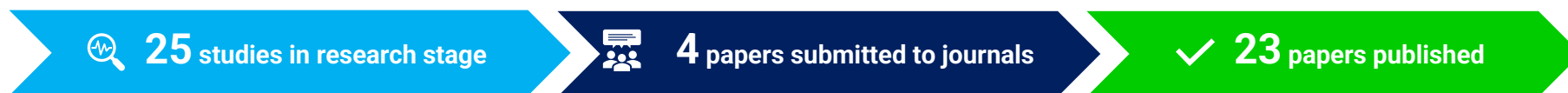


International Methane Emissions Observatory (IMEO)

Published & Ongoing Coordinated Scientific Studies on Methane



Dashboard summary as of Feb 1, 2024 across all sectors.

Jump to Sector: [Oil & Gas](#) | [Coal](#) | [Waste](#) | [Multi-Sector](#)

OIL & GAS SECTOR

PROJECT	PAPERS <i>Progress</i>	STATUS	KEY FINDINGS
<p>QUANTIFICATION OF EMISSIONS FROM FLOATING PRODUCTION STORAGE OFFLOADING SITE</p> <p>Location: Europe <i>University of York, UK</i></p> <p>Rationale This work will compare methane emission quantifications of a Floating Production Storage and Offloading (FPSO) site at Glen Lyon, Shetland using aerial, drone and bottom-up quantification methods. There is currently no directly quantified emission data for FPSO's and there is also a lack of</p>	<p><i>Project initiation ongoing</i></p>	<p>PROJECT INITIATION</p>	

<p>multi-scale offshore measurements in the literature from O&G facilities.</p>			
<p>FEASIBILITY ANALYSIS FOR IMEO DEDICATED HELICOPTER TOWED SENSOR PLATFORM Location: Global <i>Technical University of Braunschweig, Germany</i></p> <p>Rationale The project will determine the technical, logistical, and financial feasibility of constructing and operating an aerial methane monitoring platform dedicated for IMEO measurement campaigns. The platform will be designed to address the existing challenges of long lead times for scientifically instrumented aircraft as well as securing permits for operating such aircraft in international airspace.</p>	<p><i>Project initiation ongoing</i></p>	<p>PROJECT INITIATION</p>	
<p>SATELLITE-BASED DETECTION AND QUANTIFICATION OF OFFSHORE PLUMES Location: Global <i>València Polytechnic University, Spain</i></p> <p>Rationale The study aims to facilitate the implementation of offshore plume detection methods for operational exploitation in IMEO's Methane Alert and Response System (MARS). Component 1 of MARS only considers land surfaces now. However, data processing remains highly manual and there are knowledge gaps regarding the potential and limitation of satellite observations for offshore methane mapping.</p>	<p><i>Project initiation ongoing</i></p>	<p>PROJECT INITIATION</p>	

<p>MULTI-SCALE MEASUREMENTS OF OIL & GAS PRODUCTION IN COLOMBIA Location: Colombia <i>Carleton University, Canada</i></p> <p>Rationale There are few, if any, empirically based estimates of methane emissions from South American oil and gas producing countries. This study will combine measurements at regional, site and source level to characterize emissions from oil and gas production in Colombia.</p>	<p><i>Project initiation ongoing</i></p>	<p>PROJECT INITIATION</p>	
<p>PERMIAN BASIN SYNTHESIS STUDY Location: United States <i>Environmental Defense Fund, US</i></p> <p>Rationale There are more data characterizing emissions from the Permian Basin in the US than any other O&G producing basin the world. The goal of this project is to synthesize as much of the multiscale data collected to date as is possible to provide a comprehensive assessment of emissions from the largest oilfield in the US.</p>	<p><i>Data analysis ongoing</i></p>	<p>DATA ANALYSIS ONGOING</p>	
<p>OGMP 2.0 LEVEL 5 FEASIBILITY CASE STUDIES Location: Global <i>Queen Mary University of London, UK</i></p> <p>Rationale This study is an analysis to develop strategies to help companies meeting OGMP 2.0 Level 5, which requires the reconciliation of source- and site-level data.</p>	<p><i>Project initiation ongoing</i></p>	<p>PROJECT INITIATION</p>	

