



# Environmental Impact of Unconventional Gas Resources Development

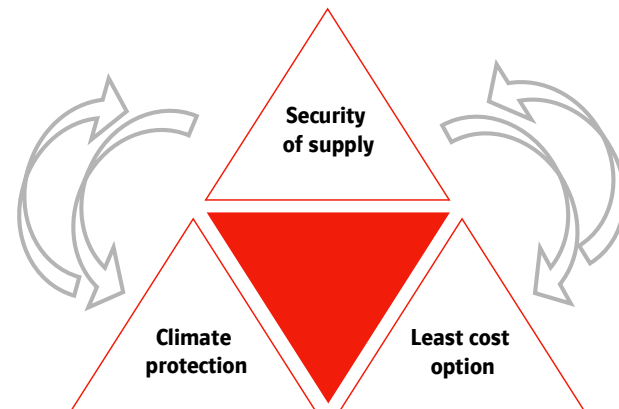
Dr. Thomas Jung, VP Gas Supply Analysis & Support  
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Geneva, 24.11.2010

## Why all the excitement?

### Natural gas: ideal partner for an intelligent energy architecture in the 21st century

- Clean, affordable, locally abundant energy
- Energy security and independence
- Lower carbon footprint
- enables Renewables
- Hundreds of billions in annual economic impact and tax revenues
- Investment attraction and retention
- Key part of a sustainable energy future

### Secure long-term gas supplies



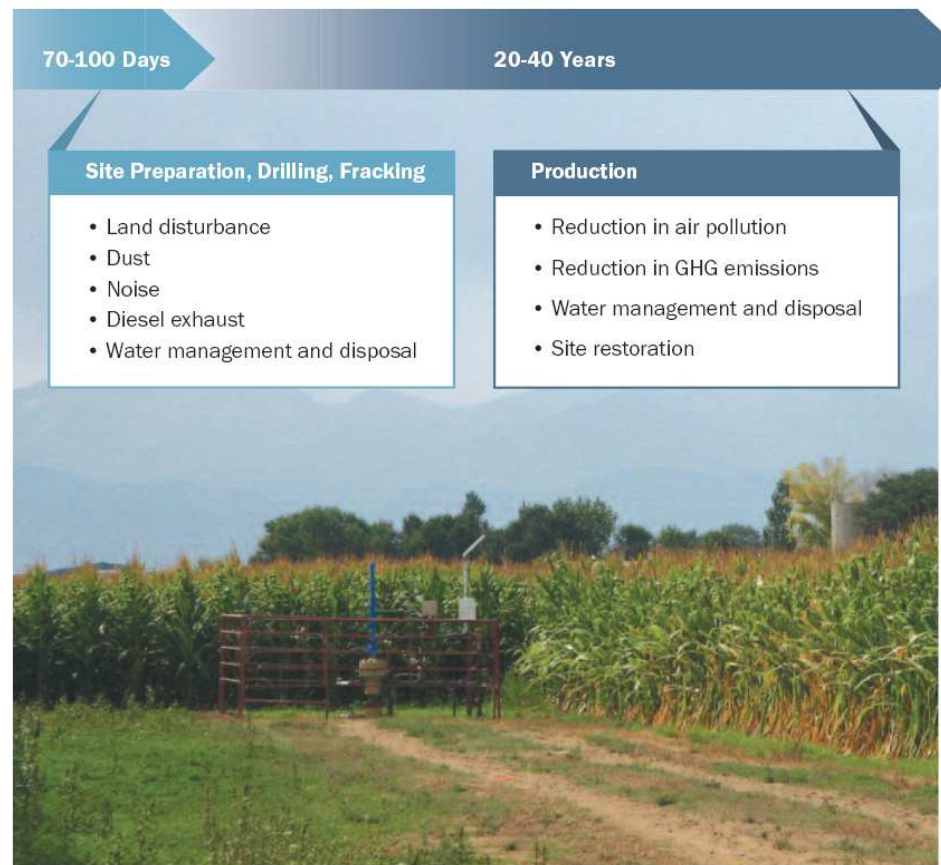
- Natural gas balances the triangle of energy policy

## Environmental footprint

### Societal response to...

- Water use and management
- Land requirements
- Air emissions
- Viewshed
- Noise pollution
- Truck traffic
- Safety

## Timeline and Impacts for shale gas Development and Production – single well



Source: IHS/CERA. Photo by Richard Ranger.

