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执行蒙特利尔议定书
多边基金执行委员会
第六十五会议
2011 年 11 月 13 日至 17 日，印度尼西亚巴厘

关于多边基金气候影响指标的报告

（第 59/45、第 62/62、第 63/62 和第 64/51 号决定）

导言

1. 执行委员会第五十九次会议通过了第 59/45 号决定。该决定的（g）分段请秘书处向第六十二次会议提交一份关于执行同一决定的（c）和（d）分段所取得的经验的报告。（c）分段请秘书处“说明自第六十次会议后，将多边基金气候影响指标适用于一系列项目呈件的情况，这将通告各机构和各国技术选择的气候影响”，并请秘书处“收集更多关于应用多边基金气候影响指标的数据，供执行委员会审查”。此外，同一决定的（d）分段还请秘书处完成多边基金气候影响指标的制订。

2. 执行委员会第六十二次会议简要讨论了多边基金气候影响指标的问题，并通过了第 62/62 号决定，将对关于实施多边基金气候影响指标所取得经验的报告的审议推迟至第六十三次会议。

3. 第六十三次会议的讨论涉及：

(a) 执行委员会有必要澄清多边基金气候影响指标的确切目标和目的，因为这将确定该模式今后发展的方向，并会对所希望的复杂程度产生直接的影响；

(b) 作为下一步提出的非正式会议的建议，组织召开这一会议将让执行委员会成员能够讨论模式本身，同时也讨论同秘书处、执行机构和专家一道组成一模式问题专家小组的可能性；

(c) 参与 2010 年底举行的网络讨论的机构很有限，导致必须鼓励各执行机构参与讨论，包括多边基金的网络讨论；以及

(d) 为维修行业制订一项气候影响指标并利用这一指标评估氟氯烃淘汰管理计划对于气候的影响（仅侧重于维修行业）的可能性。在这方面，有成员建议秘书处应同执行委员会成员、各执行机构以及必要时同专家密切协商制订一种方法，然后再视执行委员会的决定开始实际指标的工作。

4. 根据上述讨论，执行委员会通过了第 63/62 号决定，注意到 UNEP/OzL.Pro/ExCom/62/58 号文件所述关于执行多边基金气候影响指标所取得的经验的报告，并决定在第六十四次会议上继续讨论多边基金气候影响指标。

5. 第六十四次会议期间，普遍的共识是，虽然就多边基金气候影响指标做了实质性的工作，但仍需要进行深入的讨论以便弄清多边基金气候影响指标的确切目的、目标和最终用户。另一个好处是酌情借鉴各执行机构和其他专家的意见和经验。执行委员会几位成员表示，他们觉得在本次会议期间将多边基金气候影响指标用于正在审查的氟氯烃淘汰管理计划的提案，对于如何选择替代技术来说是有益的。但有成员指出，多边基金气候影响指标受到某些限制，例如，无法顾及设备升级和在行业分析中的用途的影响等因素。此外，执行委员会还有必要澄清多边基金气候影响指标应该有何种具体的目的和目标，以便决定模式今后的发展方向。执行委员会将在第六十五次会议期间继续讨论第 64/51 号决定。

6. 本文件根据第 59/45、第 62/62、第 63/62 和第 64/51 号决定编制，最新情况反映了第六十三次会议期间的讨论以及嗣后的决定。鉴于第六十三次和第六十四次会议所作继续

进行讨论以使执行委员会能一步审议这一问题的决定，秘书处没有进一步扩展 UNEP/OzL.Pro/ExCom/63/58 号文件。

背景

7. 在 UNEP/OzL.Pro/ExCom/55/47 号文件中，秘书处提出了“考虑淘汰氟氯烃供资问题相关成本的修订分析”；本文件还包括关于环境问题的部分内容，以及说明在含有氟氯烃的产品的生命周期中评估气候相关排放量的功能单元法提案的附件。根据第 55/43 号决定，执行委员会请秘书处进一步分析，是否本文件中所列的这种方法将为优先使用氟氯烃淘汰技术提供令人满意和透明的基础，以最大限度地减少对环境产生的其他影响，其中包括对气候的影响，正如缔约方第十九次会议第 XIX/6 号决定最初设想的那样。

8. 在 UNEP/OzL.Pro/ExCom/57/59 号文件中，秘书处提交了一份关于进一步分析指标工作的情况报告。这些指标被确认为优先使用氟氯烃淘汰技术的令人满意和透明的基础，以最大限度地减少对气候的影响。执行委员会注意到这份情况报告，请秘书处编制一份列举应用实例的报告，以促进进一步审查该方法，并决定讨论将与正在制定的指标相关奖励措施类型所涉的更多问题和其他相关问题（第 57/33 号决定）。

9. UNEP/OzL.Pro/ExCom/59/51 号文件向执行委员会通报了与“优先使用氟氯烃淘汰技术以最大限度地降低其对环境的影响”相关的问题。在本文件中，秘书处临时确定了该指标的范围，以便适用于转化生产能力、替代或结束这种能力。这种模式经历了很多次简化、提炼和分化过程，并且为提高结果的透明度和可用性进行了尝试。作为这些努力的一部分，“多边基金气候影响指标”这一术语替代了“功能单元法”中的术语。

自第五十九次会议后多边基金气候影响指标的制定情况

10. 自执行委员会第五十九次会议后，进一步制定和拓宽了多边基金气候影响指标的概念。该指标旨在为项目对气候产生的影响提供一个数值，很像“淘汰消耗臭氧层物质”设立的显示该项目对臭氧层影响值的指标。多边基金气候影响指标的另一个目标是用一种在行业和国家之间提供公平和可比较的结果的方式来规范对气候影响的计算。同时，秘书处正在关注仅应用在项目制定期间收集的数据的编制工作。

11. 与向第五十九次会议提交的报告相比，秘书处通过纳入溶剂和维修行业延伸了范围，同时坚持原则，只对与由多边基金供资的活动直接相关的气候影响的变化负责。涉及制冷、空调设备、泡沫塑料、溶剂、加工剂和制冷维修行业的相关技术说明见附件二。

应用示范

12. 在筹备第五十九次会议的过程中，设计了数据输入和数据提交的格式，并且该格式被载入 UNEP/OzL.Pro/ExCom/59/51/Add.1 号文件。但是，当时甚至迄今，大部分相关计算是手工完成的，时间成本过高，而且计算出错的可能性大。直到筹备执行委员会第六十二次会议的最后阶段，计算制冷行业多边基金气候影响指标的模式才大体实现自动化，得以用新制定的模式进行相关计算。相关信息见附件三。

13. 对于泡沫塑料行业，自第五十九次会议后，根据转化前后使用同吨位发泡剂的假设，手工进行了简化计算。尽管这并未考虑能效问题，但仍是个合理的近似值。还使用了在该产品的使用期限内排放发泡剂总量的设想。

现状

14. 在这一时间点上，已计划将制冷行业的气候影响指标完全在微软的 Excel 表格上使用，并且目前正在检查该指标的准确性。也正在确定将泡沫塑料行业以及溶剂和加工剂行业的多边基金气候影响指标用于 Excel。维修行业的多边基金气候影响指标已经概念化了。秘书处有待开展的剩余工作涉及数据输入的定义和质量，以提交大型氟氯烃淘汰管理计划。

15. 制冷和空调设备的多边基金气候影响指标的第一个版本被设计为一种 Excel 工具，并自第六十二次会议后载入秘书处的网页。随着概念性工作和程序设计方面取得的进展，将出现后续版本。各机构和执行委员会成员将随时能从秘书处网页上下载最新版本。根据可比较的和公正的评估，并在保持追踪多边基金氟氯烃淘汰活动对气候的影响时，该工具将在理解拟议活动的气候影响方面为秘书处和执行委员会提供支持。

16. 在完成编制 Excel 模式时，将需要多边基金气候影响指标的专家进行更广泛的审查，以将该工具用作将相同计算纳入多年期协定数据库的蓝图。在编撰氟氯烃淘汰管理计划多年期协定表格的概念时，充分考虑了进行更广泛审查的重要性。这最后一个步骤将显著减少数据输入的需要，并将允许进行更密切的监测和对该数据进行不断分析。鉴于在筹备即将召开的执行委员会会议过程中对秘书处的时间要求是未知的，而且存在大量有待审查的氟氯烃淘汰管理计划，所以无法在目前的时间点上明确指出完成 Excel 模式和多年期协定表格的时间框架。

