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EXECUTIVE COMMITTEE OF
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IMPLEMENTATION OF THE MONTREAL PROTOCOL
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Montreal, 15-19 December 2023
Item 9(d) of the provisional agenda[1]

PROJECT PROPOSAL: SOUTH AFRICA

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

Energy efficiency

- Energy-efficiency strategy for the Kigali HFC implementation plan UNIDO

[1] UNEP/OzL.Pro/ExCom/93/1

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

SOUTH AFRICA

PROJECT TITLE	**BILATERAL/IMPLEMENTING AGENCY**
(a) Energy-efficiency strategy for the Kigali HFC implementation plan	UNIDO

PROJECT OBJECTIVE

The project will replace HCFC- and HFC-based chillers in large public buildings with highly efficient systems using R-290/R-600a, R-717, and HFO-1233zd(E), demonstrating the availability, applicability, and viability of low-global-warming-potential technologies for these applications; the benefits of potential reductions in both direct and indirect greenhouse-gas emissions; and the cost and energy savings on utility bills to consumers derived from the new systems' increased efficiency and improved maintenance and operating standards.

The project will also provide the know-how, data, and tools to assist the refrigeration and air-conditioning (RAC) sector stakeholders and officials in implementing the existing building regulations, and serve as a platform for developing minimum energy-efficiency performance standards (MEPS) for chillers and large-building RAC systems in line with the National Cooling Plan.

NATIONAL COORDINATING AGENCY	National ozone unit

LATEST ARTICLE 7 DATA (Annex F)	**Year:** 2022	3,618 mt	8,647,454 CO_2-eq tonnes

Particulars	Non-investment activities	
	RAC servicing	
HFC consumption in the servicing sector:	Not available (Kigali HFC implementation plan under preparation)	
Project duration:	months	36
Initial amount requested:	US $	5,130,000
Final project cost:	US $	1,120,000
Requested grant:	US $	1,120,000
Implementing agency support costs:	US $	78,400
Total cost of project to Multilateral Fund:	US $	1,198,400
Energy-efficiency savings:	kWh/year	1,730,726
Status of counterpart funding:	Y/N	Y
Project monitoring milestones included:	Y/N	Y
MEPS available for the relevant sector:	Y/N	N

SECRETARIAT'S RECOMMENDATION	Individual consideration

ENERGY-EFFICIENCY STRATEGY FOR THE KIGALI HFC IMPLEMENTATION PLAN

PROJECT DESCRIPTION

Background

1. On behalf of the Government of South Africa, UNIDO has submitted, in line with decision 91/65, a request for a pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down, in the amount of US $5,130,000, plus agency support costs of US $359,100, as originally submitted.[2]

Pilot project on energy efficiency

Policy, regulatory and institutional framework

2. The Government of South Africa ratified the Kigali Amendment on 1 August 2019. The Department of Mineral Resources and Energy is the body responsible for energy issues in the country. Its Energy White Paper (1998) provides the basis for improving energy efficiency in the country, while National Energy Act 33 (2008) *inter alia* gives authority to the Department to set minimum levels of energy efficiency in each sector of the economy; define procedures for the application of energy-efficient technologies; prescribe energy-efficiency labelling for household appliances, devices, and motor vehicles; prohibit the manufacture, import, or sales of electrical and electronic products and fuel-burning appliances with poor energy efficiency; and set energy-efficiency standards for specific technologies, processes, appliances, devices, motor vehicles, and buildings.

3. Minimum energy-efficiency performance standards (MEPS) for split air conditioners of up to 7.1 kW cooling capacity, refrigerators, and freezers came into effect in 2016 in the form of the South African National Standards (SANS), complemented by awareness-raising programmes, directives to increase compliance rates, and revisions introduced in 2020. While this programme is the most comprehensive in the region, it does not include standards for large centralized systems, chillers, or industrial equipment.

