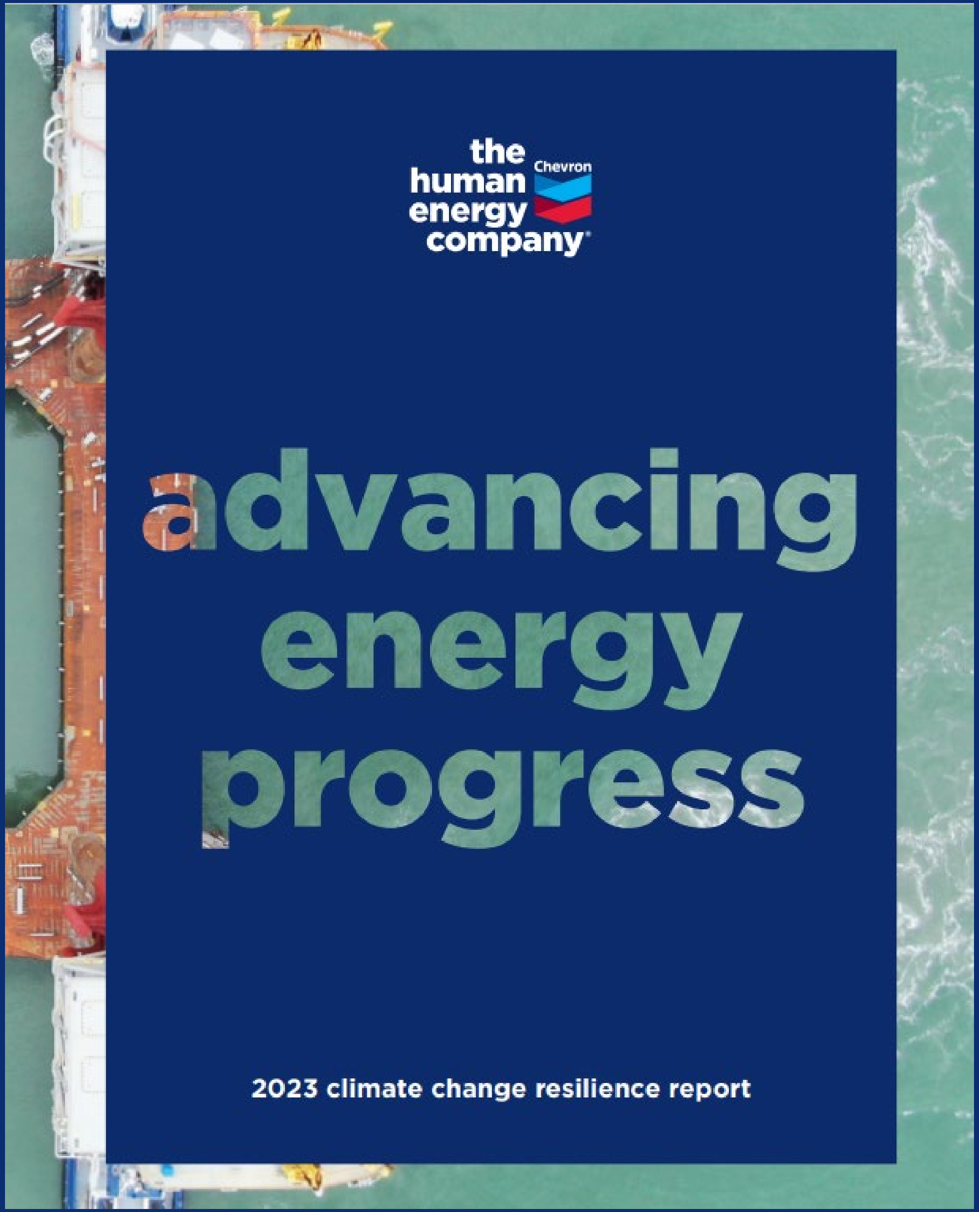


GHG calculations in the oil & gas industry

Julie Mulkerin Ortiz
GM of decarbonization strategy, Chevron

GHG calculations in the oil & gas industry

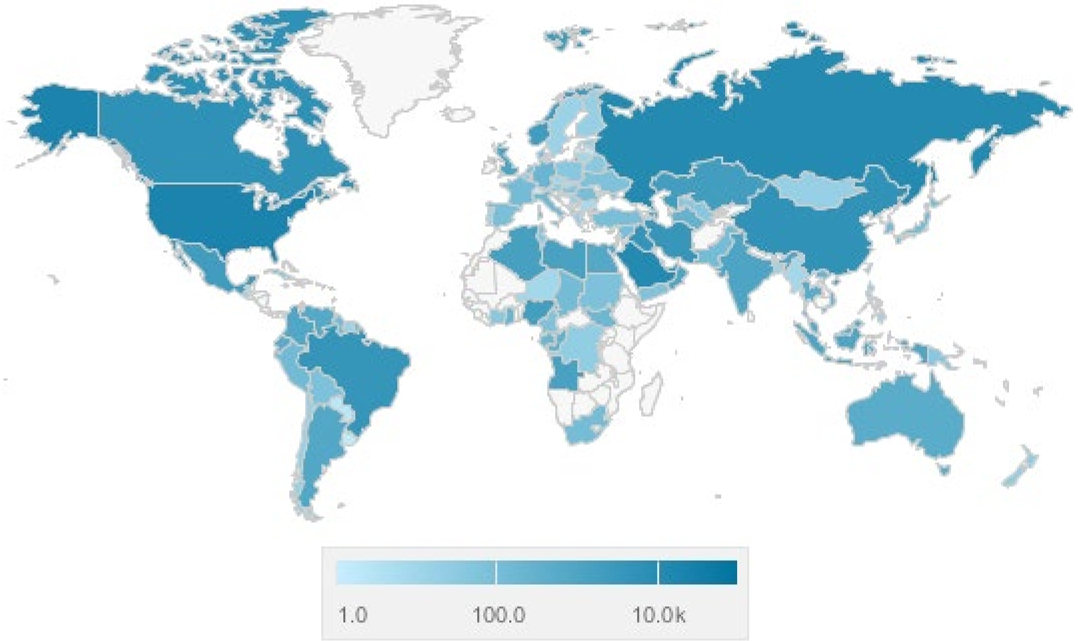
Oil & gas industry

Overview of emissions
& calculation methods

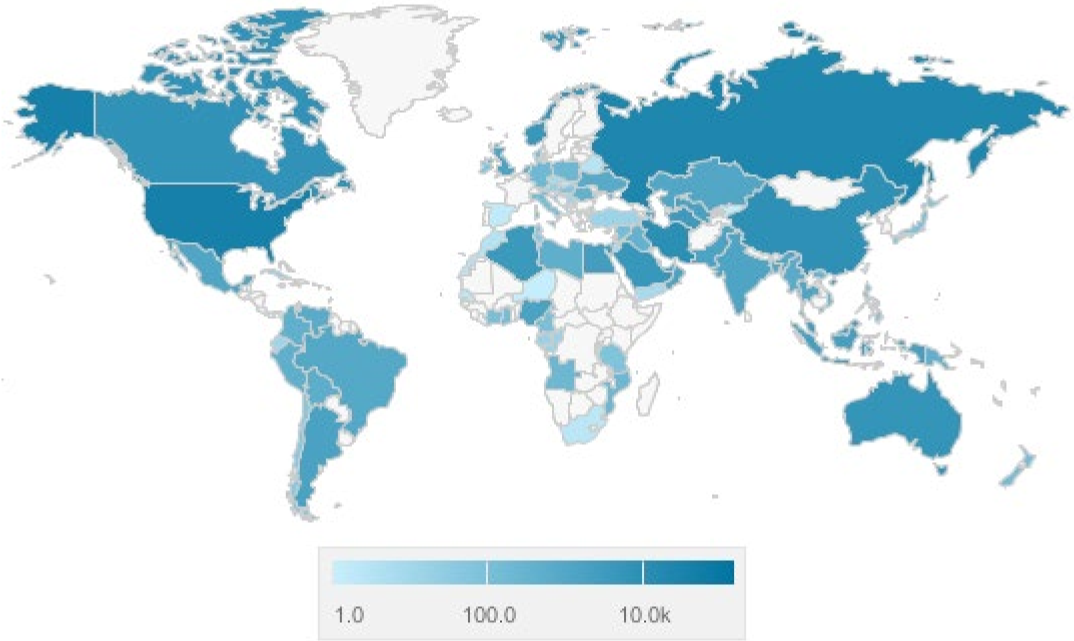
Advancing progress in data quality

95+ countries produce oil & gas

Total petroleum and other oil liquids

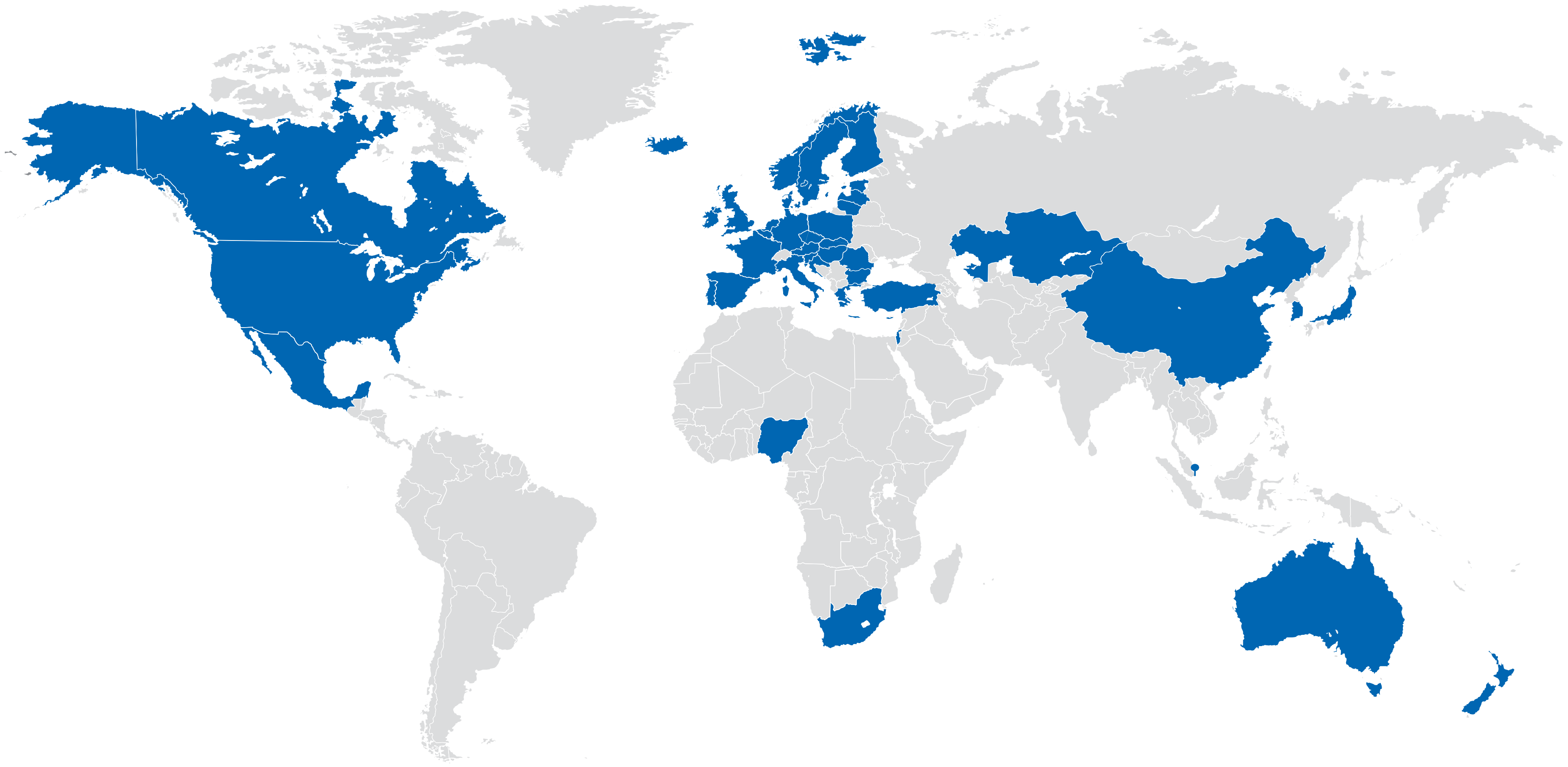


Dry natural gas



Source: EIA, 2022 data

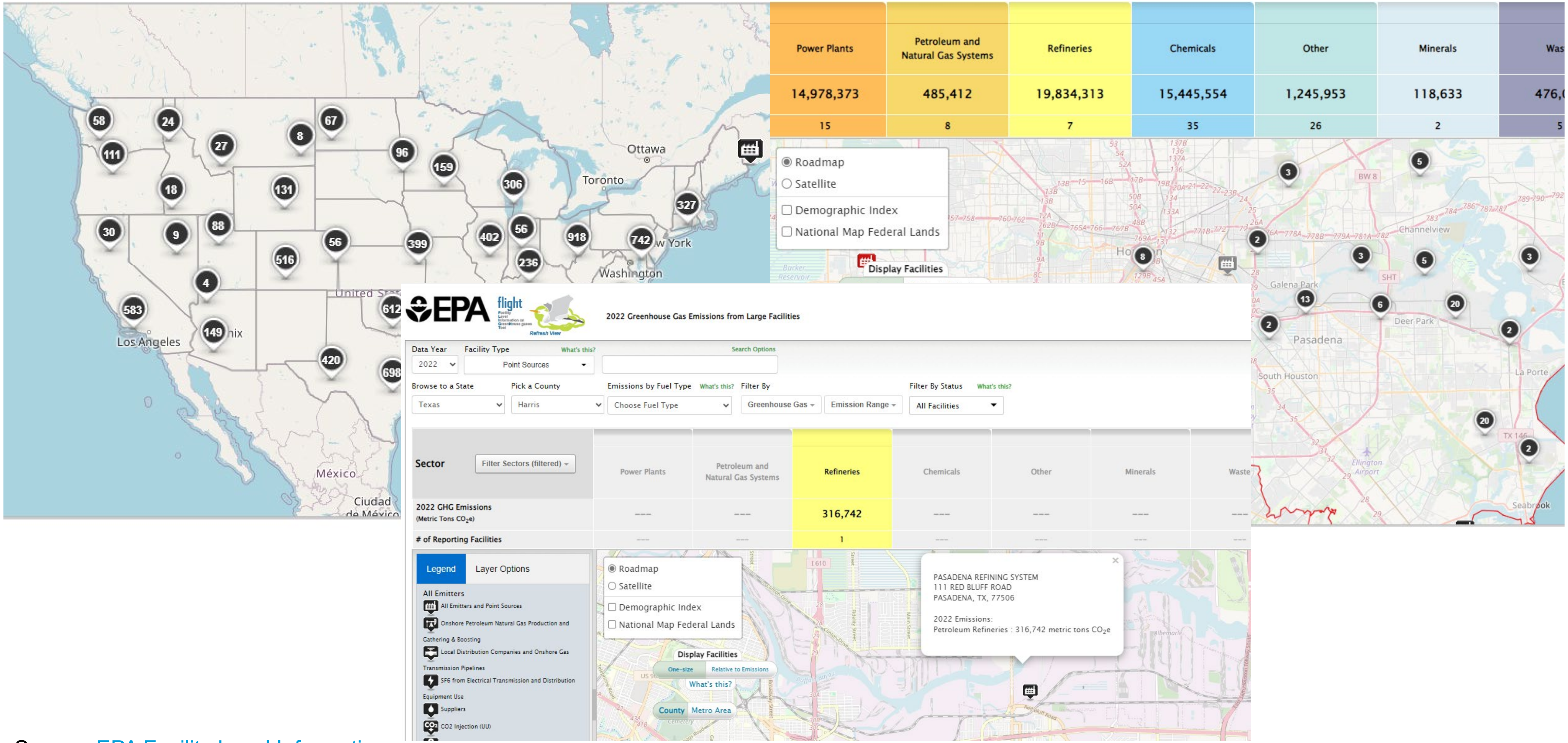
~40 countries have mandatory GHG reporting requirements