17. 制定多边基金气候影响指标的最初设想是提供将进行以下活动的工具：

(a) 当考虑哪种氟氯烃替代物将用作不同用途时，在各国选择技术以制定氟氯烃淘汰管理计划过程中为它们提供支助；

(b) 允许执行委员会考虑是否采用奖励措施，以使用无害气候物质替代氟氯烃，并允许执行委员会鼓励开发新的替代资金来源，以支持气候相关活动，如能效活动；

(c) 使秘书处和执行委员会有可能客观测量并比较呈件中提交的技术选择的气候影响；以及

(d) 使执行委员会监测并负责由多边基金支助的项目的气候影响。

18. 执行委员会第五十五次会议上第一次提出该问题。在自那次会议起的两年时间内框架条件发生了变更。根据这项变更，自以下活动后开始使用多边基金气候影响指标：

(a) 执行委员会在第六十次会议的第 60/44 号决定决定商定了数目众多的奖励措施，用更多无害气候替代物质替代氟氯烃，且独立于多边基金气候影响指标。尽管该决定第（五）、（八）和（九）分段通过对增量经营成本供资，减少了间接激励使用高全球升温潜能值的物质，但第（四）和（七）段包括使用低全球升温潜能值技术的明确奖励措施。

(b) 对建立一项设施的讨论尚未结束。该设施将允许提供除符合多边基金项目资格外的额外资金。而且不能确定这些讨论何时和如何才能结束。

(c) 在广泛的基础上和短时间内为开展能源效率活动调动来自全球环境基金等资源的资金存在困难。这一点为人所知，并且限制了为与减少气候相关排放量有关的活动提供奖励措施制的前景。而这些奖励措施将为有资格获得多边基金供资的活动补充一项额外的气候变化内容。

(d) 多边基金以前的淘汰项目发生的模式转变重点关注独立活动或剩余消费量。开展了大型和具体活动后，该模式转变发展了自身对资源的动力和需求。由于执行委员会会议间的时间限制，不可能分配足够的时间给多边基金气候影响指标有关的问题，也不可能过早地以原本期望的速度取得进展。

19. 过去 24 个月越来越清楚地显示，由中央指导技术选择过程的设想可能不符合第 5 条国家的决策现实。从迄今收到的项目呈件来看，似乎明确的是，尽管并非所有问题（诸如内容的可用性）已完全澄清，但一些国家选择了现有的先进的无害气候替代物，而其他国家不愿意要求它们的工业使用非主流的技术，因为这在很多情况下将导致选择使用对气候影响大的替代物。多边基金气候影响指标不可能对这些决定造成重大影响，因为这些决定似乎基于更为基本的考虑，即在选择一种新技术时是否将考虑气候变化的问题，以及如何评估相关的经济风险和机遇。多边基金气候影响指标能决定的对气候变化产生影响的程度似乎只能起到次要作用。这种状况被以下事实进一步放大，即在有资格获得多边基金支助的范围内，直接或间接地考虑到一些气候变化问题，且执行委员会提供了一些关于项目优先问题的明确信息，但与除符合多边基金支助资格的活动外的活动有关的供资很少兑现。此外，对发展中国家缓解活动的未来供资仍然具有高度的不确定性。

<u>结论</u>

20. 最初设想是制定气候影响指标，以用四种不同方式支持各国、各机构和秘书处的工作，即：

(a) 对选择替代物进行决策；

(b) 可能根据多边基金提供奖励措施，同时还允许根据可量化的气候影响寻求可替代的资金来源；

(c) 理解提交至执行委员会的项目提案的气候影响；以及

(d) 不断监测多边基金的工作对气候产生的影响。

21. 基于上文第 19 段所述的原因，此时制定多边基金气候影响指标的主要目的可能是后两者，即通知执行委员会对氟氯烃各种替代物供资和监测多边基金的工作对气候产生的影响的结果。在第二阶段的筹备过程中，多边基金气候影响指标将帮助提供所有最初设想的支助，特别是早在决策过程中帮助各国评估不同的技术选择。各国和各机构在氟氯烃淘汰管理计划第一阶段中所得到的经验将便于适用多边基金气候影响指标。

22. 数据要求将与评估资格和增量必备的要求一致，包括数据收集的相关格式。将筹备和制定计算消防行业的气候影响的概念。一旦全面编制并应用了 Excel 模式，将实施多边基金气候影响指标工具向多年期协定表格的转移。将多边基金气候影响指标工具纳入多年期协定表格将大幅简化各机构和秘书处对该工具的适用，因为只有计算了资格、消耗臭氧潜能值和多边基金气候影响指标，并提供了关于该国的汇总信息，才能输入数据。秘书处最迟将在第六十七次会议上通知执行委员会转移该模式的状态和在该过程中做出的努力。

<u>建议</u>

23. 谨建议执行委员会：

(a) 注意到关于实施多边基金气候影响指标所取得经验的报告；

(b) 请秘书处完成制定 UNEP/OzL.Pro/ExCom/65/54 号文件所列各不同行业的多边基金气候影响指标的工作；

(c) 请秘书处不晚于第六十九次会议向执行委员会通报在将多边基金气候影响指标用于项目呈件方面所取得的进展和积累的经验；

(d) 请秘书处将气候指标用于所提交的相关项目和次级项目，以便让各呈件所提技术备选办法的气候影响能够加以衡量；以及

(e) 请秘书处不晚于第六十八次会议向执行委员会提交一份编撰充实的多边基金气候影响指标，以便评估可否将其作为编制及评估项目呈件的充分协调的工具加以应用，以计算多边基金氟氯烃消费项目的气候影响。

附件一

多边基金执行委员会对气候影响指标反馈
（第 62/56 和 Add.1 号文件）

（摘自秘书处的在线讨论论坛）

澳大利亚政府的评论意见

第 62/56 号文件

1. 第 11 段提及专家评审这一概念－我们感谢就专家评审计划提供更多信息。这是否仅仅涉及计算方法？

基金秘书处的答复：

基金秘书处认为，多边基金气候影响指标提供的计算方法是一种适用工具，可以表明执行委员会供资活动的气候影响情况，在这方面实现广泛共识非常重要。为了实现普遍接受，秘书处认为最大限度地提高透明度会有帮助，并愿意建议为利益攸关方提供机会，以推动多边基金气候影响指标的最终编制。不过，区分有关多边基金气候影响指标基本特征的讨论和影响计算的技术细节也很重要。

关于技术问题，秘书处认为基于具体转换建议的对话将是促成沟通并推动接受这一工具的最佳途径。秘书处方面的当前考虑是收集书面答复；这可以通过汇编一个适用于评审的必要信息包并要求执行委员会成员提供各自的评论和/或向秘书处提供可以向其发送信息包的有关专家的地址来进行。然后，秘书处必须收集答复并解决各种问题。

尽管专家评审的范围可能比单纯的计算审查更广泛，但它仍然侧重于计算审查。它可以包括以下问题：

- 多边基金气候影响指标的相关注释
- 计算的概念
- 替代技术方面的多边基金气候影响指标范围
- 算法
- 基本数据
- 不确定性

将讨论进行任何程度的扩大似乎并无益处，因为涉及意图、一般定义、适用性和后果的问题似乎属于非技术问题，需要由执行委员会加以讨论。

2. 第 14 段暗示多边基金气候影响指标工具可能并无必要，因为第 5 条国家正独立于多边基金气候影响指标信息之外做出技术选择，而且氟氯烃准则已经定义了相关术语，基于这些术语，将向进一步的共同气候惠益提供超出成本效益阈值的资金。不过，多边基金气候影响指标的一个关键作用是更好地向执行委员会提供有关技术决定对气候影响的信

息，而且如果能很好地做到这一点，此类信息将有益于商定下一年度的项目和氟氯烃淘汰管理计划。它还将有利于确定供资准则能在多大程度上实现其鼓励使用气候友好替代技术的目标。最后，对于各种替代技术的潜在气候惠益信息，无论其替代成本是否在氟氯烃准则的设定参数范围内，都有助于针对特定项目调动额外资金。

基金秘书处的答复：

秘书处赞同上段所述意见，并将有必要限定和监测气候变化的类似结论列入了此前UNEP/OzL.Pro/ExCom/62/56 号文件的第 16 段。另外还有可能利用多边基金气候影响指标来评估其他供资机制是否有兴趣进行联合供资。考虑到这一指标或任何其他指标的编制周期，此项工作业已启动是一个有利条件，而且确实有可能证明这有助于在未来调动额外基金。秘书处相信多边基金气候影响指标会在编制第二阶段氟氯烃淘汰管理计划的过程中起到评估融资可能性的作用。

第 62/56/Add.1 号文件

3. 我们大体同意第 6(a)段的提议（即与根据多边基金气候影响指标计算的能耗相关的二氧化碳排放应有一个基本假设：技术升级不会超出允许转换发生的必要条件）；不过，在某些情况下，对于在转换过程中实施某种技术升级可能导致的气候影响进行模型演示，以期将此类信息用于动员联合供资，这也十分有用。举例而言，多边基金气候影响指标在一个拟议项目中生成两种结果，一种表明未经技术升级的气候影响，另一种表明经过明确升级的气候影响，这是否具有可行性？