<p>TOP-DOWN & BOTTOM-UP RECONCILIATION STUDY Location: Global <i>University of Texas at Austin, US</i></p> <p>Rationale This work will support further development and implementation of the Oil and Gas Methane Partnership (OGMP 2.0) by performing reconciliation of source and site-level data globally.</p>	<p><i>Analysis of data from field measurement campaigns has started.</i></p>	<p>DATA ANALYSIS ONGOING</p>	
<p>GLOBAL ANALYSIS OF EMISSIONS FROM ABANDONED WELLS Location: Global <i>McGill University, Canada</i></p> <p>Rationale Globally, there are millions of abandoned oil and gas wells but the number of abandoned wells at the global scale has not been estimated. Currently, only a very small number of measurements exist outside North America. This work will add much needed data from other parts of the world as well as reconciling the current data to attempt to understand the conditions that are likely to lead to high emitting abandoned oil and gas wells.</p>	<p><i>Field measurements campaigns are planned with some already ongoing for several locations in EU and additional measurements expected in South America.</i></p>	<p>MEASUREMENT CAMPAIGN ONGOING</p>	

<p>LNG RECONCILIATION STUDY Location: Australia <i>National Physical Laboratory, UK</i></p> <p>Rationale This study attempts to reconcile emissions estimates obtained from two independent measurement approaches at two LNG liquefaction plants located in Australia. The reconciliation will explore the agreement between source- and site-level measurements and whether the source-level approaches sufficiently represent all sources of emissions within the LNG facilities after accounting for the uncertainties in both approaches.</p>	<p><i>Data from aerial surveys is being reconciled with on-site activity data and bespoke emission factors derived from previous measurements.</i></p>	<p>DATA ANALYSIS ONGOING</p>	
<p>CHARACTERIZATION OF LNG FACILITIES IN AUSTRALIA Location: Australia <i>Airborne Research Australia, Australia</i></p> <p>Rationale This study aims to conduct facility-level airborne measurements of all onshore LNG liquefaction facilities in Australia. Multiple measurement-based quantifications at each facility will derive emission estimates under a range of operating conditions. The results will improve knowledge of industry-wide emissions and emission intensities and identify common factors behind variations in emissions performance.</p>	<p><i>Measurements ongoing. Western Australia measurements completed in May 2023. Northern and Eastern Australia measurements will take place in 2024.</i></p>	<p>MEASUREMENT CAMPAIGN ONGOING</p>	

<p>NORD STREAM GAS LEAKS SYNTHESIS Location: Europe <i>IMEO</i></p> <p>Rationale The goal of the work is to compile and reconcile reported emissions estimates from the Nord Stream pipeline leaks to derive a plausible range of emissions estimates from the incident. The synthesis will showcase the different measurement approaches that are available for quantifying emissions from similar events and explain and contextualize the emission reported to a wider scientific audience.</p>	<p>Synthesis of emissions estimates undertaken throughout 2023.</p>	<p>SUBMITTED TO JOURNAL</p>	
<p>AIRBORNE MEASUREMENTS FROM THE NORD STREAM GAS LEAKS Location: Europe <i>German Aerospace Center (DLR), Germany</i></p> <p>Rationale The goal of this work is to quantify the short-lived methane emissions occurring shortly after, and directly near, the Nord Stream leak sites.</p>	<p>Rapid-response airborne campaign conducted early October 2022 in the vicinity of the gas leak sites.</p> <p>Paper has been submitted to journal for publication.</p>	<p>SUBMITTED TO JOURNAL</p>	
<p>MEASUREMENT CAMPAIGN IN AZERBAIJAN Location: Azerbaijan <i>German Aerospace Center (DLR), Germany Environmental Defense Fund, US</i></p> <p>Rationale</p>	<p><i>Project scoping phase.</i></p>	<p>PROJECT SCOPING</p>	

