Roundtable members, foundation and civic leadership, and representatives of regional higher education institutions.

PROPOSED FRAMEWORK FOR THE SHALE GAS RESEARCH FUND

The Roundtable – based on the demonstrated need for additional balanced research, the investigation of models, stakeholder input, and other information gathered – recommends that a fund be created to support rigorous and enhanced research to guide shale gas development.

Characteristics of the Shale Gas Research Fund

- **Diverse funding streams.** State and federal governments, industry, and private philanthropy will be asked to contribute to a unified fund. These contributions will support the overall research agenda and cannot be directed to individual projects. Ideally, funders would make three-to-five-year commitments in alignment with the strategic planning cycle, with each funding sector contributing an equal amount. Other stakeholders that may be unable to contribute will still be consulted on an ongoing basis. Increased, multi-sector, multi-year funding will help to address the overall amount of research completed and the perceived bias of that research. Full disclosure of funding sources and amounts will be required.
- **Regularly updated multi-year strategic research plan.** Research priorities in the plan will be based on diverse input, from funders and non-funders, and designed to inform regulatory and legislative decision making at the state and federal levels.
- **Scientifically rigorous.** Research funding will be competitively awarded and research products intensely reviewed – both using peer-review protocols. While such processes do slow research, the gains in perceived trustworthiness and rigor are worth the slightly slower output. Given the ongoing national challenges in shale gas research, researchers have recently reported an emerging difficulty in recruiting a sufficient number of qualified peer reviewers. A funding structure, such as the one proposed here, may help to increase the attractiveness for researchers who consider serving in this capacity.
- **Transparency.** Ethical and transparent operations will be essential to gaining the trust of diverse audiences. Given the heightened media and public attention to shale gas issues, the fund will need to make substantial preparations for transparent, effective communication regarding the strategic priorities and the meaning of research outcomes. Methodologies that respect the local populations and offer opportunity for their active participation will be preferred.

- **Strong government and stakeholder relationships.** The research fund will need strong relationships with industry, environmental organizations, the federal government, and all state governments in which it operates.
- **Supports informed policy and practice based on state-of-the-art science.** Research supported by the fund will not make direct policy recommendations. Rather, emphasis will be placed on translating and communicating research results in a timely manner in order to inform legislative/regulatory decision making and best practice improvements. Pennsylvania Senate President Pro Tempore Joseph Scarnati has introduced Senate Bill 555, which would establish the Health Advisory Panel on Shale Gas Extraction and Natural Gas Use. Should that legislation be enacted, the Health Advisory Panel could be a potential partner in helping to identify research needs and a natural recipient of the resulting findings.
- **Able to synthesize available shale gas research.** In addition to funding original research, this effort can, at the request of policymakers, provide additional value by synthesizing high-quality completed research or aggregating existing data on a given topic. This approach could help with timeliness concerns. For example, if a West Virginia legislator requested information on a given topic and there was a lack of time to commission original work, the fund could consider supporting a synthesis of the available research in the short term.
- **Adequacy of funding support and staffing.** It is estimated that \$4-7 million per year will be necessary to meet reasonable expectations of success (though less funding may be sufficient in the startup phase and, if the effort is successful, substantially more funding could be gainfully invested in additional, valuable research). Funding structures could include an endowment to decrease the ongoing fundraising burden. This level of funding over a full strategic plan cycle could support multiple, large research projects and assorted smaller original research and synthesis efforts. The Roundtable estimates that five to seven administrative, scientific, and external relations staff members will be needed for full implementation. Every effort will be made to minimize overhead costs and maximize funding for research. For comparison, the Health Effects Institute operates its national air quality research efforts with approximately \$10 million annually and 25 staff members.

In combination, these characteristics will help the research fund to maintain its ability to be nimble and responsive to the constantly evolving natural gas arena while being deliberative, strategic, and scientifically rigorous.

Geographic Scope

The Roundtable identified three facets of geography for this effort:

1. From which geographic territory should the funding be drawn?
2. In which geographic territory should the research activities be directed?
3. From which geographic territory would the fund draw eligible researchers/applicants?

