National Research Council:

Current Research and Gaps in Knowledge on Shale Gas

Report on two Workshops convened by US NRC

Committee on Risk Management and Governance Issues in Shale Gas Development

EUCE conference on Environment & Energy:
A Comparison of US and EU Policies

Mitchell J. Small
Carnegie Mellon University

Principal Activities of Committee

- **Organized two workshops to examine the range of technical, social and decision-making issues in risk characterization and governance for shale gas development**

- **Disseminate summaries and papers presented at the workshops**

  but . . .

  → *no consensus judgments or recommendations*

  - **Workshop 1 on Risks of Unconventional Shale Gas Development (30 & 31 May, 2013)**
  - **Workshop 2 on Governance of Risks of Unconventional Shale Gas Development (15 & 16 Aug, 2013)**
  - **Workshop agenda, abstracts, ppt's, full video: http://sites.nationalacademies.org/DBASSE/BECS/CurrentProjects/DBASSE_069201**
  - **Upcoming special issue of *Environmental Science & Technology* (~12 papers)**

Narratives Illustrative of Polarized Views on Shale Gas Development

Pro . . .

Shale gas development is . . .

a relatively new, but well-tested technology that utilizes subsurface hydraulic fracturing to recover large quantities of domestic natural gas, posing modest risks to the environment, public health and communities similar to those of other natural gas and energy development technologies, but well-managed by the current mix of responsible drillers and operators utilizing ongoing improvements in industry standards for best practice, together with the appropriate mix of local and state regulations, thereby providing broad economic, national security, air quality, and greenhouse gas reduction benefits to the US and potentially other nations.

Con . . .

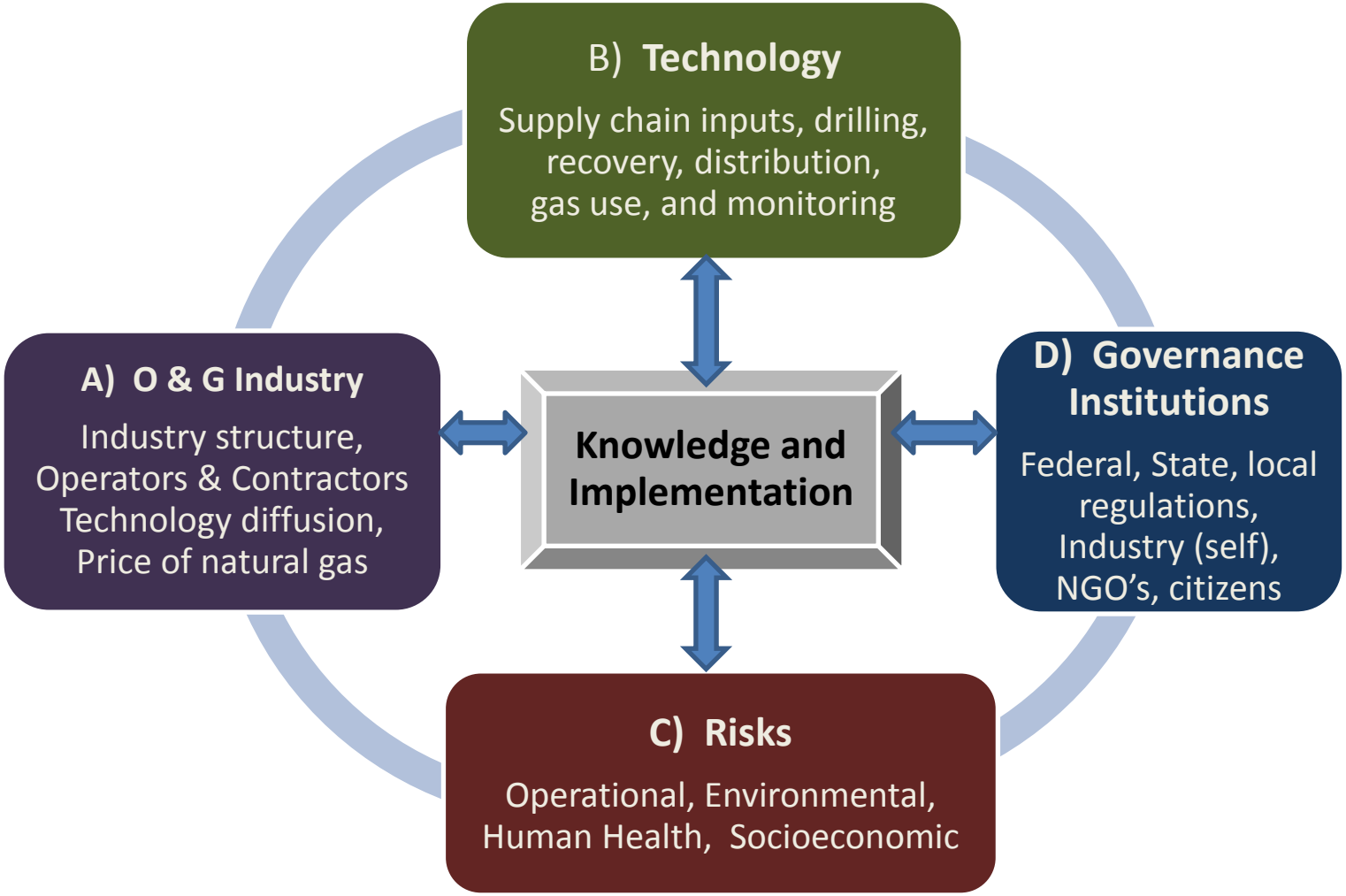
Shale gas development is . . .

