The geopolitics of the energy transition

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Harmful effects of CO2 are well known

Arrhenius, 1886

[FIFTH SERIES.]

APRIL 1896.

XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* *By* Prof. SVANTE ARRHENIUS *.

I. *Introduction : Observations of* Langley *on Atmospherical Absorption.*

A GREAT deal has been written on the influence of the absorption of the atmosphere upon the climate. Tyndall † in particular has pointed out the enormous importance of this question. To him it was chiefly the diurnal and annual variations of the temperature that were lessened by this circumstance. Another side of the question, that has long attracted the attention of physicists, is this : Is the mean temperature of the ground in any way influenced by the presence of heat-absorbing gases in the atmosphere? Fourier‡ maintained that the atmosphere acts like the glass of a hot-house, because it lets through the light rays of the sun but retains the dark rays from the ground. This idea was elaborated by Pouillet § ; and Langley was by some of his

Hansen, 1988

28 August 1981, Volume 213, Number 4511 **SCIENCE**

Climate Impact of Increasing Atmospheric Carbon Dioxide

J. Hansen, D. Johnson, A. Lacis, S. Lebedeff
P. Lee, D. Rind, G. Russell

Summary. The global temperature rose by 0.2°C between the middle 1960's and 1980, yielding a warming of 0.4°C in the past century. This temperature increase is consistent with the calculated greenhouse effect due to measured increases of atmospheric carbon dioxide. Variations of volcanic aerosols and possibly solar luminosity appear to be primary causes of observed fluctuations about the mean trend of increasing temperature. It is shown that the anthropogenic carbon dioxide warming should emerge from the noise level of natural climate variability by the end of the century, and there is a high probability of warming in the 1980's. Potential effects on climate in the 21st century include the creation of drought-prone regions in North America and central Asia as part of a shifting of climatic zones, erosion of the West Antarctic ice sheet with a consequent worldwide rise in sea level, and opening of the fabled Northwest Passage.

Atmospheric CO_2 increased from 280 to 300 parts per million in 1880 to 335 to 340 ppm in 1980 (*1, 2*), mainly due to burning of fossil fuels. Deforestation and changes in biosphere growth may also have contributed, but their net effect is probably limited in magnitude (*2, 3*). The CO_2 abundance is expected to reach 600 ppm in the next century, even if growth of fossil fuel use is slow (*4*).

Carbon dioxide absorbs in the atmospheric "window" from 7 to 14 micrometers which transmits thermal radiation emitted by the earth's surface and lower atmosphere. Increased atmospheric CO_2 tends to close this window and cause outgoing radiation to emerge from higher, colder levels, thus warming the surface and lower atmosphere by the so-called greenhouse mechanism (*5*). The most sophisticated models suggest a mean warming of 2° to 3.5°C for doubling of the CO_2 concentration from 300 to 600 ppm (*6–8*).

The major difficulty in accepting this theory has been the absence of observed warming coincident with the historic CO_2 increase. In fact, the temperature in the Northern Hemisphere decreased by about 0.5°C between 1940 and 1970 (*9*), a time of rapid CO_2 buildup. In addition, recent claims that climate models overestimate the impact of radiative perturbations by an order of magnitude (*10, 11*) have raised the issue of whether the greenhouse effect is well understood.

We first describe the greenhouse mechanism and use a simple model to compare potential radiative perturbations of climate. We construct the trend of observed global temperature for the past century and compare this with global climate model computations, providing a check on the ability of the model to simulate known climate change. Finally, we compute the CO_2 warming expected in the coming century and discuss its potential implications.

Greenhouse Effect

The effective radiating temperature of the earth, T_e, is determined by the need for infrared emission from the planet to balance absorbed solar radiation:

$$\pi R^2(1 - A)S_0 = 4\pi R^2\sigma T_e \quad (1)$$

or

$$T_e = [S_0(1 - A)/4\sigma]^{1/4} \quad (2)$$

where R is the radius of the earth, A the albedo of the earth, S_0 the flux of solar radiation, and σ the Stefan-Boltzmann constant. For $A \sim 0.3$ and $S_0 = 1367$ watts per square meter, this yields $T_e \sim 255$ K.

The mean surface temperature is $T_s \sim 288$ K. The excess, $T_s - T_e$, is the greenhouse effect of gases and clouds, which cause the mean radiating level to be above the surface. An estimate of the greenhouse warming is

$$T_s \sim T_e + \Gamma H \quad (3)$$

where H is the flux-weighted mean altitude of the emission to space and Γ is the mean temperature gradient (lapse rate) between the surface and H. The earth's troposphere is sufficiently opaque in the infrared that the purely radiative vertical temperature gradient is convectively unstable, giving rise to atmospheric motions that contribute to vertical transport of heat and result in $\Gamma \sim 5°$ to 6°C per kilometer. The mean lapse rate is less than the dry adiabatic value because of latent heat release by condensation as moist air rises and cools and because the atmospheric motions that transport heat vertically include large-scale atmospheric dynamics as well as local convection. The value of H is ~5 km at midlatitudes (where $\Gamma \sim 6.5°C\ km^{-1}$) and ~6 km in the global mean ($\Gamma \sim 5.5°C\ km^{-1}$).

