QUESTIONS & ANSWERS ABOUT REGULATING HYDROFLUOROCARBONS UNDER THE MONTREAL PROTOCOL

INTRODUCTION

Strengthening the Montreal Protocol on Substances that Deplete the Ozone Layer ("Montreal Protocol") to regulate hydrofluorocarbons ("HFCs") will provide fast-action climate mitigation to complement long-term reductions in greenhouse gas ("GHG") emissions under the United Nations Framework Convention on Climate Change ("UNFCCC"). Fast-action to reduce HFC emissions is necessary to avoid tipping points for abrupt, irreversible, and catastrophic climate changes and other "dangerous anthropogenic interference with the climate system."[1] The amendments put forward by the Federated States of Micronesia ("FSM 2011 HFC Amendment") and by the United States of America, Mexico, and Canada ("North American HFC Amendment") to regulate the production and consumption of HFCs under the Montreal Protocol will seize this important climate mitigation opportunity and prevent the emission of between 88 and 147 billion tonnes ("Gt") of carbon-dioxide equivalent ("CO_2-eq.") between 2014 and 2050.[2] In terms of radiative forcing, ***these avoided emissions are equivalent to 8-13 years of CO_2 emissions growth***.[3]

QUESTION 1: What are HFCs?

HFCs are synthetic GHGs produced for use as substitutes for ozone-depleting substances ("ODSs") in refrigeration, air-conditioning, insulating foams, aerosols, solvents, and fire protection[4] and as an unintentional byproduct during the production of the ODS HCFC-22.[5] Most HFCs currently in use have high global warming potentials ("GWPs") and short atmospheric lifetimes.[6] Over the last decade, HFC use and emissions have increased dramatically as ODSs controlled under the Montreal Protocol—such as chlorofluorocarbons ("CFCs") and hydrochlorofluorocarbons ("HCFCs")—have been phased-out and replaced by HFCs.[7]

QUESTION 2: How much will HFCs contribute to climate change?

HFC emissions have increased at an alarming rate. In 2015, HFC emissions will reach 1.4 Gt CO_2-eq.—a 325% increase since 2002.[8] Thereafter, in the absence of additional regulation under the Montreal Protocol, HFC emissions growth will accelerate dramatically and eventually will comprise a significant percentage of the overall climate problem. By 2040, HFC emissions are expected to reach 4.2-6.9 Gt CO_2-eq. per year.[9] ***By 2050, HFC emissions will reach 5.5–8.8 Gt CO_2-eq. per year, which is equivalent to 9-19% of projected global CO_2 emissions under business-as-usual ("BAU") scenarios and 28-45% under a CO_2 stabilization scenario of 450 parts per million*** ("ppm").[10] Notably, by this time HFC emissions in developing countries are predicted to be up to 800% greater than in developed countries.[11]

QUESTION 3: What are the climate benefits of phasing down HFCs?

Adopting the FSM 2011 HFC Amendment will result in cumulative ***emissions reductions of 89-146 Gt CO_2-eq.*** from 2014-2050 versus BAU scenarios.[12] Reducing HFC emissions through a production and consumption phase-down offers policymakers a win-win opportunity to cost-effectively achieve substantial climate mitigation. The FSM 2011 HFC Amendment serves as a blueprint for capturing this significant climate mitigation opportunity by following the successful formula used by the Montreal Protocol to eliminate ODSs used in the same sectors.

The FSM 2011 HFC Amendment will establish a baseline using historic production and consumption data of the chemicals used in the sectors now transitioning to HFCs and imposing a gradual phase-down schedule on industrialized countries beginning in 2014 and in developing countries in 2020, following a 6-year grace period, with a maximum reduction of 90% in 2031 and 2037 respectively.[13] The CO_2-eq. emissions reduced or avoided by the FSM 2011 HFC Amendment are roughly ***9 to 15 times the CO_2-eq. emissions reduced or avoided under the Kyoto Protocol*** assuming full compliance through the end of its first commitment period in 2012.[14]

QUESTION 4: Are existing international regulations adequate to control HFC emissions?

No. Although several drivers of HFC proliferation are controlled under the Montreal Protocol, HFCs themselves are not.[15] Instead, HFCs have been included among the six GHGs targeted for emission reductions under the Kyoto Protocol to the UNFCCC ("Kyoto Protocol").[16] For those HFCs that are used as substitutes for ODSs (all HFCs except HFC-23), the Montreal Protocol's imminent phase-out of ODSs and the lack of binding international or national HFC control measures in most countries mean an enduring and growing market for HFCs will be established in the near future ensuring HFC emissions increase significantly in the mid and long terms. HFC growth has, and will continue, to outstrip the growth of other GHGs despite the availability of low-GWP alternatives to HFC products until a comprehensive governance approach to the sectors that use ODSs and HFCs is agreed to under the Montreal Protocol.[17]

HFC-23 is produced as a byproduct of HCFC-22 production—a production process that is exclusively under the control of the Montreal Protocol.[18] The current regulatory approach, whereby HCFC-22 production is controlled by the Montreal Protocol and HFC-23 emissions are included in the Kyoto Protocol's basket of GHGs, has led to an increase in HFC-23 emissions despite the fact that HCFC-22 production is being phased-down under the Montreal Protocol and technological advances have decreased proportional amount of HFC-23 necessarily produced as an HCFC-22 byproduct.[19] This disconnected regulatory approach to the sectors that use ODSs and HFCs and their production processes has led the existing ozone and climate regimes to work, at times, at cross-purposes and is creating regulatory loopholes that undermine international efforts to protect the climate system and ozone layer.

QUESTION 5: Why should we use the Montreal Protocol to phase-down HFC production and consumption for those HFCs that are ODS substitutes (all HFCs except HFC-23)?

For the simple reason that it provides the fastest, most cost-effective means of reducing HFC emissions. The Montreal Protocol benefits from unique structural advantages, decades-long institutional expertise and cost-effective implementation tools. Further, the increased reliance on HFC products is a direct result of Montreal Protocol's regulation of ODSs, creating potentially conflicting environmental mandates that can only be addressed by bringing these substances under the same regulatory authority.