Mandatory GHG reporting required

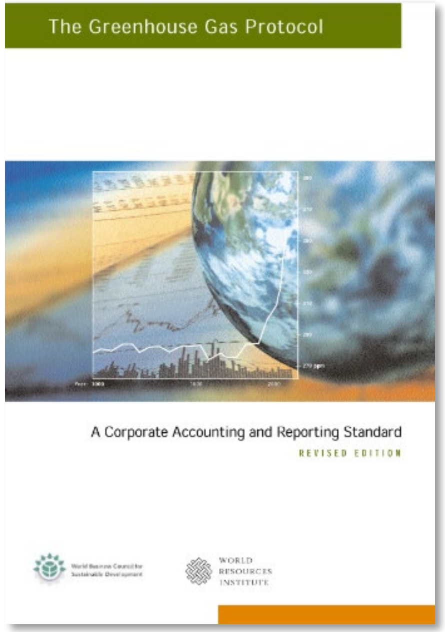
Source: WRI, UNFCC, NUPRC, DFFE, Seneca

Data is often publicly available under mandatory regimes



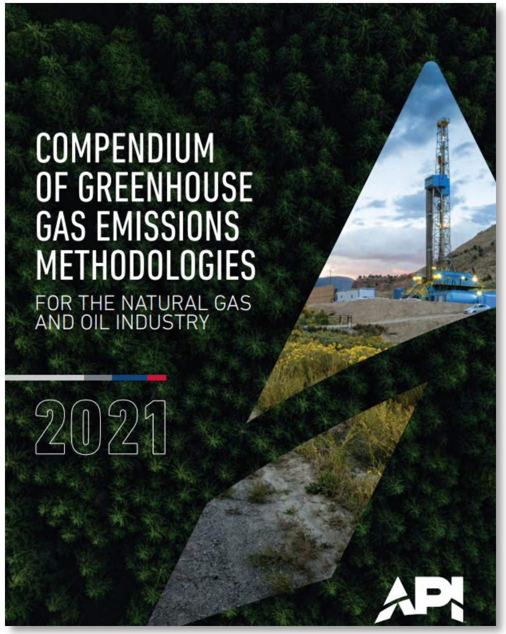
Source: EPA Facility Level Information on GreenHouse gases Tool (FLIGHT)

