

Development of Domestic Oil and Natural Gas Resources – Where Water and Energy Mix

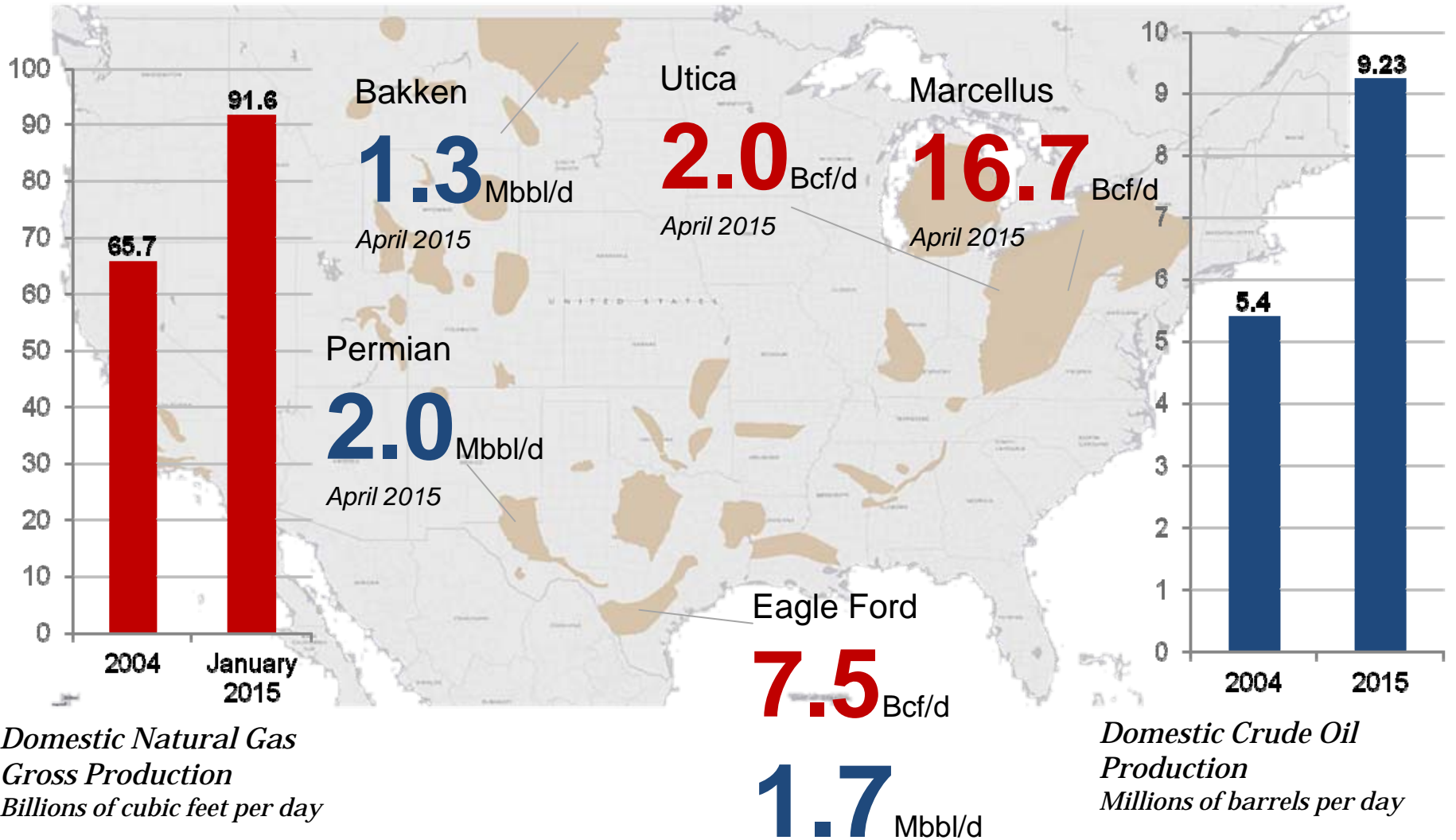
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ERA OF ENERGY ABUNDANCE

