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执行蒙特利尔议定书
多边基金执行委员会
第六十七次会议
2012 年 7 月 16 日至 20 日，曼谷

情况报告和履约情况

执行摘要

本文件由七部分。主要问题和结论总结如下：

- 由于委员会对精简进展报告程序做出决定（第 66/16 号决定），本次会议不要求提交未附供资要求的 81 份无氟氯烃和 109 份氟氯烃付款执行计划报告；
- 产生和未产生供资影响的工作计划应当在本文件中讨论，还是像印度四氯化碳工作计划那样列示在“投资项目”议程项目下；
- 根据 2011 年第 7 条报告的数据和截至 2012 年 6 月 12 日提交的国家方案数据，似乎没有国家出现违约现象；
- 然而，最新的消费数据表明，大多数国家的剩余物质（不包括氟氯烃和豁免使用）实现了零消费，只有 1 个国家报告有氟氯化碳消费（2009 年的数据）；2 个国家报告了 2009 年的哈龙消费情况；27 个国家报告有甲基溴消费；1 个国家报告有甲基氯仿消费；
- 在 2011 年与履约有关的 25 个问题中，根据第 7 条数据已经解决了一个问题；根据来自执行机构和臭氧秘书处的资料，14 个与履约有关的问题被报告为已完成，而 10 个问题还没有解决或尚未报告为已完成；
- 南非政府是否应当只提供氟氯烃活动的国家方案数据；
- 有关国家方案执行情况的数据表明：
  - 所有国家均按照六年前核定的新格式提供了数据，但 47 个国家提交了 2011 年使用网络系统的数据；
  - 除氟氯烃外，所有 823.7 ODP 吨的剩余消费量为甲基溴消费；
  - HCFC-22 和 HCFC-142b 的价格低于列入国家方案数据中的替代品价格。HCFC-141b 价格低于替代品 HCFC-245fa 和 HFC-356mfc，但根据 2010 年价格高于环戊烷、甲酸甲酯和戊烷；
  - 在 77 个报告 2010 和 2011 年数据的国家中，氟氯烃消费量削减了 5.4%；
  - 在报告有关许可证制度的资料的国家中，144 个有报告要求，其中 134 个国家报告称许可证制度正在运营之中（在 67 个报告了 2011 年数据的国家中，有 65 个拥有经营许可证制度，其中 97%运行“令人满意”或“非常好”）；
- 在 14 个执行拖延的项目中，有 13 个建议继续监测。没有收到以色列提交的拖延报告；
- 建议针对向本次会议提交情况报告的 21 个项目另提交一份报告，并建议针对 6 项氟氯烃淘汰管理计划的准备活动提交额外报告；
- 需要双边机构和执行机构同在挤压聚苯乙烯泡沫塑料应用中准备淘汰 HCFC-142b/HCFC-22 的第 5 条国家分享 HFO-1234ze 示范项目的资料。

导言

1. 这是《情况报告和履约情况文件》第五版，按照执行委员会第 66/16 号决定的要求，由以前名为“拖延项目的执行情况和第 5 条国家实现遵守《蒙特利尔议定书》今后管制措施的前景”和“关于附有具体报告规定的核定项目执行情况的报告”的文件合并而成。

2. 本文件由七部分组成：

(a) 第一部分涉及上述第 66/16 号决定的执行情况。

(b) 第二部分是为响应第 32/76（b）和 46/4 号决定编写的，决定请秘书处为执行委员会每次会议编写有关遵守《蒙特利尔议定书》管制措施的第 5 条国家的最新履约情况。

(c) 第三部分包含遵守各缔约方决定和履约委员会关于履约建议的第 5 条国家的资料。

(d) 第四部分提出了关于国家方案执行情况的数据，包括按行业分列的消耗臭氧层物质消费量数据的分析。还包含一部分述及国家消耗臭氧层物质淘汰方案特点的内容。

(e) 第五部分介绍了有关出现执行拖延及要求提交特别情况报告的项目结果情况。

(f) 第六部分涉及关于氟氯烃示范项目的报告。

(g) 第七部分涉及关于资源调动活动的报告。

3. 本文件进行的分析和得出的结论，不妨碍由缔约方会议所确定的履约情况，缔约方会议是唯一得到授权对履约情况进行评估的机构。根据《议定书》第 7 条报告的数据专门用于确定一个国家每年的履约情况。本文件中的分析混合采用了向基金秘书处报告的有关各个履约阶段国家方案执行情况的数据和第 7 条数据。因此，文件本身没有决定履约情况，而是评估了第 5 条国家努力遵守《蒙特利尔议定书》一项或多项管制措施的前景。其主要目的是，确定有待通过多边基金支持的行动加以处理的消耗臭氧层物质。

第一部分：第 66/16 号决定的执行情况

4. 执行委员会第六十六次会议决定：

“(b) 要求：

(一) 在执行委员会第六十七次会议上，“关于附有具体报告规定的核定项目执行情况的报告”议程项目目前要求的资料，应在题为“情况报告和履约情况”的一个议程项目和文件内连同履约问题一同报告，这将替代目前题为“拖延项目的执行情况和第 5 条国家实现遵守《蒙特利尔议定书》今后管制措施的前景”的报告和议程项目；

(二) 年度进展情况和财务报告说明栏内关于多年期协定的资料应包含在付款执行计划的陈述部分中，并对任何差异做出解释；

(三) 没有申请资金付款，不需要付款执行计划报告，除非遇到适用惩处条款问题或核定付款执行计划中的目标发生变化的情形；

(四) 各机构按照第六十五次会议在第 65/6 号决定中所做的说明，为制冷剂管理计划、最终淘汰管理计划、氟氯化碳、四氯化碳和甲基溴国家淘汰计划提交多年期协定项目完成报告，并附任何已有的核证报告以及多年期协定项目完成报告核定格式的、题为“总体执行计划和年度执行报告”的表格（表 8），代替付款执行计划和付款执行报告，万一核证报告在项目完成报告之前完成，就在情况报告或年度进展情况和财务报告范围内提交核证报告；

(五) 环境规划署在年度履约协助方案核定的范围内，向每年的第三次会议提出详尽的履约协助方案活动年度进展情况报告，并在年度进展情况和财务报告的履约协助方案项目内指明项目执行中遇到的障碍。

(c) 在 2015 年第一次会议上审查本决定的有效性；以及

(d) 年度进展情况和财务报告两个说明栏中有一个将用来报告与项目有关的、现有的最新非财务数据”（第 66/16 号决定）。

5. 本文件涉及上述决定 b（一）至（四）段。秘书处对环境规划署进展报告的评论（UNEP/OzL.Pro/ExCom/67/13）涉及（b）（五）段，综合进展报告（UNEP/OzL.Pro/ExCom/67/10）载有一节涉及（d）段的内容。将为 2015 年第一次会议起草一份文件，以涉及该决定（c）段。

将题为“关于附有具体报告规定的核定项目执行情况的报告”的文件纳入本文件（第 66/16(b)(i)号决定）

6. 第 66/16(b)(i)号决定导致将关于附有具体报告规定的项目的资料纳入本文件。本次会议没有要求提交无氟氯烃多年期协定的 81 份付款执行计划。相反，各执行机构的年度进展情况和财务报告中所载的资料用来评估进展情况，并且酌情提出建议以对付审查中指明的执行障碍。这些资料载入本文件第五部分，该部分涉及情况报告、之前指明需要额外监测的项目情况以及须接受执行委员会项目取消程序的出现执行拖延的项目情况。谨建议执行委员会注意到精简决定迄今导致报告数量大幅削减，包括取消本次会议的 81 份无氟氯烃多年期协定的 81 份付款执行计划报告。

7. 另外增加了两节，以便解决附有具体报告规定的项目。增加的第一节涉及关于氟氯烃示范项目的报告“在制造挤压聚苯乙烯泡沫塑料木板料时将 HFO-1234ze 用作发泡剂：多边基金项目中的应用评估”。该报告也后附于本文件。增加的另一节涉及关于资源调动的报告，也后附于本文件。

将附有供资要求的付款执行计划的进展报告资料提交本次会议（第 66/16(b)(ii)号决定）

8. 有关上述第 66/16(b)(ii)号决定，没有一个执行机构在提交本次会议的附有供资要求的付款执行计划的陈述部分按要求提供了资料。谨建议执行委员会请各执行机构确保今后满足第 66/16(b)(ii)号决定的要求，将此作为向第六十七次会议之后会议提交付款执行计划的一个条件。

没有供资要求的付款执行计划和适用惩处条件的情形（第 66/16(b)(iii)号决定）

9. 没有供资要求的付款执行计划的资料与关于提交执行障碍的后续报告的相关建议一并纳入本文件第五部分。由于第 66/16(b)(iii)号决定，采用了年度进展情况和财务报告提供的资料而不是提交 69 个国家的 109 份氟氯烃淘汰管理计划报告的机构具体而详细的付款执行计划中的资料。谨建议执行委员会注意到精简决定迄今导致报告数量大幅削减，包括取消了 69 个国家的 109 份氟氯烃淘汰管理计划付款执行计划报告。

10. 已经查明没有目标变化要求和可能适用惩处条款的情形。如果查明遇到上述情况，则要求提供详细的付款执行计划，按照此项决定，该项目将列在“投资项目”议程项目下供讨论。印度四氯化碳行业的一个项目提交了一份付款工作计划但供资已经审定，该项目将在这一议程项目下提交，[1]因为该工作计划可能对已经审定的供资有所影响。关于统一和精简进展报告的文件（UNEP/OzL.Pro/ExCom/66/18）没有涉及这一问题，因为工作计划可能产生也可能不产生供资影响。基金秘书处预计将向第六十八次会议提交具有供资影响的审定氟氯烃淘汰管理计划的工作计划变动申请。谨建议执行委员会考虑具有和不具有供资影响的工作计划变动申请是在“情况报告和履约情况”文件中涉及，还是在“投资项目”议程项目下列示。

项目完成报告和核证报告

11. 第 66/16(b)(iv)号决定涉及提交无氟氯烃活动的多年期协定完成报告。自做出此项决定以来没有提交过项目完成报告，尽管一个机构要求了解该协定如何执行的情况。

12. 既没有以项目完成报告形式也没有作为本文件的一部分向第六十七次会议提交核证报告。如果提交核证报告而不提交项目完成报告，这种情况将在本文件关于核证报告新的一节中讨论。

第二部分：履约情况和前景（根据最新获得的数据）

13. 本节介绍了截至 2010 年对各类氟氯化碳、哈龙和四氯化碳、截至 2015 年对甲基溴和三氯乙酸[2]以及 2013 年冻结时对氟氯烃的最终淘汰管制措施的履约情况的分析结果。该分析假设，根据第 7 条或在国家方案数据中所报告的最新消费量已考虑到已完成的、由执行委员会批准的项目的淘汰量。自多边基金启动以来，一直到 2011 年 12 月，已完成的项目淘汰了 242,954 ODP 吨的消费量和 191,936 ODP 吨的生产量。在大约 25.4 亿美元的核定总额中，已完成的项目估价为 20.6 亿美元。有关该分析中所使用的方法的详细说明，见提交执行委员会第三十七次会议的 UNEP/OzL.Pro/ExCom/37/18 号文件。

14. 该分析使用了最新的可用数据。截至 2012 年 6 月 12 日，35 个第 5 条国家根据第 7 条报告了 2011 年的数据（而 2011 年 6 月有 23 个国家）。另有 42 个国家仅向基金秘书处报告了 2011 年有关国家方案执行进展情况的数据（第 17/34 号决定）。对于尚未提交 2011 年数据的国家，在分析中使用了最新可用的消费数据。这涉及到使用 68 个国家 2010 年根据第 7 条报告的数据、使用 2 个国家 2009 年根据第 7 条报告的数据。该分析假设，

[1] 本次会议的“投资项目”议程项目还将涉及基准变化和不产生供资影响的《中国协定》。
[2] 没有确定述及附件 B-I 物质的项目；执行委员会既没有审议也没有资助涉及须遵守从 2007 年开始的 85%基准削减量的项目。

最新报告的、不包括氟氯烃的消耗臭氧层物质的消费水平没有增加，虽然对于没有获取 2010 和 2011 年数据的 2 个国家而言这或许不实。

15. 双边和多边执行机构向执行委员会第六十七次会议提交了年度进展报告，其中包含一直到 2011 年底委员会核定的所有活动和项目执行情况的数据。有关 2012 年可能获准的数据，已从在第六十六次会议上核定的《2012-2014 年综合业务计划》（UNEP/OzL.Pro/ExCom/66/7）中提取。

16. 基金秘书处将继续综合以前基金秘书处用于分析目的的、有关履约情况和前景的报告各版本中所包括的全部数据。一旦提出要求，可提供这些数据。

生产行业

17. 在 7 个[3]有氟氯化碳生产设施的第 5 条国家，阿根廷、中国、朝鲜民主主义人民共和国、印度、墨西哥和委内瑞拉玻利瓦尔共和国政府签署了有计划削减的协定。氟氯化碳生产行业的所有项目均已完成，但中国报告在继续进行，印度的其余付款虽已报请第六十七次会议批准，但尚未被同意。巴西政府表示已自行淘汰了氟氯化碳的生产。关于哈龙生产，中国政府已有一项协定，而印度政府得到了关闭其哈龙生产设施的一次性赠款。

18. 四个国家（巴西、中国、朝鲜民主主义人民共和国和印度）拥有四氯化碳的生产基准。执行委员会已批准了在 3 个国家（中国、朝鲜民主主义人民共和国和印度）的生产和消费行业完全淘汰四氯化碳的项目。在第五十四次会议上，批准了巴西的四氯化碳加工剂行业项目。三氯乙酸生产关闭项目只批准了中国的项目。

19. 中国作为仅有的两个拥有甲基溴生产设施的第 5 条国家之一，其甲基溴生产关闭项目已获批准。第二个国家大韩民国没有寻求基金援助。

20. 2009 年或 2010 年，有 6 个国家生产了氟氯烃：阿根廷、中国、朝鲜民主主义人民共和国、印度、墨西哥和委内瑞拉玻利瓦尔共和国。生产行业分组将在执行委员会第六十七次会议休会期间其召开的会议上收到来自顾问的、有关中国氟氯烃生产行业技术审计的最后报告，并审议世界银行代表中国提出的、氟氯烃生产行业淘汰计划第一阶段的一项请求。

消费行业

21. 本节概述了对各国似乎违约的程度或在哪些方面其最新消费超出管制措施的详细分析结果。对所有六种受控物质都提供了汇总表。该汇总表显示了使用 2011 年数据时没有遵守 2010 年管制措施以及其消费数据超出今后管制措施（包括 2010 年数据）的国家。概述基于附件一所载数据，其中包括按物质分列的各国的详细资料。附件一还说明各国是否已得到预期由多边基金提供的所有援助。

22. 附件一的履约情况评估中还载有关于何时批准了有助于履约的活动及该国是否报告了许可制度建立情况的资料。由于批准日期表明了项目或协定已经执行的时间长度，因此，这些资料应使执行委员会能够进一步评估各国的履约前景。此外，有关建立许可制度的资料表明，不管当前的消费水平有多高，管制措施的存在使今后履约成为可能。项目批

[3] 虽然罗马尼亚获得了淘汰生产和消费的供资，但由于从 2008 年 1 月 1 日起它被重新归入非第 5 条国家，因而未被纳入其中。

准的资料取自《审定项目清单》。2012 年 6 月 7 日，臭氧秘书处提供了关于建立许可制度的最新资料

各类氟氯化碳

23. 表 1 概括了各国遵守各类氟氯化碳管制措施的情况。

表 1

氟氯化碳管制措施：

最新消费数据超出 2010 年管制措施的国家汇总

数据	最新消费量超出 2010 年 100%淘汰目标的国家
2011 年数据（第 7 条或国家方案）	0 个国家*
最新消费量	1 个国家（2009 年，也门）

*不包括被豁免的国家。

24. 也门是唯一一个最新消费数据超出 2010 年管制措施的国家，已得到多边基金的支助。

哈龙

25. 表 2 概括了各国遵守哈龙管制措施的情况。75 个国家报告在 1995 年至 2010 年期间没有消费哈龙。61 个国家已获得对于哈龙库活动或淘汰协定的支持，其中包括参与区域哈龙库的国家。

表 2

哈龙管制措施：
最新消费数据超出 2010 年管制措施的国家汇总

数据	最新消费量超出 2010 年 100%淘汰目标的国家
2011 年数据（第 7 条或国家方案）	无
最新消费量	2 个国家（利比亚和也门）。（利比亚没有遵守 2009 年维持零消费水平的行动计划）。

26. 所有最新消费数据超出 2010 年管制措施的国家均得到了多边基金的支助。

甲基溴

27. 表 3 概括了各国遵守甲基溴管制措施（不包括检疫和装运前）的情况。在 147 个已批准《哥本哈根修正案》的第 5 条国家中，有 144 个国家已报告完成了基准数据；有 58 个国家对基准消费量和最新消费量报告为零。100 个第 5 条国家得到了多边基金对甲基溴淘汰活动和/或项目的支助。

表 3

甲基溴管制措施:
最新消费数据超出今后管制措施的国家汇总*

数据	最新消费量超出甲基溴 2005 年削减量目标 20%的国家	最新消费量超出 2015 年 100%淘汰目标的国家
2011 年数据（第 7 条或国家方案）	无	12 个国家
最新消费量	土库曼斯坦（2010 年数据）	27 个国家

* 本表涉及报告有基准数据和最新消费数据的 144 个第 5 条国家。

28. 土库曼斯坦是唯一一个最新消费量超出其 2005 年管制措施的国家。土库曼斯坦核定了将促成完全淘汰甲基溴的项目。

四氯化碳

29. 表 4 概括了各国遵守四氯化碳管制措施的情况。所概括的数据不包括原料，也没有区分特定的最终用途（如溶剂和加工剂）。在 146 个已报告基准数据的国家中，有 90 个国家对基准消费量和最新消费量均报告为零。

表 4

四氯化碳管制措施：
最新消费数据超出 2010 年管制措施的国家汇总

数据	最新消费量超出 2010 年 100%淘汰目标的国家
2011 年数据（第 7 条或国家方案）	0 个国家*
最新消费量	0 个国家*

* 不包括被豁免和不寻求多边基金支助的国家。

甲基氯仿

30. 表 5 概括了各国遵守三氯乙酸管制措施的情况。在 146 个已报告基准数据的国家中，有 103 个国家的基准消费量和最新消费量均报告为零。

表 5

甲基氯仿管制措施：
最新消费数据超出今后管制措施的国家汇总

数据	最新消费量超出 2010 年三氯乙酸削减量目标 70%的国家	最新消费量超出 2015 年三氯乙酸削减量目标 100%的国家
2011 年数据（第 7 条或国家方案）	无	无
最新消费量	无	大韩民国

31. 大韩民国作为唯一一个最新消费数据超出其今后管制措施的国家，同意不接受多边基金的供资。

氟氯烃

32. 附件一的附录六载有对氟氯烃最新消费数据的分析，并指明该国是否得到了编制氟氯烃淘汰管理计划的资金、已批准的投资项目数量、已批准的示范项目数量、已批准的以ODP 吨表示的总淘汰量，及 2012 年业务计划中规划的活动。还提供了额外的资料，表明迄今已批准的氟氯烃淘汰管理计划、那些提交第六十七次会议的氟氯烃淘汰管理计划，及氟氯烃淘汰管理计划所涵盖的期限（如，已批准的氟氯烃淘汰管理计划在 2015 年实现10%的削减量，或者在 2020 年实现 35%的削减量）。执行委员会迄今已批准 122 个国家的氟氯烃淘汰管理计划。

33. 截至 2012 年 6 月 12 日，有 145 个第 5 条国家报告了基准消费量和最新消费量。除大韩民国、新加坡和阿拉伯联合酋长国，所有国家都得到了氟氯烃淘汰管理计划的项目编制资金。大韩民国和新加坡同意不申请多边基金的供资。所有国家都批准了《哥本哈根修正案》。批准《哥本哈根修正案》是按照第 53/37 号决定向氟氯烃淘汰管理计划供资的先决条件。

34. 表 6 概括了各国遵守氟氯烃管制措施的情况。

表 6

氟氯烃管制措施：
最新消费数据超出今后管制措施的国家汇总

数据	最新消费量超出 2013 年冻结削减目标的国家
2011 年数据（第 7 条或国家方案）	36 个国家
最新消费量	74 个国家

35. 在 74 个国家中，有 60 个国家已得到多边基金对氟氯烃淘汰协定的资助。

第三部分：须遵守缔约方履约决定的国家的执行情况

36. 本节述及须遵守履约决定的第 5 条国家。

37. 有适用于 23 个国家的、与履约相关的 25 项缔约方决定。根据第 7 条数据已解决了1 个与履约相关的问题；根据来自执行机构和臭氧秘书处的信息，14 个与履约相关的问题被报告为已解决，而 10 个问题尚未解决或尚未报告已解决。根据提交给臭氧秘书处和臭氧机构的信息，表 7 表明在执行委员会各项决定方面的进展程度。

表 7

已报告的遵守缔约方与履约相关的决定的情况

履约问题	基于第 7 条数据已完成	报告执行机构和/或臭氧秘书处已完成	未完成或未向执行机构和/或臭氧秘书处报告完成	共计
哈龙淘汰		1		1
修正书批准和许可制度			1	1
许可制度		13	6	19
数据报告	1		3	4
共计	1	14	10	25

附件二中的信息

38. 附件二介绍了 2011 年须遵守缔约方履约决定的国家信息。所提供的信息按履约问题和国家编排。附件二还包括题为“执行机构评论意见”和“多边基金基于各机构的初步意见、第 7 条数据和来自臭氧秘书处的信息进行的评估”两个栏目。

第四部分： 关于国家方案执行情况的数据

39. 第四部分载有在每年 5 月 1 日之前提交基金秘书处的有关国家方案执行情况的数据，并包括按行业分列的消耗臭氧层物质消费量。本节还提供了关于国家消耗臭氧层物质淘汰方案特点的补充信息。国家方案的数据报告格式在执行委员会第三十五次会议的第 35/58(e)号决定中获得批准，并根据第 46/39 和 60/4(b)(iv)号决定进行了修改。

按行业分列的消耗臭氧层物质消费数据（氟氯烃除外）

40. 截至 2012 年 6 月 12 日，基金秘书处已从 144 个被要求提交此类报告的国家中收到 67 个国家的 2011 年国家方案执行情况最新报告、63 个国家的 2010 年报告、12 个国家的 2009 年报告和 1 个国家的 2008 年报告。应当指出的是，体制建设项目的延期取决于收到国家方案数据的情况。此外，国家方案执行数据必须在本年度最后一次会议和后续会议之前提交，作为核准和发放项目资金的先决条件。除了中国、库克群岛、厄立特里亚、冈比亚、几内亚比绍、印度、马达加斯加、马尔代夫、缅甸、瑙鲁、尼泊尔、尼日利亚、沙特阿拉伯、阿拉伯叙利亚共和国、坦桑尼亚联合共和国、泰国和图瓦卢以外，向第六十七次会议提交供资请求的所有国家也提交了 2011 年的国家方案数据。谨建议执行委员会敦促尚未提交 2011 年国家方案数据的缔约方必须在年度最后一次会议之前提交该数据。

41. 南非也向第六十七次会议提交了供资请求，但尚未得到多边基金的供资，原因或者出在国家方案编制方面，或者出在体制建设方面。国家方案数据报告涉及到所有消耗臭氧层物质。南非只符合氟氯烃活动的供资条件。谨建议执行委员会考虑请南非提供有关其在氟氯烃淘汰管理计划获得批准之后开展的氟氯烃活动的国家方案数据。

42. 尽管所记录的消费量水平来自不同年份，还可能未必符合所报告的第 7 条数据，但国家方案数据仍提供了全球范围内按国家分列的最新行业评估。这些数据应协助相关的第 5 条国家和执行委员会评估各行业仍需淘汰的物质。

43. 表 8 按行业分列了要淘汰的剩余消耗臭氧层物质的消费总量（不包括氟氯烃），并考虑到已核准但尚未执行的项目。它还包括了来自已批准但尚未完成的项目的淘汰消费总量。

表 8

按行业分列的消耗臭氧层物质剩余消费总量(不包括氟氯烃)

行业	最新消费总量	最新消费总量的百分比	已核准但尚未完成的淘汰总量	将要淘汰的剩余量
气雾剂	0.0	0.0%	485.1	*
泡沫塑料	0.0	0.0%	20.0	*
熏蒸剂	2,047.3	45.3%	1,556.1	491.2
哈龙	1.2	0.0%	0.0	1.2
实验用途	283.5	6.3%	0.0	283.5
计量吸入器	1,379.3	30.5%	545.6	833.7
加工剂	198.0	4.4%	6,587.0	*
制冷	603.9	13.4%	1,459.0	*
溶剂	3.8	0.1%	0.2	3.6
消毒剂	0.0	0.0%	0.0	0.0
烟草	0.0	0.0%	0.0	0.0
共计	4,517.0	100.0%	10,653.0	1,613.2

*已核准的淘汰量超出最新消费量。

44. 已核准但尚未执行的消耗臭氧层物质（氟氯烃除外）削减总量（表 8）不包括针对多年期协定原则上批准的数量，或者预期通过执行制冷剂管理计划和哈龙库各项活动而产生的数量。除了已获供资的削减之外，执行委员会原则上批准了根据已实现的计划削减量发放年度付款的行业和国家淘汰项目。

45. 通过未来年度付款实现的削减将解决表 8 中所确定的大量剩余消费量。此外，低消费量国家的制冷剂管理计划占这些国家基准消费和最终淘汰管理计划剩余基准的 85%。然而，已核准但尚未执行的项目数据不计入所有这些吨数。另外，表 8 中已核准但尚未执行的消耗臭氧层物质淘汰量不包括已有哈龙库项目的国家的某些哈龙消费量。

46. （考虑到最终淘汰管理计划和低消费量国家的制冷剂管理计划、哈龙库、全部淘汰项目和原则上获得批准的多年期协定所代表的淘汰量），仍有待解决的消耗臭氧层物质剩余消费总量（不包括氟氯烃）似乎为 823.7 ODP 吨（表 9）。这个数字少于已报告第六十四次会议的 1,057.9 ODP 吨。

表 9

以国家方案和第 7 条数据为基础、按物质分列的
消耗臭氧层物质剩余消费总量（不包括氟氯烃）
（考虑到最终淘汰管理计划和低消费量国家的制冷剂管理计划、
哈龙库、全部淘汰项目和原则上获得批准的多年期协定所代表的淘汰量）

化学品	消耗臭氧层物质剩余消费量（ODP 吨）
氟氯化碳	0.0*
四氯化碳	0.0
哈龙	0.0
甲基溴	823.7
甲基氯仿	0.0
共计	823.7

*按照第 60/5(d)号决定。

氟氯烃数据

47. 表 10 介绍基于最新可用数据的氟氯烃消费水平。该表表明，氟氯烃消费量为 503,079 公吨（33,310 ODP 吨），主要由 HCFC-22（占总量的 61%）和 HCFC-141b（占总量的 32%）构成。503,079 公吨的氟氯烃意味着比报告给第六十四次会议的数量（469,494 公吨）增加了 33,585 公吨。相比之下，截至 2011 年 12 月 31 日，基金已减少 239,282 公吨（255,642 ODP 吨）的消耗臭氧层物质消费量。本报告的消费水平基于 67 个国家 2011 年数据、63 个国家的 2010 年数据、12 个国家的 2009 年数据和 1 个国家的 2008 年数据。既报告 2010 年又报告 2011 年数据的国家，其氟氯烃消费量下降了 5.4%。

表 10

按化学品分列的最新氟氯烃消费水平

化学品	公吨	ODP 吨	占总量的百分比
HCFC-123	1,689.3	33.8	0.10%
HCFC-124	1,099.9	24.2	0.07%
HCFC-141b	96,414.1	10,605.5	31.84%
进口预混多元醇中所含 HCFC-141b	2,441.8	268.6	0.81%
HCFC-142b	30,030.9	1,952.0	5.86%
HCFC-21	3.1	0.1	0.00%
HCFC-22	371,340.9	20,423.7	61.31%
HCFC-225	1.6	0.1	0.00%
HCFC-225ca	56.8	1.4	0.00%
HCFC-225cb	0.9	0.03	0.00%
合计	503,079.2	33,309.6	100.00%

国家方案的特点

48. 第 46/39 号决定通过的、并在第六十次会议（第 60/4(b)(iv)号决定）上订正的国家方案新的报告格式，为国家臭氧机构提供了一次从质和量两个角度评估履约前景的机会。

数据的完整性

49. 今年是使用新格式报告国家方案数据的第六年。有 2 个国家仍在使用在第四十六次会议上批准的格式提供 2011 年的数据，有 65 个国家使用在第六十次会议上批准的订正格式。但大部分以新格式提供的数据都不完整，主要表现在三个方面：质量、数量和规范性。仅有 7 个国家，即伯利兹、中非共和国、萨尔瓦多、巴拉圭、塞尔维亚、多哥和委内瑞拉玻利瓦尔共和国针对所有三个方面提供了全部信息（没有漏填任何数据）。

50. 根据第 59/4(b)(iv)号决定，秘书处审查了使用网络的国家方案执行数据。秘书处注意到，在 67 个提交数据的国家中，有 47 个国家使用 2007 年 4 月 25 日启动的网络系统提交 2011 年的数据。

51. 在被要求提供数据的 144 个国家中，只有 67 个国家按时提供了 2011 年的国家方案数据，有 63 个国家及时提供了 2010 年数据，用于本文件中的分析。

数据概要

<u>氟氯烃除外的所有消耗臭氧层物质</u>

52. 在 67 个报告制冷剂管理计划/国家淘汰计划/最终淘汰管理计划的国家中，有 60 个国家显示有进步，或者完成了对其制冷剂管理计划/国家淘汰计划/最终淘汰管理计划的执行。包括已报告 2011 年以前数据的国家在内，143 个国家中有 123 个国家显示有进步或者完成了对其制冷剂管理计划/国家淘汰计划/最终淘汰管理计划的执行。

53. 包括报告 2011 年以前数据的国家在内，共有 14,301 台回收机和 4,873 台再循环机在运行。在使用回收机和再循环机的国家中，66%的国家报告机器运行状况一直“令人满意”或“非常好”。回收的 CFC-11 共计 227.6 ODP 吨，其中 153.7 ODP 吨得到了再利用；回收的 CFC-12 共计 18,205.4 ODP 吨，其中 2,045.8 ODP 吨得到了再利用。未收集其他消耗臭氧层物质的数据。2006-2011 年报告的最新数据，结合此前数年报告的数据表明，共培训了 52,983 名制冷维修技师，49,146 人已得到认证，并有 2,549 名制冷技师培训员接受了培训。

54. 在 143 个报告数据（包括来自往年报告的数据）的国家中，有 110 个国家表示已建立配额制度。此外，有 122 个国家建议需要进行进口商登记。据报告，共有 15,839 名海关官员接受了培训。尚不清楚这是年度数据还是累计数据。

55. 在 144 个有报告要求的国家中，有 134 个国家已报告了经营许可制度（在报告了 2011 年数据的 67 个国家中，有 65 个国家拥有经营许可制度，其中 97%运行情况“令人满意”或“非常好”）。

氟氯化碳和氟氯烃及其替代品的价格数据

56. 表 11 中汇总了一些消耗臭氧层物质和替代品的成本。

表 11

氟氯化碳和氟氯烃及其替代品的平均价格

消耗臭氧层物质	平均价格/公斤（美元/公斤）(2005 年价格，根据提交给第五十次会议的报告)	平均价格/公斤（美元/公斤）(2006 年价格，根据提交给第五十四次会议的报告)	平均价格/公斤（美元/公斤）(2007 年价格，根据提交给第五十七次会议的报告)	平均价格/公斤（美元/公斤）(2008 年价格，根据提交给第六十次会议的报告)	平均价格/公斤（美元/公斤）(2009 年价格，根据提交给第六十三次会议的报告)	平均价格/公斤（美元/公斤）(2010 年价格，根据提交给第六十六次会议的报告)	平均价格/公斤（美元/公斤）(2011 年报告)	价格上涨的国家数	价格下降的国家数	范围 (美元/公斤) (2011 年报告)	2011 年报告非零数据的国家数	计算平均价格时未计入的数据* (美元/公斤) (2011 年报告)
CFC-11	7.09 美元	9.67 美元	10.65 美元	11.42 美元	12.30 美元	13.55 美元	16.25 美元	1	1	7.5 美元(黎巴嫩)至 25.00 美元(墨西哥)	3	40.40 美元(巴西)
CFC-12	8.98 美元	10.95 美元	12.81 美元	11.52 美元	10.84 美元	12.08 美元	19.54 美元	6	2	8.33 美元(菲律宾)至 36.00 美元 (中非共和国)	11	7.00 美元(伊拉克)、46.70 美元(巴西)
CFC-113	9.02 美元	19.41 美元	19.00 美元	16.52 美元	9.91 美元	5.94 美元	暂缺	暂缺	暂缺	无	0	无
CFC-114	9.98 美元	17.37 美元	18.92 美元	16.31 美元	6.35 美元	15.25 美元	暂缺	暂缺	暂缺	无	0	无
CFC-115	10.94 美元	12.41 美元	11.97 美元	8.82 美元	11.62 美元	11.51 美元	暂缺	暂缺	暂缺	无	0	无
环戊烷	暂缺	暂缺	4.03 美元	1.91 美元	3.74 美元	4.68 美元	5.12 美元	1	暂缺	4.64 美元(菲律宾)至 5.60 美元 (亚美尼亚)	2	无
HCFC-123	暂缺	暂缺	暂缺	暂缺	9.09 美元	15.23 美元	14.11 美元	2	1	9.52 美元(菲律宾)至 20.24 美元 (巴拉圭)	6	1.50 美元(多民族玻利维亚国)、32.00 美元(委内瑞拉玻利瓦尔共和国)
HCFC-124	暂缺	暂缺	暂缺	暂缺	12.73 美元	9.14 美元	暂缺	暂缺	暂缺	无	0	无
HCFC-133	暂缺	暂缺	暂缺	暂缺	19.25 美元	暂缺	暂缺	暂缺	暂缺	无	0	无
HCFC-141b	暂缺	暂缺	3.87 美元	6.66 美元	5.00 美元	6.02 美元	6.88 美元	12	4	2.88 美元(摩洛哥)至 14.36 美元 (洪都拉斯)	25	2.40 美元(伊朗伊斯兰共和国)、19.00 美元(委内瑞拉玻利瓦尔共和国)
进口预混多元醇中所含 HCFC-141b	暂缺	暂缺	暂缺	暂缺	3.99 美元	3.81 美元	4.13 美元	2	1	3.00 美元(黎巴嫩和摩洛哥)至 8.00 美元 (多民族玻利维亚国)	8	8.20 美元(吉尔吉斯斯坦)
HCFC-142b	暂缺	暂缺	5.46 美元	6.59 美元	7.75 美元	7.09 美元	7.78 美元	暂缺	暂缺	6.25 美元(纳米比亚)至 9.30 美元 (吉尔吉斯斯坦)	3	美元 30.00 (格鲁吉亚)
HCFC-22	5.41 美元	6.52 美元	7.21 美元	7.75 美元	7.35 美元	8.61 美元	8.91 美元	28	16	3.00 美元(伊朗伊斯兰共和国)至 23.85 美元 (瓦努阿图)	61	69.00 美元(牙买加)、146.29 美元(圣文森特和格林纳丁斯)
HCFC-225	暂缺	暂缺	暂缺	暂缺	9.00 美元	10.00 美元	暂缺	暂缺	暂缺	无	0	无

消耗臭氧层物质	平均价格/公斤（美元/公斤）(2005年价格，根据提交给第五十次会议的报告)	平均价格/公斤（美元/公斤）(2006年价格，根据提交给第五十四次会议的报告)	平均价格/公斤（美元/公斤）(2007年价格，根据提交给第五十七次会议的报告)	平均价格/公斤（美元/公斤）(2008年价格，根据提交给第六十次会议的报告)	平均价格/公斤（美元/公斤）(2009年价格，根据提交给第六十三次会议的报告)	平均价格/公斤（美元/公斤）(2010年价格，根据提交给第六十六次会议的报告)	平均价格/公斤（美元/公斤）(2011年报告)	价格上涨的国家数	价格下降的国家数	范围 (美元/公斤)(2011年报告)	2011年报告非零数据的国家数	计算平均价格时未计入的数据*(美元/公斤)(2011年报告)
HCFC-225ca	暂缺	暂缺	暂缺	暂缺	32.22美元	37.10美元	42.86美元	1	暂缺	42.86美元(菲律宾)	1	无
HCFC-225cb	暂缺	暂缺	暂缺	暂缺	19.11美元	37.10美元	42.86美元	1	暂缺	42.86美元(菲律宾)	1	无
HFC-134a	12.21美元	13.16美元	12.44美元	11.37美元	12.52美元	15.14美元	16.6 2美元	24	17	7.00美元(伊拉克)至48.00美元 (中非共和国)	62	3.54美元(多米尼加)、355.55美元(圣文森特和格林纳丁斯)
HCFC-227ea	暂缺	暂缺	9.32美元	12.97美元	18.03美元	28.30美元	16.10美元	暂缺	2	2.20美元(塞舌尔)至30.00美元 (塞尔维亚)	3	95.24美元(菲律宾)
HCFC-245fa	暂缺	暂缺	7.44美元	10.38美元	10.11美元	12.26美元	暂缺	暂缺	暂缺	无	0	无
HFC-356mfc	暂缺	暂缺	15.52美元	10.38美元	9.63美元	11.00美元	暂缺	暂缺	暂缺	无	0	无
异丁烷(HC-600a)	暂缺	暂缺	14.24美元	22.53美元	24.36美元	21.08美元	25.40美元	7	4	7.08美元(蒙古)至51.10美元(多民族玻利维亚国)	19	3.67美元(加纳)、66.66美元(菲律宾)
计量吸入器(泡沫塑料生产)	暂缺	暂缺	3.83美元	3.34美元	2.91美元	3.15美元	3.09美元	1	1	3.08美元(阿根廷)至3.10美元 (菲律宾)	2	无
甲酸甲酯	暂缺	暂缺	暂缺	暂缺	5.02美元	3.62美元	暂缺	暂缺	暂缺	无	0	无
戊烷	暂缺	暂缺	1.40美元	6.00美元	2.20美元	3.30美元	4.00美元	暂缺	暂缺	4.00美元(亚美尼亚)	1	无
丙烷(HC-290)	暂缺	暂缺	6.49美元	7.88美元	20.53美元	21.79美元	28.05美元	3	2	13.10美元(摩尔多瓦共和国)至52.38美元 (菲律宾)	7	3.00美元(阿根廷)、175.00美元(塞内加尔)
R-404A	暂缺	暂缺	12.44美元	16.46美元	16.13美元	18.67美元	19.76美元	19	18	2.50美元(伊朗伊斯兰共和国)至56.00美元 (布隆迪)	57	0.02美元(多米尼克)、250.00美元(海地)、370.37美元(圣文森特和格林纳丁斯)
R-407C	暂缺	暂缺	14.21美元	17.42美元	16.95美元	20.80美元	20.05美元	19	11	8.85美元(毛里求斯)至47.00美元 (布基纳法索)	47	2.50美元(伊朗伊斯兰共和国)、55.00美元(布隆迪)
R-410A	暂缺	暂缺	14.21美元	15.43美元	16.44美元	20.26美元	19.79美元	17	15	2.50美元(伊朗伊斯兰共和国)至45.00美元 (布基纳法索)	50	250.00美元(海地)、442.59美元(圣文森特和格林纳丁斯)
R-502	14.20美元	16.74美元	21.44美元	16.97美元	16.20美元	13.50美元	17.95美元	4	暂缺	6.00美元(伊朗伊斯兰共和国)至30.10美元 (克罗地亚)	8	250.00美元(海地)
R-507A	暂缺	暂缺	12.47美元	17.69美元	17.48美元	17.55美元	19.77美元	11	5	8.20美元(伊拉克)至30.00美元 (格鲁吉亚)	28	8.00美元(乍得)、31.00美元(贝宁)

*未包括所有零美元条目。

57. 未提供哈龙、甲基溴或四氯化碳的此种数据。

58. 只有 3 个国家提供了 CFC-11 价格数据，11 个国家提供了 CFC-12 价格数据，不清楚大多数国家是否有氟氯化碳出售，因为此种氟氯化碳来自库存数量。HCFC-22 和 HCFC-142b 的价格低于国家方案数据中所包含的替代品价格。HCFC-141b 价格低于替代品 HCFC-245fa 和 HFC-356mfc 的价格，但高于 2010 年的环戊烷、甲酸甲酯、戊烷价格。

氟氯烃

59. 今年是使用经订正的格式载入第六十次会议核准（第 60/4(b)(iv)号决定）的、有关氟氯烃淘汰情况相关信息的第三年。在 67 个国家中，有 65 个国家使用经订正的格式提供了 2011 年有关氟氯烃的信息。

60. 在报告数据的 138 个国家中，有 64 个国家表示它们已建立了配额制度，102 个国家建议需要进行进口商登记。共回收了 378.1 ODP 吨的 HCFC-22，其中 246 ODP 吨得到再利用。据报告，共有 4,166 名海关官员接受了氟氯烃方面的培训。总数为 1,263 台的回收机和 403 台再循环机在运行之中，5,277 名技师已得到认证，8,625 名技师得到了培训，且 1,580 名技师培训员接受了回收和再循环氟氯烃的培训。

第五部分：存在执行延期及需要特殊情况报告的项目

61. 有 14 个正在进行的项目被归于执行拖延项目类别，并被委员会列入项目取消程序。存在执行拖延的项目有：(一) 预计延迟 12 个月以上完成的项目，和/或 (二) 项目获得批准后 18 个月内未付款的项目。按执行机构和双边机构分列的拖延执行项目细目见以下表 12：工发组织（5 个）；开发计划署（4 个）；世界银行（2 个）；环境规划署（1 个）和西班牙（1 个）。尚未收到以色列的报告（1 个）。企业和外部原因是造成拖延的最常见原因，其次是技术原因和政府。

表 12

执行拖延项目的进展情况汇总

	国际复兴开发银行	西班牙	开发计划署	环境规划署	工发组织	共计
已报告的项目数量	2	1	4	1	5	13
取得一定进展的项目数量	2	1	4	1	5	13

取得一定进展的项目

62. 有 13 个项目被归类为显示“取得了一定进展”，执行机构和双边机构表明，将继续对这些项目进行监测（附件三）。尽管取得了进展，但应当注意的是，必须依照第 32/4 号决定继续对三年多以前核准的项目进行监测。因此，无论取得的进展如何，在最终完成之前不能从监测列表中删除。所以建议对这些项目继续进行监测。

需提交补充情况报告的项目

63. 体制建设、哈龙库、海关培训、回收和再循环以及示范项目不受项目取消程序的制约。然而，执行委员会决定酌情继续对其进行监测（第 36/14(b)号决定）。执行委员会第

六十六次会议要求提交 33 份补充情况报告。要求提交此类情况报告的条件是，自上一次报告以来没有任何进展迹象，以及/或者报告称执行过程中存在其他障碍。有 12 个项目已取得了进展。对于 21 个有具体原因需要提交补充情况报告的项目，应向第六十八次会议提交补充情况报告（附件四）。

氟氯烃淘汰管理计划的编制/项目文件签署

64. 迄今为止，执行委员会批准了 144 个国家 297 项氟氯烃淘汰管理计划和氟氯烃淘汰项目编制活动，使得 122 个国家的氟氯烃淘汰管理计划获得批准。根据在第六十七次会议已经批准的氟氯烃淘汰管理计划和提交的氟氯烃淘汰管理计划数量，17 个国家将在第六十七次会议之后提交其氟氯烃淘汰管理计划。

65. 在其第六十六次会议上，执行委员会要求为氟氯烃淘汰管理计划编制项目提交 6 份补充情况报告。要求提交此类情况报告的条件是，自上一次报告以来没有任何进展迹象，以及/或者报告称执行过程中存在其他障碍。有关的氟氯烃淘汰管理计划处于完成的各个阶段，其中 1 个尚未开始（毛里塔尼亚）、1 个正在进行调查（秘鲁）、9 个氟氯烃淘汰管理计划正在编制或正在完成、5 个已提交氟氯烃淘汰管理计划，但推迟或将再次提交、1 个已提交但未获得批准。有 5 个项目需要向第六十八次会议提交补充情况报告（附件五）。

有具体报告要求的项目

66. 执行委员会第六十六次会议要求 43 个项目提交具体报告。其中两个项目已经取消：由工发组织执行的克罗地亚（CRO/FOA/59/INV/34）和埃及（EGY/FOA/62/INV/109）泡沫塑料项目。6 个项目无需提交补充报告，包括开发计划署执行的资源分配项目（GLO/SEV/63/TAS/306）、工发组织执行的资源分配项目（GLO/SEV/63/TAS/307）、世界银行执行的印度四氯化碳淘汰计划（IND/PHA/58/INV/434）、工发组织执行的摩洛哥甲基溴项目（MOR/FUM/56/INV/61 和 MOR/FUM/62/INV/66）和环境开发署执行的赞比亚最终淘汰管理计划核证工作（ZAM/PHA/57/TAS/25）。第六十六次会议要求提交这些报告的原因包括：

- 与最终淘汰管理计划有关的低消费量国家氟氯化碳消费核证工作未完成；
- 2011 年第三次会议核准的关于正在执行的多年期协定的进展情况报告以及提交第六十五次会议的年度报告；
- 单个氟氯烃示范和投资项目核准条款根据第 55/43(b)号决定报告增支资本成本、增支经营成本和技术应用的具体报告要求；
- 继续向第六十七次会议报告最终淘汰管理计划/国家淘汰计划执行进度，并在最终淘汰管理计划/国家淘汰计划完成时提交项目完成报告；
- 至迟在第六十七次会议之前根据第 63/20(a)(i)号决定向执行委员会通报 4 个提案；
- 至迟在第六十七次会议之前根据第 63/20(a)(i)号决定向执行委员会通报 2 个提案；
- 向第六十七次会议提供有关四氯化碳淘汰计划剩余资金的工作计划；
- 向第六十七次会议提交一份关于评估生产聚氨酯泡沫塑料中使用碳氢化合物这种低成本选择的补充报告。

67. 谨建议执行委员会要求向第六十九次会议提交关于其余 34 个项目的具体情况的补充报告（附件六）。

第六部分：氟氯烃示范项目

68. 一个氟氯烃示范项目报告已提交本次会议。讨论本报告后秘书处提出了建议。

在制造挤压聚苯乙烯泡沫塑料木板料时将 HFO-1234ze 用作发泡剂：多边基金项目中的应用评估

背景

69. 开发计划署向第六十七次会议提交了一份技术报告“在制造挤压聚苯乙烯泡沫塑料木板料时将 HFO-1234ze 用作发泡剂：多边基金项目中的应用评估”。技术报告全文作为附件七后附于本文件。

70. 执行委员会第六十次会议核准了验证在制造挤压聚苯乙烯泡沫塑料木板料时将 HFO-1234ze 用作发泡剂的一个试点项目（第一阶段），有一项谅解是该项目是制造聚苯乙烯泡沫塑料过程时将 HFO-1234ze 用作发泡剂的最后验证项目，技术宣传讲习班将根据验证过程的结果推迟到项目第二阶段，核准该项目不妨碍执行委员会对项目第二阶段今后的供资请求的审议（第 60/33 号决定）。

摘要

71. 开发计划署对 HFO-1234ze 和二甲醚的不同制剂进行了一系列试验，二甲醚是一种非常易燃的气体。根据迄今收集到的验证数据，认为 HFO-1234ze 技术在聚苯乙烯应用中具有取代使用氟氯烃和/或全球升温潜能值高的氢氟碳化物的良好前景，同时具有公认的绝热和结构特性。不过，要使此种产品在商业上可以接受，需要一定程度上优化密度和表面（气孔）。

72. 试验表明，有可能减小 HFO-1234ze/二甲醚混合物的易燃性，并通过减少二甲醚数量来改进绝热性能。但这需要进一步试验（成本估计为 150,000 美元），目前没有提供资金，因为批准用于示范项目的全部供资（165,000 美元）已投入使用。开发计划署愿意应请求进一步优化，前提是提供追加供资。

<u>秘书处的评论</u>

73. 秘书处注意到，关于 HFO-1234ze 示范项目的报告显示，还需要利用不同比例的 HFO-1234ze 和二甲醚混合物和不同的挤压机进行额外试验。在第六十次会议上，在核准 HFO-1234ze 示范项目时，秘书处注意到，该项目第一阶段的成本低于其他氟氯烃试点项目，因为这种物质的制造商（霍尼韦尔）同意在其设施中进行大多数试验，因此避免了购买实验设备。开发计划署解释说，在编制项目提案时，期望利用两种不同的氢氟碳化物混合物进行至少一次试验；但项目执行期间遇到的问题要求进一步试验。

74. 根据示范项目取得的成果，秘书处注意到，HFO-1234ze 可能是一种含氟氯烃的挤压聚苯乙烯技术的可行替代技术。但是，该技术目前还无法获得，尽管价格尚不清楚，但预计会高于目前市场上可用的任何替代技术高得多。随着与优化有关的大多数（或全部）问题得到解决，该技术还有望在不久的将来投入商业使用。

<u>秘书处的建议</u>

75. 谨建议执行委员会：

(a) 赞赏地注意到开发计划署提交的题为“在制造挤压聚苯乙烯泡沫塑料木板料时将 HFO-1234ze 用作发泡剂：多边基金项目中的应用评估”的报告；以及

(b) 请双边和执行机构在协助第 5 条国家编制在挤压聚苯乙烯泡沫塑料应用中淘汰 HCFC-142b/HCFC-22 项目时，分享开发计划署关于 HFO-1234ze 的评估报告以及有关其他替代物的资料。

第七部分：为气候共同惠益调动资源

76. 执行委员会第六十三次会议为开发计划署（200,000 美元）、环境规划署（100,000 美元）、工发组织（200,000 美元）和世界银行（180,000 美元）执行的四个单独的全球资源调动项目核准了 680,000 美元的供资。这些项目旨在调动资源，以实现超出通过氟氯烃淘汰独自可实现的气候惠益。开发计划署、环境规划署、工发组织和世界银行向第六十六次会议提交了临时报告。在第 66/15(l) 和 (n)号决定中，执行委员会决定请开发计划署和工发组织向第六十七次会议进一步提交报告。

全球：为气候共同惠益调动资源（开发计划署）

进展情况报告

77. 开发计划署提供了第六十六次会议和第六十七次会议之间为调动资源所开展的活动的进展情况的补充资料。它指出，已从美利坚合众国为开发计划署划拨 170 万美元，用于印度、印度尼西亚和马来西亚全球升温潜能值低的能效技术的示范和应用，覆盖聚氨酯泡沫塑料和商用空调及制冷行业。除了技术示范，这些项目还有望为持续进行技术干预的政策和条例提供备选办法，推荐计算气候惠益的办法，以及制定成本基准和执行时间表。

78. 开发计划署继续为印度尼西亚的全球环境基金项目提案提供技术支援，重点是空调和制冷行业能效改进的融资。该项目目前正在最后确定，费用为 450 万美元。开发计划署还根据第 63/20(a)(i)号决定的要求就以下方面提供资料：拟议项目的额外贷款；透明度和善治；保证这些项目将避免对各国起消极作用；探索共同获益的可能性，包括将资金返还多边基金；确保拟议项目的可持续性；避免类似项目重复；交易成本方面的资料。开发计划署提交的报告作为附件八后附于本文件。

秘书处的评论

79. 秘书处指出，开发计划署就进展情况提供了更多的实质性资料，并建议根据第 63/20 号决定确定具体项目。在与开发计划署讨论后，秘书处建议开发计划署确保如果活动与已经获得供资的氟氯烃淘汰管理计划有联系，则必须明确界定来自其他渠道的供资将覆盖哪些方面，以便同一活动不可能得到双重供资。它重申，根据多边基金现在的氟氯烃淘汰指南，此类活动显然没有资格获得供资。

秘书处的建议

80. 谨建议执行委员会注意开发计划署提交的关于为气候共同惠益调动资源的临时报告，并敦促开发计划署在第六十八次会议前提交这些项目的最终报告。

全球：为淘汰氟氯烃和气候共同惠益调动资源（工发组织）

<u>进展情况报告</u>

81. 工发组织就第六十六次会议和第六十七次会议期间为调动资源所取得的进展提供了补充资料。工发组织侧重于将全球环境基金作为潜在的供资来源和这些活动的合作伙伴。它确定了冈比亚、摩洛哥和越南实施渔业和食品加工等行业的项目。项目概念已提交全球环境基金供审议，重点是这三个国家的渔业和食品加工行业冷库维修方面的能效改善。设想全球环境基金的供资承担这些国家已确定设施的初步和最终能源审计的费用，并提出解决方案，以通过设施转产使用全球升温潜能值低的制冷剂和绝缘材料来提高能效。工发组织认为，通过全球环境基金的供资安装更多的节能设备，将促成能源收益，而这将提供财务收益以维持今后的活动。

82. 工发组织还按照第 63/23(a)(i)号决定的要求就以下方面提供详细资料：拟议项目的额外贷款；透明度和善治；保证这些项目避免对国家起消极作用；探索共同获益的可能性，包括将资金返还多边基金；确保拟议项目的可持续性；避免类似项目的重复；交易成本方面的资料。工发组织提交的报告作为附件九后附于本文件。

<u>秘书处的评论</u>

83. 秘书处指出，工发组织就为调动资源所开展活动的进展情况提供了更多的实质性资料。它注意到，正在拟议项目的三个国家的氟氯烃淘汰管理计划第一阶段获得核准，项目概念似乎是针对第二阶段可能有资格获得多边基金资助的各项活动。此外，工发组织不是越南氟氯烃淘汰管理计划的牵头机构和合作执行机构，秘书处对执行的影响表示关切。在与工发组织讨论后，秘书处还提醒该机构确保如果活动与已经获得供资的氟氯烃淘汰管理计划有联系，则必须明确界定来自其他渠道的供资将覆盖哪些方面，以避免同一活动获得双重供资。它重申，根据多边基金现在的氟氯烃淘汰指南，此类活动显然没有资格获得供资。秘书处还指出了国家臭氧机构与负责氟氯烃淘汰管理计划此类活动的执行机构达成协议的重要性，以确保密切协调，避免任何一个项目的执行拖延。

<u>秘书处的建议</u>

84. 谨建议执行委员会注意开发计划署提交的关于为气候共同惠益调动资源的临时报告，并敦促开发计划署在第六十八次会议之前提交这些项目的最终报告。

建议

85. 谨建议执行委员会考虑：

(a) 注意到：

(一) 赞赏地注意到 UNEP/OzL.Pro/ExCom/67/6 号文件所载、由执行机构和法国、日本和西班牙政府提交给秘书处的情况报告和有关拖延执行项目的报告；

(二) 2011 年的 47 个国家方案执行情况报告是通过 2007 年 4 月 25 日启动的网络系统提交的；

(三) 秘书处和执行机构将按照秘书处的评估（按照附件三取得了一定进展）采取既定行动，并在必要时报告和通知各国政府和执行机构；

(四) 迄今为止由于精简决定，报告数量大幅减少，包括取消了本次会议的 81 个无氟氯烃多年期协定的 81 份付款执行计划报告，取消了 69 个国家氟氯烃淘汰管理计划的 109 份执行计划报告；

(b) 具有或没有供资影响的工作计划的改变请求是在 “情况报告和履约情况”文件中讨论，还是列示在“投资项目”议程项目下；

(c) 敦促尚未提交 2011 年国家方案数据的国家在今年最后一次会议之前提交数据：中国、库克群岛、厄立特里亚、冈比亚、几内亚比绍、印度、马达加斯加、马尔代夫、缅甸、瑙鲁、尼泊尔、尼日利亚、沙特阿拉伯、阿拉伯叙利亚共和国、坦桑尼亚联合共和国、泰国和图瓦卢；

(d) 请：

(一) 执行机构确保今后将满足第 66/16(b)(ii)号决定的要求，将此作为向第六十七次会议之后各次会议提交付款执行计划的前提；

(二) 南非政府在核准其氟氯烃淘汰管理计划之后提交其氟氯烃活动的国家方案数据；

(三) 关于项目的补充情况报告载于本文件附件四和附件五；

(四) 以色列政府向执行委员会第六十八次会议提交其执行拖延报告；

(五) 向第六十九次会议提交关于其余 34 个项目具体情况的补充报告（附件六）；

(e) 关于氟氯烃示范项目：

(一) 赞赏地注意到开发计划署提交的、题为“在制造挤压聚苯乙烯泡沫塑料木板料时将 HFO-1234ze 用作发泡剂：多边基金项目中的应用评估”的报告；

(二) 请双边机构和执行机构在协助第 5 条国家编制挤压聚苯乙烯泡沫塑料应用中淘汰 HCFC-142b/HCFC-22 项目时，分享开发计划署关于 HFO-1234ze 的评估报告以及有关其他替代物的资料；

(f) 关于为气候共同惠益调动资源：

(一) 注意到开发计划署提交的关于为气候共同惠益调动资源的临时报告，并敦促开发计划署在第六十八次会议之前提交这些项目的最终报告；

(二) 注意到工发组织提交的关于为气候共同惠益调动资源的临时报告，并敦促工发组织在第六十八次会议之前提交这些项目的最终报告。

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Annex I

DETAILED ANALYSIS OF THE STATUS OF IMPLEMENTATION IN COUNTRIES SUBJECT TO DECISIONS OF THE PARTIES ON COMPLIANCE AND THOSE WHOSE LATEST CONSUMPTION DATA EXCEEDS THE CONTROL MEASURES

1. Annex I presents the detailed analysis of the status of implementation in countries subject to decisions of the Parties on compliance and those whose latest consumption data exceeds the next control measures. The data tables in Appendices I-VI indicate whether a country has received a total phase-out agreement for a specific controlled substance. The analysis of halons (Appendix II) indicates whether a halon banking activity has been approved. Halon banking guidelines require that regulations facilitating production and import bans are established within six months of the establishment of a reclamation centre (decision 18/22). The methyl bromide analysis (Appendix III) indicates further whether a country has received funding for a phase-out to meet the 2005 control measures. Appendices IV and V present information on the carbon tetrachloride (CTC) and methyl chloroform (TCA) phase-out, respectively. Appendix VI provides information on HCFC consumption only.

ANALYSIS OF COMPLIANCE FOR CFCs (Appendix I)

2. Countries have been grouped into one category: (a) those whose latest consumption exceeds the 2010 100 per cent phase-out target.

(a) <u>Countries whose latest consumption exceeds the 2010 phase-out target</u>

3. This category consists of 7 countries which may need to achieve additional CFC phase-out amounting to 1,538 ODP tonnes by 2010 in order to comply with the 100 per cent reduction target.

4. The Executive Committee has approved national CFC phase-out agreements for all of these countries.

5. Six of the 7 countries that have latest consumption that exceeded zero consumption either have essential use authorizations for CFC consumption (Argentina, Bangladesh, China, India and Syrian Arab Republic) as per decision XXI/4 or emergency essential use for CFC-113 2010-2011 consumption as per decision XXII/4 para. 7 (Dominican Republic (the)).

ANALYSIS OF COMPLIANCE FOR HALONS (Appendix II)

6. Seventy-five countries have reported no consumption of halons between 1995 and 2010.

7. Sixty-one countries have received support for halon banking activities or phase-out agreements. This includes those countries participating in regional halon banks. Halon banking is presumed to be the last funded activity in the halon consumption sector for most countries but there are some halon phase-out activities that are part of multi-sectoral phase-out agreements.

8. Countries have been grouped into the following one category: (a) those whose latest consumption exceeds the 2010 100 per cent phase-out target.

(a) <u>Countries whose latest consumption exceeds the 2010 phase-out target</u>

9. This category consists of two countries that may need to phase-out additional halons amounting to 3 ODP tonnes by 2010 in order to comply with the 100 per cent reduction targets. These countries have received support from the Multilateral Fund.

ANALYSIS OF COMPLIANCE FOR METHYL BROMIDE (Appendix III)

10. This section presents the analysis for compliance with methyl bromide control measures. It should be noted that all data reported and used in this analysis relate to controlled use only, which means that the data exclude quarantine and pre-shipment (QPS). 144 of the 147 Article 5 countries that have ratified the Copenhagen Amendment have reported complete baseline data. Of these 147 countries, 58 reported zero for both the baseline consumption and the latest consumption.

11. One-hundred Article 5 countries have received support from the Multilateral Fund for methyl bromide activities and/or projects. This includes projects that will lead to a complete phase-out of methyl bromide in 63 of these countries, partial phase-out in an additional 8, and other forms of assistance received by 29.

12. Countries have been grouped into the following two categories: (a) those whose latest consumption exceeds the 20 per cent reduction target of 2005 that applies until December 2014; and (b) those whose latest consumption exceeds the 2015 100 per cent phase-out target. Appendix III identifies those countries that have not ratified the Copenhagen Amendment.

(a) Countries whose latest consumption exceeds the 20 per cent MB baseline reduction target

13. This category consists of only one country, Turkmenistan. This country may need to meet additional combined reduction amounting to 0.02 ODP tonnes in order to comply with the 20 per cent reduction targets. Turkmenistan has approved projects that will lead to complete phase-out of methyl bromide.

(b) Countries whose latest consumption exceeds the 2015 phase-out target

14. This category consists of 27 countries that may need to meet additional combined reduction amounting to 1,821 ODP tonnes by 2015 in order to comply with the 100 per cent reduction targets. Of the 27 countries, 23 countries have approved projects that will lead to complete phase-out of methyl bromide. Three countries may need additional assistance from the Multilateral Fund to achieve the phase-out of methyl bromide by 2015. The remaining country (Singapore) is currently not eligible to receive funding from the Multilateral Fund.

CARBON TETRACHLORIDE (CTC) (Appendix IV)

15. This section presents the analysis of compliance with CTC control measures. All data reported and used in this analysis are those related to controlled use only, which excludes feedstock. Reported CTC consumption was not differentiated by specific end use, such as solvents, process agents and laboratory use.

16. Of the 146 countries with reported baseline data, 90 reported zero both for the baseline and the latest consumption.

17. Countries have been grouped into the following one category: (a) those whose latest consumption exceeds the 2010 100 per cent phase-out target. Appendix IV notes those countries that have not ratified the London Amendment.

(a) Countries whose latest consumption exceeds the 2010 phase-out target

18. This category consists of 5 countries that may need to phase out additional CTC amounting to 283.5 ODP tonnes to meet the 100 per cent reduction by 2010. Three of the 5 countries have received

funding for CTC phase-out agreements or projects from the Multilateral Fund. The Republic of Korea has agreed not to receive CTC funding from the Multilateral Fund.

19. Countries with latest CTC consumption that exceeded zero consumption have process agent use exemptions for CTC consumption as per decision XXII/8 (China) or CTC consumption for laboratory and analytical uses (Croatia, Nepal, Panama), except Republic of Korea (the).

METHYL CHLOROFORM (TCA) (Appendix V)

20. This section presents the analysis for compliance with TCA control measures. Of the 146 countries that have reported baseline data, 103 reported zero both for the baseline and the latest consumption.

21. Countries have been grouped into two categories: (a) those whose latest consumption exceeds the 70 per cent reduction target of 2010; and (b) those whose latest consumption exceeds the 2015 100 per cent phase-out target. Appendix V specifies those countries that have not ratified the London Amendment.

(a) <u>Countries whose latest consumption exceeds the 70 per cent TCA baseline reduction target</u>

22. All countries are in compliance with the 70 per cent TCA baseline reduction target.

(b) <u>Countries whose latest consumption exceeds the 100 per cent TCA baseline reduction target</u>

23. This category consists of one country (Republic of Korea (the)) that may need to meet additional combined reduction amounting to 66.7 ODP tonnes by 2015 in order to comply with the 100 per cent reduction target. The Republic of Korea is not eligible to receive TCA funding from the Multilateral Fund.

HCFCs (Appendix VI)

24. Appendix VI also includes an analysis of the latest consumption and baseline data on HCFCs and indicates whether the country had received HPMP preparation funding, the number of investment projects approved, the number of demonstration projects approved, total phase-out approved in ODP tonnes and activities planned in the 2012 business plans. 145 of the 147 countries already reported both the baseline and the latest consumption.

25. All countries have received HPMP project preparation funds except the Republic of Korea, Singapore and the United Arab Emirates. The Republic of Korea and Singapore had agreed not to receive funding from the Multilateral Fund.

(a) <u>Countries whose latest consumption exceeds the freeze reduction target</u>

26. This category consists of 74 countries that may need to phase out additional HCFC amounting to 1,551 ODP tonnes to meet the freeze reduction target by 2013.

27. 60 of the 74 countries have received funding for HCFC phase-out agreements from the Multilateral Fund. Of the 22 remaining countries, 6 countries have submitted HCFC phase-out projects to the 67th meeting, 11 countries have activities planned in the 2012-2014 business plans and the Republic of Korea has agreed not to receive HCFC funding from the Multilateral Fund.

