I.R.C.E

INSTITUTE FOR RESARCH AND COMMUNICATION ON EUROPE
SYMPOSIUM ON ENERGY

EUROPEAN ENERGETIC AUTONOMY, INTERDEPENDENCE, SECURIZATION, SEGMENTATION AND OPTIMIZATION

NATURAL GAS

PARIS, 15-16 MAY 2019

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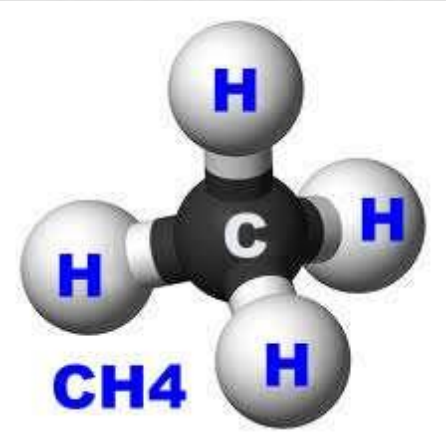
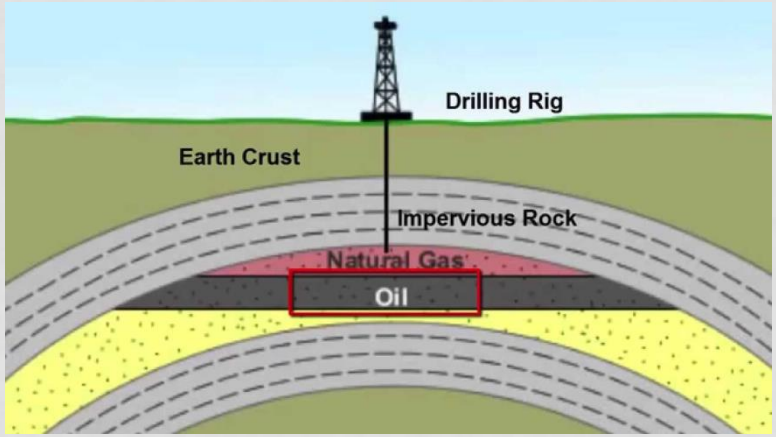
WHERE DOES NG COME FROM ?



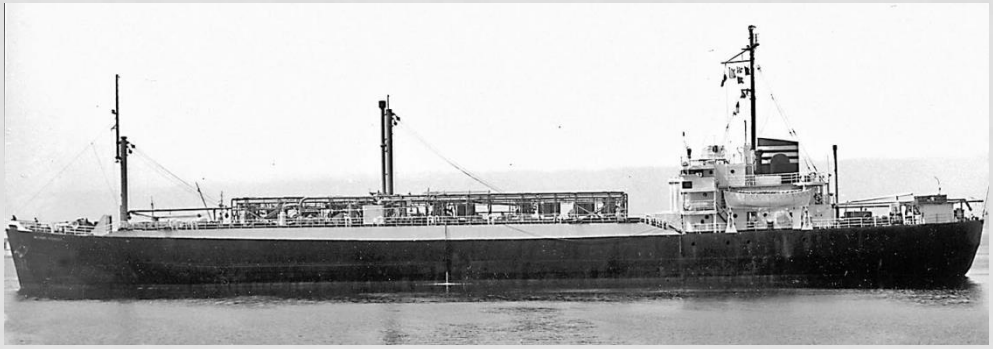
WHERE DOES NG COME FROM ?

- Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of **methane (CH4),** but commonly including varying amounts of other higher alkanes, and sometimes a small percentage of carbon dioxide, nitrogen, hydrogen sulfide, or helium.
- **NG** is formed when layers of decomposing plant and animal matter are exposed to intense heat and pressure under the surface of the Earth over millions of years. The energy that the plants originally obtained from the sun is stored in the form of chemical bonds in the gas.
- **Natural (fossil) gas** is a non-renewable **hydrocarbon** used as a source of energy for heating, cooking, and electricity generation. It is also used as a fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals.



