



Réseau Pacte Mondial  
France

# *Les hydrocarbures du futur* **Les gaz de schiste**

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***15 septembre 2011***

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**TOTAL**

# Natural gas trapped in a low-perm rock

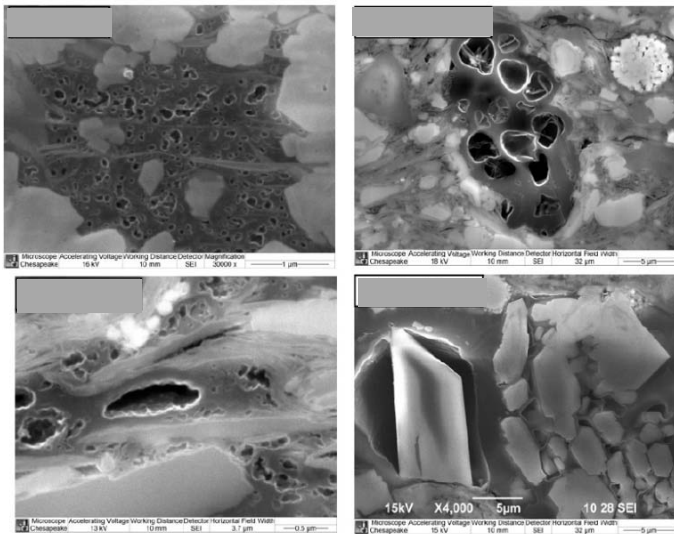
- ▶ Shale gas is generated through burial of argillaceous sediments, rich in organic matter, where it remained trapped.
- ▶ It is mostly made of methane.

Shale gas and natural gas differ neither in their origin nor in their nature.



- ▶ Permeability of these rocks is extremely low.

Rock characteristics require the usage of specific techniques, to ensure an acceptable level of well productivity.



