Oil and Gas Infrastructure and Climate Change

Jessica Wentz
Senior Fellow, Sabin Center for Climate Change Law at Columbia Law School

Pipeline Safety Trust Conference - October 18, 2018
Cumulative emissions of CO₂ and future non-CO₂ radiative forcing determine the probability of limiting warming to 1.5°C

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways

Global warming relative to 1850-1900 (°C)

- Observed monthly global mean surface temperature
- Estimated anthropogenic warming to date and likely range

Likely range of modeled responses to stylized pathways:
- Global CO₂ emissions reach net zero in 2055 while net non-CO₂ radiative forcing is reduced after 2030 (grey in b, c & d)
- Faster CO₂ reductions (blue in b & c) result in a higher probability of limiting warming to 1.5°C
- No reduction of net non-CO₂ radiative forcing (purple in d) results in a lower probability of limiting warming to 1.5°C

b) Stylized net global CO₂ emission pathways
Billion tonnes CO₂ per year (GtCO₂/yr)

- CO₂ emissions decline from 2020 to reach net zero in 2055 or 2040

Faster immediate CO₂ emission reductions limit cumulative CO₂ emissions shown in panel (c).

c) Cumulative net CO₂ emissions
Billion tonnes CO₂ (GtCO₂)

- Cumulative CO₂ emissions in pathways reaching net zero in 2055 and 2040

Maximum temperature rise is determined by cumulative net CO₂ emissions and net non-CO₂ radiative forcing due to methane, nitrous oxide, aerosols and other anthropogenic forcing agents.

d) Non-CO₂ radiative forcing pathways
Watts per square metre (W/m²)

- Non-CO₂ radiative forcing reduced after 2030 or not reduced after 2030
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Emissions Trajectory for 1.5 °C

1. Emissions peak

2. With rapid reduction of carbon emissions

3. Global temperature still overshoots goal but begins to level out or possibly reduce as emissions decrease

Past

Global temperature goal

Temperature

Emissions

Today

Future

Removal of carbon from atmosphere
1.5°C of warming vs 2°C of warming

**Heatwaves**
- Up to 1.1 months
- 9%

**Freshwater availability in the Mediterranean**
- 17%

**Heavy rainfall increase in intensity**
- 7%

**Crop yields in tropical regions**
- Wheat production down 16%
- Maize production down 6%
- Soy production up 7%
- Rice production up 6%

**Sea level rise by 2100 relative to 2000**
- 40cm

**Coral bleaching from 2050 onwards**
- 90% of reefs at risk

**Coral bleaching from 2050 onwards**
- 98% of reefs at risk

*relative to 1986-2005
bit.ly/1point5Cve2C

All data from Schleussner, C. et al., (2016)
Coral/wheat/maize/rice icons: © eyawg/T-Kol/Marnikus/Wozuiker & Shutterstock.com
Contribution of Oil and Gas Sector to Climate Change?
Oil and Gas Sector, Contribution to Climate Change: Direct Emissions

Global Non-CO₂ Greenhouse Gas Emissions
Oil and Natural Gas Systems baseline emissions are estimated to be 1,677 MtCO₂e in 2010. In 2030, emissions from this source are projected to be 2,113 MtCO₂e or 16% of total non-CO₂ emissions.

CH₄ Emissions from Oil and Natural Gas Systems: Projected Global Emissions in 2030

Emissions from Top 5 Emitting Countries (MtCO₂e)

- Russia: 418 MtCO₂e
- United States: 313 MtCO₂e
- Iraq: 188 MtCO₂e
- Kuwait: 107 MtCO₂e
- Uzbekistan: 116 MtCO₂e

Rest of World: 971 MtCO₂e

Oil and Gas Sector, Contribution to Climate Change: “Downstream” Emissions

**GLOBAL**

![Figure 6. World primary energy supply and CO₂ emissions: shares by fuel in 2015](chart)

