



# *Thoughts on Research Relating to the Water Lifecycle and Unconventional Production*

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## My Perspective

- I will offer some observations and thoughts on research based on more than 20 years experience working as a national laboratory researcher
- During that time I published many reports, peer-reviewed and non-peer-reviewed articles, and made hundreds of technical presentations to a wide variety of audiences.
- I have interacted with researchers, good and bad, from many different research organizations.

# Topics for Discussion

- In the context of water research relating to unconventional oil and gas development:
  - Why is research done?
  - Who does research?
  - Who funds research?
  - What are the research topics
  - How are those subjects determined?
  - What are the challenges in communicating and disseminating research results?



# Why Is Research Done?

- To answer questions and provide new information
- To improve and develop processes and technologies (applied research)
- To advance science (basic research)
- To support regulations and laws
- To train next generation of researchers in research methods and approaches

## Cynic's view:

- *To keep researchers employed and research organizations in existence*
- *To lay groundwork for the next research project*
- *To build empires at funding and oversight agencies*

# Who Does Research?

- Research organizations
  - Academia
  - National labs
  - Private sector research institutes
  - Think tanks
- Industry
  - Producing companies often have some R&D capacity in-house
  - Service companies and water technology companies have extensive internal R&D departments
- Consultants and Data Purveyors
  - Often do applied and targeted research projects for their clients
- NGOs
  - Do research as needed to support their organizations' positions



# Who Funds Research?

- Internal
  - Industry
  - Service companies
  - Water technology companies
  - Federal government
  - Data purveyors
- External
  - Federal government
  - Industry (individually and jointly)
  - State government (not often, but TWDB is an exception)
  - Foundations, charitable trusts
  - Donor contributions



# Research Topics

- Basic research
  - Chemistry
  - Physics
  - Biology
  - Others
- Applied research
  - Compiling data on water sources, volumes, locations, wastewater volumes, characteristics, and disposition
  - Evaluating more effective transportation and storage methods
  - Estimating economic impacts
  - Developing new technologies for any component of the water lifecycle
  - Many others

# How Are Research Topics Determined?

- Targeted research project with scope/subject determined by funder
  - RFP or sole source
- Researcher identifies gaps in knowledge and proposes project to fill the gap
- Open solicitations for research proposals (usually have some guidelines)
  - RPSEA, National Science Foundation, etc.
- Some in-house R&D specialists may be given free rein to determine what should be studied next
- Others

## Cynic's view:

- *Research priorities and funding awards can be influenced by persons or organizations with strong marketing capabilities and active presence in decision-making bodies*
- *Merit may not always be the deciding factor*





# Challenges Relating to Research

# 1. Determining the Target Audience for the Research Results

- Who funded the work and how widely do they want the results to be disseminated
  - Company in-house research
    - Internal proprietary information shared with a limited audience
  - Government funding
    - Open literature unless information is protected by security concerns
    - Distributed by internet
  - Industry or NGO work intended to inform decisionmakers
    - Press releases and social media
    - Distribute via internet with easy availability
  - Joint Industry Projects
    - Results shared only with project participants
    - May be shared to wider audience after several years



## 2. How Are the Results Reviewed and Disseminated?

- Academia – often peer-reviewed literature
  - May be unwilling to share details of information prior to publication because of fear of being scooped by other researchers
  - Published in places that may not be readily available at no cost to the public
  - Long lag-time to publication
  - Written in a more formal style in order to satisfy peer reviewers
    - Hard to follow unless you are a specialist in the field
  - Often do not contain large amounts of raw data due to space requirements

# Review and Dissemination of Results (2)

- “Grey” literature
  - Often these are government-funded reports or conference papers/presentations
  - May be subjected to some level of internal and external review but not the same as academic peer review
  - Larger volume of information that is readily available on government and research organization websites
  - Display a broader range of quality control in content and readability
- Policy/opinion pieces
  - Often written to influence public or decision maker opinions
  - Unlikely to undergo any external review
  - Tend to highlight data that supports the authors’ point of view without necessarily being balanced and thorough
  - Data can be presented out of context



## Review and Dissemination of Results (3)

- Think tank reports
  - Often done using good scientific methods and analyses
    - Generally well-educated authors
  - But may fail to understand the full picture of how the oil and gas industry works
  - May overlook valid and useful data because of their unfamiliarity with the relevant literature and knowledge base

### 3. How Do Regulatory Changes Influence Research Priorities?

- Issues that have low priority today could become important following a regulatory change
- Technologies and practices in common use today could be prohibited or restricted by a regulatory change
- These provide opportunities to conduct research on new technologies, practices, and environmental impacts
  - It is often difficult to anticipate these new issues and research problems
- Traditionally, researchers have shied away from following regulatory developments
  - There can be advantages to anticipating new issues worthy of research that come about following regulatory changes
  - Proactive researchers will be aware of what is going on and be prepared with proposals to address questions

## 4. How Can Industry Get Research Done?

- Directly fund researchers
  - Internal
  - External (sole source or RFP)
- Work through industry association
  - API/IPAA/ANGA etc.
- Participate in JIP or PERF project
- Become involved with helping to shape the scope of government solicitations