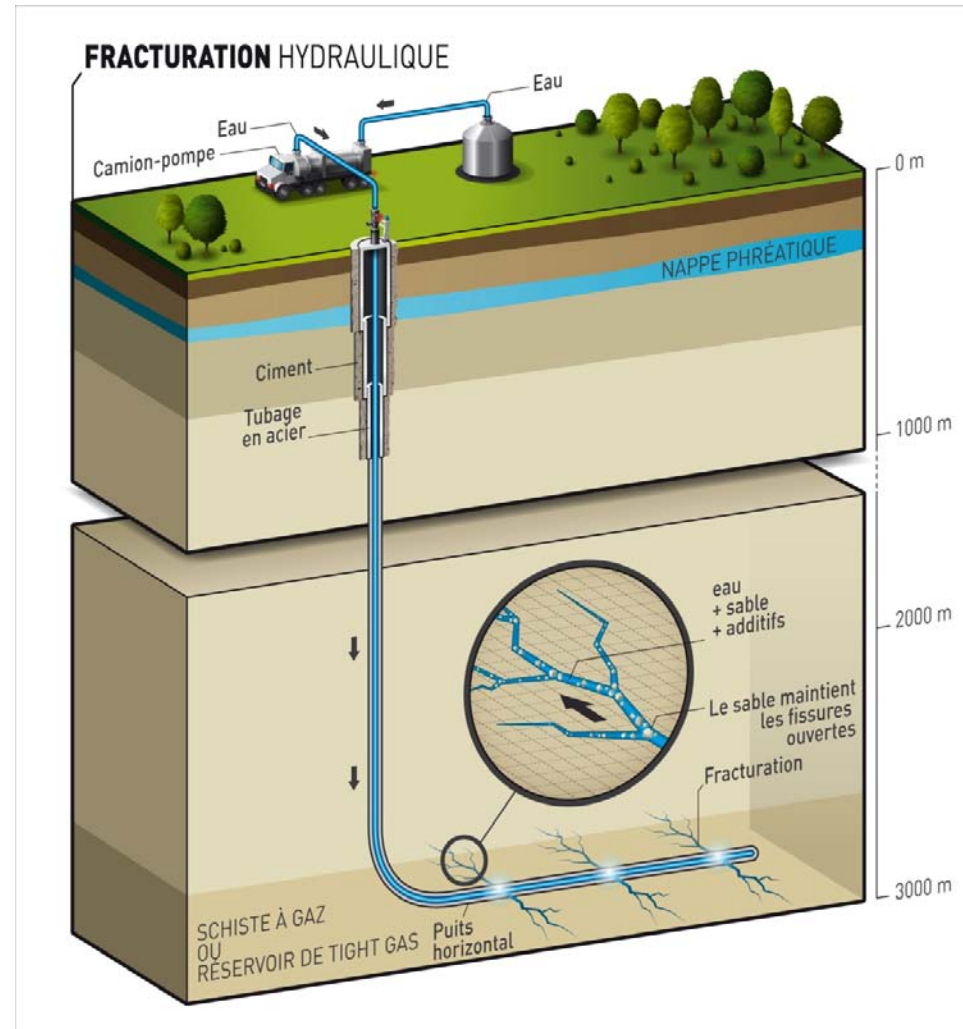
# Specific production techniques

## Two types of technology required to enable sustainable production :

- Horizontal drilling, which increases the productive section of each well (compared to vertical drilling).
- Controlled hydraulic fracturing, which artificially improves rock permeability.

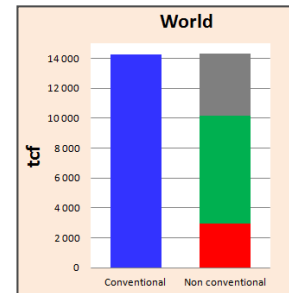
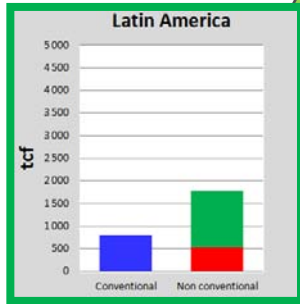
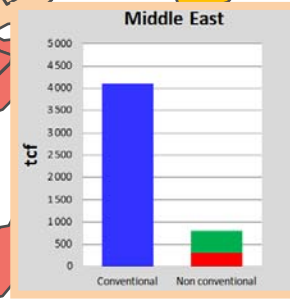
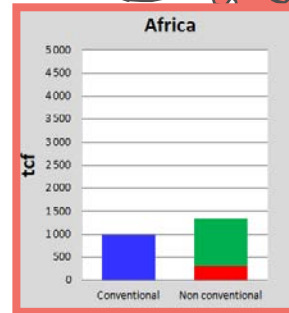
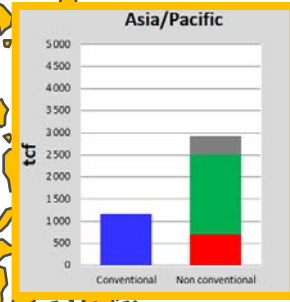
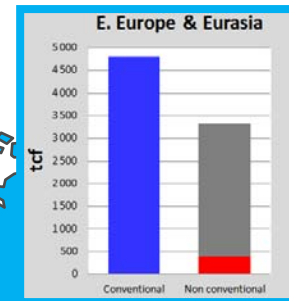
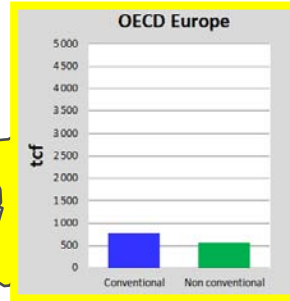
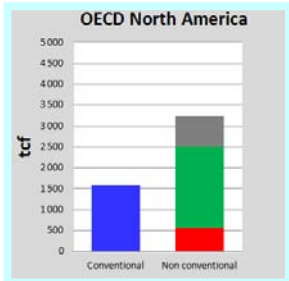
**These techniques are known to the industry and also used for conventional hydrocarbon production and geothermal energy.**

- ▶ The amount of gas retrieved from each well remains low, which implies a large number of wells to reach a significant level of production

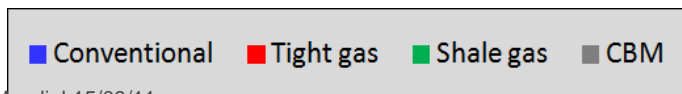


# Remaining recoverable resources of natural gas

(Source: IEA special report 2011)




