Supplementary evidence from Glen Thistlethwaite (MET0045)

Noting that the UK inventory work programme covers all methane emission sources, gathering data and evidence from across all relevant UK regulators, statistical agencies and researchers, and that inventory colleagues and I work with clients and our peers globally on the development of methane evidence, monitoring and reporting systems etc., this written evidence exceeds the recommended 3000 words and 5 pages. Apologies for that, but hopefully the response is proportionate and adds value. Further, in addition to responses to specific questions in the call for evidence, this submission includes clarifications to issues raised during the oral evidence session that I attended on 20th March 2024.

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Response to specific questions in the call for evidence

1) What role could methane emissions reduction play in meeting the UK's domestic and international climate change targets?

Methane reduction will become increasingly important as we move towards Net Zero, especially as the harder-to-abate sources such as agriculture emit large amounts of methane. It is important to understand the impact of the high GWP of methane relative to carbon dioxide and also that methane has a much shorter residence time in the atmosphere, i.e., its radiative forcing impact occurs in a short time-frame relative to other GHGs. This means the mitigation of methane is an effective way to accelerate progress towards overall GHG reduction targets and to quickly reduce the radiative forcing impacts of UK anthropogenic GHG emissions.

3) What are the implications of the separate Global Methane Pledge for overall UK efforts to reduce greenhouse gas emissions?

In the energy sector, several UK oil and gas companies have signed up to GMP Energy Pathway initiatives[1] such as the World Bank Global Flaring and Methane Reduction Partnership and the Oil and Gas Methane Partnership 2.0. These company commitments are supporting co-ordinated action across the industry and regulators in the UK to both: (i) develop better evidence of methane emissions, and (ii) take action to improve gas management and reduce methane emissions. The imminent EU Methane Regulation, which will place new methane measurement and reporting obligations on those selling fossil fuels into the EU market, is also incentivising such action.

[1] https://www.globalmethanepledge.org/annual-report/energy-pathway

5) How significant are UK methane emissions when compared to global emissions? What impact could UK efforts on reducing methane emissions have on total emissions?

UK emissions of methane are broadly equivalent to emissions from other major European economies; data for 2021 from UNFCCC national inventory submissions[2] indicates that the UK emits ~10% less methane than France and ~10% more than Germany. For context, the UK emits ~8% methane compared to the US total.

The impacts of UK action to mitigate methane emissions are not *only* to reduce domestic emissions but also to demonstrate our global leadership, the development of measurement and mitigation technology that can be applied worldwide, capacity building to support cost-effective action globally and aligning with other global regulatory / other mechanisms to drive down methane emissions in other regions, e.g., other energy producing countries.

6) What is the UK doing to lead and facilitate international action on methane reduction? Could this be enhanced?

UK experts have supported the design and testing of the global GHG transparency mechanisms that will be enacted through the Enhanced Transparency Framework of the Paris Agreement. Starting in 2024, many more developing countries, including very large economies / emitters, will start to report more regular evidence to the UNFCCC (including on methane emissions and on mitigation actions) via Biennial Transparency Reports (BTRs)[3]. Underpinning this, many UK experts have supported the development of IPCC GHG inventory methodological guidance, IPCC Assessment Reports (e.g., AR6) and also the agreement of future UNFCCC reporting and review practices. This step forward in the global effort to develop better GHG emissions evidence will support future prioritisation and funding for methane mitigation.

UK experts have also supported specific programmes targeting methane mitigation, such as Clean Development Mechanism projects on landfill gas mitigation (many projects globally) and the development of the reporting systems for the (imminent) EC Methane Regulation, which targets methane reporting from the energy supply sector (oil, gas and coal). UK experts deliver GHG evidence capacity building within developing countries, using funds from a range of sources, e.g., the German Government GIZ agency has a mature international network to experts that co-ordinate such action and fund projects to deliver capacity building support globally. The development and dissemination of the 2050 Calculator by BEIS/DESNZ is a good example of the UK exporting practical tools to help other countries to estimate, report and then prioritise, fund and track projects to mitigate methane and other GHGs.