<table>
<thead>
<tr>
<th>Percent share</th>
<th>TPES</th>
<th>CO₂</th>
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</thead>
<tbody>
<tr>
<td><strong>32%</strong></td>
<td><strong>34%</strong></td>
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<tr>
<td><strong>28%</strong></td>
<td><strong>45%</strong></td>
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<tr>
<td><strong>21%</strong></td>
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<td><strong>20%</strong></td>
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<tr>
<td><strong>19%</strong></td>
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<td><strong>1%</strong></td>
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*Other includes nuclear, hydro, geothermal, solar, tide, wind, biofuels and waste.*

**OECD**

![Figure 1. CO₂ emissions by fuel](chart)

Effect of Climate Change on Oil and Gas Infrastructure?
Documented Increase in Record-Breaking Extreme Weather Events
Documented Increase in Record-Breaking Extreme Weather Events

U.S. 2017 Billion-Dollar Weather and Climate Disasters

- North Dakota, South Dakota, and Montana Drought, Spring–Fall 2017
- Western Wildfires, California Firestorm, Summer–Fall 2017
- California Flooding, February 8–22
- Colorado Hail Storm and Central Severe Weather, May 8–11
- Midwest Severe Weather, June 12–16
- Midwest Severe Weather, June 27–29
- South/Southeast Severe Weather, March 26–28
- Hurricane Harvey, August 25–31
- Hurricane Irma, September 6–12
- Hurricane Maria, September 19–21
- Midwest Tornado Outbreak, March 6–8
- Central/Southeast Tornado Outbreak, February 28–March 1
- Missouri and Arkansas Flooding and Central Severe Weather, April 25–May 7
- Southeast Freeze, March 14–16
- Southern Tornado Outbreak and Western Storms, January 20–22

This map denotes the approximate location for each of the 16 billion-dollar weather and climate disasters that impacted the United States during 2017.
Figure 1. Number of releases associated with various natural phenomena

Source: Sengul et al., Analysis of hazardous material releases due to natural hazards in the United States (2012)
GULF OF MEXICO FACT SHEET

Map Sources: Infrastructure—Energy Information Administration (GasTren System), Ventyx (Energy Velocity)
Increased intensity of tropical cyclone activity in Western North Pacific and North Atlantic
Sea level rise and storm surge

Storm Surge and High Tides Magnify the Risks of Local Sea Level Rise

Sea level sets a baseline for storm surge—the potentially destructive rise in sea height that occurs during a coastal storm. As local sea level rises, so does that baseline, allowing coastal storm surges to penetrate farther inland. With higher global sea levels in 2050 and 2100, areas much farther inland would be at risk of being flooded. The extent of local flooding also depends on factors like tides, natural and artificial barriers, and the contours of coastal land.

Image adapted from Union of Concerned Scientists 2013; www.ucsusa.org/sealleverisescience
Figure 4: Oil Refineries on the Gulf Coast exposed to storm surge from Category 1 Hurricanes under four increments of future SLR.
<table>
<thead>
<tr>
<th>Number of Facilities Exposed</th>
<th>Petroleum</th>
<th>Oil Refineries</th>
<th>Strategic Reserves $^{11}$</th>
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<td></td>
<td>Petroleum Pumping</td>
<td>Oil &amp; NG Pipelines $^{12}$</td>
<td>Power Plants</td>
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<td>SLR (in)</td>
<td>C-1</td>
<td>C-3</td>
<td>C-5</td>
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<td>115</td>
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<td>32</td>
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$^{11}$ Strategic Reserves includes only the following SPR storage sites: West Hackberry, Bryan Mound, Bayou Chocktaw, Big Hill.

