Validated Terminal Review of the UNEP-GEF Project "SolarChill Development, Testing, and Technology Transfer Outreach" (GEF ID 4682)

2016 – 2021

UNEP Industry and Economy Division

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For further information on this report, please contact:

Cicilia Magare
Senior Programme Management Assistant
GEF Climate Change Mitigation Unit
Industry and Economy Division

United Nations Environment Program
UN Avenue, Gigiri, Nairobi
P. O. Box 30552 - 00200
Telephone: +254 20 7625118
Cicilia.magare@un.org
www.unep.org

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SOLARCHILL DEVELOPMENT, TESTING, AND TECHNOLOGY TRANSFER OUTREACH
GEF ID 4682
14/11/2023

ACKNOWLEDGEMENTS

This Terminal Review was prepared for the UNEP Climate Change Mitigation Unit, Industry and Economy Division by Antoine Azar, a sustainability and energy efficiency professional based in Belgium, as the Lead Consultant.

The reviewer would like to express his gratitude to all persons met and who contributed to this review, as listed in Annex II.

There are a great number of people to mention by name and everyone who contributed has been included in the list of stakeholders interviewed in Annex II but the evaluators would like to mention specially the support received from Nancy Finger, Dietram Oppelt, Dr. Simon A. Mischel, Ramona Nosbers, Rebekka Oelze, Elizabeth Kudakwashe, Peter Chawira, Carlos Ferney Lopez, and Rafael Rivera (HEAT GmbH), and, Dr. Sanjay K. Gupta (SKAT), Nika Greger and Nils Hansen (GIZ), Ivan Katic (DTI) and Janos Maté (Greenpeace International) for their contribution and collaboration throughout the Review process. Sincere appreciation is also expressed to the whole steering committee (SKAT, DTI, HEAT, WHO, UNICEF, GIZ, UNEP) who took time to provide comments to the draft report. The reviewer would also like to thank the Governments and the involved Ministries of Kenya, eSwatini and Colombia.

Special acknowledgements to the Senior Programme Management Assistant Cicilia Magare, UN Environment Programme, for her support and guidance!

The review consultant hopes that the findings, conclusions, and recommendations will contribute to the successful formulation of new projects.

BRIEF CONSULTANT BIOGRAPHY

Antoine Azar graduated from Liège University in Belgium, with a master's degree in Energy Engineering.

He worked 16 years at The Coca-Cola Company, last position as Global Program Director in the field of refrigeration and energy efficiency.

Since January 2017, Antoine is managing his Engineering and Training Services Bureau, for areas including cooling/refrigeration, energy management, MEPS and labels, supply chain and cost optimization.

Before that, Antoine performed in a variety of roles, including engineering, design and innovation, Quality Control, and telecommunication.

Reviewer

Antoine Azar

ABOUT THE REVIEW

Joint Review: No

Report Language(s): English.

Review Type: Terminal Review

Brief Description: This report is a Terminal Review of a UNEP/GEF project implemented between 2016 and 2022. The project's overall goal is to develop, transfer and commercialize a refrigerator for the sustainable, environment friendly and grid-independent cooling of vaccines (SolarChill A) and food (SolarChill B). The SolarChill Technology was launched in 2001, to develop and deliver affordable, technically reliable, ozone layer and climate friendly, solar powered and lead acid battery free refrigeration technology. Two applications will use the SolarChill technology, in vaccine coolers (SolarChill A) and in light commercial and household coolers (SolarChill B). The project installed and field tested a total of 113 SC-A and 45 SC-B in Colombia, Kenya and eSwatini. The review sought to assess project performance (in terms of relevance, effectiveness and efficiency), and determine outcomes and impacts (actual and potential) stemming from the project, including their sustainability. The review has two primary purposes: (i) to provide evidence of results to meet accountability requirements, and (ii) to promote learning, feedback, and knowledge sharing through results and lessons learned among UNEP, the GEF, and the relevant agencies of the project participating countries.

Key words: SolarChill technology, Vaccine cooler, Mid-Term Review, GEF, SKAT, HEAT, UN Environment Programme, WHO, UNICEF, technology transfer, Sustainability, commercial cooler, domestic refrigerator, environment friendly, greenhouse gas, hydrocarbon refrigerant, Mobisol, Remote areas, Power/electricity grid, Colombia, Kenya, eSwatini.

Primary data collection period: September 2022 – July 2023

Field mission dates: 05-09 December 2022 to Colombia and 13-17 February 2023, to eSwatini.

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LIST OF ACRONYMS

MTR	Mid Term Review
UNEP	United Nations Environment Programme
GEF	Global Environment Facility
UNICEF	United Nation International Children's Emergency Fund
WHO	World Health Organization
MOHK	Ministry of Health, Kenya
MOHSP	Ministry of Health and Social Protection, Colombia
MOEC	Ministry Of Environment of Colombia
MCIT	Ministry of Commerce, Industry and Trade, eSwatini
MNRE	Ministry of Natural Resources & Energy, Kingdom of eSwatini
MOHE	Ministry of Health of eSwatini
MOI	Ministry Of Industry (in general)
SKAT	Schweizerische Kontaktstelle für Angepasste Technik, meaning Swiss Centre for Appropriate Technology
HEAT	Habitat, Energy Application & Technology
GIZ	Gesellschaft für International Zusammenarbeit (German International Cooperation)
DTI	Danish Technological Institute
CHAK	Christian Health Association of Kenya
SELF	Solar Electric Light Fund
PATH	Program of Appropriate Technology in Health
IEA	International Environmental Agency
GAVI	Vaccine alliance
Global LEAP	Global Lighting and Energy Access Partnership
RFQ	Request For Quotation
TCO	Total Cost of Ownership
SDD	Solar Direct Drive
SC-A	SolarChill-A: SolarChill technology for vaccine refrigerators
SC-B	SolarChill-B: SolarChill technology for small commercial and household refrigerators
OEM	Original Equipment Manufacturer
SELF	Solar Electric Light Fund

PROJECT IDENTIFICATION TABLE

Table 1 below contains the Project Identification table with the key parameters of the project. It was taken from the ToR for this review.

Table 1: Project Identification.

UNEP Sub-programme:	Climate Change	UNEP Division/Branch:	Industry and Economy
Expected Accomplishment(s):	Medium-Term Strategy (MTS) 2022-2025: Outcome 1A Decision makers at all levels adopt decarbonisation, de-materialization and resilience pathways; and to Outcome 1B Countries and stakeholders have increased capacity, finance and access to technologies to deliver on the adaptation and mitigation goals	Biennium 2020–2021 Subprogramme 1 Climate change (i) Countries increasingly adopt and/or implement low greenhouse gas emission development strategies and invest in clean technologies (ii) Increase in climate finance invested by countries or institutions for clean energy, energy efficiency and/or amount of decarbonized assets	
SDG(s) and indicator(s)	SDG2: Zero Hunger. SDG3: Good health and wellbeing. SDG 7: Ensure access to affordable, reliable, sustainable, and modern energy for all. 7.2 By 2030, increase the share of renewable energy in the global energy mix. 7.2.1 Renewable energy share in the total final energy consumption.		
GEF Core Indicator Targets	The SolarChill project was approved in the GEF V cycle which did not include such indicators for projects		
Dates of previous project phases:	N/A	Status of future project phases:	N/A

Project Title:	SolarChill Development, Testing, and Technology Transfer Outreach

Executing Agency:	SKAT Foundation

Project partners:	HEAT, Danish Technology Institute, Greenpeace International, UNICEF, GIZ, Technische Universität of Dresden, WHO

Geographical Scope:	Global

Participating Countries:	Colombia, Kenya and eSwatini

GEF project ID:	4682	Umoja number*[1]:	P1-33GFL-000949
Focal Area(s):	Climate Change Mitigation	GEF OP #:	
GEF Strategic Priority/Objective:	Climate Change Mitigation: Promote the demonstration, deployment, and transfer of innovative low-carbon technologies	GEF approval date*:	February 20, 2014
UNEP approval date:	03 June 2016	Date of first disbursement*:	27 June 2016
Actual start date[2]:	03 June 2016	Planned duration:	30 months
Intended completion date*:	31 December 2018	Actual or Expected completion date:	30 September 2021
Project Type:	Full-Size Project (FSP)	GEF Allocation*:	2,712,150
PPG GEF cost*:	N/A	PPG co-financing*:	$ 131,529
Expected MSP/FSP	8,033,500	Total Cost*:	10,745,650

[1] Fields with an * sign have been filled by the Fund Management Officer.

[2] Only if different from first disbursement date, e.g., in cases were a long time elapsed between first disbursement and recruitment of project manager.

Co-financing*:			
Mid-term Review/eval. (Planned date):	October 2017	Terminal Review (planned date):	December 2018
Mid-term Review/eval. (Actual date):	October 2018	No. of revisions*:	3
Date of last Steering Committee meeting:	September 2021	Date of last Revision*:	2 February 2021
Disbursement as of 30 September 2021	2,589,221.98.	Date of planned financial closure*:	31 July 2023
Date of planned completion*:	30 September 2021	Actual expenditures reported as of 30 September 2021:	2,642,692
Total co-financing realized as of 15 March 2023:	5,654,219 (in-kind)	Actual expenditures entered in Umoja as of 31 December 2021	2,667,360

The project was extended three times.

Table 2: Overview of project extensions.

Duration	**Implementation end date**	**Months**	**PCA signed on**
Planned Implementation end date	Dec-18	30	
Extensions			
Revision 1	Dec-19	12	24-01-19
Revision 2	Jan-21	13	17-01-20
Revision 3	Sep-21	8	02--02--21

I. EXECUTIVE SUMMARY

Project background

1. Refrigeration is a key element in the cold chain for food, medicine, and vaccines preservation. Lack of relevant cooling systems results in extensive food, medicine, and vaccines spoilage. SolarChill project address such lack of needed refrigeration equipment. It also addresses adaptation to climate change particular in vulnerable and impaired off-grid regions in developing countries.
2. In regions of the world without reliable electrical grid (impacting over 1 billion people), preservation of temperature-sensitive vaccines, medicines and food is problematic. In such regions and until recently, fossil fuel operated units are mainly used. These refrigerators are inexpensive but present a number of problems related to operating costs, effectiveness in maintaining appropriate temperatures, fuel supply, flammability, environmental impact through greenhouse gas emissions and the emission of toxic fumes that are dangerous to humans in enclosed spaces.
3. In addition, most of current solar vaccine refrigerators rely on lead acid batteries to store energy. These batteries break down frequently, especially in hot climates. Batteries are also vulnerable to theft and pose an environmental hazard upon disposal. Hence, the SolarChill Direct Drive (no battery, no fuel needed) technology combined with a refrigeration system using an environment friendly natural refrigerant seems to be the most appropriate technical solution for such applications.
4. The SolarChill project was launched back in 2001, to develop and deliver affordable, technically reliable, ozone layer and climate friendly, solar powered and lead acid battery free refrigeration technology. It uses solar power to run a direct current (DC) hydrocarbon-based refrigerator compressor. Hydrocarbons (isobutane R600a), used as refrigerants, are safe for the ozone layer and for the climate. The energy efficient refrigeration system freezes an ice bank in the SolarChill (SC) cabinet. Solar energy is thus stored in an “ice battery”. An electronic thermostat maintains the units at the required temperatures. The required temperature range for vaccines is between 2 and 8 degrees Centigrade, day and night. The optimum temperature range for perishable food storage is 3 to 5 °C.
5. In low-sun situations, or with power completely disrupted, the ice bank combined with the thick insulation of the cabinet maintains acceptable temperatures for up to 5 days. The thickness of the insulation varies according to the ambient temperature for which the specific SolarChill units are designed.
6. This technology is a reliable and sustainable solution to meeting refrigeration needs. It is an environment friendly approach to supporting the delivery of health care and food security to low-income populations in difficult access remote areas.
7. The field test covered two types of SolarChill applications:
    - SolarChill-A (SC-A) vaccine cooler, for temperature-sensitive vaccines and medicines

- SolarChill-B (SC-B) for food preservation for domestic and small commercial applications

8. The SolarChill consortium/partners include the Danish Technological Institute (DTI); Gesellschaft für International Zusammenarbeit (German International Cooperation, GIZ); Greenpeace International; Programs for Appropriate Technologies in Health (PATH); Habitat, Energy Application & Technology (HEAT); SKAT Foundation; UN Environment Programme; United Nations Children's Fund (UNICEF); World Health Organization (WHO); with consultation by SELF.
9. The review identifies lessons of operational relevance for future project formulation and implementation (especially for the remainder of this project).
10. The project succeeds in identifying multiple off-grid installation sites, training local facilities, installing the units, having remote monitoring of a statistically relevant number of units, over period of a full year, providing feedback to manufacturers. The SolarChill-A and B field tests were conducted in Colombia, Kenya, and the Kingdom of eSwatini. During the Project Preparation Phase (2012/2013) the field test sites (health centers) for SolarChill-A were pre-selected by the Ministry of Health (MOH) of each country, in coordination with HEAT, with the purpose of covering a wide range of climatic conditions. The project has collected data for more than a full year of operation from about 55 sites plus additional data for some locations.
11. According to the IEA, in 2010, the total demand (SC-A and SC-B) is estimated to grow from currently some 30,000 units in all three countries to over 1.5 million units in 2050 (with over 90% of the demand coming from Kenya).
12. SolarChill-A units to be field tested require having WHO PQS (Performance, Quality, Safety) Certification). These performance requirements are to ensure a level of quality for refrigerators that are used to store temperature-sensitive vaccines and medicines. SolarChill-B units to be field tested will first be tested at the Danish Technological Institute (DTI) laboratory before field deployment.
13. The selected SolarChill-A suppliers include Vestfrost, Godrej & Boice, B-Medical, Haier and Zero Appliances. The Ministry of Health of each country was involved in the selection of the models that were field tested.
14. Each SolarChill unit was delivered with solar panels, mounting rails, needed cables and accessories. Data logging systems were shipped separately by DTI and were mounted by HEAT's country managers at the field test sites.
15. The intention of the GEF SolarChill Project was to stimulate the global market uptake of the SolarChill direct drive technology, especially in off-grid areas, in both the health and food security applications. The Project also intended to provide transparent field test data, which would be widely referenced and used for outreach activities and

technology transfer. Further, these results were be used to provide valuable feedback to SolarChill manufacturers for design improvement.

16. Clearly, the set objectives were:

    1. Procure and install (for field test) a total of 200 SolarChill-A units in three countries (about 66 in each), namely Colombia, Kenya and eSwatini. Field test to run for 12 months.
    2. Laboratory testing of prototypes, procurement, and field testing of a total of 45 SolarChill-B units in the above three countries (15 in each country).
    3. Information dissemination (e.g., marketing campaign, increased awareness, etc.) and technology transfer.

17. With regard to the above objectives, and from the available field information that have been collected in the three countries, the SolarChill project did not meet the original ending date planned for December 2018, but the project was extended until September 2021.

18. Key factors influencing the above-mentioned delays varies by country. They are principally linked to logistics (shipping and in-land transport – Kenya and Colombia), missing parts (Colombia and eSwatini), custom clearance and import duties (Kenya and Colombia), technical trainings that had to be provided first (eSwatini and Kenya), access to test sites (eSwatini and Colombia), low installation rate, length of the field test, miscommunication due to language barriers (mainly in Colombia), Covid-19 pandemic, etc.

19. The important objective of technology transfer could have been met in eSwatini through sufficient financial and technical support and ongoing SolarChill technology development work with the local refrigerator manufacturer, The Fridge Factory (formerly Palfridge). In Colombia, Interhospitalaria developed SC-A unit and Fricon and Martinkas built SC-B prototypes, but commercial production was stopped due to the COVID pandemic Interruptions, frequent power supply issues and high price of main components (e.g., DC compressor, PV panels, etc.). In Kenya, no technology transfer work was undertaken due to the lack of a manufacturer.

20. Requests for Quotations (RFQs) for SC-A were raised by Skat-HEAT for the procurement of SC-A. All units were negotiated and procured by the UNICEF. Ministry of Health (MoH) in Colombia and in eSwatini financed the import duties, taxes and the cost of warehousing and transportation to the test sites. In Kenya, was an issue where the government refused to bear these costs. After the government declined to agree on the custom exemption, it had earlier agreed to, the project partners decided to alter the choice of brands and number of units to be supplied to cover custom and excise duties. For Eswatini and Colombia, the countries contributed co-finance to clear the importation, transportation, and installation of the units.

21. The project did not fully deliver on the planned output in component 1. In Colombia, 37 SC-A units were field tested, 36 in Kenya and 40 in eSwatini. Relevant to note that there was significant time lapse from the initial design of project and start of execution and during this period, prices had increased which the budget could not accommodate to procure 200 units. Thus, the alternative was to have Palfridge meet

the difference. Hence, it was planned that Palfridge passes the WHO PQS with its SC-A unit and that 70 of those units could then be tested in the field, but this did not happen. Thus, a total of 113 SC-A refrigerators were installed and tested from 5 different manufacturers and 55 were monitored. Although the expected numbers have not been met, the project demonstrated and made a cross-comparison of currently available SolarChill-A products under field conditions and shows that they are safe vaccine storage solutions. One major problem was that the supplier of Nexleaf data loggers could not deliver to the agreed time and quality, this reduced the number of monitored units in Colombia. On many sites connectivity was too poor for data transfer despite a thorough site selection procedure.

22. 39 SC-B refrigerators from 3 different manufacturers (Palfridge, Vestfrost, and Leff) were installed and 28 were monitored. A fourth appliance (from Defy) was also tested but, according to DTI, and from the current lab test results, it won't qualify for the project.

A. Conclusions

Project objectives and incremental values achieved.

23. The project has partly delivered on field testing of solar-powered vaccine coolers without batteries (SC-A). From the 200 SC-A planned, 113 were installed and 65 provided data and confidential feedback to manufacturers of these products, or 33% of the planned number.

24. The project, with SolarChill-B, did not deliver fully on the planned field testing of solar-powered coolers without batteries for household and commercial applications. 40 of the planned 45 were installed (89%). Of these, only for one location, temperature measurement data have been reported.

25. The technology transfer package towards manufactures produced a detailed report as an output, and as an outcome: knowledge transfer to manufacturers in eSwatini and Colombia.

26. The review has been structured around strategic questions on the achievement of the project objectives:

27. **Q1:** What alternative approaches have been implemented to ensure Palfridge succeeded in developing a SC-A vaccine refrigerator that passed the internal manufacturing testing protocol to enable for independent testing at DTI and obtain WHO prequalification?

28. **A1:** from the field visit and meetings with Palfridge, three key issues were raised, 1) the need for a direct on the ground (face-to-face) support from DTI for performance optimization (instead of the online support), 2) more freedom for Palfridge to adjust the SC-A technology instead of replicating an existing design with very little room for adjustments, and 3) many partners highlighted the need for a procurement support to find alternative suppliers for expensive components (e.g., DC compressor, PV

panels, etc.) to be able to reduce their production costs and consequently the unit's price.

29. **Q2:** what value has the collected data from the field monitoring in contributing to changes or improvement in production or business operations by the manufacturers based on the units' performance results?

30. **A2:** the field monitoring data for SC-A showed both, the potential of the SolarChill technology as well as pointing some quality issues for certain tested products. This type of data was hardly available before and is of value 1) for manufacturers so that they can improve their product's reliability, 2) for end-users to make an informed purchasing decision.

31. The field test identified few recurrent failures of certain models which were communicated to the relevant suppliers for design adjustment. Another key value of the field test is the identification, by the beneficiaries, of the most reliable models for future purchases.

32. **Q3:** What has been the impact of the installation of SolarChill-A units in the various clinics and the future possibilities by the various ministries in procuring similar models for other facilities?

