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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Ninety-sixth Meeting
Montreal, 26–30 May 2025
Item 9(d) of the provisional agenda[1]

PROJECT PROPOSAL: CHILE

This document consists of the comments and recommendation of the Secretariat on the following project proposal:

Energy efficiency

• Pilot project to maintain and/or improve the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): Demonstration project for the use of heat pumps based on R-744 (carbon dioxide) as refrigerant in industrial refrigeration	UNDP	Individual consideration

[1] UNEP/OzL.Pro/ExCom/96/1

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

Chile

PROJECT TITLE	BILATERAL/IMPLEMENTING AGENCY
Pilot project to maintain and/or improve the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): Demonstration project for the use of heat pumps based on R-744 (carbon dioxide) as refrigerant in industrial refrigeration	UNDP

PROJECT OBJECTIVE

The pilot project aims to assess and demonstrate the performance and energy efficiency of heat-pump technology based on CO_2 as refrigerant in industrial applications in different regions in Chile through the installation, start up and operation of at least three individual pilot projects, with different heat and cooling capacities, in the dairy processing sector. The project seeks to demonstrate the potential advantages of this technology in terms of energy consumption reduction, refrigerant performance, process quality, operating cost reduction and, if possible, food loss reduction.

NATIONAL COORDINATING AGENCY	National Ozone Unit, Ministry of the Environment

LATEST ARTICLE 7 DATA (Annex F)	**Year:** 2023	1,973.56 metric tonnes (mt)	4,943,654 CO_2-eq tonnes

Particular	Non-investment activities
Project duration (months):	36
Initial amount requested (US $):	1,300,000
Final project costs (US $):	1,170,000
Requested grant (US $):	720,000
Implementing agency support cost (US $):	50,400
Total cost of project to Multilateral Fund (US $):	770,400
Co-financing (US $):	450,000
Energy-efficiency savings (kWh/year):	983,094*
Status of counterpart funding (Y/N):	Y
Project monitoring milestones included (Y/N):	Y
Minimum energy performance standards (MEPS) available for the relevant sector (Y/N):	N**

*Savings in the energy consumption of two CO_2-based heat pumps

**Current MEPS cover domestic refrigerators and non-ducted air-conditioning units with capacity up to 12kW

SECRETARIAT'S RECOMMENDATION	Individual consideration

PROJECT DESCRIPTION

Background

1. On behalf of the Government of Chile, UNDP has submitted, in line with decision 91/65, a request for a pilot project to enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities), in the amount of US $1,300,000, plus agency support costs of US $91,000, as originally submitted.[2]

Energy-efficiency pilot project

2. Chile ratified the Kigali Amendment on 19 September 2017, with HFC quotas allocated to importers as of January 2024. Under stage I of the Kigali HFC implementation plan (KIP) approved at the 93rd meeting, the country has committed to reducing HFC consumption by 10 per cent by 2029.

Policy, regulatory and institutional framework

3. In 2021, the Government of Chile enacted the Energy Efficiency Law to institutionalize energy efficiency by requiring the publication of a National Energy Efficiency Plan every five years. The Law also aims to reduce energy intensity by at least 10 per cent by 2030. In 2021, the Government of Chile updated the Long-Term Energy Policy (PELP), which emphasizes the country's commitment to achieving net-zero emissions by 2050 and includes a clear decarbonization pathway for all sectors of the national economy.

4. Mandatory minimum energy performance standards (MEPS) were adopted for the first time in 2015 through Exempt Resolution No. 74 of 2014 of the Ministry of Energy. Since 2016, only refrigerators of energy-efficiency classes A, A+ and A++ can be sold. Since 2018, air-conditioning units below class A cannot be commercialized.

5. The Energy Efficiency Division from the Ministry of Energy is responsible for the implementation of the Energy Efficiency Act and the National Energy Efficiency Plan, as well as for the energy management of large consumers and the energy labelling of buildings. This division works closely with the national ozone unit (NOU) for all regulations related to the refrigeration and air-conditioning (RAC) sectors and will be directly involved in the implementation of the pilot project.

HFC consumption and sector background

6. The HFC consumption baseline for Chile has been established at the level of 6,698,107 CO_2-equivalent (CO_2-eq) tonnes. Table 1 presents HFC consumption in Chile.

