Ensure full consideration of other greenhouse gas emissions (CO_2e)

1. EXECUTIVE SUMMARY

1.1. This workstream is intended to review the Isle of Man inventory of non CO_2 greenhouse gas (GHG) emissions (CO_2e) and to identify any potential sources of CO_2e GHG that are not included in that inventory.

1.2. The IoM impacts on climate change through emissions of GHGs other than CO_2. These gases are: methane (CH4) released from landfills, natural gas, agriculture, especially from the digestive systems of grazing animals; nitrous oxide (N_2O) released though agriculture and livestock, fertilizer, manure, and the burning of fuel in cars; Fluorinated gases such as hydrofluorocarbons (HFCs), perfluorocarbons, chlorofluorocarbons, sulphur hexafluoride (SF6), and nitrogen trifluoride (NF3) used in refrigerants, solvents, and in shoe manufacturing.Each CO_2e is a more potent GHG than CO_2 (CH4 x 84; N_2O x 264; SF6 x 23,000) although they make up a much smaller percentage of total global GHG emissions.

1.3. Aether, the consultants used to submit the IOM GHG data to the UK annually, are producing a report identifying the data sources used for the inventory. Once this is produced it will be reviewed.

1.4. The IOM is reviewing its data on non CO_2 GHG emissions to identify areas where it can affect a reduction. This process also means seeking to identify potential future sources of CO_2e GHG so these can be taken into account. For example, a move to renewable energy production through development of windfarms is likely to increase the amount of SF6 emitted by the IoM. SF6, a synthetic gas which does not degrade naturally, is used widely by the electrical industry (large power stations, wind turbines, electrical sub-stations in towns and cities) to prevent short circuits and accidents.

2. THE CHALLENGE

2.1. To reduce the volume of non CO_2 GHG emitted by the IoM as a contribution to achieving net zero GHG emissions by 2050.

3. THE OPPORTUNITY

3.1. The IOM impacts on climate change through emissions of GHGs other than CO_2. These gases are:

- Methane (CH4) released from landfills, natural gas and agriculture, especially from the digestive systems of grazing animals

- Nitrous oxide (N2O) released though agriculture and livestock, fertilizer, manure, and the burning of fuel in cars
- Fluorinated gases such as hydrofluorocarbons (HFC), perfluorocarbons (PFC), and chlorofluorocarbons (CFC), used in commercial refrigeration, industrial refrigeration, air-conditioning systems, heat pump equipment, and as blowing agents for foams, fire extinguishants, aerosol propellants, and solvents
- Sulphur hexafluoride (SF6) used as an electrical insulator, to manufacture semiconductors, as a filler for cushioning (such as in tennis balls or the soles of trainers)
- Nitrogen trifluoride (NF3) a very powerful oxidizing agent use as an etchant in microelectronics and in the high-volume production of liquid-crystal displays and silicon-based thin-film solar

3.2. These gases are referred to as CO_2e GHG or CO_2 equivalent Greenhouse Gases. Although they make up a much smaller percentage of total global GHG emissions than CO2, their global warming potential[1] is higher than CO_2.

3.3. The GWP for each CO_2e GHG is published by The Intergovernmental Panel on Climate Change through its Assessment Reports (AR). For the purpose of international reporting requirements the GWPs included in AR4 are used (Aether, 2019).

3.4. The GWPs for each CO_2e over a 100-year time horizon and relative to CO_2 are as follows:

- Methane (CH4) x 25
- Nitrous oxide (N2O) x 298
- Fluorinated gases x thousands or tens of thousands
- Sulphur hexafluoride (SF6) x 22,800
- Nitrogen trifluoride (NF3) x 17,200

(United States Environmental Protection Agency, NA) (Greenhouse Protocol, NA)

3.5. Fluorinated gases are also known as Ozone Depleting Substances (ODS). The ozone layer, which lies high in the atmosphere, shields earth from harmful ultraviolet (UV) rays from the Sun. The use of fluorinated gases, such as CFCs in spray cans and refrigerants, breaks down ozone molecules in the upper atmosphere, creating a

[1] Global warming potential (GWP) is a measure of how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon, relative to carbon dioxide. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide and is expressed as a factor of carbon dioxide (whose GWP is standardized to 1).