HFCs that are produced as products themselves (all HFCs except HFC-23) will constitute 75% of total HFC CO_2-eq. emissions in 2015 and an increasing proportion thereafter.[20] For these HFCs, it is far more cost-effective to reduce HFC production and consumption upstream than to control emissions downstream—in some cases by a factor of several hundred.[21] The emissions-based Kyoto Protocol has proven ineffective at controlling rising HFC emissions from HFC products largely because it cannot address HFC production and consumption—something that the Montreal Protocol is uniquely qualified to do. The Kyoto Protocol also does not place binding emissions limitation or reduction targets on developing countries—nor is it likely its successor treaty will either—which is problematic because future growth in HFC production, consumption, and emissions will occur primarily in developing countries.[22]

The Montreal Protocol enjoys several advantages that will allow it to quickly adopt and implement effective regulations for HFCs. The treaty has achieved universal ratification; there are 196 Parties to the Montreal Protocol.[23] It applies the principle of common but differentiated responsibilities by providing differentiated reduction commitments for both developed and developing countries and funding to developing countries to meet all agreed incremental costs of compliance.[24]

All the Parties to the Montreal Protocol have reduction commitments under the treaty, including developing countries, which accept the same reduction commitments as their developed-country counterparts but with a grace period negotiated by the Parties.[25] There also exists a fully-functioning and effective financial-transfer mechanism—the Multilateral Fund for the Implementation of the Montreal Protocol ("MLF")—that can assist developing countries in phasing down high-GWP HFCs by providing financing for the incremental costs of compliance with HFC control measures.[26] It also has an effective technology-transfer mechanism, enforceable compliance mechanisms, and is supported by real-time scientific and technical assessments that facilitate rapid regulatory responses through "adjustments."[27] Together, these tools have resulted in unrivaled environmental protection and compliance with the commitments and obligations established under the Montreal Protocol. These mechanisms and the expertise and experience of the institutions that support the Montreal Protocol are fully transferable to implement a phase-down of HFCs.

QUESTION 6: Why should the Montreal Protocol coordinate the phase-out of HCFC-22 production and reduction of HFC-23 emissions?

Because the current disconnected regulatory framework is allowing HCFC-22/HFC-23 production and emissions to increase unnecessarily thereby undermining the Montreal Protocol and Kyoto Protocol and its Clean Development Mechanism ("CDM"). The FSM 2011 HFC Proposal will end the perverse incentives that created this problem by ensuring no new HFC-23 CDM projects are approved and requiring all Parties to increase the efficiency of their HCFC-22 production facilities and destroy all HFC-23 byproduct emissions from all non-CDM HCFC-22 production facilities thereby healing the ozone layer and protecting climate system.

The growing majority of HFC-23 emissions will occur in developing countries and the Kyoto Protocol does not require developing countries to freeze or reduce their emissions of HFC-23.[28] Instead, the only incentive for developing countries to reduce HFC-23 emissions is through the CDM.[29] However, because of the serious environmental damage caused by HFC-23 CDM projects, the Executive Board of the CDM has imposed limitations on the eligibility of future HFC-23 destruction CDM projects that effectively place a moratorium on all new HFC-23 destruction CDM projects.[30] Further, the European Commission (EC), which oversees the European Union Emissions Trading Scheme (EU ETS)—the largest carbon market in the world—recently imposed a ban, beginning May 1, 2013, on carbon credits created through HFC-23 destruction.[31] This means that now and into the future the majority of HCFC-22 production facilities in developing countries will have no incentive to destroy the unwanted HFC-23 they continue to produce.[32] As a result, global HFC-23 emissions continue to increase despite the cost-effective means of destroying it.[33]

For those CDM-approved HCFC-22 production facilities, the CDM provides a perverse incentive to produce more HCFC-22 than is needed to meet market demand and more HFC-23 emissions than would otherwise occur. This is because HFC-23 CDM projects make 2.9-5.7 times more money from selling CERs generated by destroying the useless HFC-23 byproduct than from the HCFC-22 they produce.[34]

The methodology used by the CDM to determine how many HFC-23 CERs a production facility can generate per year places a limit on the amount of HCFC-22 that can be produced where the HFC-23 byproduct can be destroyed to generate CERs based on historic HCFC-22 production from 2000 to 2004.[35] The methodology erroneously assumes that HCFC-22 demand and corresponding production will remain stable or grow now and into the future. However, several factors have combined to ensure that HCFC-22 demand will decrease in the coming years which would correspond to a reduction in HCFC-22 production in the absence of a perverse incentive created by the CDM. These factors include: the 2007 agreement under Montreal Protocol to accelerate the phase-out of HCFCs (which uses of the recession years of 2009 and 2010 as its baseline for developing countries);[36] restrictions placed on HCFC-22 consuming equipment in the United States and elsewhere; and the construction of new, more efficient, HCFC-22 production facilities.

The CDM, however, provides a perverse incentive for HCFC-22 production facilities to produce the maximum amount of CDM-eligible HCFC-22 regardless of whether there is a market for it in order to maximize HFC-23 destruction profits. A review of the production patterns of CDM-approved facilities shows that in some cases where the maximum amount of HFC-23 CERs has been reached for a particular crediting year before the end of that crediting year, facilities drastically reduce or stop their production of HCFC-22 altogether.[37] These production patterns clearly demonstrate that the CDM's policies and the desire to profit from HFC-23 destruction are driving production of HCFC-22—not market demand. The unused, excess HCFC-22 is almost never destroyed and instead is emitted into the atmosphere where it damages the ozone layer and undermines the work of the Montreal Protocol.

The excess HCFC-22 also harms the climate system. HCFC-22—an ODS—is also a GHG with a GWP of 1,810 and has a larger climate impact than its HFC-23 byproduct.[38] The production of one tonne of HCFC-22—equal to 1,810 CO_2-eq. tonnes—at a CDM-approved facility will produce up to 30 kilograms of HFC-23—with a GWP of 14,800—equal to 440 tonnes of CO_2-eq.[39] Thus, in the name of preventing 440 CO_2-eq. tonnes of HFC-23, four times as much CO_2-eq. unwanted HCFC-22 will be produced erasing most or all of the climate benefits of any given HFC-23 CDM project.

