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HFC Emissions Report for Moldova

Prepared under contract to UNDP for US Government

PROJECT OBJECTIVE

TO DEVELOP AN EMISSIONS MODEL FOR HFCs IN MOLDOVA BASED ON INFORMATION AND MATERIALS GENERATED IN AN EARLIER COUNTRY REVIEW OF HFC CONSUMPTION.

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OUTLINE OF THE BASIC METHODOLOGY

The US Government sponsored HFC Survey on the historic consumption of HFCs in Moldova and the predictions in growth in demand to 2020 has been used as the basis for the assessment of likely emission profiles. The survey was authored by Dr. Anatol Tarita, National Ozone Unit Coordinator in the Republic of Moldova. Annual demand within Moldova can be viewed as being consumed in either one of two ways:

1. Servicing demand to replace refrigerants and fire protection agents emitted during the year

or

2. Demand created by the manufacture/installation of new products or equipment within the year

All demand for sectors such as foam will fall into the 'new product' category, since no servicing of foam products takes place once installed. However, the split between (1) and (2) for refrigerants and fire protection agents will depend on the balance between annual leakage rates by sector and the growth in the overall installed base of relevant equipment.

For the purposes of this work, it has been assumed that the historic and projected consumption values for each HCFC and HFC (and blends thereof), as presented in the HFC Survey, are reliable. In the case of Moldova, the differentiation between new equipment and servicing requirements has been particularly good. Hence, a bottom-up, additive approach has been used to compile inputs to the emissions models. Although leakage rates have also been estimated throughout the HFC Survey, the emissions models have assumed default IPCC emission rates. In most cases, this has still led to an increase in the bank of HFCs in the period to 2020 (see Table 2).

ANALYSIS OF CONSUMPTION AND DERIVATION OF EMISSIONS

The model to assess emissions of HFCs from various sources was developed by firstly generating an analysis of consumption patterns for each agent (whether an individual substance or a blend) by sub-sector of use. In the case of Moldova, this was assisted not only by the HFC Survey itself, but also from the

2011 UNDP Project Proposal which provided important information on the use patterns for HCFCs in the period from 2005 to 2015. From this source, it was shown that HCFCs were exclusively used in the RAC sector, but spread across a range of commercial, industrial and transport refrigeration uses, as well as stationary & mobile air conditioning applications.

Although data for each sub-sector of use was very comprehensive it was only given for the period from 2010 to 2014. Most specifically, projections of future consumption were only given in five year intervals (i.e. 2020 and 2025). In order to interpolate for the intervening years, linear incremental change was assumed between 2014 and 2020. For 2008 and 2009, 10% annual growth was assumed in order to reach the given 2010 value. Generally, the sub-sector categorization provided in the Moldovan HFC Study was similar to that consistently adopted in this series of emissions reports, although one significant difference was the fact that Domestic & Commercial Refrigeration were combined. This aspect was addressed by assigning 'fridges' and small 'freezers' to Domestic use, while assigning larger 'freezers' and 'showcases' to the Commercial sector. A further unusual observation was the reported use of HFC-143a in 'fridges' for the single year of 2010. Use was also assumed for 2008 and 2009, but not beyond 2010.

With HFC-134a being the largest element of consumption, the following table illustrates those consumption trends.

Kg						Consumption of Gas by Sector - HFC134a									
		%	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Total Consumption			97,973	71,555	78,847	75,332	67,820	61,135	57,892	56,311	55,175	54,435	54,045	53,966	54,163
Growth Rate				*-27%*	*10%*	*-4%*	*-10%*	*-10%*	*-5%*	*-3%*	*-2%*	*-1%*	*-1%*	*0%*	*0%*
Refrigeration	Domestic	1%	292	324	360	1,460	900	630	550	621	693	764	836	907	979
	Commercial	12%	4,390	4,878	5,420	5,887	7,136	6,497	6,742	7,557	8,372	9,187	10,001	10,816	11,631
	Industrial/Supermarkets	0%	82	74	67	60	30	20	20	20	20	20	20	20	20
	Transport	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Conditioning	Stationary A/C	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Air Conditioning	25%	9,372	10,413	11,570	13,150	13,580	14,690	15,730	17,200	18,670	20,140	21,610	23,080	24,550
	Other A/C	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
Solvents	Chesterton (45%)	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
Foams		62%	83,830	55,850	61,410	54,730	46,120	39,230	34,790	30,853	27,361	24,264	21,518	19,082	16,923
Aerosols		0%	8	16	20	45	54	68	60	60	60	60	60	60	60
Fire Protection		0%	0		0		0		0		0		0		
Other Uses		0%	0												

