BULGARIAN ENERGY FORUM 2012
REGIONAL ENERGY CONFERENCE

„ENERGY DEVELOPMENT IN THE CHANGING WORLD – STRATEGIES, CHALLENGES AND OPTIONS”

"Polish energy strategy for national energy security – versus European ROADMAP 2050"

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Instytut
Studiów Energetycznych

Disclaimer

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However, the Oil&Gas business is characterized
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Accordingly, we do not accept any liability
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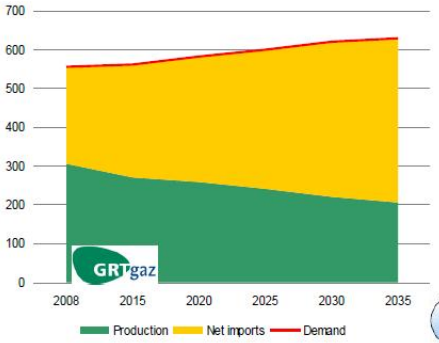
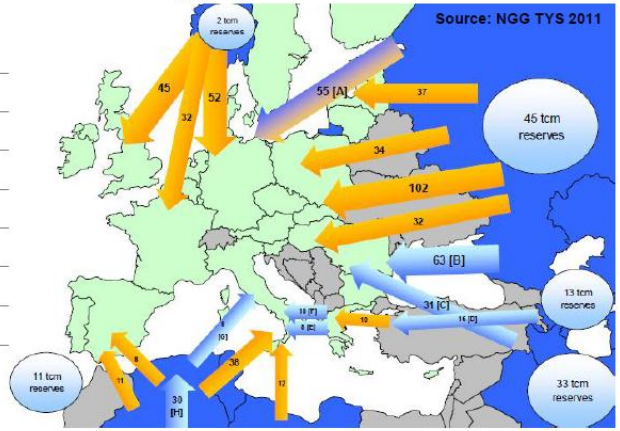
AGENDA

- ✓ Few words about European forecasts for natural gas
- ✓ Current market players and new possible clients for hydrocarbons in the EU
- ✓ New demand – is energy generation the only possible ways for new gas?
- ✓ No place for nuclear, no place for coal Common European Energy Market based on natural gas instead of renewables?
- ✓ Will unconventional gas break the trend and Poland is ready to lead the European quest for gas independence?

Supply/demand in Europe

- Indigenous production is falling
- Europe is reliant on an ever greater import volumes
- LNG will account for an ever greater share of those imports





Gas imports to Europe come from four main sources: Norway, Russia/Central Asia, North Africa and LNG

Understanding greenhouse gases

- **„Water vapor:** The main greenhouse gas is water vapor (H_2O), which is responsible for about two-thirds of the natural greenhouse effect. In the atmosphere, water molecules capture the heat that the earth radiates and then re-radiate into all directions, warming earth's surface, before it is eventually radiated back to space. Water vapor in the atmosphere is part of the hydrological cycle, a closed system circulating water – of which there is a finite amount on earth - from the oceans and land to the atmosphere and back again through evaporation and transpiration, condensation and precipitation. *Human activities do not add water vapor to the atmosphere*. However, warmer air can hold much more moisture, so increasing temperatures further intensify climate change.

- **Methane:** The second-most important greenhouse gas for the enhanced greenhouse effect is methane (CH_4). Since the beginning of the Industrial Revolution, atmospheric methane concentrations have doubled and contributed some 20% to the enhancement of the greenhouse gas effect. *In industrialized countries, methane accounts typically for 15% of greenhouse gas emissions.* Methane is created predominantly by bacteria that feed on organic material where there is a lack of oxygen. It is therefore emitted from a variety of natural and human-influenced sources, with manmade emissions accounting for the majority. Natural sources include wetlands, termites, and oceans. Human-influenced sources include the mining and burning of fossil fuels, livestock husbandry (cattle eat plants that ferment in their stomachs, so they exhale methane and their manure contains it), rice cultivation (flooded paddy fields produce methane since organic matter in the soil decomposes without sufficient oxygen) and landfills (again, organic waste decomposes without sufficient oxygen). *In the atmosphere, methane traps heat and is 23 times more effective at that than CO_2*

- **Carbon dioxide:** The main contributor to the enhanced **(manmade)** greenhouse effect is carbon dioxide (CO2). Globally, it accounts for over 60% of the enhanced greenhouse gas effect. In industrialized countries, CO_2 makes up more than 80% of greenhouse gas emissions. (Oceans absorb CO_2 which, in dissolved form, is used by marine life in photosynthesis.) Recently, European researchers discovered that current concentrations of CO_2 in the atmosphere are higher now than at any time during the past 650,000 years. Ice cores were drilled from a depth of more than 3km in the Antarctic ice, which formed hundreds of thousands of years ago. The ice contains air bubbles that provide a history of atmospheric compositions from different ages in the earth's history".

http://ec.europa.eu/clima/sites/campaign/pdf/gases_en.pdf

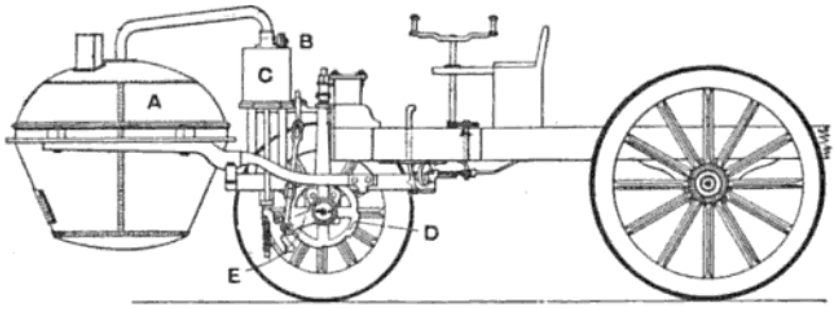
Understanding greenhouse gases

- Agriculture 10%
- Energy use excl.transport 21%
- Transport **61%**
- Waste 2%
- Industrial processes 6%

"America's First Steam Locomotive, 1830", EyeWitness to History, www.eyewitnesstohistory.com (2005) http://www.eyewitnesstohistory.com/tomthumb.htm

How it works?

