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COST-EFFECTIVENESS OF ODS PHASE-OUT PROJECTS

(Draft)

INTRODUCTION

1. The Executive Committee, at its Twelfth Meeting, "requested the Secretariat to consult with the implementing agencies to produce a paper which would help the Executive Committee to consider the possible future use of reasonable cost-effectiveness ranges on a sub-sector by sub-sector basis with a view to ensuring the most expeditious, effective and efficient possible utilization of funds to address the ozone depletion problem".

2. The rationale behind this request of the Executive Committee is to develop some benchmarks for the measurement of cost-effectiveness for phase-out projects. This will contribute to:

(a) comparison of cost-effectiveness of phase out of ODS within a sub-sector in the various sectors;

(b) project review and approval by the Executive Committee;

(c) project formulation work by the implementing agencies;

(d) the overall programming of the Multilateral Fund resources in the global phase-out of ODS.

3. The paper will have the following components:

- Definitions
- Methodologies for Calculating Cost-Effectiveness
- Assessment
- Methodology Selection
- Analysis
- Constraints
- Results

Definitions

Cost-effectiveness

4. For the purpose of this paper, cost-effectiveness is defined as the lowest possible amount of funds required to eliminate the maximum amount of controlled substances during a certain period of time.

Cost

5. Cost refers to the eligible incremental capital and operational costs requested for converting to an environmentally sound alternative technology using substitute chemicals to the substances restricted by the Montreal Protocol.

ODS Consumption

6. ODS consumption is defined as the actual consumption by the enterprise expressed in ODP weighted tonnes.

Methodologies for Calculating Cost-Effectiveness

7. Currently, two methods are being used for the calculation of cost-effectiveness of phase-out projects.

8. The first method uses the total incremental capital costs and incremental operating costs divided by the total annual ODS consumption.

$$C = \frac{IC + IO}{M[ODP]}$$

where:

C	Cost-effectiveness
IC	Incremental capital costs
IO	Incremental operating costs
M[ODP]	Amount of ODS to be phased out annually (weighted kg ODP)

9. Method 2, known as the Unit Abatement Cost (UAC),[1] is mathematically expressed as follows:

$$C = \frac{CC * CRF + (AOC - AOS)}{M[ODP]}$$

where:

CC	Capital incremental cost (US dollars)
CRF	Capital recovery factor, the annualized capital cost charges, discounted at a standard rate of 10 per cent per year, over a ten-year period
AOC	Average annual operating costs (US dollars)
AOS	Average annual operating savings (US dollars)
M[ODP]	Amount of ODS to be phased out annually (weighted kg ODP)

For the application of this equation, the following assumptions are normally made:

- Capital costs are annualized over the expected life of the investment at a real discount rate of 10 per cent per year.
- ODS is assumed to be saved at the same rate each year throughout the project life.
- The costs of ODS and ODS replacements are standardized (i.e., for comparability, the same typical values are used throughout and are not meant to reflect country differences).

Assessment

Method 1

Advantages

10. Since it uses the actual ODS consumption to be phased out as a common denominator for all the projects, it provides the basis for comparison of projects. As for the cost items in

[1] Described by the World Bank in its publication entitled "Sourcebook of Benchmark Unit Abatement Costs", October 1992.

the numerator, they represent the actual disbursements from the Fund to the project. The result is the cost-effectiveness of the project to the Fund.

11. This method is easy to use; there is no need to annualize the incremental capital costs and therefore avoids the disparities in using different economic lives of projects.

Disadvantages

12. Since the durations of incremental operating costs have not been standardized, either cross-sectorally or sectorally, projects approved so far have different periods of operating costs. Therefore, those projects which have longer periods of operating costs approved for them, even within the same sector/sub-sector, will end up having higher cost-effective values.

Method 2

Advantages

13. This method could serve the purpose of measuring the cost-effectiveness of projects to the Multilateral Fund if some uniform economic life of projects could be developed for each sector/sub-sector.

Disadvantages

14. Since there is no consistency in using the economic life of the projects, even within the same sub-sector, this distorts the annualized capital cost. For instance, the same piece of equipment annualized on a ten-year economic life will certainly have a higher cost than one annualized on a twelve-year economic life.

15. The rationale behind annualizing the capital costs is to reflect the annual portion of the capital costs for the elimination of ODS annually. However, the elimination of the ODS is a one-time business. That means no matter how much one spends on capital costs, it is just for the elimination of the ODS currently consumed in an enterprise, and the same thing will not be repeated beyond that. Annualizing the capital costs over a number of years of economic life of the project does not serve the purpose of reflecting the cost of ODS elimination because it is not the same as amortization of investment costs over the economic life of a production facility, which has an actual and not would-be production every year.

Methodology Selection

16. After weighing the advantages and disadvantages of both methods, it is decided to use Method 1 for the calculation of cost-effectiveness of phase-out projects for the purpose of this paper.

Analysis

17. The preparation of this paper is based on the review of more than 120 investment projects that have been approved by the Executive Committee[2]. The projects were classified by sector, sub-sector and, where appropriate, by technology as shown in Table 1. For some of the technologies, there have not been sufficient numbers of projects approved to establish credible ranges. Therefore, no attempt is made for these technologies at this moment.

18. Each project is analyzed for the alternative technology chosen, the equipment selected and their costs, and the operational costs/savings estimated.

Constraints

19. The following constraints are experienced in the process of preparing this paper and should also serve as caution against the attempt of using one value as an indicator of cost-effectiveness:

(a) Cost-effectiveness values are provided in only 65 projects, and are not reported in those projects which do not lead to direct elimination of controlled substances (e.g., polyol production, MACs compressors, and the phased-in conversion of domestic refrigeration plants);

(b) It is not possible to ascertain the accuracy of estimating the amount of ODS to be eliminated at the project level, particularly for the first projects that were submitted to the Committee, and where no country studies or country programmes were available at the time;

(c) There is no consistency in assessing some variables in the Unit Abatement Cost equation, even for projects in the same sector. For example, the annual discount rate to calculate the capital recovery factor is 10 per cent in most of the projects, but a 12 per cent is also used. The lifetime of the projects varied from 4 to 12 years. This is of particular importance, since the unit abatement cost is sensitive to any changes in these variables;

(d) There is not always uniformity in the selection and costing of the equipment needed to implement the same phase-out technology, even for similar enterprises in the same country;

(e) There is no uniformity in the prices of ODS and their substitutes;

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[2] The distribution of the projects analyzed is as follows: 54 projects by UNDP, 3 projects by UNIDO, 69 projects by the World Bank and 1 project through bilateral assistance.

(f) In some projects, the first-year operational costs/savings of the project is used while, for others, the average of the net present value of those costs/savings over more than a one-year period is utilized; and

(g) In some projects, operational costs are not considered at the time the projects are approved with the understanding that these costs will be calculated at a later stage. This is of particular importance for projects with high-operational cost (e.g., manufacturing of domestic refrigerators), since the cost-effectiveness value could become very high at the time when considering the operational costs.