33. **A3:** three common feedback from the field, 1) increased vaccination capacity especially during the Covid-19 pandemic, 2) reduced vaccines replenish rate, and 3) based on the field performance, beneficiaries (e.g., ministries of health) identified the most reliable models for future purchases.

34. Increasing the stock of vaccines in remote clinics is the main impact especially in Colombia where access to certain locations is extremely difficult. On the other hand, clinics' managers in eSwatini (where road access is easier compared to Colombia) indicated the need for a larger unit to increase the storage capacity.

35. **Q4:** what prospects exist in large scale production and commercialisation of the SC-B model units developed by participating manufacturers under the project?

36. **A4:** SC-B technology suffer from a high purchase price for most potential end-users hindering a wider market penetration of this specific technology. That being said, multitude initiatives have emerged, not necessarily following the rigid quality guidelines from SolarChill but offering solar cooling solutions with ice batteries. Yet, from the meetings with all participating manufacturers, and the profile of end-users, SC-B's current design has little chance to be commercialized due to its high purchase price partially caused by high component prices.

Strengths of the project.

37. Based on the findings from this review, the project demonstrates performance at the satisfactory level. The project has shown robust performance in the areas of field testing solar direct drive refrigerators for vaccines (SC-A). Areas that would have

benefited from further attention are the solar direct drive refrigerators for food (SC-B), which should have received the same attention.

38. The SolarChill project helped to improve the vaccines logistics for remote clinics, especially in Colombia. In Colombia as well, it was reported by the ministry of Health that the supply of vaccines could now be done on monthly basis (or longer in some cases) instead of on a weekly or bi-weekly basis, and it also improved the vaccination coverage in remote areas.
39. The project encouraged suppliers in the partner countries to develop their own SC-A and SC-B technology.
40. The performed field test and the supplied data helped relevant ministries of Health to determine the most qualified supplier for future purchases of SolarChill A units.
41. The SolarChill website supported the dissemination of field test results, although some stakeholders (e.g., the ministry of energy in eSwatini) were not aware or did not check the publications on the SC website of the field test results.
42. Through the installation of SC-B units in Kenya and eSwatini, local small businesses could increase their revenues through the higher sales of food and beverages that require cold storage.
43. The project helped and facilitated in producing several prototypes with more than 2 manufacturers and excelled particularly with the Colombia Manufacturers for both SC A and B types.

Weaknesses of the project.

44. Lack of an after sales agreement and spare parts provisions caused delays in field service and maintenance of the deployed units (SC-A and SC-B).
45. The high price and low storage capacity of SC-B is a significant barrier to wider commercialisation of these units.
46. In line with the above comment, end-users should have been consulted at the project's inception to better understand their needs, and consequently, provide the relevant product.
47. The co-financing commitment did not happen as expected, especially in Kenya.

B. Lessons learned.

48. Lessons learned can be summarised as non-technical aspects and emphasize the importance of effective human interactions.

Lesson 1. ***Only remote technical support is not enough in complex projects.***

49. The technical support in eSwatini happened mainly online, yet feedback from Palfridge and DTI confirm that DTI should have travelled to eSwatini to locally support Palfridge in the final development of the prototype.

50. Likewise, the field monitoring, being the key activity in the project, suffered from the fact that the experts implementing the monitoring, were not planned to travel and did not do so partly due to project budget constraints and Covid19 pandemic.

Lesson 2. ***Local presence of suppliers is essential.***

51. Procurement should have paid extra attention to the local presence of suppliers (or their official representative), providing a solid after sales service and spare parts provision in order to reduce the service lead time. For example, in Colombia, the main supplier's contact person for Vestfrost (who supplied 14 SC-A units) is sitting in Europe at 7 hours difference and do not speak Spanish. Same situation with Godrej who supplied 7 SC-A units. This issue was highlighted by the Colombian MoH and already mentioned in the mid-term review report.

Lesson 3. ***The world around the project evolves as well.***

52. Strikingly tests with direct drive solar vaccine chillers had been executed and reported by others after the initial writing of the SolarChill project plan but before the start of the project. Also, measurement methods for such products had been documented elsewhere. It is good to have a project plan and stick to it, but it would help to search and check what else is happening in this specific field of solar powered refrigerated units.

C. Relevance

53. From the field visits, there is **no doubt about the relevance and the importance of this project (SC-A and SC-B) for the local communities**. For example, the installed SolarChill-A units have increased the vaccines storage capacity from about a week to more than a month (e.g., in remote clinics in Colombia). SC-B units, in remote small shops, allowed the availability and sales of cold drinks and dairy product.

54. Nevertheless, this project suffers important missing element in its construction as well as in its execution. Here are a few insights, which will be further developed in this report:

- The project objectives have been developed and set about twenty years ago. Since then, these objectives and budgetary requirements haven't been re-evaluated taking into consideration the technology advancement, the real local needs, the longer-term goals, etc.
- The field test countries haven't been selected based on real needs e.g., electrification level, which is much lower in some west African countries compared to Colombia and eSwatini.
- Suppliers and manufacturers, of field test equipment, haven't been involved in the field test as a major player.

- Some missing elements in the Request for Quotation (RFQ) creating delivery delays and additional fees e.g., procurement via non-local representatives, no clear after sales and servicing contract with local agencies, spare parts provision, etc.
- There is no clear plan on how the units' initial price will be reduced to allow mass adoption, production, and commercialization. Nevertheless, an important approach the project took is to connect with few companies to investigate possible micro-financing in order to facilitate the purchase of SC technology by low-income populations. Such activities have been conducted by the project in Kenya with companies like Pawame and SolarFreeze. This micro-financing allows end-users to pay small monthly amounts for a certain period of time after which they own the equipment. This way, it eliminates the barrier of high initial cost. That being said, there is no proof that micro-financing has been applied on the SC technology during the project duration.

D. Main Recommendations

Foresee face-to-face interactions during technology transfer work.

55. It was reported during the reviewers´ field trip to Palfridge in eSwatini that on site interactions with international experts were missing during the technical development of the SC-A cooler and that they could have been beneficial in achieving the WHO PQS. We recommend for future projects that include technology transfer providing sufficient travel budget for international experts.

During procurement, pay attention to local presence of suppliers for after sales and spare parts.

56. Procurement staff was in a different time zone (Europe) and did not speak Spanish (Colombia). Support was not clearly included during procurement. The aim of the recommendation is to reduce service lead-time.

The project design should contain explicit tasks for the project team to make use of and to build upon pre-existing institutions, agreements and partnerships, data sources, synergies and complementarities with other initiatives, programmes, and projects.

57. Before the project start and during the SolarChill project, others were testing SC-A refrigerators and rolling out SolarChill B initiatives without the project team seemingly being aware of this. The WHO has done field tests of Solar direct drive before the start of the SolarChill project. As a result, the number of possible partners remained limited, and the outreach and technical dissemination activities did not reach these other initiatives. The reviewer recommends that future project plans are screened so that they include a planned activity which is building upon other initiatives, complementary to the project.

See reduction of costs as a relevant factor in UNEP projects as lower costs facilitates the introduction of new technologies.

58. Intentions should be translated in project outputs and outcomes and not be left as an intention only. In this particular project, there was an intention to reduce the cost of SolarChill refrigerators (SC-A and SC-B), but this intention was not an explicit objective in the project plan although it was a target in the project's results framework.

Foresee an "Initial Project Review".

59. The reviewer recommends for future projects, to foresee an "Initial Project Review" exercise, by an external expert, to identify weakness and/or gaps in the project structure before the execution and implementation process starts.

Validation

The report has been subject to an independent validation exercise performed by UNEP's Evaluation Office. The performance ratings for the 'SolarChill Development, Testing, and Technology Transfer Outreach' project (GEF ID 4682) set out in the Conclusions and Recommendations section (p64), have been adjusted as a result. The overall project performance is validated at the 'Moderately Satisfactory' level. The Evaluation Office has found the overall quality of the report to be 'Moderately Satisfactory' (see Annex VIII).

II. INTRODUCTION

60. This report contains the Terminal Review of the UN Environment Programme-GEF Project entitled "SolarChill development, testing and outreach" (herein referred to as the "SolarChill Project," or "Project") The project countries are Kenya, the Kingdom of eSwatini and Colombia.

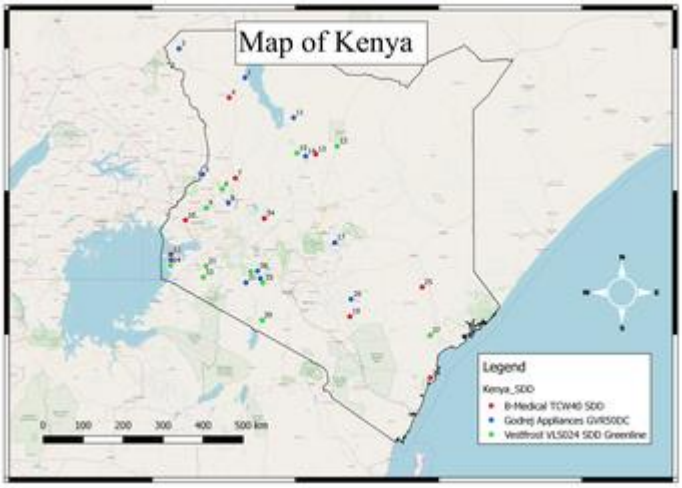


Figure 1: Map of Kenya.

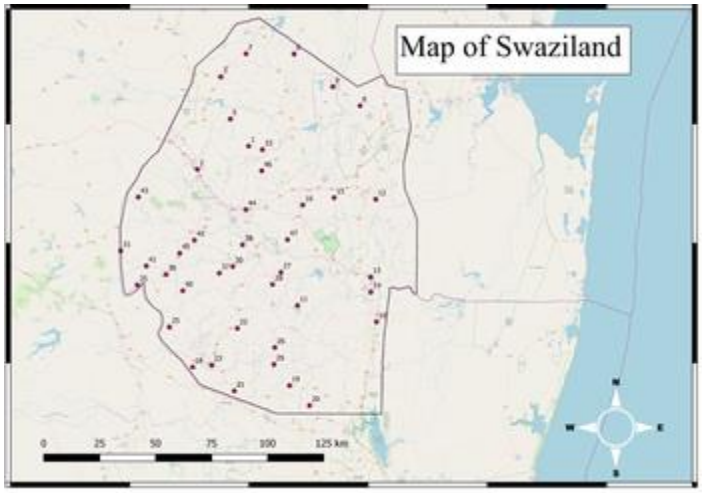


Figure 2: Map of the Kingdom of eSwatini.

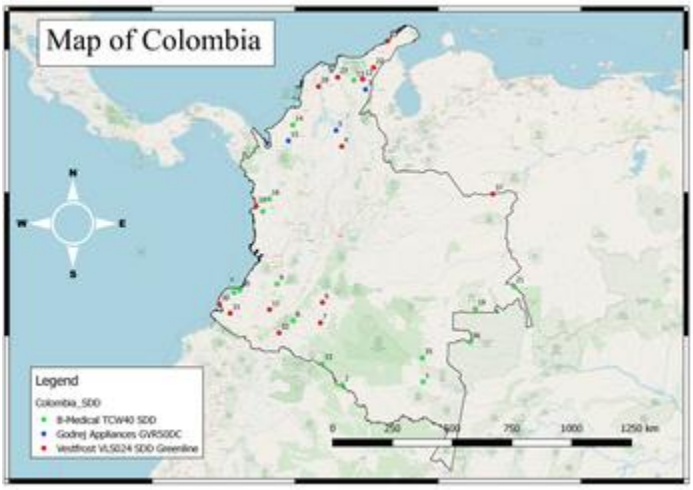


Figure 3: Map of Colombia.

61. The maps above indicate the sites where the SolarChill units were installed in the 3 countries.
62. The SolarChill project was launched back in 2001, to develop and deliver affordable, technically reliable, ozone layer and climate friendly, solar powered and lead acid battery free refrigeration technology. It uses solar power to run a direct current (DC) hydrocarbon-based refrigerator compressor. Hydrocarbons (isobutane R600a), used as refrigerants, are safe for the ozone layer and for the climate.
63. In low-sun situations, or with power completely disrupted, the ice bank combined with the thick insulation of the cabinet maintains acceptable temperatures for up to 5 days. The thickness of the insulation varies according to the ambient temperature for which the specific SolarChill units are designed.
64. This technology is a reliable and sustainable solution to meeting refrigeration needs. It is an environment friendly approach to supporting the delivery of health care and food security to low-income populations in difficult access remote areas.
65. The field test covered two types of SolarChill applications:
66. SolarChill-A (SC-A) vaccine cooler, for temperature-sensitive vaccines and medicines
67. SolarChill-B (SC-B) for food preservation for domestic and small commercial applications
68. According to the IEA, in 2010, the total demand (SC-A and SC-B) is estimated to grow from currently some 30,000 units in all three countries to over 1.5 million units in 2050 (with over 90% of the demand coming from Kenya).
69. SolarChill-A units to be field tested require having WHO PQS (Performance, Quality, Safety) Certification). These performance requirements are to ensure a level of

quality for refrigerators that are used to store temperature-sensitive vaccines and medicines.

70. SolarChill-B units to be field tested will first be tested at the Danish Technological Institute (DTI) laboratory before field deployment.

71. The selected SolarChill-A suppliers include Vestfrost, Godrej & Boice, B-Medical, Haier and Zero Appliances. The Ministry of Health of each country was involved in the selection of the models that were field tested.

72. Each SolarChill unit was delivered with solar panels, mounting rails, needed cables and accessories. Data logging systems were shipped separately by DTI and were mounted by HEAT's country managers at the field test sites.

73. The project was approved by GEF on 20 February 2014 and by UNEP on 03 June 2016. The planned duration of the project was 30 months (June 2016 - December 2018). The project was extended by 42 months with a final completion on 30 September 2021.

74. The planned project budget was USD 10,745,650 of which USD 2,712,150 was granted by GEF, and USD 8,033,500 was co-financing contributions (see Table 6 on page 36 for the co-financing details). The final expenditures for GEF were USD 2,642,692 (as of 30 September 2021). Proof to support the submitted numbers on committed co-financing was given mid-way through the terminal review (on 15 March 2023), with a total of USD 5,654,219 (in-kind).

75. The SolarChill project addresses the climate crisis (direct and indirect emissions from refrigerators), health (vaccine refrigerator, food refrigerator) and pollution (avoiding the use of fossil fuel driven local electricity generators). The project is thus well aligned with the UNEP Medium Term Strategies.

76. The UNEP Medium Term Strategy 2014-2017 identifies climate change as one of the six focus areas and aims at increased energy efficiency and the reduction of greenhouse gas emissions and other pollutants.

77. The Medium-Term Strategy (MTS) 2022-2025 is UNEP's vision for reversing three interconnected crises – climate change, biodiversity loss and pollution.

78. UNEP implemented the project and SKAT as Executive Agency executed it. Involved countries were Colombia, eSwatini and Kenya. Each country had a lead agent responsible for coordination and administration of activities, as well an in-country focal point and technical coordinator to lead the in-country activities. The project was implemented by the United Nations Environment Programme under its Economy Division, Climate Change Mitigation Unit, Energy and Climate Branch, and executed by SKAT. Other project partners were HEAT, Danish Technological Institute,

Greenpeace International), UNICEF, GIZ, Technische Universität of Dresden, and the WHO.

79. The project goal is to demonstrate low-carbon technologies and to deploy them on the ground.

80. The objective of the project is to transfer and commercialize the SolarChill vaccine refrigerator (SolarChill A) and to begin the process of transferring and commercializing the SolarChill household and light commercial refrigerator (SolarChill B).

81. Other secondary objectives include the procurement, installation, and monitoring of 200 SolarChill A units (=vaccine coolers), as well as the procurement, installation and monitoring of 45 SolarChill B units in the 3 countries. Last, the project aims to increase awareness of the availability of SolarChill products and their technological, performance, cost, and environmental benefits as well as to engage in technology transfer with refrigerator production companies that have converted their production lines to hydrocarbon refrigerant (e.g., R600a), or are willing to do so. (See Annex G, M&E Budget and work plan, from the project document).

82. The Terminal Review has been undertaken in line with the UN Environment Programme Evaluation Policy, UN Environment Programme Manual and guidance material to assess the project performance (in terms of relevance, effectiveness, and efficiency), and determine outcomes and impacts (actual and potential) stemming from the project, including their sustainability.

83. This review has two primary purposes, which are:

    - Provide evidence of results for accountability requirements,
    - Promote operational improvement, learning and sharing of knowledge.

84. The Terminal Review looked forward and identified lessons learned for future project formulation and implementation.

85. In agreement with the Terms of Reference (ToR), the review has been structured around strategic questions on the achievement of the project objectives as stated in the project document which are[3]:

    - Q1: What alternative approaches would have been implemented to ensure Palfridge succeeded in developing a SC-A vaccine refrigerator that passed the internal manufacturing testing protocol to enable for independent testing at DTI and obtain WHO prequalification?
    - Q2: What value has the collected data from the field monitoring in contributing to changes or improvement in production or business operations by the manufacturers based on the units' performance results?
    - Q3: What has been the impact of the installation of SolarChill units in the various clinics and the future possibilities by the various ministries in procuring similar models for other facilities?

[3] Strategic questions from Inception report

- Q4: What prospects exist in large scale production and commercialisation of the SC-B model units developed by participating manufacturers under the project?

86. The strategic questions allowed for an open-ended sharing of the most important aspects of the project, as well as areas on which the project could have been improved.

87. The target audiences for the review findings included UN Environment Programme, governments of the three countries and all the key stakeholders involved. The aim was to promote operational improvement, learning and knowledge sharing through the results and lessons learned for the formulation and implementation of future interventions in each of the involved countries and regions.

Photos


GOLDEN PENNY


SOLARCHILL PROJECT


TCW 40 SDD
SOLARCHILL PROJECT
B medical systems

III. REVIEW METHODS

A. Review framework

88. The review methods adopted for the terminal review consisted of an initial desk review of available documentation, a review of the Programme of Work of the UN Environment Programme and interviews with stakeholders.

89. The Terminal Review has been an in-depth review using a participatory approach whereby key stakeholders were informed and consulted during the review process. Both quantitative and qualitative review methods have been used as appropriate to determine project achievements against the expected outputs, outcomes, and impacts.

90. Throughout this review process and in the compilation of the Final Review Report, efforts have been made to represent the views of both mainstream and more marginalised groups. Data were collected with respect for ethics and human rights issues. All pictures were taken, and other information gathered after prior informed consent from people, all discussions remained anonymous, and all information was collected according to the UN Standards of Conduct.

B. Theory of Change (TOC)

91. The TOC of the project was reconstructed during the inception phase, indicating causal linkages among outputs, direct outcomes, 'intermediate states' and impacts plus assumptions and drivers. This TOC was updated based on interviews and discussions held during the missions to eSwatini and Colombia.

C. Review data sources

92. The desk research used the following documents:

- CEO Endorsement Request Package,
- Project design documents (including minutes of the project design review meeting at approval);
- Annual Work Plans and Budgets or equivalent, revisions to the project (Project Document Supplement), the logical framework and its budget,
- Project reports such as the available six-monthly progress and financial reports, progress reports from collaborating partners, meeting minutes, relevant correspondence and including the Project Implementation Reviews and Tracking Tool etc.
- Project deliverables e.g., website, field monitoring reports, technology transfer packet, prototype designs and assessments, laboratory testing results,
- Mid-Term Review report of the project,
- Publications from similar projects.