<p>There is currently no independent empirical data to derive representative emission estimates of oil and gas sources from former Soviet Union states apart from a limited number of point sources. A local study in Azerbaijan would be the first to derive such estimates.</p>			
<p>TOP-DOWN MEASUREMENT & ROOT CAUSE ANALYSIS OF EMISSIONS IN BRITISH COLUMBIA Location: Canada <i>Carleton University, Canada</i></p> <p>Rationale The goal of this project is to establish robust procedures for producing quantitative, measurement-based methane inventories backed by robust uncertainty analysis, while supporting development of comprehensive MRV protocols. This study is being undertaken in close collaboration with the government of British Columbia (BC), Canada to produce a measurement-based oil and gas sector methane inventory and perform root cause analysis.</p>	<p><i>Project started in January 2023. Conversations are ongoing with the BC government.</i></p>	<p>RESEARCH ONGOING</p>	
<p>OFFSHORE MEASUREMENT STUDY IN ANGOLA & GABON Location: Angola; Gabon <i>German Aerospace Center (DLR), Germany</i></p> <p>Rationale This offshore O&G methane study focuses on Angola with potential additional measurements in Congo and/or Gabon and is led by DLR in cooperation with the National Agency of Oil, Gas and Biofuels. The region is home to substantial O&G production by both national and international oil companies and has been identified as a flaring hotspot.</p>	<p><i>Field measurement campaign was completed in September 2022. Data analysis ongoing.</i></p>	<p>DATA ANALYSIS ONGOING</p>	

<p>VALIDATION OF METHANE QUANTIFICATION TECHNOLOGIES Location: France <i>Stanford University, US</i></p> <p>Rationale Accurate quantification of methane emissions is crucial for both tracking mitigation and to inform regulatory decision making. Therefore, methodologies claiming to quantify methane emissions require independent and rigorous validation – which this study will provide – to give confidence and reassurance that accurate reporting of emissions through measurement is viable.</p>	<p><i>Project initiation ongoing.</i> The field campaign is expected to last for four weeks with 2 weeks in June 2024 and 2 weeks in September 2024. Participants will be from a range of academic and commercial organisation and will test a range of methods from static ground-based sensors to satellites</p>	<p>PROJECT INITIATION</p>	
<p>VALIDATION OF SATELLITE AND MOBILE MEASUREMENT APPROACHES THROUGH A CONTROLLED RELEASE IN US Location: United States <i>Stanford University, US</i></p> <p>Rationale Validation of satellite-based quantification approaches will be key to support development of an ultra-emitters response system. This controlled release campaign will follow existing protocols with several planned improvements in metering accuracy, wind speed measurement, and gas composition analysis. These should allow more thorough characterization and reduction of uncertainties in ground release volumes.</p>	<p><i>Project initiation ongoing.</i></p>	<p>PROJECT INITIATION</p>	