Results

20. In order to develop a cost-effectiveness range on a sub-sector by sub-sector basis as requested by the Executive Committee, the cost-effectiveness value of each project is calculated using the Method 1 referred to above (i.e., total funds allocated divided by the amount of the ODS to be eliminated). The cost-effectiveness values are then plotted against the amount of ODS to be phased out.

21. For a few sub-sectors no meaningful graphs could be obtained due to the very wide variation in the cost-effectiveness values, even for projects employing the same technology and eliminating about the same quantity of controlled substances.

22. Through a closer scrutiny of equipment selected and capital and operational cost estimates of each project, a smaller subset of projects are selected to arrive at more credible cost-effectiveness ranges.

23. The results by sub-sector and technology are presented graphically in Annex I (Figure 1-12). As is expected, the cost of phasing-out a unitary amount (kilogram) of a controlled substance decreases as the amount of the substance to be eliminated increases.

24. The rate of change (slope of the curve) varies from sub-sector to sub-sector. This is of particular importance when dealing with projects with low ODS elimination and projects where the capital cost is high due to test and quality control equipment.

25. Using the graphs, indicative cost-effectiveness ranges are estimated for each sub-sector and for the technology used with the sub-sector when applicable. The ranges are presented in Table 2.

26. Two ranges of cost-effectiveness are estimated for most of the sub-sectors; one range for lower ODS consumption (less cost-effective projects), and the other for larger consumption. The boundary for each range varies from sub-sector to sub-sector.

27. These ranges should not be considered as absolute, since a comparison model is not attainable at the time of writing this paper. However, the ranges point to two discrete values associated with low and high consumptions.

CONCLUSION AND RECOMMENDATIONS

28. Due to the lack of standardization of projects, cost of equipment and materials vary from country to country and sometimes within the same country. This makes it extremely difficult to fix a value for cost-effectiveness.

29. The graphs provided in Annex I clearly indicate that economy of scale is a critical factor in determining whether a project is cost-effective.

30. It is therefore recommended that projects which will result in the elimination of the maximum amount of ODS should be given priority. However due regard should be given to smaller ODS consumers so that they are not discriminated against.

31. This would serve two purposes: decrease the level of chlorine loading in the upper stratosphere, and creating new capacities in large enterprises in Article 5 countries which may provide assistance to smaller enterprises within the country in the context of a sectoral strategy.

32. The cost-effectiveness ranges provided in Table 2 are indicative and do not represent upper and lower limits.

33. The implementing agencies should be encouraged to develop strategies for formulating more cost effective projects for small consuming enterprises.

Table 1.

Distribution of projects by sector, sub-sector and technology chosen

Sector	Sub-sector/ Technology	N° of projects approved
Aerosol	Conversion to LPG	6
	Deodorization of LPG	1
	Subtotal	7
Foam	Flexible polyurethane foam	
	• Methylene chloride	10
	• Water blown	4
	• Trial runs with new formulations	1
	Polystyrene and polyolefin foam	
	• Hydrocarbon	11
	• Transitional substance (HCFC)	2
	• CO_2 and transitional substance (HCFC)	1
	Rigid polyurethane foam (excluding refrigeration insulation foam)	
	• 50% reduced CFC (*)	2
	• Transitional substance (HCFC)	15
	• Water blown	5
	Refrigeration insulation foam	
	• 50% reduced CFC	6
	• Transitional substances (HCFC)	4
	• Cyclopentane	(**)
	Polyol production	5
	Subtotal	66
Halon	Production of substitute (ABC)	1
	Extinguisher conversion	1
	Recycling	2
	Subtotal	4
Other	Tobacco fluffing	1
	Subtotal	1

Table 1. (cont.)

Sector	Sub-sector/ Technology	N° of projects approved
Refrigeration	Commercial refrigeration manufacturing	
	• Non-ODS foam and refrigerant	1
	• Non-ODS refrigerant	1
	Domestic refrigeration manufacturing	
	• Non-ODS foam and refrigerant	7
	• Non-ODS refrigerant	1
	Compressor manufacturing	7
	MAC production	1
	Heat exchanger manufacturing	1
	Retrofitting of commercial refrigeration systems	3
	CFC refrigerant recycling	6
	Subtotal	28
Solvent	Aqueous cleaning	
	• Non-CFC-113	4
	• Non-TCA	4
	• Non-TCA and non-CFC-113	1
	Semi-aqueous cleaning	
	• Non-CFC-113	3
	Aqueous and semi-aqueous cleaning	
	• Non-CFC-113	3
	• Non-TCA and non-CFC-113	1
	Aqueous and hydrocarbon cleaning	
	• Non-TCA	1
	Organic solvent cleaning	
	• Non-CFC-113	2
	• Non-TCA	1
	Manufacturing of cleaning equipment	1
	Subtotal	21
	TOTAL	127

N/A Not applicable

(*) Conversion to non-CFC rigid polyurethane insulation panels will be implemented in a plant in which polyol for reduced CFC formulation will also be produced (considered under the polyol production).

(**) In one project, under the commercial refrigeration manufacturing sub-sector, replacement of CFC-11 with cyclopentane as foam blowing agent for cold storage room insulation will be implemented in three plants.

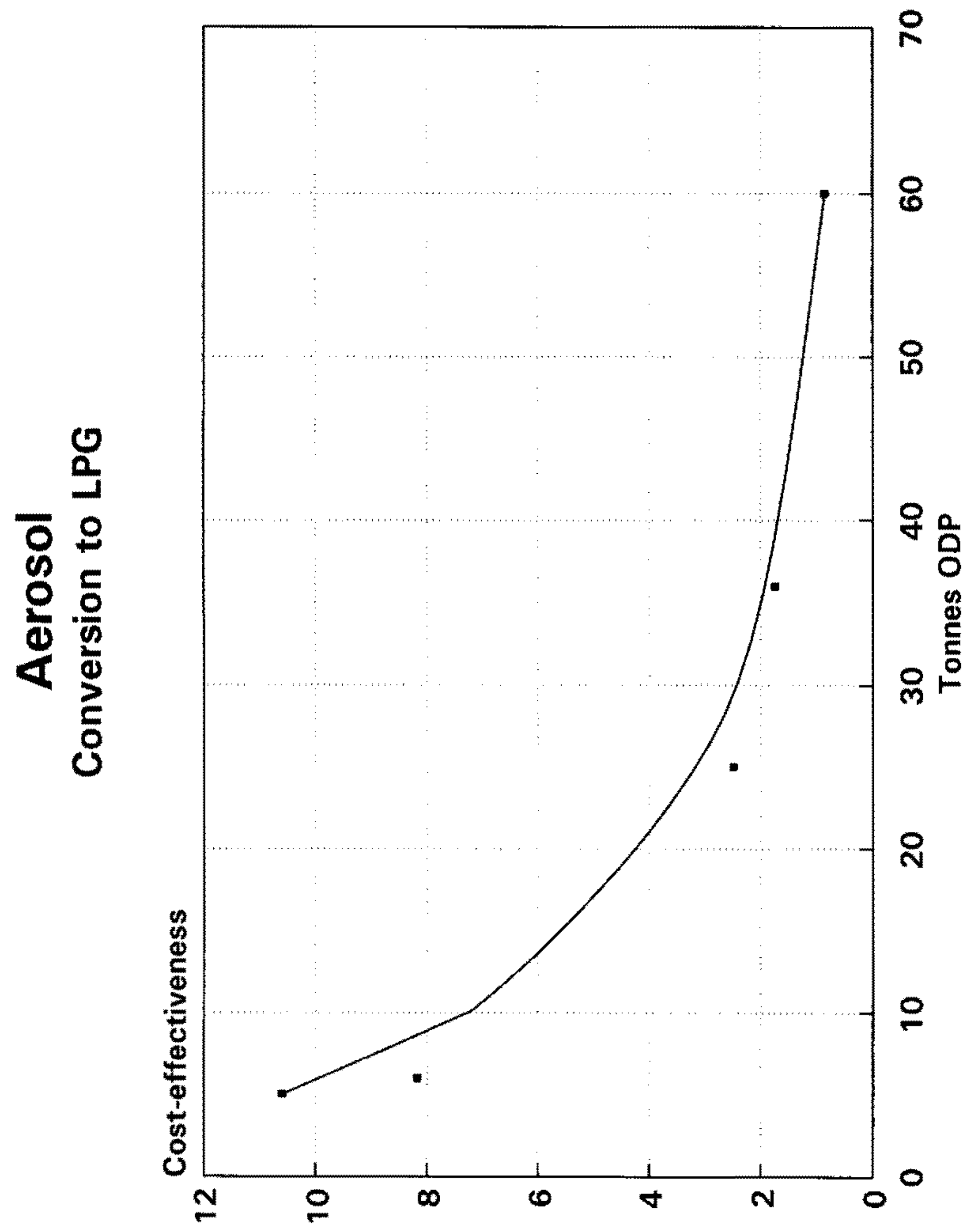
Table 2.

