UN Escwa

Oil and Gas parameters influencing efficiency and renewables energy activities

Kuwait – 12/6/13

Dominique Venet
1.1 Hydrocarbon definition

– A Hydrocarbon is an organic compound consisting entirely of Hydrogen and Carbon.

– Hydrocarbons can be:
  • Gases : eg methane
  • Liquids : eg hexane or benzene
  • Waxes or low melting solids : eg paraffin wax
  • Polymers : eg polyethylene
1.1 Hydrocarbon definition

- **Gas Field**
  - Non-Associated Gas
  - Associated Gas

- **Unsaturated Oil Field**
  - Oil
  - Water

- **Saturated Oil Field**
  - Oil
  - Water
1.2 Interaction between Renewables and Hydrocarbons

1. Environment
2. Power Production
3. Power Network Operations
4. Financial interactions
1.2.1 Environment

- **CO2 issues:**
  - Renewables: zero emission
  - Natural Gas: 400 gCO2/kwh – (average OECD – 2008/2010)
  - Fuel-Oil: 670 gCO2/kwh
  - Coal: 900 gCO2/kwh

- **Other emissions:**
  - SOx, NOx, particles etc...
  - Renewables and Natural Gas: close to zero
  - Coal and Oil (eg FO): stringent emission limits lead to closure of many obsolete coal and fuel fired plants
1.2.2 Power Production

• **Oil fired Power Plants**:
  – Diesel or Fuel Oil
  – Steam cycle, Open cycle gas turbine
  – Diesel Engine (*isolated areas eg islands*)
  – Typical efficiency : 35%

• **Gas fired Power Plants**
  – Steam cycle, Open cycle GT, Diesel Engine :
    • Typical efficiency 35%
  – Combined Cycle Gas Turbine (CCGT) :
    • Typical Efficiency 55%
1.2.2 Power Production
Combined Cycle Gas Turbine (CCGT)
1.2.2 Power Production

World electricity generation by type in the New Policies Scenario
1.2.2 Power Production
Electricity generation by fuel and region in the New Policies Scenario

Note: For each region, the largest source of electricity generation in 2008 and 2035 is denoted by its percentage share of the overall mix.

Source: WEO 2010 (AIE)
Power Production

Power generation: the main driver for gas consumption

World primary natural gas demand by sector

- Power generation: significant increase from 2008 to 2035
- Buildings: moderate increase from 2008 to 2035
- Industry: slight increase from 2008 to 2035
- Non-energy use: minimal change from 2008 to 2035
- Other*: small increase from 2008 to 2035

bcm
1.2.3 Power Network Operations

- Power production from renewables (e.g., windmills or solar) is very difficult to predict accurately within the accuracy range necessary to balance a power network.

- Increasing share of renewables in power mix generates additional instability on the power grid.
Power Network instability
One week in Germany Summer 2011

Source: RTE
• **Increase availability of flexible generation assets**
  
  – **Hydro**
    
    • Pumped storage
    • High head hydro plant
  
  ➔ But lack of acceptable sites in Europe

  – **Natural gas**
    
    • Open cycle
    • CCGT
1.3 Conclusion Renewables / HC interaction
Power production technologies

• **Zero CO₂ emission**
  – Renewable (non hydro): will be on the rise
  – Hydro: no substantial development in Europe (lack of sites)
  – Nuclear: impacted by Fukushima (Germany, Italy etc.)

• **CO₂ emission**
  – Liquid fuel: on the verge of extinction
  – Coal: mainly in China
  – Gas: is the fuel of choice
    • Low CO₂ emission
    • Low capex
    • Higher flexibility
1.3 Conclusion Renewables / HC interaction
World incremental power generation, 2000-2009*

* estimated data for 2009
Source WEO-2001 Golden Age of Gas
1.3 Conclusion Renewables / HC interaction

• Oil is not a competitor any more in Power Generation (except for small scale plants or oil producing countries); Natural Gas is the Power Generation hydrocarbon.

• Oil still has an indirect influence on Power Generation thru the Gas Prices mechanisms.
2 – OIL FUNDAMENTALS
2-1 Oil Production and Reserves
2.1.1 Proven Conventional Oil Reserves

Figure 3.12  Proven oil reserves in the top 15 countries, end-2011

Source: IEA – WEO 2012
2.1.2 Ultimate recoverable Oil Reserves

Figure 3.13  
Ultimately technically recoverable resources and cumulative production by region in the New Policies Scenario

Source: IEA – WEO 2012
2.2 Oil Refining

• Oil is very rarely used as such
• Oil is a mixture of various hydrocarbons (ie molecules with a variable number of Carbon atoms)
• Refining is used to:
  – Separate the various component
  – « break » and remodel the heavier components
  – Remove unwanted pollutants (eg sulfur)
Simple refinery - Early 70s

Crude

Atmospheric Distillation

Reforming

H2

C3 - C4

HDS

Fuel

C3

C4

Refining gas

Fuel

LPG

Naphtha

Gasoline

Kerosene

Diesel

Heating oil

Heavy oil
Refinery with classical conversion – 80s-90s

Source: CEG-IFP
R136
2.3 International Oil Markets
2.3.1 Crude oil price

Source: Platts

S 402*16 – January 2013
**Historical pricing of crude oil**

- **Posted Price**
- **Official Price**
- **Spot Prices**... Higher volatility...
- **Futures Prices**

Source: Platt’s

Historical pricing of crude oil shows a significant rise in prices, with marked periods of higher volatility and futures price development. The chart highlights key events such as OPEC domination and majors’ control.
Development of international oil markets

1970’s
Controlled Markets
- Upstream / downstream decoupling
- Domination by OPEC countries

Guarantee
Security of supplies
- Long term contracts

1980’s
Advent of Market Freedom
- Sharp price rises
- Increasing volatility
- Supply surplus

Purchase at the lowest possible price
- Limit financial risks
- Spot markets
- Future and forward markets

1990’s
Advent of Financial Markets
- Moderate prices
- New geopolitical order
- Generalized need for hedging

Use reliable benchmark prices
- Formula price 3 benchmark crude
- Screen quotations
- Swaps & options
## Crude Oil contracts (physical market)

