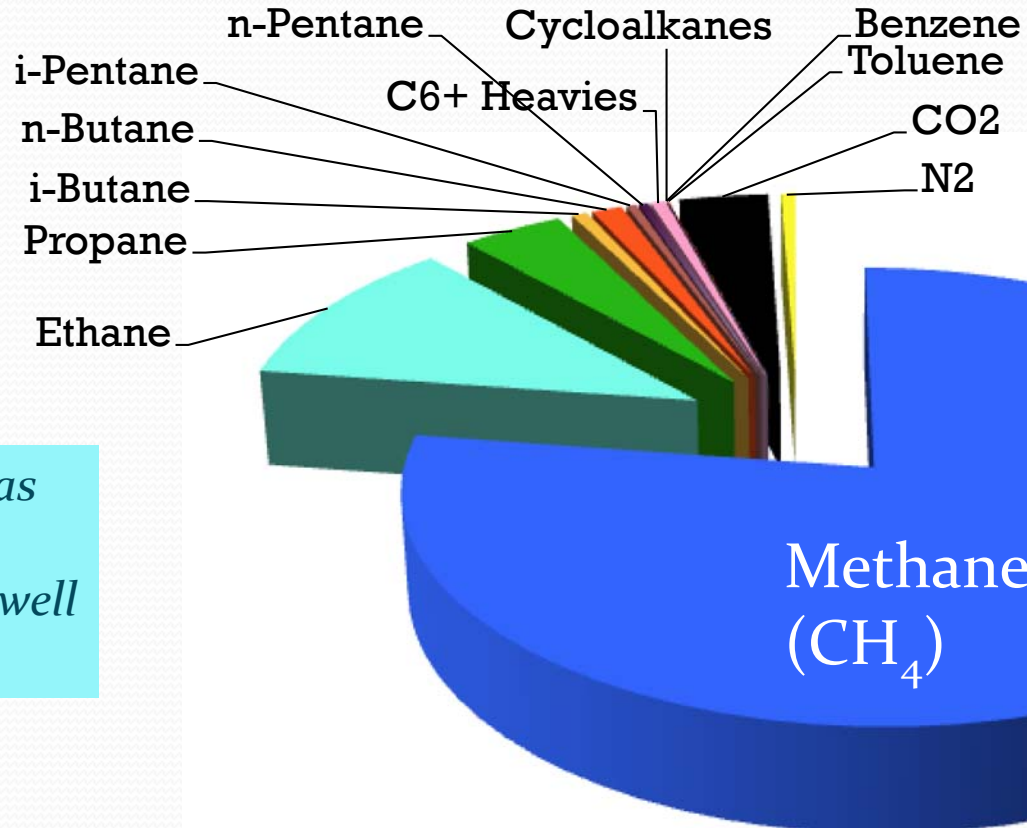


Approaches for Air Quality Monitoring Related to Unconventional Oil and Gas Extraction

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What's in natural gas?



Composition of gas varies from one basin/formation/well to another.