Appendix I

CFC ANALYSIS

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Afghanistan	A7	2010	380.0	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Nov-05	Yes
Albania	A7	2011	40.8	0.0	Decision XV/26	0.00	0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-03	Yes
Algeria	CP	2011	2,119.5	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Nov-07	Yes
Angola	A7	2011	114.8	0.0					0%	0%	No	No	LVC country with RMP/RMP update approved in accordance to Decision 31/48	Apr-03	Yes
Antigua and Barbuda	A7	2010	10.7	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-04	Yes
Argentina	CP	2011	4,697.2	28.3					0%	*	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-04	Yes
Armenia	A7	2011	196.5	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan. (Phase-Out Plan funded through the GEF when country was a non-Article 5 Party)	Not Available	Yes
Bahamas (the)	A7	2010	64.9	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-01	Yes
Bahrain	A7	2010	135.4	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-06	Yes
Bangladesh	A7	2010	581.6	48.0	Decision XXI/17	140.00	0.00		0%	*	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-04	Yes
Barbados	A7	2011	21.5	0.0					0%	0%	No	No	LVC country with RMP/RMP update approved in accordance to Decision 31/48	Jul-04	Yes
Belize	CP	2011	24.4	0.0	Decision XIV/33	0.00	0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Benin	CP	2011	59.9	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-08	Yes
Bhutan	A7	2010	0.2	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Bolivia (Plurinational State of)	CP	2011	75.7	0.0	Decision XV/29		0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-07	Yes
Bosnia and Herzegovina	A7	2010	24.2	0.0	Decision XV/30 and Decision XXI/18	0.00	0.00		0%	0%	Yes	No	LVC country with total CFC phase-out plan	Dec-03	Yes
Botswana	A7	2011	6.9	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-09	No
Brazil	A7	2011	10,525.8	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-02	Yes
Brunei Darussalam	CP	2011	78.2	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-04	Yes
Burkina Faso	A7	2011	36.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-06	Yes
Burundi	CP	2011	59.0	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-08	Yes
Cambodia	A7	2010	94.2	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Cameroon	A7	2010	256.9	-6.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-06	Yes
Cape Verde	A7	2010	2.3	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Central African Republic (the)	A7	2011	11.2	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-08	Yes
Chad	CP	2011	34.6	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Chile	A7	2010	828.7	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-08	Yes
China	A7	2010	57,818.7	968.6					0%	*	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-2005 (Last agreement approved by the ExCom for CFC)	Yes
Colombia	CP	2011	2,208.2	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-03	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Comoros (the)	CP	2011	2.5	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Congo (the)	A7	2010	11.9	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Cook Islands (the)	A7	2010	1.7	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-04	Yes
Costa Rica	CP	2011	250.2	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Cote d'Ivoire	A7	2010	294.2	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Croatia	CP	2011	219.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-03	Yes
Cuba	A7	2011	625.1	0.0					0%	0%	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-04	Yes
Democratic People's Republic of Korea (the)	A7	2010	441.7	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Nov-05	Yes
Democratic Republic of the Congo (the)	A7	2011	665.7	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-06	Yes
Djibouti	A7	2011	21.0	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Dominica	CP	2011	1.5	0.0	Decision XVIII/22	0.00	0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-06	Yes
Dominican Republic (the)	A7	2011	539.8	1.5					0%	**	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-05	Yes
Ecuador	A7	2010	301.4	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Dec-03	Yes
Egypt	CP	2011	1,668.0	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-05	Yes
El Salvador	A7	2011	306.5	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Equatorial Guinea	A7	2010	31.5	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Apr-09	Yes
Eritrea	A7	2010	41.1	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Ethiopia	A7	2010	33.8	0.0	Decision XIV/34		0.00	0.00	0%	0%	No	No	LVC country with RMP/RMP update approved in accordance to Decision 31/48	Dec-04	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Fiji	A7	2011	33.4	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-05	Yes
Gabon	A7	2010	10.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Gambia (the)	A7	2010	23.8	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Georgia	CP	2011	22.5	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-06	Yes
Ghana	A7	2011	35.8	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-06	Yes
Grenada	CP	2011	6.0	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-06	Yes
Guatemala	CP	2011	224.6	0.0	Decision XV/34		0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-08	Yes
Guinea	A7	2010	42.4	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-08	Yes
Guinea-Bissau	A7	2011	26.3	0.0	Decision XVI/24	3.94	0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-08	Yes
Guyana	A7	2010	53.2	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Haiti	A7	2011	169.0	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-09	Yes
Honduras	CP	2011	331.6	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-08	Yes
India	A7	2010	6,681.0	316.1					0%	*	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-04	Yes
Indonesia	A7	2010	8,332.7	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-04	Yes
Iran (Islamic Republic of)	CP	2011	4,571.7	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-03	Yes
Iraq	CP	2011	1,517.0	0.0					0%	0%	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-09	Yes
Jamaica	CP	2011	93.2	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-02	Yes
Jordan	A7	2011	673.3	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Nov-02	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Kenya	A7	2010	239.5	0.0	Decision XVIII/28	0.00			0%	0%	Yes	No	LVC country with total CFC phase-out plan	Dec-04	Yes
Kiribati	A7	2010	0.7	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-02	Yes
Kuwait	A7	2010	480.4	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Kyrgyzstan	CP	2011	72.8	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-06	Yes
Lao People's Democratic Republic (the)	CP	2011	43.3	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Lebanon	CP	2011	725.5	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-04	Yes
Lesotho	A7	2011	5.1	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-03	Yes
Liberia	CP	2011	56.1	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Libya	A7	2009	716.7	0.0	Decision XV/36		0.00	0.00	0%	0%	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-03	Yes
Madagascar	A7	2010	47.9	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Malawi	CP	2011	57.7	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Malaysia	A7	2010	3,271.1	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-01	Yes
Maldives	A7	2011	4.6	0.0	Decision XV/37	0.00	0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Mali	CP	2011	108.1	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Marshall Islands (the)	A7	2010	1.1	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-02	Yes
Mauritania	A7	2010	15.7	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Mauritius	A7	2011	29.1	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-03	Yes
Mexico	A7	2011	4,624.9	-6.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-04	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Micronesia (Federated States of)	A7	2011	1.2	0.0	Decision XVII/32	0.00	0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-02	Yes
Mongolia	A7	2011	10.6	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-05	Yes
Montenegro	CP	2011	104.9	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Morocco	CP	2011	802.3	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-04	Yes
Mozambique	A7	2010	18.2	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-08	Yes
Myanmar	A7	2010	54.3	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Not Available	Yes
Namibia	CP	2011	21.9	0.0	Decision XV/38	1.00	0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-03	Yes
Nauru	A7	2010	0.5	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-04	Yes
Nepal	A7	2011	27.0	0.0	Decision XVI/27	4.00	0.00		0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Nicaragua	A7	2010	82.8	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Nov-08	Yes
Niger (the)	A7	2010	32.0	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Nigeria	A7	2010	3,650.0	0.0	Decision XIV/30	100.00	0.00	0.00	0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Nov-02	Yes
Niue	A7	2010	0.1	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Dec-04	Yes
Oman	A7	2011	248.4	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Pakistan	A7	2010	1,679.4	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-04	Yes
Palau	CP	2011	1.6	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-02	Yes
Panama	CP	2011	384.1	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-04	Yes
Papua New Guinea	A7	2011	36.3	0.0	Decision XV/40		0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-03	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Paraguay	CP	2011	210.6	0.0	Decision XIX/22	31.60	0.00		0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-07	Yes
Peru	A7	2011	289.5	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Jul-08	Yes
Philippines (the)	CP	2011	3,055.8	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Nov-02	Yes
Qatar	A7	2010	101.4	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Republic of Korea (the)	A7	2010	9,159.8	0.0					0%	0%	No	No			Yes
Republic of Moldova (the)	A7	2011	73.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Rwanda	A7	2010	30.4	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Saint Kitts and Nevis	A7	2010	3.7	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-06	Yes
Saint Lucia	A7	2010	8.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Saint Vincent and the Grenadines	A7	2011	1.8	0.0	Decision XVI/30	0.10	0.00	0.00	0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-05	Yes
Samoa	A7	2010	4.5	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Sao Tome and Principe	A7	2010	4.7	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Saudi Arabia	A7	2010	1,798.5	0.0	Decision XXII/15		0.00		0%	0%	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Nov-07	Yes
Senegal	CP	2011	155.8	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Jul-07	Yes
Serbia	A7	2011	849.2	0.0					0%	0%	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-04	Yes
Seychelles	A7	2011	2.9	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-07	Yes
Sierra Leone	A7	2010	78.6	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-09	Yes
Singapore	A7	2010	210.5	0.0					0%	0%	No	No			Yes
Solomon Islands	A7	2010	2.1	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-02	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Somalia	CP	2011	241.4	0.0	Decision XXI/23		0.00		0%	0%	No	No	LVC country with no RMP		Yes
South Africa	A7	2010	592.6	0.0					0%	0%	No	No			Yes
Sri Lanka	CP	2011	445.6	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-04	Yes
Sudan (the)	A7	2010	456.8	0.0					0%	0%	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-04	Yes
Suriname	CP	2011	41.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-08	Yes
Swaziland	A7	2010	24.6	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-08	Yes
Syrian Arab Republic	A7	2010	2,224.6	44.7					0%	*	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-06	Yes
Thailand	A7	2010	6,082.1	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-01	Yes
The Former Yugoslav Republic of Macedonia	A7	2011	519.7	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-05	Yes
Timor-Leste	A7	2010	36.0	0.0					0%	0%	No	No	LVC country with no RMP		No
Togo	A7	2011	39.8	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Tonga	A7	2010	1.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-02	Yes
Trinidad and Tobago	A7	2011	120.0	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Jul-03	Yes
Tunisia	CP	2011	870.1	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-06	Yes
Turkey	A7	2010	3,805.7	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-01	Yes
Turkmenistan	A7	2010	37.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan. (Phase-Out Plan funded through the GEF when country was a non-Article 5 Party)	Not Available	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Licensing System
Tuvalu	A7	2010	0.3	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-02	Yes
Uganda	A7	2010	12.8	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Jul-08	Yes
United Arab Emirates (the)	A7	2010	529.3	0.0					0%	0%	No	No			Yes
United Republic of Tanzania (the)	A7	2010	253.9	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Apr-08	Yes
Uruguay	CP	2011	199.1	0.0					0%	0%	No	No	LVC country with total CFC phase-out plan	Nov-06	Yes
Vanuatu	CP	2011	0.0	0.0	Decision XXII/18		0.00		0%	0%	No	No	LVC country with total CFC phase-out plan	Mar-02	Yes
Venezuela (Bolivarian Republic of)	CP	2011	3,322.4	0.0					0%	0%	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-04	Yes
Viet Nam	A7	2010	500.0	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Apr-05	Yes
Yemen	A7	2009	1,796.1	130.6					0%	Over	Yes	No	Non-LVC country with an approved terminal CFC phase-out plan	Jul-08	Yes
Zambia	A7	2010	27.4	0.0					0%	0%	Yes	No	LVC country with total CFC phase-out plan	Nov-07	Yes
Zimbabwe	A7	2010	451.4	0.0					0%	0%	No	No	Non-LVC country with an approved terminal CFC phase-out plan	Dec-04	Yes

*For essential use authorizations for CFC consumption.
** For emergency essential use for CFC-113 2010-2011 consumption per decision XXII/4 para. 7.

Appendix II

HALON ANALYSIS

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 50% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved
Afghanistan	A7	2010	1.9	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Albania	A7	2011	0.0	0.0					0%	0%	No	No		
Algeria	CP	2011	237.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01 and Nov-07
Angola	A7	2011	0.0	0.0					0%	0%	No	No		
Antigua and Barbuda	A7	2010	0.3	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Argentina	CP	2011	167.8	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-98
Armenia	A7	2011	0.0	0.0					0%	0%	No	No		
Bahamas (the)	A7	2010	0.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-98
Bahrain	A7	2010	38.9	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Mar-00
Bangladesh	A7	2010	0.0	0.0					0%	0%	No	No		
Barbados	A7	2011	0.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-98
Belize	CP	2011	0.0	0.0					0%	0%	No	No		
Benin	CP	2011	3.9	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-02
Bhutan	A7	2010	0.3	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Bolivia (Plurinational State of)	CP	2011	0.0	0.0					0%	0%	No	No		

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 50% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved
Bosnia and Herzegovina	A7	2010	4.1	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Apr-04
Botswana	A7	2011	5.2	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01
Brazil	A7	2011	21.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	May-96
Brunei Darussalam	CP	2011	0.0	0.0					0%	0%	No	No		
Burkina Faso	A7	2011	5.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-02
Burundi	CP	2011	0.0	0.0					0%	0%	No	No		
Cambodia	A7	2010	0.0	0.0					0%	0%	No	No		
Cameroon	A7	2010	2.4	0.0	Decision XV/32		0.00	0.00	0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-02
Cape Verde	A7	2010	0.0	0.0					0%	0%	No	No		
Central African Republic (the)	A7	2011	0.0	0.0					0%	0%	No	No		
Chad	CP	2011	0.0	0.0					0%	0%	No	No		
Chile	A7	2010	8.5	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Mar-07
China	A7	2010	34,186.7	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-97
Colombia	CP	2011	187.7	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-03
Comoros (the)	CP	2011	0.0	0.0					0%	0%	No	No		
Congo (the)	A7	2010	5.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-02 and Apr-08
Cook Islands (the)	A7	2010	0.0	0.0					0%	0%	No	No		
Costa Rica	CP	2011	0.0	0.0					0%	0%	No	No		
Cote d'Ivoire	A7	2010	0.0	0.0					0%	0%	No	No		

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 50% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved
Croatia	CP	2011	30.1	-83.5					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-04
Cuba	A7	2011	0.0	0.0					0%	0%	No	No		
Democratic People's Republic of Korea (the)	A7	2010	0.0	0.0					0%	0%	No	No		
Democratic Republic of the Congo (the)	A7	2011	218.7	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-02
Djibouti	A7	2011	0.0	0.0					0%	0%	No	No		
Dominica	CP	2011	0.0	0.0					0%	0%	No	No		
Dominican Republic (the)	A7	2011	4.2	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Mar-07
Ecuador	A7	2010	5.5	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Egypt	CP	2011	705.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-00
El Salvador	A7	2011	0.7	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Equatorial Guinea	A7	2010	28.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Apr-09
Eritrea	A7	2010	2.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Apr-08
Ethiopia	A7	2010	1.1	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01
Fiji	A7	2011	0.0	0.0					0%	0%	No	No		
Gabon	A7	2010	0.0	0.0					0%	0%	No	No		
Gambia (the)	A7	2010	0.0	0.0					0%	0%	No	No		
Georgia	CP	2011	42.5	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-05
Ghana	A7	2011	0.0	0.0					0%	0%	No	No		
Grenada	CP	2011	0.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-98

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 50% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved
Guatemala	CP	2011	0.2	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Guinea	A7	2010	8.6	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-02
Guinea-Bissau	A7	2011	0.0	0.0					0%	0%	No	No		
Guyana	A7	2010	0.1	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-98
Haiti	A7	2011	1.5	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-06
Honduras	CP	2011	0.0	0.0					0%	0%	No	No		
India	A7	2010	1,249.4	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-00
Indonesia	A7	2010	354.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Mar-99
Iran (Islamic Republic of)	CP	2011	1,420.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-99
Iraq	CP	2011	70.4	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-09
Jamaica	CP	2011	1.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-98
Jordan	A7	2011	210.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-99
Kenya	A7	2010	5.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01
Kiribati	A7	2010	0.0	0.0					0%	0%	No	No		
Kuwait	A7	2010	3.0	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Kyrgyzstan	CP	2011	0.0	0.0	Decision XVII/36	0.00	0.00	0.00	0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Apr-06

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 50% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved
Lao People's Democratic Republic (the)	CP	2011	0.0	0.0					0%	0%	No	No		
Lebanon	CP	2011	0.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Mar-00
Lesotho	A7	2011	0.2	0.0	Decision XVI/25				0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01
Liberia	CP	2011	19.5	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Libya	A7	2009	633.1	1.8	Decision XVII/37	0.00	0.00	0.00	0%	Over	No	No	Country with approved halon banking and/or halon phase-out project	Nov-05
Madagascar	A7	2010	0.0	0.0					0%	0%	No	No		
Malawi	CP	2011	0.0	0.0					0%	0%	No	No		
Malaysia	A7	2010	8.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Mar-93
Maldives	A7	2011	0.0	0.0					0%	0%	No	No		
Mali	CP	2011	0.0	0.0					0%	0%	No	No		
Marshall Islands (the)	A7	2010	0.0	0.0					0%	0%	No	No		
Mauritania	A7	2010	0.0	0.0					0%	0%	No	No		
Mauritius	A7	2011	0.0	0.0					0%	0%	No	No		
Mexico	A7	2011	124.6	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01
Micronesia (Federated States of)	A7	2011	0.0	0.0					0%	0%	No	No		
Mongolia	A7	2011	0.0	0.0					0%	0%	No	No		
Montenegro	CP	2011	2.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-07
Morocco	CP	2011	7.0	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Mozambique	A7	2010	0.9	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Myanmar	A7	2010	0.0	0.0					0%	0%	No	No		

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 50% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved
Namibia	CP	2011	8.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01
Nauru	A7	2010	0.0	0.0					0%	0%	No	No		
Nepal	A7	2011	2.0	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Nicaragua	A7	2010	0.0	0.0					0%	0%	No	No		
Niger (the)	A7	2010	0.0	0.0					0%	0%	No	No		
Nigeria	A7	2010	285.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-02
Niue	A7	2010	0.0	0.0					0%	0%	No	No		
Oman	A7	2011	13.7	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-05
Pakistan	A7	2010	14.2	0.0	Decision XVI/29		0.00	0.00	0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-03
Palau	CP	2011	0.0	0.0					0%	0%	No	No		
Panama	CP	2011	0.0	0.0					0%	0%	No	No		
Papua New Guinea	A7	2011	0.0	0.0					0%	0%	No	No		
Paraguay	CP	2011	0.0	0.0					0%	0%	No	No		
Peru	A7	2011	0.0	0.0					0%	0%	No	No		
Philippines (the)	CP	2011	103.9	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-95
Qatar	A7	2010	10.7	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Mar-00
Republic of Korea (the)	A7	2010	3,678.0	0.0					0%	0%	No	No		
Republic of Moldova (the)	A7	2011	0.4	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Rwanda	A7	2010	0.0	0.0					0%	0%	No	No		
Saint Kitts and Nevis	A7	2010	0.0	0.0					0%	0%	No	No		
Saint Lucia	A7	2010	0.0	0.0					0%	0%	No	No		
Saint Vincent and the Grenadines	A7	2011	0.0	0.0					0%	0%	No	No		

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 50% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved
Samoa	A7	2010	0.0	0.0					0%	0%	No	No		
Sao Tome and Principe	A7	2010	0.0	0.0					0%	0%	No	No		
Saudi Arabia	A7	2010	1,064.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-07
Senegal	CP	2011	0.0	0.0					0%	0%	No	No		
Serbia	A7	2011	3.8	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01
Seychelles	A7	2011	0.0	0.0					0%	0%	No	No		
Sierra Leone	A7	2010	16.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Mar-07
Singapore	A7	2010	0.0	0.0					0%	0%	No	No		
Solomon Islands	A7	2010	0.0	0.0					0%	0%	No	No		
Somalia	CP	2011	17.7	0.0	Decision XX/19	9.40	0.00		0%	0%	No	No	Country with a halon baseline and no current consumption	
South Africa	A7	2010	0.0	0.0					0%	0%	No	No		
Sri Lanka	CP	2011	0.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-04
Sudan (the)	A7	2010	2.0	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Suriname	CP	2011	0.0	0.0					0%	0%	No	No		
Swaziland	A7	2010	0.0	0.0					0%	0%	No	No		
Syrian Arab Republic	A7	2010	416.9	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-01
Thailand	A7	2010	271.7	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-99
The Former Yugoslav Republic of Macedonia	A7	2011	32.1	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-02
Timor-Leste	A7	2010	1.5	0.0					0%	0%	No	No	Country with a halon baseline and no current consumption	
Togo	A7	2011	0.0	0.0					0%	0%	No	No		
Tonga	A7	2010	0.0	0.0					0%	0%	No	No		

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 50% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved
Trinidad and Tobago	A7	2011	46.6	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-98
Tunisia	CP	2011	104.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Jul-06
Turkey	A7	2010	141.0	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Nov-02
Turkmenistan	A7	2010	0.0	0.0					0%	0%	No	No		
Tuvalu	A7	2010	0.0	0.0					0%	0%	No	No		
Uganda	A7	2010	0.0	0.0					0%	0%	No	No		
United Arab Emirates (the)	A7	2010	75.4	0.0					0%	0%	No	No		
United Republic of Tanzania (the)	A7	2010	0.3	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01 and Apr-08
Uruguay	CP	2011	0.0	0.0					0%	0%	No	No		
Vanuatu	CP	2011	0.0	0.0					0%	0%	No	No		
Venezuela (Bolivarian Republic of)	CP	2011	0.0	0.0					0%	0%	No	No		
Viet Nam	A7	2010	37.1	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Apr-05
Yemen	A7	2009	140.0	1.2					0%	Over	No	No	Country with approved halon banking and/or halon phase-out project	Mar-00
Zambia	A7	2010	0.0	0.0					0%	0%	No	No		
Zimbabwe	A7	2010	1.5	0.0					0%	0%	No	No	Country with approved halon banking and/or halon phase-out project	Dec-01

Appendix III

METHYL BROMIDE ANALYSIS

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Afghanistan	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Albania	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Algeria	CP	2011	4.7	1.8					0%	Over	No	No	Country with approved projects that would as a minimum enable compliance with the 2005 MB limit	Nov-06	Yes
Angola	A7	2011	NDR	0.0							No	No			Yes
Antigua and Barbuda	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Argentina	CP	2011	411.3	232.2					0%	Over	Yes	No	Country with approved projects that would as a minimum enable compliance with the 2005 MB limit	Mar-02	Yes
Armenia	A7	2011	0.0	0.0	Decision XVIII/20	0.00	0.00	0.00	0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption (At its 47th Meeting, the Committee decided that support for achieving compliance should be provided under UNEP CAP)		Yes
Bahamas (the)	A7	2010	0.2	0.0					0%	0.0	No	No	Country that has not received assistance to achieve the 2005 MB phase out target		Yes
Bahrain	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Bangladesh	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Barbados	A7	2011	0.1	0.0					0%	0.0	No	No	Country that has not received assistance to achieve the 2005 MB phase out target		Yes
Belize	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Benin	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Bhutan	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Bolivia (Plurinational State of)	CP	2011	0.6	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-01	Yes
Bosnia and Herzegovina	A7	2010	3.5	0.0	Decision XV/30	0.00	0.00	0.00	0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-03	Yes
Botswana	A7	2011	0.2	0.0	Decision XV/31	0.00	0.00	0.00	0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-98	Yes
Brazil	A7	2011	711.6	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-05	Yes
Brunei Darussalam	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Burkina Faso	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Burundi	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Cambodia	A7	2010	0.0	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-05	Yes
Cameroon	A7	2010	18.1	0.0					0%	0.0	Yes	No	Country with approved projects for complete phase-out of MB	Jul-07	Yes
Cape Verde	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Central African Republic (the)	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Chad	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Chile	A7	2010	212.5	161.9	Decision XVII/29				0%	Over	No	No	Country with approved projects for complete phase-out of MB	Apr-10	Yes
China	A7	2010	1,102.1	201.7					0%	Over	Yes	Yes	Country with approved projects for complete phase-out of MB (Possible additional funding for 100 ODP tonnes of MB used as a soil fumigant in ginsen crop).	Dec-03	Yes
Colombia	CP	2011	110.1	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-08	Yes
Comoros (the)	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Congo (the)	A7	2010	0.9	0.0					0%	0.0	No	No	Country with approved projects that would as a minimum enable compliance with the 2005 MB limit	Nov-02	Yes
Cook Islands (the)	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Costa Rica	CP	2011	342.5	106.1					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Dec-01	Yes
Cote d'Ivoire	A7	2010	8.1	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Apr-04	Yes
Croatia	CP	2011	15.7	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-01	Yes
Cuba	A7	2011	50.5	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-04	Yes
Democratic People's Republic of Korea (the)	A7	2010	30.0	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-98	Yes
Democratic Republic of the Congo (the)	A7	2011	1.5	0.0					0%	0.0	No	No	Country with approved projects that would as a minimum enable compliance with the 2005 MB limit	Nov-02	Yes
Djibouti	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Dominica	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Dominican Republic (the)	A7	2011	104.2	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Nov-02	Yes
Ecuador	A7	2010	66.2	40.8	Decision XX/16	52.80	52.80	52.80	0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-2002 and Nov-2011	Yes
Egypt	CP	2011	238.1	133.2					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-08	Yes
El Salvador	A7	2011	1.4	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Apr-05	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Equatorial Guinea	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Eritrea	A7	2010	0.5	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Ethiopia	A7	2010	15.6	0.0					0%	0.0	No	No	Country that has not received assistance to achieve the 2005 MB phase out target		Yes
Fiji	A7	2011	0.7	0.0	Decision XVII/33				0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Nov-05	Yes
Gabon	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Gambia (the)	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Georgia	CP	2011	13.7	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Nov-05	Yes
Ghana	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Grenada	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Guatemala	CP	2011	400.7	0.0	Decision XVIII/26				0%	0.0	Yes	Yes	Country with approved projects for complete phase-out of MB	Nov-09	Yes
Guinea	A7	2010	NDR	0.0							No	No			Yes
Guinea-Bissau	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Guyana	A7	2010	1.4	0.0					0%	0.0	No	No	Country that has not received assistance to achieve the 2005 MB phase out target		Yes
Haiti	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Honduras	CP	2011	259.4	112.8	Decision XVII/34				0%	Over	No	No	Country with approved projects for complete phase-out of MB	Nov-06	Yes
India	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Indonesia	A7	2010	40.7	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-04	Yes
Iran (Islamic Republic of)	CP	2011	26.7	0.7					0%	Over	No	No	Country with approved projects for complete phase-out of MB	Nov-05	Yes
Iraq	CP	2011	4.6	0.0					0%	0.0	Yes	No	Country with approved projects for complete phase-out of MB	Dec-10	Yes
Jamaica	CP	2011	4.9	1.2					0%	Over	No	No	Country with approved projects for complete phase-out of MB	Nov-05	Yes
Jordan	A7	2011	176.3	19.2					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-99	Yes
Kenya	A7	2010	217.5	6.6					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-2002 and Nov-2011	Yes
Kiribati	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Kuwait	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Kyrgyzstan	CP	2011	14.2	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-03	Yes
Lao People's Democratic Republic (the)	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Lebanon	CP	2011	236.4	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-01	Yes
Lesotho	A7	2011	0.1	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Liberia	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Libya	A7	2009	94.1	30.0	Decision XVII/37		0.00	0.00	0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-05	Yes
Madagascar	A7	2010	2.6	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Apr-05	Yes
Malawi	CP	2011	112.8	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-00	Yes
Malaysia	A7	2010	14.6	5.3					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Jul-04	Yes
Maldives	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Mali	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Marshall Islands (the)	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Mauritania	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Mauritius	A7	2011	0.1	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-03	Yes
Mexico	A7	2011	1,130.8	488.2					0%	Over	Yes	Yes	Country with approved projects for complete phase-out of MB	Apr-08	Yes
Micronesia (Federated States of)	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Mongolia	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Montenegro	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Morocco	CP	2011	697.2	56.9					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-08	Yes
Mozambique	A7	2010	3.4	NDR							Yes	No	Country with approved projects for complete phase-out of MB	Apr-10	Yes
Myanmar	A7	2010	3.4	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Namibia	CP	2011	0.8	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Nauru	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Nepal	A7	2011	0.0	0.0					0%	0.0	No	No	Country that is not yet Party to the Copenhagen Amendment		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Nicaragua	A7	2010	0.4	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Apr-05	Yes
Niger (the)	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Nigeria	A7	2010	2.9	0.0					0%	0.0	No	No	Country with approved projects that would as a minimum enable compliance with the 2005 MB limit	Nov-02	Yes
Niue	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Oman	A7	2011	1.0	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-04	Yes
Pakistan	A7	2010	14.0	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Apr-05	Yes
Palau	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Panama	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Papua New Guinea	A7	2011	0.3	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Apr-03	Yes
Paraguay	CP	2011	0.9	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Nov-05	Yes
Peru	A7	2011	1.3	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-00	Yes
Philippines (the)	CP	2011	10.3	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-04	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Qatar	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Republic of Korea (the)	A7	2010	0.0	0.0					0%	0.0	No	No			Yes
Republic of Moldova (the)	A7	2011	7.0	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Apr-05	Yes
Rwanda	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Saint Kitts and Nevis	A7	2010	0.3	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Nov-06	Yes
Saint Lucia	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Saint Vincent and the Grenadines	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Samoa	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Sao Tome and Principe	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Saudi Arabia	A7	2010	204.1	36.0					0%	Over	No	No	Country with approved projects for complete phase-out of MB	Nov-07	Yes
Senegal	CP	2011	53.2	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-01	Yes
Serbia	A7	2011	8.3	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Seychelles	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Sierra Leone	A7	2010	2.6	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Nov-05	Yes
Singapore	A7	2010	5.0	0.8					0%	Over	No	No			Yes
Solomon Islands	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Somalia	CP	2011	0.5	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
South Africa	A7	2010	602.7	0.0					0%	0.0	No	No			Yes
Sri Lanka	CP	2011	4.1	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Nov-02	Yes
Sudan (the)	A7	2010	3.0	1.5					0%	Over	No	No	Country with approved projects that would as a minimum enable compliance with the 2005 MB limit	Nov-02	Yes
Suriname	CP	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Swaziland	A7	2010	0.6	0.0					0%	0.0	No	No	Country with approved projects that would as a minimum enable compliance with the 2005 MB limit	Nov-02	Yes
Syrian Arab Republic	A7	2010	188.6	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-01	Yes
Thailand	A7	2010	183.0	60.3					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Dec-04	Yes
The Former Yugoslav Republic of Macedonia	A7	2011	12.2	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Dec-00	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Timor-Leste	A7	2010	0.2	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Togo	A7	2011	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Tonga	A7	2010	0.2	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Trinidad and Tobago	A7	2011	1.7	0.1					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-11	Yes
Tunisia	CP	2011	8.3	0.0					0%	0.0	No	No	Country that has not received assistance to achieve the 2005 MB phase out target (Decision XV/12)		Yes
Turkey	A7	2010	479.7	0.0					0%	0.0	No	No	Country with approved projects that would as a minimum enable compliance with the 2005 MB limit	Dec-01	Yes
Turkmenistan	A7	2010	3.6	2.9					1%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-09	Yes
Tuvalu	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Uganda	A7	2010	6.3	0.0	Decision XV/43	0.00	0.00	0.00	0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Jul-01	Yes
United Arab Emirates (the)	A7	2010	7.2	0.0					0%	0.0	No	No			Yes
United Republic of Tanzania (the)	A7	2010	0.0	0.0					0%	0.0	No	No	Country with MB baseline equal to zero, or no calculated baseline or with no current consumption		Yes
Uruguay	CP	2011	11.2	6.0	Decision XVII/39	8.90	6.00	6.00	0%	Over	No	No	Country with approved projects for complete phase-out of MB	Jul-01	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 20% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified Copenhagen Amendment
Vanuatu	CP	2011	0.2	0.0					0%	0.0	No	No	Country that has not received assistance to achieve the 2005 MB phase out target		Yes
Venezuela (Bolivarian Republic of)	CP	2011	10.3	0.0					0%	0.0	No	No	Country with approved projects for complete phase-out of MB	Apr-05	Yes
Viet Nam	A7	2010	136.5	76.8					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-06	Yes
Yemen	A7	2009	54.5	25.0					0%	Over	Yes	Yes	Country with approved projects for complete phase-out of MB	Nov-08	Yes
Zambia	A7	2010	29.4	2.0					0%	Over	Yes	No	Country with approved projects for complete phase-out of MB	Nov-08	Yes
Zimbabwe	A7	2010	557.0	10.8					0%	Over	No	No	Country with approved projects for complete phase-out of MB	Nov-06	Yes

Appendix IV

CTC ANALYSIS

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Afghanistan	A7	2010	0.9	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-05	Yes
Albania	A7	2011	3.1	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-03	Yes
Algeria	CP	2011	20.9	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-07	Yes
Angola	A7	2011	NDR	0.0							No	No			Yes
Antigua and Barbuda	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Argentina	CP	2011	187.2	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-03	Yes
Armenia	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Bahamas (the)	A7	2010	0.0	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 CTC phase out target		Yes
Bahrain	A7	2010	0.8	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Bangladesh	A7	2010	5.7	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-04	Yes
Barbados	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Belize	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Benin	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Bhutan	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Bolivia (Plurinational State of)	CP	2011	0.3	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Mar-07	Yes
Bosnia and Herzegovina	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Botswana	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Brazil	A7	2011	411.6	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-08	Yes
Brunei Darussalam	CP	2011	0.0	0.0					0%	0%	No	No			Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Burkina Faso	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Burundi	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Cambodia	A7	2010	0.0	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-09	Yes
Cameroon	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Cape Verde	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Central African Republic (the)	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Chad	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Chile	A7	2010	0.6	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-03	Yes
China	A7	2010	49,142.1	282.6					0%	*	Yes	No	Country with an approved CTC phase-out plan/project	Nov-02	Yes
Colombia	CP	2011	6.1	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-06	Yes
Comoros (the)	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Congo (the)	A7	2010	0.6	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-08	Yes
Cook Islands (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Costa Rica	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Cote d'Ivoire	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Croatia	CP	2011	3.9	0.6					**	**	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Cuba	A7	2011	2.7	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Jul-04	Yes
Democratic People's Republic of Korea (the)	A7	2010	1,285.2	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-03	Yes
Democratic Republic of the Congo (the)	A7	2011	15.3	0.0	Decision XVIII/21				0%	0%	No	No	Country with an approved CTC phase-out plan/project	Mar-07	Yes
Djibouti	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Dominica	CP	2011	0.0	0.0					0%	0%	No	No			Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Dominican Republic (the)	A7	2011	29.0	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 CTC phase out target		Yes
Ecuador	A7	2010	0.5	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 CTC phase out target		Yes
Egypt	CP	2011	38.5	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-04	Yes
El Salvador	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Equatorial Guinea	A7	2010	1.5	0.0					0%	0%	No	No			Yes
Eritrea	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Ethiopia	A7	2010	0.0	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Fiji	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Gabon	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Gambia (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Georgia	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Ghana	A7	2011	0.4	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-04	Yes
Grenada	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Guatemala	CP	2011	10.6	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 CTC phase out target		Yes
Guinea	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Guinea-Bissau	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Guyana	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Haiti	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Honduras	CP	2011	0.0	0.0					0%	0%	No	No			Yes
India	A7	2010	11,505.3	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Jul-03	Yes
Indonesia	A7	2010	0.0	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-04	Yes
Iran (Islamic Republic of)	CP	2011	77.0	0.0	Decision XIX/27				0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-06	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Iraq	CP	2011	21.4	0.0					0%	0%	Yes	No	Country with an approved CTC phase-out plan/project	Jul-09	Yes
Jamaica	CP	2011	2.8	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-04	Yes
Jordan	A7	2011	40.3	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-02	Yes
Kenya	A7	2010	65.9	0.0					0%	0%	Yes	No	Country with an approved CTC phase-out plan/project	Apr-09	Yes
Kiribati	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Kuwait	A7	2010	0.0	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Jul-07	Yes
Kyrgyzstan	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Lao People's Democratic Republic (the)	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Lebanon	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Lesotho	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Liberia	CP	2011	0.2	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 CTC phase out target		Yes
Libya	A7	2009	0.0	0.0					0%	0%	No	No			Yes
Madagascar	A7	2010	0.0	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Jul-07	Yes
Malawi	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Malaysia	A7	2010	4.5	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-01	Yes
Maldives	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Mali	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Marshall Islands (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Mauritania	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Mauritius	A7	2011	0.0	0.0					0%	0%	No	No			Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Mexico	A7	2011	62.5	0.0	Decision XVIII/30 and Decision XXI/20	0.00	0.00	0.00	0%	0%	No	No	Country with an approved CTC phase-out plan/project	Jul-07	Yes
Micronesia (Federated States of)	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Mongolia	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Montenegro	CP	2011	1.1	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-07	Yes
Morocco	CP	2011	1.1	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Mozambique	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Myanmar	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Namibia	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Nauru	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Nepal	A7	2011	0.9	0.1					0%	**	No	No	Country with an approved CTC phase-out plan/project	Nov-05	Yes
Nicaragua	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Niger (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Nigeria	A7	2010	152.8	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Jul-04	Yes
Niue	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Oman	A7	2011	0.1	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Pakistan	A7	2010	412.9	0.0	Decision XVIII/31				0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-03	Yes
Palau	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Panama	CP	2011	0.0	0.1					0%	**	No	No			Yes
Papua New Guinea	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Paraguay	CP	2011	0.6	0.0	Decision XIX/22	0.10	0.00		0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Peru	A7	2011	1.0	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 CTC phase out target		Yes
Philippines (the)	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Qatar	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Republic of Korea (the)	A7	2010	638.0	0.1					0%	Over	No	No			Yes
Republic of Moldova (the)	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Rwanda	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Saint Kitts and Nevis	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Saint Lucia	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Saint Vincent and the Grenadines	A7	2011	0.0	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-05	Yes
Samoa	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Sao Tome and Principe	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Saudi Arabia	A7	2010	259.2	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-07	Yes
Senegal	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Serbia	A7	2011	18.8	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-08	Yes
Seychelles	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Sierra Leone	A7	2010	2.6	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-09	Yes
Singapore	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Solomon Islands	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Somalia	CP	2011	0.0	0.0					0%	0%	No	No			Yes
South Africa	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Sri Lanka	CP	2011	35.1	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Jul-04	Yes
Sudan (the)	A7	2010	2.2	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-04	Yes
Suriname	CP	2011	0.0	0.0					0%	0%	No	No			Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 85% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Swaziland	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Syrian Arab Republic	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Thailand	A7	2010	7.5	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-01	Yes
The Former Yugoslav Republic of Macedonia	A7	2011	0.1	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 CTC phase out target		Yes
Timor-Leste	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Togo	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Tonga	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Trinidad and Tobago	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Tunisia	CP	2011	2.9	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Turkey	A7	2010	105.1	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Dec-03	Yes
Turkmenistan	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Tuvalu	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Uganda	A7	2010	0.4	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Jul-08	Yes
United Arab Emirates (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
United Republic of Tanzania (the)	A7	2010	0.1	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-08	Yes
Uruguay	CP	2011	0.4	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Vanuatu	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Venezuela (Bolivarian Republic of)	CP	2011	1,107.2	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Viet Nam	A7	2010	1.6	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Yemen	A7	2009	0.0	0.0					0%	0%	No	No			Yes
Zambia	A7	2010	0.7	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Apr-05	Yes
Zimbabwe	A7	2010	11.6	0.0					0%	0%	No	No	Country with an approved CTC phase-out plan/project	Nov-06	Yes

* For process use exemptions.
** For laboratory and analytical uses.

Appendix V

TCA ANALYSIS

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 70% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Afghanistan	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Albania	A7	2011	0.0	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-03	Yes
Algeria	CP	2011	5.8	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Nov-07	Yes
Angola	A7	2011	NDR	0.0							No	No			Yes
Antigua and Barbuda	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Argentina	CP	2011	65.7	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-03	Yes
Armenia	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Bahamas (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Bahrain	A7	2010	22.7	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-05	Yes
Bangladesh	A7	2010	0.9	0.0	Decision XVII/27	0.55	0.26		0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-04	Yes
Barbados	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Belize	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Benin	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Bhutan	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Bolivia (Plurinational State of)	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Bosnia and Herzegovina	A7	2010	1.6	0.0	Decision XVII/28				0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-03	Yes
Botswana	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Brazil	A7	2011	32.4	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 70% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Brunei Darussalam	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Burkina Faso	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Burundi	CP	2011	0.1	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-05	Yes
Cambodia	A7	2010	0.5	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-09	Yes
Cameroon	A7	2010	8.2	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Nov-06	Yes
Cape Verde	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Central African Republic (the)	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Chad	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Chile	A7	2010	6.4	0.0	Decision XVII/29	4.51	1.93		0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-03	Yes
China	A7	2010	721.2	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Mar-00	Yes
Colombia	CP	2011	0.6	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes
Comoros (the)	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Congo (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Cook Islands (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Costa Rica	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Cote d'Ivoire	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Croatia	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Cuba	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Democratic People's Republic of Korea (the)	A7	2010	7.7	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes
Democratic Republic of the Congo (the)	A7	2011	4.7	0.0	Decision XVIII/21				0%	0%	No	No	Country with an approved TCA phase-out plan/project	Mar-07	Yes
Djibouti	A7	2011	0.0	0.0					0%	0%	No	No			Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 70% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Dominica	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Dominican Republic (the)	A7	2011	3.6	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes
Ecuador	A7	2010	2.0	0.0	Decision XVII/31				0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes
Egypt	CP	2011	26.0	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-04	Yes
El Salvador	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Equatorial Guinea	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Eritrea	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Ethiopia	A7	2010	0.5	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-05	Yes
Fiji	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Gabon	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Gambia (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Georgia	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Ghana	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Grenada	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Guatemala	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Guinea	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Guinea-Bissau	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Guyana	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Haiti	A7	2011	0.2	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes
Honduras	CP	2011	0.0	0.0					0%	0%	No	No			Yes
India	A7	2010	122.2	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes
Indonesia	A7	2010	13.3	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-04	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 70% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Iran (Islamic Republic of)	CP	2011	8.7	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Nov-06	Yes
Iraq	CP	2011	0.0	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Jul-09	Yes
Jamaica	CP	2011	1.4	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-04	Yes
Jordan	A7	2011	18.2	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Nov-02	Yes
Kenya	A7	2010	1.1	0.0					0%	0%	Yes	No	Country with an approved TCA phase-out plan/project	Apr-09	Yes
Kiribati	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Kuwait	A7	2010	0.0	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Jul-07	Yes
Kyrgyzstan	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Lao People's Democratic Republic (the)	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Lebanon	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Lesotho	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Liberia	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Libya	A7	2009	0.0	0.0					0%	0%	No	No			Yes
Madagascar	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Malawi	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Malaysia	A7	2010	49.5	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-01	Yes
Maldives	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Mali	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Marshall Islands (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Mauritania	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Mauritius	A7	2011	0.1	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-03	Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 70% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Mexico	A7	2011	56.4	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes
Micronesia (Federated States of)	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Mongolia	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Montenegro	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Morocco	CP	2011	0.1	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-05	Yes
Mozambique	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Myanmar	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Namibia	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Nauru	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Nepal	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Nicaragua	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Niger (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Nigeria	A7	2010	32.9	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Jul-04	Yes
Niue	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Oman	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Pakistan	A7	2010	2.3	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Jul-03	Yes
Palau	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Panama	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Papua New Guinea	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Paraguay	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Peru	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Philippines (the)	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Qatar	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Republic of Korea (the)	A7	2010	513.3	66.7					0%	Over	No	No			Yes
Republic of Moldova (the)	A7	2011	0.0	0.0					0%	0%	No	No			Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 70% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Rwanda	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Saint Kitts and Nevis	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Saint Lucia	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Saint Vincent and the Grenadines	A7	2011	0.0	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Nov-05	Yes
Samoa	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Sao Tome and Principe	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Saudi Arabia	A7	2010	29.8	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Nov-07	Yes
Senegal	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Serbia	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Seychelles	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Sierra Leone	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Singapore	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Solomon Islands	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Somalia	CP	2011	0.0	0.0					0%	0%	No	No			Yes
South Africa	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Sri Lanka	CP	2011	3.0	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Jul-04	Yes
Sudan (the)	A7	2010	0.0	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-04	Yes
Suriname	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Swaziland	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Syrian Arab Republic	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Thailand	A7	2010	54.6	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-01	Yes
The Former Yugoslav Republic of Macedonia	A7	2011	0.0	0.0					0%	0%	No	No			Yes
Timor-Leste	A7	2010	0.1	0.0					0%	0%	No	No			Yes
Togo	A7	2011	0.0	0.0					0%	0%	No	No			Yes

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Compliance Decision	2009 Action Plan Target	2010 Action Plan Target	2011 Action Plan Target	Percentage Over 70% Reduction	Percentage Over 100% Reduction	Ongoing Phase-Out (As of June 2012)	Phase-Out in 2012 Business Plans	Remarks	Date Approved	Ratified London Amendment
Tonga	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Trinidad and Tobago	A7	2011	0.7	0.0					0%	0%	No	No	Country that has not received assistance to achieve the 2005 TCA phase out target		Yes
Tunisia	CP	2011	0.1	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-05	Yes
Turkey	A7	2010	37.4	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Dec-03	Yes
Turkmenistan	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Tuvalu	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Uganda	A7	2010	0.0	0.0					0%	0%	No	No			Yes
United Arab Emirates (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
United Republic of Tanzania (the)	A7	2010	0.0	0.0					0%	0%	No	No			Yes
Uruguay	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Vanuatu	CP	2011	0.0	0.0					0%	0%	No	No			Yes
Venezuela (Bolivarian Republic of)	CP	2011	4.7	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-05	Yes
Viet Nam	A7	2010	0.2	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-05	Yes
Yemen	A7	2009	0.9	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-2005 and Jul-2008	Yes
Zambia	A7	2010	0.1	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Apr-05	Yes
Zimbabwe	A7	2010	0.0	0.0					0%	0%	No	No	Country with an approved TCA phase-out plan/project	Nov-06	Yes

Appendix VI

HCFC ANALYSIS

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Percentage Over Freeze	Phase-out approved (as of June 2012)	HPMP Project Preparation Approved	Number of Individual Investment Projects Approved	Number of Demonstration Projects Approved	Activities in 2012 Business Plan	HPMP/ Individual Projects Approved	Date of Approval	HPMPs or Individual Projects Submitted to the 67th Meeting for Consideration	Control Measures Addressed by HPMPs (Approval/Submission)	Additional Percent of Starting Point/BP Baseline Addressed by Individual Projects (Approval/ Submission)
Afghanistan	A7	2010	23.8	24.9	5%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Albania	A7	2011	6.0	6.5	8%	0.0	Yes			No	HPMP	Jul-11		35% by 2020	
Algeria	CP	2011	30.2	76.7	154%	13.5	Yes			Yes	HPMP	Dec-10		20% by 2017	
Angola	A7	2011	16.0	11.6	0%	0.0	Yes			Yes	HPMP	Nov-11		10% by 2015	
Antigua and Barbuda	A7	2010	0.3	0.1	0%	0.0	Yes			Yes	HPMP	Apr-12		10% by 2015	
Argentina	CP	2011	400.7	468.1	17%	79.0	Yes			Yes	HPMP	Jul-10		17.5% by 2017	
Armenia	A7	2011	7.0	7.5	7%	2.2	Yes			Yes	HPMP	Dec-10		10% by 2015	
Bahamas (the)	A7	2010	4.8	6.1	27%	0.0	Yes			No	HPMP	Nov-11		35% by 2020	
Bahrain	A7	2010	51.9	58.7	13%	0.0	Yes			Yes					
Bangladesh	A7	2010	72.6	77.5	7%	20.8	Yes			No	HPMP	Nov-11		30% by 2018	
Barbados	A7	2011	3.7	2.7	0%	0.0	Yes			Yes					
Belize	CP	2011	2.8	1.9	0%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Benin	CP	2011	23.8	23.7	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Bhutan	A7	2010	0.3	0.3	0%	0.0	Yes			No	HPMP	Apr-11		100% by 2025	
Bolivia (Plurinational State of)	CP	2011	6.1	7.69	26%	0.0	Yes			No	HPMP	Jul-11		35% by 2020	
Bosnia and Herzegovina	A7	2010	4.7	3.5	0%	5.3	Yes			Yes	HPMP	Apr-12		35% by 2020	
Botswana	A7	2011	11.0	2.7	0%	0.0	Yes			Yes					
Brazil	A7	2011	1,327.3	1,046.4	0%	63.5	Yes		2	Yes	HPMP	Jul-11		10% by 2015	
Brunei Darussalam	CP	2011	6.1	8.1	32%	0.6	Yes			Yes	HPMP	Apr-12		35% by 2020	
Burkina Faso	A7	2011	28.9	27.9	0%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Burundi	CP	2011	7.2	7.0	0%	0.4	Yes			No	HPMP	Nov-11		35% by 2020	

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Percentage Over Freeze	Phase-out approved (as of June 2012)	HPMP Project Preparation Approved	Number of Individual Investment Projects Approved	Number of Demonstration Projects Approved	Activities in 2012 Business Plan	HPMP/ Individual Projects Approved	Date of Approval	HPMPs or Individual Projects Submitted to the 67th Meeting for Consideration	Control Measures Addressed by HPMPs (Approval/Submission)	Additional Percent of Starting Point/BP Baseline Addressed by Individual Projects (Approval/ Submission)
Cambodia	A7	2010	15.0	12.8	0%	0.0	Yes			No	HPMP	Jul-10		100% by 2035	
Cameroon	A7	2010	88.8	73.4	0%	22.1	Yes			No	HPMP	Jul-11		20% by 2017	
Cape Verde	A7	2010	1.1	0.3	0%	0.0	Yes			No	HPMP	Jul-11		35% by 2020	
Central African Republic (the)	A7	2011	12.0	12.0	0.2%	0.5	Yes			No	HPMP	Jul-11		35% by 2020	
Chad	CP	2011	16.1	17.0	6%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Chile	A7	2010	87.5	99.8	14%	7.6	Yes			Yes	HPMP	Apr-11		10% by 2015	
China	A7	2010	19,269.0	19,935.3	3%	92.4	Yes	1	9	Yes	HPMP	Jul-11		10% by 2015	
Colombia	CP	2011	225.6	220.5	0%	65.2	Yes		1	Yes	HPMP	Dec-10		10% by 2015	
Comoros (the)	CP	2011	0.1	0.1	16%	0.0	Yes			No	HPMP	Jul-11		35% by 2020	
Congo (the)	A7	2010	8.9	10.6	19%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Cook Islands (the)	A7	2010	0.1	0.1	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Costa Rica	CP	2011	14.1	40.5	187%	14.0	Yes			No	HPMP	Jul-11		35% by 2020	
Cote d'Ivoire	A7	2010	63.8	65.9	3%	3.3	Yes			Yes	HPMP	Apr-12		35% by 2020	
Croatia	CP	2011	4.0	4.2	4%	14.0	Yes			Yes	HPMP	Jul-10		100% by 2016	
Cuba	A7	2011	16.9	14.3	0%	15.0	Yes			No	HPMP	Nov-11		35% by 2020	
Democratic People's Republic of Korea (the)	A7	2010	78.0	94.1	21%	0.0	Yes			Yes					
Democratic Republic of the Congo (the)	A7	2011	81.2	56.9	0%	0.0	Yes			No	HPMP	Apr-11		10% by 2015	
Djibouti	A7	2011	0.7	0.7	0%	0.0	Yes			Yes	HPMP	Apr-12		35% by 2020	
Dominica	CP	2011	0.4	0.16	0%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Dominican Republic (the)	A7	2011	51.2	50.1	0%	12.5	Yes			No	HPMP	Nov-11		10% by 2015	
Ecuador	A7	2010	17.5	14.3	0%	15.0	Yes			No	HPMP	Nov-11		35% by 2020	

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Percentage Over Freeze	Phase-out approved (as of June 2012)	HPMP Project Preparation Approved	Number of Individual Investment Projects Approved	Number of Demonstration Projects Approved	Activities in 2012 Business Plan	HPMP/ Individual Projects Approved	Date of Approval	HPMPs or Individual Projects Submitted to the 67th Meeting for Consideration	Control Measures Addressed by HPMPs (Approval/Submission)	Additional Percent of Starting Point/BP Baseline Addressed by Individual Projects (Approval/ Submission)
Egypt	CP	2011	386.3	401.6	4%	115.3	Yes	1	1	Yes	HPMP	Nov-11		25% by 2018	
El Salvador	A7	2011	11.7	9.6	0%	6.5	Yes			No	HPMP	Nov-11		35% by 2020	
Equatorial Guinea	A7	2010	10.2	6.4	0%	0.3	Yes			No	HPMP	Nov-11		35% by 2020	
Eritrea	A7	2010	0.1	0.1	0%	0.0	Yes			Yes			HPMP	35% by 2020	
Ethiopia	A7	2010	5.5	11.0	100%	0.0	Yes			No					
Fiji	A7	2011	8.5	14.5	70%	0.0	Yes			No	HPMP	Nov-11		35% by 2020	
Gabon	A7	2010	30.2	30.6	1%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Gambia (the)	A7	2010	1.5	1.5	0%	0.1	Yes			No	HPMP	Nov-11		35% by 2020	
Georgia	CP	2011	5.3	4.3	0%	0.7	Yes			No	HPMP	Apr-11		35% by 2020	
Ghana	A7	2011	57.3	30.7	0%	0.0	Yes			Yes	HPMP	Jul-10		35% by 2020	
Grenada	CP	2011	0.8	0.2	0%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Guatemala	CP	2011	8.3	10.9	31%	1.7	Yes			No	HPMP	Jul-11		35% by 2020	
Guinea	A7	2010	22.6	23.4	4%	1.2	Yes			Yes	HPMP	Apr-12		35% by 2020	
Guinea-Bissau	A7	2011	1.5	2.9	91%	0.1	Yes			No	HPMP	Nov-11		35% by 2020	
Guyana	A7	2010	1.8	2.4	33%	0.0	Yes			No	HPMP	Apr-11		10% by 2015	
Haiti	A7	2011	1.9	4.2	123%	0.0	Yes			Yes					
Honduras	CP	2011	19.9	26.7	34%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
India	A7	2010	1,608.2	1,617.6	1%	145.4	Yes			Yes	HPMP	Apr-12		10% by 2015	
Indonesia	A7	2010	403.9	433.0	7%	71.9	Yes			No	HPMP	Jul-11		20% by 2018	
Iran (Islamic Republic of)	CP	2011	380.5	376.88	0%	61.5	Yes			Yes	HPMP	Apr-11		10% by 2015	
Iraq	CP	2011	108.4	110.4	2%	0.0	Yes			No	HPMP	Nov-11		13.82% by 2015	
Jamaica	CP	2011	16.3	4.5	0%	3.6	Yes			No	HPMP	Jul-11		35% by 2020	
Jordan	A7	2011	83.0	101.3	22%	15.9	Yes			No	HPMP	Nov-11		20% by 2017	
Kenya	A7	2010	52.2	49.6	0%	3.1	Yes			Yes	HPMP	Apr-12		21.1% by 2017	
Kiribati	A7	2010	0.1	0.1	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Kuwait	A7	2010	418.6	439.1	5%	60.7	Yes			Yes	HPMP	Apr-12		39.2% by 2018	

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Percentage Over Freeze	Phase-out approved (as of June 2012)	HPMP Project Preparation Approved	Number of Individual Investment Projects Approved	Number of Demonstration Projects Approved	Activities in 2012 Business Plan	HPMP/ Individual Projects Approved	Date of Approval	HPMPs or Individual Projects Submitted to the 67th Meeting for Consideration	Control Measures Addressed by HPMPs (Approval/Submission)	Additional Percent of Starting Point/BP Baseline Addressed by Individual Projects (Approval/ Submission)
Kyrgyzstan	CP	2011	4.1	3.0	0%	0.0	Yes			No	HPMP	Apr-11		10% by 2015	
Lao People's Democratic Republic (the)	CP	2011	2.3	6.2	171%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Lebanon	CP	2011	73.5	92.0	25%	12.1	Yes			No	HPMP	Jul-11		17.5% by 2017	
Lesotho	A7	2011	3.5	2.5	0%	0.0	Yes			No	HPMP	Jul-11		35% by 2020	
Liberia	CP	2011	5.3	5.4	2%	0.6	Yes			No	HPMP	Apr-11		35% by 2020	
Libya	A7	2009	NDR	97.5		0.0	Yes			No					
Madagascar	A7	2010	24.9	16.8	0%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Malawi	CP	2011	10.8	12.7	18%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Malaysia	A7	2010	515.8	537.5	4%	53.7	Yes			No	HPMP	Nov-11		15% by 2016	
Maldives	A7	2011	4.6	3.8	0%	0.0	Yes			No	HPMP	Apr-10		100% by 2020	
Mali	CP	2011	15.0	16.0	6%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Marshall Islands (the)	A7	2010	0.2	0.2	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Mauritania	A7	2010	20.5	20.5	0%	0.0	Yes			No					
Mauritius	A7	2011	8.0	8.8	10%	0.0	Yes			No	HPMP	Apr-11		100% by 2030	
Mexico	A7	2011	1,148.8	1,083.4	0%	162.0	Yes		1	Yes	HPMP	Jul-11		30% by 2018	
Micronesia (Federated States of)	A7	2011	0.2	0.1	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Mongolia	A7	2011	1.4	1.2	0%	0.5	Yes			No	HPMP	Apr-11		35% by 2020	
Montenegro	CP	2011	0.8	0.7	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Morocco	CP	2011	59.7	78.8	32%	11.0	Yes			Yes	HPMP	Nov-11		20% by 2017	
Mozambique	A7	2010	6.5	8.7	34%	0.3	Yes			Yes	HPMP	Apr-12		35% by 2020	
Myanmar	A7	2010	4.3	4.5	5%	0.0	Yes			Yes					
Namibia	CP	2011	8.4	9.9	18%	0.9	Yes			No	HPMP	Apr-11		100% by 2025	
Nauru	A7	2010	0.0	0.0	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Percentage Over Freeze	Phase-out approved (as of June 2012)	HPMP Project Preparation Approved	Number of Individual Investment Projects Approved	Number of Demonstration Projects Approved	Activities in 2012 Business Plan	HPMP/ Individual Projects Approved	Date of Approval	HPMPs or Individual Projects Submitted to the 67th Meeting for Consideration	Control Measures Addressed by HPMPs (Approval/Submission)	Additional Percent of Starting Point/BP Baseline Addressed by Individual Projects (Approval/ Submission)
Nepal	A7	2011	1.1	1.1	0%	0.3	Yes			Yes	HPMP	Apr-12		35% by 2020	
Nicaragua	A7	2010	6.8	7.5	10%	0.7	Yes			Yes	HPMP	Apr-12		35% by 2020	
Niger (the)	A7	2010	26.2	16.0	0%	2.7	Yes			Yes	HPMP	Apr-12		35% by 2020	
Nigeria	A7	2010	398.2	426.4	7%	0.0	Yes			Yes	HPMP	Dec-10		10% by 2015	
Niue	A7	2010	0.0	0.0	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Oman	A7	2011	31.5	34.8	11%	5.2	Yes			No	HPMP	Nov-11		10% by 2015	
Pakistan	A7	2010	247.4	255.0	3%	71.6	Yes			No	HPMP	Dec-10		10% by 2015	
Palau	CP	2011	0.2	0.17	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Panama	CP	2011	24.8	37.4	51%	0.0	Yes			No	HPMP	Nov-11		10% by 2015	
Papua New Guinea	A7	2011	3.3	1.7	0%	0.2	Yes			No	HPMP	Apr-11		100% by 2025	
Paraguay	CP	2011	18.0	18.5	3%	1.8	Yes			No	HPMP	Apr-11		35% by 2020	
Peru	A7	2011	26.9	32.5	21%	0.0	Yes			Yes					
Philippines (the)	CP	2011	208.4	176.3	0%	40.0	Yes	2		No	Individual	Dec-10			20%
Qatar	A7	2010	86.9	94.1	8%	22.0	Yes			No	HPMP	Nov-11		20% by 2015	
Republic of Korea (the)	A7	2010	1,908.0	2,047.1	7%	0.0	No			No					
Republic of Moldova (the)	A7	2011	1.0	1.3	31%	0.0	Yes			No	HPMP	Apr-11		10% by 2015	
Rwanda	A7	2010	4.1	4.4	7%	0.2	Yes			No	HPMP	Jul-11		35% by 2020	
Saint Kitts and Nevis	A7	2010	0.5	0.6	20%	0.2	Yes			No	HPMP	Jul-11		35% by 2020	
Saint Lucia	A7	2010	0.2	0.0	0%	0.0	Yes			Yes	HPMP	Jul-11		35% by 2020	
Saint Vincent and the Grenadines	A7	2011	0.3	0.3	0%	0.2	Yes			No	HPMP	Jul-11		100% by 2025	
Samoa	A7	2010	0.3	0.3	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Sao Tome and Principe	A7	2010	2.2	0.2	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Saudi Arabia	A7	2010	1,468.7	1,575.4	7%	55.0	Yes	4		Yes	Individual	Dec-10			12%
Senegal	CP	2011	36.2	36.1	0%	3.6	Yes			No	HPMP	Nov-11		35% by 2020	

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Percentage Over Freeze	Phase-out approved (as of June 2012)	HPMP Project Preparation Approved	Number of Individual Investment Projects Approved	Number of Demonstration Projects Approved	Activities in 2012 Business Plan	HPMP/ Individual Projects Approved	Date of Approval	HPMPs or Individual Projects Submitted to the 67th Meeting for Consideration	Control Measures Addressed by HPMPs (Approval/Submission)	Additional Percent of Starting Point/BP Baseline Addressed by Individual Projects (Approval/ Submission)
Serbia	A7	2011	8.4	12.5	49%	2.3	Yes			No	HPMP	Dec-10		35% by 2020	
Seychelles	A7	2011	1.4	0.9	0%	0.4	Yes			No	HPMP	Apr-11		100% by 2025	
Sierra Leone	A7	2010	1.7	1.8	6%	0.1	Yes			No	HPMP	Nov-11		35% by 2020	
Singapore	A7	2010	216.1	206.2	0%	0.0	No			No					
Solomon Islands	A7	2010	2.0	2.3	15%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Somalia	CP	2011	45.1	45.2	0.2%	0.0	Yes			Yes			HPMP	35% by 2020	
South Africa	A7	2010	369.7	400.1	8%	0.0	Yes			Yes			HPMP	26.9% to 2018	
Sri Lanka	CP	2011	13.9	16.9	22%	0.5	Yes			No	HPMP	Dec-10		35% by 2020	
Sudan (the)	A7	2010	52.7	54.7	4%	11.9	Yes			Yes	HPMP	Dec-10		30% by 2017	
Suriname	CP	2011	2.0	4.0	100%	0.1	Yes			No	HPMP	Nov-11		35% by 2020	
Swaziland	A7	2010	7.3	5.0	0%	7.7	Yes			No	HPMP	Apr-11		35% by 2020	
Syrian Arab Republic	A7	2010	135.0	122.8	0%	12.9	Yes	1		Yes	Individual	Dec-10	HPMP	10% by 2015	8%
Thailand	A7	2010	927.6	1,028.5	11%	0.0	Yes			Yes			HPMP	10% by 2015	
The Former Yugoslav Republic of Macedonia	A7	2011	2.7	2.5	0%	0.0	Yes			Yes	HPMP	Apr-10		35% by 2020	
Timor-Leste	A7	2010	0.5	0.5	0%	0.0	Yes			No	HPMP	Apr-11		10% by 2015	
Togo	A7	2011	20.0	19.1	0%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Tonga	A7	2010	0.1	0.1	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Trinidad and Tobago	A7	2011	46.0	34.2	0%	2.5	Yes			No	HPMP	Jul-11		35% by 2020	
Tunisia	CP	2011	40.7	33.9	0%	0.0	Yes			Yes					
Turkey	A7	2010	608.0	606.0	0%	213.2	Yes	1	1	Yes	Individual	Dec-10			46%
Turkmenistan	A7	2010	6.8	6.7	0%	0.0	Yes			No	HPMP	Dec-10		35% by 2020	
Tuvalu	A7	2010	0.1	0.1	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Uganda	A7	2010	0.2	0.3	50%	0.0	Yes			No					

Country	Source	Year of Latest Consumption	Baseline	Latest Consumption	Percentage Over Freeze	Phase-out approved (as of June 2012)	HPMP Project Preparation Approved	Number of Individual Investment Projects Approved	Number of Demonstration Projects Approved	Activities in 2012 Business Plan	HPMP/ Individual Projects Approved	Date of Approval	HPMPs or Individual Projects Submitted to the 67th Meeting for Consideration	Control Measures Addressed by HPMPs (Approval/Submission)	Additional Percent of Starting Point/BP Baseline Addressed by Individual Projects (Approval/ Submission)
United Arab Emirates (the)	A7	2010	557.1	583.6	5%	0.0	No			No					
United Republic of Tanzania (the)	A7	2010	1.7	2.0	18%	0.0	Yes			Yes			HPMP	35% by 2020	
Uruguay	CP	2011	23.4	22.2	0%	0.0	Yes			Yes	HPMP	Nov-11		10% by 2015	
Vanuatu	CP	2011	0.3	0.1	0%	0.0	Yes			No	HPMP	Apr-11		35% by 2020	
Venezuela (Bolivarian Republic of)	CP	2011	207.0	165.6	0%	0.0	Yes			Yes	HPMP	Apr-11		10% by 2015	
Viet Nam	A7	2010	221.2	234.9	6%	44.7	Yes			No	HPMP	Apr-11		10% by 2015	
Yemen	A7	2009	NDR	NDR		0.0	Yes			Yes					
Zambia	A7	2010	5.0	9.2	84%	0.4	Yes			No	HPMP	Jul-11		35% by 2020	
Zimbabwe	A7	2010	17.8	18.5	4%	6.1	Yes			Yes	HPMP	Nov-11		35% by 2020	

Annex II

INFORMATION ON COUNTRIES SUBJECT TO DECISIONS OF THE PARTIES ON COMPLIANCE

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Bolivia (Plurinational State of)	UNEP	XXIII/31	Licensing system	To provide disaggregated information on its licensing system as a matter of urgency and no later than 31 March 2012	UNEP followed up on the Ozone Secretariat letter by phone and email. NOU Bolivia (Plurinational State of) is drafting an official response.	Achievement not reported
Botswana	UNEP	XXIII/31	Amendment ratification and licensing system	To ratify the Amendment and to establish a licensing system	Assistance and guidance provided to country on ratification requirements.	Achievement not reported
Chad	UNEP	XXIII/31	Licensing system	To ensure that the licensing system is structured in accordance with Article 4B of the Protocol and that it provides for the licensing of exports and to report to the Secretariat	The country discussed with the Ozone Secretariat during the Comoros thematic meeting in May 2012. The issue was clarified and the country decided to report to the Secretariat in June.	Achieved
Comoros (the)	UNEP	XXIII/31	Licensing system	To ensure that the licensing system is structured in accordance with Article 4B of the Protocol and that it provides for the licensing of exports and to report to the Secretariat	The country discussed with the Ozone Secretariat during the Comoros thematic meeting in May 2012. The issue was clarified and the country decided to report to the Secretariat in June.	Achieved

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Democratic People's Republic of Korea (the)	UNEP	XXIII/31	Licensing system	To provide disaggregated information on its licensing system as a matter of urgency and no later than 31 March 2012	The country has established its licensing system for the ODS control, which has covered the export control as well. On 2 March 2012, the country was reminded of decision XXIII/31, and was requested to send in the information urgently. UNEP has not received a copy of any submission to MLF as of 24 April 2012.	Achievement not reported
Dominica	UNEP	XXIII/31	Licensing system	To provide disaggregated information on its licensing system as a matter of urgency and no later than 31 March 2012	UNEP followed up on the Ozone Secretariat letter by phone and email. NOU Dominica is drafting an official response.	Achievement not reported
Ecuador	UNEP	XXIII/31	Licensing system	To provide disaggregated information on its licensing system as a matter of urgency and no later than 31 March 2012	UNEP followed up on the Ozone Secretariat letter by phone and email. NOU Ecuador actually sent official response in April 2012.	Achieved
Ethiopia	UNEP	XXIII/31	Licensing system	To complete the establishment and operation of the licensing system and report to the Secretariat no later than 31 March 2012	The issue will be discussed during Lusaka meeting in May 2012. After that meeting the country will report to the Secretariat.	Achieved