Voluntary emissions calculation guidance for >20 years



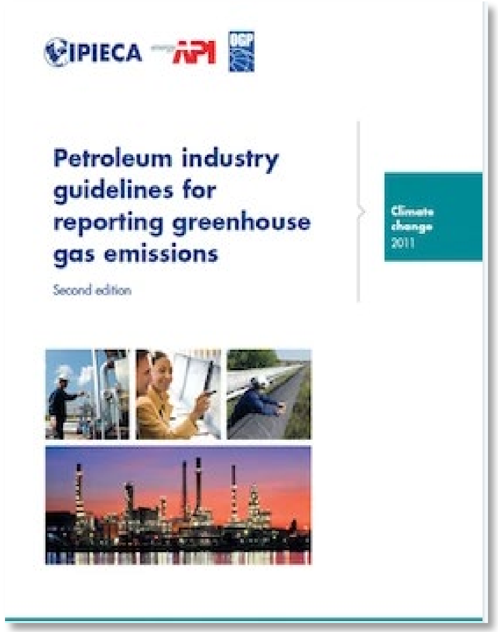
116 pages

2001



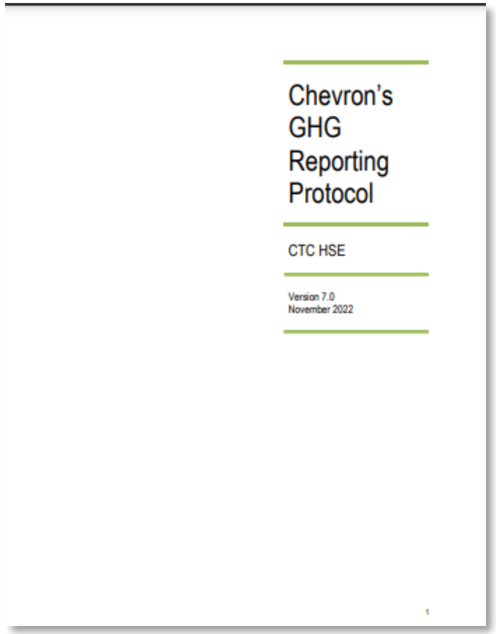
898 pages

2001



84 pages

2003



45 pages

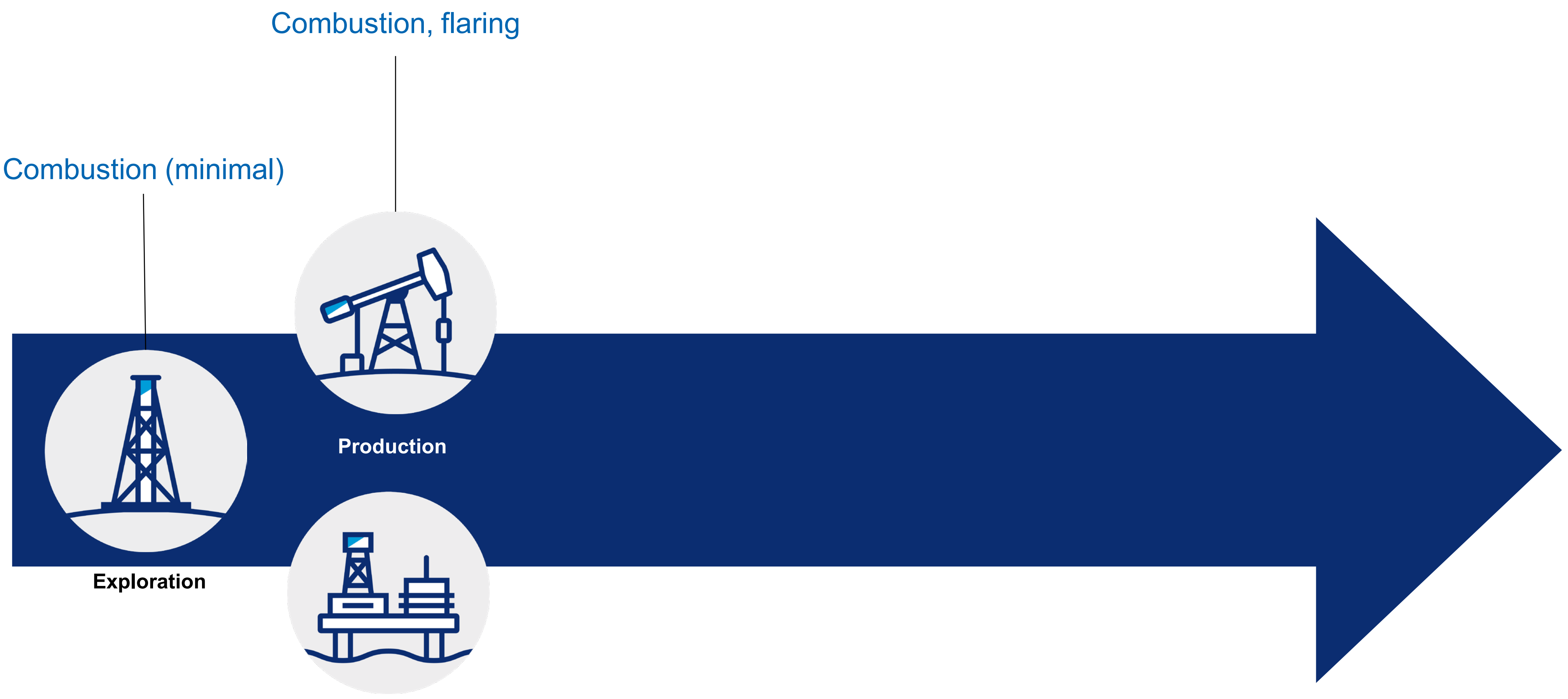
2004

Source: GHG Protocol, API, IPIECA, Chevron

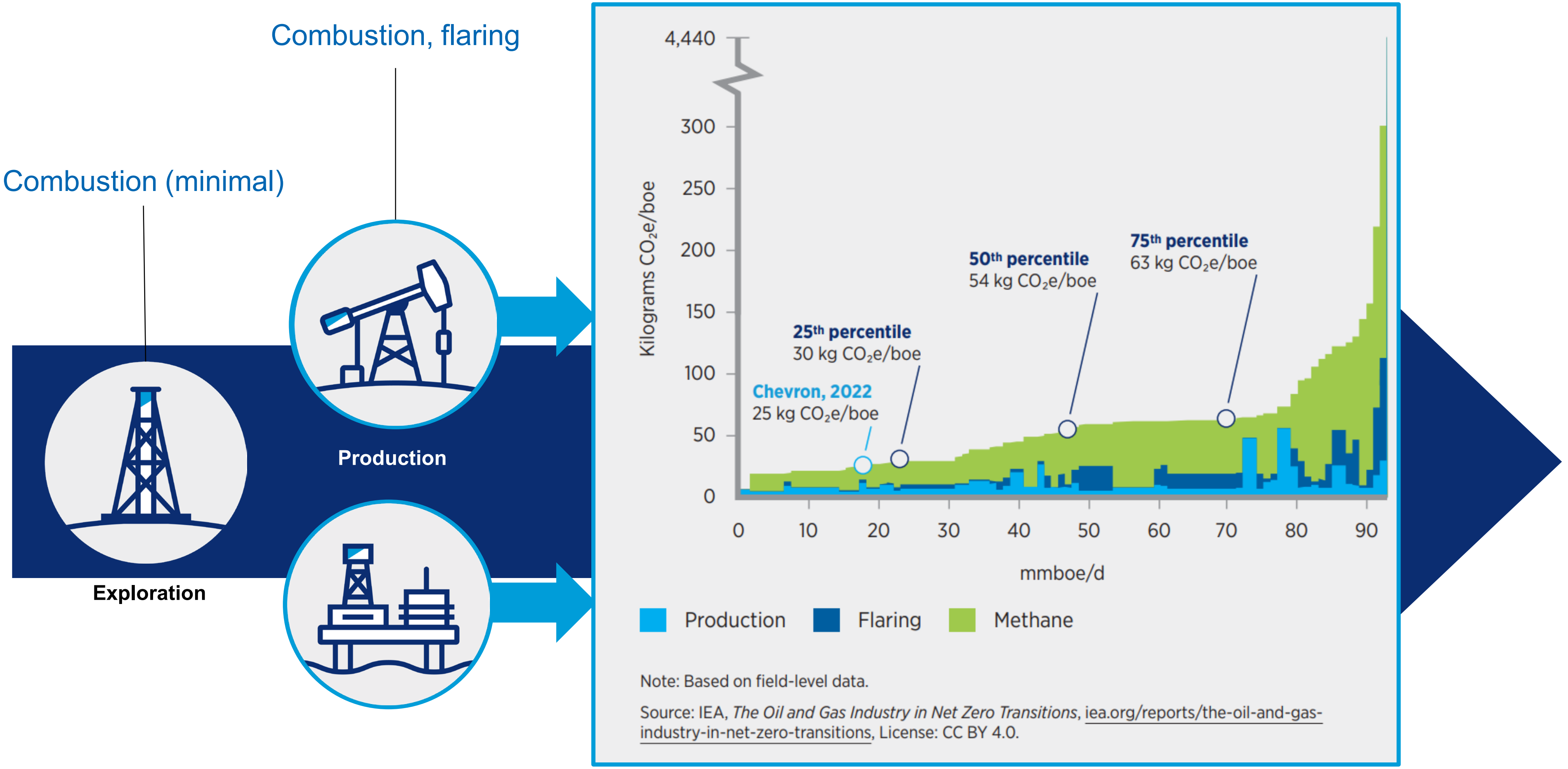
Chevron

