# NORM aspects of shale gas extraction

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# Content

- Generalities
- Shale gas in Belgium
- Radiological aspects
- Conclusions/Remarks

# Conventional - Unconventional

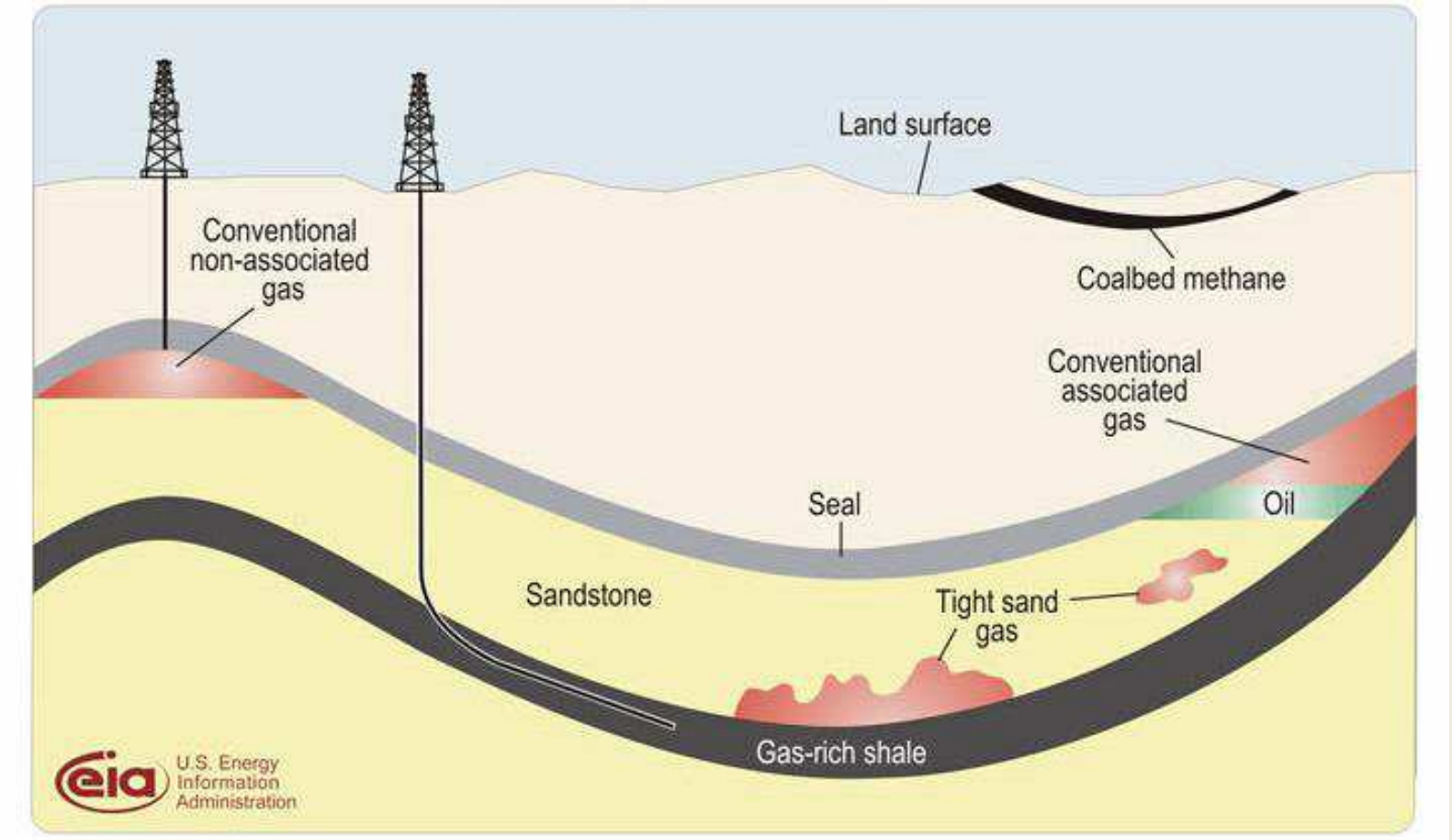
**Conventional natural gas**
*(associated and non-associated)*

- Reservoir
- Vertical wells
- Recovery rate ~80%

**Unconventional natural gas**
*(tight gas, coalbed methane, shale gas)*

- Source is rock formation
- Well stimulation (fracking)
- Recovery rate 15-30%

# Conventional - Unconventional



# Shale gas

- Shale gas is an unconventional natural gas trapped in fine grained shale formations
- Potential for extraction determined by:
  - Organic fraction (TOC)
  - Maturity (vitrinite reflectance VR0)
  - Depth range
  - Tectonic settings

# Shale gas reserves in Europe

| Country | Technically recoverable shale gas resources ($10^{12}$ $m^3$) |
|---|---|
| France | 5,10 |
| Germany | 0, 23 |
| Netherlands | 0, 48 |
| Norway | 2,4 |
| UK | 0,57 |
| Denmark | 0,65 |
| Sweden | 1,16 |
| Poland | 5,30 |
| Turkey | 0,42 |
| Ukraine | 1,19 |
| Lithuania | 0, 113 |
| Romania,Hungary, Bulgaria | 0,54 |

# Shale gas investigations in Belgium

- No interest in shale gas till 2012
- Analysis in 2013 of the huge amount of information available on shale in Belgium by an expert group of geologists

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Conclusion for Belgium:

