

Social License to Operate – Challenges & Opportunities for the Fossil Fuels Industry

Dag Nummedal

**Department of Petroleum Engineering (ret.)
Colorado School of Mines**

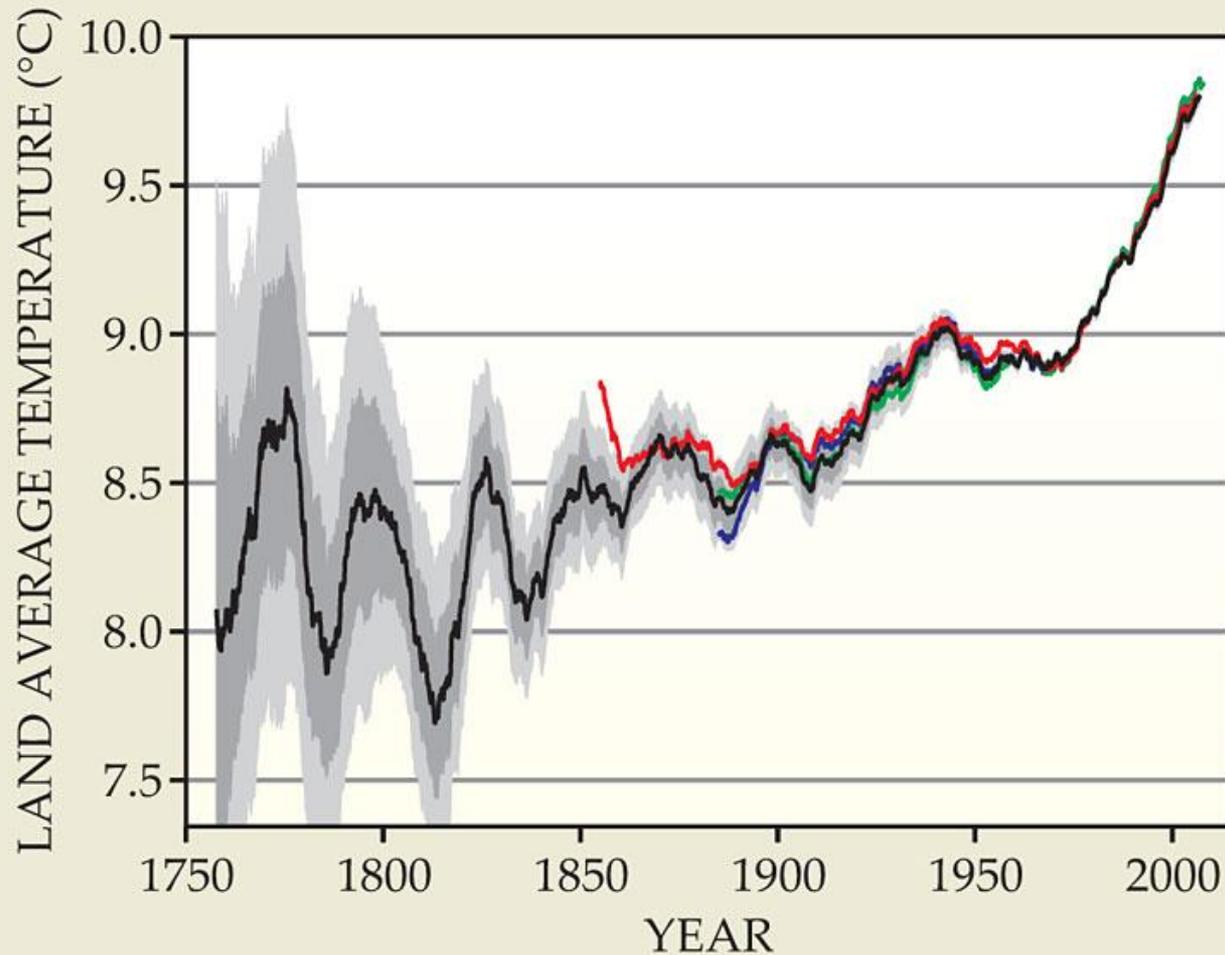
- 1. Evidence for global warming: overwhelming**
- 2. Switch to natural gas from coal – then accelerate renewables**
- 3. An even better step: utilize NG's combustion product: CO₂**

