

THE ROAD TO NET ZERO GOES THROUGH YOUR TANKS

Direct Measurements from the Field Compared to EPA Emissions Estimates



REVIEW OF INDEPENDENT CASE STUDIES

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OUR PANEL



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Bridger Photonics



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Access to reliable and affordable energy is vital, and our industry is critical to meeting these demands, but we can do better, and will continue to face rising pressure to reduce emissions



“Zero Routine Flaring by 2030” Initiative

53 oil and gas companies and 34 governments are Endorsers and more are signing-on.



Industry Initiatives

API issued new framework for tracking, emissions, including flared natural gas, to increase transparency.



TEP initiatives on reducing flaring and fugitive emissions.



More Methane Regulations

Recent SCOTUS decision did not specifically address EPA's efforts to develop rules for methane emissions. EPA has proposed new NSPS requirements.



SEC currently developing rules for climate risk disclosures.



States Increasing Gas Capture Rules

Colorado, New Mexico and North Dakota have implemented regulations restricting flaring, venting and emissions and/or creating compelling tax incentives for reducing flaring and emissions.



Wall Street Demanding Better ESG Performance, Ratings Agencies Jump-In

World's largest money manager with \$8.7 trillion – “We believe that sustainability should be our new standard for investing.” – Q2 2022 *Earnings Letter to Clients*

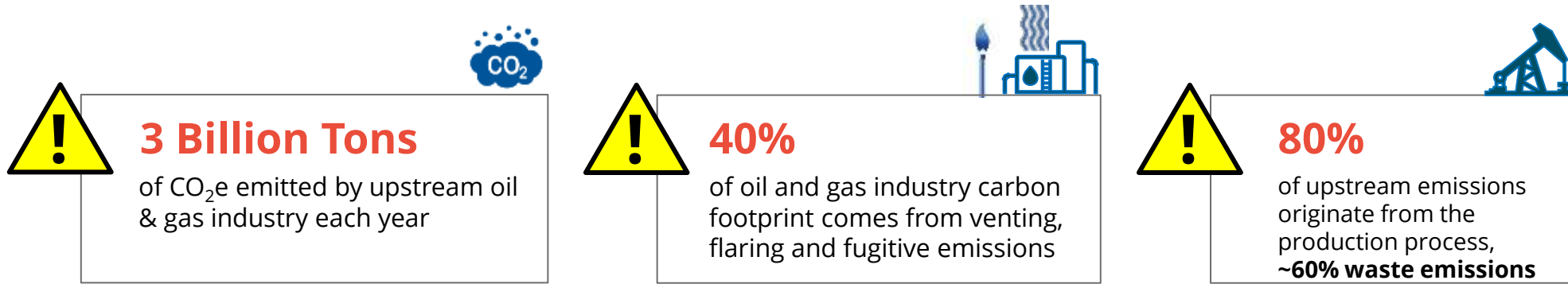


Sustainable Fitch rates public and private debt for ESG.



Permian Basin

- EPA considering designating SE New Mexico and West Texas as Non-Attainment for ozone. Would reduce threshold for major sources; decision to proceed expected in September.
- TCEQ permitting incentives to maximize capture percentage.
- TX RRC SWR 32 amended to require operators to record and report volumes flared or vented and why.
- NM - New 98% Capture requirement.
- NMOCD requiring daily reports on flaring or venting and cause, including O₂.



Solutions to Eliminate Natural Gas Flaring and Venting



Oil & Gas Solutions

Reduce Waste Emissions from the Production Process

ENABLE RECOVERY & SALES OF FULL VAPOR STREAM

- Tank Battery Vapor Management & Treatment (O₂ & H₂S removal)
- Eliminate venting with tank pressure control
- Mobile Capture and Treating Solutions (tank clean out, flowback)
- Site Assessments, including O₂ & H₂S metering



Renewable Natural Gas Solutions

Ensure Pipeline Ready Gas from RNG applications

GAS PURIFICATION

Deliver pipeline-ready gas using:

- **Zero₂** Patented oxygen removal solutions
- **Sulfur Sentinel** Simple, economic H₂S removal



GAS MAPPING LiDAR™

Emissions Reduction Made Simple.

Gas Mapping LiDAR™ sensitively images, pinpoints, and quantifies your methane emissions from the air.