4. The Government has established several national standards to encourage energy management, including SANS 10400–XA, which sets the requirements for maximum annual demand and consumption per square meter in buildings. Although the implementation of this regulation has driven some building refurbishments, the local authorities' limited capacity and skills do not allow for its consistent implementation. The setting up of energy-efficiency standards for chillers and large air-conditioning (AC) systems, development of educational material, and raising awareness among property developers and building owners will further contribute to reducing energy consumption per square meter in buildings.

Project objective

5. The project will replace chillers in large public buildings with highly efficient systems using refrigerants with low global-warming potential (GWP), including R-290/R-600a, R-717, and HFO-1233zd(E), resulting in energy savings based on the new systems' increased efficiency, improved maintenance and operating standards, and, in some cases, use of heat recovery to offset coal consumption by on-site boilers Its main objectives include:

[2] As per the communication of 22 November 2023 from the Department of Forestry, Fisheries, and the Environment of South Africa to UNIDO.

(a) *HFC phase-down:* Demonstrate the availability and applicability of highly efficient AC systems charged with low-GWP refrigerants to replace the existing HFC-based systems, as well as their viability as alternatives to high-GWP HFCs in replacing HCFC-22-based systems;

(b) *Demand-side energy-efficiency and cost savings:* Demonstrate the potential benefits of substituting the RAC systems currently operating in buildings by systems based on low-GWP technologies, including reductions in both direct and indirect greenhouse-gas emissions, and energy and cost savings to consumers on utility bills; and

(c) *Capacity building:* Provide the know-how, data, and tools to assist the stakeholders and officials in the construction and RAC sectors in implementing the existing building regulations; and create a platform for developing MEPS for chillers and large-building RAC systems in line with the National Cooling Plan (NCP).

6. The project will result in the adoption of low-GWP technologies in large-building installations, which will be replicable across the sector, will also benefit the RAC servicing sector, and assist the Government in achieving compliance with the Kigali Amendment obligations and in the implementation of national energy-efficiency policies.

HFC consumption and sector background

7. The HFC consumption baseline for South Africa has been established at the level of 13,843,139 CO_2-equivalent (CO_2-eq) tonnes. A portion of the national consumption of HCFC-22 has already been replaced with HFC-based technologies. HCFC and HFC consumption in the country is presented in table 1.

Table 1. Consumption of HCFCs and HFCs in South Africa (2018-2022)

Substances		2018	2019	2020	2021	2022
HCFCs	metric tonnes	2,077	2,029	1,779	1,625	1,348
HFCs	metric tonnes	2,214	4,006	3,118	3,856	3,618
	CO_2-eq tonnes	5,329,096	10,074,432	8,221,905	9,164,240	8,647,454

8. The biggest demand for HFC refrigerants used in the servicing sector comes from large commercial and industrial systems with relatively high refrigerant charges. HCFC-22 is still the most common refrigerant used in the cooling systems of large public buildings in South Africa. Whereas significant amounts of HCFC-22 have been phased out by the private sector, the most adopted alternatives are high-GWP refrigerants such as HFC-134a, R-410A, and R-407C. Lower-GWP refrigerants, such as HFC-32 and R-290/R600a, have limited penetration due to safety and training concerns.

9. Buildings owned by the public sector are equipped with numerous and diverse RAC systems, many of them at or near the end of their operational life. While the public-sector servicing technicians are generally trained, they tend to have little or no information on the latest market and technology trends or opportunities to address performance-improvement issues. Given these limitations as well as budgetary constraints, a voluntary shift to the use of highly efficient low-GWP systems in public buildings is unlikely.

10. Cooling in large buildings is provided by imported chillers (2-2,400 kW), mini chillers, and small- to medium-sized chillers (below 100 kW), with energy-efficiency ratio and coefficient of performance ranges of 2.68-5.93 and 3.07-3.38, respectively.

11. Cooling electricity represents 31 per cent of all electricity consumed by buildings and 16 per cent of total electricity consumption. In the commercial sector, cooling electricity represents 26 per cent of total

use and has not been regulated to date. The implementation of standards for large AC installations is expected to result in significant reductions of carbon dioxide (CO_2) emissions linked to energy savings.