93. Interviews (individual or in group) were held with (number of persons):

- Project Manager (1)

- Project management team (1)
- UNEP Fund Management Officer (1)
- Gesellschaft für Technische Zusammenarbeit (GIZ) (1),
- Danish Technological Institute (DTI) (1).
- Colombian Ministry of Health and Social Protection Health, (Ministerio de Salud y Protección Social) (3)
- Ministry of Environment (MOE), Colombia (2)
- Interhospitalia (Inter), Colombia (1)
- eSwatini Energy Authority (EEA), Eswatini (4)
- Ministry of Health (MOH), Eswatini (1)
- Ministry of Commerce, Industry and Trade (MCIT), Eswatini (3)
- Ministry Natural Resources and Energy (MNRE), Eswatini (2)
- End-users of SC-A (clinics) and SC-B (small businesses) (6).
- Two missions (to Colombia and Eswatini) were filled with meetings with ministries, suppliers of SC technology, end-users of SC units, and other key stakeholders.

D. Limitations to the terminal review

94. The terminal review faced limitations due to the long duration of the project. The initial duration of 30 Months has been extended (at no extra budget) by 42 Months and many key personnel that initially worked on the project changed in this timeframe. As a mediation strategy the consultant has placed extra attention on actors that were in the project from the beginning.

95. For the field missions, local support would have been needed to reach the remote test locations. As the available local support was limited, only locations with shorter travel distances and easier access were visited.

96. The first draft of the terminal review was also impacted by the later availability of the co-financing report. The co-financing report was integrated into this terminal review report.

IV. THE PROJECT

A. Context

97. In regions of the world without reliable electricity, preservation of temperature sensitive vaccines and food is problematic while refrigeration of vaccines is essential. Fossil fuel operated units dominate the market for vaccine refrigerators in remote areas without reliable electricity. These refrigerators present problems related to operating costs, effectiveness in maintaining appropriate temperatures, and environmental impact. In remote areas, obtaining fuel on a timely and consistent basis, is challenging and expensive.

98. The COVID-19 pandemic has also shown that in regions without access to the grid, off-grid refrigeration for vaccines is essential. Reliable PV powered off-grid refrigerators (SolarChill A) are the most suited and sustainable solution to provide off-grid refrigeration for vaccines.

99. The project covered Colombia, Kenya, and the Kingdom of eSwatini. Maps with the site locations have been provided in the introduction.

100. In addition, fossil fuel (mostly kerosene but also propane gas or diesel) powered vaccine refrigerators result in greenhouse gas emissions through normal operation and emit toxic fumes that are dangerous to humans. Finally, solar vaccine refrigerators were on the market and relied on lead acid batteries to store energy [this has changed in the 2020's]. These batteries are typically the weakest link in solar systems in developing countries because they break down frequently, especially in hot climates. Batteries are also vulnerable to theft and pose an environmental hazard upon disposal. SolarChill (SC) is a technology and product-centred initiative with the mission to create a refrigerator design that works under conditions without a reliable power supply. The SolarChill technology uses solar power to run a direct current (DC) refrigerator, using hydrocarbon (R600a – isobutane) as refrigerant. Hydrocarbons are safe for the ozone layer and for the climate. The compressor-driven refrigerant cycle freezes an ice bank in the walls of the SolarChill unit. The ice bank and thick insulation enable the unit to maintain the required 2°C to 8°C temperature range for four (4) to five (5) days, even without any sunlight, thus batteries are not needed in the design. SolarChill promises efficient use of limited solar energy and is free of emissions that may threaten human health, the climate and/or the environment.

101. The SolarChill technology not only improves human health or food security, but also avoids CO_2 emissions from fossil fuels, that would otherwise be emitted when fridges are powered from a conventional grid with fossil fuel-based power plants or even worse, when powered with local diesel generators. The key aim of the SolarChill project was to conduct standardized field-testing of off-grid solar powered vaccine and commercial refrigerators across different countries, climate zones, and brands. Until 2013, there had not been a coordinated monitoring and review program to

demonstrate in a reliable way that this technology would work effectively in off-grid settings.

102. A secondary aim was to provide learnings, from the field testing to manufacturers in order to bring solar refrigerator technology to a breakthrough point of higher market penetration, especially for health facilities, domestic use, and small businesses in off-grid areas. Through rigorous field testing and sharing results, the SolarChill consortium sought to prove the viability of off-grid solar refrigeration and spur its widespread adoption.

103. The project aimed to achieve these objectives and to provide clear and transparent field test data, for future reference by manufacturers and end users. Further, the project team planned to use the results from the field tests to provide valuable feedback to SolarChill producers both for enhancing the properties of SolarChill-A units and for the R&D and design of SolarChill-B units.

104. The project consisted of three main components:

- Demonstration and cross-comparison of solar powered vaccine refrigerators in the field. These will be referred to throughout the report as “SolarChill A” or “SC-A”.
- Testing of solar powered refrigerators. These will be referred to throughout the report as “SolarChill B” or “SC-B”.
- Technology transfer (Solar Direct Drive technology) towards national producers of solar powered refrigerators.

B. Results Framework

105. Initial Project Objective: to transfer and commercialize the SolarChill vaccine refrigerator (SolarChill A) and to begin the process of transferring and commercializing the SolarChill household and light commercial refrigerator (SolarChill B). This objective was divided into three parts:

- Procurement and installation of 200 SolarChill A units in three countries (66 per country).
- Laboratory testing of prototypes, procurement, and field testing of 15 (total of 45) SolarChill B units in each of the three countries.
- Information dissemination and technology transfer.

106. The long-term aim of this project is to bring down costs of the technology, increase local manufacturing capacities, and stimulate consumer demand so the product can compete on price and performance with fossil fuel-driven refrigerators, even on the short-term horizon.

107. The project aimed to accomplish these goals through the demonstration of the SolarChill vaccine refrigerator technology in Colombia, eSwatini, and Kenya and the

collection of technical data, followed by knowledge transfer, promotion, and support to manufacturers to achieve emergence of a SolarChill market.

108. Table 3 below contains the originally formulated outputs and outcomes. The reviewer reformulated those to make the expected outputs more concrete.

Table 3: Planned and reformulated project outputs and outcomes.

Project Component	Expected Outcomes	Expected Outputs	Expected outputs (Terminal review)
1. Procure, install 200 SolarChill A units in three countries (66 per country)	Demonstration experience and cross-comparison of available SolarChill products (especially SolarChill A units) under field conditions in representative health centres to ensure that safe vaccine storage conditions are met.	Support participating manufacturers in the target countries in their efforts to market SolarChill units and support their efforts to reduce the costs of the SolarChill refrigerators.	Deployment of SolarChill A vaccine chillers under field conditions, demonstrating their functionality in the long term (years) with respect to serviceability, energy efficiency, hygiene. Demonstration of the cost reduction of SolarChill A due to the efforts of the SolarChill project.
2. Laboratory testing of prototypes, procurement, and field testing of 15 (total of 45) SolarChill B units in each of the three countries	Development of SolarChill coolers from different manufacturers / suppliers to test and gain first-hand experience with in practical SolarChill B applications.	Test results of SolarChill B under field conditions in a variety of small institutional and light commercial applications Brokerage activities to connect financing organizations (micro-financing and venture capitalists) for increased market penetration.	Test results of solar driven refrigerators without electrical batteries, both in the laboratory and in field conditions, not only for the project internal developments but also comparing to other private offerings.

3. Information dissemination and technology transfer	Information regarding SolarChill more widely available; increased industry interest in SolarChill A and B production in Latin America and Africa	Marketing campaign, business plans, increased awareness, and interest in SolarChill, and updated SolarChill website In cooperation with and contingent upon MLF and bilateral country program HCFC and HFC phase out activities, and contingent on manufacturers capacity to produce fluorocarbon-free refrigerators, facilitation of partnerships and licensing agreements, including assessment of potential partner companies by an unbiased engineer and business specialist. Preparation of a technology transfer packet	Marketing campaign and business plans on two levels: 1. Manufacturers understanding the market potential. 2. Attractive solution for the end users addressing their needs e.g., food storage (SCB) and vaccine/medicine storage (SCA).

C. Stakeholders

109. The Evaluation Office of UN Environment Programme identifies stakeholders broadly as all those who are affected by, or who could affect (positively or negatively) the project's results.

110. The main stakeholders can be categorized as:

- Beneficiaries = End users of solar refrigerators. For SC-A these are medical centres in need of conservation of vaccines. For SC-B these are typically small shops that sell refrigerated food and drinks. Both types of end users were not part of the project design. SC-A users are typically government agencies or NGOs/foundations who can afford an elevated price. SC-B users are local small businesses that cannot be identified individually. There is no indication that a market study was conducted before or at the start of the SolarChill project to identify and communicate with these end-users.
- Manufacturers
- In Colombia, the Technology guideline prepared by the project was taken up initially by 5 Colombian manufacturers. 3 of them eventually developed and tested prototypes (Interhospitalaría: SC-A, Fricón and Martinkas: SC-B).
- In eSwatini, Palfridge has produced SolarChill B units during the project period and has been developing a SolarChill A unit since project inception. Palfridge achieved both SC-A and SC-B prototypes with the help of the project and tested them internally.
- Kenya: SolarFreeze and Pawame participated in the project by i) providing the project donated SolarChill refrigerators to end users applying the Pay&Go model

and ii) agreeing to finance and to continue developing business models for SolarChill refrigerators beyond the assignment.

- Government authorities
- eSwatini: The project interacted with the Ministry of Health (MoH), which assigned a team during the implementation period which provided critical help in completing the activities of the project. Orientation was done with the help of Eswatini Environment Authority EEA.
- Kenya: The Ministry of Health (MoH) cooperated, though the project did not receive the financial support committed as co-financing.
- Others Stakeholder Engagements:

  • Engagement with GIZ both in Eswatini and in project update meetings

  • Exchange with Global alliance for vaccines and immunization (GAVI) and Clinton Health Access Initiative (CHAI) as potential donor agencies until project end.

111. The SolarChill executing partners were SKAT Foundation, supported by project partners, HEAT, Danish Technology Institute, Greenpeace (Janos), UNICEF and GIZ.4

112. The bulk of the consultancy services were delivered by private company HEAT GmbH (Habitat, Energy Application & Technology), which thus had a significant impact on the project.

113. SC-B storage capacity was generally too small for the product to be highly useful in the field. This aspect could have been avoided if projected SC-B end users had been interviewed during the conception of the project or at the start of the project. The approach taken in this project was to start with the technology and to see capacity as secondary once the technology is proven with the selected manufacturers. The reviewer sees this as valid and congruent with the project plan of SC-A, where existing models already in use were to be tested.

114. The stakeholder analysis, below in Table 4, highlights some issues that were apparently not considered during the conception of the project, and which could constitute relevant learnings for future UNEP's projects.

Table 4: Stakeholders analysis.

Stakeholders	Power over project results/implementation + the level of interest	Did they participate in the project design, and how.	Potential roles and responsibilities in project implementation	Changes in their behaviour expected through implementation of the project
Type A: High power / high interest = Key player				

[4] Project Document, first page.

Beneficiaries = End users of solar refrigerators	High power because only when the end users start buying and using SolarChill units, can the project reach its' desired outcomes.	no	They received the units either in the clinics (SC-A) or small commercial businesses (SC-B) for testing and providing feedback on the performance of the units. The reviewer did not find evidence that any end-user was consulted regarding their needs.	Beneficiaries will search for other ways to meet their refrigeration needs.
Type B: High power/ low interest over the project =Meet their needs				
Manufacturers of (solar) refrigerators	Manufacturers have high power but might have lower interest depending on the business case and projected potential sales. Sales price point is a key element for them.	no	Approached as suppliers but should have been risk-bearing partner. Closer contact with Palfridge for the technology transfer activities on SC-B	Unlikely unless a critical mass of the market switches to solar driven refrigerators.
Type C: Low power/ high interest over the project= Show consideration				
Local government authorities	Authorities have high interest in the outcomes to increase public's health, which is of interest to government policies	yes	Partners in the project yet low power on the outcome, because they cannot build the SolarChill units	Unlikely
Type D: Low power /low interest over the project= Least important				
None				

115. The project document hardly addresses gender specifically, so men and women were not identified as specific stakeholders. The gender subject is discussed in paragraph 135.

D. Project implementation structure and partners (Figure 4)

116. Executing Agency was the Skat Foundation with project partners: HEAT, Danish Technology Institute, Greenpeace (Janos), UNICEF and GIZ. HEAT organized the activities in the three countries, eSwatini, Kenya, and Colombia. In Kenya, the country

management was organized under a contract with the Christian Health Association of Kenya (CHAK).

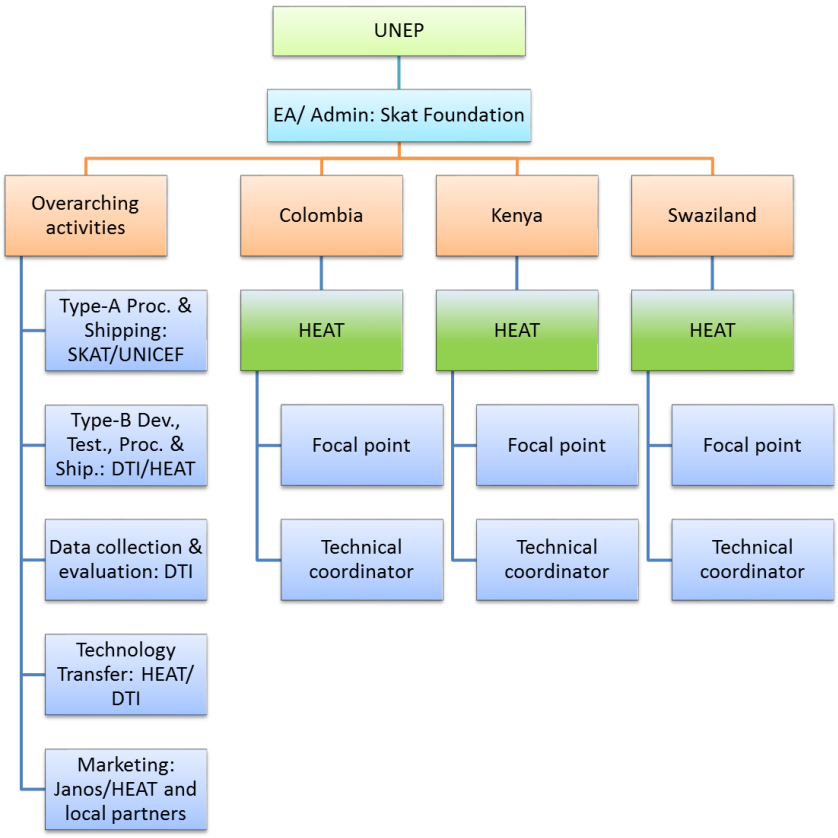


Figure 4: Organigram of the Project with key project key stakeholders.

E. Changes in design during implementation

117. The timeline of the project has been extended three times, to manage logistical delays and the range of impacts of the Covid-19 pandemic. These extensions were with no-cost extensions, but budgets have been moved between budget lines, thus reducing the funding of the outreach activities.

118. For the second revision clear arguments have been given such as the difficulties of WHO PQS certification of SolarChill A fridges being developed at Palfridge in eSwatini, procedural delays in signing the MoUs with country partners, delays in procurement and administration of SolarChill B fridges. Also, prototypes lab testing, and design adjustments of SolarChill A and B were time consuming (especially Palfridge's SC-A prototype against the WHO PQS requirements).

119. The third amendment was signed in February 2021, and it mentions the Revised Technical completion date: 30 September 2021. The problems mentioned in the

arguments for Revision 2 have not been fully solved and the Covid-19 pandemic has clearly restricted the activities.

120. Table 5: Revisions and extension dates, summarizes the dates of the three extensions of the SolarChill project.

121. Table 5: Revisions and extension dates.

Version	Date	Main changes introduced in this revision
1	24.01.2019 12 months	Extension of project completion date
2	18.12.2019 13 months	Extension of project completion date
3	02.02.2021 8 months	Extension of project completion date
RevN (latest version at the time of this PIR)	End Date Sept. 2021	Extension of project completion data – final September 2021

F. Project financing

122. The planned co-financing per source of co-financing can be found in Table 6.

123. The final signed co-finance report from 15 March 2023 shows USD 5.654.219 of in-kind co-financing, of which 96% from GIZ. In Annex IV you can find the estimated in-kind co-financing from the different ministries in eSwatini.

Table 6: Planned Co-financing sources (CEO endorsement request – February 2016).

Sources of Co-Financing	Name of Co-financier (source)	Type of Co-Financing	Co-Financing Amount ($)
Bilateral Aid Agency	GIZ	Cash	1,820,000
National Government	Colombia, Kenya, ESwatini MOH	In-kind	675,000
Bilateral Aid Agency	GIZ	In-kind	40,000
Not profit	Greenpeace	In-kind	6,000
Not profit	Greenpeace	cash	6,500
Not profit	PATH	In-kind	56,000
Bilateral Aid Agency	GIZ	Cash	2,600,000
Bilateral Aid Agency	UNEP	In-kind	230,000
Bilateral Aid Agency	GIZ	Cash	650,000

Not profit organization, Bilateral Aid Agency	DTI, UNEP	PATH, Greenpeace (Combined exp. Jan 2000 to Nov 2009)	In-kind	1,600,000
Not profit organization, Bilateral Aid Agency	DTI, UNEP	PATH, Greenpeace (Combined exp. Nov 2009 to Nov 2011)	In-kind	350,000
Total Planned Co-Financing				8,033,500

124. The budgeted expenses per project component are given in Table 7. The table gives the shift in the budget lines. The totals estimated and spent are known by the actual expenses cannot be split per component due to the financial reporting system in which the project started (UMOJA). Als the reporting did not happen per component because the template was not structured as such. In the meantime, a new financial reporting system and new templates have been put in place, so that reporting per component is now possible in new projects.

Table 7: Expenditure by Outcome/Output.

Component/sub-component/output All figures as USD	Estimated cost at design	Actual Cost/ budget	Expenditure ratio (actual/planned)
Component 1 / Outcome 1	1,138,000	1,054,025	-7%
Component 2 / Outcome 2	547,650	953,321	+74%
Component 3 / Outcome 3	827,000	371,343	-55%

125. The below Table 8 summarizes the reported co-financing.

Table 8: Reported co-financing.

No.	Co-finance partner name	Type of co-finance	Prior Years Actual Total	Total	Cummulative Actual Total
1	GIZ	In-Kind	5,410,000	5,410,000	**5,410,000**
2	Colombia Ministry of Health	In-Kind	68,201	68,201	**68,201**
3	Christian Health Association of Kenya	In-Kind	12,640	12,640	**12,640**
4	Eswatini Environment Authority	In-Kind	3,151	3,151	**3,151**
5	Ministry of Commerce, Industry and Trade - Eswatini	In-Kind	16,204	16,204	**16,204**
6	Ministry of Natural Resources and Energy - Eswatini	In-Kind	1,351	1,351	**1,351**
7	Ministry of Health - Eswatini	In-Kind	147,174	147,174	**147,174**
Total			**5,654,219**	**5,654,219**	**5,654,219**

Table 9: Financial Management.