Table 1. Consumption of HFCs in Chile (2019–2023)

HFC consumption	2019	2020	2021	2022	2023
mt	1,747.26	1,684.22	1,854.98	2,556.05	1,973.56
CO_2-eq tonnes	4,763,686	4,465,255	4,957,950	7,089,350	4,943,654

7. HFC consumption has shown a general growing trend between 2019 and 2023 with a small reduction in 2020 and a notable increase in 2022 due to a swift economic recovery after the COVID-19 pandemic, requiring more services and installations based on HFCs, coupled with the introduction HFC-based technology in air conditioners and commercial refrigeration installations, including energy-efficient R-507A-based systems in industrial refrigeration applications, used as replacement of old systems based on HCFC-22 and also R-404A.

[2] As per the letter of 12 March 2025 from the Ministry of the Environment of Chile to UNDP.

8. In 2023, 459 mt (1,568,479 CO_2-eq tonnes) of HFCs were used for industrial refrigeration systems, representing 23 per cent of the total HFC consumption in mt or 32 per cent in CO_2-eq tonnes.

9. The dairy processing industry includes 14 large enterprises, which process more than 90 per cent of the milk and other milk-based products. The remaining 10 per cent is processed by around 111 medium- and small-sized enterprises, which also produce cheeses and yogurt. There are also more than 1,000 micro enterprises producing only milk without further process for self-consumption, or as providers of larger enterprises. The meat processing industry includes 54 identified small, medium and large enterprises that process beef, pork and poultry.

10. The specific quantity of HFCs used in the dairy or meat processing sectors is difficult to estimate given the wide variety in the size of the establishments, the cooling requirements, the type and age of the equipment, and enterprise practices. However, it has been determined that the few very large enterprises in the dairy and beef industries use ammonia as refrigerant, while a large number of small and medium-sized enterprises in the dairy and poultry industries have been using HCFC and HFC refrigerants for decades.

Project objectives

11. The pilot project aims to assess and demonstrate the performance and energy efficiency of heat-pump technology based on CO_2 as refrigerant in industrial applications in different regions in Chile through the installation, start up and operation of at least three individual pilot projects, with different heat and cooling capacities, in the dairy processing sector.

12. The project seeks to demonstrate the potential advantages of this technology in terms of energy consumption reduction, refrigerant performance, process quality, operating cost reduction and, if possible, food loss reduction. Through this project, it is estimated that energy consumption can be reduced between 30 to 50 per cent by replacing conventional separate cooling (HFC-based) and heating systems by an integrated heat-cooling system based on CO_2.

13. Out of the most important agro-industrial sectors in Chile (wine, fruits and vegetable processing, dairy, poultry and fishery) the dairy sector was chosen for the project given the significant number of medium-to-small dairy processors, primarily Chilean-owned, showing strong interest. Following a detailed examination of HFC usage reports, the preparation of a directory of potential candidates, a survey to collect basic information about enterprises' operations, energy use and process requirements, and a workshop to present the project goals, as well as interviews and visits, three beneficiaries from the dairy sector were pre-selected as they met the technical requirements to be able to optimally install a heat pump.

Technology

14. Heat-pump systems have a demonstrated positive impact on the reduction of HFC consumption and an increase in energy efficiency.

15. The industry in Chile typically uses conventional HFC-based refrigeration systems and separate water heating using oil or natural gas. The integrated CO_2 heat pumps proposed through the pilot project manage industrial cooling and heating within a single system, using electricity to transfer heat between areas, minimizing energy waste and preventing unnecessary heat or cold release into the environment. They operate across a wide temperature range (-30°C to +70°C), making them versatile for industries like dairy processing and animal protein production.

Proposed activities

16. Activities with their cost breakdown (as initially submitted) are described below.

(a) Installing CO_2-based integrated heat pumps for industrial processes in the dairy sector at three beneficiary plants to replace existing HFC refrigeration equipment and separate heat production (US $1,200,000);

(b) Monitoring the performance and energy consumption of the installed systems and developing energy-efficiency guidelines to provide sustainability to the project (US $70,000);

(c) Publishing the results obtained (US $15,000); and

(d) Promoting, once the advantages of the technology have been validated, the use of the demonstrated heat pump systems (US $15,000).