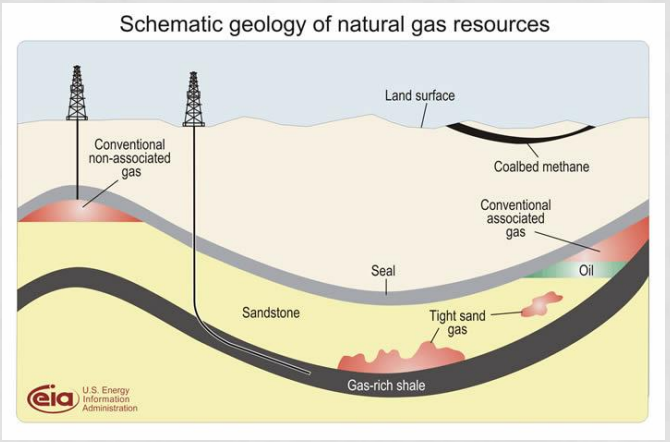
WHERE DOES NG COME FROM ?

- In **1820**, British scientist **Michael Faraday** first experimented and successfully chilled natural gas into a condensed, liquefied form.
- In **1873**, German engineer **Carl von Linde** built the first compression refrigeration machine.
- By **1912**, the world's first LNG plant was constructed in West Virginia.
- The first LNG production and regasification facilities (peak shaving plant) in the United States started operating in **1941** in Cleveland, Ohio.
- In **1959**, the **Methane Pioneer** carried LNG from Lake Charles, Louisiana, to Canvey Island in England, demonstrating for the first time that LNG could be safely transported across the ocean.



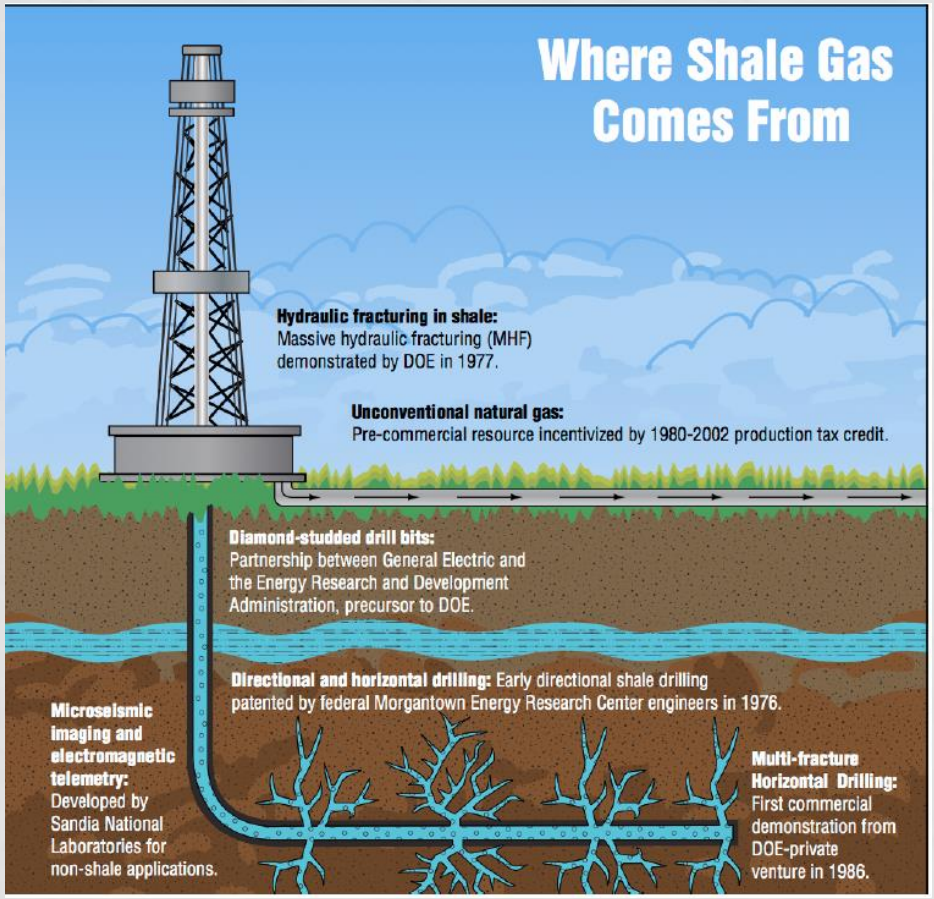
WHERE DOES NG COME FROM ?