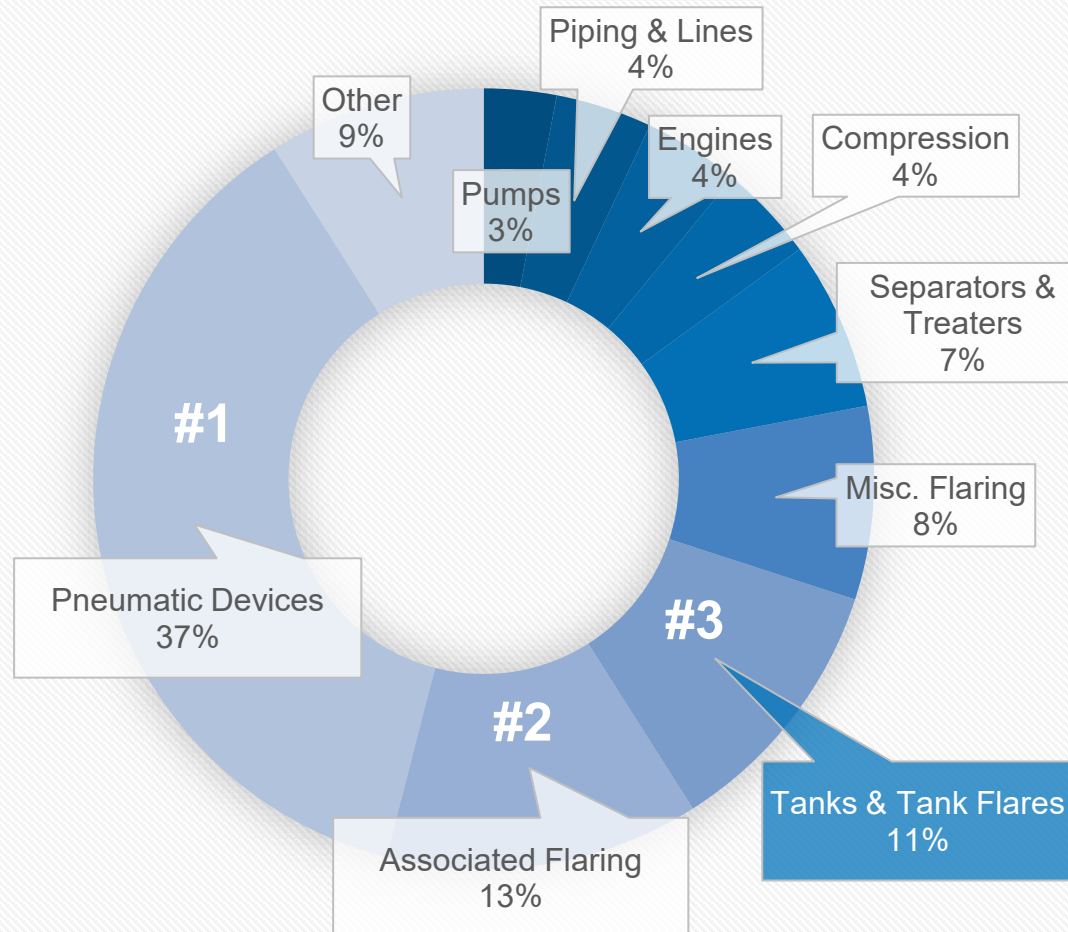
To protect client confidentiality, gas plumes shown do not correspond to sites shown

EPA GREENHOUSE GAS INVENTORY

Oil & Gas Air Emissions



2019 CO₂e Emissions From Upstream O&G – EPA Estimate



Based on the latest EPA Greenhouse Gas Inventory, pneumatic devices represent the largest source of CO₂e emissions, followed by Associated Gas flaring, then tanks and tank flares.

The estimates are based on emission factors - not direct or measured observation.

Emission factors are applied to the estimated frequency of events and activities at production operations. These factors are used in permitting and compliance reporting as well as for estimation of the national emission inventory.

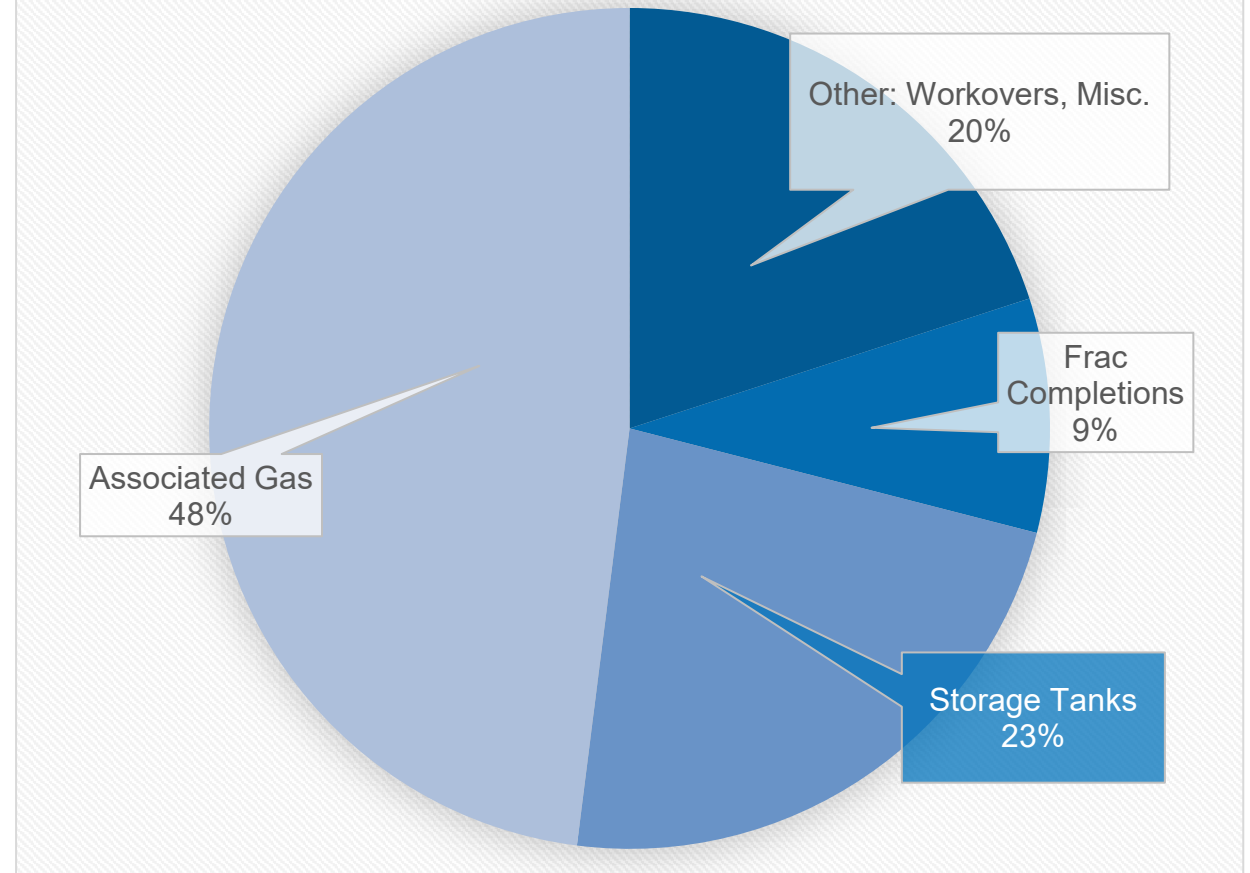
EPA developed the emission factors from a variety of sources, including:

- Modeling
- Surveys
- Industry panels
- Consulting studies
- Technical reports

While flaring of Associated Gas is the largest source of flaring, tank batteries are 2nd and are roughly half the emissions from Associated Gas flaring. This data is also from the emission inventory data using emission factors.

Conclusion: Based on emission factors, tank venting and flaring is one of the top three emission sources in the upstream O&G sector.

Upstream Flaring in 2017: 22 MM Tons CO₂e – EPA Estimates



Source: U.S. Dept of Energy, "Natural Gas Flaring & Venting", June 2019

DIRECT MEASUREMENT

Four Independent Case Studies



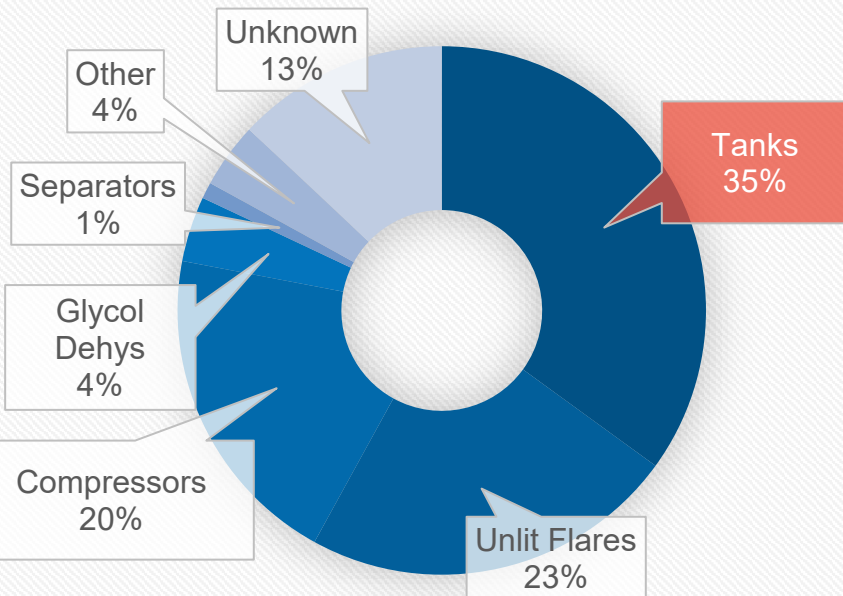
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CASE 1: LiDAR & OGI MEASUREMENTS IN CANADA (2019)

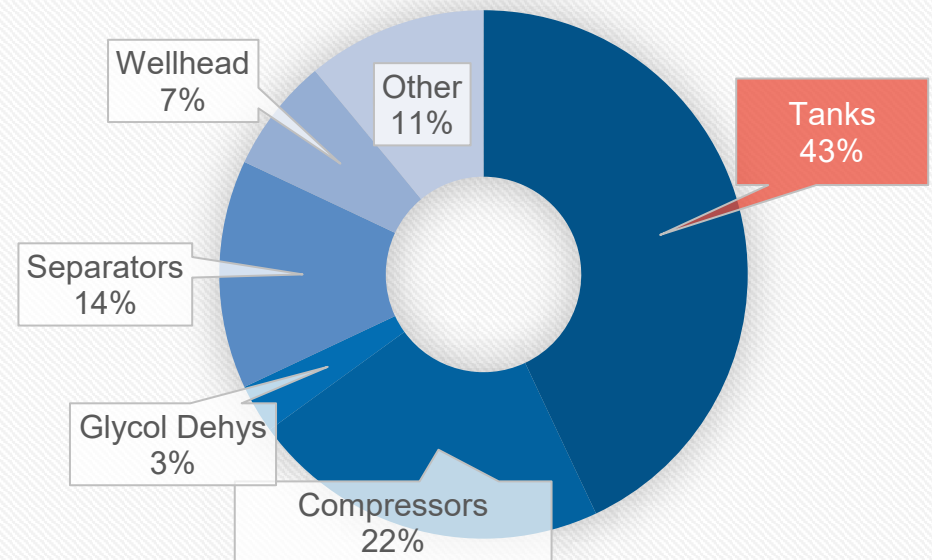
In 2019, Gas mapping LiDAR (Bridger Photonics) was used to evaluate 167 geographically distinct sites in British Columbia which included 80 well locations, 72 tank batteries, 8 gas plants, 4 compressor stations and 4 unidentified facilities. The results were compared to an OGI survey performed the prior year by Cap-Op Energy at 140 of these sites.

Aerial Survey Results



Both surveys confirmed tanks were the largest emissions sources, although the aerial survey estimated far higher volumes emitted.