Table 1 – Consumption trends by sub-sector for HFC-134a (2008-2020)

It can be seen that the HFC Survey reports the dominant consumption of HFC-134a in the foam sector. Since there is no reported foam manufacture in Maldova, this estimate is made purely on the basis of imported products. The HFC Survey considers both polystyrene and polyurethane foam types. However, Anthesis-Caleb has concerns that the values for HFC-134a consumption stated in the HFC Survey may be significantly over-stated for the following reasons:

- The use of 'primary forms' Product Codes for both Polystyrene and Polyurethane. Since both polymers have significant (possibly dominant) non-foam uses, the use of codes 3903-11 and 3909-50 almost certainly over-state the foam imports. The fact that separate tariff codes exist for Cellular Products made from both polymers, suggests that these alone might be the only foam products imported. However, since considerable misallocation of tariff codes is common in these product types, the most likely reality is somewhere between the two.

- The report assumes that all of the polystyrene foam imported is extruded polystyrene foam (XPS) containing HFCs, rather than expanded polystyrene foam (EPS). This is important, since

EPS has never used CFCs, HCFCs or HFCs as blowing agents. Accordingly, the assumption may further over-estimate HFC consumption, even under the 'Cellular Product' definition.

- The report assumes that all foams are blown with HFC-134a. This is based on the 1996 IPCC Good Practice Guidelines. Had the HFC Survey referred to the 2006 IPCC Guidelines, it would have recognized that those polyurethane foams that are HFC-based are likely to be blown with either HFC-245fa or HFC-365mfc/227ea blends. The net consequence, is that the HFC-134a assumption is likely to over-state the climate impact of the emissions because of its higher GWP when compared with HFC-245fa or HFC-365mfc/227ea blends.

Although this may mean that some HFC-245fa, HFC-365mfc and HFC-227ea might be present in products within Moldova, it is not seen as appropriate for this Emissions Assessment Report to speculate on that. Neither is it appropriate to speculate on the EPS/XPS split. However, by mapping the lower bound of the foam imports based solely on the 'Cellular' tariff codes, the impact on emissions can be assessed, and is indeed shown in Figures 2 and 3, with Figure 3 illustrating the lower bound scenario.

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In a second step dealing with emissions, the consumption by agent (substance or blend), as set out by example in Table 1, was then transposed to an analysis by sub-sector, which then assembled the different agents used and the emission factors related to each of those sub-sectors. In some instances, where there was evidence of a potential reduction in emission rates over time, this was factored into the modelling of emissions, as shown in Table 2 below.

Sub-Sector	***Annual Emission Rate***	***Growth in Installed Base (2008-2020)***
Refrigeration – Domestic	1%	55%
Refrigeration – Commercial	25% reducing to 19%	23%
Refrigeration – Industrial	20%	905%
Refrigeration – Transport	40%	-67%
Stationary A/C	10%	368%
Mobile A/C	25%	64%
Other A/C	10%	N/A
Solvent	50% reducing to 26%	N/A
Foams	8%	18%
Aerosols	100%	689%
Fire Protection	5%	N/A%

Table 2 – Adopted IPCC Annual Emission Rates and resulting Growth in Installed Bases

INSTALLED BASES BY SUB SECTOR AND RESULTING EMISSIONS

The Moldovan HFC Survey provides estimates of banked HFCs across the Refrigeration & Air Conditioning (RAC) sectors, although this information is missing for foams. To compensate for this, Anthesis-Caleb has assumed that HFC-134a came into use in relevant products in 2000 and has aggregated the consumption over the next eight years to reach an assessment of the bank in 2008. As shown in Table 2, the model used assumes an average emissions rate of 8% per year, which is logical assuming that the split between polystyrene and polyurethane foams is as shown in the HFC Survey, which broadly favours polystyrene. This still delivers and overall growth in the bank of HFCs in foams of 18% by 2020, even though the proportion of HFCs used in foams is expected to drop over that period.