'hole'. Although not causing global warming, this ozone hole is now known to be affecting the climate in the Southern Hemisphere, resulting in faster winds near the pole, which impacts to the equator affecting tropical circulation and rainfall at lower latitudes (NASA Climate Change Panel , NA).

3.6. In 1987 the Montreal Protocol, a multilateral environmental agreement, was signed. This committed signatories to, inter alia, regulate substances that deplete the ozone layer, and phase out the use of HCFCs from 2020. Globally the consumption of ODSs controlled under the Montreal Protocol declined by 98.41 % worldwide between 1986 and 2017 (European Environment Agency, n.d.). However, since 2012, unexpectedly high concentrations of the ODS trichlorofluoromethane (CFC-11) have been detected in the atmosphere. This suggests that the production of CFC-11 has illegally been resumed in recent years, which could delay the recovery of the ozone layer significantly.

IoM CO_2e Emissions

3.7. IOM CO_2e emissions are compiled annually as part of the UK National Atmospheric Emissions Inventory Programme. A new report explaining the process for emissions calculation and reporting has recently been prepared by Aether, designed to aid knowledge and understanding of the Isle of Man's inventory (Aether, 2019). The main conclusions of that report, which are of relevance to this work stream, are included in Annex A.

3.8. Annex B shows the sum of main CO_2e GHGs emitted by all sectors in the IOM since 1999. To note, the GWP factors have already been applied to actual non CO2 GHG emissions to provide CO_2e emissions data.

3.9. In terms of the assessing the scale of non CO_2 emissions by the IoM, using 2017 IOM data on emissions (as the most contemporary data available), non CO_2 GHGs were responsible for the release of 0.146 Mt CO_2e*. This represents 17% of total GHG emissions in 2017 (0.839 Mt), with CO_2 accounting for a 0.692 Mt CO_2 release. Of this 17%, methane is the most significant gas, produced by the agricultural sector.

3.10. The IPCC comment that 'The largest human source of nitrous oxide emissions is from agriculture which accounts for 67%' (Intergovernmental Panel on Climate Change, 2007). Agriculture creates both direct and indirect emissions. The IPCC reports that 'Direct emissions come from fertilized agricultural soils and livestock manure (42%). While indirect emissions come from runoff and leaching of fertilizers (25%)' HCFCs and Nitrogen Dioxide emissions are the next most significant gases.

4. OPPORTUNITIES FOR REDUCING EMISSIONS

4.1. To identify opportunities for reducing emissions, the first step is to understand the baseline data used to calculate each of the CO_2e emissions, where this data has been obtained and what assumptions have been used. Aether has recently produced its 'Guide to the Isle of Man Greenhouse Gas Inventory'.

4.2. This will allow the IOM to:

- Rank the sectors
- Identify the sectors/activities producing the highest CO_2e emissions
- Identify options for reducing these emissions, considering costs and benefits, and potential consequential impacts
- Determine which options to progress as part of the Climate Change target of net zero 2050

4.3. As CO_2 emissions from all sectors are being reviewed and assessed through other CCAT work programs, their proposals for reducing CO_2 emissions to achieve net zero 2050 will, however, also impact on emissions of CO_2e GHGs.

5. THE ACTIONS

5.1. This work stream, and lead authors for other related work programs, will need to review the recommendations of the Aether report with specific focus on the three priority actions for data improvements:

- Improvements to the completeness of the Isle of Man energy balance
- Improvements to the livestock numbers time series:
- Isle of Man specific insights: Provision of information on specific Isle of Man circumstances and where this may differ from activities in the UK. For example, the vehicle fleet mix, including age of the vehicles, may be different in the Isle of Man compared to the UK, and therefore applying UK assumptions may not be the best approach

and to then:

- Consider if there are other sources of non CO_2 GHGs which have not been taken into account in the inventory
- Consider whether any of the proposed actions in the work programmes to reduce GHG emissions in the IOM could result in an increase in CO_2e emissions

6. THE RISKS

6.1. A move to renewable energy production through development of windfarms is likely to increase the amount of SF6 emitted by the IOM. SF6, a synthetic gas which does not degrade naturally, is used widely by the electrical industry (large power stations,

wind turbines, electrical sub-stations in towns and cities) to prevent short circuits and accidents.

