Understanding Shale Gas Development
From drilling to end user.....
Key Questions

• What is the development process and why is it important?
• Where are various materials, equipment & labor sourced, how are they handled on site, what happens to them after use?
• What are the implications of development – landowner, local business, workforce, community, environment?
• Are other technologies available and what are the trade-offs?
Discussions Continue to Evolve

- Information sources varied, differing levels of accuracy and quality.
- Scientific process, scientific uncertainty.
- Role of media and social media?
- Dynamic, fast-paced change (technology, regulations and policies, markets, etc.).
- Polarization (is it growing?).
Segments of the Oil and Gas Industry

- **Exploration and Production (Upstream)**
- **Gathering, Compression, Treating, Processing, Transportation (Midstream)**
- **Petrochemical and Refining (Downstream)**

**Oil, Gas, Water**
- **Gas**
- **Water Injection Well**
- **Oil**

**Oil and/or Gas Reservoir** 5,000-16,000 ft deep

**Well**

**Interstate Oil Pipelines**

**Gathering Pipelines**

**Compression**

**Gathering, Compression, Treating, Processing, Transportation (Midstream)**

**Oil Refineries**

**Natural Gas (Methane)**
- **Propane**
- **Ethane**
- **Butanes**
- **Propane, Butanes, Gasoline's**

**Petrochemical Plants**

**Home Heating/Cooking**
- **Electric Power**
- **Industrial Boilers/Furnaces**
- **LNG (Liquefied and shipped)**
- **CNG (Fleet Fuel, Buses, etc)**
- **Home Heating, Cooking**
- **Transportation, Industrial fuel**
- **Glad Baggies**
- **Plastics**
- **Styrofoam**
- **Alcohols**
- **Other Chemicals**
- **Unleaded Gasoline**
- **Diesel**
- **Jet Fuel**
- **Asphalt**
- **Other**
General Operations

- Leasing
- Legal
- Seismic
- Pad Development
- Others…

Activities / Workforce

- Hospitality services
  - Hotels
  - B&B’s
  - Restaurants
  - Convenience stores

Activities / Workforce

- Leasing
- Permitting
- Legal
  - Lawyers
  - Abstractors
  - Para-legal
- Civil engineering
- Heavy construction
- Logging & land clearing
- Surveying
- Mechanics
- Fencing
- Equipment Rental
Upstream -> Siting Process

- Compressor Station
- Access (Lease) Road
- Fresh Water Impoundment
- Well pad
- Pipeline access
Upstream -> Seismic
## General Operations
- Drilling
- Casing
- Cement
- Solids management
- Others…

## Activities / Workforce
- Engineering
- Employment pre-screening
  - Workforce readiness
- Hot shot
- Hoses
- Fluids
- Wildlife Inventory

## Activities / Workforce
- Heavy hauling
- Auto Sales and Service
- Water handling/ management
- Environmental support
- Machine/fabrication shops
- General welding
- Mechanics & Diesel technician
- Compressor technician
- Pipe threading
- Pressure testing
- Food service
- Laundry
Upstream -> Drilling

Large Rotary Rigs

• Power Systems
  – Mechanical
  – Electrical
  – LNG / CNG

• Walking

• “Double” or “Triple”

VIP Rig Tour

Photo Courtesy Penn State Marcellus Center
Upstream -> Drilling Pad
Upstream -> Well Construction

- Steel Casing
- Cement
- Centralizers
General Operations

- Well stimulation
- Water management
- Proppant & chemical management
- Others….

Activities / Workforce

- Proppants / Chemicals
- Commercial Trucking
  - Transloading/ storage/ hauling
- Water management
  - Flowback iron
- Meters
- ROW Work
- Site Restoration
- Pipes & valves

Activities / Workforce

- Gas field roustabouts
  - Employment pre-screening
  - Safety equipment
  - Food service
  - Local real estate
- Rail, river, and road
- Service yards/buildings
- Hot shot hauling
- Environmental support
  - Permitting
- Diesel technician/mechanic
- Equipment rental
## Chemical Disclosure

[Fracfocus.org](http://Fracfocus.org)

### Hydraulic Fracturing Fluid Composition:

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<th>Trade Name</th>
<th>Supplier</th>
<th>Purpose</th>
<th>Ingredients</th>
<th>Chemical Abstract Service Number (CAS #)</th>
<th>Maximum Ingredient Concentration in Additive (% by mass)**</th>
<th>Maximum Ingredient Concentration in HF Fluid (% by mass)**</th>
<th>Comments</th>
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<td>Anadarko</td>
<td>Carrier / Base Fluid</td>
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<td>7732-18-5</td>
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<td>Sand</td>
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<td>Proppant</td>
<td>Crystalline Silica (quartz)</td>
<td>14806-60-7</td>
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<td>11.61420%</td>
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<td>GBW-30</td>
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<td>Gelling Agent</td>
<td>Carbohydrates</td>
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<td>Hemicellulose Enzyme</td>
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<td>SP</td>
<td>Halliburton Energy Services</td>
<td>Gel Breaker</td>
<td>Sodium Persulfate</td>
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<td>Acid, Hydrochloric (7.5%)</td>
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<td>Solvent</td>
<td>Hydrochloric Acid</td>
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<td>Paraffinic solvent</td>
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Upstream -> Water Management
Upstream-> Water Management
Upstream -> Water Management
Midstream

General Operations

• Measurement
• Gathering
• Compression
• Construction
• Processing
• Treating
• Land reclamation
• Transportation
• Others…

Activities / Workforce

• Construction/Fabrication
  • Compressor stations
  • Processing facilities
  • Custody transfer stations
• Well head
• Meter runs
• Storage tanks
• Site reclamation
• Machine shops
• Earth moving
• Commercial trucking
• Service yards/buildings
Midstream

- Meter Runs
- Separators
- Production Tanks
- Pig Launchers
- Pig Receivers
- Pipe Risers
Midstream

Gathering/Midstream
Midstream

Gathering/Midstream
Midstream

Gathering/Midstream
Midstream
Midstream
Midstream Supply Chain

Compressor Station
Midstream Supply Chain
Midstream Supply Chain
Emerging Technologies - Utilization

Vehicle Conversion
- Compressed Natural Gas (CNG)
- Liquefied Natural Gas (LNG)

Gas to Liquids (GTL)
- New engine technologies
- New Fuel Formulations
- Increased R & D

Residential Gas Service

Manufacturing
- Paper
- Steel
- Glass

Petro-chemical
- Ethane
- Fertilizer
- Fuel conversion

Power generation

Others…
Thank You

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Photo Courtesy Penn State Marcellus Center