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FURTHER DEFINITION OF INCREMENTAL COSTS

INTRODUCTION

1. This paper examines the practical problems which are being experienced in applying the incremental cost concept and makes practical recommendations for their resolution.

THE INCREMENTAL COST CONCEPT

2. The Financial Mechanism, established under the Montreal Protocol, is intended to meet all agreed incremental costs of eligible Parties to enable them to comply with the control measures of the Protocol. The Protocol provides an Indicative List of Categories of Incremental Costs (ILCIC). The concept is that, compared to doing nothing, a country will find that it will incur economic costs as a result of phasing-out the production and use of ozone depleting substances, and that these incremental costs should be met in full.

3. A strict interpretation of the incremental cost concept for an individual country would include the following features:

- a forecast of the evolution of industries producing and using ODSs, in the absence of any controls on consumption;
- a forecast of the evolution of these industries as they adapt to the Montreal Protocol constrains;
- the estimation of the cost increases and decreases, within the whole economy, of phasing-out consumption. This would involve calculating economic cost differences for each year.

4. This approach is driven by a forecast of what the industries' growth would have been in the absence of constraints, and therefore gives a forward looking estimate of incremental costs, dependent on two forecasts of the future evolution of the industries. An alternative approach, more suited to determining the appropriate scale of financial assistance, would be to use the actual evolution of the industries in response to Montreal Protocol constraints as the base and estimate what costs would have been if the industries had not been forced to adapt. The indicative list of incremental costs, which refers to "project" costs, but is not wholly consistent with either approach, appears to be closer to the second.

DIFFICULTIES IN APPLYING THE CONCEPTS

5. Difficulties arising in applying the incremental cost concept include the following:

- the Protocol envisages that incremental costs should be estimated as the change in national economic costs as a result of complying with the Protocol, whereas most projects will be prepared at the enterprise level and will be framed as total financial costs;

- incremental costs evaluated for individual projects are not additive to give total incremental costs to a country and could result in double-counting;

- not all incremental costs are internalised to conversion projects;

- the duration of the transition period for allowable recurring costs has not been decided;

- premature retirement and enforced idleness of production plant are allowable causes of incremental costs, but the basis for estimating these costs has not been agreed;

- the problem of evaluating the incremental costs of replacing a partly depreciated asset with a new asset has not been addressed;

- the incremental costs of projects presented by a country for financial assistance at different times may not be evaluated on a consistent basis.

6. In addition to these practical difficulties in applying the concept of incremental costs, a number of additional types or causes of incremental cost have been identified, and many of the existing categories could benefit from detailed definition. Finally, the question of the distribution of funds needs to be addressed. The simple model, that an enterprise receives the financial costs involved in its changeover project, does not apply for Montreal Protocol projects. It is open to the recipient government to decide on the distribution of funds to support individual projects.

DETAILED DISCUSSION OF PRACTICAL DIFFICULTIES

Economic and Financial Costs

7. Incremental cost information on projects will become available to governments applying for assistance under the financial mechanism from individual enterprises and other organisations making changes to their processes or products. This information will almost certainly present

the project's total financial costs as anticipated by the enterprise. These are different from incremental national economic costs for a number of valid reasons, and would need to be translated to economic costs, combined with other economic costs and benefits at the country level and compared with a "business as usual" base case to establish the incremental costs.

8. The economic incremental costs are costs to the country as a whole representing the true value of resources used for phasing out ODSs. Financial costs would include various transfer payments which do not include the use of resources and are therefore not costs to the country as a whole. However, for some small enterprises with a limited range of uses of ozone depleting substances, the work involved in aggregating projects, translating from financial to economic costs, and comparing with a base case, may make little difference to the amount of the incremental costs involved, because the total incremental economic costs and the aggregate financial costs could both be very small.

Costs which are not internalized to projects

9. Not all of the incremental costs which are experienced in a country will be directly associated with conversion projects. Some will be relatively easy to identify, such as public awareness campaigns, and administration of project applications and financial assistance. These costs will have to be added to the total of project costs in making applications to the fund for financial assistance.

Consumer Costs

10. There will be significant difficulties in identifying and quantifying the incremental costs incurred by consumers as a result of phase out. The most obvious costs are higher prices for products made with or using ODSs, such as refrigerators. However, the incremental costs in the supply chain should be accounted for in the projects. The inclusion of higher product prices would be another example of double-counting.

11. More difficult will be the higher (or lower) operating costs as a result of using substitute substances. Electricity consumption by refrigeration equipment is an obvious example.

12. The costs incurred by consumers as a result of the early retirement of refrigeration equipment which cannot be recharged, because the necessary CFCs are no longer available, should also be accounted for. However, these costs will be very difficult to estimate, will arise well into the future (up to 20 years after CFC phase out is complete), and their level will be strongly influenced by decisions to be taken in the near future on the timing of phase-out.

Recurrent and Capital Costs

13. Recurrent and capital costs will be derived from recurrent and capital expenditures associated with the economic incremental costs for the implementation of The Montreal Protocol projects. Capital expenditures are those expenditures related to the creation of physical assets which have a lifetime of more than one year. All other expenditures are regarded as current or recurrent. The ILCIC states that "the incremental recurring costs apply only for a transition period to be defined". The reason for restricting financial assistance to a transition period is presumably to limit The Fund's liability which otherwise could be open-ended. However, there are no useful criteria to guide the setting of such a limit.

Retroactive Cost Financing

14. The issue here is whether project financing can be retroactive, i.e. should The Fund provide reimbursement for projects implemented prior to a country becoming a signatory to The Montreal Protocol. This would require an ex post determination of incremental costs and an ex post approval by The Executive Committee. It would seem that those countries which proceeded to implement projects to phase-out ODSs, prior to their ratification of The Montreal Protocol, were in a position to determine the benefits of such projects and garner the necessary inputs and financial resources to put them on stream. Such a scenario suggests that such projects would not now require reimbursement. Moreover, it is not logical to make a Protocol retroactive. If reimbursement is deemed to be retroactive then how can one avoid arguments in favour of retroactive contributions. Surely, this would not be logical, legal, nor acceptable. Moreover, the required administrative framework for making assessments with respect to retroactive payments would be undeniably cumbersome and divisive.

Accounting for Economic Savings or Benefits

15. The ILCIC states that "Savings or benefits that will be gained at both the strategic and project levels during the transition process, should be taken into account on a case-by-case basis....". This has been subject to varying interpretations by the implementing agencies. Some have interpreted that statement as corresponding to the direct capital costs excluding any net operating benefits of the projects. Others, particularly the World Bank, have interpreted the statement as an intent for net operating benefits to be included in determining the amount eligible for financing from The Multilateral Fund.