6.2. While steps have been taken to reduce and ban the use of CFCs in manufacture processes, owing to the long life cycle of cooling appliances, CFCs and HCFCs still make up a significant part of IOM end of life waste electronic and electrical equipment waste stream (C.Keri, 2012).

7. CONCLUSION

7.1. Based on current reported IOM GHG emission data non CO_2 GHGs contribute nearly one fifth of all GHG emissions by IOM. However as identified by Aether in its Guide to the Isle of Man Greenhouse Gas Inventory, there is a need to ensure more Isle of Man specific data is used as this will allow a more comprehensive and accurate inventory. The starting point is, therefore, to review the source data currently provided, specifically that relating to non GHG emissions.

7.2. Once this data review is completed, and any amendments made, there will be opportunities to review options for reducing these emissions, with reference to relevant CO2 focussed work programmes.

7.3. There is a need to identify potential sources for new CO_2e emissions, particularly those associated with renewable energy, waste management and the decarbonising of the transport system.

ANNEX A

Aether 2019 Report - Recommendations and next steps

Data improvements

In each sector chapter of the report, possible improvements to the inventory have been outlined. As a general rule, the more Isle of Man specific data that can be provided, the more comprehensive and accurate the inventory will be. Three priority actions for data improvements are:

- Improvements to the completeness of the Isle of Man energy balance: provision of data on fuel use, split by fuel type and sector (domestic, commercial or public sector) for 2001 onwards.

- Improvements to the livestock numbers time series: Provision of a complete timeseries (1990 – latest year minus 2), preferably from one data source, for livestock numbers for each category (e.g. dairy cattle, non-dairy cattle, sheep).

- Isle of Man specific insights: Provision of information on specific Isle of Man circumstances and where this may differ from activities in the UK. For example, the vehicle fleet mix, including age of the vehicles, may be different in the Isle of Man compared to the UK, and therefore applying UK assumptions may not be the best approach.