Total cost of the pilot project

17. The project is expected to be completed in 36 months after approval, between July 2025 and June 2028 for a total cost of US $1,300,000, as initially submitted. The beneficiary enterprises would provide co-funding of US $400,000. Table 2 provides a breakdown of the project costs for each of the activities and related components.

Table 2. Total project budget and breakdown of financing sources, as submitted

Item	Total (US $)	MLF funding (US $)	Co-funding* (US $)
Replacement of HFC-based refrigeration systems by CO_2-based heat pumps			
Installation of CO_2-based integrated heat pumps for industrial processes at three plants, each with heating/cooling capacity of 300 kW and above	1,600,000	1,200,000	400,000
Technical assistance			
Selection, design, monitoring and follow up	40,000	40,000	-
Development of energy-efficiency guidelines	30,000	30,000	-
Final report, public edition and awareness	15,000	15,000	-
Workshops to disseminate the results of the project	15,000	15,000	-
Subtotal	*100,000*	*100,000*	-
GRAND TOTAL	**1,700,000**	**1,300,000**	**400,000**

*Calculated at 25 per cent of total cost corresponding to installation, start-up and engineering project costs

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

18. The Secretariat has reviewed the project proposal in light of the activities described under decisions 89/6 and 91/65 as well as those being implemented under stage I of the KIP.

Eligibility under decision 91/65

19. The pilot project intends to enhance energy efficiency in heating and cooling in industrial processes in the context of HFC phase-down at end-users' sites. UNDP confirmed that the Energy Efficiency Division from the Ministry of Energy will be directly involved in the implementation of the pilot project in coordination with the NOU. Other stakeholders involved in the project include the Sustainable Energy Division of the Ministry of Energy, the Department of Climate Mitigation and Transparency of the Ministry of the Environment, as well as regional associations from the dairy, meat and poultry industries.

20. In line with decision 91/65(b)(iv), the Government of Chile has also confirmed that if Chile were to mobilize funding from sources other than the Multilateral Fund for energy-efficiency components when phasing down HFCs, the project would not result in the duplication of activities among those funded by the Multilateral Fund and those funded from other sources; the information on project progress, results and key learning would be made available, as appropriate; the date of completion of the project would be set as no more than 36 months after the date of approval by the Executive Committee and a detailed project report would be submitted to the Executive Committee within six months of the date of completion of the project.

Relationship to HFC phase-down and the Kigali HFC implementation plan

21. The pilot project will be implemented in coordination with the activities under stage I of the KIP. Training institutions participating in the implementation of the KIP will be involved in the pilot project to learn how to install this new technology. The KIP's activities include the training of highly specialized technicians in technologies based on CO_2. The HFC refrigerants in the existing facilities to be replaced will also be recovered for subsequent reclamation or disposal as part of the activities under stage I of the KIP. The components and materials collected from the dismantled HFC-based equipment will be separated and scrapped for other uses as much as possible, and the hazardous wastes will be disposed of as per the applicable regulations.

22. Currently, there is a trend in the industrial refrigeration sector in Chile to transition from HCFC-22 and R-404A-based systems to R-507A-based systems due to energy-efficiency considerations, which has partially contributed to the increase of R-507A consumption in recent years. The pilot project will supplement the KIP efforts by reducing R-507A consumption and providing an alternative option through the dissemination of the energy-efficiency, environmental and financial benefits, and performance of CO_2-based heat pumps, as well as the technical requirements for the installation and servicing of heat pumps in industrial refrigeration. This is intended to encourage other users in the dairy and meat processing sectors or other industrial sectors with similar requirements and capacities to adopt this technology, reducing energy consumption and HFC use.

Technical and cost-related issues

Technology selection

23. UNDP explained that other technologies considered for the project included R-290 and ammonia. R-290 performs well for smaller systems but does not meet the temperature gradient requirements for dairy processes and raises safety concerns. Ammonia meets heat and cold requirements but has high maintenance costs and safety concerns, making it more suitable for larger installations. UNDP determined that CO_2-based heat pumps are the most appropriate alternative for medium-sized industrial plants, as they offer suitable temperature gradients for dairy processes without the flammability and hazardous issues of the other options. Required training to deal with high pressure-related issues of CO_2-based technology will be provided through the KIP.