HFC consumption by end users

12. Several installations have been selected for baseline assessment. Site visits and initial technical assessment have revealed that system performance data and technical parameters are generally not well understood or recorded, indicating an aspect that should be addressed by the proposed project. The installations' current performance in terms of capacity, efficiency, and operating parameters has been estimated based on the limited information available and system inspections carried out in preparation for this project.

13. Most of the assessed chiller systems have been found to be inefficient, whether because of their age, limited availability of spare parts, or inadequate monitoring of the equipment and processes. Common issues to be addressed include inexistent record-keeping procedures for energy efficiency and leakages, no log-book system, and repairs done by estimation.

14. A conservative estimate indicates that a 30 per cent increase in energy efficiency could be achieved by adopting a combination of replacing the systems with highly efficient ones based on low-GWP refrigerants and adopting operational improvements. The application of heat pumps could also have a positive effect where hot-water systems are used in the same location as cooling systems, due to the poor efficiency of the existing steam boilers.

15. The following sites have been selected for the implementation of the project:

(a) Chris Hani Baragwanath (CHB) Hospital in Johannesburg: with 3,400 beds and 6,760 staff, this establishment is representative of the 400 public hospitals in the country. Its RAC systems include chillers, split AC units, and refrigerators charged with HCFC-22, R-410A, R-407C, HFC-134a, R-404A, and R-507A;

(b) International Convention Centre (ICC) in Durban: the facility is served by three HCFC-22-based chillers, each with a capacity of 1,900 kW and refrigerant charge of 500-600 kg; the chillers were all installed in 1997 and are in need of replacing, most likely with R-410A-based systems, as an order has already been placed for an R-410A chiller in another building;

(c) Military Hospital in Pretoria: there are around 50 split AC units, four HCFC-22-based chillers, and one R-410A-based variant-refrigerant-volume system serving the building's needs. The chillers, each with a charge of 370 kg, were installed in 1995 to serve four operating theatres and need replacing;

(d) Military Dental Clinic in Pretoria: the building is exclusively cooled by split AC units, some also operating as heat pumps; the clinic's laboratory ventilation system has never worked properly; and

(e) South African Air Force (SAAF) Headquarters in Pretoria: the building disposes of six rooftop chillers and three chillers for cooling the bunker, including IT equipment. The HCFC-22 charge for each chiller is 40-60 kg, with an estimated capacity of 100 kW/year. The three bunker chillers are currently not operational, as they are old, in poor condition, and await replacement, likely with R-410A-based systems.

Technology

16. The chillers at selected sites will be replaced with highly efficient R-290/R-600a chillers and heat pumps to make use of the efficiency benefits of heating mode in winter months. One project will demonstrate the use of R-717 in combination with a separate steam-generating heat pump using HFO-1233zd(E).

Proposed activities

17. The focus of this project is on large public buildings, which form a significant proportion of the national building-cooling load. The RAC systems to be replaced are characterized with generally low efficiency and insufficient technical capacity in the areas of performance and energy management. As they are highly representative of similar installations across South Africa, the replicability potential of replacement technologies is significant. The activities proposed for this project include:

(a) Performance evaluation of the existing systems over at least six months of operation;

(b) Design of specifications and installation of new systems;

(c) Installation of monitoring equipment;

(d) Performance evaluation of the new systems over at least six months of operation;

(e) Preparation of technical evaluation reports and case studies; and

(f) Training of 20 public-sector servicing technicians.

18. The project will further demonstrate the use of the monitoring and evaluation technology, both applied to the existing systems to establish a baseline situation performance and built into the new units, as well as methods of volume flow monitoring (cold water) for an accurate determination of cooling loads and energy consumption. This element of the project is critical to establishing a methodology for assessing other installations and for the replicability of demonstration systems.