”However beautiful the strategy, you should occasionally look at the results”



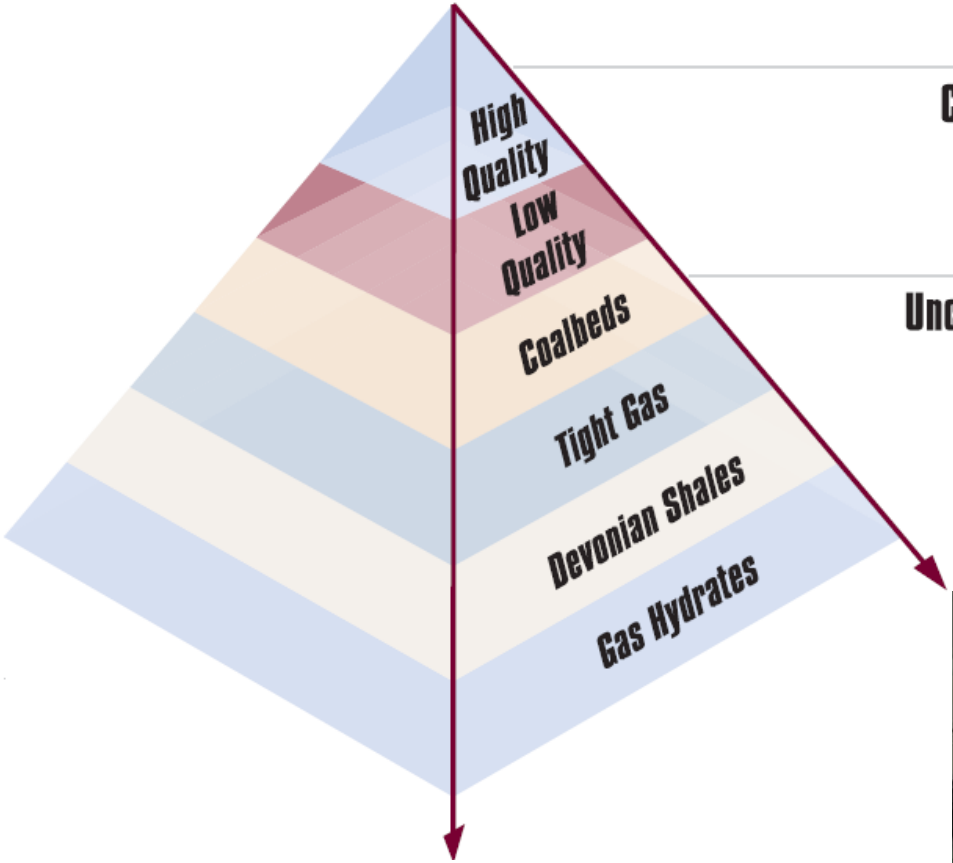
- ✓ **1865** The Locomotive Act 1865 (popularly known as the Red Flag Act) imposes a speed limit of 2mph in cities, towns and villages, and 4mph elsewhere. Also requires a pedestrian carrying a red flag in front of the vehicle at a distance of 60yds. The vehicle was required to have three drivers aboard it.

- ✓ **1878** The Locomotive Amendment Act 1878 made the red flag optional under local conditions and reduced the distance of the warning red flag to 20 yards.

- ✓ **1879** George B. Selden, a patent lawyer and inventor who never manufactured a motor vehicle, filed patent on a 'road engine'. The high speed internal combustion engine was yet to be invented, and Selden managed to keep the patent 'pending' for over 15 years--it issued as United States patent number 549,160 in 1895. He and his Association of Licensed Automobile Manufacturers (formed 1903) attempted to enforce a strict monopoly on motor manufacturing. Henry Ford (among others) infringed the patent, and in 1911 achieved a ruling which overturned the attempted monopoly.

- ✓ **1885** Sylvanus F Bowser invents the petrol delivery pump […]

Unconventional gas sources

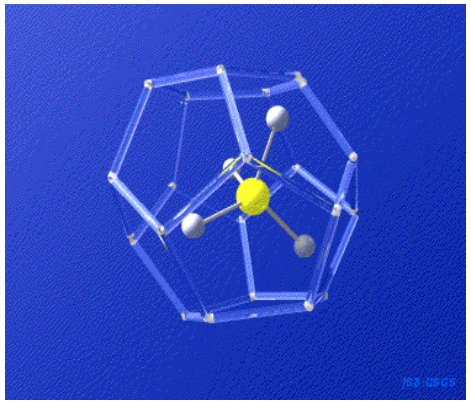


Dry, sweet natural gas with high methane content

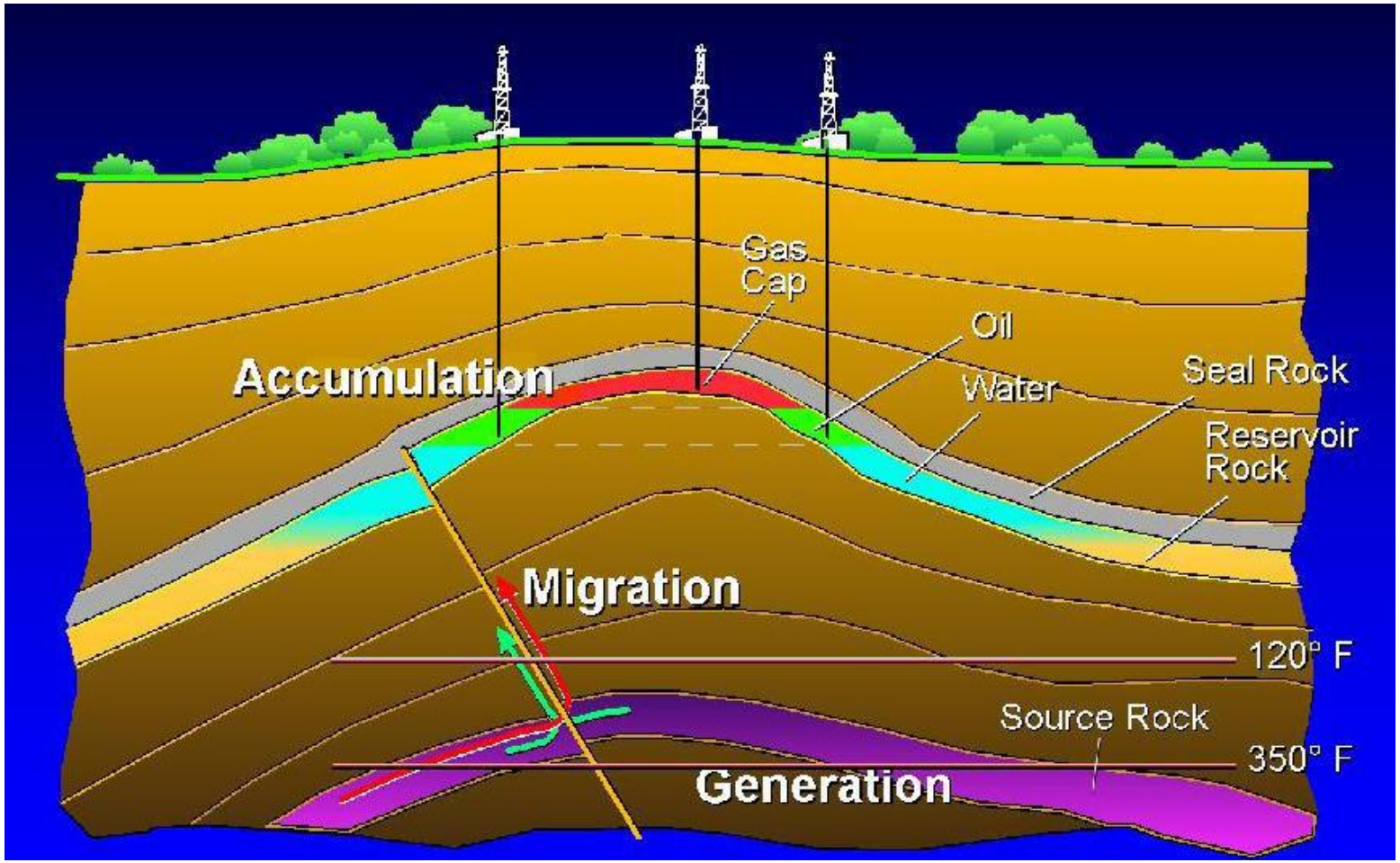
- wet, sour gas
- condensate
- Gas from the zones of extreme pressure