## 5. Research Priorities and Funding Opportunities Change over Time

- As new issues and technologies are introduced, funding priorities can shift dramatically
  - Example: DOE funding for oil and gas environmental projects was heavily weighted toward coal bed methane in late 1990s and early 2000s
  - As shale gas development advanced rapidly, DOE shifted its focus to funding shale research and ignored CBM
  - Likewise RPSEA included unconventional production as one of its three major research themes
- Currently there appears to be very heavy (and maybe disproportionate) interest in shale gas water and wastewater



## Disproportionate Emphasis on Shale Gas Wastewater

- Assumptions (tried to choose conservative estimates)
  - 20,000 shale gas wells are fractured in a year
  - Each frac job requires 5 million gallons
  - Only 50% of the frac fluid volume returns as flowback and produced water
- Total shale gas flowback and produced water for the U.S. = 50 billion gallons per year

## Disproportionate Emphasis on Shale Gas Wastewater (2)

- U.S. produced water volume in 2007 for all oil and gas = 21 billion bbl (Source: Clark and Veil, 2009)  
= 882 billion gal/year
- Compare shale gas water to all produced water
  - 50 billion/882 billion or about 5.7%.
- Putting this in perspective, ***shale gas receives more than 90% of the attention yet it consists of less than 6% of all the volume of produced water.***



# **Keeping Track of the Research Now Underway and When It Will Be Available**

## Research Process and Timeline

Step	Length of Time (months)
Search for funding opportunity	Always – ongoing
Develop project concept	1
Prepare proposal	1
Obtain funding	1-6
Assemble research team	1
Procure needed materials and supplies, permits, access permissions, etc.	1-3
Begin research	n/a
Assess and report intermediate progress	3-12
Revise research scope and procedures to accommodate issues that arise during initial stages	n/a
Complete research	1-12
Prepare report of results	1-3
Publish findings in literature	3-12



## Read, Listen, Talk to Colleagues, and Learn

- Read daily and weekly newsletters and magazines to see what new projects have been started or completed
- Read scientific journals or at least check tables of contents
- Plenty of commercial information on new technologies and products developed by service companies and water technology providers
- Attend conferences, workshops, and seminars
  - Often can get tips on new projects or work underway
- Call or email your contacts at other producers, service companies, and water technology providers to see if they have any news
- Call or email consultants, researchers, or other specialists to see what they have heard

# Government-Funded Research

- Government-funded research
  - Lists of awarded projects, scope, research organization, and schedule are generally available on the internet
  - As status reports, draft, and final reports are completed, they are posted
- Examples
  - DOE/NETL
    - <http://www.netl.doe.gov/technologies/oil-gas/Projects/index.html>
  - RPSEA
    - List of awarded projects  
<http://www.rpsea.org/en/cms/2959/>
    - March 2013 – new solicitation for proposals  
[http://www.rpsea.org/attachments/content\\_managers/43/RFP-DOC-RFP2012UN001-Final\\_03-05-13\\_P.pdf](http://www.rpsea.org/attachments/content_managers/43/RFP-DOC-RFP2012UN001-Final_03-05-13_P.pdf)

The screenshot shows a webpage titled "Oil and Natural Gas Projects" with a subtitle "Index of Research Project Summaries". Below the title is a search bar with the text "Search Natural Gas and Oil Projects". The page is divided into two columns: "Current Projects" and "Completed Projects". Under "Current Projects", there are several categories with sub-links: "Natural Gas Resources" (with sub-links for Shale Gas, Environmental, and Other Natural Gas Resources), "Enhanced Oil Recovery" (with sub-links for CO<sub>2</sub> EOR, Environmental, and Other EOR & Oil Resources), "Deepwater Technology" (with sub-links for Offshore Architecture, Safety & Environmental, and Other Deepwater Technology), and "Methane Hydrates" (with a sub-link for DOE/NETL Projects). Under "Completed Projects", there are links for "Completed Natural Gas Resources", "Completed Enhanced Oil Recovery", "Completed Deepwater Technology", "Completed E&P Technologies", "Completed Environmental Solutions", "Completed Methane Hydrates", "Completed Transmission & Distribution", "Completed Petroleum Refining", "Completed Natural Gas Processing", and "Completed Natural Gas Storage".

## Consortia

- Some research organizations feel their chances for winning NETL and RPSEA awards are enhanced by forming large consortia of organizations
  - Brings a wider range of knowledge and skills to the project
  - Keeps elected officials from multiple states happy by sending research funding back to their states
- One noteworthy example is the Environmentally Friendly Drilling (EFD) program
  - Initially led by Texas A&M
  - Now led by Houston Advanced Research Center