Chiller replacements

19. The project includes the replacement of 19 chillers in seven locations, as described below. Detailed information on the baseline situation and expected impact of the replacement of chillers at these sites is presented in annex I to the present document:

(a) CHB Hospital (two sites): Replacement of four HCFC-22-based rooftop chillers of 231 kW capacity and heat recovery for hot water (100 kW) by R-290-based chillers with heat-pump mode and heat-recovery facilities, generating an estimated 30 per cent of energy savings (US $700,000); and replacement of one HCFC-22-based and one R-404A-based operating theatre chillers by R-290-based chillers, generating an estimated 30 per cent of energy savings (US $360,000);

(b) ICC (one site): Replacement of three chillers at 1,900 kW nominal capacity by a large R-290-based system, generating estimated energy savings of 30 per cent (US $2,020,000);

(c) Military Hospital (one site): Replacement of four HCFC-22 chillers by four cold-water chillers, and replacement of a coal-fired boiler used for steam requirements by a high-pressure heat pump charged with R-717 or HFO-1233zd(E), generating estimated energy savings of 30 per cent (US $820,000);

(d) Military Dental Clinic (one site): Replacement of several split AC units by one cold-water chiller, generating an estimated 30 per cent of energy savings (US $245,000); and

(e) SAAF (two sites): Replacement of six HCFC-22 chillers at the headquarters' location with two new chillers, generating an estimated 35 per cent of energy savings (US $360,000); and replacement of three bunker chillers by units that could potentially be configured for heat-pump operation and heat recovery, generating an estimated 30 per cent of energy savings (US $535,000).

Performance monitoring

20. The performance-monitoring component (US $10,000 per chiller) includes real-time monitoring of the replaced chillers by collecting data to assist in the daily, monthly, and yearly analysis of the chillers' efficiency. The parameters measured include evaporation temperature; condensing temperature; ambient temperature; room temperature; water temperatures (water loop in/out); operation of electronic expansion valves; operation of compressor; volume flow/temperature of cold water calculated in kWh of refrigeration; energy consumption (chiller, pump); water consumption (evaporative condensers); difference of temperature for heat exchangers; load percentage; and efficiency. The system will also feature alarms for refrigerant loss, failure of components, or temperature variations.

Evaluation and reporting

21. The evaluation and reporting component (US $10,000 per site) consists of reports to be produced after project implementation, indicating whether the systems were correctly installed and documented in line with the contract (components, schematics, pressure tests), and whether the installations met the main parameters defined in the contract (i.e., pressure drop, heat recovery, temperatures) and were running efficiently compared to the previous systems, while also identifying any safety issues encountered (e.g., in the assessments of sensors, ventilation, and alarms).

Training

22. Training for 20 public-sector servicing technicians and maintenance managers (US $80,000) will focus on proper performance monitoring and collection of relevant data on the energy-efficiency project, as well as servicing R-290-based applications with more than 500 g of refrigerant charge.

Total cost of the pilot project

23. The project will be implemented over 36 months. Table 2 provides a breakdown of the project costs for each of the activities and related components at each of the seven locations.

Table 2. Cost breakdown of replacing 19 chillers at seven locations in South Africa (US $)

Particulars	**CHB Hospital**		**ICC**	**Military Hospital**	**Military Dental Clinic**	**SAAF**	
	rooftop	**operating theatre**				**HQ building**	**bunker**
Baseline technology	HCFC-22	HCFC-22/ R-404A	HCFC-22	HCFC-22	HCFC-22	HCFC-22	HCFC-22
Replacement technology	R-290 HP	R-290 chiller	R-290 chiller	R-717 R-1233zd(E)	R-290 HP	R-290 HP	R-290 HP
No. of replacement units	4	2	3	4	1	2	3
Unit cost	150,000	150,000	600,000	150,000	150,000	150,000	150,000
Total equipment cost	600,000	300,000	1,800,000	700,000	200,000	300,000	450,000
Design (10%)	60,000	30,000	180,000	70,000	20,000	30,000	45,000

Particulars	CHB Hospital		ICC	Military Hospital	Military Dental Clinic	SAAF	
	rooftop	operating theatre				HQ building	bunker
Performance monitoring	40,000	20,000	30,000	40,000	15,000	20,000	30,000
Evaluation and reporting	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Total cost (US $)	**710,000**	**360,000**	**2,020,000**	**820,000**	**245,000**	**360,000**	**535,000**
Training							80,000
Grand total (US $)							**5,130,000**