The CDM methodology also sets a ratio of HFC-23 byproduct to HCFC-22 product based on historic production patterns to determine the amount of HFC-23 CERs a HCFC-22 production facility can produce in a given year with 3% as the maximum allowable ratio.[40] But the methodology does not account for autonomous technological improvements that have subsequently occurred within the industry (some facilities in developing countries currently operate at a ratio to 1.1%),[41] does not require plants operate at historically achievable ratios (some facilities in developing countries operated at a ratio of 1.64% as early as 2003),[42] or even require plants operate at a ratio they themselves can achieve.

Rather, the methodology actively discourages improving the efficiency of CDM approved facilities by rewarding less efficient plants. As a result, some CDM-approved facilities actually improved their efficiency during periods in which they had already achieved their maximum allowable CERs for the crediting year and no further CERs can be generated—in some cases voluntarily eliminating more than 50% of their HFC-23 byproduct emissions.[43] This proves that not only is the lower ratio achievable in the normal course of business with no additional cost to the plant operator, but that most HFC-23 emissions are fabricated simply to profit from the CDM.

Finally, the reductions that are achieved are done so at a higher cost than they would be under the Montreal-Protocol. The incremental cost of destroying HFC-23 is just $US 0.20 per CO_2-eq. tonne.[44] However, the CERs generated from the destruction are, on average, sold for US$13—65 times the actual cost of destruction.[45] Through the end of first commitment period of the Kyoto Protocol, HFC-23 destruction CDM projects will generate more than US$6.5 billion from carbon markets and destroy only 0.45 Gt CO_2-eq. which could have been destroyed through the MLF at a cost of US$90 million dollars.[46]

Article 12 of the Kyoto Protocol created and defines the CDM, the purpose of which is "to assist Parties not included in Annex I ... in contributing to the ultimate objective of the UNFCCC ... [47] However, HFC-23 CDM projects do not always represent actual climate mitigation and in some cases produce CO_2-eq. emissions than would not otherwise occur in the absence of the CDM project. Fabricated HFC-23 CERs are flooding the carbon market is with cheap credits that only serve to shield industrialized countries from making meaningful GHG reductions. As such, they are not consistent with the purpose of the CDM as articulated in Article 12 of the Kyoto Protocol.

Kyoto Protocol Article 12 also establishes requirements for certifying CDM projects, including that the project shall contribute "[r]eal, measureable, and long-term benefits related to the mitigation of climate change ..." [48] As demonstrated herein, HFC-23 CDM projects do not contribute to either of these objectives. These CDM projects do not produce "real" climate benefits nor do they contribute to sustainable development. Instead, they draw funding away from other CDM projects that will reduce long-lived CO_2 emissions and promote sustainable development (e.g., renewable energy and energy-efficiency projects). In sum, continuing to allow the Montreal Protocol to regulate HCFC-22 production and leaving HFC-23 emissions within the Kyoto Protocol and its CDM does not benefit the climate system or ozone layer.

QUESTION 7: Are alternatives available that will allow Parties to meet their HFC phase-down obligations?

Yes. The Montreal Protocol has a history of driving innovation in the sectors it regulates and the Parties to the Montreal Protocol have always had technically and economically feasible alternatives available to them to meet their phase-out obligations under the treaty. In the case of HFCs, a recent report by the Technical and Economic Assessment Panel ("TEAP") of the Montreal Protocol reviewed the commercially available and in-development alternatives to high-GWP HFCs for all sectors that are currently using HCFCs and HFCs and demonstrates that the HFC phase-down schedule proposed in the FSM 2011 HFC Amendment is economically and technically feasible.[49] The TEAP's conclusions have been buttressed by series of U.S. and EC-commissioned reports on available alternatives to high-GWP HFCs published in 2010.[50]

The mobile air-conditioning ("MAC") sector currently uses HFC-134a (GWP of 1,440) and is responsible for 30% of current global HFC use.[51] A directive from the European Commission ("EC")—EC Directive 2006/40/EC—mandates that beginning in 2011 vehicles sold in the European Union ("EU") use low-GWP refrigerants and eventually requires all new cars sold in the EU use refrigerants with a GWP of less than 150 by 2017.[52] Similar to the historic market-driving force of Montreal Protocol control measures, this regulation has resulted in the commercialization of at least two low-GWP HFC-134a replacements—HFO-1234yf, with a GWP of 4 and HFC-152 with a GWP of 124.[53] Both alternatives will be commercially available in advance of the first step of the FSM 2011 HFC Amendment phase-down schedule in 2014.[54] Due to the large purchasing power of the EU, it is almost certain that all vehicle manufacturers will meet the EC timeline and phase-out of HFC-134a in MAC globally by 2017. A global transition to HFO-1234yf in the MAC sector would mean industrialized countries could meet

their consumption phase-down commitments under the FSM 2011 HFC Amendment through 2020 without any further HFC reductions.[55]

The stationary air-conditioning ("SAC") sector will likewise comfortably transition away from high-GWP HFCs in the timeframe required by the FSM 2011 HFC Amendment. In domestic and commercial refrigeration (together accounting for approximately 30% of current HFC use),[56] low-GWP alternatives are already commercialized and in use—although in the absence of additional regulatory pressure from the Montreal Protocol, only 36% of domestic refrigeration and less than 5% of commercial refrigeration use the available low-GWP alternatives.[57]

In the industrial refrigeration sector (accounting for less than 5% of current HFC use), low-GWP alternatives are already in use and replacing HCFCs in many applications—with most applications likely to leapfrog HFCs entirely.[58] Low-GWP alternatives in the chillers sector have also been commercialized and in use for several years in developed and developing countries in all but the largest applications (where commercialization of low-GWP alternatives is expected to be complete by 2015).[59] However, without any market or regulatory pressure to the contrary, industrialized countries have largely adopted high-GWP HFCs as replacements for HCFCs (developing countries still utilize HCFCs) in chillers.[60]

At the moment, only the unitary air-conditioning (commercialization of low-GWP alternatives is expected to occur between 2015 and 2017),[61] and transport refrigeration (commercialization of low-GWP alternatives is expected to occur between 2020 and 2025)[62] subsectors of the refrigeration and air-conditioning sectors require significant additional development before commercialization.[63] Low-GWP HFC replacements in foams, which currently account for nearly 15-20% of current global HFC use, are already in use or under development (with commercialization expected in 2012-2013) with pilot projects in developing countries currently being considered by the MLF.[64]

Motivated by Montreal Protocol control measures, most sectors now relying on HCFCs and high-GWP HFCs will have commercially available low-GWP alternatives in the near-term. Developed and developing Parties will have ample time to meet their HFC phase-down obligations under the FSM 2011 HFC Amendment.