Gas from coal seams (Coalbeds)

- Gas from tight sands (tight gas)
- Gas from shale (Devonian shales)
- Gas Hydrates



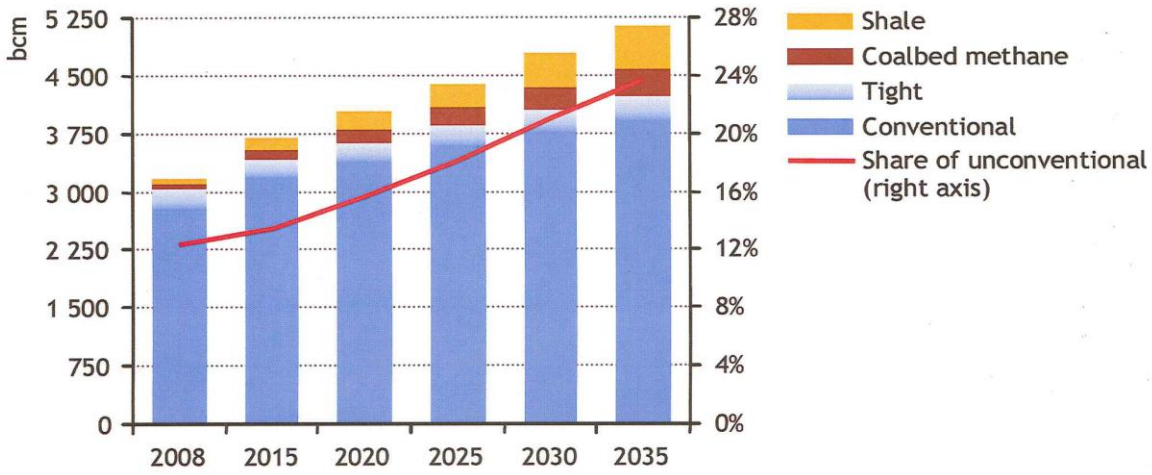
Geology of oil and gas - a summary

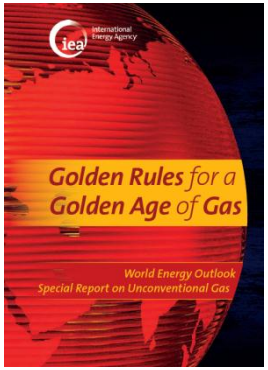


How big worldwide is yearly unconventional gas production today?

- ✓ 50 bcm
- ✓ 250 bcm
- ✓ 450 bcm
- ✓ 900 bcm

Figure 1.7 ▷ Natural gas production by type in the GAS Scenario





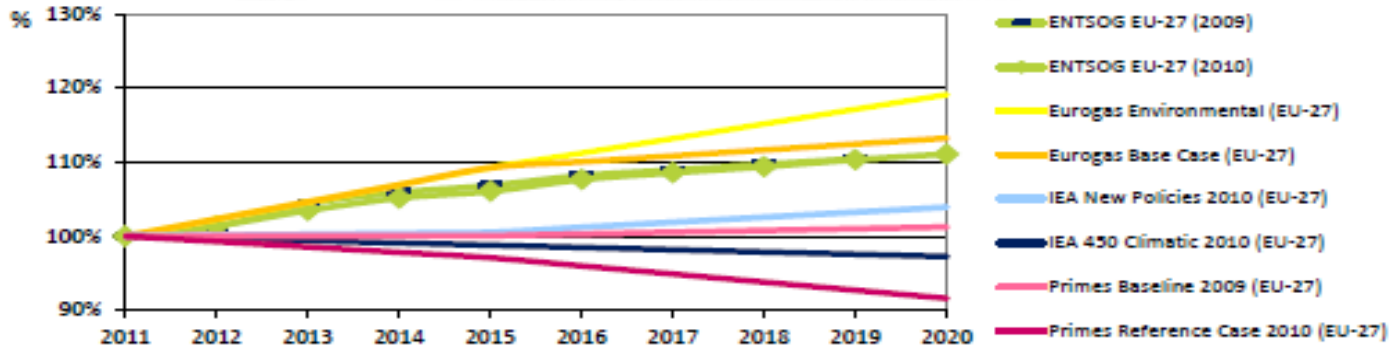
European forecasts for natural gas

Demand Outlook 2011-2020

(Growth trends (%), 2011 start)

Demand is a highly uncertain variable

- Forecasts range from a 9% decrease in demand to a 19% increase
  - in absolute numbers, the difference is equal to the combined consumption of Germany and Belgium
- This reflects differing assumptions on the role of gas in the future energy mix and makes it difficult for the TSOs to define the High Daily Demand* which is the basis for designing resilient networks



*HDD is to be understood as demand outlook for extreme climatic conditions occurring statistically at low frequency

entsog

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Source: www.entsog.eu
And
http://ec.europa.eu/energy/energy2020/roadmap/doc/roadmap2050_ia_20120430_en.pdf

European forecasts for natural gas

Energy
Roadmap 2050
Impact assessment and scenario analysis

2.4. Business as usual developments

2.4.1. Modelling approach

The Commission has carried out an analysis of possible future developments in a scenario of unchanged policies, the so-called **"Reference scenario"**. The Reference scenario was also used in the IA for the "Low-carbon economy 2050 roadmap" and IA for the "White Paper on Transport". The Reference scenario is a projection, not a forecast, of developments in the absence of new policies beyond those adopted by March 2010. It therefore reflects both achievements and deficiencies of the policies already in place. In order to take into account the most recent developments (higher energy prices and effects of the nuclear accident in Japan) and the latest policies on energy efficiency, energy taxation and infrastructure adopted or planned after March 2010, an additional scenario called **Current Policy Initiatives scenario (CPI)** was modelled.