Shale Plays Driving Natural Gas & Crude Oil Production Growth



*Domestic Natural Gas
Gross Production
Billions of cubic feet per day*

*Domestic Crude Oil
Production
Millions of barrels per day*

UNCONVENTIONAL OIL & GAS: U.S. FEDERAL MULTIAGENCY COLLABORATION ON RESEARCH



Topic 1) Unconventional Oil and Gas Resources

Inform resource assessments

Topic 5) Human Health

Safeguard human health

Topic 3) Water Availability

Prevent water shortages

Topic 4) Air Quality and Greenhouse Gas Emissions

Protect the air we breathe

Topic 6) Ecological Effects

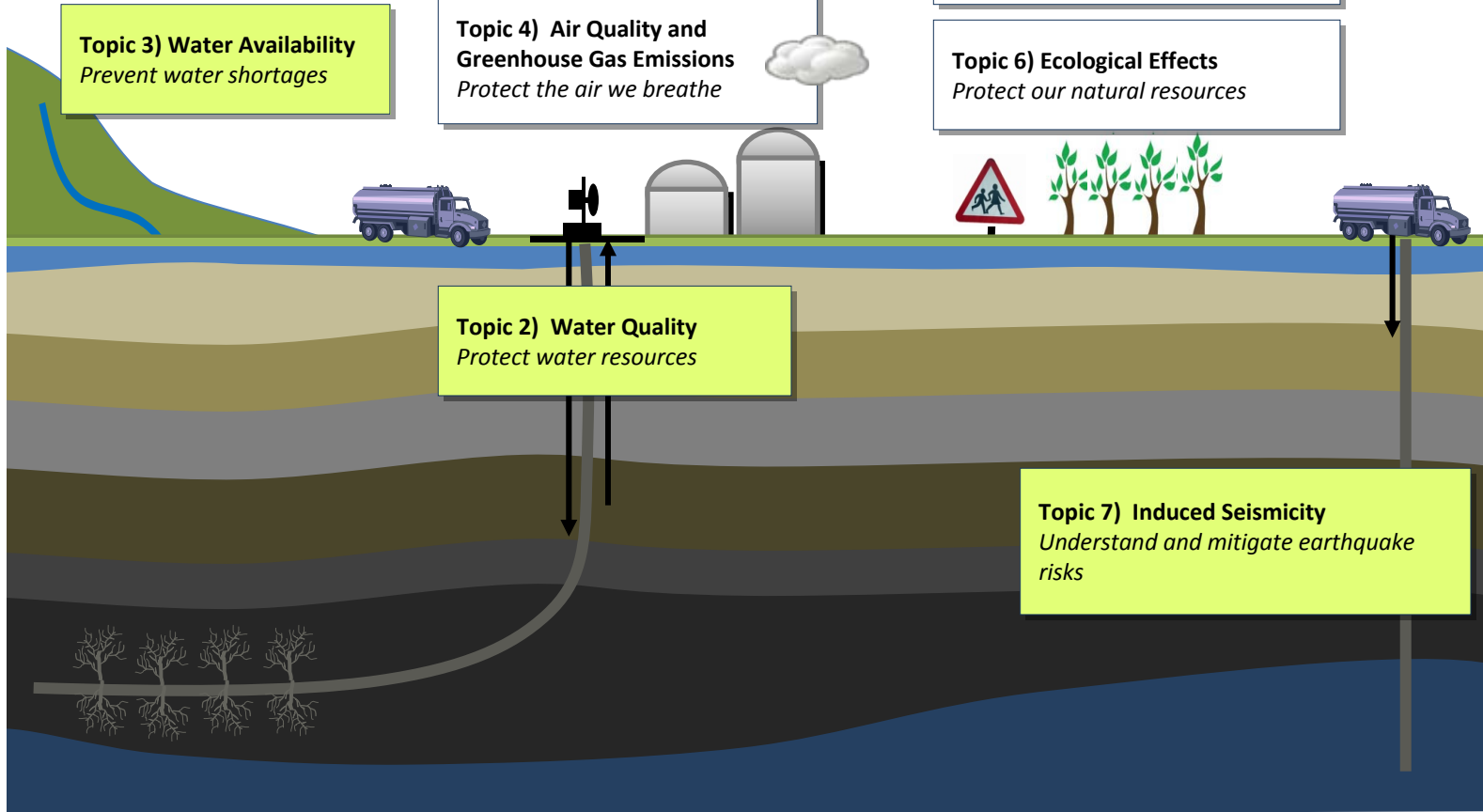
Protect our natural resources

Topic 2) Water Quality

Protect water resources

Topic 7) Induced Seismicity

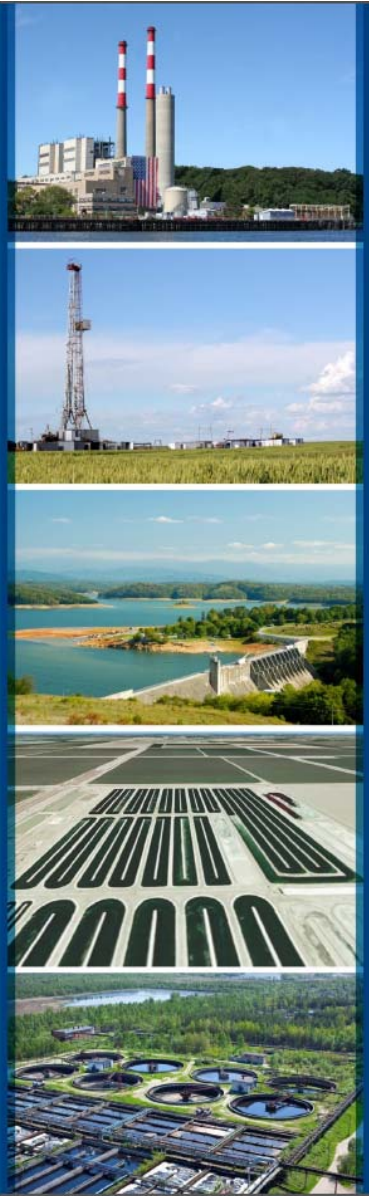
Understand and mitigate earthquake risks