16. It is customary for net economic benefits to be included in the monetary quantifications in project analysis. Unlike costs (direct and indirect project inputs) which are somewhat easier to calculate, the quantifying of benefits is not always straightforward. Benefits are the net outputs derived from a project, both tangible and intangible. For the Montreal Protocol Projects, some benefits may be intangible but, to the extent that economic benefits and savings can be quantified, they should be taken into consideration in the project appraisal. This should be done within the context of the need to fund projects that otherwise would not have been

implemented in the absence of The Montreal Protocol. However, it is probable that the only projects which will be submitted to a country government will be those for which financial assistance is justified, some of the benefits of reduced costs may be overlooked. The obvious, and perhaps the only example arises in the changeover from CFCs to petroleum gases as propellants in aerosol dispensers. The petroleum gases are cheaper and in the simple case of import, savings to both the enterprise and the country may offset any one-off costs of changeover. The enterprise may not submit the project to the country government for financial assistance, and the net benefits would therefore not be identified for inclusion in the government's submission to The Fund.

Premature retirement and enforced idleness

17. The indicative list of incremental costs includes this category. However, it raises both conceptual and practical difficulties.

18. At the conceptual level, the question arises as to whether, if the country is including in its incremental economic costs the cost of constructing an industry based on ODS substitutes and alternatives, premature retirement and enforced idleness are incremental costs at all.

19. An individual ODS producer who is forced out of the business and fails to get into substitute production would argue that he has lost the prospect of a future profit stream. But, if another producer, or a new entrant submitted a project for substitute production, this would replace the redundant capacity, and at the national level the incremental costs are only the costs of new plant. This assumes that there is a profit or value added equivalence between the old and the new capacity, although in different ownerships.

20. It therefore appears that the inclusion of premature retirement and enforced idleness costs may be a distributional issue concerned with which companies within a country should receive financial assistance from their government, rather than with the level of assistance.

21. At the practical level, the incremental costs to the enterprise, which closes or reduces throughput, could be regarded as the profit stream foregone.

22. The incremental costs are not related to the residual asset values (although these figures might provide a basis for compensation by government to closing companies).

Asset Lives

23. Where an asset (production plant) which has limited remaining life is replaced by an asset with a longer life, as will frequently be the case, there is a need to account for these different lives. The theoretical approach should be to compare the equivalent annual ownership and operating costs of the new plant with the replacement costs of the existing plant but only over the life of the existing plant.

Timing of Submissions

24. Different projects will come forward for financial assistance at different times. It will prove difficult to ensure consistency between submissions. For example, the principles of how to handle transfer prices will have to be dealt with consistently to avoid double counting.

Double Counting

25. In developing estimates of incremental costs, there is a strong risk that some costs will be double counted. This is likely to occur in a multi-stage industry, where higher costs translate into higher prices at the next stage. For example, compressor manufacturers could incur higher costs in redesigning and producing new compressors to work with HFC134a. It is likely that refrigerator manufacturers would claim these higher costs as incremental costs, also.

26. If the incremental costs of these two projects were added, the increased compressor costs would be double counted, which must be avoided.

The most frequently occurring examples of the risk of double-counting are:

- substance producers converting to substitutes, and substance users;
- compressor manufacturers adapting their designs to use substitute substances and to their refrigeration customers.

27. Double counting can be avoided by:

- disallowing, in the incremental cost calculation, the incremental costs of the first stage (substance producers or compressor manufacturers); or
- disallowing their price increases as incremental costs for their customers.

28. The latter approach has the attraction that it is consistent with the project approach and indeed suggests that companies which receive financial assistance should not raise their prices to compensate for the full increase in their costs. This would avoid the companies making excessive profits as a result of both prices, reflected in higher costs, and the receiving of financial assistance.

RECOMMENDATIONS

29. Incremental costs to be financed by The Fund are to be economic costs and not financial costs.

30. Both recurrent and capital costs should be determined on a project by project basis and be eligible for financing as incremental costs. However, the transition period for recurrent costs should not exceed four years.

31. Incremental costs should not be considered to be reimbursable for projects implemented prior to a Party becoming a signatory to The Protocol.

32. Incremental costs will not be financed by The Fund where there is evidence of double counting.

33. Institutional strengthening will be eligible for funding as incremental costs on a case by case basis.

34. Transnational corporations that are majority-owned by industrialized countries would not be eligible for support from The Fund.

35. For plants prematurely retired or forced into idleness to satisfy The Protocol, incremental costs will be regarded as the profit stream foregone as a result of closure or reduced throughput for no more than the transition period.

ANNEX I

INCREMENTAL COST TEMPLATES

General

The annex provides "templates" of costs that are considered as incremental costs for projects within all the sectors, namely Aerosols, Refrigeration and Air Conditioning (including Mobile Air Conditioning), Foams, Halons and Solvents. There is also a special section dealing with "Production", i.e. conversion of CFC-producing plants to CFC substitute-producing plants and premature retirement of CFC and halon producing facility. Each template is supported by explanatory notes.

In each case, the list of incremental costs is organized to reflect the applicable indicative incremental cost headings contained in Annex IV, Appendix I as adopted by the Second Meeting of the Parties to the Protocol.

The templates do not provide specific costs but rather indicate;

1) Areas where incremental costs may be accepted.
2) Areas where incremental costs may not be accepted.
3) Areas where there will be acceptable benefits.

The acceptable incremental costs are determined at the time of preparation and appraisal of the projects.

Purpose

The purpose of the templates is to develop as far as possible, clear and unambiguous definitions of incremental costs for particular cases to provide guidance to the Parties and Implementing Agencies involved in project preparation or appraisal, on the types and levels of incremental costs which the Fund could meet. They may also help the Secretariat and the Executive Committee in evaluating project proposals.

Key to the Templates

X : Acceptable costs
Y : Acceptable benefits.
O : Cost are not acceptable.

The horizontal rows indicate the list of incremental costs while the vertical columns represent duration of suggested transition period. The transition period defined in the templates is arbitrary and is for demonstration purposes only.

AEROSOL SECTOR

Project: **Aerosol container filler, switching over from a CFC to an LPG based propellant**

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• New filling equipment	X	0	0	0
• Fire safety	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• New aerosol can specifications	X	X	0	0
• Gas commodity cost	Y	Y	Y	Y

NOTES

1. Patents, designs and royalties:

   The cost of patents, designs and royalties are not acceptable. In the case of new filling equipment, these costs are embodied in the purchase cost of the equipment. The same applies to fire safety equipment and new valves. Finally, CFC-LPG substitution does not involve buying-in a patented manufacturing process which would justify royalties.

2. Capital costs:

   - New filling equipment

     New filling equipment may be acceptable, but the level of costs would depend on the size and complexity of the operation. In general, the incremental costs would be the cost for new equipment of the same filling capacity less the disposal value of the old equipment less any energy, repair and maintenance savings.