This work could be enhanced by UK Government taking a more pro-active role and/or greater funding to these global mechanisms. The UK has a lot to offer;

[2] https://unfccc.int/ghg-inventories-annex-i-parties/2023
[3] https://unfccc.int/biennial-transparency-reports

we have a good track record in developing efficient, reliable Monitoring, Reporting and Verification systems to handle methane emissions data, identify mitigation priorities and then to verify mitigation action impacts.

7) What lessons could the UK learn from abroad?

Regarding regulation, measurement and reporting of methane emissions, we could learn from the approaches taken by regulators and other organisations in other domains such as:

USEPA and other US regulatory agencies (*use of drones and aircraft to monitor fugitive emissions*); Norway (*upstream oil and gas source analysis and subsequent reconfiguration of their operator reporting systems*[4]); the imminent European Union Methane Regulation, which will require much more detailed reporting of methane emissions and abatement efforts from energy companies and countries alike; development of industry source standards / protocols such as for downstream gas network leakage[5].

Data, measurement, and monitoring

8) What is the status of methane accounting, monitoring, and reporting in the UK at present and how does it compare internationally? Is UK accounting and reporting considered to be accurate and robust? What improvements, if any, are possible and what benefits would these deliver?

The UK GHG Inventory is widely regarded as world-leading; it receives favourable feedback via UNFCCC expert review teams / reports and through subsequent engagement of UK inventory experts within global capacity building projects to showcase the UK inventory data and methods. The UK methane inventory : 1) has been developed over many decades via continual investment in the inventory and the underpinning statistical and regulatory organisations / mechanisms that generate the essential UK evidence; 2) is subject to rigorous QAQC requirements to ensure its quality; 3) is maintained through a process of continuous improvement, managed by DESNZ and engaging science and policy leads from across Government e.g. Defra, DfT, regulatory agencies such as the Environment Agency, SEPA, NRW, NIEA and OPRED, and also engaging devolved Government representatives. The inventory complies with the latest IPCC methodological guidelines and implements many of the *2019 Refinement*[6] methods (e.g., for energy sector fugitives). It is subject to annual reviews by UNFCCC expert review teams, the reports from which are publicly available on the UNFCCC web site. At the COP and other negotiations, the high standing / reputation of the UK inventory helps to underpin UK Government's influence.

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[4] https://www.iea.org/policies/8895-cold-venting-and-fugitive-emissions-from-norwegian-offshore-oil-and-gas-activities-summary-report-prepared-for-the-norwegian-environment-agency

[5] https://www.marcogaz.org/publications/assessment-of-methane-emissions-for-gas-transmission-distribution-system-operators

[6] *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC, 2019); https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

The inventory is developed and maintained to adhere to the IPCC quality objectives of: 1) **completeness** (i.e. no gaps – all anthropogenic GHG emissions by sources – fugitives included – and removals by sinks are estimated using IPCC methods); 2) **accuracy** (i.e. using best available UK data and evidence; applying models that accurately represent UK circumstances); 3) **transparency** (>1000 page annual National Inventory Report that sets out results, data inputs, assumptions, and methods applied for every emission source and sink); 4) **comparability** (applying methods that enables comparability of the UK GHG inventory against those provide by all other reporting parties to the UNFCCC); 5) **consistency** (applying methods and data that generate as accurate a trend across the time series as practicable, i.e. from the Base Year (1990) to latest reported year).

Global capacity to enhance the GHG evidence base: UK inventory experts have played a leading role in the development of the global GHG data reporting and QA systems, via IPCC method guideline development (many UK experts from across academia and industry have been invited to work on IPCC products as Lead Authors or Review Editors) and UNFCCC transparency and reporting processes (e.g., expert reviews of country submissions, development of Paris Agreement reporting systems). UK experts have a long track record of providing capacity building support to many countries to enhance their GHG evidence base and reporting. The UK is one of only three countries globally that conducts 'top-down' verification of its inventory; the InTEM verification work is world-leading, and the results are reported transparently in the annual UK National Inventory Report. UK experts from the Met Office and Bristol University are supporting other European countries to develop similar capability.

Regulatory and other UK reporting systems: The GHG inventory is underpinned by a mature, near-comprehensive system of regulatory, voluntary, and financial reporting mechanisms and national statistics compared to most other countries. The UK's systems reliably provide a set of high-quality activity data for the GHG inventory; there is always room for improvement, however, and we must remain vigilant to maintain high quality evidence, especially for new / emerging sources and sinks where emissions research / evidence is limited.