- The world's first commercial LNG production and export facility was constructed in Algeria, where exports began in **1964**.
- Exports from the Kenai Peninsula, Alaska, to Japan began in **1969**, that helped grow the Asian natural gas market into the largest demand center in the world.



WHERE DOES NG COME FROM ?

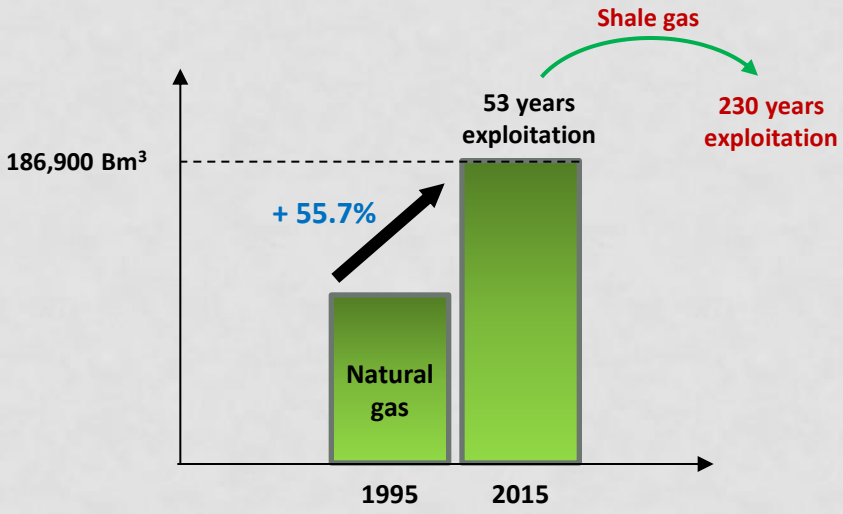
- The United States began importing LNG in the **1970s** when four LNG terminals were constructed in Louisiana and along the East Coast.
- By the **mid-2000s**, technological innovations, such as horizontal drilling, helped American natural gas producers unlock previously unreachable natural gas deposits.
- USA kicked off a "**shale revolution**" that has allowed them to surpass Russia and Iran to become the world's top producer of oil and natural gas.

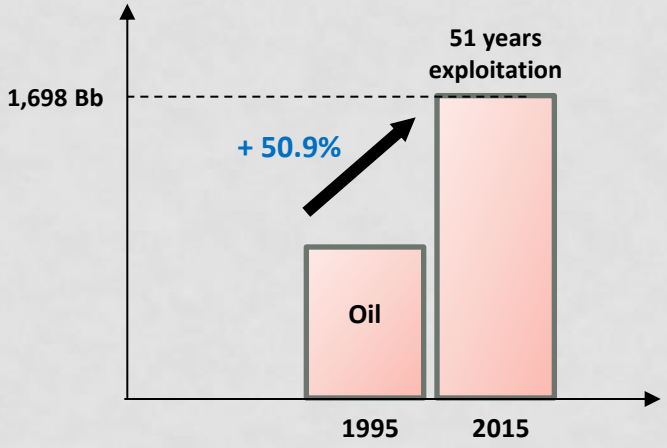


Breakthrough Institute Energy & Climate Program

WHERE DOES NG COME FROM ?

- Natural Gas **resources** are forming during millions of years.
- The **reserves** are resources which can be technically accessed and extracted from the Earth crust. The reserves are permanently re-evaluated depending on available extraction techniques.
- A **proven reserve** means 90% probability to be exploited in viable economic conditions.





