



Prospects for unconventional gas  
in Europe

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## Prospects for unconventional gas in Europe

**What is unconventional gas?**

**Unconventional gas in North America**

**Unconventional gas resources**

**Technical and economical aspects**

**Conclusion**

## Differences between conventional and unconventional gas

**Conventional**

**Unconventional**

Source: DTE Energy

**Conventional gas**

- Accumulations in medium to highly porous reservoir with sufficient permeability to allow gas to flow to producing well
- Pressure regime tends to move gas towards producing well (i.e. natural flow)

**Unconventional gas**

- Deposits of natural gas found in relatively impermeable rock formations – tight sands, shale and coal beds
- To get resources out of the ground, artificial pathways (fractures) have to be created
- Key technologies are horizontal drilling and modern fracturing techniques

**Consequences**

- Need to understand geology better
- Need for much higher number of extraction points

**Unconventional gas requires extensive use of horizontal drilling and hydraulic fracturing**

## Types of unconventional gas

### Tight gas



- Located in conventional pore spaces in sandstone
- Low vertical permeability because of laminated structures
- No significant gas flow without fractures, natural or induced

### Shale gas



- Located in shales in source rock
- Very low permeability, almost no drainage radius, very heterogeneous
- Must be fractured

### Coalbed methane

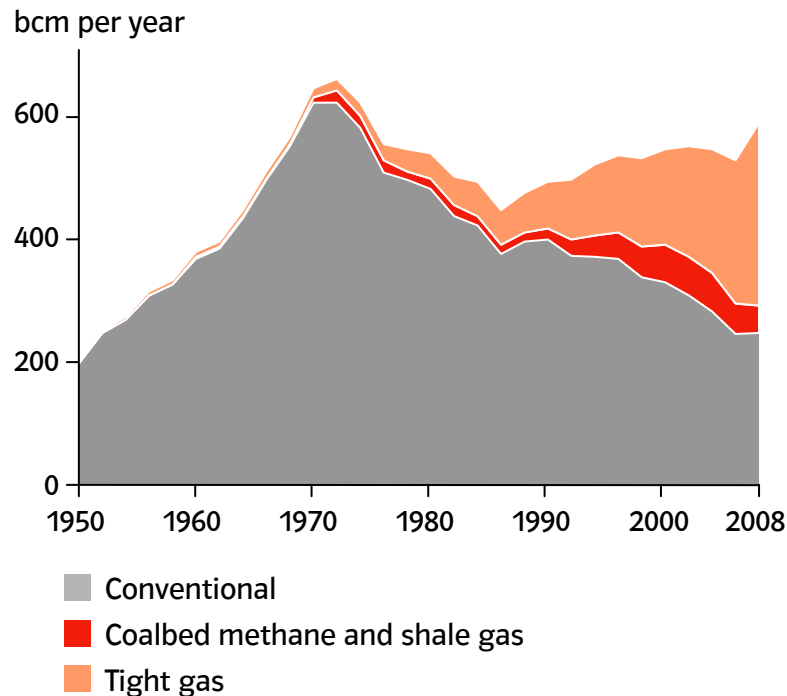


- Located in coal seams, often near surface
- Natural Fractures often filled with water and gas
- Key challenge is removal of water

**Each type of unconventional gas requires specific approach**

## Significant development in North America

**US gas production, 1950-2008**



Source: Schlumberger, 2009, R. Nehring, 2009

- Technologies and business model for unconventional gas took two decades to develop
- Progress in horizontal drilling techniques and in hydraulic fracturing were key to unlock potential of unconventional gas
- Today, unconventional gas is highly competitive and has become primary source of North-American indigenous gas production: ~259 bcm or 47% of total production in 2007
- US is experiencing a second peak in total gas production
- Tight gas has highest share but shale gas is gaining momentum

**Unconventional gas has become primary source of indigenous gas production in North-America**

# Unconventional gas resources worldwide

**Resource potential in 1000 bcm (tcm)**

	Coalbed methane	Shale gas	Tight gas	Unconventional	Conventional
Australia & Asia	49	165	36	250	38
<b>North America</b>	<b>85</b>	<b>109</b>	<b>39</b>	<b>233</b>	<b>43</b>
Former Soviet Union	112	18	26	156	177
Africa & Middle East	0	80	46	126	132
Latin America	1	60	37	98	18
<b>Europe</b>	<b>8</b>	<b>16</b>	<b>12</b>	<b>36</b>	<b>14</b>
<b>World</b>	<b>255</b>	<b>448</b>	<b>196</b>	<b>899</b>	<b>422</b>

Source: Rogner, 1997

- Globally, wide distribution of unconventional resources
- In gas-exporting regions such as the former Soviet Union and the Middle East, unconventional resources will not displace, but might complement conventional gas production
- In gas-importing regions such as Europe and Asia, unconventional gas might reduce import needs

