# " Economia dell'Energia e dell'Ambiente."

*a.a. 2019-20*

# Lezione 3 – appendice

## La rivoluzione dello Shale-Gas ed il crollo dei prezzi del Petrolio: effetti economici, politici e sociali

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# The Shale Revolution and the oil slump

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ISPI Energy Watch
*Osservatorio Energia dell'Istituto per gli Studi di Politica Internazionale, Milano*

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**Unconventional** alludes to a method of production,
not to the **quality** of the hydrocarbons actually produced.

**Unconventional** includes:

- Coal Bed Methane
- Oil Shale
- Tight Oil / Tight Gas
- Shale Oil / Shale Gas
- Extra Heavy Oil / Oil Sands

- Extra Heavy Oil and Oil Shale are basically untapped
- Material volumes of CBM are produced mostly in Australia, Canada and the US
- Tar sands account for 56% of the Canadian oil production
  - approximately 2 Mbbl/d
- Tight/shale gas accounts for over 40% of the US Natural Gas production
  - approximately 300 Bcm/year
- Tight/shale oil US production has surpassed 3,5 Mbbl/d

# TAR SANDS

- Energy intensive production makes Tar Sands the environmentally most controversial unconventional production

- Methods of production include:
  - Surface mining (open pit)
  - CHOPS (Cold Heavy Oil Production with Sands)
  - CSS (Cyclic Steam Stimulation)
  - SAGD (Steam Assisted Gravity Drainage)

- Thanks mainly to Tar Sands, Canada ranks as the third country worldwide for proved oil reserves (over 174 thousand million barrels)

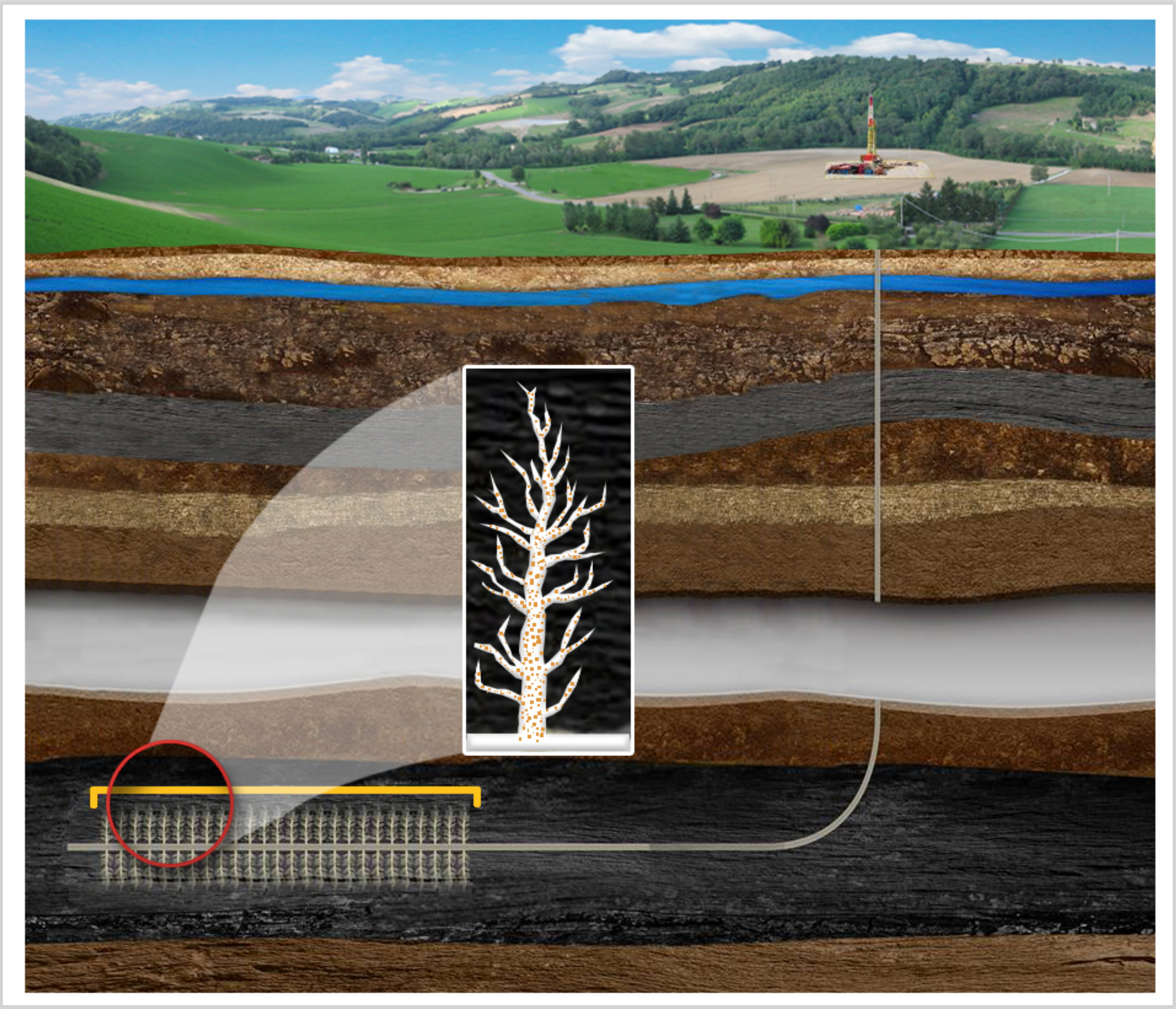
# THE SHALE REVOLUTION: COMMON FEATURES

- A developing technology
- A new production model
- An American story

# A DEVELOPING TECHNOLOGY

- No new invention:
  - a fracking process was patented in 1949
  - continuous process upgrade
- The breakthrough was optimising and combining fracking techniques and horizontal drilling
- In parallel, new technological developments to optimise drilling control have contributed to a steep reduction of drilling time

# A DEVELOPING TECHNOLOGY

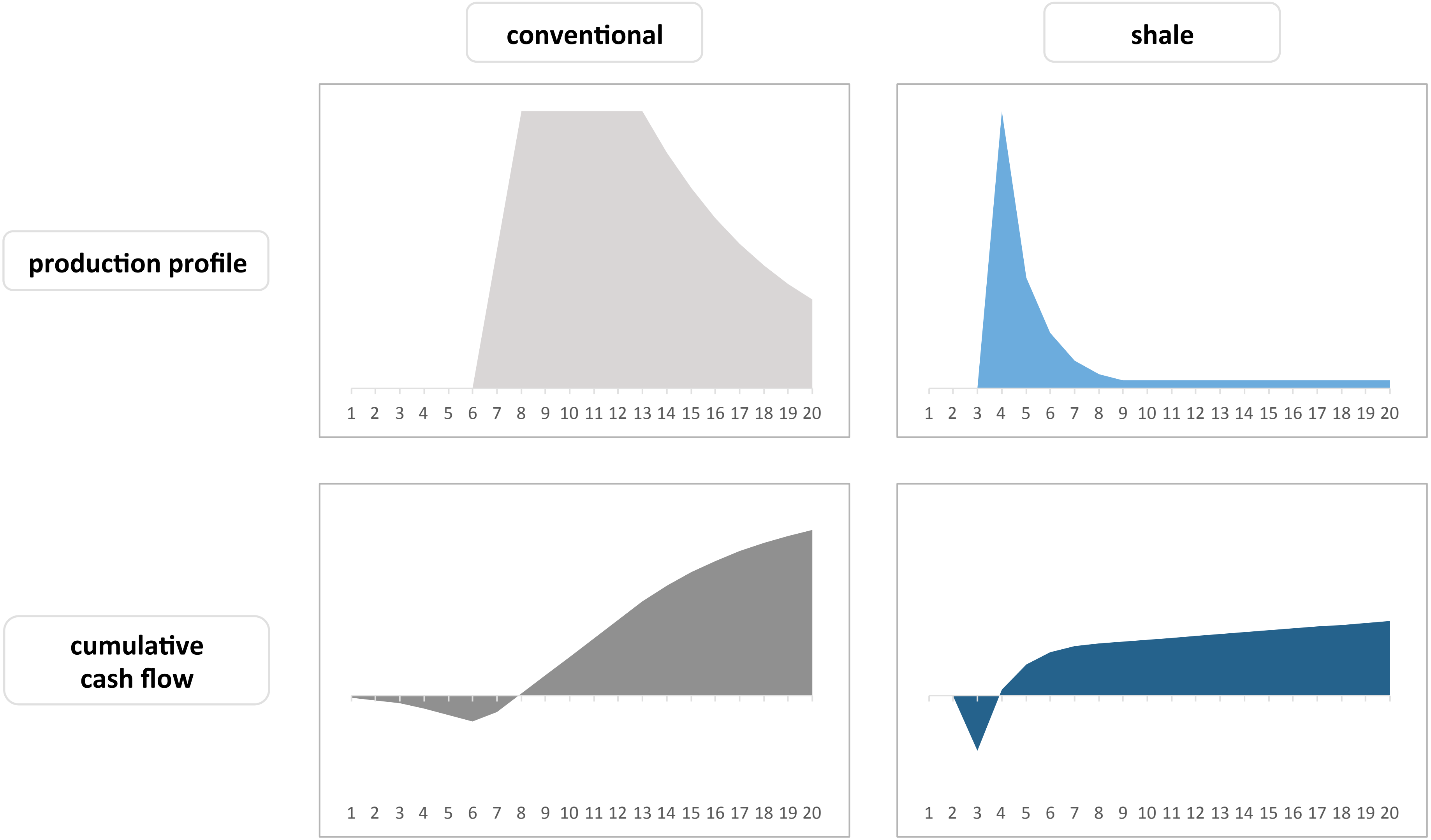


## The production model: conventional vs. unconventional

- **Conventional** (except for small/marginal fields):
  - long term investment period
  - cash flow deferred up to 5/10 years from investment inception
  - stable production flow for the first years without further capex