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Gambia (the)	UNEP	XXIII/31	Licensing system	To ensure that the licensing system is structured in accordance with Article 4B of the Protocol and that it provides for the licensing of exports and to report to the Secretariat	The issue will be discussed during Lusaka meeting in May 2012. After that meeting the country will report to the secretariat.	Achievement not reported
Ghana	UNDP	XXIII/31	Licensing system	To provide disaggregated information on its licensing system as a matter of urgency and no later than 31 March 2012	EPA Ghana provided detailed inputs on the status and in particular the disaggregated substance-by-substance licensing system in place under Legislative Instrument 1812. This information can be found in a letter signed by the Acting Executive Director, EPA-Ghana, dated 8 March 2012 (thus within the deadline given in decision XXIII/31) and addressed to the Executive Secretary Ozone Secretariat. Copy of the above-mentioned letter is attached to this document.	Achieved
Guinea	UNEP	XXIII/31	Licensing system	To provide disaggregated information on its licensing system as a matter of urgency and no later than 31 March 2012	The licensing system already includes the control of imports and exports of ODS and ODS based equipment. However the HCFC quota system is planned to be in placed not later than January 2013. The country has been asked to report to the Secretariat.	Achieved

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Honduras	UNEP	XXIII/31	Licensing system	To ensure that the licensing system includes import and export controls for substances in Annex C, Group I (hydrochloro-fluorocarbons) and to report to the Secretariat	UNEP followed up on the Ozone Secretariat letter by phone and email. NOU Ecuador is drafting an official response.	Achievement not reported
Libya	UNIDO	XXIII/22	Data reporting issues	To report 2010 data in accordance with Article 7 as a matter of urgency	UNIDO continued with communication efforts to assist the country to get focal point to report. Permanent Mission was contacted to resume collaboration in post-crisis activities and environmental issues in particular, including ozone protection. Ozone office was contacted several times after cease of unrest was declared. UNIDO invited Ozone Officer for training on institutional strengthening activities and monitoring and reporting in particular. Preparation of the training in UNIDO is in progress.	Achievement not reported

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Libya	UNIDO	XXIII/23	Halon phase-out	To submit to the Secretariat, no later than 31 March 2012, an explanation for the excess consumption of halons, together with a plan of action with time specific benchmarks. To monitor closely Libya's progress with regard to the phase-out of halons	UNIDO advised Ozone Office to examine the source of halon 1211 and prompted to report accordingly and in given time line. According to information obtained by Ozone Office, 600 kg of halon 1211 was found in 2009 as a stock at State Oil Company. This was reported that time as consumption and later it was even declared as not virgin. UNIDO is monitoring Libya's progress with regard to all ODS phase out, including halons after resuming of MP Focal Point activities.	Achieved
Micronesia (Federated States of)	UNEP	XXIII/31	Licensing system	To ensure that the licensing system is structured in accordance with Article 4B of the Protocol and that it provides for the licensing of exports and to report to the Secretariat	The country has established their licensing system structured in accordance with Article 4B, the licensing system is being implemented by the Ozone unit within the Office of Environment and Emergency Management with assistance of Customs Department. On 2 March 2012, the country was reminded of the decision of the XXIII/31, and was requested to send in the information urgently. UNEP has not received a copy of any submission to MLF as of 24 April 2012.	Achieved

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Papua New Guinea	Germany	XXIII/31	Licensing system	To provide disaggregated information on its licensing system as a matter of urgency and no later than 31 March 2012	PNG has a license system in place which covers CFS's HCFC's and MB. 2011 Data by importer: 1) Kenmore t/a Daikin Air conditioning - R22 - 6,392kg. 2) Kenmore t/a Daikin Air conditioning - R409A - 381kg. 3) Brian Bell Co Ltd - R22 - 23.12kg. 4) RD Fishing Ltd - R22 - 1000kg. 5) Chemical Ltd - MB - nil. 6) Trukai Industries - MB - 900kg.	Achieved
Peru	UNEP	XXIII/22	Data reporting issues	To report 2010 data in accordance with Article 7 as a matter of urgency	Data submitted and received by the Ozone Secretariat. Compliance maintained	Achieved
Solomon Islands	UNEP	XXIII/31	Licensing system	To ensure that the licensing system is structured in accordance with Article 4B of the Protocol and that it provides for the licensing of exports and to report to the Secretariat	The country has established their licensing system structured in accordance with Article 4B, a policy on licensing has been passed and newly reorganized under Department of Environment working on formal legislation. On 2 March 2012, the country was reminded of decision XXIII/31, and was requested to send in the information urgently. UNEP has not received a copy of any submission to MLFS as of 24 April 2012.	Achieved

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Sudan (the)	UNEP	XXIII/31	Licensing system	To ensure that the licensing system is structured in accordance with Article 4B of the Protocol and that it provides for the licensing of exports and to report to the Secretariat	UNEP is working with the NOO in order to get the required reports and information related to the licensing of export.	Achieved
Thailand	IBRD	XXIII/31	Licensing system	To provide disaggregated information on its licensing system as a matter of urgency and no later than 31 March 2012	A letter of clarification on the information requested has been prepared and signed by the focal point for the Montreal Protocol, the Department of Industrial Works (DIW). Letter will be sent to the Ozone Secretariat in May 2012.	Achieved
Timor-Leste	UNEP	XXIII/31	Licensing system	To complete the establishment and operation of the licensing system and report to the Secretariat no later than 31 March 2012	UNEP has dispatched a legal expert to Timor-Leste in February 2011 to assist the NOU in the implementation of a new licensing system. The Decree Law, prepared with help of UNEP and reviewed by UNDP, is currently undergoing a review in the Ministry of the Economy and Development (MED). Once finalized, the Decree Law will be passed to line ministries for comments before endorsement by the Council of Ministers.	Achievement not reported

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Togo	UNEP	XXIII/31	Licensing system	To ensure that the licensing system includes import and export controls for substances in Annex C, Group I (hydrochloro-fluorocarbons) and to report to the Secretariat	UNEP contacted the National Ozone Unit and the country will send a report to the Secretariat.	Achieved
Tonga	UNEP	XXIII/31	Licensing system	To ensure that the licensing system is structured in accordance with Article 4B of the Protocol and that it provides for the licensing of exports and to report to the Secretariat	The country has established their licensing system structured in accordance with Article 4B, a compulsory licensing is also part of Environment Bill. On 2 March 2012, the country was reminded of decision XXIII/31, and was requested to send in the information urgently. On 29 March 2012, the country wrote to the OS, with c.c. to UNEP, the following: "Although Tonga only imports ODS to the country however our existing licensing system has been in place over the years is used to control both the imports and exports of all ozone depleting substances in Annexes A, B, C and E of the Protocol."	Achieved

Party	Agency	Decisions	Compliance issue	Actions	Implementing Agency Comments	MLF assessment based on agencies preliminary comments, A7 data and information from Ozone Secretariat
Yemen	UNEP	XXIII/22	Data reporting issues	To report 2010 data in accordance with Article 7 as a matter of urgency	The delay is due to instability faced by the country over 2011 and still. NOU was not functioning normally and is facing difficulty to collect and verify ODS data. Since beginning of 2012, situation started to get back to normal partially and NOU is working to respond to many pending reporting, it's expected that NOU will do reporting by July latest since HPMP of Yemen planned for submission to the 68th meeting	Achievement not reported
Yemen	UNEP	XXIII/25	Data reporting issues	To provide 2009 data for hydrochlorofluorocarbons to the Secretariat as a matter of urgency	NOU delayed reporting to HCFC, when reported 2009 data, as it was verifying the consumption as part of the HPMP preparation. However the instability faced by the country over 2011 and still didn't allow NOU to complete the verification process. Since beginning of 2012, situation started to get back to normal partially and NOU is working to respond to many pending reporting; it's expected that NOU will do reporting by July latest since HPMP of Yemen planned for submission to the 68th meeting	Achievement not reported

Annex III

PROJECTS THAT ARE CLASSIFIED AS "SOME PROGRESS"

Agency	Code	Project Title
IBRD	ARG/REF/18/INV/39	Elimination of CFC in the manufacturing plant of domestic refrigerators of Neba, S.A.
IBRD	CPR/ARS/51/INV/447	Phase-out of CFC consumption in the pharmaceutical aerosol sector (2007-2008 biennial programme)
Spain	LAC/FUM/54/TAS/40	Technical assistance to introduce chemical alternatives in countries which have rescheduled methyl bromide phase out plan (Argentina and Uruguay)
UNDP	AFR/FUM/38/TAS/32	Technical assistance for methyl bromide reductions and formulation of regional phase-out strategies for low-volume consuming countries
UNDP	BGD/ARS/52/INV/26	Phase-out of CFC consumption in the manufacture of aerosol MDIs (Beximco, Square Pharmaceutical and Acme Pharmaceutical)
UNDP	CHI/REF/48/INV/160	Terminal umbrella project for phase-out of the use of CFC-11, CFC-12 and R-502 (CFC-115) in the manufacture of refrigeration equipment
UNDP	PAK/ARS/56/INV/71	Plan for phase-out of CFCs in the manufacture of pharmaceutical MDIs
UNEP	GLO/REF/48/TAS/275	Global technical assistance programme in the chiller sector
UNIDO	ALG/REF/44/INV/62	Conversion of CFC-11 to HCFC-141b and CFC-12 to HFC-134a technology in the last group of commercial refrigerator manufactures (refrigeration sector terminal project)
UNIDO	ARG/SOL/41/INV/137	Plan for phase-out of ODS in the solvent sector
UNIDO	EGY/ARS/50/INV/92	Phase-out of CFC consumption in the manufacture of aerosol metered dose inhalers (MDIs)
UNIDO	KEN/SOL/57/TAS/47	Technical assistance for the total phase-out of CTC and TCA in the solvent sector
UNIDO	SYR/FUM/49/TAS/95	Methyl bromide national phase-out plan (soil fumigation)

Annex IV

PROJECTS FOR WHICH ADDITIONAL STATUS REPORTS WERE REQUESTED

Agency	Code	Project Title	Reasons
France	AFR/SEV/53/TAS/39	African customs enforcement networks for preventing illegal trade of ODS in the African sub-regional trade organizations (CEMAC, COMESA, SACU and UEMOA)	To request a milestone for achievement between the 68th meeting and the 69th meeting or consideration of possible cancellation of this project.
IBRD	ARG/FUM/29/DEM/93	Demonstration project for testing methyl bromide alternatives in post-harvest disinfestation for cotton and citrus (phase I)	To request the submission of additional status report to the 68th meeting in order to monitor the preparation of the report on unused funds and the final report for project closing.
IBRD	ARG/PHA/47/INV/148	National CFC phase-out plan: 2006 work programme	To request the submission of additional status report to the 68th meeting in order to monitor the signature of the agreements for the three remaining companies.
IBRD	IDS/DES/57/PRP/187	Preparation for pilot demonstration project on ODS waste management and disposal	To request the submission of additional status report to the 68th meeting on the status of completion of the report on ODS destruction if not submitted at the 68th meeting.
IBRD	PHI/DES/57/PRP/85	Preparation for pilot demonstration project on ODS waste management and disposal	To request the submission of additional status report to the 68th meeting on the status of completion of the report on ODS destruction if not submitted at the 68th meeting.
UNDP	BRA/DES/57/PRP/288	Preparation for pilot demonstration project on ODS waste management and disposal	To request the submission of additional status report on activities since the 67th meeting on project preparation since the project is not expected to be submitted until 2013.
UNDP	IND/DES/61/PRP/437	Preparation of a project for demonstration of a sustainable technological, financial and management model for disposal of ODS	To request the submission of additional status report to the 68th meeting in order to monitor the project preparation.
UNEP	ANT/SEV/44/INS/11	Extension of institutional strengthening project (phase III)	To request the submission of additional status report to the 68th meeting in order to monitor this institutional strengthening project for which the financial and progress reports was outstanding.
UNEP	BAH/SEV/60/INS/24	Extension of institutional strengthening project (phase VI)	To request the submission of additional status report to the 68th meeting in order to monitor this institutional strengthening project for which the financial and progress reports was outstanding.
UNEP	BEN/SEV/62/INS/24	Renewal of institutional strengthening project (phase VII)	To request the submission of additional status report to the 68th meeting on project document signature for institutional strengthening.

Agency	Code	Project Title	Reasons
UNEP	IRQ/SEV/57/INS/05	Institutional strengthening (phase I)	To request the submission of additional status report to the 68th meeting in order to monitor this institutional strengthening project for which the financial and progress reports was outstanding.
UNEP	MAU/SEV/49/INS/17	Renewal of institutional strengthening project (phase IV)	To request the submission of additional status report to the 68th meeting in order to monitor this institutional strengthening project for which the financial and progress reports was outstanding.
UNEP	MOR/SEV/59/INS/63	Renewal of the institutional strengthening project (phase IV)	To request the submission of additional status report to the 68th meeting on project document signature for institutional strengthening.
UNIDO	AFR/REF/48/DEM/37	Strategic demonstration project for accelerated conversion of CFC chillers in 5 African Countries (Cameroon, Egypt, Namibia, Nigeria and Sudan)	To request the submission of additional status report to the 68th meeting on the completion of the agreement with Nigerian bank of Industry.
UNIDO	ETH/FUM/54/PRP/18	Project preparation in the fumigant sector (flowers)	To request the submission of additional status report to the 68th meeting in order to monitor the project preparation in case the project is not submitted at the 68th meeting
UNIDO	IND/PHA/45/INV/385	CTC phase-out plan for the consumption and production sectors: 2005 annual programme	To request the submission of additional status report to the 68th meeting on the selection of a supplier of the equipment for the project.
UNIDO	IND/PHA/49/INV/402	CTC phase-out plan for the consumption and production sectors: 2006 annual programme	To request the submission of additional status report to the 68th meeting on the selection of a supplier of the equipment for the project.
UNIDO	LEB/DES/61/PRP/72	Preparation for pilot demonstration project on ODS waste management and disposal	To request the submission of additional status report to the 68th meeting on the status of completion of the report on ODS destruction if not submitted at the 68th meeting.
UNIDO	QAT/SEV/59/INS/15	Renewal of institutional strengthening project (phase III)	To request the submission of additional status report to the 68th meeting on project document signature for institutional strengthening.
UNIDO	SYR/REF/62/INV/103	Phase-out of HCFC-22 and HCFC-141b from the manufacture of unitary air-conditioning equipment and rigid polyurethane insulation panels at Al Hafez Group	To request the submission of additional status report to the 68th meeting on project progress.
UNIDO	TKM/PHA/62/INV/08	HCFC phase-out management plan (stage I, first tranche)	To request the submission of additional status report to the 68th meting on project progress.

Annex V

PROJECTS FOR WHICH ADDITIONAL STATUS REPORTS WERE REQUESTED FOR HPMP DEVELOPMENT

Agency	Code	Project Title	Reasons
IBRD	PHI/REF/59/PRP/88	Preparation for HCFC phase-out investment activities (domestic air-conditioning sector) in the Philippines	To request the submission of additional status report to the 68th meeting in order to monitor the submission of the HCFC refrigeration sector plan if not submitted at the 68th meeting
UNDP	PER/PHA/55/PRP/40	Preparation of a HCFC phase-out management plan in Peru	To request the submission of additional status report to the 68th meeting in order to monitor the submission of the HPMP if HPMP not submitted to the 68th meeting
UNEP	BAR/PHA/55/PRP/18	Preparation of a HCFC phase-out management plan in Barbados	To request the submission of additional status report to the 68th meeting in order to monitor the submission of the HPMP if HPMP not submitted to the 68th meeting
UNEP	HAI/PHA/57/PRP/13	Preparation of a HCFC phase-out management plan in Haiti	To request the submission of additional status report to the 68th meeting in order to monitor the submission of the HPMP if HPMP not submitted to the 68th meeting
UNEP	MAU/PHA/55/PRP/20	Preparation of a HCFC phase-out management plan in Mauritania	To request the submission of additional status report to the 68th meeting in order to monitor the submission of the HPMP if HPMP not submitted to the 68th meeting

Annex VI

PROJECTS WITH SPECIFIC REPORTING REQUIREMENTS

Agency	Code	Project Title	Secretariat Assessment
Japan	COL/FOA/60/DEM/75	Pilot Supercritical CO2 in spray foam	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 68th meeting based on the anticipated completion date of the project with an explanation for the reason for the delay, what is expected to be completed, and when the report will be submitted.
Japan	PHI/FOA/62/INV/91	Sector plan for the phase-out of HCFC-141b in the foam sector	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting based on the anticipated completion date of the project.
Japan	SAU/FOA/62/INV/12	Phase-out of HCFC-22 and HCFC-142b in the manufacturing of XPS foams at Al Watania Plastics and Arabian Chemical Company	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting based on the anticipated completion date of the project.
Japan	SAU/FOA/62/INV/14	Phase-out of HCFC-22 and HCFC-142b in the manufacturing of XPS foams at Al Watania Plastics and Arabian Chemical Company	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting based on the anticipated completion date of the project.
UNDP	BGD/FOA/62/INV/38	Phase-out of HCFC-141b at Walton Hi-Tech Ind. Ltd.	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including status report on the analysis/compare of the estimated and actual costs of equipment items as presented in the proposal (decision 55/43(d))
UNDP	BRA/PHA/50/INV/278	National CFC phase-out plan	To report progress on the implementation of the NPP to the 68th meeting and submit project completion report when NPP completed
UNDP	BRA/PHA/53/INV/280	National CFC phase-out plan	To report progress on the implementation of the NPP to the 68th meeting and submit project completion report when NPP completed
UNDP	BRA/PHA/56/INV/284	National CFC phase-out plan	To report progress on the implementation of the NPP to the 68th meeting and submit project completion report when NPP completed
UNDP	BRA/PHA/59/INV/293	National CFC phase-out plan	To report progress on the implementation of the NPP to the 68th meeting and submit project completion report when NPP completed

Agency	Code	Project Title	Secretariat Assessment
UNDP	COL/FOA/60/INV/76	Phase-out of HCFCs to hydrocarbons at Mabe Colombia, Industrias Haceb, Challenger and Indusel S.A.	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including status report on the analysis and compare the estimated and actual costs of equipment items as presented in the proposal (decision 55/43(d))
UNDP	CPR/REF/60/DEM/498	Phase-out of HCFC-22 in the commercial air-source chillers/heat pumps at Tsinghua Tong Fang Co.	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting.
UNDP	CPR/REF/60/DEM/499	Phase-out of HCFC-22 in the manufacture of two stage refrigeration systems at Yantai Moon Group Co. Ltd.	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting.
UNDP	EGY/FOA/62/INV/105	Conversion from HCFC-141b to n-pentane in the manufacture of polyurethane rigid insulation foam panels at MOG for Engineering and Industry	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including information on dates when the equipment will be installed and HCFCs phased-out.
UNDP	EGY/FOA/62/INV/106	Conversion from HCFC-141b to methyl formate in the manufacture of polyurethane rigid insulation foam for water heaters at Fresh Electric for Home Appliances	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including information on dates when the equipment will be installed and HCFCs phased-out.
UNDP	EGY/FOA/62/INV/107	Conversion from HCFC-141b to methyl formate in the manufacture of polyurethane spray foams at Specialized Engineering Contracting Co.	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including information on dates when the equipment will be installed and HCFCs phased-out.
UNDP	EGY/FOA/62/INV/108	Conversion from HCFC-141b to n-pentane in the manufacture of polyurethane rigid insulation foam panels at Cairo Foam	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including information on dates when the equipment will be installed and HCFCs phased-out.
UNDP	MEX/FOA/59/INV/148	Phase-out HCFC-141b at Mabe Mexico	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including information on dates when the equipment will be installed and HCFCs phased-out.
UNDP	Not in Database	HCFC demonstration and investment projects	Supplementary report to be submitted to the 68th meeting.

Agency	Code	Project Title	Secretariat Assessment
UNEP	KYR/PHA/55/TAS/19	TPMP verification	To submit report as required by decision 66/15(e) to the PCR to the 68th meeting.
UNIDO	ALG/FOA/62/INV/75	Phase-out of HCFC-141b at Cristor (domestic refrigeration foam)	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting.
UNIDO	ARG/REF/61/INV/164	Phase-out of HCFC-22 in the RAC manufacturing sector	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including information on dates when the equipment will be installed and HCFCs phased-out.
UNIDO	CPR/REF/61/DEM/503	Phase-out of HCFC-22 in the manufacturing of RACs at Midea and conversion of RAC compressors at Meizhi	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting.
UNIDO	CPR/REF/61/DEM/502	Phase-out of HCFC-22 in the manufacturing of RACs at Midea and conversion of RAC compressors at Meizhi	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting.
UNIDO	EGY/FOA/62/INV/104	Phase-out of HCFC-141b from manufacturing of polyurethane foam at Mondial Freezers Company	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including information on dates when the equipment will be installed and HCFCs phased-out.
UNIDO	EGY/FOA/62/INV/110	Phase-out of HCFC-141b from manufacturing of polyurethane foam at El-Araby Co. for Engineering Industries	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including information on dates when the equipment will be installed and HCFCs phased-out.
UNIDO	JOR/REF/60/INV/86	Phase-out of HCFC-22 and HCFC-141b at Petra Co.	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting.
UNIDO	MOR/FOA/62/INV/67	Phase-out of HCFC-141b at Manar (domestic refrigeration foam)	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including dates when the equipment will be installed and HCFCs phased-out.
UNIDO	PAK/FOA/60/INV/77	Phase-out of HCFC-141b in the manufacture of PU foams at United Refrigeration, HNR, Varioline Intercool, Shadman Electronics and Dawlance	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including dates when the equipment will be installed and HCFCs phased-out.
UNIDO	PHI/FOA/62/INV/90	Sector plan for the phase-out of HCFC-141b in the foam sector	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including dates when the equipment will be installed and HCFCs phased-out.

Agency	Code	Project Title	Secretariat Assessment
UNIDO	SAU/FOA/62/INV/11	Phase-out of HCFC-22 and HCFC-142b in the manufacturing of XPS foams at Arabian Chemical Company	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including dates when the equipment will be installed and HCFCs phased-out.
UNIDO	SAU/FOA/62/INV/13	Phase-out of HCFC-22 and HCFC-142b in the manufacturing of XPS foams at Al Watania Plastics	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including dates when the equipment will be installed and HCFCs phased-out.
UNIDO	SUD/FOA/62/INV/28	Phase-out of HCFC-141b in the manufacture of PU foams at Modern, Amin, Coldair and Akabadi	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including dates when the equipment will be installed and HCFCs phased-out.
UNIDO	SYR/REF/62/INV/103	Phase-out of HCFC-22 and HCFC-141b at Al Hafez Co.	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting.
UNIDO	TUR/FOA/62/INV/97	Phase-out of HCFC-141b in the PU foam sector and phase-out of HCFC-22 and HCFC-142b in the XPS foam sector	Additional report on individual HCFC demonstration and investment projects approval clause to report on ICC, IOC and technology application in line with decision 55/43 (b) for submission to the 69th meeting including dates when the equipment will be installed and HCFCs phased-out.

HFO-1234ze AS BLOWING AGENT IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE FOAM BOARDSTOCK

AN ASSESSMENT FOR APPLICATION IN MLF PROJECTS

MAY 2012

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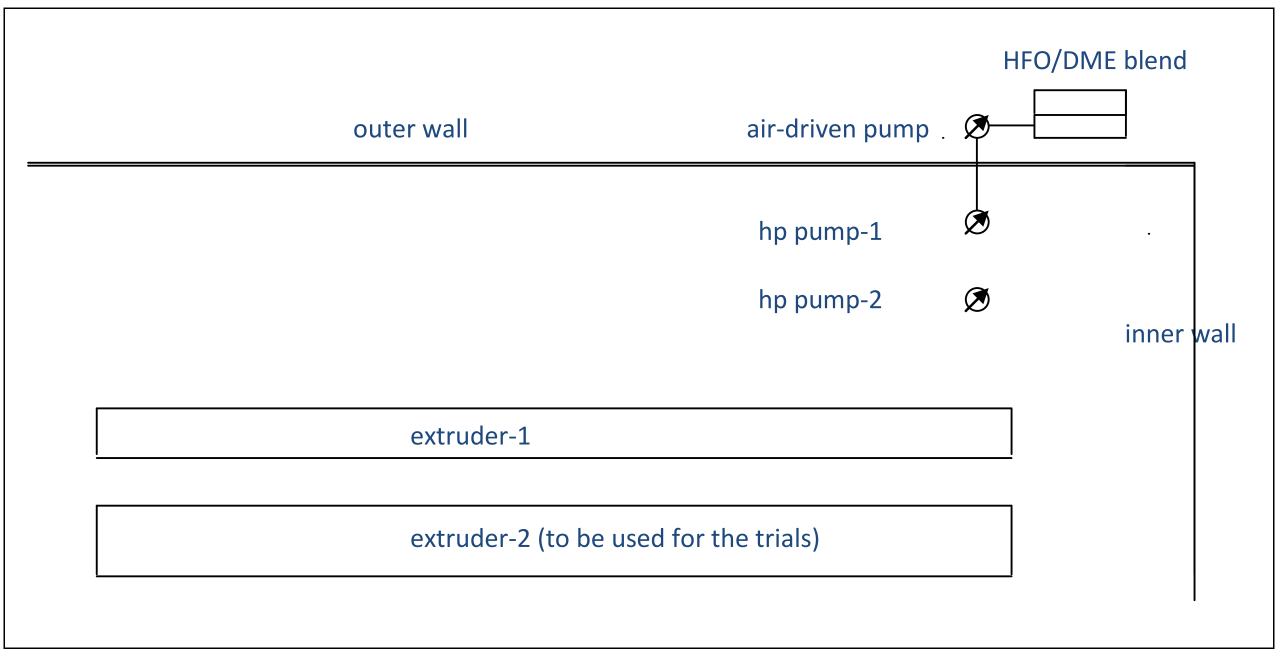
EXECUTIVE SUMMARY

This project is designed to assess the use of HFO-1234ze in a developing country context. HFO-1234ze appears to offer equal climate impact advantages as hydrocarbons without the fire risk and promises improved insulation values compared with other HCFC replacements in extruded polystyrene (XPS) plank.

The project has been divided into

- **Preparatory activities** – which consisted of an implementation Inception Meeting which took place July 6, 2010 and during which the modifications and hardware needed for the trials, the qualities to be trialed, the related testing and the timing were discussed.
- **Trial Preparations –** under which B-PLAS prepared the trial configuration as designed and installed the procured testing equipment. This part is completed as well.
- **Procurement of Testing Equipment and Chemicals –** which included an insulation tester, a closed cell counter and the HFO gas. For cost and processing reasons, HFO-1234ze has been blended by the supplier with DME. At a later stage DME has been directly injected as a co-blowing agent.
- **Trials/Testing –** Before the trials, B-Plas installed an air powered booster pump along the following configuration:

Fig-1: B-Plas Trial Configuration



The products trialed were tested for:

- Thickness
- Density
- Cell Size
- Compressive Strength
- Lambda Value
- Flammability
- Dimensional Stability

- **Assessment –** After the trial results are in, the stakeholders will assess the results and decide how to use these. Follow-up trials and assessments would be conducted as needed. The assessments will then be incorporated in a final assessment report along with recommendations for future use of HFO-1234ze.

The first trials were conducted March 8-11, 2011 and evaluated April 4, 2011. Following observations were made:

- The produced foam sheet's surface properties were pronounced unacceptable
- Physical test results were acceptable

It was decided to conduct a new round of trials on a different production line to eliminate impact of equipment. Because of heavy production commitments these trials could not be made before December 23/24, 2011. The new trials were made starting with the original formulation followed by a new formulation and then again the original formulation. These trials were initially, again, not good in surface and showed large longitudinal pinholes. Adding DME as co-blowing agent improved the product to an acceptable level, although some optimization in density and surface quality will still be needed. Because of the high amount of DME, the blowing agent blend is flammable and proper precautions are needed and outlined in the assessment. An assessment of operating costs could not be completed because of lack of data. From the trials results it was concluded that

- HFO-1234ze XPS foams match HCFC as well as HFC-based foams in insulation and structural properties;
- HFO solubility in the XPS blend appears to be critical. A relatively large amount of co-blowing agent appears necessary to achieve proper processing and cell structure. Alternatively, the equipment used for the trials could be a critical factor;
- Based on the current trials, HFO-1234ze needs 50% co-blowing to be acceptable in processing. If this can be reduced, it is to be expected that the insulation properties of HFO-1234ze will be superior to any other HCFC alternative.

Following recommendations are offered:

1. HFO-1234ze can replace the HCFCs and/or high GWP HFCs in XPS plank while providing acceptable thermal insulation and structural properties;
2. To make this commercially acceptable optimization of density and surface (pinholes!) will be required;
3. The conversion requires equal amounts of DME as co-blowing agent making the blend flammable therefore requiring adequate process safeguards. These are described in the assessment;
4. There is potential to improve thermal insulation performance by reducing the relative amount of DME. This would require further trials for which funding is currently not available. UNDP recommends to continue this project as follows:

    - Duplicate the trials with HFO-1234ze/DME (50/50) on different equipment
    - If these trials are successful, repeat with a 70/30 blend
    - If this is also successful, then there is an equipment compatibility issue at hand with the extruders used in the UNDP trials
    - In that case, continue with an 80/20 blend. The outcome will allow through extrapolation prediction of expected insulation values and provide the manufacturer with a choice between the best insulation (highest amount of HFO) or best cost price (highest amount of DME)

1. Introduction

XPS foam panels have their most important application in buildings to provide thermal insulation. Decisions about thermal insulation are among the most important one will make relative to the environmental impact of buildings. Because insulation reduces energy consumption, it provides ongoing environmental benefits throughout a building's life. However, not all insulation materials are equal environmentally. In assessing the environmental characteristics of insulation materials, one needs to consider a broad range of issues relating to their effectiveness, production and use. This chapter addresses in sequence

- The general principles of heat transfer
- How different insulation materials compare, and
- The impact of blowing agents in thermal insulation

1.1 Thermal Conductivity

Thermal conductivity is defined as the ability of a material to conduct ("transfer") heat. An important function of rigid PU and PS foams is to resist the conduction of heat. Therefore, understanding heat and heat transfer theory is an important factor in understanding thermal conductivity. Heat transfer is a characteristic of a process and is not statically contained in matter. *Heat* is often taken as synonymous to thermal energy. Heat transfer is classified into various mechanisms, such as

- Conduction — also called diffusion is the transfer of energy between objects that are in physical contact
- Convection — is the transfer of energy between an object and its environment, due to circular fluid motion
- Radiation — is the transfer of energy to/from a body through emission or absorption of electromagnetic radiation
- Mass transfer — is the transfer of energy from one location to another as a side effect of physically moving an object containing that energy.

These mechanisms are explained in more detail below:

Conduction - On a microscopic scale, heat conduction occurs as hot, rapidly moving or vibrating atoms and molecules interact with neighboring atoms and molecules, transferring some of their energy (heat) to these neighboring particles. In other words, heat is transferred by conduction when adjacent atoms vibrate against one another, or as electrons move from one atom to another. Conduction is the most significant means of heat transfer within a solid or between solid objects in thermal contact. Fluids—especially gases—are less conductive. Thermal contact conductance is the study of heat conduction between solid bodies in contact. *Steady state conduction* (see Fourier's law) is a form of conduction that happens when the temperature difference driving the conduction is constant, so that after an equilibration time, the spatial distribution of temperatures in the conducting object does not change any further.[7] In steady state conduction, the amount of heat entering a section is equal to amount of heat coming out. *Transient conduction* (see Heat equation) occurs when the temperature within an object changes as a function of time. Analysis of transient systems is more complex and often calls for the application of approximation theories or numerical analysis by computer.

Convection - Convective heat transfer, or convection, is the transfer of heat from one place to another by the movement of fluids. (In physics, the term *fluid* means any substance that deforms under shear stress; it includes liquids, gases, plasmas, and some plastic solids). Bulk motion of the fluid enhances the heat transfer between the solid surface and the fluid.[8] Convection is usually the dominant form of heat transfer in liquids and gases. Although often discussed as a third method of heat transfer, convection actually describes the combined effects of conduction and fluid flow. Free, or natural, convection occurs when the fluid motion is caused by buoyancy forces that result from density variations due to variations of temperature in the fluid. *Forced* convection is when the fluid is forced to flow over the surface by external means—such as fans, stirrers, and pumps—creating an artificially induced convection current. Convective heating or cooling in some circumstances may be described by Newton's law of cooling: "The rate of heat loss of a body is proportional to the difference in temperatures between the body and its surroundings." However, by definition, the validity of Newton's law of cooling requires that the rate of heat loss from convection be a linear function of ("proportional to") the temperature difference that drives heat transfer, and in convective cooling this is sometimes not the case. In general, convection is not linearly dependent on temperature gradients, and in some cases is strongly nonlinear. In these cases, Newton's law does not apply.

Radiation - Thermal radiation is energy emitted by matter as electromagnetic waves due to the pool of thermal energy that all matter possesses that has a temperature above absolute zero. Thermal radiation propagates without the presence of matter through the vacuum of space. Thermal radiation is a direct result of the random movements of atoms and molecules in matter. Since these atoms and molecules are composed of charged particles (protons and electrons), their movement results in the emission of electromagnetic radiation, which carries energy away from the surface. Unlike conductive and convective forms of heat transfer, thermal radiation can be concentrated in a small spot by using reflecting mirrors, which is exploited in concentrating solar power generation. For example, the sunlight reflected from mirrors heats the PS10 solar power tower and during the day it can heat water to 285 °C (545 °F).

Mass Transfer - In mass transfer, energy—including thermal energy—is moved by the physical transfer of a hot or cold object from one place to another. This can be as simple as placing hot water in a bottle and heating a bed, or the movement of an iceberg in changing ocean currents. A practical example is thermal hydraulics.

Applied to the function of XPS foam panels following heat-transfer principles apply:

Insulation - Thermal insulators are materials specifically designed to reduce the flow of heat by limiting conduction, convection, or both. Radiant barriers are materials that reflect radiation, and therefore reduce the flow of heat from radiation sources. Good insulators are not necessarily good radiant barriers, and vice versa. Metal, for instance, is an excellent reflector and a poor insulator. The effectiveness of an insulator is indicated by its **R-value**, or resistance value. The R-value of a material is the inverse of the conduction coefficient (*k*) multiplied by the thickness (*d*) of the insulator. In most of the world, R-values are measured in SI units: square-meter kelvin per watt ($m^2 \cdot K/W$). In the United States, R-values are customarily given in units of British thermal units per hour per square-foot degrees Fahrenheit ($Btu/h \cdot ft^2 \cdot °F$).

$$R = \frac{d}{k}$$
$$C = \frac{Q}{m\Delta T}$$

Critical insulation thickness - Low thermal conductivity (*k*) materials reduce heat fluxes. The smaller the *k* value, the larger the corresponding thermal resistance (*R*) value. Thermal conductivity is measured in watts-per-meter per kelvin ($W \cdot m^{-1} \cdot K^{-1}$), represented as *k*. As the thickness of insulating material increases, the thermal resistance—or R-value—also increases. However, adding layers of insulation has the potential of increasing the surface area, and hence the thermal convection area. For example, as thicker insulation is added to a cylindrical pipe, the outer radius of the pipe-and-insulation system increases, and therefore surface area increases. The point where the added resistance of increasing insulation thickness becomes overshadowed by the effect of increased surface area is called the critical insulation thickness. In simple cylindrical pipes, this is calculated as a radius:

$$R_{critical} = \frac{k}{h}$$

Buildings - In cold climates, houses with their heating systems form dissipative systems. In spite of efforts to insulate houses to reduce heat losses via their exteriors, considerable heat is lost, which can make their interiors uncomfortably cool or cold. For the comfort of the inhabitants, the interiors must be maintained out of thermal equilibrium with the external surroundings. In effect, these domestic residences are oases of warmth in a sea of cold, and the thermal gradient between the inside and outside is often quite steep. This can lead to problems such as condensation and uncomfortable air currents, which—if left unaddressed—can cause cosmetic or structural damage to the property. Such issues can be prevented by use of insulation techniques for reducing heat loss. Thermal transmittance is the rate of transfer of heat through a structure divided by the difference in temperature across the structure. It is expressed in watts per square meter per kelvin, or W/m^2K. Well-insulated parts of a building have a low thermal transmittance, whereas poorly-insulated parts of a building have a high thermal transmittance. A thermostat is a device capable of starting the heating system when the house's interior falls below a set temperature, and of stopping that same system when another (higher) set temperature has been achieved. Thus, the thermostat controls the flow of energy into the house, that energy eventually being dissipated to the exterior.

1.2 Comparison of Insulation Materials

XPS belongs to the top insulation materials available. While rigid PU foam provides an even more effective insulation, XPS foams, being lower in weight and costs, are frequently preferred. The following comparison shows the performance of the most important insulation materials (thickness in mm to give 0.4 W/m^2K insulation):

Table-2: Comparison of Insulation Materials

MATERIAL	THICKNESS
polyurethane	60
extruded polystyrene	80
expanded polystyrene	90
mineral wool	95
glass fiber	100
light weight block	400

The data provided are approximations. Optimized polystyrene foam may perform better than a non-optimized polyurethane foam. Of importance, apart of—and even more than--the base material is the cell gas applied and the cell size.

1.3 Impact of the Blowing Agent

Blowing agents in XPS are solely physical blowing agents. They are introduced in the production extruder under pressure as a liquid but, upon exiting the extruder they turn into a gas and, in the process, expand the polystyrene blend into a cellular foam and fill the cells. As a cell gas, the blowing agent impacts the conductivity of the foam. For a given foam type, the less the thermal conductivity of the blowing agent, the better the insulation value of the foam is. Other criteria for blowing agents are:

- **solubility in the resin,**
- **worker safety (flammability, toxicity),**
- **consumer safety (toxicity),**
- **thermal and chemical stability,**
- **diffusivity,**
- **environmental impact.**

Extruded polystyrene foams can be categorized into sheet and boardstock. Sheet is mostly used for food applications and insulation requirements are modest. For boardstock, however, good thermal insulation is critical. Therefore, while virtually all CFC that was originally used in sheet has been converted to hydrocarbons, boardstock has initially been converted to more thermal efficient HCFCs and then later, where forced by regulations, to a mixture of the following options:

Table-1: HCFC Replacements for XPS board

Substance	GWP	MW	Δ GWP	Observations
HCFC-142b/22 (75/25)	2185	97	Baseline	Not allowed in MLF projects
HCFC-22	1810	87	-562	
HCF-134a	1430	102	-681	Expensive; performance
HFC-152a	124	66	-2101	Flammable, performance
HFC-152a/DME (75/25)	85	61	-2132	Flammable, performance
(Iso) butane, LPG	4	58	-2183	Flammable , performance
CO2 (gas/liquid)	1	44	-2185	In combinations only; performance

It should be noted that

- All options mentioned, except perhaps HFC-134a, are lower (less good) than the baseline in thermal insulation performance
- HFC-134a, however, shows from all replacement options the largest global warming effect
- HFC-152a and hydrocarbons are flammable
- Because of solubility issues, most replacements need a co-blowing agent

The UNEP Foams Technical Options Committee (FTOC) mentions therefore that the phaseout of HCFCs in developed countries *"has been—and continues to be—a problem"*. North American XPS boardstock producers use HFC blends, CO_2 (LCD) and hydrocarbons. The significant variety in products required to serve the North American market (thinner and wider products with different thermal resistance standards and different fire-test-response characteristics) require different solutions than in Europe where the use of HFC-134a, HFC-152a and CO_2 prevails and Japan, where the use of hydrocarbons is significant.

However, recently introduced so called F-Gas regulations in Europe may change the scenario in that region as HFC-134a will have to be phased out. With so many uncertainties it is a challenge to provide guidance to developing countries.

The manufacture of XPS boardstock has traditionally been an insignificant market in the developing world. However, the FTOC mentions that recently production took off in China and Turkey. In addition, there is rapidly increasing production in Argentina, Egypt, Saudi Arabia, Kuwait, Brazil and Mexico. This increase in prominence, in addition to the mentioned lack of comparable performance requires a close look at potential HCFC phaseout options.

Blowing agent manufacturers are diligently working on a new generation of blowing agents that aim to combine zero ODP and good thermal insulation properties with low GWP. However, the horizon for industrialization in industrialized countries is around 2015 which would imply that any phaseout efforts in A5 countries would not initiated before 2016 and therefore not contribute to phase-1 of the HCFC phaseout strategy of these countries (“freeze + 10 %”).

There is one exception and that is HFO-1234ze. This substance, which is produced by Honeywell, is already industrially applied by one-component PU foam (OCF) manufacturers in Europe which were in July 2008 struck by a ban on the use of HFC-134a and needed a replacement urgently. Indicative trials show promise for the use of this substance in XPS boardstock as well.

This project was designed to assess the use of HFO-1234ze in a developing country context. HFO-1234ze appears to offer equal climate impact advantages as hydrocarbons without the fire risk and promises improved insulation value compared with other HCFC replacements.

Technology validation is a global task. Experience gained in one country can be applied in MLF-sponsored XPS projects worldwide and could save in this way millions of dollars in addition to making costs more transparent. Past experience in the HCFC phaseout in PU foams has shown this.

2. Project Design

This project has been implemented under the supervision of the Government of Turkey. The UNDP Country Office in Turkey has been in charge of the implementation activities. The activities have been conducted at the facilities of Bursa Plastic Corporation (B-Plas). The company was selected on recommendation by the XPS Association. The implementation consisted of:

1. Preparatory Activities;
2. Trials/Testing
3. Assessment

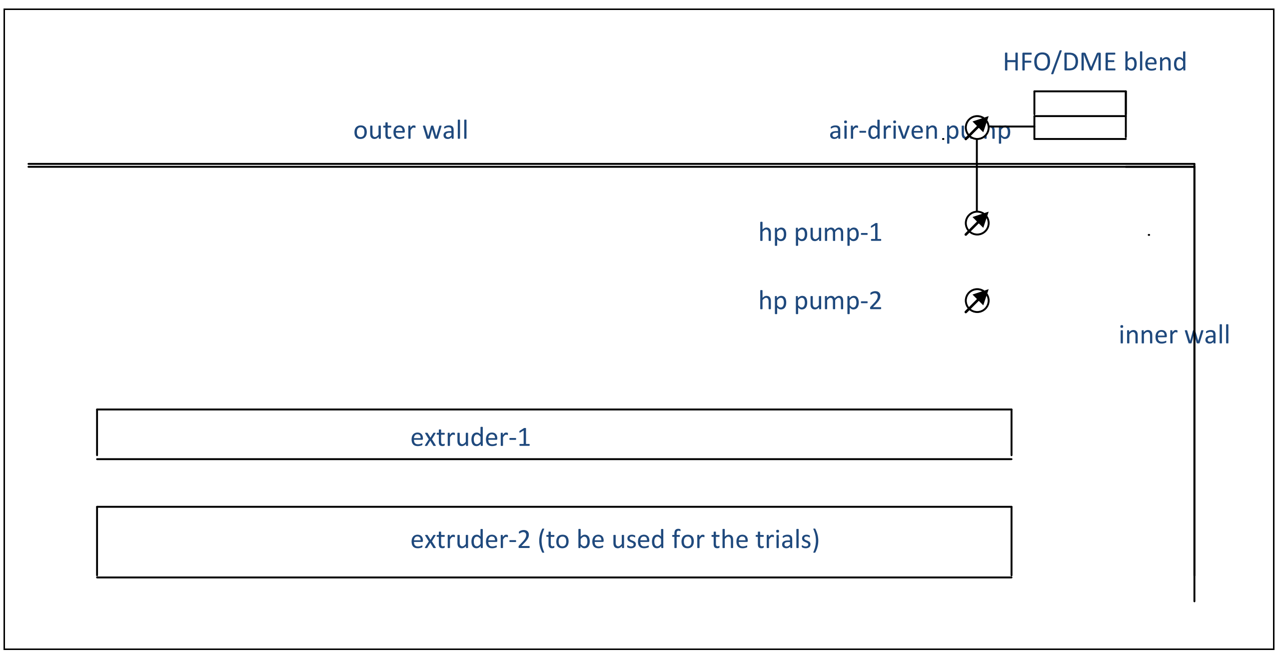
These activities are discussed in detail below.

1. **Preparatory activities** – these consist of

- **Implementation Inception Meeting –** during this meeting, at BPLAS, which took place July 6, 2010, the modifications and hardware needed for the trials, the qualities to be trialed, the related testing and the timing was discussed.
- **Trial Preparations –** B-PLAS prepared the trial configuration as designed and installed the procured testing equipment. Additional testing was conducted by a certified laboratory.
- **Procurement of Testing Equipment and Chemicals –** these included a insulation tester and the HFO gas. For cost and processing reasons, HFO-1234ze has been blended by the supplier with DME. At a later stage DME has been directly injected as a co-blowing agent.

2. **Trials/Testing –** Before the trials, B-Plas installed an air powered booster pump along the following configuration:

Fig-1: B-Plas Trial Configuration



Following is the initial formulation, based on a dry rate of 300 kg/hr:

- Sabic Virgin PS MFI 7 97%
- Recycle PS 0.0%
- Flame-retardant 1.5%
- Talcum 1.5%
- Color 0.0%
- Blowing Agent 8.0% (might be varied during trials)

Trial products were continuous planks of 30 mm X 600 mm and 40 mm X 600 mm

The products were tested for:

- Thickness
- Density
- Cell Size
- Compressive Strength
- Lambda Value
- Flammability
- Dimensional Stability

Samples were retained from each trial and tested on:

- Compressive Strength after: 10 days 20 days 30 days
- Lambda values after: 10 days 20 days 30 days
- Dimensional Stability: 1 bundle of each sample

3. **Assessment –** After the 30 days trial results were assessed by the stakeholders. The outcome of the first trials was not satisfactory and a new set of trials was conducted and assessed. B-Plas prepared extended reports on these trials that are appended to this report.

3. Implementation

3.1 Health, Safety and Environment (HSE)

HFO-1234ze is a hydrofluoroolefin developed by Honeywell as a fourth generation blowing agent aimed to replace HCFCs or HFCs. HFOs are also known as unsaturated HFCs but this name creates confusion as they replace (saturated) HFCs as well. Comparative properties are as follows:

Table-2: Comparative properties of blowing agents

Property	HCFC-142b	HCFC-22	HCFC-142b/-22 (75/25)[1]	Isobutane	DME	HFC-152a	HFC-134a	HFO-1234ze
Molecular Weight	100	86	**97**	58	46	66	102	**114**
Boiling Point (^{0}C)	-9	-41	**-25**[2]	-12	-25	-27	-26	**-19**
TLV or OEL (ppm)	1000	1000	**1000**	800	500	1000	1000	**1000**[3]
LEL/UEL(vol% in air)	6-18	None	**8-24**	1.8-8.4	3.3-18	3.8-21.8	None	**None**[5]
Λ (mW/m^{0}K@ 10^{0}C)	8.4	9.9	**8.7**	16 (20^{0}C)	17 (20^{0}C)	14 (25^{0}C)	12.4	**13**[4]
ODP	0.066	0.05	**0.063**	0	0	0	0	**0**
GWP	2270	1810	**2185**	4	2	124	1430	**6**

Notes: [1]linear weighted averages
[2]there may be a boiling point range
[3]recommended
[4]not known at what temperature
[5]however, at 30^{0}C LEL/UEL values of 7.0/9.5 exist

Apart from the molecular weight, the comparison appears favorable for HFO-1234ze. However, it should be kept in mind that the original baseline, CFC-12, has a molecular weight of 121 and that other factors determine the blowing efficiency as well! A safety data sheet and a technical data sheet are attached (**Attachment II, III**).

Atmospheric Chemistry

In general, hydrofluoroolefins—being unsaturated hydrofluorocarbons—will have shorter atmospheric life times than saturated hydrofluorocarbons. This is evident from their much lower GWPs. However, the issue of decomposition products may be brought up. The University of Copenhagen conducted a study on the atmospheric chemistry of HFO-1234ze[1]. While trifluoroacetic acid (HFA) is mentioned as a major final breakdown product, this is a natural component of the background oceanic environment and any environmental burden associated with trans CF_3CH =CHF oxidation will be of negligible environmental significance. The study concludes *"that the products of the atmospheric oxidation of trans-CF_3CH=CHF will have negligible environmental impact."* **(Attachment IV)**

The USEPA (**Attachment-V**) came to the same conclusion when evaluating HFO-1234ze under the Significant New Alternatives Policy (SNAP) program[2]. EPA's decision states that:

Hydrofluoroolefin (HFO)–1234ze is acceptable as a substitute for CFCs and HCFCs in:

- ***Rigid Polyurethane Appliance Foam.***
- ***Rigid Polyurethane Spray, Commercial Refrigeration, and Sandwich Panels.***
- ***Polystyrene Extruded Boardstock & Billet.***

[1] M.S. Javadi et all, Atmospheric chemistry of trans-CF_3CH=CHF: products and mechanisms of hydroxyl radical and chlorine atom initiated oxidation
[2] Federal register / Vol. 74, No 188 / Wednesday, September 30, 2009 / rules and regulations, pg 50129 ev

Toxicity

The toxicity of HFO-1234ze has been relatively extensively researched. Following table summarizes current information—which shows low toxicity levels:

Table-3: HFO-1234ze Toxicology Assessment

Test		Results
Cardiac Sensitization		No Effect to 120,000 ppm
Genetic Testing:	Mouse micronucleus Ames assay	Not Active at 100,000 Not Active at 50,000 ppm
Acute Inhalation		LC50>400,000 ppm
Chromosome Aberration Test:	Inhalation: 2 week Inhalation 4 week	Test Complete Test Complete
Unscheduled DNA Synthesis	rat; 4 week @15,000	Not Active
Bone Marrow Micronucleus Formation rat; 4 week@ 15,000		Not Active
Carcinogenicity Screen Test		Complete
Metabolism Study		Underway
Inhalation	13 week	Test Complete
Developmental Toxicity Pilot Test		Complete

Based on these data as well as other data mentioned in Attachments III-V, HFO-1234fa is assumed to be a non-ODP/insignificant GWP substance with low toxicity and valid for XPS applications—as is already the case in one component PU foams.

3.2 System Processability

HFO-1234ze needs to be shipped in pressurized containers (1,000 kPa or 10 Bar), identical to CFC-11, HCFC-142a and HCFC-22 ones. When kept out of sunlight and a room temperatures (<25^0 C), the substance is stable for at least one year. No data on solubility in the polystyrene matrix are known but in all tested plastics except PFTE, absorption is less than 1% (PFTE 2%).

Because the gas is not chemically aggressive or flammable, it can be processed on the same equipment as currently used for HCFC-142b, HCFC-22 and HFC-134a.

3.3 Process Trials and Evaluation

Several challenges caused delays in conducting the trials, such as

- Picking a time that the production at B-Plas would allow freeing up an extruder for three days
- Finding a contractor that would blend HFO-1234ze with DME
- Shipping/receiving HFC-1234ze, which was never before imported in Turkey
- Getting the test equipment lined up

Trials were finally conducted March 8-11, 2011 and evaluated April 4, 2011.

B-Plas prepared an extensive report on these trials (**Attachment-V**) that included:

- Information on formulations and processing conditions
- Test results, on 10 and 20 days age of the trial materials

Following observations were made:

- The produced foam sheet's surface properties are not meeting standards and pronounced unacceptable
- Physical test results are acceptable

It was decided that a new round of trials would be needed. This was done on B-Plas' second production line to assess impact of equipment. Because of heavy production commitments these trials could not be conducted until December 23/24, 2011. The new trials were made starting with the original formulation followed by revised formulations. An extended report, prepared by B-Plas, can be found in **Attachment-VI**. These trials were initially, again, not good in surface and showed large longitudinal pinholes. An additional DME supply was then rigged to the extruder and the amount of DME was increased to 50%. Following observations were made:

- At HFO-1234ze/DME 50/50 , a good product was obtained
- Some further surface optimization would be needed. However, material was short and budget depleted, so that further optimization could not be taken on
- Physical test results are acceptable with the k-value equal to the base line (HCFC-142b/-22) and better that the current blowing agent as shown below:

Table-4: Comparison of Past and Current Blowing Agents at B-Plas

Tests	Standard	Unit	50/50% HFO1234ze/DME	75/25% 152a/DME	[1]50/50% 152a/DME	[2]75/25 142b/22a
Thermal conductivity	TS EN 12667	W/mK	0.030	0.035	0.032	0.028

[1] Current blowing agent
[2] Original blowing agent

Attachment VIII provides a more detailed comparison.

4. Conversion Costs

4.1 Incremental Capital Costs

HFO-1234ze can be metered with the same dosing pump and from the same tank as HCFC-142b/-22. Therefore, conversion can basically be made without any capital costs apart from trials and testing. However, with the higher costs of HFOs, it would be advisable to meter DME separately so that its use can be optimized depending on the customers' specifications. This would imply that a separate stream—tank, booster pump, metering pump, connecting piping--would have to be installed. As DME is flammable (but not explosive!), proper precautions need to be incorporated. A very tentative budget for such a conversion would be:

- Pressurized Tank US$ 50,000 – 60,000
- Booster pump US$ 5,000 – 5,000
- Metering pump US$ 30,000 – 50,000
- Miscellaneous safety (grounding, ventilation, sensors) US$ 15,000 – 25,000
- Laboratory equipment (k-tester, pycnometer) US$ 25,000 – 40,000
- Technology Assistance, Trials, Testing US$ 30,000 – 30,000
- Contingencies (~10%) US$ 15,000 – 20,000

- **Total** **US$170,000 – 210,000**

4.1 Incremental Operating Costs

UNDP prepared the following comparison of HFO-1234ze/DME 50/50 with HFC-152a/DME 50/50:

Table 5: cost comparison between different blowing agents

Chemical	Formulation (%)	Costing HFC-152/DME		Costing HFO-1234ze/DME	
		Price (€/kg)	Price (€)	Price (€/kg)	Costs (€)
Resin	90.0	1.40	1.26	1.40	1.26
Flame Retardant	1.4	8.50	0.12	8.50	0.12
Nucleating Agent	1.4	2.2	0.03	2.2	0.03
Blowing agent	7.2	2.65	0.19	7.35	0.53
Costs (€/kg)			**1.60**		1.94
Difference (%)					**21**

The difference is substantially and probably more that the market can bear. However, the difference with the baseline (HCFC-142b/-22) and the most prevalent replacement (HFC-134a) is much less. UNDP does not have sufficient process and cost information to calculate these.

5. Conclusions

Based on the information presented in this report and its attachments it is concluded that:

5.1 Health, Safety, Environment

- The use of HFO-1234ze does not create incremental health concerns;
- HFO-1234ze is inert, not flammable and in itself does not require any related safety precautions;
- HFO-based blowing agent blends do not pose an environmental hazard based on current knowledge. Its atmospheric profile is benign, there is no ODP and its global warming potential is negligible.

5.2 System Processability

- Based on blowing potential at equimolecular comparison, HFO 1234ze requires almost the same mass as CFC-12 but 15% more than HCFC-142b and HFC-134a and 70% more than HFC-152a. The customary co-blowing with DME will flatten these differences to some extent;
- Shipment and storage of HFO-1234ze must take place in pressurized containers—which is the case for all other competing blowing agents as well and therefore no incremental burden;
- The shelf life for HFC-1234ze is at par with most other alternatives;
- Flammability of HFO-1234ze/DME 50/50 requires process safeguards. However, the blend is not explosive.

5.3 Foam Properties

- HFO-1234ze-based XPS foams match HCFC as well as HFC-based foams in insulation properties and structural properties;
- The resulting foam from the assessment trials will need surface and density optimization to be commercially acceptable;
- The amount of co-blowing agent appears critical for processing and cell structure. Alternatively, the equipment used for the trials could be a critical factor. Further trials will be needed on other equipment to assess the impact of the extruder;
- **Based on the current trials, HFO-1234ze needs 50% co-blowing with DME to be acceptable in processing. If this can be reduced, it is to be expected that the insulation properties of HFO-1234ze will be superior to other HCFC alternatives and can match those of HCFC-142b/-22.**

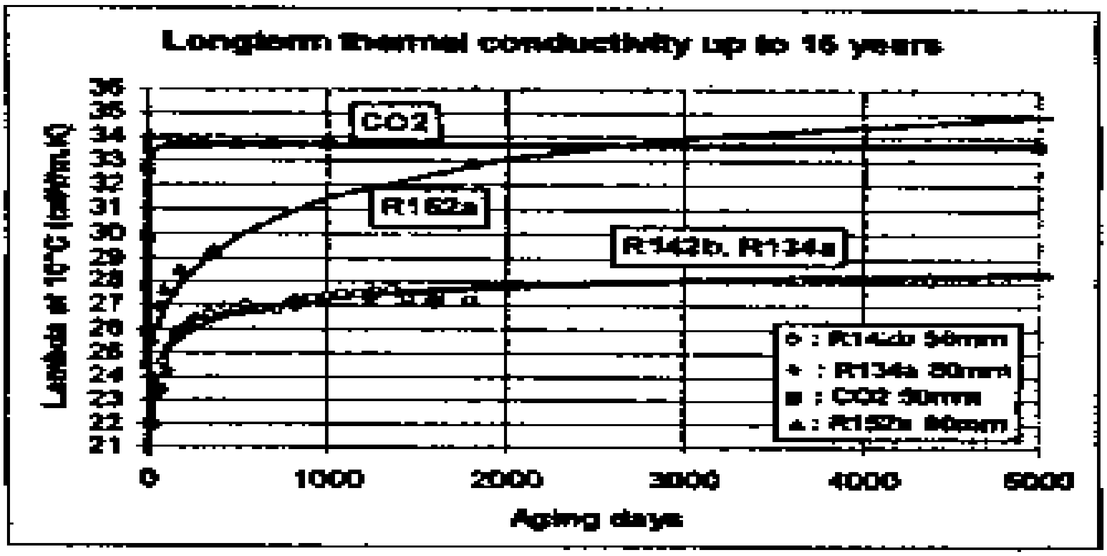
5.4 Conversion Costs

- HFO-1234ze is non-flammable and can be used with the same equipment as HCFC-142b/-22. However, the large amount of DME as co-blowing agent will make the blend flammable. UNDP estimates investment conversion costs therefore around US$ 200,000, as detailed under 4.1;
- Most other current non-ODS/low GWP, however, show very similar or even more severe flammability characteristics;
- A preliminary operational costs analysis indicates a substantial increase of up to 21% compared to using HFC-152a/DME 50/50.

6. Recommendations

6.1 Preface

HFO-1234ze is the only non-ODP/low GWP blowing agent that shows the potential to replace HCFCs in XPS foam without compromising insulation performance. The following graph, showing other alternatives, illustrates this:



However, the price of HFO-1234ze might only justify its use in high performance higher end of the market while the less demanding lower end of the market might be served with HFC-152a and/or CO2—both with a co-blowing agent. In at least one case an MLF project reflects option this already.

The solubility of HFO-1234ze in the polymer blend requires incorporation of a co-blowing agent—which reduces the insulation performance. Alternatively, a retrofit of the extruder to improve solubility or to decrease its impact might allow the full benefit of the inherent insulation performance of HFO-1234ze. The project budget did not allow investigating the latter option.

The project budget also did not allow full optimization of product surface and density. The result is that a potential user of HFO-1234ze still has to conduct optimization trials that can reach from product fine-tuning all the way through extruder retrofit. Rather than having every company coping with this on an individual basis, an extension of the current pilot project to include these items would be a more cost-effective option

Based on these observations, UNDP recommends to continue this project as follows:

- Retrofit the current extruder to improve the solubility of the blowing agent;
- Do trials with the HFO-1234ze/DME 50/50 to optimize surface and density;
- If these trials are successful, conduct repeat trials with a 70/30 blend;
- If this is also successful, then the equipment compatibility issue is proven.
- In that case, continue with an 80/20 blend. The outcome will allow through extrapolation prediction of expected insulation values and provide the manufacturer with a choice between the best insulation (highest amount of HFO) or best cost price (highest amount of DME);

- If the retrial with a 70/30 blend is not successful, another co-blowing agent might be needed. This could be methyl formate and UNDP will look into the results of the Chinese MF project before taking any action;
- Processability for thinner board such as below 30 mm will be studied as well in more detail to apply the results to those countries which operate within these ranges.

It is expected that for this follow-up assessment following costs will be incurred

1.	Retrofit of existing extruder	US$ 65,000
2.	Surface/density trials	US$ 25,000
3.	70/30 blend trials	US$ 25,000
4.	80/20 blend trials	US$ 25,000
5.	Final optimization trials	US$ 25,000
6.	Contribution Honeywell (provision of HFO-1234ze at no costs)	US$ -15,000
	Total	**US$ 150,000**

The Executive Committee may wish to consider whether to grant UNDP additional funding based on the above justification or accept the assessment "as is" and allow UNDP to discontinue its work on this HFO demo project.

60th Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol

COUNTRY: Turkey	**IMPLEMENTING AGENCY: UNDP**
PROJECT TITLE:	**Validation of the use of HFO-1234ze as Blowing Agent in the Manufacture of Extruded Polystyrene Foam Boardstock (Phase-I)**
PROJECT IN CURRENT BUSINESS PLAN:	**Yes (added, based on ExCom Decision 55/43e i-iii)**
SECTOR:	**Foams**
Sub-Sector:	**Extruded Polystyrene Boardstock Foam**
ODS USE IN SECTOR	
Baseline:	**Not yet determined**
Current (2007):	**923 ODP t HCFCs, as per Government reporting**
BASELINE ODS USE:	**N/A**
PROJECT IMPACT (ODP targeted):	**N/A for this phase**
PROJECT DURATION:	**10 months**
PROJECT COSTS:	**US$ 165,000 (Phase-I only)**
LOCAL OWNERSHIP:	**100 %**
EXPORT COMPONENT:	**0 %**
REQUESTED MLF GRANT:	**US$ 165,000**
IMPLEMENTING AGENCY SUPPORT COST:	**US$ 12,375 (7.5 %)**
TOTAL COST OF PROJECT TO MLF:	**US$ 177,375**
COST-EFFECTIVENESS:	**N/A**
PROJECT MONITORING MILESTONES:	**Included**
NATIONAL COORDINATING AGENCY:	**Ministry of Environment and Forestry**

PROJECT SUMMARY

Turkey is a Party to the Vienna Convention and the Montreal Protocol. It also ratified the London, Copenhagen, Montreal and Beijing amendments to the Protocol. The country is committed to an early phaseout of HCFCs (2015) and willing to take the lead in assessing and implementing new HCFC phaseout approaches to achieve that goal. The objective of this project is to validate the use of a recently industrialized hydrofluoroolefin, HFO-1234ze, in the production of extruded polystyrene foam boardstock. This substance has no ODP and a very low GWP. Turkey hosts 12 local manufacturers of extruded polystyrene boardstock, most using a mixture of HCFC-142b and -22 because of safety (non-flammable) and performance (good thermal insulation). These producers tested already several HCFC replacement options with mixed results and are eager to round off their evaluations with the testing of this HFO that may make the use of high-GWP HFCs unnecessary. The project is divided into two phases:

Phase I: validate on existing equipment the use of HFO-1234ze and determine conditions under which commercial conversion could be implemented.
Phase-II: in case of a positive outcome, conversion of the existing operation to HFO-1234ze

At this stage funding only for Phase-I is requested. The costs of Phase-II cannot be determined at this stage and will be calculated after completion of Phase-I and then submitted for approval.

IMPACT OF PROJECT ON COUNTRY'S MONTREAL PROTOCOL OBLIGATIONS

Phase-I of this project is a pilot project and will not directly contribute to the fulfillment of Turkey's Montreal Protocol obligations. However, if successfully validated, the technology will contribute to availability of cost-effective options that are urgently needed to implement HCFC phase-out in extruded polystyrene boardstock. Such options can be applied in all XPS manufacturers in Turkey and world-wide. **Gaining experience through just one project rather than 12 (in Turkey) or in excess of 50 (worldwide A2 countries only) may save millions of dollars on actual phaseout costs compared to just over US$ 200,000 for one pilot project.**

Prepared by: Rappa, Inc. **Date: February, 2010**

60th Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol

PROJECT OF THE GOVERNMENT OF TURKEY

VALIDATION OF USE OF HFO-1234ze AS BLOWING AGENT IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE (XPS) FOAM BOARDSTOCK (PHASE-I)

1. PROJECT OBJECTIVES

The objective of this project is to validate the use of HFO-1234ze in the manufacture of XPS foam boardstock and, if the outcome is positive, apply the technology subsequently in a sector phaseout project. Lessons learned may be of use for similar manufacturing plants worldwide.

2. INTRODUCTION

2.1 GENERAL

Extruded polystyrene foams can be categorized into sheet and boardstock. Sheet is mostly used for food applications and thermal insulation requirements are modest. For boardstock, however, which is mostly used for construction applications, good thermal insulation is critical. Therefore, while virtually all CFC use in sheet has been converted to hydrocarbons, boardstock has initially been converted to HCFCs and then later, where forced by regulations, to a mixture of options that all are less than desired from a performance point of view. The UNEP Foams Technical Options Committee (FTOC) mentions that the phaseout of HCFCs in non-A5 countries *"has been—and continues to be—a problem"*. North American XPS boardstock producers are on course to phaseout HCFC use by the end of 2009. Phaseout choices will be HFC blends, CO_2 (LCD) and hydrocarbons. The significant variety in products required to serve the North American market (thinner and wider products with different thermal resistance standards and different fire-test-response characteristics) require different solutions than in Europe and Japan, who have already phased out HCFCs with HFC-134a, HFC-152a and CO_2 in Europe and significant use of hydrocarbons in Japan. However, recently introduced so called F-Gas regulations in Europe may change the scenario in that region as HFC-134a will have to be phased out." With so many uncertainties in non-A5 countries, it is a challenge to provide guidance to A5 countries.

The manufacture of XPS boardstock has been traditionally an A2 market. There has been minor production in A5 countries but the FTOC states that recently production took off in China and Turkey. In addition, there is production in Argentina, Egypt and Saudi Arabia, while Kuwait, Brazil and Mexico are starting up new production lines. This increase in prominence, combined with the urgency caused by Turkey's decision to early HCFC phaseout, requires a close look at HCFC phaseout options.