NON-GEF AND GEF PROJECTS			
Financial management components:		Rating	Evidence/ Comments
1. Adherence to UNEP's policies and procedures:		HS	
Any evidence that indicates shortcomings in the project's adherence to UNEP or donor policies, procedures, or rules		No	Tables and information were provided swiftly and show no anomality's.
2. Completeness of project financial information:		HS	
Provision of key documents to the reviewer (based on the responses to A-H below)			
A.	Co-financing and Project Cost's tables at design (by budget lines)	Yes	Detailed per component
B.	Revisions to the budget	Yes	Detailed per revision and per component
C.	All relevant project legal agreements (e.g., SSFA, PCA, ICA)	Yes	PCA was received, SSFA and ICA non applicable.
D.	Proof of fund transfers	Yes	A table with the funds transfers was provided by the finance team on November 1, 2022.
E.	Proof of co-financing (cash and in-kind)	Yes	In-Kind 16 March 2023
F.	A summary report on the project's expenditures during the life of the project (by budget lines, project components and/or annual level)	Yes	Detailed per budget line and per project component.
G.	Copies of any completed audits and management responses (where applicable)	Yes	5 yearly audit reports on factual findings of agreed-upon procedures from 2017-2021
H.	Any other financial information that was required for this project (list):	No	All info provided
3. Communication between finance and project management staff		HS	
Project Manager and/or Task Manager's level of awareness of the project's financial status.		HS	Financial status was discussed every half year and possible changes made once a year.
Fund Management Officer's knowledge of project progress/status when disbursements are done.		MS	Some issues on fund manager on fund disbursals due to lack of clarity in the first year only.
Level of addressing and resolving financial management issues among Fund Management Officer and Project Manager/Task Manager.		S	After year 1 minimal issues and in cases of unclarity, there was enough communication.

Contact/communication between by Fund Management Officer, Project Manager/Task Manager during the preparation of financial and progress reports.	S	Meetings between parties while preparing financial reports. Explanations were sought and found.
Project Manager, Task Manager and Fund Management Officer responsiveness to financial requests during the review process	S	Good communication between and most issues were flagged off and resolved. UNEP provided good guidelines on financial reviews, processes and expectations.
Overall rating	S	

V. THEORY OF CHANGE AT REVIEW

126. The (reconstructed) Theory of Change (ToC) is a particularly important framework for assessing project performance and results-achievements. While it needs to maintain the elements of the original targets and intended results of the project (as the project was designed), it also needs to allow the reviewer to understand the flow from outputs through to project outcomes, intermediate states to the eventual long-lasting impact of the project, and the long-term impact the project aims to contribute to.

127. The project did not develop a Theory of Change at design. The Project Document (ProDoc) does not show any reference to the theory of change, but it does contain a "Project Results Framework" which has been included in Annex A of the report. There is also an "Annex G - M&E Budget and Work Plan" that contains mid-term and end-term targets.

128. The Mid-Term Reviewer did not re-construct a Theory of Change as part of the Mid Term Review (MTR). The reviewer has therefore reconstructed a ToC framework as part of the terminal review, which is graphically represented in Figure 5 below.

129. The re-shuffling and re-wording of impacts, intermediate states, outcomes, and outputs (and justification for changes) can be found in the two tables below which summarizes the originally planned outputs and expected outcomes. Table 10 contains the rephrased and re-aligned outcomes that will guide the terminal review. There are three causal pathways demonstrated in the diagrammatic Theory of Change.

130. The pathway on the left (blue arrows) follows the existing manufacturers of SolarChill A products from field testing through insight and improved performance towards increased use of (well-performing) SolarChill A refrigerators, which thus lead to health benefits through improved vaccine storage. This pathway depends on the assumption that knowledge will lead to action by the manufacturers and that end-users will deploy a rational procurement process.

131. The pathway on the right (red arrows) follows the knowledge transfer path. It is designed to support the entry into the market by new manufacturers. It takes the insights from the field tests, captured in trainings and training materials, performance testing and support with the start of the production and marketing.

132. The pathway in the middle (green arrows) follows the financial brokerages activities towards the availability of financial support. This financial support is relevant for the end users, especially for SolarChill B as the target end users are homes and micro companies with small budgets. Access to financing is also relevant for the local intermediates (here summarized as "installers") that sell SolarChill B as a solution, so that they can offer a total package. Financing is also relevant for the existing and new manufacturers to set up new production infrastructure and for investments in product development.

133. Relevant assumptions have been listed on the right and can be summarised as the assumption that the actors will act within the logic of the project, which is that they

will use the outputs and outcomes to improve their products and to offer them to the market at a lower price level and with better performance.

134. The drivers on the left indicate significant external factors that, if present, are expected to contribute to the realization of the intended results of a project and which can be influenced by the project and its partners. In summary, they represent external opportunities that can or could have been integrated during the execution of the project.

135. Work to promote human rights and gender equality is central to the aims of UNEP but this subject does not appear in the results framework of the project document, however gender dimensions are discussed in one paragraph in section B2 on page 37 of the project document: "Vaccine programmes help make children and old people better able to withstand disease under poor hygiene conditions. Women are typically the carers under these conditions, and sick family members assume considerable time women could be using for other tasks. By promoting solar power vaccine coolers this project helps government provide reliable health care in remote areas at lower cost, and so benefiting women and the poor." The feedback the reviewer received from the field in Colombia is that SC-A units increased the vaccination coverage and hence reduced the travelled distances, mainly by women, to vaccinate their children.

Table 10: Project framework at inception.

Project Component	Grant Type	Expected Outcomes	Expected Outputs
1. Procure, install and field test a total of 200 SC-A units in the 3 countries (66 per country)	Inv.	Procure and install 200 SC-A	Demonstration experience and cross-comparison of currently available SolarChill A products, under field conditions in representative health centres to ensure that safe vaccine storage conditions are met
2. Laboratory testing of prototypes, procurement, and field testing of 15 (total of 45) SolarChill B units in each of the three countries	Inv+TA	Development by more than one manufacturer of SolarChill B and first-hand experience with SolarChill B in practical applications	-Testing results of SolarChill B under field conditions in a variety of small institutional and light commercial applications - Brokerage activities to connect financing organizations (micro-financing and venture capitalists) for increased market penetration.
3. Information dissemination and technology transfer	TA	Information regarding SolarChill more widely available, increased industry interest in SolarChill A and B, production in Latin America and	Marketing campaign, business plans, increased awareness, and interest in SolarChill, and updated SolarChill website In cooperation with and contingent upon MLF and bilateral country program HCFC and HFC phase out activities, and

		Africa Brokerage activities to connect financing organizations (micro-financing and venture capitalists) for increased market penetration of the SolarChill technology.	contingent on manufacturers capacity to produce fluorocarbon- free refrigerators, facilitation of partnerships and licensing agreements, including assessment of potential partner companies by an unbiased engineer and business specialist. Preparation of a technology transfer packet to be shared with manufacturers.

Table 11: Justification for Reformulation of Results Statements.

Formulation in original project document(s)	Formulation for Reconstructed ToC at Review Inception (RTOC)	Justification for Reformulation
LONG TERM IMPACT		
Health and social benefits of SolarChill include improved vaccine storage and reduced food spoilage and offers obvious and substantial economic and health benefits to a community (formulated as opportunity, not strategic)	Health benefits through improved vaccine storage in off-grid areas	The Covid-19 pandemic highlighted the importance of vaccine storage and since it was the primary focus of the project, improved vaccine storage is best seen as a separate long-term impact
	Reduced food spoilage in off-grid areas and conservation of vaccines in off-grid areas	This is a separate impact for the review
INTERMEDIATE STATES		
Information regarding SolarChill more widely available, increased industry interest in SolarChill A and B	End users know how to operate the units, which have known performance. Increased capacities and interest	The relevant information shall be available to the respective interest groups to replace fuel-based off-grid refrigerators with solar driven products
Increased industry interest in SolarChill A and B production in Latin America and Africa	SolarChill A and B production in Latin America and Africa	Interest cannot be measured, production numbers can.
PROJECT OUTCOMES		
Support participating manufacturers in the target countries in their efforts to market SolarChill units and support their efforts to increase the SC units' cost competitiveness	Enhanced capacities to produce and lower production costs of SolarChill A and B	An important goal of the project is to reduce the upfront costs (keeping same high performance) of the SolarChill technology.
OUTPUTS		

Formulation in original project document(s)	Formulation for Reconstructed ToC at Review Inception (RTOC)	Justification for Reformulation
Demonstration experience and cross-comparison of currently available SolarChill products (especially SolarChill A units) under field conditions in representative health centres to ensure that safe vaccine storage conditions are met. .	Training of local technicians to become familiar with equipment's installation. Performance data of SolarChill A (and B) from existing manufacturers under field conditions. .	Field performance data of existing SolarChill A products were not available before the project. Focus lied on A, while B was secondary.
Brokerage activities to connect financing organizations (micro-financing and venture capitalists) for increased market penetration.	Financing organisations are connected to equipment manufacturers and or end users with the aim to increase market penetration.	Brokerage is an activity, not a result so the originally formulated output has been reformulated as a concrete output.
Technology transfer package of SC technology	Technology transfer: 1. training and development of technology transfer guide; 2. prototype development; 3. internal preliminary testing of prototypes Performance data of SolarChill A from manufacturers under laboratory conditions to support the development of prototypes (technology transfer) including initial performance data, with the objective to meet WHO PQS criteria.	For new (and existing) manufacturers it was/is relevant to meet the formal criteria of WHO.
Marketing campaign, business plans, increased awareness, and interest in SolarChill, and updated SolarChill website. In cooperation with and contingent upon MLF and bilateral country program HCFC and HFC phase out activities, and contingent on manufacturers capacity to produce fluorocarbon- free refrigerators, facilitation of partnerships and licensing agreements, including assessment of potential partner companies by an unbiased engineer and business specialist.	Marketing and business plans support as well as technical assistance for new producers of SolarChill technology.	A clearer formulation to include technical assistance (next to marketing) to manufacturers to meet positive business results.

Formulation in original project document(s)	Formulation for Reconstructed ToC at Review Inception (RTOC)	Justification for Reformulation
Preparation of a technology transfer packet	Training materials on website with resources. A transfer packet was developed for manufacturers interested in producing material and the training materials was for the chain of end users.	Formulated more explicitly towards the intended actions and outputs. Training materials are a tangible output. The website is a source for producers and end-users.

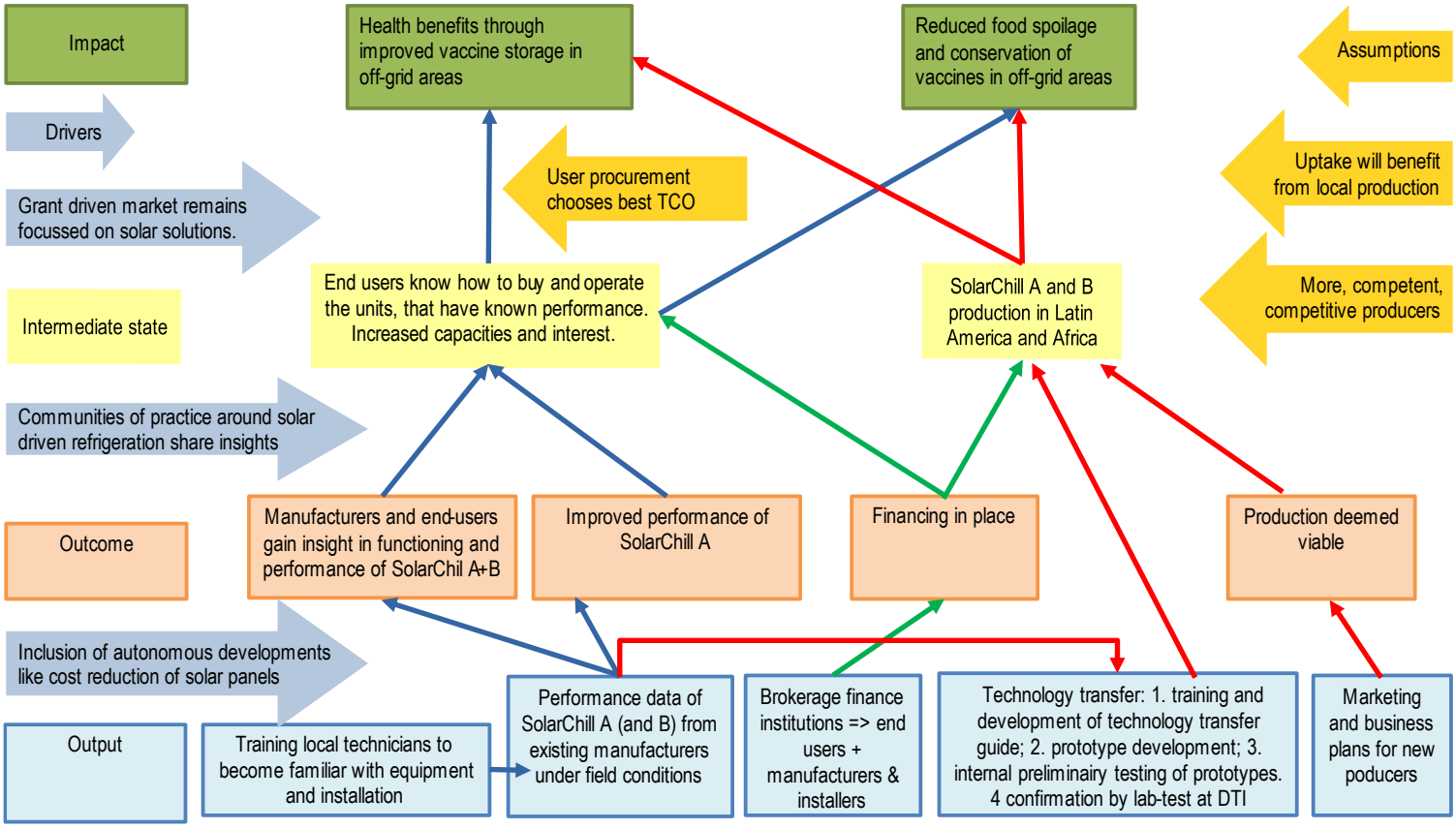


Figure 5: Reconstructed Theory of Change for the SolarChill project.

VI. REVIEW FINDINGS

A. Strategic Relevance

136. Strategic relevance is rated as Highly Satisfactory (HS).

Alignment to UNEP's Medium-Term Strategy (MTS), Programme of Work (POW) and Strategic Priorities (HS)

137. The UNEP Medium Term Strategy 2014-2017 identifies climate change as one of the six focus areas. Within this focus area, an expected accomplishment is low emission growth with increased energy efficiency and reduction of greenhouse gas emissions and other pollutants. The medium-term strategy is also articulated around the concept of green economy and its role in sustainable development and poverty eradication. The 2014-2017 MTS further identifies the implementation of environmentally friendly energy systems as an emerging issue for consideration. The SolarChill is thus in full alignment with the MTS through the integration of solar energy and refrigerators for vaccines and food, hence supporting vulnerable regions and populations in remote areas.

138. The Medium-Term Strategy (MTS) 2022-2025 is UNEP's vision for reversing three interconnected crises – climate change, biodiversity loss and pollution. The SolarChill project aims to address both climate change through reduced refrigerants emissions and reduced emissions from fossil fuels. It thus also contributes to solving the pollution crisis. The project in particular aims to contribute to Outcome 1A (Decision makers at all levels adopt decarbonisation, de-materialization and resilience pathways) and to Outcome 1B (Countries and stakeholders have increased capacity, finance and access to technologies to deliver on the adaptation and mitigation goals of the Paris Agreement).

139. The SolarChill project addresses the climate crisis (direct and indirect emissions from refrigerators), Health (Vaccine refrigerator, food refrigerator) and pollution (avoiding the use of fossil fuel driven local electricity generators). The project is thus well aligned with the current and previous MTS.

140. The project document outlines the alignment with key ministries in the three countries, with NGOs and other key players. It also aligns with the countries' national communication on emissions reduction and increasing the use of renewable energies.

141. The project tends to fulfil a need and a demand by the three countries, specifically for rural and remote regions with inexistant or unreliable electricity grids, for access to refrigeration in two main fields: health and nutrition.

142. The project supports three key sustainable development goals: SDG2 (Zero Hunger), SDG3 (Good health and wellbeing), and SDG 7 (Ensure access to affordable, reliable, sustainable, and modern energy for all).

Alignment to Donor/GEF/Partners Strategic Priorities (HS)

143. The project has largely been financed by UNEP via the Global Environment Fund (GEF) in GEF-cycle 5, with relatively small financial contributions from the

involved three receiving countries. SolarChill is consistent with the current UNEP-GEF focal area of Climate Change Mitigation and with the GEF-5 Strategic Goal 2 - Reduce global climate change risks by stabilizing atmospheric GHG concentrations through emission reduction actions.

144. The largest co-financing party is GIZ, which is an organisation that focuses on development for a liveable future. Promoting the use of natural refrigerants for many years, the SolarChill project fits well with the priorities of GIZ.

Relevance to Global Regional, Sub-regional and National Priorities (HS)

145. Each of the participating countries have policies to phase-out HCFC's and HFC's but are in different stages of development of such plans. The project is relevant for Global Regional, Sub-regional and National Priorities, as the issue of non-existing or non-reliable electricity supply is affecting lives in all developing countries. As these countries tend to be located relatively close to the equator, they have year-round solar energy, so the SolarChill technology can be a reliable solution for many regions.

146. In Colombia, the use of HFC's in household refrigeration has been forbidden since 2012. The country has updated the Environmental Policy for the Comprehensive Management of Hazardous Waste and Action Plan (2021-2030) and the use of HCFC and HFC stances controlled by the Montreal Protocol is to be phased out. Colombia has also adopted a plan to manage ODS(HFC) banks in 2022.

147. Kenya has a National Action Plan in place since 2022 with the aim to transition the cooling sector to refrigerants with low global warming potential to natural refrigerants in the cooling chains[5].

148. eSwatini is currently in the process of conducting a National Hydrofluorocarbons (HFCs) Survey for Eswatini until 31 august 2023, in order to develop a phase-down action plan[6].

Complementarity with Existing Interventions/Coherence (MS)

149. The project is coherent with the Kigali Amendment to the Montreal Protocol (phasing out refrigerants with Ozone-depleting and/or high global warming potential (GWP)). It is coherent with the worldwide climate target (Paris agreements etc.).

150. The project did not seek complementarity with existing interventions, more specifically it did not use other initiatives to implement solar driven refrigerators and freezers, that were going on simultaneously.

Rating for Strategic Relevance:	**Highly Satisfactory (HS)**

[5] https://uzalendonews.co.ke/national-ozone-unit/
[6] https://eea.org.sz/national-ozone-unit/

B. Quality of Project Design

151. Quality of project design is rated as Satisfactory (S)

152. Based on the meetings and interviews with the project's stakeholders, there is a clear alignment on the extreme importance of this project, from both health care

and environmental point of views. There is also a high-level of commitment from key stakeholders to successfully achieve the set objectives.

153. SolarChill Direct Drive (SDD) technology has confirmed strong advantages when compared to existing Kerosene or LPG or battery driven technologies. Amongst these strengths are:

- Reliable and continuous energy supply without the continuous need for supplying fossil fuel.
- Clean and pollution-free energy supply.
- Reduced electronic waste amounts (no battery).
- Lower maintenance costs.
- Lower operating costs.
- Lower carbon source energy supply.
- Elimination of potent greenhouse gas refrigerants (HFCs).

154. Project strengths:

- Government support and cooperation in Colombia and eSwatini: Tax exemption, warehousing, transportation, etc.
- Great appreciation from the end-users: fit for purpose project.
- Quality training materials and technical trainings sessions led by HEAT.
- Quality project management team and country managers (HEAT): relevant technical trainings, quality installation of the field test units, follow-ups with local stakeholders, etc.
- Important technical and review work done by DTI to make sure that the delivered units are of required quality and compliant with relevant standards.
- SC-A technology transfer to Palfridge in eSwatini was well supported by HEAT and DTI.
- Performance data collection and its review by DTI provided solid evidence to other potential end-users on the SolarChill technology's reliability.
- Collected data was shared with suppliers for design and performance improvement.

155. On the other hand, there are gaps and weaknesses in the project design that should be highlighted and taken as "lessons learned" for future projects.