- **Unconventional** (shale):
  - time to market
  - production and cash flow 2-3 months from the investment inception
  - dramatic decrease in production flow after first year: 60% or even more

# UNCONVENTIONAL VS. CONVENTIONAL PRODUCTION MODEL



# THE PRODUCTION MODEL: DRILLING INTENSITY

- To maintain or increase overall yearly shale production, the production curve of the wells mandates that drilling and investment be **continuous**

- Investment financing for drilling operations is often provided through the **hedging** of future production

- The combination of drilling intensity and financing requirements makes **shale production** volumes **price sensitive in the short term**

- **Conventional** production volumes are price sensitive only in the **medium/long term**, i.e. the current price may slow reserves replacement investment but has no immediate impact on the production capacity

- The Oil & Gas US Industry has a long history and currently employs almost 600 thousand workers
- Unconventional development is driven by **independent** producers, not by majors: the Independent Petroleum Association of America has approximately 8.000 associates/ members
- Legal framework: private property of natural resources promotes local population consensus
- Drilling intensity requires an adequate drilling stock:
  - in 2014, the number of unconventional wells drilled in the US was close to 5.000
  - US and Canada host more than 60% of the global drilling stock, and US alone 80% of the hydraulic fracturing HP worldwide

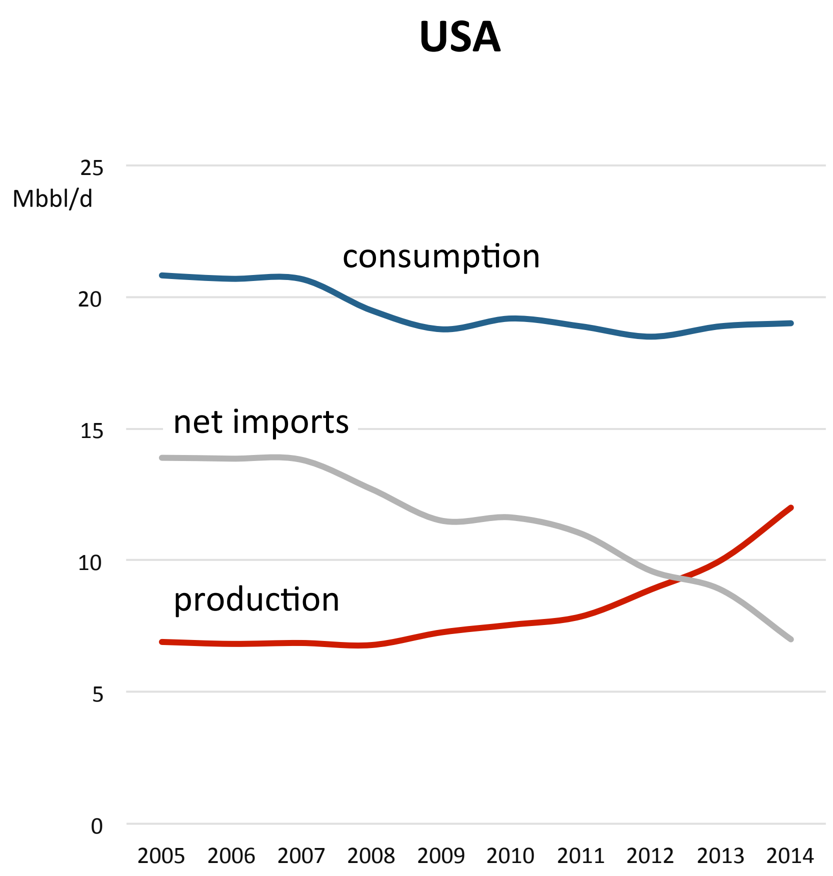
# An American story. Exporting the model

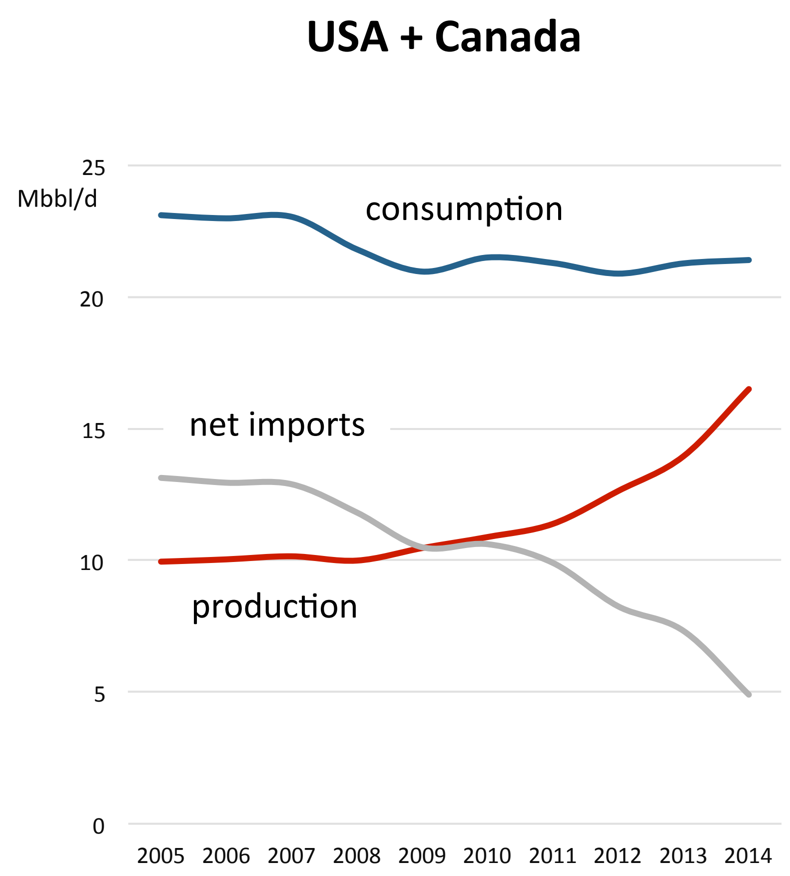
- Drilling intensity can not coexist with population density
- The regulatory framework should be readjusted
- Unless and until optimised practices and adequate drilling costs are in place, production costs will remain significantly higher than in the States
  - To date, up to 300% in Poland
- Shale gas and shale oil resources are however "globally abundant" (EIA, June 2013)
- Russia ranks first for oil, China for gas and Argentina is a major in both. Whether any of them will be capable to fully implement the model is a question for the beginning of the next decade

⇨ Environmental issues may become a limiting factor also for US expansion

- The Shale Revolution may be assumed to have started in 2005:
  - Bush Energy Act
  - President fears for a nation «addicted to oil»
- Fear of oil import dependence helps the introduction of some environmental flexibility:
  - certain activities related to fracking are exempted from federal standards (Cheney/Halliburton loophole)
- The increase in oil price (2001-2008) helps developing and optimising drilling techniques
- After 10 years the outcome is spectacular:
  - Gas production has increased by almost 200 Bcm/y
  - Liquids production has increased by more than 4 Mbbl/d