Oil and gas emissions are predominantly from combustion, flaring, process and venting, and fugitives

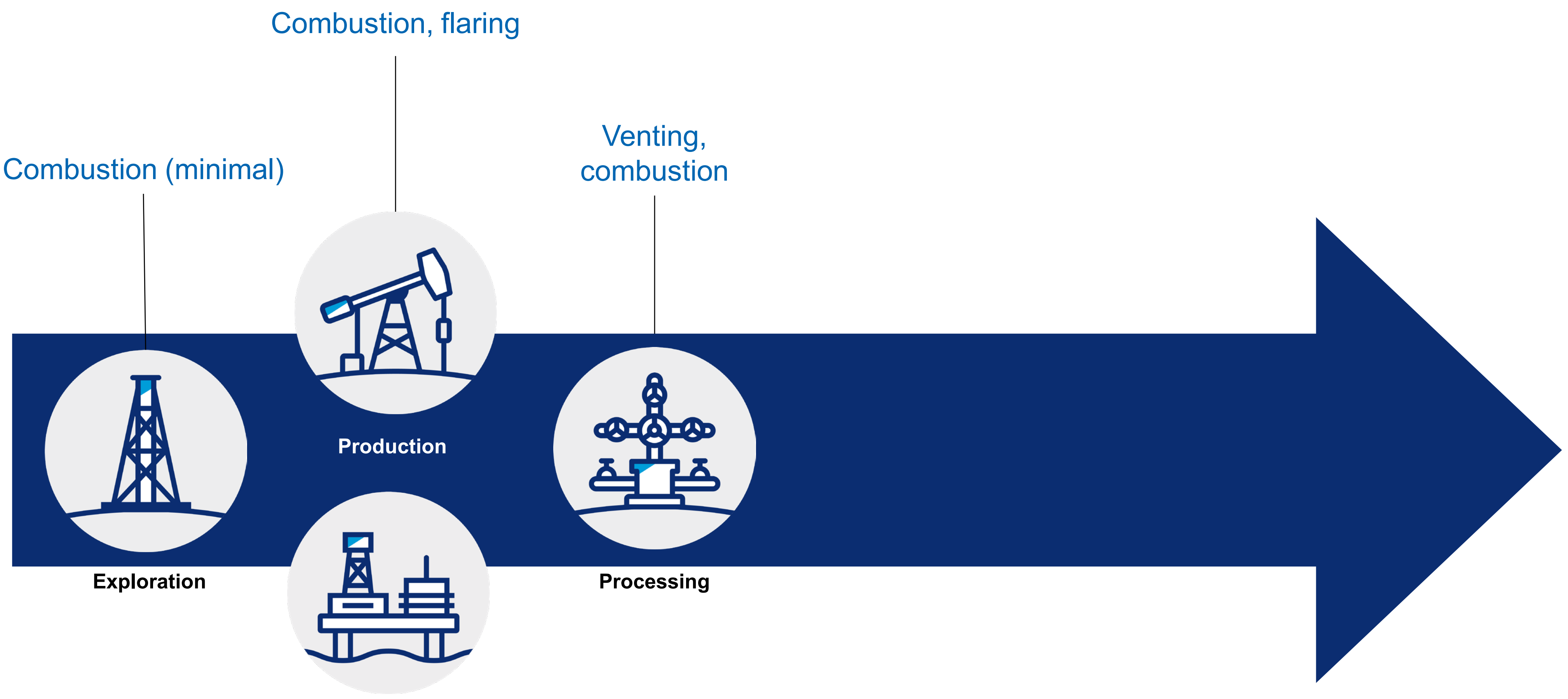
Oil and gas emissions are predominantly from combustion, flaring, process and venting, and fugitives



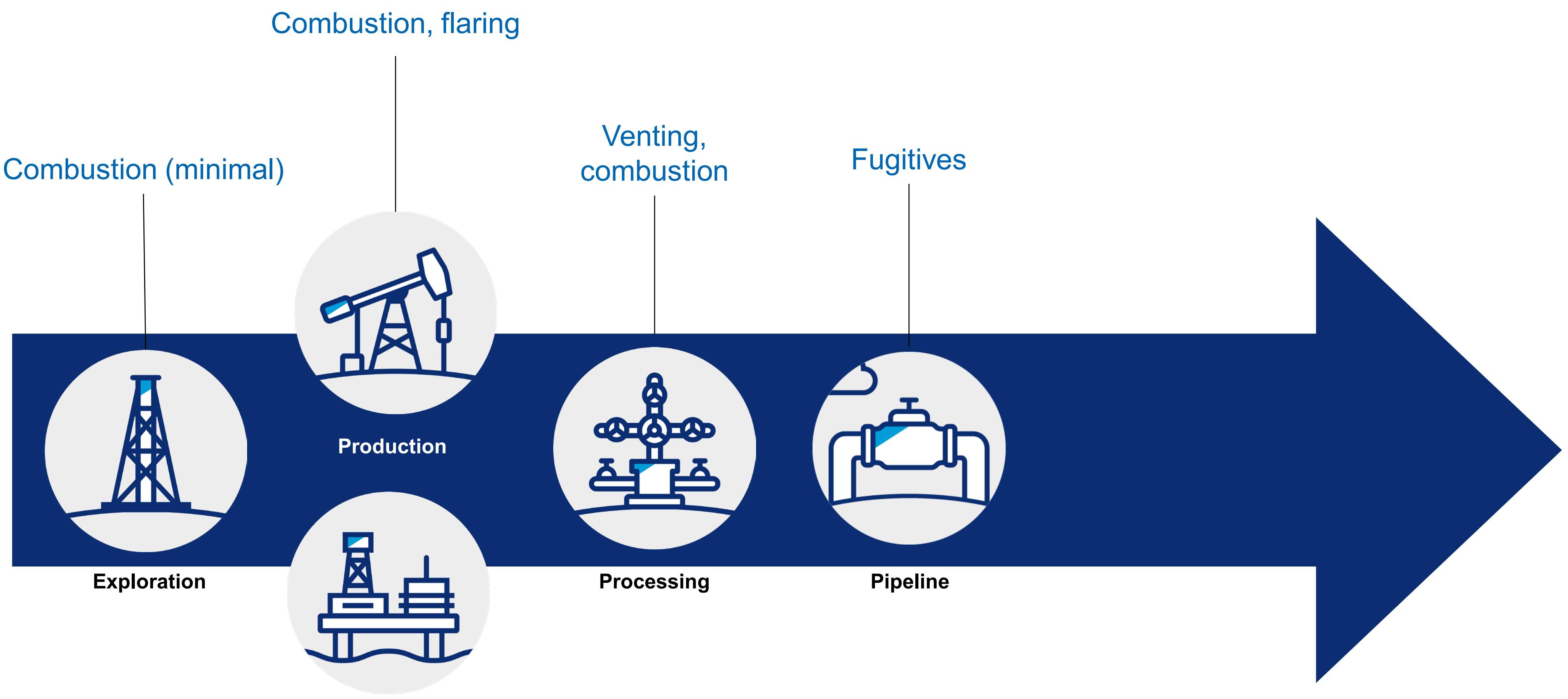
Oil and gas emissions are predominantly from combustion, flaring, process and venting, and fugitives