Blowing agent manufacturers are working diligently on a new generation of blowing agents that aim to combine zero ODP and good thermal insulation properties with low GWP. However, the horizon for industrialization in industrialized countries is 2-4 years which would imply that any phaseout efforts in A5 countries would not contribute to the period through 2016 ("freeze + 10 %"). There is one exception and that is HFO-1234ze. This chemical which is produced by Honeywell is already industrially applied in one component PU foam (OCF) manufacturers in Europe which were struck by a ban on the use of HFC-134a in July 2008 and needed a replacement urgently. The properties of this chemical as well as preliminary trials show promise for use in XPS boardstock but there has been no formal validation so far. If the MLF desires a full range of HCFC phaseout options for XPS boardstock that are not sub-standard in performance or unwanted in climate impact, evaluation of HFO-1234ze will be needed. This substance appears to offer the same climate impact advantages as hydrocarbons without the fire risk and to promise improved insulation value compared with other HCFC replacements.

But, with no diffusion data available, this is a very preliminary statement. UNDP is in contact with its manufacturer, Honeywell, which has agreed to support a validation project.

Technology validation is a global task. Experience gained can be applied in all MLF project dealing with XPS (estimated to exceed 50) and could save in this way millions of dollars in addition to making costs more transparent. Past experience in CFC phaseout has shown this. However, it has to be executed in one particular country. Because of the global impact, deduction of the first phase, which deals with development, optimization and validation from the national aggregate HCFC consumption would not be considered fair and it is requested to treat phase-1 in this way.

2.2 THE USE OF HCFCs IN XPS BOARDSTOCK APPLICATIONS IN TURKEY

The XPS Boardstock industry in Turkey consumed in 2008 about 4,100 t blowing agents from which ~70% (2,860 t) consisted of HCFCs. Growth in this industry has been impressive as the following overview shows:

Table-1: production of XPS Boardstock in Turkey

	2006	2007	2008	2009
XPS Boardstock Capacity (m^3)	1.200.000	1.900.000	2.200.000	2.400.000
Capacity Use (%)	75	75	75	
XPS Boardstock production	900,000	1,425,000	1,650,000	
Average Density (kg/m^3)	~31	~31	~31	
Annual production (t)	28,000	44,200	51,000	
Blowing Agent (%)	8	8	8	
Blowing agent use	2,240	3.540	4,080	
HCFC Share (%)	100	80	70	
HCFC Consumption (t)	**2,240**	**2,830**	**2,860**	

The industry is under pressure from the Government—that wants to phaseout the use of HCFCs by the end of 2015—and has been testing alternatives with the following outcome:

- HFC-134a — trials have been successful but the high GWP makes it less attractive
- HFC-152a — most trials have been in combination with dimethylether (DME) and have been Successful, albeit with a penalty in insulation value of around 10%. There is current commercial production using this approach
- Hydrocarbons — trials are imminent, pending the finalization of safety measures
- CO_2 — trials have been so far unsuccessful (inconsistent product)

See paragraph 5 below for a detailed discussion of these options.

3. RECIPIENT INFORMATION

This pilot project has been prepared around B-Plas, a Turkish manufacturer of extruded polystyrene foam boardstock. Contact information is as follows:

Company: B-Plas Bursa Plastic, Metal ve Turizm San. Ve Tic. A.S.
Contact: Levent Ceylan
Address: Yeni Yalova Yolu 5. km No: 365 Bursa, Turkey
Ph/Fx: +90-224-261-0900/+90-224-261-0918
Email: leventc@bplas.com.tr

B-Plas was established in 1987 and is owned by Celal and Memduh Gökçen, both Turkish nationals and residents of Osmangazi/Bursa. The XPS plant is located in Bursa, about 170 km from the port of Istanbul and 25 km from the port of Gemlik. It employs 36 and produces XPS on three twin screw extruders. Production has developed as follows:

Table 2: XPS Boardstock Production at B-Plas

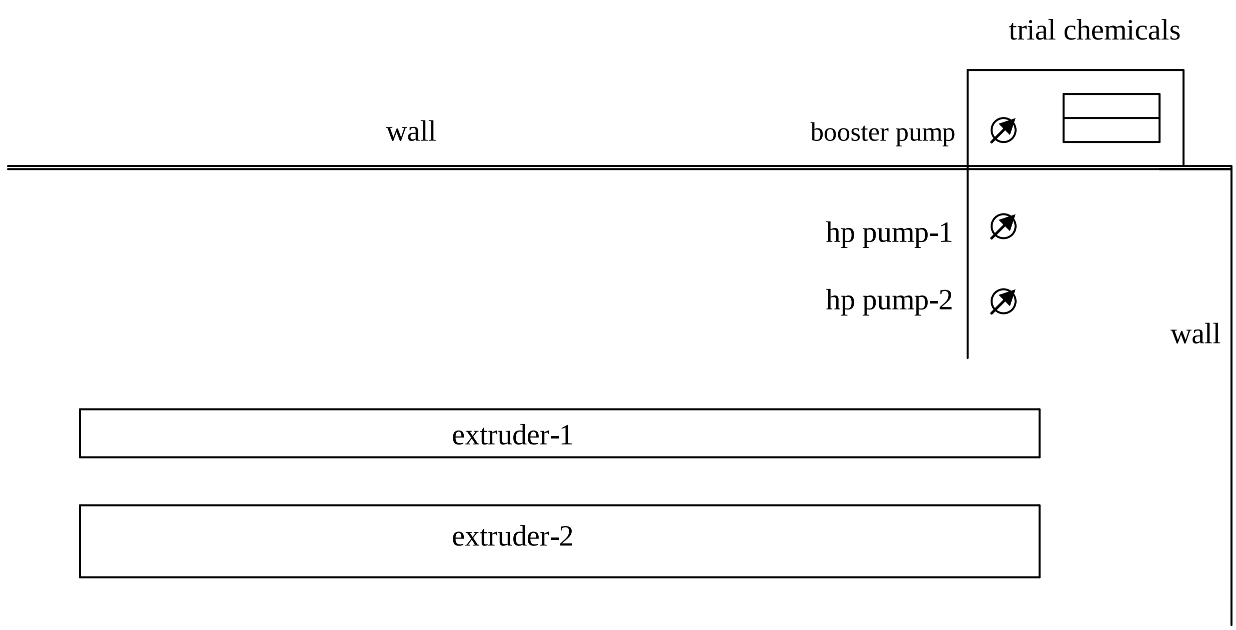
	2006	2007	2008	Comments
Production (m^3)	38,000	44,000	79,000	Increase through higher sales and lower density
Sales (m^3)	38,000	44,000	75,000	
Resin use (kg)	1,550,000	1,600,000	2,350,000	
Blowing agent use (kg)	220,000	240,000	369,000	

There is no export to other countries. The operation belongs to the B-Plas Bursa Plastic Group which employs about 1,600, had in 2007 sales of over US$ 200 million.

4. PROJECT DESCRIPTION

The aim of the trials proposed under this pilot project will be to validate the use of HFO-1234ze and in this way to determine processability and cost impact when replacing current HCFC-142b/-22 blends. It is expected that such trials can be conducted with unchanged production equipment. However, a separate storage/feed operation for the trial chemical will have to be installed, because the existing feed system is too remotely located and would incur substantial contamination if used (see layout below).

FIG-1: B-PLAS TRIAL CONFIGURATION



It is emphasized that this trial configuration is unique for this being a pilot project that needs to keep the existing flow of blowing agents to other extruders than the one used for the trial to avoid costly business interruption. It will not need to be repeated in other XPS conversions. Apart from using HFO-1234ze as sole blowing agent, combinations with co-blowing agents will be tested as well.

During the trial, process conditions will be checked against baseline. Boards with several thicknesses will be produced. The baseline and the trial material will be tested for:

- board density
- appearance
- compression strength
- thermal performance
- water absorption
- diffusivity

Properties testing will be conducted at B-Plas and the HFO-1234ze manufacturer, Honeywell. However, final validation testing will be certified through an independent testing laboratory in Turkey. Honeywell and an independent expert recommended by Honeywell will attend and advise with the trials. A report will be prepared for the ExCom, outlining the quality of the product, changes recommended to equipment—if any—for future commercial production and cost analyses. Based on these trials and other trials conducted by the Turkish XPS manufacturers—independently and on their own costs—a phase-II proposal for the entire Turkish XPS boardstock industry (12 plants) will be prepared for commercial conversion from HCFCs to non ODP/low GWP alternatives – if agreed with by the Government.

5. TECHNICAL OPTIONS FOR HCFC REPLACEMENT IN XPS FOAMS

5.1 GENERAL INFORMATION

Extruded polystyrene foam can be categorized into sheet and boardstock applications. In virtually all sheet applications CFCs have been replaced by hydrocarbons—butane, isobutane, LNG or LPG. In boardstock, most of the replacement has been a blend of HCFC-142b and HCFC-22 in a 70-80%/30-20% ratio. The use of HCFC-22 was aimed at countering HCFC-142b's (modest) flammability. With the prices of HCFC-22 ever decreasing, many manufacturers—mainly in China—converted to HCFC-22 alone. This had its toll on product quality as the use of HCFC-22 only is prone to shrinkage.

The FTOC 2006 report offers following overview of past and expected conversions:

Table-3: Past and expected Blowing Agents for XPS Boardstock

XPS Type	CFC Alternatives		
	Currently in Use (2005/2006)	Anticipated in 2010-2015 period	
		Developed Countries	Developing Countries
Sheet	Primarily hydrocarbons, HCFCs are not technically required for this end use	CO_2 (LCD), hydrocarbons, inert gases, HFC-134a, -152a	Hydrocarbons, CO_2 (LCD)
Boardstock	CO_2 (LCD) or with HC blends, hydrocarbons (Japan only), HFC-134a, HFC-152a, HCFC-22, HCFC-142b	CO_2 (LCD) or with HC blends, hydrocarbons (Japan only), HFC-134a, HFC-152a and HC blends	HCFC-142b, HCFC-22

As already mentioned in the introduction, the 2008 FTOC update reports that *"the phaseout of HCFCs in non Article 5 countries has been—and continues to be—a problem"*. North American XPS boardstock producers are scheduled to phaseout HCFC use by the end of 2009 through HFC blends, CO_2 (LCD) and hydrocarbons. The significant variety in products required to serve the North American market (thinner and wider products with different thermal resistance standards and different fire-test-response characteristics) will result in different solutions than in Europe and Japan, who have already phased out HCFCs. In Europe, this has been achieved with HFC-134a, HFC-152a and CO_2 (sometimes with a co-blowing agent or blended with an additives) while in Japan there has been significant use of hydrocarbons. Recently introduced so-called F-Gas regulations in Europe may change the scenario in that region as this regulation introduces limits on allowed GWPs.

Following is the current commercial/technical status on potential replacement for HCFCs:

Table-4: Status of HCFC replacements in XPS Boardstock

SUBSTANCE	COMMENTS
HFC-134a	Considered expensive; high GWP
HFC-152a	Moderately flammable and considered expensive
(Iso)butane	Highly flammable; high investment
CO_2	As gas only capable to replace 30% of the blowing agent. As liquid, high in investment and not fully mature
HFO-1234ze	Non-flammable, ideal boiling point, but still experimental

It will be important to assess for all technologies their climate impact. Using GWP and MW data as provided by the FTOC (2006), following indicative GWP changes are to be expected for the replacement of HCFC-141b in PU foam applications:

Table-5: Indicative GWP Changes when Replacing HCFC-142b/-22

SUBSTANCE	GWP	MOLECULAR WEIGHT	INCREMENTAL GWP	COMMENTS
HCFC-142b/-22 (75/25)	2,185	97	Baseline	
HCFC-22	1,810	87	-562	Non flammable
HFC-134a	1,430	102	-681	Non flammable
HFC-152a	124	66	-2,101	Moderately flammable
(Iso)butane	4	58	-2,183	Flammable
CO_2 (LCD)	1	44	-2,185	Non Flammable
HFO-1234ze	6	114	-2,178	Non flammable

Green = favorable GWP effect; red = favorable comparable GWP effect but higher that the EU F gas limit (150)

Based on these data, it appears that HCs, CO_2 (LCD) and HFO-1234ze have by far the lowest climate impact based on GWP.

HFC-152a may also be an acceptable alternative from a climate change perspective.

While HFC-134a reduces the comparable global warming effect, it will be disallowed in the future in the EU and its use is therefore discouraged. An HCFC substitution program for XPS boardstock may therefore include HFC-152a, Hydrocarbons, Carbon Dioxide and HFO-1234ze

5.2 PROPERTIES OF HFO-1234ze

General

HFO-1234ze is a hydrofluoroolefin developed by Honeywell as a fourth generation blowing agent to replace HFCs in non-A5 countries. Comparative properties are as follows:

Table-6: Comparative properties of blowing agents

Property	HCFC-142b	HCFC-22	HCFC-142b/-22 (75/25)[1]	Isobutane	HFC-152a	HFC-134a	HFO-1234ze
Molecular Weight	100	86	**97**	58	66	102	**114**
Boiling Point (^{0}C)	-9	-41	**-25[2]**	-12	-27	-26	**-19**
TLV or OEL (ppm)	1000	1000	**1000**	800	1000	1000	**1000[3]**
LEL/UEL(vol% in air)	6-18	None	**8-24**	1.8-8.4	3.8-21.8	None	**None[5]**
λ (mW/m^{0}K@ 10^{0}C)	8.4	9.9	**8.7**	16 (20^{0}C)	14 (25^{0}C)	12.4	**13[4]**
ODP	0.066	0.05	**0.063**	0	0	0	**0**
GWP	2270	1810	**2185**	4	124	1430	**6**

[1]linear weighted averages. [2]there may be a boiling point range [3]recommended [4]not known at what temperature
[5]however, at 30^{0}C LEL/UEL values of 7.0/9.5 exist

The two gases that will be compared in these trials are shown in bold. Apart from the molecular weight, the comparison appears favorable for HFO-1234ze. However, it should be kept in mind that the original baseline, CFC-12, has a molecular weight of 121!

Atmospheric Chemistry

In general, hydrofluoroolefins—being unsaturated hydrofluorocarbons—will have shorter atmospheric life times than saturated hydrofluorocarbons. This is evident from their much lower GWPs. However, the issue of decomposition products may be brought up. The University of Copenhagen conducted a study on the atmospheric chemistry of HFO-1234ze[1]. While trifluoroacetic acid (HFA) is mentioned as a major final breakdown product, this is a natural component of the background oceanic environment and any environmental burden associated with trans CF_3CH =CHF oxidation will be of negligible environmental significance. The study concludes ***"that the products of the atmospheric oxidation of trans-CF_3CH=CHF will have negligible environmental impact."***

The USEPA came to the same conclusion when evaluating HFO-1234ze under the Significant New Alternatives Policy (SNAP) program[2]. EPA's decision states that:

Hydrofluoroolefin (HFO)–1234ze is acceptable as a substitute for CFCs and HCFCs in:

- ***Rigid Polyurethane Appliance Foam.***
- ***Rigid Polyurethane Spray, Commercial Refrigeration, and Sandwich Panels.***
- ***Polystyrene Extruded Boardstock & Billet.***

Toxicity

The toxicity of HFO-1234ze has been relatively extensively researched. Following table summarizes current information—which shows low toxicity levels:

[1] M.S. Javadi et all, Atmospheric chemistry of trans-CF_3CH=CHF: products and mechanisms of hydroxyl radical and chlorine atom initiated oxidation
[2] Federal register / Vol. 74, No 188 / Wednesday, September 30, 2009 / rules and regulations, pg 50129 ev

Table-7: HFO-1234ze Toxicology Assessment

Test		Results
Cardiac Sensitization		No Effect to 120,000 ppm
Genetic Testing:	Mouse micronucleus Ames assay	Not Active at 100,000 Not Active at 50,000 ppm
Acute Inhalation		LC50>400,000 ppm
Chromosome Aberration Test:	Inhalation: 2 week Inhalation 4 week	Test Complete Test Complete
Unscheduled DNA Synthesis	rat; 4 week @15,000	Not Active
Bone Marrow Micronucleus Formation	rat; 4 week@ 15,000	Not Active
Carcinogenicity Screen Test		Complete
Metabolism Study		Underway
Inhalation	13 week	Test Complete
Developmental Toxicity Pilot Test		Complete

In conclusion, the outcome of toxicity and atmospheric studies confirm that HFO-1234fa is a non-ODP/insignificant GWP substance with low toxicity and valid for XPS applications—as is already the case in one component PU foams.

6. PROJECT COSTS

Following are the summarized cost expectations:

Table-8: Project Budget

#	ACTIVITY	COSTS (US$)		
		INDIVIDUAL	SUB-TOTAL	TOTAL
PHASE-I – CONDUCTION OF TRIALS AND TESTING				
1	Preparative work Project Preparation (incl. second phase) Technology Transfer, Training	 40,000 30,000	70,000	165,000
2	Trials Purchase of materials (see **Annex-1**) Testing Retrofit	 40,000 10,000 20,000	70,000	
3	Validation	10,000	10,000	
4	Contingencies/Rounding (~10%)	15,000	15,000	

The costs for phase-1 of this project are relatively limited compared to most other pilot projects because cooperation with the manufacturer of HFO-1234fa, Honeywell, makes it possible to have most tests performed in existing facilities, avoiding in this way expensive equipment purchases and the trials can be performed on existing production equipment with only minor retrofits. No costs for phase-II have been calculated at this point. While it is assumed that existing production equipment can be used with few—if any—changes, phase-I will have to confirm this.

UNDP requests a grant for the first phase of this project amounting to

US$ 165,000.

7. IMLEMENTATION/MONITORING

Table-9: Implementation Schedule

TASKS	2009				2010			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Project Start-up								
MF Project Approval			X					
Receipt of Funds			X					
Grant Signature				X				
Procurement arrangement				X				
Phase I								
-Arrival of chemicals					X			
-Trials					X			
-Testing					X			
-Analysis/Reporting/preparation phase II					X			

Table-10: MILESTONES FOR PROJECT MONITORING

TASK	MONTH*
(a) Project document submitted to beneficiaries	2
(b) Project document signatures	3
(c) Procurement	4, 5
(e) Chemicals delivered	5
(f) Trial Runs	6
(g) Testing/analysis/reporting	7
(h) Project closure/start Phase II	12

* As measured from project approval

7. ANNEXES

Annex 1: Budget Details

ANNEX-1

BUDGET DETAILS

Assumptions:

- Chemical prices: Crystalline Polystyrene US$ 2.50/kg
  Talcum US$ 1.00/kg
  HFO 1234ze US$ 20.00/kg (US$ 12.00 +freight & logistics)
- Output: 200 kg/hr total
  180 kg/hr PS
  20 kg/hr gas
- Trial duration: 6 hours total per thickness

Trial costs:

Trials	Duration [hours]	PS Crystal [kg]	Cost [US$]	Talcum [kg]	Cost [US$]	HFO-1234ze [kg]	Cost [US$]	Total Cost
20 mm	6	1,080	2,700	11	11	150	3,000	5,711
25 mm	6	1,350	3,375	14	14	187.5	7,500	7,139
40 mm	6	2.160	5,400	22	22	300	6,000	11,422
50 mm	6	2,700	6,750	28	28	375	7,500	14,278
Calibration	n/a	n/a	n/a	n/a	n/a	50	1,000	1,000
Total	**24**	**7,290**	**18,225**	**75**	**75**	**1,012.5**	**21,250**	**39,550**

*** Say US$ 40,000**

Total Budget:

#	ACTIVITY	COSTS (US$) INDIVIDUAL	SUB-TOTAL	TOTAL
	PHASE-I – CONDUCTION OF TRIALS AND TESTING			
1	Preparative work Project Preparation (incl. second phase) Technology Transfer, Training	 40,000 30,000	70,000	**165,000**
2	Trials Purchase of materials (see **Annex-1**) Testing Retrofit	 40,000 10,000 20,000	70,000	
3	Validation	10,000	10,000	
4	Contingencies/Rounding (~10%)	15,000	15,000	

SAFETY DATA SHEET
according to Regulation (EC) No. 1907/2006

Honeywell

HFO-1234ze, HBA-1

Version 1.6 Revision Date 13.08.2008 Print Date 15.09.2008

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Product information

Trade name : HFO-1234ze, HBA-1

Use of the Substance/Preparation : Aerosol propellant
Foam blowing agent
Refrigerant

Company/Undertaking Identification

Company : Honeywell Fluorine Products Europe B.V.
Laarderhoogtweg 18
1101 EA Amsterdam
Telephone : (31) 020 5656911
Telefax : (31) 020 5656600
Emergency telephone : (32) 14584545
For further information, please contact: : SafetyDataSheet@Honeywell.com

2. HAZARDS IDENTIFICATION

Risk advice to man and the environment

Not a hazardous substance or preparation according to EC-directives 67/548/EEC or 1999/45/EC.
Additional advice : Rapid evaporation of the liquid may cause frostbite.

See Section 11 for more detailed information on health effects and symptoms.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical characterization

Chemical Name : trans-1,3,3,3-Tetrafluoroprop-1-ene
CAS-No. : 1645-83-6
EC-No. : 471-480-0

Occupational Exposure Limit(s), if available, are listed in Section 8.

4. FIRST AID MEASURES

General advice : Show this safety data sheet to the doctor in attendance.
Keep warm and in a quiet place.
Inhalation : If inhaled, remove to fresh air.
Get medical attention if irritation develops and persists.
Skin contact : Rapid evaporation of the liquid may cause frostbite.
If there is evidence of frostbite, bathe (do not rub) with lukewarm (not hot) water. If water is not available, cover with a clean, soft cloth or similar covering.
Call a physician if irritation develops or persists.
Eye contact : If eye irritation persists, consult a specialist.

Notes to physician

Symptoms	:	headache Dizziness Nausea Palpitation Respiratory disorders Rapid respiration

See Section 11 for more detailed information on health effects and symptoms.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Water mist Dry powder Foam Carbon dioxide (CO_2)
Specific hazards during fire fighting	:	Heating will cause pressure rise with risk of bursting Some risk may be expected of corrosive and toxic decomposition products. Fire may cause evolution of: Hydrogen fluoride However, this material can ignite when mixed with air under pressure and exposed to strong ignition sources.
Special protective equipment for fire-fighters	:	Wear self-contained breathing apparatus and protective suit. Exposure to decomposition products may be a hazard to health.
Further information	:	In the event of fire, cool tanks with water spray.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	:	Provide adequate ventilation. Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing. Avoid skin contact with leaking liquid (danger of frostbite). Use personal protective equipment. Keep people away from and upwind of spill/leak.
Environmental precautions	:	Prevent further leakage or spillage if safe to do so. The product evaporates readily. Prevent spreading over a wide area (e.g. by containment or oil barriers).
Methods for cleaning up	:	Do not direct water spray at the point of leakage. Allow to evaporate.

For personal protection see section 8.

7. HANDLING AND STORAGE

Handling

Advice on safe handling	:	Pressurized container: Protect from sunlight and do not expose to temperatures exceeding 50 °C. Do not pierce or burn, even after use. Do not burn.

Exhaust ventilation at the object is necessary.

Advice on protection against fire and explosion : Do not spray on a naked flame or any other incandescent material.
Keep away from direct sunlight.
Fire or intense heat may cause violent rupture of packages.
Vapours may form explosive mixtures with air.
The product is not easily combustible.

Storage

Further information on storage conditions : Keep containers tightly closed in a cool, well-ventilated place.
Keep only in the original container at temperature not exceeding 50°C
Keep away from direct sunlight.

Advice on common storage : Do not store together with:
Oxidizing agents

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational exposure controls

Components	Basis	Value type	Control parameters	Exceeding Factor	Form of exposure	Remarks
trans-1,3,3,3-Tetrafluoroprop-1-ene	HONEYWELL	Time Weighted Average (TWA):	1.000 ppm			We are not aware of any national exposure limit.

Engineering measures

Local exhaust

Personal protective equipment

Respiratory protection : Remarks: In case of insufficient ventilation wear suitable respiratory equipment.
Wear a positive-pressure supplied-air respirator.

Hand protection : Glove material: Viton (R)
Heat insulating gloves

Eye protection : Goggles

Skin and body protection : impervious clothing
Wear cold insulating gloves/face shield/eye protection.

Hygiene measures : Avoid breathing vapors, mist or gas.
Keep working clothes separately.
Do not smoke.

Protective measures : The Personal Protective Equipment must be in accordance

with EN standards:respirator EN 136, 140, 149; safety glasses EN 166; protective suit: EN 340, 463, 468, 943-1, 943-2; gloves EN 374, safety shoes EN-ISO 20345.
The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Avoid inhalation of vapour or mist.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	:	compressed liquefied gas
Colour	:	colourless
Odour	:	slight, original odour

Safety data

Boiling point/boiling range	:	-19 °C
Flash point	:	Remarks: does not flash
Ignition temperature	:	288 - 293 °C
Vapour pressure	:	4.192 hPa at 20 °C
Vapour pressure	:	10.998 hPa at 54,4 °C
Density	:	1,12 g/cm3 at 21,1 °C
Water solubility	:	0,373 g/l
Partition coefficient: n-octanol/water	:	log Pow estimated 2,01
Relative vapour density	:	4 Remarks: (Air = 1.0)

10. STABILITY AND REACTIVITY

Conditions to avoid	:	Some risk may be expected of corrosive and toxic decomposition products. Heat, flames and sparks.
Materials to avoid	:	Reactions with alkali metals.
Hazardous decomposition products	:	Pyrolysis products containing fluoride Fluorocarbons Hydrogen fluoride

Thermal decomposition	:	Note: Hazardous decomposition products formed under fire conditions., To avoid thermal decomposition, do not overheat.

11. TOXICOLOGICAL INFORMATION

Acute inhalation toxicity	:	LC50 Species: rat Dose: > 965 mg/l > 207000 ppm Exposure time: 4 h
Further information	:	Remarks: Not mutagenic in Ames Test. May cause headache and dizziness. No experimental indications on genotoxicity in vivo found. Detailed toxicological data and examinations, exceeding the data set in the MSDS are available for professional users on request.

12. ECOLOGICAL INFORMATION

Elimination information (persistence and degradability)

Biodegradability	:	aerobic Result: Not readily biodegradable.

Ecotoxicity effects

Toxicity to fish	:	NOEC Species: Cyprinus carpio (Carp) Value: > 117 mg/l Exposure time: 96 h
Toxicity to aquatic plants	:	NOEC Growth inhibition Species: Algae Value: > 170 mg/l Exposure time: 72 h
Acute toxicity to aquatic invertebrates	:	EC50 Species: Daphnia magna (Water flea) Value: > 160 mg/l Exposure time: 48 h

13. DISPOSAL CONSIDERATIONS

Product	:	Dispose according to legal requirements. Contact manufacturer.
Packaging	:	Legal requirements are to be considered in regard of reuse or disposal of used packaging materials

14. TRANSPORT INFORMATION

ADR

UN Number	:	3163
Description of the goods	:	LIQUEFIED GAS, N.O.S. (TRANS-1,3,3,3-TETRAFLUOROPROP-1-ENE)
Class	:	2
Classification Code	:	2A
Hazard identification No	:	20
Hazard Label	:	2.2

IATA

UN Number	:	3163
Description of the goods	:	Liquefied gas, n.o.s. (trans-1,3,3,3-Tetrafluoroprop-1-ene)
Class	:	2.2
Hazard Label	:	2.2
Packing instruction (cargo aircraft)	:	200
Packing instruction (passenger aircraft)	:	200

IMDG

UN Number	:	3163
Description of the goods	:	LIQUEFIED GAS, N.O.S. (TRANS-1,3,3,3-TETRAFLUOROPROP-1-ENE)
Class	:	2.2
Hazard Label	:	2.2
EmS Number	:	F-C
Marine pollutant	:	no

RID

UN Number	:	3163
Description of the goods	:	LIQUEFIED GAS, N.O.S. (TRANS-1,3,3,3-TETRAFLUOROPROP-1-ENE)
Class	:	2
Classification Code	:	2A
Hazard identification No	:	20
Hazard Label	:	2.2

15. REGULATORY INFORMATION

Labelling according to EC Directives 67/548/EEC

Further information : Not a hazardous substance or preparation according to EC-directives 67/548/EEC or 1999/45/EC.
The product does not need to be labelled in accordance with EC directives or respective national laws.

National legislation

16. OTHER INFORMATION

Further information

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text. Final determination of suitability of any material is the sole responsibility of the user.
This information should not constitute a guarantee for any specific product properties.

SAFETY DATA SHEET

According to Regulation (EC) No.1907/2006

HARP® DME

1. Identification of the substance / preparation and company / undertaking

Product name Harp® DME

REACH registration number 01-2119472128-37-0000

Company

Harp International Ltd
Gellihirion Industrial Estate
Pontypridd
Rhondda Cynon Taff
CF37 5SX
Tel: +44 (0) 1443 842255
Fax: +44 (0) 1443 841805
Email: harp@harpintl.com

Emergency phone number +44 (0) 1270 502891 (24 hour)

Use Aerosol propellant

2. Hazards identification

EC Classification of the substance or mixture

Hazard Class & category code:
Regulation (EC) No. 1272/2008 (CLP):

- **Physical hazards** Flammable gases - Category 1 – Extremely flammable gas (H220)
  Gases under pressure - Contains gas under pressure; may explode if heated (H280)

Classification EC67/548 or EC 1999/45 : R12 – Extremely flammable.

Label Elements

Labelling Regulation EC 1272/2008 (CLP)

- **Hazard pictogram(s)**


GHS02


GHS04

- **Hazard pictograms code** GHS02 (Flame) - GHS04 (Gas cylinder).
- **Signal word** Danger
- **Hazard statements** H220 : Extremely flammable gas
  H280 : Contains gas under pressure; may explode if heated.

- **Precautionary statements**
  -Prevention P210 : Keep away from heat/sparks/open flames/hot surfaces - No smoking.
  -Response P377 : Leaking gas fire : Do not extinguish unless leak can be stopped safely.
  P381 : Eliminate all ignition sources if safe to do so.
  -Storage P403 : Store in a well ventilated place.
  P410 : Protect from sunlight.

2. Hazards identification continued

Labelling EC 67/548 or EC 1999/45

Symbol(s) F+ : Extremely flammable.

R Phrase(s) R12 : Extremely flammable.

S Safety phrase(s) S9 : Keep container in a well-ventilated place.
S16 : Keep away from sources of ignition.

Other hazards
This substance is not considered to be persistent., bio-accumulating nor toxic (PBT).
This substance is not considered to be very persistent., nor very bio-accumulating nor toxic (vPvB).
May form explosive peroxides.
Rapid evaporation of the liquid may cause frostbite.
Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.
May cause cardiac arrhythmia.

3. Composition / information on ingredients

Substance / Preparation Substance.

Chemical name Dimethyl ether.

Chemical formula $(CH_3)_2O$

Substance name	Contents	CAS no.	EC No	Registration no.	Classification According to Directive 67/548/EEC	Classification According to Regulation 1272/2008 (CLP)
Dimethyl ether	100%	115-10-6	204-065-8	01-2119472128-37-0000	F+; R12	Flam. Gas; H220 Press. Gas; H280

4. First aid measures

The first aid advice given for skin contact, eye contact and ingestion is applicable following exposures to the liquid or spray. Also see section 11.

Inhalation
Remove patient from exposure, keep warm and at rest. Administer oxygen if necessary. Apply artificial respiration if breathing has ceased or shows signs of failing. In the event of cardiac arrest apply external cardiac massage. Obtain immediate medical attention.

Skin contact
Thaw affected areas with water. Remove contaminated clothing. Caution: clothing may adhere to the skin in the case of freeze burns. After contact with skin, wash immediately with plenty of warm water. If irritation or blistering occur, obtain medical attention.

4. First aid measures continued

Eye contact	Immediately irrigate with eyewash solution or clean water, holding the eyelids apart for at least 15 minutes. Obtain immediate medical attention.
Ingestion	Unlikely route of exposure. Do not induce vomiting. Provided the patient is conscious, wash out mouth with water and give 200-300ml (half a pint) of water to drink. Obtain immediate medical attention.
Most important symptoms and effects both acute and delayed.	Skin contact may produce the following symptoms : Frostbite Inhalation may produce the following symptoms : Shortness of breath, dizziness, weakness, nausea, headache, narcosis, irregular cardiac activity.
Indication of any immediate medical attention and special treatment needed	Do not give adrenaline or similar drugs.

5. Fire-fighting measures

Specific hazards	Exposure to fire may cause containers to rupture/explode.
Hazardous combustion products	Incomplete combustion may form carbon monoxide.
Extinguishing media	
-Suitable extinguishing media	All known extinguishants can be used.
Specific methods	If possible, stop flow of product. Move away from the container and cool with water from a protected position. Do not extinguish a leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire.
Special protective equipment for fire fighters	In confined space use self-contained breathing apparatus.

6. Accidental release measures

Personal precautions	Evacuate personnel to safe areas. Ventilate area.. Refer to protective measures listed in sections 7 and 8.
Environmental precautions	Should not be released into the environment.
Clean up measures	Evaporates.

7. Handling and storage

Precautions for safe handling

Advice for safe handling	**Avoid breathing vapours or mist. Avoid contact with skin, eyes and** clothing. Provide sufficient air exchange and/or exhaust in work rooms. For personal protection see section 8. See Annex – Section 2.2

7. Handling and storage continued

Advice on protection against fire and explosion

Vapours are heavier than air and may spread along floors. Vapours may form explosive mixtures with air. The products should only be used in areas from which all naked lights and other sources of ignition have been excluded. Electrical equipment should be protected to the appropriate standard. No sparking tools should be used. Take measures to prevent the build of electrostatic charge. Keep away from heat and sources of ignition. Keep away from open flames., hot surfaces and sources of ignition. When using do not smoke.
Avoid breathing vapours or mist. Avoid contact with skin, eyes and clothing.

Conditions for safe storage, including any incompatibilities

Requirements for storage areas and Containers

Keep containers tightly closed in a cool, well ventilated place.
Store in original container.

Specific end uses

No data available.

8. Exposure controls / personal protection

Control parameters

Components with workplace control parameters

Components	CAS-No.	Type form of exposure	Control parameters	Update	Basis
Dimethyl ether	115-10-6	TWA	766mg/m^3, 400ppm	2007	EH40 WEL
		STEL	985mg/m^3, 500ppm	2007	
		TWA	1920mg/m^3, 1000ppm	02 2006	

Derived No Effect Level

- Dimethyl ether

Type of Application (Use): Workers exposure routes: Inhalation health effect: Chronic effects, systematic toxicity value: 1894mg/m^3

Type of Application (Use): Consumers exposure routes: Inhalation health effect: Chronic effects, systematic toxicity value: 471mg/m^3

Predicted No Effect Concentration

- Dimethyl ether

Value: 0,155 mg/l
Compartment: Fresh water

Value: 0,016 mg/l
Compartment: Marine water

Value: 1,549 mg/l
Compartment: Water
Remarks: Intermittent use/release

Value: 160 mg/l
Compartment: Water
Remarks: sewage treatment plants

Value: 0,681 mg/l
Compartment: Fresh water sediment

Value: 0,069 mg/l
Compartment: Marine sediment

8. Exposure controls / personal protection continued

Value: 0,045 mg/l
Compartment: Soil

Personal protection

Wear suitable protective clothing, gloves and eye/face protection. Wear thermal insulating gloves when handling liquefied gases. In cases of insufficient ventilation, where exposure to high concentrations of vapour is possible, suitable respiratory protective equipment with positive air supply should be used.
Do not smoke while handling product.

Safety glasses. Additionally wear a face shield where the possibility exists for face contact due to splashing, spraying or airborne contact with this material.

Heat insulating gloves

9. Physical and chemical properties

Form	Liquefied gas
Physical state at 20°C	Gas
Colour	Colourless
Odour	Slight ether-like.
Molecular weight [g/mol]	46.07
Solubility in water [g/l]	45.6 at 25°C at 1013 hPa
Boiling point/boiling range (°C)	-24.8 at 1013 hPa
Melting point/range (°C)	-141.5 at 1013 hPa
Relative density	1.88 at 25°C
Vapour pressure (25°C)	5132,9 hPa
Flammability range [vol% in air]	3.3 to 26.2
Auto ignition temperature [°C]	226 at 1013 hPa
Explosive properties	Not explosive
Partition coefficient: n-octanol/water	POW 0.07 at 25°C
Other data	No data available.

10. Stability and reactivity

Reactivity	Extremely flammable gas.
Chemical Stability	The product is chemically stable
Possibility of hazardous reactions	Vapours may form explosive mixture with air.
Conditions to avoid	Temperatures > 52°C
Incompatible materials	Oxygen, oxidising agents, acid anhydrides, strong acids, Carbon monoxide, acetic anhydride, powdered metals.
Hazardous decomposition products	Hazardous thermal decomposition products may include: Formaldehyde, carbon dioxide, Carbon monoxide, Methanol.

11. Toxicological information

Information on toxicological effects

Acute oral toxicity

• Dimethyl ether	Not applicable

Acute inhalation toxicity

• Dimethyl ether	LC50/rat: 164000 ppm Respiratory effects, anaesthetic effects, central nervous system depression, narcosis, cardiac irregularities, coma. / dog Cardiac sensitization.

Acute dermal toxicity

• Dimethyl ether	Not applicable

Skin irritation

• Dimethyl ether	Not tested on animals. Classification: Not classified as irritant. Result: No skin irritation. Not expected to cause skin irritation based on expert review of the properties of the substance.

Eye irritation

• Dimethyl ether	Not tested on animals. Classification: Not classified as irritant. Result: No eye irritation. Not expected to cause eye irritation based on expert review of the properties of the substance.

Sensitisation

• Dimethyl ether	Not tested on animals. Classification: Not classified as skin sensitizer. Not expected to cause sensitization based on expert review of the properties of the substance.
• Dimethyl ether	There are no reports of human skin sensitization. **There are no reports of human respiratory sensitization.**

Repeated dose toxicity

• Dimethyl ether	Inhalation rat: No toxicologically significant effects were found.

Mutagenicity assessment

• Dimethyl ether	Animal testing did not show mutagenic effects. Tests on bacterial or mammalian cell cultures did not show mutagenic effects.

Carcinogenicity assessment

• Dimethyl ether	Animal testing did not show any carcinogenic effects.

Toxicity to reproduction assessment

• Dimethyl ether	No toxicity to reproduction.

Further information	May cause cardiac arrhythmia. Rapid evaporation of the liquid may cause frostbite.

12. Ecological information

Toxicity

Toxicity to fish

• Dimethyl ether	LC50/96 h/Poecilia reticulate (guppy): >4000 mg/l

Toxicity to aquatic invertebrates

• Dimethyl ether	EC50/48 h/Daphnia: >4000 mg/l LC50/48 h/Daphnia: 755,549 mg/l

Chronic toxicity to fish

• Dimethyl ether	Due to its physical properties, there is no potential for adverse effects.

Persistence and degradability

Biodegradability	Method: Closed bottle test. According to the results of tests of biodegradability this product is not readily biodegradable.
Physio-chemical removability	The product can be degraded by abiotic (e.g. chemical or photolytic) processes.

Bio-accumulative potential

Bio-accumulation	No data available.

Mobility in soil

Mobility in soil	Koc: 7,759

Results of PBT and vPvB assessment

Results of PBT and vPvB Assessment	This substance is not considered to be persistent, bio-accumulating nor toxic (PBT). This substance is not considered to be very persistent nor very bio-accumulating (vPvB).

Other adverse effects

Ozone depletion potential	0
Global warming potential (GWP)	1

13. Disposal information

Waste treatment methods

Product	Can be used after re-conditioning. In accordance with local and national regulations. Must be incinerated in suitable incineration plant holding a permit delivered by the competent authorities. See Annex – Section 2.1
Contaminated packaging	Empty pressure vessels should be returned to the supplier.

14. Transport information

UN No.	1033
Labelling ADR, IMDG, IATA	

2.1 : flammable gas

Land transport

ADR/RID	
H.I.nr	23
UN No.	1033
UN Proper shipping name	Dimethyl ether
Labelling No.	2.1
Transport hazard class(es)	2
DR/RID Classification code	2 F
Tunnel instructions	(B/D)

Sea transport

IMO-IMDG code	
Proper shipping name	Dimethyl ether
Class	2.1
UN No.	1033
Labelling No.	2.1

Air transport

IATA_C	
-Proper shipping name	Dimethyl ether
Class	2.1
UN No.	1033
Labelling No.	2.1
Further information	ICAO/IATA cargo aircraft only.

15. Regulatory information

Safety, health and environmental regulations/legislation specific for the substance or mixture	No data available.
Chemical safety Assessment	A chemical Safety Assessment has been carried out for this substance.

16. Other information

Text of R-phrases mentioned in Section 3	R12 Extremely flammable
Full text of H-Statements referred to Under Section 3	H220 - Extremely flammable gas. H280 - Contains gas under pressure; may explode if heated.

16. Other information continued

Further information

For further information contact Harp International Limited.

This datasheet was prepared in accordance with Regulation (EC) No. 1907/2006.

Information in this publication is believed to be accurate and is given in good faith but it is for the user to satisfy itself of the suitability for its own particular purpose. Accordingly, Harp International Limited gives no warranty as to the fitness of the product for any particular purpose and any implied warranty or condition, statutory or otherwise, is excluded except to the extent that such exclusion is prevented by law. Freedom under Patent, Copyright and Designs cannot be assumed. HARP® is a trademark, the property of Harp International Ltd.

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Annex:

1 Exposure Scenario (2)
Formulation and repacking
SU 3, 10 PC1, 3, 4, 8, 9a, 14, 15, 21, 23, 24, 25, 26, 27, 29, 31, 32, 34, 35, 38, 39 PROC 1, 2, 3, 4, 5, 8b, 9 ERC 2
Formulation/blending in batch processes, transfers and packaging will describe the group of contributing scenarios listed below:

Scenario name	**Process Category (PROC)**	**Type of setting**	**Short name**
Use in closed process	PROC 1	Industrial	CS 1
Use in closed continuous process w/occasional controlled exposure	PROC 2	Industrial	CS 2
Use in closed batch process	PROC 3	Industrial	CS 3
Use in batch and other process where opportunity for exposure	PROC 4	Industrial	CS 4
Mixing and blending	PROC 5	Industrial	CS 5
Transfer to small containers	PROC 9	Industrial	CS 6
Transfer at dedicated facilities	PROC 8b	Industrial	CS 7

2.1 Contributing scenario (1) controlling environmental exposure for formulation/blending in batch processes and packaging
Product characteristics
Physical state: gas/liquefied gas Concentration: max, 100%
Amounts used
Max. 6000 t/year or 20 t/day [largest site tonnage]
Frequency and duration of use
300 days/year
Environment factors not influenced by risk management
Dilution factor river: 10 Dilution factor marine: 100
Other given operational conditions affecting environmental exposure
None
Technical conditions and measures at process level (source) to prevent release
Containment in process
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
None
Organisational measures to prevent/limit release from site
None
Conditions and measures related to municipal sewage treatment
Effluent rate of municipal STP: 2000 m^3/days River flow rate: 18000 m^3/days
Conditions and measures related to external treatment of waste disposal
No waste generated as substance is a gas and will evaporate to air.
Conditions and measures related to external recovery of waste
None.
2.2 Contributing scenario (2) controlling worker exposure for Formulation/blending in batch processes, transfers and packaging
Product characteristic
Physical state: gas/liquefied gas Concentration: max. 100%

Amounts used

Not relevant

Frequency & duration of exposure

Exposure frequency: daily for all PROCs

Scenario name	Duration of activity [hours/day]
CS1	>4 hours
CS2	>4 hours
CS3	>4 hours
CS4	>4 hours
CS5	>4 hours
CS6	>4 hours
CS7	>4 hours

Human factors not influenced by risk management

None

Other given operational conditions affecting workers exposure

Scenario name	Use of ventilation
CS1	Indoors without LEV
CS2	Indoors without LEV
CS3	Indoors without LEV
CS4	Indoors without LEV
CS5	Indoors without LEV
CS6	Indoors without LEV
CS7	Indoors without LEV

Technical conditions and measures at process level (source) to prevent release

Handling in industrial settings.
Containment according to definition of PROCs for liquefied gas.
See SDS section 7.

Technical conditions and measures to control dispersion from source towards the worker

None

Organisational measures to prevent/limit release, dispersion and exposure

See SDS.

Conditions and measures related to personal protection, hygiene and health evaluation

See SDS section 8.

3. Exposure estimation and reference to its source

Scenario name	Inhalative Exposure Estimate (mg/m^3)
CS1	0.0192
CS2	96.0
CS3	192
CS4	192
CS5	480
CS6	384
CS7	288

Comment: Tables below are reporting worst case values for PROC 5 – CS 5:

(Semi) Quantitative risk characterisation for workers

	Leading toxic end point/critical effect	Risk characterisation ratio
Long term- systematic effects - inhalation	Anaesthetic	0.3

(Semi) Quantitative risk characterisation for humans exposed via environment

Route	Leading toxic end point/critical effect	Risk characterisation ratio (RCR)
Long term- systematic effects - inhalation	Anaesthetic	0.00002

Risk characterisation for the aquatic compartment

Compartments	RCR
Freshwater	0.00001
Marine water	0.00006
Sediment	0.00001
Marine sediment	0.00006

Risk characterisation for the terrestrial compartment

Compartments	RCR
Agricultural soil	0.07
Grassland	0.07

Microbiological activity in sewage treatment systems

Compartments	RCR	Discussion
STRP (mg/l)	0.003	No release to STP

Assessment method:
Worker inhalation: ECETOC TRAM worker (May 2010 release)
Man via Environment: ECETOC TRAM Environment (May 2010 release)
Consumer: ECETOC TRAM Consumer (May 2010 release)
Environment: ECETOC TRAM Environment (May 2010 release)

Release factors:
Air: 0.2%, max release rate of 40 kg/day per site
Wastewater: no release to wastewater
Soil: no processes/process steps leading to direct release to soil

4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Worker exposure

Input parameters resulting in highest exposure estimates (worst-case) were used to evaluate worker exposures (see section 3). If the downstream user reduces exposure duration each activity/process to less than 8 hours, it may be necessary to consider summing exposure estimates if the same worker may be engaged in multiple tasks during the day.

For DNELs, see SDS section 8.

Environmental exposure

Downstream users should check whether they are still within the boundaries of the ES if:

- Release factors exceed those listed (see Section 3),
- Number of operating days is less than the frequency and duration of use (see Section 2.1), or
- Actual tonnage (one location) exceeds amount used (see Section 2.1)

ECETOC/TRAM basic input parameters
Molecular weight: 46.07 g/mol
Vapour pressure, water solubility, octanol-water partition coefficient [Kow] (see SDS Section 9), organic-carbon adsorption coefficient [Koc], bio-degradability (see SDS Section 12)

For PNECs, see SDS Section 8.

1 Exposure Scenario (6)

Industrial/professional use of propellants

SU 3, 19, 22
PC1, 3, 4, 8, 9a, 14, 15, 21, 23, 24, 25, 26, 27, 29, 31, 32, 34, 35, 39
PROC 7, 11, 15
PC1, 3, 4, 8, 9a, 14, 15, 21, 23, 24, 25, 26, 27, 29, 31, 32, 34, 35, 39
ERC 8a, 8d

Spraying of propellant and laboratory use as a chemical will describe the group contributing scenarios listed below:

Scenario name	**Process Category (PROC)**	**Type of setting**	**Short name**
Industrial spraying	PROC 7	Industrial	CS 1
Industrial spraying	PROC 7	Industrial	CS 2
Professional spraying	PROC 11	Professional	CS 3
Professional spraying	PROC 11	Professional	CS 4
Use of laboratory in small scale laboratory	PROC 15	Professional	CS 5

2.1 Contributing scenario (1) controlling environmental exposure for spraying of propellant and laboratory use as a chemical

Product characteristics

Physical state: gas/liquefied gas
Concentration: >25% (ECETOC TRAM does not modify exposure estimates for substances in mixtures if >25%)

Amounts used

Max. 15000 t/year
Fraction to region 0.1 (default for wide dispersive use)
Fraction used at main local source: 0.002 (default for wide dispersive use)

Frequency and duration of use

Continuous release, 365 days/year (default for wide dispersive use)

Environment factors not influenced by risk management

Dilution factor river: 10
Dilution factor marine: 100

Other given operational conditions affecting environmental exposure

None

Technical conditions and measures at process level (source) to prevent release

None

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

None

Organisational measures to prevent/limit release from site

None

Conditions and measures related to municipal sewage treatment

Effluent rate of municipal STP: 2000 m^3/days
River flow rate: 18000 m^3/days

Conditions and measures related to external treatment of waste disposal

No waste generated as substance is a gas and will evaporate to air.

Conditions and measures related to external recovery of waste

None.

2.2 Contributing scenario (2) controlling worker exposure for spraying of propellant and laboratory use as a chemical

Product characteristic

Physical state: gas/liquefied gas
Concentration: >25% (ECETOC TRAM does not modify exposure estimates for substances in mixtures if >25%)

Amounts used

Not applicable

Frequency & duration of exposure

Exposure frequency: daily for all PROCs

Scenario name	Duration of activity [hours/day]
CS1	>4 hours
CS2	>4 hours
CS3	>4 hours
CS4	1-4 hours
CS5	>4 hours

Human factors not influenced by risk management

None

Other given operational conditions affecting workers exposure

Scenario name	Use of ventilation
CS1	Outdoors
CS2	Indoors without LEV
CS3	Outdoors
CS4	Indoors without LEV
CS5	Indoors without LEV

Technical conditions and measures at process level (source) to prevent release

Handling in industrial settings.
Containment according to definition of PROCs for liquefied gas.
See SDS section 7.

Technical conditions and measures to control dispersion from source towards the worker

None

Organisational measures to prevent/limit release, dispersion and exposure

See SDS.

Conditions and measures related to personal protection, hygiene and health evaluation

See SDS section 8.

3. Exposure estimation and reference to its source

Scenario name	Inhalative Exposure Estimate (mg/m^3)
CS1	672
CS2	960
CS3	1340
CS4	1150
CS5	96

Comment: Tables below are reporting worst case values for PROC 5 – CS 3:

(Semi) Quantitative risk characterisation for workers

	Leading toxic end point/critical effect	Risk characterisation ratio
Long term- systematic effects - inhalation	Anaesthetic	0.7

(Semi) Quantitative risk characterisation for humans exposed via environment

Route	Leading toxic end point/critical effect	Risk characterisation ratio (RCR)
Long term- systematic effects - inhalation	Anaesthetic	0.0000005

Risk characterisation for the aquatic compartment

Compartments	RCR
Freshwater	0.00001
Marine water	0.00006
Sediment	0.00001
Marine sediment	0.00006

Risk characterisation for the terrestrial compartment

Compartments	RCR
Agricultural soil	0.03
Grassland	0.004

Assessment method:
Worker inhalation: ECETOC TRAM worker (May 2010 release)
Man via Environment: ECETOC TRAM Environment (May 2010 release)
Consumer: ECETOC TRAM Consumer (May 2010 release)
Environment: ECETOC TRAM Environment (May 2010 release)

Release factors:
Air: 100%, max release rate of 4110 kg/day (regional release)
Wastewater: no release to STP
Soil: no direct release to soil

4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Worker exposure

Input parameters resulting in highest exposure estimates (worst-case) were used for all activities/processes except for professional spraying (PROC 11), which is limited to 4 hours or less where the activity occurs indoors without LEV. If operating conditions differ, exposure estimates can be scaled using ECETOC TRAM exposure modifiers as follows:

$$RCR_s = RCR_o \times \sum_{i=1}^{n} CF_s \div CF_o$$

RCR_o = original exposure prediction
RCR_s = scaled exposure prediction
$CF_{s,i}$ = original correction factor
$CF_{o,i}$ = correction factor for the ith determinant scaling

Correction factor for professional spraying (PROC 11) indoors without LEV = 1 (CF_o)
Correction factor for professional spraying indoors with LEV = 0.2 (CF_s)

Other notes
If the downstream user reduces the exposure duration for each activity/process to less than 8 hours, it may be necessary to consider summing exposure estimates if the same worker may be engaged in multiple tasks during the day.

For DNELs, see SDS section 8.

Environmental exposure
If conditions differ significantly from those listed in Section 2.1, downstream user (DU) should check whether they are still within the boundaries of the ES. For wide-dispersive releases, DU should check that the RCR from all wide-dispersive releases are below one. This is shown in column ET of the "datasheets" worksheet in ECETOC TRAM. Basic input parameters required for the environmental assessment using ECETOC TRAM are: ECETOC/TRAM basic input parameters Molecular weight: 46.07 g/mol Vapour pressure, water solubility, octanol-water partition coefficient [Kow] (see SDS Section 9), organic-carbon adsorption coefficient [Koc], bio-degradability (see SDS Section 12) For PNECs, see SDS Section 8.

1 Exposure Scenario (7)			
Consumer use of propellants			
SU 21 PC1, 3, 4, 8, 9a, 24, 39 ERC 8a, 8d (ERC 8a covered by ERC 8d)			
Scenario name	**Product Category (PC)**	**Type of setting**	**Short name**
Spraying of propellants indoors and outdoors	PROC1, 3, 4, 8 9a, 24, 39	Consumer	CS 1
2.1 Contributing scenario (1) controlling environmental exposure for spraying of propellant indoors and outdoors			
Product characteristics			
Concentration: typically <50% substance in preparation Physical state: gas/liquefied gas			
Amounts used			
3000 t/year Fraction to region 0.1 (default for wide dispersive use) Fraction used at main local source: 0.002 (ESVOC spERC 8.23b.v1 [ESVOC 22]))			
Frequency and duration of use			
Continuous release, 365 days/year (default for wide dispersive use)			
Environment factors not influenced by risk management			
Dilution factor river: 10 Dilution factor marine: 100			
Other given operational conditions affecting environmental exposure			
None			
Conditions and measures related to municipal sewage treatment plant			
Effluent rate of municipal STP: 2000m^3/day River flow rate: 18000m^3/day			
Conditions and measures related to external treatment of waste disposal			
None			
Conditions and measures related to external recovery of waste			
None.			
2.2 Contributing scenario (2) controlling worker exposure for spraying of propellants indoors and outdoors			
Product characteristic			
Concentration: typically <50% substance in preparation Physical state: gas/liquefied gas			
Amounts used			
Up to 10g per application			
Frequency & duration of exposure			
Frequency: 4 times/day Duration [for contact]: 15 minutes			
Human factors not influenced by risk management			
None			
Other given operational conditions affecting workers exposure			
This product is used indoors and outdoors. Only indoors is considered since it leads to worst case potential exposure. Indoor air volume: min. >2.5m3, 1.5/hr air exchange rate			
Conditions and measures related to information and behavioural advice to consumers			
Label advices on safe use.			
Conditions and measures related to personal protection and hygiene			
Label advices on safe use.			

3. Exposure estimation and reference to its source

Scenario name	Inhalative Exposure Estimate (mg/m^3)
CS1	57.1

Comment: Tables below are reporting worst case values for PC 9a:

(Semi) Quantitative risk characterisation for workers

	Leading toxic end point/critical effect	Risk characterisation ratio
Long term- systematic effects – inhalation	Anaesthetic	0.4

(Semi) Quantitative risk characterisation for humans exposed via environment

Route	Leading toxic end point/critical effect	Risk characterisation ratio (RCR)
Long term- systematic effects – inhalation	Anaesthetic	0.0000005

Risk characterisation for the aquatic compartment

Compartments	RCR
Freshwater	0.00001
Marine water	0.00006
Sediment	0.00001
Marine sediment	0.00006

Risk characterisation for the terrestrial compartment

Compartments	RCR
Agricultural soil	0.00005
Grassland	0.00005

Assessment method:
Consumer: ECETOC TRAM Consumer (May 2010 release), ConsExpo 4.1, and AISE REACT
Man via Environment: ECETOC TRAM Environment (May 2010 release)
Environment: ECETOC TRAM Environment (May 2010 release)

Release factors:
Air: spERC ESVOC 22 (refinement of ERC 8a): release to air is 100%, max release rate of 8220 kg/day (regional release)
Wastewater: No release to wastewater as 100% goes to air
Soil: no direct release to soil as 100% goes to air

4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

If conditions differ significantly from those listed in Section 2, downstream user (DU) should check whether they are still within the boundaries of the ES. This evaluation may be based on expert judgement or on the risk assessment tools that are recommended by ECHA.

Honeywell HFO-1234ze Blowing Agent

trans – 1,3,3,3-tetrafluoropropene

Honeywell HFO-1234ze blowing agent is the Honeywell trade name for trans – 1,3,3,3-tetrafluoropropene, Honeywell's new low global warming potential (GWP), fourth generation blowing agent and propellant. The low GWP molecule is the first hydrofluoroolefin (HFO) to be commercialised into these industries. This molecule has low environmental impact, as measured by its ultra-low global warming potential and zero ozone depletion potential (ODP). Honeywell HFO-1234ze blowing agent is fully compliant with the EU F-Gas regulation. As a gas material at room temperature, this molecule has diverse applications including as a blowing agent for polyurethanes, polystyrene and other polymers; as well as an aerosol propellant.

Honeywell HFO-1234ze blowing agent has received Notification VIII, Level 1 by the EU Competent Authority for quantities to 1000 tonnes/annum, allowing commercialisation in the EU, as of October 2008.

Honeywell remains committed to developing new innovative low environmental impact technology to meet ever exacting market needs for products that have low GWP and zero ODP properties, plus are safe to use and impart energy saving benefits due to thermal conductivity performance in insulation foams. Honeywell HFO-1234ze blowing agent is non-flammable by ASTM E-681 and EU A11 test methods. However, the material does exhibit flame limits at elevated temperatures.

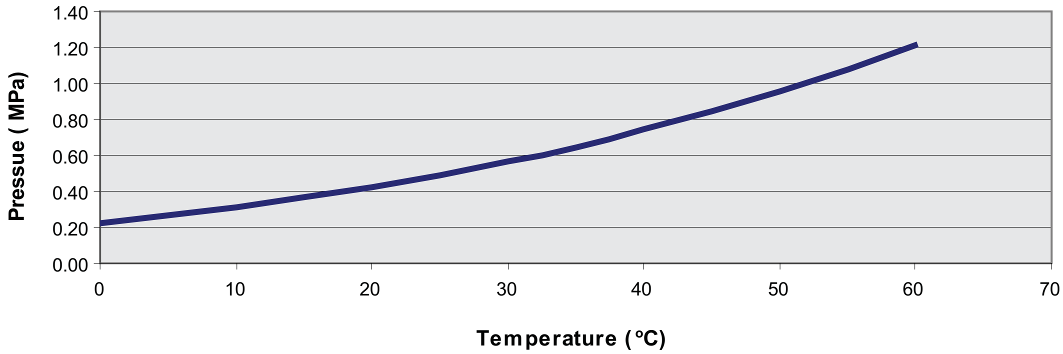
HONEYWELL HFO-1234ZE BLOWING AGENT SALES SPECIFICATION

Parameter	Limit
Assay as trans – 1,3,3,3-tetrafluoropropene	99.5 wt. % min.
Moisture	0.0050 wt.% max.
Acidity	
as HCl	0.0001 wt.% max.
as mg KOH/gm.	0.0015, max.
Non-volatile residue	0.0050 wt.% max

GENERAL PROPERTIES

Molecule	Honeywell HFO-1234ze Blowing Agent trans – 1,3,3,3-tetrafluoropropene
CAS #	1645 – 83 – 6
ELINCS # (EU)	471 – 480 – 0
Formula	trans – $CHF=CHCF_3$
Molecular Weight	114
Boiling Point	- 19° C
Vapor Pressure @ 25° C	490 kPa
Vapor Pressure @ 55° C	1080 kPa
Liquid Density @ 25° C	1.18 gm/cm^3
Vapour Thermal Conductivity	13.0 mW / m• °K (@ 25°C)
Flame Limits	None to 30° C
Ozone Depletion Potential	Zero (non-ODS)
Global Warming Potential	6 (100 yr time horizon)

TRANS-1,3,3,3-TETRAFLUOROPROPENE VAPOUR PRESSURE



MATERIALS COMPATIBILITY WITH HONEYWELL HFO-1234ZE BLOWING AGENT

Substrate	Hardness	Avg Percentage Change Weight	Volume
Plastics			
HDPE		+0.82	-3.74
Polypropylene		+0.83	0.0
PVC – Type 1		+0.01	-0.44
PET		-0.01	0.0
Polyetherimide		-0.04	0.0
Nylon 6,6		-0.26	0.0
PVDF		+0.21	0.0
PTFE		+2.03	-2.43
Elastomers			
Fluoroelastomer	-11.29	+4.43	+5.71
Nitrile Rubber	+8.91	-4.95	-7.18
EPDM	-1.50	-2.00	-2.49
Butyl Rubber	-1.13	+1.27	+0.88
Neoprene	+7.32	-7.70	-11.47

HEALTH, SAFETY AND ENVIRONMENTAL

Honeywell HFO-1234ze blowing agent has progressed through a battery of toxicity testing for human health effects (data for which EU Competent Authority uses for Notification Status). The Honeywell material safety data sheet (MSDS) for HFO-1234ze(E) contains comprehensive and the most current detail for the health, safety and environmental aspects and considerations.

EU ELINCS Number: 471 – 480 – 0

Flammability Characteristics

Honeywell HFO-1234ze blowing agent is a non-flammable gas by test methods ASTM E-681, and by EU Test method A-11. Flammability characterization of Honeywell HFO-1234ze blowing agent was performed by Chilworth Technologies Ltd – UK, with the finding, “It has been concluded beyond reasonable doubt that the material (Honeywell HFO-1234ze blowing agent) will not possess oxidizing or explosive properties.”

It should be noted that flammability characterization and flammability regulations for gaseous materials are evaluated at room temperature ~21°C. Honeywell HFO-1234ze blowing agent exhibits narrow vapour flame limits at elevated temperatures (>28°C). At 30°C, Honeywell HFO-1234ze blowing agent exhibits flame limits LEL/UEL at 7.0/9.5 volume percent in air.

Further investigation into the flammability characterization of Honeywell HFO-1234ze blowing agent has yielded evidence that (at elevated temperatures, 60°C) the minimum ignition energy is significantly high – 61,000 mJ. This is several orders of magnitude higher than other commonly used low GWP blowing agents, such as hydrocarbons, meaning HFO-1234ze is more difficult to ignite.

Safe handling and use in processes utilizing Honeywell HFO-1234ze blowing agent, as well as any other halogenated materials, include avoidance of fire, open flame, smoking, and hot surfaces in the vicinity of these materials.

STORAGE AND HANDLING

Honeywell HFO-1234ze blowing agent should be handled in a manner consistent with materials categorized as 'liquefied gases under pressure.' As illustrated by the vapour pressure data, Honeywell HFO-1234ze blowing agent is a moderate pressure gas, and containers (bulk storage tanks or packages) should be pressure rated to Honeywell HFO-1234ze blowing agent vapour pressure at the ambient temperature, or nominally (minimally) at 1000 kPa (10 Bar).

Honeywell HFO-1234ze blowing agent, in approved packages (containers), should be stored in a cool, well-ventilated area. Honeywell HFO-1234ze blowing agent packages (containers) should neither be punctured or dropped, nor exposed to open flames, excessive heat or direct sunlight. The package (container) valves should be tightly closed after use and when the container is empty.

Based on industry experience, Honeywell HFO-1234ze blowing agent should not be mixed with oxygen or air at elevated pressures. Applications necessitating pressurization – exceeding the vapour pressure of Honeywell HFO-1234ze blowing agent– should use dry nitrogen.

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Honeywell

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Atmospheric Chemistry and Physics Discussions

Atmospheric chemistry of trans-$CF_3CH=CHF$: products and mechanisms of hydroxyl radical and chlorine atom initiated oxidation

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Abstract

Smog chamber/FTIR techniques were used to study the products and mechanisms of OH radical and Cl atom initiated oxidation of trans-$CF_3CH{=}CHF$ in 700 Torr of N_2/O_2 diluent at 295±1 K. Hydroxyl radical initiated oxidation leads to the formation of CF_3CHO and HC(O)F in yields which were indistinguishable from 100% and were not dependent on the O_2 partial pressure. Chlorine atom initiated oxidation gives HC(O)F, CF_3CHO, $CF_3C(O)Cl$, and $CF_3C(O)CHFCl$. The yields of $CF_3C(O)Cl$ and $CF_3C(O)CHFCl$ increased at the expense of HC(O)F and CF_3CHO as the O_2 partial pressure was increased over the range 5–700 Torr. The results are discussed with respect to the atmospheric chemistry and environmental impact of trans-$CF_3CH{=}CHF$.

1 Introduction

Recognition of the adverse environmental impact of chlorofluorocarbon (CFC) release into the atmosphere (Molina et al., 1974; Farman et al., 1985) has led to an international effort to replace these compounds with environmentally acceptable alternatives. Saturated hydrofluorocarbons (HFCs) have become widely used CFC replacements. For example, CF_3CH_2F (HFC-134a) is used as the working fluid in all modern vehicle air conditioning systems. Hydrofluorocarbons do not contain chlorine and hence do not contribute to the well established chlorine based catalytic ozone destruction cycles (Wallington et al., 1994). The atmospheric lifetime of HFCs is determined by their reactivity towards OH radicals. HFC-134a has a direct global warming potential of 1440 over a 100 y time horizon; a factor of 8 lower than the CFC-12 that it replaced (World Meteorological Organization, 2007).

Unsaturated hydrofluorocarbons are a class of compounds, which are potential replacements for CFCs and saturated HFCs in air conditioning units. In general, unsaturated hydrofluorocarbons react more rapidly with OH radicals, have shorter atmospheric lifetimes, and have lower global warming potentials than saturated hy-

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drofluorocarbons. Prior to their large-scale industrial use an assessment of the atmospheric chemistry, and hence environmental impact, of these compounds is needed. The present paper provides information concerning the atmospheric oxidation products of trans-CF_3CH=CHF. Specifically, smog chamber/FTIR techniques were used to determine the products of the OH radical and Cl atom initiated oxidation of trans-CF_3CH=CHF. The present work builds upon a recent kinetic study in which values of k(Cl+trans-CF_3CH=CHF)=(4.64±0.59)×10^{-11} and k(OH+trans-CF_3CH=CHF)=(9.25±1.72)×10^{-13} cm^3 $molecule^{-1}$ s^{-1} in 700 Torr total pressure at 296 K were determined (Søndergaard et al., 2007).