CHAPTER 2

NG MEANS OF TRANSPORTATION (MARITIME, TERRESTRIAL)

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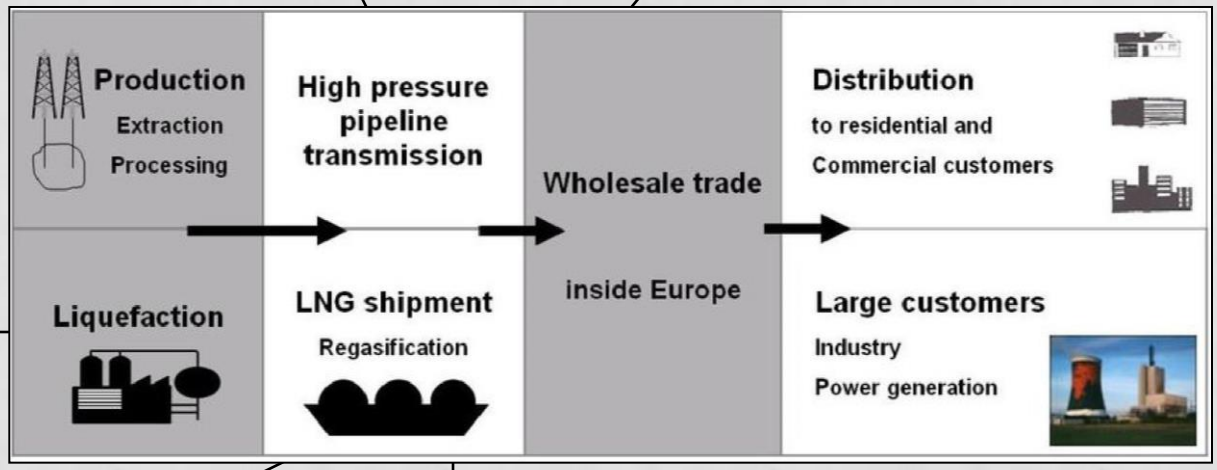
LNG VALUE CHAIN

P up to 100 bar – 40 km/h



NG MEANS OF TRANSPORTATION (MARITIME, TERRESTRIAL)

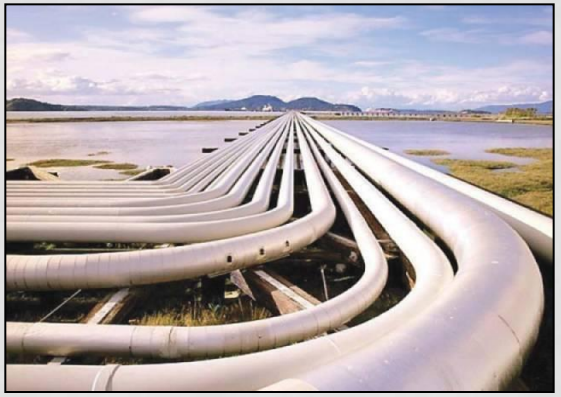
Road transportation by truck of **liquid** natural gas

Temp. -163°C. Pressure ≈ 250 mb.

Maritime transportation by LNG carrier (160,000 – 180,000 m^3 of **liquid** natural gas. Ship length ≥ 300m, width > 50m

Terrestrial transportation through pipelines. Natural **gas** is pressurized between 16 and 100 bars. Gas velocity up to 40 km/h. Pipe length up to 3,000 km.

Pipelines can be installed on ground or under water.