1 tcf = 28 Gm3




**Unconventional gas:  
large and uncertain figures**

# Total shale gas positions

- ❑ 25% of CHK's Barnett Shale
- ❑ 1800+ active wells in 2010
- ❑ 180 mmscfd net production in 2010
- ❑ 20 rigs in operation


 Barnett



 Neuquen

- ❑ Acreage 1,548 km<sup>2</sup> net over 12 blocks
- ❑ 1 exploration well ongoing

- ❑ 2 licences of 2972 & 2289 km<sup>2</sup>
- ❑ 3-phase exploration permit (6 yrs)
- ❑ 1<sup>st</sup> phase ongoing (studies)

 Nordjylland and NordSjaelland

 Chelm and Werbkowice

- ❑ 2 licences of 1162 & 995 km<sup>2</sup>
- ❑ exploration blocks (5 yrs)
- ❑ 1 well drilled and being evaluated

 Montélimar

- ❑ Acreage 4327 km<sup>2</sup>
- ❑ 3-phase exploration permit (5 yrs), under administrative re-evaluation
- ❑ 1<sup>st</sup> phase ongoing (studies)

# Shale Gas: Acceptability and responsibility

Legitimate questions requiring adequate answers and actions

## Aquifers



**Protection of aquifers during drilling, fracking and production**



*Security and reliability of wells and installations*

*Reduction in quantity and impact of additives*

*Use of seismic data for localization and control of intervals to be fracked*

## Water



**Optimized water management**



*Origin / Transportation / Quantity / Treatment / recycling / Disposal*

*Reduce water usage in fracking operations*

*Search for solutions avoiding uses of public domain water domain and fresh water*

*Maximize water re-usage after adequate treatment*

## Ground



**Minimize impact of industrial activities**



*Reduce number of industrial sites by drilling more production horizontal wells in each clusters*

*Install clusters close to existing infrastructures.*

*Transport fluids by pipelines.*

*Site restoration*

## Local communities



**Impact of operations**



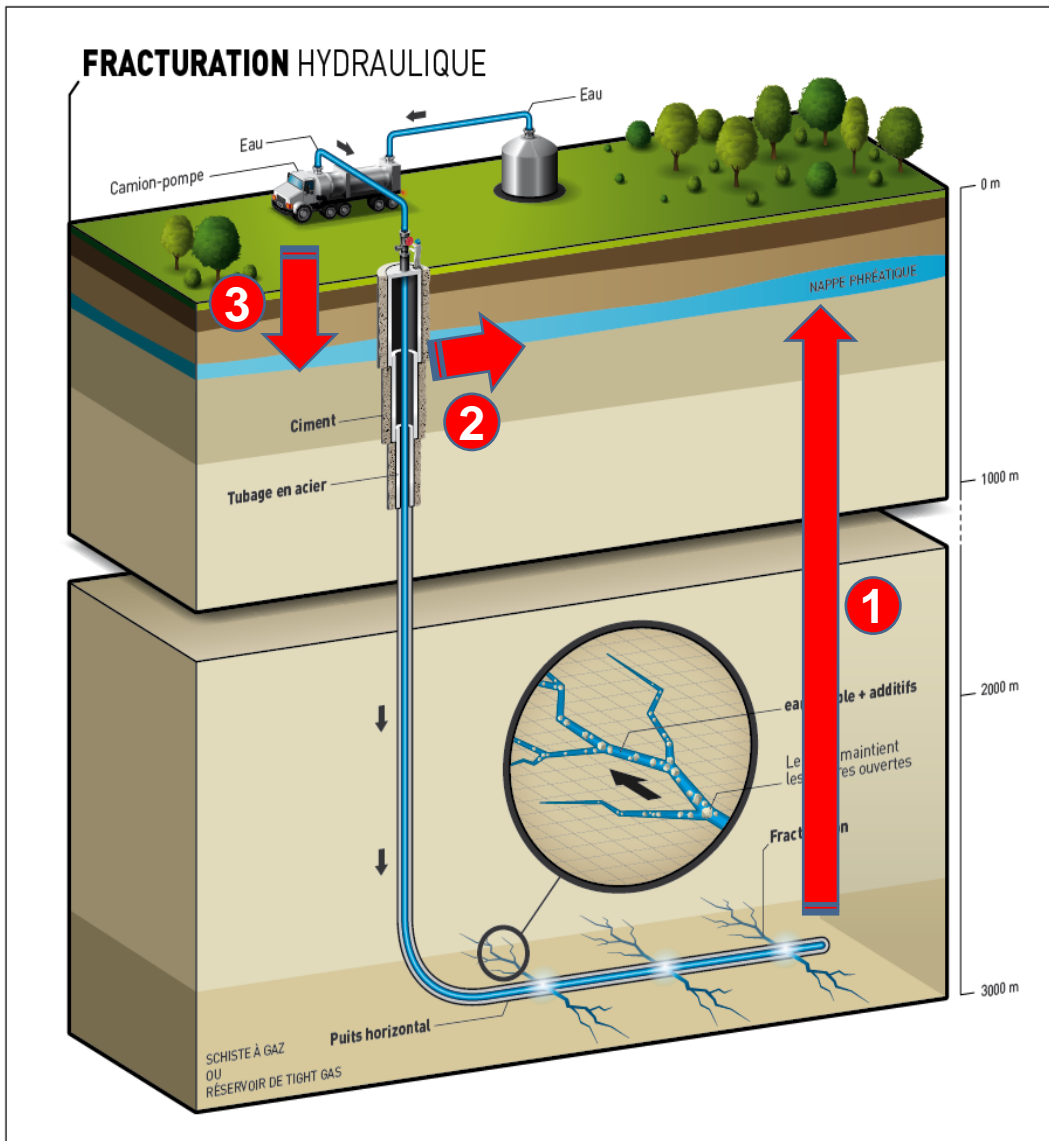
*Consult and exchange with local communities*

