Gas:
Social, environmental and economic concerns

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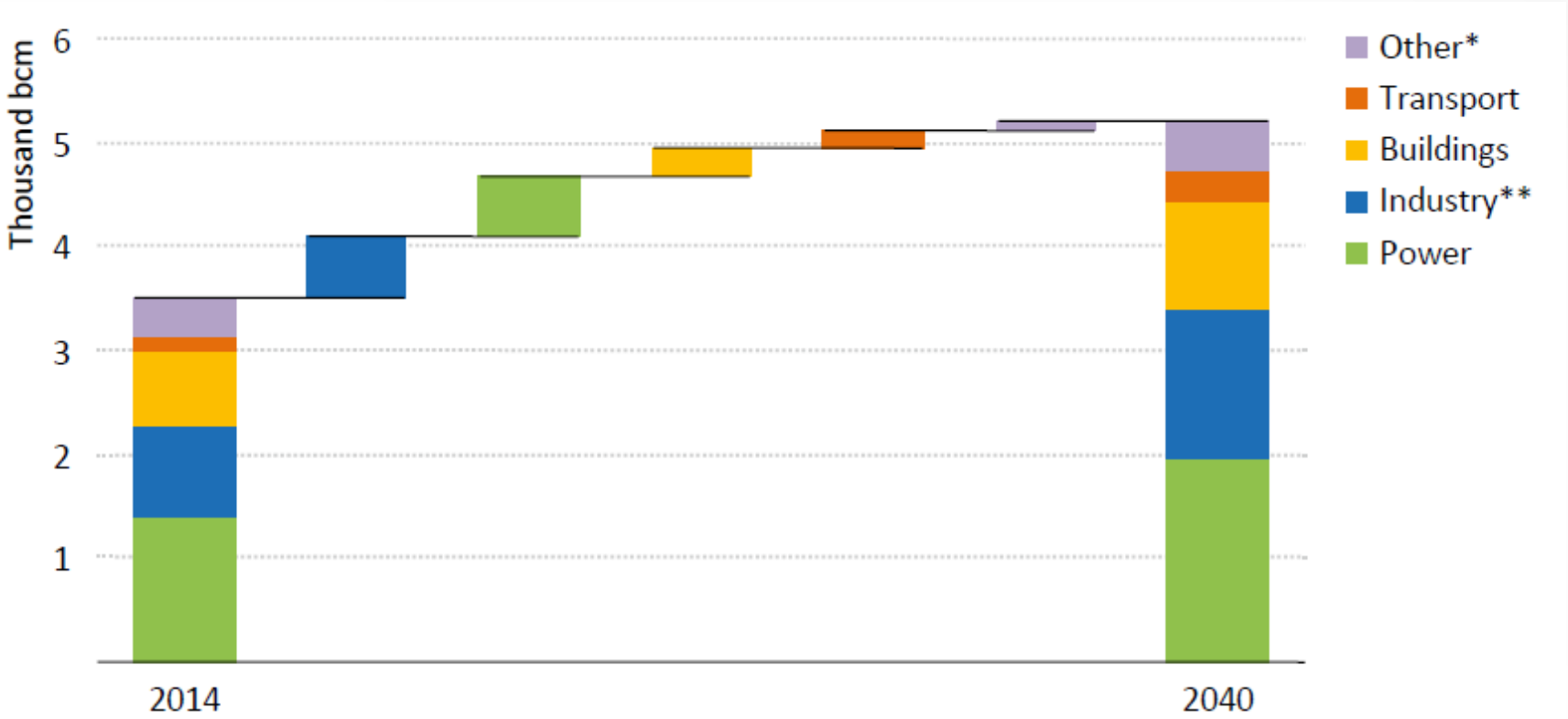
Introductory lecture – Energy commodities and technologies