an untested technology utilizing subsurface "fracking" and posing significant upstream, operational and downstream risks, currently implemented with inadequate safeguards and monitoring to protect against multiple contamination pathways, landscape and social disruption, with known and suspected harmful physical and economic impacts to the air, water, ecosystems, public health and communities; with inadequate state and local capacity for regulation and oversight; and potential serious impact on long-term greenhouse gas emissions due to methane leakage and displacement or delay of low-carbon energy options.

Which parts of these conflicting narratives, if any, are supported by current data and research?

Are there further disciplinary or multidisciplinary studies and monitoring that could refute or corroborate these conflicting assertions?

Characterize State of Knowledge for Technical-Social Shale Gas System



Principal Risk Domains and Issues

1. Operational: mishap occurrence and detection (accidents and leakage events), induced seismicity
2. Water Quantity and Quality: source drawdown, well leakage, return flow wastewater management
3. Air Quality: local criteria pollutants and air toxics, regional ozone and PM, global methane
4. Global Climate: life cycle emissions, fuel price/substitution effects
5. Ecological: habitat & connectivity impacts, air & water toxicity
6. Human Health: worker safety, pollutant exposure and effects, stress (traffic, light, noise)
7. Community/Social: economic impacts, boom-bust cycles, equity of benefit-cost distributions, community conflict and trust

Cumulative? Synergistic?

Synthesis of Hazards, Mitigation Options and Research Needs (Operational)

Risk Domain	Principal Hazards	Mitigation Options	Research Needs
1. Operational Leaks, accidents	- Low probability explosions and other accidents - Undetected leakage -Improper well closure at completion of gas recovery	- High standards for well design and construction - Operations monitoring and tracking - Maintained or improved corporate safety culture - Liability, taxes, fees, and bonds to ensure proper closure	-Advances in low-cost ubiquitous monitoring -Advances/standardization of SCADA systems for automated reporting of malfunctions -Behavioral studies of factors influencing individual and firm safety knowledge and behavior

Synthesis of Hazards, Mitigation Options and Research Needs (Groundwater)

Risk Domain	Principal Hazards	Mitigation Options	Research Needs
2. Subsurface (GW) Contamination	-Contamination of shallow aquifers by stray methane and other gases -Leaks and spills from surface operations to shallow soil and groundwater -**Deep formation contamination (little or no evidence to date)**	-**Perform baseline measurements** -Verify groundwater isolation from fluids in wellbore and the integrity of well casing -Use of more benign hydraulic fracturing fluids -Monitor and report all material flows at a site	-Intelligent completion, allowing dynamic adjustment of in-hole operations and monitoring -Addition of (non-radioactive) tracers to fluid and gas streams -Development of integrated monitoring systems for fracture evolution and real-time tracking of material flows

Synthesis of Hazards, Mitigation Options and Research Needs (Socioeconomic)

Risk Domain	Principal Hazards	Mitigation Options	Research Needs
7. Socio-economic	-Boom-bust economic cycles -Increased housing costs **-Impacts on preexisting local industries** -Requirement for new community infrastructure, police and social services -Uneven distribution of private benefits, costs, and externalities -Community conflict and mistrust	-Coordinated planning with community participation -Community sharing and investment of income (e.g., schools, libraries, renewable energy projects) -Transparency in operations, with all monitoring and operating data available on company or State website.	-Studies to evaluate the extent of sustainable capture of wealth by drilling communities **-Long-term studies of shifts in local economies and sectors** -Long-term studies of community impacts and responses, including support for active participation of communities in these studies

Risk Governance

- US Federal role limited by formal exemptions of O & G from environmental legislation
- (Rapidly) Evolving US decentralized system (State-focused)
- State agencies and programs variable in approach, capacity, and extent of local land-use and rulemaking autonomy
- Role of regional compacts and commissions
- Governance in other nations

New Initiatives in Governance

1. Voluntary standards and certification
2. Comprehensive development plans
3. Potential evolution of Federal role in
   - research
   - information standardization, collection, and dissemination
   - adoption of state or voluntary rules and practices for more consistent national regulation