The Namurian shales have the greatest potential for shale gas extraction

# Shale gas potential map Belgium

# Shale gas reserve in Campine Basin (1)

| Prospective area | Thickness | Porosity | Expansion factor | Saturation | Gas in Place |
|---|---|---|---|---|---|
| ($km^2$) | (m) | (%) | | (%) | (trillion $m^3$) |
| 3000 | 30 | 10 | ~200 | 23 | ~ 0,4 |

With 8-15% extractable (recovery factor)

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*Technically recoverable shale gas resource:*

***0,05 trillion $m^3$***

# Shale gas reserve in Campine Basin (2)

- Yearly natural gas consumption in Belgium is about 16 x $10^9$ $m^3$

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Recoverable resource sufficient for ***2-3 year***

- For covering 5% of yearly natural gas consumption (0,8 x $10^9$ $m^3$) by shale gas:

***250 – 300 wells***

# Radiological issues

- No much experience in Europe (except for UK)
- Most data from Marcellus shale (US) and Bowland shale (UK)
- Items of interest:
  - Waste waters (flowback and produced water)
  - Scalings and sludges
  - Radon (at extraction sites and in households)

# Waste waters (1)

- ~ 15000 $m^3$ of water required for fracking a well (amount needed to run a 1000 MW coal-fired power plant for 12h)
- 20-80% of injected water returns within weeks after depressurization of the well (flowback)
- Produced water (formation water) generated by well at lower rates throughout the life-time
- Waste waters are considered as “extractive waste” $\longrightarrow$ regulated under Mining waste directive

# Waste waters (2)

- Flowback water from Bowland shale wells

  14 – 90 Bq/l (Ra-226)

  2 – 12 Bq/l (Ra-228)

  Ratio (228/226) < 0,3

- Produced water from Marcellus shale wells

  3 – 500 Bq/l (Ra-226)

  ? (Ra-228)

  Ratio (228/226) < 0,3

# Waste waters (3)

- Flowback and produced water partly ( pre-treatment necessary due its high TDS) re-used for fracking
- Remaining fraction has to be treated for disposal (due to Mining waste directive)
- Treatment at municipal plants no option due its composition $\longrightarrow$ special facilities as for much industrial waste water

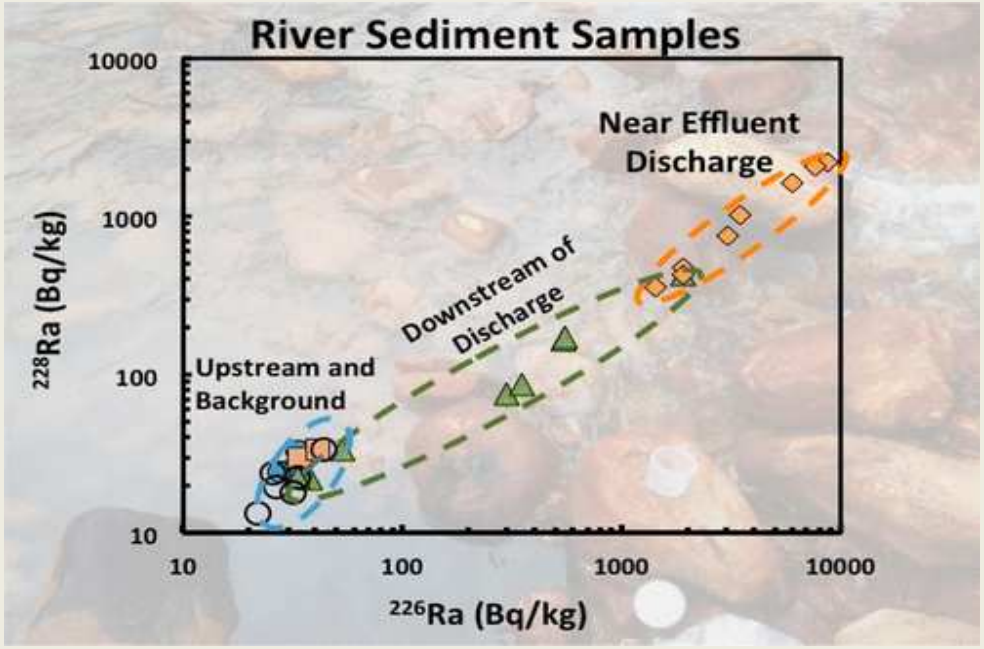
# Waste waters (4)

*In Pennsylvania oil and gas waste water treated at brine treatment facilities and discharged in local streams*

In river sediments near effluent point:

Radium > 200 BG.

Composition points to shale gas waste water



# Radon (1)

- For Marcellus shale, a significant health effect was calculated for the population of New York State by using shale gas for cooking :

  1183 up to 30484 LC (population of $11{,}9 \times 10^6$)
  Results based upon *calculated* Rn at wellheads (max 95 Bq/l)
  and a contribution to the indoor Rn con. of max 20 $Bq/m^3$

- Recent *measured* Rn conc. at wellheads in Marcellus shale significantly lower (max. 3 Bq/l) →the calculated LC are probably largely overestimated

# Radon (2)

- Workers may be exposed to radon in *confined* production units

and to

- External radiation and internal exposure during *maintenance* activities.

No information about this was available

# Conclusions/Remarks (1)

Problems are manageable

*(comparable to conventional oil and gas)*

– Good practice, technology, logistics

– Appropriate regulation framework

– Intensive monitoring

– Involvement of the public

# Conclusions/Remarks (2)

*The role of shale gas in a carbon-constrained world*

EU Energy roadmap 2050

(energy system less carbon intensive and more sustainable)

EU's commitment to reduce greenhouse gas emissions by 80-95% by 2050

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More gas in the transition to renewable energies

*Shale gas can contribute for 5 – 10%*