These questions could conceivably be answered differently, and the options could include the 10-county region, Pennsylvania, the Marcellus Shale area, or the nation. However, interviewee input and Roundtable deliberations made it clear that answering all the questions in the same manner would

avoid confusion and give the effort more consistency. The selection of the uniform answer is a more complicated issue. On one hand, a regional or Pennsylvania-specific effort could be unduly limiting, ensnare projects in an individual state's politics, and potentially cause competitive funds to be established in other nearby states. This is particularly problematic for industry and nonprofit partners that operate across state lines. On the other hand, a national effort could be difficult to launch with the right partners due to the diversity of shale plays and state actors. Unlike many other environmental issues, oil and gas regulation is managed mostly by the states.

The best option may be to focus specifically on geologic formations found in the Appalachian Basin. Exact geographic dimensions of the basin vary, but the most commonly included states are New York, Pennsylvania, Ohio, and West Virginia. These states share unconventional resources in the Marcellus, Utica, and other shale formations. They have a shared historical experience with resource extraction and, in many ways, similar regulatory regimes. The main potential complication from a multi-state, basin approach is related to the alignment of funding sources and expenditures. For example, if Pennsylvania invests in the fund, it may object to the expenditure of those dollars in West Virginia and vice versa.

At the end of 2011, the U.S. Secretary of Energy's Shale Gas Subcommittee endorsed the creation of Regional Centers of Excellence that would involve public interest groups, state and local regulatory agencies, local colleges and universities, and industry in basin-specific best practice development. While this research fund would have a slightly different mission, an Appalachian Basin scale would be consistent with DOE's emphasis on regional, shale-basin defined, and cross-sector approaches.

Importantly, the Appalachian Basin boundaries would not be "un-crossable" but rather would serve as initial geographic guides to answering the three questions at the top of this section. If funding sources or researchers from outside that area wanted to participate, it would not make much sense to arbitrarily and permanently exclude those participants. The research fund leadership, in consultation with funders and stakeholders, could make such decisions on a case-by-case basis. Conceivably, an Appalachian Basin focused fund could expand, over time, into a national or even international effort, which presents an opportunity for Southwestern Pennsylvania to lead the way in innovatively supporting and using shale gas research.

Focus of Research Activities

A multi-sector research fund appears particularly well suited to support research on the acute and cumulative environmental, ecological, public health, social, and community impacts of unconventional oil and gas extraction, production, transport, and use. These are the most contentious areas that require enhanced attention and skilled impartial investigation. In addition, investments in the unbiased evaluation of new technologies and innovations and their potential to decrease the environmental footprint of oil and gas development would be useful. In response to the Roundtable's original research assumptions, the fund should prioritize research in areas needing increased attention where unbiased data will be most helpful and where policymakers lack reliable information.

By suggesting this type of research focus, the Roundtable avoids being either overly prescriptive or overly broad. Dictating specific research projects at this stage would limit the flexibility and diminish the attractiveness of an unbiased, independent funding and research effort.

IMPLEMENTATION STRATEGY AND NEXT STEPS

In order to begin the implementation of the research fund proposal, planning is underway for a process to establish a multi-year unconventional oil and gas research agenda that will include targeted, carefully timed, and policy-relevant research questions. This initial process and resulting agenda will, to the highest degree possible, conform to the characteristics of the fund itself.

Research priorities in the agenda will be based on diverse input and designed to inform regulatory and legislative decision making at the state and federal levels. The process will not be a series of linear steps but rather a set of concurrent activities that include: recruiting a research committee to guide the process; completing a scan of existing research; framing future research questions with critical input from policymakers, researchers, and relevant stakeholders; drafting an agenda for stakeholder review; and adopting a final agenda for implementation.

It will be essential for diverse stakeholders to be able to trust the rigor and independence of the process and the resulting agenda. The agenda cannot be viewed as being driven by one sector or one institution. Expert scientific staff with experience in collaboratively identifying research questions, setting priorities, and establishing strategic research plans will be essential ingredients in the process. A scientifically-credible, impartial facilitator with a track record in this type of work and with experienced staff would heighten the chances of successfully crafting an agenda that can attract implementation funding.

In parallel with the agenda-setting process, a detailed plan for the implementation of the agenda through a multi-year, cross-sector fund will be constructed. Longer-term emphasis will be on securing stability and predictability for the research fund through multi-year funding commitments, regular stakeholder communications, hiring full-time staff, establishing research and review committees, and eventually drafting requests for proposals based on the strategic research agenda. The next round of dialogue among regional stakeholders will define a path forward that best positions the fund for valuable contributions to unconventional oil and gas research and policy.