Commodity: global trends

- Demand
- Supply
- Resources

Demand

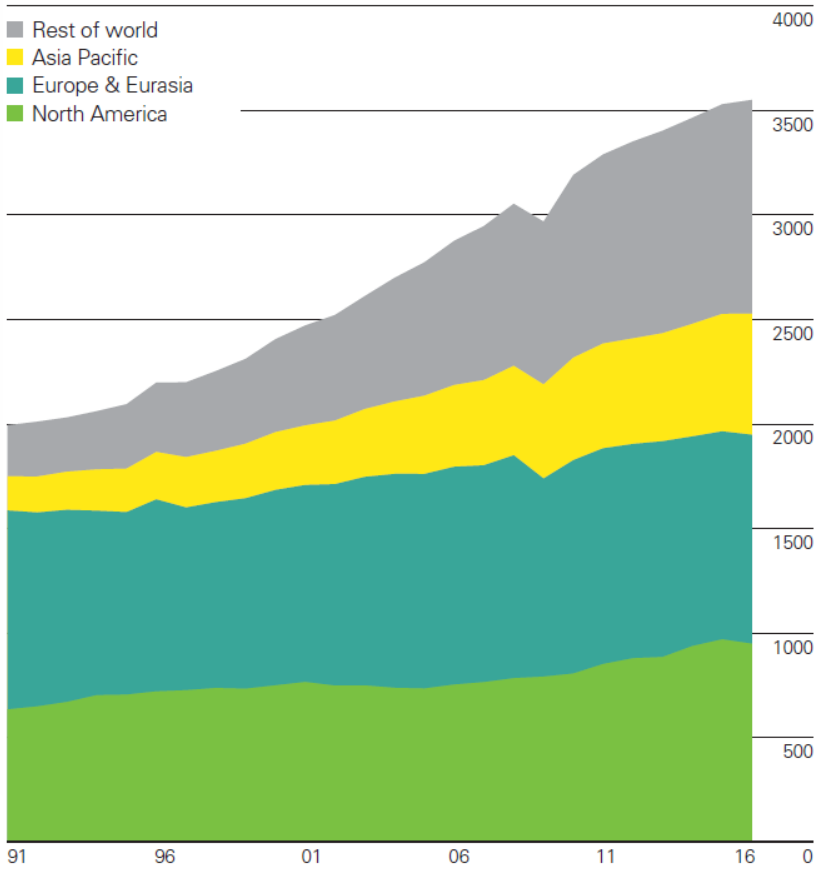
World gas demand by sector in IEA New Policies Scenario



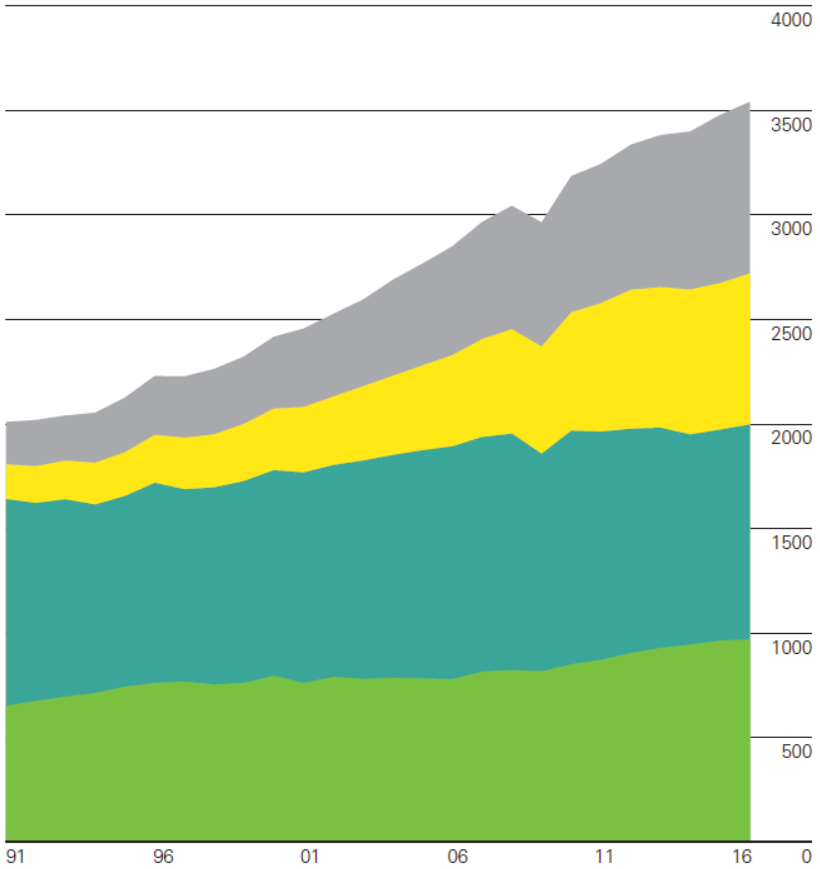
Source: IEA World Energy Outlook 2016.

Supply

Gas production (billion cubic metres)



Gas consumption (billion cubic metres)



Source: BP Statistical review of World Energy 2017.

Resources

Conventional resources:

- NG: mixture of hydrocarbons containing mostly methane (c.ca 90% mole), ethane (5%), propane and butane. Raw gas can contain significant quantity of sulphur and must be treated.
- LNG: Natural Gas that has been liquefied for ease of storage and transport. The chain includes liquefaction facilities, transport usually in ships, re-gasification facilities.

Unconventional resources:

- Tight gas: natural gas produced from reservoir rocks with very low permeability, requiring intensive hydraulic fracturing (***fracking***) for economic production. Mostly US.
- Shale gas: natural gas found trapped in shale formations (clastic sedimentary rocks). Produced by fracking. Biggest production currently in US. Biggest reservoirs estimated in China.
- Coalbed methane: natural gas extracted from coal beds. Produced mainly in US, Canada, Australia.