156. Project weaknesses:

- Project is spread over a too long period of time between the initial start and the execution. Pre-set objectives haven't been neither reviewed nor updated in-view of the technological advancement that occurred during these years. The GEF approval process should be more flexible to allow objectives' adjustment for such long project.

- High initial price of SC-A and lack of a clear plan on how it will be reduced to allow mass adoption are a major barrier. This price barrier will be even more impactful on the SC-B units as it impacts remote population with lower income level. Key drivers of these high initial prices are mainly related to component prices such as DC compressor and solar panels. Therefore, the intention to have SC-B units for the off-grid lower income bracket like individual is still not feasible without relevant financing schemes such as micro-financing and pay-as-you-go.
- Procurement process did not take into consideration neither the time difference between supplier and end-user nor the potential language barrier (highlighted by the MoH in Colombia). During the project execution there were arrangements for the after-sale services. However, after the project closed there was not structure put in place to continue supporting Ministries/Clinics to keep getting the after-sale services with the exit of the project.
- Although it's not in the project's objectives, a clear long-term commercialization plan would have supported the market penetration of the SC technology (the project ended at the completion of the field test).

157. The project was executed over abnormally long period of time. The first initiatives were taken in 2000, a project plan was formulated in 2009, then adapted and resubmitted on 17 January 2014. The GEF Global Environment Facility signed its endorsement on 20 February 2014 and the project finally started in 2016. While the project document had a clear understanding of the baseline situation and a strong stakeholder engagement process, it failed to adapt to the changing outside circumstances. The initiators did not actively engage with, as far as the reviewer can see, with the end-users in order to understand their needs. The review learned that the end users of SC-A and SC-B were not consulted and not considered as stakeholders in the project design.

158. The reviewer does understand the scope and the available budget of the SC project, but wanted to share feedback from the field visits where end users said they have not been consulted on their needs regarding the optimal size of the units, which has led to a too low storage capacity for both the SC-A and SC-B. Also, their need for affordable equipment, especially for SC-B has not been fully captured by the project.

159. The quality of the project design was calculated with the tool provided by UNEP and based on the review table in Annex H. At the inception terminal review, the project received a score of 4.2, which is moderately satisfactory to satisfactory. This rating has been adjusted to satisfactory during the terminal review process. The reason for this adjustment lies in extra documents made available to the reviewer, which were not included in the initial package of documents shared. Also, the site visits gave further valuable input for the review. For details see: Annex H of the project Document and the Review Findings.

160. The following Project Documents were used for the review of project design: The PIR (2020, 2021 and 2022), the five financial audits, the CEO Endorsement

Request, the Mid-Term Review and Management Responses, and the guiding documents.

Rating for Project Design: Satisfactory (S)

C. Nature of the External Context

161. Nature of the External Context is rated as Unfavourable (U)

162. The Covid-19 Pandemic was a key external element of the project's implementing context that has limited the project's performance between 2020 and 2021. The initial timeline was 03 June 2016 – 31 March 2018, well before the Covid-19 pandemic. The first extension of the end date to 24 January 2019, meant that the first effects of the pandemic were not visible, could not yet be understood. The second extension to 17 January 2021, meant that the last part of the project happened during the pandemic. The effects are known e.g., interruption of supply chains, restrictions on flights and travel, staff getting ill or in isolation, etc. The project team has responded by working more remotely, which may have led to less results in the third project component of outreach and technology transfer.

163. Important to mention that collaborating countries/governments took almost a year to sign the MoUs and decide on units' models which was originally planned for.

164. Key external features in the project's context were the "geographical" context like areas with no network coverage, areas with no access roads. This was not identified as a major factor in the project design but in reality, it did influence the results of the project.

Rating for Nature of the external context: Unfavourable (U)

D. Effectiveness

165. Effectiveness is rated as Satisfactory (S)

166. This section analyses the results achieved covering both SC-A and SC-B, including price analysis and the environmental impact of introducing SolarChill technology in replacement of existing fuel and/or lead battery driven technologies.

Component 1: procurement and field testing of 200 SC-A units (MS).

167. The project did not fully deliver on the planned output in component 1. In Colombia, 37 SC-A units were field tested, 36 in Kenya and 40 in eSwatini. A total of 113 SC-A refrigerators were installed and tested from 5 different manufacturers and 57 were monitored. Although the expected numbers have not been met, the project demonstrated and made a cross-comparison of currently available SolarChill-A products under field conditions and shows that they are safe vaccine storage solutions.

168. The lower number of SC-A installed is due to the fact that about 70 units were planned to be provided by Palfridge, through GIZ funding, but this did not happen

as planned. In addition, there was a long period from the time of design to implementation of the project which resulted in insufficiency of the budget to procure the targeted 200 Units for SC-A as prices in the market for the units had increased.

Solar Chill A Procurement for Field Testing

169. The Ministries of Health (MOH) were actively involved in both the site selection and the models' selection.

170. The MOH had experience with specific models and wanted more of the same brand. The relatively low number of SC-A monitored is mainly due lack of network coverage in many remote areas, and technical issues with the data logger. Nevertheless, due to the initially high number of sites and extended field test period, there is a data base across different brands and climates.

Procurement and Installation

171. Procurement and installation of various models was coordinated by HEAT and executed UNICEF. There were numerous issues, including logistical hiccups and delays, particularly with import and transportation. There were also challenges with coordination due to significant time differences between the procurement office and Colombia.

Heat Trainings and Project Monitoring

172. The trainings were performed by HEAT. Trainings were done locally, and the training materials were supplied by DTI in coordination with HEAT. Local technicians were trained on basic maintenance needs e.g., drain the condensation water, clean the condenser, etc.

Field testing

173. The field tests lasted almost two years, with varying degrees of monitoring times due to practical issues. However, an average of 18 months of monitoring was achieved, albeit with gaps. The project was initially planned for continuous measurement for a year. Time has been a factor. In all three countries, there were procedure issues regarding customs exemption that were more complicated than foreseen. The reviewer remarks that custom clearance work should have been handed over to professional shipping agents to avoid delays.

174. The project had limited resources for travelling so DTI did not visit the recipient countries for training and installation of the monitoring systems. Logistic issues, poor connectivity or technical faults were recorded but could thus not be easily solved.

175. It proved to be too expensive to send experts in the field to correct errors, especially in Colombia where some locations would take days to reach, if possible, at all. This led to a high failure rate if there is no way to correct even

small technical problems. In many cases the medical staff was reportedly unable or unwilling to help because they were afraid to damage other parts of the unit.

176. A large part of the monitoring devices or sensors have not been sending the amount of data the project was aiming for. Nevertheless, due to the initially high number of sites and extended period, there is a data base across different brands and climates.

Communication on Technical Issues with Manufacturers

177. DTI invited all participating manufacturers to dedicated webinars to share the issues, avoiding public disclosure to prevent competitors from gaining knowledge. They successfully engaged with three manufacturers, but some did not respond to the invitation. There 7 brands in total and 6 in the field test (Haier, Godrej, B-Medical, Vestfrost, Surechill)

Component 2: procurement and field testing of 45 SC-B units (S).

178. 39 SC-B refrigerators from 3 different manufacturers (Palfridge, Vestfrost, and Leff) were installed and 28 were monitored. A third appliance (from Defy) was also tested but, according to DTI, and from the current lab test results, it did not qualify for the project.

Solar Chill A Procurement for Field Testing

179. Procurement of various models was coordinated by HEAT. Laboratory tests has been performed at/by DTI to confirm the unit's performance under the relevant climatic conditions.

Procurement and Installation

180. Procurement and installation of various models was coordinated by HEAT and executed SKAT. There were minor issues, including logistical hiccups and some delays.

HEAT Trainings and Project Monitoring

181. The trainings were performed by HEAT. Trainings were done locally, and the training materials were supplied by DTI in coordination with HEAT. Local technicians were trained on basic maintenance needs e.g., drain the condensation water, clean the condenser, etc.

Field testing

182. Delays occurred due to interruptions on business operations arising from the COVID 19 pandemic experienced by Palfridge in eSwatini and the Colombian manufacturers in the development and testing of SolarChill B commercial prototypes as well as SolarChill A in both countries.

183. Field test delays were caused by missing parts at reception, delayed shipment of SC units, paperwork at customs, lack of technicians training, etc.

184. Further delays were caused by administration and formalities which led to a chain reaction of late deliveries. The 2020 PIR report shows delays caused by

challenges in installations of units in very remote areas which the countries chose for field testing (Site selection). The 2021 PIR report shows the Covid-19 pandemic as an additional and unavoidable cause for delay.

185. There were few results on the technical monitoring, but the returned questionnaires proved to be insightful. The collected field data helped end-users to select quality units for their future purchases, and guided manufacturers to improve the quality of their product and to improve performance.

Communication on Technical Issues with Manufacturers

186. No webinars have taken place for SolarChill B with the exception of Palfridge, with whom extensive communication has taken place. This was largely remote as on the side of DTI there was not budget foreseen for travel. HEAT did send a consultant for local transfer of knowledge.

Component 3: technology transfer (S).

187. A technology transfer package was developed. This is an extensive report based on the test results and designed to inform manufacturers on how to design a solar powered refrigerator, either for vaccines or for food. Further, work has been done to support Palfridge in developing a SC-A prototype which in the end failed to meet all formal WHO requirements.

188. The technology transfer guidelines shared with the manufacturers in Colombia and eSwatini. They are also available on the SolarChill website (https://www.solarchill.org/) At the project inception, it was unclear and not defined how the knowledge transfer would take place. But later, the project developed the SolarChill website and papers have been published. The SolarChill website (available in English and in Spanish) was key for knowledge sharing, training materials, and lessons learned and to disseminate field test results. The reviewer remarks that since 2018, the website has not been maintained, as can be seen in the history section of the website, where the end results are missing.

189. SolarChill related information was published on other websites such as:

- https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/solarchill-technology-brief.pdf
- https://www.facebook.com/SolarChillProject/
- https://www.dti.dk/projects/project-solarchill-gef-development-testing-and-technology-transfer-outreach/38203
- https://skat.ch/portfolio-item/6631/
- beside UNEP and GEF websites.

190. HEAT lead the technology transfer effort with Palfridge in eSwatini. A lot of delays have been accumulated (due e.g., to the availability of spare parts, COVID-19 pandemic, etc.) and the timelines have proven to be optimistic. Palfridge did produce SolarChill B units during the project period and has been developing a

SolarChill A unit since project inception. SC B units produced by Palfridge were also procured by the project for field testing in eSwatini and Kenya.

191. The Technology guideline prepared by the project team was taken up by 5 Colombian manufacturers. 3 of them developed and tested prototypes (Interhospitalaría: SC A; Fricón and Martinkas: SC B). The results of the field monitoring of SC B units have been shared with the manufacturers.

192. Face-to-face interactions were limited due to Covid-19 travel restrictions. Both DTI and Palfridge informed the reviewer that more personal interactions would have been beneficial for the technology transfer activities.

Achievement of Project Outcomes (MS)

Outcome 1: procure and install a total of 200 SC-A units in the three countries (MS).

193. A total of 130 units SC-A has been installed and field tested in Kenya (36), eSwatini (40) and Colombia (37). 65 SolarChill A fridges have been continuously monitored and data gathered have been analysed from 55. A total of 100 data loggers was purchased and installed while an additional 18 data loggers were part of the units from the manufacturers.

194. The Colombian ministry of health explained, during the mission to Colombia, how this project helped expand the vaccination coverage and rate in remote areas, reducing the needed logistics to replenish the vaccines stocks, and helped women to reduce the number of travels to vaccinate children.

195. The project, and from the field test results and related service calls, also helped the ministry identifying quality and reliable appliances for future possible purchases, and field test data helped manufacturers to improve the units' quality and cooling performance.

196. Few clinic managers indicated to the evaluator that the provided SC-A unites have a too small internal volume which reduces the number of stored vaccines and medicines.

197. Lack of clear after sales services and spare parts provision with manufacturers caused important delays in servicing the units in the field.

Outcome 2: development by more than one manufacturer of SolarChill B units. Procurement and field testing of 45 SC-B units (MS).

198. Palfridge in eSwatini and Fricon and Martinkas in Colombia developed SC-B prototypes. Only Palfridge reach an advanced development stage allowing the production of 40 field test units and deployed them in eSwatini and Kenya.

199. According to end-users of SC-B refrigerators, installing them helped small shops to increase their sales as it enabled them to sell cold products, they hadn´t been able to sell before.

200. Despite the relatively good electrification rate in eSwatini, owners of small shops highlighted the relevance of SC-B for their businesses as it reduces their

electrical bill. On the other hand, they complained about the too small internal volume of the units which reduces the amount of stored goods.

201. Complains from end users have been raised concerning the availability of spare parts and difficult communication with Palfridge.

202. Delays occurred due to interruptions on business operations arising from the COVID-19 pandemic (as highlighted by the PIR 2021 report) experienced by most partners, missing spare parts, administrative formalities, etc.

Outcome 3: information regarding SolarChill more widely available; increased industry interest in SolarChill A and B production in Latin America and Africa (MS).

203. Field test data have been collected from 55 SC-A units by DTI, analysed, and published on the SolarChill website. These results were also shared with manufacturers with the aim to help them address the technical issues, improve quality and performance of their products. From the 6 manufacturers, three responded to the invitation from DTI to have a one-on-one webinar on the specific issues detected in their specific product.

204. In Colombia, both Fricon and Martinkas decided to interrupt the development of SC-B units due to the high cost of certain components (such as the DC compressor and the solar panels). These high costs implied a too high price of the units for the target customers.

205. By the project end, and from the evaluator's field visits, all three manufacturers interrupted the development and production of SC-B units. Nonetheless, both Palfridge and Martinkas are planning to develop similar technologies building on the learnings they accumulated from the performed work on the SC-B technology.

206. No development nor production of SC-B technology has been initiated in Kenya.

Market outreach (MS)

207. The market outreach activities have shown significant interest from consumers and small businesses in SolarChill B units, which have not yet been met by a fitting supply chain (page 19-23 of GEF_SolarChill_A54_market study and emission reduction potential"). The high investment cost seems to be the most prominent limiting factor, which has not been addressed within the SolarChill project.

208. The market outreach could have been better by using up to date information on similar initiatives. It is notable that the report dates from January 2022 and it uses the "Global LEAP State of the Global Off-Grid Appliance Market Report 2016" instead of the https://www.clasp.ngo/rfps/state-of-the-off-grid-appliance-market-report/ from November 2018 and which builds on the report from 2016. It would have been interesting to include the more recent information. Other sources that were used date from 2013 and 2014, suggesting that the market report was written earlier in the project and not updated with recent data.

209. Cost reduction did not receive much attention according to the reviewer. The Project Plan foresees to work on cost reduction potential, few concrete actions

were reported. During the activities the only reporting action on reducing costs was by changing components in the design of SC-B.

Technology transfer (MS)

210. The technology transfer has not resulted in a new certified SolarChill A product. Local manufacturers such as Palfridge in eSwatini as well as Interhospitalaría, Martinkas, and Fricon in Colombia became SolarChill project partners. YPalfridge came close but did not manage to meet the WHO criteria, at the DTI laboratory, for their SC-A unit.

Achievement of Likelihood of Impact (MS)

211. The likelihood of impact is rated as moderately satisfactory.

212. **On one hand**, this project collected important and useful field data for end users (selecting quality units) and for manufacturers (for design and performance improvement). Also, detailed design guidelines, use instructions, and field technical data have been published for solar direct drive refrigerators.

213. Health benefits through improved vaccine storage (SC-A) in off-grid areas have been specifically reported during the visits to Colombia by the MoH. The Covid-19 pandemic showed indeed the importance of vaccine storage.

214. In Colombian remote areas, SC-A reduced the travel frequencies (especially for women) to vaccinate their children.

215. Reduced food spoilage (SC-B) in off-grid areas has not been reported but is a likely consequence of better temperature control of products.

216. SC-B allowed small business to improve their income by providing cold drinks and temperature sensitive food to local customers.

217. **On the other hand**, the mid- and long-term market impacts are limited. The project could have been more impactful in the following areas:

- Feedback from the market that the units' (SC-A and SC-B) internal volume is too small,
- SC-B unit's price is/still too expensive. Commercialisation is very challenging as the targeted end-users of SC-B are within the low-income population,
- Create new manufacturers,
- Drive more market competition.

218. The impact could be improved by better connection to other initiatives.

Rating for Effectiveness: **Satisfactory (S)**

E. Financial Management

219. Financial Management is rated as Satisfactory (S)

Adherence to UNEP's Financial Policies and Procedures (S)

220. Financial reports are clear and follows the relevant UNEP's policies. Hence the financial management is rated as satisfactory.

Completeness of Financial Information (S)

221. The below table 12 is meant to compare the estimated (budgeted) costs at design with the actual costs incurred. Although the financial reporting received is rigorous and complete with regards of the overall expenditures, the financial reporting does not show the actual split between the components. The reviewer assumes that the actual expenditure follows the budget revision 3, but this has not been documented by component expenditures due to limitations at conversion from IMIS to Umoja at the time this matter has since been resolved. The budget's final revision has been added as an extra column.

Table 12: Expenditure by Outcome/Output in USD ($).

Component/sub-component/output All figures as USD	Estimated cost at design	Budget Revision 3	Actual Cost/ expenditure	Expenditure ratio (actual/planned)
Component 1 / Procure and install 200 SolarChill A units in 3 countries	1.138.000,00	1.054.025,00	Not reported	
Component 2 / Laboratory testing of prototypes, procurement, and field testing of 15 SolarChill B units in each of the three countries (total of 45)	547.650,00	953.321,00	Not reported	
Component 3 / Information Dissemination and technology transfer.	827.000,00	371.343,00	Not reported	

222. Table 13 below summarizes the planned and actual costs per class of expenses. The grant was $2.712.150, of which $2.652.572 was spent, corresponding to 99%.

Table 13: summary of planned and actual costs per class of expenses.

Class	Original budget	Actual cost/Expenditures
010-IP-Staff and Other Personnel Costs	977,236.00	1,051,199.00
20-IP-Travel	12,560.00	48,093.00
30-IP-Contractual Serv	344,300.00	390,648.00

40-IP-Equipment, Vehicles and Furniture	1,069,554.00	764,815.00
50-P-Operating and Other Direct Costs	24,630.00	29,943.00
PMC010	213,870.00	346,678.00
Total	**2,642,150.00**	**2,631,376.00**
Monitoring and Evaluation	70,000.00	35,983.66
Monitoring and Evaluation - Payable		18,685.00
Grant Total	2,712,150.00	2,686,044.66

Unused **26,105.34**
99%

223. The timeline of the project has been extended three times and budgets have been moved between budget lines, thus reducing the funding of the outreach activities. The reviewer initially did not find a clear argumentation for this change in the revision packages, but further information was provided. Budget was moved away from Component 3 (Outreach) towards Component 2 (SC-B) in order to provide more budget for site visits, repairs and service, replace stolen components (e.g., solar panels), and additional interviews, which were helpful in analysing the overall impact of the project.

224. The respective half year and yearly technical reports give clear arguments why the project time frame had to be extended. These reports do mention the moving of funds between budget lines, but numbers are not given within these reports, just like in the in the financial reporting the split is not clear. The revision documents available to the reviewer also do not inform about the changes in the budgets, so it is hard to see on what basis the signatures were placed. From the budget lines reported in the tables above, it can be seen that the budget for component three has been significantly reduced, and from the financial tables received, it can be seen that the overall costs have been rigorously followed-up. The effect of the changes in the budgets cannot be judged positively nor negatively as technology transfer also happened informally in the components 1 and 2.