QUESTION 8: Can the Montreal Protocol, an ozone treaty, be used to regulate a GHG that does not deplete the ozone layer?

Yes. The Montreal Protocol can lawfully regulate HFCs to harmonize the regulation of the chemicals and sectors it covers to ensure that activities aimed at protecting the ozone layer do not inadvertently result in "adverse effects" to the environment.[65] Here, the regulation and phase-out of CFCs and HCFCs under the Montreal Protocol is driving rising production, consumption, and emissions of HFCs. In addition, through the MLF, developed countries have funded projects in developing countries aimed at replacing these ODSs with high-GWP HFCs to assist them in complying with their Montreal-Protocol-mandated obligations but, in the process, are creating an enduring market for HFCs. With respect to HFC-23, it is a produced as an unintentional byproduct during the production of HCFC-22, an ODS whose production is authorized by the

Montreal Protocol.[66] The undeniable causal connection between activities undertaken pursuant to the Montreal Protocol and HFC proliferation creates a special relationship and obligation on the Montreal Protocol under Article 2(2)(b) of the Vienna Convention for the Protection of the Ozone Layer to minimize the adverse environmental effects of HFCs on the climate system.[67] This is a more than an adequate nexus to allow the Montreal Protocol to regulate of HFCs.

QUESTION 9: How will HFC regulation under the Montreal Protocol interface with the UNFCCC, Kyoto Protocol, and the post-2012 climate regime?

At present, no international agreement regulates HFC production and consumption. Governments can decide to establish HFC production and consumption control measures under the Montreal Protocol to complement emissions-based HFC regulation under the UNFCCC, Kyoto Protocol and post-2012 climate regime.

Allowing the Montreal Protocol to control HFC production and consumption is complementary to, and in furtherance of, the ultimate objective of the UNFCCC.[68] It will facilitate a simpler, more politically-expedient means of solving this piece of the climate puzzle utilizing an existing international institution as envisioned in Article 7(2)(l) of the UNFCCC which states:

> To this end, [the Conference of the Parties] shall: … Seek and *utilize, where appropriate, the services and cooperation of, and information provided by, competent international organizations and intergovernmental* and non-governmental *bodies* …[69]

The operation of the Kyoto Protocol would likewise be unaffected by the FSM 2011 HFC Amendment. The first commitment period under the Kyoto Protocol extends from 2008–2012 and the FSM 2011 HFC Amendment does not impose any obligations on Parties in advance of 2013.[70]

The FSM 2011 HFC Amendment also specifically states that the inclusion of HFCs as controlled substances within the Montreal Protocol is not intended to affect commitments and obligations with respect to HFCs under the UNFCCC and Kyoto Protocol.[71] If adopted unanimously, this intent would have binding effect, as the Montreal Protocol is the only treaty in the world that has achieved universal ratification.[72]

The FSM 2011 HFC Amendment also specifically excludes HFC-23 emissions from the requirements of Article 2J where "the destruction of such substances has been approved as a [CDM] project under the Kyoto Protocol as of January 1, 2010 and that quantity is, in fact, destroyed pursuant to that agreement."[73] The language of the excluding provision is intended to allow the Parties to the UNFCCC and Kyoto Protocol to decide whether existing HFC-23 CDM projects are renewed for an additional crediting period but to require, and therefore remove the "additionality," from any new, future HFC-23 CDM projects.[74] In sum, the FSM 2011 HFC Amendment will ensure, beginning in 2013, all HFC-23 is destroyed and will prevent HCFC-22 production facilities from "gaming" the system in the future.

Concerns that countries would fail to receive credit for reductions otherwise achieved are moot because, under Article 3 and Annexes I and A of the Kyoto Protocol, Parties are permitted to take advantage of any HFC emissions reductions—without limitation—regardless of the international body that mandates them.[75]

A submission has also been made to the UNFCCC negotiations proposing that post-2012 climate regime include a specific provision "[u]*rg[ing]* Parties, without prejudice to the scope of the Convention and its related instruments, to pursue, under the Montreal Protocol on Substances that Deplete the Ozone Layer, the adoption of appropriate measures to progressively reduce the production and consumption of [HFCs]."[76]

QUESTION 10: How will Article 5 Parties' compliance with new HFC commitments be funded?

The FSM 2011 HFC Amendment proposes to amend Article 10 of the Montreal Protocol to include the new HFC production and consumption phase-down commitments and HFC-23 efficiency and destruction requirements, thereby triggering automatic incremental cost funding assistance for compliance with these new obligations to developing countries.[77] Per CO_2-eq. tonne, the cost of preventing these HFC emissions in developing countries through the MLF (estimated to be between US$ 7 – 12 billion from 2013-2050) will be less than 1% of the average price paid per CO_2-eq. tonne of emissions avoided through the Kyoto Protocol CDM in 2007-2008.[78]

Under Article 5(5)-(6) of the Montreal Protocol, compliance by Article 5 Parties, i.e., developing countries, with their obligations under the Montreal Protocol are conditioned upon the effective implementation of Article 10 and Article 10A (technology transfer).[79] Therefore, Article 5 Parties should understand that they will receive the same financial and technology transfer assistance toward compliance with the new HFC production and consumption phase-down commitments as they have received ODSs phase-downs in the past.[80]

The FSM 2011 HFC Amendment also includes commitments by Article 5 Parties to destroy HFC-23 byproduct—commitments that must be funded through the MLF. This level of destruction of controlled substances is unprecedented within the Montreal Protocol, but not unanticipated. The Parties to the Montreal Protocol originally included destruction in the Indicative List of Incremental Costs where destruction is "cost-effective".[81] The estimated cost of HFC-23 destruction is US$0.20 per CO2-eq. tonne.[82] On a CO_2-eq. basis this is extremely cost effective compared to other climate mitigation measures, including the destruction of ozone-depleting substances in banks.[83]

[1] *See* Timothy Lenton et al., *Tipping elements in the Earth's climate system*, 105 PROC. OF THE NAT'L ACAD. OF SCI. 1786-93 (2008); *see also* V. Ramanathan & Y. Feng, *On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead*, 105 PROC. OF THE NAT'L ACAD. OF SCI. 14245-50 (2008). Avoiding "dangerous anthropogenic interference with the climate system" is the ultimate objective of the UNFCCC. *See* United Nations Framework Convention on Climate Change, 31 I.L.M. 849 (9 May 1992) [hereinafter UNFCCC] at Art. 2.