Selection of beneficiaries

24. UNDP explained that extensive work was undertaken to identify potential beneficiaries, including surveys, a workshop and visits to several enterprises. The project costs were estimated based on the actual cost of replacement of systems in potential beneficiaries, for which information was collected on the type of facilities, cold and heat needs, and times at which cold and heat are required within the processes. However, the final decision to define the beneficiaries will be through a broad public call that will select the plants that best suit the objectives of the project. The Secretariat notes that there are already several potential beneficiaries identified that comply with the requirements and that the public call would ensure transparency in the selection process and the opportunity to choose the best sites.

Type of equipment to be replaced and calculation of cost

25. Regarding the type of systems to be replaced, UNDP explained that because these plants have expanded over time based on market requests and needs, the cooling systems are generally individual and independent for each process rather than centralized systems. The specific equipment to be replaced, cooling capacities, type of refrigerant, and energy consumption will depend on the specific production process and heating/cooling needs of each plant. For the heating process, generally natural gas is used as fuel. The current use of electricity among the enterprises visited varies broadly from 200 kWh to 1,000 kWh. The estimated energy consumption reduction through the pilot project is between 30 to 50 per cent based on similar projects implemented mostly in South-East Asia.

26. Given the large variety of systems and capacities where the technology could be adopted, a revised representative cost calculation was made based on the specific case of a plant with 18 different systems at different chambers and steps in the production process with a total capacity of around 1,000 kW in production of heat and cold. The calculation was made against four different systems in the process (yogurt evaporators and cells, cold tunnel, frozen food storage, and logistics reefers) for a capacity of 300 kW and an installed capacity of 388 kg of R-507A, supplying refrigeration (from 5°C to 10°C), cold rooms (3°C to -18°C), and water heating for different processes inside the plant (from 22°C up to 85°C). The estimated coefficient of performance (COP) is 2 on the refrigeration part and 3 on the heating part. On this basis, the project was designed to:

(a) Integrate in a single system the production of refrigeration, chilled and heated water, increasing the system COP above 5 or 6;

(b) Reduce the use of R-507A. Most plants have large leakage rates of up to 35 per cent per year; based on the reference system this corresponds to an estimate of 135 kg per year used in servicing plus the installed capacity of 388 kg removed with the replacement of the system;

(c) Reduce the use of electricity in the production of cooling and the use of natural gas or oil in the production of hot water or steam; and

(d) Cover with the pilot replacement only a portion of a plant, to be later replicated by the beneficiary in other parts of the same plant and other plants.

27. The Secretariat and UNDP discussed several aspects of the proposal and agreed that, for the purposes of the pilot project, the demonstration of the CO_2-based heat pumps should only include two sites rather than three. Given the variety of processes and the fact that the technology is not well known in the sector, the Secretariat considers that two sites would be sufficient to demonstrate the technology.

28. The Secretariat notes that the estimated additional cost of replacing a conventional R-507A-based system with an energy-efficient CO_2-based heat pump instead of a basic R-507A-based heat pump is around US $350,000. Upon discussion of the cost elements, it was agreed that level of funds to be covered by the Multilateral Fund per site would be US $325,000, while the beneficiaries would provide a larger amount of co-financing, increasing it from the proposed 25 per cent of project costs to 40 per cent or above depending on the size of the project. The Multilateral Fund will cover the main part of the equipment (heat pump, pumps, heat exchangers, controls), while the co-financing by the beneficiary will cover installation, engineering, civil works (construction, piping, electrical arrangements, grounding), and the remaining costs of the main equipment.

29. The level of funds agreed per site will ensure that the beneficiary enterprises will be willing to participate and be the first ones to use this technology in the country. The funds will also ensure that the

project is properly designed and engineered, which will result in fewer problems, better performance and more confidence in the technology.

30. UNDP also agreed to reduce the following technical assistance costs: selection, design, verification and follow up (from US $40,000 to US $30,000); development of energy-efficiency criteria and/or guidelines to give sustainability to the project from US $30,000 to US $20,000; final report, public edition and awareness from US $15,000 to US $10,000; and workshops to disseminate the results of the project from US $15,000 to US $10,000.