2 Experimental

Experiments were performed in a 140-liter Pyrex reactor interfaced to a Mattson Sirus 100 FTIR spectrometer (Wallington and Japar, 1989). The reactor was surrounded by 22 fluorescent blacklamps (GE F15T8-BL), which were used to photochemically initiate the experiments. The products of the atmospheric oxidation of trans-CF_3CH=CHF were investigated by irradiating trans-CF_3CH=CHF/CH_3ONO/O_2/N_2 and trans-CF_3CH=CHF/Cl_2/O_2/N_2 mixtures. All samples of trans-CF_3CH=CHF used in this work were supplied by Honeywell International Inc. at a purity >99.9% and were used without further purification.

Chlorine atoms were produced by photolysis of molecular chlorine,

$$Cl_2 + h\nu \rightarrow 2Cl \quad (1)$$

OH radicals were produced by photolysis of CH_3ONO in the presence of NO in air,

$$CH_3ONO + h\nu \rightarrow CH_3O + NO \quad (2)$$

$$CH_3O + O_2 \rightarrow HO_2 + HCHO \quad (3)$$

$$HO_2 + NO \rightarrow OH + NO_2 \quad (4)$$

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CH_3ONO was synthesized by the drop wise addition of concentrated sulfuric acid to a saturated solution of $NaNO_2$ in methanol. Other reagents were obtained from commercial sources at purities >99%. Experiments were conducted in 700 Torr total pressure of N_2/O_2, or air diluent at 295±1 K.

Concentrations of reactants and products were monitored by FTIR spectroscopy. IR spectra were derived from 32 coadded interferograms with a spectral resolution of $0.25\ cm^{-1}$ and an analytical path length of 27.1 m. Unless stated otherwise, quoted uncertainties are two standard deviations from least squares regressions.

3 Results

3.1 Products of OH radical initiated oxidation of trans-$CF_3CH=CHF$

To investigate the products and mechanism of the reaction of OH radicals with trans-$CF_3CH=CHF$ reaction mixtures consisting of 8.3–34.9 mTorr trans-$CF_3CH=CHF$, 82.3–117.3 mTorr CH_3ONO, 15.1–19.6 mTorr NO, and 126–700 Torr O_2 in 700 Torr total pressure of N_2 diluent were introduced into the chamber and subjected to UV irradiation. Figure 1 shows IR spectra at 1750–1950 cm^{-1} obtained before (a) and after (b) subjecting a mixture containing 34.9 mTorr trans-$CF_3CH=CHF$, 82.3 mTorr CH_3ONO, 19.6 mTorr NO, and 126 Torr O_2 in 700 Torr of N_2 diluent to 6 min of UV irradiation. The consumption of trans-$CF_3CH=CHF$ was 6%. Subtraction of IR features attributable to $CF_3CH=CHF$, H_2O, NO, and HCHO (product of CH_3ONO photolysis) from panel (b) gives the product spectrum shown in panel (c). Comparison of the IR features in panel (c) with the reference spectra of HC(O)F and CF_3CHO in panels (d) and (e) shows the formation of these products.

HC(O)F and CF_3CHO were the only identified carbon containing products of the OH radical initiated oxidation of trans-$CF_3CH=CHF$. Figure 2 shows a plot of the observed formation of HC(O)F and CF_3CHO versus loss of trans-$CF_3CH=CHF$. The yields of HC(O)F and CF_3CHO were indistinguishable. For low consumptions (<1 mTorr) the

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linear least squares fit to the combined data sets has a slope =0.93±0.08 indistinguishable from 100%. For consumptions of $CF_3CH{=}CHF$ greater than 1 mTorr the observed yields of HC(O)F and CF_3CHO are less than 100% indicating that either the efficiency of conversion of trans-$CF_3CH{=}CHF$ into HC(O)F and CF_3CHO is lower, or there are significant losses of these products at higher trans-$CF_3CH{=}CHF$ conversions, or both. To test for heterogeneous loss of HC(O)F and CF_3CHO, reaction mixtures were allowed to stand in the dark for 15 min; there was no discernable loss (<2%) of either compound. For the 2–14% conversions of trans-$CF_3CH{=}CHF$ in the data shown in Fig. 2, loss of HC(O)F and CF_3CHO via secondary reactions with OH radicals should be of minor importance as their reactivity with OH is less than that of trans-$CF_3CH{=}CHF$; k(OH+trans-$CF_3CH{=}CHF$)=$(9.25\pm1.72)\times10^{-13}$ (Søndergaard et al., 2007), k(OH+HC(O)F)<4×10^{-15} (Wallington et al., 1993), and k(OH+CF_3CHO)=$(6\pm1.2)\times10^{-13}$ cm^3 molecule^{-1} s^{-1} (IUPAC, 2007). It seems likely that the curvature in Fig. 2 reflects a lower yield of both HC(O)F and CF_3CHO with increased consumption of $CF_3CH{=}CHF$. A possible explanation of this effect is the reaction of NO_2 (which increases in concentration with consumption of trans-$CF_3CH{=}CHF$) with the alkoxy radicals formed in the system leading to the formation of small amounts of nitrates. In the atmosphere such reactions will not be of any significance and we did not pursue the origin of the curvature further.

By analogy to the well established oxidation mechanism of propene (IUPAC, 2007), the reaction of OH radicals with trans-$CF_3CH{=}CHF$ is expected to proceed via addition to the >C=C< double bond. The mechanism of the OH radical initiated oxidation of trans-$CF_3CH{=}CHF$ which explains the observed formation of HC(O)F and CF_3CHO as shown in Fig. 3. The results from the present work indicate that irrespective of whether the OH radicals add to the terminal, or central carbon atom, the subsequent reactions lead to the formation of one molecule of both HC(O)F and CF_3CHO.

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3.2 Products of Cl atom initiated oxidation of trans-CF_3CH=CHF

The products of the Cl atom initiated oxidation of trans-CF_3CH=CHF were studied using the UV irradiation of trans-CF_3CH=CHF/Cl_2/O_2/N_2 mixtures. Mixtures consisting of 6.6–8.4 mTorr trans-CF_3CH=CHF, 102.9–134 mTorr Cl_2 and 5–700 Torr of O_2 in 700 Torr total pressure of N_2 diluent were introduced into the reaction chamber and subjected to UV irradiation. Figures 4 and 5 show IR spectra at 675–1000 cm^{-1} and 1650–2000 cm^{-1}, respectively, obtained before (a) and after (b) subjecting a mixture containing 6.6 mTorr trans-CF_3CH=CHF and 109 mTorr Cl_2 in 700 Torr air diluent to 20 s of UV irradiation. Comparison of the IR features formed in low and high [O_2] experiments revealed that four products were formed in the chamber; HC(O)F, CF_3CHO, CF_3C(O)Cl, and a product with a broad absorption feature in the carbonyl stretching region centered at 1801 cm^{-1} which we attribute to the ketone CF_3C(O)CHFCl. We do not have a calibrated reference spectrum for CF_3C(O)CHFCl. The concentration of this compound in the chamber was estimated by assuming that the carbonyl stretching band integrated absorption cross section at 1780–1820 cm^{-1} is the same as that in $CF_3C(O)CH_2Cl$ (1.06×10^{-17} cm $molecule^{-1}$, Nakayama et al., 2007).

Figure 6 shows a plot of the concentrations of HC(O)F, CF_3CHO, CF_3C(O)Cl, and CF_3C(O)CHFCl versus the loss of trans-CF_3CH=CHF observed following the UV irradiation of a mixture of 6.61 mTorr trans-CF_3CH=CHF and 109 mTorr Cl_2 in 700 Torr of air diluent. As seen from Fig. 6 the formation of HC(O)F, CF_3C(O)H, CF_3C(O)Cl and CF_3C(O)CHFCl scaled linearly with the loss of trans-CF_3CH=CHF over the range of trans-CF_3CH=CHF consumption of 10–95%. The linearity of the formation of HC(O)F, CF_3CHO, CF_3C(O)Cl and CF_3C(O)CHFCl suggests that loss of these compounds via secondary reactions is not significant. This observation is consistent with the fact that Cl atoms react much more slowly with these products than with the parent trans-CF_3CH=CHF compound; k(Cl+trans-CF_3CH=CHF)=$(4.64\pm0.59)\times10^{-11}$ (Søndergaard et al., 2007), k(Cl+HC(O)F)=$(1.9\pm0.2)\times10^{-15}$ (Meagher et al., 1997), and k(Cl+CF_3CHO)=$(1.85\pm0.26)\times10^{-12}$ cm^3 $molecule^{-1}$ s^{-1} (Sulbaek Andersen et al.,

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2004). Previous work has shown that $CF_3C(O)Cl$ is not lost by heterogeneous processes, photolysis, or reaction with Cl atoms in the chamber (Møgelberg et al., 1995).

As shown in Fig. 7, the yields of HC(O)F, CF_3CHO, $CF_3C(O)Cl$ and $CF_3C(O)CHFCl$ varied with $[O_2]$. In experiments with high $[O_2]$ the yields of $CF_3C(O)Cl$ and $CF_3C(O)CHFCl$ increased at the expense of HC(O)F and CF_3CHO. As in the case of the OH radical attack, the reaction of Cl atoms with trans-$CF_3CH{=}CHF$ is expected to proceed via electrophilic addition to the terminal and central carbon atoms:

$$CF_3CH{=}CHF + Cl \rightarrow CF_3CH(\bullet)CHFCl \quad (5a)$$

$$\rightarrow CF_3CHClCHF(\bullet) \quad (5b)$$

The radicals produced in Reaction (5) will react with O_2 to give peroxy radicals which will undergo self- and cross-reaction to give the corresponding alkoxy radicals (in the equations below M represents a third body):

$$CF_3CH(\bullet)CHFCl + O_2 + M \rightarrow CF_3CH(OO\bullet)CHFCl + M \quad (6a)$$

$$CF_3CHClCHF(\bullet) + O_2 + M \rightarrow CF_3CHClCHF(OO\bullet) + M \quad (6b)$$

$$CF_3CH(OO\bullet)CHFCl + RO_2 \rightarrow CF_3CH(O\bullet)CHFCl + RO + O_2 \quad (7a)$$

$$CF_3CHClCHF(OO\bullet) + RO_2 \rightarrow CF_3CHClCHF(O\bullet) + RO + O_2 \quad (7b)$$

Decomposition via C-C bond scission or reaction with O_2 are likely fates of the alkoxy radicals. The observed formation of the ketone $CF_3C(O)CHFCl$ in a yield which varies with $[O_2]$ shows that $CF_3C(O\bullet)HCHFCl$ radicals undergo reaction with O_2 and decomposition via C-C bond scission:

$$CF_3C(O\bullet)HCHFCl + O_2 \rightarrow CF_3C(O)CHFCl + HO_2 \quad (8)$$

$$CF_3C(O\bullet)HCHFCl + M \rightarrow CF_3CHO + CHFCl(\bullet) + M \quad (9)$$

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The CHFCl(•) radicals formed in Reaction (9) will add O_2, undergo reaction with other peroxy radicals in the system to give CHFCl(O•) radicals, and decompose via Cl atom elimination to give HC(O)F (Tuazon et al., 1993). The data in Fig. 7 contain information concerning the rate constant ratio k_8/k_9. The yield of $CF_3C(O)CHFCl$, $Y_{CF3C(O)CHFCl}$, can be described by the expression $Y_{CF3C(O)CHFCl}=Y_{CF3CH(O\bullet)CHFCl}(k_8[O_2]/(k_8[O_2]+k_9))+C$, where $Y_{CF3CH(O\bullet)CHFCl}$ is the yield of $CF_3CH(O\bullet)CHFCl$ radicals in the system, k_8 and k_9 are the rate constants for Reactions (8) and (9), and C is the $[O_2]$ independent yield of $CF_3C(O)CHFCl$ (e.g., from self-reaction of $CF_3CH(OO\bullet)CHFCl$ peroxy radicals).

The curve through the $CF_3C(O)CHFCl$ data in Fig. 7 is a fit of the expression above to the data which gives $k_8/k_9=(8.0\pm2.6)\times10^{-19}$ cm^3 $molecule^{-1}$. This value can be compared to the analogous rate constant ratio $k_{O2}/k_{diss}=(3.8\pm1.8)\times10^{-18}$ cm^3 $molecule^{-1}$ measured for $CF_3CH(O\bullet)CH_2Cl$ radicals (Nakayama et al., 2007). The increased importance of decomposition as an atmospheric fate of $CF_3CH(O\bullet)CHFCl$ compared to $CF_3CH(O\bullet)CH_2Cl$ radicals is consistent with theoretical work showing that the barrier to C-C bond scission decreases as the degree of fluorine substitution on the two carbon atoms becomes more even and the bond becomes less polar (Somnitz et al., 2001). The limiting value for the $CF_3C(O)CHFCl$ yield reached at high $[O_2]$ provides a measure of $k_{5a}/(k_{5a}+k_{5b})=47\pm7\%$.

Figure 8 shows the mechanism of Cl atom initiated oxidation of trans-$CF_3CH{=}CHF$ which is consistent with our experimental observations. From $k_8/k_9=(8.0\pm2.6)\times10^{-19}$ cm^3 $molecule^{-1}$ it can be calculated that in 700 Torr of O_2 the reaction with O_2 accounts for 92% of the $CF_3CH(O\bullet)CH_2Cl$ radicals with decomposition accounting for the remaining 8%. Given the estimate of $k_{5a}/(k_{5a}+k_{5b})=47\pm7\%$ we then expect a 4% HC(O)F yield resulting from addition of Cl atoms to the terminal carbon atom (left hand side of Fig. 8). Hence, we can attribute the bulk of the approximately 40% HC(O)F yield in experiments in 700 Torr of O_2 to the decomposition of $CF_3CHClCHF(O\bullet)$ radicals. Decomposition via C-C bond scission is the dominant fate of $CF_3CHClCHFO(\bullet)$ radicals. Finally, the increase in the yield of $CF_3C(O)Cl$

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with $[O_2]$ evident in Fig. 7 is consistent with the expected competition between reaction with O_2 and decomposition for the available $CF_3CHCl(O\bullet)$ radicals. The yield of $CF_3C(O)Cl$, $Y_{CF3C(O)Cl}$, can be described by the expression $Y_{CF3C(O)Cl}=Y_{CF3CHCl(O\bullet)}(k_{10}[O_2]/(k_{10}[O_2]+k_{11}))+C$, where $Y_{CF3CHCl(O\bullet)}$ is the yield of $CF_3CHCl(O\bullet)$ radicals in the system, k_{10} and k_{11} are the rate constants for Reactions (10) and (11), and C is the $[O_2]$ independent yield of $CF_3C(O)Cl$.

$$CF_3CHCl(O\bullet)+O_2 \rightarrow CF_3C(O)Cl+HO_2 \quad (10)$$

$$CF_3CHCl(O\bullet)+M \rightarrow \text{products} \quad (11)$$

The curve through the $CF_3C(O)Cl$ data in Fig. 7 is a fit of the expression above to the data which gives $k_{10}/k_{11}=(4.6\pm1.9)\times10^{-19}\,cm^3\,molecule^{-1}$. This result is larger than the previous more direct determination of $k_{10}/k_{11}=(2.1\pm0.4)\times10^{-19}\,cm^3\,molecule^{-1}$ (Møgelberg et al., 1995). A likely explanation for this discrepancy lies in the indirect and complex route by which $CF_3CHCl(O\bullet)$ radicals are formed in the present system. As indicated in Fig. 8, decomposition and reaction with O_2 are possible competing fates for $CF_3CHClCHF(O\bullet)$ radicals. Increased loss of $CF_3CHClCHF(O\bullet)$ via reaction with O_2 at high $[O_2]$ will lead to a decreased yield of $CF_3CHCl(O\bullet)$ radicals and hence $CF_3C(O)Cl$. The net effect will be to cause the $CF_3C(O)Cl$ yield to plateau at a lower $[O_2]$ which will lead to an overestimation of k_{10}/k_{11}. To investigate this effect further would require the use of $[O_2]$ levels higher than 700 Torr where a decrease in the yield of $CF_3C(O)Cl$ would be expected with increased loss of $CF_3CHClCHF(O\bullet)$ via reaction with O_2. Such experiments are beyond the scope of the present work.

4 Atmospheric chemistry and environmental impact of trans-CF_3CH=CHF

The present work improves our understanding of the atmospheric chemistry of trans-CF_3CH=CHF. The atmospheric lifetime of trans-CF_3CH=CHF is dictated by its reaction with OH radicals (Søndergaard et al., 2007) and has been estimated at approximately 2

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weeks. The OH initiated oxidation of trans-$CF_3CH{=}CHF$ gives CF_3CHO and HC(O)F in yields of approximately 100%. CF_3CHO is removed from the atmosphere via photolysis and, to lesser extents, reaction with OH radicals (Chiappero et al., 2006) and addition of water to give the hydrate (Sulbaek Andersen et al., 2006). Photolysis gives CF_3 and HCO radicals (Chiappero et al., 2006) while reaction with OH gives CF_3CO radicals. CF_3 radicals will add O_2 to give CF_3O_2 radicals which are then converted into COF_2 (Wallington et al., 1994) which hydrolyzes to give CO_2 and HF. CF_3CO radicals will add O_2 to give $CF_3C(O)O_2$ radicals, the majority of which will be converted into COF_2, with a small fraction converted into $CF_3C(O)OH$ (Hurley et al., 2006) via reaction with HO_2 radicals. The hydrate, $CF_3CH(OH)_2$ is lost via reaction with OH radicals to give $CF_3C(O)OH$ (Sulbaek Andersen et al., 2006). The available data suggest that while $CF_3C(O)OH$ is not a natural component of the freshwater environment (Nielsen et al., 2001), it is a natural component of the background oceanic environment (Frank et al., 2002), and any additional burden associated with trans-$CF_3CH{=}CHF$ oxidation will be of negligible environmental significance. We conclude that the products of the atmospheric oxidation of trans-$CF_3CH{=}CHF$ will have negligible environmental impact.

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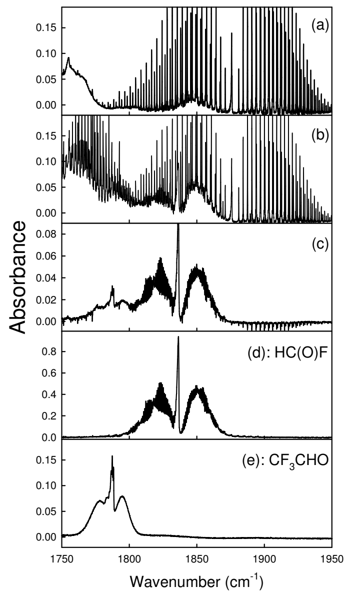

Fig. 1. Infrared spectra acquired before **(a)** and after **(b)** UV irradiation of mixtures 34.9 mTorr trans-$CF_3CH{=}CHF$, 82.3 mTorr CH_3 ONO, 19.6 mTorr NO and 126 Torr O_2 in 700 Torr total pressure of N_2 diluent. Panel **(c)** show the residual IR features after subtraction of features attributable to trans-$CF_3CH{=}CHF$, H_2O, NO, and HCHO from panel (b). Panels **(d)** and **(e)** show reference spectra of HC(O)F and CF_3CHO, respectively.

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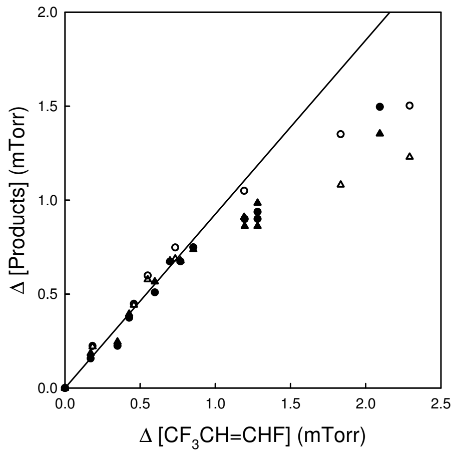

Fig. 2. Formation of HC(O)F (triangles) and CF_3CHO (circles) versus loss of trans-$CF_3CH=CHF$ observed following the UV irradiation of mixtures of 8.32–9.18 mTorr trans-$CF_3CH=CHF$ and 109.1–113.8 mTorr CH_3ONO in 700 Torr total pressure of air diluent at 296±1 K. The open symbols are results obtained in the absence of NO.

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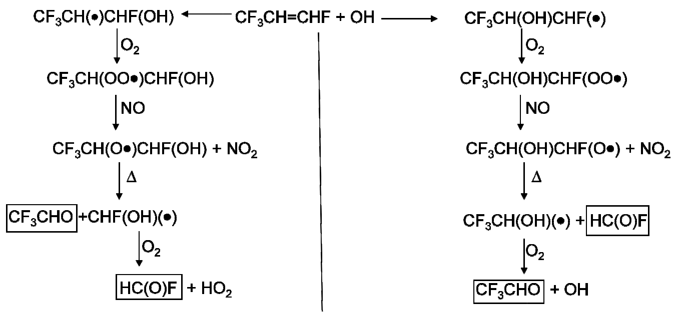

Fig. 3. Mechanism of OH radical initiated oxidation of trans-$CF_3CH=CHF$, boxes indicate observed products.

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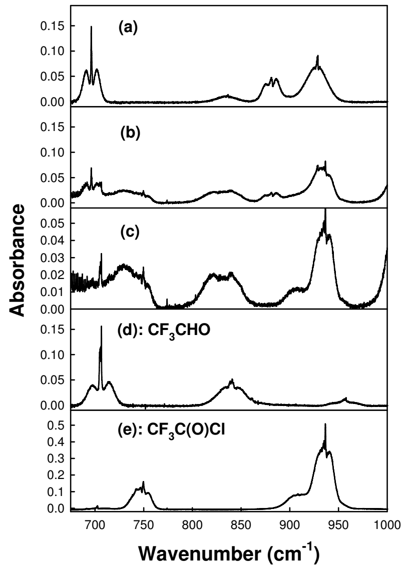

Fig. 4. Infrared spectra acquired before **(a)** and after **(b)** UV irradiation of 6.6 mTorr trans-$CF_3CH=CHF$ and 109 mTorr Cl_2 in 700 Torr of air diluent. Panel **(c)** show the residual IR features after subtraction of trans-$CF_3CH=CHF$ from panel (b). Panels **(d)** and **(e)** show reference spectra of CF_3CHO and $CF_3C(O)Cl$, respectively.

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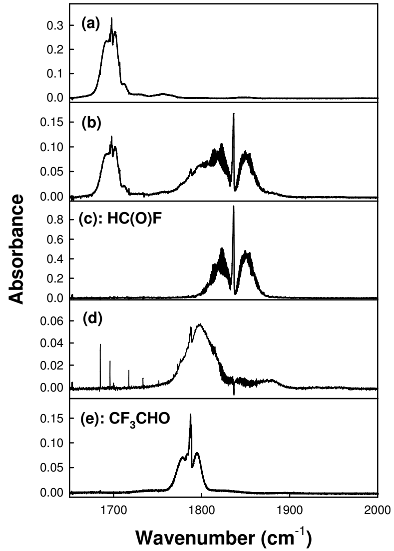

Fig. 5. Infrared spectra acquired before **(a)** and after **(b)** UV irradiation of 6.6 mTorr trans-$CF_3CH=CHF$ and 109 mTorr Cl_2 in 700 Torr of air diluent. Panel **(c)** show a reference spectrum of HC(O)F. Panel **(d)** show the residual IR features after subtraction of trans-$CF_3CH=CHF$ and HC(O)F from panel (b). Panel **(e)** shows a reference spectrum of CF_3CHO.

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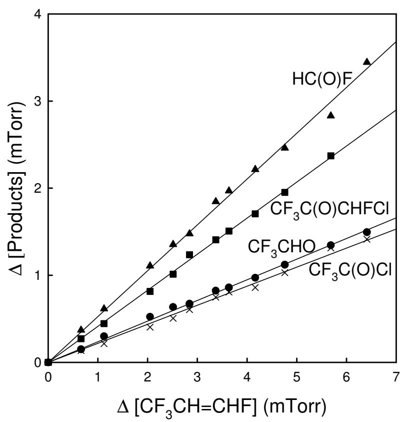

Fig. 6. Formation of HC(O)F (triangles), $CF_3C(O)CHFCl$ (squares), CF_3CHO (circles) and, $CF_3C(O)Cl$ (crosses) versus loss of trans-$CF_3CH{=}CHF$ observed following the UV irradiation of a mixture of 6.6 mTorr trans-$CF_3CH{=}CHF$ and 109 mTorr Cl_2 in 700 Torr of air diluent.

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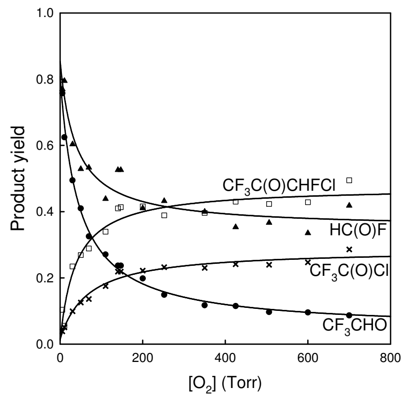

Fig. 7. Observed molar yields of HC(O)F (triangles), CF_3CHO (circles), $CF_3C(O)Cl$ (crosses) and $CF_3C(O)CHFCl$ (squares) versus the O_2 partial pressure following the UV irradiation of trans-$CF_3CH{=}CHF/Cl_2/N_2/O_2$ mixtures at 700 Torr total pressure. Curves through the $CF_3C(O)CHFCl$ and $CF_3C(O)Cl$ are fits to the data using the expressions described in the text. The curves through the HC(O)F and CF_3CHO data are polynominal fits to aid visual inspection of data trends.

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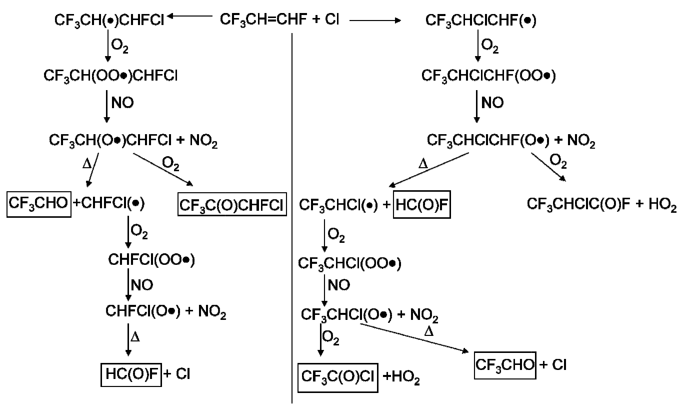

Fig. 8. Mechanism of Cl atom initiated oxidation of trans-$CF_3CH{=}CHF$, boxes indicate observed products.

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Atmospheric Chemistry and Physics Discussions

Atmospheric chemistry of trans-$CF_3CH{=}CHF$: products and mechanisms of hydroxyl radical and chlorine atom initiated oxidation

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Abstract

Smog chamber/FTIR techniques were used to study the products and mechanisms of OH radical and Cl atom initiated oxidation of trans-$CF_3CH{=}CHF$ in 700 Torr of N_2/O_2 diluent at 295±1 K. Hydroxyl radical initiated oxidation leads to the formation of CF_3CHO and HC(O)F in yields which were indistinguishable from 100% and were not dependent on the O_2 partial pressure. Chlorine atom initiated oxidation gives HC(O)F, CF_3CHO, $CF_3C(O)Cl$, and $CF_3C(O)CHFCl$. The yields of $CF_3C(O)Cl$ and $CF_3C(O)CHFCl$ increased at the expense of HC(O)F and CF_3CHO as the O_2 partial pressure was increased over the range 5–700 Torr. The results are discussed with respect to the atmospheric chemistry and environmental impact of trans-$CF_3CH{=}CHF$.

1 Introduction

Recognition of the adverse environmental impact of chlorofluorocarbon (CFC) release into the atmosphere (Molina et al., 1974; Farman et al., 1985) has led to an international effort to replace these compounds with environmentally acceptable alternatives. Saturated hydrofluorocarbons (HFCs) have become widely used CFC replacements. For example, CF_3CH_2F (HFC-134a) is used as the working fluid in all modern vehicle air conditioning systems. Hydrofluorocarbons do not contain chlorine and hence do not contribute to the well established chlorine based catalytic ozone destruction cycles (Wallington et al., 1994). The atmospheric lifetime of HFCs is determined by their reactivity towards OH radicals. HFC-134a has a direct global warming potential of 1440 over a 100 y time horizon; a factor of 8 lower than the CFC-12 that it replaced (World Meteorological Organization, 2007).

Unsaturated hydrofluorocarbons are a class of compounds, which are potential replacements for CFCs and saturated HFCs in air conditioning units. In general, unsaturated hydrofluorocarbons react more rapidly with OH radicals, have shorter atmospheric lifetimes, and have lower global warming potentials than saturated hydrofluorocarbons. Prior to their large-scale industrial use an assessment of the atmospheric chemistry, and hence environmental impact, of these compounds is needed. The present paper provides information concerning the atmospheric oxidation products of trans-$CF_3CH=CHF$. Specifically, smog chamber/FTIR techniques were used to determine the products of the OH radical and Cl atom initiated oxidation of trans-$CF_3CH=CHF$. The present work builds upon a recent kinetic study in which values of k(Cl+trans-$CF_3CH=CHF$)=(4.64±0.59)×10^{-11} and k(OH+trans-$CF_3CH=CHF$)=(9.25±1.72)×10^{-13} cm^3 $molecule^{-1}$ s^{-1} in 700 Torr total pressure at 296 K were determined (Søndergaard et al., 2007).

2 Experimental

Experiments were performed in a 140-liter Pyrex reactor interfaced to a Mattson Sirus 100 FTIR spectrometer (Wallington and Japar, 1989). The reactor was surrounded by 22 fluorescent blacklamps (GE F15T8-BL), which were used to photochemically initiate the experiments. The products of the atmospheric oxidation of trans-$CF_3CH=CHF$ were investigated by irradiating trans-$CF_3CH=CHF/CH_3ONO/O_2/N_2$ and trans-$CF_3CH=CHF/Cl_2/O_2/N_2$ mixtures. All samples of trans-$CF_3CH=CHF$ used in this work were supplied by Honeywell International Inc. at a purity >99.9% and were used without further purification.

Chlorine atoms were produced by photolysis of molecular chlorine,

$$Cl_2 + h\nu \rightarrow 2Cl \quad (1)$$

OH radicals were produced by photolysis of CH_3ONO in the presence of NO in air,

$$CH_3ONO + h\nu \rightarrow CH_3O + NO \quad (2)$$

$$CH_3O + O_2 \rightarrow HO_2 + HCHO \quad (3)$$

$$HO_2 + NO \rightarrow OH + NO_2 \quad (4)$$

CH_3ONO was synthesized by the drop wise addition of concentrated sulfuric acid to a saturated solution of $NaNO_2$ in methanol. Other reagents were obtained from commercial sources at purities >99%. Experiments were conducted in 700 Torr total pressure of N_2/O_2, or air diluent at 295±1 K.

Concentrations of reactants and products were monitored by FTIR spectroscopy. IR spectra were derived from 32 coadded interferograms with a spectral resolution of 0.25 cm^{-1} and an analytical path length of 27.1 m. Unless stated otherwise, quoted uncertainties are two standard deviations from least squares regressions.

3 Results

3.1 Products of OH radical initiated oxidation of trans-$CF_3CH=CHF$

To investigate the products and mechanism of the reaction of OH radicals with trans-$CF_3CH=CHF$ reaction mixtures consisting of 8.3–34.9 mTorr trans-$CF_3CH=CHF$, 82.3–117.3 mTorr CH_3ONO, 15.1–19.6 mTorr NO, and 126–700 Torr O_2 in 700 Torr total pressure of N_2 diluent were introduced into the chamber and subjected to UV irradiation. Figure 1 shows IR spectra at 1750–1950 cm^{-1} obtained before (a) and after (b) subjecting a mixture containing 34.9 mTorr trans-$CF_3CH=CHF$, 82.3 mTorr CH_3ONO, 19.6 mTorr NO, and 126 Torr O_2 in 700 Torr of N_2 diluent to 6 min of UV irradiation. The consumption of trans-$CF_3CH=CHF$ was 6%. Subtraction of IR features attributable to $CF_3CH=CHF$, H_2O, NO, and HCHO (product of CH_3ONO photolysis) from panel (b) gives the product spectrum shown in panel (c). Comparison of the IR features in panel (c) with the reference spectra of HC(O)F and CF_3CHO in panels (d) and (e) shows the formation of these products.

HC(O)F and CF_3CHO were the only identified carbon containing products of the OH radical initiated oxidation of trans-$CF_3CH=CHF$. Figure 2 shows a plot of the observed formation of HC(O)F and CF_3CHO versus loss of trans-$CF_3CH=CHF$. The yields of HC(O)F and CF_3CHO were indistinguishable. For low consumptions (<1 mTorr) the linear least squares fit to the combined data sets has a slope =0.93±0.08 indistinguishable from 100%. For consumptions of $CF_3CH=CHF$ greater than 1 mTorr the observed yields of HC(O)F and CF_3CHO are less than 100% indicating that either the efficiency of conversion of trans-$CF_3CH=CHF$ into HC(O)F and CF_3CHO is lower, or there are significant losses of these products at higher trans-$CF_3CH=CHF$ conversions, or both. To test for heterogeneous loss of HC(O)F and CF_3CHO, reaction mixtures were allowed to stand in the dark for 15 min; there was no discernable loss (<2%) of either compound. For the 2–14% conversions of trans-$CF_3CH=CHF$ in the data shown in Fig. 2, loss of HC(O)F and CF_3CHO via secondary reactions with OH radicals should be of minor importance as their reactivity with OH is less than that of trans-$CF_3CH=CHF$; k(OH+trans-$CF_3CH=CHF$)=$(9.25\pm1.72)\times10^{-13}$ (Søndergaard et al., 2007), k(OH+HC(O)F)<4×10^{-15} (Wallington et al., 1993), and $k(OH+CF_3CHO)=(6\pm1.2)\times10^{-13}$ cm^3 $molecule^{-1}$ s^{-1} (IUPAC, 2007). It seems likely that the curvature in Fig. 2 reflects a lower yield of both HC(O)F and CF_3CHO with increased consumption of $CF_3CH=CHF$. A possible explanation of this effect is the reaction of NO_2 (which increases in concentration with consumption of trans-$CF_3CH=CHF$) with the alkoxy radicals formed in the system leading to the formation of small amounts of nitrates. In the atmosphere such reactions will not be of any significance and we did not pursue the origin of the curvature further.

By analogy to the well established oxidation mechanism of propene (IUPAC, 2007), the reaction of OH radicals with trans-$CF_3CH=CHF$ is expected to proceed via addition to the >C=C< double bond. The mechanism of the OH radical initiated oxidation of trans-$CF_3CH=CHF$ which explains the observed formation of HC(O)F and CF_3CHO as shown in Fig. 3. The results from the present work indicate that irrespective of whether the OH radicals add to the terminal, or central carbon atom, the subsequent reactions lead to the formation of one molecule of both HC(O)F and CF_3CHO.

3.2 Products of Cl atom initiated oxidation of trans-$CF_3CH=CHF$

The products of the Cl atom initiated oxidation of trans-$CF_3CH=CHF$ were studied using the UV irradiation of trans-$CF_3CH=CHF/Cl_2/O_2/N_2$ mixtures. Mixtures consisting of 6.6–8.4 mTorr trans-$CF_3CH=CHF$, 102.9–134 mTorr Cl_2 and 5–700 Torr of O_2 in 700 Torr total pressure of N_2 diluent were introduced into the reaction chamber and subjected to UV irradiation. Figures 4 and 5 show IR spectra at 675–1000 cm^{-1} and 1650–2000 cm^{-1}, respectively, obtained before (a) and after (b) subjecting a mixture containing 6.6 mTorr trans-$CF_3CH=CHF$ and 109 mTorr Cl_2 in 700 Torr air diluent to 20 s of UV irradiation. Comparison of the IR features formed in low and high $[O_2]$ experiments revealed that four products were formed in the chamber; HC(O)F, CF_3CHO, $CF_3C(O)Cl$, and a product with a broad absorption feature in the carbonyl stretching region centered at 1801 cm^{-1} which we attribute to the ketone $CF_3C(O)CHFCl$. We do not have a calibrated reference spectrum for $CF_3C(O)CHFCl$. The concentration of this compound in the chamber was estimated by assuming that the carbonyl stretching band integrated absorption cross section at 1780–1820 cm^{-1} is the same as that in $CF_3C(O)CH_2Cl$ (1.06×10^{-17} cm $molecule^{-1}$, Nakayama et al., 2007).

Figure 6 shows a plot of the concentrations of HC(O)F, CF_3CHO, $CF_3C(O)Cl$, and $CF_3C(O)CHFCl$ versus the loss of trans-$CF_3CH=CHF$ observed following the UV irradiation of a mixture of 6.61 mTorr trans-$CF_3CH=CHF$ and 109 mTorr Cl_2 in 700 Torr of air diluent. As seen from Fig. 6 the formation of HC(O)F, $CF_3C(O)H$, $CF_3C(O)Cl$ and $CF_3C(O)CHFCl$ scaled linearly with the loss of trans-$CF_3CH=CHF$ over the range of trans-$CF_3CH=CHF$ consumption of 10–95%. The linearity of the formation of HC(O)F, CF_3CHO, $CF_3C(O)Cl$ and $CF_3C(O)CHFCl$ suggests that loss of these compounds via secondary reactions is not significant. This observation is consistent with the fact that Cl atoms react much more slowly with these products than with the parent trans-$CF_3CH=CHF$ compound; k(Cl+trans-$CF_3CH=CHF$)=$(4.64\pm0.59)\times10^{-11}$ (Søndergaard et al., 2007), $k(Cl+HC(O)F)=(1.9\pm0.2)\times10^{-15}$ (Meagher et al., 1997), and $k(Cl+CF_3CHO)=(1.85\pm0.26)\times10^{-12}$ cm^3 $molecule^{-1}$ s^{-1} (Sulbaek Andersen et al., 2004). Previous work has shown that $CF_3C(O)Cl$ is not lost by heterogeneous processes, photolysis, or reaction with Cl atoms in the chamber (Møgelberg et al., 1995).

As shown in Fig. 7, the yields of HC(O)F, CF_3CHO, $CF_3C(O)Cl$ and $CF_3C(O)CHFCl$ varied with $[O_2]$. In experiments with high $[O_2]$ the yields of $CF_3C(O)Cl$ and $CF_3C(O)CHFCl$ increased at the expense of HC(O)F and CF_3CHO. As in the case of the OH radical attack, the reaction of Cl atoms with trans-$CF_3CH{=}CHF$ is expected to proceed via electrophilic addition to the terminal and central carbon atoms:

$$CF_3CH{=}CHF+Cl \rightarrow CF_3CH(\bullet)CHFCl \quad (5a)$$

$$\rightarrow CF_3CHClCHF(\bullet) \quad (5b)$$

The radicals produced in Reaction (5) will react with O_2 to give peroxy radicals which will undergo self- and cross-reaction to give the corresponding alkoxy radicals (in the equations below M represents a third body):

$$CF_3CH(\bullet)CHFCl+O_2+M \rightarrow CF_3CH(OO\bullet)CHFCl+M \quad (6a)$$

$$CF_3CHClCHF(\bullet)+O_2+M \rightarrow CF_3CHClCHF(OO\bullet)+M \quad (6b)$$

$$CF_3CH(OO\bullet)CHFCl+RO_2 \rightarrow CF_3CH(O\bullet)CHFCl+RO+O_2 \quad (7a)$$

$$CF_3CHClCHF(OO\bullet)+RO_2 \rightarrow CF_3CHClCHF(O\bullet)+RO+O_2 \quad (7b)$$

Decomposition via C-C bond scission or reaction with O_2 are likely fates of the alkoxy radicals. The observed formation of the ketone $CF_3C(O)CHFCl$ in a yield which varies with $[O_2]$ shows that $CF_3C(O\bullet)HCHFCl$ radicals undergo reaction with O_2 and decomposition via C-C bond scission:

$$CF_3C(O\bullet)HCHFCl+O_2 \rightarrow CF_3C(O)CHFCl+HO_2 \quad (8)$$

$$CF_3C(O\bullet)HCHFCl+M \rightarrow CF_3CHO+CHFCl(\bullet)+M \quad (9)$$

The $CHFCl(\bullet)$ radicals formed in Reaction (9) will add O_2, undergo reaction with other peroxy radicals in the system to give $CHFCl(O\bullet)$ radicals, and decompose via Cl atom elimination to give HC(O)F (Tuazon et al., 1993). The data in Fig. 7 contain information concerning the rate constant ratio k_8/k_9. The yield of $CF_3C(O)CHFCl$, $Y_{CF3C(O)CHFCl}$, can be described by the expression $Y_{CF3C(O)CHFCl}=Y_{CF3CH(O\bullet)CHFCl}$ $(k_8[O_2]/(k_8[O_2]+k_9))+C$, where $Y_{CF3CH(O\bullet)CHFCl}$ is the yield of $CF_3CH(O\bullet)CHFCl$ radicals in the system, k_8 and k_9 are the rate constants for Reactions (8) and (9), and C is the $[O_2]$ independent yield of $CF_3C(O)CHFCl$ (e.g., from self-reaction of $CF_3CH(OO\bullet)CHFCl$ peroxy radicals).

The curve through the $CF_3C(O)CHFCl$ data in Fig. 7 is a fit of the expression above to the data which gives $k_8/k_9=(8.0\pm2.6)\times10^{-19}$ cm^3 molecule^{-1}. This value can be compared to the analogous rate constant ratio $k_{O2}/k_{diss}=(3.8\pm1.8)\times10^{-18}$ cm^3 molecule^{-1} measured for $CF_3CH(O\bullet)CH_2Cl$ radicals (Nakayama et al., 2007). The increased importance of decomposition as an atmospheric fate of $CF_3CH(O\bullet)CHFCl$ compared to $CF_3CH(O\bullet)CH_2Cl$ radicals is consistent with theoretical work showing that the barrier to C-C bond scission decreases as the degree of fluorine substitution on the two carbon atoms becomes more even and the bond becomes less polar (Somnitz et al., 2001). The limiting value for the $CF_3C(O)CHFCl$ yield reached at high $[O_2]$ provides a measure of $k_{5a}/(k_{5a}+k_{5b})=47\pm7\%$.

Figure 8 shows the mechanism of Cl atom initiated oxidation of trans-$CF_3CH{=}CHF$ which is consistent with our experimental observations. From $k_8/k_9=(8.0\pm2.6)\times10^{-19}$ cm^3 molecule^{-1} it can be calculated that in 700 Torr of O_2 the reaction with O_2 accounts for 92% of the $CF_3CH(O\bullet)CH_2Cl$ radicals with decomposition accounting for the remaining 8%. Given the estimate of $k_{5a}/(k_{5a}+k_{5b})=47\pm7\%$ we then expect a 4% HC(O)F yield resulting from addition of Cl atoms to the terminal carbon atom (left hand side of Fig. 8). Hence, we can attribute the bulk of the approximately 40% HC(O)F yield in experiments in 700 Torr of O_2 to the decomposition of $CF_3CHClCHF(O\bullet)$ radicals. Decomposition via C-C bond scission is the dominant fate of $CF_3CHClCHFO(\bullet)$ radicals. Finally, the increase in the yield of $CF_3C(O)Cl$

with $[O_2]$ evident in Fig. 7 is consistent with the expected competition between reaction with O_2 and decomposition for the available $CF_3CHCl(O\bullet)$ radicals. The yield of $CF_3C(O)Cl$, $Y_{CF3C(O)Cl}$, can be described by the expression $Y_{CF3C(O)Cl}=Y_{CF3CHCl(O\bullet)}$ $(k_{10}[O_2]/(k_{10}[O_2]+k_{11}))+C$, where $Y_{CF3CHCl(O\bullet)}$ is the yield of $CF_3CHCl(O\bullet)$ radicals in the system, k_{10} and k_{11} are the rate constants for Reactions (10) and (11), and C is the $[O_2]$ independent yield of $CF_3C(O)Cl$.

$$CF_3CHCl(O\bullet)+O_2 \rightarrow CF_3C(O)Cl+HO_2 \quad (10)$$

$$CF_3CHCl(O\bullet)+M \rightarrow \text{products} \quad (11)$$

The curve through the $CF_3C(O)Cl$ data in Fig. 7 is a fit of the expression above to the data which gives $k_{10}/k_{11}=(4.6\pm1.9)\times10^{-19}\,cm^3\,molecule^{-1}$. This result is larger than the previous more direct determination of $k_{10}/k_{11}=(2.1\pm0.4)\times10^{-19}\,cm^3\,molecule^{-1}$ (Møgelberg et al., 1995). A likely explanation for this discrepancy lies in the indirect and complex route by which $CF_3CHCl(O\bullet)$ radicals are formed in the present system. As indicated in Fig. 8, decomposition and reaction with O_2 are possible competing fates for $CF_3CHClCHF(O\bullet)$ radicals. Increased loss of $CF_3CHClCHF(O\bullet)$ via reaction with O_2 at high $[O_2]$ will lead to a decreased yield of $CF_3CHCl(O\bullet)$ radicals and hence $CF_3C(O)Cl$. The net effect will be to cause the $CF_3C(O)Cl$ yield to plateau at a lower $[O_2]$ which will lead to an overestimation of k_{10}/k_{11}. To investigate this effect further would require the use of $[O_2]$ levels higher than 700 Torr where a decrease in the yield of $CF_3C(O)Cl$ would be expected with increased loss of $CF_3CHClCHF(O\bullet)$ via reaction with O_2. Such experiments are beyond the scope of the present work.

4 Atmospheric chemistry and environmental impact of trans-CF_3CH=CHF

The present work improves our understanding of the atmospheric chemistry of trans-CF_3CH=CHF. The atmospheric lifetime of trans-CF_3CH=CHF is dictated by its reaction with OH radicals (Søndergaard et al., 2007) and has been estimated at approximately 2

weeks. The OH initiated oxidation of trans-CF_3CH=CHF gives CF_3CHO and HC(O)F in yields of approximately 100%. CF_3CHO is removed from the atmosphere via photolysis and, to lesser extents, reaction with OH radicals (Chiappero et al., 2006) and addition of water to give the hydrate (Sulbaek Andersen et al., 2006). Photolysis gives CF_3 and HCO radicals (Chiappero et al., 2006) while reaction with OH gives CF_3CO radicals. CF_3 radicals will add O_2 to give CF_3O_2 radicals which are then converted into COF_2 (Wallington et al., 1994) which hydrolyzes to give CO_2 and HF. CF_3CO radicals will add O_2 to give $CF_3C(O)O_2$ radicals, the majority of which will be converted into COF_2, with a small fraction converted into $CF_3C(O)OH$ (Hurley et al., 2006) via reaction with HO_2 radicals. The hydrate, $CF_3CH(OH)_2$ is lost via reaction with OH radicals to give $CF_3C(O)OH$ (Sulbaek Andersen et al., 2006). The available data suggest that while $CF_3C(O)OH$ is not a natural component of the freshwater environment (Nielsen et al., 2001), it is a natural component of the background oceanic environment (Frank et al., 2002), and any additional burden associated with trans-CF_3CH=CHF oxidation will be of negligible environmental significance. We conclude that the products of the atmospheric oxidation of trans-CF_3CH=CHF will have negligible environmental impact.

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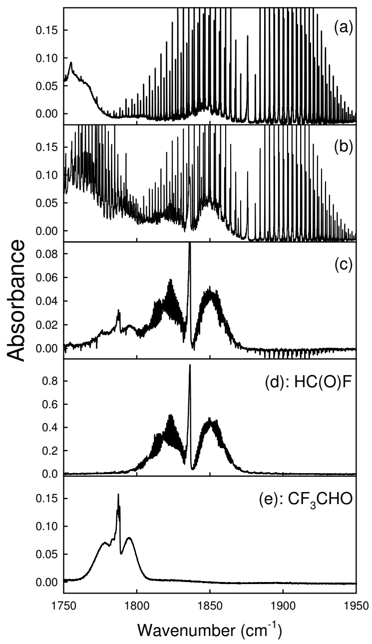

Fig. 1. Infrared spectra acquired before **(a)** and after **(b)** UV irradiation of mixtures 34.9 mTorr trans-$CF_3CH{=}CHF$, 82.3 mTorr CH_3 ONO, 19.6 mTorr NO and 126 Torr O_2 in 700 Torr total pressure of N_2 diluent. Panel **(c)** show the residual IR features after subtraction of features attributable to trans-$CF_3CH{=}CHF$, H_2O, NO, and HCHO from panel (b). Panels **(d)** and **(e)** show reference spectra of HC(O)F and CF_3CHO, respectively.

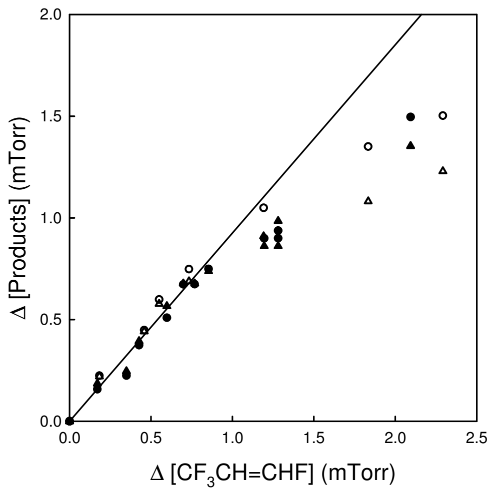

Fig. 2. Formation of HC(O)F (triangles) and CF_3CHO (circles) versus loss of trans-$CF_3CH{=}CHF$ observed following the UV irradiation of mixtures of 8.32–9.18 mTorr trans-$CF_3CH{=}CHF$ and 109.1–113.8 mTorr CH_3ONO in 700 Torr total pressure of air diluent at 296±1 K. The open symbols are results obtained in the absence of NO.

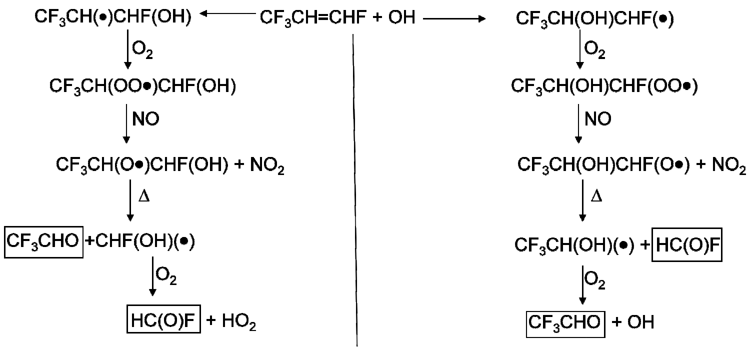

Fig. 3. Mechanism of OH radical initiated oxidation of trans-$CF_3CH{=}CHF$, boxes indicate observed products.

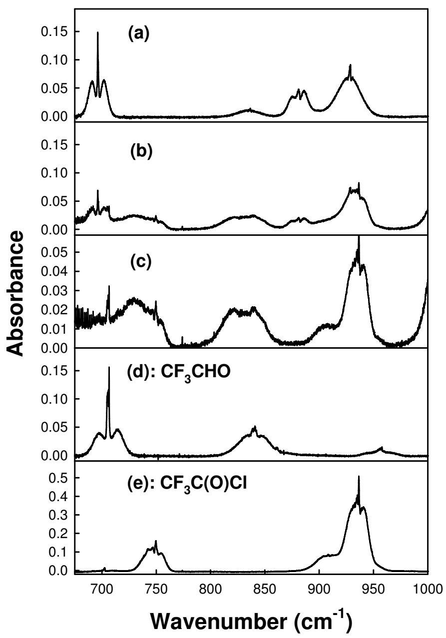

Fig. 4. Infrared spectra acquired before **(a)** and after **(b)** UV irradiation of 6.6 mTorr trans-$CF_3CH{=}CHF$ and 109 mTorr Cl_2 in 700 Torr of air diluent. Panel **(c)** show the residual IR features after subtraction of trans-$CF_3CH{=}CHF$ from panel (b). Panels **(d)** and **(e)** show reference spectra of CF_3CHO and $CF_3C(O)Cl$, respectively.

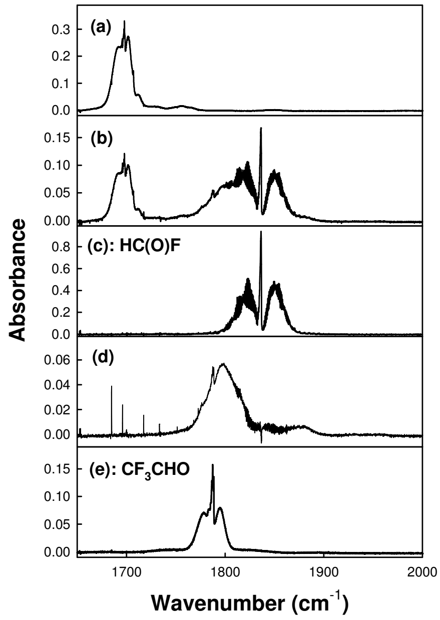

Fig. 5. Infrared spectra acquired before **(a)** and after **(b)** UV irradiation of 6.6 mTorr trans-$CF_3CH=CHF$ and 109 mTorr Cl_2 in 700 Torr of air diluent. Panel **(c)** show a reference spectrum of HC(O)F. Panel **(d)** show the residual IR features after subtraction of trans-$CF_3CH=CHF$ and HC(O)F from panel (b). Panel **(e)** shows a reference spectrum of CF_3CHO.

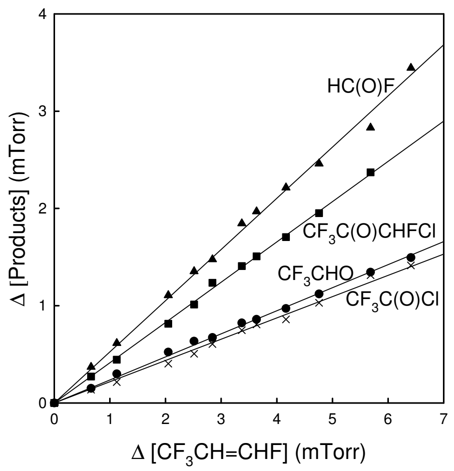

Fig. 6. Formation of HC(O)F (triangles), $CF_3C(O)CHFCl$ (squares), CF_3CHO (circles) and, $CF_3C(O)Cl$ (crosses) versus loss of trans-$CF_3CH=CHF$ observed following the UV irradiation of a mixture of 6.6 mTorr trans-$CF_3CH=CHF$ and 109 mTorr Cl_2 in 700 Torr of air diluent.

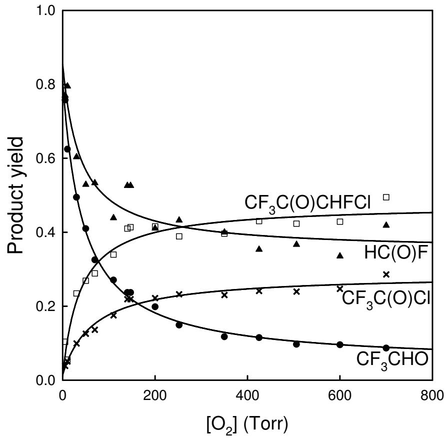

Fig. 7. Observed molar yields of HC(O)F (triangles), CF_3CHO (circles), $CF_3C(O)Cl$ (crosses) and $CF_3C(O)CHFCl$ (squares) versus the O_2 partial pressure following the UV irradiation of trans-$CF_3CH{=}CHF/Cl_2/N_2/O_2$ mixtures at 700 Torr total pressure. Curves through the $CF_3C(O)CHFCl$ and $CF_3C(O)Cl$ are fits to the data using the expressions described in the text. The curves through the HC(O)F and CF_3CHO data are polynominal fits to aid visual inspection of data trends.

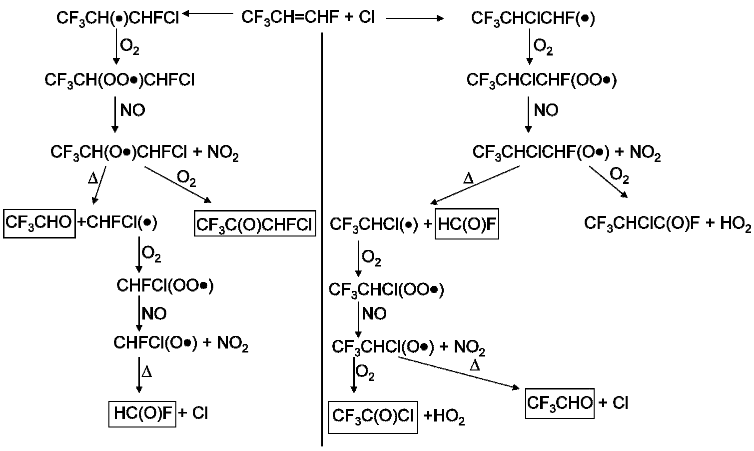

Fig. 8. Mechanism of Cl atom initiated oxidation of trans-$CF_3CH{=}CHF$, boxes indicate observed products.

EPA's decision: Hydrofluoroolefin (HFO)–1234ze is acceptable as a substitute for CFCs and HCFCs in:

- Rigid Polyurethane Appliance Foam.
- Rigid Polyurethane Spray, Commercial Refrigeration, and Sandwich Panels.
- Polystyrene Extruded Boardstock & Billet.

HFO–1234ze is also known as HFC– 1234ze or trans-1,3,3,3-tetrafluoroprop-1-ene (CAS Reg. No.29118–24–9). You may find the submission under Docket item EPA–HQ–OAR–2003–0118–0222 at *http://www.regulations.gov*.

Environmental information: HFO– 1234ze has no ODP. HFO–1234ze has a GWP of 6 and an atmospheric lifetime of approximately 2 weeks (''Atmospheric chemistry of trans-CF3CH=CHF: products and mechanisms of hydroxyl radical and chlorine atom initiated oxidation,'' M.S. Javadi, R. Sondergaard, O.J. Nielsen, M.D. Hurley, and T.J. Wellington, *Atmospheric Chemistry and Physics Discussions* 8, 1069–1088, 2008). HFO–1234ze is currently defined as a VOC as defined under Clean Air Act regulations (*see* 40 CFR 51.100(s)) addressing the development of SIPs to attain and maintain the national ambient air quality standards. Hydrofluoroolefins are a subset of hydrofluorocarbons that contain double bonds between carbon atoms.

Flammability information*:* HFO– 12. HFO–1234ze

EPA's decision: Hydrofluoroolefin [1] *(HFO)–1234ze is acceptable as a substitute for CFCs and HCFCs in:*

- Rigid Polyurethane Appliance Foam.
- Rigid Polyurethane Spray, Commercial Refrigeration, and Sandwich Panels.
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Flammability information: HFO– 1234ze is non-flammable.

Toxicity and exposure data*:* Potential health effects of this substitute at lower concentrations include drowsiness and dizziness. The substitute may also irritate the skin or eyes or cause frostbite. At sufficiently high concentrations, it may cause central nervous system depression or irregular heartbeat. The substitute could cause asphyxiation, if air is displaced by vapors in a confined space. The substitute may also irritate the lungs, skin or eyes or cause frostbite. These potential health effects are common to many foam blowing agents.

EPA anticipates that HFO–1234ze will be used consistent with the recommendations specified in the manufacturer's MSDSs. EPA recommends a preliminary workplace exposure limit of 375 ppm for HFO– 1234ze. EPA anticipates that users will be able to meet this recommended workplace exposure limit and will be able to address potential health risks by following requirements and recommendations in the MSDSs and other safety precautions common in the foam blowing industry. Further, EPA is reviewing this substance as a Pre-manufacture Notice under the Toxic Substances Control Act (TSCA). Therefore, use of HFO–1234ze must be in accord with EPA's final decision under TSCA.

Comparison to other foam blowing agents*:* HFO–1234ze is not ozone depleting in contrast to the ozone depleting substances which it replaces. In its lack of risk for ozone depletion, HFO–1234ze is comparable to other substitutes for HCFC–22 and HCFC– 142b, such as HFC–134a and HFC– 245fa. (HCFC–22 and HCFC–142b have ODPs of 0.05 and 0.07, respectively (WMO, 2006).) HFO–1234ze's GWP is 6, comparable to or lower than that of other substitutes for HCFC–22 and HCFC–142b. For example, the GWP of HFC–134a is about 1430 and the GWP of HFC–245fa is about 1030. Additionally, the GWP for HFO–1234ze is significantly lower than the GWPs for the ozone-depleting substances it will replace. (The GWPs of HCFC–22 and HCFC–142b are 1810 and 2310, respectively (WMO, 2006).) Flammability risks can be addressed by procedures common in the industry. The toxicity risks are low, as discussed above. Thus, we find that HFO–1234ze is acceptable because it does not pose a greater overall risk to public health and the environment than the other substitutes acceptable in the end uses listed above.

October 9, 2009

THE USE OF HFO-1234ze BLOWING AGENT IN THE PRODUCTION OF XPS (EXTRUDED POLYSTYRENE FOAM BOARD)
PHASE 1

Prepared by
Yasemin Gündoğdu Ceylan
Project Manager

18 March 2011

CONTENTS

1- ABSTRACT

The purpose of this project is; use of HFO-1234ze blowing agent in XPS foam with Standard production equipment (all ingredients are same except blowing agent) to phaseout of HCFCs in XPS. If the new gas is acceptable according to test results this gas can be use all of XPS production in the world.

This gas was approved by the U.S. Environmental Protection Agency to use in foam and aerosol applications. This gas was used with other co blowing agents like acetone, ethyl alcohol. These tryouts are the first use of DME (dimethyl ether) co blowing agent with HFO 1234ze in XPS foam production. This month the tryouts were made at B-PLAS factory on 8th – 11th of March 2011 in Bursa, Turkey.

The tryouts were made according to project implementation plan.

The product thickness was 30mm, the equipment was twin screw corotating extruder. The other details can be seen at related chapters.

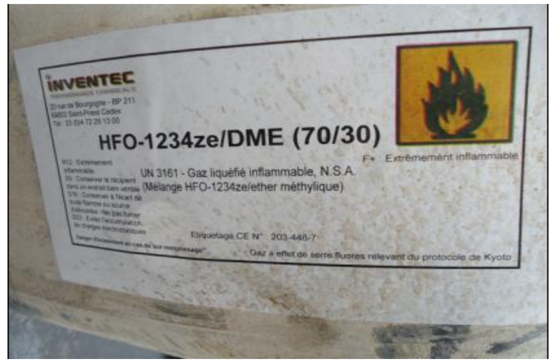
2- THE ACTIVITIES IN THE PERIOD OF 08/02/2011 – 18/03/2011

2.1- PURCHASING OF HFO 1234ze

The gas tanks arrived to B-PLAS on 23rd of February. There were 2 gas tanks on the production side, one of them was belonging to 70/30 HFO 1234ze/DME blend, other was belonging to 80/20 HFO 1234ze/DME blend. The photographs of the gas tanks are below.

Picture 1- 80/20 HFO 1234ze/DME blend

Picture 2- 70/30 HFO 1234ze/DME blend



Picture 3- The whole gas tank

2.2- PURCHASING OF THE THERMAL CONDUCTIVITY TESTER

The tester will be choiced through below suppliers. The alternative equipments and suppliers are;

* QuickLine™-30 (Anter)
* C-Therm TCi (C Therm Technology)
* Lambda (F 5 Techmology GmbH)

2.3- THE TRYOUTS

2.3.1- THE GAS DELIVERY TO B-PLAS

The gas tanks were sent from France by Honeywell. The tryouts will have made at the end of year 2010. But the gas wasn't supplied on time. So the tryouts were postponed to end of February 2011. The documents of gas delivery can be seen at Annex 1.

2.3.2- FINAL PREPARATIONS

2.3.2.1- B-PLAS supplied below safety equipments before the tryouts. These safety equipments conform to CE standards which can be seen in MSDS documents and data sheet of gases (Annex 2).

1- Safety glass, 3M 2740 (EN 166:2001)

2- Mask with filter 3M 6800 filtreli (EN 136 CL1) and the filter 3M 6059 (EN 14387:2004)

3- Glove Rytill hot

4- Glove for chemicals Rytill CE 0321 (Soleyn 33)

5- Safety shoes (B-PLAS requirement)

2.3.2.2- The MSDS documents were explained to the workers.

2.3.2.3- The production line was controlled by Production department.

2.3.2.4- The tryout plan was prepared and send to all tryout participants.

From: Yasemin Gündoğdu Ceylan
Sent: Tuesday, February 15, 2011 10:41 AM
To: 'Katalin Zaim'; Mehmet AŞKINER; Mehmet Askiner
Cc: Berkan Toros; Maksim Surkov; Jacques Van Engel; William Buchanan; Bowman, Jim; Bert Veenendaal; Lucarelli, Francesco; Ulrika Richardson-Golinski; Levent Ceylan; yasemingc@gmail.com; Yasemin Gündoğdu Ceylan
Subject: HFO 1234ze TRIALS
Importance: High

Dear All,
I kindly inform you that I have prepared a time table for HFO 1234ze gas trials. Please send me your opinions . Today I will send you to do list for trials. Please inform me Is there any other participant ?

The participants are ;
Katalin Zaim
Jim Bowman
Bert Veenendaal
William Buchanan
Berkan Toros
Mehmet Aşkıner

TIME TABLE OF HFO 1234 ze PROJECT at B-PLAS A.Ş.

07 March 2011, Monday	*Travelling and arrive to Bursa*
08 March 2011, Tuesday	*Discussion about the trials, control of the production line, safety requirements and trials*
09 March 2011, Wednesday	*Trials*
10 March 2011, Thursday	*Trials*
11 March 2011 ,Friday	*Discussion, meeting*

2.3.3- THE TRYOUTS

The experts and other participants arrived to Bursa on 7th of March. All participants and B-PLAS management have a dinner at an authentic restaurant of Bursa.

2.3.3.1- THE RAW MATERIALS AND PRODUCT

A- Polystyrene (PS) (Melt flow rate is: 10 g/10min , 200^0C, 5 kg)

B- Nucleating agent

C- Flame retardant

D- Gas d1- **70/30 HFO1234ze/DME blend (750 kg)**

d2- **80/20 HFO1234ze/DME blend (750kg)**

The porposal formulation according to Project implementation plan is;

- Sabic Virgin PS MFI 7 97%
- Recycle PS 0.0%
- Flame-retardant 1.5%
- Talcum 1.5%
- Color 0.0%

The product thickness is 30 mm

2.3.3.2- FIRST DAY OF THE TRYOUT (08 March 2011)

The below participants had a meeting about the tryout organisation. The participants are;

Jim Bowman	Honeywell Gas Expert
William Buchanan	IFC Process Expert
Berkan Toros	UNDP Turkey
Mehmet Aşkıner	Expert at National Ozone Office of T.C Ministry of Environment and Forests
Levent Ceylan	B-PLAS Recipient Coordinator
Vahit Babacan	B-PLAS Production Responsible
Yasemin Gündoğdu Ceylan	Project Manager

Picture 4- The participants

From left to right; Mehmet Aşkıner, Berkan Toros, Jim Bowman, Vahit Babacan, Levent Ceylan, William Buchanan, Yasemin G.Ceylan.

