Transitional Role of the Oil and Gas Industry in Addressing Climate Change*

Ray Leonard[1] and Art Berman[2]

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[1]Anglo Eurasia LLC, Houston, Texas (RayLeonard@angloeurasiallc.com)
[2]Labyrinth Consulting, Houston, Texas

Abstract

The current atmospheric concentration of CO_2 is at 411 ppm, rising at 2.7-3 ppm/year and by 2050 will be at a level not seen in the past 30 million years. World temperature rise is about 1.3 deg. C above pre-industrial levels with the climate change effects already noticeable. A realistic objective at this point is to limit the ultimate CO_2 level below 700 ppm, limiting world temperature increase to below 3.2 deg. C to avoid the eventual melting of the Antarctic ice sheet, which would cause catastrophic sea level rise. There are substantial differences in the amount of CO_2 emissions depending on the type of hydrocarbons burned, with the lowest level of emissions coming from combustion of natural gas and ultra-light oils, including natural gas liquids. The oil and natural gas industry have undergone a shift in the past decade, with the largest new source of oil produced by the technical and economic breakthrough of hydraulic fracturing. This technology, the "marriage" of hydraulic fracturing and horizontal drilling, often also described as tight oil production, has several distinct characteristics; most importantly, the oil produced is virtually all ultra-light (lighter than 40-degree API) and natural gas liquids.

Natural gas production is also rapidly rising in the USA due to hydraulic fracturing of shales and internationally due to many supergiant gas discoveries that will likely be transported to markets by new export pipelines and as liquified natural gas (LNG). This makes feasible a scenario where greenhouse gases emitted by hydrocarbons could plateau over the coming decades and then decline after 2040. Critical pre-requisites for this scenario include that coal production is gradually reduced by 50% during 2020-2040 and an additional 50% by 2060; that oil production reaches a peak by 2025 followed by a plateau through 2040 before declining at 1% per year; and while continuing the current shift to ultralight production, that gas production increases (by 60% over current levels by 2040) to fill the energy gap. The renewable, plus nuclear share of energy production, will need to increase from the present level of 15% to 30% by 2040 and 50% by 2060 so that overall world energy supply can continue to grow at the current rate. These targets can be reached with the impetus of a carbons emission tax on coal calibrated to encourage a shift to use of renewables, nuclear and gas for power generation. The United States is well positioned for this scenario. Natural gas production is booming, with the greatest increase ever recorded in the past 12 months and set to continue in the coming decade. The USA is now a net gas exporter and growing LNG supplier. Meanwhile, oil production has doubled within the past 10 years with virtually all the

increase ultra-light oil and natural gas liquids. This trend should continue for the next several years. Greenhouse gas emissions are declining as lower price gas is replacing coal in power generation.

Selected References

Boden, T.A., G. Marland, and R.J. Andres, 2015, Global, regional, and national fossil-fuel CO_2 emissions: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn.

Dore, J.E., R. Lukas, D.W. Sadler, M.J. Church, and D.M. Karl, 2009, Physical and biogeochemical modulation of ocean acidification in the central North Pacific: Proceedings of the National Academy of Sciences, v. 106, p. 12235-12240. doi:10.1073/pnas.0906044106

Foster, Gavin L., Dana L. Royer, and Daniel J. Lunt, 2017, Future climate forcing potentially without precedent in the last 420 million years: Nature Communications, v. 8, article 14845.

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Ray Leonard: Anglo Eurasia Exploration LLC

Art Berman: Labyrinth Consulting

AAPG ACE May 2019 San Antonio

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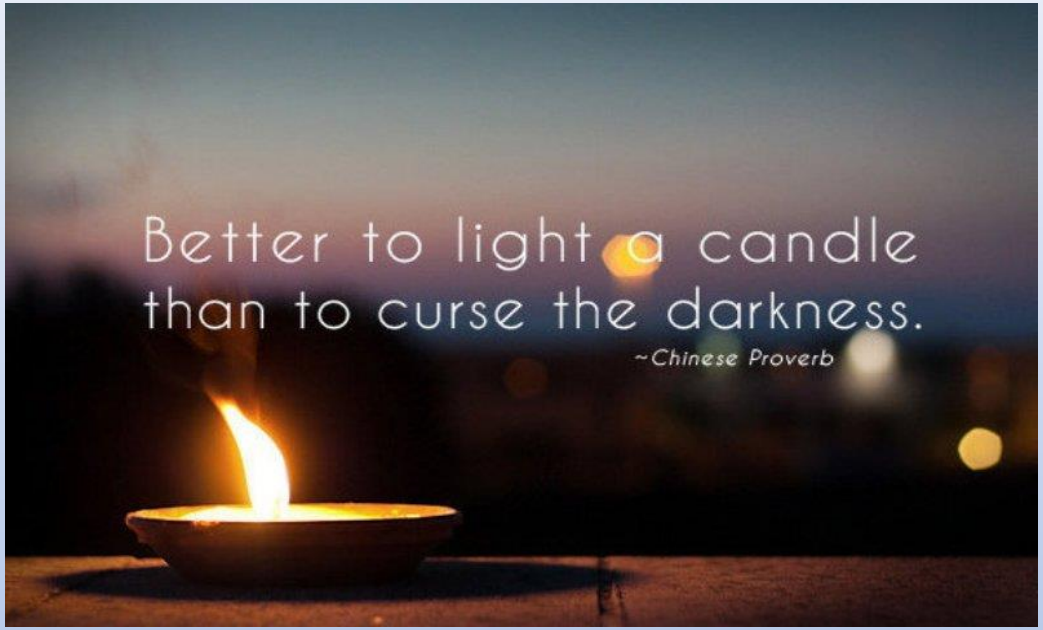
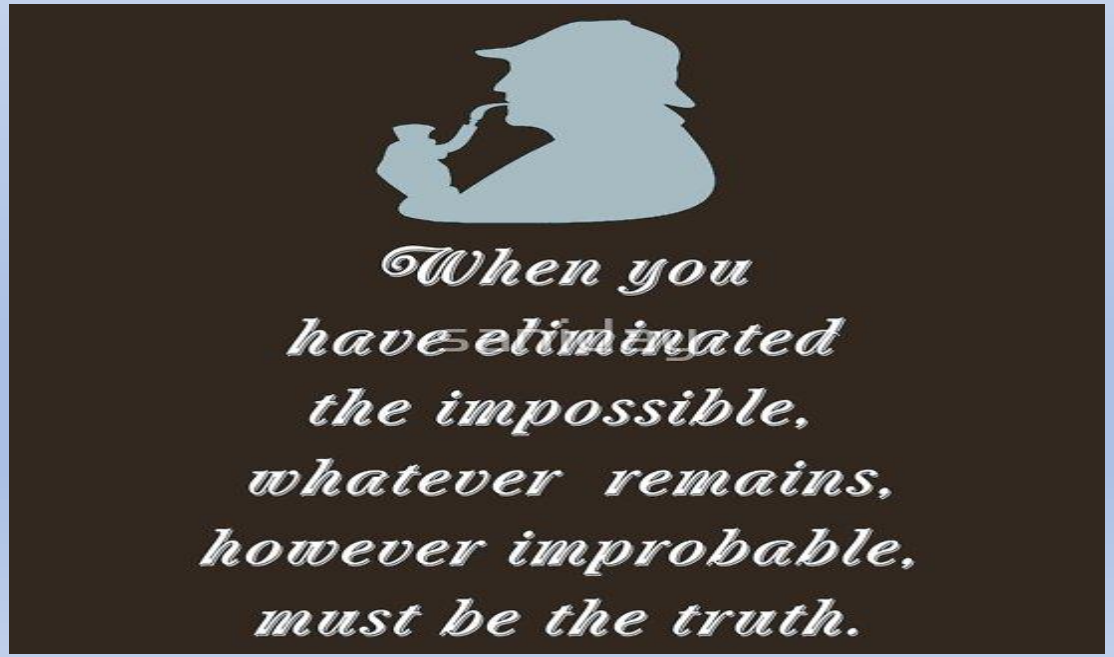