<table>
<thead>
<tr>
<th>Description</th>
<th>Approximate Share</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>« Long Term » Contracts</strong></td>
<td>~60 %</td>
</tr>
<tr>
<td>Duration: 1 year, renewable</td>
<td></td>
</tr>
<tr>
<td><strong>Barter</strong></td>
<td>~5 %</td>
</tr>
<tr>
<td>Exchange of oil for goods and services</td>
<td></td>
</tr>
<tr>
<td><strong>Cargo by cargo</strong></td>
<td>~35 %</td>
</tr>
<tr>
<td>Spot: within 1 month</td>
<td></td>
</tr>
<tr>
<td>Forward: 1 - 3 month delivery</td>
<td></td>
</tr>
</tbody>
</table>
2.3.3 Crude oil differentiation
<table>
<thead>
<tr>
<th></th>
<th>LPG</th>
<th>Lights</th>
<th>Middle Distillates</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demand (World)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Saharan Blend</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Brent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Arab light</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safaniyah</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Boscan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>0,806</th>
<th>0,837</th>
<th>0,855</th>
<th>0,893</th>
<th>0,995</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Density</strong> ° API</td>
<td>44</td>
<td>37,5</td>
<td>34</td>
<td>27</td>
<td>10,7</td>
</tr>
<tr>
<td><strong>Sulphur content % vol</strong></td>
<td>0,2</td>
<td>0,3</td>
<td>1,7</td>
<td>2,8</td>
<td>5,3</td>
</tr>
</tbody>
</table>
**Price differential**

1 - **Quality Differential**

**LIGHT CRUDE**

° API > 33°

**HEAVY CRUDE**

° API < 22°

Light Crude Price > Heavy Crude Price*

(*) Sulphur content differential in addition
Price differentials
2 - Transportation Differentials

North Sea
2 $/b

Arabian Gulf

Price FOB Gulf + 6 $
= Price FOB North Sea + 2 $

Rotterdam

6 $/b
Incoterms have been created in 1936 by the ICC (International Chamber of Commerce). New version Incoterms 2010, applicable as from Jan 1st. 2011

Set of international rules (11) for the interpretation of trade terms, defined by the ICC

They define the roles and responsibilities between sellers and buyers in terms of costs allocations and risk transfer

Incoterm is almost always mentioned in the contract*

*The hierarchy of contractual documents:
1) Specific terms
2) GTC’s (General terms and conditions)
3) Incoterms
The main incoterms

BRENT FOB = Free On Board:

- The cargo is available in the vessel at the loading terminal
- The buyer pays the transportation and insurance costs

BRENT CIF = Cost Insurance Freight

- The seller pays the transportation costs and the insurance
- The cargo is available in the offloading terminal

60 $/b + transportation + insurance + 2 $/b = 62 $/b
## The main Incoterms

<table>
<thead>
<tr>
<th></th>
<th>FOB Free on Board</th>
<th>CIF Cost Insurance Freight</th>
<th>DAP Delivery at Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risks of loss and damage affecting the cargo</td>
<td>Buyer</td>
<td>Buyer</td>
<td>Seller</td>
</tr>
<tr>
<td>Costs resulting from events arising after loading</td>
<td>Buyer</td>
<td>Buyer</td>
<td>Seller</td>
</tr>
<tr>
<td>Transport charges</td>
<td>Buyer</td>
<td>Seller</td>
<td>Seller</td>
</tr>
<tr>
<td>Insurance charges</td>
<td>Buyer</td>
<td>Seller</td>
<td>Seller</td>
</tr>
</tbody>
</table>

Note: In the Incoterms 2000, for FOB/CIF transfer of risks occurs when goods passes the ship’s rail. In the new version (Incoterms 2010) transfer of risks takes place when goods are on board the vessel. Anyway, as a rule this clause is amended in the contract specifying that the transfer of risk occurs when the oil passes the vessel’s permanent flange connection at load port.
**Incoterms 2010**

- **CFR** Cost and Freight
- **CIF** Cost, Insurance and Freight
- **CIP** Carriage and Insurance Paid to
- **CPT** Carriage Paid to…
- **DDP** Delivered Duty Paid
- **DAT** Delivered at Terminal
- **DAP** Delivered at Place
- **EXW** EX Works
- **FAS** Free Alongside Ship
- **FCA** Free Carrier
- **FOB** Free On Board
Different markets
(spot, forward, future)
Petroleum markets

Physical

OTC (over the counter)

SPOT

FORWARD

Dating

FUTURES

Futures
Physical market
Spot transactions

Free markets, either “spot” or “forward”

- Exchanges on a case by case basis
- OTC markets (OTC: Over The Counter)
- No regulation body: low price transparency
- Actors:
  - Producers
  - Refiners
  - Brokers
  - Traders
- “Spot” prices for some crudes, indexed on benchmark crude prices for the others
- “Forward” price = price set for a future delivery
Price determining factors of the oil markets

FUNDAMENTALS

Day to day balance of the regional physical markets
Production levels and capacity
Variation in consumption
Level and variation of the different stocks

The NEWS

Technical, economic and political information likely to affect the estimated supply demand balance even at the pre-confirmation.

TECHNICALS

Analysis of historical price series, chart-methods
Daily published quotations for crudes and products

The most famous reporting agency: **PLATT’S**

- In an OTC market, actual prices are known only by the buyer and the seller
- To be considered as a benchmark, Brent market has to be observable (need for REPORTING)
- **PLATT’S** journalists assess, with a specific methodology (MOC- Market on close), the market and issue a daily price for different crudes and products

Dated Brent:

- low Platt’s 120,20
- high Platt’s 120,30
- mean of Platt’s 120,25

- Other reporting agencies: London Oil Report (LOR), Petroleum Argus
Les prix en Europe sont indiqués en USD/T, lire les commentaires Platt’s concernant les densités de référence.
Platt’s product quotations \( \Delta (\text{CIF} - \text{FOB}) \approx 10 \) $/t