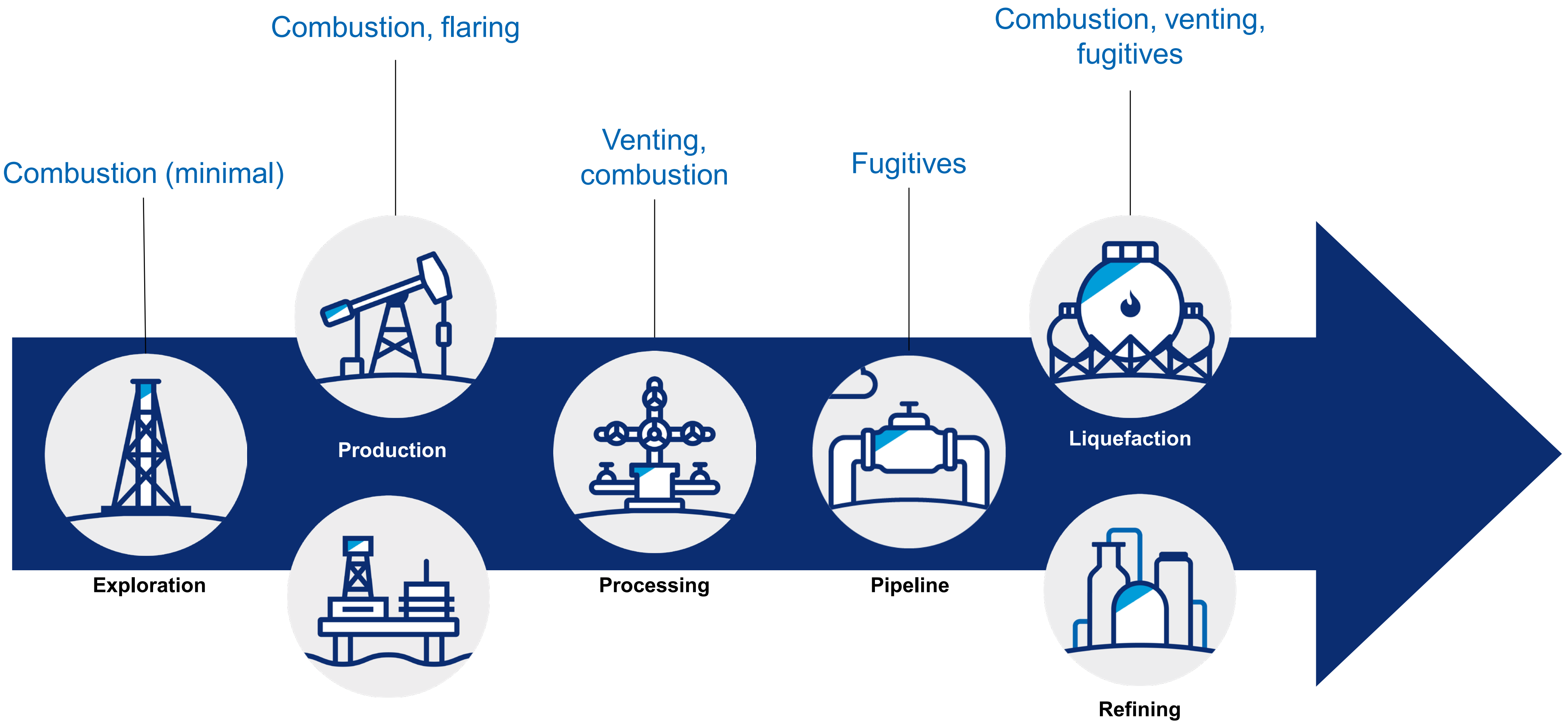
Oil and gas emissions are predominantly from combustion, flaring, process and venting, and fugitives



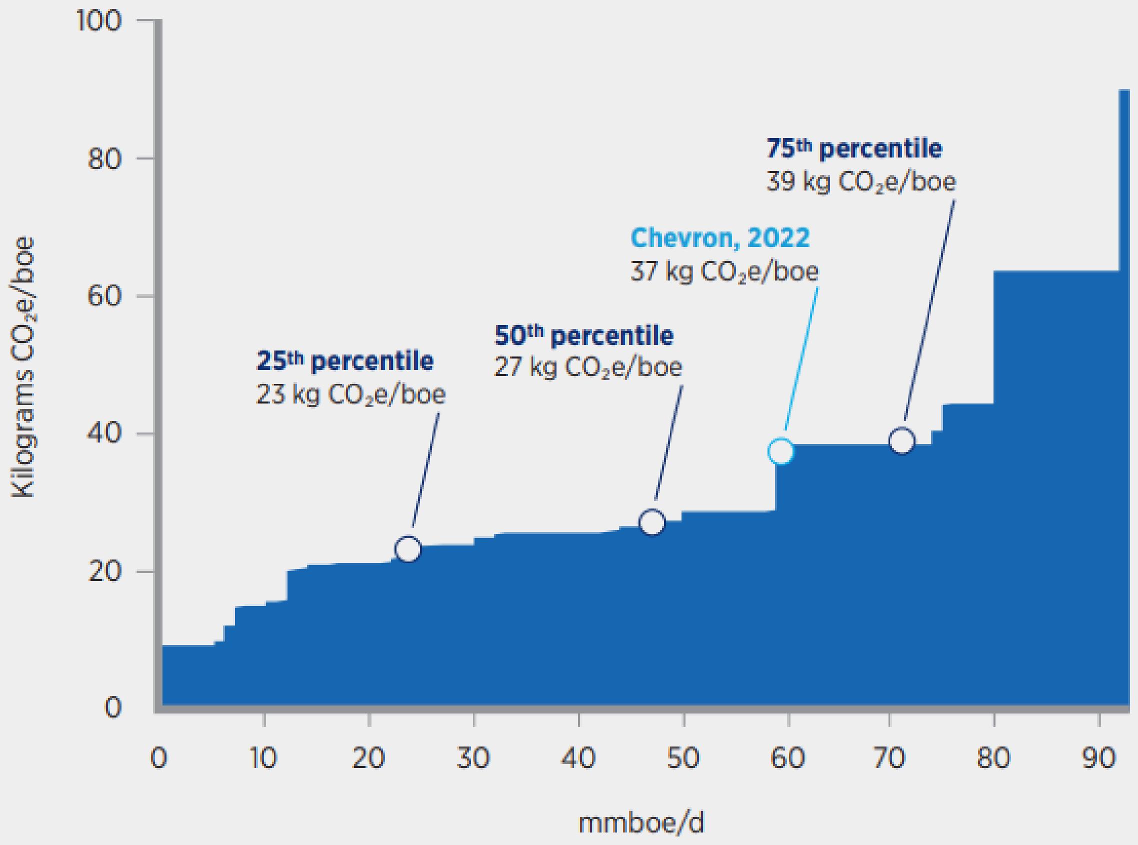
Oil and gas emissions are predominantly from combustion, flaring, process and venting, and fugitives