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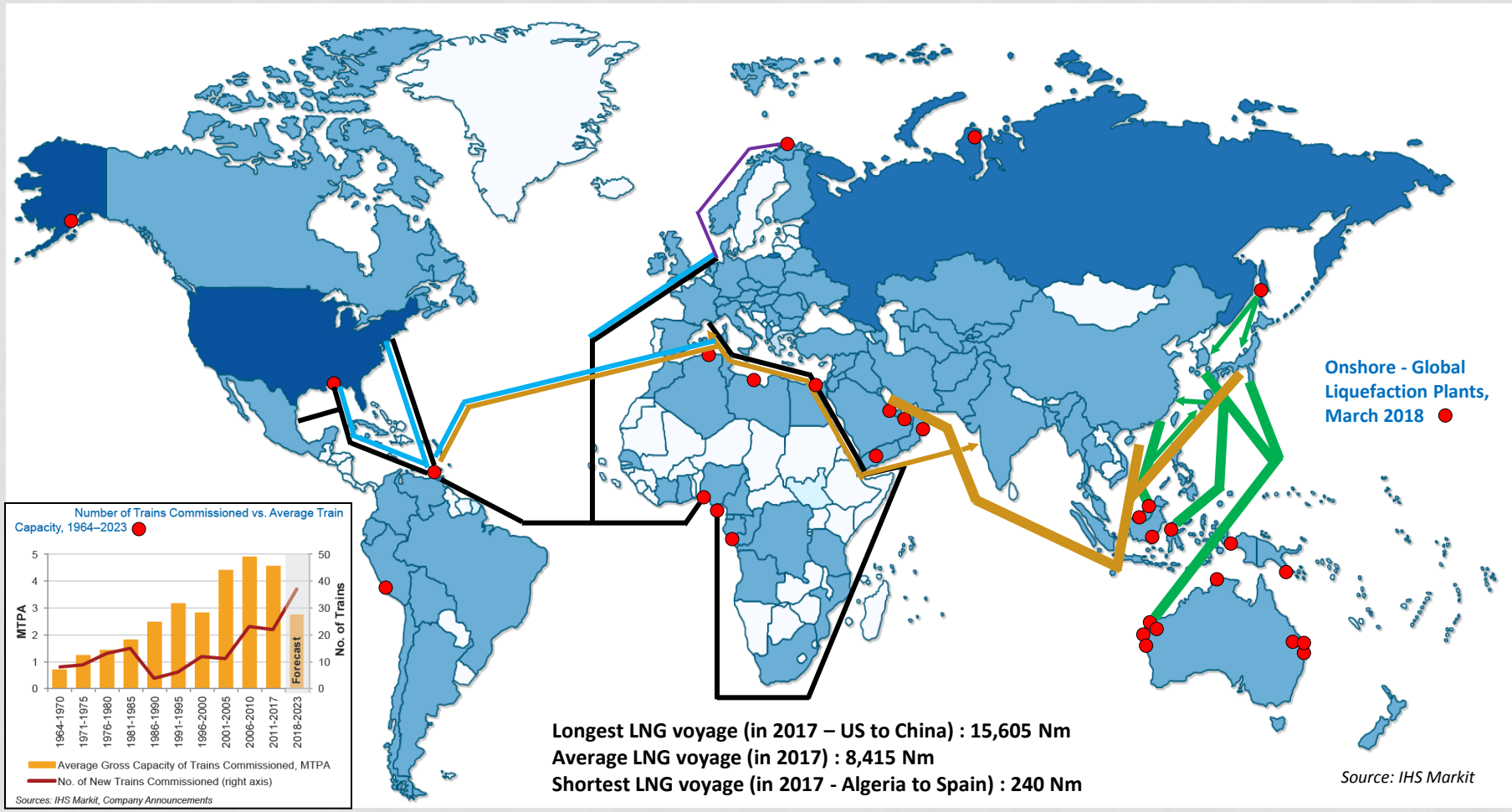