Many UK data gathering and reporting mechanisms have developed alongside similar systems across Europe, e.g., for industrial operator reporting of emissions (e.g., UK ETS / EU ETS), and are underpinned by well-designed emissions reporting systems including operator guidance, established standards and protocols for estimation and reporting of emissions across Europe. The same applies for key national statistics, e.g., the Digest of UK Energy Statistics, which is fully consistent with IEA / Eurostat format and quality requirements.

Considering key UK methane sources (*data from DESNZ GHG stats release, Feb 2024*[7]):

The **agriculture** sector (~49% of 2022 UK methane emissions) is based on detailed (often holding level) statistics of livestock, crop production and fertiliser

[7] https://www.gov.uk/government/collections/uk-greenhouse-gas-emissions-statistics

use. The inventory model is built bottom-up, within a 10x10 km grid system developed by Defra following a major investment into UK research (~2010-2015, GHG Research Platform[8], Defra contracts AC0114, AC0115) to derive emission models and factors that accurately represent UK conditions (climate, soil types, livestock types, production systems etc.). As such the UK inventory model is accurate for UK circumstances and also designed to accommodate new evidence on uptake of mitigation actions as they become available from farm surveys, e.g., slurry management techniques, new livestock types, feed additives etc.

There is considerable scope to develop further evidence regarding the various methane mitigation options, e.g., through changes to livestock nutrition, selective breeding / genetics etc, and indeed Defra is in the process of tendering a Dairy Demonstrator[9] project to explore exactly this area of science to develop effective methane mitigation options for UK farming.

The waste management sector is dominated by emissions of methane generated within **landfills** (~24% of 2022 UK methane emissions), although there are other sources (e.g., waste water treatment, ~3.5% of 2022 UK methane emissions) that also warrant continued investment in activity data and research to better-characterise the process emission sources. The landfill modelling conducted under UK environmental regulatory permitting systems, and in the UK inventory, draw upon a wide range of parameters (e.g., waste disposal data per European Waste Catalogue code, assumed compositional data per waste stream type, decomposition rates, landfill gas gathering systems and data on landfill gas / methane use in flares and gas engines). It is not currently cost-effective nor practicable to conduct routine on-site methane measurements from across landfill sites. However, there are several emerging measurement systems are being tested by Defra and the environmental regulators through use of monitors mounted on drones, vehicles or stationed at the site boundaries.

This area of research could be advanced through greater investment into the development of monitoring standards and protocols, as well as greater resources for regulators and to develop UK monitoring capacity. Such investment could (i) improve the calibration of landfill methane emission models, and (ii) support quicker, effective landfill gas management, minimising leakages through rapid abatement action on site, following the detection of leaks. UK is well-placed to advance such standards and protocols, noting the specific expertise of UK metrology experts from the National Physical Laboratory and many experts that help to develop ISO / EN sampling standards across industry.

Downstream gas distribution (~6% of 2022 UK methane emissions) emission estimates are derived using a UK-specific model developed by British Gas and maintained via the Joint Office of Gas Transporters – Shrinkage Working Group. There is an existing reporting obligation for each Gas Distribution Network (GDN) operator to report on total annual gas leakage to Ofgem as part of the RIIO-GD2

[8] https://assets.publishing.service.gov.uk/media/5a79044240f0b679c0a07e0c/greenhouse-gas-agriculture-research-20121122.pdf
[9] https://tenderbase.co.uk/find-tender/1254431

price control mechanism[10]. The Shrinkage and Leakage Model (SLM) reflects the UK network infrastructure, typical leakage rates per asset and parameters such as Mono-ethylene glycol (MEG) saturation within the network. Inventory estimates are derived using additional data on gas composition per distribution network. This theoretical model therefore does reflect measurement of methane content of the annual UK natural gas supply.

Further improvements to the model may be achieved through greater use of measurements across the network and at Above Ground Installations (AGIs), and indeed a project is ongoing[11] to test and develop measurements from monitors mounted on drones, road vehicles and planes; the use of satellite data has been considered in the inception phase and discounted as not suitable.