**Surplus Supply**
- Export
- FOB Parity

**Deficit Supply**
- Import
- CIF Parity

Gasolines in Europe

Diesel in Europe
## Main international cargo markets for oil products

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>TYPE</th>
<th>SUPPLY</th>
<th>MARKET</th>
</tr>
</thead>
<tbody>
<tr>
<td>US East Coast (New-York)</td>
<td>Import</td>
<td>Gasoline - Europe (summer)</td>
<td>US oil market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gas-oil - US &amp; Caribbean in winter</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuel-oil - US Gulf, Caribbean, Mediterranean</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>US East Coast power utilities</td>
</tr>
<tr>
<td>Gulf of Mexico Caribbean</td>
<td>Export</td>
<td>Local refineries</td>
<td>Fuel oil, mainly to US East Coast</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gas oil to New-York in winter</td>
</tr>
<tr>
<td></td>
<td>Export</td>
<td>Local refineries plus products</td>
<td>North West Europe, especially</td>
</tr>
<tr>
<td></td>
<td>Import</td>
<td>from Mediterranean, Caribbean and CIS</td>
<td>gas oil to Germany, and for peak demand: US</td>
</tr>
<tr>
<td>NWE/ARA Zone (Rotterdam)</td>
<td>Export</td>
<td>Mediterranean refineries</td>
<td>Mediterranean, North West Europe</td>
</tr>
<tr>
<td></td>
<td>Import</td>
<td></td>
<td>US, Red Sea, Arabo Persian Gulf</td>
</tr>
<tr>
<td>Med . Zone (Gênes, Lavera)</td>
<td>Export</td>
<td>Local refineries</td>
<td>Far East, mainly fuel oil and naphtha</td>
</tr>
<tr>
<td>Arubo Persian Gulf</td>
<td>Export</td>
<td>Local refineries</td>
<td>Mainly Japan, also balancing requirements of other South East Asian</td>
</tr>
<tr>
<td>Singapore</td>
<td>Export</td>
<td>Singapore refineries</td>
<td>markets and China</td>
</tr>
</tbody>
</table>
Marker crude
Spot Crude Oil Trading

- The Oil is physically available
- Otherwise known as the Cash market
- Over 100 grades of Crude traded worldwide (on more than 400 grades of crude worldwide)
- Cargo and Cash exchanged almost immediately
- Spot Product trading also widespread
- All the crude/products can’t be followed on a daily basis, hence the need to have crude/products benchmarks (marker crude)
**Benchmarks ~ What & Why ?**

- **Benchmarks** provide a standard industry reference point which is fair, market related, transparent and understood by all participants.
- Benchmarks facilitate business by providing a focal point for differential pricing of related commodities.
- Example: Brent minus $.50
- Two main benchmarks: **WTI** (West Texas Intermediate in the US, 38 to 40 °API and 0.3 %S) and the **Brent** (North sea crude, 38 °API and 0.3%S).
- Others crude are used locally as benchmark: **Oman/Dubai** in the Middle East/Asia. More recently **ASCI** (Argus Sour Crude Index) for US Gulf Coast. The daily price of the ASCI is the weighted average of all the deals done on 3 crudes (Mars, Poseidon, Southern Green Canyon) and is used by Saudi Arabia, Kuwait, Iraq as a benchmark for their exports to the US in their long term contracts.
European benchmark crude: the Brent

A Benchmark Crude

- A « classical » crude: light (38° API) and sweet (0.3 S%), corresponding to the market demand in Europe
- Production in the consuming area, thus possibility of quick supply for the refiner
- Considerable physical production (no longer… problem !)
- Large number of producers
- Brent trade is well organised and attracts a lot of traders
- Forward Brent et Dated Brent
- 2/3 of the crudes worldwide are priced on the Brent!
- Actually Brent price was a price rule of 3 crudes named BFO (since 2002) and became BFOE since June 2007 (Brent, Forties, Oseberg, Ekofisk)

Price transparency ?
Major international petroleum markets

**BRENT ZONE**
- Amsterdam
- Rotterdam
- Antwerpen
- London
- Genoa
- Lavera

**OMAN - DUBAI ZONE**
- Arabian/Persian Gulf
- Singapore
- Tokyo

**W.T.I. ZONE**
- New-York
- Caribbean

**Crude oil spot market**

**Products spot market**
3 – Gas Industry
3.1 Natural gas uses, reserves, supply and demand

3.1.1 Gas uses
Natural gas uses – competitors
Energy context

Combined Cycle Gas Turbine (CCGT)
3.1 Natural gas uses, reserves, supply and demand

3.1.2 Gas reserves and productions
Conventional gas reserves

Proven reserves: $187\,100\,000\,000\,m^3 = 168\,Gtoe$ (01.01.2011)
Marketed production: $3193\,000\,000\,m^3 = 2.9\,Gtoe$ (2010)

Source: BP Stat Review
A113*6 – July 2010
### Proven conventional natural gas reserves

<table>
<thead>
<tr>
<th>Region</th>
<th>Reserves (Bcm)</th>
<th>%</th>
<th>Ratio R/P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North America</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>8500</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Canada</td>
<td>2000</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td><strong>S. &amp; Cent. America</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venezuela</td>
<td>5500</td>
<td>3</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Bolivia</td>
<td>300</td>
<td>0.1</td>
<td>18</td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>2100</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1100</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td><strong>FSU</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>44600</td>
<td>22</td>
<td>74</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>24300</td>
<td>12</td>
<td>&gt;100</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nigeria</td>
<td>5100</td>
<td>3</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Algeria</td>
<td>4500</td>
<td>2</td>
<td>58</td>
</tr>
<tr>
<td><strong>Middle East</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td>33100</td>
<td>16</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Qatar</td>
<td>25000</td>
<td>12</td>
<td>&gt;100</td>
</tr>
<tr>
<td><strong>Asia-Pacific</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>3100</td>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td>China</td>
<td>3100</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td><strong>TOTAL WORLD</strong></td>
<td>208400</td>
<td>100</td>
<td>64</td>
</tr>
</tbody>
</table>

**R/P = Reserves (1.1.2012) / Production (2011)** (brute – re-injected)

Source: BP Stat. Review
G212*20 – September 2012
3.1 Natural gas uses, reserves, supply and demand