<p>MEASUREMENTS OF LNG FACILITIES Location: Global <i>National Physical Laboratory, UK</i></p> <p>Rationale There is significant uncertainty in terms of methane emissions from LNG facilities (liquefaction, regasification, and shipping) with no empirical measurements publicly available.</p>	<p>Comparative assessment using DIAL technique (Innocenti et al., 2023)</p>	<p>PUBLISHED</p>	<p>Large leaks and large non-continuous sources measured demonstrate continuing need for full site surveying for leak detection, maintenance and repair processes to minimize emissions.</p>
<p>TROPOMI-BASED QUANTIFICATION OF REGIONAL EMISSIONS Location: Algeria, Venezuela <i>Netherlands Institute for Space Research, Netherlands</i></p> <p>Rationale There is significant uncertainty regarding methane emissions from several high-producing regions where TROPOMI can be utilized to quantify regional emissions.</p>	<p>Algeria (Naus et al., 2023)</p>	<p>PUBLISHED</p>	<p>The study looks at the importance of point sources in relationship to total emissions. Top-down analysis indicates that a larger fraction of Algeria's methane emissions come from oil production than national reporting suggests. Roughly a quarter and half of emissions are due to super-emitters in the Hassi R'Mel and Hassi Messaoud basins, respectively.</p>
	<p>Venezuela</p>	<p>JOURNAL SUBMITTED</p>	
<p>EMISSIONS FROM OFFSHORE PRODUCTION IN THE US GULF OF MEXICO Location: United States <i>University of Michigan, US</i></p> <p>Rationale There are few to no empirical-based estimates of methane emissions from oil and gas offshore infrastructure. This study, undertaken in the US, is the first to provide offshore emissions assessment via direct measurement.</p>	<p>Methods paper on ship-based measurements (Yacovitch et al., 2020)</p>	<p>PUBLISHED</p>	<p>Highlights important differences in emissions between shallow and deep-water production infrastructure, and the presence of super-emitters.</p>
	<p>Airborne-based measurements (Gorchov Negron et al., 2020)</p>	<p>PUBLISHED</p>	<p>Highlights important differences in emissions between shallow and deep-water production infrastructure, and the presence of super-emitters. The study's inventory reports emissions higher by a factor of 2 than the Environmental Protection Agency Greenhouse Gas Inventory (GHGI) with regional airborne estimates.</p>

<p>NORTH SEA OFFSHORE EMISSIONS: NORWAY Location: Norway <i>Royal Holloway and Bedford New College, UK</i> <i>University of Manchester, UK</i></p> <p>Rationale There are few empirical-based estimates of methane emissions from international oil and gas offshore infrastructure. This project will help in characterizing emissions from different offshore production regions in the North Sea. Norway is a major European O&G producer accounting for about 45% of European (EU+UK+Norway) oil and natural gas production over the past decade, with that share of production increasing.</p>	<p>Norwegian infrastructure (Foulds et al., 2022)</p>	<p>PUBLISHED</p>	<p>Offshore facility-level emissions can vary substantially over time, sufficiently large and representative sampling is needed for meaningful comparisons with reported emissions, which is relevant for OGMP2.0. The measurements are in good agreement with O&G operator reports, but >40% larger than a widely cited globally gridded fossil fuel methane emission inventory based on UNFCCC country-level reports.</p>
<p>NORTH SEA OFFSHORE EMISSIONS: UK & NETHERLANDS Location: UK, Netherlands <i>German Aerospace Center (DLR), Germany</i> <i>University of York, UK</i> <i>British Antarctic Survey, UK</i> <i>University of Cambridge, UK</i></p> <p>Rationale There are few empirical-based estimates of methane emissions from international oil and gas offshore infrastructure. This project will help in characterizing emissions from different offshore production regions in the North Sea. In addition to the Gulf of Mexico and Norway studies, data will be collected on British and Dutch oil and gas infrastructure across the North Sea.</p>	<p>Methods paper (France et al., 2021)</p>	<p>PUBLISHED</p>	<p>Describes potential pitfalls in offshore surveying. Makes recommendations to improve future offshore studies in North Sea-like environments. Focus: complex meteorology of marine boundary layer, discrete plumes from airborne platform.</p>
	<p>Flaring efficiencies (Shaw et al., 2023)</p>	<p>PUBLISHED</p>	<p>First aircraft-based measurements of gas flaring combustion efficiency in an offshore O&G production area. Median combustion efficiency of 98.4% was close to industry and government assumptions that flares are 98% efficient.</p>
	<p>Southern North Sea (British & Dutch facilities) (Pühl et al., 2024)</p>	<p>PUBLISHED</p>	<p>Demonstrates general agreement between measurements and operator reports. Snap-shot emission measurements show large discrepancies when scaled to compare to annualized bottom-up inventories, demonstrating the need for Levels 4 and 5 OGMP 2.0 reporting.</p>