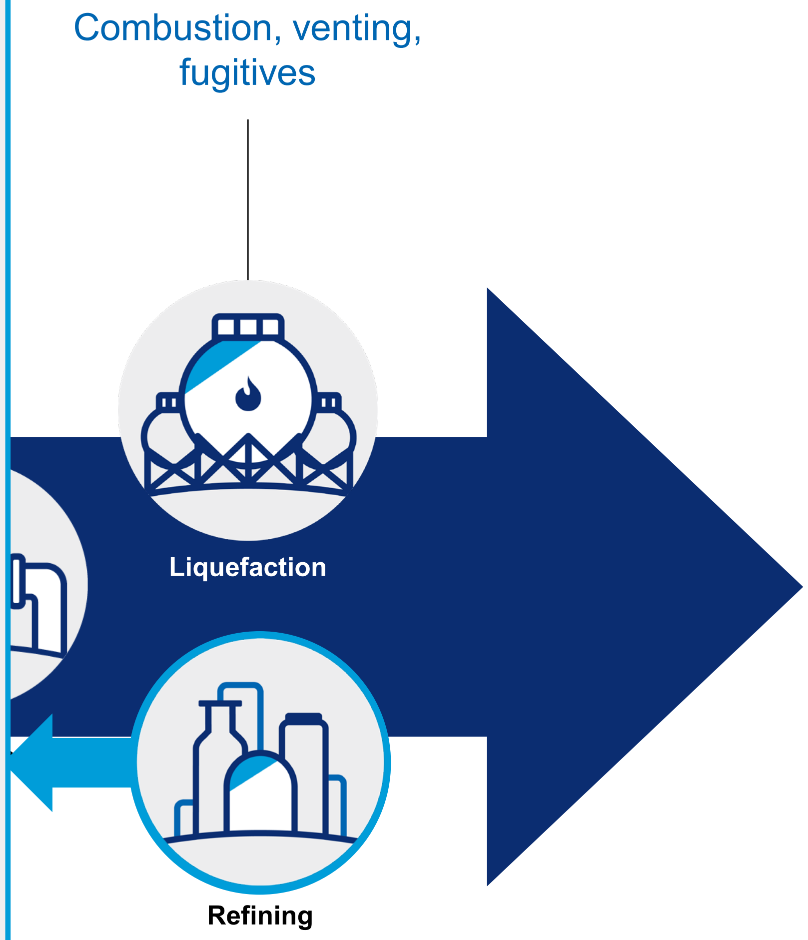
Oil and gas emissions are predominantly from combustion, flaring, process and venting, and fugitives



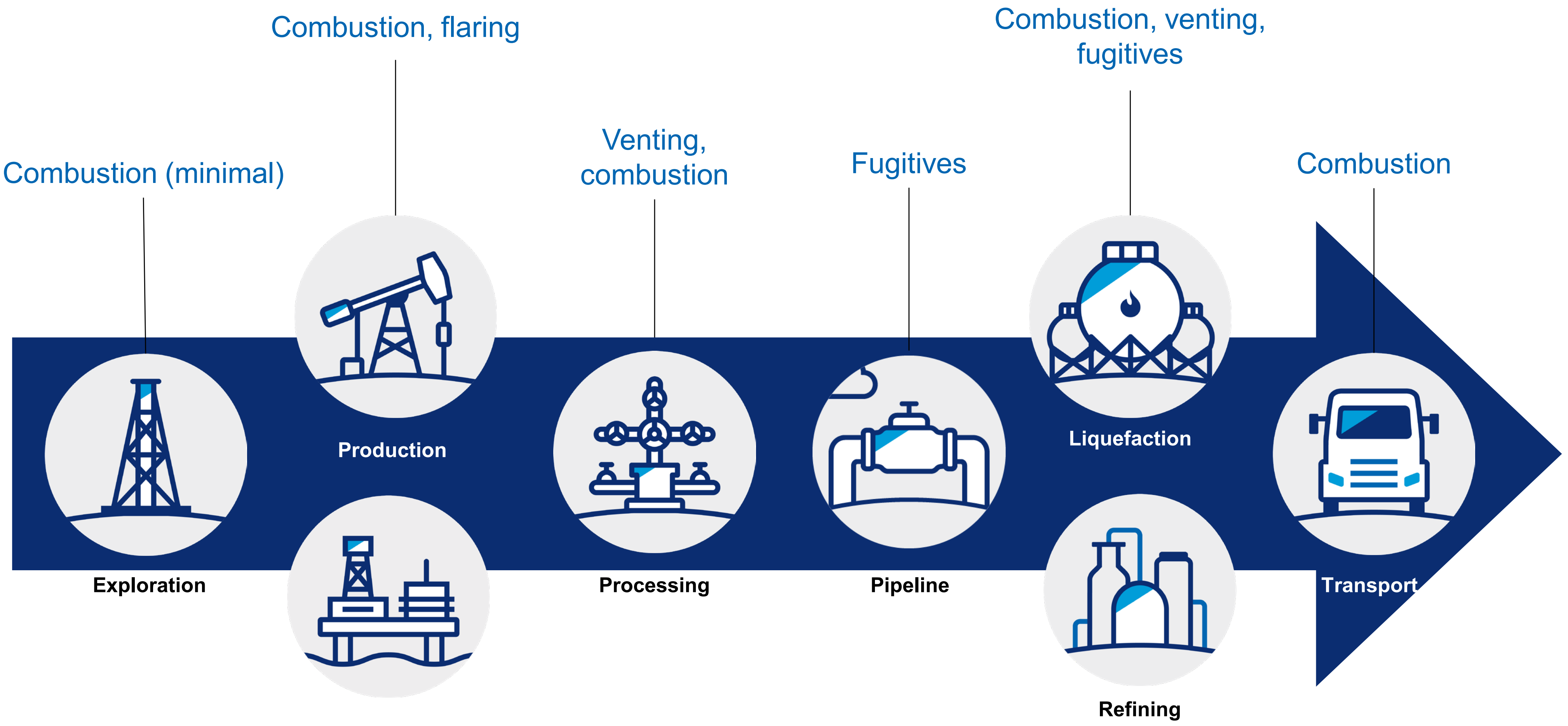
Oil and gas emissions are predominantly from combustion, flaring, process and venting, and fugitives



Source: IEA, *The Oil and Gas Industry in Net Zero Transitions*, iea.org/reports/the-oil-and-gas-industry-in-net-zero-transitions, License: CC BY 4.0.



Oil and gas emissions are predominantly from combustion, flaring, process and venting, and fugitives



Calculation approaches vary by emission source

Emission sources	Activity data	Calculation approach	Uncertainty
Combustion ~72%	Fuel consumption & composition (when available)	Site-specific or published emission factors, engineering calculations, periodic monitoring	Low
Process & Venting ~17%	Number of events, unique properties of equipment	Site-specific or published emission factors	Low to medium
Flaring ~10%	Fuel consumption & composition (when available)	Site-specific or published emission factors, engineering calculations	Low to medium
Fugitives ~1%	Count of equipment or detection data	Published emission factors or periodic monitoring	Medium to high

Source: Chevron direct emissions, 2022; Chevron analysis

Moving down the data hierarchy can reduce uncertainty for sources with more variability

Activity data (usually metered) x

Data approach	Example
Published emission factors	Transport fuel use Fugitives
Equipment manufacturer emission factors	Generator combustion
Engineering Calculations	Process venting
Monitoring over a range of conditions and deriving emission factors	Flaring
Periodic monitoring of emissions or parameters	Crude unit combustion
Continuous emissions* or parameters monitoring	FCC process emissions