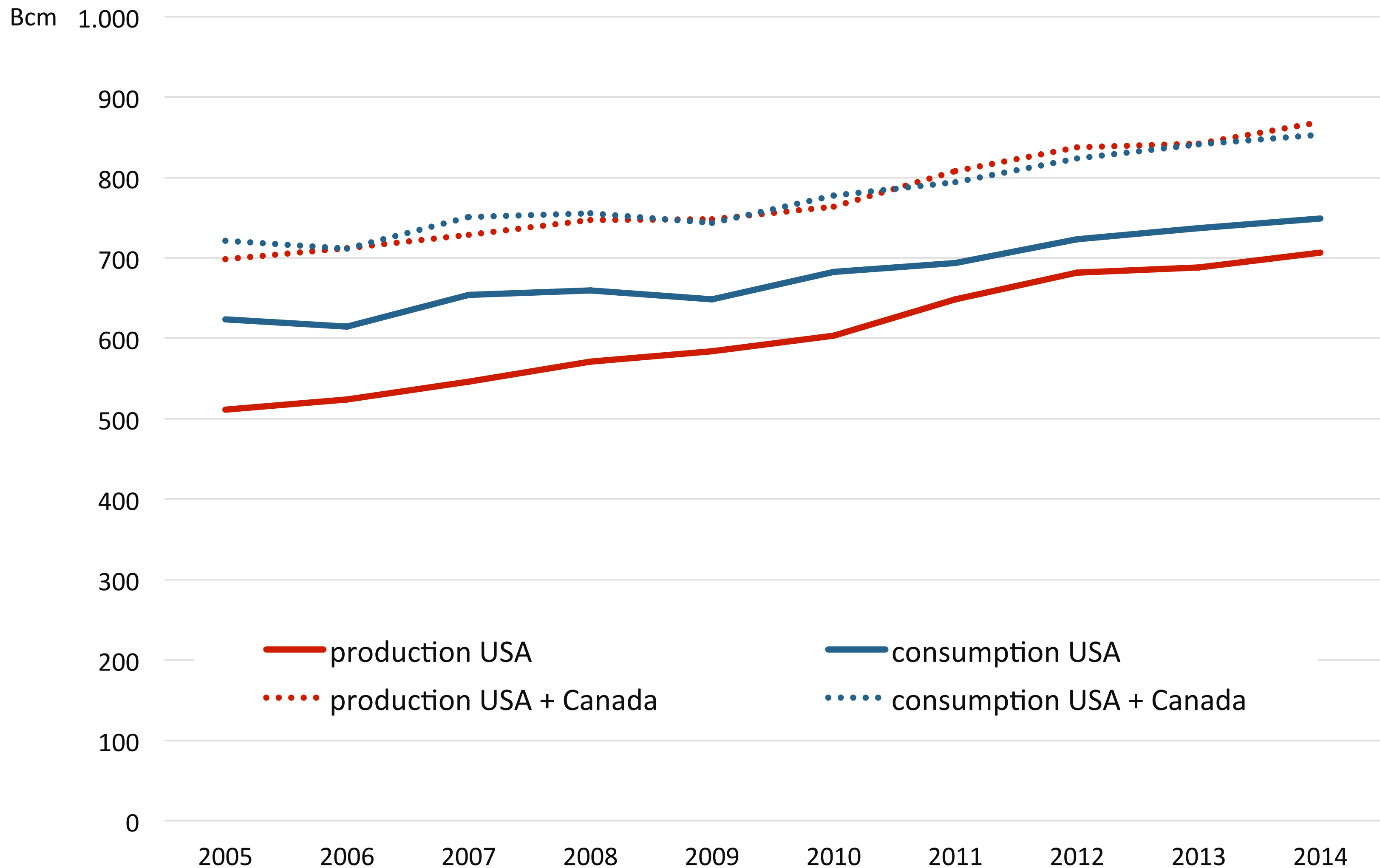
# US OIL CONSUMPTION, PRODUCTION AND NET IMPORTS




2014 figures are provisional – Source: elaboration on BP e EIA

# US GAS PRODUCTION AND CONSUMPTION

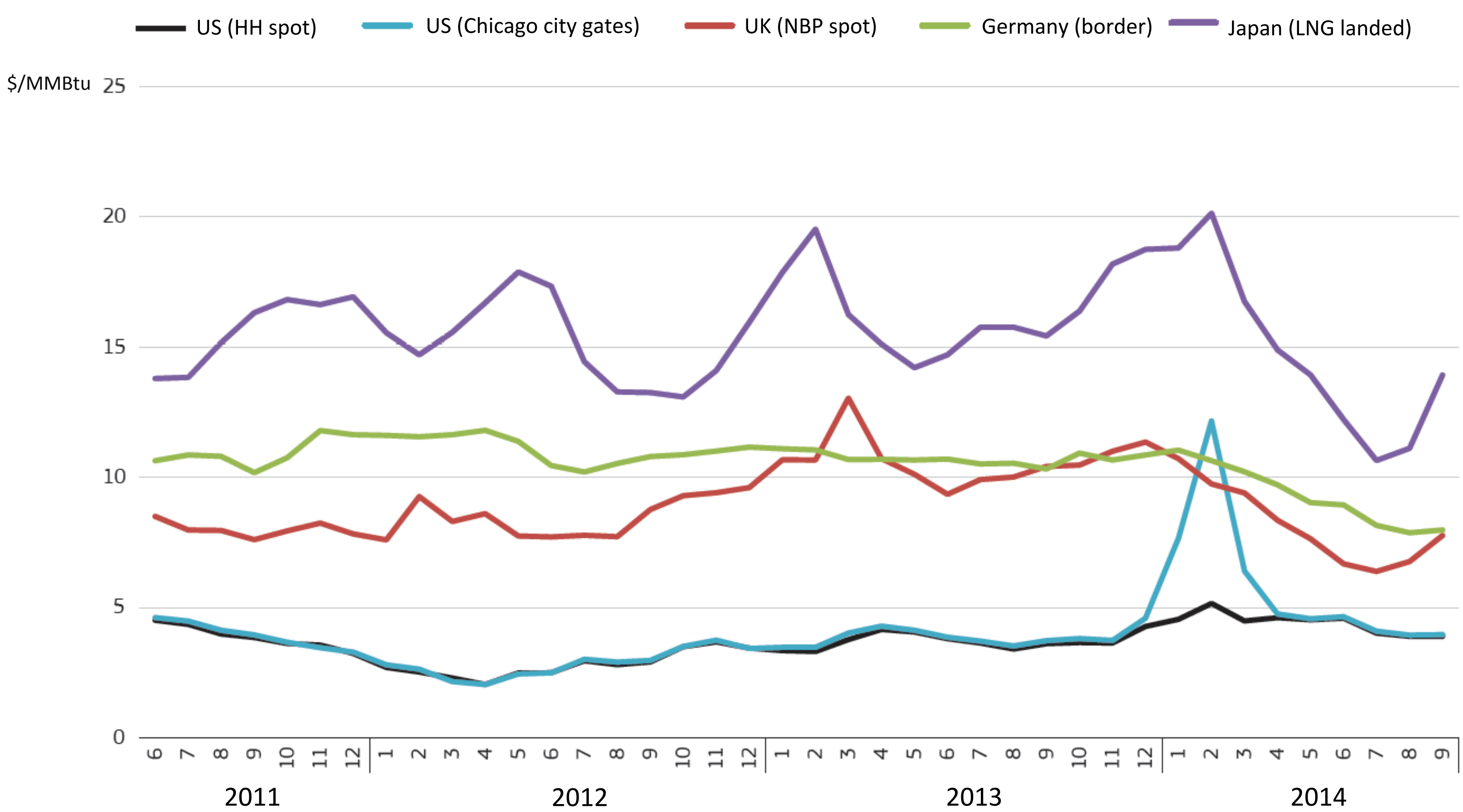



2014 figures are provisional – Source: elaboration on BP and JODI gas

# Unconventional oil/unconventional gas: the split

- "The oil market, like the ocean, is a great pool" (M.A. Adelmann)
- The gas market remains regional
- Same technology, different markets
- Non-fungibility:
  - Oil concentrates on transportation
  - Gas concentrates on power
  - Exception: petrochemicals