   - Fire safety

     These costs are acceptable. The use of butane or propane would require the installation of fire safety systems due to the potentially explosive nature of the gases. The costs of installing fire safety systems, however, varies enormously depending on the type of system chosen, the size and complexity of the manufacturer's operations and the fire and safety regulations in force.

Possible options would include installing extractor hood(s) to vent the bases and building concrete walls around the filling/storage area so as to contain the damage from a possible explosion. The costs of the chosen installation would be a one-off capital cost.

The cost of relocating a filling plant to a low risk site is/is not acceptable.

- Retraining

A small one-off retraining cost may be acceptable, as there may be a need to retrain staff to use the new equipment and to comply with safety regulations. The allowable cost is out-of-pocket training expenses, not employee man-hours spent on training.

- Research and development

These costs are not acceptable. CFC-LPG substitution does not involve developing new manufacturing processes or product development which would justify incremental R&D spend.

3. Operational costs:

- New aerosol can specifications

There may be a need for adjustments to the can specifications, including a different valve for the top of the can. The cost of the new valves would be subject to specifications, demand and availability. It may well be the case that a new valve is more expensive due to small initial orders. However, as demand picks up, there would be downward pressure on price through economies of scale in production and increased competition between suppliers. Therefore, although initially there may be incremental costs associated with purchasing new valve types, there should be a cut-off period for aid. This cut-off may well depend on individual project/country circumstances, but as a general rule it should come sooner rather than later; in the above table it is set at 2 years.

- Gas commodity cost

Butane and propane are cheaper to buy than CFCs. There is therefore a recurring net saving from substituting one for the other. The level of this benefit per can (as volume requirements may be different) should be ascertained. The table shows the benefit to occur over 4 years.

Cosmetics aerosols should use de-stenched gases. It may be the case that an allowance has to be made that some of the "commodity saving" involved in the CFC-LPG substitution is lost if de-stenched gases are not readily available in the developing country and de-stenching costs are therefore occurred.

Project: Filler of aerosol containers of medium coarse to coarse spray quality switching over from a CFC to a CO_2 based propellant.

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• Modifications to manufacturing facilities (ventilation)	X	0	0	0
• New filling equipment	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• New aerosol can specifications	X	0	0	0
• Gas commodity cost (CO_2 cheaper than CFC)	Y	Y	Y	Y

NOTES

1. Patents, designs and royalties:

The cost of patents, designs and royalties are not acceptable. In the case of new filling equipment, these costs are embodied in the purchase price of the equipment. The same applies to new valves, which are examined in the next paragraph. Finally, the CFC-CO_2 substitution does not involve buying-in a patented manufacturing process which would justify royalties.

2. Capital costs:

- Modifications to Manufacturing Facilities

  Some modifications to manufacturing facilities may be necessary to ensure safe operations. Costs incurred in the construction of explosion - and fire - proof barriers and installation of efficient ventilation system are incremental.

- New filling equipment

  In general, the incremental costs will be the cost for new equipment of the same filling capacity less the disposal value of the old equipment less any operational energy, repair and maintenance savings.

- Retraining

  A small one-off retraining cost may be acceptable, as there may be a need to retrain staff to use the new equipment and to comply with safety regulations. The allowable cost is out-of-pocket training expenses, not employee man-hours spent on training.

- Research and development

  These costs are not acceptable. CFC-CO_2 substitution does not involve developing new manufacturing processes or product development which would justify incremental R&D spend.

3. Operational costs:

- New aerosol can specifications

  Aerosols using CO_2 as propellant are plagued by poor performance characteristics related to variable spray quality; they are generally characterised by poor spray pattern and loss of quality (inconsistent product delivery rate). These problems can be overcome to a large extent by using aluminium cans which have a higher pressure resistance compared to the standard 3 piece tinplate cans, and improved value systems.

  Nevertheless, these measures would add to the operational costs of manufacturing the aerosols. In this template it is assumed that production of medium-coarse to coarse sprays would incur incremental operating costs in the form of higher priced valves and cylinders.

  However, in the case of new valves, prices would be subject to valve specifications, demand and availability. New valves may be expensive to start with, due to small initial orders. However, as demand picks up, there would be downward pressure on price through economies of scale in production and increased competition between suppliers. Therefore, although initially there may be an incremental costs associated with purchasing new valve types, there should be a cut-off period for assistance. This cut-off will depend on individual project/country circumstances.

  The time scale for which a manufacturer should be assisted with incremental operating costs is set at 2 years in the template; this is an arbitrary period and would have to be discussed further.

- Gas Commodity cost

  CO_2 is cheaper to buy than CFCs. There is therefore a recurring net saving from substituting one for the other. The template shows the benefit to occur over an arbitrary period of 4 years.

FOAM SECTOR

Project: **Manufacturer of flexible low density foams, substituting for CFC 11 with other foam blowing agents**

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• Improved safety, ventilation	X	0	0	0
• Retraining	X	0	0	0
• Research & development	0	0	0	0
3. Operational costs:				
• Chemicals, additives	X	X	0	0

NOTES

CFC 11 is used as a blowing agent in the production of flexible Polyurethane (PUR) foams (slabstock and moulded). However, more than 50% of flexible PUR foam is produced without CFCs, using only carbon dioxide from the reaction of isocyanate with water. Discontinuing the use of CFCs will affect only the production of low density (low quality) flexible foams. A switch to higher density foams, will not require significant changes to existing production equipment, but may involve some small increases in operating costs due to the changes in chemicals used.

If low density foams continue to be produced because of market demand, then there are alternative blowing processes that could enable production without the use of CFC 11. A tried and tested approach is the use of formic acid and water as blowing agents. This process emits carbon monoxide however, so there may be some incremental costs for worker safety measures. Other approaches include the use of methylene chloride and CFCs 123 and 141b. The first is not particularly suited to low density foams and has been found to have carcinogenic potential. CFCs 123 and 141b are still being experimented with and the incremental costs of using these are not well established.

CFC 11 is also used as a release agent in the production of flexible cold moulded PUR foams, but the quantities involved are small and CFC 11 could be easily substituted by "soft" polyols or softening additives. This may involve small incremental material costs to be included in "Operational Costs".

Finally, adsorption techniques using activated charcoal can remove CFC 11 from the exhaust air of flexible PUR equipment and closed storage areas, and result in the successful reuse of over 90% of CFC 11. Although this is a well developed technology, costs may be high involving installation of adsorption equipment, remodelling of closed cooling areas or new construction for open storage areas. These techniques for recycling CFCs which have been proposed as an interim measure may therefore be unnecessary if the incremental cost of substitutes is low. This case is not considered in the template.