For sources with more variability

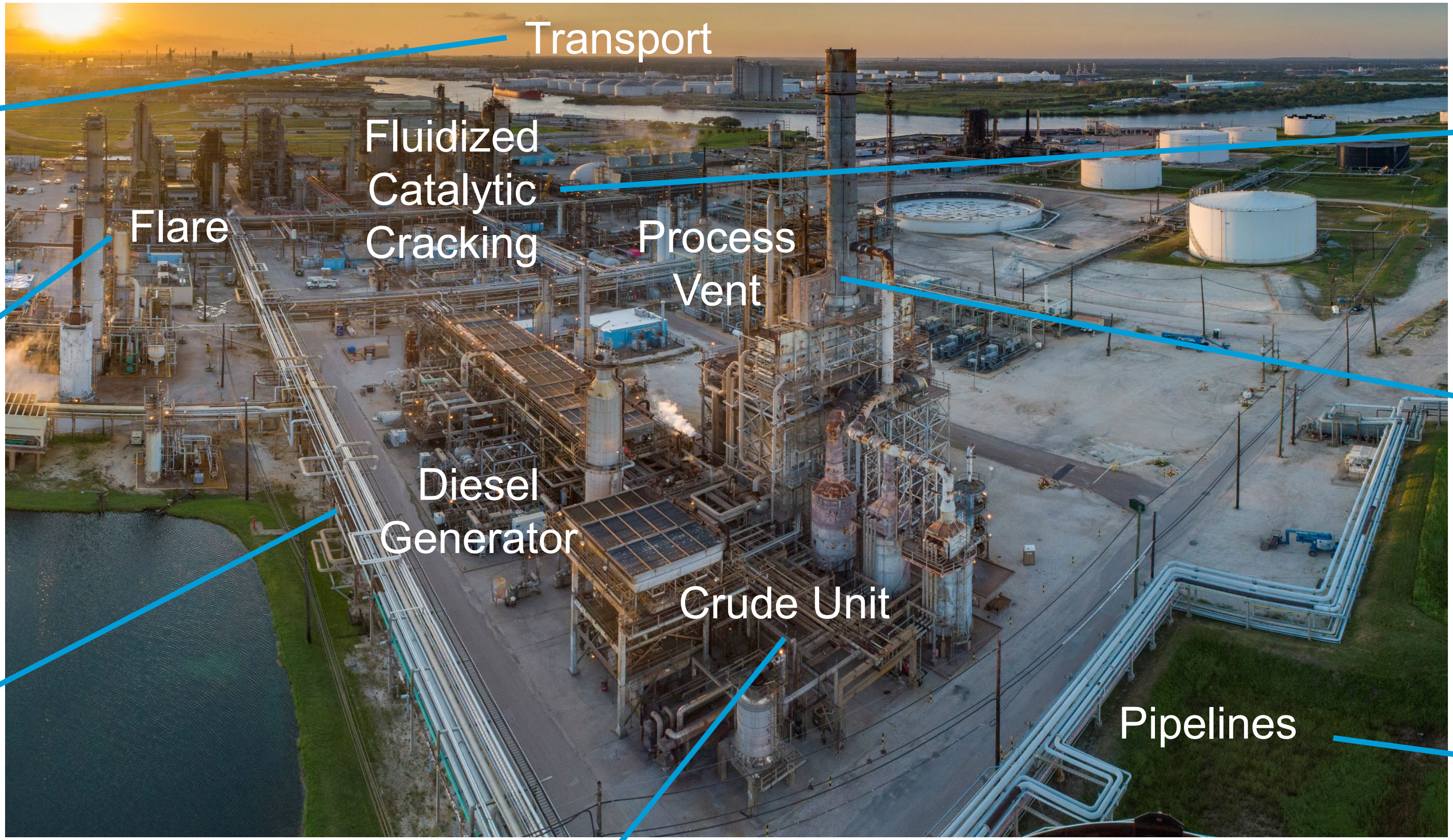
Improved accuracy

* Continuous emissions monitoring may not be directly applicable to certain greenhouse gases or to all emission sources.

Source: Ipieca

Calculations can vary by source, even within the same facility

Pasadena Refinery



Combustion
Fuel consumption
for ships/rail/trucks
x
published
emissions factor

Flaring
Gas meter
x
gas composition from
monitoring

Combustion
Fuel consumption
x
equipment
manufacturer
emissions factor

Source: Chevron

Combustion
Gas meter
x
gas composition from monitoring

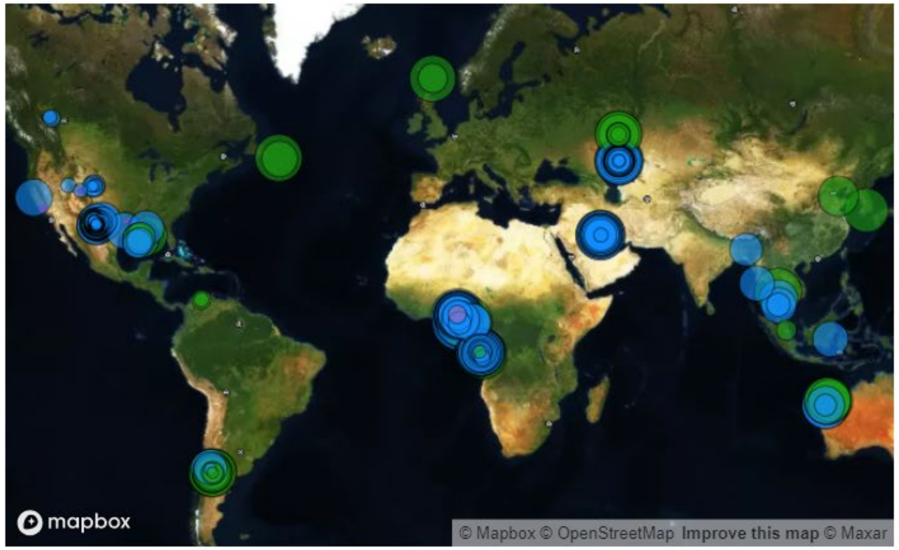
Process
Gas meter
x
continuous emissions
monitoring

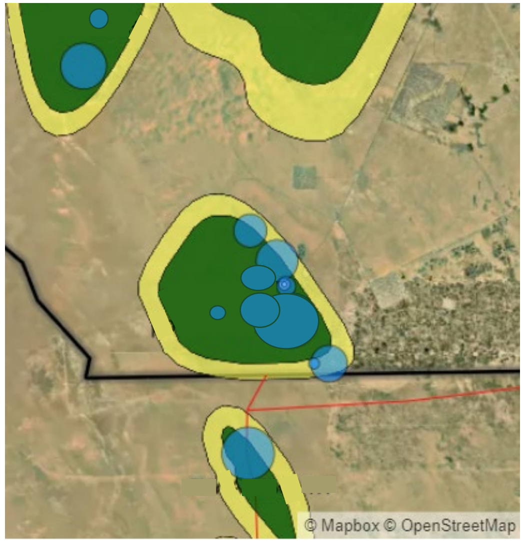
Venting
Gas meter
x
gas composition from
engineering calculations

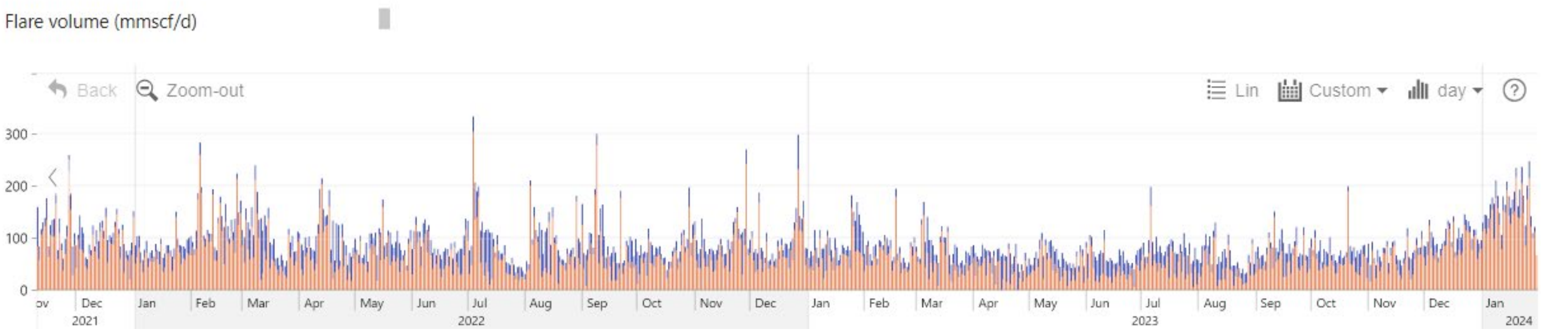
Fugitives
Equipment count
x
emissions factor
or methane detection