*HP = heat pump

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

Institutional coordination and development of minimum energy performance standards

24. UNIDO confirmed that representatives of the Department of Mineral Resources and Energy would be involved with the national ozone unit (NOU) during the implementation of the project. Their collaboration is considered critical by the Government given their roles in developing South Africa's NCP and the Kigali HFC implementation plan (KIP). The project will serve as a platform for developing energy-efficiency performance standards for chillers and large-building cooling systems, in line with the NCP. One of the challenges in developing MEPS for South Africa is the requirement that systems are efficient in different climates. Parameters such as ambient temperatures, humidity, or running hours in South Africa are different than those set out in the existing MEPS, such as the ECO Design directive of the European Union. Demonstrating chiller applications in different climate zones, including the appropriate monitoring of the systems, will provide information on these parameters to help develop MEPS for large AC systems in South Africa.

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

25. Noting that most chillers included in the demonstration were based on HCFC-22 rather than HFCs, the Secretariat raised a concern about the role of this project in the context of HFC phase-down. UNIDO explained that the outcomes of this pilot project would be instrumental in informing South Africa's KIP, which was currently under development and expected to be submitted in 2024. The pilot aims to demonstrate a shift to low-GWP refrigerants without going through transitional HFCs, a key strategy for the KIPs. The demonstrations will help curb the growth of banks of installed HFCs and future consumption in servicing by influencing building owners to transition to low-GWP technologies when replacing both HCFC- and HFC-based equipment. This is particularly important in the case of chillers, which generally remain in operation for more than 20 years. The project will also facilitate case studies and capacity building for technicians and building owners, aiding the transition outlined in the KIP. The Secretariat considers that in the context of South Africa, given the significant number of HCFC-22-based chillers going out of circulation, the demonstration of low-GWP alternatives will contribute to avoiding the installation of new HFC-based chillers and related future consumption in servicing.

Technical and cost-related issues

Scope of the proposal

26. As submitted, the project proposes to replace 19 chillers at seven sites at a cost of US $5,130,000. All sites except for one are currently using HCFCs rather than HFCs, with several sub-projects aiming to demonstrate the replacement of similar types of equipment. UNIDO explained that because the project was

designed to demonstrate the adoption of low-GWP technologies in a variety of conditions and climates, it was difficult to select only a few demonstrations. However, taking into consideration the available implementation time frame and the pilot nature of projects under decision 91/65, the Secretariat discussed possible approaches to selecting a representative pilot sample of chillers, from which sufficient information could be obtained to help develop MEPS and showcase energy savings to other users.

27. The final selection of demonstration projects was based on a combination of parameters, including potential energy-efficiency savings and the overall cost-effectiveness of introducing systems based on low-GWP refrigerants; impact on HFC phase-down; end-user readiness to undertake the investment and provide co-financing; confirmation that baseline equipment was fully operational and that its replacement would generate energy savings; overall reduction of emissions in CO_2-eq tonnes; and the potential for and ease of replicability. Upon discussion, UNIDO agreed to maintain the replacement of one chiller using R-404A and one using HCFC-22 at the CHB Hospital in Johannesburg, and the replacement of three chillers at the ICC in Durban, as follows:

(a) CHB Hospital (hospital site): The project will fund one of the four proposed chiller replacements, including heat recovery for hot water (currently provided by coal-fired steam boilers). This project will generate one of the largest energy savings in kW/h coming from cooling and heat recovery, is more cost-effective than other replacements, and has high potential for replicability in other hospitals;

(b) CHB Hospital (operating theatre site): Out of the two chillers proposed for replacement, the project will fund the one using R-404A. This project aims to demonstrate the use of R-290 chillers in difficult operating conditions, as the chillers being replaced are locked in by walls and have poor ventilation, a situation that is not uncommon in other buildings. This project could also be replicable in other hospitals with HFC-based chillers; and

(c) ICC Durban: This site will be maintained because of the project's cost effectiveness and impact on energy savings. Noting that the ICC is ready to replace its chillers (with plans to adopt R-410A-based technology) and provide co-funding, the project will only fund one-third of the funds required for complete replacement. This funding level is equivalent to the cost difference of replacing three chillers based on R-290 rather than with R-410A technology, or the cost of replacing one of the three chillers.