Project: **Manufacturer of rigid foams, substituting for CFC 11 with other foam blowing agents**

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• Improved ventilation	X	0	0	0
• Conversion to seals, gaskets, etc.	X	0	0	0
• Retooling	X	0	0	0
• New internal chamber design costs	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• Increased volume of material and catalysts used	X	X	0	0

NOTES

CFC 11 is used as a blowing agent in the production of rigid Polyurethane (PUR) foams (laminated, slabstock, appliance insulation and sprayed foams). Alternative blowing processes for production of high density rigid foams without the use of CFC 11 use water or pentane as blowing agents. Nevertheless, this process produces foams that have higher thermal conductivity so there is a need for modifications to final product specifications e.g. internal chamber design, insulation thickness etc. in refrigerator design. These processes would involve incremental capital and operating costs in blowing the foams.

Other approaches include the use of CFC 123 and 141b, but these processes are still experimental.

REFRIGERATION AND AIR CONDITIONING SECTOR

Project: Substitution of existing purge device in a large industrial/commercial air conditioning system's chiller, with a high-efficiency purge unit (transitional measure).

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• Purchase and fitting of new purge units	X	0	0	0
• Retraining	X	0	0	0
• Research and Development	0	0	0	0
3. Operational costs	Y	Y	Y	Y

NOTES

General

Chillers are the main components of air conditioning systems in large commercial/industrial buildings. Chillers usually use CFC 11 as a refrigerant. Chillers vent some refrigerant into the atmosphere during normal operation due to purging. Purge systems remove water and non-condensible gases (e.g., air) from refrigeration systems, to improve refrigerator efficiency and wear by ensuring that:

- the pressure of non-condensible gases does not artificially increase the condenser pressure;
- the presence of moisture and acids (formed by moisture and refrigerant) does not cause corrosion.

The water removed, however, contains some refrigerant which is then vented into the atmosphere. To minimise the amount of CFC 11 vented in the atmosphere, high efficiency purge units have been developed. The introduction of purge units is nevertheless a transitional measure, where substitution of CFC 11 by HCFC 123 is not technically or economically feasible. Other transitional measures not examined here include improvements in maintenance and operating procedures, and recycling of CFC 11.

1. Patents, designs and royalties:

   Purging technology is well developed and the development costs would be included in the purchase cost of the purge devices. There is no need for R&D or royalties.

2. Capital costs:

- Purchase and fitting of new purge units.

  These are the incremental one-off costs to purchase and fit the new purge devices into the chiller system and for operational/maintenance training. There are readily available mechanical and thermal purging units in the market. The cost of a new unit would be a one-off capital cost. There may be some residual salvage costs from the old purge units.

- Retraining

  A small one-off retraining cost may be acceptable.

- Research and development

  These costs are not acceptable.

3. Operational costs:

As a result of more efficient purging, there are operating cost savings in the form of reduced refrigerant used. Furthermore, there are improvements in refrigerator efficiency and wear, which could result in energy savings and repair and maintenance savings. The time scale for which a user should enjoy these incremental operating cost savings is set at 4 years in the template; this is an arbitrary period and would have to be discussed further.

Project: Manufacturer of commercial refrigerators using CFC 12 as refrigerant, converting facilities to produce refrigerators utilising HCFC 22 as a substitute (transitional measure).

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties				
• Licence costs	X	0	0	0
2. Capital costs:				
• Retooling	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• Compressors, seals, insulation and raw materials	X	X	X	X

NOTES

General

There are two types of commercial refrigerators:

- refrigeration systems with mechanically removable fittings, which are used for large commercial cold storage warehouses;

- hermetically sealed refrigeration systems, which are used for small commercial refrigerators (refrigerator cases).

Commercial refrigeration equipment primarily uses CFC 12 as a refrigerant. HCFC 22 is not a drop-in substitute, and there is a need for changes in design to cope with the different thermodynamic/pressure properties of HCFC 22; the types of incremental retooling costs required are discussed in the following paragraphs, and these will apply equally to both types of systems, but the scale of costs will differ according to size and complexity.

In addition, the use of HCFC 22 is a transitional measure, along with other measures not examined in this template, such as design changes to improve gas tightness, reduction in refrigerant charge, recycling, etc.. The use of new designs utilising HFC 134a would be more effective, and these are currently under development.

1. Patents, designs and royalties/Research and development

   The switch from CFC 12 to HCFC 22 presents technical problems due to increased pressure requirements. There may be incremental costs in buying-in new designs and incurring licence fees.

2. Capital costs:

   - Retooling

     There is a need for retooling in manufacturing and assembly processes to implement the new designs.

   - Retraining

     A small one-off retraining cost may be acceptable.

   - Research and development

     Additional research and development may be required.

3. Operational costs:

   There may be incremental recurring costs for: new compressor units (due to the somewhat different thermodynamic and pressure requirements of the refrigerants), new seals and insulation materials, and HCFC 22 commodity costs.

   The time scale for which a manufacturer would incur such incremental operating costs is set at 4 years; this is an arbitrary period and would have to be discussed further.

Project: Manufacturer of domestic refrigerators using CFC 12 as refrigerant, optimising refrigerator design and converting production facilities to achieve a reduction of the CFC charge (transitional measure).

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	X	0	0	0
2. Capital costs:	0	0	0	0
• Retooling	X	0	0	0
• Retraining	0	0	0	0
• Research and development	X	0	0	0
3. Operational costs:				
• Volume of refrigerants	Y	Y	Y	Y

NOTES

1. Patents, designs and royalties:

   The reduction in the refrigerant charge can be achieved by suitable design changes, e.g., a reduction in the diameter of pipe that carries refrigerant. This is a transitional measure, as CFC-12 is not substituted; there is merely a reduction of volume used in fridge manufacture. Alternatively, there would be costs for buying-in new designs, as an upfront payment in the form of a licence fee.

2. Capital costs:

   - Retooling

     No new equipment would be required, but there may be a need for limited retooling in the manufacturing and assembly processes for the new designs.

   - Retraining

     There is no need for retraining.

   - Research and development

     The optimum design may involve some additional R&D costs.

3. Operational costs:

The reduction in the volume of refrigerants used implies on-going commodity savings. The time scale for which a manufacturer would enjoy such incremental benefits is set at 4 years in the template; this is an arbitrary period and would have to be discussed further.

Project: Manufacturer of refrigerator compressors using CFC 12 as refrigerant, converting facilities to produce compressors utilising CFC substitutes (HFC 134a) as refrigerants.

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties				
• License costs	X	0	0	0
2. Capital costs:				
• Retooling	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• Lubricants	X	X	X	X

NOTES

General

Compressors are an input into refrigerator manufacture. To avoid double counting of incremental costs, it is necessary to ensure that:

- either the compressor manufacturer is assisted with the incremental costs of producing compressors utilising HFC 134a, and therefore the refrigerator manufacturer who is converting to HFC 134a does not incur increased prices for the new compressors;

- or the compressor manufacturer is not assisted with the incremental costs of developing and producing compressors utilising HFC 134a, and passes these costs on to refrigerator manufacturers in the form of higher unit prices.