3.1.3 Gas demand
## World Demand

<table>
<thead>
<tr>
<th>BCM</th>
<th>2000</th>
<th>2010</th>
<th>2030</th>
<th>Growth rates p.a.</th>
<th>00/10</th>
<th>10/30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential &amp; Commercial</td>
<td>780</td>
<td>990</td>
<td>1,238</td>
<td>2.4%</td>
<td>1.1%</td>
<td></td>
</tr>
<tr>
<td>Industry &amp; Chemical</td>
<td>782</td>
<td>1,053</td>
<td>1,510</td>
<td>3.0%</td>
<td>1.8%</td>
<td></td>
</tr>
<tr>
<td>Power Generation</td>
<td>734</td>
<td>1,062</td>
<td>1,845</td>
<td>3.8%</td>
<td>2.8%</td>
<td></td>
</tr>
<tr>
<td>Other Uses</td>
<td>146</td>
<td>177</td>
<td>238</td>
<td>1.9%</td>
<td>1.5%</td>
<td></td>
</tr>
<tr>
<td><strong>Total World</strong></td>
<td>2,442</td>
<td>3,282</td>
<td>4,831</td>
<td>3.0%</td>
<td>2.0%</td>
<td></td>
</tr>
</tbody>
</table>

Source IGU
World natural gas consumption in 2011 (10⁹ m³)

North America * 864
South & Central America 155
Europe 502
Africa 110
Middle East 403
CIS 600
Asia Pacific 591

World Total 3 223 10⁹ m³

Source: BP Statistical Review
G311 – Septembre 2012
Gas demand: Environmental concerns

BEFORE
- Gas used to be considered as environmental-friendly and was not associated with other fossil fuel
  - Gas was then foreseen as the energy for the 21st century

NOW
- Gas is no longer seen as a green energy even though it is the cleanest fossil fuel, and renewable energies are requested
  - Gas demand hinges upon implementation of the environmental policy
- Energy efficiencies have already been put in place in the recent years due to high gas prices
- The economic crisis has enhanced environmental concerns
- Environmental policies could be set up within the economic crisis time frame (energy efficiency…) and lead to a gas demand destruction (vs to a gas demand reduction)
- Growing environmental concerns could strongly impact gas demand
### Main gas producers and consumers - 2011

#### PRODUCTION Mtoe/y

<table>
<thead>
<tr>
<th>Country</th>
<th>Production (Mtoe/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>592</td>
</tr>
<tr>
<td>Russia</td>
<td>546</td>
</tr>
<tr>
<td>Canada</td>
<td>144</td>
</tr>
<tr>
<td>Iran</td>
<td>137</td>
</tr>
<tr>
<td>Qatar</td>
<td>132</td>
</tr>
<tr>
<td>China</td>
<td>92</td>
</tr>
<tr>
<td>Norway</td>
<td>91</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>89</td>
</tr>
<tr>
<td>Algeria</td>
<td>70</td>
</tr>
<tr>
<td>Indonesia</td>
<td>68</td>
</tr>
<tr>
<td><strong>Total mondial</strong></td>
<td><strong>2955</strong></td>
</tr>
</tbody>
</table>

#### CONSUMPTION Mtoe/y

<table>
<thead>
<tr>
<th>Country</th>
<th>Consumption (Mtoe/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>626</td>
</tr>
<tr>
<td>Russia</td>
<td>382</td>
</tr>
<tr>
<td>Iran</td>
<td>138</td>
</tr>
<tr>
<td>China</td>
<td>118</td>
</tr>
<tr>
<td>Japan</td>
<td>95</td>
</tr>
<tr>
<td>Canada</td>
<td>94</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>89</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>72</td>
</tr>
<tr>
<td>Germany</td>
<td>65</td>
</tr>
<tr>
<td>Italy</td>
<td>64</td>
</tr>
<tr>
<td><strong>Total mondial</strong></td>
<td><strong>2906</strong></td>
</tr>
</tbody>
</table>

Source: BP Statistical review

S342*14 – Septembre 2012
Impact of the crisis on Gas demand: for the first time a reality

- 1st year of major European gas demand decline after 30 years of largely unbroken growth
- According to CERA: ~ -35 Gm3 in 2009 divided into:
  - -14% in 2009 for industrial gas demand
  - -13% in 2009 for power demand
  - +6% in 2009 for residential and commercial demand (cold winter)

- European gas consumption forecasts falling even deeper than expected – quick recovery looks increasingly unlikely

- No recovery until 2010 at the earliest but gas demand won’t reach 2008 levels until 2013/2014 (equivalent of several years of lost growth)
3.2 Recent key evolution affecting the Gas Industry

- Gas Fired power generation (CCGT)
- Unconventional Gas (tight, shale, CBM)
- Liquefied Natural Gas (LNG)
Reminder of « conventional » versus « Unconventional gas »

Schematic geology of natural gas resources
3.2.1 Unconventional gas

- Tight Gas
- Shale Gas
- Coal Bed Methane (CBM)
3.2.1 Unconventional gas

Tight gas

• **Similar to conventional gas**
  – Source rock
  – Reservoir rock
• **But very low permeability**
  – Similar to shale gas
3.2.1 Unconventional gas
Shale gas

• **No migration**
  – The source rock is also the reservoir
• **No « dome shaped » reservoir**
  – Comparatively to conventional gas or tight gas, thin layers of gas-prone formation
• **Low permeability**
3.2.1 Unconventional gas
Coal Bed Methane (CBM)

• Also known as Coal Seam Gas (CSG)
• Gas is adsorbed onto the coal and maintained in this status by hydraulic pressure
• Used to be the main hazard in coal mines (explosions)
Film

Shale gas production
3.2.1 Unconventional gas Fracking

- **Target is to improve permeability by inducing micro-fractures in the rocks (fracking)**

- **Principle is:**
  - Use the non-compressibility of liquids (ie. Water) to transmit high pressure to the rock to fracture
  - Maintain micro-fractures open after the pressure shock by sending micro-particles (sand) into the micro-fractures

- **Sand will not naturally be evenly distributed in pure water:**
  - Use additives to obtain a good sand distribution

- **These additives are the know-how of drilling contractors**
  - Keep formula as commercialy sensitive information
Main Environmental issues in Shale Gas Production

• **Water table pollution:**
  – Issue: pollution of water tables during drilling or production
  – Mitigation: proper drilling/cementation when crossing water table horizon (say 100m); gas production itself much deeper (say 3000m)

• **Use of chemical additives:**
  – Issue: toxicity of additives injected in water to keep even distribution of sand grains in frack fluid
  – Mitigation: most additives now edible and derived from food industry.