[2] *Compare* Proposed Amendment to the Montreal Protocol (submitted by the Federated States of Micronesia), 28 Apr. 2011 [hereinafter FSM 2011 HFC Amendment] at 4-6 and 9, http://ozone.unep.org/Meeting_Documents/oewg/31oewg/FSM-Proposed-Amendment.pdf *with* Guus J.M.Velders, et al., *The large contribution of projected HFC emissions to future climate forcing*, 106 PROC. NAT'L. ACAD. SCI. 10949 (2009) [hereinafter Velders et al. 2009] (providing business-as-usual estimates of HFC consumption and emissions growth through 2050) *and* Guus J.M. Velders et al., *The Large Contribution of Projected HFC Emissions to Future Climate Forcing, Supporting Information*, 106 PROC. NAT'L ACAD. SCI. 3 (2009) [hereinafter Velders et al. 2009 Supporting Information], http://www.pnas.org/content/suppl/2009/06/22/0902817106.DCSupplemental/0902817106SI.pdf. A similar amendment was also put forward by the United States of America, Canada, and Mexico and would capture roughly the same climate benefits as the FSM 2011 HFC Amendment. *See* Proposed Amendment to the Montreal Protocol (submitted by the United States of America, Canada, and Mexico), 30 Apr. 2011 [hereinafter North American HFC Amendment], http://ozone.unep.org/Meeting_Documents/oewg/31oewg/HFC_Amendment_Proposal_Text.pdf.

[3] *See supra* note 2 Velders et al. 2009 at 10953.

[4] *See* IPCC AND TEAP, IPCC/TEAP SPECIAL REPORT ON SAFEGUARDING THE OZONE LAYER AND THE GLOBAL CLIMATE SYSTEM: ISSUES RELATED TO HYDROFLUOROCARBONS AND PERFLUOROCARBONS (2005) [hereinafter IPCC/TEAP 2005 SPECIAL REPORT], at *Summary for Policymakers* at 4.

[5] *Id.* at *Technical Summary* at 77.

[6] *See* P. Forster & V. Ramaswamy et al., IPCC, *Changes in Atmospheric Constituents and Radiative Forcing*, *in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS, CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE [hereinafter AR4 THE PHYSICAL SCIENCE BASIS] 212 (S. Solomon et al. eds., 2007). The three most pervasive HFCs—HFC-134a, HFC-125, and HFC-143a—have atmospheric lifetimes of 14, 29, and 52 years, respectively.

[7] *See* Montreal Protocol on Substances that Deplete the Ozone Layer, *opened for signature* Sept. 16, 1987, 26 I.L.M. 1550 (1989) (as amended 32 I.L.M. 84) (1992) [hereinafter Montreal Protocol] at Arts. 2A and 2F.; *see also supra* note 4, IPCC/TEAP 2005 SPECIAL REPORT at *Summary for Policymakers* at 4 and 8; TEAP, ASSESSMENT OF ALTERNATIVES TO HCFCS AND HFCS AND UPDATE OF THE 2005 SUPPLEMENT REPORT DATA (2009) [hereinafter TEAP DECISION XX/8 REPORT] 92-129; *supra* note 2, Velders et al. 2009.

[8] *See supra* note 7, TEAP DECISION XX/8 REPORT at 10.

[9] *See supra* note 2, Velders et al. 2009 at 10949; *supra* note 2, Velders et al. 2009 Supporting Information.

[10] *Id.*

[11] *Id.*

[12] *See supra* note 2. Compared to the same BAU scenarios, the North American 2010 HFC Amendment yields climate mitigation benefits of 87-147 Gt CO_2-eq. through 2050. *Compare supra* note 2, Velders et al. 2009 at 10952 *with supra* note 2, North American 2010 HFC Amendment at 2-3 and 5-6. Based on their own internal emissions growth projections, the North American countries estimate the North American 2010 HFC Amendment will prevent HFC emissions of 88 Gt CO_2-eq. through 2050. *See supra* note 2, North American 2010 HFC Amendment at *Summary Points: North American HFC Submission to the Montreal Protocol*.

[13] *See supra* note 2, FSM 2011 HFC Amendment at 4-6 and 9. The North American 2010 HFC Amendment follows the same formula as the FSM 2011 HFC Amendment but uses a different baseline for developing countries and different phase-down schedules for industrialized countries and developing countries. *See supra* note 2, North American 2010 HFC Amendment at 2-3 and 5-6.

[14] The combined amount of emissions reduced or avoided from 1990 levels by 2012 under the Kyoto Protocol is approximately 10 Gt CO_2-eq., of which approximately 5 Gt CO_2-eq. represent reduced emissions and another 5 Gt CO_2-eq. represent avoided emissions growth. *See* Guus J.M. Velders, et al., *The importance of the Montreal Protocol in protecting climate*, 104 PROC. NAT'L. ACAD. SCI. 4814, 4818 (2007) [hereinafter Velders et al. 2007].

[15] *See supra* note 7 Montreal Protocol at Art. 2F.

[16] *See* Kyoto Protocol to the United Nations Framework Convention on Climate Change, *opened for signature* March 16, 1998, U.N. Doc FCCC/CP/1997/7/Add.1, 37 I.L.M. 22 (1998) [hereinafter Kyoto Protocol] at Annex A.

[17] *Compare supra* note 2, Velders et al. 2009 *and supra* note 2, Velders et al. 2009 Supporting Information *with* L. Bernstein et al., IPCC, CLIMATE CHANGE 2007 SYNTHESIS REPORT 44 (A. Allali et al. eds., 2007).