# Gas prices 2010-2015 Henry Hub, Europe, Asia (Japan)

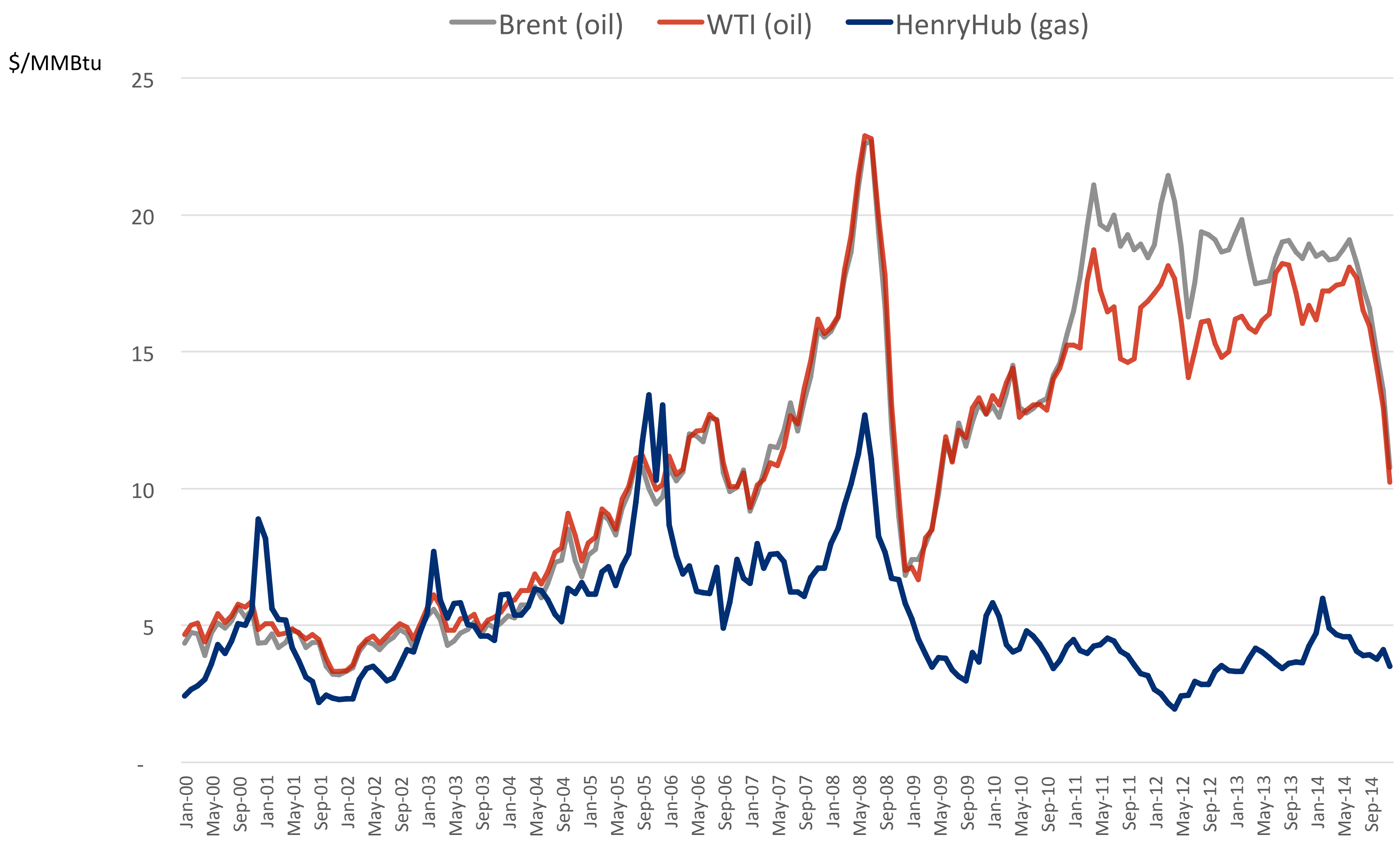



Source: European Commission

# The gas market: domestic impact

- Gas power market share from 18 to 29%
- Up to 3 to 1 ratio per calorific unity vs. oil (previously 5 to 1 with oil at 100). Gas-to-oil potentially feasible
- Re-coupling. Natural gas and LNG growing consumption as transportation fuels resuming (marginal) competition with oil
- Boosting energy intensive industry
- The petrochemical threat: up to 3 to 1 cost of production differential between European and US produced ethylene.

# GAS/OIL CALORIFIC PARITY

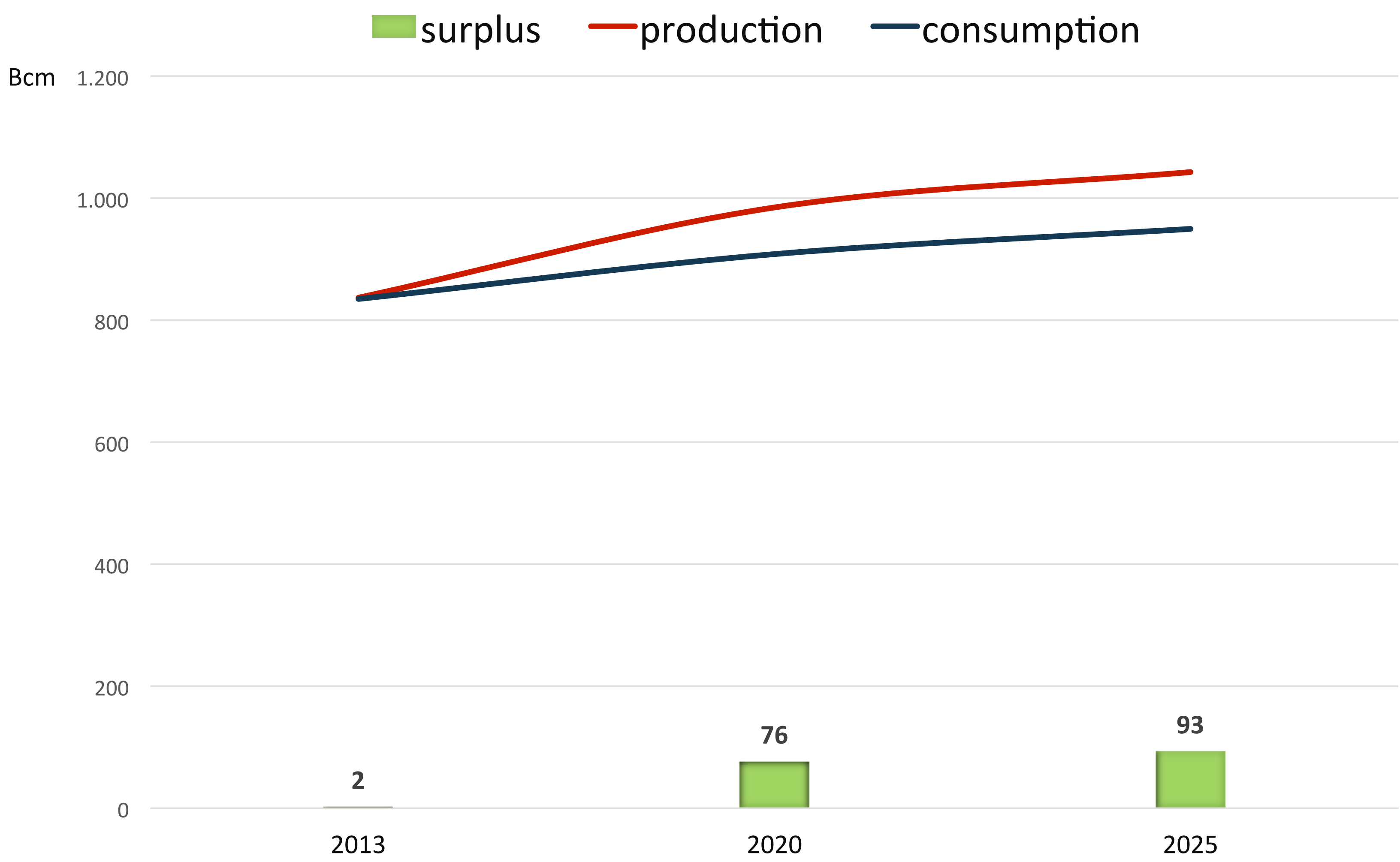



Energy parity for WTI, Brent, and Henry Hub natural gas – Source: elaboration on EIA

# The gas market: international impact

- North America production surplus and export infrastructure will have material impact only towards end of decade
- Market share could reach between 10 and 20% of the LNG market:
  - 4-8% of internationally traded natural gas
- Dramatic impact on gas prices unlikely due to market share and transportation costs
- Market liquidity will be positively affected
- Export direction will be decided by regional price differentials

# US + Canada estimated gas production surplus forecast




Source: elaboration on IEA

# LIQUEFACTION CHAIN DIAGRAM AND COSTS




| | Exploration & Production | Liquefaction | Shipping | Storage & Regasification |
|---|---|---|---|---|
| | Gas production and preplant processing and transport | Liquefaction plant, including preliquefaction processing, storage, and carrier loading | Shipping | Receiving terminal, including unloading, storage, regasification, and delivery |
| % Total Capital Costs (EIA, 2003) | 15 to 20 | 30 to 45 | 10 to 30 | 15 to 25 |
| Example Capital Costs | Varies widely | $1.5 to $2 billion for a plant that produces 8.2 million tons of LNG per year | $155 million to purchase a single 138,000 cubic meter ship, or $60,000 per day to charter | $400 million for a U.S. terminal capable of delivering between 180 and 360 Bcf per year |

Source: EIA (2004)