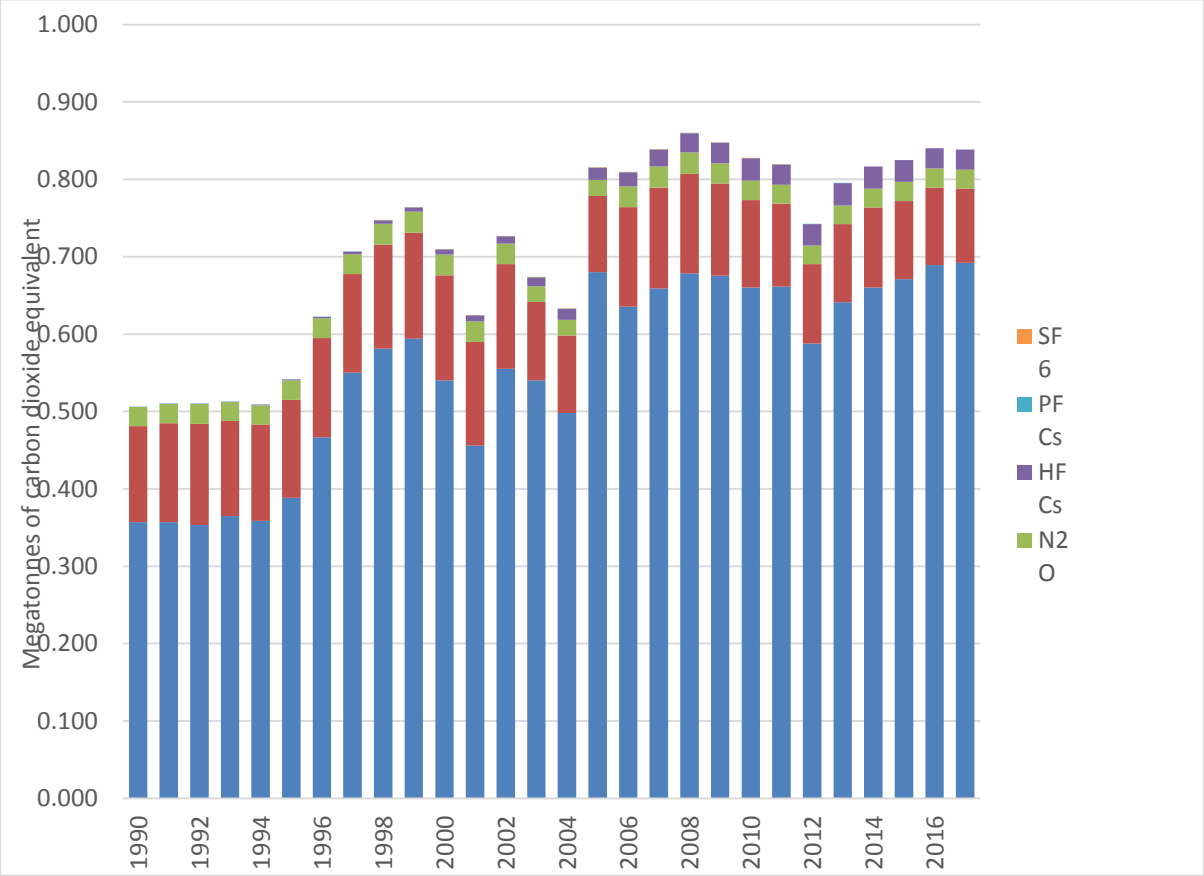
ANNEX B

Greenhouse Gas Inventory (1990-2017) by Gas

GHG inventory for	Isle of Man
Units	Mt GWP CO2_AR4
IPCC2006GLs	(All)

Sum of Emission	Pollutant					
EmissionYear	CO_2	CH4	N2O	HFCs	PFCs	SF6
1990	0.357	0.124	0.025		0.000	
1991	0.357	0.128	0.025	0.000	0.000	
1992	0.353	0.131	0.025	0.000	0.000	
1993	0.365	0.123	0.024	0.000	0.000	
1994	0.359	0.125	0.025	0.001	0.000	
1995	0.388	0.127	0.025	0.001	0.000	
1996	0.467	0.128	0.026	0.002	0.000	
1997	0.550	0.128	0.026	0.003	0.000	
1998	0.581	0.134	0.027	0.005	0.000	0.000
1999	0.594	0.137	0.027	0.005	0.000	0.000
2000	0.540	0.136	0.027	0.007	0.000	0.000
2001	0.456	0.134	0.026	0.008	0.000	0.000
2002	0.555	0.135	0.027	0.010	0.000	0.000
2003	0.540	0.101	0.020	0.012	0.000	0.000
2004	0.498	0.100	0.020	0.014	0.000	0.000
2005	0.680	0.098	0.021	0.016	0.000	0.000
2006	0.635	0.129	0.027	0.018	0.000	0.000
2007	0.659	0.130	0.027	0.022	0.000	0.000
2008	0.679	0.129	0.028	0.025	0.000	0.000
2009	0.676	0.119	0.026	0.027	0.000	0.000
2010	0.660	0.113	0.025	0.029		0.000
2011	0.661	0.107	0.024	0.026	0.000	0.000
2012	0.588	0.103	0.024	0.027	0.000	
2013	0.641	0.101	0.024	0.029	0.000	
2014	0.660	0.103	0.025	0.028		
2015	0.671	0.101	0.025	0.028		
2016	0.689	0.100	0.025	0.026		
2017	0.692	0.096	0.024	0.026		
Grand Total	15.552	3.320	0.700	0.396	0.000	0.002

ANNEX C


1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Megatonnes of carbon dioxide equivalent
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
SF6
PFCs
HFCs
N2O

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Isle of Man Government	2016	A climate challenge mitigation strategy for the Isle of Man 2016 – 2020	Available on line at:	http://www.tynwald.org.im/business/opqp/sittings/Tynwald%2020142016/2016-GD-0031.pdf
Keri, C	2012	Recycling cooling and freezing appliances' in Waste Electrical and Electronic Equipment (WEEE) Handbook	Available on line at:	https://www.sciencedirect.com/book/9780857090898/waste-electrical-and-electronic-equipment-weee-
NASA	Accessed September 2019	Is the ozone hole causing climate change?	Available on line at:	https://climate.nasa.gov/faq/15/is-the-ozone-hole-causing-climate-change/
United States Environmental Protection Agency	accessed September 2019	Understanding Global Warming Potentials	Available on line at:	https://www.epa.gov/ghgemissions/understanding-global-warming-potentials
What's Your Impact	accessed 31 September 2019	Main sources of nitrous oxide emissions	Available on line at:	https://whatsyourimpact.org/greenhouse-gases/nitrous-oxide-emissions