**Potential for unconventional gas is ~7 times higher in North America than in Europe**

# Unconventional gas resources in Europe



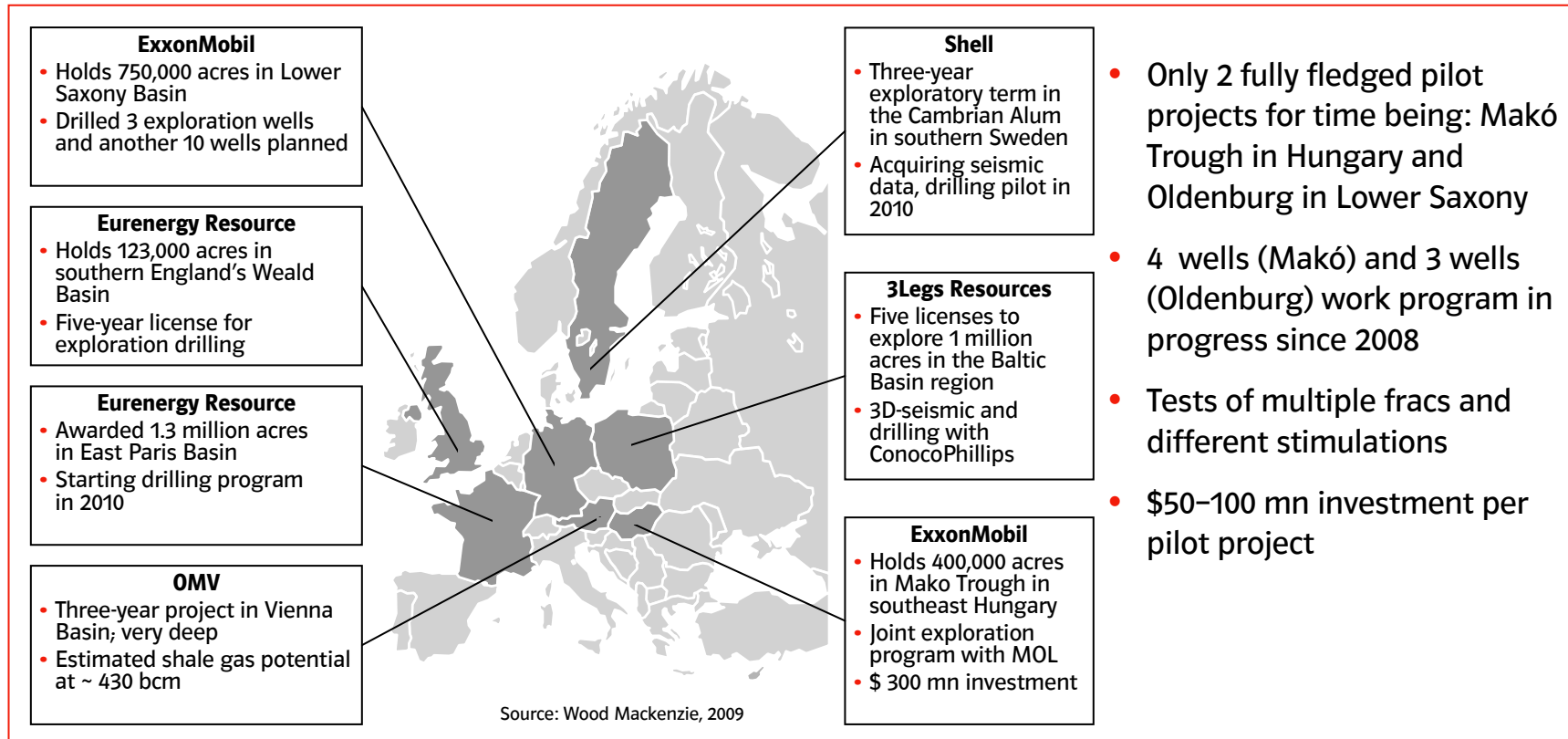
■ Shale gas    ■ Tight gas    ■ Coalbed methane

Source: Schlumberger, 2009

- Europe holds diverse inventory of shale gas, coalbed methane, and tight gas
- Individual size and resource potential in Europe is in same order of magnitude as typical North-American basins
- Three major European shale gas basins: Poland, Northern Germany, and Southern North Sea
- No production of unconventional gas established yet

**Transforming geological potential into profit opportunity is the key challenge**

# Activity in European unconventional gas



- Only 2 fully fledged pilot projects for time being: Makó Trough in Hungary and Oldenburg in Lower Saxony
- 4 wells (Makó) and 3 wells (Oldenburg) work program in progress since 2008
- Tests of multiple fracs and different stimulations
- \$50–100 mn investment per pilot project