The surface temperature resulting from the greenhouse effect is analogous to the depth of water in a leaky bucket with constant inflow rate. If the holes in the bucket are reduced slightly in size, the water depth and water pressure will

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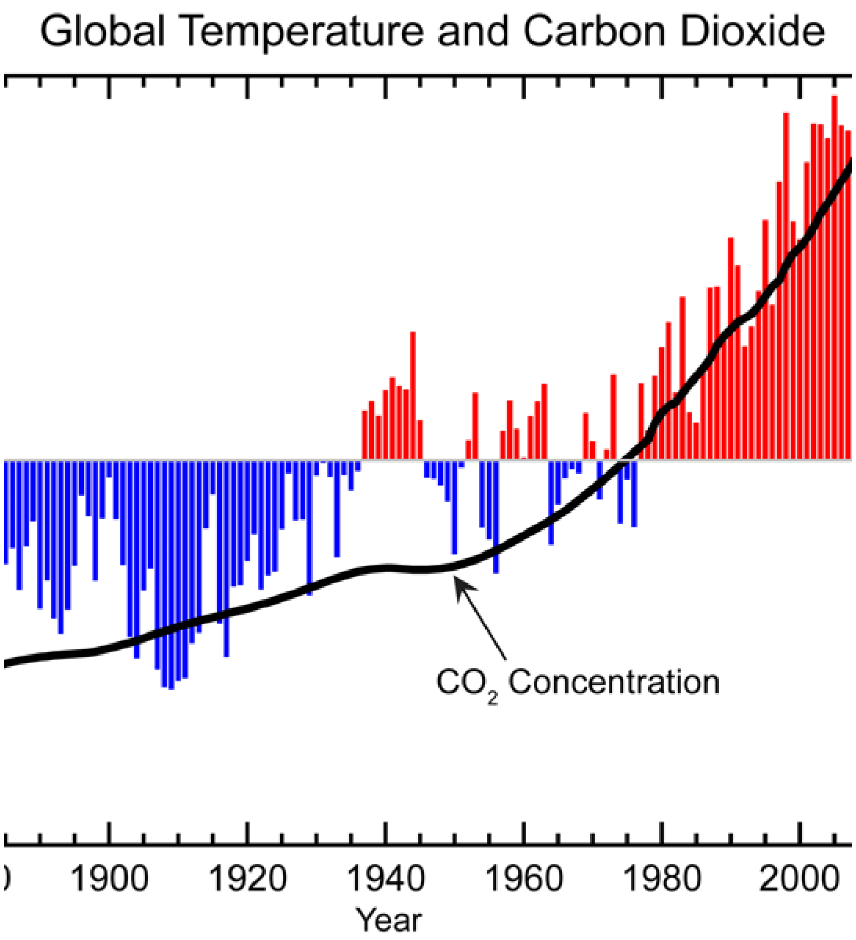
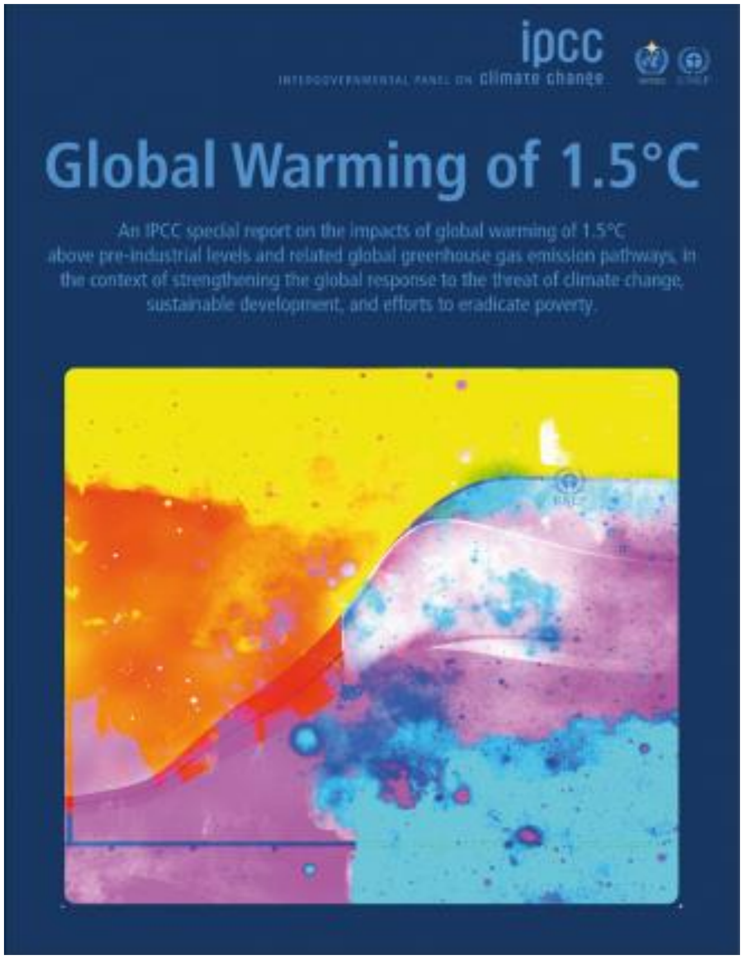
From prevention to mitigation