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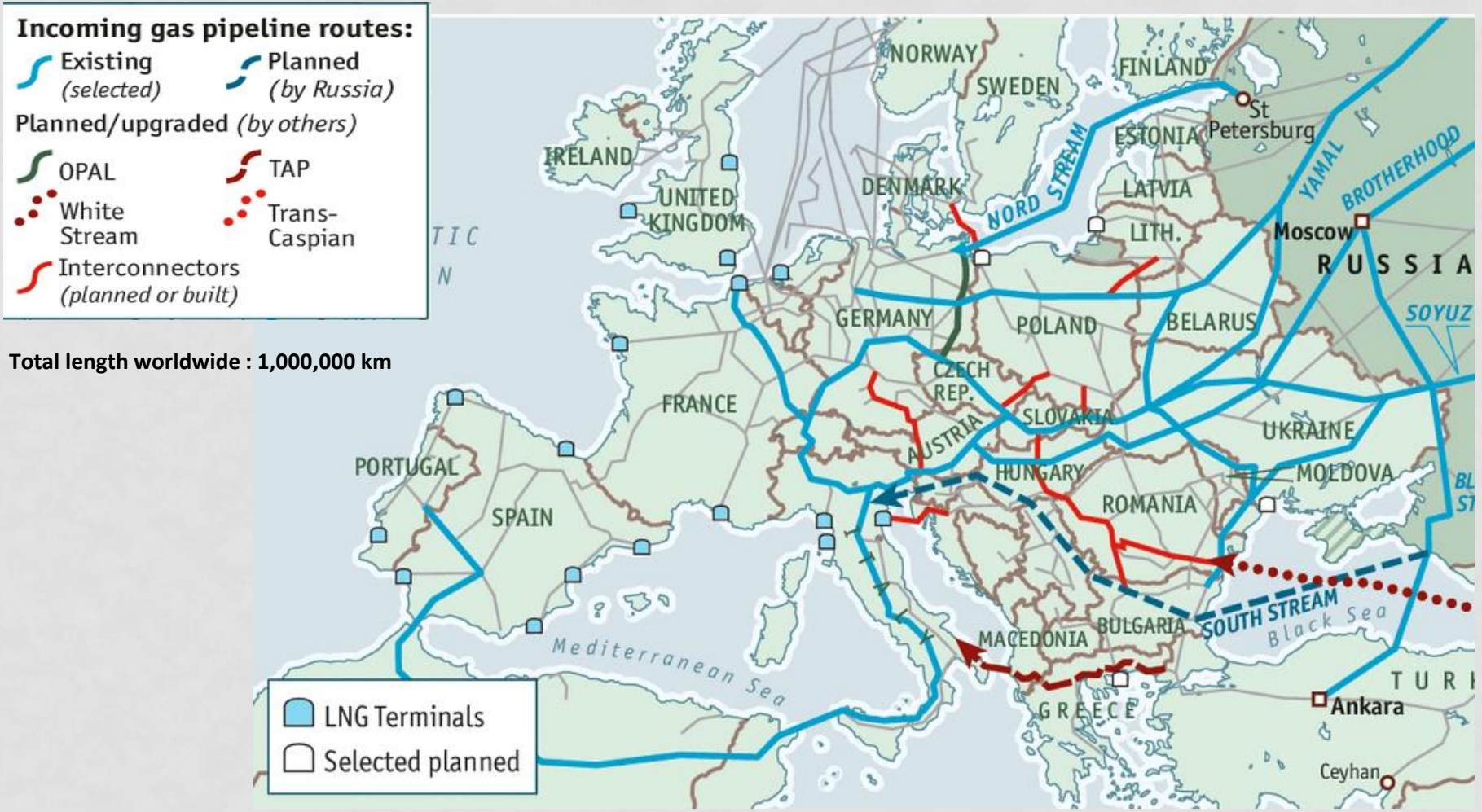

