THE BENEFITS OF BASING SHORT TERM CLIMATE PROTECTION POLICIES ON THE 20 YEAR GWP OF HFCS

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ABSTRACT

The short-term global warming contribution of HFCs is more accurately accounted for through the 20-year global warming metric (GWP_{20}) than through the 100-year global warming metric (GWP_{100}) that is conventionally used. The GWP_{20} metric better reflects the true potency of HFCs during their actual time in the atmosphere. Since global warming induced climate change is already happening it is essential to take all available measures to reduce greenhouse gas emissions. Depending on variations in emission scenarios, at a business as usual trajectory, HFC emissions are projected to be between 7 to 19% of total greenhouse gas emissions by 2050. Under a 450ppm CO2 stabilizations scenario combined with un-curtailed HFC emissions, in 2050 HFCs could represent between 18 to 45% of global CO2 emissions (UNEP Synthesis Report, 2011). Phasing out the use of HFCs by 2020 is one of the readily available measures to combat global warming. The climate benefits of such phase out are better understood when the GWP_{20} of HFCs is used in policy formulation. The intent of this paper is to reignite discussion on the benefits of basing policies on the 20-year global warming potential of HFCs rather than on the current standard of 100 year GWP.

1. NEED FOR SHORT TERM STRATEGIES TO PROTECT THE CLIMATE

1.1 Approaching Climate Tipping Points

2010 was one of the two hottest years on record (UN Dispatch, 2010). At the same time, according to the International Energy Agency (2011), CO_2 emissions in 2010 reached a record high of 30.6 Gt. Global greenhouse gas emissions have increased 36 per cent since the 1992 Rio Convention, despite the treaties in place to stabilize and to cut emissions (Steiner, 2011).

The steady growth in extreme weather events around the world signals that human-induced climate change is happening right now. 2010 and 2011 were punctuated with extreme weather events. We have witnessed unparalleled devastation around the world from record floods, fires, droughts, more frequent and intense tornadoes and hurricanes. In some countries, millions of acres of agricultural land have been lost due to flooding, while other countries report massive declines in crop harvests due to heat and drought. There were an estimated 38 million "climate refugees" in the world in 2010 (Internal Displacement Monitoring Centre, 2011).

In 2009, NASA's eminent climate scientist, Dr. James Hansen warned that the "climate is nearing dangerous tipping points…" A tipping point in the climate system implies abrupt, non-linear, unforeseen and unpredictable changes. It is reaching thresholds of no return, where human intervention has little or no capacity to restore nature's balance. Human activity is bringing the climate ever closer to self-accelerating turning points, whereby due to positive feedback, a change in one system triggers a cascade of changes in others. For example, the warming of the oceans will melt mountains of frozen methane at the seabed, which will eventually release massive amounts of methane into the atmosphere causing further warming of the atmosphere, resulting in accelerated melting of polar sea-ice and more global warming through increased oceanic absorption of the sun's radiation (McDonald, 2011).

The fact is that climate "tipping points" could be reached within a few decades. We must therefore act now to ensure that overall greenhouse gas emissions peak no later than 2015, decline rapidly thereafter, and reach as close to zero as soon as possible.

We must think both long and short term, and take immediate measures that will have significant climate benefits over the next several decades. There is now scientific and political agreement that we must keep 21st Century temperature rises between 1.5^{O} to 2^{O} C if we are to avert full-scale climate catastrophes (Steiner, 2011). To ensure that by 2020 temperature levels do not exceed the 1.5^{O} to 2^{O} centigrade threshold, global greenhouse gas emissions must be limited to around 44 gigatonnes (Gt) of CO_2 equivalent. However, under a business as usual scenario, emissions are projected to rise to around 56 gigatonnes, and even if all the highest climate protection ambitions of all countries are implemented and supported the global emissions are still expected to reach 49 gigatonnes of CO_2 equivalent by 2020 (Steiner, 2011).

The question then becomes: What are the most available and effective steps to reduce the flow of greenhouse gas emissions in the short term while we tackle the overall challenge of weaning the world from dependence on fossil fuels?

1.2 Need to phase out HFCs

Phasing down, and eventually phasing out, HFCs is one of the short-term preventative measures that the international community could undertake today to avoid unnecessary greenhouse gas emissions.

HFCs (hydrofluorocarbons) are a 'low-hanging fruit' in the battle to prevent dangerous climate change. Being extremely potent and short-lived greenhouse gases, their elimination would have an immediate and positive effect on the global climate.

As stated by the UNEP Executive Director Achim Steiner (2011), "By some estimates, action to freeze and then reduce this group of gases could buy the world the equivalent of a decades-worth of CO_2 emissions." Essentially, such action can be taken now to "buy back some time" to further tackle the challenges of reducing CO_2 emissions.