Both scenarios build on a modelling framework including PRIMES, PROMETHEUS, GAINS and GEM-E3 models. The PRIMES model is a modelling system that simulates a market equilibrium solution for energy supply and demand. The model is organized in sub-models (modules), each one representing the behaviour of a specific (or representative) agent, a demander and/or a supplier of energy. GAINS complements PRIMES with consistent estimates of non-CO2 emissions and their contribution to reach the policy targets included in the reference scenario. PROMETHEUS is a stochastic world energy model used for determining fossil fuel import prices, while the results of the GEM-E3 general equilibrium model are used as inputs of macro-economic (e.g. GDP) and sectoral numbers (e.g. sectoral value added) for PRIMES. Several EU scenarios were established at different points in time using a framework contract with National Technical University of Athens (author and owner of the PRIMES model).

Source: http://ec.europa.eu/energy/gas_electricity/index_en.htm
And
http://ec.europa.eu/energy/energy2020/roadmap/doc/roadmap2050_ia_20120430_en.pdf

European forecasts – no econometric model!

What PRIMES cannot do

- Cannot deliver short-term forecasts as it is not an econometric model (so projections are not statistically based on past observations, which in PRIMES are only used for parameter calibration)
- Cannot perform closed-loop energy-economy equilibrium analysis, unless linked with a macroeconomic model such as GEM-E3
- Cannot perform detailed short-term engineering analysis of electricity system or gas system operation, as specialised models do (e.g. for an hourly operation for a single year)
- Although rich in sectoral disaggregation, PRIMES is limited by the concept of representative consumer per sector, not capturing differences due to heterogeneity of consumer types and sizes
- PRIMES lacks spatial information and representation (at a level below that of countries) and so lacks details about distribution and transport infrastructure and flows that depend on detailed spatial information (except electricity and gas flows over a country-to-country based grid infrastructure, which is represented in PRIMES)
- PRIMES is an empirical numerical model with emphasis on sectoral and country specific detail; it has a very large size and so some compromises were necessary to limit computer time at reasonable levels; compact small models may have a more sound theoretical foundation but lack the level of detail and the richness of PRIMES in representing technologies and policy instrum

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PRIMES Model Presentation for Peer Review – Part 1

Source: http://www.e3mlab.ntua.gr/e3mlab/index. 26/09/2011 Brussels E3MLAB

ROADMAP 2050 Key points:

(no unconventional gas in Europe and global climate deal being agreed)

eurogas
THE EUROPEAN UNION OF THE NATURAL GAS INDUSTRY

European Commission

The 2050 target means a 32 – 41% reduction in primary energy demand achieved by:

- ✓ **Energy Efficiency**: all sectors including buildings and households, but without identifying how it will meet the high de carbonisation targets.
- ✓ **Diversified Supply Technologies**: there are 3 related scenarios:
  - driven by carbon pricing and that both nuclear and carbon capture and storage (CCS) are publicly accepted;
  - assuming CCs is delayed and nuclear fills the gap based on carbon prices;
  - no new nuclear with more CCS (32% in power generation);
- ✓ **Renewable Energy Sources:** 75% in gross final energy consumption and 97% in electricity consumption.

ROADMAP 2050 Key points:

(no unconventional gas in Europe and global climate deal being agreed)

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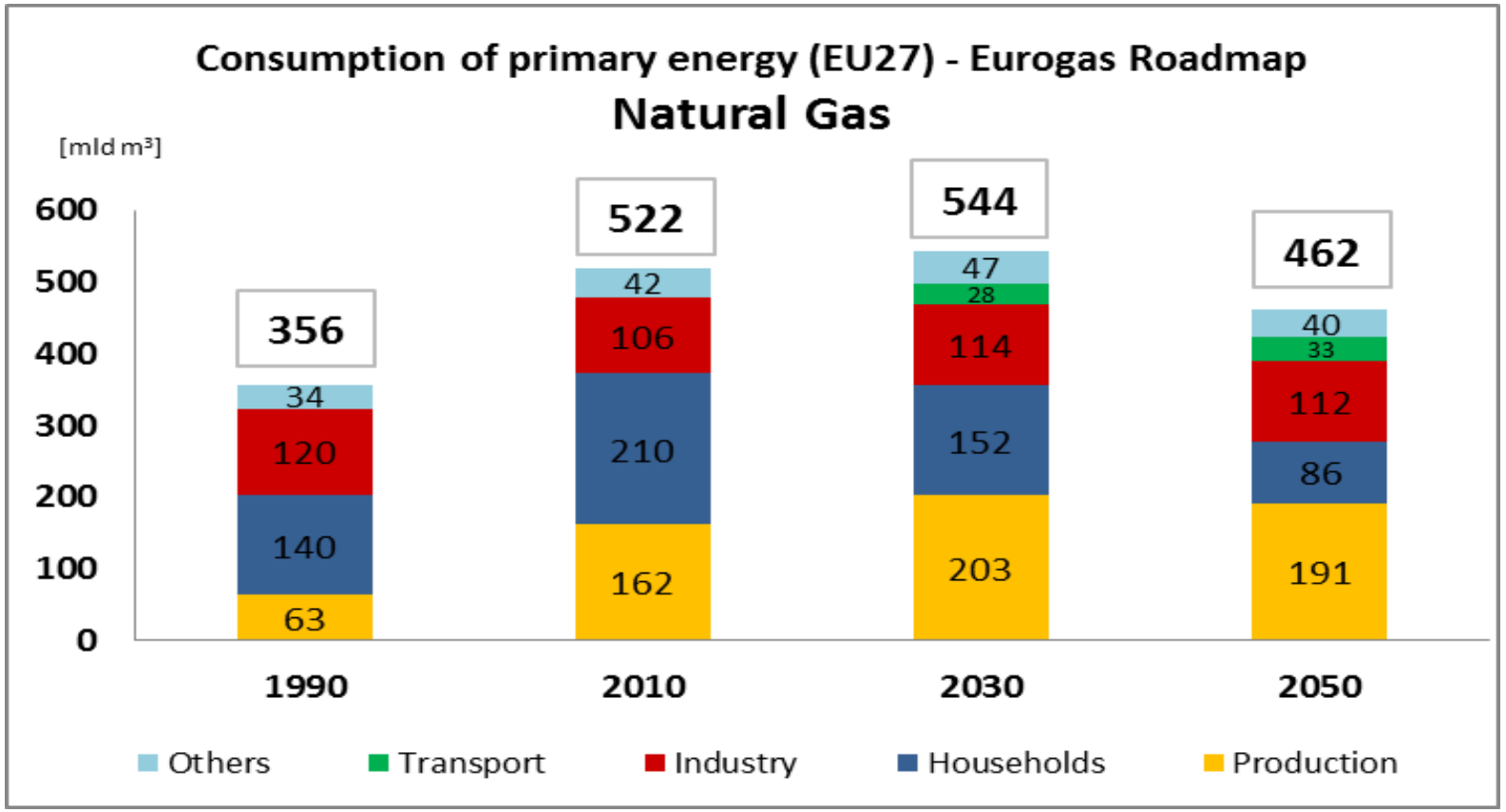
European Commission