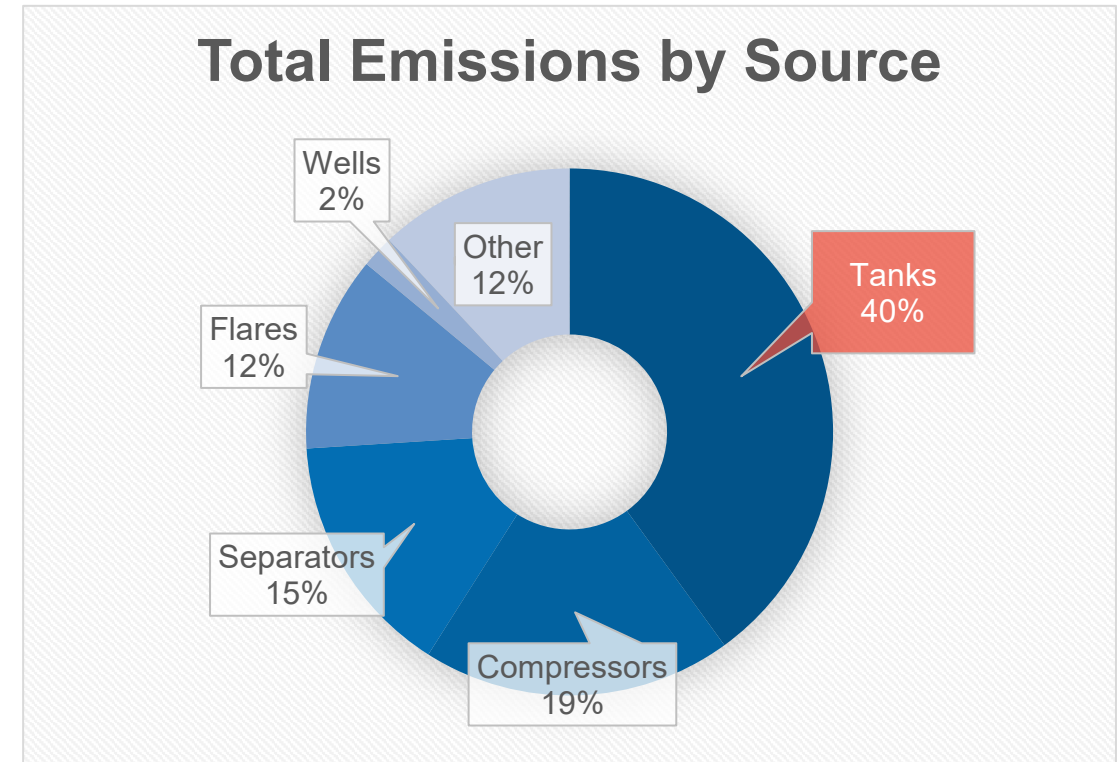
OGI Survey Results



Source: David Tyner & Matthew Johnson, "Where the Methane Is: Insights from Novel Airborne LiDAR Measurements Combined with Ground Survey Data", *Environmental Science & Technology*, 55, 9773-9783.

Gas mapping LiDAR (Bridger Photonics)

- Early 2020
- 5,361 pieces of equipment surveyed
- over 250 square miles
- 1,450 facilities



CAMS is an industry-led research collaboration administered by GTI Energy

Source: Collaboratory to Advance Methane Science, CAMS Scientific Insights, August 2021.

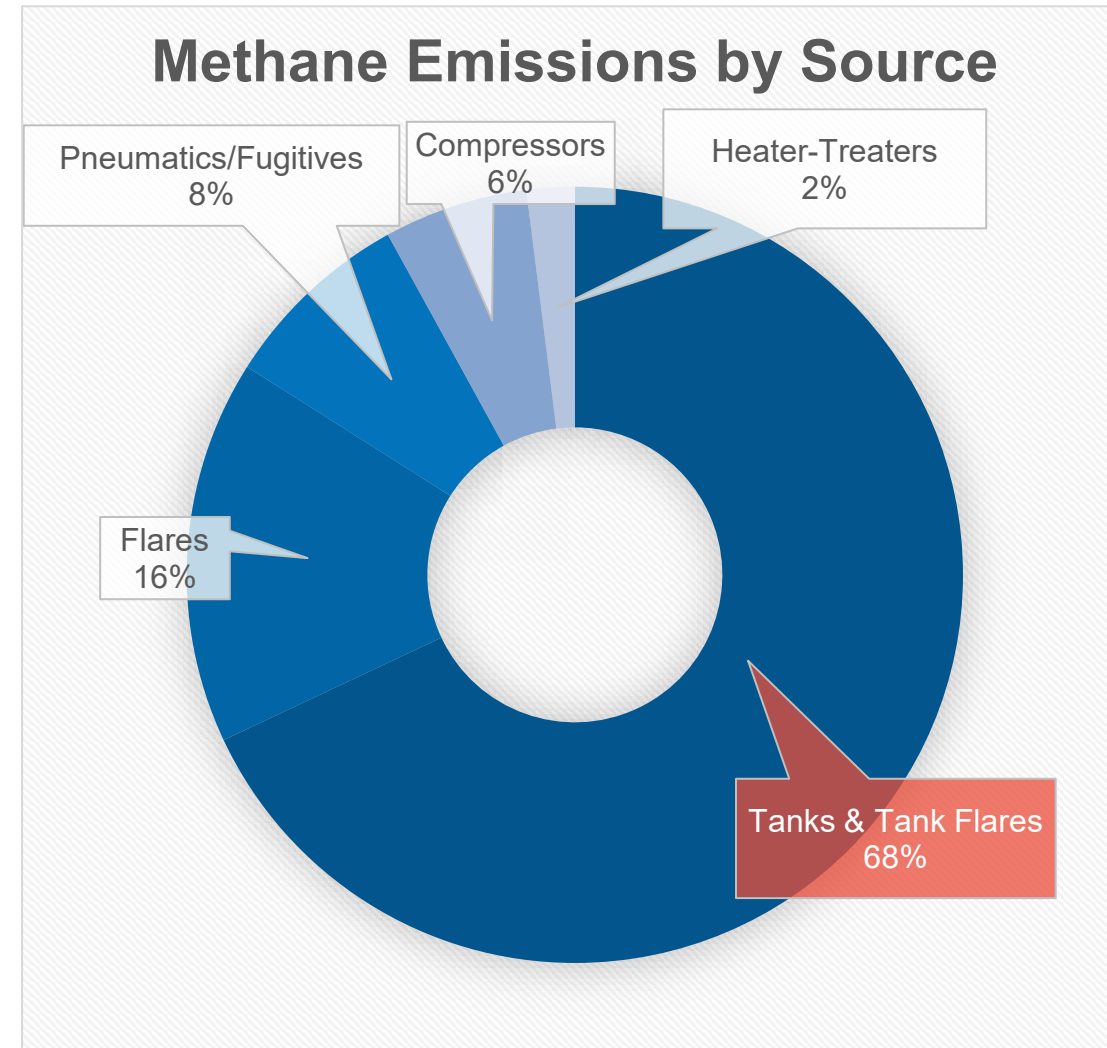
CASE 3: TRP ENERGY FIELD STUDY (2020)