The below tryout plan was recommended by Process expert.

Table 1 Draft tryout plan

Date	Explanation
08.03.2011	STEP 1- B-PLAS production will be continued, the thickness is 30 mm
09.03.2011	STEP 2- Production with UNDP Project formule (%97 PS+%1,5 Flame retardant+%1,5 Nucleating agent)+ with B-PLAS gas. STEP 3- After the production stable conditions the gas will be changed with same formule (Production with UNDP Project formule (%97 PS+%1,5 Flame retardant+%1,5 Nucleating agent)+ with %70/30 HFO1234ze/DME gas blend).
10.03.2011	STEP 4- Repeat 1st and 2nd steps. STEP 5- then change gas blend to %80/20 HFO1234ze/DME
11.03.2011	STEP 5- Meeting and discussion on tryouts.

The production line and safety precautions were controlled by experts

The production was continued until 09 March morning with STEP 1.

2.3.3.3- SECOND DAY OF THE TRYOUT (09 March 2011)

The STEP 2 was began at 09 March morning and all Project team was participated this tryout. The Processing conditions which are screw velocity, barrel temperatures, pressures, gas velocity,… were recorded (Annex 3 processing conditions of STEP 2). The product was good surface properties, No waves no some holes. STEP 3 was begun after 3-4 hours later.The product surface was no good. too much waves and some holes. The width of the panel was decreased to 58 cm and the panel density increased to 40 g/cm3. When the gas was fed to the production equipment the die pressure was decreased until 19 bar. Later the screw velocity was decreased by process expert to increase the die pressure (If the die pressure is increased the foaming level will be homogene and small cell size). Because of surface waves and holes, the process expert decreased the nucleating agent ratio by order of % 1.25 and % 1, increased the gas feeding ratio from % 7 to % 7.75 and increased the temperatures. But the surface properties didn't change. The process expert's opinion that latest product with %1 nucleating agent ratio was succesfull (Annex 4 processing conditions).

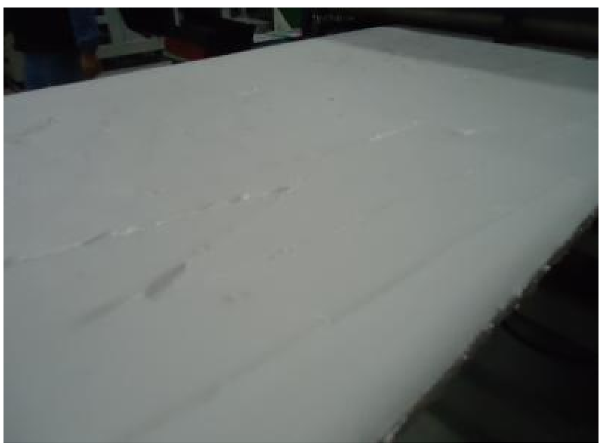
Picture 5- The photograps of the product which the gas blend is 70/30 HFO1234ze/DME, %1 Nucleating agent.

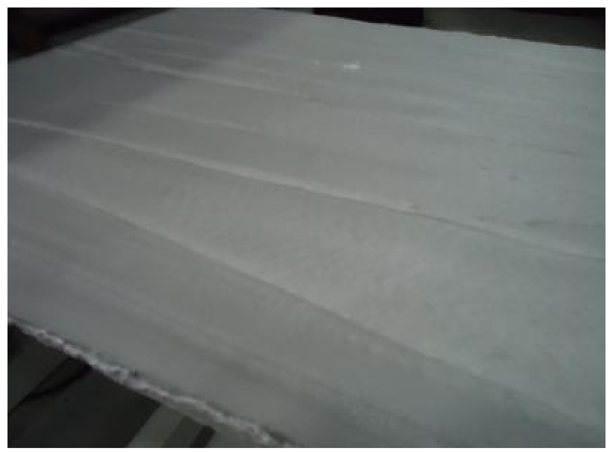
2.3.3.3- THIRD DAY OF THE TRYOUT (10 March 2011)

The STEP 4 wasn't applied on processing, STEP 5 was began at 10 March morning. But the production formule was changed ; (**%97,5 PS+%1,5 Flame retardant+%1 Nucleating agent)**+ with %80/20 HFO1234ze/DME gas blend).

The product surface was no good, too much waves and some holes on the surface. The gas feeding ratio was increased from %7 to % 8,5 to avoid these problems. But there was't been any solution (Annex 5 processing conditions)

Picture 6- The photograps of the product which the gas blend is 80/20 HFO1234ze/DME %1 Nucleating agent.





2.3.3.4- THE FINAL FORMULAS

% 70/30 HFO 1234ze/DME % 97,5 PS % 1,5 Flame Retardant % 1 Nucleating agent	% 80/20 HFO 1234ze/DME % 97,5 PS % 1,5 Flame Retardant % 1 Nucleating agent

2.4- DISCUSSIONS, RESULTS (11 March 2011)

2.4.1- THE PROCESSING RESULTS

The results were evaluated by all tryout participants;

2.4.1.1- B-PLAS evaluation; B-PLAS participants said that the produced product wasn't good according to their expectations. The surface properties weren't good to sell on the market.

The density was 40 – 45 g/cm3 this value is high according to XPS which is on the market. The price of HFO gas is high.

HFO-1234ze gas couldn't use alone on XPS product, must be used with other co blowing agents like, DME, ethyl alchole, aceton.

2.4.1.2- T.C Ministry of Environment and Forests evaluation;

He was happy to see this gas can be used for XPS production. But need other try outs for stable processing conditions, homogene flat surface.

2.4.1.3- Process expert's evaluation;

The tryouts were made according to Project implementation plan. He observed this gas blend (with DME co blowing agent) can be used for XPS production with B-PLAS machinery technology. The surface of product can be improved with optimum process conditions. So this gas must be tried with other HFO1234ze/DME ratios, other Polystyrenes with lower melt flow ratio and with optimum processing conditions (temperatures , velocitiy, pressures, …).

The die pressure couldn't be increased to 45 bar. If the pressure can be increased, the surface can be homogeneous and with no holes.This gas must be tried with other machinery technologies. The other requirements can be determined according to other tryouts results.

2.4.2- THE USED MATERIALS

Polystyrene : 5566 kg

Flame retardant: 86 kg

Nucleating agent: 86 kg

B-PLAS gas: 103 kg

2.4.3- THE TESTS

The tests (except cell size) will be applied according to Project plan and EN 13164 XPS Standard at TEBAR laboratory which is an accredited laboratory. The cell size will be tested by Process Expert Mr. William Buchanan. The TEBAR price offer is attached (Annex 6)

Table 2- The tests

The test name	Explanation
Thickness	-
Density	-
Cell size	-
Compressive strength	will be made 10 days, 20 days, 30 days and 45 days after the production date
Thermal conductivity	will be made 10 days, 20 days, 30 days and 90 days after the production date
Flammability	-
Dimensional Stability (will be explained by Bill on day one)	These tests were cancelled by Process expert. Because the dimensions of prodyct were not good to measure.

The test results will be issued in next report

2.5- GENERAL EVALUATION

All tryout results will be discussed at the meeting which will be held on 4th April, 2011.

THE USE OF HFO-1234ze BLOWING AGENT IN THE PRODUCTION OF XPS (EXTRUDED POLYSTYRENE FOAM BOARD)
PHASE 1

Prepared by
Yasemin Gündoğdu Ceylan
Project Manager

05 January 2012
Report on the second trials
December 23/24,2011

CONTENTS

1. THE SECOND TRYOUTS

Mr Bill Buchanan and Mr. Berkan Toros arrived to Bursa and B-PLAS on 22th of December.
A pre-meeting was made with the Project Manager and Production Responsible at BPLAS production sites and details for the trials discussed.

2. THE MEETING NOTES

1- The gas is 70/30 HFO1234ze/DME
2- The used XPS line has much capacity than the first tryouts' line.
3- The used PS (The MF is 2g/10dk) has lower melt flow value than the first tryouts' PS (The MF is 10g/10dk)
4- The formulation is 97% PS (because of lower MF value and to get easy processing the recycled material will be added into the raw material; later the recycle material ratio will be decreased). The formulation will use 1.5% nucleating agent and 1,5% Flame retardant
5- First the BPLAS gas (152a/DME) will be used with formulation later gas will be changed to 70/30 HFO1234ze/DME later turn to BPLAS gas.
6- The expected die pressure with 70/30 HFO1234ze/DME is approximately 50-60 bar, with 152a/DME is approximately 30 bar.

3. THE TRYOUTS on 23th of DECEMBER

The tryouts were started with 152a/DME blend with above formulation but the PS contain recycle material (%97 PS (%32 Recycle +%65 Orj PS)). We get good product with this gas. Later the gas was changed to 70/30 HFO1234ze/DME blend. We didn't get a good product with this gas blend. The produt surface has no pinholes but too much longitudinally waves.

The below formulations have been tried and the processing conditions were not changed too much.

High Original PS ratio with lower gas feeding ratio,
High Original PS ratio with higher gas feeding ratio

Gas 1	152a	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze	HFO 1234ze
Gas 2	DME	DME	DME	DME	DME	DME	DME	DME	DME	DME	DME	DME	DME	DME	DME	DME	DME
Gas1/gas2 ratio,%	-	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30	70/30
Gas feeding ratio, %	7,9	7,9	6,5	6,5	6,5	6,5	6,5	6,5	5,7	7,3	7,6	8,9	9,6	9,6	9,6	9,6	9,6
Capacity, kg/h	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375
PS, %	65	65	65	70	77	80	82	82	82	57	62	62	62	82	97	67	67
Recyle, %	32	32	32	27	20	17	15	15	15	40	35	35	35	15	0	30	30
Nucleante, %	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
Flame retardant,%	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
Die, bar	35	45	47	42	41	43	47	49	49	51	43	43	39	40-41	38	38	66

The photographs;

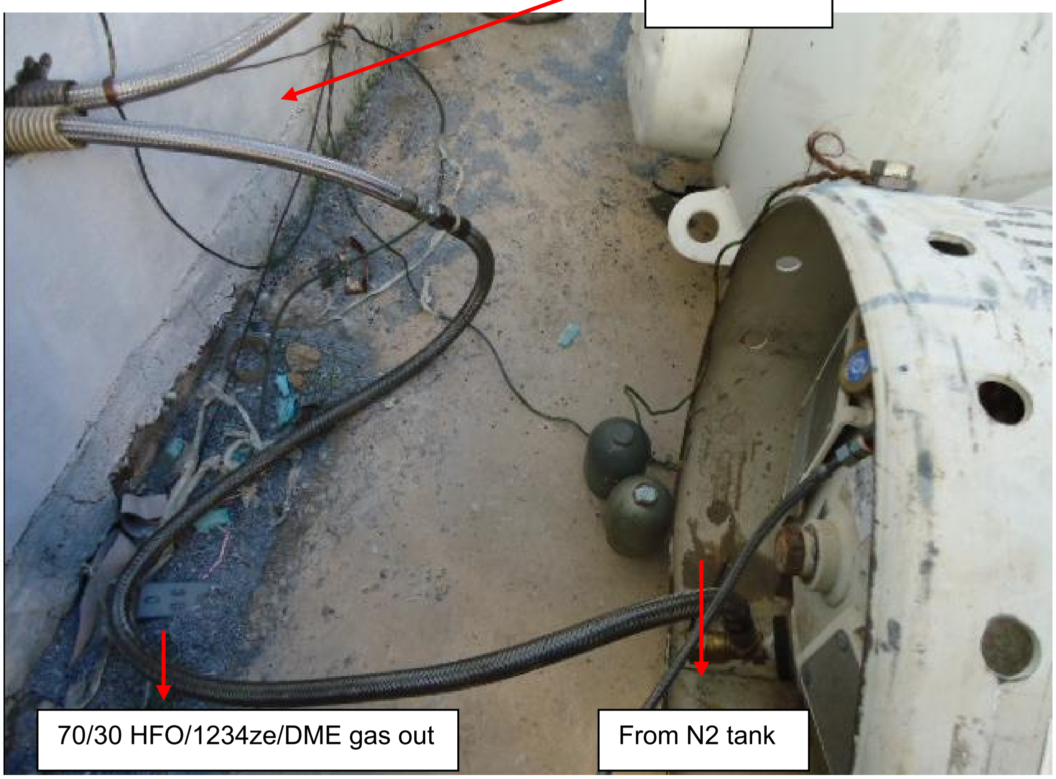
4. THE PREPARATIONS FOR THE SECOND DAY TRYOUT

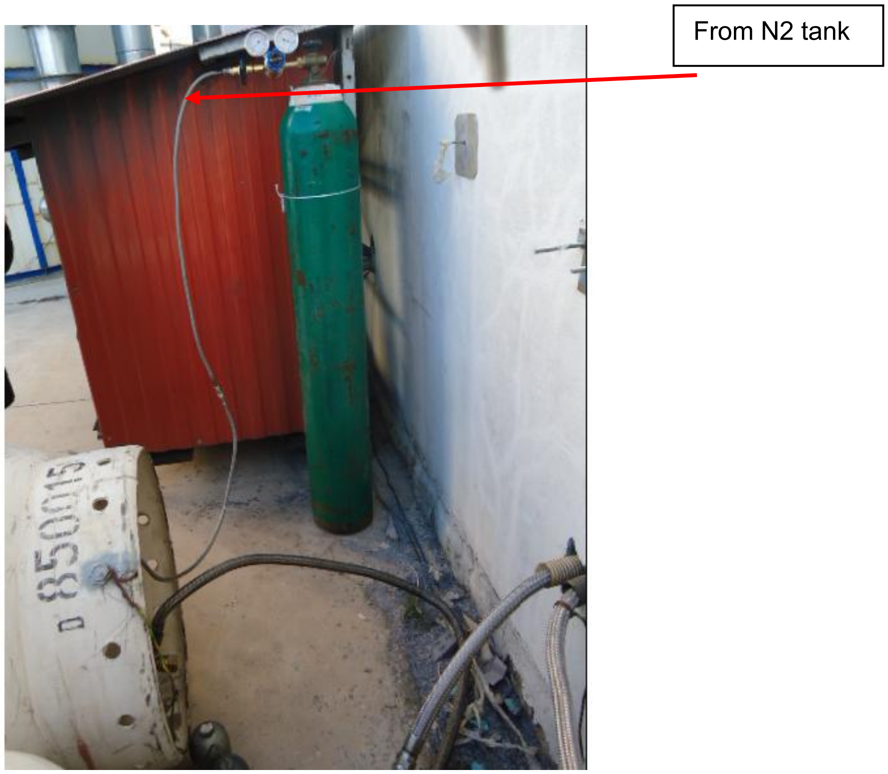
The below preparations were made:

- 180 lt tanks were filled with DME
- The high pressure pump which belongs to the lower capacity line was connected to other high capacity line to pump the DME gas into the extruder.
- Nitrogen gas was used to pressure 70/30 HFO1234ze/DME blend into the extruder.

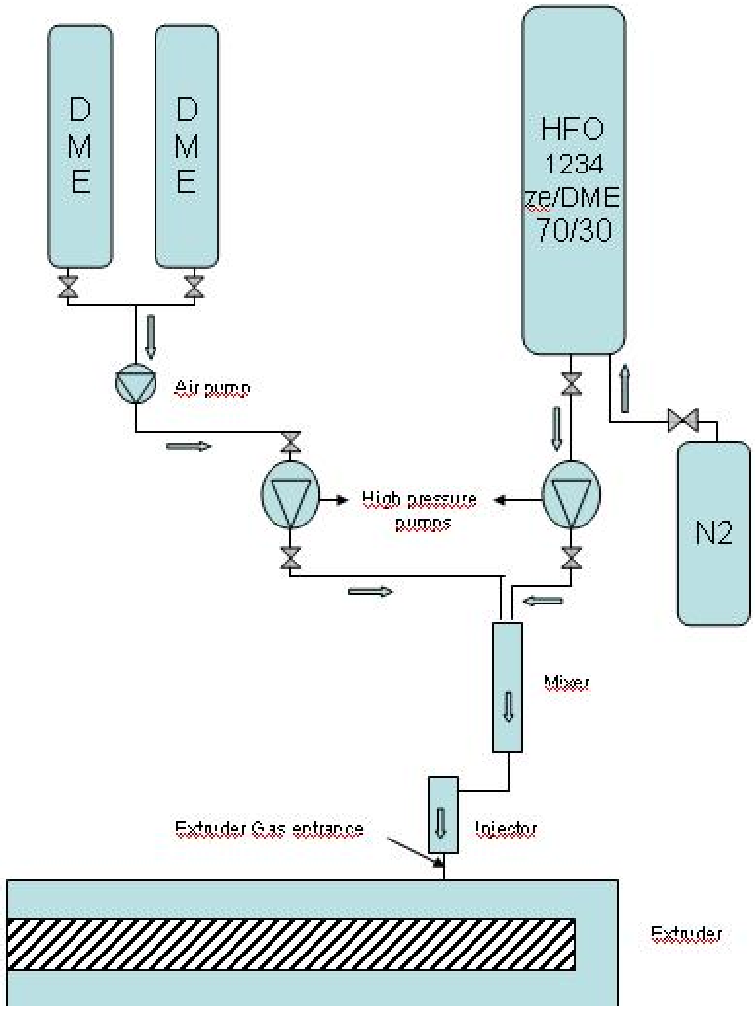
The photographs of the connections;


DME
tanks


DME tanks
connection
70/30 HFO/1234ze/DME gas out
From N2 tank



The flow chart of the connections,



5. THE TRYOUTS on 27th of DECEMBER

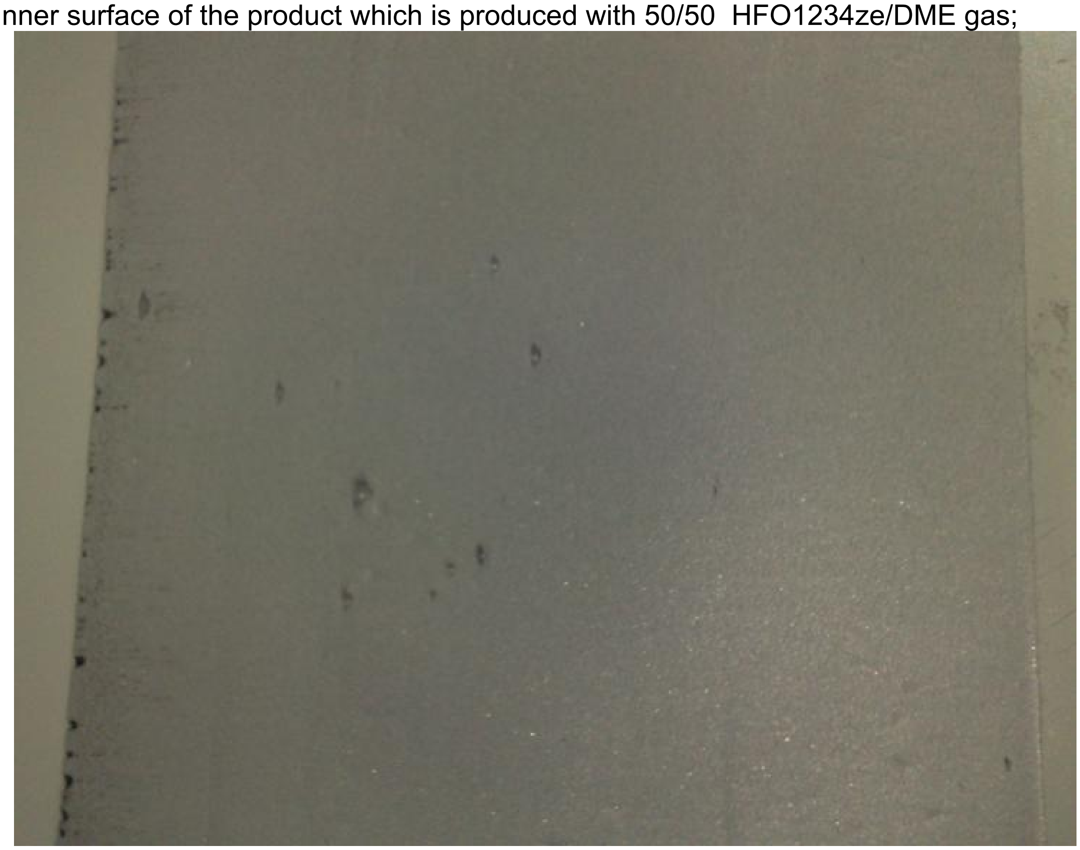
The tryouts were started with 152a/DME blend the surface of the product is good. Later change to the gas DME and 70/30 HFO1234ze/DME blend. The line capacity is 350kg/h, the total gas feeding is 28 kg/h (total gas ratio is %8).

First the gas ratio is adjusted to 55/45 HFO1234ze/DME blend. The surface of the product is good, with no pinholes, but too much of longitudinally waves.

Later the gas ratio is adjusted to get 50/50 HFO1234ze/DME blend. The surface of the product is good, no pinholes, no waves. But there are some pinholes in the product which is cut for aged thermal conductivity test.

The outer surface of the product which is produced with 50/50 HFO1234ze/DME gas;

The inner surface of the product which is produced with 50/50 HFO1234ze/DME gas;



The inner surface of the product which is produced with 50/50 HFO1234ze/DME gas;

The processing conditions are:

Gas 1	HFO/DME (70/30)	HFO/DME (70/30)
Gas 2	DME	DME
Gas1/gas2 ratio,%	55/45 (HFO/DME)	50/50 (HFO/DME)
Gaz feeding ratio, %	7,4	8,0
Capacity, kg/h	350	350
PS, %	56	56
Recyle, %	41	41
Nucleante, %	1,5	1,5
Flame retardant,%	1,5	1,5
Die, bar	42	37
Zone1, °C	215	215
Zone2,°C	220	220
Zone3,°C	210	210
Zone4,°C	180	180
Zone5,°C	110	110
Zone6,°C	105	105
Zone7,°C	96	96

6. THE MEETING NOTES AFTER THE TRYOUTS

Generally the product is good according to the first tryout sample. If the new tryout is scheduled, the below equipments will be required to attain good gas blend ratio and processing conditions.

1- DME pump
2- Air pump
3- High pressure pump
4- DME tank
5- HFO 1234 ze tank
6- Tryout 3-4 days.

7. THE USED MATERIALS

Polystyrene	:	5411 kg
Flame retardant	:	84 kg
Nucleating agent	:	84 kg
B-PLAS gas	:	379 kg

8. THE TESTS AND RESULTS

The tests will be applied according to Project plan and EN 13164 XPS Standard at B-PLAS laboratory.

The tests

The test name	Explanation
Thickness	-
Density	-
Cell size	-
Compressive strength	will be made 10 days, 20 days, 30 days and 45 days after the production date
Thermal conductivity	will be made 10 days, 20 days, 30 days and 90 days after the production date
Flammability	-

The test results are;

TEST	TEST DATE	UNIT	VALUE
Density	the test were made at the production date	kg/m^3	35
Max Compressive strength		kPa	217,87
Thermal conductivity		W/mK	0,02268
Thermal conductivity	The samples were cut into slices and waited 10 days at laboratory conditions	W/mK	0,02899

COMPARATIVE TEST RESULTS FOR BLOWING AGENTS USED IN TURKEY

Tests	Standard	Unit	80/20% HFO1234ze/DME 18-21/03/2011	70/30% HFO1234ze/DME 18-21/03/2011	50/50% HFO1234ze/DME 12/27/2011	75/25% 152a/DME 3/16/2010	50/50% 152a/DME 9/28/2011	75/25 142b/22a 7/12/2004	Standard Requirement
Length	TS EN 822	mm	1201	1201	1201	1200.3	1200	1250	*1200
Width		mm	599	573	601	598	600	603	*600
Thickness		mm	28.61	31.65	30.6	31.6	29.78	30.66	*30
Density	TS EN 1602	kg/m^3	44.22	38.64	35	33.8	29.8	32	*30 – 32
Thermal conductivity 90 days	TS EN 12667	W/mK	0.03371	0.02889	0.02987	0.035	0.03168	0.028	*0,029-0,031
Aged Thermal conductivity 90 days			0.03309	0.02908	0.03097	n/a	0.03178	n/a	
Compressive strength 45 days	TS EN 826	kPa (N/m^2)	380	276	298	257.4	250	248.36	*>=200
Flammability	TS EN ISO 11925-2	-	E	E	E	E	E	B1	E
Open cell ratio		%	31.69	3.41	10	-	-	-	No value

*Depends on producer declaration

67th Meeting of the Executive Committee for the Multilateral Fund for the Implementation of the Montreal Protocol

RESOURCE MOBILIZATION FOR CLIMATE CO-BENEFITS
Additional Report as per ExCom Decision 66/15 (l)

Introduction

Through Decision 63/20, the Executive Committee approved US$ 200,000 plus agency fees for UNDP, for the preparation of four pilot demonstration projects in the refrigeration and air-conditioning manufacturing sector to examine technical interventions to improve energy efficiency, national policy and regulatory measures to sustain such interventions in order to maximize the climate impact of HCFC phase-out, to be funded as resource mobilization activities on the following conditions:

(i) That UNDP inform the Executive Committee of the four proposals specified above no later than the 67th meeting, noting that this would be submitted for information only and that these proposals would not be funded under the Multilateral Fund;

(ii) That an interim report would be provided at the 66th meeting, which would include an update on the activities so far undertaken and address the following elements:

a. Additionality of the projects proposed;
b. Transparency and good governance, as well as covering the cash flow;
c. Assurance that these projects would avoid perverse incentives for countries;
d. Exploring possibilities of profit-sharing, including return of funds to the Multilateral Fund;
e. Ensuring sustainability of the projects proposed;
f. Avoidance of duplication of similar projects;
g. Information on transaction costs.

UNDP submitted an interim report to the 66th ExCom meeting, providing an update on the progress on this project. Upon discussing this progress report, through Decision 66/15 (l) ExCom requested UNDP to submit an additional and more detailed report to the 67th ExCom meeting.

Background

The peak timeframe for implementation of HPMP Stage-I in A5 countries is during 2012-2015. During the implementation of HCFC phase-out in enterprises/sub-sectors/sectors involved in HPMP Stage-I, there is a unique window of opportunity to phase-in alternative technologies that are low-GWP, safe, cost-effective and energy-efficient, and thus maximize climate benefits of HCFC phase-out in HPMP Stage-I and beyond. This window is narrow and needs to be fully leveraged, because the enterprises would already be in the process of plant/process modifications during HCFC phase-out, and they may be reluctant to carry out plant/process modifications again/frequently. In the Air Conditioning and Refrigeration Sectors, additional opportunities exist for maximizing climate benefits through energy-efficiency enhancements, because of the intense energy use by the equipment, which contributes 60-90% to the lifecycle emissions.

Technical interventions needed to achieve additional climate benefits such as energy-efficiency enhancements, outside of the objective of phasing out HCFCs, may not be eligible for funding from the MLF.

Taking the above into account, UNDP has sought to mobilize resources from bilateral and multilateral sources as well as the private sector, which would be applied at the enterprise/sub-sector/sector level, to achieve/maximize climate benefits, beyond those that would be normally available through funding for HCFC phase-out alone.

The expected outcome of the funding approved for UNDP for resource mobilization, was the development of four concrete proposals, demonstrating the maximization of climate benefits during HCFC phase-out. It may be noted that preparing such proposals is meaningful only if the corresponding financing for the proposals is also mobilized, to ensure resources to successfully implement these proposals, and serve as an example of how such projects could be replicated in future.

Status Update

The following provides a summary of UNDP's efforts to date:

1. US Department of State

   US$ 1.7 million including agency fees was mobilized from US Department of State under its Global Climate Change Initiative, to carry out technology demonstrations for low-GWP and energy-efficient alternative technologies, at select enterprises in selected sectors/sub-sectors in the Asia-Pacific region. Funds have already been received by UNDP. The planned five sub-projects cover the following:

Country	Sector/sub-sector	Baseline	Technology
India	Polyurethane Foams (Rigid)	HCFC-141b/HC	HBA-2/FEA-1100/AFA-L1
	Commercial Refrigeration	HCFC-22/Energy-efficiency	R-290/R-600a
Indonesia	Commercial Air Conditioning	Energy efficiency	Compressors, fans, heat exchangers
Malaysia	Polyurethane Foams	HCFC-141b/HC	HBA-2/FEA-1100/AFA-L1
	Commercial Refrigeration	HCFC-22/Energy-efficiency	R-290/R-600a and compressors, fans and heat-exchangers

   In addition to the technology demonstrations, following are the expected additional outcomes:

   - Options for policies and regulations for sustaining technical interventions
   - Recommendations for accounting of climate benefits
   - Establishing benchmarks for costs and implementation timeframes

   The overall project work plan comprises of the following key milestones:

   Until 3Q2012: Preparatory work (host country agreements, enterprise-level agreements)
   Until 3Q2013: Enterprise-level technology demonstrations
   Until 3Q2014: Compilation of results and supplementary interventions

2. Global Environmental Facility (GEF)

   In collaboration with UNDP's GEF-Climate Change Mitigation team, a proposal was developed and submitted to GEF, for energy-efficiency enhancements in the Air Conditioning and Refrigeration Sectors in Indonesia. The proposal, under GEF's climate change focal area, and within Indonesia's STAR allocation, has a projected grant funding of about US$ 5 million.

   Indonesia plans to phase-out HCFC consumption in manufacturing in these two sectors, as part of its HPMP Stage-I. This project includes technical and policy interventions, which would enable the Indonesian government and industry to enhance energy-efficiency of air conditioning and refrigeration equipment, contributing to Indonesia's voluntary CO_2 emission reduction targets by

2020. The key element of the proposal is that the same stakeholders who would participate in Indonesia's HPMP Stage-I, would receive additional assistance to achieve higher energy-efficiencies in their products. The HPMP Stage-I funding for these sectors, has been shown as concrete co-financing for the GEF proposal.
The proposal is currently under review and discussion with the GEF Secretariat and upon satisfactory conclusions of the review, may be expected to be approved in November 2012.

3. Other bilateral and private sector partnerships

UNDP is pursuing mobilization of financing for energy-efficiency improvements and low-GWP alternatives from other bilateral donors.

UNDP is also in extensive engagement with private sector technology providers in the Foams, Air Conditioning and Refrigeration sectors, to precipitate additional investments for low-GWP and energy-efficient alternatives, through their subsidiaries in A5 countries.

Compliance with other provisions of Decision 63/20

Additionality of the proposed projects

The proposed projects specifically target outcomes that are additional to the HCFC phase-out objectives, either through use of further/emerging low-GWP alternatives or through achieving energy-efficiency enhancements or both, which are not normally eligible or funded by MLF.

Transparency, good governance and covering cash flow

The funds mobilized would be managed and utilized in accordance with UNDP's rules and procedures and consistent with the agreements with the relevant donors. These funds would be accounted for and reported distinctly from MLF funds. It is not expected that the funding mobilized would be adequate to cover all costs, and therefore co-financing commitments from the participating enterprises to the extent necessary would be obtained.

The MLF funding provided to UNDP will be utilized for developing the proposals and for mobilization of additional financing, for covering costs and overheads that are additional to UNDP's normal work under the MLF.

Avoiding perverse incentives

The technical and other outcomes for the sub-projects are clearly defined. The funds mobilized would be disbursed to the participating enterprises and/or other beneficiaries through performance-based agreements, with clear milestones, indicators and targets. The diligence as required in the agreements with donors will be duly carried out.

Profit-sharing and return of funds to MLF

The purpose of these resource mobilization efforts is to provide a guide/template on how such projects with multiple objectives and sources of financing can be developed and implemented. None of these projects envisage any revenue generation or profits. None of the external resources mobilized as a result of this effort, can be returned to the MLF. If there are any unutilized funds from the original US$ 200,000 provided by MLF, then these could be returned to MLF under the normal terms of agreement between UNDP and MLF.

Ensuring sustainability

Due diligence has been and will be carried out to ensure that the selected beneficiaries are technically and financially sound. It is also expected that co-financing from beneficiaries would be needed for most of the interventions planned. This will ensure sustainability.

Avoidance of duplication of similar projects

UNDP has taken care to ensure that the sub-projects and beneficiaries are selected where UNDP already has a clear mandate to work in the specific sectors/sub-sectors in context of the HPMP Stage-I in the relevant countries. UNDP will also ensure that overlaps with other similar initiatives from different sources of financing are avoided.

Further, Decision 63/20 is specific to UNDP and overlaps with other agencies in this regard, are not envisaged. UNDP will however be ready to coordinate with other agencies to avoid any duplication of efforts.

Information on transaction costs

Information on transaction costs would be available only upon completion of the sub-projects. The expected completion of these projects would be by 2014.

Final Report

The final report on the resource mobilization for climate co-benefits will be submitted to the 68th ExCom meeting, with the understanding that this report would not be able to cover results of implementation of the projects.

INTERIM REPORT ON DEVELOPMENT OF PILOT PROPOSALS FOR POSSIBLE CO-FINANCING FOR HCFC ACTIVITIES, TO BE FUNDED AS RESOURCE MOBILIZATION ACTIVITIES

COUNTRY:	Global
PROJECT TITLE:	Conversion of HCFC-22 Based Facilities to Ozone and Climate Friendly Alternatives in the Fishing / Food Processing (Servicing) Sectors
SECTOR COVERED:	Replacement of existing industrial Refrigeration installations
TOTAL PROJECT COSTS:	USD 200,000 (excluding support costs)

67th ExCom Meeting

May 2012

RESOURCE MOBILIZATION FOR CLIMATE CO-BENEFIT

1 EXECUTIVE SUMMARY

The Executive Committee of the Multilateral Fund requested UNIDO to provide two proposals for co-financing that describe the Agency's resource mobilization activities in projects that combine ODS elimination and energy efficiency improvements. The Executive Committee also requested UNIDO to address key elements related to the design and implementation of the projects. In this paper, UNIDO provides information on *inter alia* methods that it proposes to use for the selection of alternatives to HCFC-22, and procedures to select financial partners for the projects. UNIDO believes the Global Environment Facility will be one of the key partners for the projects because of the GEF's continued interest in funding energy efficiency projects as a key method for mitigating against the impact of climate change. UNIDO sees value in partnering with the GEF in this endeavor, and seeking other financial partners when necessary. UNIDO describes 18 other partners as well as many more bilateral opportunities for financial partnerships. UNIDO does not see a role at present for carbon finance for these projects because of the relatively expensive transaction costs and depressed carbon market. Should this situation change and the carbon market become more financially viable, UNIDO could become interested in the future in implementing energy efficiency projects as part of a Programme of Activities. Building on the experiences of implementing agencies in resource mobilization activities aimed at the elimination of CFCs used in chillers, UNIDO describes activities for the analysis, design, implementation and verification/reporting of three projects that eliminate ODS and improve energy efficiency. The first project describes the replacement of HCFC-22 with ammonia in cold stores used for storing seafood in Viet Nam, the second describes the replacement of HCFCs with CO_2 systems in cascade with HFO in the fishing industry in Morocco, and the third describes the replacement of HCFCs used for commercial refrigeration in seafood-related activities in Gambia.

The three countries – Morocco, The Gambia and Viet Nam – were chosen to target a broad range of operating conditions, social, political and economic environments. Project concepts have been circulate within partners in the various countries, UNIDO, GEF Secretariat and a number o bilateral donors, receiving positive notes of appreciation.

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2 MLF-FUNDED MOBILIZATION PROJECTS TO CO-FINANCE ENERGY EFFICIENCY COMPONENTS UNDER HPMPs

HCFCs are refrigerants which are generally used as alternative to highly ozone depleting substances (mainly CFCs) because of their relatively low ozone depletion potential. In 2007, Parties to the Montreal Protocol decided for an accelerated phase-out of HCFCs and requested implementing agencies to take into consideration other environmental issues in their phase-out, climate change in particular.

Additional environmental concerns related to the replacement of HCFCs are related to their impact on climate, in particular to the global warming potential (GWP), of HCFCs and their substitutes. For instance, HCFC-22 has a global warming potential of 1810 and most common alternatives to HCFC-22 are HFCs, with zero ozone depletion potential (ODP) but very high global warming potential. However, natural and low-GWP refrigerants exist, which are ozone and climate friendly and better energy-performing.

2.1 RESOURCE MOBILIZATION FOR CLIMATE CO-BENEFITS

The MLF Secretariat's document "*Global: Resource Mobilization for HCFC phase out and climate co-benefits*"[1] reported that the Executive Committee had approved funding of $680,000 for four individual global resource mobilization projects to be implemented by UNDP ($200,000), UNEP ($100,000), UNIDO ($200,000) and the World Bank ($180,000). These projects aimed to mobilize resources to achieve climate benefits beyond those that could be achieved through HCFC phase-out alone.

With regard to UNIDO, at the 63rd Meeting of the ExCom 4-8 April 2011, the ExCom decided:

(a) To approve funding at the level of US $200,000, plus agency support costs of US $18,000 for UNIDO, for the preparation of two project proposals for possible co-financing for HCFC activities, to be funded as resource mobilization activities on the following conditions:

(i) That UNIDO inform the Executive Committee of the two proposals specified above no later than the 67th meeting, noting that this would be submitted for information only and that the two proposals would not be funded under the Multilateral Fund;

(ii) That an interim report is to be provided to the 66th meeting, which would include an update on the activities so far undertaken and address the following elements:

a. Additionality of the projects proposed;

b. Transparency and good governance, as well as covering the cash flow;

c. Assurance that these projects would avoid perverse incentives for countries;

d. Exploring possibilities of profit sharing including return of funds to the Multilateral Fund;

e. Ensuring sustainability of the projects proposed;

f. Avoidance of duplication of similar projects;

g. Information on transaction costs.

(b) To note that the funds approved would be taken from the budget reserved for unspecified projects that had been set aside from the funds returned from the Thai chiller project; and

[1] UNEP/OzL.Pro/ExCom/63/20

(c) *To request UNIDO to provide a Final Report for consideration by the ExCom at its 69th meeting in 2013.*

2.2 SUMMARY OF AGENCY WORK ON RESOURCE MOBILIZATION FOR CLIMATE CO-BENEFITS

2.2.1 UNDP global resource mobilization activities

UNDP prepared four pilot demonstration projects as examples of resource mobilization activities in the refrigeration and air-conditioning manufacturing sector to show the feasibility of improvements in energy efficiency, as well as national policy and regulatory measures to sustain such intervention in order to maximize the climate impact of HCFC phase-out.

UNDP mobilized financial resources from bilateral and multilateral donors as well as the private sector for application at the enterprise, sub-sector and sector level. Approximately $1.7 million was transferred to UNDP from the US for demonstration and application of low-GWP and energy-efficient technologies in selected sub-sectors in countries in the Asia-Pacific region.

UNDP provided technical information to assist in the preparation of a GEF project proposal for Indonesia focusing on financing of energy-efficiency improvements in the air conditioning and refrigeration sectors. The proposal for $4.5 million will also demonstrate opportunities for similar proposals in other countries. UNDP is continuing efforts with other bilateral donors to mobilize financing for energy-efficiency improvements and low-global-warming potential (low-GWP) alternatives. The agency has also engaged with private sector technology providers (foam, air-conditioning and refrigeration sectors) to bring about additional investments in low-GWP and energy-efficient alternatives through subsidiaries in Article 5 countries.

2.2.2 UNEP global resource mobilization activities

UNEP aims to address climate co-benefits for HCFC phase-out in low volume consuming countries (LVC) with servicing sector only, in cooperation with other agencies. The Executive Committee approved funding for a study on financing options, regional workshops on co-financing, and/or one or more pilot applications of co-financing for one or more LVC countries with an approved HCFC phase-out management plan (HPMP). UNEP was requested to ensure that the regional workshops coincided with network meetings and that it would incorporate the experiences of other agencies' resource mobilization activities.

UNEP drafted a terms of reference for the study on financing options and compiled a list of invitees/partners for the regional workshops to be held in 2012. Co-financing aspects will be addressed during the thematic workshop for French speaking North and Western Africa in 2012, possibly in conjunction with a resource mobilization project for LVCs.

2.2.3 World Bank Global resource mobilization for HCFC phase-out co-benefits study

The Executive Committee approved funding for a study that would focus solely on monetizing carbon credits. The World Bank prepared a revised concept note to focus the project on using market mechanisms at the project level taking into account the developments related to carbon finance at the United Nations Climate Change Conference in Durban in 2011. The study will be undertaken by a consulting firm with supervision from the World Bank and will be completed by 31 December 2012 with a view to submitting the final report to the 69th meeting in accordance with decision 63/24.

2.2.4 UNIDO Global resource mobilization for HCFC phase-out and climate co-benefits

In order to expand the consideration of linkages among HCFC phase-out under the Montreal Protocol and other environmental issues, such as climate change and energy efficiency, the Executive Committee approved funds to UNIDO to prepare and submit two project proposals that identify potential sources of co-financing to cover costs that are non-eligible under the MLF but that could generate climate benefits under the HCFC phase-out. UNIDO identified potential countries in Africa, Latin America, Asia and the Pacific in the fishing and food processing sectors. UNIDO's pilot projects will convert HCFC-22-based installations to operate on equipment that no longer depends on refrigerants that are ozone depleting or global warming. By undertaking these projects UNIDO will demonstrate the role of donors such as the Global Environment Facility (GEF) that contribute toward the capital cost of equipment that improves energy efficiency and reduces the impact of climate change. Such donors will be essential for reducing the capital costs of conversion while at the same time ensuring that donor organizations remain consistent with their terms of reference for funding components of projects related to ODS elimination (the MLF) and energy improvement (the GEF).

3 MAIN FRAMEWORK FOR ENERGY EFFICIENCY PROJECTS

3.1 MULTILATERAL FUND

At the request of the Executive Committee, the World Bank submitted a report entitled "*Study on Financing the Destruction of Unwanted Ozone-Depleting Substances through the Voluntary Carbon Market*"[2]. This report addressed the need for funding of ODS destruction, possible sources of finance and how to access them, as well as challenges and potential solutions. The report contained examples of methodologies that could be used for ODS destruction in the Voluntary Carbon Market. Although focused on ODS destruction rather than energy efficiency, elements contained within these methodologies are considered useful in this report for addressing the elements listed in Section 1 above and are discussed further in Section 4.

At its forty sixth meeting, the Executive Committee of the Multilateral Fund adopted decision 46/33, which invited implementing agencies to submit project proposals to demonstrate the feasibility of and the modalities for replacing centrifugal chillers through the use of resources outside the Multilateral Fund and which could be replicated in other countries. The Executive Committee established a funding window amounting to US $15.2 million for chiller projects. The aim of chiller projects is to reduce the consumption of ozone depleting substances (ODS) as required under the Montreal Protocol, as well as to improve the energy efficiency of liquid chillers, demonstrating actual energy savings resulting from the replacement of old CFC chillers and therefore reducing greenhouse gas emissions in the refrigeration and air conditioning sector.

Implementing agencies, supported by bilateral and local partners, have implemented chiller projects throughout all regions. UNIDO has, for instance, regional chiller projects in East Europe, Central Asia and Africa. Other agencies have developed chiller projects in countries such as Brazil, Colombia, Cuba and Latin America and Caribbean Region (UNDP), India, Philippines, Indonesia and Jordan (World Bank).

3.2 GLOBAL ENVIRONEMENT FACILITY

The Global Environment Facility (GEF) provides grants for projects related to biodiversity, climate change, international waters, land degradation, and chemicals, including persistent organic pollutants and ODS.

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[2] World Bank. 2010. *Study on Financing the Destruction of Unwanted Ozone-Depleting Substances through the Voluntary Carbon Market – Final Report.* Prepared by ICF International.

The GEF also manages the Least Developed Countries Fund and the Special Climate Change Fund and provides Secretariat Services to the Adaptation Fund Board. GEF funding is channeled to recipient countries through 10 Agencies, including the World Bank and the Regional Development Banks and UN Agencies such as UNDP, UNIDO and UNEP. The GEF has recently approved a process for accrediting new national Agencies.

The GEF provides financial support to projects according to 6 strategic objectives agreed in the latest replenishment (GEF-5, 2010 to 2014)[3]:

Objective 1: Promote the demonstration, deployment, and transfer of innovative, low-carbon technologies

The GEF funds innovative technologies with potentially significant long-term impacts on carbon emissions, including the demonstration, deployment and transfer of commercially available technologies that have not been widely adopted. GEF support includes technical assistance for creating an enabling policy environment for technology transfer, North-South, and South-South technology cooperation, purchase of technology licenses, and investment in pilot projects.

Objective 2: Promote market transformation for energy efficiency in the industrial and buildings sectors

Projects supported under this objective aim to step up policy interventions and scale up energy efficiency investments. For industry, emphasis is placed on energy-efficient industrial production and manufacturing, particularly in small and medium enterprises (SMEs). For buildings, the GEF support covers the building envelope; energy-consuming systems; appliances; and equipment used for heating, cooling, lighting, and building operations. Emphasis is also placed on integrated and systematic approaches. Projects under this objective may also include the reduction and phase-out of HCFCs used in industry and buildings, in advance of the phase-out dates under the Montreal Protocol[3].

Objective 3 (renewable energy), Objective 4 (low carbon transport) and Objective 5 (land use and forestry) are not relevant to this paper.

Objective 6: Support enabling activities and capacity building

This objective aims to provide support to non-Annex 1[4] Parties to prepare their National Communications to the UNFCCC and meet their obligations under the Convention. The GEF will also continue to fund the preparation and updating of technical needs assistance in accordance with Convention guidance.

3.2.1 Expenditure on energy efficiency

Since the first Rio Conference in 1992, the GEF has invested over $872.2 million toward incremental costs to fill efficiency gaps in 162 energy efficiency projects in 35 countries[5]. These projects[6] cover almost all aspects of energy efficiency including policy, standards, codes, technologies, engineering, energy service companies, industry, commerce, households, buildings, lighting, energy supply side and demand side. The GEF has analyzed its energy efficiency investment portfolio, funding sources and uses, cost-effectiveness of investments, and implementation and termination of projects.

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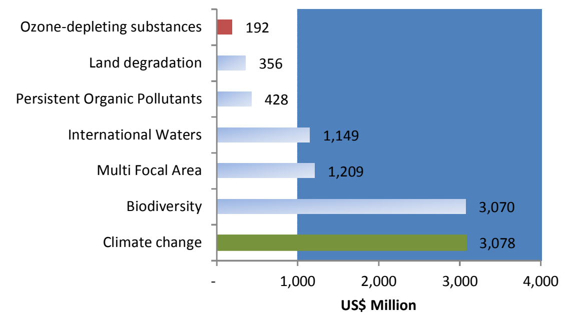
[3] GEF. 2012. Activities supported. http://www.thegef.org/gef/strategies
[4] UNFCCC. 2012. Non-Annex 1 Parties to the Convention.
[5] Ming Yang. 2012. Closing the global energy efficiency gap : The GEF experience. The Greenline – focus on the GEF.
[6] PMIS. 2010. Project Management Information System (2010) http://www.gefpmis.org. Accessed on December 1, 2011

Addressing climate change has become a top priority in the GEF investment portfolio. As of June 30, 2010, the GEF had invested US$ 9.083 billion in global environmental projects, including $8.859 billion from the GEF Trust Fund, $122.5 million from the Least Developed Countries Fund, and $101.3 million from the Special Climate Change Fund. Of the US$9.083 billion GEF investment, $2.891 billion, or about 32 percent of the total funding was utilized in the climate change focal area.

Figure 1: Distribution of GEF expenditure of $9.083 billion by focal area

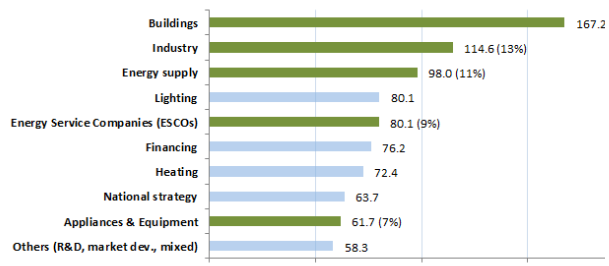


Source: GEF PMIS (2010).

This amount ranked the highest among all GEF focal areas. Figure 1 demonstrates that the GEF has been a major partner for ODS projects in the past, and that expenditure on climate change is a top priority for the GEF.

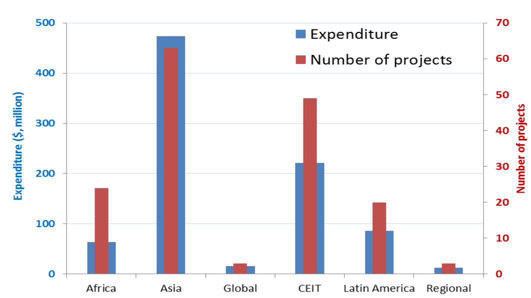
Within the climate focal area (green bar) energy efficiency projects accounted for the greatest expenditure, accounting for 30.2% of the funding or $872.2 million. This expenditure was second only to renewable energy.

Figure 2: GEF expenditure in energy efficiency projects



About 60% of the funding on energy efficiency was allocated to buildings, industry, energy supply, ESCOs and appliances / equipment (Figure 2) as these focal areas were a priority for the GEF. The demonstration projects in Viet Nam and Morocco focus on the same priorities where 60% of the GEF expenditure has been placed in the past, which suggests that UNIDO's demonstration project should be favorably reviewed by the GEF as it is consistent with existing funding priorities of the GEF.

Figure 3: GEF expenditure on energy efficiency projects by region

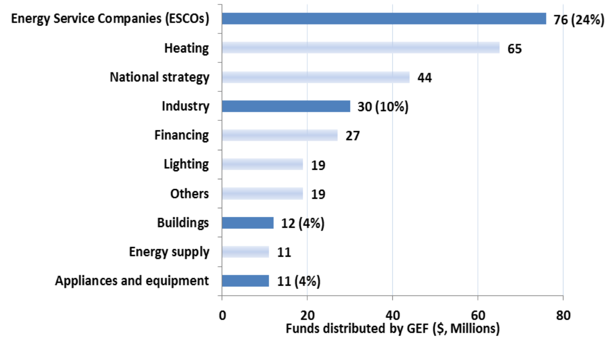


Source: GEF PMIS (2010).

About 80% of the GEF expenditure ($694 million) has been on energy efficiency projects in Asia and the CEIT countries (Figure 3). Expenditure was proportional to the number of projects in Asia, but in Africa and CEIT countries expenditure was relatively small for each project. UNIDO's demonstration project is located in Asia where the GEF has a history of expenditure on energy efficiency projects, and therefore expenditure on this project by the GEF would be consistent with historical expenditure trends. The GEF expenditure in Africa has been greater on projects unrelated to energy efficiency and consistent with the developmental needs of the continent.

GEF analysis of 49 completed energy efficiency projects showed that ESCOs received 24% of the funding or $76 million (Figure 4), which was proportionately larger than any of the other sub-sectors in energy efficiency. As such a high proportion of the funds for energy efficiency were handled via ESCOs, it is reasonable to conclude that the GEF has confidence in the ESCO approach and structure as a means of delivering energy efficiency objectives.

Figure 4: Distribution of GEF expenditure on energy efficiency by sub-sector



Source: GEF PMIS (2010).

3.3 FINANCE FOR DEMONSTRATION PROJECTS ON ENVIRONMENTAL IMPROVEMENTS

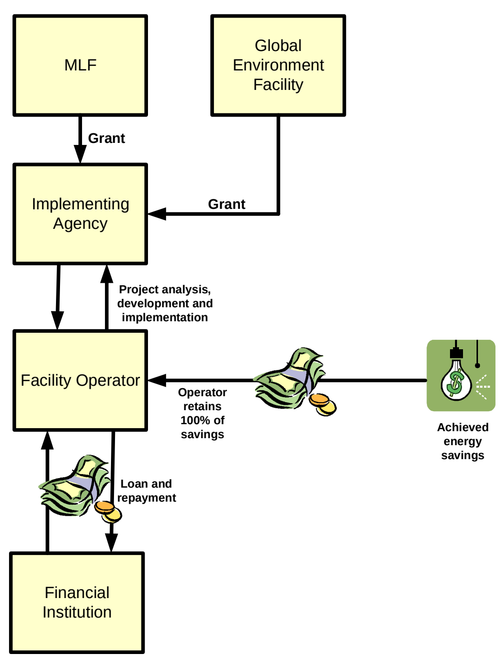
Funding for the demonstration project could be obtained from three main sources: The Multilateral Fund, The Global Environment Facility, and possibly bilateral investors. Local financial institutions (e.g. bank and foundations, national and regional thematic development programmes) as well as other partners (e.g. technology providers, associations, beneficiaries, etc.) can be involved on a case by case basis if finance from these bodies is insufficient.

The funds from each source would be used to fund different activities in the project, in order to remain within the mandate of each funding organization. The funding structure would need to be adjusted to promote a sustainable funding arrangement that would encourage the conversion of hundreds of cold stores in Viet Nam and the Gambia and fishing vessels in Morocco to ODS-free, low-GWP energy efficient refrigeration technology.

3.3.1 Multilateral fund

The funding structure for the demonstration project consists of a grant based on incremental costs from the Multilateral Fund that is provided to the Facility (the cold store operator) via UNIDO (Figure 5). The incremental costs for HPMP projects have been defined in Decision 60/54. The funds provided by the MLF would be deployed mainly for activities related to the reduction and phase out of ODS, which in the case of the cold storage facilities in Viet Nam and the Gambia and fishing vessels in Morocco would be the HCFC-22.

Figure 5: Funding structure for the demonstration project



As it is important to not release the ODS to the atmosphere, this could also include training on the effective and efficient recovery, recycling and reclamation (RRR) of ODS. If a programme does not already exist, the

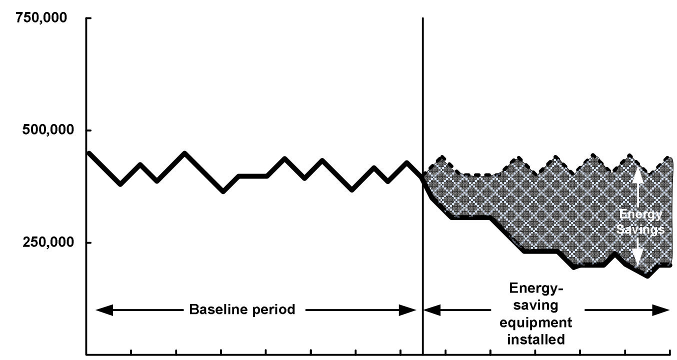
MLF funds may be part of a larger standalone project that seeks to establish such a programme. However, in most countries an RRR programme was established for CFCs, but there may need to be supplementary funds to improve its effectiveness for HCFCs since the recovery equipment may need to be adapted or even replaced if it is too old. There also may need to be 'refresher' training for technicians that focuses on HCFC recovery. Main streaming the training programmes into the Education Ministry could be useful for ensuring that training and certification of technicians is carried out at least for the next 10-20 years on a regular basis.

3.3.2 Global Environment Facility

The GEF could provide a grant, based on incremental costs, to the Facility (the cold store operator) via UNIDO or another Implementing Agency for activities related to the reduction of energy consumption.

GEF-funded activities could include the costs of undertaking an initial and final energy audits to determine the reduced electricity consumption of the refrigeration equipment relative to the original baseline (Figure 6), a review of legal or regulatory instruments that are in force in Viet Nam, the Gambia and Morocco that set energy efficiency targets and standards and encourage compliance with them such as subsidies and taxes, metering equipment to measure electricity consumption if this is not already installed, electricity consumption under full and partial loads during commissioning of new equipment, improved insulation to the cold stores and to contribute information to the Final Report on the outcomes of the Project that are related to energy efficiency.

Figure 6: Baseline measurement for energy saving



As a result of installing more energy efficient equipment, the operational cost of the cold store will decline resulting in reduced payments for electricity. For the demonstration project, UNIDO proposes that this financial benefit remains with the cold store operator in order to compensate as much as possible for expenses on any loan, for assistance in the workshops and for assistance provided to UNIDO for other activities related to the project.

3.3.3 MLF and GEF funding

Both MLF and GEF funds would also contribute toward the cost of:

1) Awareness raising activities such as a national workshop with cold store owners, to share information on the financial and environmental benefits of installing more efficient refrigeration technology that also has less environmental impact than HCFCs. The workshop(s) would best be undertaken in collaboration with national refrigeration and/or exporters associations in order to facilitate contacts, scheduling of events and workshop delivery;
2) Training courses to ensure operational safety, when this was necessary. For example, ammonia is proposed for the cold store demonstration in Viet Nam. Training is necessary to

ensure that local staff is aware of operational requirements associated with ammonia, and safety procedures in the event of a leak.

The proposed allocation of costs between the different organizations is shown in Table 1.

Table 1: Proposed allocation of costs between funding organizations

Activity	MLF	GEF
Examples of ODS-related activities		
Project design for national HCFC phase-out management plans – HPMP	X	
Technical data and initial assessment report for HPMP funding	X	
Project costing	X	
Assist with development of inventory of existing industrial refrigeration installations, such as cold stores / fishing vessels	X	
Selection of alternative technology for conversion of HCFC-manufacturing processes	X	
Sourcing of suppliers of alternative technology and quotes for procurement for the conversion of HCFC-manufacturing processes	X	
Installation of equipment for the conversion of HCFC-manufacturing processes	X	
Recovery and recycling programme for HCFC-22 (courses, equipment needs assessment)	X	
Review of legal instruments related to ODSs	X	
ODS audit and owner survey	X	
Project monitoring, reporting and evaluation	X	
Examples of activities related to energy efficiency improvements		
Project design for replacement of existing industrial refrigeration installations		X
Selection of alternative technology for replacement of existing industrial refrigeration installations		X
Project costing, arranging financial support, co-finance partners		X
Sourcing of suppliers of alternative technology for replacement of existing industrial refrigeration installations		X
Installation of equipment and replacement for replacement of existing industrial refrigeration installations		X
Review of legal instruments related to energy efficiency targets & standards on various refrigerants		X
Review of legal instruments that promote improved energy efficiency performance, such as taxes and subsidies		X
Initial and final energy audits		X
Project monitoring, reporting and evaluation		X
Other activities related to both funding organizations		
Awareness raising workshop(s)	X	X
Centralized storage of ODS ready for destruction	X	X

3.4 OPPORTUNITIES FOR ENERGY EFFICIENCY IMPROVEMENTS

3.4.1 General

The selection of appropriate financing instruments needs to take into account the specific investment climate for technology upgrade in a country. It is essential to develop a systematic approach to identify the financial barriers existing in specific countries and to establish strategies to overcome them. The problem may sometimes not be a lack of finance, but a lack of access to finance. In any case, building a project pipeline and stimulating the market to create demand for financing is usually a priority.

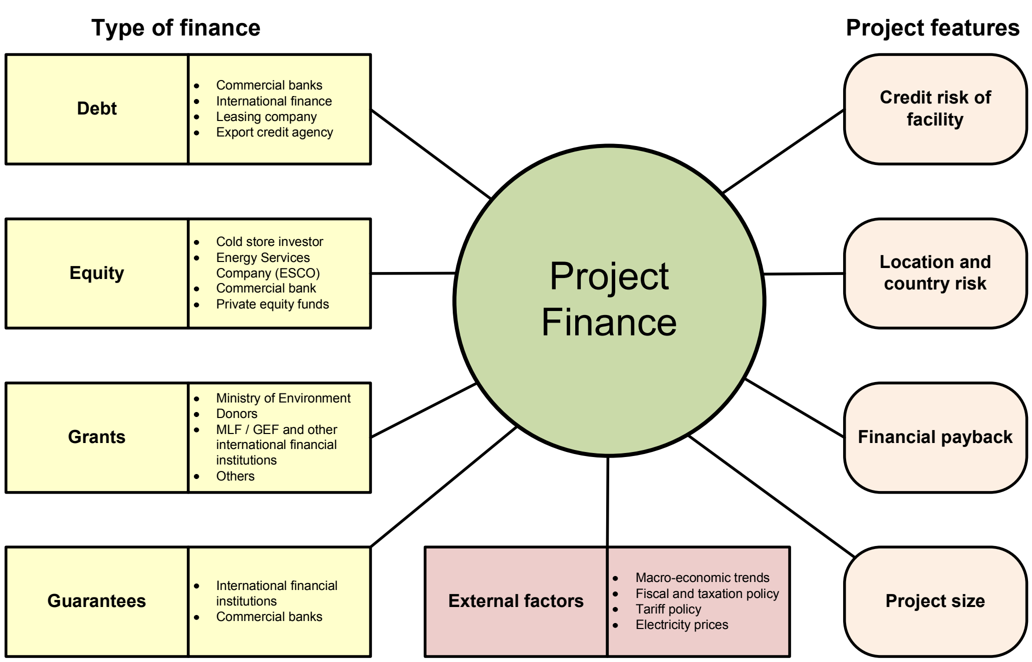
Figure 7 shows that there are many factors that will influence the financial and technical viability of a project, including the level of debt held by businesses, equity claims by lenders, grants already in the pipeline or disbursed, and guarantees for reassurance that a loan can be repaid in the event of a default by the borrower. The external factors related to macro-economic trends are unusual as many developing countries have economic growth that is much greater than in developed countries, which encourages project implementation at this time.

3.4.2 Potential financial partners

Implementing agencies involved in projects have an increasing variety of finance mechanisms and funding sources, each with its specific purposes and requirements for access and spending.

Almost 40 financial organizations were identified that could potentially partner with UNIDO to assist in the delivery of energy reduction targets. They offered a range of financial instruments including debt, equity, grants and guarantees (as shown in Figure 7). However, some of them were screened out because they did not fund enterprises in regions where the projects were taking place. Others were short term and their operational period had ended or there was some doubt as to whether the fund would still be operational after 2012.

Figure 7: Factors that influence the sources of funding for multiple cold stores



There were 19 potential financial partners that remained after this initial screening, and these are listed in ANNEX7. Information is summarized according to the name of the fund, the total amount available for funding, the financial mechanism operated by the fund (e.g., co-finance, grant, and loan), eligibility criteria, and their suitability as a financial partner for the reduction of energy in cold stores. The funding partner was hyperlinked to their respective website where further information can be obtained, if required.

All of these potential financial partners aimed to mitigate climate change through a range of activities including energy reduction. Some of them could be more suitable in the future under the CDM as part of a Programme of Activities e.g., MDB Clean Technology Fund, but most were applicable in the short term. Some funding organizations require the owners of facilities to contribute funding whereas others do not and supply funds on the basis of a grant. The ADB Clean Energy Financing Partnership Facility not only provided funding directly to businesses but also finance of policy, regulatory, and institutional reforms that encourage clean energy development, which could be particularly useful for regulators.

The funding provided by many organizations requires investment from SMEs and the country in which the funds are being invested, in order to ensure that the programme is sustainable. Many funding organizations are therefore seeking to leverage their input through partnerships with SMEs, country governments and other implementing agencies. Some funding organizations, such as the "*ADB Clean Energy Financing Partnership Facility (CEFPF)*" and the "*Renewable Energy and Energy Efficiency Partnership (REEEP)*" focused in particular on providing finance for the development of Energy Service Companies (ESCOs), which is indicative of the high value they place on these companies for addressing energy efficiency programmes.

Bilateral partner countries which focused on regional financial institutions and multilateral donors are not included, but are also important potential partners in these energy reduction programmes. Examples of potential bilateral donor partners are shown in ANNEX8.

3.4.3 Performance contracting

Energy Performance Contracting or EPC is becoming increasingly common in developed and developing countries as a way of generating energy efficiency benefits to end users. North America is the largest market for EPCs where the market it estimated at $3-4b annually. There is a large potential for EPCs in Latin American countries and Asia. China currently has 300 ESCO companies registered and is becoming increasingly widespread as a means to address national energy policies that require a 20% reduction in energy use by 2020[7].

Energy demand in some developing countries, such as China, India and Brazil, is forecast to increase significantly over the next few decades, with non-OECD countries accounting for just over 90 per cent of the increase in global primary energy demand between 2007 and 2030 in the International Energy Agency's (IEA) baseline case (IEA, 2009). In addition, the intensity of energy use in many developing countries, particularly in industrial settings, is higher than those in developed countries, providing even greater opportunity for savings through energy efficiency. In an IEA "*Alternative Policy Scenario*" intended to highlight how a more sustainable global energy supply could be established by 2030, the IEA estimates that two-thirds of carbon dioxide emission reductions in developing countries would need to come from energy-efficiency measures[8].

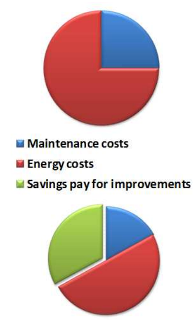
Energy-efficiency investments can also pay off dramatically from a cost savings perspective, often within several years. The financial savings that could be achieved from energy-efficiency measures in certain countries are very high. Some projects in India result in annual savings that are close to half the total project cost, or in some cases exceed the total project cost. Most companies have established a typical payback period for the energy saving technology of one to three years.

Energy Performance contracts consist of an "… *agreement between a beneficiary and a provider an Energy Services Company (ESCO) for the implementation of an energy efficiency project where the global investments have to be paid for through a contractually agreed level*

[7] Dr Pierre Langlois, President Econoler, pers. comm. 5 Apr 2012
[8] IISD. 2010. Energy Service Companies (ESCOs) in developing countries. International Institute for Sustainable Development. 72pp.

of energy cost reduction". In these contracts, the remuneration for the services provided is paid for through energy savings (Figure 8). Thus, the ESCO assumes the technical and performance risks associated with the project. If the energy savings are not achieved, the ESCO does not get paid.