Source: "Roadmap for moving to a low-carbon economy in 2050" www.eurogas.com

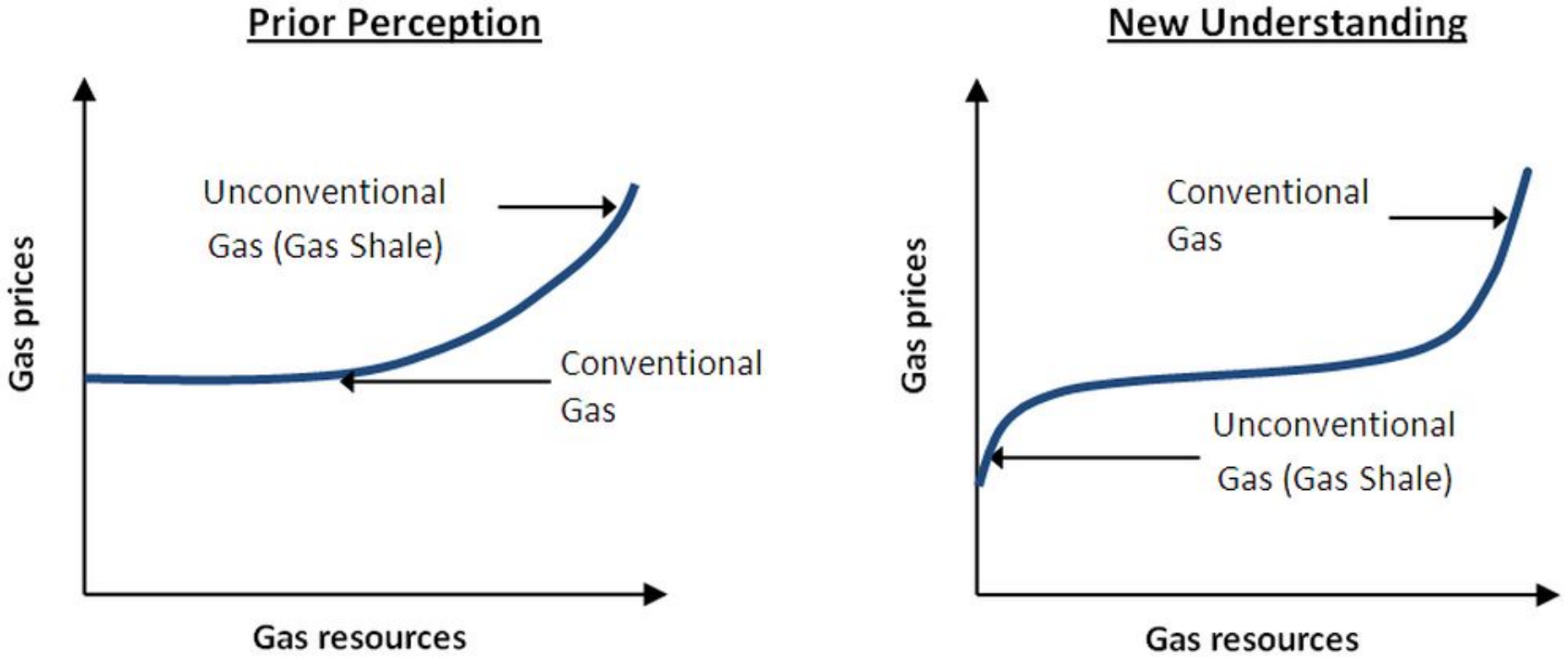
Who dares duplicate the American unconventional gas revolution ?

Source: Stanisław Rychlicki PGNiG S.A..

Oil linked prices – GAZPROM (Russia) ?

✓Shale gas has moved to the bottom of the US gas supply curve.

✓Until recently, conventional gas was viewed as low-cost, while shale gas was an abundant but high-cost US resource – that perception has now reversed.



Source: Vello A. Kuuskraa, „Gas Shales Drive the Unconventional Gas Revolution", Advanced Resources International, Inc., Washington Energy Policy Conference: The Unconventional Gas Revolution, March 9, 2010, Washington, D.C.

The EU Commission publishes new studies on unconventional gas

7th. September 2012

- ✓ Three new studies on unconventional fossil fuels, in particular shale gas.
- ✓ The studies look at the potential effects of these fuels on:
  - a) energy markets,
  - b) the potential climate impact of shale gas production,
  - c) the potential risks shale gas developments and associated hydraulic fracturing ("fracking") to human health and the environment.

„The study on energy market impacts shows that unconventional gas developments in the US have led to greater LNG supplies becoming available at global level, indirectly influencing EU gas prices.[…]"

The importance of competition to make shale economical.