University of Houston

Tuesday, September 24th, 2019

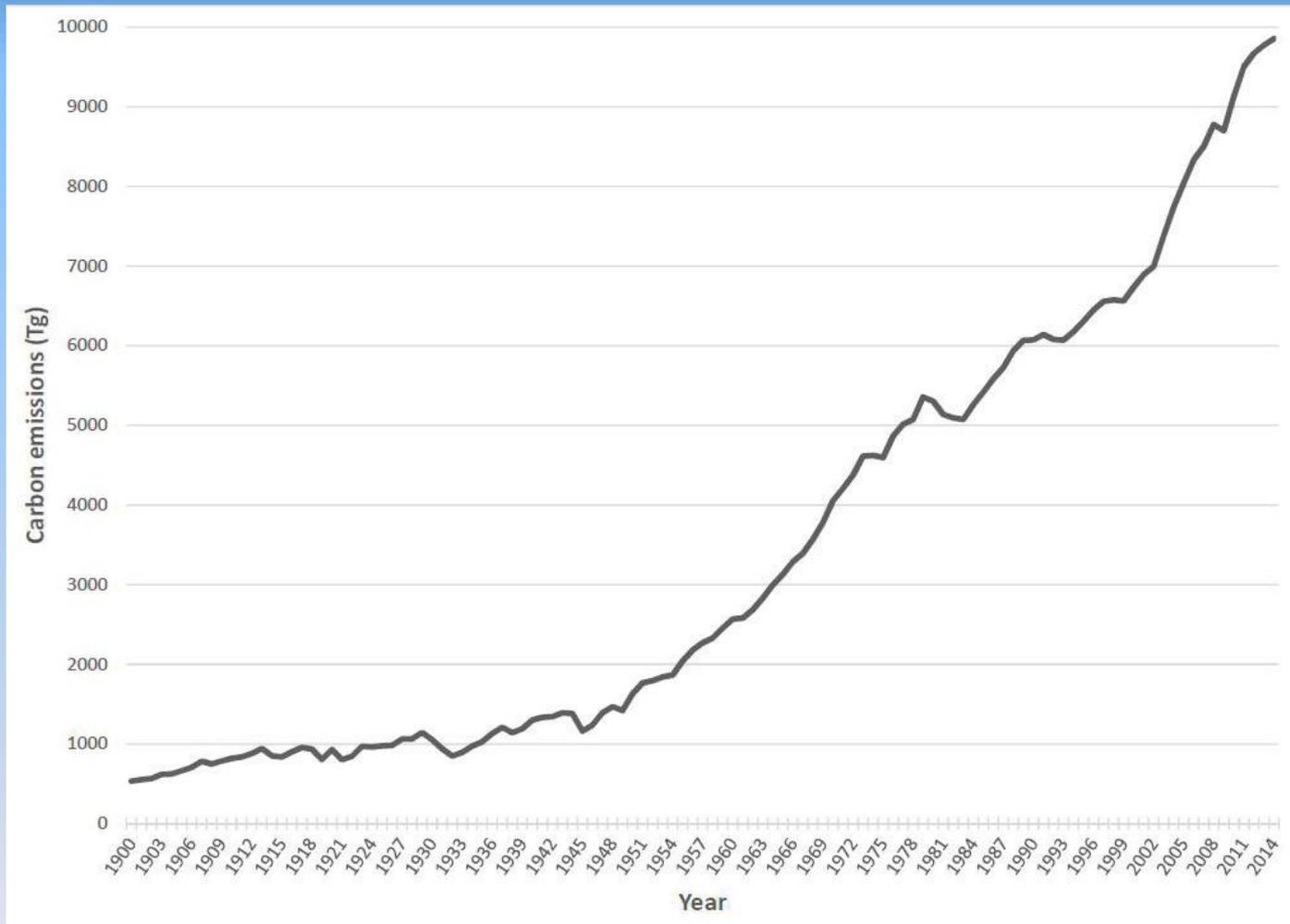
The Key Problem: Global Temperatures are Going Up!

Data from post “Little Ice Age” through global industrialization



Global land surface temperatures, shown as 10-year running averages. The new estimate made by the Berkeley Earth Surface Temperature project is shown in black, with shaded areas representing uncertainties of one and two standard deviations.