- Climate change, mainly due to the rise in CO2 in the atmosphere from the burning of fossil fuels is a fact and accelerating.
- We are entering a crucial period and the USA oil and gas industry can play a positive role in confronting the challenge and avoiding the worst outcome.

- Eliminating near term the use of fossil fuels will likely cause extreme human hardship and economic collapse.
- Shifting to natural gas and the lightest oils as a bridge while the renewable + nuclear share of energy generation increases is an achievable goal

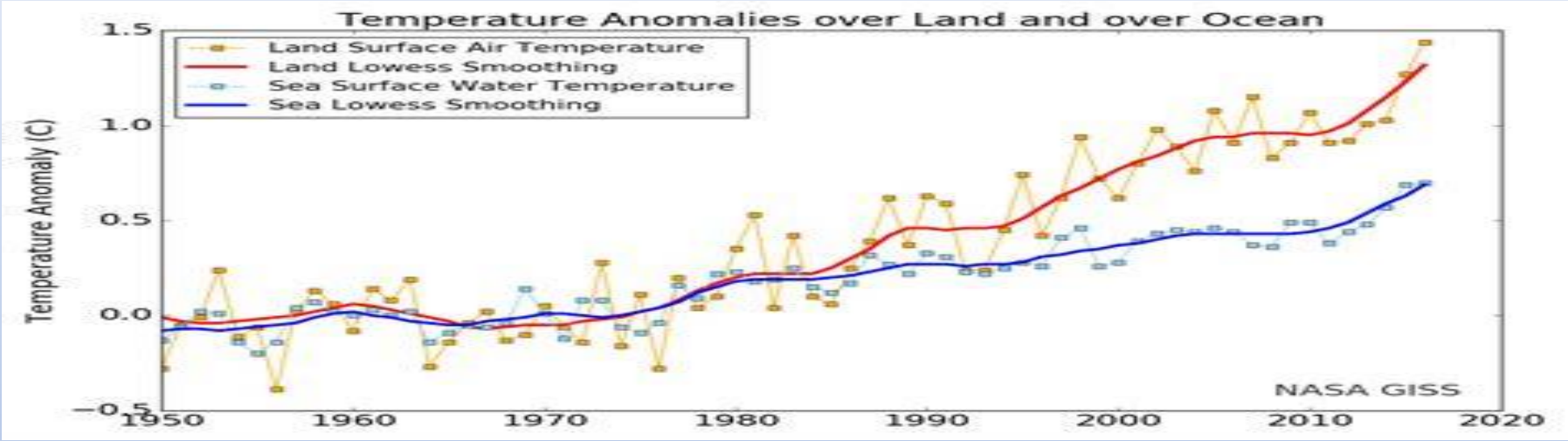


Arthur Conan Doyle

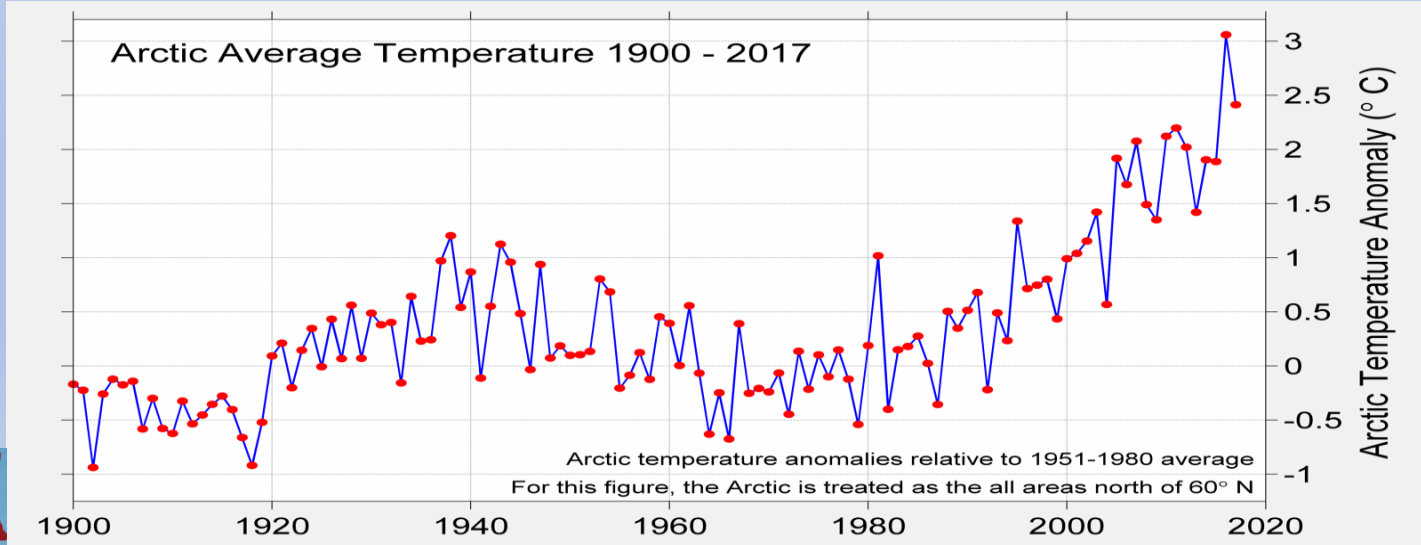
Temperature increasing faster on land and in Arctic

World temperature has risen 1.1 degrees C, however we have reached the 1.5 degree level for land temperatures and surpassed the 2 degree threshold for arctic and high altitude regions