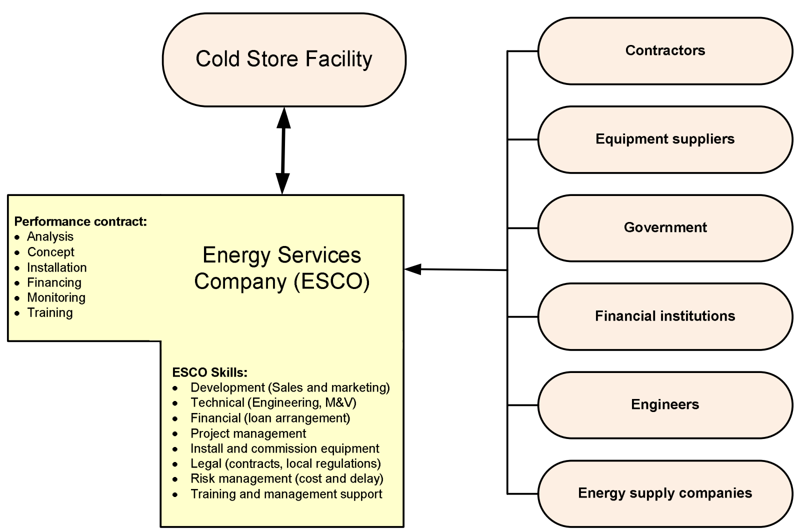
Figure 8: Energy savings pays for technology upgrades



In this way, the clients such as the cold stores that benefit from the improvements to energy efficiency do not have to pay up-front costs for the technology upgrade. The cold stores would benefit by having lower operational costs, equipment with less emissions, less servicing, improved equipment reliability and increased building value. Other less tangible benefits could include improved competitiveness, enhanced company image and last but not least reduced environmental impact. The technology replacement results in the reduction of greenhouse gas emissions that would have occurred, and the reduction in CO_2 emissions associated with the generation of electricity as less is generated as the equipment is more energy efficient.

The complexity facing individual cold store owners that were described in Figure 7 can be made more manageable by the inclusion of an Energy Services Company (Figure 9). Energy Services Companies have a range of skills including technical analysis, financial arrangements, project management, equipment installation, legal (contracts, local regulations) and risk management. Some Energy Services Company can also undertake training programmes and provide management support, which could be important for some technology upgrades that require particular attention to safety improvements. Importantly, ESCOs facilitate a dialogue with the client and steps they can take to reduce electricity consumption. As a result of the dialogue there should be a convergence in expectations on equipment and payback times to achieve realistic energy reductions.

Figure 9: Activities carried out by Energy Services Company



ESCOs can help companies overcome barriers that prevent technology upgrades. These barriers include a lack of awareness and knowledge of the benefits (operational, environmental) of such an upgrade, a lack of confidence in savings that will pay for the upgrade, and a lack of capacity in the organization to address all the issues for an upgrade as their business is selling seafood rather than cold store improvement. The largest barrier, however, is generally obtaining finance as most do not want to commit to a loan. The ESCO can arrange finance and payback terms from savings on energy costs.

ESCOs require a legal base in which to operate in a country in order to protect them from risks when financing a technology upgrade. The role of energy service companies, performance contracting business models, the economics and financing structures behind energy efficiency retrofits and key green building trends have been analyzed for Viet Nam and other countries in the Asia Pacific where performance contracting has become a more and more common business model to assist building owners and managers in optimizing energy use in existing buildings[9]. Most ESCOs are focusing on developing comprehensive and business-wide optimization solutions, such as engineering, construction, maintenance, designing, and consulting. They aim to assist customers in guaranteeing long-term reductions in energy use through energy-saving modifications. Recently, ESCOs in Asia have also started to help customers gain access to subsidy schemes in energy savings performance contracts.

The range of activities that can be offered by ESCOS vary according to the type of ESCO. For example, some are full service or 'one stop shop' that designs, finances and implements projects, verifies energy savings and shares a percentage of the savings with the client. Other ESCOs can take over the operation and maintenance of equipment and sells the output of the equipment at an agreed price, and in this situation the ESCO bears the cost of upgrades. Other ESCOs involve variations in third party financing, supplier credit arrangements, leasing, and variations in fees for technical consultations.

3.4.4 Clean Development Mechanism

A technology upgrade project involving cold stores in Viet Nam, Morocco and the Gambia may be eligible for the status of a CDM project under the Kyoto Protocol. The energy-efficiency gains achieved could potentially result in certified emission reductions that can be sold to contribute to the financing of the technology upgrades.

To realize this contribution, cold store operators would need the services of an enterprise familiar with CDM methodologies[10] to prepare the necessary documents for the CDM Executive Board of the Kyoto Protocol and the relevant Designated National Authority in the country. There is currently no methodology for energy efficiency for refrigeration equipment in cold stores, and therefore this would have to be developed and approved by the CDM Board before a project could be submitted.

Apart from the lack of methodology, the cost of formulating a project for carbon crediting, including project preparation, third party validation and annual verification, could cost $120,000 to $150,000[11]. Initial estimates indicate CO_2 savings of about 200tCO_2/eq per cold store (range 38-294 tCO_2/eq) which equates to a return of only about $1600 per cold store based on the current carbon price of about $8/tonne. Assembling the 400 cold stores into a programme of activities related to energy efficiency improvements could improve the financial viability of the project in the future if the price per tonne of carbon increases. But at today's prices the carbon market does not appear to be attractive for this project.

9 Pike Research. 2010. Energy Efficient buildings: Asia Pacific. ESCO Market Dynamics, Performance Contracting, Energy Efficiency Retrofits, Green Building Certifications, Financing Structures, Market Analysis and Forecasts. Cleantech Market Intelligence.

10 UNFCCC. 2012. Approved large scale methodologies related to energy efficiency improvements: AM0017 (steam), AM0020 (water pumps), AM0038 (silicon and ferro alloys), AM0044 (boilers), AM0046 (light bulbs), AM0060 (chillers), AM0062 (power plant turbines), AM0070 (domestic refrigerator production), AM0091 (fuel switching in new buildings). CDM Methodologies.

11 World Bank. 2010. Study on financing the destruction of ODS through the voluntary carbon market. ICF. Table 3, p37 showing indicative transaction costs for project preparation and registration.

4 OPPORTUNITIES FOR MITIGATING CLIMATE CHANGE THROUGH PROJECTS FUNDED BY THE MULTILATERAL FUND

4.1 THE PARTIES TO THE MONTREAL PROTOCOL

In 2007, the Parties to the Montreal Protocol agreed "… *the Executive Committee … should give priority to cost-effective projects and programmes which focus on inter alia … substitutes and alternatives that minimize other impacts on the environment, including on the climate, taking into account global-warming potential, energy use and other relevant factors*". In addition, the Parties agreed that the Executive Committee should give priority to cost-effective projects and programmes that focus on "…*small and medium-size enterprises*"[12].

Parties were also encouraged to promote the selection of alternatives to HCFCs that minimize environmental impacts, in particular impacts on climate, as well as meeting other health, safety and economic considerations[13].

In 2009, the Parties agreed Decision XX1/9 that requested the Executive Committee, when developing and applying funding criteria for projects and programmes regarding in particular the phase-out of HCFCs to: (a) take into consideration paragraph 11 of decision XIX/6; (b) consider providing additional funding and/or incentives for additional climate benefits where appropriate; (c) take into account, when considering the cost-effectiveness of projects and programmes, the need for climate benefits; and (d) consider in accordance with decision XIX/6 further demonstrating the effectiveness of low-GWP alternatives to HCFCs, including in air-conditioning and refrigeration sectors in high ambient temperature areas in Article 5 countries, and to consider demonstration and pilot projects in air-conditioning and refrigeration sectors which apply environmentally sound alternatives to HCFCs[14].

4.2 THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND

In 2009 after the Meeting of the Parties, the Executive Committee agreed similar wording to the Decisions of the Parties by agreeing "… *to promote substitutes, alternatives and practices in Multilateral Fund programmes to minimize other impacts on the environment, including on the climate, taking into account global-warming potential, energy use and other relevant factors whenever possible*". Underlined phrases added by the Executive Committee to the Decision of the Parties had the effect of expanding the options to also include "*practices*" in addition to substitutes and alternatives, and to qualify the extent to which "*global-warming potential, energy use and other relevant factors*" should be taken into account as "*whenever possible*"[15].

In 2010, the Executive Committee agreed additional funding of up to 25% above the cost effectiveness threshold for projects that involve low-GWP alternatives[16]. Supplementary funding applies to investment projects only, for example conversion of factories, and not capacity building.

4.3 UNEP COMMENTS ON REFRIGERANT REPLACEMENT OPTIONS

UNEP (2011) warned that the growth in HFCs at 8% per year could negate the climate benefit of the phase-out of CFCs and other ODS[17]. Due to the growing demand in emerging economies for refrigeration and air-conditioning, the consumption of HFCs is projected to

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12 Montreal Protocol. 2007. Decision XIX/6: Adjustments to the Montreal Protocol with regard to Annex C, Group 1, Substances (Hydrofluorochlorocarbons). **Paragraph 11**. Ozone Secretariat website.
13 Montreal Protocol. 2007. Decision XIX/6: Op cit. **Paragraph 9**. Ozone Secretariat website.
14 Montreal Protocol. 2009. HCFCs and environmentally sound alternatives. Paragraph 7. Ozone Secretariat website.
15 ExCom. 2009. UNEP/OzL.Pro/ExCom/59/59, Decision 59/44, para.218. Supporting doc: UNEP/OzL.Pro/ExCom/59/50 and Corr.1.
16 ExCom. 2010. Decision 60/44 in UNEP/OzL.Pro/ExCom/60/54.
17 UNEP. 2011. HFCs: A critical link in protecting climate and the ozone layer. A UNEP synthesis Report.

exceed by 2050 the peak consumption level of CFCs in the 1980s. Annual emissions of HFCs are projected to rise to about 3.5 to 8.8 Gt CO2eq in 2050, which is comparable to the elimination in ODS annual emissions of 8.0 GtCO2eq between 1988 and 2010. HFC emissions would be equivalent to 7 to 19% of the CO2 emissions in 2050 based on the IPCC's Special Report on Emissions Scenarios, and equivalent to 18 to 45% of CO_2 emissions based on the IPCC's 450 ppm CO_2 emissions pathway scenario that limits global temperature increase to less than 2°C.

To reduce the noticeable influence of HFCs on the climate, UNEP described three options to replace them that included:

1) Not-in-kind alternatives such as improved insulation materials;
2) The use of non-HFC substances with low or zero GWP such that includes hydrocarbons (R290, R600a), ammonia (R717) and carbon dioxide (R744); and
3) Using low GWP HFCs, such as HFOs. Each of these options is discussed in Section 3.4 and 3.5 when considering the suitability and benefit for replacements for HCFCs.

UNEP (2010) noted that although low-GWP (that is, those with GWP < 15) alternatives were known they were not generally used[18]. A survey of stakeholders in 40 countries revealed a variety of barriers that prevented low-GWP alternatives being used including a lack of technical information, they were unavailable to purchase, manufacturers were unwilling to invest in components and refrigerant manufacture, there were restrictive rules on their use, consultants developing HPMPs were not recommending their use in projects, and they were not considered safe. Apart from the projects that converted domestic refrigerator production from CFCs to HCs, UNEP noted that the Executive Committee had approved only one low-GWP refrigerant out of several hundred projects. UNEP proposed overcoming these barriers by raising the awareness of low-GWP alternatives, undertaking training programmes including technical guidance, undertaking efficiency (for CO_2) and safety (for NH_3) improvements, providing financial incentives, encouraging regulatory changes, and addressing funding criteria. Some of these options are addressed in Section 4.4 and 4.5 when considering replacements for HCFCs in cold stores.

Even when a low-GWP was being used such as ammonia in cold stores, UNEP (2010) reported of an instance where it was being removed and replaced with an HFC refrigerant[18]. Although the funding organization was not clear, it did however suggest the need for commonly agreed policies that would reduce global warming between the various funding organizations.

UNEP (2010) predicts that, based on current trends, HCFC consumption by 2020 is likely to be double the 2010 consumption, which makes the 35% reduction step in 2020 as required by the Montreal Protocol particularly challenging. This highlights the need to not only reduce and eliminate the consumption of HCFCs as soon as possible, but also to substitute them with low-GWP, climate-mitigating alternatives in order to avoid "*jumping from the fat into the fire*".

Recently UNEP reported that it is developing a tool that interrogates energy-efficiency policies related to lighting in countries around the world[19]. Information for each country will be provided on standards, labels, supporting policies, product quality control activities, end-of-life policies and additional information on other activities. Each country will be ranked according to its policy development and gaps. Information ratings will be regularly updated according to country's progress in achieving a sustainable transition. This information will be useful for formulating parallel policies on technology improvements to refrigeration equipment in the cold chain.

[18] Colbourne, D. 2010. Study on barriers to the use of low-GWP refrigerants in developing countries. UNEP OzonAction. 110pp.
[19] UNEP. 2012. New on-line global mapping tool. E-Newsletter.

4.4 RETROFIT

Retrofitting existing equipment with another refrigerant is often less expensive and faster to implement than replacing the equipment entirely. However, there can be disadvantages. The energy consumption might increase and cooling capacity decrease, not all plants are able to be retrofitted with another refrigerant due to equipment material compatibility issues, the retrofitted plant may be less reliable and retrofitting may not extend the commercial life of the plant significantly.

The options of retrofitting with another refrigerant or completely replacing the plant are addressed in Section 4 when considering the demonstration projects in Viet Nam, the Gambia and Morocco.

4.5 NEW EQUIPMENT

The refrigeration technology in the cold stores can be upgraded with new equipment depending on the end-user requirements for the equipment, the climatic conditions in which it has to operate, existing regulations that promote or restrict its use, the technical know-how of local staff, operating cost, reliability and many other factors. Selection of the equipment also depends on the cooling capacity required, the compressor type (air or water cooled), the refrigerant and the life-cycle environmental impact.

There are a range of environmental, safety, efficiency, cost and other issues that need to be considered when selecting new equipment to replace HCFCs. An overview of these factors that influence the selection of refrigerant type is shown in Table 2.

Table 2: Overview of low-GWP refrigerant options for industrial refrigeration such as a cold store

Refrigerant type	Safety	GWP	Efficiency	Cost of refrigerant	Other	Available
Hydrocarbon (HC)	Lower toxicity, higher flammability – changes to system construction MUST be addressed, and reduce charge sizes to mitigate flammability risk; easier to use in new systems	~3	Good	Half to twice the cost of HCFC-22	Miscible with mineral oils, but should avoid drop-in for safety reasons	Yes, for industrial refrigeration
Ammonia (R717)	Higher toxicity, lower flammability – use mainly limited to indirect systems or direct systems in unoccupied spaces; needs specialist design work	0	Excellent	Lower than HCFC-22	Incompatibility with copper materials, cannot be used as drop-in	Yes, for industrial refrigeration
Carbon dioxide (R744)	Lower toxicity, non-flammable – very little restriction in application, but has high operating pressures so entire construction must be suitable for such pressures	1	Medium in cool climates, poor in hot climates	Less than HCFC-22	High operating pressures so cannot be used in existing systems; supercritical cycle demands expert design work	Yes, for industrial refrigeration
< 15 GWP HFC e.g., "HFO" such as R1234yf and R1243zf	Lower toxicity, lower flammability – changes to system construction is necessary	~4	Medium	Much more than HCFC-22	New products with limited commercial availability, unknown factors	Yes, for industrial refrigeration

Source: Adapted from Colbourne, D (2010), Tables 2 and 3 (See footnote 18 in this report for citation)

5 UNIDO's THREE PILOT PROPOSALS

5.1 TARGET COUNTRIES AND ALTERNATIVE TECHNOLOGIES

The funding approved by the MLF for the preparation of project proposals allowed UNIDO to identify three pilot cases in existing industrial refrigeration installations in the fishing / food processing (servicing) sectors, which are significant sources of greenhouse gas emissions and user of ozone-depleting substances (ODS). After mapping several possibilities and considering a broad range of operating conditions of facilities, as well as social, political and economic environments, the best sites for the pilot projects were identified in existing industrial refrigeration installations in Viet Nam, Morocco and the Gambia. As part of the project preparation, international experts were appointed to visit the sites and explore the best technical solutions for the conversion of existing industrial refrigeration installations, keeping in mind that alternatives to HCFC-based systems should be ozone and climate friendly with highest priority to natural refrigerants (whenever possible), as well as bring improved energy efficiency to the system.
Therefore the three project proposals will target two main goals with three different approaches: minimizing the emission of chemicals damaging the ozone layer (i.e. HCFC-22) and mitigating direct and indirect greenhouse gas emissions, thereby building synergies across global environmental conventions.

The three project proposals explore a range of refrigerants with low global-warming potential, including ammonia-brine systems and CO2 cascade, pioneer and unique in its kind for such application, along with reduction of leaks of ozone-depleting substances and implementation of energy efficiency solutions. The goal is to find the best choice of replacement technology with the best environmental performance and best cost effectiveness.

Furthermore, capacity building activities will be an integral part of the proposals, ensuring that the conditions are favorable for the replication and sustainability of the projects after its completion.

Each of the targeted countries has ongoing HCFC Phase-out Management Plans (HPMPs) and is fully committed to phase-out HCFCs according to the Montreal Protocol deadlines. These countries are also signatories of the UNFCCC and Kyoto Protocol and are committed to curbing CO_2 emissions. They are also committed to adopting and enforcing standards and regulations that are essential for the project to have an impact through replication.

Thus, the proposal's strategy is fully in line with the priorities of the Countries.

5.1.1 Viet Nam

The Ministry of Natural Resources and Environment (MONRE) estimated 400 cold stores operating 4,000 refrigeration units. Maintenance and servicing of this rather old and mostly HCFC equipment was assessed as mediocre. Electricity to operate the stores is becoming increasingly expensive to the extent that some owners switch off the refrigeration plant to save operating costs. The cold stores stored seafood products for export are an important part of the Vietnamese economy.

An international consultant assessed the cost, environmental benefit and likely operating costs of retrofitting or replacing the refrigeration equipment and/or upgrading the whole building at two facilities (Seaprodex and Tran Cong). Refrigerants considered for retrofitting were ammonia, CO2, hydrocarbons (HC-290) and HFCs (R-407F and R-422D). The advantages and disadvantages of each refrigerant were assessed, as well as their energy consumption under full and partial loads.

These assessments show that ammonia cost about the same as the HCFC-22 equipment to operate per year, but the Seaprodex site under full load would have less than half the environmental impact (indirect emissions, 120 tCO2eq per year) as HCFC-22 (294 tCO2eq per year). The environmental impact was even less (85 tCO2eq per year) under partial load. Ammonia, however, was about twice as expensive as replacing HCFC-22 with HFC-404A system. At the Tran Cong site, under full load the environmental impact (38 tCO2eq per year) was about 20% of the environmental impact (indirect emissions) of HCFC-22 (216 tCO2eq per year).

An ammonia system was proposed as the best alternative for both sites as it had the lowest climate impact, lowest operating expense (when a variable speed drive was added), and there was some experience and aftersales service with the technology in Viet Nam. However, there was a need to expand training on its safe use and maintenance. In order to fully benefit (environmental, operating cost) from these refrigeration technology upgrades to ammonia, it was also important to reduce cooling losses from the cold stores by undertaking work to also improve the insulation in the roof, walls and floor.

The proposal describes the responsibilities of UNIDO, MONRE, international and national experts, mechanical engineers, equipment suppliers, installation contractors and sub-contractors, the commissioning contractor and training contractor. Further information on the proposal is contained in Annex 2.

5.1.2 Morocco

HCFC-22 refrigerant is used to maintain the cold chain in the Moroccan fishing industry for land based ice-making facilities to mobile storage rooms on fishing vessels or refrigerated trucks and containers. There are about 250 fishing vessels in the fleet. Emissions of refrigerant were large and varied from 1.3 to 1.8 times the charge, whereas on the land based facilities (cold rooms and a freezing tunnel) the leakage was about 20% per year.

An international consultant assessed the environmental benefit (ODP, GWP), cooling performance, safety, as well as the difficulty, time and cost of replacing the HCFC-22 refrigeration equipment with ammonia, HCs (propane R-290 or isobutene R-600), HFOs (R1234yf and others) or CO2.

There was a 15% increase in cooling performance when using CO2 alone or in cascade with HFO or ammonia, whereas the other two refrigerants were about the same cooling performance as HCFC-22. Replacing HCFC-22 on vessels was the most difficult but the cost was low to moderate. Replacing HCFC-22 on the land-based facilities was assessed as low to moderate difficulty and cost. Replacement of HCFC-22 with HFOs alone was assessed as the most unknown scenario. The freezing units on the vessels would take the longest time to replace, though would generate the highest impact on GWP emission reduction.

The cold room units in vessels operating on CO2 in cascade with HFO would have 40% less total global warming impact over 20 years than if they operated on HCFC-22. The freezing units on fishing vessels operating on CO2 in cascade with HFO would have about 80% less total global warming impact over 20 years than if they operated on HCFC-22.

This project shows that there are very good energy efficiencies that can be gained with investment in CO2 in cascade with HFO cold storage for both land-based and sea-going operations. Further information on the proposal is contained in Annex 3.

5.1.3 Gambia

HCFC-22 refrigerant is used to maintain the cold chain in four locations for enterprises involved maintaining the seafood cold chain. Three of them manufacture used to manufacture ice but have gone bankrupt due to difficult economic conditions, while the fourth is economically viable on the basis of seafood products stored and then sold for export.

An international consultant assessed the environmental benefit (ODP, GWP), cooling performance, safety, and cost of replacing the HCFC-22 refrigeration equipment with ammonia, HCs (propane R-290 or isobutene R-600), HFOs (R1234yf and others) or CO2.

The consultant recommended that HCFC-22 should remain installed for as long as possible or until the equipment has to be replaced. Replacement could be with HFCs or natural refrigerants. Replacing the HCFC-22 with HFC-134a drop-in or new plant would lower the GWP impact by about 30%, but it would increase the operating costs by about 9%. Another option would be the installation of a CO2 system alone which would result in a significantly lower global warming impact compared to HCFC-22 and HFCs, but the associated 60% estimated increase in electricity consumption would not be economically feasible. R422D would result in a net increase in GWP of around 50% compared to R22 if installed in the existing systems. Ammonia was not recommended because of safety concerns when such systems are operated in crowded districts.

This project shows that there are potential energy efficiencies that can be gained with investment in these ice making and cold storage facilities, but a number of existing refrigerant supply quality and cost constraints make implementation challenging. This is the reason why this proposal concentrates instead on the removal of barriers to increased energy efficiency and on the establishment of the enabling environment for the introduction of low global warming potential (GWP) alternatives to HCFC-22. The project will use a synergistic combination of technical assistance on policy, regulation, capacity building and awareness-raising; design and implementation of incentives to support the adoption of energy efficiency measures; and piloting innovative technical assistance delivery mechanisms. Further information on the proposal is contained in Annex 4.

5.2 CO-FINANCING AND STRATEGIC PARTNERSHIP

As part of the preparatory phase, additional funding sources have been also explored in the target countries (UNIDO, bilateral donors, GEF). Upon preliminary discussions with these sources, there is good opportunity to create a unique scheme of partnership and cooperation.

By implementing this proposal, UNIDO will help the countries not only to reduce their consumption of ozone-depleting substances and greenhouse gases, but also to develop a project design, which later can be replicated in the other existing industrial refrigeration installations of the countries and worldwide.

5.2.1 UNIDO

The proposal was submitted to the Screening and Technical Review Commission of UNIDO in May 2012. The Commission found the project concept interesting and innovative, requested the continuation of the project development fostering the cooperation of various interested departments, such as those involved in Agro-Industry and Green-Industry development. Subject to next developments, UNIDO is willing to co-finance the project activities.

5.2.2 Bilateral Donors

Bilateral donors, particularly countries usually cooperating with UNIDO under MP projects, were contacted to explore the possibilities of cooperation in the project implementation. The positive feedbacks received so far give reason for optimism in this form of robust co-financing.

5.2.3 GEF

UNIDO passed the preliminary project concepts to the GEF Secretariat, as it is contained in Annex 1, 2, 3 and 4, through UNIDO’s GEF Focal Point and Liaison Officer. The ongoing informal discussions are highly encouraging given the relevance of the concept to the GEF priorities and expected positive stance from the GEF Secretariat towards the project proposals.

5.3 EXPECTED TARGET BENEFICIARIES

The target beneficiaries of this proposal can be defined at two levels:

- Country-level: Through the implementation of the pilot cases, the countries will be supported to be in compliance with their obligations under the Montreal Protocol, particularly with their primary short term commitment, the freeze of HCFC consumption at the baseline level by 1 January 2013. On the long term, the countries can benefit from the functioning scheme of the technical conversion by scale-up and replication. The pilot projects would also bring benefits in terms of mitigation of CO2 emissions therefore supporting these countries in comply with their obligations under the UNFCCC and Kyoto Protocol.
- Owners' level: Targeting this segment is of major importance, since the technical conversion at the owners of refrigerating- or air-conditioning installations (called "end-users" in the Montreal Protocol terminology) is not eligible under the approved HPMPs. The phase-out could be accelerated if end-users were targeted.

5.4 COUNTERPART ORGANIZATIONS

The counterpart organizations involved in this proposal are the Ministries of Environment of the targeted Countries, more specifically their National Ozone Units (NOUs). The NOUs of the Countries are informed about our proposal and ready to support the implementation. The project concepts have also been discussed with GEF focal points in the 3 countries, which readily supported the development of the PIFs by UNIDO.

Besides the NOUs, the representatives of the fishing / food processing sectors, associations, experts, etc, will be also involved in the implementation of the pilot cases in each country along with the National Cleaner Production Centres in Morocco and in Viet Nam.

5.5 INTERNATIONAL DEVELOPMENT GOALS

The proposal addresses the targets set in the context of the Millennium Development Goals of the United Nations. Goal number 7 defines "Environmental Sustainability" as one of the key steps towards a livable future. It encourages integrating the principles of sustainable development into country policies and programs and particularly supports the reverse of the loss of environmental resources.

In addition, thanks to the conversion to state of the art and novel technologies, the countries will benefit not only from the phase-out of HCFCs, but also from the reduced direct and indirect emission of greenhouse gases.

The proposal will also create positive impact at industry level due to the technology transfer, which corresponds to MDG 8 "Global partnership for development".

5.6 IMMEDIATE OBJECTIVES AND EXPECTED OUTCOMES AND OUTPUTS

- Expected outcomes:
  1. HCFC-22 based industrial installations are converted and need for HCFC-22 for servicing sector is reduced.
  2. Energy efficient and low global warming potential technologies are adopted in the countries along with relevant standards and policies.

- Performance indicator:

Ozone and climate friendly technologies are implemented and energy consumption and purchase of HCFC-22 is reduced at project site.

- Related outputs:

1. The planned technical conversions at the selected project sites are carried out.

- Performance indicator: Numbers of installation converted from HCFC-22.

2. Improved capacity/knowledge of installation technicians.

- Performance indicator: Number of technicians trained.

3. National policy-makers are provided with targeted outreach on the benefits of refrigerants with low global warming potential.

Performance indicator: Number of regulations updated.

5.7 COUNTRY-LEVEL COHERENCE

It is important to note that the ongoing HPMPs of the countries will be used as "baseline projects". The HPMPs of the countries are being implemented by UNIDO and the other implementing agencies of the Multilateral Fund. (By the World Bank in Viet Nam, jointly by UNEP as lead- and UNIDO as co-implementing agency in the Gambia and exclusively by UNIDO in Morocco.) During the preparatory phase of this proposal, the scales of activities were defined particularly in reflection to these ongoing HPMPs. This careful planning ensures that the proposal will complement and not overlap with the work undertaken during the first stage of the HPMPs.

6 MLF'S REQUIREMENTS FOR PROJECTS INVOLVING FUND MOBILIZATION

6.1 ENSURING SUSTAINABILITY OF PROJECTS

The projects aim at identifying the best technology options for replacing HCFC-22-based industrial refrigeration facilities in different sectors, climates and environments. Pilot conversions will enable generating experiences on the adoption of low-environmental impact technologies in the conversion of existing industrial refrigeration installations, including cost for conversion and assessment of climate benefits. The projects will provide information on most suitable financial mechanisms to leverage additional funds to promote the conversion of the remaining similar industrial refrigeration installations, including fishing vessels.

From the implementation of the approved pilot cases, UNIDO's ultimate goal is to gain experience and expertise that can be used to better assist various countries in developing their national strategy for the HCFC-22 phase-out in the fishing / food processing sectors.

Besides the above mentioned, the demonstrated willingness of the potential partners gives the promise of a successful cooperation for sustainable project outcomes.

6.2 ADDITIONALITY

6.2.1 Elimination of ODS

The projects in Viet Nam, the Gambia and Morocco aim to replace HCFCs with non-ODS, low GWP alternatives, thereby eliminating the use of ODS for refrigeration. As a result of the implementation of the projects, the emission of ODS would decrease to zero.

The UNFCCC's Clean Development Mechanism (CDM) determines a project to be "*additional*" "… *if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the proposed project*"[20]. In other words, the project must demonstrate that a Business-As-Usual scenario would not result in the project taking place and there will be no emission reductions.

The CDM Board provided examples that demonstrate "additionality" for small scale projects, and advises project developers to "…*identify the most relevant barrier and provide transparent and documented third party evidence such as national/international statistics, national/provincial policy and legislation, studies/surveys by independent agencies etc*". The CDM Board recently elaborated on the definition of "*additionality*" when relevant to developing projects within a Programme of Activities[21] which remains similar to the definition above. Tools have been developed by the UNFCCC to demonstrate and assess additionality[22].

The CDM Board described a number of barriers to implementing the project, including those related to investment, financial (loan), technological and regulatory/policy instruments. In general, the project should demonstrate additionality by providing information that shows 1) there is no regulation or incentive scheme in place covering the project; or 2) the project is financially weak or not the least cost option; or 3) there is a country risk with the implementation of new technology in the country[2].

Each barrier identified by the Board, its definition and best practice examples to demonstrate that a project is "*additional*" are shown in Annex 5. The relevance of these barriers to UNIDO's projects in Viet Nam, the Gambia and Morocco is also shown in Annex5.

The proposed projects in Viet Nam, the Gambia and Morocco would comply with most of the criteria used in the CDM for "additionality", even though compliance with only one of the criteria would be necessary to demonstrate "additionality". For example, replacing HCFCs with HFCs would cost $143,400 compared with $251,500 for ammonia, but emissions (direct and indirect) would be 50% higher with HFCs than NH3. The project has additionality as a less-costly alternative (HFCs) would have led to 50% higher emissions. Similar examples can be developed for other 'additionality' criteria shown in Annex5.

6.2.2 Improvements in energy efficiency

Energy efficiency improvements reduce the energy use per unit of activity. Because the cost of energy is increasing in many countries, there is an increasing interest in minimizing energy use and improving profitability. Electricity charges also play a major role in the control and running of cold stores in Viet Nam and the Gambia as operators try to limit the operation of their refrigeration plants to the lowest tariffs periods, and sometimes even over-ride the plant automatic controllers.

The projects aim to replace HCFCs, thereby eliminating the use of ODS for refrigeration. UNIDO for instance estimated that a cold storage facility in Viet Nam operating on ammonia

[20] UNFCCC. 2011. CDM Methodology Booklet. Glossary [of Terms], p236. November 2011.
[21] UNFCCC. 2011. Standard for demonstration of additionality…for programme activities. EB65 Annex 3.
[22] UNFCCC. 2012. Methodological tool for the demonstration and assessment of Additionality. Vers. 06.0.0. EB65Report, Annex 21: 13pp.

would consume 24% less kWh/year of electricity than the existing facility that operates on HCFCs.

When demonstrating and assessing '*additionality*' under the CDM, "… *changing the technology with and without a change to the source of energy (including an energy efficiency improvement)*" is one of four types of measures that are applicable for reducing greenhouse gas emissions[22]. Therefore energy efficiency improvement is one of the core 'additionality' criteria for which measures have been developed, even though a 'reduction in energy' is grouped within the jargon of the CDM as 'additional'.

The CDM has developed methodologies for projects that use steam, pump water, make silicon and ferro alloys, replace inefficient boilers for space heating, light bulbs, chillers, power plant turbines, domestic refrigerator production, and fuel switching in new buildings[23]. Elements in these methodologies would be applicable to additionality tests for projects involving energy efficiency improvements related to the replacement of HCFCs.

In order to quantify the reduction in GHG emissions (direct and indirect) as a result of the change to non-ODS, low GWP alternatives, UNIDO will need to accurately assess the reduction in energy consumption by undertaking an energy audit. This will require an examination of the electrical consumption of the building and equipment over a number of years. A register will need to be developed of the equipment and its operational time, when relevant its capacity and power estimates. The thermal characteristics of the buildings will need to be determined with k values determined for the existing and future insulation. Load profiles for the cold stores need to be examined over several months. It is important to draw up an Energy Balance for the building and its equipment, and to make sure that the 'balance closes' and that there are no 'unexplained' gaps in the supply and demand. This procedure needs to be standardized so that benchmarking can take place between the existing and other cold stores in the project sites.

6.3 AVOIDANCE OF PERVERSE INCENTIVES

A perverse incentive is one that "… *has an unintended and undesirable result which is contrary to the interests of the incentive makers*".

The funding of HFC-23 abatement as a by-product of HCFC-22 production is often used as an example of a "*perverse incentive*". Although the CDM methodology contains a cap on HCFC-22 production eligible for crediting, the incentives from the CDM resulted in more HCFC-22 being produced (to generate HFC-23) than would have been produced without the CDM. Increased production of HCFCs was not intended by the Parties to the Montreal Protocol that agreed in 2007 to significantly accelerate the phase out of HCFCs[24]. As a result, the HFC-23 abatement projects have generated almost half of the Certified Emission Reductions generated under the CDM as the return on investment through the carbon market is 70-90 times more than the cost of destroying HFC-23[27]. Since 2007, 19 HFC-23 abatement projects have been approved including eleven in China, five in India and one each in Argentina, Mexico and South Korea[27]. Changes[25] to the methodology[26] that were recently approved by the CDM

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[23] UNFCCC. 2012. Approved large scale methodologies related to energy efficiency improvements: AM0017 (steam), AM0020 (water pumps), AM0038 (silicon and ferro alloys), AM0044 (boilers), AM0046 (light bulbs), AM0060 (chillers), AM0062 (power plant turbines), AM0070 (domestic refrigerator production), AM0091 (fuel switching in new buildings). CDM Methodologies.

[24] UNEP. 2007. Decision IXX/6: Adjustments to the Montreal Protocol with regard to Annex C, Group 1, substances (hydrochlorofluorocarbons). Ozone Secretariat website.

[25] UNFCCC. 2011. Report of the 65th Meeting of the CDM Board. Paragraph 86: Summary of changes to AM0001 methodology.

[26] UNFCCC. 2011. Approved baseline and monitoring methodology AM0001 "Decomposition of fluoroform (HFC-23) waste streams. Vers. 06.0.0. Annex 10 of EB65.

Board with the aim of eliminating this perverse incentive are believed by some to be insufficient[27].

The MLF, in establishing the Terms of Reference[28] for the audit of HCFC production in developing countries, aimed to determine if the high HCFC-22 production was driven either by the demand for feedstock for TFE/PTFE or refrigeration purposes, or for financial reward of the CDM credits. Tetrafluoroethylene, the direct reaction product of HCFC-22, is not just used to make PTFE polymer, but is also used to make HFC-125 which is one component of R410a. The audit was required to collect national and individual plant data, place them in the global context for a supply and demand analysis, and assess the impact of the CDM on an individual company, as well as on national and global situations.

6.3.1 Other activities that might result in a perverse incentive

There are concerns that carbon payments for destruction of ODS will result in virgin ODS being deliberately contaminated and then submitted for destruction. As the projects in Viet Nam, the Gambia and Morocco do not require destruction of the HCFCs, they might legitimately be placed on the market as recycled HCFCs that could be used for servicing of equipment. A perverse incentive related to destruction therefore is unlikely to eventuate.

6.3.2 Organizational activities that guard against perverse incentives

Unlike the CDM review process that failed to act in a timely manner to address deficiencies in the methodology that led to the perverse incentives associated with the production of HFC-23, the MLF has a number of procedures in place that make the likelihood of perverse incentives unlikely. The MLF activities that limit the liability of the Fund to perverse incentives include:

1) Timely project assessment and review through various MLF committees, most notably the ExCom. The ExCom routinely requests further information on a project as part of the process of deciding whether or not to fund the project;

2) Timely modification of the HPMP requirements to ensure appropriate action by Parties e.g. for all submissions from the 68th Meeting onwards, the MLF requires notification by the Party requesting funds for HPMP that an enforceable national system of licensing and quotas for HCFC imports and, where applicable, production and exports is in place and that the system is capable of ensuring the country's compliance with the Montreal Protocol HCFC phase-out schedule for the duration of this agreement[29];

3) Projects for the conversion of HCFC-based manufacturing capacity installed after 21 September 2007 would not be considered. This restricts the quantity of HCFCs that would need to be phased out, in the event that some facilities are installed after this date. Since HCFC consumption has continued to increase after this date, it is reasonable to assume that in many countries additional facilities have been put in place for which the fund is not liable.

4) The MLF reduces its liability for ODS phase out by operating at a country level.

In addition, it is important for the MLF establish a registry that contains the relevant details for projects that are co-financed with the MLF. Such a registry could be checked to reduce the risk of duplication of requests, or conversely that a single enterprise is not “double dipping” for funds from multiple sources. These aspects are discussed further in Section 6.4.

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[27] EIA. 2012. Response to call for public inputs on issues to be addressed in the CDM policy dialogue. UNFCCC website.

[28] MLF. 2010. Terms of Reference for the Technical Audit of HCFC Production in Article 5 countries. UNEP/OzL.Pro/ExCom/60/54 Annex IX para 4.

[29] MLF. 2011. UNEP/OzL.Pro/ExCom/63/60, Decision 63/17 para 71

In addition, it is important that the MLF does not specify eligibility criteria based on the minimum size of the cold store equipment, as those with smaller equipment may increase the size in order to comply with a the project criteria.

6.4 AVOIDANCE OF DUPLICATION

All GHG programmes must address double counting of GHG emission reductions and removals to ensure environmental integrity. Duplication of projects has been an issue in projects in the Kyoto Protocol, the EU Emissions Trading Scheme and the Voluntary Carbon Market that have the potential to claim the same greenhouse gas credits more than once.

The term double counting can refer to *Double Monetization* which occurs when a singular GHG emission reduction or removal is monetized once as a GHG credit and a second time as a GHG allowance[30]. GHG programmes can address this by requiring the cancellation of GHG allowances on the back of credit issuance. *Double selling* occurs when a single GHG emission reduction or removal is sold to multiple buyers.

Rules have been developed to guard against both eventualities in all reputable protocol standards that have been developed to track carbon offsets[31]. Similar rules could be adopted in the MLF's resource mobilization projects to guard against programme participants making multiple claims for financial support for the same project. GHG programmes can address this through oversight procedures such as a registry (see Section 6.6) that could be developed for resource mobilization projects.

6.5 TRANSPARENCY AND GOOD GOVERNANCE

6.5.1 Transparency

UNIDO has developed an Enterprise Resource Planning (ERP) system to improve transparency, information flow, efficiency and effectiveness[32]. ERP facilitates the flow of information between all business functions inside an organization and manage the connections to outside stakeholders. Built on a centralized database, ERP systems consolidate all business operations into a uniform and organization-wide system environment.

ERP provides an integrated suite of IT applications that, following best practice, support business processes and activities such as project management, human resource management, finance, procurement and other corporate core functions, both at Headquarters and the field. The implementation of an ERP system will deliver a fully transparent end-to-end process from identification of needs to achievement of project results i.e. the whole project cycle on one ERP platform; and it will share information without duplication, seamlessly connecting operations at Headquarters and field and across business functions and units.

ERP is part of UNIDO's Programme for Change and Organizational Renewal (PCOR) that aims to increase organizational efficiency and effectiveness by fundamentally changing UNIDO's way of doing business and, at the same time, promote a proactive work environment, organization-wide knowledge sharing, risk management and better results-based management to allow for consistent reporting of results to all stakeholders.

6.5.2 Good governance

Since 1994 UNIDO and UNEP have been partners in the establishment of National Cleaner Production Centres (NCPCs), which are currently operational in over 40 countries. These

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[30] VCS. 2012. Double counting: Clarification of the rules. VCS 1 February 2012.

[31] 3Degrees. 2011. Carbon Protocols, standards and registries: Climate Action Reserve; Clean Development Mechanism; Good Standard Foundation; Verified Carbon Standard; Chicago Climate Exchange (CCX).

[32] UNIDO. 2012. What is ERP? UNIDO website.

NCPCs provide services to businesses, governments and other stakeholders in their home countries for the promotion and implementation of cleaner production methods, practices, technologies and policies.

NCPCs have a unique mandate to combine the delivery of services that serve the specific interests of clients with activities that benefit the business sector and society at large. The latter public interest activities can include advocacy, information dissemination, networking and policy advice at the national and sub-national levels. The key elements and key factors are not only applicable to NCPCs but also to service providers with dual public interest and private benefit service mandates in energy efficiency, productivity and quality management

UNIDO has developed a primer[33] that provides information on good organization, management and governance practices for organizations that fulfill at least in part a public good role, and practical applications for providers of RECP services in different regions. Governance is defined as "*… the processes and interactions by which the organization engages and consults with its stakeholders and accounts for its achievements. Governance characterizes how things are decided and then realized within an organization, be it a government or a company. Governance determines how organizations are directed, administered or controlled*".

This primer developed by UNIDO and UNEP provides information on the role and composition of a board; procedures used to control, decide and govern; transparency and accountability; conflicts of interest; stakeholder engagement and external communication; operational management; financial management; other aspects.

At present there is no common agreement on how governance can be specifically applied to resource mobilization projects that are implemented for improvements in energy efficiency. UNIDO is willing to work with other agencies and the MLF to use rules and procedures that have been developed to track carbon offsets and other relevant programmes, such as establishing a board and advisory groups; setting boundaries on project eligibility and geographic restriction; defining what types of energy efficiency projects would be included; defining validation and verification procedures; defining the project approval process; establishing a registry; establishing rules to avoid double counting and accounting for energy efficiency reductions; and providing financial information on transaction costs.

6.6 REGISTRY

A "Registry" has recently come to mean a central depository of accounts for the holding and trading of Carbon Credits. A registry provides carbon market participants with a secure and reliable system to manage credits associated with greenhouse gas reductions. The registry typically manages issuance, holding, transfer, acquisition, cancellation and retirement of credits. It aims to ensure transparency (via websites) and traceability for each credit from emission to retirement, avoiding double counting. Once a carbon credit is cancelled or retired, it will cease to exist and thus cannot be traded or utilized for any future offsetting purposes.

The MLF already operates a registry for projects that have received funding for the reduction and phase out of ozone depleting substances and associated activities. One option is to expand the MLF registry to include organizations that have received funding for energy efficiency. Other options are to explore the possibility of using a non-MLF but existing database to include resource mobilization projects, or commencing with a new database that would reside with one of the implementing agencies. Criteria that have been used to establish

[33] UNIDO. 2010. Good organisation, management and governance practices: A primer for providers of services in Resource Efficient and Cleaner Production. UNIDO.

registries by organizations to track carbon offsets[31] could be used for guidance in the development of any new registry.

6.7 FINANCIAL INFORMATION ON TRANSACTION COSTS

Transaction costs typically apply for the project preparation and registration of project on the carbon market are shown in Table 3.

Table 3: Indicative transaction costs for project preparation and registration in the carbon market

Item	Description	$
Project preparation	This is typically the cost of consultant support to undertake an initial feasibility assessment, develop project documents, and support the validation and registration processes. This cost may be considerably lower than estimated if local consultants (in-country) are used or, particularly, if expertise exists in-house to undertake these tasks.	Zero to 60,000
Third party validation	This one-off fee is largely a fixed cost, but might be slightly reduced for particularly simple or small projects. Note that this fee is not required for CCX or the Reserve.	Zero to 40,000
Third party verification (annual)	Like the cost of validation, this cost is largely fixed, but might be slightly lower for particularly simple or small projects. For projects carried out on an on-going or multi-year basis, this would be an annual cost.	20,000
Project fee	Some standards charge a project submission fee. For example, the Reserve charges US$500 per project.	Zero to 500
Issuance/ registration fee	Some standards charge an issuance fee per credit (tCO2e) issued. For example, CCX charges 0.15 US$/tCO2e, while the Reserve charges 0.20 US$/tCO2e.	$0.05 – 0.20 tCO2eq

Source: See footnote 2.

UNIDO does not plan to apply for carbon finance for the resource mobilization projects that achieve energy reductions as a result of upgrading the technology. Reasons for not giving preference to the carbon market as a source of finance at this stage were provided in Section 3.4.4 on the Clean Development Mechanism. UNIDO does not therefore believe that transaction costs are applicable at this time.

7 GUIDANCE ON THE DEVELOPMENT OF PROJECTS LINKING HPMPs WITH ENERGY EFFICIENCY PROGRAMMES

Based on the report by the MLF Secretariat of the experiences of implementing agencies in fund mobilization activities for the replacement of CFC chillers, UNIDO will put in place a range of activities relevant to mobilizing funds for energy reduction projects.

The experience in the implementation of chiller projects, with an important co-financing component, suggests that significant delays in HCFC phase-out projects might occur due to difficulties in arranging co-finance from regional or multilateral sources. UNIDO and other agencies are aware that such delays are creating potentially large challenges in achieving the planned outcomes. UNIDO has carefully examined the experiences of agencies recorded in the MLF Secretariat's report on fund mobilization. In response, UNIDO will make every effort to expedite financial arrangements by, for example, carrying out as many activities as possible in parallel and bringing the attention of the project to potential financial partners as early as possible.

Activities related to project Analysis, Design, Implementation, and Verification and Reporting are summarized in Annex6.

7.1 ANALYSIS

The initial phase of the project commences with obtaining the most accurate inventory possible of equipment that will be replaced by the project. The local industry or association will be a useful partner who may already have a list of enterprises together with their contact details. Such geographic data is important for analyzing the scope of the project. Questionnaires can be sent to enterprises to obtain technical details on the type and age of equipment, refrigerant, capacity and operational sector (transport, food etc). An accurate inventory is essential for sound planning, for initializing discussions with clients and for determining the clients' interest in a potential project.

The clients may have records (invoices, payments) of electricity consumption over several years, which will be essential for establishing baseline energy consumption. It will be important to include back-up generator consumption of diesel as in many developing countries electricity supply is intermittent and generators are essential during such black-out periods. It is important to examine the records under different loadings (e.g., empty store versus full store) on the refrigeration equipment, which may vary according to the time of the year and the main activity of the client e.g., export of frozen food. Clients that have kept detailed information useful for the baseline will be preferred and should be selected in preference so those that have insufficient records. In this way, a detailed energy audit can be taken into consideration.

In parallel with these activities, the National Competent Authority may wish to provide information on regulatory instruments that are in force or planned for the near future on ODS requirements, energy efficiency targets or standards. Energy suppliers may be under a requirement to participate in demand-side management of energy. There may be a requirement, for example, for owners of equipment to put in replace equipment that exceeds a specific energy threshold. Any tariff policies in place that encourage efficient use of electricity should be documented. Sometimes the government has in place subsidies for the installation of energy saving equipment, or taxes for electricity consumption that is higher than the industry average.

UNIDO will review the technology that is available to replace the ODS-technology, including its availability, cost, operating conditions (high, low pressure), ODP/GWP, energy efficiency rating, reliability, suitability, maintenance, end-of-life disposal options and other factors. Local suppliers will be requested to supply estimates of costs for some of the equipment in order to begin the cost estimates. The opinion of the clients on the type of replacement technology will be sought in order to determine whether in their view a particularly type of technology upgrade is regarded more favorably than others, and the reasons for their opinion. This can be helpful in formulating prospective training programmes for maintenance and safety, if these become necessary when associated with particular technology e.g., ammonia.

Annex6 summarizes these activities and suggests entities that would be primarily and secondarily responsible.

7.2 DESIGN

Based on the work undertaken in the analysis, the design phase aims to define the project in terms of the type of technology upgrade recommended, the financial support that will be needed, awareness raising activities with the clients that are suitable for the project, and a list of actions that should be undertaken by the owners of the equipment.

The technology should be based on calculations such as TEWI demonstrating the environmental benefit of the upgrade. The percentage energy reduction for the clients should also be calculated and demonstrated to the clients. From these calculations, the clients will be involved in the likely estimates of energy cost savings for their facility, as this will translate into reduced operational costs.

These savings are also need to demonstrate to financial institutions the quantity of CO2 that will be avoided, as direct (emissions) and indirect (electricity), based on average estimates of CO2 emission values for the country with mixed (hydro, oil) energy sources. UNIDO will not pursue Certified Emission Reduction credits via the Kyoto Protocol's CDM (for reasons provided above) in this project, but will remain open to this potential source of revenue in the future. The quantity of CO2 avoided is needed by many finance organizations to demonstrate the environmental value of a project within the climate change context.

UNIDO will seek support from a range of financial partners, in particular the GEF, the European Commission and local financial institutes. A list of 19 potential financial partners that specialize in energy efficiency projects is shown in Annex7 and bilateral partners in Annex8. UNIDO has already communicated its intentions on this project with partners such as the GEF and European Commission and will follow up with them in more detail in the near future to determine their willingness for financial support. The GEF has a strong track record in energy efficiency projects and ESCO development in particular and would be a valuable partner in the UNIDO projects that demonstrate energy reduction and other environmental benefits. The European Commission founded a Regional Fund Support Facility, which is administered by the European Investment Bank group within its Global Energy Efficiency and Renewable Energy Fund activities.

UNIDO will commence awareness raising activities with relevant associations (e.g., seafood exporters, cold store) and owners in order to begin the process of communicating the technology upgrade path, estimates of costs and value of the project to the owners (e.g., environmental benefit, enterprise environmental reputation, reduced operating cost). UNIDO will work with local Cleaner Production Centres (such as the ones in Viet Nam, the Gambia and Morocco) that have been formed to add focus to national activities that improve the environmental performance of key enterprises that improve the GDP income of the country, such as food exporters.

UNIDO will address uncertainty in the project by proposing training on particular aspects such as safety and maintenance. Local enterprises that can deliver training courses on these aspects will be invited to the awareness programmes so that they can better understand the context of any future training programmes.

UNIDO is mindful that these awareness programmes are addressing future clients that cannot be funded in the programme but should be encouraged to adopt more efficient technology. The awareness programme would therefore also be an opportunity for participants to hear from government representatives on legislation incentivizing technology change, such as subsidies for equipment (e.g., import duty waived), taxes and tariffs for electricity consumption above a threshold, electricity supply company demand-side energy efficiency initiatives, energy audits, penalties for non-compliance and enforcement.

At these meetings, the government representatives may wish to suggest the use of log books that remain with the equipment to record basic maintenance operations, in particular the refilling of equipment with refrigerant as this provides valuable information on annual emissions. Later the log books can be used as part of an electronic database to better monitor equipment performance and to identify makes and models that have better environmental performance.

At the awareness raising seminars, UNIDO will describe best practices for recovery, reclamation and recycling (RRR) of ODS. In the event that RRR is inadequate, UNIDO will put in place training programmes that provide academic and practical exercises. UNIDO will ensure centralized storage of contaminated ODS that is and not recyclable so that it can be destroyed in an environmentally acceptable way at a later date. HCFCs recovered from the replacement of chillers and small commercial equipment will be recycled not only to ensure a smooth transition and to reduce the risk of illegal trade, but also to provide a cost-effective alternative of reducing global warming. In this way, the technology upgrades in the commercial refrigeration sector will address climate (energy efficiency improvements, global warming avoidance) and ozone layer benefits (emissions avoidance). Discussions will be held with the government to promote the sustainability of training for RRR, such as courses approved the Ministry of Education for delivery by accredited third-party organizations possibly in collaboration with local refrigeration associations.

UNIDO will initiate capacity building with the government in areas where there is mutual agreement of the need for, and benefit from, such effort. The capacity building should be focus on the enabling policies and measures that will promote energy efficiency. UNIDO will work with permanent (rather than temporary) government representatives in order to promote programme sustainability.

Annex6 summarizes these activities and suggests entities that would be primarily and secondarily responsible.

7.3 IMPLEMENTATION

UNIDO will engage specialists in energy measurement to determine baseline energy consumption for each facility in the period leading up to the installation of the new equipment. These specialists will be guided by "*The Industrial Energy Audit Guidebook: Guidelines for Conducting an Energy Audit in Industrial Facilities*"[34], which provides guidelines for energy auditors regarding the key elements for preparing for an energy audit, conducting an inventory and measuring energy use, analyzing energy bills, benchmarking, analyzing energy use patterns, identifying energy-efficiency opportunities, conducting cost-benefit analysis (including payback periods), preparing energy audit reports and undertaking post-audit activities. The guidebook assists energy auditors and engineers in the plant to conduct a well-structured and effective energy audit, and to produce a report that follows a similar outline to that shown in **Error! Reference source not found.**.

The performance of the equipment needs to be tested under full and partial loads in order to determine system efficiency. Partial-load efficiency (integrated part load value) is preferred for more variable loads accompanying variable ambient temperature and humidity, which is the more common situation. Full-load is appropriate where the cold store load is high and ambient temperature and humidity are relatively constant.

Overall, selecting a high-efficiency chiller does not guarantee high performance. It is cost effective to combine chiller replacement with other measures that reduce cooling load. An integrated refrigeration equipment/control system upgrade with improvements to the insulation of the cold store provides the best outcome for energy efficiency. Investments in insulation improvements to reduce the cooling load can be quickly recouped through reduced operating costs. An energy audit is needed to determine the savings potential of various efficiency improvement measures.

As a result of the energy analysis, UNIDO will provide advice to the government on amendments to policies and measures that would motivate owners to upgrade refrigeration

[34] Hasanbeigi A. and L Price. 2010. *The Industrial Energy Audit Guidebook: Guidelines for Conducting an Energy Audit in Industrial Facilities*. China Energy Group and Environmental Energy Technologies Division, US Government.

equipment to more energy efficient technology. Such measures could include compulsory audits, obligations for owners to transition if their consumption exceeds the legislated threshold, promotion of tariff policies for electricity designed to deter consumption above the threshold, and tax breaks for owners that comply with requirements. The government should develop and maintain information in a database that can be accessed by multiple stakeholders and that contains data to demonstrate the value of these policies and measures in reducing energy consumption.

UNIDO will undertake further activities on awareness raising, including reporting to stakeholders on progress in the project and steps that have been taken to overcome difficulties in the programme. UNIDO will put in place a management structure composed of government and enterprise stakeholders to promote the smooth financial (within budget, on time) and technical management of the project. Milestones in the project will be documented and progress reported to the owners on a regular basis.

UNIDO aims to ensure that owners of equipment are kept abreast of steps being taken to secure finance for the project from multiple partners. In this regard, and based on the experiences of the chiller programme, UNIDO will aim to engage the financial partners in the selection of financial instruments as early as possible and to work with private funding organizations that have generally less bureaucracy than publically-funded organizations. The involvement of ESCOs will be encouraged as they can implement cost effective programmes that are attractive to equipment owners, and GEF has demonstrated financial support for the work of ESCOs.

UNIDO will ensure that the financiers are aware of a pipeline of opportunities for the implementation of energy efficiency technology, since the project as a demonstration aims to provide examples of what can be achieved. UNIDO will partner with the government and local associations to deliver awareness programmes to owners of refrigeration equipment in the demonstration project.

The RRR programme will be actioned, as described in the design phase. UNIDO will ensure that owners are aware of their obligations on ODS recovery, and seek the support of the government in putting in place policies and measures that will set standards for RRR, and training to achieve those standards. Arrangements will be made for centralized storage of ODS that cannot be recycled, and records will be kept of quantities of ODS stored for destruction. UNIDO will work with the relevant education ministry to promote mainstreaming of RRR courses into the educational programme for technicians, so that training continues in a sustainable way after the demonstration projects have concluded.

UNIDO will ensure that HCFC equipment is not recycled to other facilities and that it is destroyed after being converted. An “equipment destruction report” will be produced toward the end of the demonstration project for storage by the NOU.

7.4 VERIFICATION AND REPORTING

UNIDO will verify the quantity of ODS recycled or destroyed, and the energy reduced as a result of the refrigeration technology upgrades. UNIDO and the government can prepare reports for stakeholders based on a common set of data. For example, the Cleaner Production achievements are important to many government programmes; the Energy Ministry would require information on the energy saved, and potential for further energy reductions with more widespread use of the technology; and the Parties to the Montreal Protocol require information from the competent authority on reductions in the consumption of ODS.

UNIDO will assist in the joint preparation of reports where this is required, and in providing reports to financial partners including the MLF. Special reports will be prepared on energy savings and reduction of greenhouse emissions, since these programmes are at the inception stage and therefore subject to greater scrutiny than more established programmes.

Annex 1: Reducing GHG and ODS emissions in Viet Nam, Morocco and the Gambia

GEF CCM1 & 2 Project Concepts

In order to expand linkages between HCFC phase-out under the Montreal Protocol and other environmental issues, such as climate change and energy efficiency, the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol decided at its 63rd meeting to approve funding for UNIDO to prepare project proposals to identify potential sources of co-financing to cover costs that are not eligible under the Multilateral Fund but that could generate climate benefits as the result of HCFC phase-out.

The Executive Committee is interested in establishing a platform to explore and promote synergies between the UNFCCC and the Montreal Protocol. This is consistent with the GEF's Climate Change Mitigation Objective 2 that seeks to "build synergy across global environmental conventions", which may "extend to supporting the phase-out of hydrochlorofluorocarbons (HCFCs) used in industry and buildings such as chillers, air-conditioners, and refrigerators, even before the required phase-out dates under the Montreal Protocol."

Recent support from the Multilateral Fund of USD 200,000 allowed UNIDO to appoint national and international consultants to visit three countries to explore possibilities for projects minimizing the discharge of chemicals damaging to the ozone layer and greenhouse gas emissions thereby building synergies across global environmental conventions.

The three countries – Morocco, The Gambia and Viet Nam – were chosen to target a broad range of operating conditions, social, political and economic environments.

In each country refrigeration, specifically in the fish-processing sector, was selected for review as it is a significant source of GHG emissions and user of Ozone Depleting Substances (ODS). Globally, the IPCC has estimated the global potential for mitigating GHG emissions in the refrigeration sector through 2030 through ODS substitutes as 80 MtCO2e, and the potential for mitigating GHG emissions in industrial facilities through more-efficient equipment is high (IPCC AR4, Working Group III, Chapter 7).

Based on the above fieldwork and subsequent analysis, UNIDO has developed the three concepts listed in Table 1 to be presented for GEF funding. This group of projects explores a range of alternative ("natural") refrigerants including ammonia-brine systems and CO2 cascade, and low-GWP refrigerants such as HFOs, along with reduction of leaks of ozone depleting substances and implementation of energy efficiency solutions. These refrigerants have virtually zero Global Warming Potentials, which are substantially below that of the currently used HCFC-22 (GWP of 1700), or the baseline alternatives like HFC-404A (GWP 3922).

Each project will include the preparation of lessons learned analysis for scale-up and replication in other countries worldwide. As part of its commitment to exploring synergies between the Montreal Protocol and the GEF, UNIDO will take leadership on synthesizing and disseminating lessons from these projects.

Table 4. UNIDO GEF-MP Concepts

Country	Proposed Project	CCM	Focus	Requested GEF Grant	Anticipated Co-financing
Morocco	Demonstration of leapfrogging technology for reducing GHG and ODS emissions in fishing vessels	1 and 2	Cold storage conversion on fishing vessels using a cascade system of CO2 and HFO1234ze This is an emerging innovative technology ready for demonstration and deployment	900,000	2,750,000
Viet Nam	Improving Energy Efficiency and Reducing ODS Emissions in the Cold Storage Sector in Viet Nam	2	Conversion of cold stores to ammonia-brine systems This is an established proven technology in Europe, ready for technology transfer	600,000	2,300,000
The Gambia	Improving Energy Efficiency and Reducing ODS Emissions in the Industrial Refrigeration Sector in The Gambia	2	Industrial refrigeration in food processing and tourism, using energy efficiency improvements, reduced refrigerant leaks and improved refrigerant quality This project focuses on creating the enabling environment for cost effective mitigation and preparation for technology transfer.	300,000	860,000

Annex 2: Improving Energy Efficiency and Reducing ODS Emissions in the Cold Storage Sector in Viet Nam

GEF CCM-2 PROJECT CONCEPT FOR VIET NAM

PROJECT OBJECTIVE

The objective of the project is to reduce greenhouse gas emissions by creating a market for the use of natural refrigerants in cold storage facilities in Viet Nam that currently consume HCFC-22 for servicing and maintenance purposes. The project as a whole will focus on synergies between the UNFCCC and the Montreal Protocol and will also reduce ODS emissions.

As consistent with the CCM-2 focal area strategy, the project will: (1) adopt and enforce appropriate policy, legal and regulatory frameworks for the further conversion of HCFC-22 based facilities; (2) leverage sustainable financing, including sources from the HCFC Phase-out Management Plans (HPMP) approved by the Multilateral Fund for the Implementation of the Montreal Protocol; and (3) offset GHG emissions through two pilot projects.

The Vietnamese Government is committed to adopting and enforcing standards and regulations that are essential for the project to have an impact through replication. Viet Nam signed the UNFCCC in June 1992, ratified it in November 1994 and it entered into force in February 1995. Viet Nam also ratified the Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol and its Amendments on 26 January 1994.

PROJECT SUMMARY

Equipment upgrades will greatly reduce the emission of ozone depleting substances (ODS) and greenhouse gases by replacing HCFC-22 with natural refrigerants with very low global warming potentials. The proposed demonstration projects will serve as a pilot for the conversion of other cold storage facilities in Viet Nam and elsewhere in both the choice of technology and project parameters.

The project will include three components in order to develop a market for natural refrigerants in the cold storage sector:

1) Policy and regulatory support;
2) Technology transfer; and
3) Capacity building and awareness raising.

Anticipated outcomes and activities are described in the “Project Components” section below.

BASELINE: CONTEXT, BARRIERS AND BASELINE PROJECT

Context

Viet Nam is one of the leading countries for aquaculture, aquatic product processing and export in the world. According to the Ministry of Natural Resources and Environment (MONRE), there are close to 400 cold storage facilities in the country used for fisheries, each with an average of 10 refrigeration machines running on HCFC-22, for a total of around 4,000 units with capacities between 10 and 200 HP. The majority of cold storage equipment is domestically manufactured using second-hand or locally produced compressors and unit coolers. Due to the age and the particular design of the cold storage systems, the overall efficiency is generally low and there is great room for improvement, and, when it becomes necessary for equipment to be upgraded, owners are currently likely to favour the use of HFCs that have very high global warming potentials.

In order to expand linkages between HCFC phase-out under the Montreal Protocol and other environmental issues, such as climate change and energy efficiency, the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol decided at its 63rd meeting to approve USD 200,000 for UNIDO to prepare two project proposals to identify potential sources of co-financing to cover costs that are not eligible under the Multilateral Fund but that could generate climate benefits as the result of HCFC phase-out. Globally, the IPCC has estimated the global potential for mitigating GHG emissions in the refrigeration sector through 2030 through ODS substitutes as 80 $MtCO_2e$, and the potential for mitigating GHG emissions in industrial facilities through more-efficient equipment is high (IPCC AR4, Working Group III, Chapter 7).

Support from the Multilateral Fund allowed UNIDO to appoint national and international consultants to visit cold storage facilities in Viet Nam to collect information on the HCFC-22 technology used, leakage rate, size, age of refrigeration plant, and accessibility, as well as the willingness of the owners and operators to convert to a different refrigerant. Based on this information, two sites were selected for pilot conversion and a full assessment on the best alternative technology was done. For both cold storage facilities, an ammonia brine system is considered to be the most appropriate alternative, bringing the most climate benefits in terms of reduction of emission of CO_2e and its ease of use compared to system based solely on ammonia. Furthermore, the pilot projects would boost GHG reductions by introducing more energy-efficient equipment such as variable speed drives, highly-efficient compressor systems, and highly-efficient evaporator and condenser fan motors, among others.

According to estimates, the replacement of both HCFC-22 systems to ammonia brine systems would result in a total reduction of 510 tCO_2e per year. If the project penetrates a 10% of the cold storage market in Viet Nam (i.e. 40 facilities with 400 refrigeration units, respectively), GHG emission reductions over a 10-year project lifetime would total approximately 1.02 $MtCO_2e$.

Viet Nam has committed itself to the phase-out of HCFCs through the approval of its HCFC Phase-out Management Plan (HPMP) by the Multilateral Fund of the Montreal Protocol in 2011. The Vietnam HPMP addresses the conversion of facilities using ODSs in their manufacturing processes and customs control, with stage I focusing on the foam sector, technical assistance and project management. However, the conversion of end-users and existing installations is not eligible under the Multilateral Fund. GEF support for market development for alternative refrigerants for end users with very low global warming potentials, would therefore accelerate the phase-out of HCFCs considerably, in addition to achieving GHG mitigation benefits.

Key Barriers

Policy barriers: Currently, there is an overall lack of policy and regulatory incentives to move away from HCFC-22 prior to 2040. There is also a lack of policies and measures that would encourage cold storage facilities to consider lower-carbon, low-GWP alternatives in refrigeration. Finally, there are currently no policies or regulations pertaining to the safe handling of ammonia, which hurts the perception of ammonia and ammonia brine systems among enterprise owners.

Awareness barriers: In most cases, owners' purchasing decisions are based only on initial costs instead of on the lifetime performance of the system. According to MONRE, the use of outdated equipment and the lack of good servicing and maintenance practices results in significant refrigerant losses of up to 20 – 25% of the total refrigerant charge contained in the units. In most cases, enterprises are forced to recharge every 3 to 6 months because of these leaks. Furthermore, due to a lack of planning and priority setting, owners and operators are reluctant to try new technologies -- and to invest to update or upgrade their facilities more generally -- due to the absence of planning and priority setting at the enterprise level. In the fishery sector, cold storage facilities are operated 24 hours per day, 365 days a year and only stop for maintenance and repair. Finally, awareness on the handling and best practice for ammonia in refrigeration and the advantages of ammonia brine systems in particular are still lacking among facility owners and operators.

Capacity barriers: Although most enterprises have technical staff responsible for equipment operation and maintenance, they can only handle ordinary failure or refrigerant recharge. Tools for repair and maintenance are often poor quality and only few enterprises have tools for recuperating refrigerants. For major breakdowns, the enterprises have to hire specialists from the manufacturer or from electro-mechanical companies. Because there is a lack of trained personnel in the area of ammonia, safety is still an issue connected to the use of ammonia and ammonia brine technologies.

Financial Barriers: The conversion of cold storage facilities using HCFC-22 is taking place at a very slow speed because the Multilateral Fund of the Montreal Protocol generally does not finance such conversion where energy efficiency gains could offset the capital costs of conversion. Financial barriers are also closely related to policy and awareness barriers: alternative financing options have not been identified because Montreal Protocol activities have not been explicitly linked to national industrial development programs in the cold storage sector, and enterprises are not aware of other financing alternatives.