The growth in most other banks to 2020 is also relatively modest, which may reflect the reality that assumed emission rates on which the servicing requirements are based are typically 10% across the board for stationary applications (Commercial, Industrial & SAC) and lower than the IPCC defaults assumed in the model. Since there was no justification given in the HFC Survey for the 10% assumption, the IPCC model is still seen to be most appropriate for modelling emissions. In the case of Transport Refrigeration the emission assumption used was 15%. However, since this is considerably lower than the value assumed by the IPCC (40%) and adopted in this emissions model, the net effect is a significant decrease in the bank over the period to 2020.

A similar effect is also observed for mobile air conditioning (MAC) where a 15% leakage rate has been used to drive the service requirement against an IPCC default assumption of 25%. In this case, however, the bank is still seen to grow by 64% through to 2020. This is indicative of the substantial underlying growth anticipated in vehicles incorporating MAC systems over that period.

Finally, the more significant growth rates in Industrial Refrigeration and Aerosol applications is most probably a result of the low base of the applications in 2008, where, proportionately, the uptake of HFCs in the period from 2008-2020 have been at their highest.

The net consequence of these various assumptions on emissions is shown in Figure 1, where HFC-134a is unsurprisingly seen as the most significant contributor to emissions.

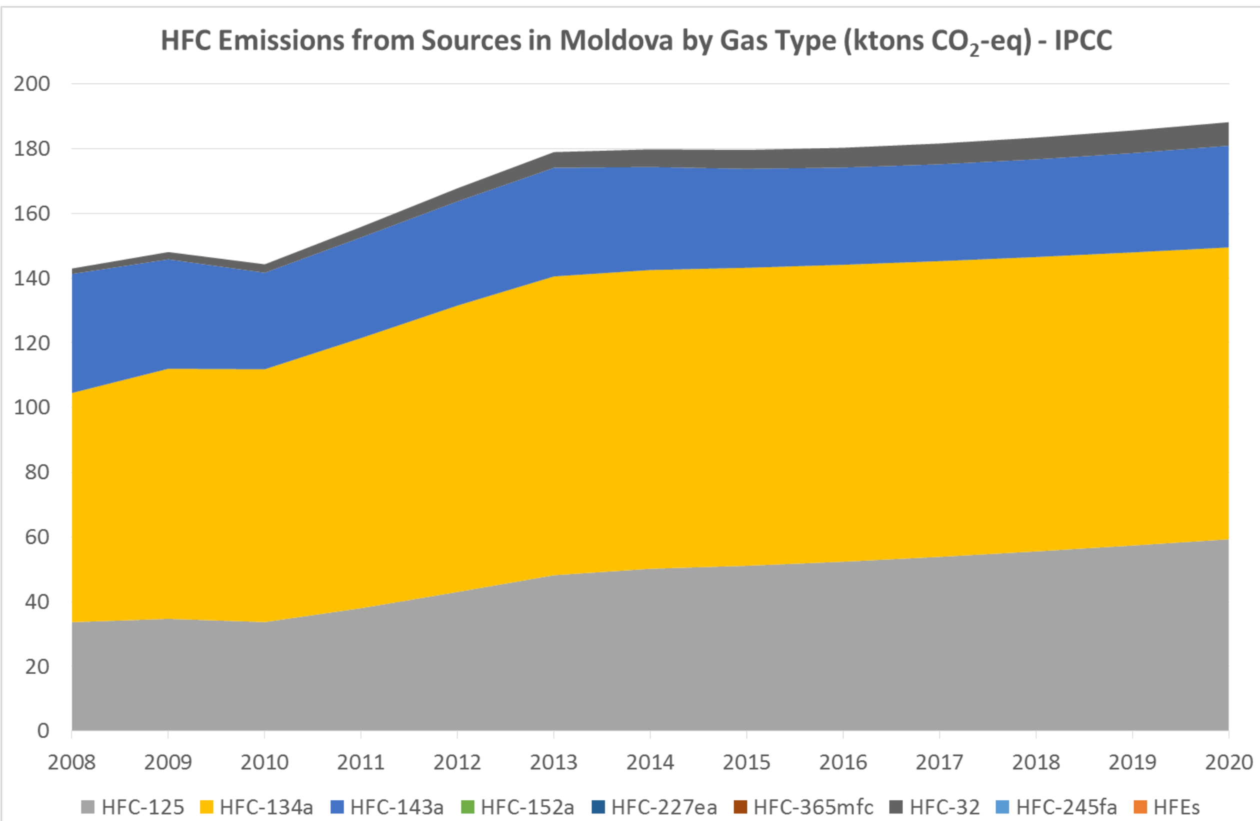

Figure 1 – Growth in HFC Emissions in Moldova by gas type

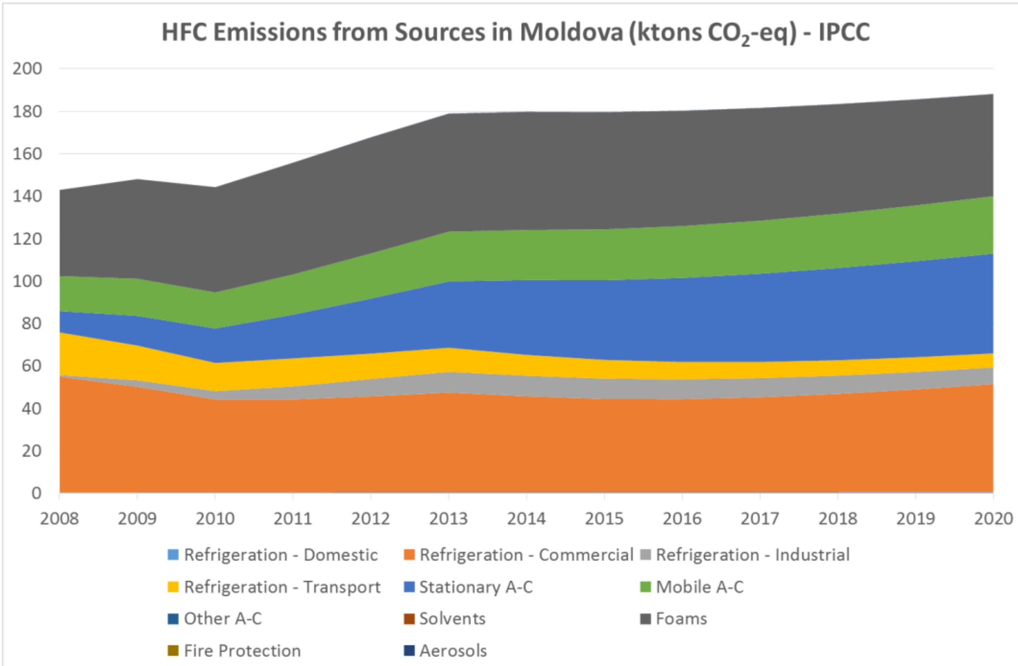

Figure 2 – Growth in HFC Emissions in Moldova by sector based on HFC Survey approach on foams

The significant contribution of emissions from foams is certainly evident from Figure 2, contributing up to 60 ktons CO_2-eq. per annum even at relatively modest emission rates. This can be compared with the outcomes from the 'Cellular-only' approach to the tariff codes in Figure 3.