Indicative Cost-effectiveness range by sub-sector and technology chosen

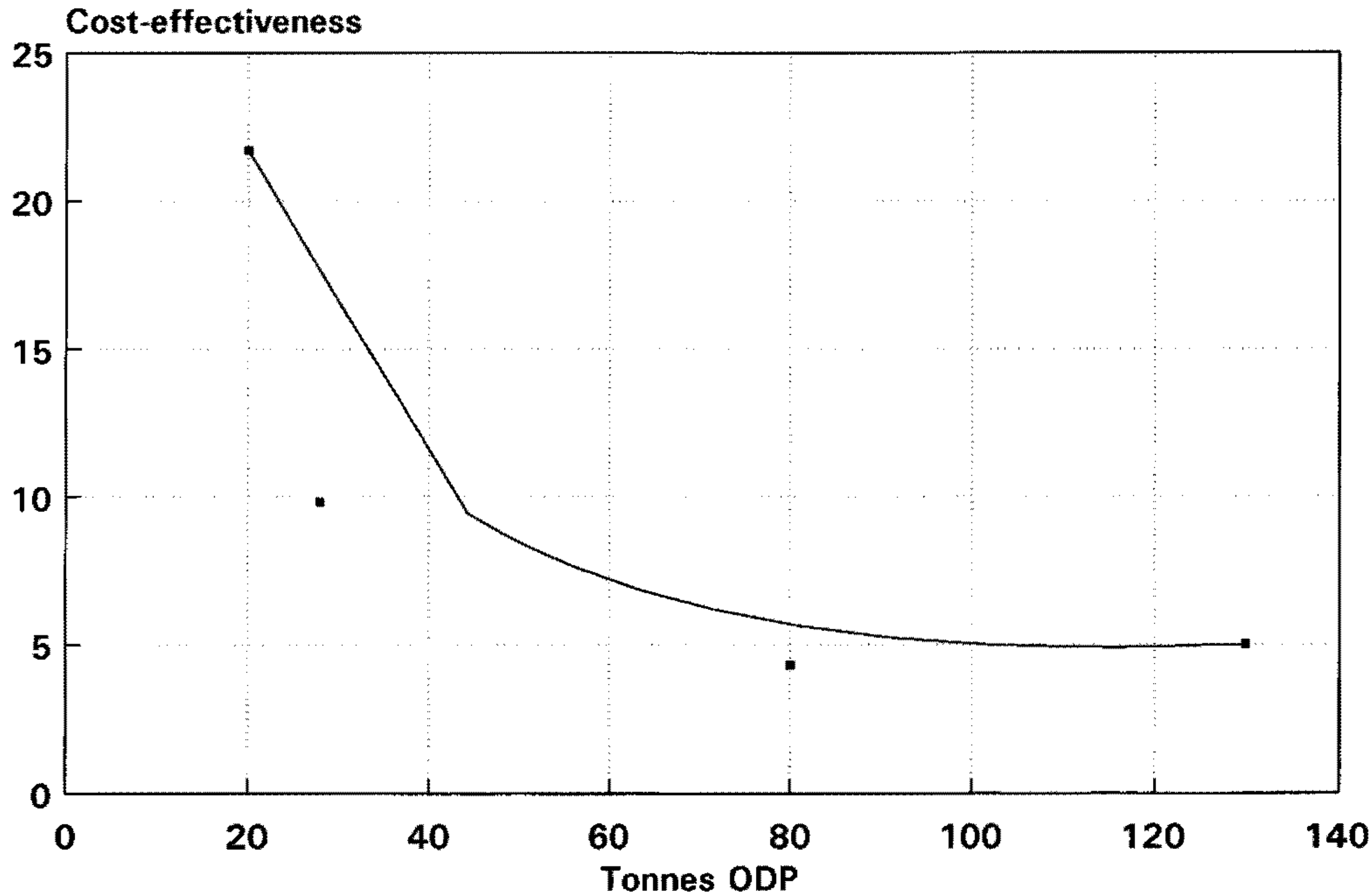
Sector	Sub-sector/ Technology	ODS range (in ODP tonnes)	CE (US$/kg)
Aerosol	Conversion to LPG	below 10	9.00
		20 - 100	2.00
Foam	Flexible polyurethane foam		
	• Methylene chloride	below 200	3.00
	• Water blown	below 40	15.00
		80 - 140	5.00
	Polystyrene and polyolefin foam	below 100	7.00
		100 - 500	3.00
	Rigid polyurethane foam (*)		
	• Transitional substance (HCFC)	below 20	18.00
		20 - 140	13.00
	• Water blown	below 10	30.00
		10 - 80	15.00
	Insulation refrigeration foam	below 30	40.00
		30 - 200	20.00
Refrigeration	Domestic refrigeration manufacturing	below 100	35.00
		100 - 800	15.00
	Compressor manufacturing (**)		
		below 100	15.00
		600 - 2,000	2.00
Solvent	Non-CFC-113	below 20	35.00
		80 - 120	7.00
	Non-TCA	below 4	180.00
		10 - 25	25.00

(*) Excluding refrigeration insulation foam.
(**) In terms of compressors manufactured (in thousand units/year).