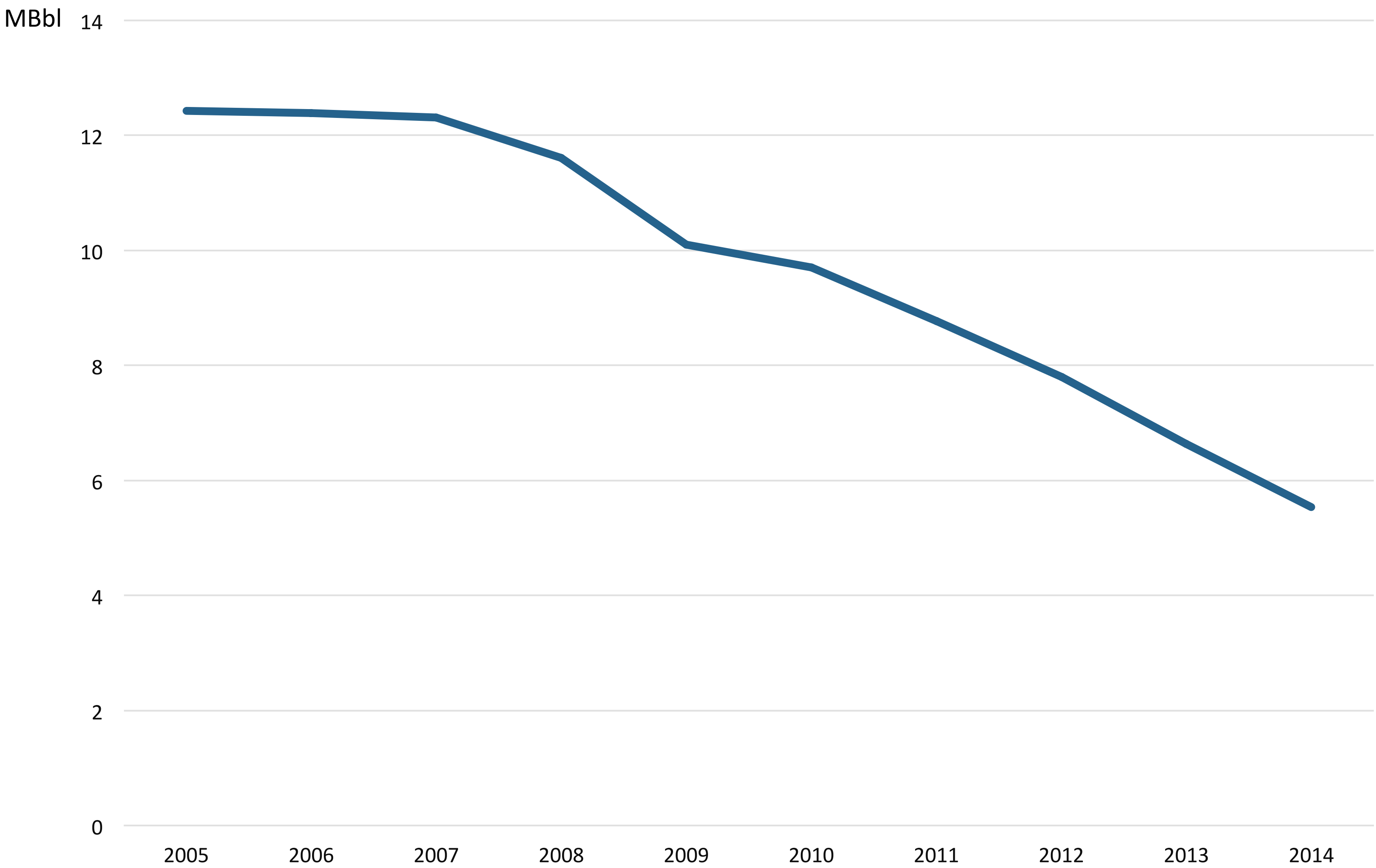
# The oil market: domestic impact

- National effects: trade balance savings ranging in time from 100 to over 200 thousand million dollars
- Origin of imports redefined on the basis of the refining system in place
- Sweet crude imports fully substituted by national shale production
- No material impact on national prices

# The oil market: international impact

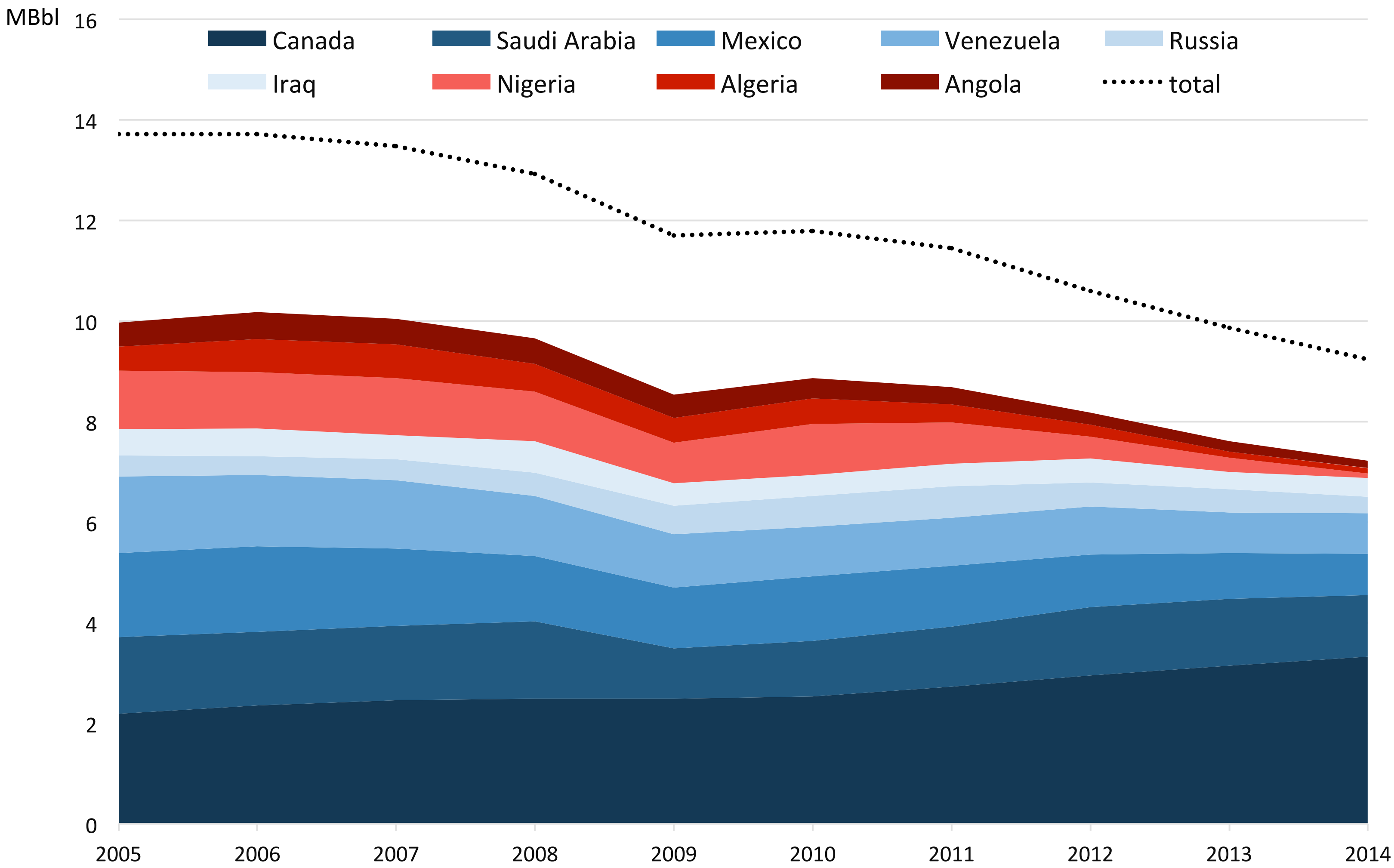
- More than 6 Mbbl/d disappearing from the “conventional market” since 2005
- Price stabilizing effect during the 2011-2013 disruptions (Arab spring etc)
- Thereafter one of the main factors of the current slump
- US already a net exporter of oil products (over 1,5 Mbbl/d)
- Exports of crude will not be subject to the US becoming «independent» from imports but will happen as a consequence of the unfitness of the US refining system for the handling of huge volumes of LTO («Light Tight Oil»)