Communication Between Finance and Project Management Staff (S)

225. The communication has been evaluated through an interview with the finance staff and written questions that have been answered by the Project Management Staff.

Rating for Financial Management: Satisfactory (S)

F. Efficiency

226. Efficiency is rated as Unsatisfactory (U)

227. **SC-A Component 1:** only a total of 113 SolarChill A units have been installed compared the 200 foreseen. A key factor has been that the planned delivery from

Palfridge did not happen as the WHO PQS test results were seen as unsatisfactory and the remaining planned Palfridge units neither could be produced within the project closure period nor WHO PQS tested. GIZ, who had supported Palfridge since 2008 with the development, mentioned numerous challenges in the development such as that WHO PQS criteria had changed in during the development, that the capacities for product development at Palfridge had been over-estimated. The prototype came close to what was needed. It performed well during testing in the factory but failed during the testing at DTI which happened after closure of the SolarChill project. No staff from Palfridge had been invited to participate, in the development phase, due to budget constraints. For such a crucial step in the project, personal presence of the developers would have been crucial to meet the technical requirements.

228. **SC-B Component 1:** the number of procured and field-tested units are close to the foreseen in the project plant. While in Kenya and eSwatini there were 15 SolarChill B units installed, in Colombia there were 10 SolarChill B units installed at the manufacturer's facilities for benchmarking purposes during the development of their prototypes. Due to the Covid-19 pandemic, these prototypes stayed at the manufacturer's workshops. In Colombia, the two manufacturers, Fricón and Martinkas, had developed SolarChill B prototypes and tested them internally.

229. Data were largely gathered qualitatively instead of quantitatively. Although the information is insightful, it does not match the intentions of the project plan, which is to provide quantative data. It is worth mentioning that after the prototypes were prepared and the manufacturers considered them market worthy, they were reluctant to share the performance data and the project was helpless with that regard.

230. For the technology transfer, an extensive report was written. This was written early in the project, in 2017, so this was an efficient part of the project.

231. The project is spread over a too long period of time between the initial start and the project end, but it has been wise to extend the project that part of the planned outputs and outcome were realised.

232. The project end date was extended by 33 months, to September 2021, which is double of the time originally intended for the project implementation. This raises a red flag in the planning at the design phase in terms of time-efficiency (although could have been external circumstances).

233. The field test protocol and success criteria were not defined in the project plan and had to be developed during the project. The field test protocol is not available on the project website but was shared by DTI and the reviewer recommends that is made public. The protocol describes which qualitative and quantitative data should be collected and by which means. Technical details of the monitoring are available on the website in report "Webinar Materials: Digital Monitoring for Remote Settings. Experiences from the SolarChill Project".

234. The project missed opportunities to build on pre-existing institutions, agreements and partnerships, data sources, synergies and complementarities

with other initiatives, programmes, and projects etc. The prerequisite that no field tests had been done before the SolarChill project, was correct at the time of writing of the project plan, yet this was no longer the case when the project started in 2016. From the project design until the project started, results of other projects became available from which the SolarChill project could have benefited. For instance, the document SolarDirectDrive_WHO.pdf7 which is available on the Solarchill.org website, mentions field tests with solar driven refrigerators which were executed in 2011. The SolarChill project does not mention these tests but could have benefited from integrating these results to better prepare its' own field tests. The document from May 2013 describes field tests with Direct-drive solar vaccine refrigerators in Vietnam and Senegal. In Vietnam the Vietnam field test: Sure Chill® BLF 100 DC was tested, which uses R600a as refrigerant, but this model was not tested in SolarChill. The project could have benefited from further documentation and reports available to better prepare the monitoring. The report "Immunization Systems and Technologies for Tomorrow", a collaboration between the World Health Organization and PATH, contains paragraphs on "Implementation, Monitoring results, Acceptability and feasibility, Cost, Challenges and lessons learned". All these would have given the SolarChill project a head start.

235. At the start and during the SolarChill project, the team should have done web searches to find other organisations that promote solar powered off-grid refrigerators in order to correctly inform the project's own reporting. The field test protocol says that no SolarChill B products are on the market, but a quick search on the internet reveals that The 2017 Buyer's Guide for Outstanding Off-Grid Refrigerators[8] shows 17 models, available in 2017, but the project did not use this readily available information. The Verasol database[9] contains 95 models today of which 6 are solar direct drive types. The website https://verasol.org/solutions/test-methods also contains (laboratory) test methods for off-grid refrigerators, available since 2018 and from which the SolarChill project could have taken important focus points that were now missed. Efficiency and cool down time are crucial parameters in other measurement protocols but were not evaluated in the SolarChill B field tests. As a lesson learned it should be emphasised that projects need to use existing materials and methods and build on those.

236. Lack of after sales service agreement and spare parts provision agreement, with suppliers, caused delays in the field service activities.

237. Field test delays caused by missing parts at reception, delayed shipment of SC units, paperwork at customs, initial administrative delays and formalities led to a chain reaction of late deliveries. The delays were then aggravated by challenges in installations of units in very remote areas which the countries chose for field

[7] Evidence Brief - Direct-drive solar vaccine refrigerators-a new choice for vaccine storage https://www.solarchill.org/app/download/7410517856/SolarDirectDrive_WHO.pdf?t=1660747255 accessed 12-12-2022
[8] https://efficiencyforaccess.org/publications/global-leap-buyers-guide-refrigerators accessed 22-11-2022
[9] https://data.verasol.org/products/ref accessed 22-11-2022

testing (Site selection). Last, the Covid-19 pandemic came an additional and unavoidable cause for delay.

Rating for Efficiency: **Unsatisfactory (U)**

G. Monitoring and Reporting

238. Monitoring and Reporting is rated as Satisfactory (S).

Monitoring Design and Budgeting (MS)

239. This is considered moderately satisfactory. The budget lines have been changed significantly in three revisions. As mentioned in paragraph 124, the UMOJA financial reporting system and the spreadsheet templates did not foresee a financial reporting per outcome. As a consequence, the arguments for change in budget lines can be found in the spreadsheets but no overall argumentation is given, neither in the spreadsheet nor in the accompanying documents of the revisions. This is not so much a short-coming in the project, but the result of the way the financial reporting was organised. Meanwhile, this issue has been resolved.

240. Interestingly the third component received 55% less funding than initially foreseen, and this third component did not lead to fully satisfactory outcomes, as Palfridge and Interhospitaria being the only manufacturers aiming to produce SolarChill A units, failed to do so within the extended timeline of the SolarChill project. The Colombian manufacturers did start the development of SC-A but did not find compressors for an acceptable price, so the development was stopped. That being said, and from the meeting with Palfridge, it was mentioned that the request to Palfridge was to “produce a SC-A unit” instead of to “develop a SC-A unit”. An approach that limited Palfridge’s development work as they were tasked to reproduce an already existing design.

Monitoring of Project Implementation (HS)

241. This is rated as highly satisfactory from the provided documents. The half year reports, and the PIR reports give a very good sense of what happened in the project, the problems encountered, and the measures taken.

Project Reporting (S)

242. Rated as satisfactory. An extensive set of reports has been published on the website www.solarchill.org. One relevant report on the field test has been sent to the reviewer separately and was not available on the website. There are Annual, half year and expenditure reports and inception report that were not to be uploaded on the website. There are also a monthly ppt reflecting the minutes of the key stakeholders’ monthly meetings.

Rating for Monitoring and Reporting: **Satisfactory (S)**

H. Sustainability (S)

Institutional Sustainability (S).

243. Upon project closure, extensive documentation packages, handover letters have been prepared. The goods purchased in the project have been handed over as well as documentation and results of the field tests. This gave the possibility to end-users (e.g., ministries of health and different NGOs and international organizations) to select best quality and performing units.

Republic of Kenya

244. The Ministry of Health of the republic of Kenya

245. Christian Health Organisation of Kenya (CHAK)

246. Pawame

247. SolarFreeze

Colombia

248. Ministry of Health and Social Protection

249. Fricon Soluciones SAS

250. Interhospitalaría SAS

251. Martin Kas

eSwatini

252. The Ministry of Commerce, Industry and Trade of the Kingdom of eSwatini

253. The Ministry of Health of the Kingdom of eSwatini

254. Ministry of Natural Resources & Energy (MNRE) of the Kingdom of eSwatini.

255. eSwatini Environment Authority (EEA)

256. Palfridge

Socio-political Sustainability (HS)

257. From the field visits it was found that SC-A lead to improved logistics for vaccines and temperature sensitive medicines in remote areas e.g., more flexible stock, less stock replenishes needed (mainly in Colombia's remote clinics), etc. It also led to a better vaccines' coverage at the national level in Columbia where SC-A units were of great help during the COVID-19 pandemic.

258. For SC-B in eSwatini, it was found that the units are very appreciated by the beneficiaries as it opened the possibility of selling cold drinks and keeping other product cold despite the electrical cuts. Despite the recent improved country electrification (83% in 2023 according to the ministry of energy), the SC-B units still in use and appreciated as it reduces the electricity bills for those small and

fragile businesses. Yet the unit has too small storage capacity with regards to the user needs, purchasing and repair is also too expensive.

Financial Sustainability (MS)

259. No progress has been made on the price level of SolarChill technology, which is the largest hindering factor for its wider use. SolarChill A is a donor dominated market that is willing to pay high prices. The market for SC-A is relatively closed towards newcomers due to the WHO PQS criteria and the prequalification is required for entering. The SC-A prototype development by Palfridge was not only frustrated by problems within the development phase but also by an increased WHO PQS standards in the meantime.

260. Potential clients (owners of remote small shops) for SC-B cannot afford the same price tag as the clients for SC-A. The project did not focus on financial schemes to lower production costs and, consequently, the sales prices.

Rating for Sustainability: **Satisfactory (S)**

I. Factors Affecting Performance and Cross-Cutting Issues

261. Rated as Satisfactory (S)

Preparation and Readiness (MU)

262. Due to the long preparation phase which caused some assumptions to be partly outdated at the start of the project. No major measures were taken neither to address weaknesses in the project design. In fact, no third-party design review has been performed to evaluate the project conception and identify potential gaps (this is a recommendation from the reviewer for future UNEP projects).

263. Preparation and Readiness is rated Moderately Unsatisfactory (MU).

Quality of Project Management and Supervision (S)

264. The quality of project management and supervision was Satisfactory (S). The project was well managed given the difficult implementation and monitoring circumstances. According to all interviewed (online interviews and during the countries' visits) project partners, the information was timely provided to stakeholders.

265. The project implementation adhered substantially to the project document, except for the no-cost extension, no other major adaptive decisions were made.

266. Quality of Project Management and Supervision is rated Satisfactory (S).

Stakeholders Participation and Cooperation (MS)

267. According to the interviewed stakeholders and the countries' missions performed by the reviewer (e.g., meetings with ministries, project partners other national organizations, etc.), the cooperation between the project and the national

partners was good apart from some issues in Kenya related to the non-exemption from import tax of the SolarChill units.

268. Local technicians received basic trainings for equipment servicing.

269. Manufactures proved to be less motivated to share knowledge with the project, but overall, the participation was good.

270. Stakeholders Participation and Cooperation is rated Moderately Satisfactory (MS).

Responsiveness to Human Rights and Gender Equality (S)

271. The nature of the project did not leave much room for mainstreaming human rights and gender equity in the implementation and in the results of the project.

272. There was no specific plan or action on human rights and gender equality but arguably women benefit from better health care for their children and reduced travel time and frequency to the medical clinics, as they tend to be in charge of taking care of them.

273. Participation of women and men in project activities was conditional on their roles in the respective ministries / institutions. The reviewer noticed a fair (around 50%) gender representation at the multiple meetings during the country visits in Colombia and eSwatini.

274. Finally, the nature of the project outputs and outcome is gender neutral.

275. Responsiveness to Human Rights and Gender Equality is rated Satisfactory (S).

Environmental and Social Safeguards (S)

276. The project adhered to the environmental and social safeguards laid out in UNEP policy. The project focusses on an environmentally benign technology (using natural refrigerant R600a, no batteries used, and reducing the reliance on Diesel electrical generators) with positive social safeguards but it did not address these within its own work.

277. Environmental and Social Safeguards is rated Satisfactory (S).

Country ownership and Drivenness (HS)

278. Apart from the co-financing issue (in Kenya) mentioned above, the country ownership was high and greatly helped the implementation of the project in the three countries. Different ministries were physically involved in the equipment's on-site mounting (e.g., the ministry of commerce in eSwatini), which was confirmed during the reviewer's field visits.

279. In addition to the above, the ministries availing the clinics for this field study, the nurses and/or local technicians allocating time to maintain the units and engaging with partner on feedback and collaboration with project partners, tax

exemption and equipment's transport in Colombia and eSwatini with significant support for equipment's installation.

280. The only issue was in Kenya related to the promised exemption from import duties. As the customs did not accept the previously agreed free-of-charge import duty of the SC units, the project had to import the less expensive units in order to cover the financial gap.

281. Country ownership and Drivenness is rated Highly Satisfactory (HS).

Communication and Public Awareness (S)

282. Communication was well done but missed some attention at the end of the project, with missing updates of the website. The ministry of natural resources and energy (MNRE) in eSwatini wasn't aware of the website and the data that being published.

283. On the other hand, the project organized multiple webinars and published papers on the SolarChill technology.

284. Communication and Public Awareness is rated Satisfactory (S).

Rating for Factors Affecting Performance and Cross-Cutting Issue:	**Satisfactory (S)**

VII. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Project objectives and incremental values achieved.

285. The key aim of the SolarChill project was to conduct standardized field-testing of off-grid solar powered vaccine and commercial refrigerators across different countries, climate zones, and brands. A secondary aim was to provide learnings, from the field testing to manufacturers in order to bring solar refrigerator technology to a breakthrough point of higher market penetration, especially for health facilities, domestic use, and small businesses in off-grid areas.

286. The project delivered on field testing of solar-powered vaccine coolers without batteries (SC-A) and provided data and confidential feedback to manufacturers of these products. The numbers deployed are 113 of the 200 planned or 57%. 65 of the 113 provided quantitative data or 33% of the planned number.

287. The project did not deliver fully on the planned field testing of solar-powered coolers without batteries for household and commercial applications. 40 of the planned 45 were installed (89%). Of these, only one location reported temperature measurement data. The qualitative data, through questionnaires, do give a positive overall view on the SC-B technology.

288. The technology transfer package towards manufactures produced one outcome: a report. In terms of knowledge transfer, the work from HEAT and GIZ in the field has certainly contributed to the knowledge transfer to manufacturers in eSwatini and Colombia.

Answers to strategic questions.

289. In agreement with the Terms of Reference (ToR), the review has been structured around strategic questions on the achievement of the project objectives as stated in the project document which are[10]:

290. **Q1:** What alternative approaches have been implemented to ensure Palfridge succeeded in developing a SC-A vaccine refrigerator that passed the internal manufacturing testing protocol to enable for independent testing at DTI and obtain WHO prequalification?

291. **A1:** from the field visit and meeting with Palfridge, three key issues were raised, 1) the need for a direct on the ground (face-to-face) support from DTI performance optimization (instead of the online support), 2) more freedom for Palfridge to adjust the SC-A technology instead of replicating an existing design with very little room for adjustments, and 3) many partners highlighted the need for a procurement support to find alternative suppliers for expensive components

[10] Strategic questions from Inception report

(e.g., DC compressor, PV panels, etc.) to be able to reduce their production costs. From the field visit and the meeting with Palfridge, it was highlighted that Palfridge did not has the freedom to develop their own SC-A design, instead they were asked to build a proto based on an existing third-party model.

292. **Q2:** what value has the collected data from the field monitoring in contributing to changes or improvement in production or business operations by the manufacturers based on the units' performance results?

293. **A2:** the field monitoring data for SC-A showed both, the potential of the SolarChill technology as well as some quality issues for certain tested products. This type of data was not available before and is of value to 1) manufacturers so that they can improve their product's reliability, and 2) to end-users to make informed purchasing decision.

294. The field test identified few recurrent failures of certain models which was communicated to the relevant suppliers for design adjustment. Another key value of the field test is the identification, by the beneficiaries, of the most reliable models for future purchases.

295. **Q3:** What has been the impact of the installation of SolarChill-A units in the various clinics and the future possibilities by the various ministries in procuring similar models for other facilities?

296. **A3:** Three common feedback from the field, 1) increased vaccination capacity especially during the Covid-19 pandemic, 2) reduced vaccines replenish rate, and 3) based on the field performance, beneficiaries (e.g., ministries of health) identified the most reliable models for future purchases.

297. Increasing the stock of vaccines in remote clinics is the main impact especially in Colombia where access to certain locations is extremely difficult. On the other hand, clinics' managers in eSwatini (where road access is easier compared to Colombia) indicated the need for a larger unit to increase the storage capacity.

298. **Q4:** what prospects exist in large scale production and commercialisation of the SC-B model units developed by participating manufacturers under the project?

299. **A4:** as mentioned earlier, SC-B technology suffer a high purchase price for large majority of potential end-users hindering a wider market penetration of this specific SC technology. That being said, multitude initiatives have emerged, not necessarily following the rigid quality guidelines from SolarChill but offering solar cooling solutions with ice batteries e.g., the system inspired by the SC project and developed by Martinkas in Colombia.

300. From the meetings with all participating manufacturers, and the profile of end-users, SC-B's current design has little chance to be commercialized due to its high purchase price.

Strengths of the project.

301. Based on the findings from this review, the project demonstrates performance at the satisfactory level. The project has demonstrated robust performance in the

areas of field testing of solar direct drive refrigerators for vaccines (SC-A). Areas that would benefit/would have benefited from further attention are the solar direct drive refrigerators for food (SC-B), which should have received the same attention.

302. Based on the info collected by DTI, manufacturers received specific field data identifying the technical issues in order to improve the units' design for better performance and higher quality. Three manufacturers responded to the invitation to have a webinar explaining the issues with their specific product without informing the competitors.

303. The SolarChill project helped to improve the vaccines logistics for remote clinics, especially in Colombia. In Colombia as well, it was reported by the Ministry of Health that the supply of vaccines could now be done on monthly basis (or longer in some cases) instead of on a weekly or bi-weekly basis, and it also improved the vaccination coverage in remote areas.

304. The project encouraged suppliers in the partner countries to develop their own SC-A and SC-B technology.

305. The performed field test and the supplied data helped relevant ministries of health to determine the most qualified supplier for future purchases of SolarChill A units.

306. The SolarChill website supported the dissemination of field test results, although some stakeholders (e.g., the ministry of energy in eSwatini) wasn't aware of the publications on the SC website of the field test results.

Weaknesses of the project

307. Lack of an after sales agreement and spare parts provisions caused delays in field service and maintenance of the deployed units (SC-A and SC-B).

308. Despite the higher electrification rate in eSwatini, SC-B is highly appreciated by the end-users as it reduces their electrical bill. Nevertheless, the high price and

309. low storage capacity is a significant barrier to wider commercialisation of these units.

310. In line with the above comment, end-users should have been consulted at the project's inception to better understand their needs, and consequently, provide the relevant product.

311. The commitment on co-financing did not happen as committed, especially in Kenya.

B. Summary of project findings and ratings

312. The Table 14 below provides a summary of the ratings and finding discussed in Chapter VI. Overall, the project demonstrates a rating of 'Satisfactory.'

313.

UNEP Evaluation Office Validation of Performance Ratings:

The UNEP Evaluation Office formally quality assesses (see Annex VIII) management led Terminal Review reports and validates the performance ratings therein by ensuring that the performance judgments made are consistent with evidence presented in the Review report and in-line with the performance standards set out for independent evaluations.