Resources

Gas resources (tcm)

	Conventional	Unconventional				Total	
		Tight gas	Shale gas	Coalbed methane	Sub-total	Resources	Proven reserves
OECD	**78**	**24**	**81**	**16**	**121**	**199**	**22**
Americas	51	11	55	7	73	124	14
Europe	17	4	13	2	19	37	4
Asia Oceania	10	8	13	8	29	39	4
Non-OECD	**356**	**57**	**138**	**34**	**229**	**585**	**195**
E. Europe/Eurasia	138	11	15	20	46	184	74
Asia	35	13	40	13	66	101	16
Middle East	104	9	4	-	13	117	80
Africa	51	10	39	0	49	100	17
Latin America	28	15	40	-	55	83	8
World	**434**	**81**	**218**	**50**	**349**	**784**	**217**

Source: IEA World Energy Outlook 2016.

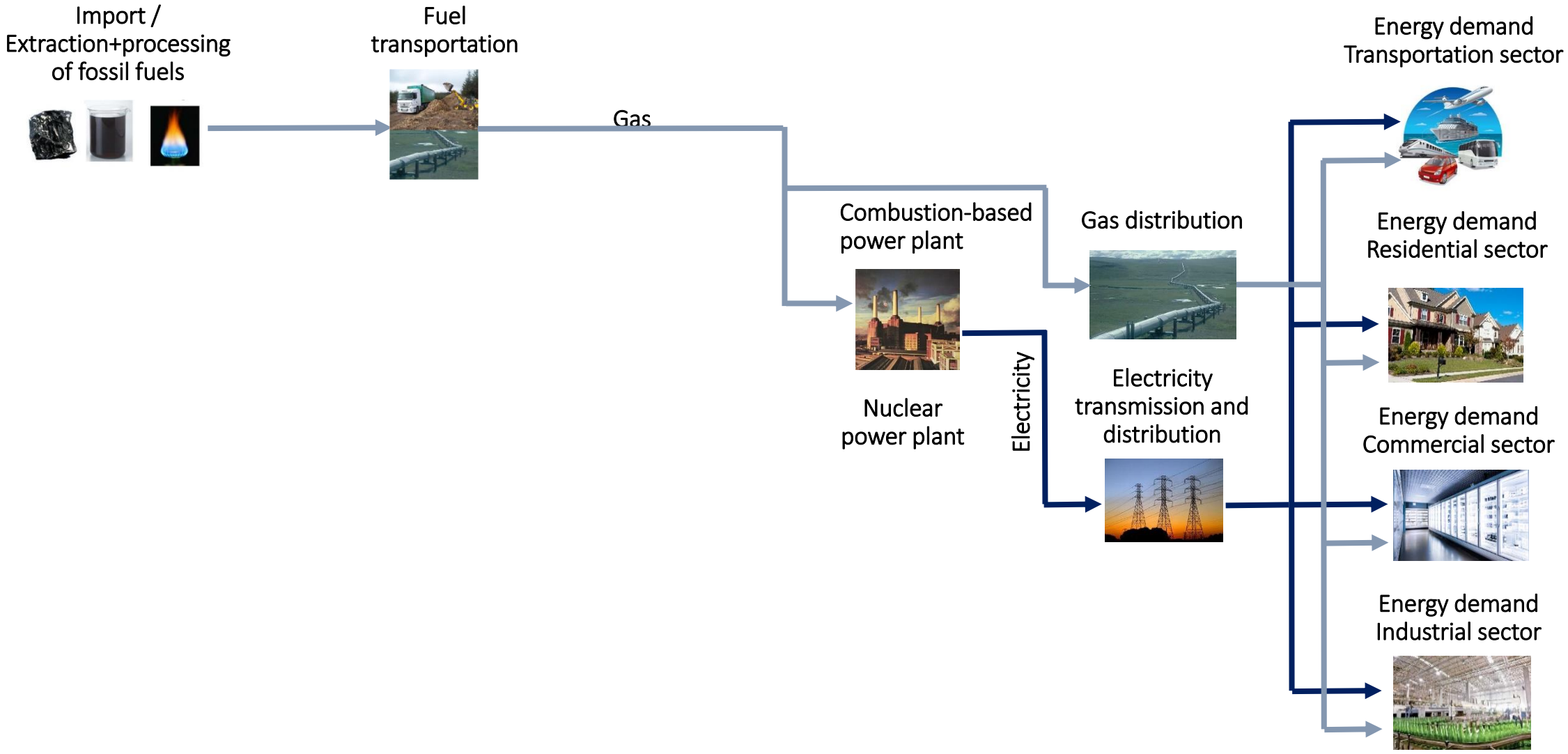
Proven reserves = 90% probability to be extracted profitably

*Reserves to Production ratio (R/P) of around **50 years***

Technologies in the gas chain

- Extraction
- Transportation and storage
- Combustion-based power plants
- Economic, Environmental and Social concerns

Sample Reference Energy System



Extraction

Processes - conventional gas:

- Conventional wells: lately case drilling is used
- Deepwater production: made possible by floating platforms. 3000 m reached in 2005.