1.3 Montreal Protocol and HFCs

By phasing out CFCs and other ozone depleting substances (ODSs), the Montreal Protocol was instrumental in the reduction of massive amounts of greenhouse gas emissions: reductions of nearly 135 gigatonnes (Gt) of CO_2e emissions between 1990 and 2010. This has delayed the effects of climate change by up to 12 years (Velders et al, 2009). In September 2007 the Parties to the Montreal Protocol accelerated the phase-out of HCFCs by 10 years in both developed and developing countries. This agreement has the potential to prevent up to 18 Gt or more of CO_2e emissions, provided that (a) HCFCs are replaced by alternatives that have zero or low global warming potential (GWP) and (b) the energy efficiency of refrigeration and air conditioning equipment is improved (UNEP/TEAP, 2007)

1.4 Projected HFC Consumption and Emissions

HCFC consumption in developing countries is expected to peak in 2013 at approximately 566 kilotonnes (Kt) per year (or at 3.14 times the peak CFC consumption) (Freedonia Group, Inc., 2009). Should HFCs replace HCFCs in developing countries, consumption of HFCs in developing countries is projected to be 4 to 8 times greater than in developed countries by 2050 (Velders et al, 2009).

Global HFC emissions are rapidly increasing. "CO_2 equivalent emissions of HFCs (excluding HFC-23) increased by approximately 8% per year from 2004 to 2008" (UNEP Synthesis Report, 2011). Such high level of HFC emissions could eventually offset the climate benefits achieved by earlier phase-outs of CFCs. "Annual emissions of HFCs are projected to rise to about 3.5 to 8.8 Gt CO2eq in 2050 which is comparable to the [reductions] in ODS annual emissions of 8.0 Gt CO_2 eq. between 1988 and 2010" (UNEP Synthesis Report, 2011).

2. GLOBAL WARMING POTENTIAL METRICS FOR HFCs

2.1 Measuring the global warming potential of HFCs

Global warming potential (GWP) measures the potency of a greenhouse gas over a specific period of time, relative to carbon dioxide (CO_2), which has a GWP of 1. It is independent of a greenhouse gas's atmospheric concentration i.e. it reflects its thermodynamic properties (how good it is at being a greenhouse gas) irrespective of how much of it is in the atmosphere. An important aspect of GWP is the timescale used: there are 20 year, 100 year and 500 year GWP values for the majority of greenhouse gases.

There is high variability in the atmospheric lifetime of greenhouse gases. For example, CO_2 can be on the order of several centuries, CH_4 (methane) 12 years, SF_6 (sulfur hexafluoride) 3200 years. Due to this variability, the GWP_{100} metric has been deemed the most appropriate tool to cross-compare the effect of different greenhouse gases.[1] While this metric may be the most appropriate across compounds with such a wide range of atmospheric lifetimes, when it comes to HFCs it has the significant drawback of not capturing the true climate impact of these chemicals. This is because the most abundant HFCs in use today have atmospheric lifetimes much less than 100 years (see table 1).

Table 1: List of the most commonly used HFCs, HCFCs and low GWP alternatives. (IPCCC Fourth Assessment Report- 2007): Atmospheric lifetime and GWP_{20} and GWP_{100}[2]

Substance	Application	20 Year GWP	100 Year GWP	Atmospheric Lifetime
HCFC -22	Air-conditioning: most commonly used refrigerant	5,160	1,810	12
HCFC -141b	Insulation foam blowing	2,250	725	9.3
HCFC-142b	Insulation foam blowing	5,490	2,310	17.9
HFC-23	Low temperature refrigerant	12,000	14,800	
HFC-32	Blend component of refrigerants	2,330	675	4.9
HFC-125	Blend component of refrigerants	6,350	3,500	29
HFC-134a	Refrigerant in domestic refrigerators, mobile air-conditioning, stationary air-conditioning, blend component of refrigerants, foam blowing agent, aerosol propellant	3,830	1,430	14
HFC-143a	Blend component of refrigerants	5,890	4,470	52
HFC -152a	Blend component of refrigerants, foam blowing agent, possible future refrigerant	437	124	1.4
HFC-227ea	Refrigerant	5,310	3,220	
HFC-245fa	Foam blowing agent Possible future refrigerant	3,380	1030	7.6
HFC-365mfc	Foam blowing agent Possible future refrigerant	2,520	794	8.6
HFC-404a	Refrigerant blend: a leading alternative to HCFC-22 in air-conditioning	6010	3922	34.2
HFC-410 a	Refrigerant blend: a leading alternative to HCFC-22 in air-conditioning, transport refrigeration	4340	2088	
HFC-407c	Refrigerant blend: a leading retrofit alternative to HCFC-22 in air-conditioning, transport refrigeration	4115	1774	
CO2	Refrigerant, foam blowing agent	1	1	
Hydrocarbons	Refrigerant, foam blowing agent	<3	<3	
Ammonia	Refrigerant	0	0	