The Evaluation Office assesses a Terminal Review report in the same way as it assesses the initial draft of a Terminal Evaluation report. It applies the following assumptions in its validation process:

– That what is being assessed is the contents of the report and the extent to which it makes a consistent and justifiable case for the performance ratings it records.

- That the consultant has, within the report, presented all the evidence that was made available to them.

- That the Review has been based on a robust Theory of Change, reconstructed where necessary, which reflects UNEP's definitions at all levels of results.

- That the project team and key stakeholders have already reviewed a draft version of the report and provided substantive comments and made factual corrections to the Review Consultant, who has responded to them. The Evaluation Office assumes, therefore, that it has received the Final (revised) version of the report.

In this instance the Evaluation Office validates the overall project performance rating at the **'Moderately Satisfactory'** level.

Table 14: Summary of project findings and ratings.

Criterion	Summary assessment	Rating	Justification for any ratings' changes due to validation (to be completed by the UNEP Evaluation Office – EOU)	EOU Validated Rating
Strategic Relevance		HS	**Rating validated**	**HS**
1. Alignment to UNEP MTS, POW, and Strategic Priorities	Well aligned with UNEP MTS and strategic priorities as it addresses multiple crisis: health, climate, energy security.	HS	Rating validated	HS
2. Alignment to Donor/GEF/Partner's strategic priorities	Good, as the partner countries benefit from increased knowledge and technology.	HS	Rating validated	HS
3. Relevance to global, regional, sub-regional and national environmental priorities	Applicable to many regions in the "global south".	HS	Rating validated	HS
4. Complementarity with relevant existing interventions/coherence	The project did not use or build on other initiatives to implement and test off-grid refrigerators. Nonetheless, it's aligned with the countries phase-out plans of HCFCs and HFCs	MS	Rating validated	MS
Quality of Project Design	Clear alignment on stakeholders' goal but the design was not done with the stakeholders. The spread over three countries in two continents made the execution more difficult then would have been necessary to realise the outcomes 1 and 2 (field testing data).	S	Rating validated	**S**
Nature of External Context	The external context was difficult due to Covid-19, difficult access to the sites, and the geographical spread of the project.	U	As indicated in the section on the Nature of External Context (para. 162), "The initial timeline was 03 June 2016 – 31 March 2018, well before the Covid-19 pandemic". Also, the first two project extensions were granted before COVID-19 was declared a pandemic by WHO in March 2020. Therefore, COVID-19 is considered to have partially affected the project implementation. Rating adjusted to 'Moderately Unfavourable'.	**MU**

Criterion	Summary assessment	Rating	Justification for any ratings' changes due to validation (to be completed by the UNEP Evaluation Office – EOU)	EOU Validated Rating
Effectiveness	Effectiveness was negatively affected by the geographical spread and the long timelines for project development and execution.	S	**Aggregated from below. The correct aggregation of the ratings provided by the Reviewer is MS.**	**MS**
1. Availability of outputs	Good	S	Targets were not quite met (56%of SC-A units installed; 86% of SC-B units) but largely for reasons outside the project's control. The units that were installed could have provided sufficient tested evidence to prove the technological concept. However, the lack of quantitative test data (para 231) limits the utility of the project's output level achievements. Yet, the project has generated learning, within a complex setup, such that further steps can be taken. Rating validated.	S
2. Achievement of project outcomes	Good	MS	There is evidence of partial take up. The Evaluation Office notes that the project's intentions were ambitious. Rating validated.	MS
3. Likelihood of impact	Could have been more impactful on units' design, reducing units' price, develop new manufacturers, and drive more market competition.	MS	Rating validated.	MS
Financial Management		S	Rating validated. However, the Evaluation Office notes that the ratings of the three Financial Management sub-criteria presented in table 9 are not consistent with what presented in the narrative section (page 52-54) and in this table.	**S**
1. Adherence to UNEP's financial policies and procedures	Good	S	Rating validated.	S
2. Completeness of project financial information	Complete but some intermediate decisions cannot be traced.	S	Rating validated.	S

Criterion	Summary assessment	Rating	Justification for any ratings' changes due to validation (to be completed by the UNEP Evaluation Office – EOU)	EOU Validated Rating
3. Communication between finance and project management staff	Good	S	Rating validated.	S
Efficiency		U	Rating validated.	**U**
Monitoring and Reporting		S	**Aggregated from below**	**MS**
1. Monitoring design and budgeting	Good with some gaps.	MS	Rating validated. Even though not mentioned in the respective narrative section on 'Monitoring design and budgeting', a monitoring plan is presented as an Annex (G). For each indicator, the plan indicates the data collection frequency, responsibility, means of verification and budget. However, the latter does not seem appropriate. The project also carried out a Mid Term Review although this Review report contains little reference to it. and it is not clear whether the findings from the MTR	MS
2. Monitoring of project implementation	Good.	HS	The project had a monitoring plan and workplan and funds were spent on monitoring. However, the report presents no evidence that baseline data and/or project implementation data were collected, or that data collected was disaggregated by vulnerable/marginalized groups, including gender. Rating adjusted to 'Moderately Satisfactory'	MS

Criterion	Summary assessment	Rating	Justification for any ratings' changes due to validation (to be completed by the UNEP Evaluation Office – EOU)	EOU Validated Rating
3. Project reporting	Good, the overall end reporting is very extensive.	S	There is no mention on the fact that project reporting was carried out with respect to the effects of the initiative on disaggregated groups. The report notes that 'end users' were not considered as a central group at design (para 110) but play a substantive role in any uptake from the project. A more differentiated view of the project's stakeholders would have been beneficial. Rating adjusted to 'Moderately Satisfactory'	MS
Sustainability		S	**The weighted ratings approach of the Evaluation Office aggregates the three sub-categories of sustainability to the lowest of the three – this is because they are considered to be mutually limiting.**	**U**
1. Socio-political sustainability		HS	The sustainability of project outcomes appears to have a moderate degree of dependency on social/political factors. Also, there is fairly strong ownership, interest and commitment among government and among other stakeholders but it does not reach the levels which have the power to sustain the project outcomes. Rating adjusted to 'Moderately likely'.	ML

Criterion	Summary assessment	Rating	Justification for any ratings' changes due to validation (to be completed by the UNEP Evaluation Office – EOU)	EOU Validated Rating
2. Financial sustainability		MS	Rating adjusted to 'Unlikely' based on the evidence presented in the narrative section. No future funding requirements have been secured and no exit strategy has been developed. Para 156: "*High initial price of SC-A and lack of a clear plan on how it will be reduced to allow mass adoption are a major barrier. This price barrier will be even more impactful on the SC-B units as it impacts remote population with lower income level. Key drivers of these high initial prices are mainly related to component prices such as DC compressor and solar panels. Therefore, the intention to have SC-B units for the off-grid lower income bracket like individual is still not feasible without relevant financing schemes such as micro-financing and pay-as-you-go*". Despite the above, it is still possible for there to be some donor funding and it reads as if the project has generated some buy in. It is not clear if there will be a follow-on project as the report is a bit ambiguous.	U
3. Institutional sustainability		S	The sustainability of project outcomes appears to have a moderate degree of dependency on institutional support. The project did not have an exit strategy. Para 156. States that "*However, after the project closed there was not structure put in place to continue supporting Ministries/Clinics to keep getting the after-sale services with the exit of the project*." Rating adjusted to 'Moderately Unlikely'.	MU

Criterion	Summary assessment	Rating	Justification for any ratings' changes due to validation (to be completed by the UNEP Evaluation Office – EOU)	EOU Validated Rating
Factors Affecting Performance		S	**Aggregated from below**	**S**
1. Preparation and readiness	Long preparation phase causing some assumptions to be partly outdated at the start of the project.	MU	Rating validated.	MU
2. Quality of project management and supervision	Good, but closer follow up of the targets would have been helpful.	S	Although not discussed explicitly the project progress and delivery implies a considerable amount of 'steering' - relationship building, negotiating, relationship building etc. Likewise, the report implies the continued engagement and positive approach from partners. Rating validated.	S
2.1 UNEP/Implementing Agency:	Good	S	Rating validated.	S
2.2 Partners/Executing Agency:	Good	S	Rating validated.	S
3. Stakeholders' participation and cooperation	Less good than expected especially in Kenya.	MS	Rating validated.	MS
4. Responsiveness to human rights and gender equality	Not explicit in the project's objectives, nevertheless, no red flags as it helped women to better take care of their children	S	Rating adjusted to 'Moderately Satisfactory' as evidence suggests weak human rights/gender considerations in project implementation	MS
5. Environmental and social safeguards	Good.	S	Evidence presented in para. 276 and 277 suggests that environmental and social impacts were considered or addressed to a moderate extent. Rating adjusted to 'Moderately Satisfactory'.	MS
6. Country ownership and driven ness	Good.	HS	Rating validated.	HS
7. Communication and public awareness	Good but some direct project partners were not aware of the existence of the SC website.	S	Rating validated.	S
Overall Project Performance Rating	GOOD.	S	**The Evaluation Office notes that the correct aggregation of the ratings provided by the Reviewer is MS. Overall rating validated.**	MS

C. Lessons learned.

Lesson 1. ***Only remote technical support is not enough in complex projects.***

314. The technical support in eSwatini happened mainly online, yet feedback from Palfridge and DTI confirm that DTI should have travelled to eSwatini to locally support Palfridge in the final development and testing of the SC-A prototype.

315. Likewise, the field monitoring, being the key activity of the project, suffered from the fact that the experts implementing the monitoring, were not planned to travel and did not do so. This is a major cause for missing monitoring data in a significant part of SC-A and SC-B.

Lesson 2. ***Local presence of suppliers is essential.***

316. Procurement should have paid extra attention to the local presence of suppliers (or their official representative), to put in place a solid after sales agreement and spare parts provision, helping to achieve a timely service lead time. For instance, Vestfrost and Godrej do not have a local presence in Colombia and in eSwatini. These factors were not considered enough in the procurement phase but lead to difficulties in the implementation. For instance, when parts break, and they always do, repairs need to be done within a reasonable amount of time, this delay needs to be agreed upon up front and the local end users need to be able to easily launch a service call.

Lesson 3. ***The world around the project evolves as well.***

317. Strikingly tests with direct drive solar vaccine chillers had been executed and reported by others after the initial writing of the SolarChill project plan but before the start of the project. Also, measurement methods for such products had been documented elsewhere. It is good to have a project plan and stick to it, but it would help to look around, occasionally do some searches, and see what is new in this field.

D. Recommendations

Recommendation 1. ***Foresee face-to-face interactions during technology transfer work.***

318. Challenge/problem to be addressed by the recommendation: the technical development at Palfridge in eSwatini has suffered (as it was confirmed during the reviewer's field trip) from a lack of personal interactions with the international

experts supporting Palfridge. The goal to develop a WHO certified SolarChill A was thus not reached.

319. Priority Level: Critical

320. Type of Recommendation: Project Level

321. Responsibility: UNEP

322. Proposed implementation timeframe: Future technology projects implemented in the field.

323. Cross-reference(s) to rationale and supporting discussions: paragraph 192.

Recommendation 2. During procurement, pay attention to local presence of suppliers for after sales services and spare parts.

324. Challenge/problem to be addressed by the recommendation: Procurement staff was in a different time zone (Europe) and did not speak Spanish (Colombia). Support was not clearly included during procurement. The aim of the recommendation is to reduce service lead-time.

325. Priority Level: Critical

326. Type of Recommendation: Project Level

327. Responsibility: UNEP

328. Proposed implementation timeframe: Future projects that involve procurement of equipment for end users/beneficiaries.

329. Cross-reference(s) to rationale and supporting discussions: paragraph 156.

Recommendation 3. The project design should contain explicit tasks for the project team to make use of and to build upon pre-existing institutions, agreements and partnerships, data sources, synergies and complementarities with other initiatives, programmes, and projects.

330. Challenge/problem to be addressed by the recommendation: Before the project start and during the SolarChill project, others were testing SC-A refrigerators and rolling out SolarChill B initiatives without the project team seemingly being aware of this. The WHO has done field tests of Solar direct drive before the start of the SolarChill project. As a result, the number of possible

partners remained limited, and the outreach and technical dissemination activities did not reach these other initiatives.

331. The reviewer recommends that future project plans are screened so that they include a planned activity which is building upon other initiatives, complementary to the project.

332. Priority Level: Critical

333. Type of Recommendation: Project Level

334. Responsibility: Project Implementing and Executing Partners

335. Proposed implementation timeframe: Future projects that experience long gaps from the time of project development to execution.

336. Cross-reference(s) to rationale and supporting discussions: paragraph 234.

Recommendation 4. See reduction of costs as a relevant factor in UNEP projects as lower costs facilitates the introduction of new technologies.

337. Challenge/problem to be addressed by the recommendation: Cost reduction was not an explicit task in the project plan although it was a target in the project's results framework.

338. Priority Level: 1

339. Type of Recommendation: Programme level

340. Responsibility: UNEP

341. Proposed implementation timeframe: One year

342. Cross-reference(s) to rationale and supporting discussions: paragraph 234 and 259.

Recommendation 5. Foresee an "Initial Project Review".

343. The reviewer recommends for future projects, to foresee an "Initial Project Review" exercise, by an external expert, to identify weakness and/or gaps in the project structure before the execution and implementation process starts.

344. Responsibility: UNEP, Project Manager

345. Proposed implementation timeframe: Two month

ANNEX I. RESPONSE TO STAKEHOLDER COMMENTS

Table 15 Response to stakeholder comments received but not (fully) accepted by the reviewers, where appropriate

Page Ref	Stakeholder comment	Reviewer Response
11	The project achieved numerous valuable outcomes that significantly advanced the goal of making solar refrigerator technology accessible in off-grid regions of developing countries. Despite some challenges, the project fully delivered on critical aspects including identifying over 150 installation sites across 3 developing countries in 2 continents, procuring units from 8 different manufacturers, and providing continuous monitoring of performance over a one year period. The extensive data gathered from multiple climates, terrains, and manufacturers provided statistically robust insights into the technology's real-world performance, applicability, and reliability. By reflecting these learnings in publicly available procurement guidelines for manufacturers, the project meaningfully improved the production quality and suitability of solar refrigerators for vulnerable populations in off-grid settings. Moreover, the project highlighted the immense potential of solar refrigerator technology to enable accessible vaccine storage and health services in remote regions that lack reliable electricity access. As the COVID-19 pandemic underscored, equitable and widespread vaccination coverage globally is an urgent health and climate adaptation priority. By driving technology improvements and deployment knowledge, this project made a significant contribution to making reliable cold chain infrastructure feasible in off-grid developing country contexts. While certain aspects such as field monitoring fell short of expectations, the project excelled in executing installations across 150 sites, gathering performance data, feeding insights back to manufacturers, and producing actionable guidelines. Given the complexity of coordinating field research across 3 developing countries, the project delivered valuable evidence, capacity building, and technology advancement that can help expand access to life-saving vaccines and medicines worldwide. The project's accomplishments and potential impact on health equity through climate-resilient infrastructure could be better highlighted, both in the Executive summary, the report and the rating of the project.	The reviewer understands and agree that good work has been done, yet looking at the overall achievements, the review leads to a satisfactory rating. The remark that learnings have been reflected in available procurement guidelines for manufactures, cannot be confirmed by the evaluator, based on the available documents. The project collected data indeed, but it did not lead to a verifiable improvement in the availability of affordable SolarChill technology to those who would benefit. None of the 4 partner manufacturers commercialized SC technology. From the interviews and field visits, all 4 of them confirmed, that mainly due to component price, there is no business case currently for such technology especially for SC-B.

Page Ref	Stakeholder comment	Reviewer Response
Review of efficiency	The 3-year timeline extension was largely outside project control. Delays due to COVID-19, customs, administrative issues should not warrant an Unsatisfactory rating. An MS rating would be more appropriate. I had pointed out during mid-term review also that a project of this nature that required prototyping of a new technology, technology transfer, 3 years is not sufficient time, and 5-6 six would have been the minimal requirement. But the project due to budgetary constraint was designed for 3 years, but eventually due to great understanding and in-kind contribution of the consortium partners, it was stretched to 5 years without any additional budget. I do think that all consortium partners including Greenpeace representative made huge time and outreach contribution that this report has not considered. If we monetize those contribution, it will be quite a huge amount.	While designing a new project, the timeline needs to reflect the actually needed time, so that the initial budget does not get overstretched or diluted. The reviewer does agree that some out-of-control circumstances led to delays in the project implementation, nevertheless, the project was extended 3 times (before and during COVID), without additional budget. This is an indicator of low efficiency. The reviewer did indicate the reasons for these delays in the report, but it's a fact that efficiency is not there. It's unrealistic to give any positive rating to efficiency. If the consortium new, from day-one, that the project timelines are too short, they (consortium members) should have better negotiated with the donor for a longer timeline.
	On paragraph "The project did not deliver fully on the planned field testing of solar-powered coolers without batteries for household and commercial applications. 40 of the planned 45 were installed (89%). Of these, only for one location, temperature measurement data have been reported." That´s too simple and incorrect: It should be mentioned that data loggers were installed, that reporting mainly took place through interviews though due to connectivity issues. Please refer to the **individual country reports where it´s clearly outlined unit was equipped with data loggers**. In SWA all 15 unit were equipped with data loggers. In COL the SCB units were installed at the technology transfer manufacturer facilities (even though there were not in the field, data loggers were installed). In KEN the SCB units were installed and managed by CHAK and local distributers (Pawame, SolarFreeze). Data loggers were installed partly.	The reviewer understands the explanation (although, and according to end-users, these interviews to collect data were not performed for the full duration of the field test), but the fact is that only 65 SC-A (out of 113) gave data and from SC-B no hard data were collected through the monitoring.

Page Ref	Stakeholder comment	Reviewer Response
	the Fridge Factory and Martin Kas in Columbia have the potential to produce at lower prices than current market prices of similar capacity.	"The potential", maybe so, but both companies did not go any further with the development of SC technology. Both are planning to develop something similar yet using AC compressors, batteries, and an inverter. So, both might have the potential, but they are not planning to do so due to a poor business case (too high cost for a successful commercialization).

ANNEX II. PEOPLE CONSULTED DURING THE REVIEW

Table 6: People consulted during the terminal review.

