



**UNIVERSITY OF  
CALGARY**

# Current Practices and Future Projections

**Workshop to Develop Recommendations for Environmental  
Monitoring Related to Unconventional Oil and Gas Extraction**

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[www.capp.ca](http://www.capp.ca)

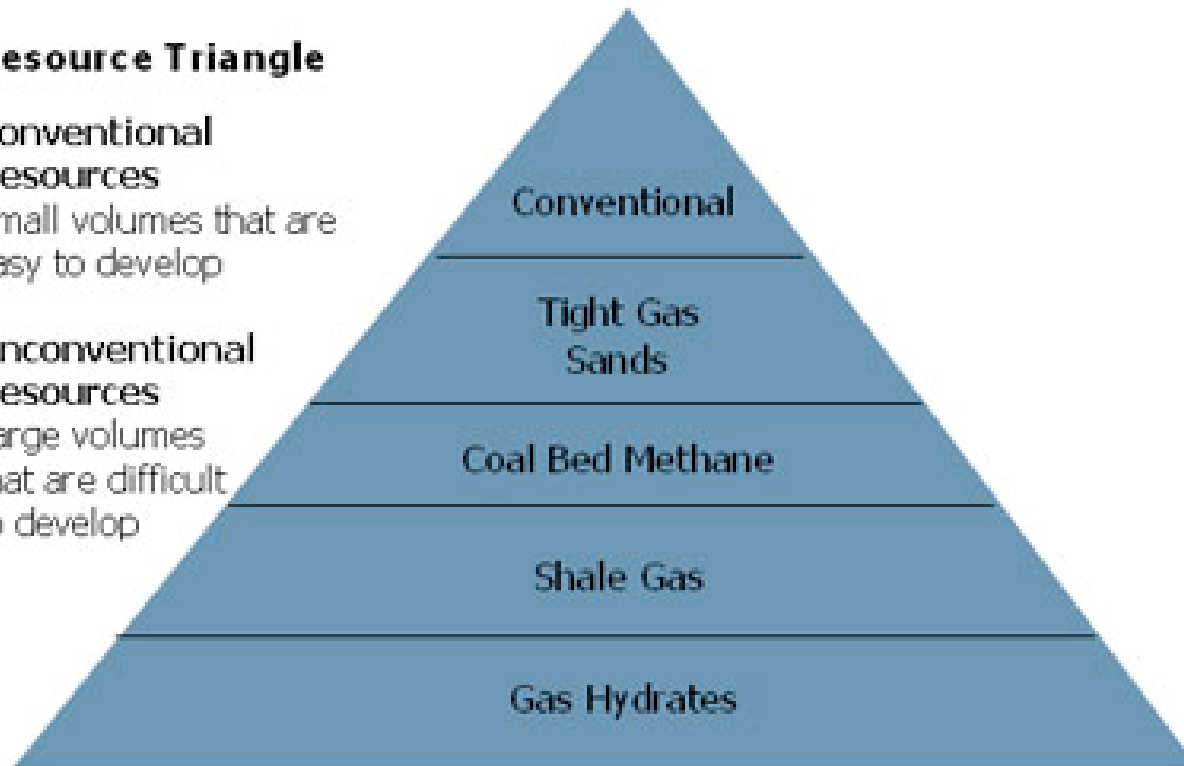
## Resource Triangle

### Conventional Resources

Small volumes that are easy to develop

### Unconventional Resources

Large volumes that are difficult to develop



- Similar for unconventional oils
- Spectrum of wells, liquids/gas production varies by region
- Gas wells aren't always gas wells and oil wells aren't always oil wells
- E.g. Arizona: <50,000 cubic feet of gas per barrel of oil means an oil well



# Methane Leakage Rates from the Natural Gas System

EPA

Inventory:

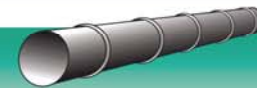
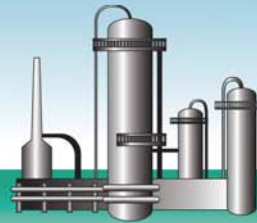
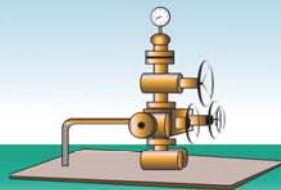
0.2 % leakage

0.4 %

0.2 %

0.7 %

Not included



● Drilling and fracturing

● Production

● Processing

● Transportation and distribution

● End use

● Total NG leakage - EPA: 1.5 %

## Evidence from other Studies

- Nationwide, NGML/EPA, 2006 ↔
- Nationwide, GTI, 2009 ↔
- Los Angeles, CARB/UC Irvine/NOAA, 2010 ↑
- Texas & New Mexico, URS/U. Texas, 2011 ↔
- Colorado, NOAA, 2012 ↑

- Los Angeles, Caltech, 2012 ↑
- Nationwide, Harvard, 2013 ↑
- Los Angeles, CU Boulder, 2013 ↑
- Utah, NOAA, 2013 ↑
- Nationwide, U. Texas, 2013 ↔

**LEGEND**  
*Study title indicates location, organization(s) that conducted study, and year of study*

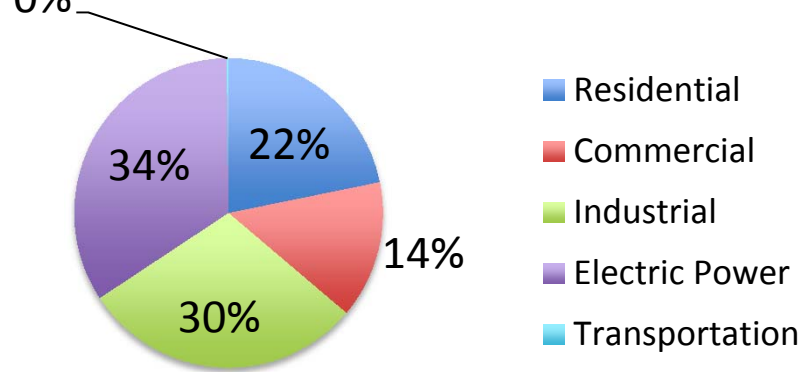
- ↑ Emissions higher than EPA
- ↓ Emissions lower than EPA
- ↔ Mixed results relative to EPA

<b>Air quality</b>	<b>Water quality</b>
<p><b><u>Challenges</u></b></p> <ul style="list-style-type: none"> <li>Fugitive emissions of methane</li> <li>NOx, VOCs (ozone precursors), H<sub>2</sub>S</li> </ul>	<p><b><u>Challenges</u></b></p> <ul style="list-style-type: none"> <li>Spills</li> <li>Adequate treatment versus disposal</li> <li>Fluid characterization</li> <li>Well-bore integrity</li> <li>Seismicity</li> <li>Leaks from impoundments</li> </ul>
<p><b><u>Current practices</u></b></p> <ul style="list-style-type: none"> <li>Metered wells</li> <li>Air tower measurements</li> <li>Flights</li> <li>Picarro/Mobile vans</li> <li>LIDAR</li> <li>Village green, EPA</li> </ul>	<p><b><u>Current practices</u></b></p> <ul style="list-style-type: none"> <li>Spill prevention, clean up</li> <li>Produced water management</li> <li>Water quality monitoring</li> <li>Zones of presumption – PA, distance to well and contamination</li> </ul>

- Air monitoring:
  - What measurement methods should be used?
  - What types of analytic methods to be employed?
  - What mitigation technologies are available/needed?
  - How can we ensure baseline monitoring and reporting is adequate?
  - What regulations are required to meet these goals?
  - How to attribute correctly?
  
- Water Monitoring:
  - What contamination pathways should be considered?
  - What type of mitigation is required for each pathway?
  - How can we ensure baseline monitoring and reporting is adequate?
  - What regulations are required to meet these goals?
  - How to attribute correctly?

# Growth of shale gas production in the US

US natural gas consumption 2012



US natural gas consumption 2035