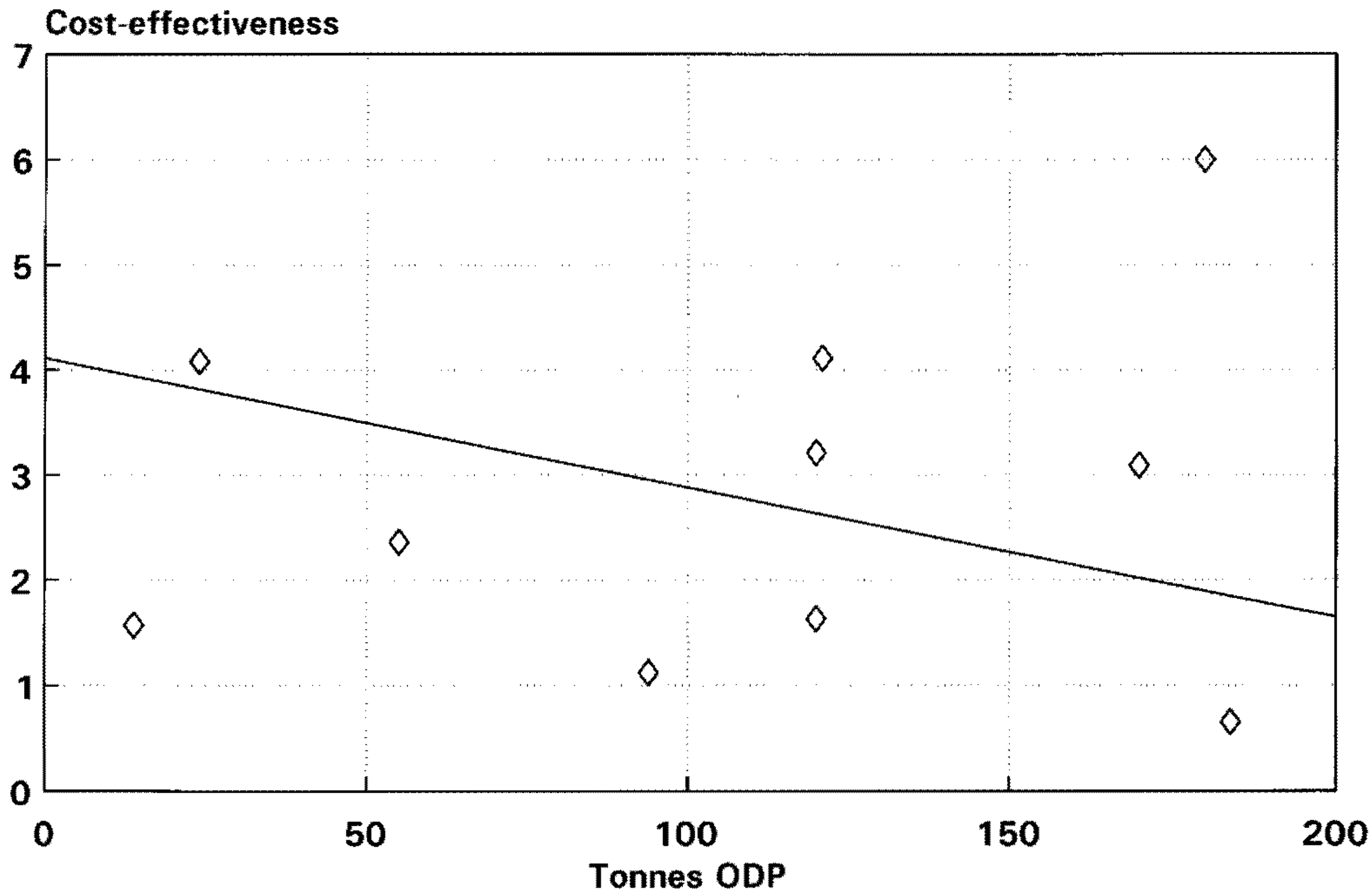
ANNEX I

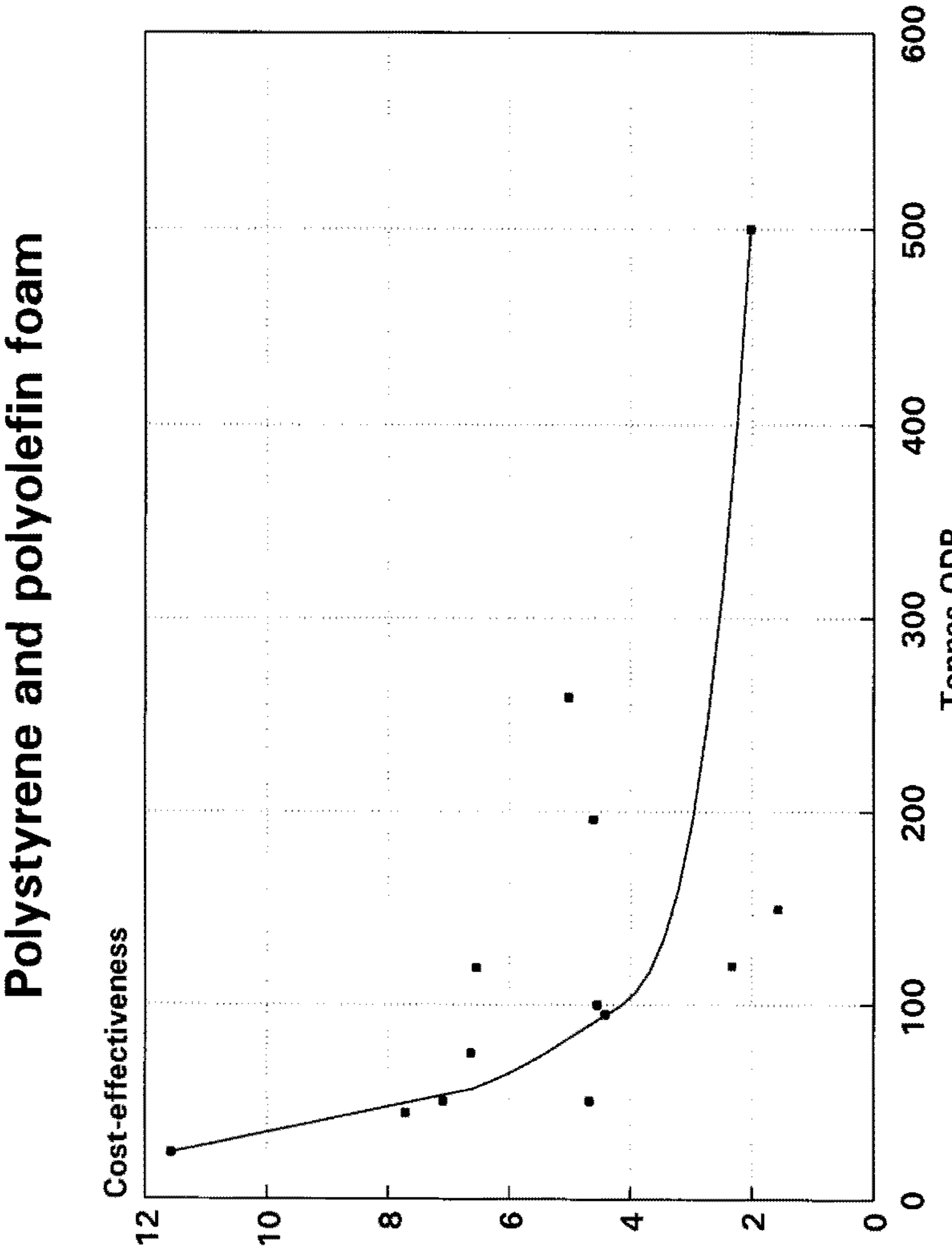

Aerosol
Conversion to LPG
Cost-effectiveness
Tonnes ODP
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70