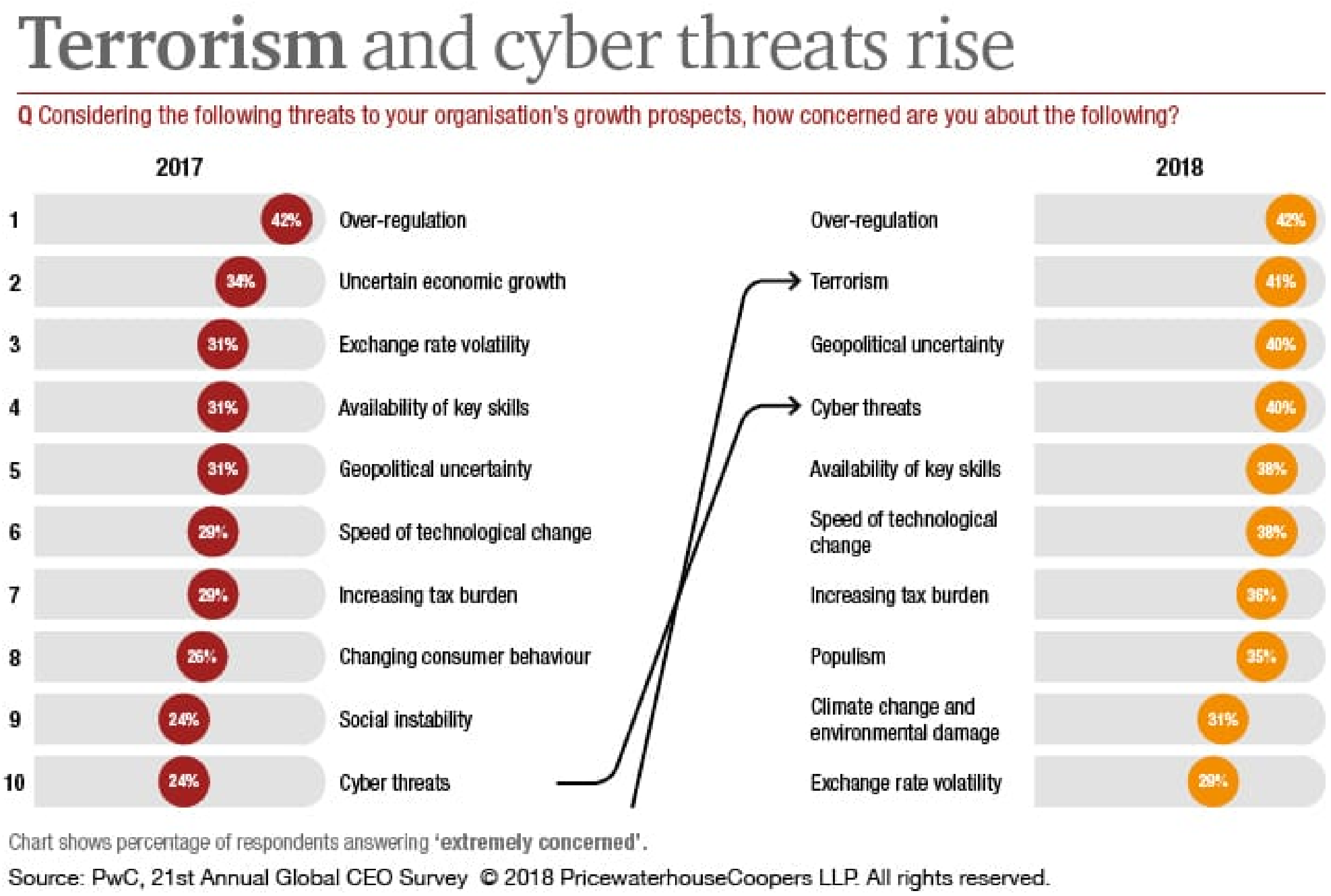


- Cognitive Dissonance
- Human nature: human mind as a cognitive miser and heuristics
- Long term versus short term gains
- Domestic political constraints
- Others should take the first step
- Self interest of individuals and states
- The world as an anarchic system that requires self help
- Zero sum games