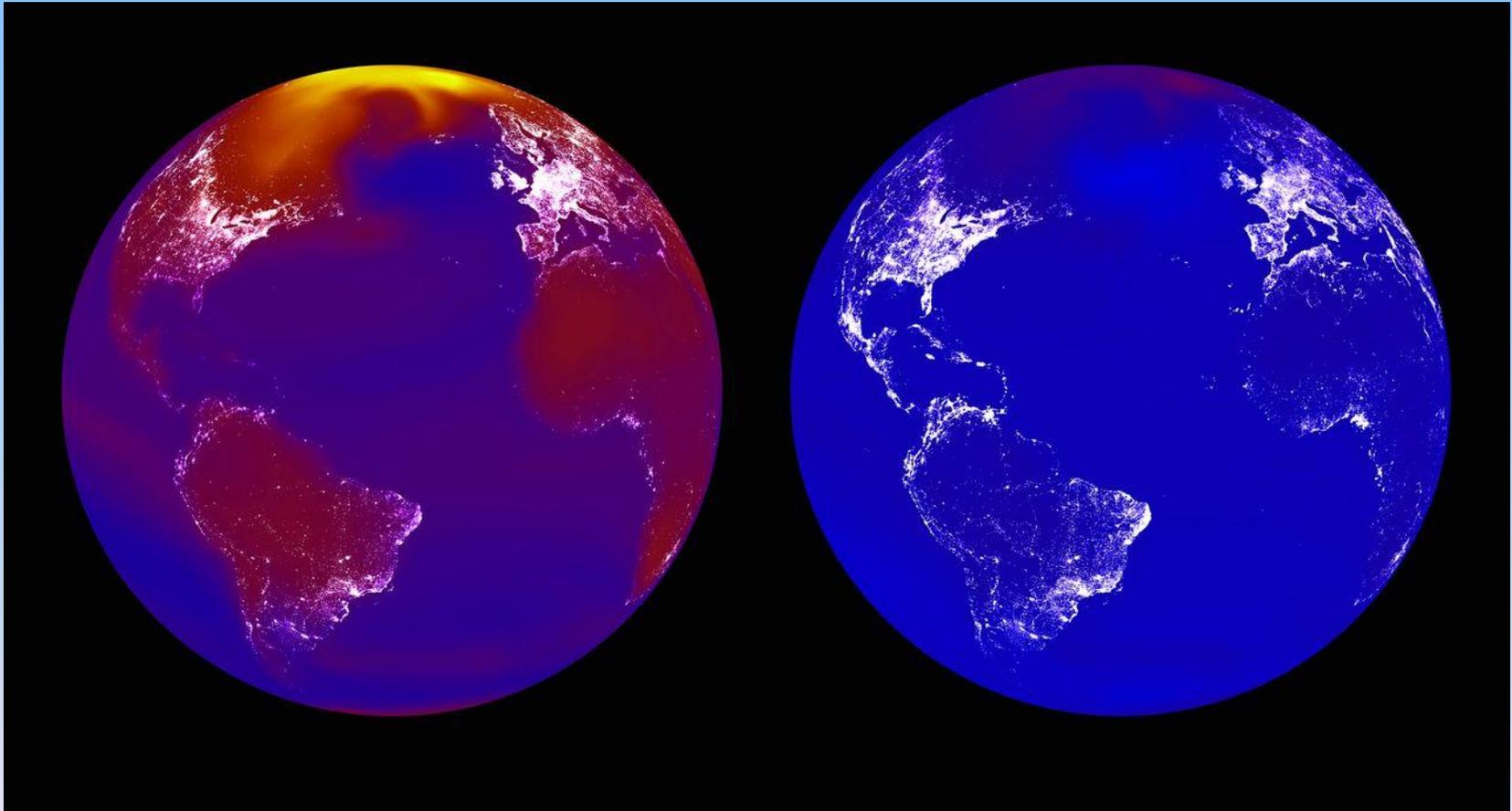
Growth In Global Carbon Emissions



From Bowden et al. 2017

Two Possible Futures

for how the climate might change and how those changes are likely to affect humanity, based on recent empirical findings



Tamma A. Carleton, and Solomon M. Hsiang *Science*
2016;353:aad9837. Sept. 2016



Broad Economic Consequences

Jones and Olken, 2010 (Northwestern U and MIT study).