Baseline Project

Under the Montreal Protocol, HCFCs will be no longer available for purchase after 2030. During the period 2030-2040 only 2.5% of the baseline will be allowed annually for servicing and maintenance purposes of existing installations (Decision XIX/6[35]).

[35] Montreal Protocol. 2007. Decision XIX/6: Adjustments to the Montreal Protocol with regard to Annex C, Group 1, Substances (Hydrofluorochlorocarbons), see http://montreal-protocol.org/new_site/en/Treaties/decisions_text.php?dec_id=924

Vietnam National HCFC Phase out Management Plan (HPMP) Stage I was approved by the Executive Committee at its 63rd Meeting in April 2011 with funding level of 9,763,820 USD. The project objective is to assist the Government of Vietnam to comply with its Montreal Protocol phase-out obligations for HCFCs. The project covers only Stage I of the HCFC phase-out, focusing on the foam sector. The project proposes a combination of financial incentives mainly for the procurement of equipment in the foam industries at the sector level, along with supporting Policies and Regulations, Technical Assistance Activities and Project Management (with a total of USD 600,000 from the MLF) including an import quota system to curb the supply of HCFCs and policies specifically addressing the foam sector. Technical assistance (TA) activities to support implementation of investment interventions, awareness campaigns on the need to phase out HCFCs and on future regulatory measures to eliminate HCFC use will also be carried out along with capacity building of customs officers to ensure effective control of import of HCFCs and products containing HCFCs. The HPMP therefore sets a valuable institutional and technical framework in which GEF market creation activities will take place. Under HPMP activities the price of HCFC-22 is expected to increase in the years to come due to the reductions on the HCFC-22 market availability, making the return to HCFC-22 unlikely. There are however no direct phase-out investment activities to be financed by the MLF in the cold store sector under the HPMP.

In the absence of a GEF project, the owners of cold storage facilities will have to cover the costs of conversion of HCFC-22 based systems by 2040 or by the end of operating lifetimes of the current systems if sooner. In the absence of the project, owners are likely to favor the use of HFC-404A, which has a global warming potential (GWP) of 3922, as an alternative technology, because initial replacement is simpler and initial costs would be lower than those for natural refrigerants such as ammonia or CO_2. Systems running HFC-404A are also usually based on the use of simple reciprocating compressors without the use of energy saving measures like variable speed drives, so have higher overall energy requirements. This would mean that significant reductions in the use of high GWP refrigerants would not take place and low efficiency equipment in the baseline case.

Until conversion is mandated, the two HCFC-22 based cold storage facilities selected for the pilot conversion alone will produce at least 510 tCO_2 eq. per year (both through direct and indirect emissions). Assuming that efficiency will drop with the aging of the systems and leaks increase, emissions of GHGs per year will also increase considerably.

PROJECT COMPONENTS

Component 1 *– Policy and Regulatory Support*

Component 1 is designed to increase the market share of more energy-efficient refrigeration equipment by providing policy, regulatory, and financial incentives to adopt low-GWP, higher-efficiency equipment.

Proposed activities include the following:

- Develop, adopt, and enforce appropriate national policy, legal and regulatory frameworks for the conversion of HCFC-22 cold storage facilities to natural refrigerants
- Introduce appropriate safety regulations to support the use of alternative refrigerants such as ammonia
- Link ongoing industrial development programmes in Viet Nam to Montreal Protocol activities
- Identify the most promising financial schemes for leveraging additional funds for the conversion of similar facilities.

Component 2 *– Technology Transfer*

Component 2 is designed to introduce natural refrigerant systems to the Vietnamese market and to demonstrate their effectiveness in reducing ODS and GHG emissions to both policy-makers and to facility owners and operators.

Proposed activities include the following:

- Convert two cold storage facilities from HCFC-22 use to an ammonia brine system.
- Design the facility upgrades in order to maximize energy savings (and subsequent GHG emission reductions)
- Involve the private sector in design and technology transfer activities
- Train technicians on best refrigeration practices and safe handling of natural refrigerants
- Monitor the actual performance of converted technology and evaluate the resulting energy savings

Component 3 *– Capacity building and awareness raising*

Component 3 is designed to increase demand for low-GWP refrigerant systems that are more energy efficient than existing technologies by increasing the awareness of enterprises and policy-makers of the potential benefits of these technologies.

Proposed activities include the following:

- Conduct an information and awareness campaign targeted at cold storage facility management to improve knowledge of ammonia brine systems perception of the effectiveness and safety of these systems.
- Provide targeted outreach to policy-makers on the benefits of natural refrigerants and on linking improvements in energy efficiency in the cold storage sector with national industrial development priorities.
- Provide information to stakeholders in the cold storage sector on life-cycle cost savings from more efficient systems and on financing options for adopting these systems.
- Raise awareness of environmental policies and associated HCFC phase-out legislation amongst users and other stakeholders.
- Prepare lessons learned analysis from the project for scale-up and replication in other countries worldwide.

Cross-cutting project outcomes:

- **Direct GHG reductions** from the pilot projects in Component 2
- **Indirect GHG reductions** from increased demand for the technology in the cold storage sector more generally as the result of a demonstration effect and from improved capacity to design better systems (from Component 2), improved policy and financial incentives (from Component 1), and increased awareness of the benefits of cold storage facility upgrades (from Component 3).
- **Accelerated HCFC phase-out** due to the introduction of natural refrigerants on the market through the two pilot projects (in Component 2), through increased policy and financial

incentives (in Component 1), and through improved awareness among policy-makers and facility owners of the phase-out requirements and options (in Component 3).

Implementation Arrangements

This project will be implemented through the offices of the Viet Nam Cleaner Production Centre that is located at the Hanoi University of Technology, under its host organization: Institute for Environmental Science and Technology, INEST. With INEST as host, VNCPC has good access to support staff, laboratory facilities, and a network covering the whole the country. The Vietnam Cleaner Production Centre was established on 22 April 1998. Funding for the centre activities is largely provided by the Swiss Government through the State Secretariat for Economic Affairs (SECO). Viet Nam Cleaner Production Centre is a member of the UNIDO/UNEP network of national cleaner production centres and is linked to the Institute of Environmental Technology at FHBB in Switzerland as a long-term counterpart.

TOTAL GEF GRANT REQUESTED AND EXPECTED CO-FINANCING

Out of the approved amount for the HPMP in Viet Nam, US $ 600,000 will be expected to contribute in kind to the implementation of the pilot conversion project. Indeed, US $ 600.000 have been estimated as the amount allocated between 2011 and 2015 for the implementation of those activities necessary to the GEF intervention to take place. The activities under the HPMP are indeed necessary to pave the way for the implementation of the pilot conversion in terms of capacity building, legislative interventions, training and awareness.

Besides the contribution from GEF and the co-financing in kind from HPMP, UNIDO has identified the following potential partners as additional potential sources of co-financing:

UNIDO, bilateral donors (Agence Française du Développement, European Commission and others), Government of Vietnam, installation owners, technology suppliers, Shecco (integrated Marketing & Communication expert association supporting the introduction of climate friendly technologies), National Cleaner Production Centre, Research institutes, and banks. A possible breakdown of GEF financing and cofinancing is shown in the table below.

COMPONENT	INV / TA	INDICATIVE GEF FINANCING	INDICATIVE COFINANCING	TOTAL
COMPONENT 1 – POLICY AND REGULATORY SUPPORT	**TA**	**60,000**	**402,500**	**462,500**
COMPONENT 2 – TECHNOLOGY TRANSFER	**INV**	**400,000**	**1,225,000**	**1,625,000**
TECHNICAL ASSISTANCE	**TA**	**50,000**	**95,000**	**145,000**
COMPONENT 3 – CAPACITY BUILDING AND AWARENESS RAISING	**TA**	**60,000**	**315,000**	**375,000**
PROJECT MANAGEMENT		**30,000**	**262,500**	**292,500**
TOTAL		**600,000**	**2,300,000**	**2,900,000**

Annex 3: Demonstration of Leapfrogging Technology for Reducing GHG and ODS Emissions in Fishing Vessels in Morocco

GEF CCM-1 & CCM-2 Project Concept for Morocco

PROJECT OBJECTIVE

The objective of this project is to lay the foundations for long-term reductions in greenhouse gas and ozone depleting substance emissions by demonstrating a leapfrog technology using alternative refrigerants in fishing vessels that currently consume HCFC-22 for servicing and maintenance purposes. The project will demonstrate the conversion of cold stores and freezing units of fishing vessels in Morocco from HCFC-22 which has a global warming potential (GWP) of 1700, to the low GWP refrigerants CO_2 and HFO-1234ze (GWP of 6). The project thereby demonstrates the worldwide potential of leapfrog technology for fishing vessels in particular, and for medium-scale industrial and commercial refrigeration in general, both of which are currently dependent on refrigerants with high Greenhouse Gas (GHG) and Ozone Depleting Substance (ODS) emissions.

As consistent with the CCM-1 focal area strategy, the project will: (1) demonstrate and deploy a high efficiency low GHG technology with significant replication potential worldwide; (2) develop policy tools and mechanisms to support the transfer of the technology; and (3) offset GHG emissions through demonstration and deployment projects. This will directly feed into the CCM-2 strategy by establishing appropriate policy, legal and regulatory frameworks and exploring sustainable financing and delivery mechanisms, leading to the direct reductions in GHG emissions.

The Government of Morocco is committed to adopting and enforcing standards and regulations that are essential for the project to have an impact through replication. Morocco signed the UNFCCC in June 1992, ratified it in December 1995 and it entered into force in March 1996. Morocco also ratified the Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol and its Amendments on 28 December 1995.

PROJECT SUMMARY

The project will demonstrate the use of a cascade system of CO_2 and HFO-1234ze to eliminate the emissions of ODS, reduce GHG emissions and improve energy efficiency substantially in deep sea fishing vessels, where viable alternatives do not currently exist. Through a pilot demonstration of this emerging clean technology followed by initial technology deployment the project will lay the foundations for large-scale replication.

The project will consist of three related components:

4) Technology adaptation, demonstration and deployment
5) Capacity building and awareness raising
6) Development of financing tools, policies and regulatory frameworks to support market scale-up.

BASELINE: CONTEXT, BARRIERS AND BASELINE PROJECT

Context

In Morocco fishing is a major activity and is mainly situated in the cities of Agadir, Safi, and Tan-Tan. The two main categories of fishing are coastal fishing and deep-sea fishing. While coastal vessels make short trips of a few days and use flake ice produced on land for refrigeration, deep-sea vessels stay at sea for 30-40 days and fish is immediately sorted and frozen directly in the vessels. Upon arrival it is stored in cold rooms and finally exported mostly to Europe and Asia. HCFC-22 is used as refrigerant throughout the cold chain in the fishing sector.

The sector consists of about 350 fishing vessels and on-shore cold stores. HCFC consumption in this sub-sector, representing 60 per cent of the total HCFC consumption in the country, is very high due to the frequent recharge of the refrigeration equipment in vessels, partly as a result of old and leaking equipment, and partly as a result of constant vibration and the rough conditions at sea. Many of the vessels are over 40 years old and must be retrofitted or replaced following a safety regulation issued by the Ministry of Fisheries in 2005. If refrigeration equipment had to be upgraded owners are currently likely to favour the use of HFCs that have very high global warming potentials.

In order to expand linkages between HCFC phase-out under the Montreal Protocol and other environmental issues, such as climate change and energy efficiency, the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol decided at its 63rd meeting to approve funding for UNIDO to prepare project proposals to identify potential sources of co-financing to cover costs that are not eligible under the Multilateral Fund but that could generate climate benefits as the result of HCFC phase-out. Globally, the IPCC has estimated the global potential for mitigating GHG emissions in the refrigeration sector using ODS substitutes at 80 $MtCO_2e$ for the period up to 2030, and also estimates that there is significant potential for mitigating GHG emissions in industrial facilities through more-efficient equipment (IPCC AR4, Working Group III, Chapter 7).

Support from the Multilateral Fund allowed UNIDO to appoint national and international consultants to visit cold storage facilities on land and in shipping vessels in Morocco to collect information on the HCFC-22 technology used, leakage rate, size, age of refrigeration plant, and accessibility, as well as the willingness of the owners and operators to convert to a different refrigerant. Based on this information, one of the vessels at the fishing school in Agadir (Institut Supérieur des Pêches Maritimes d'Agadir) was selected for replacement of the old cold store and freezing units, and a full assessment of the best alternative technology. A cascade system based on HFO 1234ze and CO_2 is considered to be the only viable zero ODS, low GHG option that will meet the requirements for on board non-toxicity and fire safety.

According to estimates, the replacement of the old cold store and freezing units to the CO_2 cascade system would result in a reduction of 780 tCO_2e per year, amounting to savings of 15,600 tCO_2e over a 20-year equipment life.

Morocco has committed itself to the phase-out of HCFCs through the November 2011 approval of its HCFC Phase-out Management Plan (HPMP) by the Multilateral Fund of the Montreal Protocol. However, the conversion of end-users (with the exception of users of chillers) is not supported under the HPMP. HPMPs address the conversion of refrigerant manufacturing facilities, sectors and customs control; with stage I up to 2015 focusing on the phase out of HCFC-141b in foam production and as a solvent in the railways, as well as reducing HCFC-22 consumption through a quota system, along with training of custom officials and awareness raising activities.

The project will have the support of the Moroccan Cleaner Production Centre and it is consistent with the long-term strategy of the Government of Morocco. The government has set as an energy policy priority the promotion of energy efficiency (National Energy Strategy, 2009), the development of the fishing industry ("Plan Halieutis"), as well as efforts against climate change through integrating the issue of climate change in the implementation of "Plan Maroc Vert".

GEF support for market development of the proposed HFC-leapfrog technology (for end users based on CO_2 use in a cascade arrangement with HFO-1234ze) could therefore accelerate the phase-out of HCFCs considerably, which would achieve substantial GHG mitigation benefits as well as provide lessons for the worldwide scale-up of this pioneer energy efficient technology.

Key Barriers

Technical barriers: Low-temperature cold stores and freezing units throughout the world currently rely on the use of HCFC 22. While there are drop-in replacements such as R422D, this has a GWP of 2600 (compared to that for HCFC 22 of 1700), and alternatives such as HFC-404A have GWPs of 3922. The natural refrigerant ammonia with zero GWP cannot be used on board a ship (or in build-up areas) because of toxicity and flammability. Flammability also means that hydrocarbon refrigerants also cannot be used on ships or in larger volumes for industrial-scale cooling. Thus, until a viable technical alternative is successfully demonstrated and deployed in the market, no viable low GHG options exist, and in the meantime the market may move to higher GHG emitting options as HCFC 22 is phased out.

Policy barriers: Currently, while there is legislation that addresses the use of Ozone Depleting Substances, and plans to introduce import quotas for HCFC under the HPMP exist, there is a lack of measures that would encourage cold storage facilities to consider lower-carbon, low-GWP alternatives in refrigeration. Since HFOs and CO_2 have not been previously used in Morocco, there are no policies in place for the safe use and maintenance of equipment using these refrigerants.

Awareness barriers: Both suppliers and users do not know about alternative technologies for refrigeration. In most cases, owners' purchasing decisions are based only on initial costs instead of on the lifetime performance of the system. The use of outdated equipment, the lack of good servicing and maintenance practices, and constant vibrations at sea results in significant refrigerant losses. In fishing vessels, cold storage facilities are operated 24 hours per day, principally during two fishing seasons, and only stop for maintenance and repair.

Financial Barriers: Given high initial costs for emergent technologies there are currently significant barriers to market entry. However, higher efficiency and lower operating costs, means that the proposed HFO+CO_2 systems, once developed as a market-ready product, is expected to have good payback rates, especially given the eventual phase-out of HCFCs. The expected cost trajectories follow reductions in technology cost of 10% for 5 units and another 20% for 20-30 units. At the same time the cost of energy and HCFC 22 are increasing.

Baseline Project

Under the Montreal Protocol, HCFCs will be no longer available for purchase after 2030. During the period 2030-2040 only 2.5% of the baseline will be allowed annually for servicing and maintenance purposes of existing installations (Decision XIX/6[36]).

The Morocco National HCFC Phase out Management Plan (HPMP) Stage I was approved by the Executive Committee at its 65th Meeting in November 2011 with funding level of USD 1,286,740. The Project Objective is to assist the Government of Morocco to comply with its Montreal Protocol phase-out obligations for HCFCs. The project covers only Stage I of the HCFC phase-out, focusing on phasing out HCFC-141b in two foam production companies and at the National Railway Bureau, freezing the consumption of HCFC-141b contained in imported polyols, and reducing HCFC-22 consumption through a quota system, training of custom officials and awareness raising activities comprised of two conferences to explain the phase-out strategy to a broad range of stakeholders.

The HPMP therefore sets a valuable institutional and technical framework in which this GEF technology transfer project will take place. Under HPMP activities the price of HCFC-22 is expected to increase in the years to come due to decreasing market availability of HCFC-22; making the return to HCFC-22 unlikely.

In the absence of the GEF project, the owners of fishing vessels will have to cover the costs of converting HCFC-22 based systems by 2040 (or by the end of life of the systems if earlier than 2040). Owners might favour the use of HFC-404A, which has a GWP=3922, as an alternative technology or HFC-422D with a GWP of 2600, since initial replacement is simpler and costs are lower than those for natural refrigerants. However, natural refrigerants such as hydrocarbons and ammonia cannot be used on ships (or in built up areas) because of flammability and toxicity risks. CO_2 is an ideal refrigerant in these cases but must be operated in a cascade arrangement to ensure subcriticality.

Under the baseline scenario where ships continue to use HCFC-22, for a typical system comprised of freezing unit and cold storage, older than 10 years, **annual** CO_{2eq} emissions have been estimated at 1183 tonnes per ship.

Considering a baseline scenario where ships convert to HFC-404A or HFC-422D, annual emissions *could be as high as 2191 tonnes per ship per year (for HFC-404A)*.

Project Components

Component 1: *Technology adaptation, demonstration and deployment*

Component 1 is designed to adapt the HFO-CO_2 cascade technology to the needs of the shipping sector, demonstrate the effectiveness in reducing ODS, GHG emissions, and operating costs of the technology, and to start initial deployment. Since this is a CCM-1 project focused on demonstration

[36] Montreal Protocol. 2007. Decision XIX/6: Adjustments to the Montreal Protocol with regard to Annex C, Group 1, Substances (Hydrofluorochlorocarbons), see http://montreal-protocol.org/new_site/en/Treaties/decisions_text.php?dec_id=924

and deployment this project component will make up the majority of the project activities and funding.

Proposed activities include the following:

- Implement the conversion of two existing installations to the use of the HFO+CO_2 cascade system through involving the private sector in the design and technology transfer activities, including of one of the vessels at the fishing school in Agadir (Institut Supérieur des Pêches Maritimes d'Agadir).
- Measurement of baseline energy consumption through simulation models and monitoring of the actual performance of converted technology, as well as evaluating the energy saving generated by the conversions.
- Adapt tools and lessons learned from the demonstration conversion for reducing costs and improving performance for initial deployment in 2-5 additional ships.

Component 2: *Capacity Building and Awareness Raising*

Component 2 is designed to communicate the results of the activities under Component 1 and increase demand for very-GWP refrigerant systems, specifically the HFO+CO_2 cascade system by increasing the awareness of the fishing sector and policy-makers about the potential benefits of these technologies.

Proposed activities include the following:

- Train technicians on best refrigeration practices, reduction of leakages and safe handling of CO_2 and HFOs.
- Provide targeted outreach to policy-makers on the benefits of natural refrigerants and on linking improvements in energy efficiency in the cold storage sector with national industrial development priorities.
- Provide information to stakeholders in the cold storage sector on life-cycle cost savings from more efficient systems and on financing options for adopting these systems.
- Raise awareness of environmental policies and associated HCFC phase-out legislation amongst users and other stakeholders (this activity is funded under HPMP, and counted as part of the co-financing).

Component 3: *Development of financing tools, policies and regulatory frameworks to support market scale-up*

Component 3 is designed to increase the market share of more energy-efficient refrigeration equipment by providing policy, regulatory, and financial incentives to adopt low-GWP, higher-efficiency equipment.

- Promote appropriate national policy, legal and regulatory frameworks to support further conversions in the fishing sector and related markets.
- Prepare a lessons learned analysis from the project for scale-up and replication in Morocco and other countries worldwide.
- Introduce appropriate safety regulations to support the use of alternative refrigerants such as CO_2.

- Link ongoing industrial development and sustainable energy programmes in Morocco to Montreal Protocol activities.
- Identify the most promising financial schemes for leveraging additional funds for the conversion of similar facilities and to stimulate the market.

Cross-cutting project outcomes:

- **Direct GHG reductions** from the demonstration and deployment projects in Component 1.
- **Indirect GHG reductions** from increased demand for the technology in the cold storage sector more generally as the result of a demonstration effect and from improved capacity to design better systems (from Component 1), improved policy and financial incentives (from Component 3), and increased awareness of the benefits of cold storage facility upgrades (from Component 2).
- **Accelerated HCFC phase-out** due to the introduction of natural refrigerants on the market through the demonstration and deployment projects (in Component 1), through increased policy and financial incentives (in Component 3), and through improved awareness among policy-makers and facility owners of the phase-out requirements and options (in Component 2).

Implementation Arrangements

This project will be implemented through the offices of the Moroccan Cleaner Production Centre (CMPP: Centre Marocain de Production Propre), which was established in June 2000. The CMPP is hosted by the General Confederation of Moroccan Enterprises (CGEM), backed by the Department of Environment and has been financially supported by the Swiss government (2000-2009), and is a member of the United Nations Industrial Development Organisation (UNIDO) / United Nations Environmental Programme (UNEP) international NCPCs Network.

TOTAL GEF GRANT REQUESTED AND EXPECTED CO-FINANCING

At its 65th Meeting, the Executive Committee of the Multilateral Fund approved US $1,286,740 for UNIDO to implement Stage I of the HPMP in Morocco. Out of the approved amount, US $ 300,000 will be expected to contribute in kind to the implementation of the proposed GEF project.

Besides the contribution from GEF and the co-financing in kind from HPMP, UNIDO has identified the potential partners below as additional sources of co-financing. These figures are rough estimates of the co-financing levels expected from UNIDO, they are, however subject to change once a concrete agreement is formed with partners.

Besides the contribution from GEF and the co-financing in kind from HPMP, UNIDO has identified the following potential partners as additional potential sources of co-financing: UNIDO, Government of Morocco, owners, technology suppliers, Shecco (Industry association), National Cleaner Production Centre, Research institutes, and Banks. A possible breakdown of GEF financing and cofinancing is shown in the table below.

Component	**Inv / TA**	**Indicative GEF financing**	**Indicative Cofinancing**	**Total**
7.38 COMPONENT 1: TECHNOLOGY ADAPTATION, DEMONSTRATION & DEPLOYMENT	INV	600,000	1,700,000	2,300,000
technical assistance	TA	100,000	175,000	275,000
Component 2: Capacity Building and Awareness Raising	INV	100,000	275000	375,000
Component 3: Development of financing tools, policies and regulatory frameworks to support market scale-up	TA	60000	350000	410,000
Project management		40000	250000	290,000
TOTAL		900,000	2,750,000	3,650,000

Annex 4: Improving Energy Efficiency and Reducing ODS Emissions in the Industrial Refrigeration Sector in the Gambia

GEF CCM-2 Project Concept for the Gambia

PROJECT OBJECTIVE

The objective of the proposed project is to reduce greenhouse gas emissions associated with industrial refrigeration facilities in The Gambia by removing barriers to increased energy efficiency and establishing the enabling environment for the introduction of low global warming potential (GWP) alternatives to HCFC-22. To reach this objective, the project will use a synergistic combination of technical assistance on policy, regulation, capacity building and awareness-raising; design and implementation of incentives to support the adoption of energy efficiency measures; and piloting innovative technical assistance delivery mechanisms.

This project concept is consistent with the GEF-5 Climate Change Mitigation Program – Objective 2: "Promote market transformation for energy efficiency in industry and the building sector"; in particular increasing energy efficiency of refrigeration systems, while minimizing the discharge of chemicals damaging to the ozone layer and building synergies across global environmental conventions.

The Gambian Government is committed to adopting and enforcing standards and regulations that are essential for the project to have an impact through replication. The Gambia signed the UNFCCC in June 1992, which entered into force in 1994. The Gambia also ratified the Vienna Convention for the Protection of the Ozone Layer in July 1990, the Montreal Protocol on Substances that Deplete the Ozone Layer in July 1990 and the London Amendments to the Montreal Protocol in March 1995.

PROJECT SUMMARY

It is expected that the policy and regulatory support, local energy service providers mechanism, and awareness and capacity development initiatives put in place under this project will help to prepare the market for the future selection and adoption of low GWP alternatives that operate both more efficiently and use chemicals with lower GWP, while minimizing the use of chemicals damaging to the ozone layer.

The proposed initiatives developed under this project will help inform companies worldwide who face the common problem of having to procure future-proof plants that are affordable to run, especially for small or medium-scale industrial applications. Instilling better practices and knowledge through this proposed project will serve as the foundation for the growing refrigeration demand in The Gambia in the future and prepare this industry to select the best technologies for this market.

The project will include three components to improve energy efficiency and reduce ozone depleting substances (ODS) emissions in the industrial refrigeration sector in The Gambia:

7) Policy and regulatory support;
8) Technology transfer support; and
9) Capacity building and awareness-raising.

BASELINE: CONTEXT, BARRIERS AND BASELINE PROJECT

Context

The Gambia is an agriculturally rich country with an economy dominated by farming, fishing and tourism. It is one of the smallest African countries with an area of 11,300 sq km (land ~ 10,000 sq km) and a population of approximately 1.7 million. The Government of The Gambia's medium to long-term objectives in the agriculture and natural resources sectors – which are the dominant sectors in the economy – include: increasing output of both domestic and export produce to ensure food security and generate earnings of foreign exchange to finance other aspects of the development process; and producing a more diverse range of food and export produce to reduce the fluctuations and uncertainties associated with rural household incomes and export earnings.

Mainly due to the establishment of fish processing and handling plants funded by Government and the private sector, The Gambia's industrial refrigeration sector has increased significantly over the last few years. As refrigeration equipment is vital to many manufacturing processes, other economic activities such as the growth of the hotel industry, expansion of breweries and increase in commercial agricultural farms are also actively consuming refrigerants. Overall, this growth has led to a general increase in the consumption of all classes of refrigerants, including HCFCs, as second hand equipment that is no longer allowed in developed countries is often imported. The use of refrigeration will only increase as the Gambian economy grows, as more industries will require refrigeration for manufacturing and distribution. This will be exacerbated by the fact that when equipment will be upgraded, or new installations are made, owners are currently likely to favour the use of HFCs that have very high global warming potentials.

HCFC-22 is currently the least expensive refrigerant available in The Gambia, costing almost half the price of some non-HCFC refrigerants available in the market. In 2010, the total HCFC-22 consumption in The Gambia was 22.2 metric tones including the amount of HCFC-22 found in some refrigerant blends, with the consumption in the industrial sector at over 5 metric tons for 2,230 units. The industrial refrigeration sector – which consumes the largest amount of HCFC-22 in The Gambia and is mainly divided between the fish processing and tourism industries – includes fish processing plants, cold rooms, central air cooling, ice-making systems and blast freezers.

Through the recent approval of its HCFC Phase-out Management Plan (HPMP) by the Multilateral Fund of the Montreal Protocol, The Gambia has committed itself to completely phase out HCFCs by 2030. The first control is the freeze on consumption of HCFCs, beginning on 1 January 2013, at the baseline levels (an average of 2009 and 2010). The second control step is the reduction of 10% from the baseline levels in 2015.

In addition to minimizing the use of chemicals damaging to the ozone layer, The Gambia also looks to operate with greater energy efficiency and use chemicals with lower GWP. Indeed, the IPCC has estimated the global potential for mitigating GHG emissions in the refrigeration sector through 2030 through ODS substitutes as 80 MtCO2e, and the potential for mitigating GHG emissions in industrial facilities through more-efficient equipment is high (IPCC AR4, Working Group III, Chapter 7). To expand the consideration of linkages among HCFC phase-out under the Montreal Protocol and other environmental issues, such as climate change and energy efficiency, the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol recently provided funding to identify potential sources of co-financing to cover costs that are non-eligible under the Multilateral Fund but that could generate climate benefits under HCFC phase-out.

This support from the Multilateral Fund allowed UNIDO with the participation of the National Environment Agency (NEA) of The Gambia to examine potential opportunities for energy efficiency gains and ODS emissions within the fisheries sector, including visiting fish-processing sites running on HCFC-22. These facilities are scattered along The Gambia's Atlantic coast and feature refrigeration equipment for medium to low temperature applications, including cold stores, ice-makers, freezers and chillers. National and international consultants visited sites and collected information on the refrigeration technology, leakage rate of HCFC-22, size, age of refrigeration plant and accessibility, as well as the potential of owners and operators to convert to low GWP alternatives.

Key Barriers

The key barriers to promoting energy efficiency in the industrial refrigeration sector in The Gambia, while using chemicals with lower GWP and minimizing the use of chemicals damaging to the ozone layer, are outlined below.

Policy barriers – Despite the planned HCFC phase-out targets, there is an overall lack of policy and regulatory incentives to support the industrial refrigeration sector in moving away from HCFC-22 prior to 2030 in The Gambia. In particular, there is a lack of measures that would encourage refrigeration facilities to consider lower-carbon, low-GWP alternatives in refrigeration.

In addition, since other refrigerants – including HFOs, CO_2 and ammonia – are not being used in The Gambia, there are no policies in place to support the safe use and maintenance of equipment using these refrigerants.

Awareness and information barriers – Due to a lack of good servicing and maintenance practices, and the use of outdated equipment, the industrial refrigeration sector experiences inefficient energy use and significant refrigerant losses (ranging from 200 kg to 300 kg per year per site). There is a lack of awareness about the potential energy savings possible from better maintenance and servicing.

The Gambian industrial refrigeration sector also lacks mechanisms to access and disseminate up-to-date information on alternatives to HCFC-22 as they develop. There is also low awareness concerning the use of other refrigerants, such as CO_2 and HFOs, including their technical performance and the attendant maintenance and safety issues.

Capacity barriers – Most refrigeration technicians lack the knowledge, basic tools and equipment required to prevent refrigerant leakages while charging refrigeration systems in plants, and better methods of purging non-condensable gases. Many of these technicians lack maintenance expertise, specific training in improving energy efficiency of refrigeration systems, and capacity to advise on HCFC-22 alternatives including energy efficiency gains and related operating costs from replacement systems that could offset the capital costs of conversion.

Technical barriers – Low-temperature cold stores and freezing units currently rely on HCFC-22. Drop-in replacements exist, yet they have very high GWPs. Ammonia and other refrigerants require new systems that are comparatively costly and may have higher energy usage in The Gambia, in addition to toxicity and flammability risks. CO_2 cannot be used alone as a refrigerant, because the high ambient temperatures in The Gambia would mean that the equipment would run at a transcritical state at all times, greatly reducing the efficiency compared to HCFC-22. Thus, until a viable technical alternative is successfully identified and deployed in the market no viable low GHG options exist, and the market may be forced to move to – and lock into – higher GHG emitting options as HCFC-22 is phased out.

Currently most of the HCFC-22 being imported by The Gambia is of a poor quality, containing other refrigerants such as HFCs as impurities, which causes loss of efficiency. Mineral oils commonly used for HCFC-22 are not compatible with HFC refrigerants such as R-134a, and using them in systems with a mixture of HCFC-22 and HFCs results in the oil breaking down followed by frequent replacement of filters and driers and even loss of compressors. While The Gambia is addressing this issue in part through capacity building of customs agents, there is a lack of testing services or quality assurance especially when buying from in-country resellers.

Financial barriers – One of the main barriers to the introduction of alternatives to HCFC-22 with low GWP is the low cost of HCFC-22 at present in the market compared to its alternatives. As HCFCs become less available on the market due to the Montreal Protocol phase-out targets, the price of HCFC-22 would rise, causing economical hardship for owners and operators of HCFC-22 based equipment.

Furthermore, the high cost of conversions to new equipment using low GWP refrigerants is a deterrent for end-users in The Gambia who already have to deal with tight market prices of their products. The high electricity costs mean that whatever replacement is chosen would have to have similar or less energy consumption as compared to an HCFC-22 system.

Baseline Project

As noted above, The Gambia has committed itself to completely phasing-out HCFCs by 2030, with a freeze on consumption levels in 2013 followed by a reduction of 10% in 2015. To reach these targets, The Gambia will apply quotas to the imports of both bulk HCFC-22 and HCFC-containing equipment to ensure that they follow the reduction schedule of the Montreal Protocol. In addition, the Government will strengthen the enforcement of the licensing system in order to closely monitor imports of HCFCs.

The Gambia's HPMP's stage I activities include, under UNIDO, strengthening of the three regional retrofitting centres through provision of technical assistance, equipment and an incentive programme for access to tool kits, spare parts, alternative fluid and conversion and development of a comprehensive programme strategy for the reduction of HCFC and carbon emissions in the refrigeration and air conditioning sector. Under UNEP, the HPMP stage I will train customs and law enforcement officers, and strengthen the customs schools, including dissemination of the amended ODS regulations and strengthening of technical colleges and training of refrigeration technicians in good refrigeration practices. The conversion of end-users (with the exception of chillers) is not eligible under the Multilateral Fund, despite the fact that this conversion would accelerate considerably the phase-out of HCFCs.

In the absence of the proposed GEF project:

- The industrial refrigeration sector would continue to produce high GHG emissions as refrigeration equipment continues to age, with the amount of these emissions increasing due to reduced operating efficiency; and
- Owners of industrial refrigeration facilities would be unlikely to make informed decisions about lower-GWP alternatives. End-users would lack information enabling them to convert voluntarily to lower-GWP alternatives when they become viable in The Gambia, perhaps converting to HFCs as alternatives to HCFC-22 based refrigeration systems and thereby continuing to have adverse effects on the climate.

PROJECT COMPONENTS

The proposed project addresses barriers to increased energy efficiency in the industrial refrigeration sector, reductions of ODS leakages and the adoption of low GWP alternatives to HCFC-22. A synergistic approach is proposed that creates a policy and regulatory environment conducive to the adoption of new technologies; develops technical capacity through the provision of targeted technical support to identify energy efficiency measures and refrigerant options, including their economic viability; and incentivizes owners/operators to carry out improvements. The proposed project targets industrial refrigeration owners and operators, and will work closely with and build upon the HPMP stage I initiatives noted above that are led by UNIDO and UNEP.

While the refrigeration operators in The Gambia face particular problems in terms of refrigerant quality, maintenance expertise and energy and operating costs, the problem of procuring a small- or medium-sized plant that is affordable to run, while not emitting ODS or GHGs is common worldwide. Therefore, this project also proposes awareness-raising activities regarding potential new technologies and their benefits, and will generate lessons learned for dissemination to other countries.

Component 1 *– Policy and regulatory support*

Component 1 focuses on developing the national policy, regulatory and legal frameworks necessary to support increasing energy efficiency and the introduction of refrigerant alternatives to HCFC, through the following activities:

- Develop, adopt and enforce appropriate national policy, legal and regulatory frameworks for conversion of HCFC-22 refrigeration facilities to higher efficiency systems with low GWP refrigerants.
- Introduce appropriate safety regulations to support the use of alternative refrigerants such as ammonia.
- Develop legislation including inspections of refrigeration and, possibly, air conditioning (AC) systems. This may include the introduction of energy performance labels for refrigeration and AC systems, e.g. partly modeled on the requirements of the Energy Performance of Buildings Directive (EPBD) in the EU, or F-Gas legislation.

Component 2 - *Technology transfer support*

Component 2 is designed to increase knowledge of replacement refrigerants, ensure better-trained technicians, reduce greenhouse gas emissions and operational costs through the following proposed activities:

- Support local energy service providers that will offer a broad range of support and comprehensive energy and refrigeration solutions including energy conservation, reducing leaks, maintaining systems, recommending specifications for new systems (chill, freezer and ice-making), recommending replacement refrigerants and encouraging better methods of purging non-condensable gases. These service providers may operate through the existing regional retrofitting centres and/or with the technical colleges being supported under the HPMP's stage I.
- Design and pilot an incentive system to reward the owners/operators that carry out improvements (leaks, maintenance, recovery, etc.), based on recommendations from the local energy service providers.
- Design and implement a quality assurance approach for refrigerants that is focused on empowering the end user (e.g. mobile testing service to ensure purity of refrigerant supply, labelling), especially targeting HCFC-22 from in-country resellers.
- Monitor the actual performance of the improvements, and evaluate their effectiveness in reducing ODS and GHG emissions.

Component 3 – *Capacity building and awareness-raising*

Component 3 seeks to improve the awareness of stakeholders regarding potential new technologies and their benefits, and relevant regulatory frameworks, through the following potential activities:

- Using the local energy service providers mechanism (Component 2), provide targeted awareness-raising among owners and operators of industrial refrigeration facilities concerning potential energy savings from better maintenance and servicing. Provide information to stakeholders on life-cycle cost savings from more efficient systems and on financing options for adopting these systems.

- Conduct an information and awareness campaign targeted at industrial refrigeration facility management to improve knowledge of new refrigerant options.
- Provide targeted outreach to policy-makers on the benefits of low GWP refrigerants and linking improvements in energy efficiency in industrial refrigeration with national industrial development priorities.
- Raise awareness of environmental policies and HCFC phase-out legislation among stakeholders.
- Prepare lessons learned from the project for dissemination to other countries worldwide.

Cross-cutting project outcomes

- *Direct GHG reductions* will come from energy efficiency improvements and reduced leakage of ODS. Assuming 30% efficiency gains and 90% leak reduction (due to both maintenance and use of uncontaminated refrigerant), with initiatives in 20 industrial refrigeration facilities in the fish processing and tourism sectors, the total direct GHG emissions reductions attributable to the project are estimated to be nearly 9,500 tCO_2e per year.
- *Indirect GHG reductions* will also come from improved policy and increased awareness of the benefits of industrial refrigeration facility upgrades. Assuming a causality factor of 20%, then over a 10-year lifetime the top-down indirect GHG emissions are estimated at 0.51 MtCO2e; and with a replication factor of 3, the bottom-up indirect emissions are estimated at 0.28 MtCO2e.
- *Accelerated HCFC phase-out* will be promoted through improved awareness among policy-makers and facility owners of the phase-out requirements and options.
- *Energy savings:* maintained and updated systems will use less energy, bringing savings in terms of lower energy costs for installation owners.
- *Lower refrigerant recharge costs:* leakage rates for better maintained systems will be lower, whereas with the current systems there is an estimated 200-300 kg of HCFC-22 lost per year per system. Funds will be saved from the purchase of refrigerants for recharge.
- *Lower maintenance costs:* efforts to minimize contaminated refrigerants will ensure that the loss of efficiency resulting from mixed refrigerants will be dramatically reduced, thus resulting in lower maintenance costs.

Implementation Arrangements

This project will be implemented through the National Environment Agency (NEA), which houses both the Ozone Unit and the GEF Focal Point. Key input will be sought from other stakeholders in the fisheries, tourism and breweries sectors.

This proposed project will coordinate with the UNIDO-led Strategic Program for West Africa (SPWA): Energy Component, of which The Gambia is a participating country. Coordination will be maintained, and duplication avoided, by coordination between the NEA and the SPWA Committee chaired by the Economic Community of West African States (ECOWAS), with support from UNIDO.

TOTAL GEF GRANT REQUESTED AND EXPECTED CO-FINANCING

The project requests a $300,000 grant from the GEF Trust Fund.

Out of the approved amount for the HPMP in The Gambia, $100,000 will be contributed in-kind to the implementation of the project. UNIDO has also identified the following potential sources of co-financing: UNIDO, Government of The Gambia, owners, technology suppliers, industry association, training centres and banks. A possible breakdown of GEF financing and co-financing is shown in the table below.

Component	Inv / TA	Indicative GEF financing	Indicative Co-financing	Total
Component 1 – Policy and regulatory support	TA	75,000	220,000	**295,000**
Component 2 – Technology transfer support	TA	130,000	385000	**515,000**
Component 3 – Capacity building and awareness-raising	TA	80000	155000	**235,000**
Project management		15000	100000	**115,000**
TOTAL		300,000	860,000	**1,160,000**

Annex 5: BEST PRACTICE EXAMPLES THAT DEMONSTRATE "ADDITIONALITY" FOR SMALL SCALE PROJECT ACTIVITIES

Barrier to implementing the project	Definition	Best practice examples that demonstrate additionality include but are not limited to …	To demonstrate 'additionality', select the most relevant barrier for UNIDO's project*
Investment	A less-costly alternative would have led to higher emissions	The application of investment comparison analysis using a relevant financial indicator, application of a benchmark analysis or a simple cost analysis, where carbon revenue is the only revenue stream such as end-use energy efficiency. National or global accounting practices and standards are recommended for such an analysis.	Replacing HCFCs with HFCs would less, but emissions (direct and indirect) would be 50% higher with HFCs than natural refrigerants. Conclusion: The project has additionality as a less-costly alternative (HFCs) would have led to 50% higher emissions.
Financial	The project could not secure appropriate capital without consideration of the carbon revenue	Demonstrate limited access to loan money in the absence of the project revenue.	Consider a statement from the financial institution that project finance is critical in the approval of any loan that might be needed by the operators of the cold stores. Conclusion: Yet to demonstrate additionality.
Technological	A less technologically advanced alternative to the project involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions	Demonstrate that human capacity to operate and maintain the technology is insufficient, or there is a lack of infrastructure to utilize the technology, or unavailability of the technology and high level of technology risk	Technical training in the use of alternative technologies to R22 will be necessary to ensure their safe use and maintenance. Conclusion: Additionality demonstrated as human capacity to operate and maintain the technology is insufficient.
Regulations or policies	Prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions	Demonstrate that the project is among the first of its kind in terms of technology, geography, sector, type of investment and investor, market etc. Demonstrate that there is no regulation or incentive scheme in place relevant to the project**.	The project by UNIDO is a pilot project for the country that demonstrates the viability of the technology for superior environmental performance. Prevailing practice would lead to HFCs being installed, as this is the cheaper option. Conclusion: Additionality demonstrated as the project is among the first of its kind, and a more expensive option is

Barrier to implementing the project	Definition	Best practice examples that demonstrate additionality include but are not limited to …	To demonstrate 'additionality', select the most relevant barrier for UNIDO's project*
			counter to the prevailing practice.
Other barriers	Institutional barriers or limited information, managerial resources, organizational capacity, or capacity to absorb new technologies	Country risk, new technology for the country.	Institutional strengthening is a key component of the project. Conclusion: Additionality demonstrated as the project will identify institutional barriers, and improve managerial resources and capacity to absorb new technologies.

Source: UNFCCC. 2007. Non-binding best practice examples to demonstrate "additionality" for small-scale project activities. EB 35 Report Annex 34 *** Only the most relevant barrier need be identified; ** World Bank. 2010. *Study on Financing the Destruction of Unwanted Ozone-Depleting Substances through the Voluntary Carbon Market – Final Report.* Prepared by ICF International. P103**

Annex 6: STAGES OF PROJECT, EXAMPLES OF ACTIVITIES ASSOCIATED WITH EACH STAGE, AND THE STAKEHOLDERS WITH RESPONSIBILITY FOR THE STAGES

	Examples of activity	**Responsible entity (Primary = ◉, Secondary = ○)**					
		Operator of cold store	**National Competent Authority**	**National Ozone Unit**	**Industry Association**	**Implementing Agency**	**Financial partner(s)**
Stage 1: Analysis							
Prepare or update the inventory	• Sector e.g. food, medical • Name of store, contact details • Legal status of company • Other details as required	○	◉	○			
Technical data	• Cooling power and capacity • Electric power (kW) • COP • Model and serial number • Other information as necessary	○				◉	
Energy audit (existing equipment)	• Electricity consumption(kWh) • Operating hours per day • Operating days per month • Refrigerant type and quantity (kg) • Average loss per year (kg)	○				◉	
Energy audit (proposed equipment)	• Electricity consumption (kWh) • Operating hours per day • Operating days per month • Refrigerant type and quantity (kg) • Average loss per year (kg)	○				◉	
Energy savings per year	• kWh avoided • Energy costs avoided per year	○				◉	

	Examples of activity	**Responsible entity (Primary = ◉, Secondary = ○)**					
		Operator of cold store	**National Competent Authority**	**National Ozone Unit**	**Industry Association**	**Implementing Agency**	**Financial partner(s)**
Determine any legal/regulatory instruments already in force on ODS and energy efficiency targets and standards; requirements on energy suppliers to participate in demand-side energy efficiency improvements	• Energy audit • Legal requirement for owners to replace equipment if energy consumption exceeds threshold • Build capacity for recovery, recycling and reclamation of ODS legislation, including provision for storage of contaminated ODS • Tariff policy for electricity that encourages efficient use • Economic incentives for installation of environmentally-friendly equipment • Tax reimbursement for investment on energy efficiency • Penalty for non-compliance • Enforcement network		◉		○		○
Alternative technology	• Select refrigerant that has zero ODP and minimal GWP (<20?) • Select technology that provides at least 30% reduction in energy consumption • Select technology that minimizes emissions	○			○	◉	
Equipment suppliers	• Type of equipment • Value to project e.g. energy efficiency, climate impact • Availability • Equipment reliability • After sales service and maintenance • Producer responsibility at end-of-life				◉	○	
Stage 2: Project Design							
Project costs	• Project preparation costs • Equipment costs • Legal fees • Pre-financing costs • Debt payment • Identification of finance required • Payback period	○				◉	
Financial support	• Funds from owner of facility • Equipment supplier credit • Grant from GEF (energy reduction) • Grant from MLF (ODS elimination) • Energy Service Provider • Bank loan • Prospects for Programme of Activity (PoA) under the CDM	○				◉	○

	Examples of activity	**Responsible entity (Primary = ◉, Secondary = ○)**					
		Operator of cold store	**National Competent Authority**	**National Ozone Unit**	**Industry Association**	**Implementing Agency**	**Financial partner(s)**
Policy instruments	• Log books on equipment • RRR training • ODS storage and destruction • Compulsory energy audit • Equipment replacement requirement, when necessary • Tariffs and subsidies • Penalties for non compliance • Enforcement		◉		○		○
Implementing Agency	• Defines project • Defines financial conditions • Arranges guarantees for grants • Coordination of activities • Monitors project performance • Reports to funding bodies	○				◉	○
Alternative technology	• Selection based on environmental and energy considerations • Operating values e.g., low cost, reliable, effective • Financial values e.g., reasonable payback time	○				◉	
Select financial support	• Equipment supplier credit • Grant from GEF (energy reduction) • Grant from MLF (ODS elimination) • Energy Service Provider subsidy • Bank loan • Prospects for Programme of Activity (PoA) under the CDM	○				◉	○
Awareness raising	• National workshop • Target cold store owners via Association • Provide information on savings by installing energy efficient equipment • Provide information on subsidies available and fund mobilization strategies • Ensure all stakeholders are present especially financier and equipment suppliers • Case studies with peer examples	○	◉	○	○	○	○
Recovery, recycling and reclamation of ODS	• Scheme and training • Certified courses delivered by the Education Ministry on a sustainable basis, funded by the association		◉		○		

	Examples of activity	Responsible entity (Primary = ⦿, Secondary = ○)					
		Operator of cold store	National Competent Authority	National Ozone Unit	Industry Association	Implementing Agency	Financial partner(s)
Stage 3: Implementation							
Implement policies on energy efficiency	• See above		⦿		○		
Install equipment	• According to technology selected • Tests under different loads	⦿				○	
Recovery, recycling or reclamation; or store ODS for later disposal	• Qualified technicians recover ODS without emissions • Quality of ODS checked • ODS not suitable for recycling or reclamation is stored for later disposal • Quantity recovered is reported to NOU and IA		⦿		○		
Stage 4: Verification and Reporting							
Energy audit	• Install electricity meters if not already present • Install equipment monitoring software • Compare energy consumption with baseline measurements recorded during 'analysis' phase	○				⦿	○
Equipment audit	• Installation of equipment satisfactory? • Was energy consumption reduced more or less as expected? • Performance under different loads was acceptable to owner • Training on operation and use completed?	○				⦿	
ODS audit	• Quantity of ODS recovered • ODS fate after recovery → placed on market, reclaimed / sold, or stored for destruction • Certificate for quantity destroyed	○		⦿			
Facility owner survey	• Evaluation of performance of all stakeholders, according to facility owner • Performance of equipment • Impact on changes on business operation e.g., staff number, business opportunities • Safety procedures adopted • Maintenance procedures implemented	○				⦿	○

	Examples of activity	Responsible entity (Primary = ◉, Secondary = ○)					
		Operator of cold store	National Competent Authority	National Ozone Unit	Industry Association	Implementing Agency	Financial partner(s)
Final Project Report and lessons learned	• Provide information to NOU and GEF • Identify performance aspects that were satisfactory across all evaluation parameters • Identify criteria that were not sufficient and actions that can be taken to improve performance • Prepare report for discussion with stakeholders	○			○	◉	○

Annex 7: EXAMPLES OF REGIONAL AND MULTILATERAL ORGANISATIONS THAT COULD PARTNER IN PROJECTS FOR ENERGY EFFICIENCY IMPROVEMENTS

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
1	DEG - Deutsche Investitions- und Entwicklungsgesellschaft mbH	Up to EUR 25 million per project, larger volumes through co-financings	Co-financing, Debt, Equity, Loan, ODA, Other, Risk management, Structured financing, Technical assistance	Private sector investment in developing and emerging market countries for profitable projects that contribute to sustainable development goals.	DEG finances startups as well as extension and modernization investments. All kinds of long-term intercompany cooperation are supported, particularly with German and European enterprises. **Conclusion: Applicable**
2	MDB Clean Technology Fund	USD 4.5 billion pledged by donors (Australia, France, Germany, Japan, Spain, Sweden, United Kingdom, United States)	Co-financing, Grant, Loan, ODA	Countries that have an active MDB country program (World Bank and Regional Development Banks) including Viet Nam	When a country expresses interest in accessing finance, the relevant MDBs conduct a joint mission with other development partners to discuss with the government, private industry and other stakeholders how the fund may help finance scaled-up low carbon activities. The outcome of the joint exercise is an investment plan developed under the recipient country's leadership for use of CTF resources in major sectors of the economy through a joint MDB program. The investment plan should build on existing country-owned strategies or action plans and demonstrate how it is complementary to activities under other available programmes. **Conclusion: Applicable**
3	GEF Trust Fund	$1.14bn pledged (climate change focal area)	Co-financing, Grant	Parties to UNFCCC, non-Annex I Parties or eligible to borrow from the WB (IBRD and/or IDA) or	The GEF is the only institution which got a mandate from the convention on technologies and is implementing the Poznan Strategic Program on Technology

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
				eligible recipient of UNDP technical assistance.	Transfer. The GEF is also managing the Least Developed Countries Fund (LDCF) and the 4Special Climate Change Fund (SCCF) e5stablished under the UNFCCC and provides secretariat services to the Adaptation Fund under the Kyoto Protocol. **Conclusion: Applicable**
4	Seed Capital Assistance Facility (SCAF)	$10.47 million	Co-financing, Equity, Grant	Commercial Private Equity or Venture Capital Funds can receive cost-sharing support for including early stage seed capital windows within their broader commercial investment offering.	SCAF provides seed financing to early stage clean energy enterprises and projects. The Facility is implemented through the United Nations Environment Programme, the Asian Development Bank and the African Development Bank. **Conclusion: Possibly applicable through enterprise development support**
5	EIB Climate Change Technical Assistance Facility	$5 million	Grant, loan	Any carbon mitigation project that will be eligible for CDM or JI crediting	Provides advance funding for the development of project-based carbon assets (credits) under the CDM and JI. The development of these projects involves considerable transaction costs and requires knowledge of regulatory and policy requirements that is often lacking for project promoters, especially in developing countries and economies in transition. The CCTAF therefore aims to promote the development of CDM and JI projects by providing advance finance for the transaction costs and by supervising the development of the carbon asset potential of an underlying project

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
					throughout the project cycle to the carbon credit certification stage. **Conclusion: Possibly applicable for CDM Programme of Activities involving cold stores**
6	EIB Post-2012 Carbon Credit Fund	€125 million	Carbon finance	All CDM and JI host countries; projects generating at least 250,000 tonnes CO2e in EURs or CERs with vintages 2013-2020	The funds support future greenhouse gas mitigation projects by giving value to their post 2012 emission reductions. By accepting the risks relating to the development of a post-Kyoto regime, these leading public banks are promoting the development of the market for reductions in greenhouse gas emissions achieved after 2012. **Conclusion: Possibly applicable for CDM Programme of Activities involving cold stores**
7	International Climate Initiative (Germany)	€120 million per year [€371 million to date]	Grant, loan, ODA ICI application information	Any project proponent must prove at least three years of international project development experience; Total project duration of less than five years;	The ICI provides financial support to projects that have a climate change focus or co-benefit, especially if the investments will catalyze larger funding streams from the private-sector. Funds are disbursed mainly in the form of grants, yet some ICI financing may be provided as interest rate subsidized loans. **Conclusion: Applicable**
8	ADB Clean Energy Financing Partnership Facility (CEFPF)	Overall target: $250 million	Co-financing, Grant, Technical assistance	CEFPF resources are used to service developing member countries through ADB's operations department	This Fund provides support for cost effective investments in technologies and practices that result in greenhouse gas mitigation. The fund finances policy, regulatory, and institutional reforms that

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
					encourage clean energy development. About 30% of CEFPF's resources are used for standalone technical assistance projects and direct charges; and about 70% are used for grant components of investments and may also be used to procure equipment and works based on advanced technologies, back financing mechanisms or risk sharing facilities to promote clean energy, and services to lower barriers. The Climate Change Fund will support projects in demand-side management projects, energy-efficient buildings and end-use facilities, and energy service companies development. **Conclusion: Applicable, especially to finance policy, regulatory, and institutional reforms**
9	ADB Climate Change Fund (CCF)	$40 million	Co-financing, Grant, Technical assistance	CEFPF resources are used to service developing member countries through ADB's operations department	ADB provides grants to projects through technical assistance, or investments in the private and public sectors. The Climate Change Fund will support projects in demand-side management projects, energy-efficient buildings and end-use facilities, and energy service companies' development. **Conclusion: Applicable**
10	ADB Carbon Market Initiative (CMI)	$115 million Future Carbon Fund, Technical Support Facility	Co-financing, carbon finance, Technical assistance	Mitigation, Low-Carbon, Renewable energy, Energy efficiency	Upfront carbon financing through the Future Carbon Fund (FCF) for carbon credits beyond 2012 up to 2020; and Technical Clean Development Mechanism (CDM) support through the Technical

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
					Support Facility. **Conclusion: Possibly applicable for CDM Programme of Activities**
11	The Hatoyama Initiative (Japan); also called "Cool Earth Partnership"	There is no minimum or maximum amount of assistance	Grant , Loan, ODA, Technical assistance.	Developing countries in consultation with Government of Japan (some private sector actors may also be considered).	Developing countries that are already making efforts to reduce greenhouse gas emissions can be funded to enable them to achieve economic growth in ways that will contribute to climate stability, on the basis of policy consultations between Japan and those countries. The program offers "Climate Change ODA Loans" with concessional conditions (preferential interest rates) provides financing to implement mitigation projects. Moreover, equity investments, guarantees, export insurance and subsidies through the Japan Bank for International Cooperation (JBIC) can be mobilized to fund projects in developing countries. **Conclusion: Applicable**
12	Nordic Environment Finance Corporation (NEFCO) Carbon Finance and Funds NEFCO Brochure	€150 million	Carbon finance, Grant, Technical assistance	Projects should be in line with the requirements of the JI Supervisory Committee and CDM Executive Board of the UNFCCC Secretariat, and the second trading period of the EU ETS (and subsequent periods)	NEFCO acts as buyer of ERUs/CERs/AAUs on the basis of emission reductions purchase agreements concluded with project owners; it also provides coverage of carbon related project preparation costs. Post-2012 emission reductions are an integral part of the procurement, up to the maximum of the first crediting period of the project (7 or 10 years). A Project Idea Note (PIN) should be submitted to the Carbon Finance and

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
					Funds Unit. On the basis of PIN, an initial screening of the project will be performed. Afterwards, if the project is considered eligible, a more detailed financial, technical and environmental analysis will have to be submitted. NEFCO gives high priority to renewable energy and energy efficiency projects, including those in industry. **Conclusion: Possibly applicable for CDM Programme of Activities**
13	Global Energy Efficiency and Renewable Energy Fund (GEEREF)	$65.66m deposited	Co-financing, Equity, Technical assistance	GEEREF will provide funding or technical assistance to private equity funds focusing on a range of activities including Energy Efficiency and Technology and Applications. GEEREF invests in energy efficiency projects in middle-income developing countries (50% share of GEEREF portfolio) and in emerging economies and CEITs (20% share of GEEREF portfolio)	For Technical Assistance: In parallel with its investment in GEEREF, the European Commission founded a Regional Fund Support Facility, which is administered by the EIB group within its GEEREF activities. The aim of the facility is to improve and facilitate the development of projects. The technical assistance grant can be up to €1 million. For Co-financing: Possible on a case-by-case basis. Up to 30% of GEEREF's total commitments by investors. For Investment: Structured for both public and private investors and as a Luxembourg SICAV, GEEREF operates as a Fund-of-Funds. GEEREF invests in private equity funds that specialize in equity finance for small and medium-sized projects. These projects must focus on renewable energy

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
					and energy efficiency production and/or technologies, requiring up to €10 million equity investment and fulfilling a substantial gap in the market. The candidate private funds must demonstrate that team members gather sufficient experience in both the renewable energy & energy efficiency sectors as well as in infrastructure investments. A verifiable pipeline of projects meeting GEEREF's investment criteria must be available. **Conclusion: Applicable**
14	Fund Solutions for Climate Finance (KfW & Partners) Financial System development Press release	Global Climate Partnership Fund (GCPF) of up to USD 500 million for international climate protection in the next five years	Loan	Focus on countries which already have a significant industrial basis and a large population like Brazil, Chile, China, India, Indonesia, Mexico, Morocco, Philippines, South Africa, Tunisia, Turkey, Ukraine and Vietnam.	The GCPF loans funds to SMEs, in the form of a public private partnership with a layered risk/return structure, to enhance energy efficiency and to foster renewable energies. The funds aim to increase the awareness of energy efficiency and renewable energy, and to develop the capacity of its investees through dedicated projects organized and financed by a technical assistance facility. **Conclusion: Applicable**
15	KfW Development & Climate Finance KfW Climate Change	Variable, depending on contract	Grant , Loan, ODA, Structured financing	KfW works bilaterally with countries to progress the country's national development strategies and structures. Countries propose projects and programmes within the framework of these agreements and	KfW finances sustainable economic development, energy and water supply, infrastructure and other areas. KfW has a focus on microfinance as this is becoming increasingly important for trade. KfW provides finance to banks or other financial institutions supplying small and micro businesses as well as retail customers with loans and equity capital.

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
				are responsible for their preparation and implementation.	**Conclusion: Applicable**
16	Climate Finance Innovation Facility (CFIF)	€28.3 million	Carbon finance, Risk management, Technical assistance	Financial Institutions	The fund provides training for the financial community in order to provide local support for projects that promote climate change solutions. The fund trains bankers to improve their knowledge of climate-mitigation technologies, including an understanding of their operating characteristics, key risks, and market potential. Funds are also provided of €50,000 – €150,000 for the development of innovative financial instruments. **Conclusion: Indirectly applicable**
17	Renewable Energy and Energy Efficiency Partnership (REEEP)	€150,000 maximum per project	Carbon finance, Co-financing, Grant, Loan guarantee, Risk management, Technical assistance	REEEP priority countries include Brazil, China, India, Indonesia, and South Africa. Viet Nam is not specifically listed but there does not appear to be any reason for exclusion. Application	Since its establishment as an NGO in 2004, REEEP has supported more than 130 projects in 65 countries. REEEP finances renewable energy and energy efficiency projects that address business, financing, policy and regulatory issues. REEEP projects have used a number of different strategies to catalyze additional investment including loan guarantees, the establishment of energy services companies (ESCOs) and micro energy service companies (MESCOs), seed money for revolving funds, carbon finance, risk management, microfinance, and other innovative sources of finance. Grants are expected to leverage other financial support.

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
					Conclusion: Possibly applicable
18	Global Climate Partnership Fund	$200 million	Co-financing, Loan, ODA, Risk management, Technical assistance	Energy efficiency, renewable energy and technical assistance in the key focus countries including Vietnam	GCPF aims to enable environmentally friendly economic growth in developing countries, particularly those experiencing rapid growth where demand for energy is rising and financing options for energy investments are not keeping pace with the need for investment. GCPF aims to: 1) Contribute to the mitigation of climate change by giving priority to countries with the largest energy consumption, the most significant greenhouse gas emissions and the highest potential to increase efficiency throughout the production and use of energy. 2) Finance energy efficiency and renewable energy projects, mainly by refinancing local financial institutions and in the future by (co-)investing directly. 3) Leverage additional private sector investment to promote financial flows that can contribute to the mitigation of climate change. **Conclusion: Applicable**
19	Vietnam Green Credit Trust Fund Funded by the Swiss Secretariat for Economic Affairs (SECO)	$5 million	Grant, loan guarantee Application is via one of three selected banks or the Vietnam Cleaner Production Centre. The	Credit size: $10,000 – $1,000,000 SMEs (either private sector or state-owned enterprises) with more	VGCTF funds cleaner production in Vietnamese SMEs. Cleaner production includes "low-cost" options (good practices) and opportunities for investment (cleaner technologies). The fund provides support to SMEs in Viet Nam

No	Name of fund	Total amount	Financial mechanism	Eligibility	Applicability to cold store project
			centre delivers energy efficiency services to SMEs. See also report by UNEP on the cleaner production centre.	than 50% Vietnamese ownership.	who offer products and/or services that decrease environmental degradation. The fund reimburses the borrower part of the investment costs after the successful installation of the cleaner production technology, if the borrower can demonstrate a reduction of the negative impact on the environment. For example, if a project achieves >30% environmental improvement, 15% is reimbursed; with 50% environmental improvement, 25% is reimbursed. The fund guarantees local financial institutions 50% of the principal of the green credit. For Viet Nam, these credits range between US$25,000 and US$ 1 million per project. Green Credits have a maximum maturity of five years with market-based interest rates. Green credit could be used to finance energy efficiency programmes. **Conclusion: Applicable**

Annex 8: EXAMPLES OF BILATERAL DONOR COUNTRIES THAT COULD PARTNER WITH UNIDO TO ASSIST WITH ACHIEVING ENERGY EFFICIENCY IMPROVEMENTS

Bilateral donor	Acronym	Website
Canadian International development agency	CIDA	http://www.acdi-cida.gc.ca/index-e.htm
Danish International Development Assistance	DANIDA	http://www.irc.nl/page/6677
United Kingdom Department for International Development	DFID	http://www.dfid.gov.uk/default.asp
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH	GIZ	http://www.giz.de/
FRANCE Direction Générale de la Coopération Internationale et du Développement	DGCID	http://www.diplomatie.gouv.fr/en/ministry_158/structure-of-the-central-administration_2051/directorate-general-for-international-co-operation-and-development_1575.html?var_recherche=DGCID
Japan International Cooperation Agency	JICA	http://www.jica.go.jp/english/index.html
United States Agency for International Development	USAID	http://www.usaid.gov/
Australia	AUSAID	http://www.ausaid.gov.au/default.cfm
Austrian Development Agency	ADAPTATION	http://www.bmeia.gv.at/
Belgian Development Cooperation	DGDC	http://www.dgcd.be/en/index.html
Belgian Technical cooperation	BTC	http://www.btcctb.org/showpage.asp?iPageID=2
Ministry of Foreign Affairs Denmark	MOFA	http://amg.um.dk/en/menu/PoliciesAndStrategies/PriorityThemes/PriorityThemes.htm
European Commission – DG Development	DG DEV	http://ec.europa.eu/development/index_en.cfm
Ministry of Foreign Affairs Finland	MoFA	http://formin.finland.fi/public/default.aspx?nodeid=15316&contentlan=2&culture=en-US
France Ministère des Affaires Étrangères et	MoFA	http://www.diplomatie.gouv.fr/e

Bilateral donor	Acronym	Website
Européenes		n
GERMANY Bundesministerium für Wirschaftliche Zusammenarbeit und Entwicklung	BMZ	http://www.bmz.de/en/index.html
KfW Bankengruppe	KfW	http://www.kfw.de/EN_Home/index.jsp
Irish Aid		http://www.irishaid.gov.ie/
Italy Cooperazione Italiana allo Sviluppo	MoFA	http://www.esteri.it/MAE/ENhttp://www.cooperazioneallosviluppo.esteri.it/pdgcs/inglese/intro.html
Ministero dell'Ambiente e della Tutela del Territorio e del Mare	MATEM	www.minambiente.it
Official Development Assistance (The Ministry of Foreign Affairs Japan)	ODA	http://www.mofa.go.jp/policy/oda/
Japan Bank for international cooperation	JBIC	http://www.jbic.go.jp/english/index.php
LUXEMBOURG Le Ministère des Affaires Étrangères		http://www.mae.lu/MAE.taf?IdNav=3&IdLang=UK
LUXEMBOURG Agence Luxembourguoise pour la cooperation au développement	LUX - Développement	http://www.lux- development.lu/
Dutch ministry of Foreign Affairs	MoFA	http://www.minbuza.nl/en/developmentcooperation/Themes
New Zealand	NZAid	http://www.nzaid.govt. nz/
Norway ministry of Foreign Affairs	MoFA	http://www.regjeringen.no/en/dep/ud.html?id=833
Norwegian Agency for Development and Cooperation	NORAD	http://www.norad.no/default.asp?V_ITEM_ID=1139
Instituto Português de Apoio Ao Desenvolvimento	IPAD	http://www.ipad.mne.gov.pt/index.php
Agencia Española de Cooperación Internacional	AECI	http://www.aeci.es/ind ex.asp
Swedish International Development Cooperation Agency	SIDA	http://www.sida.se/sida/jsp/sida.jsp?d=121&language=en_US
Swiss Agency for Development and Cooperation	SDC	http://www.sdc.admin.ch/en/Home
State Secretariat of Foreign Affairs (Switzerland	SECO	http://www.seco.admin.ch/index.html?lang=en
Millennium Challenge Corporation (USA)	MCC	http://www.mcc.gov/