• **Micro Seismicity:**
  – Issue: fracking may induce fractures or seismic activity up to surface
  – Mitigation: fracking occurs very deep (3000m); careful geological studies before and monitoring during fracking operations
3.2.1 Unconventional gas
US unconventional gas revolution

US : main country for unconventional gas production
Now accounts for over half of total US gas production (52% in 2009), with tight gas the leading unconventional source but shale gas output is growing fastest
Minimum cost of production in the US evaluated from 3.3 to 5.0 $/Mbtu
Unconventional gas brings worldwide gas reserves from 60 to 250 years.
3.3 Natural Gas Transportation

- 331 Pipelines
- 332 LNG
- 333 Other technologies
3.3.1 Pipe Transportation
Need for compression: pressure drop

![Graph showing pressure drop over distance for different flow rates.]

- **15 \times 10^9 \text{ m}^3/\text{y}**
- **12 \times 10^9 \text{ m}^3/\text{y}**
- **9 \times 10^9 \text{ m}^3/\text{y}**

36’’ pipe, i.e. 900 mm
3.3.1 Pipeline transportation

For a given diameter $D$, there is an optimal flow rate $Q$ for which the unit cost of transportation is minimal.
3.3.1 Pipeline transportation cost estimates

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1400</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>32</td>
<td>40</td>
<td>48</td>
<td>56</td>
</tr>
<tr>
<td>Investment (M$/1000 km)</td>
<td>1300</td>
<td>1600</td>
<td>2000</td>
<td>2300</td>
</tr>
</tbody>
</table>

These estimates are valid for international pipes over hundreds/thousands km

Operating costs of the gas pipe: 1 to 3% of investment per year
3.3.1 Pipeline transportation

• Natural gas fills a volume 1000 times larger than crude oil for the same energy content.

• Long-distance transportation costs for gas are higher than those for oil — by a factor of five to ten

• Natural gas transportation is characterized by very large economies of scale

• Share of transportation/distribution costs in overall natural gas supply costs is large

• Key factors in costs are:
  – Pipe diameter and pressure
  – Pipe cost is proportional to its diameter

• Parker (University of California) has estimated the cost breakdown as 26% materials, 45% labor, 22% way leaves (right of way), and 7% miscellaneous
LNG vs. Gas pipe

LNG is by far the most effective way (technical and economic) to transport natural gas from remote reserves to the main consuming areas.

Source: AFTP les journées annuelles du pétrole 2008
3.3.1 Pipeline transportation
Examples of Pipeline Data

• **Trans-Mediterranean Pipeline: Algeria – HassiR’Mel – Tunisia Border**, 48 inches (diameter), 547 km (length), 33.0 Bcm/year (capacity)

• **Greenstream: Waffah – Mellitah (onshore)**, 32 inches, 550 km, 11.5 Bcm/year

• **Interconnector UK – Zeebrugge**, 40 inches, 240 km, 20 Bcm/year

• **Gazoduc Maghreb Europe (GME) : Hassi R’Mel – Cordoba**, 48 inches, 1600 km, 12 Bcm/yr

• **Medgaz : Beni Saf (Algeria) – Almeria (Spain)**, 24 inches, 210 km, 8 Bcm/yr, offshore, max water depth 2160 m
### Natural Gas transmission network in Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Terminal</th>
<th>Starting date</th>
<th>Capacity Mt/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgique</td>
<td>Zeebrugge</td>
<td>1987</td>
<td>5.70</td>
</tr>
<tr>
<td>Espagne</td>
<td>Barcelone</td>
<td>1968</td>
<td>10.87</td>
</tr>
<tr>
<td>Espagne</td>
<td>Huelva</td>
<td>1988</td>
<td>7.98</td>
</tr>
<tr>
<td>Espagne</td>
<td>Cartagena</td>
<td>1989</td>
<td>5.72</td>
</tr>
<tr>
<td>Espagne</td>
<td>Bilbao</td>
<td>2003</td>
<td>5.00</td>
</tr>
<tr>
<td>Espagne</td>
<td>Sagunto</td>
<td>2006</td>
<td>2.75</td>
</tr>
<tr>
<td>Espagne</td>
<td>Reganosa</td>
<td>2007</td>
<td>4.50</td>
</tr>
<tr>
<td>France</td>
<td>Fos-sur-Mer</td>
<td>1972</td>
<td>5.07</td>
</tr>
<tr>
<td>France</td>
<td>Montoir</td>
<td>1980</td>
<td>7.25</td>
</tr>
<tr>
<td>Grèce</td>
<td>Revithoussa</td>
<td>2000</td>
<td>1.60</td>
</tr>
<tr>
<td>Italie</td>
<td>Panigaglia</td>
<td>1971</td>
<td>3.50</td>
</tr>
<tr>
<td>Portugal</td>
<td>Sines</td>
<td>2003</td>
<td>3.00</td>
</tr>
<tr>
<td>Turquie</td>
<td>Marmara</td>
<td>1994</td>
<td>4.20</td>
</tr>
<tr>
<td>Turquie</td>
<td>Izmir</td>
<td>2003</td>
<td>4.38</td>
</tr>
<tr>
<td>Roy.-Uni</td>
<td>Grain LNG</td>
<td>2005</td>
<td>3.30</td>
</tr>
<tr>
<td>Roy.-Uni</td>
<td>Teeside LNG</td>
<td>2007</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Source: Commission Européenne
Major natural gas infrastructure projects in Europe