<p>LOCAL DISTRIBUTION STUDIES Location: Netherlands; Germany; France; UK; Canada <i>Technical University of Munich, Germany</i> <i>Autonomous University of Barcelona, Spain</i> <i>University of Toronto, Canada</i> <i>University of Groningen, Netherlands</i> <i>Université de Versailles Saint-Quentin-en-Yvelines, France</i> <i>Environment and Climate Change Canada, Canada</i></p> <p>Rationale There is significant interest in characterizing emissions from local distribution systems in Europe and comparing them to emissions from US cities (Toronto was also characterized as a point of comparison between North American and European cities). This set of studies also incorporates measurements of midstream facilities near sampling regions.</p>	Utrecht (NL) & Hamburg (DE) (Maazallahi et al., 2020)	PUBLISHED	Local distribution emissions are important in the EU as they are a major source of non-imported O&G methane emissions. Little independent data exist from local distribution in the EU. A few large leaks are responsible for a significant proportion of natural gas related methane emissions.
	Paris (FR) (Defratkya et al., 2021)	PUBLISHED	Evidence of methane leaks that can be mitigated. Suggested efforts to reduce street-level CH4 emissions to focus on natural gas distribution network, sewage system, and furnaces.
	Toronto (Canada, for point of comparison) (Ars et al., 2020)	PUBLISHED	The waste sector is the largest CH4 emitter in Toronto area. Engineered waterways (not currently in inventories) may be a significant source. Compressor stations and leaks from natural gas distribution network contribute to emissions, though more information/measurements are needed to fully characterize.
	Street-level emissions, Bucharest (Fernandez et al., 2022)	PUBLISHED	Demonstrates that not all methane leaks at ground level are gas distribution network infrastructure leaks. Large emissions also from the sewage network. Implications for measuring methane without also measuring co-emitted species for source identification – CH4 emissions may have been mis-categorized otherwise.
	Hamburg (DE) (Forstmaier et al., 2023)	PUBLISHED	In-building methane emissions (stoves, boilers) may be missed in mobile street-level measurements. Strong indications of a large biogenic source of methane in Hamburg, correlated with rising tide of river estuary. Addition of river emissions improved performance of the model.
	Synthesis, 12 cities, 8 countries (Vogel et al., 2024)	PUBLISHED	The study finds that all cities have a spectrum of small, medium, and large methane sources in their domain. The emission rates found follow a heavy-tailed distribution, and the top 10% of emitters account for 60–80% of total emissions, which



			<p>implies that strategic repair planning could help reduce emissions quickly. Furthermore, while cities with larger reported emissions were found to generally also have larger observed emissions, there are clear discrepancies between observation-based and inventory-based emission estimates for our 12 cities.</p>
	<p>London (UK) (Fernandez et al.)</p>	<p>JOURNAL SUBMITTED</p>	