Total length worldwide : 1,000,000 km

CHAPTER 4

NATURAL GAS MARKET SEGMENTS

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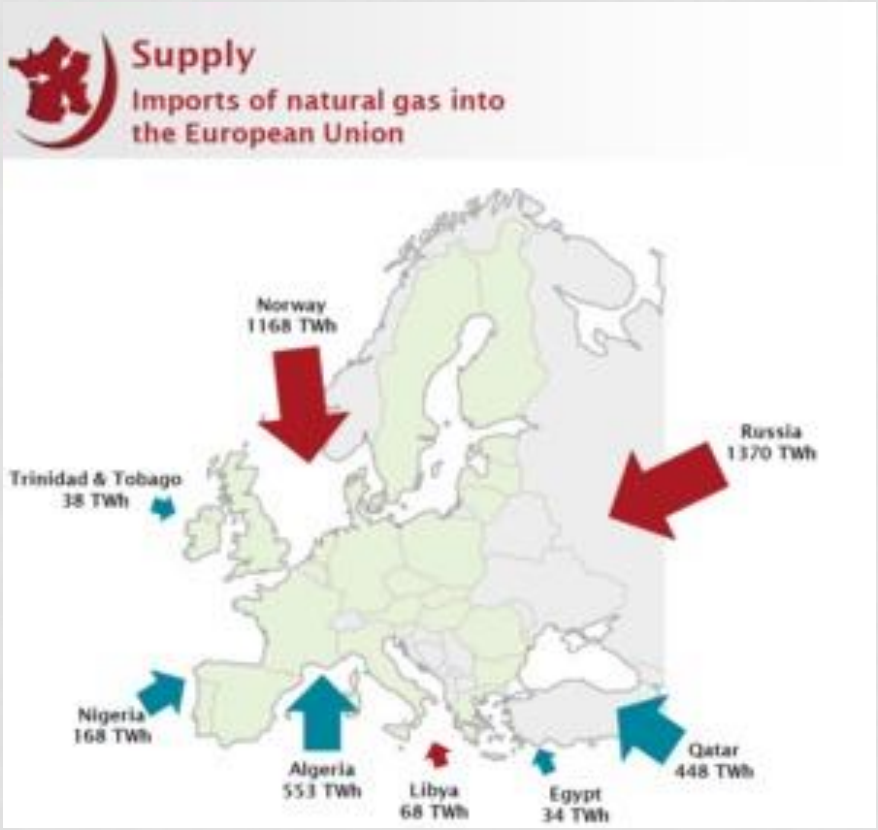
- **Natural Gas** is an important fuel and a raw material in manufacturing.
- Uses in **homes**. Most of the natural gas consumed in homes is used for space heating and water heating. It is also used in stoves, ovens, clothes dryers, lighting fixtures and other appliances.
- Uses of Natural Gas in **Commercial Buildings**. The use of natural gas in commercial buildings is similar to its use in residences. It is used mainly for space heating, water heating and sometimes for air conditioning.
- **Electric Power Generation**. natural gas emits the least carbon dioxide per unit of energy produced. It emits 30% less carbon dioxide than burning oil and 45% less carbon dioxide than burning coal notwithstaning lower amounts of nitrogen oxides, sulfur dioxide, particulates and mercury when compared to coal and oil.
- **Industrial Uses of Natural Gas**. Natural gas is used as an ingredient to make fertilizer, antifreeze, plastics, pharmaceuticals and fabrics and a wide range of chemicals such as ammonia, methanol, butane, ethane, propane, and acetic acid.

NATURAL GAS MARKET SEGMENTS

- Natural Gas **as a Vehicle Fuel**. Natural gas has an enormous potential for increased use as a vehicle fuel . Natural gas has significant advantages over gasoline and diesel fuel. Natural gas vehicles emit 60-90% less smog-producing pollutants and 30-40% less greenhouse gas emissions
- **Liquefied** Natural Gas **as a maritime Fuel**. Natural Gas can be used as a Fuel for ships . More and more Marine engines have been developed by manufacturers. The world shipping sector is now turning its eyes towards LNG-as-Fuel propulsion.
- **Space rockets' propulsion**. Methane-LOX engines may be envisaged for next rocket generations, particularly due to the environmental friendly nature of Natural Gas.