Where satellites may play a part in the short-term is exemplified from a recent incident of a super-emitter event from gas leakage from a ruptured gas pipeline just north of Cheltenham, identified from GHGSat data and subject of an academic paper published recently[12]; the Ofgem RIIO-GD2 reporting by Wales and West Utilities for 2023 leaks will be required to report estimated emissions of gas from this event, but the use of satellite data to quickly help identify such incidents and support rapid mitigation is an option to explore.

The UK also has a very active and engaged academic measurement community that works extensively on methane emissions measurement and modelling / analysis, and the associated development of sampling techniques (using planes, drones, road vehicles) including experts at numerous universities such as: Royal Holloway, Bristol, Manchester, Imperial, York, Leeds, Southampton, Queen Mary. Harnessing this expertise and improving the co-ordination and funding of these research teams (together with industry and regulatory agencies) may enable a quicker, more efficient development of new routine systems of monitoring and reporting to target methane evidence improvements across the UK (and beyond).

Upstream oil and gas (~1.5% of 2022 UK methane emissions) has been the subject of numerous studies, including a 2-year inventory improvement project finalised in 2022[13]. Key uncertainties regarding methane emissions arise from the limited evidence and monitoring of gas flares on offshore assets and the assumption that across the sector an average 98% oxidation of flare gas is achieved. Note that this assumption has been supported by recent academic studies across ~60 UK and Norwegian installations in the North Sea[14].

Further improvements to the accuracy of the UK methane emission reporting are being sought through industry research, in part driven by OGMP 2.0 reporting obligations and the commitment of the UK industry to a Methane Action Plan as part of the North Sea Transition Deal with NSTA, including to reduce emissions and flaring. There are also a wide range of academic research studies focusing

[10] https://www.gasgovernance.co.uk/shrinkage/aa2023
[11] https://smarter.energynetworks.org/projects/cad_sif0002/
[12] E Dowd et al, 2023: https://egusphere.copernicus.org/preprints/2023/egusphere-2023-2246/
[13] Thistlethwaite et al, 2022: https://naei.beis.gov.uk/reports/reports?report_id=1115
[14] JT Shaw et al, 2023: https://acp.copernicus.org/articles/23/1491/2023/acp-23-1491-2023.pdf

on upstream oil and gas emission monitoring, including by NCAS (teams at the Universities of York and Leeds) using the FAAM aircraft[15] to fly across the North Sea production areas and obtain air samples to back-calculate mass emission estimates.

Use of satellites to monitor offshore methane emissions do not currently appear to be viable due to the difficulty in obtaining data for emission sources over water; the satellite data gathering operates at specific wavelengths which work well over land but not water. Development of improved monitoring systems for satellites is needed (and is ongoing).

Less mature data reporting systems and underpinning evidence are available for methane emissions from **managed peatland** (~10% of 2022 UK methane emissions); this is an area of emerging interest for further scientific research to allow a better understanding of the mechanisms of the complex biological processes that govern emissions and hence inform any options to mitigate emissions through improved land management practices.

9) What progress is being made on methane monitoring and data collection in the UK using technologies such as satellite data and drones?

Recent research projects have explored the use of remote measurement approaches such as via sensors mounted on drones and vehicles looking at emissions from sources such as anaerobic digestor / biogas production sites, landfill sites and intensive farm units. To date these are not routine, mainstream measurement techniques; they are experimental. There is a need to scale-up these activities to develop standards and protocols for industry and regulators to follow, in order that these type of measurements can be developed to enable estimates of mass emission rates per source at sufficiently low levels of uncertainty as to be useful for reporting and tracking emissions over time, including to reflect the impact of mitigation measures.

The FAAM aircraft is a UK resource that academics can utilise to conduct atmospheric emission measurements of a wide range of pollutants, including methane, and this is being used periodically for sampling campaigns over oil and gas production facilities; this may be used to research other methane sources, e.g. onshore facilities such as refineries, oil & gas terminals.

10) Are there significant methane leakages in the UK, and if so where do they usually occur?

Yes, there can be major methane leakage incidents in the UK, although they appear to be rare events such as oil or gas well blowouts (e.g., the Elgin blow-out in 2012) or downstream gas pipeline ruptures, such as the 2023 Cheltenham incident. The UK is by no means unique in experiencing such significant leakages. Risk of occurrence is likely linked to the age and maintenance of

[15] https://www.faam.ac.uk/

infrastructure and/or limited operator controls, and where fluid pressure management systems are required to balance operational safety and efficiency.