Technology

28. The only applications charged with R-290 that are currently built in South Africa are small condensing units for supermarkets. UNIDO confirmed that R-290 chillers could be imported and that suppliers were available.

Performance monitoring

29. Noting that the efficiency of baseline chillers was not being currently monitored, the Secretariat requested more information from UNIDO on how it would ensure that the project's impact on energy-efficiency gains was properly measured. UNIDO explained that it was possible to monitor energy consumption by metering the main technically possible parameters and performing calculations on that basis. The time frame for measurement would encompass at least six months, from the moment the project starts until the delivery and installation of the new chillers. The metering and monitoring would be done by external experts, while the requirement profile for metering would be completed by UNIDO in cooperation with the NOU and bodies responsible for the development of relevant MEPS.

Agreed cost of the pilot project

30. The project's budget was adjusted based on the prioritization of chillers to be included. The most significant adjustment relates to the reduced number of demonstration replacements, from 19 chillers at seven sites to three chillers at three sites. The cost requested for training was also adjusted from US $80,000 to US $50,000. The total revised cost of the proposal is US $1,120,000. Table 3 presents the revised cost calculation and an estimation of energy-efficiency savings provided by UNIDO.

Table 3. Agreed cost for the pilot project and estimated energy savings (US $)

Particulars	**CHB Hospital**		**ICC**	**Total**
	rooftop	**operating theatre**		
Baseline technology	HCFC-22	R-404A	HCFC-22	
Replacement technology	R-290 heat pump	R-290 chiller	R-290 chiller	
Number of chillers	1	1	1*	3
Unit cost	150,000	150,000	600,000	900,000
Total equipment	150,000	150,000	600,000	900,000
Design (10%)	15,000	15,000	60,000	90,000
Performance monitoring	10,000	10,000	30,000	50,000
Evaluation and reporting	10,000	10,000	10,000	30,000
Total cost per site	**185,000**	**185,000**	**700,000**	**1,070,000**
Training				50,000
Total (US $)				**1,120,000**
Energy-efficiency impact				
Energy savings in cooling (kWh/year)	86,349	86,349	713,314	886,012
Energy savings in heat (kWh/year)	844,714	-	-	844,714
Total savings (kWh/year)	931,063	86,349	713,314	1,730,726

*The conversion at the ICC includes three chillers; the project will fund one-third of the cost (equivalent to one chiller) and the beneficiary will co-fund the remaining cost.

31. The Secretariat notes that, in the absence of the cost guidelines for HFC phase-down or projects related to energy efficiency, this proposal has been reviewed on a case-by-case basis, considering the available information on activities undertaken at other end users of large AC systems, and acknowledging a degree of uncertainty regarding the costs of replacing chillers varying in size, capacity, and other features. Based on the information received at the time of review, the Secretariat considers that the agreed costs are the best available estimate, noting that they might change as more information becomes available. The Secretariat considers that approval of the project at the levels proposed above would not constitute a precedent.

Sustainability and replicability

32. In line with decision 91/65(b)(v), UNIDO confirmed that the results of the demonstration project would be broadly promoted in South Africa and the region to encourage replication. The dissemination strategy will include case studies detailing the technical and economic benefits achieved at each site, and the subsequent dissemination of their results through workshops, industry associations, conferences, and media; leveraging the visibility of sites such as the ICC in Durban to showcase the project's outcomes to policy makers and prospective end users; training technicians from other hospitals, commercial buildings and industry on the installation, operation and maintenance of lower-GWP chillers; supporting the local manufacturing and availability of chillers, components, and servicing tools based on alternative refrigerants, to facilitate adoption; using the data and experience gained from the project to inform the development of energy-efficiency standards and labels for chillers, to drive the adoption of lower-GWP alternatives; advocating for the incorporation of lower-GWP alternatives into national standards and procurement policies based on the project's results; and exploring performance-based incentives such as rebates and tax benefits for end users for converting to energy-efficient chillers using low-GWP technologies.