In the cost template it is assumed that the former case applies. As a result, the incremental costs associated with a refrigerator manufacturer who is converting to HFC 134a do not include incremental prices for new compressors.

It would be acceptable to assess incremental costs using the alternative approach.

1. Patents, designs and royalties:

   The switch from CFC 12 to HFC 123a would require a different compressor unit due to the different thermodynamic and pressure requirements of the refrigerants. This could involve additional costs for the licence of the new designs, which are assumed as a payment in the form of a licence fee; royalties could be paid instead, over a period of time.

2. Capital costs:

   - Retooling

     No new equipment would be required, but there may be a need for limited retooling in the manufacturing and assembly processes to comply with the new designs.

   - Retraining

     Retraining is not required.

   - Research and development

     The manufacturer could develop his own designs by investing in R&D costs.

3. Operational costs:

   There may be some operating cost increases in the form of new lubricants compatible with the use of HFC 134a. If the compressor manufacturer also makes the refrigerator motor, there may be additional motor wire insulation costs. Alternatively, motor prices may be slightly increased.

   The time scale for which a manufacturer should be compensated for incremental operating costs is set at 4 years in the template; this is an arbitrary period and would have to be discussed further.

Project: Manufacturer of refrigerators using CFC 12 as a refrigerant, converting facilities to produce refrigerators utilising HCF 134a as a substitute.

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties:				
• Licence costs	X	0	0	0
2. Capital costs:				
• Retooling	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• Seals, insulation	X	X	X	X
• Compressors	X	0	0	0
• Price difference between HFC 134a and CFC 12	0	0	0	0

NOTES

General

There are two types of refrigerators:

- refrigeration systems with mechanically removable fittings, which are used for large industrial and commercial cold storage warehouses;
- hermetically sealed refrigeration systems, which are used for small industrial and commercial refrigerators (refrigerator cases), and domestic refrigerators.

CFC 12 is used in all cases as a refrigerant. HCF 134a is not a drop-in substitute, and there is a need for changes in materials, design and production processes to cope with the different thermodynamic/pressure properties of HCF 134a; the types of incremental costs required are discussed in the following paragraphs, and these will apply equally to both types of systems, but the scale of costs will differ according to size and complexity.

1. Patents, designs and royalties:

   The switch from CFC 12 to HCF 134a is likely to involve incremental costs in buying new designs and incurring licence fees.

2. Capital costs:

- Retooling

  There is a need for retooling/refitting costs to implement the new designs, but no new equipment is needed.

- Retraining

  Not incremental.

- Research and development

  The switch from CFC 12 to HFC 134a may involve incremental costs in the form of additional R&D.

3. Operational costs:

- Seals and insulation

  HCF 134a is not a drop in substitute for CFC 12; there are some incremental conversion costs for:

  - new lubricants;
  - new insulation and connection materials.

  The time scale for manufacturer's compensation for possible incremental operating costs is set at 4 years; this is an arbitrary period and would have to be discussed further.

- Compressors

  There are also incremental recurring costs for: new compressor units (due to different thermodynamic and pressure requirements of the refrigerants) and for HCF 134a commodity costs.

  In the case of the incremental compressor costs, to avoid double counting, it is necessary to ensure that:

  - <u>either</u> the compressor manufacturer is being assisted with the incremental costs of producing compressors utilising HFC 134a, and thus the refrigerator manufacturer faces no incremental costs because the compressor manufacturer will not pass on his higher costs in higher prices;
  - <u>or</u> the compressor manufacturer is not assisted with the incremental costs of producing compressors utilising HFC 134a, but passes these costs on to the refrigerator manufacturers in the form of higher unit prices.

  In this cost template it is assumed that the former case applies, which is consistent with the assumptions made for the incremental cost template of compressor manufacture.

Therefore there is no allowance for incremental prices of compressors for the refrigerator manufacturer.

It would also be acceptable to assess incremental costs using the alternative approach.

- Price difference between HFC 134a and CFC 12

There are also recurring incremental operating costs, due to the purchase of the more expensive HFC 134a compared to CFC 12. Again, to avoid double counting, it is necessary to ensure that:

- either the CFC producer is already assisted with the incremental capital and other costs of producing HFC 134a, and thus the refrigerator manufacturer should not incur incremental commodity prices;
- or the CFC producer is not assisted with the incremental costs of producing HFC 134a, but passes these incremental costs on to the refrigerator manufacturer in the form of higher unit prices.

In this cost template it is assumed that the former case applies, which is consistent with the assumptions made in the incremental cost template of the CFC manufacturer. There is therefore no assistance to the refrigerator manufacturer for incremental costs of HFC 134a.

Project: Establishment of refrigerant recovery and recycling facilities to clean CFCs and re-introduce the substances to the recharge market

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• Workshop mechanical recycling facilities for large volume recycling	X	0	0	0
• Portable suction and recycling units for on site recycling	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• Additional labour time involved (valves, etc.)	X	X	X	X
• Increased revenue from recycled CFC price premium	Y	Y	Y	Y

NOTES

In a developing country, the establishment of domestic and mobile equipment refrigerant recycling facilities will involve the following incremental costs:

- purchasing suitable mobile containers, suction and recycling equipment, to collect and process used CFCs on site in small volumes;
- installing mechanical recycling facilities at workshops, to process CFCs in larger volumes;
- some additional labour time involved in the evacuating used CFCs from appliances and storing/recycling them compared using virgin CFCs;
- some initial basic staff training in recycling techniques.

Of these costs the one-off capital set-up costs are likely to be the largest. Mobile refrigerant suction and recycling equipment is already available and in various sizes, processing up to 4 pounds per minute. There are thus no research and development costs involved. Stationary receiver tanks can be used to store impure refrigerant, and sent to a centralised facility for large volume reprocessing. CFC refrigerant contaminated by oil, acids or water presents no particular difficulty in recycling but the costs of a centralised facility will depend on the scale of the operations, the type of impurities, and the standards applying to the purity of recycled CFC. However, it is unlikely that these standards will be stringent in the case of recycled refrigerants for domestic/mobile appliances, and thus there is no justification for incremental costs of shipping out impure CFCs to CFC manufacturers for reprocessing.