The Water-Energy Nexus:

Challenges and Opportunities

June 2014



Technology RDD&D opportunities and actions:

- Water efficiency
- Substitutes for water
- Advances in water treatment
- Net-zero wastewater treatment

UOG: WATER QUALITY AND AVAILABILITY



Practices and technologies to avoid adverse impacts

? *Focus Questions*

What research is necessary to assess the impacts on water quality and availability?
.....

How can any impacts be mitigated?



Lined impoundments provide temporary storage for water needed for hydraulic fracturing. (NETL's [E&P Focus Newsletter](#))

Benefits: Lower water usage, smaller footprint

UOG: INDUCED SEISMICITY

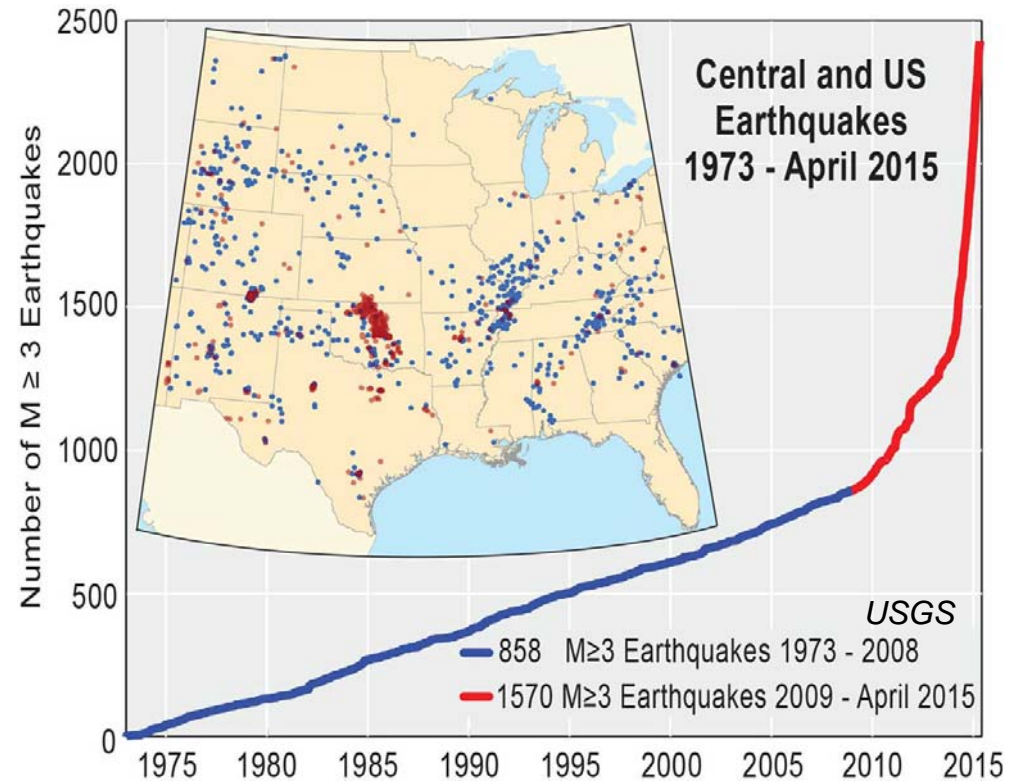


Analyze the relationship between UOG operations and induced seismic events.