One further point of note is that as we move towards Net Zero and new fuels and technologies come on-stream, the UK system of data gathering, reporting, research and regulation will need investment to maintain a high level of confidence in the evidence base. One example is the increased uptake of bioenergy fuels, driven in part by more bio-digester type processes that may emit methane; this is currently a minor emission source but can be expected to increase.

11) What are the advantages and disadvantages of available metrics used to report and compare methane emissions including GWP100 and GWP*?

Metrics are used to quantify the contributions to climate change of emissions of different GHGs. The UNFCCC maintains a watching brief on a range of reporting metrics[16], but a single metric is adopted as a common standard for all Parties reporting their GHG emissions and removals under the UNFCCC. The use of a single metric ensures comparability of reported data. No single metric can accurately compare all consequences of different emissions, and all have limitations and uncertainties. The UNFCCC Secretariat has prepared a technical report of the findings on emission metrics contained in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)[17].

Note that the UK is committed to adhere to globally agreed UNFCCC reporting guidance, which means that for the foreseeable future the UK will need to report using GWP100 metrics, in order that the UK dataset is comparable to those from other countries. The UK can decide to also report (in addition to reporting using GWP100) using other metrics, including GWP*.

UK Methane emissions and sectors

12) What progress has the UK made on reducing methane emissions and where is there room for improvement?

The latest UK GHG inventory shows that UK methane emissions have declined by an estimated 62% between 1990 and 2022[18] (with a 95th percentile uncertainty range of down 51% to down 72% across the 1990-2022 period). Progress has been made in a handful of key sectors:

- **Waste management** sector reductions comprise 57% of the UK methane reductions, due primarily to the significant uptake of landfill gas capture

[16] https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review/methods-for-climate-change-transparency/common-metrics
https://unfccc.int/sites/default/files/resource/IPCC%20Workshop%20on%20Emission%20Metrics%20-%20Overview.pdf
[17] https://unfccc.int/sites/default/files/resource/sbsta2023_inf02.pdf
[18] https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2022

and utilisation in engines and flares, as well as the impact of reducing organic material disposal to landfill.

- The **near-complete closure of the UK coal mining** sector since 1990 contributes around 36% of the total methane mitigation as the UK economy has shifted to use more natural gas, nuclear and renewables in the fuel mix for electricity production and other sectors. In the intervening years, the utilisation of coal mine methane in gas engines has also contributed to reducing emissions (from operating and closed coal mines)

- The renewal of the **downstream gas distribution network**, as incentivised via financial instruments in the sector, has contributed an estimated 8% of the total mitigation of methane in that period. The replacement of cast iron and ductile iron pipes across the UK network to use steel and then polyethylene pipes has progressively reduced pipeline leakage of natural gas and hence methane to atmosphere.

- **Lower methane emissions from livestock**, especially lower enteric fermentation emissions due to reductions in livestock numbers has contributed around 5% of total UK methane reductions since 1990

- Reductions in emissions from **upstream oil and gas** exploration and production, including lower levels of flaring, have contributed around 2.5% of the total UK methane reductions since 1990.

Regarding scope for further mitigation opportunities, given that agriculture sector emissions now account for 49% of 2022 UK methane emissions, then investing in research and development to reduce emissions from enteric fermentation and farm waste management seems a sensible priority. For example, it would be beneficial to consider research to explore the impact of changes to herd nutrition, manure management systems and how genetics impact upon the enteric fermentation emissions across different cattle breeds.

15) To what extent is there existing regulation in each emitting sector to mitigate methane emissions, and how well is this working?

Regulation is somewhat variable across the main emitting sectors. A review of the regulatory landscape for methane emission is a key priority for the Committee to consider. There are limited environmental regulatory levers for methane in many sectors. Methane is not a criteria pollutant for emissions to air as specified in the Annex II of the Industrial Emissions Directive[19] (IED) nor within the subsequent Environmental Permitting Regulations (EPR) that underpin much of the current industrial regulations in the UK. This means that environmental regulators, such as the Environment Agency in England, struggle to identify clear regulatory 'hooks' onto which provisions that will impact on methane can be made. For some emission sources, regulatory provisions to act

[19] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02010L0075-20110106

upon Non-Methane Volatile Organic Compounds (NMVOCs) may be used to impact on methane emissions also.