Set against the above incremental costs, however, are the benefits that recyclers will enjoy in the form of greater expected revenues. As the supply of new CFCs for servicing domestic/portable equipment decreases, following a phasing out of production in line with the Montreal Protocol, recyclers will be able to command a premium price for recycled CFCs. Thus, assuming the market demand for CFCs to service equipment does not decrease, recyclers' revenues will go up. There are two factors which ensure that the market demand for recycled CFCs to service mobile air conditioners and domestic refrigerators will not decrease in the short to medium term:

- CFC substitutes may be priced the same or cheaper than recycled CFCs; however, they have different chemical properties/thermal conductivity, and are thus only suitable for modified equipment. They are therefore not able to be "dropped in" old equipment still in use, in the place of recycled CFCs.
- the cost of CFC replenishing is a small part of the overall cost of servicing refrigerators and mobile air conditioning equipment. It is therefore likely that consumer demand will be inelastic, and thus will not alter significantly as a result of increases in the price of recycled refrigerants. The only case where demand for servicing old equipment may come down, and thus the volumes of CFCs needed to be recycled, is when consumers buy new equipment using CFC substitutes. This appears to be unlikely in the short to medium term in developing countries, as it would require a rapid increase in disposable incomes or a decrease in the real price of such equipment.

The timing of the one-off capital investment and set-up costs on the one hand, and the increases in operating revenues on the other, will dictate whether the net present value of any recycling project will be positive or negative. A recycling project which is undertaken immediately will incur a capital outlay for the equipment and set-up costs, but the anticipated operating revenue benefits will take time to materialise. Alternatively, if the investment were to be postponed to a point in time where demand for recycled CFCs is forecast to take off due to absence of new supplies, then the project set-up and capital costs will be offset (and may be surpassed) by operating revenue benefits within a short period.

Given the right timing the investment will pay for itself and there will not be a need for assistance from the fund to finance incremental costs. However:

- postponement of a recycling project may have inherent risks from a commercial point of view, as the first company to set up operations will enjoy learning curve benefits and may erect barriers to entry for potential entrants through effective distribution networks and long term agreements;
- the Montreal Protocol itself allows countries flexibility in phasing progress towards CFC reduction targets and in the measures to be adopted to achieve these reductions. Therefore if a country decides to immediately adopt recycling measures, it should be eligible for assistance with incremental costs as the payback period of such a project will be otherwise very long.

It remains to be decided whether the compensation should cover all or part of the incremental costs concerned.

Project: Retrofitting of mobile air conditioners to enable them to utilise HFC 134a.

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• Lubricants, hoses, connections	X	0	0	0
• Retraining	0	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• Commodity costs	0	0	0	0

NOTES

1. Patents, designs and royalties:

   There are limited design changes, and it is likely that the supplier of HCF 134a will provide technical guidelines on changes needed to enable substitution. Thus there is no need for additional expenses.

2. Capital costs:

HCF 134a is not a drop-in substitute for CFC 12, but can be used if some components of the unit are changed, including:

- new lubricants;
- new hoses made from materials with lower permeability;
- more resistant materials for hose connections;

3. Operational costs:

There is a recurring incremental operating cost, which is due to the purchase of the more expensive HCF 134a compared to CFC 12, for the purpose of replenishing refrigerant losses during operation.

Nevertheless, to avoid double counting, it is necessary to ensure that:

- either the CFC producer is already assisted with the incremental capital and other costs of producing HFC 134a, and thus the refrigerant user should not incur incremental commodity prices;
- or the CFC producer is not compensated for the incremental costs of producing HFC 134a, but passes these incremental costs on to the refrigerant user in the form of higher unit prices.

In this cost template it is assumed that the former case applies, which is consistent with the assumptions made in the incremental cost template of the CFC producer. Therefore there is no assistance to the refrigerant user for incremental costs for HFC 134a.

SOLVENT SECTOR

Project: **Manufacturer using CFC-113 or MCF for metal/PCB cleaning, wishing to reduce CFC-113/MCF use**

Note: Costs listed under three options:

- Ensuring a "closed" cleaning system;
- Recycling solvents;
- Increasing efficient use of solvents.

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
CLOSED SYSTEM				
- Automating cleaning process to ensure closed system (alternative to partial conversion of existing equipment)	X	0	0	0
- Cleaning and assembly modifications:				
. equipment modifications to ensure gastightness	X	0	0	0
. joints, small apertures modifications to minimise gas loss	X	0	0	0
- Operating sequence modifications	X	0	0	0
SOLVENT RECYCLING				
- Modification or new air circulation modifications to improve air suction and condensation	X	0	0	0
- Installing solvent catch basin	X	0	0	0

	Year 1	1	3	4
- Installing sluicegate system (PCB cleaning only)	X	0	0	0
- New filtration equipment	X	0	0	0
- New systems for removing heavy contaminants	X	0	0	0
INCREASING EFFICIENT USE OF SOLVENT				
- Retrofit/redesign batch degreaser tanks to incresae capacity				
- Retrofit automatic hoists (batch degreasing)	X	0	0	0
- Enhance compressor capacity (in-line cleaners)	X	0	0	0
- Addition of extra cooling coils on inlets/outlets (in-line cleaners)	X	0	0	0
- Amend cleaner configuration to handle output from two or more soldering machines (in-line cleaners)	X	0	0	0
• Retraining				
All measures	X	0	0	0
• Research and Development				
All measures	0	0	0	0

3. Operational costs:

CLOSED SYSTEM				
- Savings in volume of cleaning materials used	Y	0	0	0
- Reduction in labour used	Y	0	0	0

	Year 1	2	3	4
SOLVENT RECYCLING				
- Additional labour time spent e.g. on wrapping parts between assembly stages, physically removing large contaminants prior to degreasing	X	0	0	0
- Savings in volume of cleaning materials used	Y	0	0	0
EFFICIENT USE OF CLEANERS				
- Savings in volume of cleaning materials used	Y	0	0	0

NOTES

Automation of the cleaning process, so that systems is closed, can result in a CFC loss reduction of the order of 20 to 30%. The use of condensation techniques or adsorption equipment can reduce CFC consumption of closed systems by 50%.

Adsorption equipment has been used for individual applications e.g. manufacturing of PCBs. Spending on this equipment is not recouped by reused solvent, and the cost of adsorption equipment can be 3 to 5 times higher than that of surface equipment.

Project: **Manufacturer using CFC-113 or MCF for metal/PCB cleaning, wishing to switch to alternative solvents**

Note: Cost listed four options:

Option A : elimination of need for cleaning (inert gas or "no-clean" flux soldering)
Option B : gas plasma cleaning
Option C : aqueous and semi-aqueous cleaning
Option D : alternative solvents (terpenes, organic, alcohol based solvents and HCFC solvent blends).