Source: Eurogas
3.3.2 - Liquefied Natural Gas (LNG)
3.3.2 LNG
Principle

- Liquefied Natural Gas (LNG)
  - Mostly methane (CH₄) (> 90%)
  - Liquid at -160°C at atmospheric pressure
  - Low specific gravity (around 0.45)
  - 1 m³ of LNG equals 600 m³ of natural gas at 20°C/1 bar
LNG
The LNG Chain
### 3.3.2 LNG

#### LNG Plant – simplified income statement

<table>
<thead>
<tr>
<th></th>
<th>G$/yr</th>
<th>Asia</th>
<th>Europe</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG</td>
<td>6</td>
<td>4,4</td>
<td>2,9</td>
<td>0,9</td>
</tr>
<tr>
<td>Condensates</td>
<td>30 000</td>
<td>1,0</td>
<td>1,0</td>
<td>1,0</td>
</tr>
<tr>
<td>Total revenues</td>
<td></td>
<td>5,4</td>
<td>3,9</td>
<td>1,9</td>
</tr>
<tr>
<td>% condensate vs total</td>
<td></td>
<td>18%</td>
<td>25%</td>
<td>51%</td>
</tr>
<tr>
<td>Condensates income</td>
<td></td>
<td>3,2 $/mbtuLNG</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.3.3 Natural Gas Transportation
Other technologies

- **Gas Pipeline**: Natural Gas is transported in gaseous state at high pressure

- **LNG**: *Liquefied Natural Gas*
  - Natural Gas is cooled down to minus 160 deg C and transported in liquid state at atmospheric pressure

- **GTL**: *Gas To Liquids*
  - Natural Gas is converted to Petroleum Products (Diesel, Jet fuel etc...) and then transported as conventional liquid hydrocarbons at atmospheric pressure

- **Fertilizers**: Natural Gas is used as feedstock to a Fertilizer Plant, and then transported as fertilizer.

- **Petrochemicals**: Natural Gas is used as feedstock to a Petro Chemical Plant, and then transported as Petrochemical Products
3.4 Natural Gas Storage

1. Flexibility requirements
   - Strategic storage
   - Long term / Seasonal
   - Short term / intraday

2. Sources of flexibility
   - Various types of underground storage
   - Supply contracts flexibility
   - LNG
3.4 Natural Gas Storage

- 341 Flexibility requirements
- 342 Storage technologies
3.4.1 Flexibility requirements – Strategic Storage

• Increasing share of imports and of unpredictability in European supplies:

  – Piped Gas: third party countries interference (Ukraine, Bielorussia)
  – LNG: economic arbitrage
3.4.1 Flexibility requirements
Seasonal Flexibility

- Capacity to supply increased seasonal gas requirements
- European peak: winter
- Asian peaks: winter and summer (air conditioning)
- US: isolated thanks to shale gas
3.4.1 Flexibility requirements - Short term
One week in Germany Summer 2011

Source: RTE
3.4.2 Storage Technologies

- Various types of Underground Storage:
  - **Depleted fields: several BCM - fit for strategic/seasonal storage**
    - A former gas fields is converted to receive gas for storage
    - Very large capacity, implying a large «cushion gas» volume
    - Slow injection / withdrawal flowrate (say 150 days)
  - **Aquifer reservoir: 0,5 to 5 BCM - fit for strategic/seasonal storage**
    - A gas tight underground «dome» limited at bottom by water table
    - Large capacity, large cushion gas
    - Slow injection / withdrawal rate
  - **Salt Caverns: 0,01 to 0,5 BCM – fit for short term «peak» storage**
    - A hole (say 300m high /60m dia) is created in underground salt layer or salt dome, by washing out the salt : injecting water and collecting the brine
    - Small capacity, low cushion gas volume, which can be collected back 100% at decommissioning of facility
    - Very fast injection / withdrawal (say 20 days)
# LNG vs Underground storage

<table>
<thead>
<tr>
<th></th>
<th>LNG Terminal</th>
<th>UGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG storage</td>
<td>360,000 m³</td>
<td></td>
</tr>
<tr>
<td>Equiv gas volume</td>
<td>0.22 bcm</td>
<td>2.7 bcm</td>
</tr>
<tr>
<td>Energy storage</td>
<td>2.38 Twh</td>
<td>29 Twh</td>
</tr>
<tr>
<td>Approx max sendout</td>
<td>10 bcma</td>
<td>13 bcma</td>
</tr>
<tr>
<td></td>
<td>333 Gwh/d</td>
<td>447 Gwh/d</td>
</tr>
</tbody>
</table>

LNG vs Underground storage

-
Flexibility  Supply - LNG

- **LNG is a source of short term flexibility:**
  - High emission flowrate
  - Competes with salt caverns for emission flowrates
  - Less intraday market optimization capabilities than salt caverns (no injection capacities)

- **LNG in Europe is not a reliable source of seasonal flexibility:**
  - Low storage capacities: offloading terminals, not storage
  - LNG is used as arbitrage between different markets (Asia vs Europe), not as arbitrage between seasons
  - Seasonal demand peaks in winter in Asia and in Europe
# Natural Gas Storage in Europe

<table>
<thead>
<tr>
<th>Yearly cons</th>
<th>storage</th>
<th>st ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA</td>
<td>BCM</td>
<td>%</td>
</tr>
<tr>
<td>UK</td>
<td>98</td>
<td>3.7</td>
</tr>
<tr>
<td>Germany</td>
<td>86</td>
<td>10.6</td>
</tr>
<tr>
<td>Italy</td>
<td>78</td>
<td>16.5</td>
</tr>
<tr>
<td>France</td>
<td>50</td>
<td>11.7</td>
</tr>
<tr>
<td>Netherlands</td>
<td>42</td>
<td>5</td>
</tr>
<tr>
<td>Spain</td>
<td>36</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Europe : 12%
International Natural Gas Trade
3.5 International Natural Gas Trade
Regional natural gas markets

- Main natural gas flows are limited to regional markets linked by cross-border gas pipes (expensive infrastructures), which limit trade over very long distances

- Three Main Regional Gas Markets with Marginal Links

<table>
<thead>
<tr>
<th>NORTH AMERICA</th>
<th>EUROPE</th>
<th>EAST ASIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNITED STATES</td>
<td>WESTERN EUROPE</td>
<td>JAPAN</td>
</tr>
</tbody>
</table>