CHAPTER 5

AUTONOMY AND INTERDEPENDENCE



AUTONOMY AND INTERDEPENDENCE

- The EU imports a significant amount of oil, natural gas, uranium, and coal from Russia. At the same time, the EU also serves as an important energy market for Russia. Based on this interdependent relationship, the EU-Russia Energy Dialogue was set up in 2000, in order to provide the overall framework for the energy cooperation between the EU and Russia.
- Gas cooperation between the European Union and Russia has existed since 1960. It is now an important aspect of the overall EU – Russian relations. Russia is the largest importer of natural gas to the EU, where revenues from export to the EU constitute a large share of Russian Gross Domestic Product.
- On average, the EU's 28 member states import about 66% of their natural gas, and 8 of them have 100% gas import dependency, with Russia as the single source of imported gas (by pipeline) for Finland, Estonia, Latvia, the Czech Republic and Bulgaria.

AUTONOMY AND INTERDEPENDENCE

- Russia supplies approximately 33% of Europe's gas, and such a strong dependence on a single external supplier poses an ever-increasing threat to the security of Europe's gas supply, as evidenced by the confrontation between the Ukrainian government and Gazprom. The share of LNG in total gas supplies across the EU increased from 28% to 32% between 2009 and 2011, and then decreased to 19% in 2013.
- The gas relations between the EU states and Russia in the Baltic Sea region are interesting to study to see if and how it contributes to conflict or cooperation in the energy dialogue between EU and Russia.

CHAPTER 6

ENVIRONMENT

ENVIRONMENT

- **Natural gas is the cleanest** of all the fossil fuels. Composed primarily of methane, the main products of the combustion of natural gas are carbon dioxide and water vapor, the same compounds we exhale when we breathe.

Pollutant	Natural Gas	Oil	Coal
Carbon Dioxide	117 000.00	164 000.00	208 000.00
Carbon Monoxide	40.00	33.00	208.00
Nitrogen Oxides	92.00	448.00	457.00
Sulfur Dioxide	1.00	1 122.00	2 591.00
Particulates	7.00	84.00	2 744.00
Mercury	0.00	0.01	0.02

- **But……**

  Natural gas is composed largely of methane (CH4), which, if leaked unburned, is a powerful greenhouse gas. Also, poorly built gas wells can contaminate nearby aquifers.

ENVIRONMENT

- **Natural Gas** is a major contributor to reducing carbon emissions and cleaning polluted air. The COP21 position on energy mix clearly states that it would be extremely difficult to provide sufficient energy for rapid world economic growth while at the same time phasing out fossil energy for environmental reasons.
- **COP21 -** The global gas industry fully supports efforts towards a sustainable energy future. It is a future that must consider all aspects of sustainability, economic, social and environmental.
  - Switching power generation from coal to gas has the greatest short term impact
  - Gas is advancing as a transport fuel, the potential for increasing gas applications is enormous and would have a significant positive impact
  - There are similar opportunities for gas in the heating sector
  - Infrastructure regulations and permitting should encourage investment in gas systems which enable/accelerate more sustainable development.

CHAPTER 7

CONCLUSION

CONCLUSION

- The shale Gas revolution is leading us to a future of abundant and affordable oil and gas. The technology of liquefying natural gas (LNG) is increasingly used to ship gas produced in cost-competitive regions to where gas demand is growing but where local gas production is falling.
- In Europe, even though the gas demand is decreasing, its dependence on gas imports is increasing. The EU imports 53% of the energy it consumes, at a cost of more than €1 billion per day.
- Structural reforms in the power and gas sectors and rising competition from renewables and alternative fuels must be undertaken to reshape the global LNG industry. **Natural gas** provides the **fastest** and **most economic** path to a less carbon intensive and cleaner air world while taking the time to move to an efficient and sustainable renewable energy systems.

CONCLUSION

THANK YOU FOR YOUR ATTENTION

ANNEX 1

FLOATING EXTRACTION - LIQUEFACTION

Prelude FLNG – Courtesy of Shell

ANNEX 2

LIQUEFACTION CAPACITY