[18] *See supra* note 7, Montreal Protocol at Art. 2F.

[19] *See* S.A. Montzka et al., RECENT INCREASES IN GLOBAL HFC-23 EMISSIONS, 37 Geophysical Research Letters LO2808 (Jan. 2010) [hereinafter Montzka et al.] at 1.
[20] *See supra* note 4, IPCC/TEAP 2005 SPECIAL REPORT at 396 and 413; *see also supra* note 7, TEAP DECISION XX/8 REPORT at 10. The accelerated phase-out of HCFCs agreed to in 2007 will dramatically reduce the amount of HCFC-22 produced for use in products in the coming years and decades. HCFC-22 produced for use in products is responsible for 60% of all HFC-23 byproduct emissions.
[21] *Compare* Multilateral Fund for the Implementation of the Montreal Protocol, http://www.multilateralfund.org/ *and supra* note 14, Velders, et al. 2007 at 4814-19 (showing that the MLF has spent US$ 2.9 billion to phase-out ODSs in developed and developing countries preventing 135 Gt CO_2-eq. emissions from 1990-2010—approximately US$ 0.02 per CO_2-eq. tonne) *with supra* note 19, Montzka et al. at 2 (showing the average price paid for GHG reductions through the CDM in 2007-2008 was US$ 13 per CO_2-eq. tonne) *and* TEAP, TASK FORCE DECISION XX/7 – INTERIM REPORT, "ENVIRONMENTALLY SOUNDS MANAGEMENT OF BANKS OF OZONE-DEPLETING SUBSTANCES," (June 2009) [hereinafter TEAP DECISION XX/7 INTERIM REPORT] at 25-27 and 42-47 (showing the cost destroying the most cost-effective ODSs at the point of emission in the sectors that will be replaced by HFCs is US$13.2-18.7 per CO_2-eq. tonne).
[22] *See supra* note 11 and accompanying text; *see also supra* note 16, Kyoto Protocol at Art. 3 and Annex I.
[23] *See* Ozone Secretariat, *Ozone Anniversary Gifts Big Birthday Present to Human Health and Combating of Climate Change*, 16 Sep. 2009, http://ozone.unep.org/Events/ozone_day_2009/press-release-ozone-layer.pdf.
[24] *See supra* note 7, Montreal Protocol at Arts. 2, 2A, 2F, 5 and 10.
[25] *See e.g. id.* at Arts. 2, 2A, 2F and 5.
[26] *See id.* at Art. 10.
[27] *See id.* at Arts. 2(9), 4-4A, 8 and 10A.
[28] *See supra* notes 16, Kyoto Protocol at Art. 3 and Annex I.
[29] *See id.* at Arts. 3 and 12 and Annexes A and I.
[30] *See* Executive Board of the CDM, *Revision to the approved baseline and monitoring methodology AM0001*, Incineration of HFC 23 waste streams (Dec. 2006), http://cdm.unfccc.int/UserManagement/FileStorage/0TRNGTH2M00EKXXJ924MUXOOUJ115V; *see also* Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol, Decision 8/CMP.1, *Implications of the establishment of new hydrochlorofluorocarbon-22 (HCFC-22) facilities seeking to obtain certified emission reductions for the destruction of hydrofluorocarbon-23 (HFC-23)*, (9–10 Dec. 2005), http://unfccc.int/resource/docs/2005/cmp1/eng/08a01.pdf#page=100.
[31] Business Green, *EU Bans industrial gas carbon credits*, Jan. 21, 2011, http://www.businessgreen.com/bg/news/1938754/eu-bans-industrial-gas-carbon-credits.
[32] During the 2008-2012 commitment period, 1.4 Gt CO_2-eq. HFC-23 emissions will occur. However, the CDM will only provide incentives to destroy 0.45 Gt CO_2-eq. *Compare supra note* 4, IPCC/TEAP 2005 SPECIAL REPORT at 395 *with* UNFCCC, CDM Project Activities, Project Search (last accessed June 22, 2009), http://cdm.unfccc.int/Projects/projsearch.html (showing registered HFC-23 destruction projects and CERs estimated to be issued from these projects during the first commitment period).
[33] *See supra* note 19, Montzka et al. at 1-2; *see also supra* note 4, IPCC/TEAP 2005 SPECIAL REPORT at 396-97 (indicating the cost of destroying HFC-23 is US$0.20 per CO_2-eq. tonne).
[34] One tonne of HCFC-22 has a market price of US$1,000-2,000. *See* TEAP, RESPONSE TO DECISION XVIII/12, REPORT OF THE TASK FORCE ON HCFC ISSUES (WITH PARTICULAR FOCUS ON THE IMPACT OF THE CLEAN DEVELOPMENT MECHANISM) AND EMISSIONS REDUCTIONS BENEFITS ARISING FROM EARLIER HCFC PHASE-OUT AND OTHER PRACTICAL MEASURES (2007) at 57. However, the production of one tonne of HCFC-22 at a CDM-approved facility will produce up to 30 kilograms of HFC-23 equal to 440 tonnes of CO_2-eq. which can be destroyed to generate 440 CERs. *See* CDM EB, Revision to the approved baseline methodology and monitoring methodology AM0001/Version 05.2, (Dec. 2006) [hereinafter AM00001/Version 05.2] at 5. The average price per CER in 2007 and 2008 was US$13 per tonne. *See supra* 19, Montzka et al. at 1. This means the value of the destroyed HFC-23 byproduct from one tonne of HCFC-22 is US$5,720 while the HCFC-22 is valued at US$1,000-2,000. The paltry cost of destruction—US$ 0.20 per CO_2-eq. tonne of HFC-23 destroyed— does little to remove this perverse incentive. *See supra* note 4, IPCC/TEAP 2005 SPECIAL REPORT at 396-97.