**Flow of gas far below expectations, reasons not yet well understood**

## Challenges to unconventional gas in Europe

### Geology

- Total potential expected to be significant
- European shales not yet well understood in terms of geology and cost structures
- Europe in early research phase. No real development options in the short run

### Access

- Mineral rights mainly state owned
- Licences less widely available
- Acreage & land access more difficult due to high population density

### Environment

- Large amounts of water needed for fracturing
  - Recycling or disposal for produced fluids necessary
- ⇒ Main challenge for development of unconventional gas in Europe

### Economics

- European service industry much less mature than in North America
- European well costs – drilling & stimulation – up to four times NA levels
- Fiscal regime not yet in place

**Framework for unconventional gas less attractive than in NA**

## Economics of unconventional gas

### US

- Gas prices of \$4/mmbtu (~€10/MWh) indicate that development, drilling and production is competitive
- Some studies (BENITEK) estimate breakeven costs below \$3/mmbtu (~€7/MWh) for various shale plays possible
- Even conservative estimate (Wood Mackenzie) for breakeven cost lower than current gas forward prices of \$7/mmbtu (~€17/MWh)
- Both investment and production decision with very short time lag

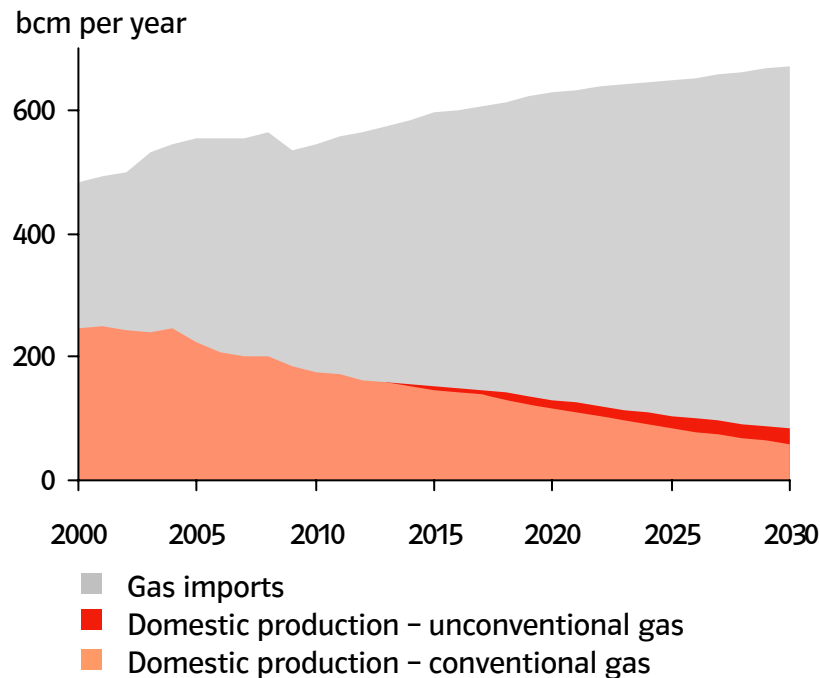
### Europe

- Estimates indicate that economical breakthrough requires gas prices above €25/MWh (~\$10/mmbtu)
  - European gas forward prices (NBP) currently at €13/MWh for 2012 (~\$5/mmbtu)
  - Optimistic estimates put breakeven cost at €14/MWh (~\$6/mmbtu) in Hungary and at €25/MWh (~\$10/mmbtu) in Poland
- ⇒ These estimates do not reflect uncertainties such as dry wells, Estimated Ultimate Recovery (EUR), assumed initial production

**Limited production of unconventional gas competitive before 2020**

## Prospects for unconventional gas in Europe

**Forecast of European gas supply**



- Size and impact of potential unconventional gas on European gas market is many times smaller than in North-America
- CERA estimates production of unconventional gas in Europe at 10-15 bcm per year from 2020 onwards
- International Energy Agency estimates production of unconventional gas in Europe at 15 bcm per year by 2030 in its latest World Energy Outlook
- Very optimistic EU unconventional case sees production of up to 40 bcm per year by 2030

**No 'unconventional gas revolution' in Europe**

## Conclusion

- **Unconventional gas resources are 7 times smaller in Europe compared to North America**
  - **Geology of unconventional gas in Europe is not well understood so far**
  - **Access to resources more difficult than in North America**
  - **Higher environmental constraints**
  - **Services more expensive**
- ⇒ **Production will be later, slower and more expensive than in North America**

**But unconventional gas will offset some of the declining North Sea production and thereby reduce expected future import needs in mid to long term**

**E.ON closely monitors developments in European unconventional gas**



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