<p>MULTI-SCALE MEASUREMENTS OF OIL & GAS PRODUCTION IN ROMANIA (ROMEO) Location: Romania <i>Utrecht University, Netherlands</i></p> <p>Rationale Prior versions of the National GHG Inventory showed Romania as the EU country with highest production-related emissions. A recent update to Romania's inventory has significantly reduced the emissions. This study included a coordinated campaign to integrate top-down (i.e., airborne-based) and bottom-up (i.e., ground-based mobile measurements) measurements in a country that relies on simple emission factors (IPCC Tier 1) to show the value of incorporating multiple measurement methods at different scales.</p>	<p>Isotopic signatures (Menoud et al., 2022)</p>	PUBLISHED	<p>Confirmed that O&G sources were top emissions in target regions. Average CH₄ isotopic signatures in Romania were found to be lower than global values commonly used for GHG emissions inventories, emphasizing importance of regional variation in CH₄ isotopes.</p>
	<p>Tracer gas dispersion method (Delre et al., 2022)</p>	PUBLISHED	<p>Both methane (CH₄) and ethane (C₂H₆) emissions factors (EFs) for Romania were calculated to be in the lower range of values in the literature (and ethane measurements were the lowest).</p>
	<p>Ground-based measurement, Southern Romania (Korbeň et al., 2022)</p>	PUBLISHED	<p>Qualitative screening data from more than 1,000 O&G sites shows that 65% emitted methane at detectable levels.</p>
	<p>Synthesized results, integrating all collected data (Stavropoulou et al., 2023)</p>	PUBLISHED	<p>Results suggest that O&G production infrastructure in Romania holds a massive mitigation potential, specifically by implementing measures to capture the gas and minimize operational venting and leaks. Results highlight the importance of the EU methane regulations (i.e., minimizing venting and frequent LDAR).</p>
<p>EMISSIONS FROM ONSHORE & OFFSHORE PRODUCTION IN MEXICO Location: Mexico <i>Environmental Defense Fund, US</i></p> <p>Rationale There is little available information characterizing the difference between onshore and offshore emission for a major oil and gas production country that relies on simple emission factors for its inventory. This study integrates</p>	<p>Integrated airborne-based & remote sensing (Zavala-Araiza et al., 2021)</p>	PUBLISHED	<p>This study integrated airborne-based measurements with remote sensing data (TROPOMI and VIIRS night-time flare data). The study found large discrepancies (more than an order of magnitude) in emission estimates, with offshore production being overestimated and onshore production being underestimated in current inventories.</p>

satellite and airborne monitoring to characterize emissions from these sources.			
---	--	--	--

COAL SECTOR

PROJECT	PAPERS Progress	STATUS	KEY FINDINGS
<p>AUSTRALIA BOWEN BASIN PILOT Location: Australia <i>Airborne Research Australia, Australia</i></p> <p>Rationale A satellite study identified high emissions from surface mines in the Bowen Basin. This pilot project was performed to determine the feasibility of the aircraft mass balance approach for estimating emissions from large surface mines.</p>	<p><i>Initial pilot measurement campaign took place in 2022, and a second phase of measurements took place in September 2023 as noted below within the project entitled "Verification of coal emissions with top-down data in Australia".</i></p>	<p>DATA ANALYSIS ONGOING</p>	
<p>INDIA ABANDONED COAL MINE STUDY Location: India <i>Indian Institute of Technology Bombay, India</i></p> <p>Rationale This project aims to refine the greenhouse gas emission inventory of the Indian coal mining sector by incorporating emissions from abandoned coal mines. Currently, there is no reliable dataset on the number of abandoned coal mines in India, which represents a major gap in the inventory processes.</p>	<p><i>Project initiation ongoing.</i></p>	<p>PROJECT INITIATION</p>	

<p>VERIFICATION OF COAL EMISSIONS WITH TOP-DOWN DATA IN AUSTRALIA</p> <p>Location: Australia <i>University of Bremen, Germany</i></p> <p>Rationale Satellite studies have shown coal mine methane emissions as higher than predicted by emission inventories. The accuracy of emissions estimates of methane emissions from both satellite and inventory methods has been questioned. In this project a comprehensive field campaign of over 1 month duration was instigated to better understand coal mine methane emissions from underground and surface mines. This was achieved through a dual aircraft approach. One aircraft performed mass balance measurements to define total mine emissions. A second aircraft performed remote sensing measurements to quantify individual point sources.</p>	<p><i>Measurement campaign completed in September 2023. Data analysis is ongoing.</i></p>	<p>DATA ANALYSIS ONGOING</p>	
---	---	-------------------------------------	--