APPENDIX B: REGIONAL RESEARCH SURVEY RESULTS SUMMARY, AUGUST 2012

Overall Response Rate: 52 individual faculty and staff members responded to the survey

Question 1: Respondent Contact Information

Responding faculty and staff members represented the following institutions:

- Allegheny College
- Carnegie Mellon University
- Cornell University
- Drexel University
- Indiana University of Pennsylvania
- Ohio State University
- Ohio University
- Pennsylvania State University
- Robert Morris University
- Saint Vincent College
- Slippery Rock University
- Temple University
- University of Pittsburgh at Bradford
- University of Pittsburgh (Oakland)
- Waynesburg University
- Washington & Jefferson College
- Westminster College
- West Virginia University

Question 2: Are any faculty/staff at your institution currently engaged in research surrounding any aspect of shale gas development?

85% answered yes and 15% answered no.

Question 3: If not, why? Has your institution made a conscious decision not to work on shale gas issues (not a good fit with faculty interests, institution strengths, etc.)? Or are there barriers to your faculty becoming more involved in the shale arena? What are these barriers?

Respondents who reported no current shale gas research at their institution cited three barriers - lack of funding resources to perform research, lack of institutional interest in this type of research, and lack of ability to collaborate with industry and/or government.

Question 4 and 5 Combined: Question 4: If yes to Question 2, what research is currently being conducted or what research has been completed in the recent past related to shale gas development (project focus areas/title are sufficient detail)? If you are not the principal investigator for these projects, please consider providing a contact name/e-mail address for each research project. Additionally, we are particularly interested in learning of any water-related shale gas research that is currently being conducted at your institution. What specific projects are you undertaking in this regard?

Question 5: Additional space to discuss research activities if needed.

Respondents reported on (13) primary research areas and (90) subset research areas across their various institutions. The 13 areas included:

- Economics/finance and shale related activities – 15 subsets
- Effect of shale gas on regional water resources – 13 subsets
- Analyzing the physical and chemical properties of Marcellus Shale gas and water – 12 subsets
- Economic and social impacts of shale gas development – 12 subsets
- Wastewater management and Marcellus Shale development – 7 subsets
- The impact of shale gas activity on air emissions and air quality – 6 subsets
- Examining public policy and legal issues surrounding the emerging regional shale gas industry – 5 subsets
- Methods for finding leak detection at CO₂ geological sequestration sites – 5 subsets
- Educational activities and workshops regarding shale gas - 4 subsets
- Exploring shale gas utilization with regard to transportation – 3 subsets
- Geology/geosciences -3 Subsets
- Wildlife and forest impacts and the Marcellus Shale – 3 subsets
- Developing demonstration projects – 2 subsets

Question 6: Are you collaborating (or have you collaborated) with other colleges or universities on any shale research projects?

45% of respondents stated they are collaborating with (or have collaborated with) at least one other college or university on shale gas research. These partnerships are most often with other regional institutions, but national and even international collaboratives were reported.

Question 7: In what geographic territory(ies) has your shale gas research been focused?

- Pennsylvania – 81% of respondents performed shale gas research focused on Pennsylvania
- Marcellus region – 26%
- Marcellus/Utica region – 16%
- Ohio – 13%
- West Virginia – 10%

Question 8: What were the main challenges you encountered in implementing these research projects?

7% responded that they did not encounter any research challenges. 3% suggested that it is too early in their research to respond. Other respondents cited five main challenges encountered in implementing research projects:

- 38% cited funding challenges, specifically difficulty obtaining funding from unbiased sources, insufficient government support for research, and a lack of multi-year research support
- 35% cited data challenges including the general inability to obtain/access data and the specific lack of access to company/industry data
- 21% cited the challenge of identifying appropriate research priorities that would add value, locating other interested researchers and designing collaborations among institutions and industry/government
- 10% cited infrastructure/technical challenges, including limited analytical equipment, technical staff and administration support
- 10% cited political sensitivity challenges, including difficulty reaching agreements with industry about research protocols and about how to handle confidentiality issues

Question 9: Has it been difficult to prioritize your institution's involvement in various shale gas issues?