- US withdrew
- ‘only’ 1,5 percent in
- ‘only’ in 2050
- So what?
- Enormous costs of energy transition…
- will affect middle class

Executives' Concerns
PWC CEO Survey 2018

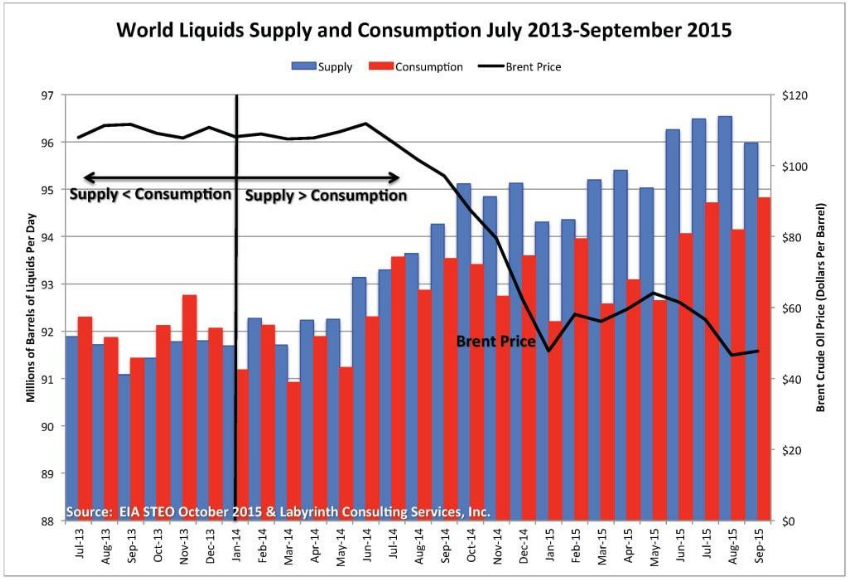


Energy transition: A societal challenge

Geopolitical unrest makes energy transition difficult

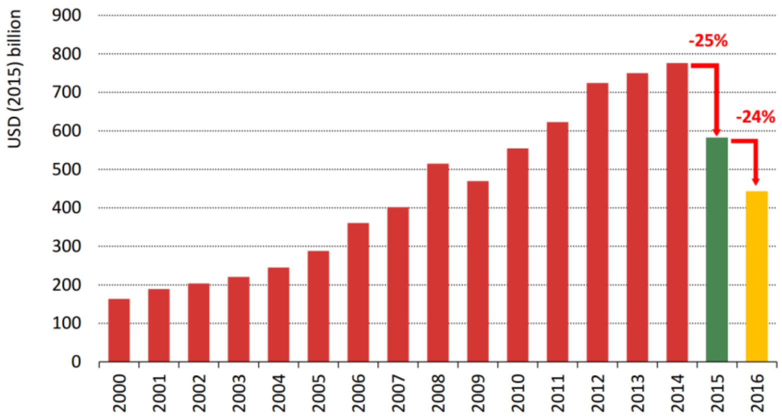
- Rise of China
- Decline of western power
- Increased frequency of systemic crises
- Great power competition
- Protectionism and attacks on multilateralism
- Due to higher prices big producers have few incentives