Cost reductions is a key…

- ✓ **The EU law - bureaucratic burden -**
  local regulations; language differences
- ✓ **Local rig market is dominated by state-controlled companies -**
  reducing the effect „competition on cost"
- ✓ **Extremely limited supply of key services -**
  just few frac, geo seismic crews (travel needs)
- ✓ **Times of drilling = experience -> money !!!**
  fast and efficient operations - proper equipment

Till now =>

30 exploration wells and 7 hydraulic facturing only

Till end of 2012 =>

34 new wells… (45 required by concessions)

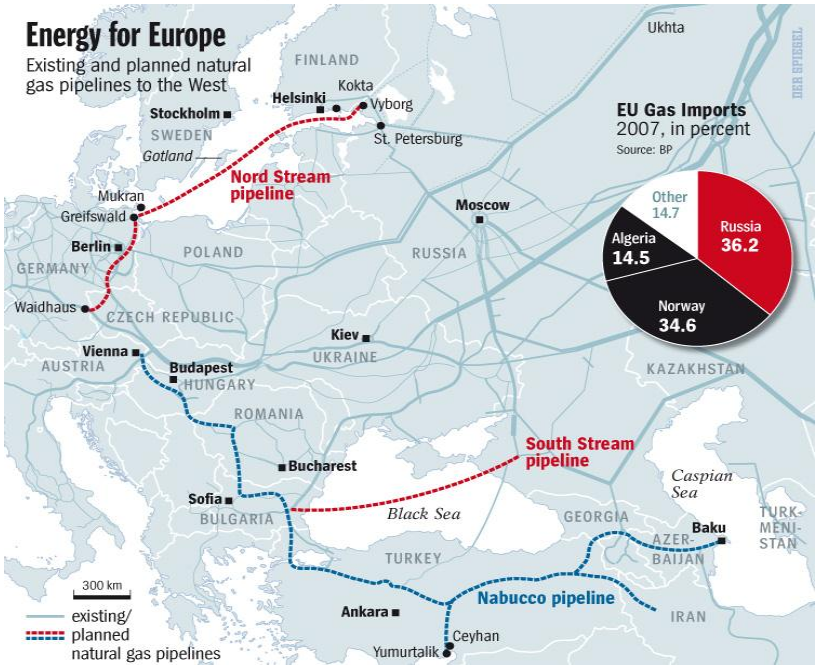
Can Poland duplicate the unconventional gas revolution ?

„With a little help from my friends…"

Strategy at first…

- ✓ Stable and long term energy policy
- ✓ Strategic planning for coal industry
- ✓ Development of the gas market
- ✓ Pro-ecological solutions:
  - CCS what for ?
  - Nuclear – to expensive ?
- ✓ Technology or support for an access to high efficient & flexible technology and services

Existing and planned natural gas pipelines to the West



Source: Der Spiegel, January 2009

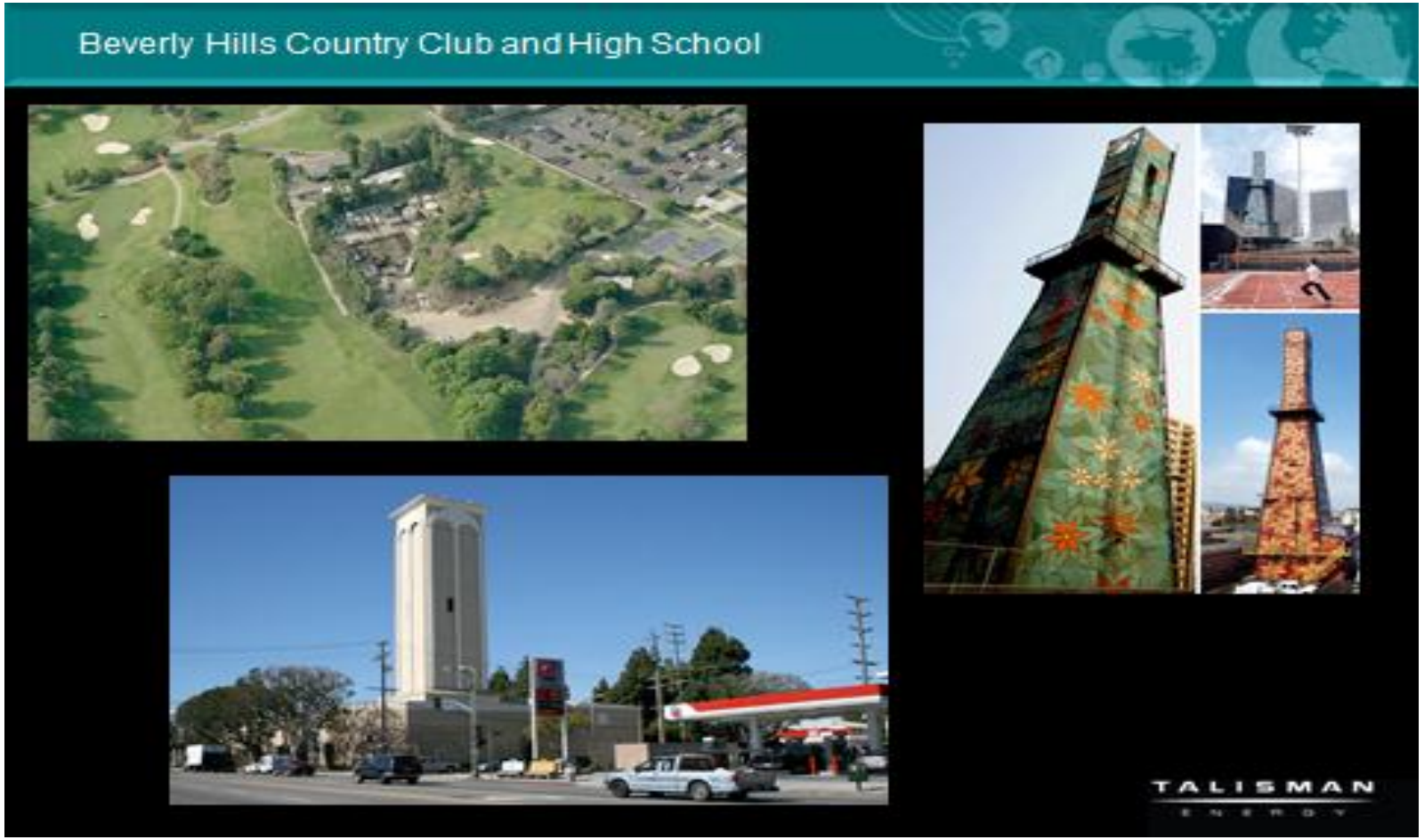
Shale revolution in the US means petrochemicals