[35] This limit is equal to the lower of actual production in any given year or the maximum historical annual HCFC-22 production during any of the last 3 years from 2000 to 2004, plus any CFC production in the case of swing plants. *See supra* note 33, AM00001/Version 05.2 at 3.
[36] *See* Montreal Protocol, Report of the Nineteenth Meeting of the Parties to the Montreal Protocol, Montreal, Canada (2007) [hereinafter Report of the 19th MOP], at Decision XIX/6 (accelerating the phase-out of HCFCs).
[37] For example, in the 2007-2008 crediting year, CDM Project 0767 reduced and then completely stopped its HCFC-22 production once it had reached its HFC-23 CER limit. The following year, CDM project 0767 once again reduced its production of HCFC-22 by 85% once it had reached its HFC-23 CER limit. In both cases, the facility immediately began production once the new HFC-23 CER crediting year began. *See* CDM EB, Project 0767: HFC-23 Decomposition Project at Zhonghao Chenguang Research Institute of Chemical Industry, Zigong, SiChuan Province, China, http://cdm.unfccc.int/Projects/DB/JQA1163409153.5/view (making available all Monitoring Reports for CDM project 0767, including 2007-2009).
[38] *See supra* note 6, AR4 THE PHYSICAL SCIENCE BASIS at 213 .
[39] *See id.*; *see also supra* note 33, AM00001/Version 05.2 at 5.
[40] *See supra* note 33, AM0001/Version 05.2 at 5.
[41] *See e.g.* Changshu Haike Chemical Co. Ltd., Third Monitoring Report of Changshu Haike HFC 23 Decomposition Project: UNFCCC CDM Ref. No. 1105, Monitoring period: Dec 1, 2008 to Apr 30, 2009 Version: 01 (26 May 2009) at 3, http://cdm.unfccc.int/UserManagement/FileStorage/LW01CUNDGI4OA2FJBT39SK67XRYQ8P.
[42] *See* CDM EB, Changshu Haike HFC 23 Decomposition Project - Version: 7, Project Design Document (Feb. 2008) at 17, http://cdm.unfccc.int/UserManagement/FileStorage/AI5XXU7ER3EOJCTY9O9NE9WD71HGMU.
[43] At CDM Project 1105, the HFC-23/HCFC-22 ratio during the no-CER crediting period dropped from 2.26% to 1.1%. *Compare* Changshu Haike Chemical Co. Ltd., Second Monitoring Report of Changshu Haike HFC 23 Decomposition Project - UNFCCC CDM Ref. No. 1105, Monitoring period: Jul 1, 2008 to Nov 30, 2008 Version: 01 (5 Dec. 2008) at 3, http://cdm.unfccc.int/UserManagement/FileStorage/M7D2ILF93OA6EZCXHUS4K5JGVBQTRN (indicating the operating ratio was 2.26% in the period in which CERs could be generated) *with* Changshu Haike Chemical Co. Ltd., Third Monitoring Report of Changshu Haike HFC 23 Decomposition Project: UNFCCC CDM Ref. No. 1105, Monitoring period: Dec 1, 2008 to Apr 30, 2009 Version: 01 (26 May 2009) at 3, http://cdm.unfccc.int/UserManagement/FileStorage/LW01CUNDGI4OA2FJBT39SK67XRYQ8P (indicating the operating ratio dropped to 1.1% during the non-crediting period). At CDM Project 0151 the HFC-23/HCFC-22 ratio decreased from an average of 2.9% during the rest of the crediting year to 1.38% during the time in which no CERs could be generated. *Compare* Quimobasicos S.A. de C.V., CDM Monitoring Report of Quimobasicos HFC Recovery and Decomposition Project – Reference Number 00000151 CDMP: Monitoring period: 31st of March 2008 to 30th May 2008 - Version 06, (6 Aug. 2007), at 36, http://cdm.unfccc.int/UserManagement/FileStorage/Q6DNANUYW5UHYYESJZ3Z922LDWKFTB *with* Quimobasicos S.A. de C.V., CDM Monitoring Report of Quimobasicos HFC Recovery and Decomposition Project – Reference Number 00000151 CDMP: Monitoring period: 31 of May 2008 to 13 of June 2008 : Version 08 (4 Aug. 2008) at 34, http://cdm.unfccc.int/UserManagement/FileStorage/UGN1YI9QVXW3R06COKMDSA5T8F7LJP (indicating the operating ratio dropped to 1.38%).
[44] *See supra* note 4, IPCC/TEAP 2005 SPECIAL REPORT at 396-97.
[45] *Compare id. with supra* note 19, Montzka et al. at 1-2.
[46] *See supra* note 19, Montzka et al. at 1-2; *see also supra* note 31.
[47] *See supra* note 16, Kyoto Protocol at Art. 12 at ¶¶1-2.
[48] *See id.* at Art. 12 at ¶5(a)-(c).
[49] TEAP, TEAP 2010 PROGRESS REPORT, VOLUME 1 – "ASSESSMENT OF HCFCS AND ENVIRONMENTALLY SOUND ALTERNATIVES" AND "SCOPING STUDY ON ALTERNATIVES TO HCFCF REFRIGERANTS UNDER HIGH AMBIENT TEMPERATURE CONDITIONS", (May 2009) [hereinafter TEAP 2010 HFC ALTERNATIVES STUDY).
[50] *See* U.S. EPA, *Transitioning to Low-GWP Alternatives in Domestic Refrigeration*, (Oct. 2010) [hereinafter 2010 U.S. EPA Domestic Refrigeration Report]; U.S. EPA, *Transitioning to Low-GWP Alternatives in Commercial Refrigeration*, (Oct. 2010) [hereinafter 2010 U.S. EPA Commercial Refrigeration Report]; U.S. EPA, *Transitioning to Low-GWP Alternatives in Unitary Air Conditioning*, (Oct. 2010) [hereinafter 2010 U.S. EPA Unitary AC Report]; *See* Oko-Recherche GmbH, *Preparatory study for the Review of Regulation (EC) No 842/2006 on certain fluorinated gases*, (Sept. 2010) [hereinafter 2010 EC F-gas Preparatory Report].