# CRUDE AND PRODUCTS: NET IMPORTS




Source: EIA

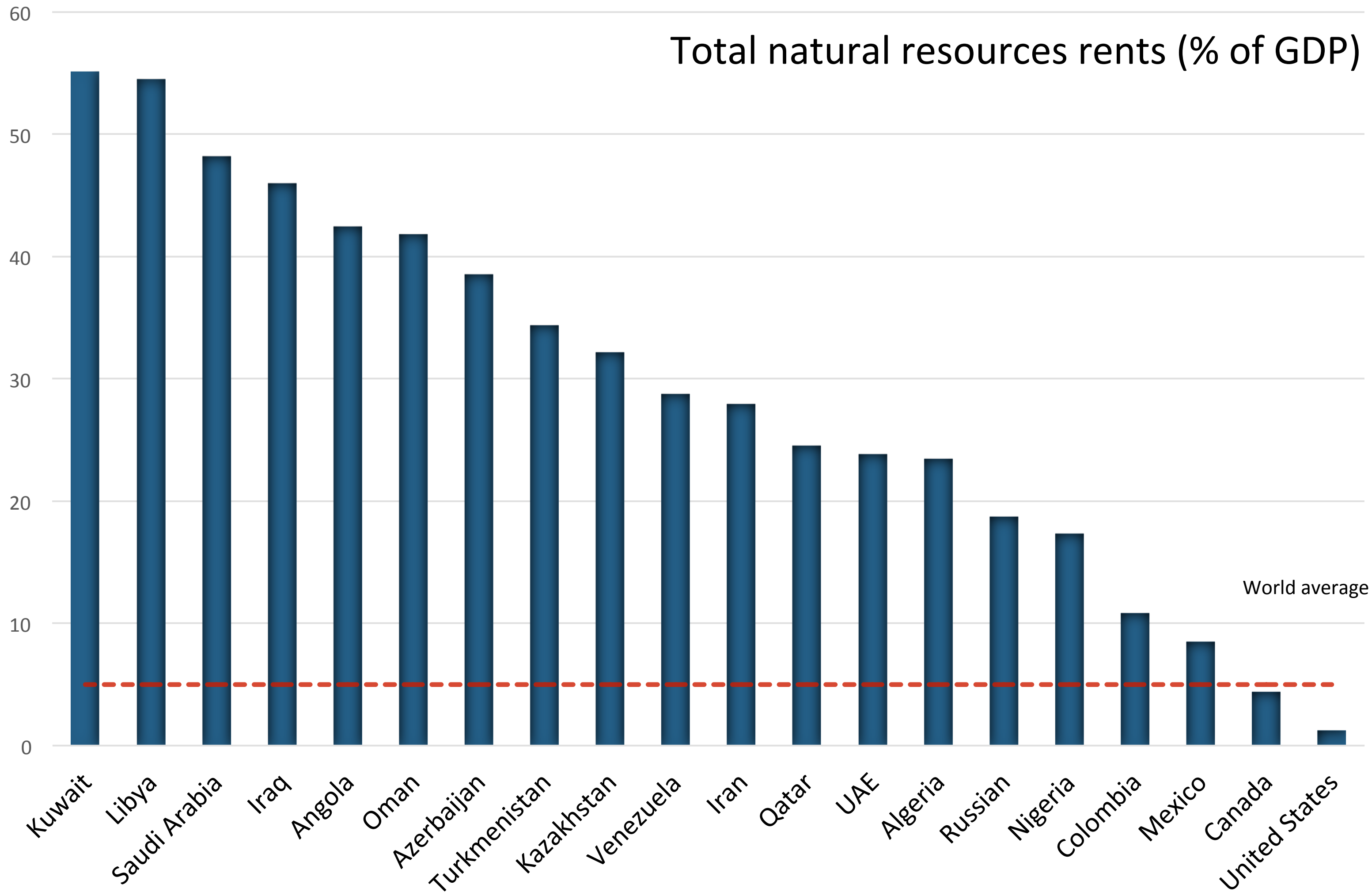
# US OIL IMPORTS BY COUNTRY OF ORIGIN




Source: elaboration on EIA

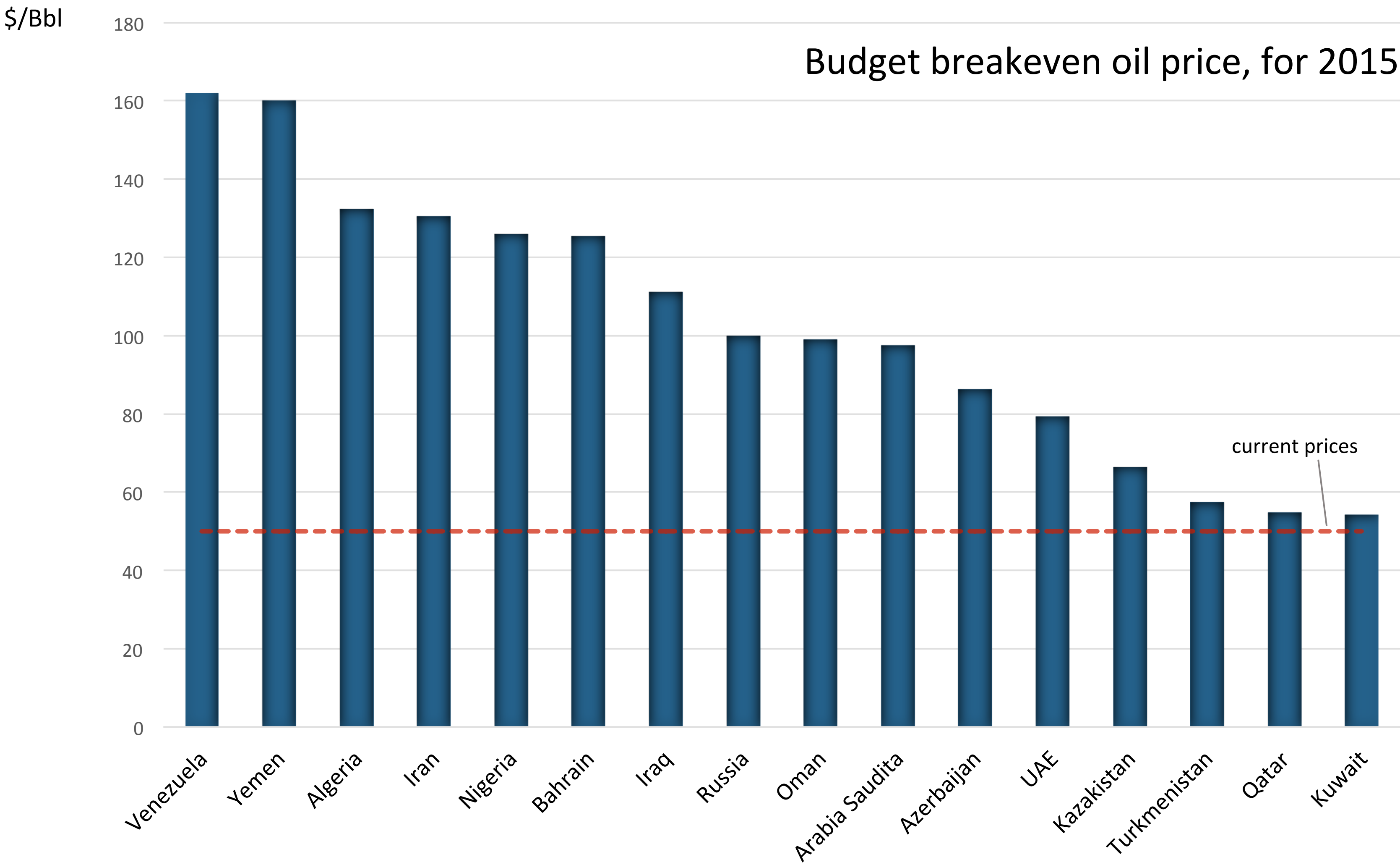
- Production costs of conventional oil remain low when compared to unconventional
- Most conventional producers rely heavily on oil revenues for their state budget, and therefore need to bargain a ***social*** break even price to maintain internal stability
- Falling prices are a threat to the ruling class and carry a potential for disruption and social unrest
- In a 53,8 $/bbl average 2015 price scenario, the producers loss of income would amount overall to 622 thousand million dollars (as modelled by Banca Intesa)