US ETHYLENE EXPANSIONS BASED ON SHALE GAS				
Planned expansions	**Project**	**Capacity**	**Location**	**Start-up**
Occidental Chemical/Mexichem	New cracker	500,000 tonnes	Ingleside, Texas	2016
ExxonMobil Chemical	New cracker	1.5 tonnes	Baytown, Texas	2016
Chevron Phillips Chemical	New cracker	1.5m tonnes	Cedar Bayou, Texas	Q1 2017
Dow Chemical	New cracker	World-scale	US Gulf Coast	2016–2017
Shell	New cracker	World-scale	US Northeast	2016–2017
Formosa Plastics	New cracker	800,000 tonnes	Point Comfort, Texas	2016
Dow Chemical	Restart	390,000 tonnes	St. Charles, Louisiana	end 2012
Westlake Chemical	Expansion	108,863 tonnes	Lake Charles, Louisiana	H2 2012
Williams	Expansion	272,158 tonnes	Geismar, Louisiana	Q3 2013
INEOS	Debottleneck	115,000 tonnes	Chocolate Bayou, Texas	end 2013
Westlake Chemical	Expansion	113,399 tonnes	Lake Charles, Louisiana	2014
LyondellBasell	Expansion	386,000 tonnes	Laporte, Texas	2014
Considered expansions				
Sasol	New cracker*	1.0m–1.4m tonnes	Lake Charles, Louisiana	n/a
Indorama Ventures	New cracker**	1.3m tonnes	n/a	2018
LyondellBasell	Expansion	n/a	Channelview, Texas	n/a
SABIC	New cracker	World-scale	n/a	n/a
Braskem	New cracker	n/a	n/a	n/a
Aither Chemicals, Renewable Manufacturing Gateway	New cracker	272,000 tonnes	US Northeast	2016
PTT Global Chemical	New cracker	n/a	n/a	n/a

NOTES: *Feasibility study to be complete by H2 2013 **Feasibility study to be complete by H1 2013 SOURCE: Companies, ICIS

Source: ICIS Chemical Business Aug. 27th. 2012

Who dares duplicate the American unconventional gas revolution ? Technology!



Shale gas influence - our view (1)

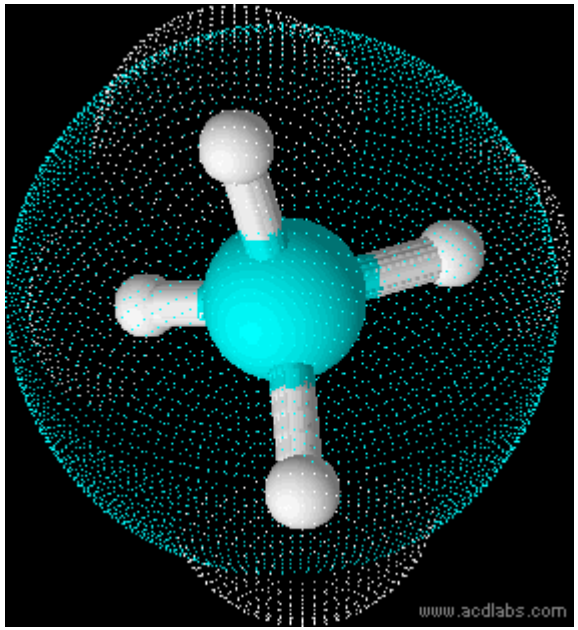
- In the very optimistic scenario, the growth potential of natural gas consumption in Poland may be more than 15 billion m^3 a year. Compared with the level of current consumption, we obtain a giant increase in demand, over 100%, but in the view of production growth from 40–80 billion m^3 per year, this is not a volume that would give the adequate level of comfort for potential energy investors.
- However, we should keep in mind that only 100% gasification of the whole economy would be able to manage all or most of these volumes, and such a scenario is quite improbable.
- In the intermediate variant, the increase in demand for gas may be less than 5 billion m^3 per year, which means that the domestic market potential would constitute a significant barrier to the development of gas production from unconventional sources.
- The largest increase in demand for natural gas may come from the backward energy sector based on solid fuels.

Shale gas influence - our view (2)

- On the basis of our knowledge regarding results of the first two boreholes (unofficial, no statements have been released) shale gas in Poland is a reality. However profitability of its production is at the moment unknown.
- We expect first economic assessments of the shale gas production in Poland to be determined and revealed in 2013 the earliest.
- Large scale production of shale gas in Poland would not take place before 2015-2016 (and only in case that significant reserves are discovered, and all abovementioned necessary preconditions fulfilled).
- Production volumes and economy of shale gas production – when determined – will allow to assess impact of domestic gas production on the Polish energy sector. Only then one will be able to foresee its influence on the future coal vs. gas energy generation.
- Therefore we do not expect any changes in the Polish Energy Policy at least until 2015. Afterwards shale gas may have an impact on the future energy mix. Its scale will be determined by the amount of domestic reserves and productivity of shale gas fields.
- However according to our estimations we believe that 7-10% of energy in Poland will be produced in gas-fired generators by 2020, and 15-20% by 2025.

Shale gas influence - our view (3)

- Shale gas production will not make Europe (the EU) self sufficient in natural gas.
- The best case scenario for shale gas development in Europe is one in which declining conventional production can be replaced and import dependence maintained at a level around 60%.
- Regarding trade flows, the structure of EU gas imports is very sensitive to the LNG cost assumptions.



„Let the power and simplicity of natural gas rise the economy, open minds and will be the base for sustainable energy future."

Sofia 2012

Source: http://www.freewebs.com/tables4ethanol/MOLECULES/METHANE_CH4.bmp

Questions ?

Thank you very much !