[51] *See supra* note 7, TEAP Decision XX/8 Report at 39.
[52] DIRECTIVE 2006/40/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF RELATING TO EMISSIONS FROM AIR-CONDITIONING SYSTEMS IN MOTOR VEHICLES AND AMENDING COUNCIL DIRECTIVE, (17 May 2006), 70/156/EEC Official Journal of the European Union L161/12.
[53] *See supra* note 48, TEAP 2010 HFC Alternatives Study at 76 and 113-14.
[54] *See id.* at 75-76; *supra* note 2, FSM 2011 HFC Amendment at 4.
[55] Because HFC-134a had a GWP of 1,440 and HFO-1234yf has a GWP of 4, more than 99% of the current MAC HFC use will be eliminated on a GWP basis by converting from HFC-134a to HFO-1234yf resulting in a 30% HFC reduction on CO_2-eq. basis. Both the FSM 2011 HFC Amendment and North American 2010 HFC Amendment use HCFC plus HFC consumption data to establish the baseline for industrialized countries. *See supra* note 2, FSM 2011 HFC Amendment at 4-6; *supra* note 2, North American 2010 HFC Amendment 2-3. This means, in terms of CO_2-eq., the baseline is 0.796 Gt CO_2-eq. while actual HFC consumption in industrialized countries in 2010 is only 0.668 Gt CO_2-eq. *See supra* note 2, Velders et al. 2009; *supra* note 2; Velders et al. 2009 Supporting Information. The phase-down schedule of the FSM 2011 HFC Amendment and North American 2010 HFC Amendment do not require industrialized countries reduce their HFC consumption beyond 30% of actual 2010 HFC consumption until 2019 and 2025, respectively.
[56] *See supra* note 7, TEAP DECISION XX/8 REPORT at 94, 99 and 105-06.
[57] *See supra* note 48, TEAP 2010 HFC Alternatives Study at 4 and 39 (stating that low-GWP alternatives are already in use In 36% of the domestic refrigeration market and are estimated to increase their market share to 75% by 2020 even without additional market pressure from the Montreal Protocol); *id.* at 42 and 50 (setting forth market penetration statistics and available alternatives for the commercial refrigeration sector and stating that "[f]or each of the three main [commercial refrigeration] systems described, options with low-GWP refrigerants exist and have already been thoroughly tested for many of them.").
[58] *See supra* note 48, TEAP 2010 HFC Alternatives Study at 51-53.
[59] *Id.* at 72.
[60] *Id.*
[61] *Id.* at 65.
[62] *Id.* at 58-59 (setting forth the timeframe ofr the commercialization of low-GWP alternatives).
[63] *Id.* at 59 and 65.
[64] *Id.* at 87-90.
[65] *See* Vienna Convention for the Protection of the Ozone Layer, *opened for signature* Mar. 22, 1985, 1513 U.N.T.S. 293 [hereinafter "Ozone Convention"] at Art. 2(2)(b).
[66] *See supra* note 7, Montreal Protocol at Art. 2F.
[67] *Supra* note 63, Ozone Convention at Art. 2(2)(b). While HFCs are not ODSs, they are powerful GHGs and are a contributing cause of climate change, which undoubtedly qualifies as an "adverse effect" as that term is defined under the Ozone Convention: "Adverse effects" means changes in the physical environment or biota, *including changes in climate*, which have significant deleterious effects on human health or on the composition, resilience and productivity of natural and managed ecosystems, or on materials useful to mankind. *Supra* note 48, Ozone Convention at Art. 1(2) (emphasis added).
[68] The ultimate objective of the UNFCCC is to ensure "stabilization of [GHG] concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." *See supra* note 1, UNFCCC at Art. 3. A HFC phase-down under the Montreal Protocol is also fully consistent with UNFCCC's Article 2 principles. *Id.* at Art. 2.
[69] *Supra* note 1, UNFCCC at Art. 7(2)(l) (emphasis added). Precedent for implementing the cooperation and coordination envisioned in Article 7(2)(l) has been established under Kyoto Protocol Article 2(2) which delegates responsibility for pursuing limitations or reductions of GHGs from aviation and bunker fuels to the International Civil Aviation Organization ("ICAO") and International Maritime Organization ("IMO") respectively. *See supra* note 16, Kyoto Protocol at Art. 2(2).
[70] *Compare supra* note 2, FSM 2011 HFC Amendment *and supra* note 2, North American 2010 HFC Amendment *with supra* note 16, Kyoto Protocol at Art. 3.
[71] *See supra* note 2, FSM 2011 HFC Amendment at 11; *supra* note 2, North American 2010 HFC Amendment at 7.
[72] *See supra* note 23.
[73] *See supra* note 2, FSM 2011 HFC Amendment at 6.

[74] Under the CDM established in Article 12 of the Kyoto Protocol, in order for emissions reductions to be generate carbon credits or Certified Emission Reductions ("CERs") the reductions must be "[r]eductions in emissions that are additional to any that would occur in the absence of the certified project activity." *See supra* note 16, Kyoto Protocol at Art. 12 (5)(c). The "additionality" requirement has been interpreted to bar certification of emission reductions that are required by law from generating CERs.
[75] *See supra* note 16, Kyoto Protocol at Art. 3, Annex I, Annex A.
[76] *See* UNFCCC, AD HOC WORKING GROUP ON LONG-TERM COOPERATIVE ACTION UNDER THE CONVENTION, FCCC/AWGLCA/2010/6, NEGOTIATING TEXT (17 May 2010) at 40.
[77] *See supra* note 2, FSM 2011 HFC Amendment at 9-10; *see also supra* note 2, North American 2010 HFC Amendment at 6.
[78] *Compare supra* note 14 *with supra* note 19, Montzka et al. at 2 (stating that the average price per CER from 2007-2008 was US$13); *see also supra* note 50, EC F-Gas Preparatory Report at 53.
[79] *See supra* note 7, Montreal Protocol at Art. 5(5)-(6).
[80] The only exception is where Article 5 Parties avail themselves of alternative funding (either through the CDM or another financial mechanism) to achieve compliance with their commitments under Article 2J, in which cases no such funding will be provided by the MLF so as not to "double pay" for compliance. *See supra* note 2, FSM 2011 HFC Amendment at 9-10; *supra* note 2, North American 2010 HFC Amendment at 6.
[81] *See* Montreal Protocol, Report of the Fourth Meeting of the Parties to the Montreal Protocol, (1992), at Annex VIII.
[82] *See supra* note 4, IPCC/TEAP SPECIAL REPORT at 396.
[83] *See supra* note 21, TEAP DECISION XX/7 REPORT at 22-25, 40-44.