Newer technologies can help improve emissions detection

Sample company Capterio global flaring map

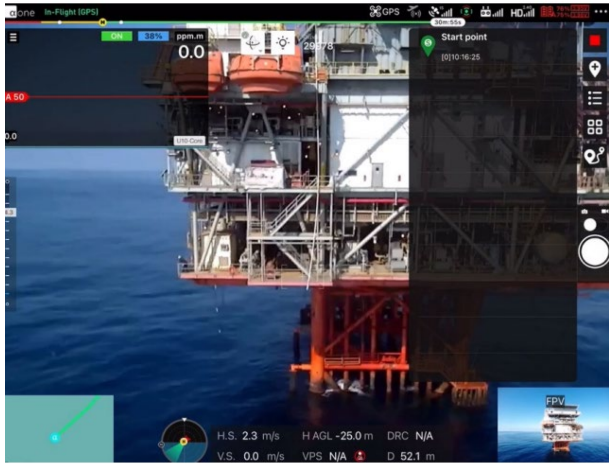


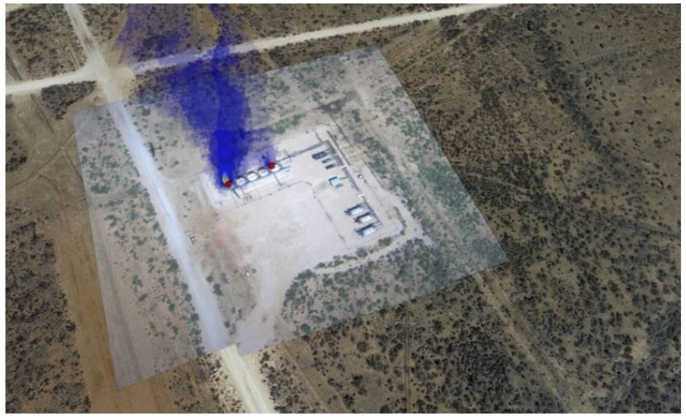




Source: Capterio

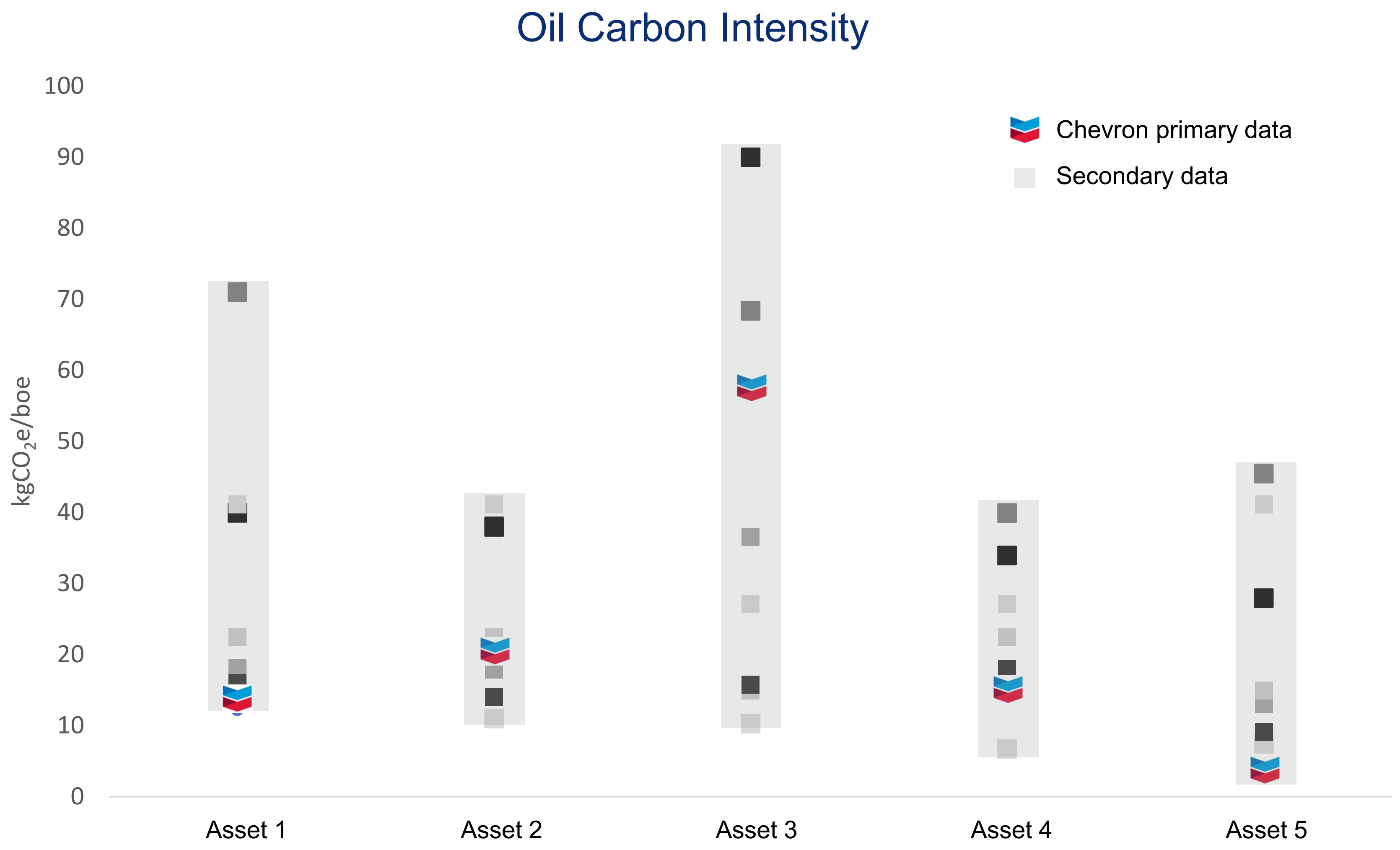
Different technologies have varying benefits and limitations





Source: Chevron Methane Report, 2022

Primary data is needed for increased accuracy



Sources: Chevron analysis, Chevron Climate Change Resilience Report, 2023

appendix

Improving detection to prevent methane detections

Source: Chevron Methane Report, 2022

Advanced detection technologies can help reduce uncertainty

technology type*	capability	benefits	current challenges	example operations
satellites	• Detection thresholds range from 25,000 kg/hr to 100 kg/hr • Monthly to daily global coverage	• Potential to be the lowest-cost option by site • Helpful in identifying super-emitters	• Detection thresholds are high and restrict detection to very large sources • Limited in producing facility-scale resolution • Does not work on cloudy days • Struggles with detection over water and identifying the emitter with multiple operators nearby • Needs accurate local wind data for quantification	Block 0/14, Angola Eastern Mediterranean, Israel El Trapial, Argentina Gorgon and Wheatstone LNG, AU Tengizchevroil, Kazakhstan
aircraft	• Detection thresholds range from 50 kg/hr to less than 3 kg/hr • Scale of hundreds of sites per day	• Leading service providers can likely capture most facility emissions	• Not all technologies provide specific source or emission size information, meaning additional detection is needed to identify the source	Denver-Julesburg Basin, U.S. Permian Basin, U.S. Vaca Muerta, Argentina Gulf of Mexico, U.S.

Source: Chevron Methane Report, 2022

Advanced detection technologies can help reduce uncertainty

facility-scale periodic monitoring (drone or mobile lab)	• Detection limits of less than 1 kg/hr are possible with the right wind conditions and site access • Scale of tens of sites per day in onshore applications	• Ability to scan an entire site, including areas that would otherwise be difficult to reach with handheld devices	• Field application requires individual site visits and travel time between sites or platforms • Challenges near electrical power lines and near airports for drones • Weight of the emissions sensors can reduce battery life and limit flight time for drones	Denver-Julesburg Basin, U.S. Gulf of Mexico, U.S. Permian Basin, U.S. Block 0/14, Angola Gorgon and Wheatstone LNG, AU
facility-scale near-continuous monitoring (fixed cameras, sensors, etc.)	• Detection limits vary with the sensor placement and wind conditions and range from 25 kg/hr to less than 1 kg/hr • Equipment is fixed at one site or location	• Potential for 24/7 site coverage • Could have uses beyond methane detection • May provide information on the duration of intermittent sources	• Research and development is needed to scale this approach • Generally need precise wind data to interpret detection results	Denver-Julesburg Basin, U.S. Permian Basin, U.S. Tengizchevroil, Kazakhstan

Source: Chevron Methane Report, 2022

Advanced detection technologies can help reduce uncertainty

manual leak detection (handheld screening like OGI and EPA Method 21)	• Detection limits vary based on environmental and human factors but are generally characterized at less than 1 kg/hr • Scale of a few sites per day	• Ability to identify exact location of a source of emissions • Third-party services available in locations with regulatory programs • Potential to incorporate into emissions reporting for fugitive components • Current industry and regulatory approach	• Labor intensive • Travel time between sites • Human and site factors impact results • Does not quantify emissions • Can be difficult to reach elevated sources with handheld detection tools	Block 0/14, Angola Denver-Julesburg Basin, U.S. Eastern Mediterranean, Israel Gorgon and Wheatstone LNG, AU Gulf of Mexico, U.S. Permian Basin, U.S. San Joaquin Valley, U.S. Tengizchevroil, Kazakhstan El Trapial, Argentina

Source: Chevron Methane Report, 2022