Flexible polyurethane foam
Water blown technology

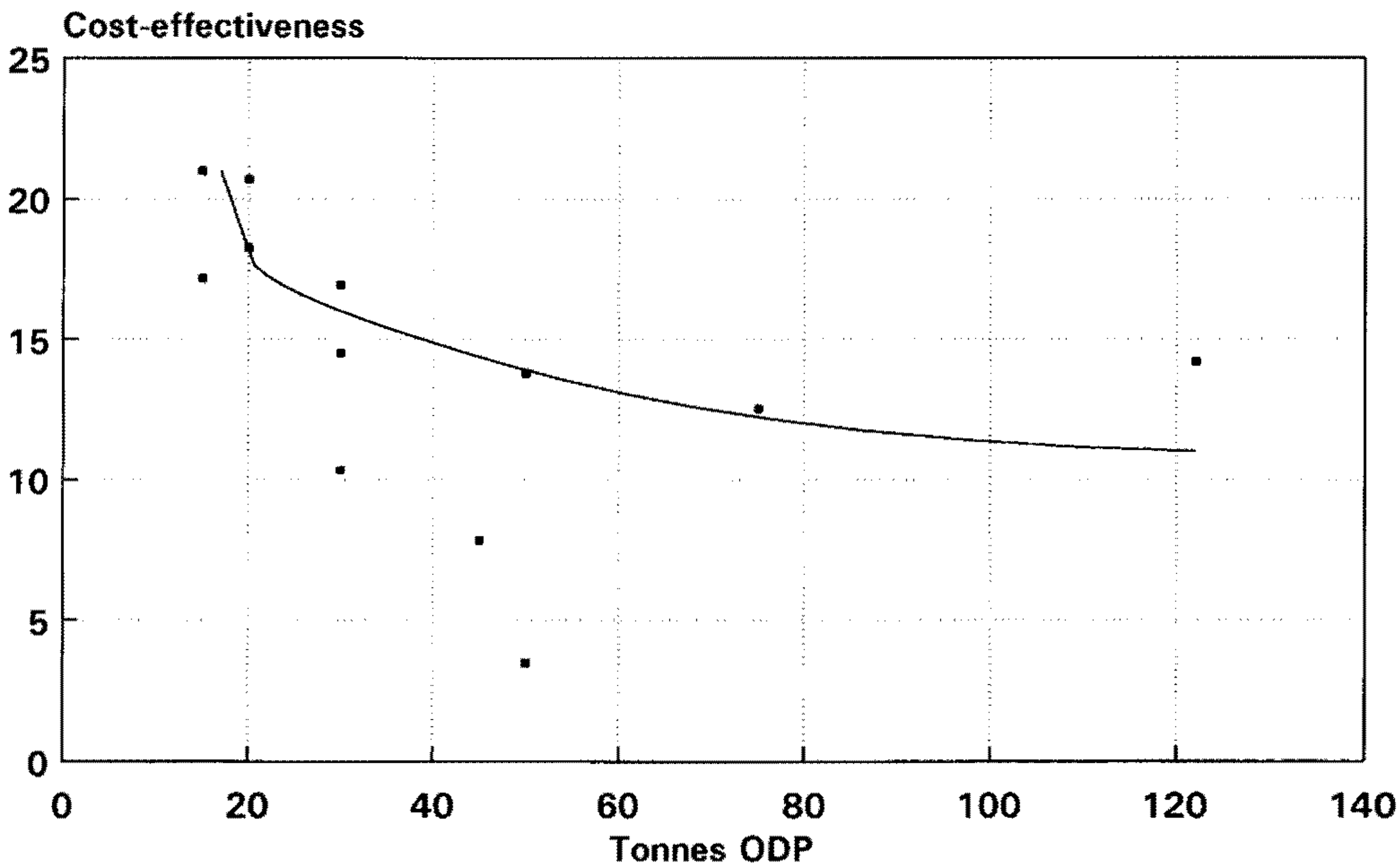


Flexible polyurethane foam
Methylene chloride technology

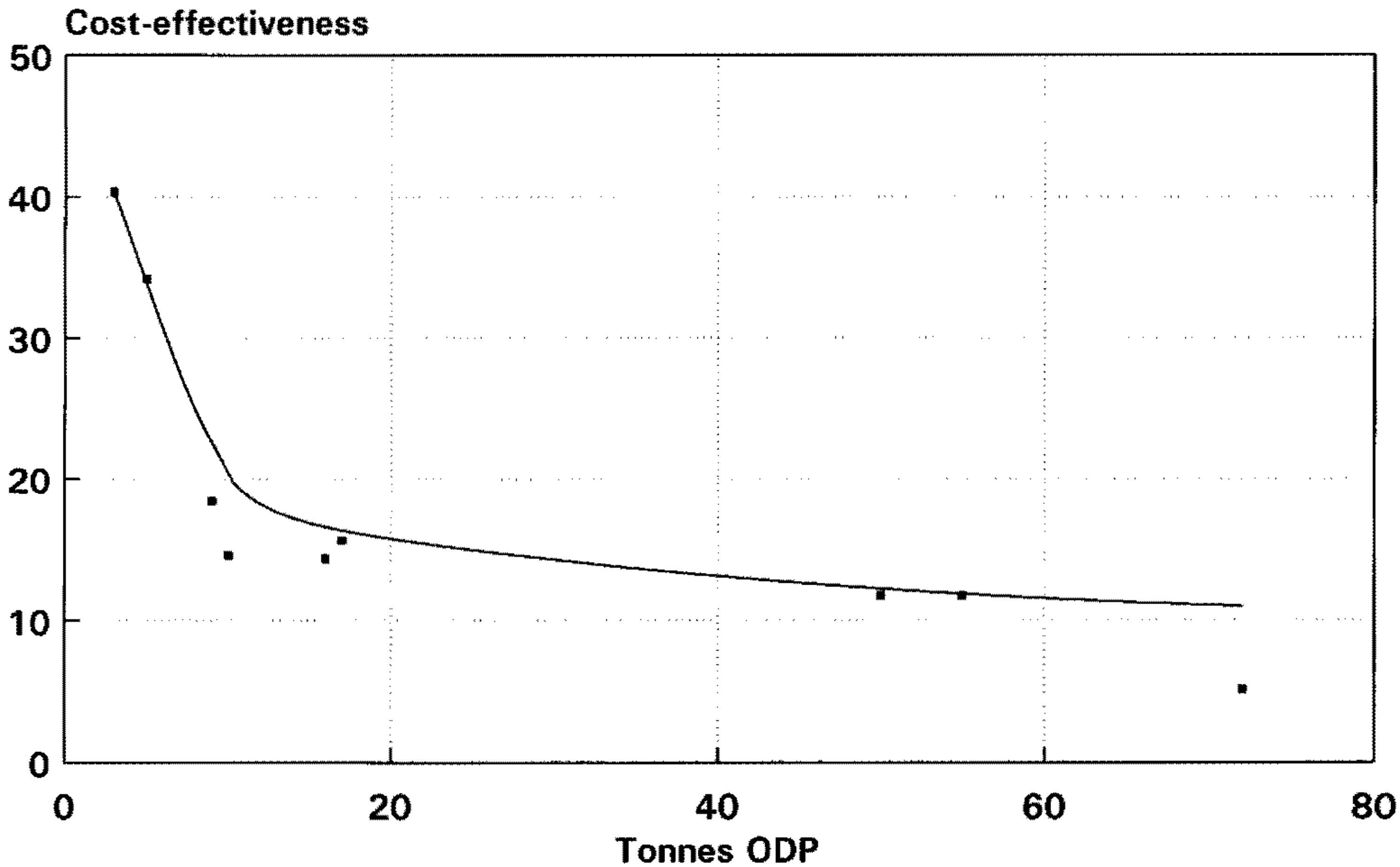


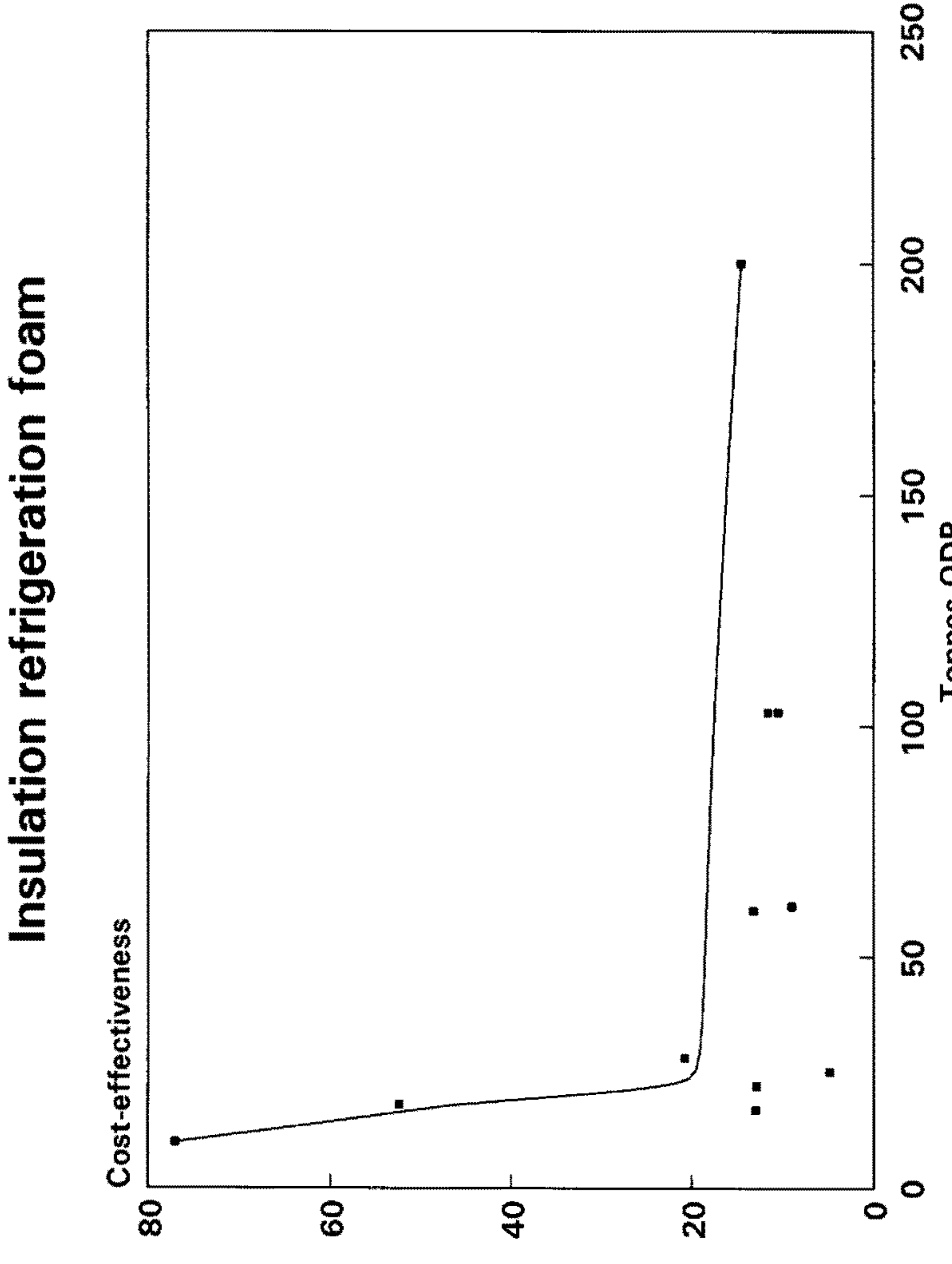

Polystyrene and polyolefin foam
Cost-effectiveness
Tonnes ODP
0
2
4
6
8
10
12
0
100
200
300
400
500
600

Rigid polyurethane foam
(excluding insulation refrigeration)
Transitional substance technology