Monitoring

31. The funding recommended also covers the energy measurement instruments needed for beneficiaries collect and share information on energy consumption and savings to ensure proper reporting to the Executive Committee on the results of the project. UNDP explained that in addition to energy consumption, other parameters will also be measured, such as the use of fuel for the water heaters, refrigerant recharge needs, and the need for corrective measures. Unlike traditional systems, the CO_2-based heat pumps include a permanent electronic monitoring system that detects possible misfunction in real time and makes it possible to resolve many issues remotely. The end users will monitor the system's operation based on templates and procedures supplied by an external technical expert who will accompany the project and the end user.

Agreed cost of the pilot project

32. The agreed costs to implement the pilot project to demonstrate the performance and energy efficiency of heat-pump technology based on CO_2 as refrigerant in industrial applications in Chile amount to US $1,170,000, including Multilateral Fund funding of US $720,000 and co-funding of US $450,000, as shown in table 3.

Table 3. Total project budget and breakdown of financing sources, as agreed

Item	Total (US $)	MLF funding (US $)	Co-funding (US $)
Replacement of HFC-based refrigeration systems by CO_2-based heat pumps			
Installation of CO_2-based integrated heat pumps for industrial processes at two plants, each with heating/cooling capacity of 300 kW and above	1,100,000	650,000	450,000
Technical assistance			
Selection, design, monitoring and follow up	30,000	30,000	-
Development of energy-efficiency guidelines	20,000	20,000	-
Final report, public edition and awareness	10,000	10,000	-
Workshops to disseminate the results of the project	10,000	10,000	-
Subtotal	*70,000*	*70,000*	-
GRAND TOTAL	**1,170,000**	**720,000**	**450,000**

Energy-efficiency improvements and preliminary estimate of electricity savings

33. UNDP calculated on an indicative basis the potential energy savings of the demonstration project based on actual information from one potential beneficiary plant. In this plant, 60 per cent of the energy consumed is related to the refrigeration processes, and the proposed heat pump would replace 27 per cent of the installed cold capacity (300 kW). The installation of a heat pump system with a COP between 5 and 7 will result in savings in electricity (refrigeration) and oil/natural gas (heating) of approximately 491,549 kWh/year per site. With an estimated average industrial electricity cost of US $0.14 per kWh, the preliminarily estimate is that the beneficiary would potentially achieve annual savings of up to US $68,817 on the electricity bill. However, these values may vary depending on the specific characteristics of the plant and final setup of the installation as well as the supplied equipment.

Sustainability, replicability and assessment of risks

34. UNDP explained that it is still early for the establishment of a standard for heat pumps in industrial processes at this stage, as the technology is being proposed and tested. In consultation with the Ministry of Energy it was decided that introducing MEPS, or equivalent measures, at this stage would disincentivize the installation of a technology that is not known in the country. However, based on the results of the demonstrations, the projects would lead to the development of energy-efficiency criteria to guide the selection of the technology for additional end users.

35. The immediate replicability of this project is expected to be high in a large number of small and medium-sized enterprises in the dairy and meat processing sectors. During the preparation of the project, consultations were conducted with associations in the dairy and meat sectors to ensure their commitment and involvement in the project. It is also expected that over time, once the energy-efficiency benefits are demonstrated, other sectors such as wineries and fisheries may also apply this technology.

36. Regarding the implementation risks identified, potential delays in beneficiary selection and in equipment procurement and installation will be mitigated by initiating the beneficiary selection process as soon as the project is approved, and by planning and coordinating the procurement processes closely with the beneficiaries in advance. To ensure the required commitment and capability of beneficiaries, the project will provide them with clear information on financial, technical and safety requirements during the selection process to allow them to plan and will closely monitor the beneficiaries' activities to provide technical assistance as required. To mitigate risks associated with local low supply of CO_2-based heat pumps, the project will divulge the implementation of the project among engineering enterprises, locally and in the region to ensure an ample offer of systems and equipment.

RECOMMENDATION

37. The Executive Committee may wish to consider approving the pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): Demonstration project for the use of R-744 (carbon dioxide) as alternative refrigerant in heat pumps applied in industrial refrigeration in Chile, in the amount of US $720,000, plus agency support costs of US $50,400 for UNDP, noting:

(a) That the Government of Chile has committed to the conditions referred to in decision 91/65(b)(iv)b. to b(iv)d.; and

(b) That the project would be operationally completed no later than 30 June 2028 and a detailed project report would be submitted to the Executive Committee within six months of the date of completion of the project.