基金秘书处的答复：

该评论与秘书处大体制备完毕的一种方法相一致。通常情况下，空调设备的能耗可通过四项措施改进：更大型的热交换器、更好的压缩机、变速驱动器以及组件特性之间的更精细调整。前三项措施的效果相对容易建模，它们的影响也相对容易评估。不过，相比以一种流体替代另一种流体的计算，这些计算有着更大程度的不确定性，因为前者使用的假设是组件特性保持不变，只是流体被更换。这种计算方法对设备及其组件的现有质量不够敏感，因为两种计算所假设的质量相同。不过，如果质量得到改进，则无论是就某种质量水平做出假设的软件需求（目前的情况正是如此）还是现有质量水平的相关信息，都需要通过一种标准化手段收集。这两种方法之间的区别是，利用软件范围内的假设所得出的结果更具指导意义且不够精确，而在第二种情况下，针对特定结果的数据收集工作更繁重，其数据处理风险也更大。秘书处有意提供基于“标准质量水平”方法计算技术升级的可能性。

4. 所做出的“排放全部泡沫塑料发泡剂”的假设是否有某些局限性？（第 8 段）一种观点认为，在填埋场处置泡沫塑料时，发泡剂的排放量可能微不足道，即使是长期排放。

基金秘书处的答复：

这一疑问需要解决两个问题。一个问题涉及对操作和（在此情形下的）处置影响气体排放的认识，以及不同的操作和处置方式在发展中国家的普及程度。第二个问题是多边基金气候影响指标应如何界定。

- 一般而言，如果能考虑到第 5 条国家的实际情况以及尽可能减少信息需求这两个准则，那么多边基金气候影响指标无疑会将不同的排放量纳入计算考虑中。因此，问题应该是：第 5 条国家生产的泡沫塑料有多少在以限制排放方式管理的填埋场得到了实际处置？
- 这必须联系第二个问题来理解：多边基金气候影响指标定义本身是指一年内所生产货物的终身总排放量近似值（包括在制造和处置过程中的排放），即一年内所生产设备在多年间的总排放量。其他气候影响定义（如根据《联合国气候变化框架公约》采取的方法）则基于每年的排放量来审视影响（总期限有可能超过 7 年或 10 年），不过它们也汇总了多年间的产量影响。对于多边基金气候影响指标而言，即使是一种缓慢排放，也能最终导致完全排放；这一点很重要，因为举例而言，在一种稳定使用的情形下，如果排放需要 50 年完成，那么 50 年之后，来自泡沫塑料库的年排放量（包括 50 年的泡沫塑料产量）将等于该物质的年使用量。因此，就多边基金气候影响指标而言，假设普及现有的终身定义，则必须考虑来自填埋场的排放是否会在若干年后实际停止，同时填埋场内会有一定数量的氟氯烃仍然有待持续捕获，或者举例而言，是否细菌正将塑料泡沫中的部分氟氯烃转换为其他物质。如果此类影响在第 5 条国家中广泛存在，就很容易适用这些计算方法。

5. 您是否能澄清在什么情况下泡沫塑料转换项目的能效因子会被多边基金气候影响指标纳入考虑，以及会如何考虑？从第 9 段来看，由更换发泡剂导致的能耗及相关二氧化碳排放量的变化，似乎仅在有限的制冷面积中使用绝缘泡沫塑料的情况下才会被纳入考虑，这是否正确？如果正确，多边基金气候影响指标的结果是否会误导其他泡沫塑料行业项目，鉴于它并未考虑到能量因素？它是否假设在大多数情况下，能耗变化的明显程度可能并不足以确保更详细的分析？

基金秘书处的答复：

迄今为止，针对泡沫塑料项目的秘书处审查文件所提及的气候影响并未考虑任何能量效应。它只是基于所计算的发泡剂全球升温潜能值和使用量，包括了用于一定量氟氯烃发泡泡沫塑料的发泡剂和用于相同数量泡沫塑料的替代发泡剂之间的气候影响差异。

基金秘书处曾尝试就解决泡沫塑料节能问题提出概念。结果最大的障碍是这样一个事实，即泡沫塑料的实际应用信息在很大程度上无法利用，而有用信息对于了解泡沫塑料的节能效果是必不可少的；举例而言，有用信息即绝缘厚度和质量、温度差异以及能耗差异所导致的温室气体排放效应，这取决于通过绝缘用来补偿任何能量

转移的初级能源类型。最后，此类信息必须涉及多边基金气候影响指标用户会在理想情况下做出的很小规模的系列选择，和/或一些基于方案背景的重大假设。

在某些情况下，当从一种泡沫塑料发泡技术转换为另一种时根本不会产生能量影响。例如，如果除了绝缘之外，整皮泡沫塑料的所有应用并非都有其他用途，则不同技术的绝缘性就无关紧要。

绝缘质量重要的应用可分为两类：可以改变绝缘厚度使其适应绝缘质量变化的应用，以及给定绝缘厚度的应用。后者通常是指用于家用冰箱和冷藏运输的应用。秘书处目前并不清楚其他绝缘应用，在这些应用中，壁厚的略微增加往往会导致重大技术问题，而且绝缘质量的欠缺并不能通过增加壁厚得到解决。具体观点是：

- 在绝缘厚度可变的情况下，拟议但尚未实施的计算方法将仅能计算厚度的必要变化，并因此可以计算达到同一绝缘质量所需泡沫塑料数量的必要变化；数量的增加将导致发泡剂使用的相应变化，而且发泡剂的相关影响将被用于计算多边基金气候影响指标值。因此，绝缘厚度及发泡剂使用的相应变化将计算通过改变壁厚抵消绝缘质量变化的工作影响。
- 即将针对家用冰箱和冷藏运输进行能耗计算，而且转换前后的能耗差将被用于多边基金气候影响指标值的计算。

6. 第 11 段提出，由政治协定造成的导致维修行业氟氯烃淘汰的气候影响不应纳入考虑，因为它们与所供资的活动无关，而与国家淘汰氟氯烃的承诺有关。不过，就各类氟氯化碳的情况而言，各国所做出的在没有多边基金进一步援助的情况下淘汰维修行业氟氯烃的承诺，是多边基金核准的氟氯烃淘汰管理计划的直接结果。因此，有理由证明由完全淘汰维修行业氟氯烃导致的气候影响与多边基金的工作相关，并应该在理论上加以说明。尽管我们认为在实践中预测这种气候影响将会非常困难，因为不可能预测各个终端用户次级行业最终会选择什么替代技术和多少数量。

<u>基金秘书处的答复：</u>

必须非常谨慎地评估纳入多边基金气候影响指标考虑的界限问题，这是决定正确的；秘书处可以在这方面提出建议，但执行委员会必须就重要定义做出决定。

秘书处对更广泛定义的一个主要关切是，这为实现多边基金气候影响指标计算的一致性造成了更大困难。一般而言，规则越严格越受限，就越容易实现一致性。作为示例，我们愿意在这个特殊问题上提出两个注意事项：

- 各国将通过从接受多边基金支助的生产商那里进口无氟氯烃空调来实现消费量的减少；这些进口将随之减少氟氯烃维修需求。如果维修行业的此类减少可以解释为积极影响，就必须寻找一个已在工厂转换时提供解释的清除此类排放的机制。终身排放可以解释工厂一级的转换，因为转换时的技术替代决定限定了设备的终身气候排放量，因此，应在做出选择时联系多边基金。
- 消费减少与蒙特利尔议定书之间存在关联，但这并非减少消费的唯一解释；例如，经济环境如加入一个拥有更严格环境法律或更多遏制气候变化国家行动的联盟，是有可能减少消耗臭氧层物质使用的其他原因。

从上述内容中也可以明显看出，随着定义的扩大，结果的可信度有可能降低，例如会出现重复计算的问题。这可能不利于多边基金气候影响指标的总体目标。

秘书处认同维修行业计算的不确定性有可能超过制造行业计算的不确定性。存在着关注与更好做法（制冷剂再利用和再循环等良好做法）相关的节约情况的可能性，但秘书处不愿贸然决定的是，对所接收信息的权衡比较是否有效。

7. 权衡甚至大略估计回收和再循环以及良好制冷方法的气候影响也很有挑战性（第 12 a 和 b 段）。对制冷剂管理计划和最终淘汰管理计划的评估并未能确定通过此类活动直接淘汰的氟氯烃数量。一旦完成这种量化（在项目完成报告或其他来源中），各国之间的差异似乎会非常显著，这可能是由不易通过项目控制的各种因素造成的，诸如消耗臭氧层物质的价格、维修行业利益攸关方（技术员协会）的认识水平和承诺、政治驱动因素、市场因素等。

至于维修行业的设备更替活动，我们同意会对气候影响加以评价的说法（第 12c 段）。不过。我们看到了两个潜在问题。一是如何避免第 12 c （二）段中提及的重复计算问题，即怎样事先获知所引进的新设备将会/不会由多边基金援助的企业生产？第二，秘书处不可能将能效纳入考虑这一事实似乎是一个重要弊端。秘书处注意到，转换前后的系统能耗差异较小。不过，附件三中的多边基金气候影响指标显示，不同技术之间与能源相关的二氧化碳排放差异事实上非常显著。至于多边基金气候影响指标在中国工业和商业制冷行业计划中的应用（附件三），似乎就转用 HFC-410a 设备而言，间接气候影响的变化（即与能源相关的二氧化碳排放变化）实际上大于直接气候影响的变化。不过，如果在维修行业设备更换项目中忽略能耗因素，多边基金气候影响指标是否仍能有效说明此类活动的气候惠益？