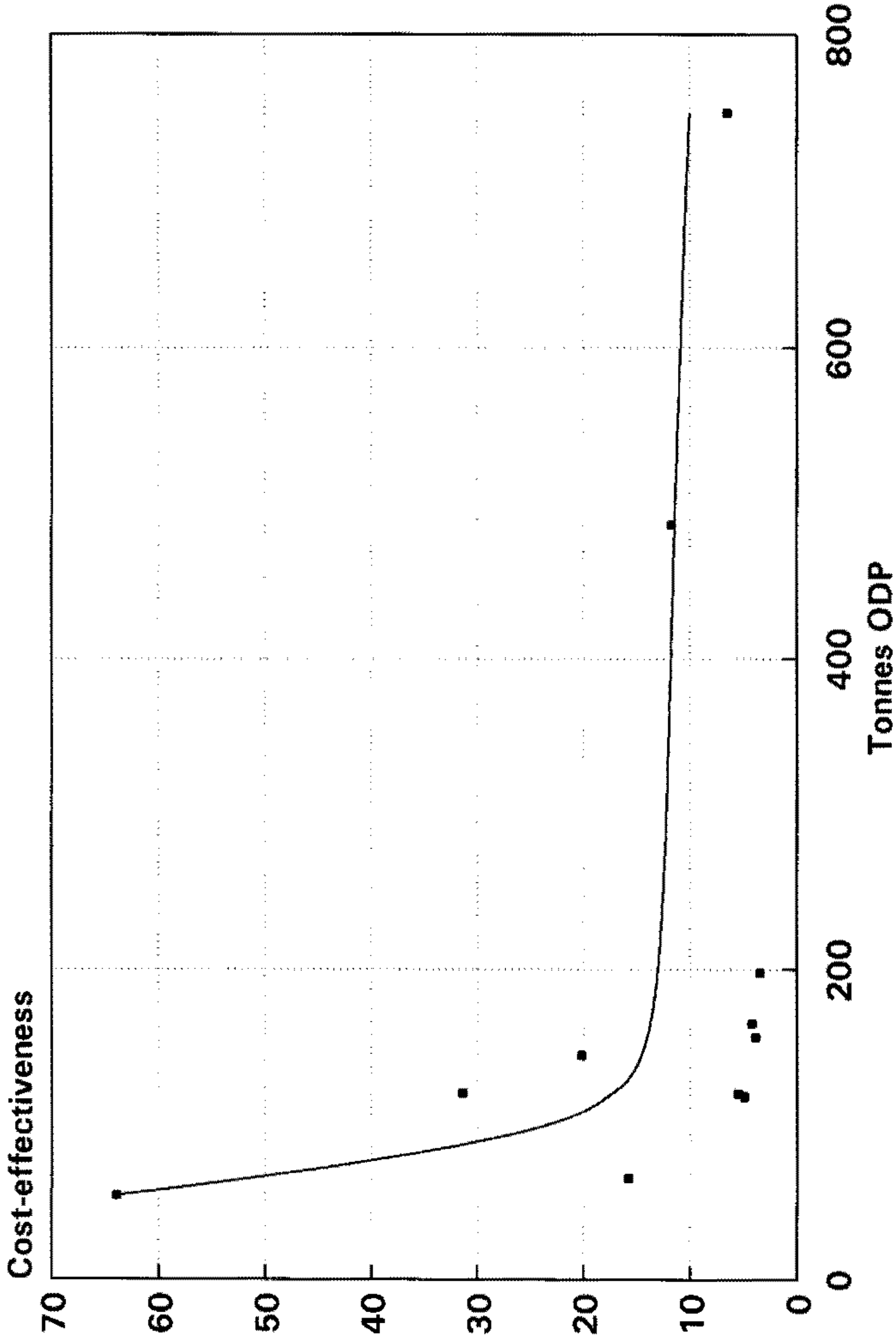


Rigid polyurethane foam
(excluding insulation refrigeration)
Water blown technology



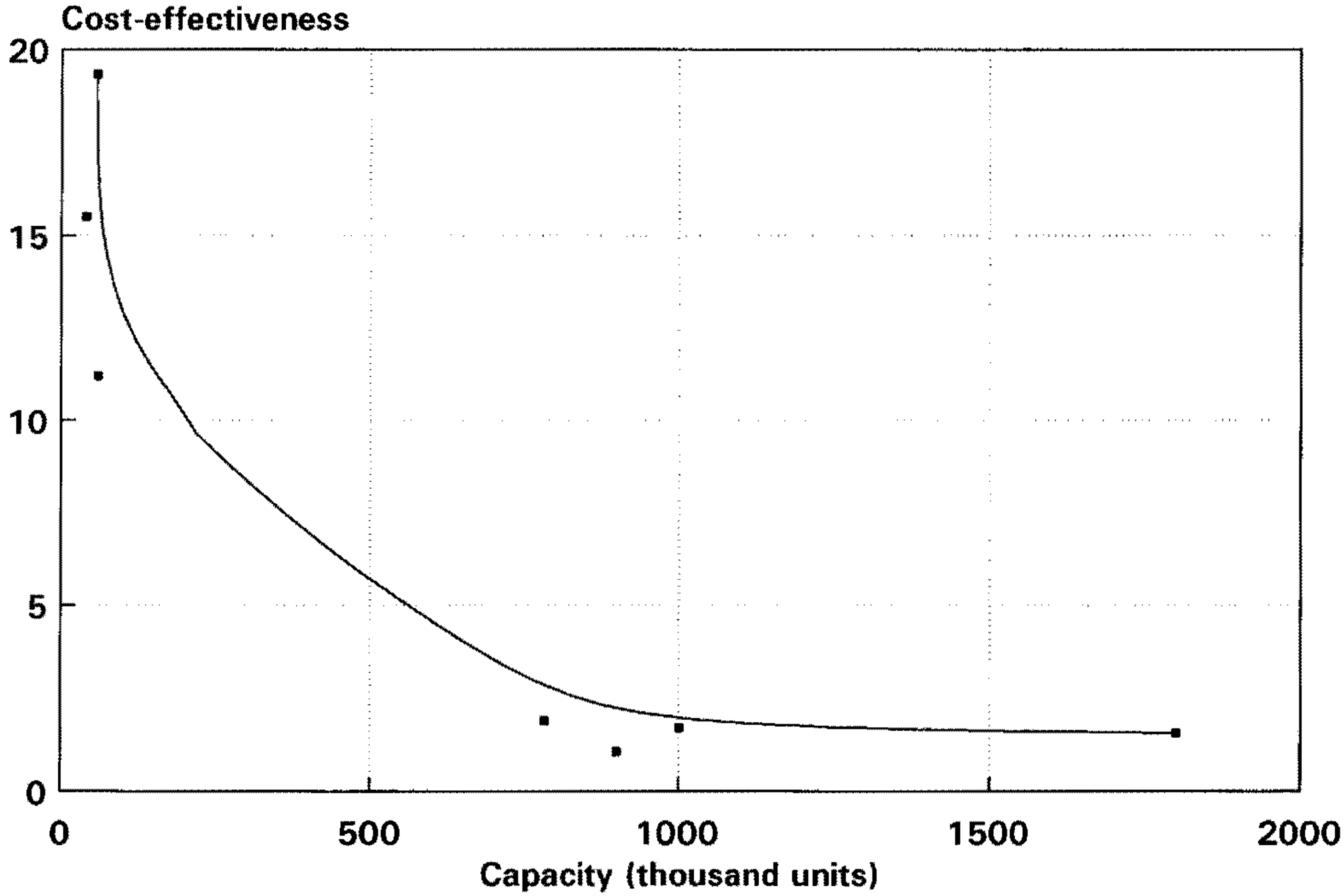

Insulation refrigeration foam
Cost-effectiveness
80
60
40
20
0
0
50
100
150
200
250
Tonnes ODP

