Driving Natural Gas Systems to Reduced Greenhouse Gas Emissions

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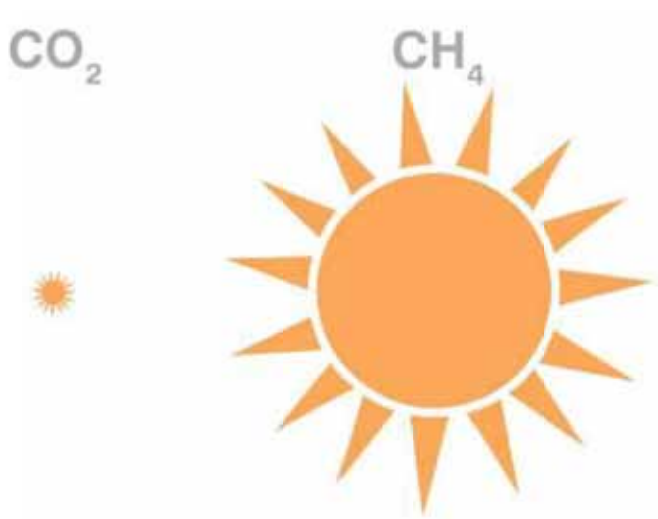
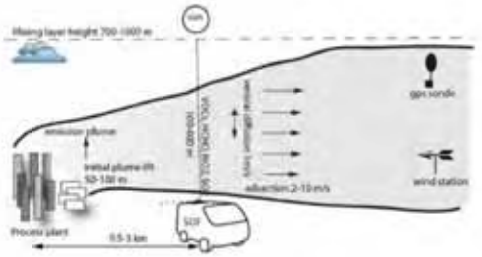
Methane, the main constituent of natural gas, is a potent greenhouse gas

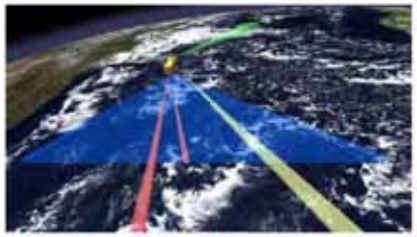
Kilogram for kilogram methane in the atmosphere produces up to 120x as much warming as CO_2



Since 2013, extensive measurements of methane emissions from oil and gas operations made using multiple techniques, primarily in the United States

- Direct measurements of sources
- Fixed ground measurement network
- Mobile ground monitoring
- Aircraft monitoring
- Satellite measurements
- Different approaches provide complementary information





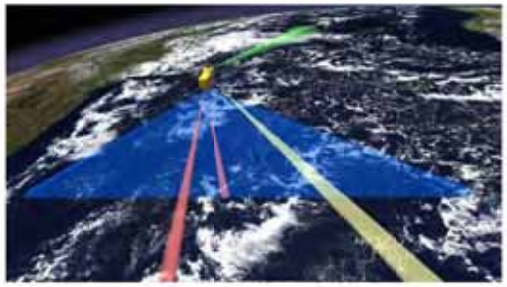
Findings

- On a global basis, emissions have been estimated as approximately ~2% of methane produced; this erodes about 2/3 of the climate advantage that natural gas has relative to coal based on its lower carbon dioxide emissions
- Small subset of sites and devices account for most of the emissions and many of these high emitting sources are not accounted for in traditional emission estimation methods
  - –2% of sites in the Barnett shale lead to >50% of the emissions
  - –19% of pneumatic controllers lead to 95% of emissions……
  - –But, the emissions are intermittent, may be hard to detect and may reoccur
- Measuring emissions has been very expensive and has provided only snapshots

Finding emissions can be challenging

How do we make progress on reducing emissions?

- Strategic approach targeting high emitting sources is likely to be most effective and economically efficient
- To "find and fix" need sensing and data assimilation technologies
  - Many new technologies emerging and undergoing field tests