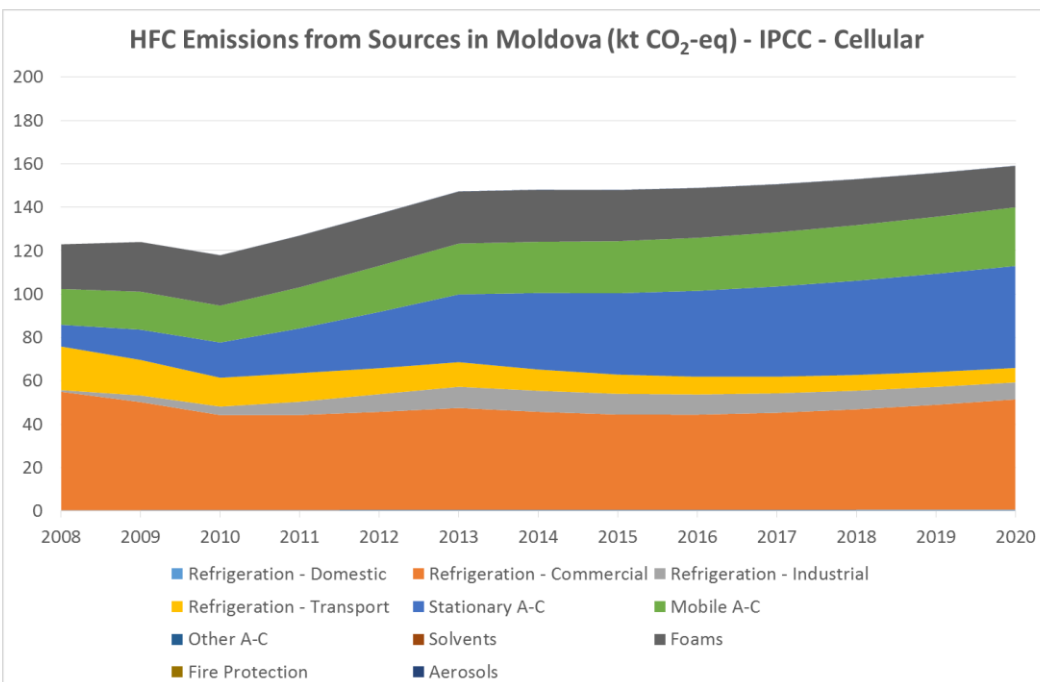

Figure 3 – Growth in HFC Emissions in Moldova by sector using a 'Cellular-only' approach for foams

LIMITATIONS OF ANALYSIS

The emissions forecasts for this assessment have not been extended beyond 2020 in order to be consistent with other analyses, even though estimates for 2025 exist for most RAC applications. However, these are understood to rely mostly on GDP drivers, which would make the projections less reliable over periods in excess of 10 years. The treatment of foam product imports has already been well documented in this Report, but the significance of the impact (up to 40kt CO_2/annum) is important to understand, since it represents up to 20% of the estimated annual emissions for Moldova. Accordingly, further analysis is recommended on the foam sector. Apart from this, it is believed that the overall consumption and emission assessments based on the Moldovan HFC Survey are robust at the macro-level.

HCFC emissions have been omitted from this Report in line with the sponsor's scope of assessing HFC emissions only. However, since HCFC's are being replaced, there should be a commensurate reduction in HCFC emissions over time. Accordingly, these are aggregated into the analysis within the graphs included in Annex 1.

CONCLUSIONS

The assessment of annual trends in HFC emissions for Moldova has proved possible based on the availability of the US Government sponsored HFC Survey and some supplementary information found in the 2011 Moldova Project Plan on the substitution of HCFCs in relevant sectors. The approach adopted has assumed that the annual consumption figures reported in both documents are reliable.

The inclusion of Domestic Refrigeration activities within the Commercial Refrigeration sector has required some additional manipulation of the data but, overall, the Moldovan HFC Survey has proved to be a very data-rich source of information, albeit with considerable caveats relating to the foam sector activities. These currently require further attention in order to derive a reliable estimate of overall annual emissions of HFCs in Moldova.