- Canada
- Norway
- Russia
- Algeria
- Indonesia
- Australia
- Middle East

With this world market structure, Gas is in Competition with Regional Energy References. No Mutual Price Adjustment and thus No International Gas Price Marker.
Evolution of natural gas international trade

Source: BP Statistical Review
G333*3O – September 2012
2011 gas trade by pipeline

**EXPORTATIONS = 694.6 Gm³**

- Russia: 30%
- Canada: 13%
- Norway: 13%
- Netherlands: 7%
- Others: 11%
- USA: 6%
- Algeria: 5%
- Turkmenistan: 5%
- Qatar: 3%
- Bolivia: 2%
- Kazakhstan: 2%
- Iran: 1%
- Myanmar: 1%
- Others: 28%
- United States: 13%
- Germany: 12%
- Italy: 9%
- Ukraine: 6%
- Turkey: 5%
- Russia: 4%
- United Kingdom: 4%
- France: 5%
- Belgium: 3%
- Belarus: 3%
- United Arab Emirates: 2%
- China: 2%

**IMPORTATIONS = 694.6 Gm³**

Source: BP Stat. Review
G337 – Aug 2012
2011 gas trade by LNG carrier

EXPORTATIONS = 297.6 Gm³

IMPORTATIONS = 297.6 Gm³

Source: BP Stat. Review
G338 – Aug 2012
World LNG demand prospects

+ 6%/year over 2011-2020

Source: CEDIGAZ

Ordinary General Meeting CEDIGAZ, Rueil Malmaison, 24 June 2011
4 - Natural Gas Contracts and Pricing

4.1 Types of gas trade
4.2 Natural Gas LT Contracts
4.3 Natural Gas Pricing
4.1 Types of Gas Trade

1. **Long Term Contracts:**
   - 10 to 25 years
   - Represent today most of the gas trade in Asia and Europe
   - Indexed Price Formulae

2. **Organized Markets:**
   - Represent most of the trade in US (Henry Hub); being developed in Europe (NBP in UK, TTF in NL, Zeebrugge in Belgium, etc.); non-existent in Asia
   - « gas to gas competition » generates Price
4.2 Natural Gas LT Contracts

Type of contracts
GSPA: a reciprocal agreement

• To sale and purchase defined quantities
  – Of a defined product
  – Delivered at an identified point
  – During a defined period
  – With a defined flexibility
  – And with a sharing of responsibility
  – At a defined price
LT Contracts: objectives of the Contracting Parties

- **Producers:** *Security of demand*
  - Have a secure outlet for their production
  - Have a predictable and maximized cash flow thru proper pricing
  - Both points being necessary for Producers to be able to finance the very large investments required by the gas chain from wellhead to customer border

- **Buyers:** *Security of Supply*
  - Have a secure source of gas to supply their customers, such secure supply being often an obligation viz their Governmental Authorities
  - Have a pricing maintaining competitiveness of gas vs other energies
  - Both points being necessary for Buyers to be able to properly market gas to end Customers

- **Often summarized as:**
  
  “Price risk lies with Producer, Quantity risk lies with Buyer”
LT Contracts – Types of contracts

Depletion contract

Supply contract
Depletion contract

• The totality of the economical recoverable reserves of a field are allocated to the Buyer ► the contract is linked with a gas source contractually and geographically defined

• Contract generally preferred by producers (sale of gas as produced)

• A part of the risk is transferred to the Buyer (quantity clause linked to the physical properties of the field) who must manage this risk (obligation of many technical information from producer)

• Lower price
Supply contract

- Commitment for the producer to deliver an annual volume of gas, for a defined period (x years)

- The gas delivered comes from many sources ► need for the producer of an aggregation of gas sources, with a dominant source for the back-up: Troll (Statoil), Groningen (GasTerra), Yamburg-Urengoy (Gazprom), Hassi R'Mel (Sonatrach)

- No need of reserves declaration of the producer to the Buyer

- Contract preferred generally by buyers (no volume risk).
Interruptible contract

- The producer has the right to interrupt gas delivery with a very short term of notice.
- Very low prices.
Peak Shaving contract

- The producer commits himself to deliver additional quantities during specific periods.
- Very high prices
« Seller's nomination » contract

• The buyer commits himself to buy the production appointed by the producer. In general, this type of contract applies to associated gas or the beginning of the production.

• Reduction on the prices.
# Long term contracts – Main clauses

**Classical framework of a GSPA:**

<table>
<thead>
<tr>
<th><strong>COMMERCIAL</strong></th>
<th><strong>RESPONSIBILITIES</strong></th>
<th><strong>OPERATIONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>Force Majeure</td>
<td>Installations</td>
</tr>
<tr>
<td>Quantities</td>
<td>Assignment</td>
<td>Counting, allocation and analysis</td>
</tr>
<tr>
<td>Quality</td>
<td>Expert</td>
<td>Communication and information exchange</td>
</tr>
<tr>
<td>Price</td>
<td>Arbitration</td>
<td>Confidentiality</td>
</tr>
<tr>
<td>Delivery point(s)</td>
<td>Applicable law</td>
<td>Invoicing and payment</td>
</tr>
<tr>
<td></td>
<td>Definitions</td>
<td>Property transfer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General provisions</td>
</tr>
</tbody>
</table>
4.3 Natural Gas Prices
• **Gas price formulae**
  – Three main types according to regions
  • North America: Gas to Gas Index « Henry Hub »
  • Europe: LT contracts, price formulae based on oil products
  • Japan/Taïwan/Korea: LT contract, price formulae based on oil
How to define a price in a LT contract?

1. « Cost Plus pricing »: the producer/seller is fixing the price at the level of the production cost and adds a profit margin

2. « Net-back pricing » or market value (comparison with other energy sources in competition with marketed gas):
   - The price is the maximum value allowed on the buyer market by the competition with the other energy sources.
   - Allows to maximize the value for the seller and to limit the commercial risk of the buyer
   - Model developed for the first time in Europe in the Netherlands in the 60’s.