<u>基金秘书处的答复：</u>

我们同意澳大利亚提出的有关确定维修行业气候影响的任何尝试的相关不确定性的意见。这可能是非常宽泛的粗略估计。如有疑惑，在此类方法中较为常见的做法是将气候影响主张减少到几乎可以确信会发生的影响水平上。举个简单的例子，通过分析可以得知，一台回收机每年平均回收 500 公斤消耗臭氧层物质，但是 95%的回收机每年回收 100[1]公斤以上。如果以 100 公斤为基准，气候影响的计算可能无法准确代表该领域的结果，但非常确定的是影响至少与估计的数值一样大。

改型系统的能源效率非常难以计算。除制冷剂固有的特点外，下列影响也可影响系统技术转换前后的能源效率差异：制冷剂特定设计的程度以及系统转换为 HCFC-22 之前的安全系数，无论在技术转换过程中是否进行任何优化，也不管是否将机会用于一般的系统检修。这些影响常常会导致较低的能源效率，但有时能源效率会更高。此外，从文献中获得的有关该领域内改型机器的数据并不总是适于从中得出总体看法，因为存在不同系统覆盖范围、测量精度和比较技术转换前后结果的能力方面的不足，而这些不足是由于不同操作条件导致的。没有大量可使用的关

[1] 这些数字为随意挑选数字，作举例之用。

于装置的数据，就不可能做出足够准确的预测；结果在很大程度上取决于所提供数据的质量。考虑到单一转换制冷装置在总体气候影响中的影响较小，这种方法的结果似乎不太可能证明所做出的努力是否合理。

8. 与可能适用多边基金气候影响指标的其他行业相比较，氟氯烃溶剂行业和消防行业看似相对较小。将多边基金气候影响指标扩展到这些行业中可能不会有太大的增值价值。也许这可以在随后阶段中考虑。秘书处也提及了多边基金气候影响指标对反应剂行业的适用性。到目前为止，执行委员会尚不知晓第 5 条国家用作反应剂的任何氟氯烃消费量。有没有可以获得的信息表明该行业可能是一个重要的或甚至较小的氟氯烃消费行业？

基金秘书处的答复：

没有具体的可获得信息表明将氟氯烃用作反应剂。

9. 关于多边基金气候影响指标对中国行业计划的适用性，请阐明：

（a） 为什么两个泡沫行业计划不包含在分析范围中？

（b） 工商制冷行业计划数据表中的 4 种“系统类型”（3 种称为“空调工厂装配”，一种称为“商业冷冻装配”）如何与计划中确定的次级行业建立相关性，即：压缩机、单机空调、多联空调/热泵、工业和商业冷水机/热泵、小型水冷机/热泵、热泵热水器、“冷凝装置、制冷机和冷藏”次级行业。

基金秘书处的答复：

关于问题（a），对两个泡沫行业计划的评估包含有关气候的段落，都包含在第六十二次会议和第六十三次会议文件中；然而，相关信息包含在项目文件中（UNEP/OzL.Pro/ExCom/62/26/Add.1 号和 UNEP/OzL.Pro/ExCom/63/26 号文件）。对于聚苯乙烯泡沫次级行业，第 63/26 号文件提供了第 99 段中的信息；对于聚氨酯泡沫刺激行业，信息载于同一文件的第 84 段和表 12 中。

关于问题（b），多边基金气候影响指标的概念允许根据 6 种不同类型在不同的制冷和空调系统中进行选择。这些类型中的每一类都具有关于操作条件（温度、……）、设计特征（压缩机质量、……）和泄漏率的潜在假设。待选择的类型为商业冷却、商业冷冻和空调，三种类型的系统在就地装配和工厂装配方面都有差异，导致产生了总共 6 种类型的系统。

压缩机和冷凝装置不是系统，视为部件，因而未反映出来。单机空调、多联空调/热泵、工业和商业冷水机/热泵、小型水冷机/热泵包含在空调项下。在空调系统中，单机空调、多联空调/热泵类别就地装配，中国工商制冷行业计划中提及的其他类别在工厂中装配。热泵热水器归为工厂装配空调，制冷机归为工厂装配商业冷冻系统，冷藏归为就地装配的商业冷却系统。秘书处承认较为简单的选择或帮助选择适当系统类型的指南可能有用。

阿根廷政府的意见

10. 在计算制冷剂的直接影响排放量时，计算模型是否假设在寿命期间内将失去所有制冷剂容量？

基金秘书处的答复：

计算模型基于寿命期间排放量，即包括处置排放量。此时，第 5 条国家的处置活动大都不从设备或泡沫中回收消耗臭氧层物质。尽管该计算模型有可能使用针对报废处置的不同设置参数，目前对设备中包含的所有消耗臭氧层物质的大气排放设定了参数。然而，对于具有较高泄漏率的制冷/空调应用（如就地装配商业制冷系统），泄漏率太高以至于设备在达到报废前只有 40%的剩余制冷剂含量。那样的话，假定设备将重新充填 100%的制冷剂容量，重新充填量增加到寿命期间内的总体制冷剂用量。因此，这时寿命期间内的制冷剂排放总是至少为初始充填量的 100%，在几种情况中排放量更高。这也说明计算模型能够计算不同报废回收率的影响（若需要）。

11. 对于 R-410a，我们注意到所描述的排放量增加了 5%，然而，使用该制冷剂的家电的总体气候影响应该较低，因为与 HCFC-22 相比，其效率较高并且制冷剂容量较低。

基金秘书处的答复：

通过多边基金气候影响指标计算的 HFC-410A 的影响在很多情况下要高于 HCFC-22 的影响。一方面这是由较高的全球升温潜能值引起的，同时也因较高的能源消耗引起，以用于多边基金气候影响指标的定义为基础。单独来看，“较低能源消费”的意见也有些道理。理由是在将 HCFC-22 转换为 HFC-410A 时，进行了大量优化，其中常常是改变压缩机技术和增加换热器的表面积，更不必说使用经常改进精心调整的部件特点重新设计。换句话说，HFC-410A 系统常常具有较高的精密化程度，如果将这种精密化程度用于 HCFC-22 系统，也可以从实质上改进 HCFC-22 系统的能源效率。因此，很难提出有关如何公正地比较技术转换前后空调模型的标准。

所选的标准实际上假定部件具有相同的质量。目前，使用压缩机的恒定等熵效率及换热器表面积与换热器传热系数的乘积的恒定值进行计算。[2]

12. 此外，有数据表明计算没有考虑到使用 R410a 的设备的设计改进，只是更改了压缩机，但没有诸如更改换热器等的任何其他改进。

13. 举例来说，在我国（阿根廷）的例子中，提供给制造商的工具包对阿根廷的平均温度更具能源效率，因此制造行业已经采纳以遵守我国的新能源效率法。

[2] 模型计算假设大多为空气-制冷剂换热器；对于液体-制冷剂换热器，使用该模型计算的精确度可能稍低。

基金秘书处的答复：

秘书处认为这一问题提出了两个方面的问题，即多边基金气候影响指标的一般定义及其应当提供的额外特征。

在上述第 11 段中，我们已经提及了以公正的方式比较不同精密程度的问题。多边基金气候影响指标也以稍微简单的方式定义了技术转换，即制造商可能承担的对他来说最具成本效率的技术转换。该比较标准具有下列优点：

- 相对容易的定义；
- 在比较相似精密程度的意义上说是公正的；
- 完全符合执行委员会的符合资助条件费用指南。

然而，正如阿根廷例子的可能情况一样，如果政府希望记录所做出的实际选择，包括提高设备精密度，这样可能会使人误解，这看似与此处给出的例子情况一样。对于这些情况，希望可以从最初的转换中更新模型的许多系统参数——换热器表面积、压缩机等熵效率，以及可能使用变速驱动系统替换定速驱动系统；这样做的结果是使能源消耗大大减少。然而，阿根廷的问题实际上表明，使用消耗臭氧层物质的很多产品的能源效率都低于监管基准。技术转换不仅意味着脱离氟氯烃，同时还添加了转向更具能源效率产品的要求。使用当前可获得的选择，多边基金气候影响指标可将两个步骤分离开来，并只计算其中的一个步骤，即从消耗臭氧层物质中脱离出来；部件升级，除了技术转换外还可以引入能源效率。如果执行委员会希望这么做，可对多边基金气候影响指标进行改变，用于单独计算可以在结果中看见的更换制冷剂的影响和部件/能源效率提升。