[1] The 100-year GWP metric was promoted by the chemical industry as part of their marketing strategy for HFCs. On a 20-year time scale the short teram global warming contribution of HFCs is many fold more damaging to the climate than on a 100-year scale, and therefore made HFCs politically less palatable. According to the industry: "Using 20 year time horizons for HFCs distorts the relative contribution of CO_2 (over 90% of it is ignored) and does not contribute to an informed and objective assessment of the use of HFCs." (http://www.fluorocarbons.org/en/info/brchures/fact_sheet_18.html) published by the European Fluorocarbon Technical Committee (members include: Mexichem Fluor, Arkema, DuPont, Solvay Fluor, Honeywell Fluorine Products)

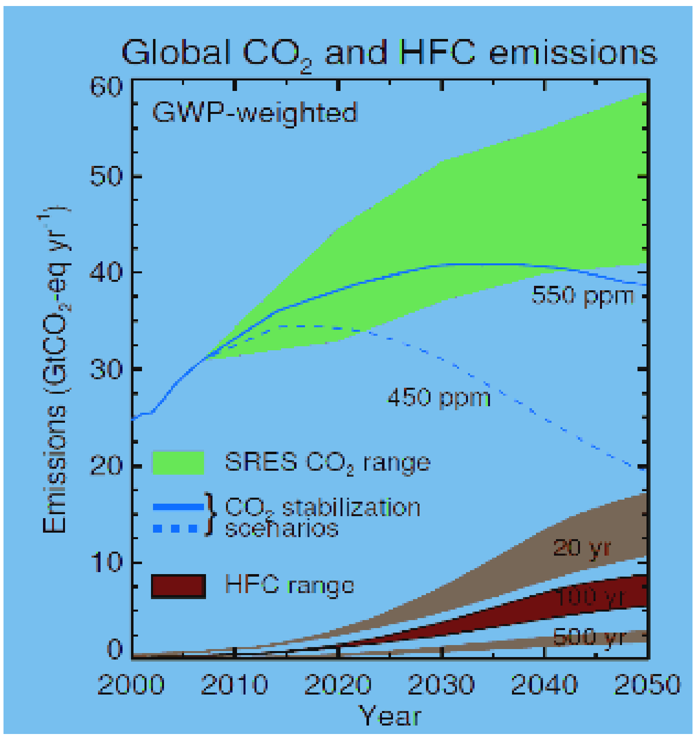
[2] WMO 2011 provides slightly altered GWP values for various substances.

The atmospheric lifetime of HFCs ranges from 1.4 years (HFC-152a) to 52 years (HFC-143a). Indeed with the average lifetime of the HFCs in use today is 21.7 years and therefore better suited to the 20 year GWP metric. Their short-term climate impact is thus diluted when measured using GWP_{100} and not adequately accounted for in climate policies. The GWP_{20} metric better reflects the true potency of HFCs during their actual time in the atmosphere.

Indeed, the average GWP_{20} for HFCs (at 4582) is 94% greater than the GWP_{100} average (at 2362) (Velders et al, 2009). As a result, the short term ramifications of high level HFC consumption are far greater when their global warming contribution is measured according to their 20 year GWPs (GWP_{20}), instead of their 100 year GWPs (GWP_{100}), the current reference point.

2.2 Comparing the GWP_{20} and GWP_{100} Global Warming Contribution of HFCs[3]

Graph 1: Comparison of emission projections based on GWP_{20}, GWP_{100} and GWP_{500} (Velders et al, 2009 – unpublished graph)



The absolute annual HFC emissions weighted by GWP_{20} are roughly twice as high as the absolute annual HFC emissions weighted by GWP_{100}.

- Under the BAU consumption scenario calculated by Öko-Recherche, by 2050, the annual HFC consumption in developed (A2) countries will be approximately 1.25 Gt CO_2 eq. when using GWP_{100}, and more than twice that at 2.8 Gt CO_2 eq. when using GWP_{20}

- Under the same scenario, by 2050, the annual HFC consumption in developing (A5) countries will be approximately 5 Gt CO_2 eq. using GWP_{100}, and more than twice that at 10.8 Gt CO_2 eq. when using GWP_{20}

Table 2: Projections for HFC consumption (Mt CO_2-eq) in developed and developing countries in a BAU scenario expressed in GWP_{100} metrics.

Consumption BAU GWP_{100} (Mt CO_2 eq.)	2010	2020	2030	2040	2050
Developed Countries	637	909	1,047	1,137	1,253
Developing Countries	163	1,179	2,570	3,802	5,008
Global	1,016	2,088	3,617	4,939	6,261

[3] HFC consumption and emission data based on Velders et al (2009) and Oko-Recherche (2009).