- At the aggregate level, Melissa Dell, Benjamin F. Jones, and Benjamin A. Olken (2008) (hereafter, DJO) have demonstrated **that higher temperatures in a given year reduce the growth rate of GDP per capita, mostly in poor countries.**
- We find that an additional one degree Celsius reduces the growth rate of a poor country's exports by between 2.0 and 5.7 percentage points. We find that the impacts are concentrated in exports of agricultural products and light manufactures. The issue is worker productivity in response to temperature increases.
Ref: Jessie Antilla-Houghes, and Solomon Hsiang, in PNAS, 2010 (UC Berkeley)

Economic output across a range of industries previous thought of as "not vulnerable to climate change" respond strongly to changes in temperature. The data suggest that the response is driven by the direct human response to high temperatures: **people generally are less productive and tire faster when it's hot.** This impact, which appears to be quite large, has not been factored into any previous estimates for the global cost of climate change.

- A whole research industry has sprung up around the cost-benefit analysis of preventing climate change.!!!

Emissions, Climate Change and Conflict

Climate change in the Fertile Crescent and implications of the recent Syrian drought; [Colin P. Kelley^{a,1}](#), [Shahrazad Mohtadi^b](#), [Mark A. Cane^c](#), [Richard Seager^c](#), [Yochanan Kushnir^c](#)

Proceedings, US National Academy of Sciences, vol. 112 no. 11
> Colin P. Kelley, 3241–3246, doi: 10.1073/pnas.1421533112

There is evidence that the 2007–2010 drought contributed to **the conflict in Syria**. It was the worst drought in the instrumental record, causing widespread crop failure and a mass migration of farming families to urban centers. Century-long observed trends in precipitation, temperature, and sea-level pressure, supported by climate model results, strongly suggest that **anthropogenic forcing has increased the probability of severe and persistent droughts in this region, and made the occurrence of a 3-year drought as severe as that of 2007–2010 2 to 3 times more likely than by natural variability alone**. We conclude that human influences on the climate system are implicated in the current Syrian conflict.

Pathways to Decarbonization - 1

According to the UN Climate Summit
in NY City this week (lead article in Science, Sept. 20th, 2019)

"Large-scale strategies" are needed immediately to reduce greenhouse gas emissions and avert "catastrophic circumstances" that threaten every part of the world. 21 researchers from 14 countries said climate change is already damaging the planet more than scientists had projected, endangering everything from food supply to the existence of island nations. The key challenges are: Heat waves intensify in North America and Europe. Underwater heat waves kill deepwater habitats and coral reefs. Insect populations are dwindling, threatening the food chain. Larger and more frequent wildfires are destroying forests and communities around the world.

U.N. Secretary-General António Guterres has invited world leaders to bring "realistic plans" to cut their nations' greenhouse gas emissions by **45% over the next decade**. Focus of UN meeting in New York City **THIS WEEK!**

73 papers and studies published in the past two years have documented the vast harm that has been caused already by global temperatures rising 1 degree Celsius over preindustrial levels.

Key challenges and opportunities in the DRAFT UN plan

- Limit global warming to 1.5 degrees Celsius over preindustrial levels by 2100. Expect widespread harm if the global mean surface temperature rises by 2 degrees in that period.
- Investments between \$2 trillion and \$4.5 trillion **per year** could prevent a 2-degree temperature increase and avoid \$500 trillion in damages by 2200. (*Current global GDP is \$87 trillion: US annual GDP is \$21 trillion; China's is \$14 trillion*).
- It draws extensively from a special report released in October by the United Nations' Intergovernmental Panel on Climate Change that warned about the danger of global temperatures rising 2 degrees above those recorded from 1850 to 1900. The paper's lead author, Ove Hoegh-Guldberg, who is director of the Global Change Institute at the University of Queensland in Australia, also was the lead author of the special IPCC report ([Climatewire](#), Oct. 15, 2018).
- We're trying to **change the message we're projecting from 'This is going to happen' to 'This is already happening'**