秘书处想借此机会指出，有关使用多边基金气候影响指标比较的内容的共同理解，对于产生可能不同的比较假设非常重要。

14. 此外，我们认为该指标提供的气候影响仅能视为一般类型的影响，并未考虑替代技术的效率。家用电器的性能根据设计会有很大不同。

15. 如上所述，可通过降低需要的充填量、改善设备设计和提高制冷剂效率来弥补 R410A 更高的全球升温潜能值所产生的额外影响。

基金秘书处的答复：

指标只能起指导作用，不能提供准确的结果，这种说法是正确的；实际上这并不是制定指标的目的。更准确地说，对于准确的气候评估而言，一旦知道设备在技术转化前后的准确特性，多边基金气候影响指标可能就不是进行比较的理想手段了。对于可得到大范围资料的情况而言，寿命周期气候评估可能是一种恰当的手段。

然而，这些情况并不是普遍情况。阿根廷的情况只是个例，并不典型，因为在阿根廷，制造商知道其未来将要建造的设备的能源效率，实际上他们甚至可以对能源效率进行选择。这是因为制造商有可能从几项具有规定的使用性能的预制套件中选出最合适的，在其组装好一台机器之前，制造商就能进行评估。但在多边基金进行的若干技术转换中，大多数时候却并不是这样；制造商通常没有洞察力，很多情况中，

他们对未来设备的耗能也不感兴趣；相当一部分情况中，他们甚至对目前的能源效率也不了解。因此在对这一问题下结论时，秘书处希望持审慎态度，因为此处阿根提提出的案例并非普遍适用。

多边基金气候影响指标允许对非常小范围的输入数据进行预测，旨在在给定的限制条件内公正地比较替代技术。它无法与测定的数据竞争，因为测定数据是预制套件使用性能的依据，且不打算将精密度增加纳入考虑范围，原因是技术升级并不符合接受多边基金资助的条件。关键的是要将对多边基金气候影响指标的预期控制在某个任务上，这个任务可以典型情况下可能要求国家臭氧机构、双边和执行机构所承担的工作为基础来完成。

秘书处想要给出的建议是，目前，文献中几乎没有证据表明制冷剂的固有效率更高；并且实际上效率更低，因此多边基金的执行机构也常常提出部件需要升级。然而，目前有明显迹象表明，与使用 HCFC-22 的模型相比，取而代之使用 HFC-410A 的新模型的能源效率通常类似或更高。这两个事实并不互相排斥。

16. 关于最后一栏的“影响指标”，我们认为可修改措辞，从而更好地强调影响，例如将排放量减少 11%视为“重大”，将减少 50%视为“非常重大”，减少 3%视为“适量”。

基金秘书处的答复：

在当前的选择中，有一个范围定义为“对气候无影响”，代表数字“零”左右两侧假定的误差范围。基于不同结果的明显频率选择其他偏差的界限。尽管这产生了可接受的相关评级，但这肯定不是最完美的方法，显然可能使用其他方法来确定其他裕度。我们很高兴地接受来自阿根廷和/或其他与会人员的建议。

17. 总体而言，我们想要补充的是，该指标的制定方法有点难以遵循，因为这意味要使用一种技术程度很高的方法，只有专家才能执行。

基金秘书处的答复：

我们同意分配的模型需要进一步加以改进，从而更易于使用。当前的要点是要让执行委员会成员有机会了解其如何发挥作用，并提供反馈，在需要时为最终制定提供更多指导。在将多边基金气候影响指标用于几份提交的文件时，已经确定了若干可能的改进之处。

秘书处也面临着困难，一方面要确保方法的透明度，另一方面其要简明易懂。遗憾的是，这两方面的要求并不相容。秘书处因此尝试将大量的纯技术信息纳入附件中。正如上文所解释过的，我们也在尽力进一步简化，以方便用户，特别是关于设备分类的方面。我们也了解深入简化也有助于结果的获得，并正在考虑如何实现简化－上文第 16 段提及的结果分类也许是可以采取的行动之一。

最后，多边基金气候影响指标工具的概念是使用者需要进行一些非常简单的输入，委托工具进行计算，并接收相对直接的反馈，若有需要，可以更深入地研究基本数据。为实现这一目标，可能需要采取额外几项步骤。

Annex II

MULTILATERAL FUND CLIMATE IMPACT INDICATOR TECHNICAL DESCRIPTIONS OF DIFFERENT CONSUMPTION SECTORS

1. Decision XIX/6 of the Meeting of the Parties requested the impact of energy consumption on the climate to be taken into account. The Secretariat focussed its work on achieving progress with the MCII for the refrigeration and air-conditioning manufacturing sectors first, since it is assumed that in these two sectors the effects of energy consumption on the climate are more prevalent than in other sectors.

MCII for refrigeration and air-conditioning manufacture conversion activities

2. The MCII has been developed to allow an indication of the effect on the climate of future conversion projects to be funded by the Multilateral Fund. The MCII is therefore a tool operating on the basis of data available during the preparation and/or review of Multilateral Fund project submissions. Consequently, data related to the characteristics of products using the current technology is often only sketchily documented, information about the conversion and the characteristics of the converted project are not available at all. On this basis, the MCII is meant to help indicating the climate impact of the activities. It is not meant to replace any possibly desired subsequent analysis undertaken on the basis of more detailed data, and maybe detailed performance information of specific models for baseline and alternative, such as a life cycle climate performance (LCCP) or a life cycle analysis (LCA).

3. The MCII for refrigeration and air-conditioning activities takes into account:

(a) the emissions of refrigerant during manufacturing, operation and at the end of life, called the direct emissions; as well as

(b) the energy consumption of products using HCFC and their alternatives as refrigerants, called the indirect emissions.

4. In a first step the model used calculates the emission of one refrigeration or air-conditioning unit over its lifetime as a sum of direct and indirect effects, and multiplies the result with the amount of units produced in one year. This interim result represents the climate impact of the annual production for a given technology. For a qualitative comparison of different alternatives, the ratio between the baseline (HCFC) and the alternative is used (percentage values). For aggregated, sector-or country-wide figures, the difference between the two is being used (absolute values in tonnes of CO_2 equiv.). Negative values for the MCII denote a reduction in the climate impact as compared to the baseline, positive values an increase,

5. The direct emissions of HCFCs and alternatives take into account a large number of factors related to the lifetime of each unit manufactured, and aims to use general assumptions to quantify them. This quantification is carried out for the lifetime of the equipment and relates to:

(a) The HCFC charge, being an input value, and the potentially different charge of the alternatives[1];

[1] Charge differences are generalized assuming same inner volume of the components, and using the ratio of the liquid densities of the different refrigerants in reference to the baseline (e.g. HCFC-22). The liquid density is assumed as the mean of the values for 42^{o}C and, depending on the application, for -32^{o}C, -4^{o}C and 0^{o}C.

(b) A 2 per cent emission at the time of manufacturing for systems assembled and charged in a factory;

(c) Typical annual emissions for an average unit, depending on the type of refrigeration or air-conditioning equipment and on assembly in a factory or on site, as shown in Table 1;

(d) An average lifetime for each unit depending on the various types of refrigeration and air-conditioning equipment as well as on assembly in a factory or on site, as shown in Table 1;

(e) Recovery at the end of life, currently, in line with practices typical for Article 5 countries assumed to be zero, as shown in Table 1; and

(f) The climate impact of the substance, calculated on the basis of the substances Greenhouse Warming Potential (GWP) for a 100-year time horizon.

Table 1: Values used as assumptions for annual emissions and lifetime

Type of application	AC, factory assembly	AC, on site assembly	Commercial Cooling, factory assembly	Commercial Cooling, on site assembly	Commercial Frozen, factory assembly	Commercial Frozen, on site assembly
Baseline refrigerant	R22	R22	R22	R22	R22	R22
Product lifespan	10	10	10	14	10	14
Leakage at manufacturing	2%	0%	2%	0%	2%	0%
Annual leakage	2%	5%	2%	25%	2%	25%
Recharge level	55%	55%	55%	55%	55%	55%
Recovery fraction	0%	0%	0%	0%	0%	0%

6. The carbon dioxide emissions related to energy consumption of refrigeration equipment depends on the size, quality of the components, quality of design, application and the operating conditions (chiefly the ambient temperature), and, finally, the CO_2 emission related to the production of electricity. In order to take the different factors into account, a number of assumptions were made and procedures were developed:

(a) It is assumed that the principle quality of components and quality of the design remain constant; reflecting the content of decision 61/44 of the Executive Committee, asking the Secretariat to "maintain the established practice when evaluating component upgrades in HCFC conversion projects for the refrigeration and air-conditioning sectors, such that after conversion the defining characteristics of the components would remain largely unchanged or, when no similar component was available, would only be improved to the extent necessary to allow the conversion to take place […]"[2];

[2] For heat exchangers decision 61/44 was reflected assuming constant product of heat exchange surface and heat transfer coefficient, based on the values calculated for an HCFC baseline system at the design temperature of the system. For compressors, decision 61/44 of the Executive Committee was reflected by using a constant isentropic efficiency while adapting the swept volume to the compressor to provide the specified capacity at the design temperature of the system. The design temperature of the system is either 32°C or 40°C, the selection of which depends on the country of production and, for export, a generalised figure of 32°C.