<u>Paul Ashford – Anthesis-Caleb, December 2016</u>

Annex 1 – Graphs inclusive of HCFC emissions

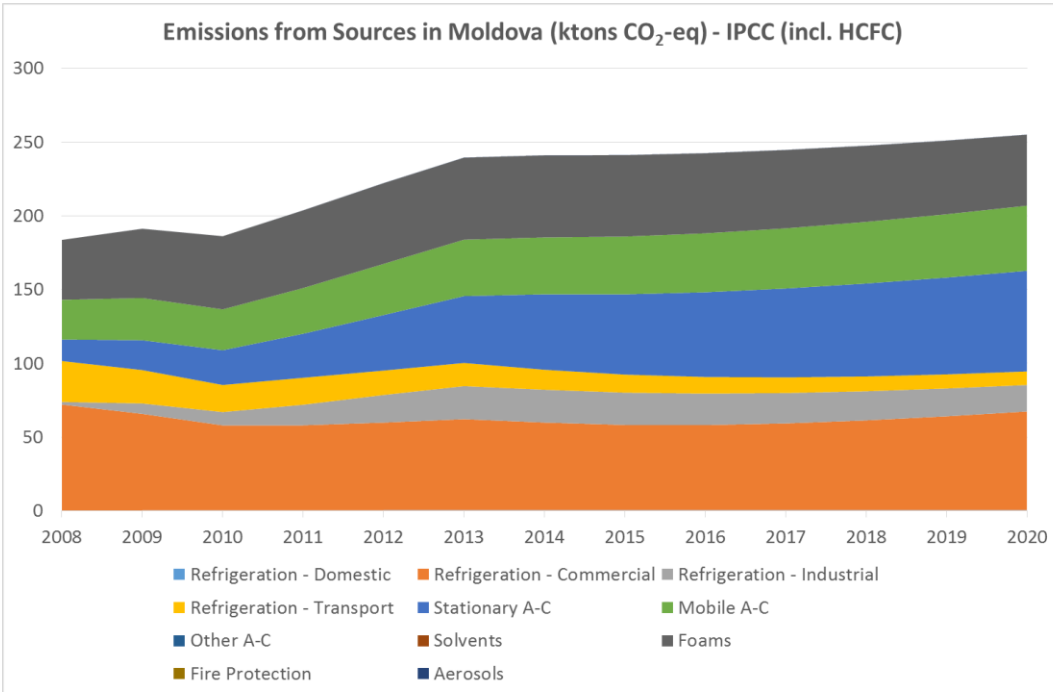

Figure A1 – Emissions from Sources in Moldova based on IPCC Emission Rates (incl. HCFCs)

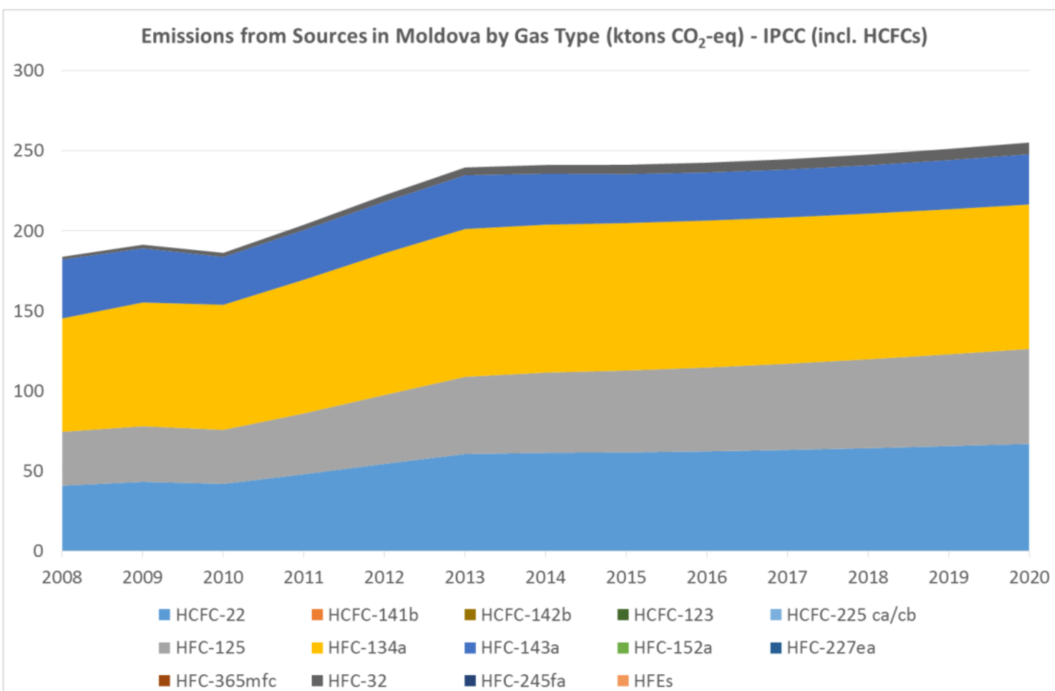

Figure A2 – Emissions by Gas Type in Moldova based on IPCC Emission Rates (incl. HCFCs)