Since 1980, air temperatures over land have been rising at rate of 0.35 deg. C per decade, 50% higher than the overall rise

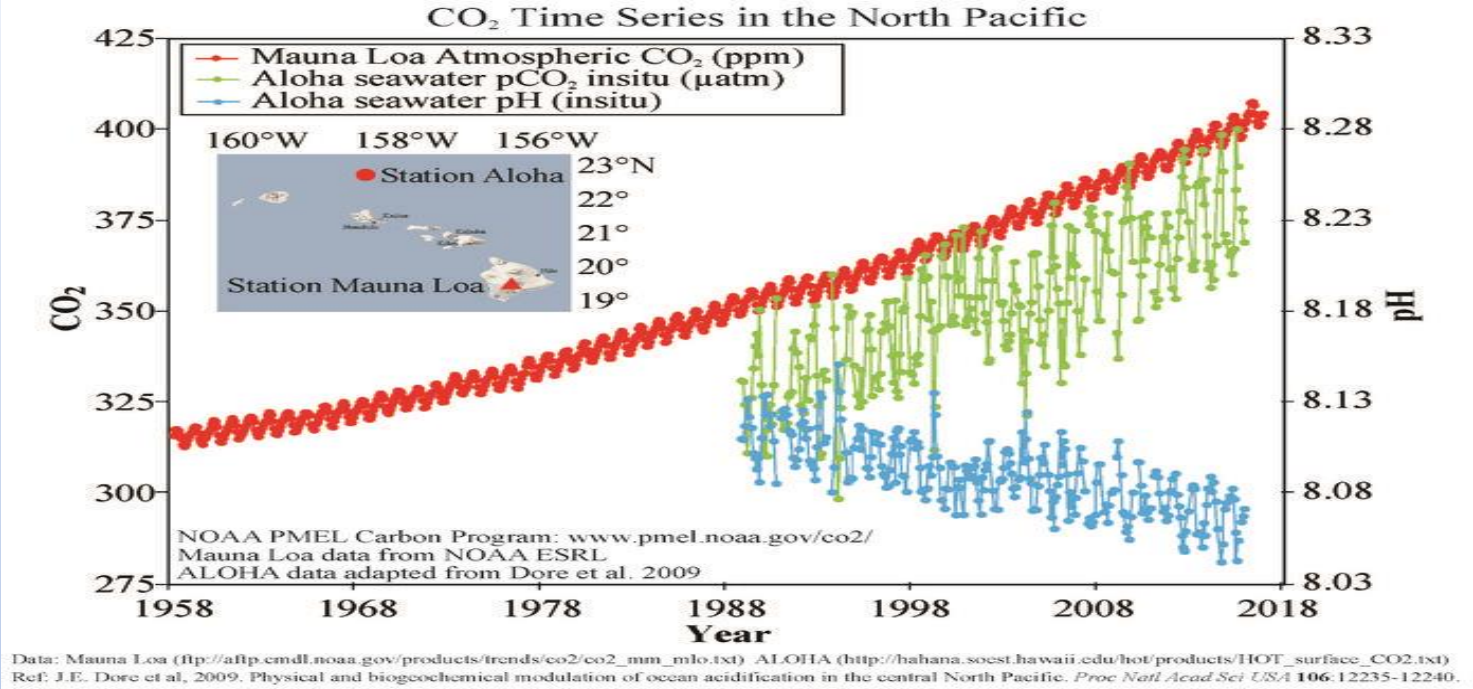


NASA GISS



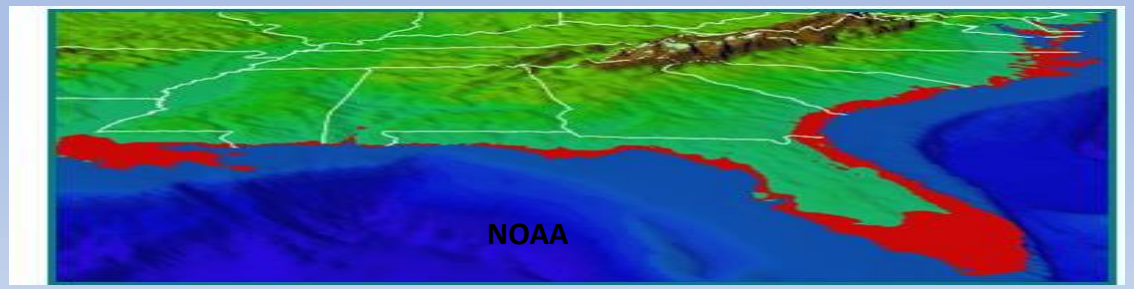
Arctic temperatures since 1980 are rising at TWICE the rate of land temperatures. Temperatures at high altitudes in temperate latitudes are warming at same rate as Arctic causing rapid melting of glaciers