In late 2020, TRP Energy performed a field study of their site emissions at their West Texas assets.

The study was conducted using **four different measurement methods** over several weeks.

METHOD	SENSOR TYPE	SURVEY	MEASUREMENT
Fixed-wing aircraft	Light detection & ranging	25 Central Processing Facilities	Bridger Photonics
Drones	Optimal Gas Imaging	9 of largest facilities	Avitas
Truck-mounted	Spectrometer	9 facilities	Univ. of Wyoming
Ground, continuous	Metal oxide	6 months - 1 facility	Scientific Aviation

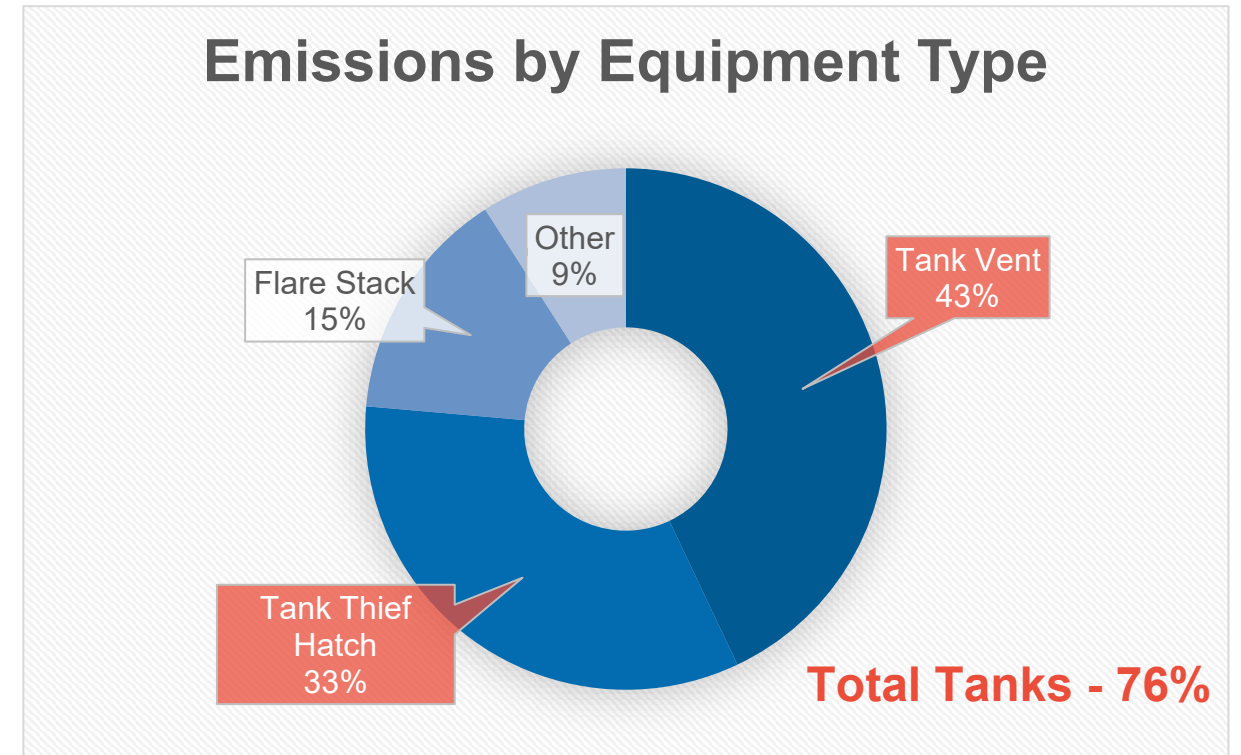


Source: TRP Energy, "Reducing Oilfield Methane Emissions: How Technology, Data Analytics and Stakeholder Engagement Can Drive Emission Reductions"

CASE 4: AERIAL SURVEYS OF THE PERMIAN BASIN (2021)