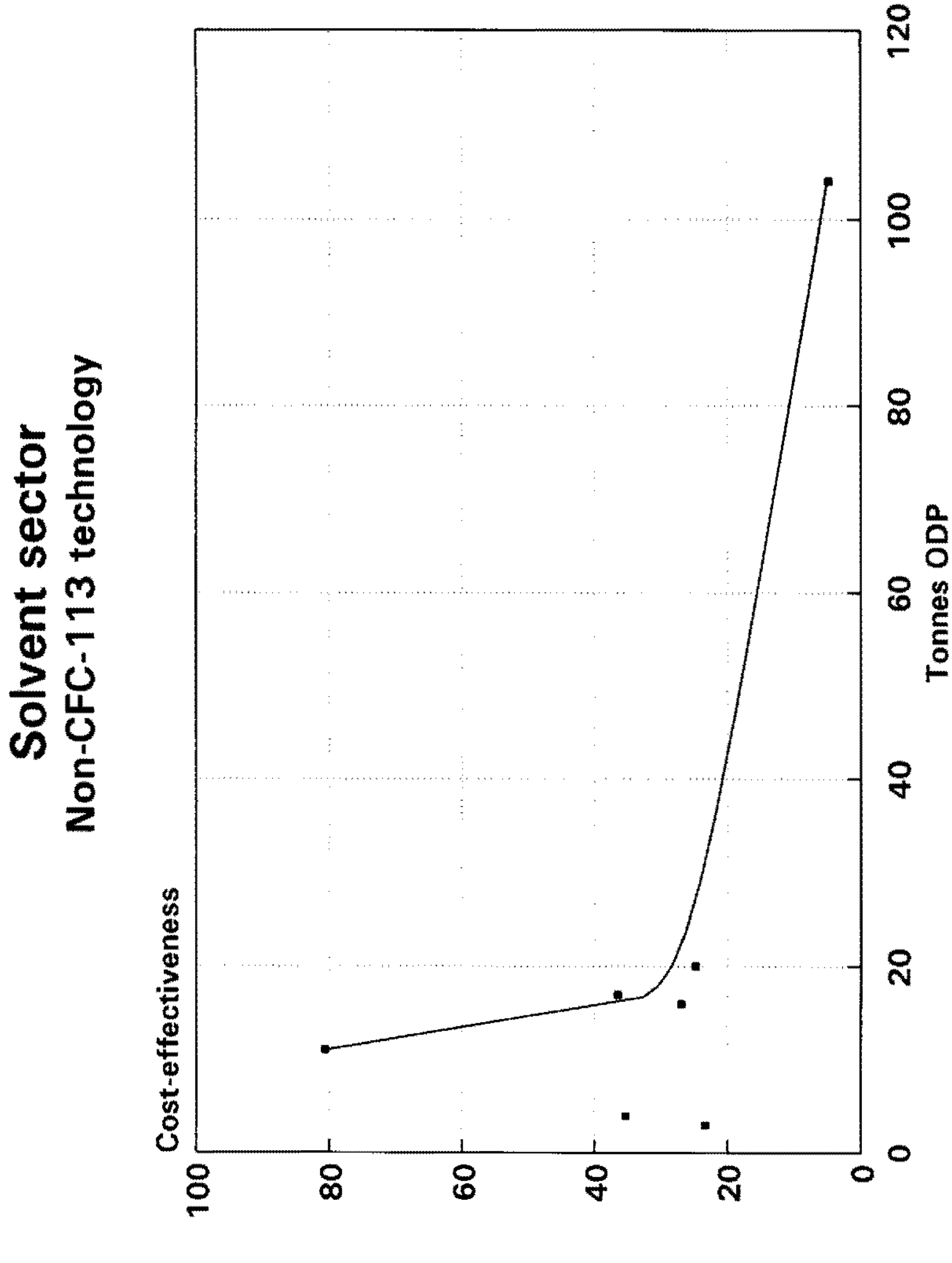
Domestic refrigeration manufacturing
(excluding operational costs)

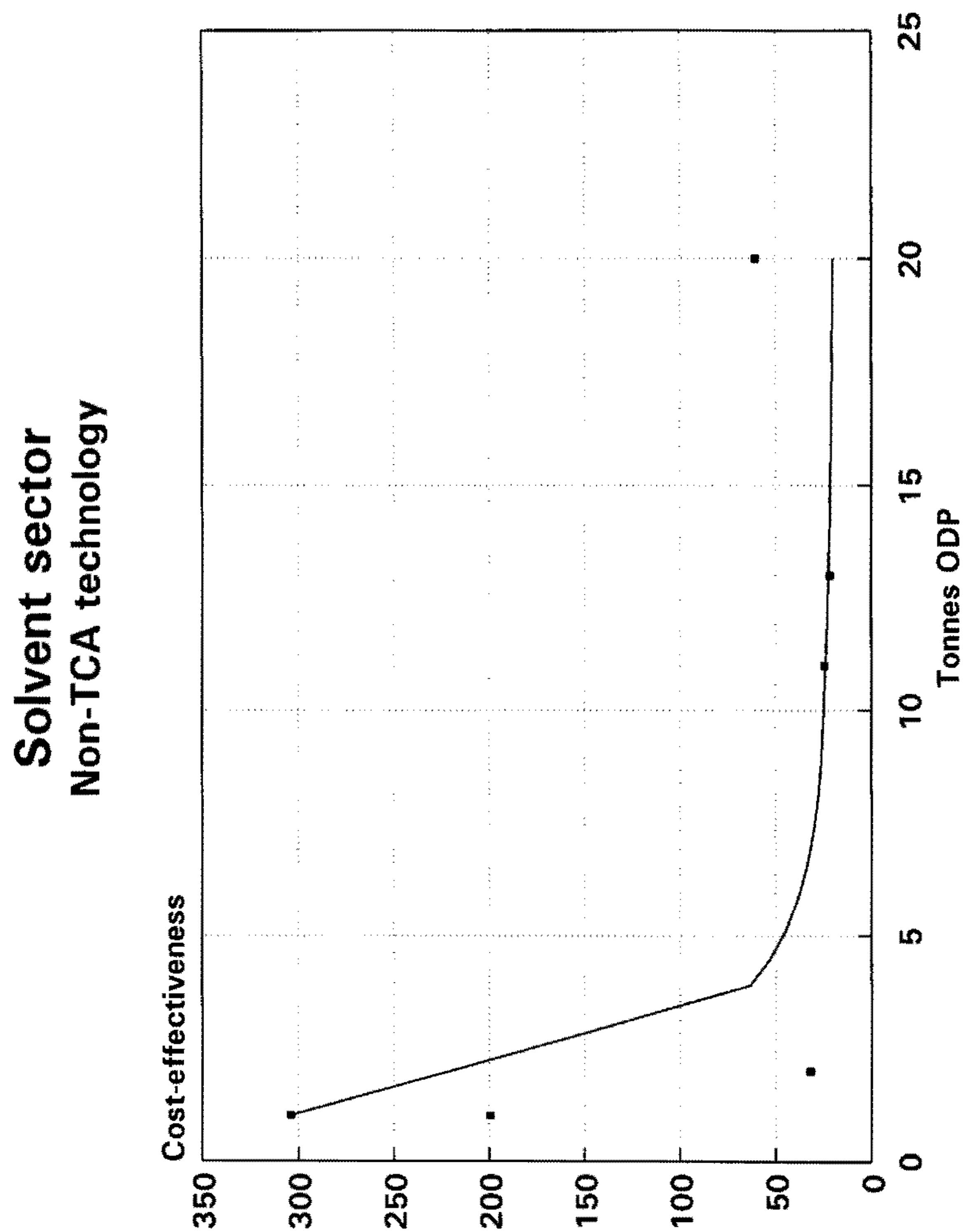


Compressor manufacturing

(excluding operational costs)




Solvent sector
Non-CFC-113 technology
Cost-effectiveness
100
80
60
40
20
0
0
20
40
60
80
100
120
Tonnes ODP


Solvent sector
Non-TCA technology
Cost-effectiveness
Tonnes ODP
0
50
100
150
200
250
300
350
0
5
10
15
20
25