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patent, design and royalties				
All options	0	0	0	0
2. Capital costs:				
Option A (PCB cleaning)				
- New soldering equipment, to eliminate need for cleaning altogether	X	0	0	0
Option B (PCB cleaning)				
- New gas plasma cleaning equipment	X	0	0	0
Option C (metal and precision cleaning)				
- New equipment for aqueous and semi-aqueous cleaning systems	X	0	0	0
- Water treatment equipment	X	0	0	0
- Redesigning of line layout and manufacturing processes	X	0	0	0
- Adapting aqueous system to mechanical handling (e.g., rinsing, brushing, steam jet, ultrasound)	X	0	0	0

	Year 1	2	3	4
- Surface changes e.g., blind holes, welts, cracks, capillary boring	X	0	0	0
<u>Option D</u>				
- New equipment for alternative solvents cleaning systems (PCB cleaning)	X	0	0	0
- Redesigning of line layout and manufacturing processes	X	0	0	0
- New fire safety equipment due to combustibility and explosive nature of non-halogenated organic solvents	X	0	0	0
• Retraining				
All Options	X	0	0	0
• Research and Development				
All Options	X	0	0	0
3. Operational costs				
<u>Option A</u>				
(i) inert gas soldering:				
. costs of nitrogen consumption	X	0	0	0
. costs of eliminating solvents (savings)	Y	0	0	0
(ii) "no-clean" flux soldering:				
. increase in flux costs	X	0	0	0
. eliminated solvent costs (savings)	Y	0	0	0
<u>Option B</u>				
Pre-cleaning costs	X	0	0	0
Process gas costs	X	0	0	0
Eliminated solvent costs (savings)	Y	0	0	0

	Year 1	2	3	4
<u>Option C</u>				
(i) Labour costs in water treatment	X	0	0	0
(ii) Excess energy costs	X	0	0	0
(iii) Savings in material costs	Y	0	0	0
<u>Option D</u>				
Savings in material costs	Y	0	0	0

NOTES

Plasma cleaning

- very expensive process;
- only for minimal residual soiling;
- difficulty in maintaining continuous operation.

Aqueous

- limiting in dealing with complicated product geometries;
- spotless surface difficult to achieve;
- water pollution problem (cost depending on legislation).

Organic, halogen-free

- combustible

Terpeness

- combustible;
- re-processing not possible.

HALON SECTOR

Project: Substitution of Halon 1301 by non-CFC extinguishants in existing Halon 1301 fixed fire extinguisher systems

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• New fire extinguishing systems	X	0	0	0
• Disposal of halon in the old extinguishing system	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs	0	0	0	0

NOTES

General

Halon 1301 is most commonly used for fixed (stationary and "flooding systems") fire extinguisher systems. The advantages of Halon 1301, as well as with other halons, is that it is not toxic and that it leaves no residues. But equally, halons can be corrosive and more expensive than other substances. Furthermore, halons can only extinguish a fire at its initial stages; halons are ineffective at extinguishing incandescent, deep seated fires, and there is therefore a need for regular testing of halon systems to ensure that they operate within the first 10 seconds of the fire starting.

Extinguishing systems using Halon 1301 can be replaced, with few exceptions, with appliances using substances not harmful to the ozone layer; particular objects, sections of rooms and whole rooms can be protected by CO_2 systems, water sprinkler systems or foam flooding systems, and combinations of these systems, as appropriate.

One of the main situations in which CO_2 flooding systems cannot be used is in the military environment, due to the risk of human life of CO_2 concentration in closed rooms.

There are also transitional measures, which are not examined here, such as reductions of halons vented into the atmosphere and leaks, through the use of technical and organisational measures, as well as halon recovery and recycling. It is not examined here, however the pattern of incremental costs is similar to recovery and recycling in the refrigeration sector.

1. Patents, designs and royalties:

   There is no need for either of these costs as the technology is well developed and the development cost is included in the purchase cost of the new systems.

2. Capital costs:

   - New fire extinguishing systems

     There is no drop-in substitute for halons. There will be a need for new fire extinguishing installations in the place of old ones. The incremental costs will be the one-off capital costs of purchasing and installing the new fire extinguishing systems, and the costs of disposing of the halon in the old installations.

   - Retraining

     There is a need for some initial retraining in operational and maintenance procedures.

3. Operational costs:

   There are no recurring incremental costs from maintaining and operating the new systems.

Project: Substitution of Halon 1211 by non-CFC extinguishants in existing Halon 1211 portable/mobile fire extinguisher systems

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital cost				
• New fire extinguishers	X	0	0	0
• Retraining	0	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• Saving on halon refill	Y	Y	Y	Y

NOTES

General

Halon 1211 is most commonly used for portable/mobile fire extinguishers. The advantages of Halon 1211, as with other halons, is that it leaves no residues and is easier to use than other systems. But equally, halons can be corrosive and more expensive than other substances. Furthermore, halons can only extinguish a fire at its initial stages; halons are ineffective at extinguishing incandescent, deep seated fires.

Extinguishers using Halon 1211 can be replaced with few exceptions, with appliances using substances not harmful to the ozone layer:

- portable halon fire extinguishers could be substituted with powder, water, CO_2 and foam extinguishers;
- mobile halon fire extinguishers systems could be substituted with fire blankets and semi-fixed CO_2 extinguishing systems.

One of the main situations in which CO_2 systems cannot be used, apart in the military environment, is in aircraft cabins, but high-pressure water systems may be a feasible alternative.

There are also transitional measures, which are not examined here, such as reductions of emissions by improving valve and filling devices, as well as halon recovery and recycling. This case is similar to that shown in MAC recycling template.

1. Patents, designs and royalties:

   There is no need for either of these costs as the technology is well developed and the development cost is included in the purchase cost of the new cylinders/systems.

2. Capital costs:

   - New fire extinguishers

     There will be need to replace halon-based extinguishers with extinguishers using non ozone depleting substances. The incremental costs will be the one-off capital costs of purchasing the new fire extinguishing equipment. The scale of the incremental costs will depend upon the size of the fire extinguishing system that is being converted.

   - Retraining

     There is no need for significant one-off retraining in operational and maintenance procedures, as training is a continuous process.

3. Operational costs:

   There is a recurring operating cost saving equal to the difference between the cost of the halon refill which the user would have had to pay if he kept the halon extinguisher, and the cheaper cost of halon alternatives such as CO_2. The timescale for which a user should enjoy these incremental savings is set arbitrarily at 4 years in the template.

Project: Establishment of central collection and recycling facilities to clean CFCs and halons and re-introduce them to the recharge market

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• Site costs	X	0	0	0
• Plants and equipment	X	0	0	0
• Storage, containers	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
3. Operational costs:				
• Labour	X	X	X	X
• Materials, energy	X	X	X	X
• Revenues	Y	Y	Y	Y

NOTES

1. Patents, designs and royalties:

The technologies are developed and readily available, and thus any R&D costs are already embodied in the purchase price of mechanical/thermal recycling equipment.

2. Capital costs:

In a developing country, the establishment of central recycling facilities will involve the following capital costs:

- one-off capital costs for site purchase;
- one-off capital costs for setting up and installing collection and recycling plant and equipment;
- one-off capital costs in storage space and containers;
- some initial staff training in recycling techniques.