Landfill gas management is regulated under EPR regulations, the Landfill Directive, and there are good quality annual statistics available to the inventory agency from the existing regulatory reporting mechanisms via the environmental regulatory agencies and also via energy statistics.

Upstream oil and gas emission sources are partly covered by the IED/EPR regulatory provisions for combustion processes, whereas emissions from sources such as venting, oil loading and fugitives are reported to OPRED via the Environmental and Emissions Monitoring System[20] (EEMS) on a voluntary basis. In parallel to these data, the North Sea Transition Authority, operating as sector regulator under the Energy Act and Petroleum Act, also gathers operational data on production-related parameters. There is scope for improvement in the regulation and reporting systems for this sector, noting that the regulators require a clear mandate and resources to then implement any new monitoring and reporting systems. Currently such developments appear to be being primarily driven by operator requirements to report against other mechanisms such as OGMP2.0[21].

Downstream gas leakage is regulated via the RIIO-GD2 financial mechanism under Ofgem; each GDN must report annually to Ofgem on the total mass of natural gas leakage from its network. Whilst this system uses a common UK industry model and has a financial mechanism in place to bring together the various stakeholders (including the GDN operators and fuel suppliers) it does not specifically deliver *methane* emission estimates; there may therefore be a need for new environmental regulations to support improvement of the monitoring and reporting of methane (and other) emissions from the network, especially as the production and supply of biogas/biomethane and hydrogen increases. Currently, only the larger gas compressor units on the network are regulated by the environmental regulators under EPR. Other infrastructure is not covered; operators do not report pollutant emission estimates.

The bulk of the agriculture sector falls outside of such environmental regulatory scope, other than for intensive pig and poultry farms.

Waste and waste management

21) What further progress could be made in the waste and waste management sector on reducing methane emissions? Are there interventions and/or technologies that could bring emissions down?

It is likely that diverting degradable wastes (to composing, anaerobic digestion or incineration) would remain the main measure for reducing landfill methane emissions. However, the sorting of mixed wastes can be a significant undertaking. Other options including increasing monitoring to pick up breaches

[20] https://www.gov.uk/guidance/oil-and-gas-eems-database
[21] https://ogmpartnership.com/

in caps, and improving cover layers to encourage oxidation of methane before it reaches the atmosphere, noting that it might be challenging to collect suitable data to validate the impact that interventions are having.

22) Given the regulations already in place for methane reduction in the waste sector, why are emissions from the waste sector static over recent years? Are existing regulations monitored and enforced?

Methane emissions from the waste sector have declined by 12% over the last 5 years. This includes a 15% reduction from landfill. The amount of waste landfilled annually has also decreased over the last 5 years. The UK inventory is dependent on data collected through EPR regulations and for the purposes of national energy statistics (e.g. on methane collection and use in gas engines) for accurate reporting, and the agreement between the inventory and the atmospheric measurements for methane is good for recent years; as such there is nothing implied from the inventory figures to suggest that regulation is not being enforced. There is a strong increasing trend for anaerobic digestion (+13%), albeit from a smaller baseline.

To note that landfill methane emissions occur over a number of years after the waste is deposited, as the different waste types degrade over many years and at different rates according to their composition. Therefore, the impact of mitigation actions, e.g., diversion of organic waste away from landfills to other fates, will not have an "instant impact" as methane will still be being generated from historic waste that still has to decompose.

24) To what extent will improved methane captured at landfill sites, remain necessary to reduce methane emissions after this date?

It would be expected that improved capture (or surface layer oxidation) would remain essential for continuing to reduce methane emissions, as even with separate food waste collection, landfill methane emissions would be expected to continue to be generated from:

- waste deposited before any policies to divert biodegradable wastes.
- a large proportion of households continuing to dispose waste to general mixed waste even when separate food waste collection is offered; and,
- other components of waste which contribute to methane emissions which could be included in mixed municipal wastes, and non-municipal waste generation.

Fossil fuels

26) How can we ensure that reducing methane emissions in the oil and gas sector are not at the expense of reducing CO_2 emissions?