## Unconventional gas production in the USA



- Vast unconventional Resource Areas
- Unconventional Gas Production in the US so far mostly in **not** densely populated areas.
- People are used to drilling activities

## Surface impact of unconventional gas operation (1/2)



- Large amount of equipment material will have to be truck lifted.
- Building of access roads, pipelines and compressor stations.
- Fracking procedure noisy
- Wellsites can reach enormous size.
- Size dependant on type of well, e.g. depth, single or multilateral well.
- **But** remaining drill site of moderate size after removal of drilling equipment etc.

Source: SGEIS Report, September 2009

**High "NIMBY" potential given in more densely populated areas**

## Surface impact of unconventional gas operations (2/2)



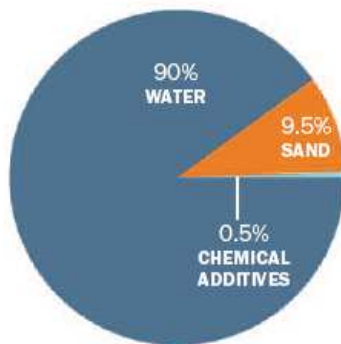
- Drilling and fracking operation depending on depth and complexity of the well design, can take more than a half year
- Pictured wellsite with fresh water and used water pond reaches size of two football fields.
- Significant volumes of water and fracking fluid are reproduced out of the wellbores and need to be treated and disposed of environmentally friendly.

**Water management is critical issue, i.e. reproduced fracking fluids plus formation water**

# Subsurface impact of unconventional gas production (1/2)

## Variety of chemicals needed to run the drilling

Typical Shale Fracturing Mixture Makeup



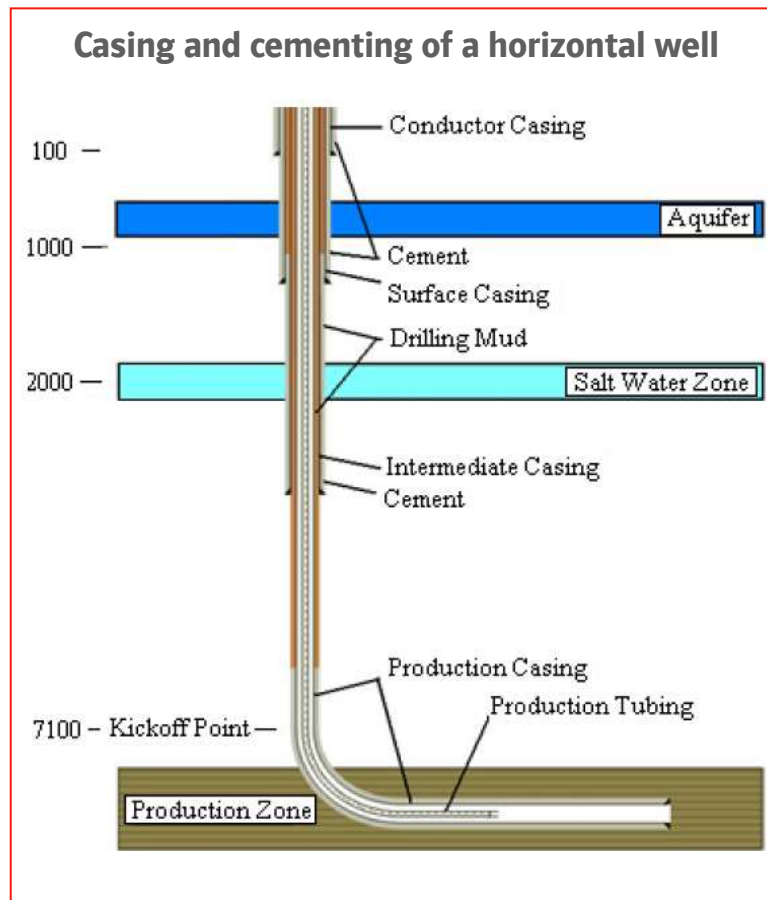
Typical Chemical Additives Used in Frac Water

Compound	Purpose	Common application
<b>Acids</b>	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
<b>Sodium Chloride</b>	Allows a delayed breakdown of the gel polymer chains	Table salt
<b>Polyacrylamide</b>	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
<b>Ethylene Glycol</b>	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
<b>Borate Salts</b>	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
<b>Sodium/Potassium Carbonate</b>	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
<b>Glutaraldehyde</b>	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
<b>Guar Gum</b>	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
<b>Citric Acid</b>	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
<b>Isopropanol</b>	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

Source: DOE, GWPC: Modern Gas Shale Development in the United States: A Primer (2009).

**Each well requires up to 10,000 m<sup>3</sup> of water**

## Subsurface impact of unconventional gas production (2/2)



- Fracture treatment of wells can lead to connection of deeper for example salty water layers with groundwater, when fracking procedure is not designed properly.
- Fracking fluids contain a number of chemicals.
- Significant volumes of water and fracking fluid are reproduced out of the wellbores and need to be treated and disposed of environmentally friendly.