From the Democratic Candidates Debate in Houston, Sept. 12th, 2019

- Candidates vying for the Democratic presidential nomination offered a range of aggressive measures to address the impacts of climate change — ranging from agricultural carbon sequestration to slashing new greenhouse gas emissions. Five candidates fielded the sole question on climate change, when asked what "meaningful action" they would pursue to address its impacts.
- Both former Texas Rep. **Beto O'Rourke** and Minnesota Sen. **Amy Klobuchar** touted plans to achieve zero greenhouse gas emissions in the next 30 years. "We will make sure that we get to net-zero greenhouse gas emissions no later than the year 2050, that we are halfway there by 2030, that we mobilize \$5 trillion over the next 10 years to do that," said O'Rourke, who also vowed to invest in "pre-disaster mitigation grants" for communities like Houston that have faced repeated flooding in recent years.
- "We're also going to make sure that we free ourselves from a dependence on fossil fuels and embrace renewable wind and solar energy technology as well as the high-paying, high-skill, high-wage jobs that come along with that," O'Rourke added. "And then we're going to pay farmers for the environmental services that they want to provide," such as cover crops, no-till farming and "regenerative agriculture."
- Klobuchar vowed to recommit the United States to the Paris climate agreement, re-establish the Obama administration's Clean Power Plan and protect gas mileage standards poised to be rolled back by the Trump administration.
- **Elizabeth Warren** stated that she would cut carbon emissions from new construction by 2028, from new vehicles by 2030, and from the manufacture of electricity by 2035. Vermont Sen. **Bernie Sanders**, an independent running in the Democratic primary and a vocal critic of the fossil fuel industry, vowed to "address the catastrophic crisis of climate change and transform our energy system."
- Former Vice President **Joe Biden** said the nation could not "postpone any longer taking on climate change and leading the world in taking on climate change."