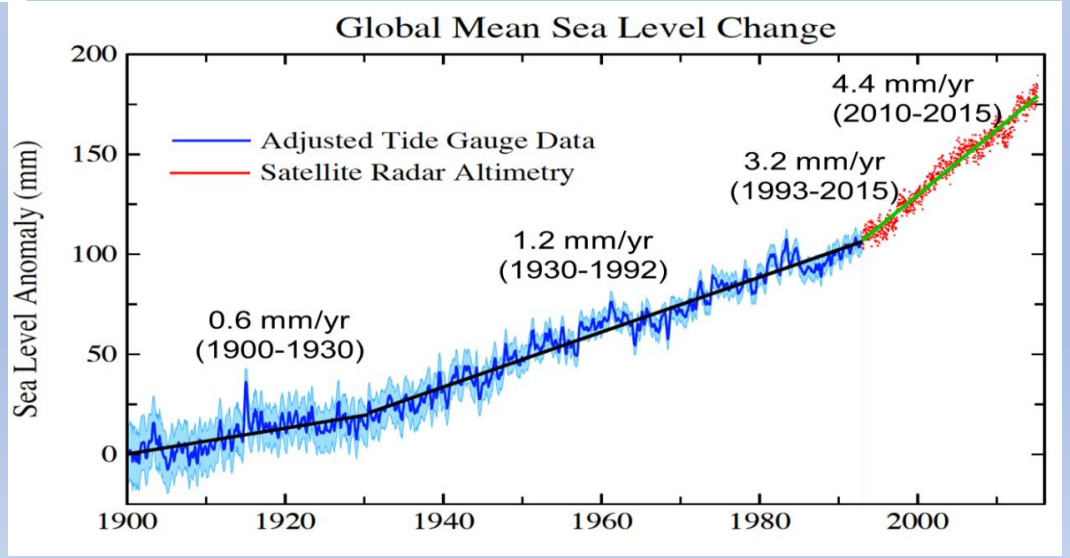
EFFECTS TO BE FELT IN THE 21ST CENTURY



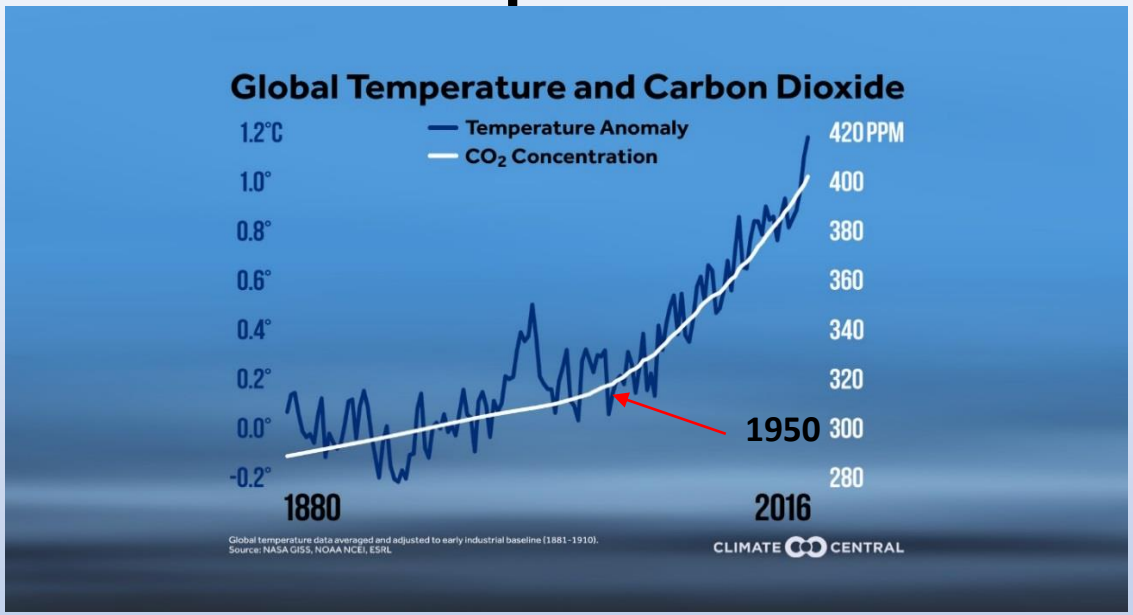
Ocean acidification: approximately 30% of increased CO2 is absorbed by ocean, reducing pH. Acidity of ocean has increased by 30% in past half century, and will increase another 30% by 2050. Dying of coral reefs is “canary in coal mine” and early indicator of major marine life changes.

Sea Level Rise: If rate of sea level rise continues to increase by 50% every 15 years, rise of 2 meters by end of century will devastate East and Gulf Coast of USA

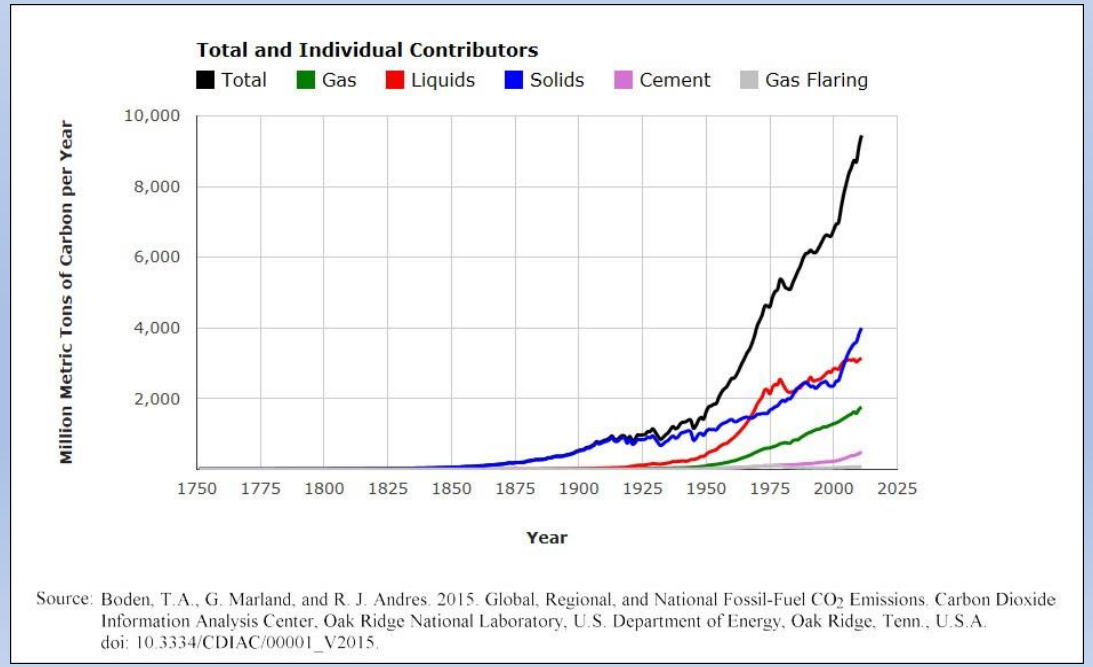




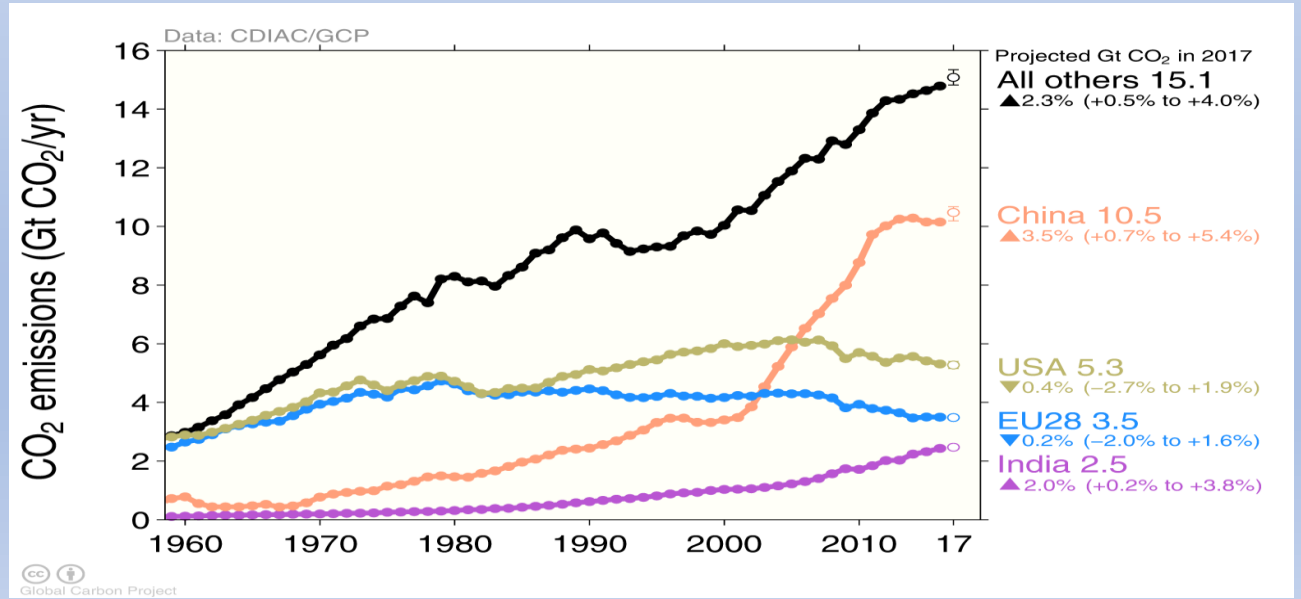
Relationship of CO2 Increase to fossil fuel emissions