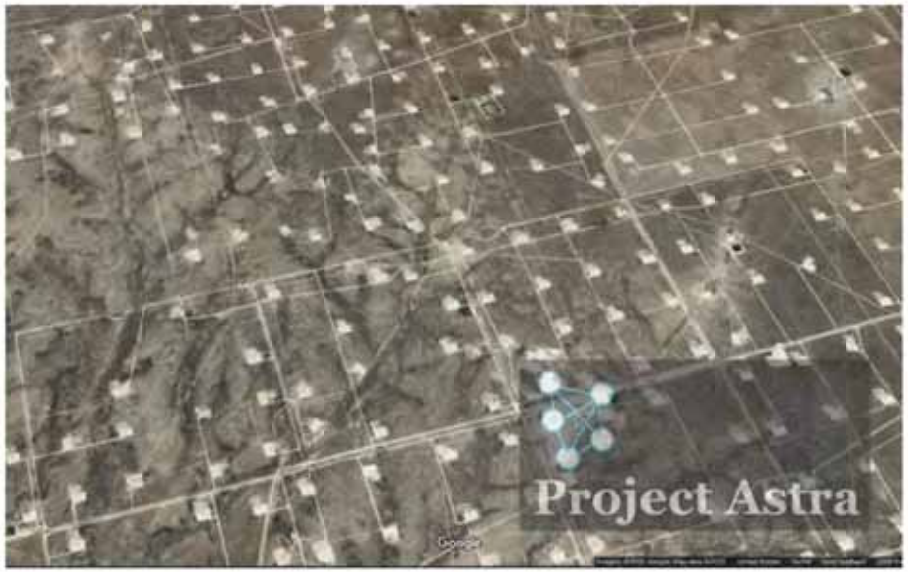


Project Astra

Project Astra will demonstrate a novel approach to measuring methane emissions from oil and gas production sites, using advanced sensing technologies and data analytics.

Project Astra will:

- Transform methane emission detection from labor intensive surveys, inefficient at finding and slow to repair emissions, to sensor intensive continuous monitoring that will efficiently deploy operators
- At the same cost as current surveys, quickly find and repair emissions



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More Information about Project Astra

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www.projectastra.energy

1.

West Texas Methane Sensor Inter-comparison

An in-field assessment and selection of sensors for the Project Astra pilot mesh network

3Q 2020-2Q 2021

2.

Digital Methane Challenge

Using a digital twin of the pilot area, determine the optimized design of the sensor mesh network and the data analytics required to identify unintended emissions

3Q 2020 – 2Q 2022

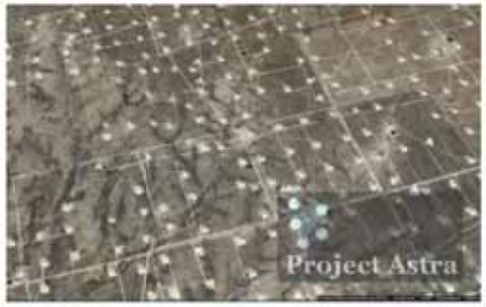
3.

Project Astra Pilot

A multi-month, operating pilot of the methane mesh network in the Permian Basin

1Q 2022 -

Partners:
Chevron
Environmental Defense Fund
ExxonMobil
Gas Technology Institute (GTI)
Microsoft
Pioneer Natural Resources
Schlumberger
University of Texas



Methane sensor field inter-comparison

Key questions assessed during sensor inter-comparison

- What precision and accuracy can be provided by low-cost methane sensors?
- What is the data capture rate?
- Does performance change over time?

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Methods:

- 9 months of testing (October 2020 – June 2021)
- 7 sensors compared against multiple certified gas standards in single blind challenges
- Sensors compared to a collocated state of the art TILDAS (1 ppb precision at 1 Hz)

Key questions assessed during sensor inter-comparison

- What precision and accuracy can be provided by low cost methane sensors?

Multiple sensors with ~10 ppb sensitivity at 1 Hz; multiple sensors able to detect ~500 ppb changes in concentration at 1 minute resolution

- What is the data capture rate?

Multiple high and medium precision sensors had high data capture rates

- Does performance change over time?

Multiple sensor systems challenged by dust

Final report available on web site

Project Astra Status

Sensor inter-comparison completed; design stage of Digital Methane Challenge completed; Pilot launched

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3Q 2020-3Q 2021

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3Q 2020 – 4Q 2021

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4Q 2021 - 2022

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Network Design Questions:

How many sensors are needed?

What temporal resolution is required of the sensors?

What accuracy is required?

DIGITAL METHANE CHALLENGE

- Use a fine spatial and temporal scale digital simulation of emissions, and concentrations of methane in the atmosphere, to design a network

Data Analytics Questions:

Once data are streaming in, how do we identify emission anomalies?

Multiple data analytics approaches are being investigated

Possibility of a “hackathon” being pursued

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