Produced “raw gas” is composed of 70-90% methane

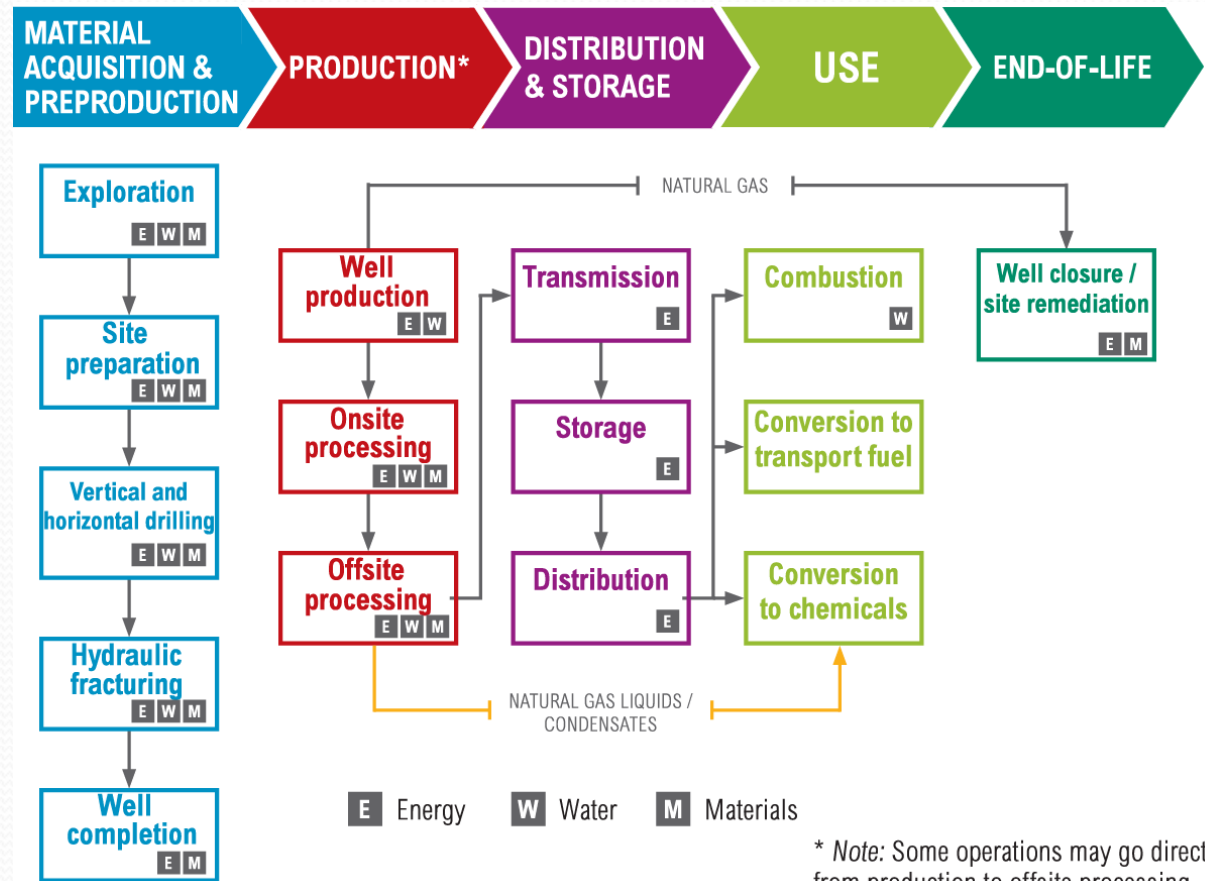


Distribution gas is >90% methane

Courtesy of G. Petron, NOAA, CIRES

Life Cycle of Shale Gas

- Hydraulic fracturing - only a small part of the overall life cycle
- Single well can produce for a few decades
- Emissions from equipment (diesel/compressor engines, PM from traffic, dust, silica)



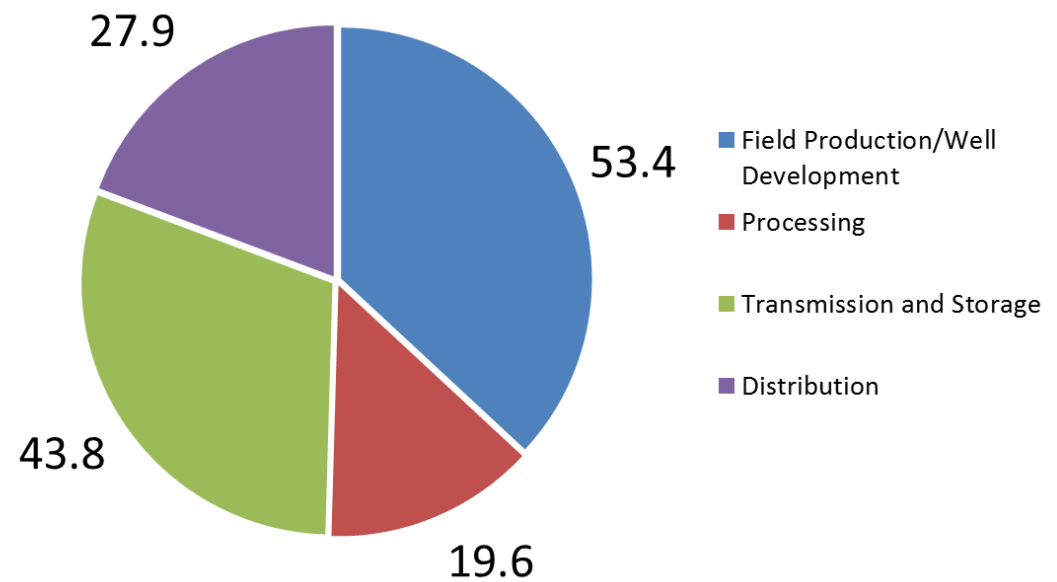
* Note: Some operations may go directly from production to offsite processing.

Branosky et al. Defining the Shale Gas Life Cycle: A Framework for Identifying and Mitigating Environmental Impacts; World Resources Institute: Washington, DC, 2012.

Methane

- Highest methane emissions during field production/well development
- CH₄ lifetime ~10 years
- 100-year GWP: 28-34 times of CO₂
(IPCC, 5th Assessment, 2013)

2011 Methane Emissions Inventory from Natural Gas Systems (Tg CO₂ eq.)



From USEPA (2013)

Moore et al., Air Impacts of Increased Natural Gas Acquisition, Processing, and Use: A Critical Review, ES&T, 2014, doi.org/10.1021/es4053472 |

Air Monitoring Methods – Continuous and Time-Integrated

- Continuous – provide data with a high time resolution
 - Often used for in-situ measurements
 - Usually collected by instrumented vans or aircrafts upwind and downwind of point or area sources
- Time-integrated - provide data with hours to days time resolution
 - Collected in fixed locations
 - Typically analyzed off-site in a laboratory
 - Example – passive samplers, no power required, easy to use



Radiello passive samplers – size of a roll of pennies

Example of Fixed Location Measurements

- Fixed location measurements provide over time information regarding community exposures and impact of various sources



Measurements of ambient concentrations of selected air toxics within a community in the Barnett Shale Area using passive samplers (saturation monitoring).

Zielinska et al., 2011

Conclusions and Recommendations

- Air quality measurements need to be made prior to oil and gas development such as drilling and hydraulic fracturing to more clearly understand the direct impacts of these activities.
- A chemical characterization of emissions including air toxics during all life cycle stages need to be obtained to properly perform source apportionment modeling and to understand air quality and health impacts.
- Scientific data on the nationwide extent of methane leaks from the production, processing, transmission, storage, and distribution infrastructure, should be acquired.
- Emissions from retired and abandoned wells should be obtained.
- Measurements on the variation of air emissions composition and magnitude by natural gas and oil plays need to be made.
- The collaboration between scientists and the industry needs to be increased in order to gain access to areas where measurements should be made and to inform effective emissions reduction and monitoring strategies.