- Correlation between CO2 increase in atmosphere and temperature increase is obvious
- First major increase in CO2 emissions came after 1950 with industrial expansion in Europe, USA and Soviet Union, second pulse in 2000-2015 with industrialization of China
- Coal causes 42% of CO2 emissions, oil 34%, natural gas 19%
- China produces 28% of all emissions, more than USA and EU combined

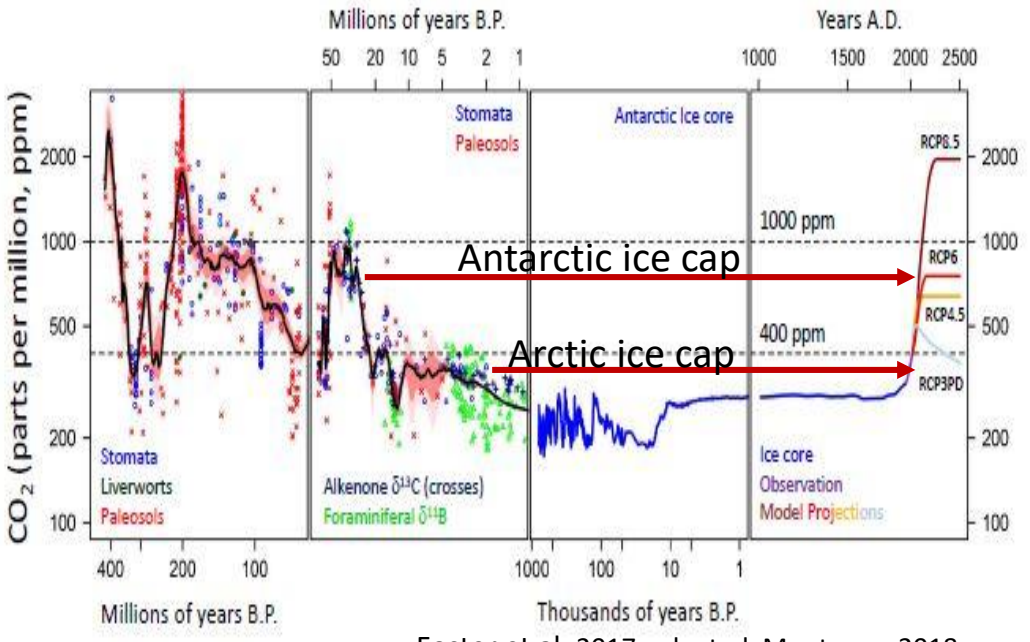


Source: Boden, T.A., G. Marland, and R. J. Andres. 2015. Global, Regional, and National Fossil-Fuel CO_2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi: 10.3334/CDIAC/00001_V2015.