? Focus Questions

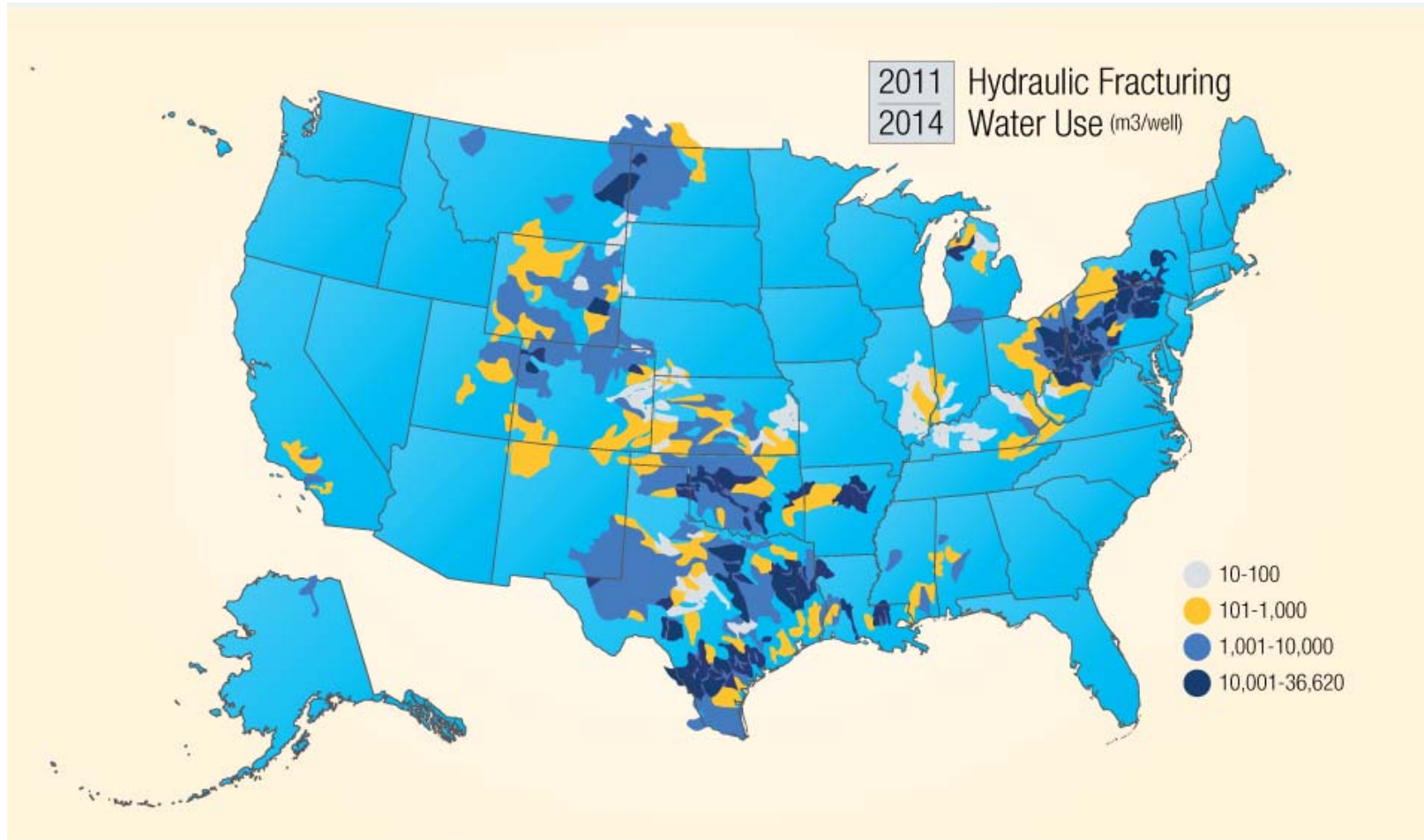
- What causes induced earthquakes?
- How can we prevent them?
- What data do we need?

Benefits: Dramatically reduce earthquakes related to UOG production



WATER USE IN HYDRAULIC FRACTURING

2011-2014 Hydraulic Fracturing Water Use Per Watershed



Source : U.S. Geological Survey

“Today, America is closer to energy independence than we’ve been in decades. One of the reasons why is natural gas – if extracted safely, it’s the bridge fuel that can power our economy with less of the carbon pollution that causes climate change.”

President Obama, 2014