*Take due care of local biodiversity, land view, heritage, dwelling and traffic issues in installations planning*

*Monitoring and respect of commitments*

**Make acceptability first priority**

# Groundwater contamination risks



3

Contamination related to spill or containment failure.

Risk known to the O&G industry and more widely to a large number of industries

2

Contamination due to well integrity issues.

Risk known to the O&G industry (and others), requires respect of regulation and good industry practices

1

Contamination due to hydraulic fracturing.

Risk considered as extremely unlikely given safe distances from aquifers are respected

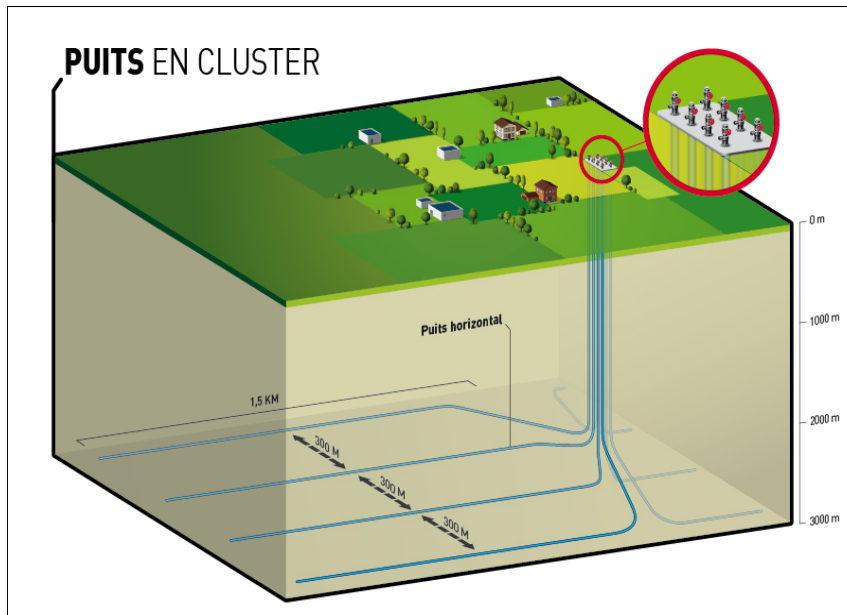
# Surface footprint

## ► A “cluster” based development

- Reduction of the number of surface locations
- Optimized surface footprint (input and output of material, fluids etc...)
- Optimized location of well horizontal section in the objective