Participants: *Houston Advanced Research Center, Texas A&M University, Texas A&M University –Kingsville, Texas AgriLife Extension Service, Texas A&M University – Texas Center for Applied Technology, Sam Houston State University, Utah State University, West Virginia University, TomWilliams, Epic Software, Petris Technology, Oak Ridge National Laboratory, University of Arkansas, University of Colorado, Land Steward Consultants, Gas Technology Institute, Black Brush Oil and Gas, Scott Environmental Services, Newpark Mats and Services, Natures Composites, MI SWACO, University of Texas Bureau of Economic Geology, Ames Energy Advisors, Fountain Quail, 212 Resources, Dow Chemical Company, Water Resources Company, Consumer Energy Alliance, Goodrich Petroleum Company, The Nature Conservancy, Campbell Applied Physics, Rancho San Pedro, Petrohawk, Huisman/Innodrill*

# Industry Research

- In-house research is generally kept quiet until completed and patented/licensed
- External research may be shared upon completion or may be kept proprietary
- Try to keep contacts with industry organizations and individual companies to learn what projects are underway

April 2013  
announcement by GE  
that it will open a new  
research center in  
Oklahoma focusing on  
unconventional  
production

**AP** Associated Press

updated 4/3/2013 1:19:29 PM ET

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**OKLAHOMA CITY** — General Electric Co. says it will build a new global research center in Oklahoma, creating 125 new engineering jobs.

GE Chairman and CEO Jeff Immelt made the announcement Wednesday alongside Gov. Mary Fallin. The company has not yet picked a specific location for the center but says that selection should happen soon.

GE says it's evaluating locations with proximity to academic institutions like the University of Oklahoma and the skilled workforce in Oklahoma City.

The research center will initially focus on technologies involving the production of unconventional oil and gas resources, such as shale. Immelt says shale gas could be "one of the biggest productivity drivers of our lifetime."

The new research center will become part of GE's global research network that has facilities worldwide.



# NGO, Think Tank, and Other Research

- Often they announce that they are doing projects (as part of fundraising efforts) and provide results upon completion
- Visit websites of organizations to see what projects are underway

The screenshot displays the website for Resources for the Future. The header includes the organization's logo and name, along with navigation links for Research Topics, Centers, Publications, News, Events, Researchers, and About. A sidebar on the left lists various research topics such as Air Quality, Climate, and Energy. The main content area features a breadcrumb trail and a list of publications under the heading 'SHALE GAS Publications'. Two specific publications are highlighted, including one about shale gas development in Pennsylvania and another about property values and drinking water sources. A 'RESEARCHERS' sidebar lists several names. At the bottom, there is a 'Join E-mail List' section and a '40 YEARS OF' anniversary banner.

**RESOURCES FOR THE FUTURE**

RESEARCH TOPICS CENTERS PUBLICATIONS NEWS EVENTS RESEARCHERS ABOUT R

RESEARCH TOPICS

- Air Quality
- Climate
- Development and Environment
- Ecosystems
- Electricity
- Energy
- Food and Agriculture
- Forests
- International
- Land Use
- Policy and Analysis
- Risk Management
- Space
- Transportation
- Waste Management
- Water

Home > RESEARCH TOPICS >

**SHALE GAS**

**Publications**

**Shale gas development impacts on surface water quality in Pennsylvania**  
Sheila M. Olmstead, Lucija A. Muehlenbachs, Jhih-Shyang Shih, Ziyang Chu, and Alan J. Krupnick  
*Proceedings of the National Academy of Sciences* | March 2013 | Vol. 110, No. 13 | pp. 4962-4967

**Shale Gas Development and Property Values: Differences across Drinking Water Sources**  
Lucija Anna Muehlenbachs, Elisheba Beia Spiller, Chris Timmins  
RFF Discussion Paper 12-40-REV | March 2013

[Show Description](#)

**What the Experts Say about the Environmental Risks of Shale Gas Development**  
Alan J. Krupnick, Hal Gordon, Sheila M. Olmstead  
RFF Report | February 2013

[View All Related Publications](#)

**RESEARCHERS**

- Krupnick, Alan J.
- Mares, Jan
- Muehlenbachs, Lucija Anna
- Olmstead, Sheila M.
- Richardson, Nathan
- Wang, Zhongmin

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RESOURCES FOR THE FUTURE  
40 YEARS OF

# Oil and Gas Research Centers at Universities

- Many universities are opening or have recently opened research centers focusing on unconventional production issues
  - Penn State Univ - Marcellus Center for Outreach and Research
  - Univ of Texas – Shell-UT Program on Unconventional Resources (SUTUR); State of Texas Advanced Oil and Gas Resource Recovery (STARR)
  - Colorado School of Mines – Unconventional Natural Gas and Oil Institute; and Advanced Water Technology Center
  - Rice Univ – spun off Shale Gas Water Research Center
  - Others
- Be careful of backlash when research is perceived to be driven and/or influenced by industry
  - Univ of Texas – Energy Institute report on shale gas
  - Univ at Buffalo – shale gas study

## Final Thoughts

- Research takes many forms
- Research is done by many entities and is funded by a smaller group of entities
- Research follows the money – money follows hot topics
  - over last 3 years, many organizations that have little to do with hydraulic fracturing sought funding to initiate projects in this area
- It is difficult to keep informed of all relevant research
  - Keeping track of key research is time-consuming, but doable
- With the exception of quick turn-around projects, there will always be a lag time from when the funding is awarded until the results are published
  - Typically 6 months to several years