<p>AERIAL & GROUND-BASED MEASUREMENTS OF COAL METHANE EMISSIONS IN POLAND Location: Poland <i>AGH University of Science and Technology, Poland</i> <i>German Aerospace Center (DLR), Germany</i> <i>Technical University of Munich, Germany</i> <i>Swiss Federal Laboratories for Materials Science & Technology, Switzerland</i></p> <p>Rationale Poland is recognized as a hotspot for methane in Europe. This hotspot is a result of extensive coal mining operations, in particular in the Upper Silesia Basin. It is known that the bulk of emissions (~70%) are from mine ventilation shafts. The air from such shafts moves in high volumes and is laden with particles and moisture. Such air is challenging to measure. This project aims to use multiple measurement methodologies, including mine-based safety sensors, to fully understand ventilation shaft emissions. Measurement platforms include mobile aircraft, helicopters, vehicles, and static ground-based systems. The latter includes measurements that range from within, at the top of, and far from the ventilation air methane shaft.</p>	<p><i>Campaigns started in June 2022 and completed in October 2023. Data analysis is ongoing.</i></p>	<p>DATA ANALYSIS ONGOING</p>	
<p>EMISSIONS FROM COAL SEAM GAS PRODUCTION IN AUSTRALIA Location: Australia <i>Airborne Research Australia, Australia</i> <i>University of New South Wales, Australia</i></p> <p>Rationale This study will provide data about emissions from coal-seam gas production, an increasing phenomenon and a critical first</p>	<p>Dual isotopic signatures (Lu et al., 2021)</p>	<p>PUBLISHED</p>	<p>This study examined whether isotopic signatures of CH₄ could be identified to distinguish coal seam gas atmospheric CH₄ from other source emitters of CH₄ such as agriculture, waste, mines, urban areas, and natural processes.</p>
	<p>Inventory comparison (Neininger et al., 2021)</p>	<p>PUBLISHED</p>	<p>CSG upstream sources emit about 0.4% of produced gas, which is comparable to some onshore dry gas fields (Marcellus Shale in the US and Groningen field in The Netherlands). However, it is substantially smaller than other regions, especially those where oil is co-produced (wet gas).</p>

<p>step in understanding other places where this production occurs. The Surat Basin is Australia’s largest CSG basin accounting for almost 20 per cent of Australian natural gas production.</p>	<p>Isotopes identify inventory knowledge gaps (Kelly et al., 2022)</p>	<p>PUBLISHED</p>	<p>Identified potential sources of CH4 emissions overlooked by bottom-up inventories, including upwind CSG brine ponds, indicating that water management ponds may be a mitigation opportunity.</p>
<p>COAL MINE METHANE EMISSIONS: SOURCES, MITIGATION POTENTIAL, MONITORING AND EMISSIONS QUANTIFICATION (COAL PHASE I) Location: Global <i>Environmental Defense Fund, US</i></p> <p>Rationale The study provides an assessment of current literature and data on coal mine methane emissions as a foundation for future measurement-based studies of the sector. It provides a state-of-the-art understanding of coal mine methane emissions with focus upon sources, mitigation approaches, monitoring and emissions quantification.</p>	<p>The final report was submitted to IMEO in August 2022.</p>	<p>PUBLISHED</p>	<p>China leads the world in estimated coal mine methane emissions. Underground coal mines account for approximately 70% of global Coal Mine Methane (CMM) emissions. Mitigation potential is through drainage and ventilation air. The main variables which affect gas emission rates in coal mining are in-situ gas content of coal seams, strength and reservoir properties of the strata surrounding longwall districts, working depth, panel dimensions, face advance rate and district age. Accounting for coal mine methane emissions is complicated and conducted in variable ways around the world.</p>