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Energy Studies Institute
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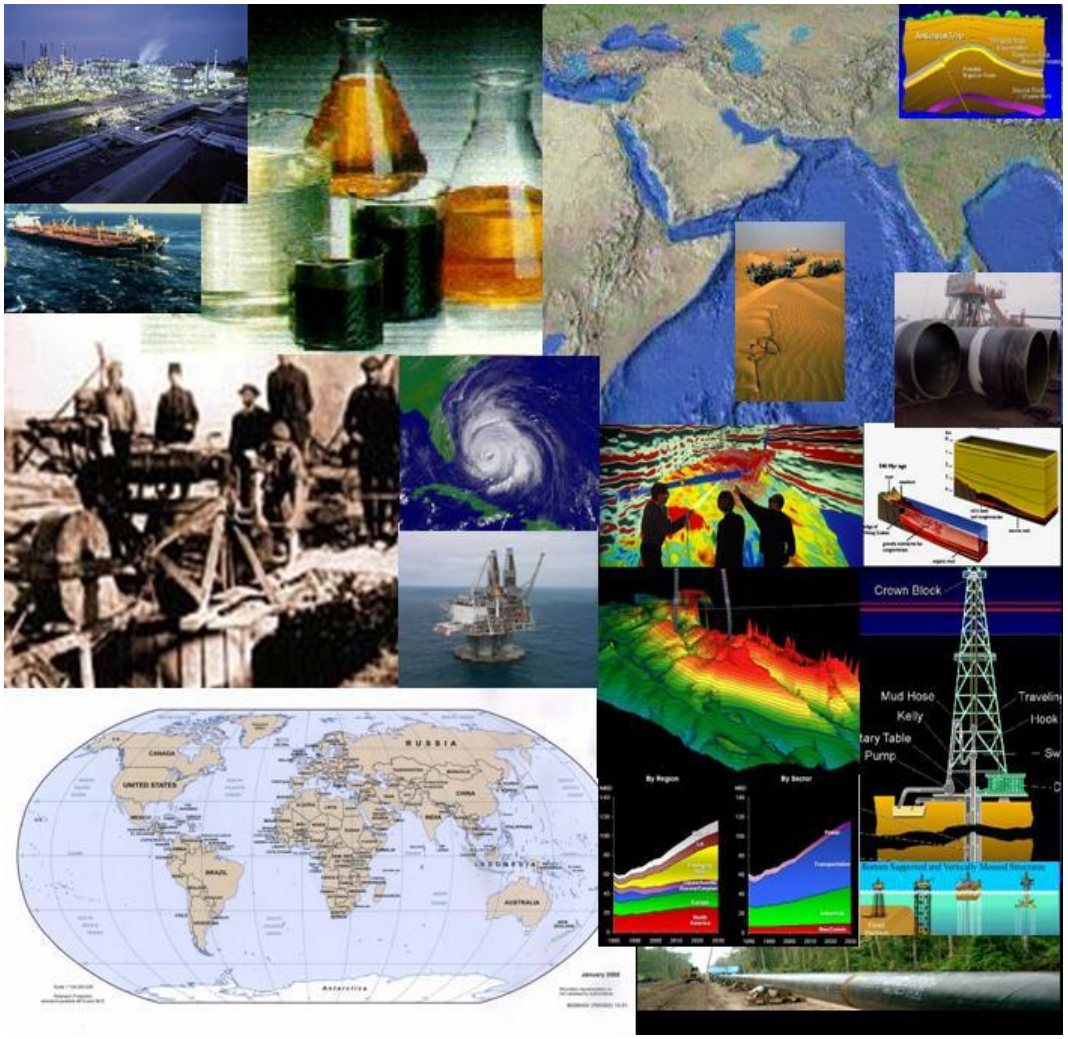
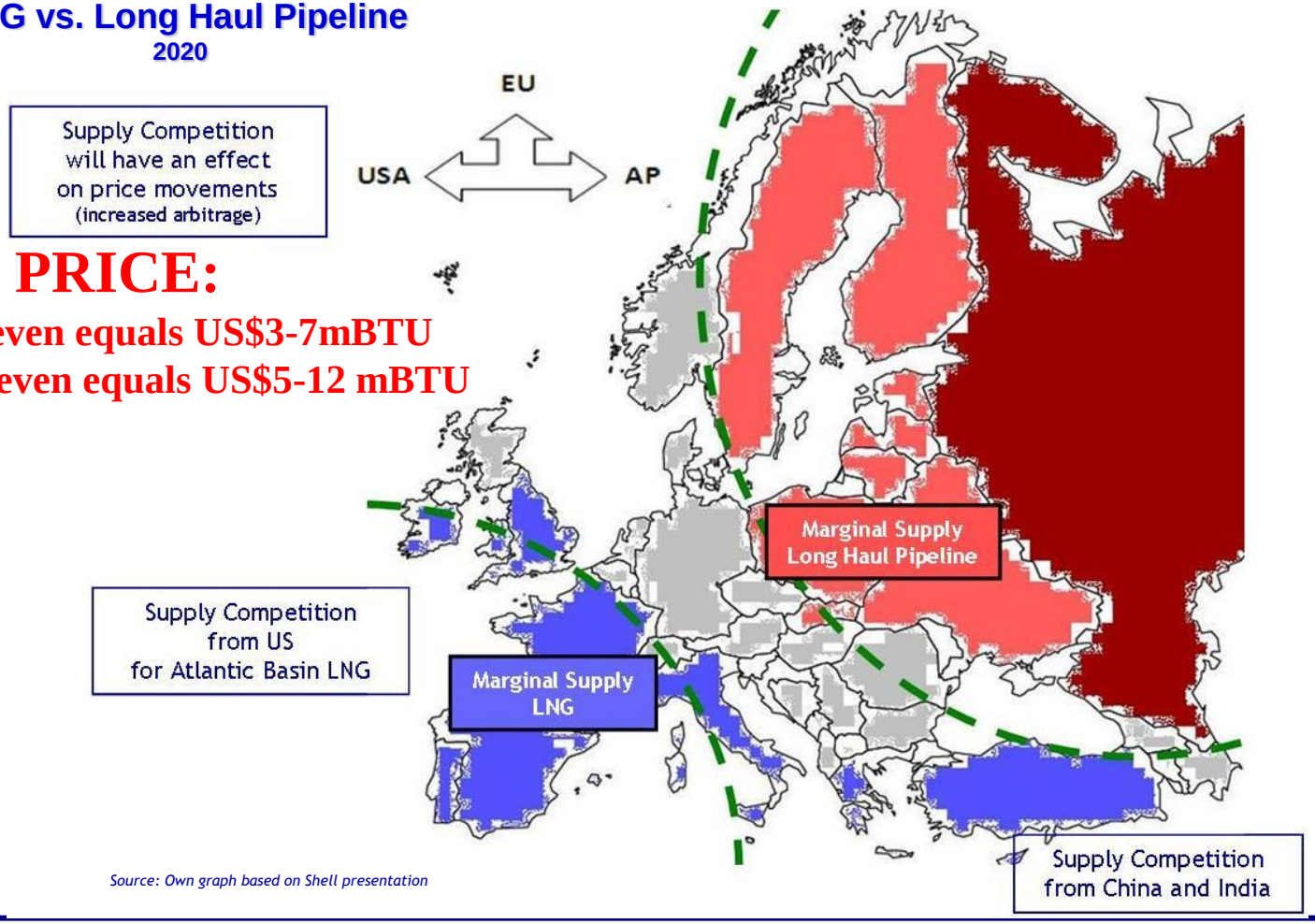


Price arbitrage LNG vs. Pipelines

(supply competition has an effect on price movements)

LNG vs. Long Haul Pipeline
2020



SHALE PRICE:

USA Breakeven equals US$3-7mBTU

EU Breakeven equals US$5-12 mBTU

Source: Own graph based on Shell presentation