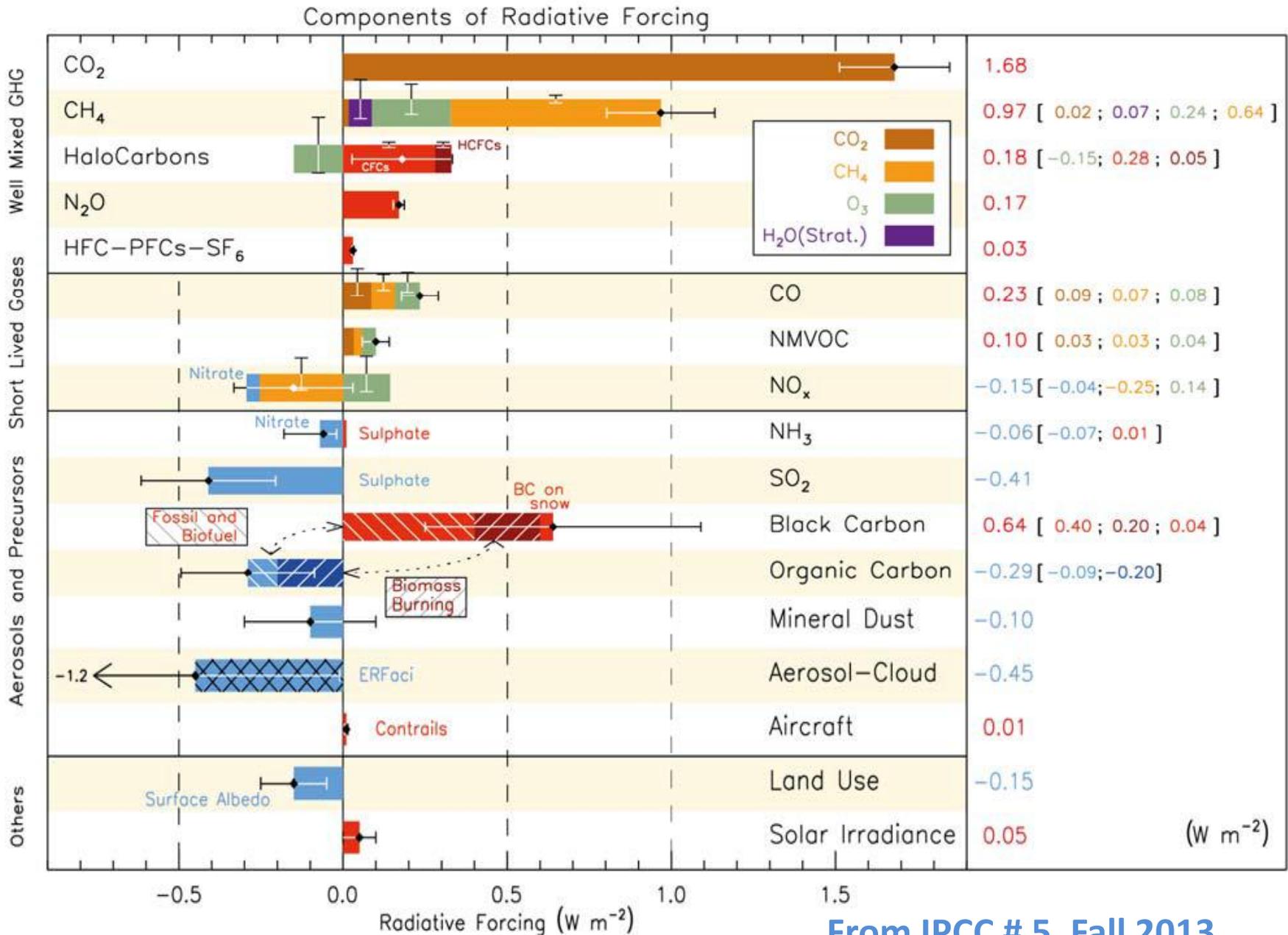
Pathways to Decarbonization – 2

Most viable technical solutions

- Afforestation and reforestation. Allowing natural regrowth, and planting new forests. This is financially supported by the COP21 UN Clean Development Mechanism
 - Biochar. Biochar is the name given to charcoal that is added to soils rather than burned as a fuel. The charcoal is produced by burning biomass such as wood, crop wastes and manure, while cutting off the supply of oxygen. E.g. the Terra Preta (“black earth”) soils in Brazil,
 - BECCS. Bio-energy with carbon sequestration. Biomass, as it grows, draws CO₂ out of the atmosphere, and then the CCUS process captures and stores what CO₂ is produced.
 - Blue carbon habitat restoration. Restoring salt marshes, mangroves and seagrass beds.
 - Direct air capture (“geoengineering”). Growing momentum for this!
 - Carbon negative oil (use CO₂ from biofermenters for EOR)
- Others: building with biomass, cloud and ocean ‘seeding’ with alkali, enhance ocean productivity, enhanced rock weathering...

<https://www.carbonbrief.org/explainer-10-ways-negative-emissions-could-slow-climate-change>

The Key GHGs Responsible: CO₂ and CH₄



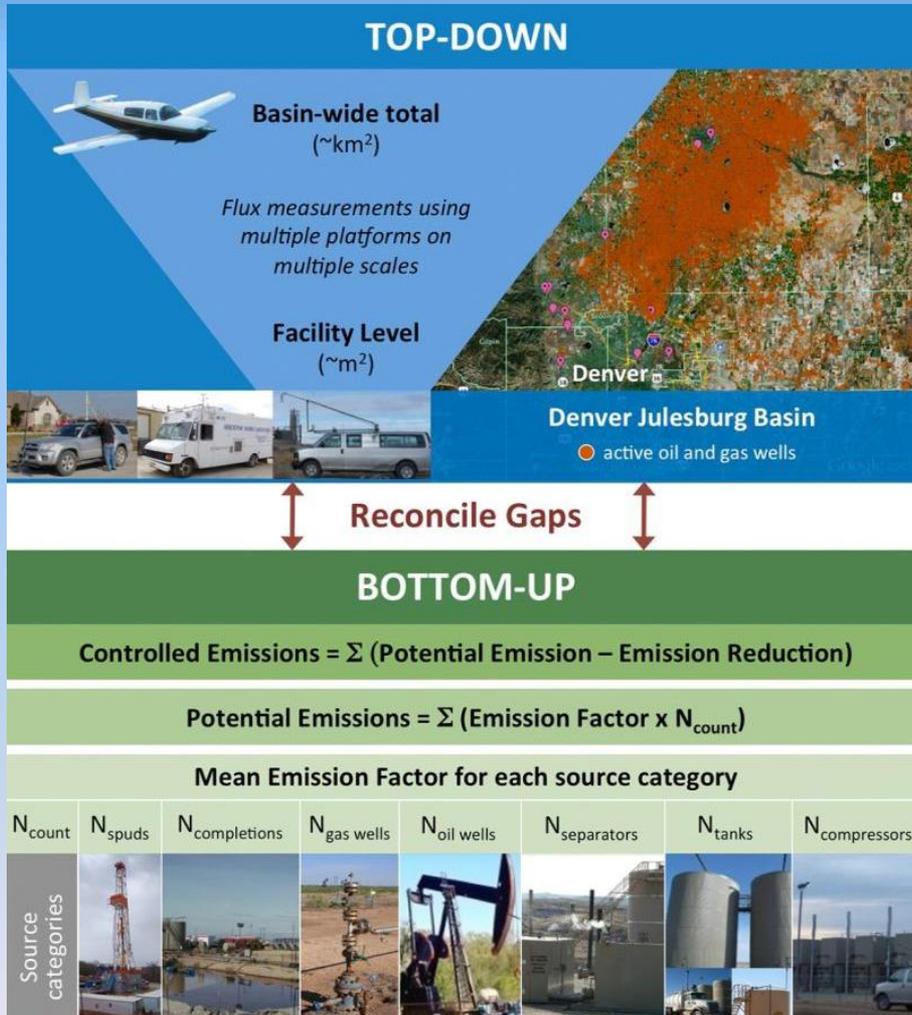
The Role of Methane (CH₄)