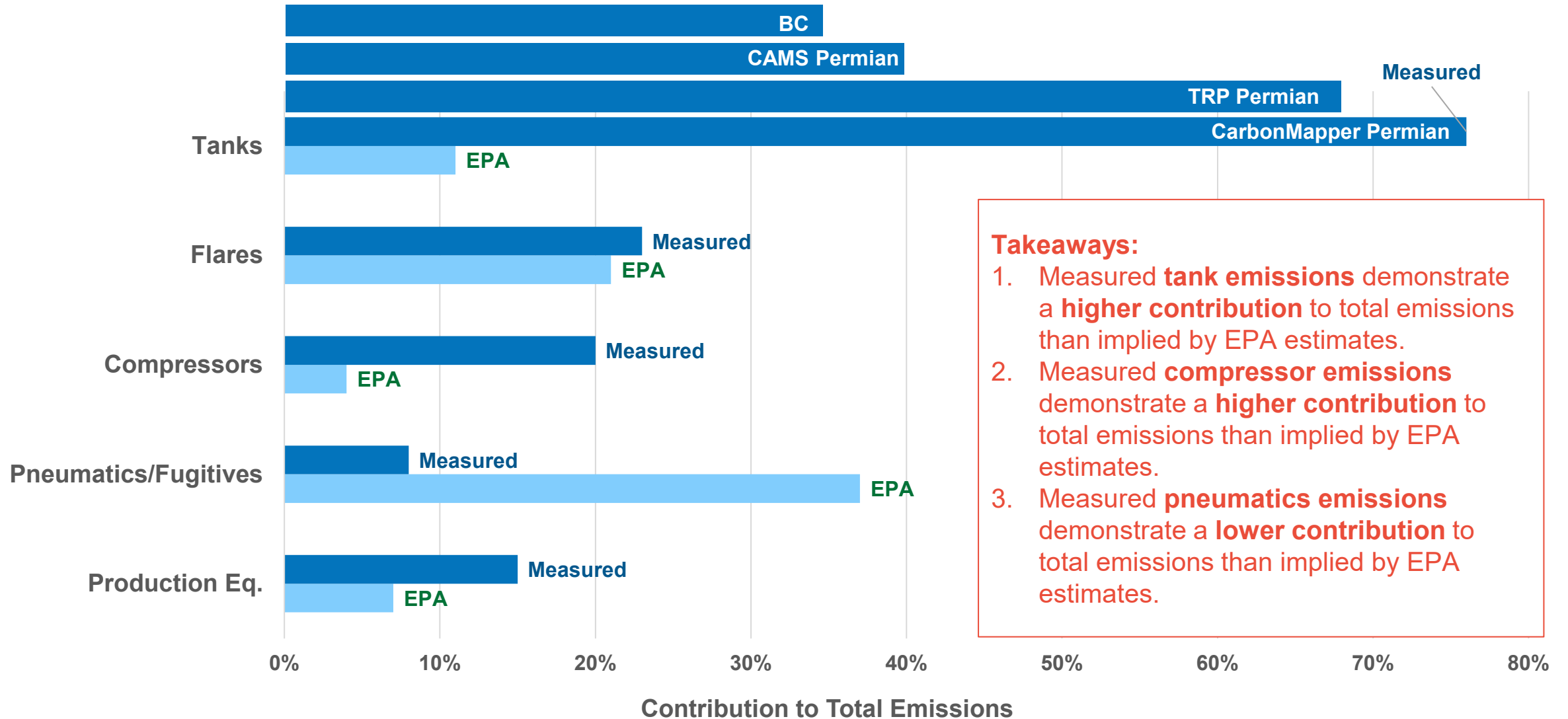
2021 surveys of more than 1,000 sites in the Permian.

- Aerial Surveys: University of Arizona / NASA Jet Propulsion Laboratory / CarbonMapper
- Aerial Surveys: Scientific Aviation
- Ground Surveys: University of Wyoming
- OGI Surveys of Emissions from Flaring & Other Equipment: Leak Surveys Inc.



Source: EDF, Permian Methane Analysis Project, www.permianmap.org.

SUMMARY | COMPARISON OF FINDINGS



Takeaways:

1. Measured **tank emissions** demonstrate a **higher contribution** to total emissions than implied by EPA estimates.
2. Measured **compressor emissions** demonstrate a **higher contribution** to total emissions than implied by EPA estimates.
3. Measured **pneumatics emissions** demonstrate a **lower contribution** to total emissions than implied by EPA estimates.

From CAMS Study:

“Tanks resulted in the most significant volume of methane emissions released from the target area. This result is consistent with findings from previous aerial studies, such as those conducted by helicopter flyover with Forward Looking Infrared (FLIR) Cameras which found most detectable emissions were from tanks.”

From Canadian Study:

“Combined data¹ suggest methane emissions are 1.6-2.2 times current federal (i.e., Canadian) inventory estimates.”

¹ Author’s estimates combining survey data with actual data on pneumatic controllers.

From TRP Energy Study:

- Tanks were the primary emission source and emissions did not correlate with production volumes.
- Separators, heater-treaters and their associated equipment represented a small share of overall emissions.
- Measured emissions were distributed across both high-rate and low-rate facilities in a relatively uncorrelated manner -- ***Low oil rate facilities cannot be dismissed as negligible.***
- The tank vent system and flare were seen as more complex issues, in some cases requiring advanced engineering solutions.
- ***“Component-level emission factors that are used for EPA reporting do a poor job approximating actual emissions. Emission factors struggle to incorporate equipment malfunctions and process upsets which, although short-lived, can comprise a significant portion of annual emissions.”***

EPA - proposed NSPS regulations, Permian ozone

- Continue to allow tank flaring as an acceptable emission control device.
- Considering designating SE New Mexico and West Texas as non-attainment for ozone, reducing major source threshold - decision to proceed expected in September.