58% of individuals said that it had not been difficult to prioritize the institution's involvement in various shale gas issues. This appears largely due to faculty interests and capabilities driving each institution's involvement. Some respondents said it was difficult to define the institution's role without being labeled "pro" or "con" shale gas development. There are strong voices on both sides of the community, and the vision is to attempt to focus on education/information/science related to the topic without "picking a side."

Question 10: Has any of this research either been published in peer-reviewed journals or other formats? If so, please provide links to the published materials if you are able.

38% of individuals reported being published in peer-reviewed journals or other formats. 17% have research that is in progress/pending being published in peer-reviewed journals or other formats. Many faculty provided links to these papers.

Question 11: Have you used any of this research to inform the public, media, or policymakers about critical shale gas? Did you find community sharing to be useful and/or impactful? Have you encountered any difficulties in translating shale gas research for consumption by these groups?

59% responded that they have not used research to inform the public, media, or policymakers about critical shale gas issues.

20% of individuals responded 'yes', using research to inform the public has been impactful but also challenging. Respondents said that the challenges are due to strongly held opinions on both sides accompanied by a resistance to accept 'gray areas,' polarization of issues by media, the quality of commentary and research being published, and the lack of good data to share.

17% responded 'yes' they have used research to inform the public, which was impactful and not challenging. Respondents noted that forms of engagement, such as working with landowner groups, business leaders, and elected officials, can create fruitful dialogue and are leading to new branches of research.

Question 12: Do you believe that your institution has the capacity and/or untapped capabilities that would allow it to further engage in research around shale gas development if the right opportunity arose? If so, what type of research and activity priorities would be of most interest to you?

97% of respondents said 'yes' - their institution has capacity and/or untapped capabilities that would allow them to further engage in shale gas research. Specific untapped capabilities or areas of interest included the following:

- Advanced materials research
- Baseline monitoring of shale areas
- Community development issues
- Cumulative impact assessment frameworks
- Development of workforce educational courses
- Downstream process engineering
- Drilling and fracturing technologies
- Economic impact on communities
- Economic impact on energy sources
- Economic/environmental impact cost/benefit analyses
- Emissions monitoring
- Environmental impact study that is comprehensive
- Gas and liquids processing research
- GIS mapping
- Leadership of multi-institution shale gas consortia
- Local planning
- Logistical/engineering and financial interface
- Making Pennsylvania a pilot jurisdiction as it relates to public policy
- Opportunities for alternative water sources
- Public health impacts
- Public policy-related issues
- Research on alternative regulatory regimes
- Safety issues
- Upstream to downstream development aspects

- Wastewater management
- Water chemistry analysis
- Water treatment technology
- Well engineering

Question 13: What barriers have prevented this additional capacity/capability from being utilized?

- 75% said that there is a lack of financial support for research (federal, state and private sources)
- 22% said that there was limited time to pursue additional research projects
- 6% said that there was a lack of support at their college to help them
- Other responses included the following:
 - Finding appropriate collaborators to make a contribution to research support
 - Some research support is viewed as biased
 - Lack of industry partners/relationships
 - Lack of understanding on the engineering side of the research issues as to how useful economists, operations, and finance faculty can be in evaluating the policy issues
 - Lack of availability of PhD Students
 - Lack of knowledge of opportunities

Question 14: Are there other areas of research that you think would require attention, even if they are outside of your institution's interest areas?

Responses included:

- Atmospheric contamination from escaped methane, diesel ground operations, etc.
- Examine international exports of huge, cheap quantities of natural gas versus the import of huge, expensive quantities of oil
- Geologic research
- Long-term well integrity evaluations
- Pipeline effects on biodiversity
- Possible negative socioeconomic impacts of boom and bust economy
- Public health, specifically whether possible illnesses that could be associated with shale gas production are impacting health
- Revisiting existing oil and gas industry legal exemptions from state and federal environmental and safety regulations
- Technological issues that could lead to better ways to conduct the resource extraction
- The need for a data warehouse for energy information that houses, reviews, and makes available pertinent statistics and information to the public
- The potential for migration of fluids and gas from horizontal hydraulic fracturing to enter surface and groundwater
- Trading tariffs and supply/demand limitations
- Workforce development issues