Oil prices went down



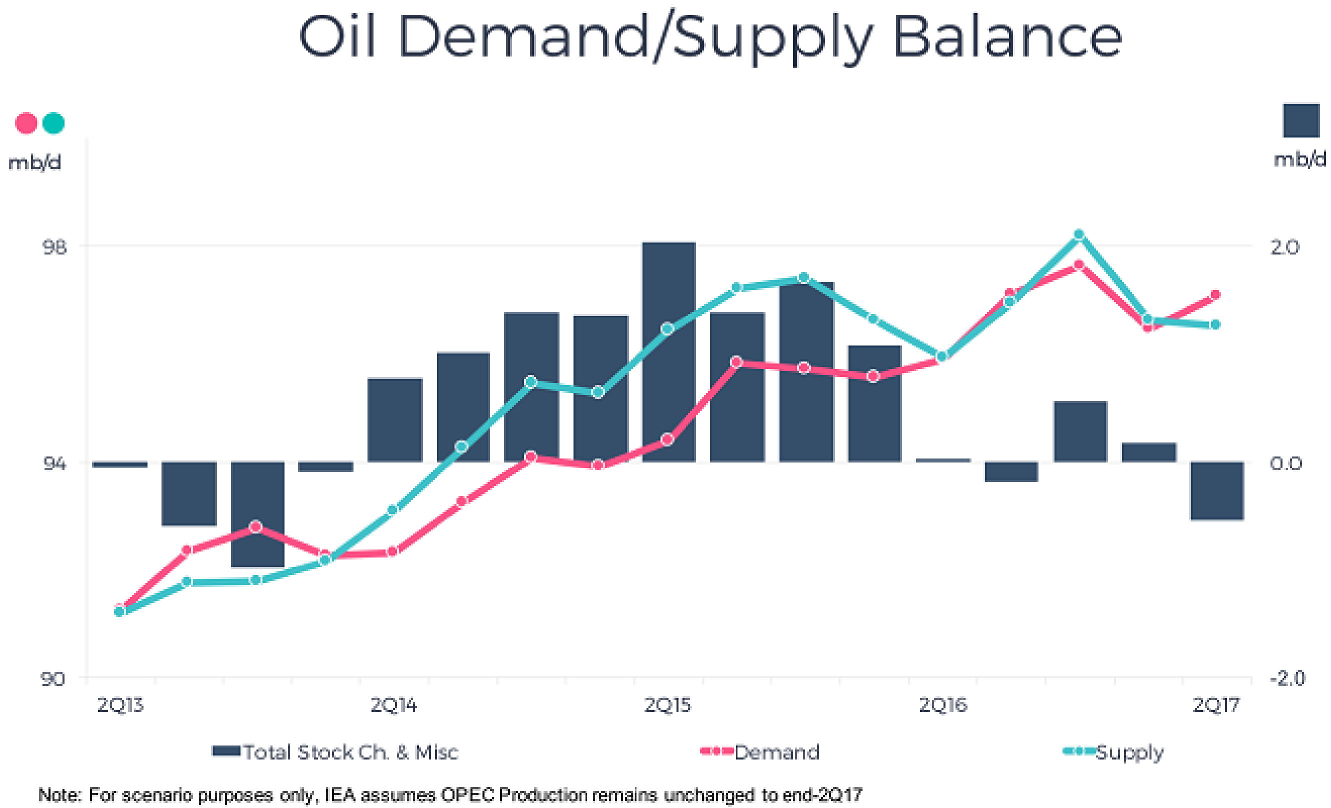
Declining investments

Figure 3.3 • **World upstream oil and gas investment**

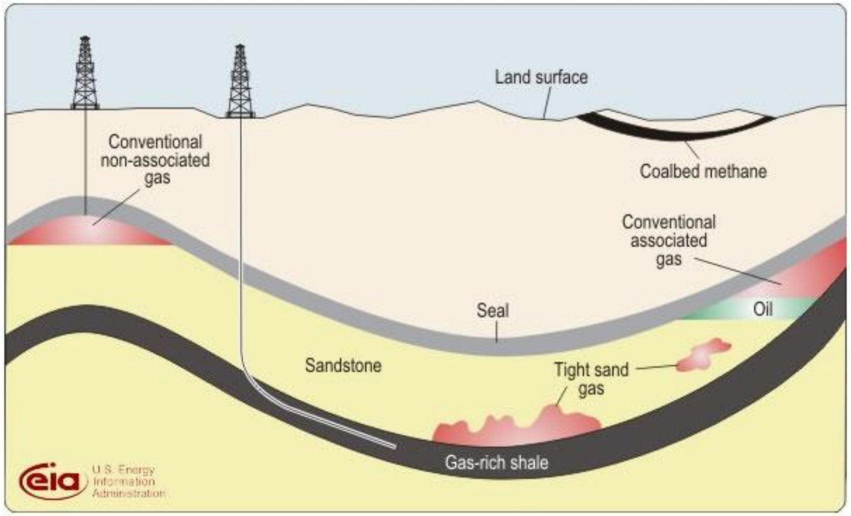


Note: 2016 is estimated based on announced company spending plans and guidance as of September 2016.