WASTE SECTOR

PROJECT	PAPERS <i>Progress</i>	STATUS	KEY FINDINGS
<p>MEASUREMENT-BASED CHARACTERIZATION OF EMISSIONS FROM CANADIAN LANDFILLS Location: Canada <i>St Francis University, US</i></p> <p>Rationale This project will quantify emissions at dozens of individual landfills across Canada. For a subset of these landfills, a method intercomparison using ground-based mobile measurements, drones, and aircraft surveys will evaluate potential benefits and limitations of each method.</p>	<p><i>The project is close to finished with measurements having been completed January 2023, and data analysis is being finalized. A paper is expected to be published in early 2024.</i></p>	<p>DATA ANALYSIS ONGOING</p>	

MULTI-SECTOR

PROJECT	PAPERS <i>Progress</i>	STATUS	KEY FINDINGS
<p>GLOBAL METHANE BUDGET Location: Global <i>Stanford University, US</i></p> <p>Rationale This project aims at supporting the Global Carbon Project (GCP) to better understand global methane emissions at large. IMEO is funding two additional elements to GCP's biennial overview reports: (1) Addition of supplementary measurements to aid in distinguishing fossil fuels from other sources, and (2) Field campaign in Azerbaijan to measure some of the largest natural geological methane seeps.</p>	<p><i>A data analysis is currently underway, which will integrate global measurement data of supplementary tracers (ethane and isotopes). This will be fed into a global model to better attribute fossil methane emissions from other source sectors. Also, a dataset of large geological methane seeps has been developed to aid in the planning of the measurements in Azerbaijan.</i></p>	<p>RESEARCH ONGOING</p>	
<p>AERIAL MEASUREMENTS OF EMISSIONS IN OMAN Location: Oman <i>German Aerospace Center (DLR), Germany</i> <i>AGH University of Science and Technology, Poland</i></p> <p>Rationale This will be the first in-depth, independent, study of O&G methane emissions on the Arabian Peninsula, with aerial</p>	<p><i>Field measurement campaign completed in Dec 2023.</i></p>	<p>DATA ANALYSIS ONGOING</p>	

<p>and ground-based methane survey characterizing O&G site-level emissions and source-level distribution. A waste component has been added to the oil and gas campaign.</p>			
<p>CONTINUOUS MONITORING OF METHANE EMISSIONS WITH TROPOMI SATELLITE OBSERVATIONS IN SUPPORT OF IMEO Location: Global <i>Harvard University, US</i></p> <p>Rationale The Integrated Methane Inversion (IMI) is an open-access, user-friendly cloud-computing facility that allows researchers and stakeholders to perform regional inversions of TROPOMI satellite observations. Research will focus on incorporate automatic construction of inversion ensembles with varying inversion parameters and quantify the sensitivity of results to prior/observational errors, prior emission estimates, satellite retrieval products, and other factors. The study will explore the incorporation of point-source information into the tool, using IMEO's MARS point-source data from independent instruments such as Sentinel-2 to help define prior errors and the emission state vector for the inversion.</p>	<p><i>Project initiation ongoing</i></p>	<p>PROJECT INITIATION</p>	

<p>TROPOMI-BASED WORLDWIDE CHARACTERIZATION OF EMISSIONS Location: Global <i>Harvard University, US</i></p> <p>Rationale This study will generate a worldwide quantification of total methane emissions from oil, gas, and coal production on national and basin scales by inversion of multi-year TROPOMI observations with prior point source and infrastructure information.</p>	<p><i>Research ongoing.</i></p>	<p>RESEARCH ONGOING</p>	
<p>BASELINE STUDY OF EMISSIONS IN COLOMBIA Location: Colombia <i>Universidad Nacional de Colombia, Colombia</i></p> <p>Rationale This multi-sectoral measurement study will estimate the current total anthropogenic methane and sectoral emissions in Colombia and the associated uncertainty. Baseline measurement studies can inform national greenhouse gas inventories, reveal areas to prioritize emission reduction and help discover the sources of discrepancies.</p>	<p><i>Measurement campaign is expected in Feb/March 2024.</i></p>	<p>RESEARCH ONGOING</p>	