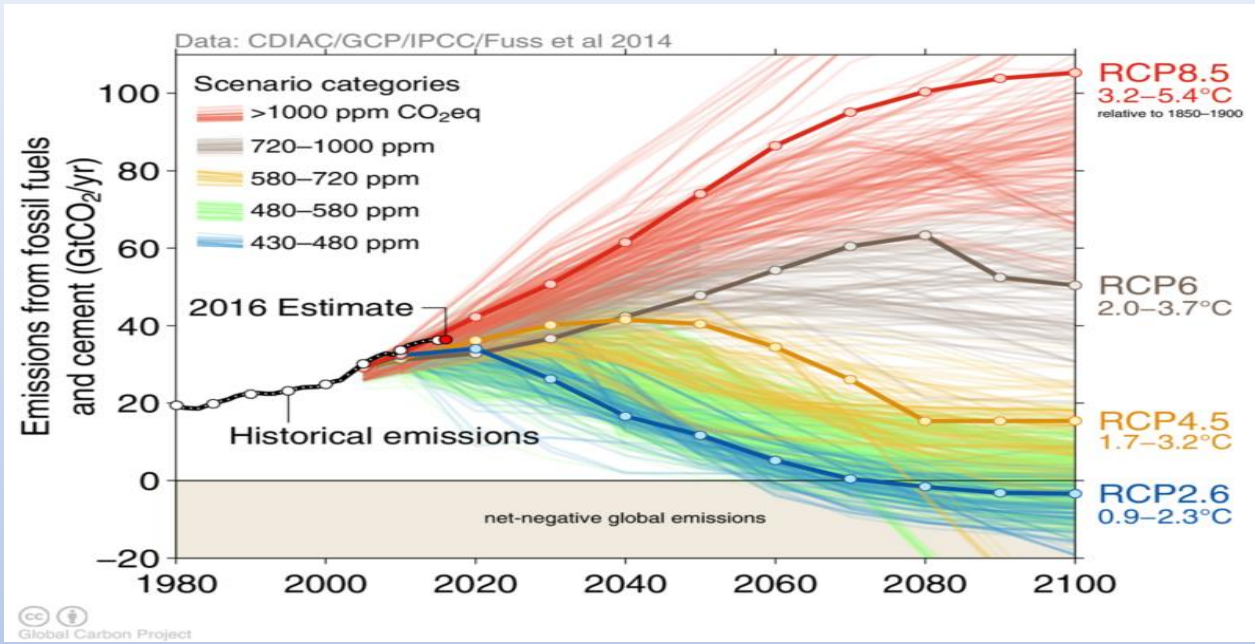


Climate Change and a realistic path forward

Ray Leonard Anglo Eurasia LLC



Foster et al, 2017, adapted, Montenez, 2018

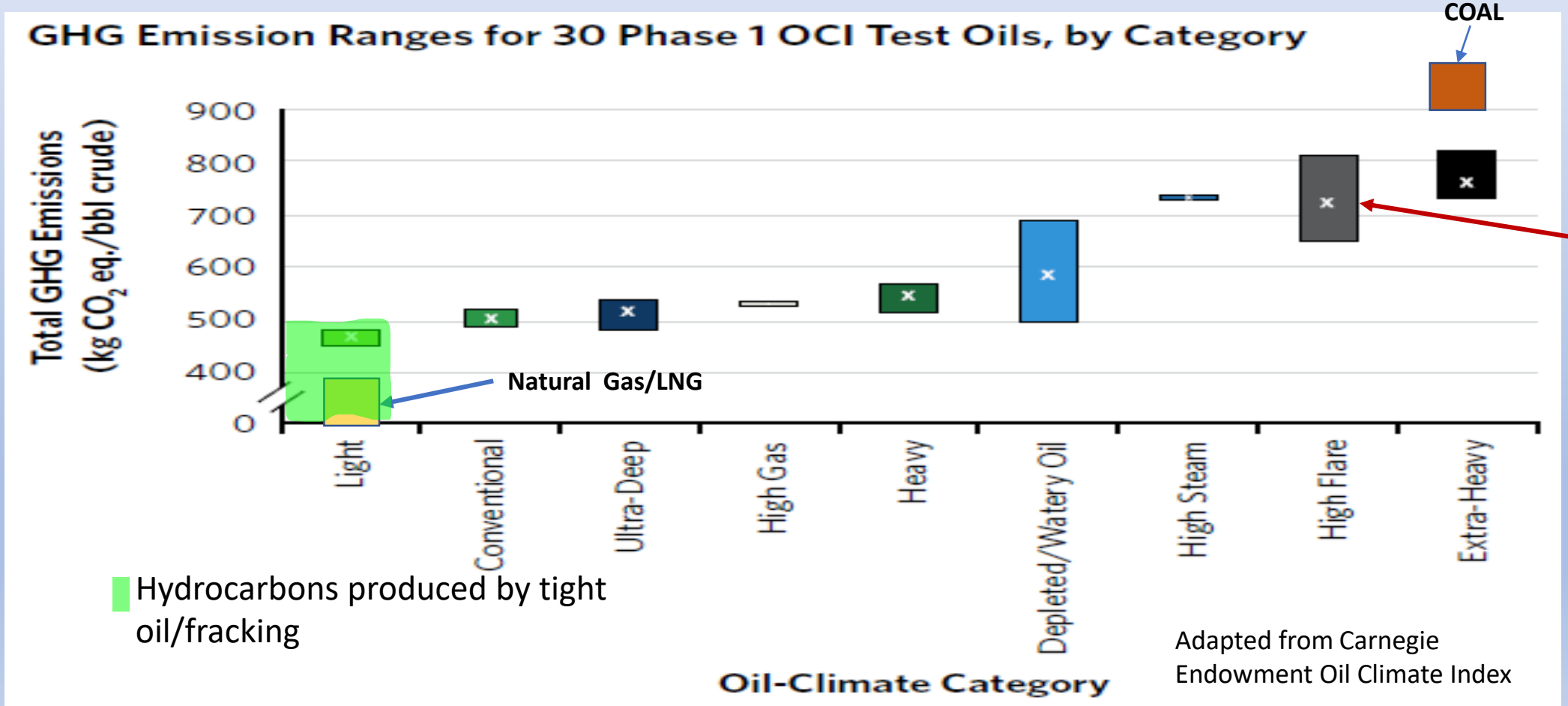


- Antarctic ice cap formed about 30 MY ago when CO2 level dropped from 800 to 400 ppm
- Arctic ice cap formed 3 MY ago when CO2 level dropped from 400 ppm to range of past million years (180-280 ppm)
- **Current level of 411 ppm rising at 3 ppm/yr. will reach 500 ppm by 2050, will reach >650 ppm by 2100 unless we respond**
- North polar cap will disappear this century, challenge is to save Antarctic ice cap, that holds 90% of planets water above sea level

- Fossil fuels produce >80% of energy we use and drastic reduction in short term is not feasible
- To limit temperature rise to 2 deg C and CO2 level below 500 ppm would need immediate major reduction in fossil fuel use which will not happen (RCP2.6)
- Following path of Paris Accord would result in rise of >3 deg C and ultimate CO2 level above 700 ppm (RCP6)
- Only realistic scenario avoiding worst case result is RCP 4.5 which requires freezing current CO2 emission level with reduction beginning after 2040

Comparison of GHG Emissions for different types of oil production

Greenhouse Gas Emissions for oil are less than coal and greater than natural gas. However, there is a wide difference in Greenhouse Gas Emissions for different Oil Types!