$^{12}$ Oil and Natural Gas pipelines are counted as exposed if any segment of a facility in the database is located in a location that is inundated by modeled storm surge.
Storage tanks failed during Harvey, spilling at least 145,000 gallons of fuel and releasing toxic pollutants

In this Wednesday, Aug. 30, 2017 file photo, large storage tanks situated in retention ponds are surrounded by rainwater left behind by Tropical Storm Harvey at ExxonMobil’s refinery in Baytown, Texas. Companies have reported that roughly two dozen storage tanks holding crude oil, gasoline and other fuels collapsed or otherwise failed during Harvey, spilling a combined 140,000 gallons of fuel, according to an Associated Press analysis of state and federal accident databases. Federal rules require companies to be prepared for spills, but don’t require them to take any specific measures to secure the massive fuel storage tanks at refineries and oil production sites that are prone to float and break during floods.
Harvey floodwaters trigger largest gasoline spill to date

By Associated Press

September 12, 2017 | 5:25am | Updated
## Hurricane Harvey Oil and Gas Spills
(as of 9/15/17)

Source: “Environmental and Health Concerns About Oil and Gas Spills After Hurricane Harvey” (2017)

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<th>Site Name</th>
<th>Operator</th>
<th>County</th>
<th>Waterway Impacted</th>
<th>Barrels Spilled (MCF for gas)</th>
<th>Contaminant Spilled</th>
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Harvey Damage Shuts Main Fuel Line From Texas to New York

by Alex Johnson / Aug.30.2017 / 9:57 PM PDT

Extreme precipitation and inland flooding
Chance of Oil Spill Rises With Floodwaters
Displaced Sediment Leaves Pipelines Beneath Riverbeds Exposed to Dangers

The Yellowstone River flows past the CHS Inc. refinery in Laurel, Mont., in July, after an underwater Exxon pipe leaked 1,000 barrels of crude.

ASSOCIATED PRESS

By Jack Nicas
August 4, 2011
Floods Put Pipelines at Risk
Records Suggest Erosion of Riverbeds Jeopardizes Oil and Gas Infrastructure

By Jack Nicas
Updated Dec. 3, 2012 8:23 p.m. ET

A year after floodwaters eroded sections of the Missouri River basin, exposing two petroleum pipelines and triggering their rupture, federal records suggest the same thing could happen to dozens of others. The records highlight a gap in regulations that could imperil pipelines buried beneath rivers nationwide.

Workers waded into the Yellowstone River to help clean up a 2011 oil spill caused by a broken pipeline. Dozens of miles of shoreline were fouled. ASSOCIATED PRESS
Wildfire
B.C. oil and gas companies say they're prepared for wildfires

Oil and Gas Commission says no energy facilities were damaged in this week's wildfires

CBC News - Posted: Apr 22, 2016 6:30 AM PT | Last Updated: April 22, 2016

The wildfires in northern B.C. this week came within 10 kilometres of 72 oil and gas facilities. (Dan Riedlhuber/Reuters)

This week's wildfires in northern B.C. threatened not just homes but also pipelines and gas wells.
Wildfires ripping through Canada’s western province of British Columbia since the weekend have forced people to flee and companies in the mining and forestry sectors to scale back or suspend operations.
Markets

Alberta Pipeline Disrupted as Fire Season Starts in Oil Patch

By Robert Tuttle
May 15, 2018, 4:27 PM PDT

- Inter Pipeline cuts power to part of Polaris line amid blaze
- Heavy Canadian oil discount shrinks to smallest since October
Regulatory context: where might these considerations factor into govt. decisions about oil and gas infrastructure?

- National Environmental Policy Act (NEPA) reviews / state equivalents

- DOE/FERC Policies and Regulations
  - Public need and convenience determinations (pipelines)
  - Public interest determinations (LNG terminals)
  - Siting and engineering decisions

- PHMSA Policies and Regulations
  - Key safety concern = effect of climate change on infrastructure; increased risk of spills

- GHG reduction plans and regulations
Accounting for Impacts of Climate Change on Oil and Gas Infrastructure?

Assessing the Impacts of Climate Change on the Built Environment under NEPA and State EIA Laws (Sabin Center for Climate Change Law 2015)

- Discusses policy rationale + legal basis for evaluating climate change impacts in EIA
- Survey of existing guidelines / technical protocols
- Survey of agency practice
- Summary of topics and case studies discussed at stakeholder workshop
- **Model protocol** for assessing climate change impacts
Thank you!

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