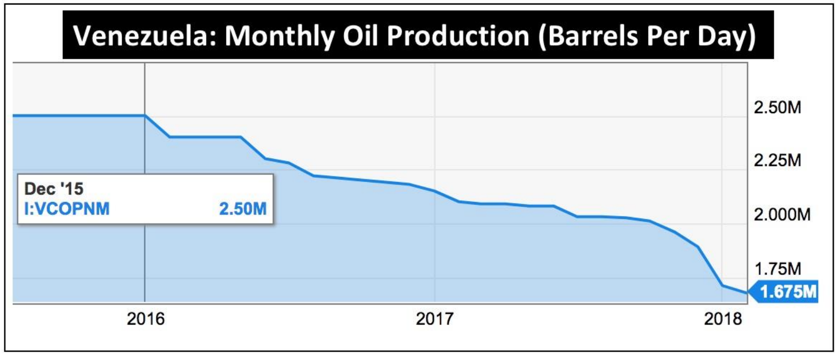
Prices are up



Challenge: shale and infrastructure



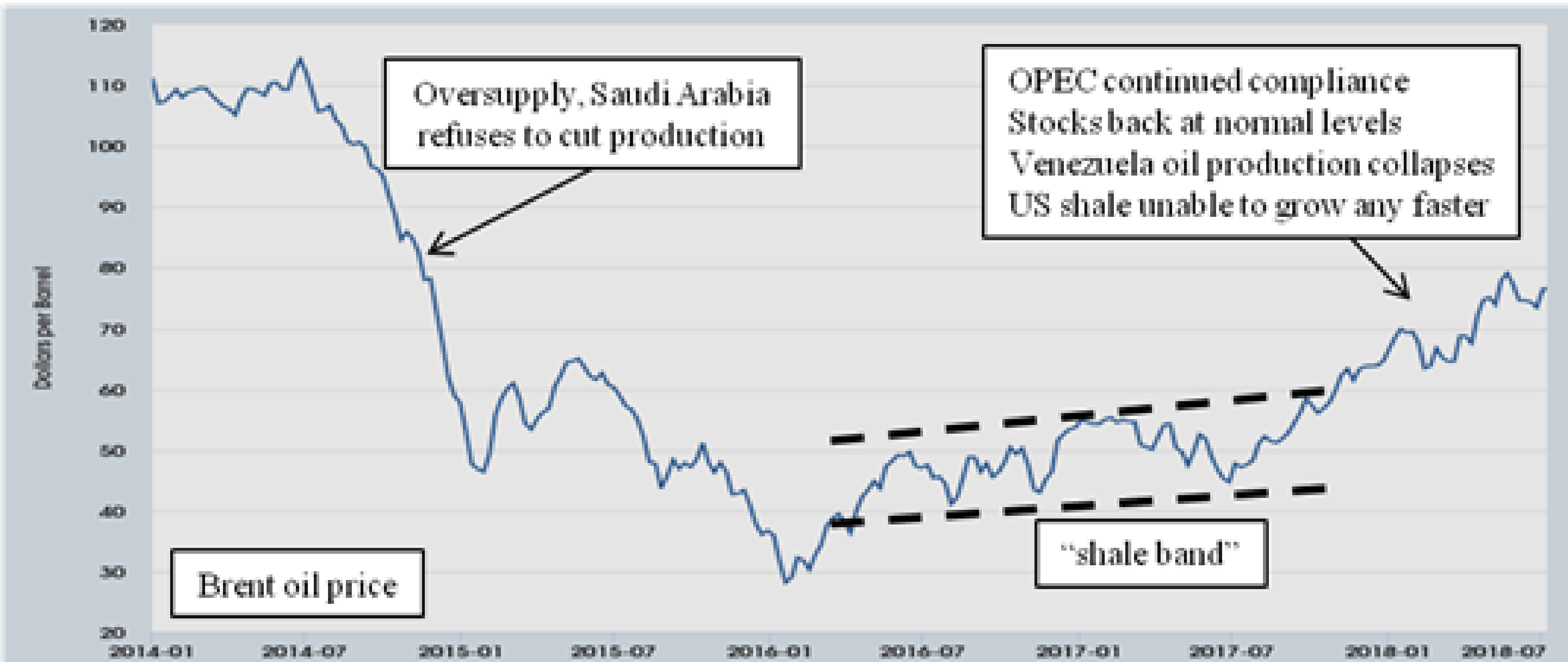
Challenge: Iran and Venezuela



Trump on OPEC

- OPEC and OPEC nations are, as usual, ripping off the rest of the world and I don't like it (UN GA)
- We protect the countries of the Middle East, they would not be safe for very long without us, and yet they continue to push for higher and higher oil prices! We will remember. The OPEC monopoly must get prices down now! (Twitter)

OPEC+ has gained pricing power



Trump at NATO summit

"It's very sad when Germany makes a massive oil and gas deal with Russia where we're supposed to be guarding against Russia and Germany goes out and pays billions and billions of dollars a year to Russia"