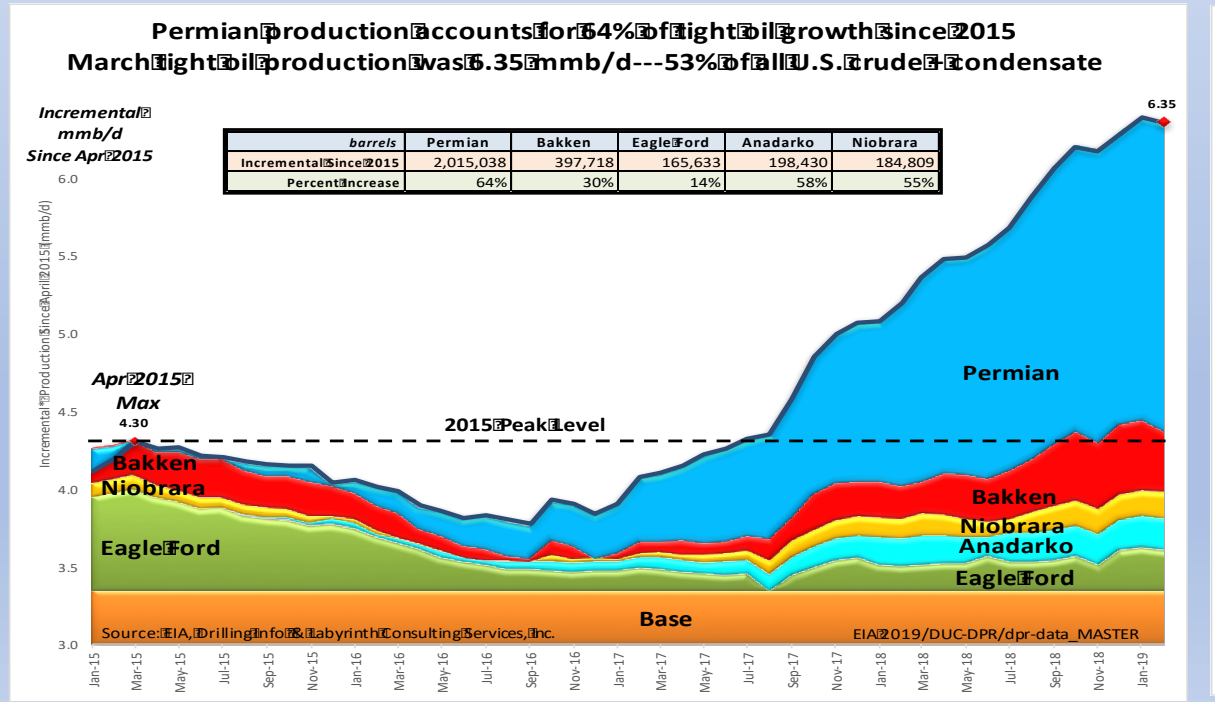


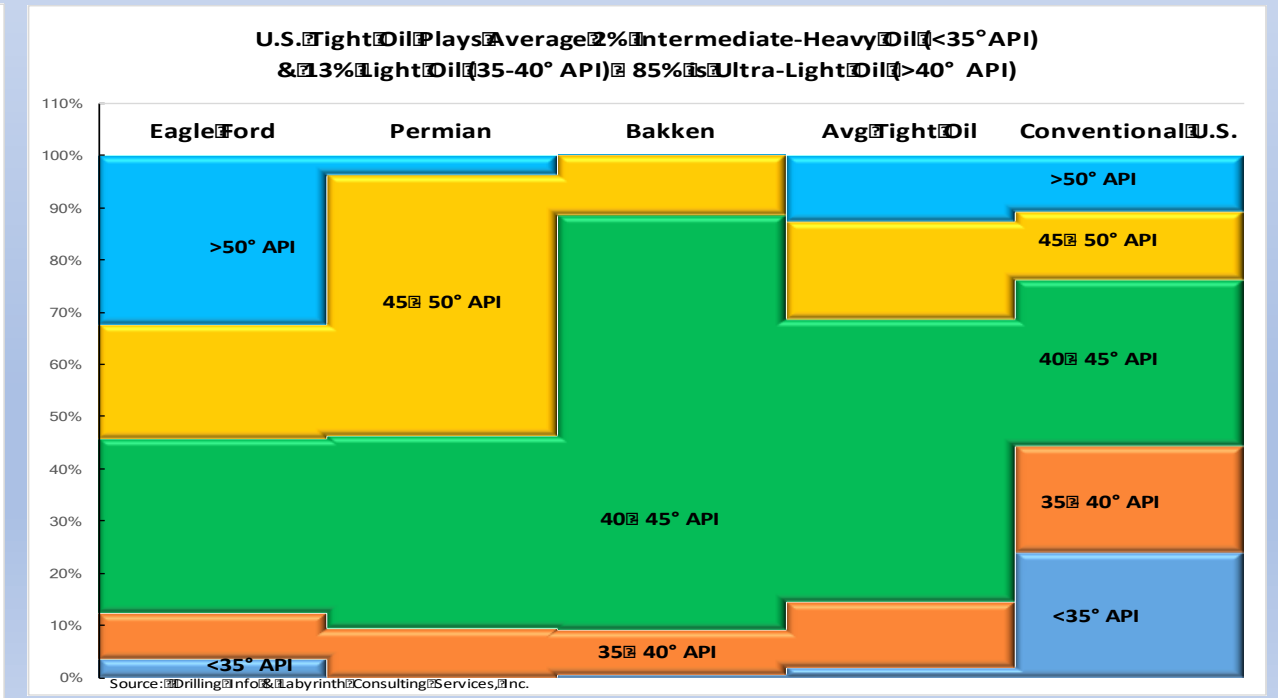
Flaring of associated gas removes low GHG benefits of tight oil production!

USA Tight Oil Production is the new dominant factor in the oil market

> "That which does not kill us makes us stronger."
>
> Friedrich Nietzsche

- After the November 2014 price collapse, USA tight oil production declined by 0.5 MMBOD over an 18 month period, however, the industry cut costs, improved technology and found a more economic play in the Permian Basin. USA tight oil production (not including NGL's) increased by >2 MMBOD in 2017-18.
- US tight oil plays produce average 85% of ultra-light oil (>40 deg. API), the lowest greenhouse gas emitting oil
- By 2040, 1/3 of world oil production will be ultra-light and natural gas liquids





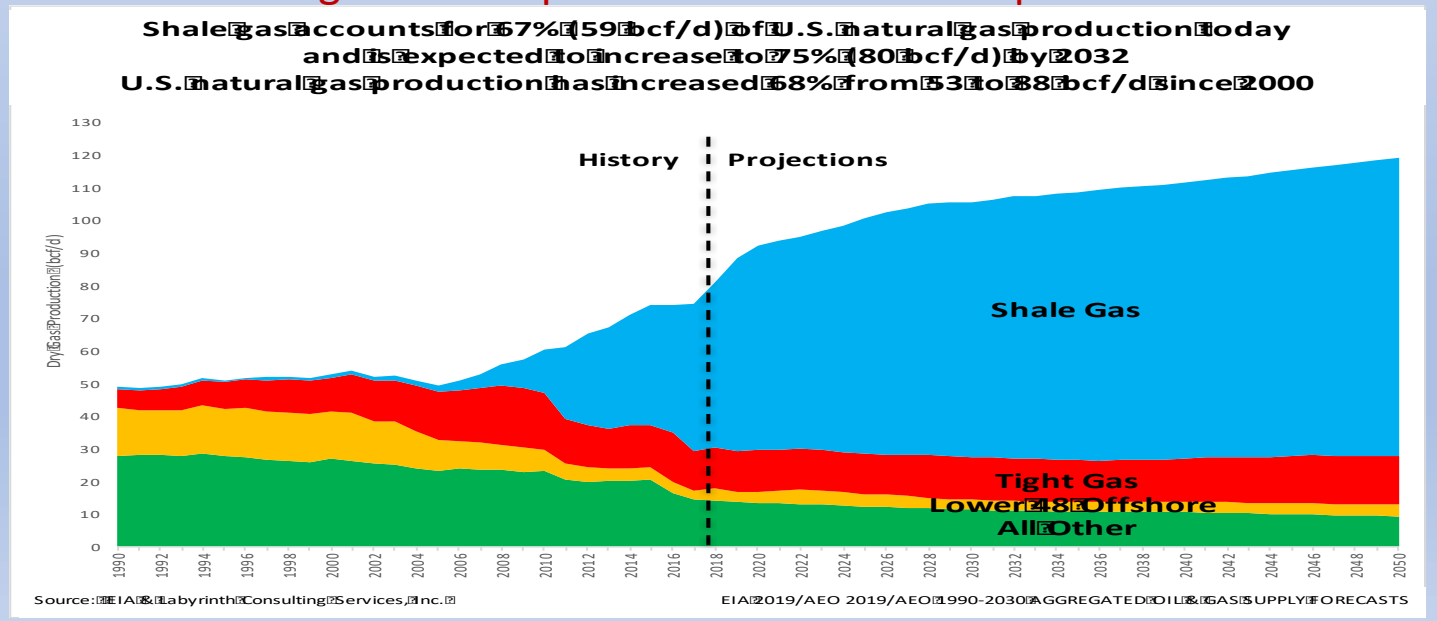
Development of shale gas in USA turned natural gas production from “sunset industry” to world’s #1 producer