(b) The parameters entered as input values are also assumed to remain constant; in particular the capacity of the system, the application and whether a unit is factory assembled or assembled in the field, as well as the country and the share of export;

(c) The load of the system is estimated depending on the design load = capacity of the unit, and an estimated deviation for different temperatures. A more detailed description can be found in Annex III;

(d) The energy efficiency varies, depending on the refrigerant used, for different outdoor temperatures; two refrigerants having the same energy efficiency at one outdoor temperature and otherwise identical operating conditions will show a difference in energy consumption at other conditions. In order to reflect this important effect, the Secretariat has attempted to collect the frequency of occurrence of temperatures for each Article 5 country in steps of 2 deg C. The energy efficiency is accordingly calculated for these outdoor temperatures and multiplied with the occurrence and the number of hours per year. In case of countries with several climate zones, the occurrence has been calculated by weighting the different climate zones according to the population living in them, as a proxy to the number of refrigeration systems used[3];

(e) The emission of carbon dioxide are published for a number of Article 5 countries and have been estimated for the remainder according to information found in literature; however, for most countries with refrigeration manufacturing capacity, i.e. larger Article 5 countries, information has been published[4].

7. Major challenges encountered by the Secretariat were related to the lack of precedent as to how countries and implementing and bilateral agencies would address the issue of data collection for refrigeration and air-conditioning equipment, due to a significant amount of submissions for projects covering more than one enterprise coming forward only to the 61st and 62nd Meetings of the Executive Committee. The formats used by the agencies to collect data lead to the need for significant changes in data management as compared to the original concept. It is assumed that these challenges faced by the Secretariat can be largely reduced in the next round of submissions by providing sufficiently detailed yet still practical data formats for submission.

<u>MCII for foam manufacture conversion activities</u>

8. For products manufactured in the foam sector, the direct effect caused by the foam blowing agent used over the lifetime of the product is relatively easily determined for the current use of HCFCs, since the entire foam blowing agent is emitted[5]. For post conversion emission, the case is more complex, since the amount of foam blowing agent used to produce a pre-defined quantity of foam will change; in addition, in some cases this quantity is defined based on mass of foam, in others on the volume of the foam. Additional variations are possible by using more than one blowing agent, e.g. in case of the common practice of adding water to HFC-245fa. Finally, in the case of insulation foams, the thickness of the insulation foam might be changed to accommodate changes in the insulation properties of the foam; a different foam thickness would be equivalent to a higher volume of foam, leading to a respective increase in foam blowing agent used.

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[3] For example, Algeria shows both Mediterranean climate as well as hot and arid climate. However, the population is predominantly concentrated at the more temperate coast; consequently the coastal conditions have a higher relative weight than the conditions in the centre of the country.

[4] The Secretariat is still in the process of assessing the quality of the related data and improving it, where necessary.

[5] While the indicator is being set-up in a way which allows accounting for collection and destruction of the substance at the end of life of the product, at this time there is little indication to assume that in Article 5 or non-Article 5 countries a significant portion of foam blowing agent will be collected from products containing such foam.

9. Based on these considerations, a concept was developed on how to incorporate energy efficiency in the calculation of the MCII. After consultation with experts, the current concept is to distinguish between several different scenarios:

(a) Use of polyurethane foam for applications which require constant insulation effect. The related calculation model is meant to use some basic information and standardized properties of polyurethane foam to determine the change in wall thickness necessary to provide the same insulation effect when changing the foam blowing agent from an HCFC to an alternative technology from a pre-defined list. The change in wall thickness, in combination with the different amount of blowing agent per volume of foam needed and the change in density, will allow a calculation of the amount of alternative foam blowing agent needed. Typical applications would be all types of insulation with a defined insulation effect: e.g. based on regulatory requirements;

(b) Applications requiring the same volume of polyurethane foam, calculating the different amounts of blowing agent for the various technologies needed to produce a given volume of foam. This would be for example applicable to integral skin foam products for automotive use;

(c) Insulation foam used in confined refrigerated spaces, where the wall thickness cannot be changed to accommodate different insulation properties and where the insulated space is refrigerated. This option can be used for the insulation of refrigerators, commercial refrigeration equipment etc. where an increase in insulation thickness is often not possible due to space constraints[6];

(d) Use of extruded polystyrene foam for applications which require constant insulation effect. The calculations are performed similar those in the case indicated in sub-paragraph (a) above for the manufacture of polyurethane foam. This is a likely occurrence in the building industry;

(e) Use of extruded polystyrene foam in confined spaces, for applications where the wall thickness cannot be changed. The calculations are carried out similar to those in sub-paragraph (c) above manufacture of polyurethane foam.

MCII for conversion activities in other manufacturing sectors

10. In preparation for the 62nd Meeting, the Secretariat has also received projects and activities in the solvent and fire fighting sectors. The concept of the MCII can be extended to those sectors by assuming a certain release pattern. For solvent as well as for process agent uses, an assumption of a complete release in a short period of time after consumption is certainly meaningful. For the fire fighting sector, a more differentiated approach is necessary, since large quantities of fire fighting agents are simply stored and typically not released or released only after many decades of storage in fire fighting systems. The Secretariat has not yet developed a methodology for the MCII for the fire fighting sector.

[6] The cycle calculation model and country-specific data from the refrigeration model is meant to be used to calculate a change in energy consumption and related emissions of CO_2 related to electricity generation, which is added to the climate impact of the blowing agents. The reason for the calculation of energy related emissions only in cases where the energy use is refrigeration, and not for heating is that the difference is in energy used for heating, from sun powered over electricity, gas, oil, and coal as well as heat pumps is so diverse that no meaningful assumptions can be made for the emissions of carbon dioxide related to the additional heating needs of e.g. a building caused by a change in the insulation properties used.

MCII for the servicing sector

11. The Secretariat has attempted to extend the concept of the MCII to the servicing sector by addressing specific activities that are undertaken as part of the funded service sector activities in HPMPs. The basis for a methodology considered for submissions is that only those emission reductions are taken into account which are directly and quantifiably linked to activities funded by the Multilateral Fund, and that double counting with manufacturing sector activities is avoided. Consequently, changes in the climate impact caused by political agreements, for example the phase-out of HCFCs, are not covered since they are not linked to funded activities but to a commitment of the country to phase-out HCFCs. Accordingly, activities such as awareness and customs training will not contribute positively to the climate impact, since they are supporting compliance with a political agreement and are not directly causing reductions in climate relevant emissions. The remaining activities have in common that they are meant to reduce the consumption of HCFCs through reducing inefficient use of refrigerant. However, should the demand for HCFCs in the country be larger than the supply, any HCFC saved by reducing inefficient use of refrigerant would be used to satisfy the demand. The likely reasons why the supply would be smaller than the demand are import restrictions caused by the need to comply with the reduction schedule of the Montreal Protocol. If the activity leads to a better distribution of refrigerant away from inefficient use towards servicing more existing refrigeration systems, this would help the country to remain in compliance with the provisions of the Montreal Protocol. It would, however, not reduce the absolute amount of HCFC refrigerant used. Consequently, it would be difficult to assign under these circumstances a reduction in climate-relevant emissions directly related to the activity. However, the effect of this provision is likely to be very small, since according to reported data most countries consume less than their compliance target.

12. The attempt to calculate the value for the MCII for the servicing sector focuses on three types of activities in the servicing sector:

(a) Activities related to recovery can reduce the amount of refrigerant used by recovering, possibly recycling and reclaiming refrigerant during service and end-of-life of the equipment. For recovery, recovery and recycling and reclamation equipment, the existing experience of the Multilateral Fund allows for some broad assumptions regarding the amount of substance recovered, recycled, or reclaimed per year. The amount of refrigerant recovered, recycled or reclaimed will reduce the amount of new HCFCs to be used, and will consequently have a climate impact for those cases where otherwise new HCFC could have been used. The available data will allow this climate impact to be quantified depending on the number of machines to be used. A problem yet unresolved is how to determine a maximum meaningful number of machines for a given country in order to take into account the law of diminishing returns for increasing effort to recover refrigerant from existing systems.

(b) Servicing practices can be improved to some extent through training and provision of better tools for servicing. It is possible to assume that training of a refrigeration technician (as compared to no training) has some impact in terms of a reduction in refrigerant consumption. However small the effect might be for each technician, the relatively large training programmes supported by the Multilateral Fund are likely to show a noticeable positive effect in reduction of use of refrigerant during the service of refrigeration and air-conditioning equipment. Since every kilogramme of reduced consumption is reducing the impact on the climate accordingly, a figure for the climate impact of these measures can be calculated for those cases where otherwise new HCFCs could have been used.