Today: market value + gas-to-gas competition
Values of indices $X$ and $Y$ are computed over a reference period (3 to 12 months), preceding the period over which the gas price $P$, derived from the formula, is applied. Gas price $P$ derived from the price formula is usually used for a period of 3 months before being readjusted with new values of the indices.

**Gas price formulae**

\[ P = P_0 + a (X - X_0) + b (Y - Y_0) \]

$P$ is the price of gas over a specific period, $P_0$ is a base price, $X$ and $Y$ are indices computed over a reference period (3 to 12 months), $a$ and $b$ are coefficients.

- $P = P_0 + 60\% * 0.8 \ (GO - GO_0) + 40\% * 0.9 \ (FO - FO_0)$
- $P = P_0 \ (30\% * GO/GO_0 + 30\% * FO/FO_0 + 40\% * I/I_0)$
- $LNG$
  \[ P(GNL \ ex \ ship) = 0.15 * JCC + Cst * Inflation \]
  JCC: Japanese Crude Cocktail
  (average price of a basket of imported crude)
- Gas for a power plant
  \[ P = P_0 \ (35\% * C/C_0 + 20\% * E/E_0 + 20\% * I/I_0 + 20\% * S/S_0 + 5\% * T/T_0) \]
Indexes definitions

- **GO**: Gas Oil
- **FO**: Fuel Oil
- **I**: Inflation
- **C**: Coal
- **E**: Electricity
- **S**: Salary / Wage
- **T**: Capital Goods (“machinery”)
Gas prices: weight of indexes in European formulas

**WESTERN EUROPE**
- Fioul lourd: 32%
- Brut: 4%
- Electricité: 1%
- Part fixe: 6%
- Inflation: 0%
- Charbon: 2%
- Marché gaz: 3%
- Gasoil: 52%

**EASTERN EUROPE**
- Fioul lourd: 49%
- Electricité: 1%
- Part fixe: 2%
- Gasoil: 48%

Source: GAS MATTERS 2006
Examples of formulas of LNG price (Asia)

\[ P(\text{ex ship}) = LE + TE \]

\[ LE = \text{LNG element} = 0, 153 \times \text{REP} + \text{Cst} \times \text{inflation} \]

\[ TE = \text{Transportation element} = \text{Cst} \times \text{fixed escalation ou cost passthrough} \]

\[ \text{REP Realized Export Prices} = \text{average price of an exported crude basket} \]

\[ P(\text{ex ship}) = 0.1485 \times \text{JCC} + \text{Cst fixe} + \text{S-curve} + \text{price review} \]

\[ \text{JCC: Japan Custom Cleared} = \text{average price of an imported crude basket} \]
Underlying reasons for oil (or oil products) index for gas (1/2)

• **Production**
  – Gas has been initially a by-product of oil production
    → *Not the case anymore: main fields (ie. Russia/Qatar/Norway) are gas fields*

• **Usage**
  – Gas used to be competing against oil for power generation in Japan, or against oil products for residential/industrial in Europe or US
    → *Not the case anymore: most increase of gas demand is for power generation in hi-efficiency CCGT, non switchable*

• **By default**
  – Except in US, no valid gas to gas index yet in Europe and Asia
Examples of formulas of LNG price (USA)

\[ P(\text{ex ship}) = X\% \times \text{Henry Hub} \]

With X around 95%
Evolution of long term contracts
# Main differences between monopolistic and deregulated markets

<table>
<thead>
<tr>
<th></th>
<th>Monopolistic market</th>
<th>Deregulated market</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration of contracts</strong></td>
<td>Mainly Long term Contracts (20/25 years)</td>
<td>Short (1 month) medium (18 months) &amp; long term (less than 10 years) Contracts</td>
</tr>
<tr>
<td><strong>Buyings</strong></td>
<td>“Take or Pay” Clause</td>
<td>“Take or Release” Clause (US)</td>
</tr>
<tr>
<td><strong>Prices</strong></td>
<td>« Netback » Calculation with competing energies indexing</td>
<td>Price market indexing (spot)</td>
</tr>
<tr>
<td><strong>Infrastructures</strong></td>
<td>Managed by the monopolistic gas company</td>
<td>Existing assets managed by a dedicated company with third party access</td>
</tr>
<tr>
<td></td>
<td>▪ Transportation</td>
<td>Exemption of third party to allow capacity investments of new comers</td>
</tr>
<tr>
<td></td>
<td>▪ Storage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Methane carrier terminal</td>
<td></td>
</tr>
</tbody>
</table>
LT Contracts – Evolution

• **Duration:**
  – more and more short and medium term transactions, but still de new long term contracts (10-15 years)

• **Take-or-Pay:**
  – still a key element of long term contracts, but these obligations could have hurt old monopolies attacked on their market owing to LT formulae/Markets gap

• **Price:**
  – emergence of spot price references

• **Regulation:**
  – to develop a single market, the European Commission opposes *joint ventures* (in upstream markets) and territorial or usage *restrictions.* *(eg “destination clauses”)*
5 - Conclusion on Gas Industry Today
Conclusion 1
On a global level…

Benchmark month ahead prices (2004-2012)

... still a 3 Ways split
Conclusion 2

Shale gas and LNG: a revolution on world gas markets

• **US shale gas**
  – Gives a much lower gas price reference
  – De facto slams the door shut to LNG imports into the largest gas market
  – May even trigger exports from Canada or even US

• **LNG developments**
  – Transmits gas price signals across the globe
  – Middle East LNG can swing to Asia or to Europe large quantities initially intended for US

→ *Gas is now a worldwide commodity per se*
Conclusion 3
Likely evolution

• Gas to gas competition is displacing oil indexation

• Size of LNG liquefaction capacity, number of LNG receiving terminals and of operators is ensuring fluidity of gas movement worldwide

• Gas is becoming a worldwide commodity (contrary to power) with its own fundamentals

• Size of gas reserves (some 250 years including unconventional gas) is 5 times size of oil reserves: peak oil concept may exist, peak gas concept is now very questionable

• Common sense should lead Europe and Asia into developing reliable gas indexes, acceptable to producers and buyers, complementing the US Henry Hub