Processes - unconventional gas:

- Hydraulic fracturing: used for tight gas, shale gas and coalbed methane. It consists in pumping high-pressure liquid in the rocks to fracture them and ease the gas flow. Coupled with horizontal wells.

Key characteristics	
Conventional gas	
Capital cost	5.3-63.7 $/boe
VOM cost	3.2-8.3 $/boe
Recovery factor	70-80%
Energy use	0.8-2.3 GJ/toe
CO2 Em. factor	64.9-273.6 ton/ktoe
Unconventional gas	
Capital cost	-
VOM cost	6.6-19.7 $/GJ
Recovery factor	10-70%
Energy use	20-30% of produced
CO2 Em. factor	9.3-15 gCO2/MJ

Transportation and storage

Transportation

- Pipelines: used for short to medium distances (including distribution to final users) and large volumes.
- LNG shipping: for long distances and large volumes. This technology also includes liquefaction and re-gasification facilities.

Storage

Natural gas is stored for commercial or energy security reasons.

- Underground storage: in depleted gas reservoirs or salt caverns.
- On-board LNG fleets.

Key characteristics	
Pipeline	
Capital cost	194-226 M$/km
Energy use	1.8-2.7% of transported
LNG liquefaction	
Capital cost	2.9-3.8 $/MMBtu
VOM and FOM cost	10500 $/ton
Natural gas losses	15%
LNG shipping	
Capital cost	245 M$/150000 m3
Energy use	Diesel, NG, HFO
CO2 Em. factor	Depends on fuel
LNG re-gasification	
Capital cost	45-75 $/ton

Combustion-based power plants

Open Cycle Gas Turbines (OCGTs):

Typical size between 10 and 300 MW. Fast ramping, usually used for peak generation. Also fed with oil products.

Combined Cycle Gas Turbines (CCGTs):

One unit consists in a Gas Turbine + a Heat Recovery Steam Generator (HRSG) with a Steam Turbine. Power plants usually combine 2 or 4 of these units. Largely used and efficient, flexible, but not as much as OCGTs. Used for both base and peak generation.

Key characteristics	
OCGTs	
Capital cost	900 $/kW
VOM and FOM cost	36 $/kW/a
Lifetime	30 years
Efficiency	35-42%
CO2 Em. factor	480-575 kg/MWh
CCGTs	
Capital cost	1100 $/kW
VOM and FOM cost	44 $/kW/a
Lifetime	30 years
Efficiency	52-60%
CO2 Em. factor	340-400 kg/MWh

Economic concerns

Are prices of oil and gas still coupled?

Spot prices of NG on selected markets compared to LNG and Oil prices [US $/million Btu]

Source: BP Statistical Review of World Energy 2017

Economic concerns

Greater geopolitical concerns about the role of natural gas in the international relationships:

- Competition between 1) the SouthStream project launched by Gazprom and initially supported by ENI (now abandoned), bringing gas from Russia, and 2) Nabucco, backed by several EU Member States, bringing gas from Iran and Azerbaijan.
- New reservoir discovered offshore Israel – Cyprus – Egypt – Lebanon – Syria. How is it going to affect the relations and diplomacy between the countries?
- Just when the revolution came in 2011, Syria had approved a pipeline from Iran, while rejecting one from Qatar through Saudi Arabia.

Economic concerns

In addition, big discussion ongoing in some markets (e.g. Europe) about the role of **NG-fired generation in the power system** in the next decades:

Increasing penetration of renewables causes generation to be **intermittent**

Gas-fired power plants are fast ramping and will be called to **balance intermittency**

This turns to be **economically unsustainable** for the operators of the power plants

Environmental and social concerns

Environmental concerns:

- The combustion of gas (e.g. for electricity generation or transportation) is again responsible for emissions at local, regional and global level, such as **CO2, NOx, SOx;**
- In addition, **Methane (CH4) is a GHG with 20 times stronger effect than CO2**! Any direct emission of CH4 from gas leaks through the production chain contributes to the global warming.

Social concerns:

- Similar concerns to those for Oil apply.

Conclusions

- There is high demand for gas and it is expected to increase, especially in the power sector;
- Gas is less CO2 intensive than oil and coal. Replacement of the latter with gas will decrease the pressure of GHGs emissions;
- Gas-fired generation is flexible enough to provide backup for large shares of variable renewables in the electricity supply;
- Still, gas shares most of the economic, environmental and social concerns of oil.

References and reading material

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Changelog and attribution

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