Merkel vs the EC

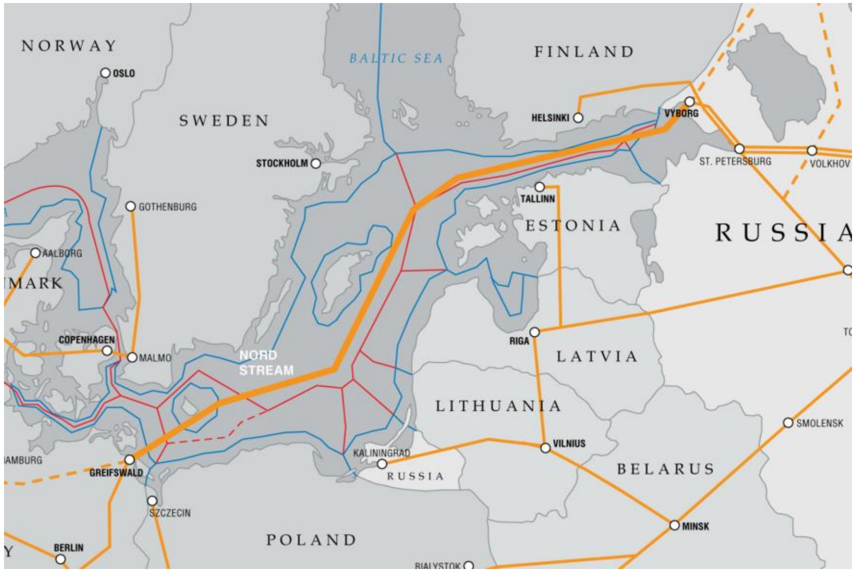
Merkel: Commercial approach

- NS 2 is a commercial project of Gazprom, ENGIE, OMV, Royal Dutch Shell, Uniper and Wintershall.
- Supported by the Netherlands, Austria, and France
- The Schroder factor Phasing out of nuclear energy, Energiewende, and CO2 reductions by 2020
- Few options for diversification
- LNG is too expensive
- NS 2 increases German dependency (from 40 % to 55%)

EC: Energy security

- Energy security strategy 2014
- Stress test 2014:
  - A complete halt of Russian gas imports
  - Disruption of the Ukraine pipeline
- Measures:
  - Efficiency
  - Diversifying of supplier countries
  - Increase LNG-imports
  - Speaking with one voice