# The rentier States by rent dependence



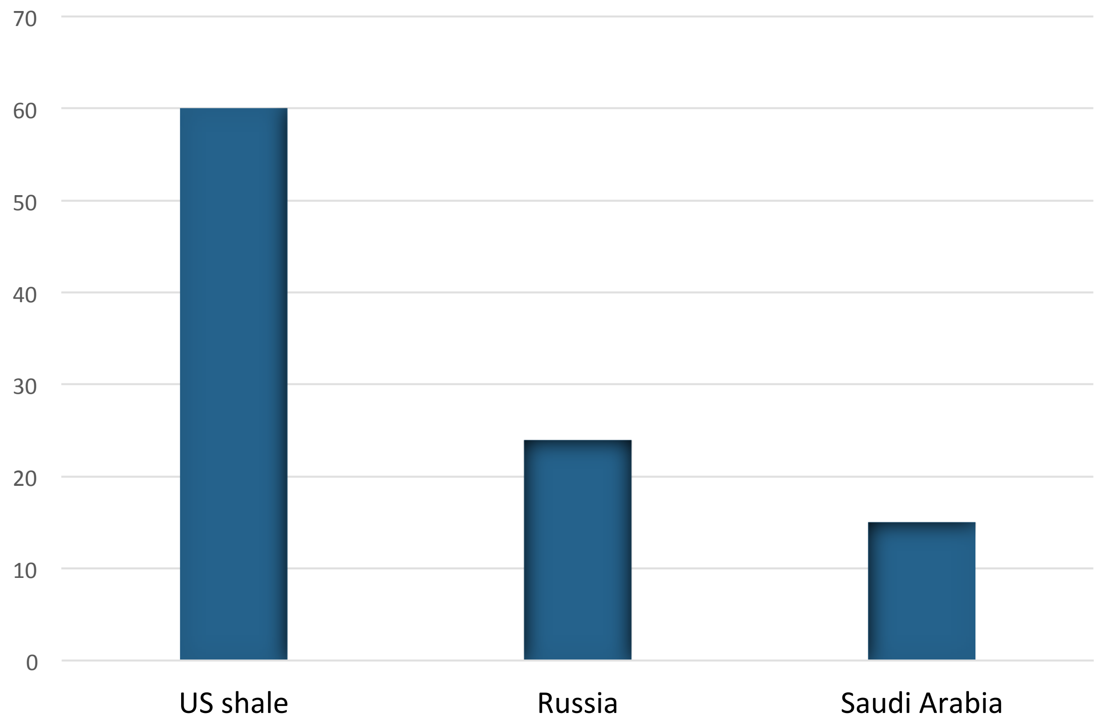

Source: World Bank (2012)

# *Social* breakeven oil price: cost of stability




Source: elaboration on IMF and Deutsche Bank

# *ECONOMIC* BREAKEVEN OIL PRICE: COST OF PRODUCTION

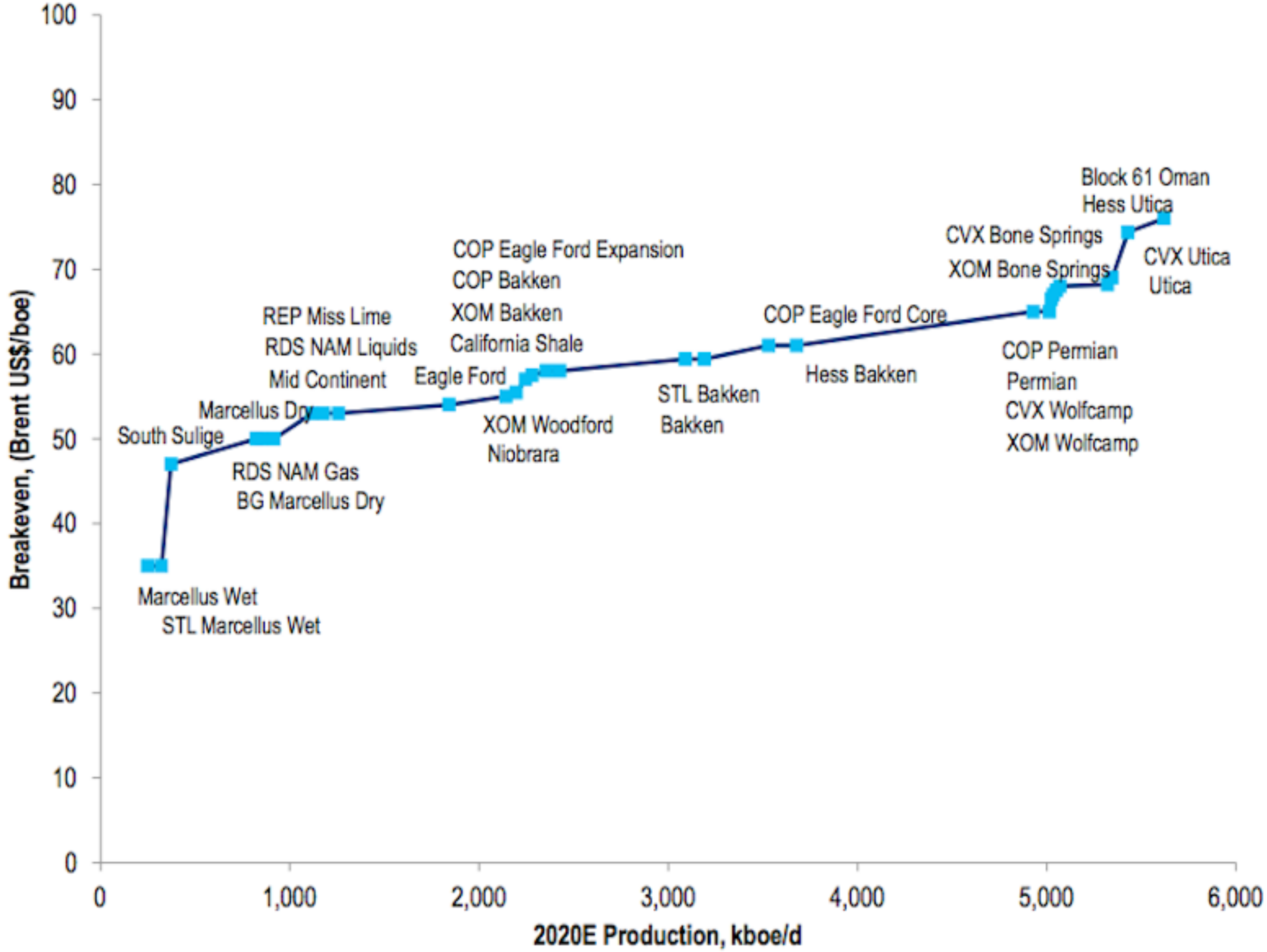



Average production costs are estimates of absolute values. but the order of magnitude should be taken as reliable

# The price dilemma: the independent producer

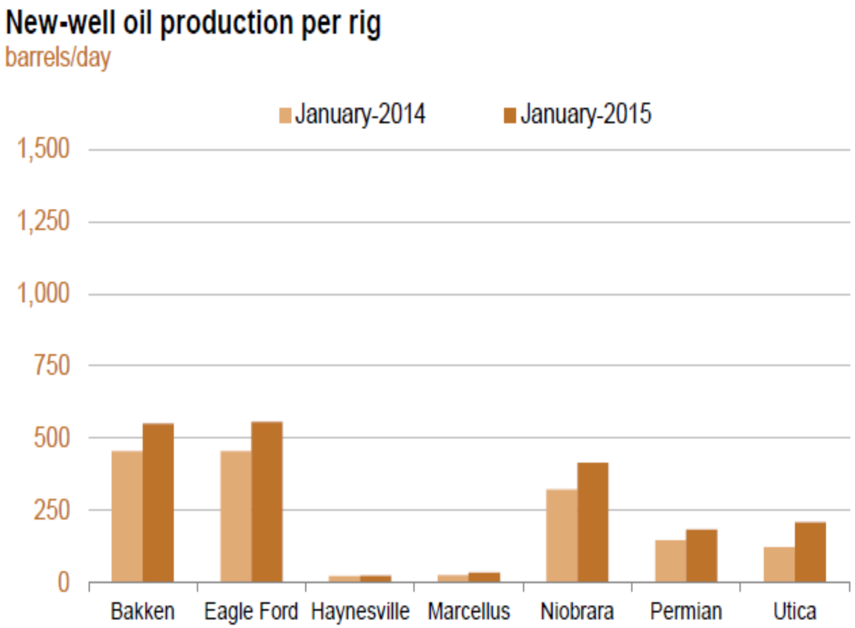
- Development of fracking technology has made tight oil economic under certain price assumptions
  - Still far from cost competitive with most of the conventional oil
- The drilling intensity model reacts swiftly to market changes
  - Investment curtailments have an almost immediate effect on production capacity
- Production costs vary between wells
  - Overall the mean economic break even should be in the low 60 $/bbl range

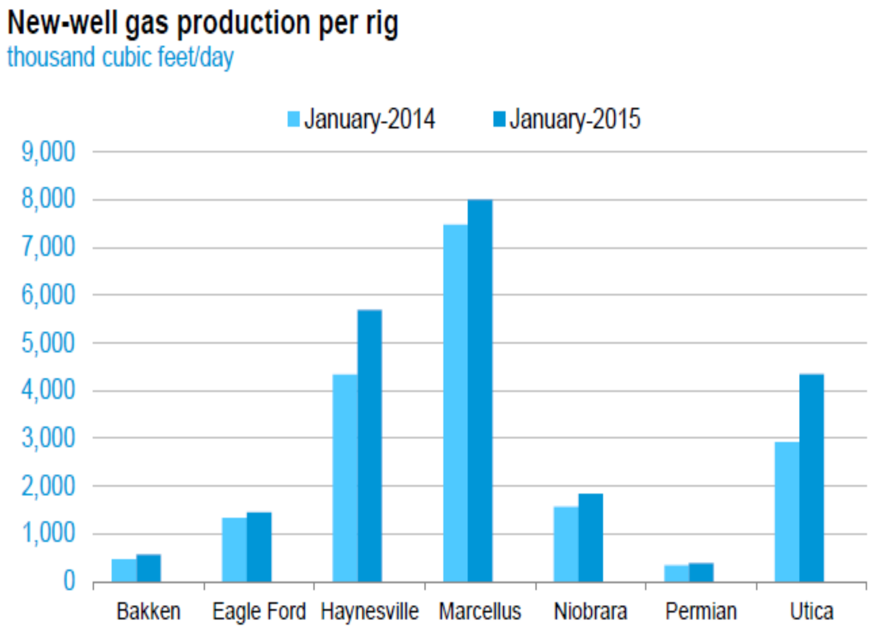
# Economic break even in US shale formation