## Will the potential environmental impact limit unconventional gas production activities in Germany?

### Very high recent interest in licenses for unconventional gas

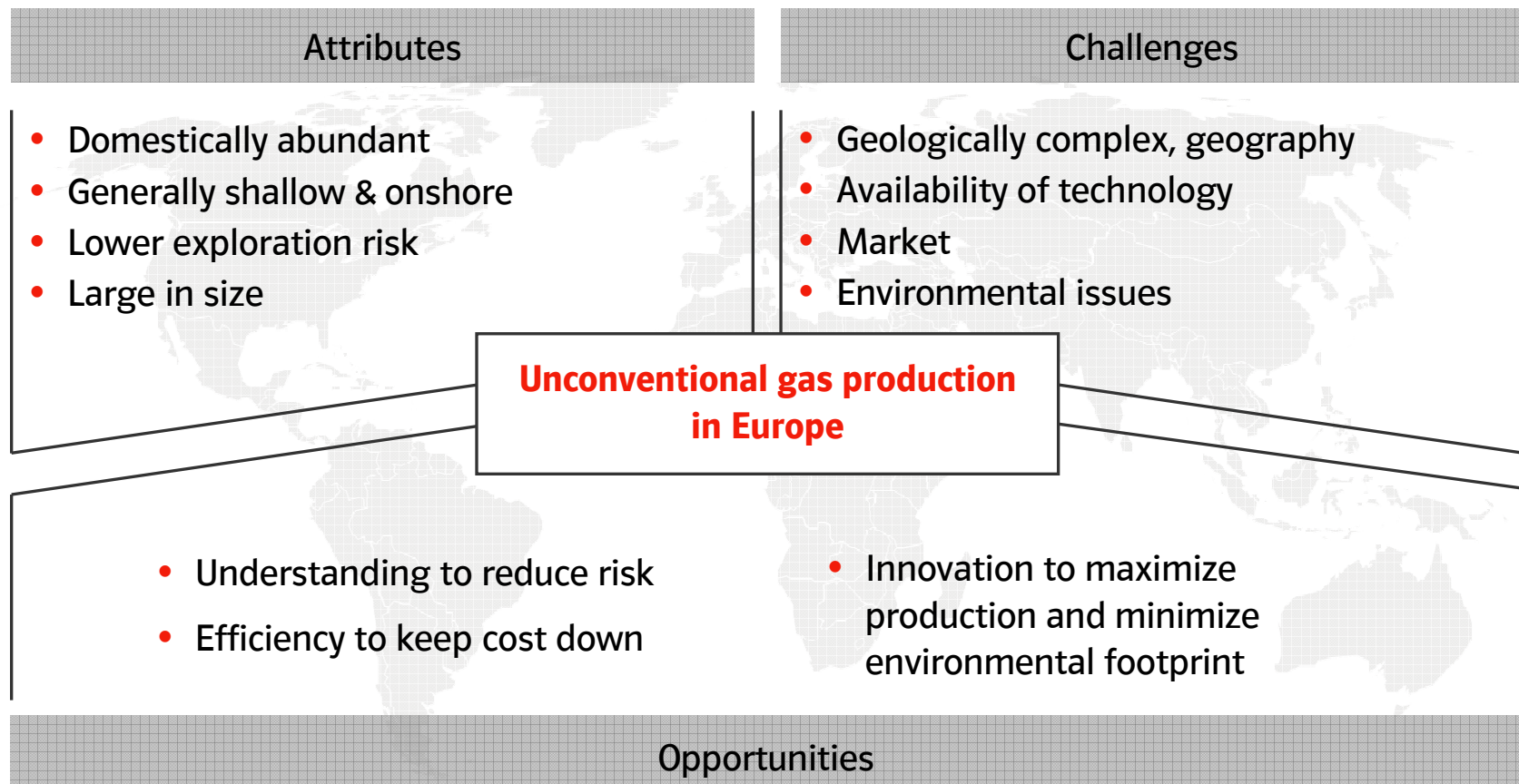


### The mining authorities take an open approach

- Already existing mining activities which have similar surface impact (reference case)
- Projects, to be performed according to German planning and environmental standards
- various legislation (e.g. mining law, riparian rights) taken into account
- Overall question whether environmental standards in Germany, are too costly to make unconventional gas economic.

**Conclusion: No clear answer today!!**

## The success story of unconventional gas production can only be realised considering environmental issues seriously





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