(c) Activities related to replace HCFC-22 in existing refrigeration systems:

(i) The precondition of a positive impact on the climate for any replacement of HCFC-22 in existing systems is the recovery of the remaining refrigerant and its destruction or, for those countries with HCFC consumption below the compliance requirements, possibly its recycling. In all other cases, the impact of a replacement on the climate is most probably negative;

(ii) The replacement of existing HCFC-22 systems in refrigeration or air-conditioning with new systems using an alternative technology might lead to an impact on the climate. In order to avoid double-counting, such replacements would only be accounted for under the MCII for systems which would not be covered by a manufacturing sector phase-out project under the Multilateral Fund, i.e. the impact would only be calculated for custom-made systems, typically assembled, installed and charged at the owners location; an example would be a supermarket system. The implementing agency would have to provide the number of systems to be replaced, their approximate refrigeration capacity[7], whether the system is assembled and charged locally, and the alternative technology. The impact indicator would use this data to estimate the charge of HCFC-22 per refrigeration system, and extend this information to all systems covered by this specific activity. Based on an average remaining charge of HCFC-22 in the system at the time of replacement, and the design charge for the replacement, the difference in climate impact between the two can be determined. In those cases, the energy efficiency is not taken into account since the specific conditions of systems assembled on site do not allow the meaningful use of the relatively small differentiation in energy consumption between the system before conversion and afterwards.

(iii) After some consideration, the Secretariat has decided not to propose retrofit of existing systems in the activities which lead to a climate impact. The reason is that for existing systems, the typical retrofit technology would be the refrigerant with the closest match in thermodynamic and thermophysical properties, i.e. HFC-407C. Other than certain efforts related to exchanging the refrigeration oil and possibly replacing some controls, chiefly the expansion valve, the retrofit would be very simple to undertake. The difference in GWP between HCFC-22 and HFC-407C is fairly small (2.0 per cent) with HFC-407C having the lower GWP, further amplified by the density difference leading to a difference in climate impact based on the amount of fluid within the system of 5.43 per cent. However, the energy consumption in an existing system is more likely to increase than decrease with a conversion to HFC-407C. In combination, the climate impact is likely to be marginal, and should be assumed zero. While in terms of refrigeration characteristics HC-290 (propane) could be used in a similar way as HFC-407C, the flammability of HC-290 should in the vast majority of cases prevent HC-290 from being used for retrofits. Should a large retrofit programme be submitted to address this particular issue in an attempt to overcome the barrier for using HC-290 safely in systems designed for non-flammable refrigerants, the related calculations could be established based on principles explained above.

[7] The refrigeration capacity would be used to calculate the likely charge of these systems, since at the time of project submission such an approach might be the most accurate one.

13. The Secretariat is presently in the conceptual phase and wanted to present the above considerations regarding the service sector to the Executive Committee and the bilateral and implementing agencies; the Secretariat welcomes any feedback on these considerations. Some modelling calculations done by the Secretariat have shown that even using conservative assumptions and despite the limitations spelled out above, the effect that the activities in the servicing sector have on the climate might in some cases be significant.

Annex III

BACKGROUND INFORMATION REGARDING THE CALCULATION OF THE MCII (REFRIGERATION PART)

Introduction

1. The refrigeration model described in this document is part of the Multilateral Fund Climate Indicator (MCII) developed by the Multilateral Fund Secretariat; this model has been developed by Re/gent, a Research & Development centre in The Netherlands specialised in refrigeration, air conditioning and heat pumps. It has been integrated into a Microsoft Excel shell for data entry and, in particular, data management by Mr. Anton Driesse from Canada. The model can at this time be used to assess the environmental impact of HCFC-22 and its alternatives under different climatic conditions. It is still in a state of development, and therefore details described in this annex might be subsequently changed and documented accordingly. This annex concentrates mainly on the description of the model used for the calculation of the refrigeration cycle.

2. This version of the model is entirely developed as a spreadsheet tool, which is able to calculate refrigeration and AC system performances under a variety of ambient conditions and compare the results with an HCFC¬22 base case. This comparison does include both energy consumption as well as the related CO_2 emissions for which regional data is included in the model.

3. The spreadsheet model is structured as follows:

(a) A main sheet which contains the user input data (such as refrigeration system to be studied, country of application, etc.). Also the main output data is shown here, such as annual energy consumption and CO_2 emission for all the HCFC-22 alternatives included. The results are shown in tabular format;

(b) A transfer sheet into the actual refrigeration model, which is contained in a separate Excel file. This second Excel file contains also the other refrigeration-relevant information, such as

(i) A detail sheet which contains some of the main results calculated. It shows the system performance at the design point as well as a diagram of system efficiencies and compressor run time over the various ambient temperatures;

(ii) A set of cycle x sheets containing the refrigeration cycle calculations[1], based on ideal loop calculations extended with isentropic efficiencies of the compression process. The cycle calculations are automatically be performed for all relevant ambient temperatures (using a bin approach with temperature intervals);

(iii) A settings sheet which contains predefined data for the refrigeration/AC systems which can be assessed; and

(iv) A work area sheet where some background calculations, intermediate results etc. are placed.

[1] With "x" representing the name of the refrigerant.

(v) The spreadsheet model further contains some code modules (using VBA programming language), which is used for the necessary user interfacing.

(c) The spreadsheet model does require refrigerant property data. The data included in the model has been derived from the refrigeration property software (Refprop 6) from the National Institute for Standards and Technology in Boulder, United States of America. The Refprop data is included in the model by using tabular data and using interpolation methods to find intermediate data points. This avoids that a real property model needs to be installed along with the spreadsheet model, in order to be able to distribute the spreadsheet model without issues related to intellectual property.

Model description

4. Within the cycle model the refrigeration system is calculated using various refrigerants and for various ambient conditions. The ambient conditions are taken from the country specific occurrence of temperatures, which is for the purpose of the calculation converted to 20 different ambient temperatures where for each temperature the number of hours is known.

5. In a first step, a calculation of the base system is performed using HCFC-22 in the design condition. This generates some system data which is then used to calculate the cycle in the various ambient conditions in the off-design point calculations. For each of the operating temperatures this results in a system cooling capacity and the energy consumption. By multiplying the consumption with the number of hours in each temperature interval, it is possible to establish the total annual energy consumption of the system.

6. There are some special cases in the cycle calculations:

(a) If the compressor run time exceeds 100 per cent in general the system will not maintain the product temperature any more (e.g. the cooling unit will start to increase in temperature). In the model this is not compensated for, i.e. it is assumed that the compressor runs 100 per cent of the time, and the product or room is actually increasing in temperature. However, this is only the case at temperatures very significantly higher than the design temperature, and has not been reached in the simulations carried out;

(b) At very low ambient temperatures the condensation temperature may drop below the evaporation temperature (e.g. for the cooling application). This is prevented in the programme by setting a minimum temperature differential between condenser and evaporator and assuming for all temperatures below 10°C constant conditions similar to 10°C outdoor temperature. This is the simulation equivalent of the reality of a condenser fan control or a condensation pressure regulator; and

(c) The model has been extensively tested and rewritten to improve both running times and convergence of the result.

Design calculation

7. After the selection of the type of refrigeration or air-conditioning system, and the country with its climate data in the background, it is necessary to specify the required thermal load for which the system was designed (the amount of heat the cooling system must extract at design condition). This is equal to the capacity to be provided by the user. By the selection of the refrigeration and air-conditioning system and the country, a large number of parameters are preset; those are partially referred to already in Annex I

of this document. With these parameters being set the following calculation structure is applied for the base refrigerant HCFC-22:

(a) First the main refrigerant loop parameters are calculated, condensation and evaporation temperatures and outlet conditions of the evaporator as well as the condenser;

(b) From the system cooling capacity, an evaporator analysis is carried out leading to the evaporator conductance used for further calculations at off-design conditions;

(c) The refrigerant mass flow is determined;

(d) From the compression process the exit conditions at the compressor, which are equal to the inlet conditions of the condenser are derived; and

(e) Finally a condenser analysis can be made leading to the condenser conductance and the condenser air flow rate.

8. After the analysis of the HCFC-22 system at design condition, the evaporator and condenser sizes (conductance or UA values) are known as well as the air flows through evaporator and condenser. In addition also the compressor size needed for HCFC-22 to match the thermal load supplied is calculated. The evaporator and condenser information (UA and flow rate) is then applied to calculate the operation of the selected system with all alternative refrigerants. For each of these refrigerants a compressor size is selected which matches the thermal load at the design condition. After these preliminary calculations the off-design point calculations can start.

Main circuit parameters

9. It is possible to derive the evaporation temperature from the air inlet temperature to the evaporator and the temperature differential given by the user. From the refrigerant properties the evaporation pressure can be calculated. As the evaporator superheat is defined by the system selection, it is possible to calculate the evaporator exit enthalpy using the appropriate refrigerant relations.