Voluntary standards and certification

Industry self-governance and collaborative identification of best practices

- Appalachian Shale Recommended Practices Group (ASRPG) and Marcellus Shale Coalition (MSC)
- Center for Sustainable Shale Development (CSSD)
  - Industry and NGO's
  - Initial set of performance standards
  - Air, Climate, Surface and Ground Water Performance Standards
  - Compliance mandatory to receive and maintain certification
  - Independent third party compliance evaluation

Comprehensive development plans

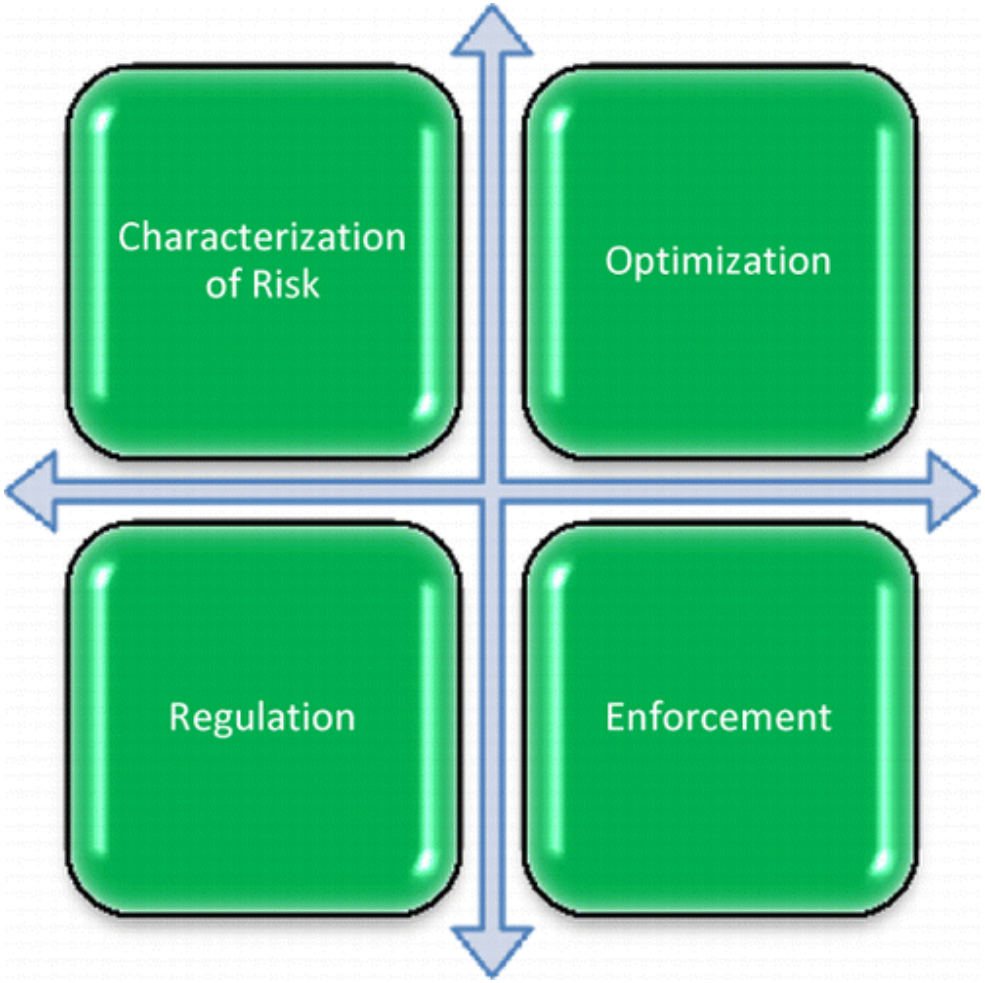
- Colorado Oil and Gas Conservation Commission (COGCC) voluntary program
  - operators may propose a Comprehensive Drilling Plan (CDP) for multiple drilling locations.
  - potential impacts and planned mitigation
- Draft Maryland Comprehensive Gas Development Plan (CGDP)
  - 5-year plan for the locations of all planned well pads, roads, pipelines and supporting facilities.
  - Reviewed by state (MDNR and MDE) and local agencies to ensure compliance with all location requirements
  - Required public participation program

Future Scenarios for Federal, State and Industrial Participation in Consistent National Regulations

- **Evolution towards a system with greater federal involvement and support for data collection and sharing, formalization of best practices, and the establishment of national regulatory instruments with significant delegation of authority to states for implementation and enforcement.**
- Special Issue (ES&T Policy Analysis)

  Shale Gas Development: A Smart Regulation Framework

  Konschnik and Boling



Data Collection and Research: Whither the US Federal Role?

- EPA implementation of a shale gas Information Collection Rule?
- Development of decision support systems to identify optimal mitigation and regulatory compliance ?
- Who will support the necessary research for integrated assessment within and across the Technical-Social System components ?
  - A NSGAP (a leaner-meaner NAPAP)?