Source: Citi

# TECHNOLOGY IMPROVEMENTS




Source: EIA

# Oversupply

- US contribution. The 2014 increase in US oil production alone has surpassed the increase in global demand (1,16 Mbbl/d vs. 0,7 Mbbl/d)

- Current forecasts (e.g. Petroleum Intelligence Weekly) assume the supply surplus for 2015 to be in excess of 2 Mbbl/d

- The surplus will fill storage capacity, to the extent available
  - China is currently importing more than 7 Mbbl/d, of which around 0,5 could be for storage

# OVERSUPPLY: OUT OF THE SLUMP

- Oversupply will not be met, at least in the short period, by a corresponding demand growth

- Reducing the offer may take three different forms
  - Voluntary, via reduction of the current conventional flow (OPEC)
  - Social, via disruption as a consequence of social unrest within a producer
  - Economic, via slow down and reduction of the US production

# DECREASING SUPPLY: VOLUNTARY

- Difficult to imagine without Saudi involvement

- Without swing producer, all other producers are forced to keep production at maximum levels
  - Their behaviour does not impact prices, they are left to choose between low revenues, or no revenues

# DECREASING SUPPLY: SOCIAL

- Negative effects of low prices on national budgets limited on yearly basis in 2014
  - **99,54 $/bbl** in **2014** vs **108,64 $/bbl** in **2013**
  - For **2015** EIA predicts an average of **68,08 $/bbl**
- Possibility of social unrest and disruption of production in some of the most rent-addicted producer states
- Impact of disruptions is debatable
  - Past disruptions, e.g. Libya, have been fully amortised by the availability of excess capacity
  - The present oversupply implies that any individual producer, except for the big three, is virtually redundant on the market

# Decreasing supply: economic

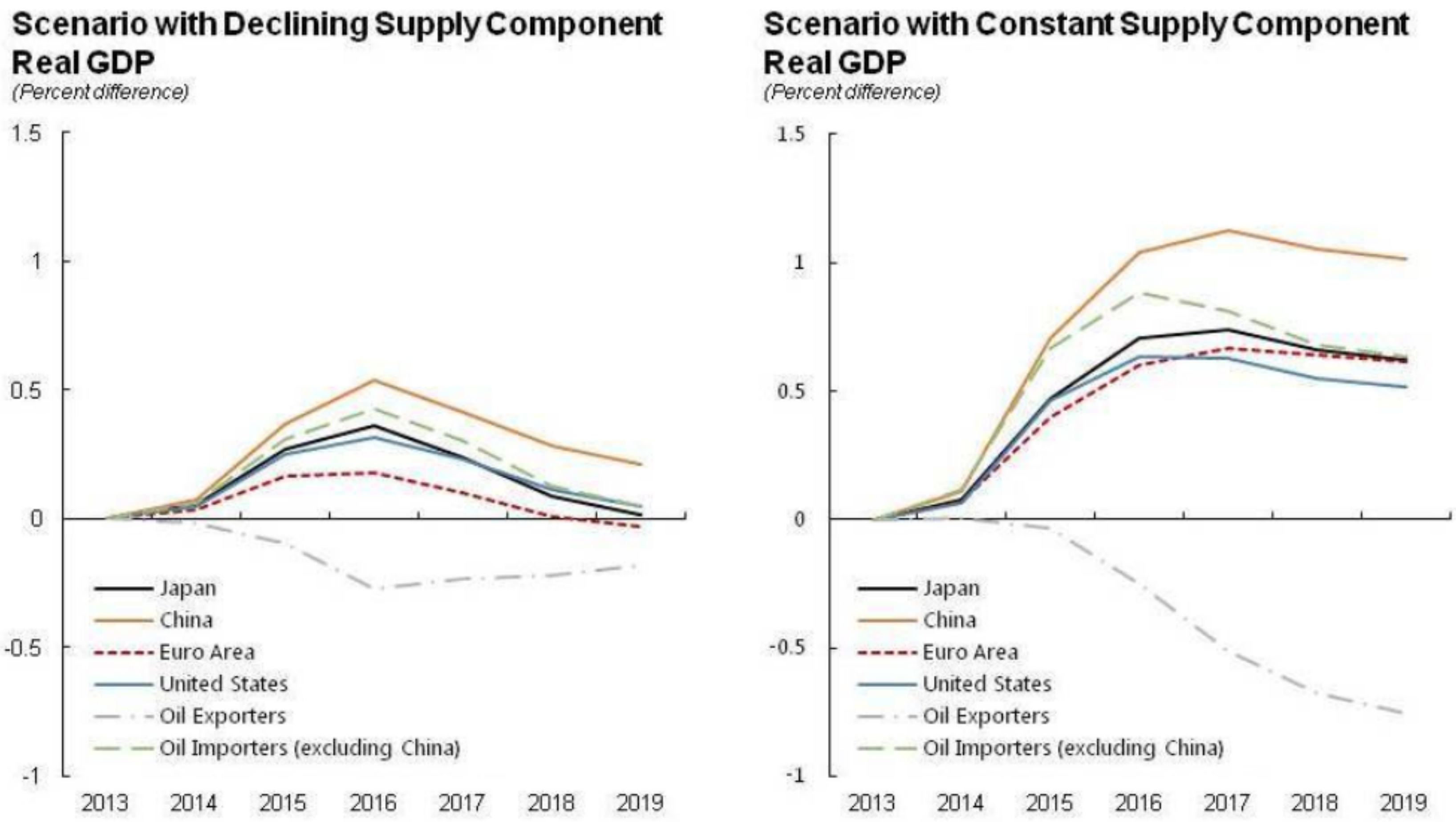
- No tight/shale drilling for one year would reduce shale production by 60-65% and reduce overall US oil production by almost 2 Mbbl/d
- Average break even prices are misleading when applied by basin instead of by well: in mature projects with fully paid infrastructure ***half cycle*** breakeven costs may settle between 37 and 45 $/bbl
- Technological development applied to a time to market technique may still have a significant short term impact on the break even benchmark (10 % or more)
- Unless the price stabilizes under 60 $/bbl, a slow down of the forecasted growth looks more likely than a sharp decline in current production

# DECREASING SUPPLY: NEW CONVENTIONAL OIL

- Most conventional production comes from old fields with low investment/production costs
- The creaming curve makes reserve replacement more technically challenging and raises the benchmark for break even
- Most key projects presently in the pipeline have estimated break even significantly higher than shale production
- Goldman Sachs estimates that a 70 $/bbl price would delay or cancel 930 thousand million dollars worth of upstream planned investment, representing a potential production of 2,3 Mbbl/d in 2020 and 7,5 in in 2025
- The oil price slump may impair medium term replacement and materially swing the pendulum towards undersupply

- Most current scenarios assume a positive impact of the price drop on importing countries GDP and trade balance
- The extent of the impact remains controversial
- The different impact on individual countries would be mainly driven by two factors:
    - Energy intensity
    - Energy taxation

# Benefits of a price drop




Source: IMFdirect

# Final remarks (1): Shale Revolution and price drop

- The Shale Revolution has contributed impetus to the price drop, and the price drop will likely slow the Shale Revolution
- The slow down in the long term will not imply loss, but just deferral of production
- Due to short term price sensitivity and available drilling stock, production increase should regain speed as soon as favourable price signals hit the market
- The process may however be delayed and require higher (risk rewarding) prices should the combination of the hedging practice and of the present price drop result in a serious crisis on the derivatives (junk bonds) market

## Final remarks (2): pros and cons of the price drop

- Short term benefits to the economic cycle (but potential booster of European deflation)
- In the medium-long term:
  - Risk of social instability affecting also neighbouring countries
  - Slow down of reserve replacement investments and potential for price volatility
  - Potential temporary slow down of green policies and increase of carbon energy consumption (before the price drop, IEA forecast was that in 2040 carbon energy sources share would still be no less than 74%)

⇩

Need for policies capable of limiting the downsize of cheap oil.
Would, amongst others, a carbon tax help?

For every complex problem there is an answer that is clear, simple, and wrong.

*H.L. Mencken*