To note that unless it is feasible to mitigate the methane at source, then to mitigate emissions by combustion/flaring to convert to carbon dioxide is better than venting the methane, given the much higher GWP of methane relative to CO_2.

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Responses specific to issues raised in the Oral Session on 20th March 2024

I note that there were a number of assertions from other witnesses related to the UK methane inventory that were factually incorrect; hence I have provided clarifications below.

Re: "*a best guess based on emission factors and activity data*" The UK inventory uses internationally approved IPCC methods to estimate emissions of GHGs that all Parties to the UNFCCC are mandated to use, and which have been developed through the efforts of hundreds of academics, industry and emission measurement/modelling experts from around the world via a rigorous IPCC guidance drafting process with multiple phases of peer / expert review. The UK inventory agency then uses the best available data and evidence from across UK research, statistics, regulatory and industry resources in these methods.

Re: "*emissions for London were under-estimated by a factor of 2*" Academic studies taking measurements at specific locations and over a specific period might well indicate a difference when compared against the inventory model, which is by nature sector-wide and annualised emission estimates, with much greater uncertainty when seeking to estimate the spatial and temporal disaggregation of that sector total. For example, gas network leakages can be more accurately estimated across the network (as within the inventory) than they can at street/area level on a specific day. Furthermore, the back-calculation of methane emission estimates from observations are methods that are subject to significant uncertainty. Differences between the inventory and measurements help to indicate areas for research and improvement (of one or both systems), not that one or the other "is wrong".

Also, to note that more recent studies that use isotopic comparisons and ethane: methane ratios to source-apportion the observed methane gas sampled across London, indicate that the measurement observations are lower than the UK inventory estimates *from gas leakage* in London. This illustrates that more research and more measurements are needed to refine our understanding of what these academic studies tell us about the source apportionment, spatial and temporal distribution of emissions, to help us improve the UK evidence base.

Re: "*Unknown fugitive emissions … are not in the inventory*" Every one of the examples[22] given during the oral evidence session <u>are</u> included within the inventory. It is incorrect to assert that they are not.

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[22] "*very small gas network leaks…, routine fugitive emissions from pressure release valves, flanges and wastewater treatment plants, and landfill site leaks from open cells.*"

Re: "*they are essentially an informed error bar*". No, this isn't the case. Fugitive emissions of methane are not "an informed error bar". Fugitive emissions are estimated in the inventory as part of the central estimate of UK emission totals, and the UK inventory agency assign appropriate uncertainties to each source of fugitive emissions which reflect the uncertainties in their estimates. The inherent characteristics of fugitive sources of methane means uncertainties associated with the emission estimates are relatively much larger than for CO_2. This is the reason why the methane inventory uncertainty range is relatively large.

It is important to note that the IPCC methods and the UK GHG inventory deployment of evidence from existing UK reporting systems does include estimates for exactly these types of fugitive releases that were mentioned (as "*not in the inventory*"). The IPCC methods and UK regulatory models and reporting systems include these hard-to-measure emission sources; the emission estimates are modelled using the best available evidence and methods that have been developed over several decades of investment via IPCC lead authors (typically: academics, industry, and inventory experts), by UK regulatory agencies and industry (e.g., EA, SEPA, Ofgem, OPRED, etc) and by UK sector experts via published UK inventory improvement research.

The accuracy of the inventory models can be improved by more investment in measurement (e.g., remote sensing techniques, such as drones etc.) and improvements in evidence gathering by regulators and industry to improve the UK dataset – i.e., more methane data, more highly resolved data (e.g., per emission source, per site, temporal and spatial resolution). This will likely require a review and strengthening of the regulatory framework, to ensure that regulators (for both onshore and offshore sectors) have the mandate and resources to design and operate new Monitoring, Reporting and Verification systems, which in turn places clear obligations on operators to invest in better measurement and reporting.

Re: "*is a fugitive emission just a leak?"* Often true but not always. Emissions that are reported as "fugitives" within national inventories include other types of sources, including:

- Emissions from gas flaring, during plant upsets / non-routine operation (e.g., during upstream oil and gas processing, maintenance operations or other events on the downstream gas supply network)
- Venting as a pressure management / safety requirement. It might be necessary to release pressure during an overpressure event to prevent damage to equipment. This is not really "a leak"; the release would represent a deliberate action by the plant operator to prevent damage.