US Production increase in past year greatest on record despite flat price

- Multiple successful plays
- Associated gas from tight oil production is not as price dependent
- Growing market due to coal plant retirements, pipeline exports and new LNG export facilities
- Growth of gas as petrochemical feedstock due to continued low price

➢ All of these factors have potential to continue through the next decade, supporting EIA prediction of 50% production increase from 2018-2040

➢ Low US gas prices, particularly associated gas from tight oil production in Texas are leading to LNG expansion and lower base price worldwide



By 2030, North America will overtake Qatar and Australia to become the #1 LNG shipper in the World

HC Emission plan to achieve RCP 4.5 Climate Change Goals

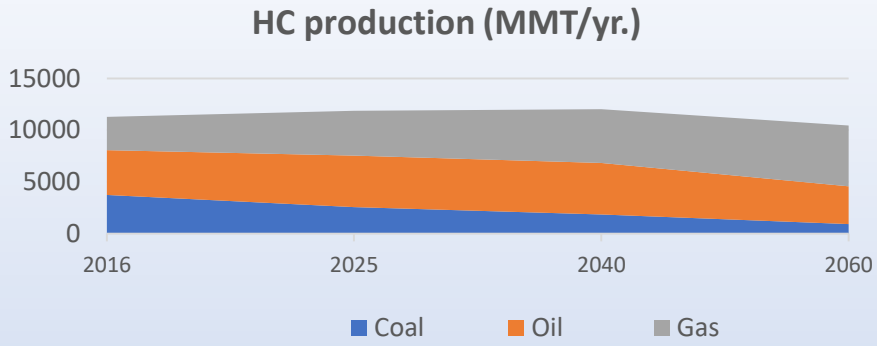
Assuming annual world economic growth of 3% and energy increase of 1%:

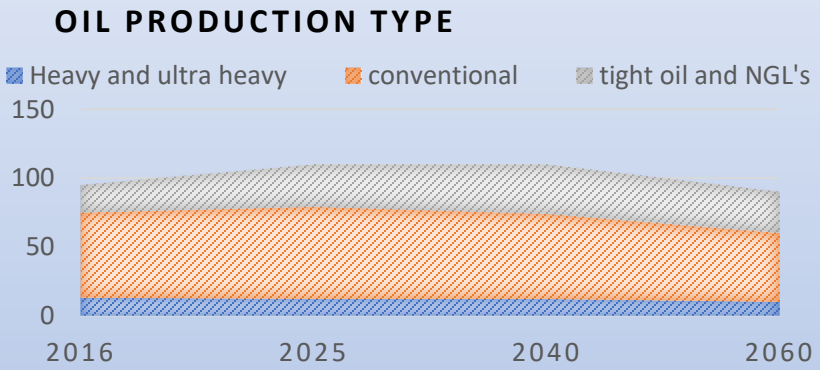
- Reduce coal production from 2016 base by 50% by 2040, another 50% by 2060
- Oil production plateau at 110 mmbo/d from 2025-2040, reduce by 1%/yr. afterwards. Ultralight and NGL 1/3 of oil production by 2040.
- Gas production increase by 60% from 2016 to 2040, another 15% by 2060
- Renewable+nuclear share of energy increase from current 15% to 30% by 2040 and 50% by 2060

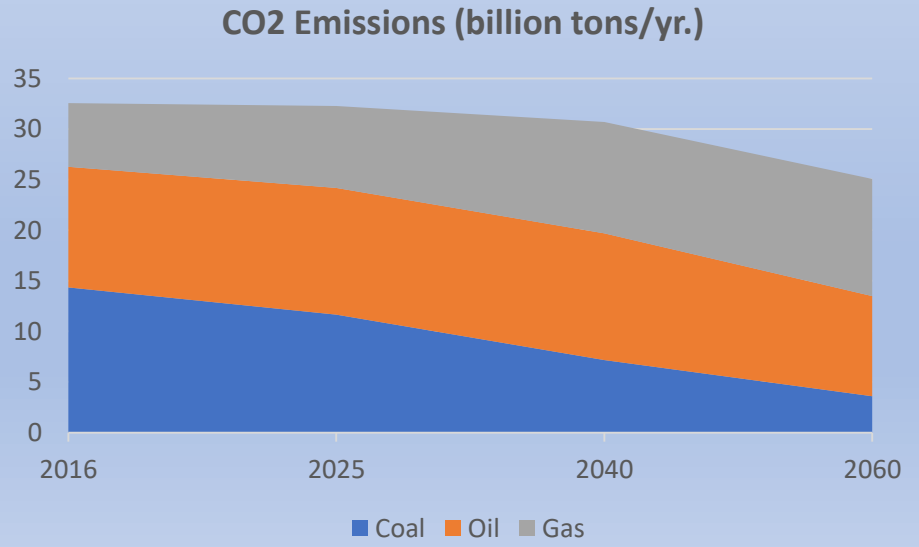
This results in GHG emission from fossil fuels reduction from 33 billion tons in 2016 to 31 billion tons in 2040 and 25 billion tons in 2060

In order to achieve this the following steps need to be taken:

1. **A "SMART" targeted carbon tax, starting with the highest GHG emitting fossil fuels**
2. **Halt construction of new coal-fired power station as soon as practical**
3. **Reduction and then elimination of gas flaring**
4. **Utilization of the proceeds from the carbon tax used as directed in each country**







Is the tight oil development a positive or negative in addressing climate change?

- Drop in price of natural gas has led to continuing replacement of coal by natural gas in power generation in USA, reducing greenhouse gas emissions
- USA is becoming major exporter of LNG, putting downward pressure on price, making LNG more affordable as substitute for coal reducing greenhouse gas emissions throughout the world
- Tight oil is ultra-light, lowest GHG gas emitting of all oils, reducing GHG emissions of liquids. By 2040 1/3 of all oil will be ultra-light and NGL's. Refiners are adapting to new mix of oils.

- Rapid growth of liquid production, particularly in Permian Basin, has resulted in significant associated gas leading to increased flaring of gas
- While major operators are reducing methane emissions, there is documentation of leaks by smaller operators

These negative factors can and should be rectified by completion of new gas pipelines and strong monitoring of operations

Taking into account the positive factors and IF the negative points are addressed, the tight oil revolution in the USA can be considered a positive factor in the transitional role of fossil fuels in dealing with the climate change crisis