Of these costs the one-off capital set-up costs are likely to be the largest.

3. Operational costs:

Operational costs represent on-going operating labour and raw material costs.

Both capital and operating costs of a centralised facility will depend on the scale of the operations, the type of impurities, and the standards applying to the purity of recycled CFC/halons.

- Revenues

Set against the above incremental costs, however, are the benefits that recyclers will enjoy in the form of greater expected revenues. As the supply of new CFC/halons for servicing existing equipment decreases, following a phasing out of production in line with the Montreal Protocol, recyclers will be able to command a premium price for recycled CFCs, if the demand for CFCs/halons to service equipment continues. There are two factors which ensure that the market demand for recycled CFCs and halons will not decrease in the short to medium term:

- CFC/halon substitutes may be priced the same or cheaper than recycled CFCs/halons; however, they are not drop-in substitutes; they have different chemical properties, and are thus only suitable for modified equipment. In the case of halon substitutes, such as CO_2 systems, completely new equipment is required. Therefore demand for CFCs and halons for recharge applications will continue;

- the cost of CFC/halon used in replenishing is a small part of the overall cost of servicing equipment. It is therefore likely that consumer demand will be inelastic, and thus will not alter significantly as a result of increases in the price of recycled refrigerants/halons. Demand for recharging will come down only when equipment using CFC/halon substitutes have substantially replaced existing equipment and appliances.

The timing of the one-off capital investment and set-up costs on the one hand, and the increases in operating revenues on the other, will dictate whether the net present value of any recycling project will be positive or negative. A recycling project which is undertaken immediately will incur a capital outlay for the equipment and set-up costs, but the anticipated operating revenue benefits will take time to materialise, because the prices of virgin substances are not yet rising. The payback period of the project will be long and there is a case for assistance with the incremental costs. Alternatively, if the investment were to be postponed to a period where demand for recycled CFCs/halons are forecast to increase due to shortages of virgin supplies, then the project set-up and capital costs will be offset (and may be surpassed) by operating revenue benefits within a short period.

The above argument says that, given the right timing, the investment will pay for itself and there may not be a case for assistance with incremental costs. In practice, however, things are not that simple as:

- postponement of a recycling project may have inherent risks from a commercial point of view, as the first company to set up operations will enjoy learning curve benefits and may erect barriers to entry for potential entrants through effective distribution networks and long term agreements;

- the Montreal Protocol itself allows countries flexibility in phasing progress towards CFC/halon reduction targets and in the measures to be adopted to achieve these reductions. Therefore if a country decides to adopt recycling measures immediately, it should be eligible for assistance with incremental costs as the payback period of such a project will be otherwise very long.

There is therefore an argument for compensating for incremental costs, but it remains to be decided whether the compensation should cover all or part of the incremental costs concerned.

CFC PRODUCTION SECTOR

Project: CFC manufacturer converting plant for production of CFC substitutes

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties				
• Licence costs	X	0	0	0
2. Capital costs:				
• New plant/equipment	X	0	0	0
• Decommissioning	X	0	0	0
• Retraining	X	0	0	0
• Research and development	0	0	0	0
• Salvage value of plant	Y	0	0	0
3. Operational costs	X	X	X	X

NOTES

General

CFCs and their proposed substitutes are themselves raw materials of other manufacturers. To avoid double counting of incremental costs, it is necessary to ensure that:

- either the CFC producer is assisted with the incremental costs of producing substitutes, and does not pass on the higher costs in higher prices, so that manufacturers who use these substitutes will not face increased costs;
- or that the CFC producer is not assisted with the incremental costs of producing CFC substitutes, and passes these costs on to the manufacturers in the form of increased unit prices.

In the current template it is assumed that the former case applies. Therefore, the templates for costs incurred by manufacturers who use CFC substitutes (e.g., refrigerator manufacturer converting to HFC 134a), assume that they do not face incremental prices for CFC substitutes.

The alternative approach is also valid.

1. Patents, designs and royalties:

   The new technology would require payment to the process patent holder. This is assumed to be a payment in the form of a licence fee; royalties could be paid instead, over a period of time.

2. Capital costs:

   - New plant equipment

     These would depend on the type of substance that is substituted in place of CFC production:

     - converting to a transitional substitute such as HCFC 22 is likely to involve incremental costs in converting existing facilities, rather than capital costs for new plant.

   - Decommissioning

     Converting to HFC 134a production is likely to involve closure of old plant and decommissioning of existing equipment on a larger scale than in the case of HCFC 22, due to the new technology involved. Thus, there would be incremental capital costs rather than conversion costs.

   - Retraining

     Retraining will be required to absorb the new technology.

   - Research and development

     The manufacturer could develop his own manufacturing process/technology by investing in R&D costs, but it is assumed that this is too costly and the licence fee is the preferred option.

   - Salvage value of plant

     The present value of plant net of all accelerated depreciation allowances already written off, is judged as an acceptable benefit.

3. Operational costs:

   The new manufacturing processes may incur higher operating costs. The time scale for which a manufacturer should be compensated for incremental operating costs is set at 4 years in the template; this is an arbitrary period and would have to be discussed further.

Project: Enforced Idleness of Production Facilities

	Year 1	2	3	4
Conversion of existing equipment and product manufacturing facilities				
1. Patents, designs and royalties	0	0	0	0
2. Capital costs:				
• Labour (human capital)	X	X	X	X
• Salvage Value	X	0	0	0
3. Profits foregone	X	X	X	X
4. Losses incurred	0	0	0	0
5. Importation of substitutes	X	X	X	X

NOTES

General

It is possible that a producer of CFCs in an Article 5 country may decide to terminate production for any of the following reasons: the traditional market may not be ready for substitutes; the producer may be unable to afford the required patents and licences to produce the substitutes as required by the Protocol; and, those industries that would demand substitutes as an input in their production process have not yet implemented alternative technologies for the use of the substitutes.

1. Patents, designs and royalties:

   The costs of patents and licences are not acceptable since there would not be any additional need for patents or licences since there will be no further production activities.

2. Capital costs:

   - Labour (human capital)

     Labour costs may be acceptable up to the duration of the transition period (four years). Labour costs include wages and benefits foregone as a result of enforced plant idleness. This represents a social cost to the country.

- Salvage Value

  The present value of a plant net of all accelerated depreciation allowances already written off is judged to be an acceptable cost.

3. Profits foregone

   This is an acceptable one-off cost. It represents the stream of profits foregone as a result of enforced plant idleness.

4. Losses incurred

   This is not an acceptable cost because the country would be eliminating an unprofitable enterprise.

5. Importation of substitutes

   If the country must import substitutes to compensate for lost capacity as a result of this project, then this is an acceptable cost. However, the eligible cost here would be the difference between the price of the eliminated product and the imported substitutes. This would be included in the incremental costs to the country.