Table 3: Projections for HFC consumption (Mt CO_2 eq) in developed and developing countries in a BAU scenario expressed in GWP_{20} metrics.

Consumption BAU GWP_{20} (Mt CO_2 eq.)	2010	2020	2030	2040	2050
Developed Countries	1,395	1,992	2,323	2,537	2,807
Developing Countries	379	2,546	5,539	8,209	10,875
Global	1,558	4,538	7,862	10,746	13,182

2.3 Political Basis for Choice of GWP Timeframe

Which time frame is used to measure the global warming potential of substances is the result of political decision-making. In the UNEP/IPCC First Assessment Report (1990) the need for three different time frames (20, 100 and 500 years) for indicating GWP was justified as follows:

"For the evaluation of sea-level rise, the commitment to greenhouse warming over a 100 year or longer time horizon may be appropriate. For the evaluation of short-term effects, a time horizon of a few decades could be taken; for example, model studies show that continental areas are able to respond rapidly to radiative forcing so that the relative effects of emissions on such timescales are relevant to predictions of near-term climate change." The IPCC (1990) underlines that "the choice of time horizon will depend on policy considerations."

Furthermore, COP17 of the UNFCCC (2011) noted "the limitations in the use of GWP based on the100-year time horizon in evaluating the contribution to climate change of emissions of greenhouse gases with short lifetimes."

Given the urgency of the climate crisis, GWP_{20} better captures the political timescales that characterize national policy discussions and international negotiations. As Velders et al (2009) notes: "The climate forcing significance of a given time series of HFC emissions is highly sensitive to the time-horizon assumed because the HFC lifetimes are short compared with CO_2 lifetime...These climate-forcing comparisons, using GWPs with a 100-year time horizon yield and HFC consumption of 6.4-9.9 Gt CO_2-eq per year in 2050. If, instead, a 20-year time horizon is used, the consumption increases to 12.6-20 GtCO_2-eq per year."

3. SUMMARY FINDINGS

1. The absolute annual HFC emissions weighted by GWP_{20} are roughly about twice as high as absolute annual HFC emissions weighted by GWP_{100} in the year.

2. The atmospheric lifetimes of the HFCs considered in the comparison of projections range from 1.4 to 52 years. Therefore, the GWP_{20} metric reflects more accurately the actual global warming impact of HFCs

3. The short-term global warming impact of HFCs becomes particularly relevant when deciding about policy measures addressing climate change in the near term.

4. Climate policies should refer to the short-term global warming impact of HFCs and aim at near term HFC consumption and emission reductions.

5. Adopting the 20-year GWP index has immediate policy ramifications.

- It would influence the level of the baseline needed to phase-out HFCs, as a GWP_{20} baseline would be higher than a GWP_{100} baseline.
- It would influence the order of how control steps are implemented, with the phase out of substances with high GWP_{20} likely to be implemented first.
- It would redefine low GWP substances. While GWP_{100} values of some substances may seem deceptively attractive to some policy makers, the same substances measured using GWP_{20} become

much less appealing. A prime example is HFC-32, with a GWP of 675 over 100 years and 2,330 over 20 years.

- It could lead to HFCs being taxed according to their climate impact across their atmospheric lifetime. The comparably high GWP_{20} values of most HFCs would result in high tax values. Fiscal instruments could thus be effective measures to significantly reduce projected HFC emissions within a very short time.
- It would encourage the uptake of low global warming natural refrigerants, such as hydrocarbons, CO_2 and ammonia.

4. CONCLUSION

To protect the climate, governments in both industrialized and developing countries must set progressive restrictions on the use of HFCs, with an aim to their global phase-out by 2020. Adopting the GWP_{20} metric for HFCs for policy formulation will present governments a more accurate accounting of the climate benefits of a vigorous HFC phase-down and phase-out regime.

At the same time, governments must enact legislation and fiscal incentives (e.g. GWP weighted greenhouse gas taxes) to support the uptake of low-climate impact technologies. This will guide industry towards natural refrigerants and foam blowing agents. These technologies are already available in most sectors and more are rapidly coming on line (Greenpeace International, 2010; Umweltbundesamt, 2011; UNEP Synthesis Report, 2011; UNEP/TEAP, 2009; UNEP/TEAP, 2010).

Since HFCs are primarily used as replacements for ODSs controlled by the Montreal Protocol, the Protocol is largely responsible for their massive global uptake. The Montreal Protocol has vast experience in phasing-out fluorocarbon substances, and as such the Protocol is well positioned to be the key international instrument for the elimination of HFCs. HFCs should, therefore, be brought into the regulatory regime of the Montreal Protocol.

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