The geopolitics of natural gas in Europe
North Stream vs Tanap

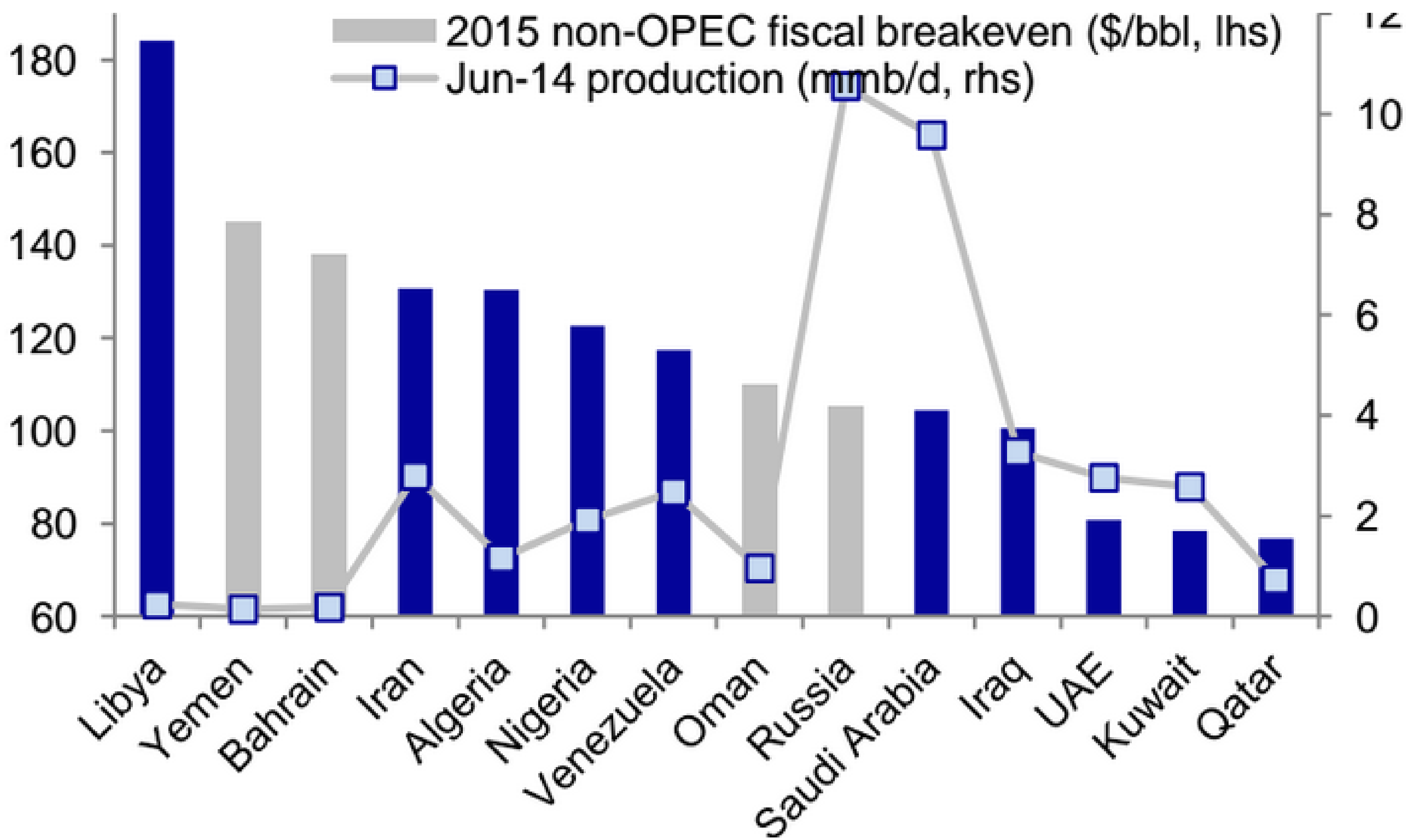


The geopolitics of natural gas in Asia

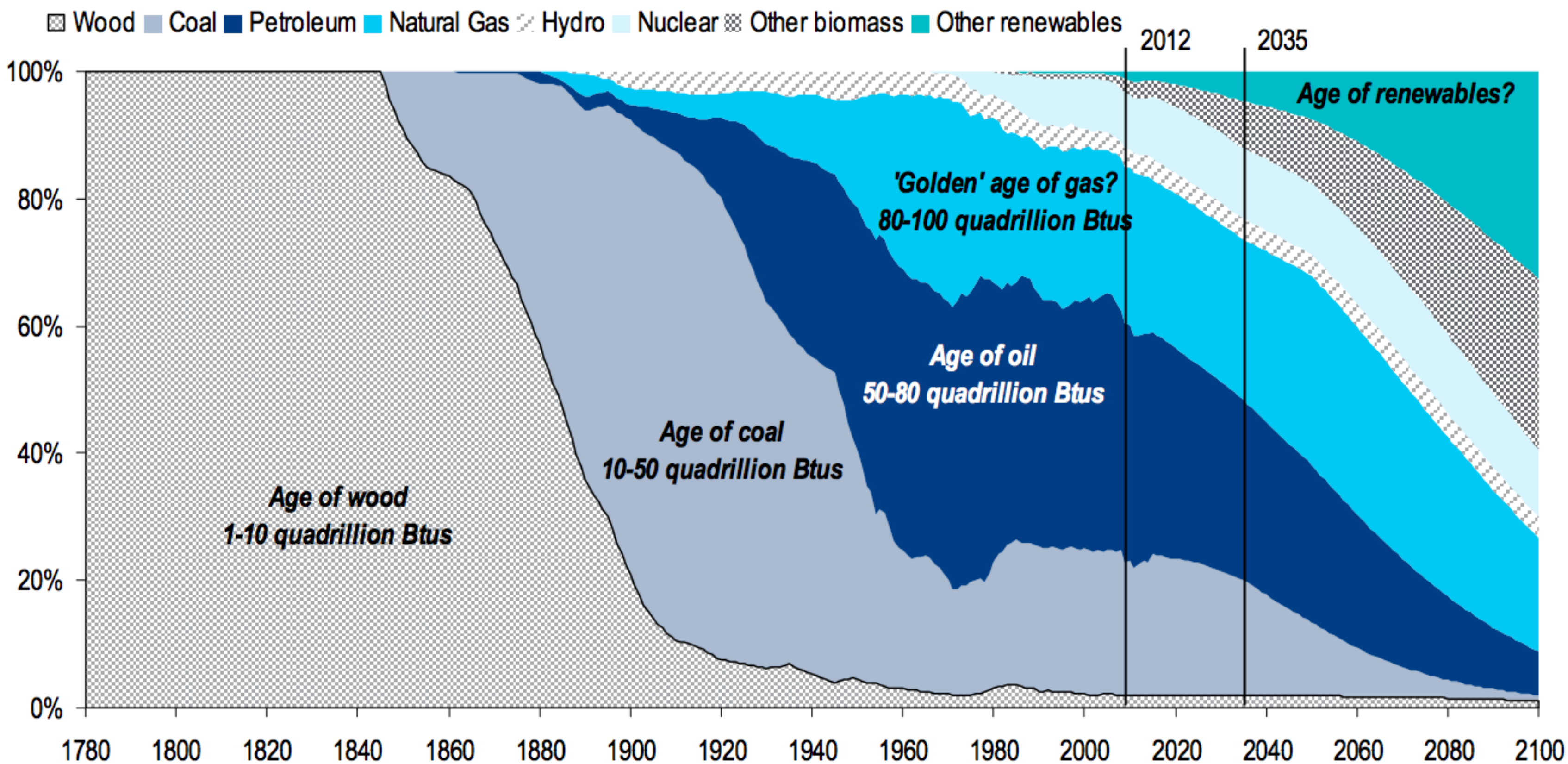
- Signed in 2014, completed in 2019
- Diversification strategy for China and Russia
- Compensation for the loss of Iran?

Winners and losers

(IMF, Deutsche Bank, 2015)



The age of fossil fuels has not yet ended



Conclusion

Drivers:

- Political and societal obstacles for energy transition
- Major energy exporters different interests
- Trump:
  - Geopolitics
  - trade war with China
  - Zero sum game
  - Transactional policies
  - Animosity with Merkel
  - Mid term elections
- Energy security strategies EU
- Pricing policies OPEC +