10. For the condenser side, the condensation temperature can be derived from the air temperature entering the condenser and the temperature differential given by the user. Also here the condensation pressure is derived from refrigerant properties. The condenser exit temperature can be found by subtracting the sub-cooling supplied by the system selection from the condensation temperature. Using the appropriate refrigerant relations it is possible to calculate the condenser exit enthalpy.

11. Assuming isenthalpic expansion in the throttling device in the circuit, the evaporator inlet enthalpy can be set equal to the condenser exit enthalpy.

Evaporator calculation at design

12. The cooling capacity of the system can be calculated from the thermal load given and the compressor run time:

$$Q_r = \frac{Q_L}{R_p}$$

13. For the evaporator air side, the temperature differential is specified during system selection. As the cooling capacity is known, it is possible to calculate the air mass flow (and hence also the air volumetric flow):

$$\dot{m}_{e,air} = \frac{Q_r}{c_{p,air}\left(T_{e,air,in} T_{e,air,out}\right)}$$

14. As all temperatures are defined it is further possible to calculate the logarithmic mean temperature difference for the evaporator. It is then simply possible to calculate the evaporator conductance by:

$$(UA)_e = \frac{Q_r}{LMTD_e}$$

This implies that the evaporator heat transfer characteristics at design conditions are fixed and can be used later for other temperature conditions.

<u>Refrigerant mass flow at design</u>

15. The refrigerant mass flow can be calculated from:

$$m_r = \frac{Q_r}{h_{e.out} - h_{e.in}}$$

<u>Compression process at design</u>

16. The compressor exit conditions can be calculated using the isentropic efficiency and the inlet conditions. These are typically taken equal to the exit conditions of the evaporator. This allows calculating in the next step the compressor exit enthalpy as follows:

$$h_{comp,out} = \frac{h_{isentropic} + h_{comp,in}(\eta_i - 1)}{\eta_i}$$

17. From the compressor volumetric relations it is possible to derive the compressor displacement volume.

<u>Condenser calculation at design</u>

18. For the warm side (the condenser) it is now possible to perform the heat transfer calculations. First it is assumed that the air entering the condenser coil is at ambient temperature (so the design ambient temperature). As the condensation temperature is known and the temperature efficiency is supplied by the user, it is possible to calculate the air exit temperature:

$$T_{c,air,out} = \eta_c\left(T_c - T_{c,air,in}\right)$$

Knowing all temperatures also the logarithmic temperature difference can be calculated.

19. The condenser reject heat can be calculated as the refrigerant mass flow has already been established and the refrigerant state points at inlet and exit of the condenser are already known from the previous analysis:

$$Q_c = \dot{m}_r \left(h_{c,in} - h_{c,out}\right)$$

Knowing the condenser heat flow, it is possible to calculate the condenser conductance:

$$(UA_c) = \frac{Q_c}{LMTD_c}$$

It is further possible to resolve the condenser air mass flow from:

$$\dot{m}_{c,air} = \frac{Q_c}{c_{\ p,air}\left(T_{c,air,out} - T_{c,air,in}\right)}$$

<u>Compressor</u>

20. The compressor mass flow can be calculated as follows:

$$\dot{m} = \rho_{comp,in}\eta_v\phi_v$$

With the compressor volumetric efficiency defined as follows (using the clearance volume ratio CL):

$$\eta_v = 1 - CL\ \left\|\left[\left(\frac{p_c}{p_e}\right)^{1/k} - 1\right]\right\|$$

and the compressor displacement is typically found as the product of the compressor swept volume and the operating frequency. In the model the compressor displacement is used rather than swept volume in order to make systems independent on operating frequency as this is generally linked to the main supply frequency.

The compressor outlet conditions can typically be found using the isentropic efficiency given by the selection of the system:

$$\eta_i = \frac{h_{isentropic} - h_{comp,in}}{h_{comp,out} - h_{comp,in}}$$

if the inlet enthalpy to the compressor is known. The isentropic enthalpy is typically found using the appropriate refrigerant property relations.

Condenser

21. Basically three heat transfer relations are relevant for the condenser, for the air side, refrigerant side and the heat transfer between air and refrigerant, respectively:

$$Q = \dot{m}_{c,air} c_{p,air} (T_{c,air,out} - T_{c,air,in})$$
$$Q = \dot{m}_r (h_{c,in} - h_{c,out})$$
$$Q = (UA)_c \, LMTD_c$$

which must result in the same heat transfer in a stationary situation.

In this relation the logarithmic mean temperature difference is defined as:

$$LMTD_c = \frac{T_{c,air,in} - T_{c,air,out}}{\text{In}\left(\frac{T_c - T_{c,air,in}}{T_c - T_{c,air,out}}\right)}$$

To evaluate the heat transfer for a coil type of heat exchanger, it is possible to use the classical number of transfer units approach. This requires first the definition of the heat exchanger temperature efficiency:

$$\eta_c = \frac{T_c - T_{c,air,out}}{T_c - T_{c.air.in}}$$

It is possible to express the number of transfer units as the ratio of the conductance and the flow capacity:

$$NTU_c = \frac{(UA)_c}{\dot{m}_{c,air} \; c_{\rho,air}}$$

Assuming a cross flow heat exchanger, it is now possible to relate the number of transfer units and the heat exchanger efficiency with

$$\eta_c = 1 - e^{-NTU}$$

In total this is a set of seven equations, with the following 11 variables:

$Q, \dot{m}_{c,air}, T_{c,air,in}, T_{c,air,out}, \dot{m}_r, h_{c,in}, h_{c,out}, (UA)_c, T_c, NTU_c, \eta_c$

In general it requires therefore that four variables needs to be specified in order to solve the remaining parameters. Typically the mass flow of air is a given parameter as well as the air inlet temperature. If also the UA-value of the condenser coil is supplied and the refrigerant inlet enthalpy is supplied the remaining parameters can be calculated.

Note that the above only holds for the single fluid refrigerants. For the mixed refrigerants using a temperature glide, an extended model for the heat transfer effectiveness is integrated.

<u>Evaporator</u>

22. Basically three heat transfer relations are relevant for the evaporator, for the air side, refrigerant side and the heat transfer between air and refrigerant, respectively:

$$Q = \dot{m}_{e,air} c_{p,air} (T_{e,air,in} - T_{e,air,out})$$
$$Q = \dot{m}_r (h_{e,out} - h_{e,in})$$
$$Q = (UA)_e \, LMTD_e$$

which must result in the same heat transfer in a stationary situation.

In this relation the logarithmic mean temperature difference is defined as:

$$LMTD_e = \frac{T_{e,air,out} - T_{e,air,in}}{\text{In}\left(\frac{T_{e,air,in} - T_e}{T_{e,air,out} - T_e}\right)}$$

To evaluate the heat transfer for a coil type of heat exchanger, it is possible to use the classical number of transfer units approach. This requires first the definition of the heat exchanger temperature efficiency:

$$\eta_e = \frac{T_{e,air,out} - T_e}{T_{e,air,out} - T_e}$$

It is possible to express the number of transfer units as the ratio of the conductance and the flow capacity:

$$NTU_e = \frac{(UA)_e}{\dot{m}_{e,air} \; c_{\rho,air}}$$

Assuming a cross flow heat exchanger, it is now possible to relate the number of transfer units and the heat exchanger efficiency with

$$\eta_e = 1 - e^{-NTUe}$$

In total this is a set of seven equations, with the following 11 variables:

$$Q_r, \dot{m}_{e,air}, T_{e,air,in}, T_{e,air,out}, \dot{m}_r, h_{e,in}, h_{e,out}, (UA)_e, T_e, NTU_e, \eta_e$$

In general it requires therefore that four variables needs to be specified in order to solve the remaining parameters. Typically the mass flow of air is a given parameter as well as the air inlet temperature. If also the UA-value of the evaporator coil is supplied and the refrigerant inlet enthalpy is supplied the remaining parameters can be calculated.

Note that the above only holds for the single fluid refrigerants. For the mixed refrigerants using a glide, an extended model for the heat transfer effectiveness is integrated.

Off-design point calculation

23. Once the system has been selected and the calculation of the refrigeration system in the design point has been completed, it is possible to calculate the refrigeration cycle at other conditions. From the design point the air flow and thermal conductance (UA) of both the evaporator and condenser have been derived and are assumed to be the same in other operating conditions. Other parameters, such as superheat, sub-cooling and isentropic compressor efficiency are all supposed to remain constant when the operating conditions of the system changes.

24. With this given set of data an iterative calculation of the system is needed. This is due to the fact that only the air entrance temperatures are given for both the condenser and evaporator, but the condensation temperature and evaporation temperature are unknown. In fact the set of relations described under the compressor, condenser and evaporator topics are all applied and calculated. This requires first some assumptions for certain parameters, here the evaporation and condensation temperature are applied. Once assumed, it is possible to derive an error in the set of equation, which is used for revising the assumed evaporator and condenser temperature, this until convergence is achieved. In the cycle sheets, the off-design calculations are performed for different external ambient conditions, which generally impact the condenser performance.

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