33. Based on the previous experience with chiller replacements implemented under the Multilateral Fund, the Secretariat notes that the project can generate savings on electricity bills for the end user. UNIDO confirmed that significant energy and cost savings expected from the technology transition would be an important factor driving replication. The comprehensive monitoring system proposed in the project will quantify the actual savings so they can be demonstrated to other building owners.

Other requirements under decision 91/65

34. Confirmation has been received that, if the Government of South Africa had mobilized or 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; that the information on project progress, results and key learning would be made available, as appropriate; that the date of completion of the project would be set at no more than 36 months after the date of approval by the Executive Committee; and that a detailed project report would be submitted to the Executive Committee within six months of the date of completion of the project.

RECOMMENDATION

35. 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 for South Africa, in the amount of US $1,120,000, plus agency support costs of US $78,400, for UNIDO, noting:

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

(b) That the project will be operationally completed no later than December 2026, and a detailed project report will be submitted to the Executive Committee within six months of the date of completion of the project.

Annex I

ANALYSIS OF THE BASELINE SITUATION AND EXPECTED PROJECT IMPACT AND COST AS SUBMITTED

Particulars	CHB		ICC	Military Hospital	Military Dental Clinic	SAAF	
	Rooftop	Operating theatre				Building	Bunker
Replacement technology	R-290 HP	R-290	R-290	R-717 HFO	R-290 HP	R-290 HP	R-290 HP
Total cost (US $)	710,000	360,000	2,020,000	820,000	245,000	360,000	535,000
Energy savings – cooling							
Coefficient of performance	2.8	2.8	2.8	2.8	2.8	2.8	2.8
kW per unit	230	230	1,900	500	200	300	250
Cooling duty (kW)	552	276	3,420	1,200	120	360	450
Space heat duty (kW)	600			600		300	
Hot water duty (kW)	100			100		100	
Steam duty (kW)				100			
Cooling energy (kWh/year)	1,151,314	575,657	7,133,143	2,502,857	250,286	750,857	938,571
Estimated savings (%)	30	30	30	30	30	30	30
Savings - cooling (kWh/year)	**345,394**	**172,697**	**2,139,943**	**750,857**	**75,086**	**225,257**	**281,571**
US $/kWh	2.06	2.08	0.94	1.09	3.26	1.60	1.90
Energy savings – heat recovery							
Space heat energy (kWh/year)	1,752,000			1,752,000		876,000	
Hot water energy (kWh/year)	876,000			876,000		876,000	
Steam energy (kWh/year)				876,000			
Total heat energy (kWh/year)	*2,628,000*			*3,504,000*		*1,752,000*	
Equivalent energy with heat pump (kWh/year)	938,571			1,251,429		625,714	
Savings - heat (kWh/year)	**1,689,429**			**2,252,571**		**1,126,286**	
Overall cost-effectiveness and replicability							
Savings – cooling (kWh/year)	345,394	172,697	2,139,943	750,857	75,086	225,257	281,571
Savings – heat (kWh/year)	1,689,429			2,252,571		1,126,286	
Total savings (kWh/year)	**2,034,823**	**172,697**	**2,139,943**	**3,003,429**	**75,086**	**1,351,543**	**281,571**
US $/kWh	0.35	2.08	0.94	0.27	3.26	0.27	1.90
Replicability	Over 400 public hospitals	Over 400 public hospitals	Large public buildings	Moderate, similar facilities	Buildings with split AC units	Similar public buildings	Similar public buildings
Estimated replicability factor	350	350	30	20	400	100	100
Total energy savings at 40% take-up (MWh/year)	284,875.2	24,177.6	25,679.3	24,027.4	12,013.7	54,061.7	11,262.8
CO_2 emission reductions at 0.84 kg/kWh (CO_2-eq kilotonnes)	239.3	20.31	21.57	20.18	10.09	45.41	9.46
Refrigerant charge replaced (kg)	500	250	2,500	1,480	100	100	350
Equivalent phase-out/ HFC avoidance tonnes (40% take-up)	70	35	30	12	16	4	14