## ► Site rehabilitation

**A solution adapted to the European context**



Drilling phase



Fracturation phase

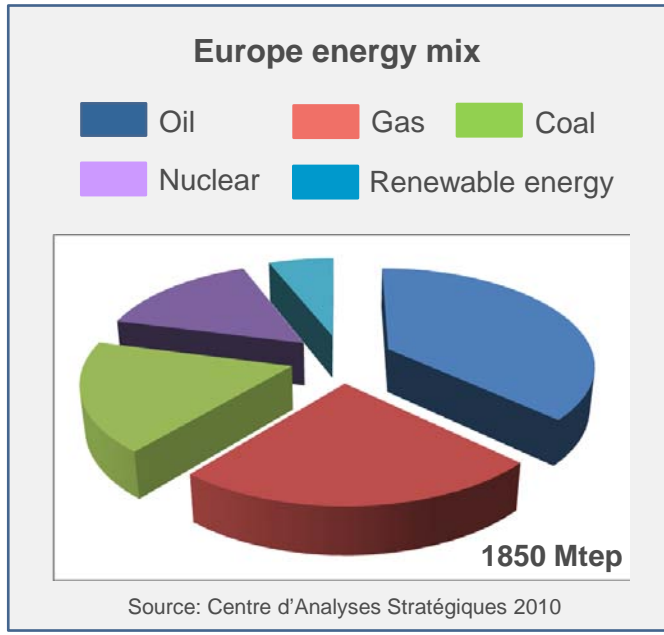
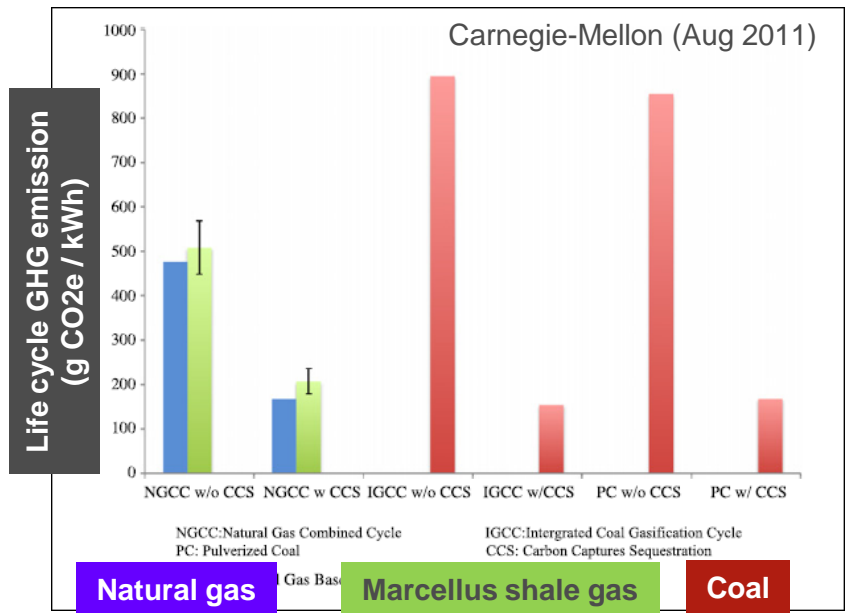


Production phase

# Climate impact

## Energy required for production

- Fuel for drilling and completion (0.002bbl/bep)
- Well logistics (0.0002 bbl/bep)
- Compression from well to processing plant & pipeline network (3% of fuel gas or 0.03 bep/bep)



## Green House Gas emissions

- Shale gas is natural gas. Its emissions are in the range of conventional gas GHG emissions
- Carnegie-Mellon estimate (Aug 2011)
  - Dvpt & completion: 1.8g of CO2e / MJ of gas
  - Life-cycle: 63-75 g CO2e / MJ
  - +11% compared to average US domestic gas (w/o combustion)
  - +3% compared to US domestic gas (with combustion)

Climate impact will depend on the usage made of shale gas.

Additional consumption of fossil fuel / replacement of gas import / coal substitution ?

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