States - variety of approaches, notable examples:

- New Mexico - requires natural gas management plan and notification of any flaring over 50 mcf; constitutes the leading practice at this time.
- Colorado - COGCC does not consider flaring from tanks as waste of the natural resource; appears tank flaring no longer measured or reported. However, ozone-nonattainment and the resulting CDPHE AQCD regulations cap Major Sources at 25 TPY of VOC or NOx in the DMFR.
- Other states are generally more lenient.

Operators

- Publicly-owned as well as some PE-backed operators now have sustainability and ESG objectives; many exclude tank flaring from flaring intensity metrics or don't consider tank flaring as "flaring."
- Private operators lagging behind - a Rystad Energy analysis found that private companies flare an average of 423 scf of gas per barrel produced compared with 74 scf for publicly-owned operators.

- Using **emission factors**, tanks are *one of the top three* sources of air emissions in the oil and gas production sector.
- However, **direct measurement** using various technologies indicates tanks are the largest source of emissions.
- Tanks, flares and compressors are the primary source of measured emissions. Emissions from separators, pneumatics, and fugitives are significantly lower.
- Tanks are a particularly special case in that emissions are not correlated to production rate - even low production facilities are an issue.
- **TANKS REPRESENT A SIGNIFICANT FINANCIAL AND ENVIRONMENTAL OPPORTUNITY FOR OIL & GAS OPERATORS**

CAUSES OF TANK EMISSIONS

Venting and Flaring

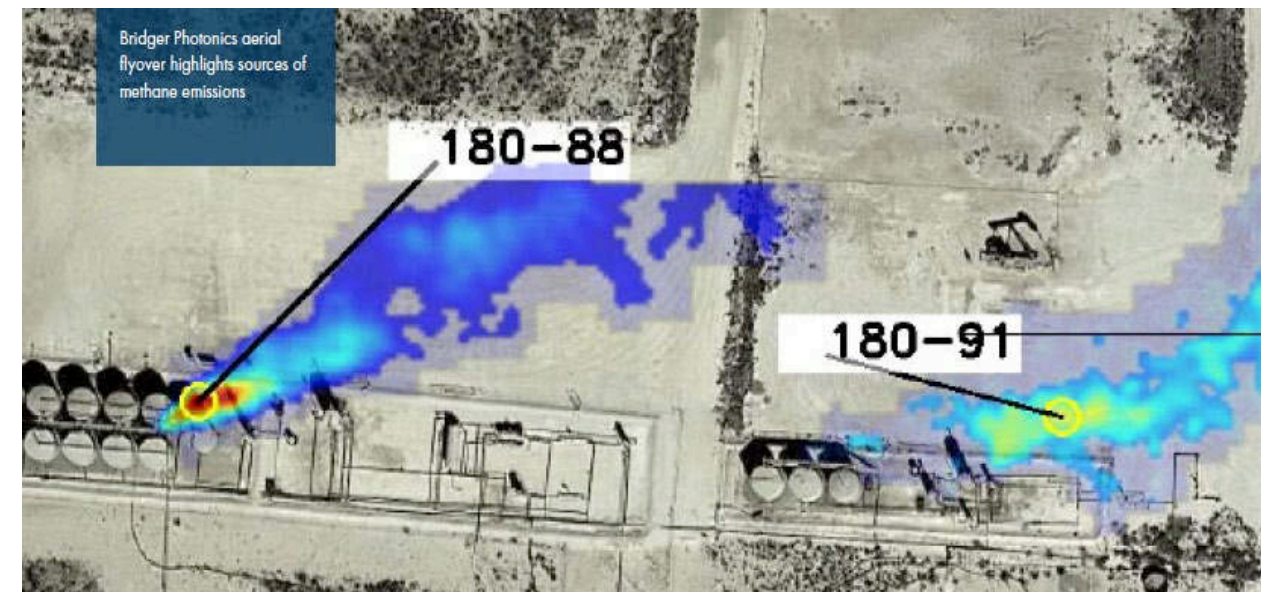


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TANK VENTING EMISSIONS

- Oil & water storage tanks typically limited to 8-12 oz/in² of internal pressure before relieving via PSV and/or tank hatch.
- Upstream factors contributing to venting are variability in oil and water production rates, production methods (e.g., plunger lift), separator dump valves, API gravity of the oil, insufficient VRT capacity, and changes in ambient temperatures, among others.
- Downstream factors contributing to venting are response capability of flares & combustors (distance, pipe size, pressure drop, flare design and capacity), among others.
- Tank pressures are normally not controlled or actively managed.
- Emissions are mostly volatile organic compounds, plus some methane, water vapor, can include H₂S.



TANK FLARING EMISSIONS

- Many operators capture some of the oil flash in VRTs but, based on field observation, only 60-70% of the total low-pressure volume is collected.
- Remaining tank gas, including that in the water tanks, and from tank truck loading, is typically flared.
- Oxygen contamination of the gas in the tanks is common and requires gas to be flared instead of sold.
- Conventional gas blankets often ineffective.
- Emissions are mostly CO₂ and NO_x but include some VOCs (VOC & NO_x a particular issue in ozone creation).
- Higher VOC destruction rates (newer flares) do not address GHG and NO_x emissions.
- Unlit flare pilots allow methane and VOCs to vent directly to the atmosphere.
- High destruction efficiency combustors often require additional fuel gas to be burned to maintain high refractory temperatures. Burning gas to burn gas.