Methane is emitted in far lower quantities than carbon dioxide and is, without chemical transformation, useful as a fuel and as a chemical feedstock. Capture and reuse of methane waste gas as a fuel are relatively mature technologies, so the potential impact of development of methane utilization technologies, beyond direct capture and use as a fuel, is limited.

Carbon dioxide, on the other hand, makes up a far larger share of overall greenhouse gas emissions and, once captured, generally requires chemical transformation for use. Most technologies for utilizing carbon dioxide are at a low level of maturity, suggesting carbon dioxide utilization technologies have both a larger potential for greenhouse gas mitigation and a greater need for research and development.

Will get back to Methane – a little bit – at the end of this talk

Top-down and Bottom-up Reconciliation of Quantitative Measures of Emissions from the Natural Gas Industry



- **Top-down:**
 - Source sector differentiation
 - Representative sampling
 - Accuracy
 - Gas composition profiles
 - Downscaling to sources
- **Bottom-up:**
 - “Fat tails” emission distribution
 - Missing sources
 - Representative samples
 - Activity data
 - Uncertainty characterization
- **The challenge:**
 - Reconcile Gaps

Graphics: Gaby Petron (NOAA/CIRES)
and Garvin Heath (NREL)

Getting to Zero: National Decarbonization Strategies

September 19, 2019 - 10:30 a.m. – Noon ET

In advance of the UN Secretary General's Climate Action Summit, national governments have been asked to demonstrate their climate leadership by coming forward with plans to achieve net zero emissions by 2050. The Paris Agreement similarly encourages parties to formulate and communicate long-term, low greenhouse gas emission development strategies. In this webinar, representatives of several national governments will provide insights into their countries' 2050 strategies, how these plans were created,

how they relate to national and global priorities, and how they plan to stay on track.

Jacob Werksman
Principal Adviser, DG Climate Action, European Commission

Jon Berg
Counselor, Climate and Environment, Embassy of Norway in Washington, D.C.

Hiroshi Seike
Deputy Director, Low-Carbon Society Promotion Office, Global Environment Bureau, Ministry of the Environment, Japan

Moderator
Jennifer Huang
Senior International Fellow, C2ES

Recommend Signing up for: Security and Sustainability Forum

[Security and https://ssfonline.org/](https://ssfonline.org/)

Mission: The Security and Sustainability Forum (SSF) is a public interest organization that produces learning events about climate security, which we define as the threats to society from a changing climate and related disruptions to natural systems

CONCLUSIONS

- Global GHG Emissions are going up - mostly due to man's combustion of coal, oil, gas, and related hydrocarbons
- Consequently, global temperatures are rising
- Environmentally, this is harmful
- Economically, it is backwards. Treat CO₂ as a resource – by making things out of it.
- The “social license to operate” for the oil and gas industry will be fine...once we embrace the complete life cycle of oil and natural gas. Let none of it be wasted.
- There is a vast “global web” – in more ways than one – working to solve this “generational challenge”. Get involved!