ORDER OF MAGNITUDE | VALUABLE RESOURCE



- Our E300 oxygen removal unit is our most popular ZerO2 model and **each of the E300s can treat the energy equivalent of 264 million cubic feet of natural gas annually.**
- The ZerO2 fleet installed in North America - from E100s to E1200s in the Eagle Ford to the Bakken - has the capacity to supply the heating needs for over 900,000 households or roughly two-thirds of the homes in the Denver metro area.
- The estimated CO2e emissions prevented by the ZerO2 fleet is the equivalent of removing over 800,000 cars annually from the road.



SOLUTIONS

Venting and Flaring



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Venting

- Tanks are normally responding to changes in upstream production rates, conditions, and equipment functionality, and to downstream flares and compressors. Pressure “swings” based on conditions upstream and downstream of the tank battery.
- ***Solution - actively manage tank pressures***

Flaring

- Partial recovery of low-pressure gas leads to flaring the balance, which can be significant
 - Contaminants (O₂, H₂S) **outside of gas pipeline specs require non-conforming** gas to be flared.
 - ***Solution - capture all gas directly from the tank battery, treat for contaminants if present***
- ***A system that **continually** manages tank pressures and provides full gas capture is required***

Full Gas Capture from tank batteries

- No VRT required
- VRU typically needed to sell into local pipeline
- Treat O₂ and H₂S to pipeline specifications

Vapor Management System

Tank pressure management and control

(NEW Product Release – August 2022)

- Finalizing field testing
- Combines both vacuum and overpressure control
- Can avoid the need for a second VRT at existing sites
- Launch webinar in early September



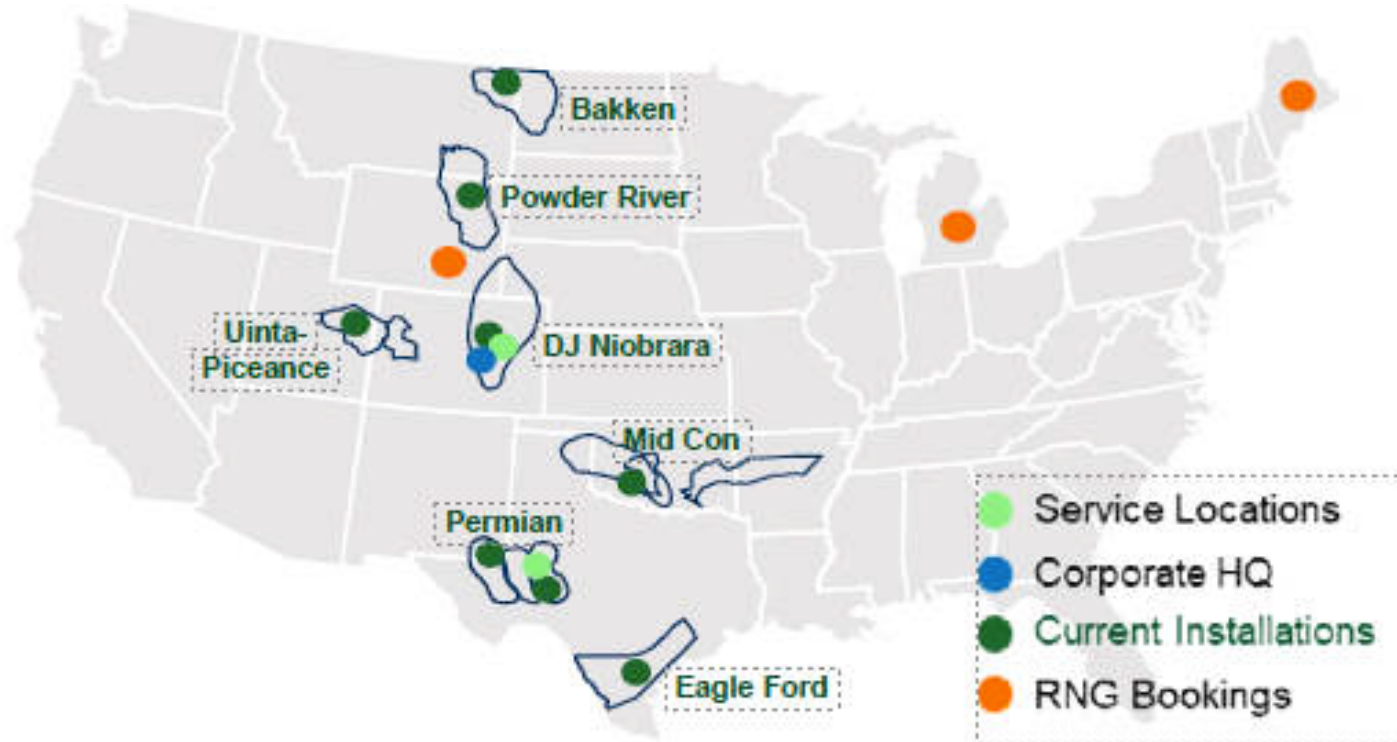
ZERO₂



SULFUR SENTINEL



VMS E300



- **Over 170 installations in seven oil and gas producing basins**
- **First installs at RNG projects**
- **27 active clients: small independents to super-majors**
- **Continued product innovation driven by operator needs**

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