Organisation	Name	Position	Gender
HEAT International	Dietram Oppelt	Managing director	M
HEAT International	Nancy Finger	Project Manager	F
DTI	Ivan Katic	Senior Specialist (Monitoring)	M
UNEP, Nairobi	Fatma Twahir	Financial specialist	F
UNEP, Nairobi	Peter Mwanzia Musau	Financial specialist	M
UNEP, Nairobi	Cicilia Magare	Senior Programme Management Assistant GEF Climate Change Mitigation Unit, Economy Division	F
HEAT International	Carlos Ferney	Tech Manager	M
Ministry of Health, Colombia	William Robles	Partially attended,	M
Ministry of Health, Colombia	Carmen Elisa	Partially attended,	F
Ministry of Health, Colombia	Natalia Zuluaga	Ministry of Health, Colombia	F
Fricon Colombia	Susana Suarez	Unit Design Manager	F
Fricon Colombia	Jason Rubio	Production and testing Manager	M
Ministry of Environment, Colombia	Nidia Pabon	Ministry of Environment, Colombia	F
Ministry of Environment, Colombia	James Mendoza	Ministry of Environment, Colombia	M
Martinkas, Colombia	Mauricio Martinez	Founder and Owner	M
Martinkas, Colombia	Sylvia Casas	Design Manager	F
Interhospitalia, Colombia	Carlos Guevara – Founder/Owner and CEO	Founder/Owner and CEO	M
GIZ Proklima	Nils Hansen	Project Consultant	M
EEA Eswatini	Thabile Dlamini		M
Ministry of Health, Eswatini	Simon Zwane	Ministry of Health, Eswatini	M
Ministry of Natural Resources and Energy (MNRE), Eswatini	Charlazi Dlamini	Ministry of Natural Resources and Energy (MNRE), Eswatini	F
Ministry of Commerce, Industry and Trade, Eswatini	Patricia Mamba	Ministry of Commerce, Industry and Trade, Eswatini	F
Palfridge, Eswatini	Markus Potgieter	Technical Manager	M

ANNEX III. KEY DOCUMENTS CONSULTED

Project planning and reporting documents

- Project Document Package
- Inception Report
- Mid-term Review Report
- Periodic Financial Statement Reports
- Half Yearly Progress Reports
- Annual Project Implementation Reports
- Project Revision Packages
- Project Final Report
- Periodic project meeting and advisory reports
- Technical Solarchill Reports on Outputs
- Project website

Project outputs – Overall

SolarChill Leaflet

OzoNews-Vol_XVII

SolarChill A (Vaccine and medical use)

SolarChill B (Commercial use)

Download

Evidence Brief - Direct-drive solar vaccine refrigerators-a new choice for vaccine storage

Archive

SolarChill Info

Training Materials

Training Module 1 - Introduction

Training Module 2 - Installation

Training Module 3 - Commissioning & Operation

Training Module 4 - Monitoring

Training Module 5 - Maintenance

REPORTS

SolarChill - Market Study and GHG emission reduction potential

SolarChill - Technology Transfer Guide for SDD refrigerators for Vaccine and Fresh Food Storage

SolarChill - Experimental investigation of solar powered vaccine chillers in the field

Webinar Materials: Digital Monitoring for Remote Settings. Experiences from the SolarChill Project

SolarChill Fieldtest Report

Previous reviews

Final Mid-term Review Report of the GEF UNEP Project "SolarChill Development, Testing, and Technology Transfer Outreach"

ANNEX IV. PROJECT BUDGET AND EXPENDITURES

Table 16: Expenditure by Outcome/Output

Component/sub-component/output All figures as USD	Estimated cost at design	Actual Cost/ expenditure
Component 1 / Outcome 1	1.138.000,00	1.054.025,00
Component 2 / Outcome 2	547.650,00	953.321,00
Component 3 / Outcome 3	827.000,00	371.343,00

Table 17 Signed co-finance report

ANNUAL CO-FINANCE REPORT - OVERALL PROJECT REPORT

Project title:	SolarChill Development, Testing, and Technology Transfer Outreach				
Project number:	GEF ID 4682				
Project Implementing Agency:	UNITED NATIONS ENVIRONMENT PROGRAMME				
Project Executing Agency:	SKAT FOUNDATION				
Project implementation period:	**From:**	01.07.2016	**To:**	30.09.2021	
Co-finance reporting period:	**From:**	01.07.2016	**To:**	30.09.2021	

No.	Co-finance partner name	Type of co-finance	Prior Years Actual Total	Current reporting period						*Planned Total*	Cummulative Actual Total
				C1	C2	C3	C4	PMC	Total		
1	GIZ	In-Kind	5.410.000						5.410.000		**5.410.000**
2	Colombia Ministry of Health	In-Kind	68.201						68.201		**68.201**
3	Christian Health Association of Kenya	In-Kind	12.640						12.640		**12.640**
4	Eswatini Environment Authority	In-Kind	3, 151						3, 151		**3, 151**
5	Ministry of Commerce, Industry and Trade - Esv	In-Kind	16.204						16.204		**16.204**
6	Ministry of Natural Resources and Energy - Esw	In-Kind	1, 351						1, 351		**1, 351**
7	Ministry of Health - Eswatini	In-Kind	147.174						147.174		**147.174**
8									-		**-**
9									-		**-**
10									-		**-**
Total			**5.654.219**	**-**	**-**	**-**	**-**	**-**	**5.654.219**	**-**	**5.654.219**

Name: Sanjay K Gupta
Project Manager

Signature:

Date: 15-3-2023

ANNEX V. FINANCIAL MANAGEMENT

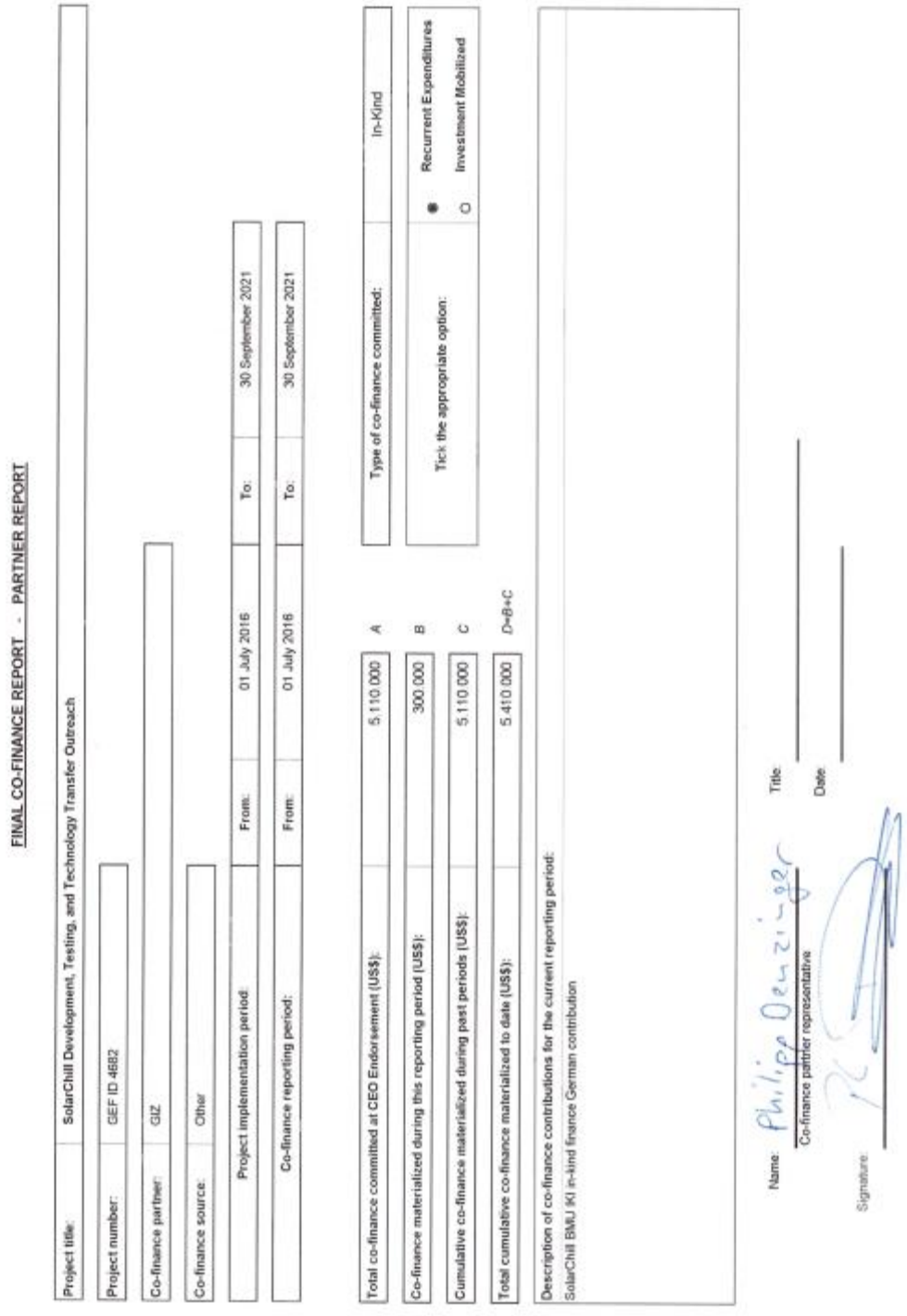
Table 9: Financial Management table.

Financial management components:		Rating	Evidence/ Comments
1. Adherence to UNEP's policies and procedures:		HS:HU	
Any evidence that indicates shortcomings in the project's adherence11 to UNEP or donor policies, procedures, or rules		No	
2. Completeness of project financial information12:			
Provision of key documents to the reviewer (based on the responses to A-H below)		HS:HU	
A.	Co-financing and Project Cost's tables at design (by budget lines)	Yes	
B.	Revisions to the budget	Yes	Provided in excel table
C.	All relevant project legal agreements (e.g., SSFA, PCA, ICA)	No	Not received
D.	Proof of fund transfers	No	Not received
E.	Proof of co-financing (cash and in-kind)	No	Nov 2022 The office is working on collecting these.
F.	A summary report on the project's expenditures during the life of the project (by budget lines, project components and/or annual level)	Yes	
G.	Copies of any completed audits and management responses (where applicable)	Yes	The audit reports on factual findings are NOT audit in accordance with Swiss Auditing Standards
H.	Any other financial information that was required for this project (list):	Yes/No or N/A	
3. Communication between finance and project management staff		HS:HU	
Project Manager and/or Task Manager's level of awareness of the project's financial status.		HS:HU	
Fund Management Officer's knowledge of project progress/status when disbursements are done.		HS:HU	
Level of addressing and resolving financial management issues among Fund Management Officer and Project Manager/Task Manager.		HS:HU	
Contact/communication between by Fund Management Officer, Project Manager/Task Manager during the preparation of financial and progress reports.		HS:HU	

[11] If the review raises concerns over adherence with policies or standard procedures, a recommendation maybe given to cover the topic in an upcoming audit, or similar financial oversight exercise.
[12] See also document 'Criterion Rating Description' for reference.

Project Manager, Task Manager and Fund Management Officer responsiveness to financial requests during the review process	HS:HU	
Overall rating	MS	

E. GIZ co-financing document



FINAL CO-FINANCE REPORT - PARTNER REPORT

Project title:	SolarChill Development, Testing, and Technology Transfer Outreach
Project number:	GEF ID 4682
Co-finance partner:	GIZ
Co-finance source:	Other
Project implementation period:	From: 01 July 2016 To: 30 September 2021
Co-finance reporting period:	From: 01 July 2016 To: 30 September 2021

Total co-finance committed at CEO Endorsement (US$):	5.110.000	A	Type of co-finance committed: In-Kind
Co-finance materialized during this reporting period (US$):	300.000	B	Tick the appropriate option: ● Recurrent Expenditures ○ Investment Mobilized
Cumulative co-finance materialized during past periods (US$):	5.110.000	C	
Total cumulative co-finance materialized to date (US$):	5.410.000	D=B+C	

Description of co-finance contributions for the current reporting period:
SolarChill BMU IKI in-kind finance German contribution

Name: Philipp Denzinger Title:
Co-finance partner representative
Date:
Signature:

346.

F. CHRISTIAN HEALTH ASSOCIATION OF KENYA co-financing document

G. Eswatini co-finaning documents

347.

REPORT OF PLANNED AND ACTUAL CO-FINANCE BY BUDGET LINE									
Name: CHRISTIAN HEALTH ASSOCIATION OF KENYA (Please prepare one worksheet per source of co-finance)									
Project title: GEF Solarchill project									
Project number:		GFL-2328-pppp-nnnn							
Project executing partner:									
Project reporting period:		US$	US$	US$	US$	US$	US$	US$	US$
From:		Prior Year	Cash Cofinance		In-kind Cofinance		Total for year		Cummulative
To:		Actual Total	Planned	Actual	Planned	Actual	Planned	Actual	Actual Total
UNEP BUDGET LINE*		A	B	C	D	E	F=B+D	G=C+E	H=A+G
1100	Project personnel	5.396	5.000		4.320		**9.320**	**-**	**5.396**
1200	Consultants	**-**					**-**	**-**	**-**
1300	Administrative support		240		240		**480**	**-**	**-**
1600	Travel on official business (above staff)	156	2.000				**2.000**	**-**	**156**
2100	Sub-contracts (UN entities)	-					**-**	**-**	**-**
2200	Sub-contracts (supporting organizations)	-					**-**	**-**	**-**
2300	Sub-contracts (commercial purposes)	-					**-**	**-**	**-**
3200	Group training (study tours, field trips, workshops, seminars, etc.)	-	-		-		**-**	**-**	**-**
3300	Meetings/conferences	-	-		-		**-**	**-**	**-**
4100	Expendable equipment	86	100		-		**100**	**-**	**86**
4200	Non-expendable equipment	-	-		-		**-**	**-**	**-**
4300	Premises (office rent, maintenance of premises, etc.)	-	4.000		3.600		**7.600**	**-**	**-**
5100	Operation and maintenance of equipment	-	-		-		**-**	**-**	**-**
5200	Reporting costs (publications, maps, newsletters, printing, etc.)	10	100		-		**100**	**-**	**10**
5300	Sundry (communications, postage,freight, clearance charges, etc.)	989	1.200		1.000		**2.200**	**-**	**989**
5400	Hospitality and entertainment	-	-		-		**-**	**-**	**-**
5500	Evaluation (consultants fees/travel/DSA, admin support,etc.)		-		-		**-**	**-**	**-**
TOTAL COSTS		**6.637**	**12.640**	**-**	**9.160**	**-**	**21.800**	**-**	**6.637**
* The actual expenditures should be reported in accordance with the specific budget lines of the approved budget (Appendix 2) of the project document in Annex 1									
Name:			Title:			Name of Project Manager:			
	Duly authorized official of Executing Division		Date:			Signature:			
Signature:						Date:			

ESWATINI

Telephone: (+268) 2404 1231
Fax: (+268) 2404 4708
Telex: 2301 WD
E-mail: mnre@swazi.net

GOVERNMENT

Ministry of Natural Resources and Energy
P. O. Box 57,
Mbabane,
Eswatini

Our Ref: NRF/E/114. **27TH MARCH, 2020.**

Your Ref:

Nancy Finger,
Habitat, Energy Application and Technology
Seilerbahnweg 14,
61462 Konigstein,
Germany,

Dear Madam,

RE: EVALUATION OF THE MINISTRY OF NATURAL RESOURCES AND ENERGY SUPPORT'S FOR THE SOLAR-CHILL DEVELOPMENT, TESTING AND TECHNOLOGY OUTREACH PROJECT.

The Ministry of Natural Resources and Energy has been supporting the Solarchill project since its inception until its completion. The Ministry assigned four officers to participate in all the planned activities of the project. The officers were not all attending at the same time but attended on a rotational basis depending on the project's needs.

Following the completion of the installation of the Solarchill A and Solarchill B fridges, the Ministry humbly forwards the attached co-financing report which is on the contribution of the Ministry towards the project.

Grateful for your understanding, cooperation and due diligence thereto.

WINNIE T. STEWART (MRS).

PRINCIPAL SECRETARY.

Ministry of Commerce
Industry & Trade

P.O.Box 451
Mbabane
H100
Tel +268 2408 3204
Fax +268 2404 3055

SOLARCHILL B PERFORMANCE AND FEEDBACK REPORT PER EQUIPMENT

The Ministry of Commerce, Industry and Trade as Authority for all beneficiaries under Solarchill B can confirm that there were fifteen 15 Equipment and devices in total installed to beneficiaries businesses around the country on Inception of this project.

We can confirm that the Ministry had been monitoring and kept in touch through electronic communication with the beneficiaries since most of these areas are remote and not easily accessible by road. However we have been doing routine physical inspections for those which are easily accessible by road. Again we have done a quick check through electronic communication after receiving an invitation for this meeting with the consultant.

Thus we can give a brief report as per a shop as was installed in all 4 regions of the country

1. **AVUKILE AMAGEBA GENERAL DEALER** .The beneficiary for this shop is **Florence Sibiya** and was installed at Nsangwini in the Hhohho region. All set of devices for this one were imported from **Vest frost China**. This fridge is performing very well to date. The beneficiary engaged their technician trying to install lighting from the solar system but was unsuccessful. Her wish is to get a fridge with a much bigger capacity
2. **EMAZOMBA GROCERY.** The beneficiary for this one is **Simanga Ngozo** and was installed at Nkhaba eMajotini in the Hhohho region .All set of devices were sourced locally from **Palfridge Eswatini** .The solar panels for this one once fell due to heavy winds and the beneficiary did not report back to our Office since expenses for remounting were no longer to be encored by the project. So after remounting by themselves the fridge wasn't cooling much as before.
3. **BHOJANE SUPERMARKET**. The beneficiary for this shop is **Abraham Dlamini** and was installed at Nkhaba eMajotini in the Hhohho region.

ESWATINI ENVIRONMENT AUTHORITY

RHUS Office Park
Lot 195, Karl Grant Street
Mbabane

P.O.Box 2602
Mbabane, Kingdom of Eswatini
Tel: 2404 6960/7893 Fax: 2404 1719
Email: reception@sea.org.sz or ceosec@sea.org.sz
www.sea.org.sz

1st June 2020

Our Ref: EEA/INT/4.1.4
Att: Nancy Finger
Programme Manager
Habitat, Energy Application and Technology (HEAT)
Seilerbahnweg 14
61462 Konigstein
Germany

Dear Madam,

RE: EVALUATION OF ESWATINI ENVIRONMENT AUTHORITY'S SUPPORT FOR THE SOLARCHILL DEVELOPMENT, TESTING AND TECHNOLOGY OUTREACH PROJECT

The Eswatini Environment Authority (EEA) has been supporting the Solarchill Development, Testing and Technology Outreach project as the leading implementing agency at national level since its inception. The project was placed under the National Ozone Unit and two officers were involved in the planning, coordinating and executing of project activities.

Following the completion of the installation of both Solarchill A and B refrigerators, EEA hereby forwards the attached co-financing report which reflects its in-kind contribution towards the project.

Your usual cooperation is appreciated.

Yours Sincerely,

Sifiso N. Dlamini
ACTING EXECUTIVE DIRECTOR

Ensuring the integration of environmental concerns in the development of the Kingdom of Eswatini.

Co-financier 1

Appendix 14_Cofinance report (1).xls

REPORT OF PLANNED AND ACTUAL CO-FINANCE BY BUDGET LINE

Name:
(Please prepare one worksheet per source of co-finance)

Project title:

Project number: GFL-2328-pppp-nnnn

Project executing partner:

Project reporting period:

From:

To:

		US$	US$	US$	US$	US$	US$	US$	US$
		Prior Year	Cash Cofinance		In-kind Cofinance		Total for year		Cummulative
		Actual Total	Planned	Actual	Planned	Actual	Planned	Actual	Actual Total
UNEP BUDGET LINE*		A	B	C	D	E	F=B+D	G=C+E	H=A+G
1100	Project personnel	8 540					-	-	8 540
1200	Consultants						-	-	-
1300	Administrative support						-	-	-
1600	Travel on official business (above staff)						-	-	-
2100	Sub-contracts (UN entities)						-	-	-
2200	Sub-contracts (supporting organizations)						-	-	-
2300	Sub-contracts (commercial purposes)						-	-	-
3200	Group training (study tours, field trips, workshops, seminars, etc.)	163					-	-	163
3300	Meetings/conferences	337					-	-	337
4100	Expendable equipment	919					-	-	919
4200	Non-expendable equipment						-	-	-
4300	Premises (office rent, maintenance of premises, etc.)	825					-	-	825
5100	Operation and maintenance of equipment	3 199					-	-	3 199
5200	Reporting costs (publications, maps, newsletters, printing, etc.)						-	-	-
5300	Sundry (communications, postage,freight, clearance charges, etc.)	135					-	-	135
5400	Hospitality and entertainment						-	-	-
5500	Evaluation (consultants fees/travel/DSA, admin support,etc.)						-	-	-
5600	Fuel	2 086					-	-	2 086
	Total Costs	16 204							16 204

* The actual expenditures should be reported in accordance with the specific budget lines of the approved budget (Appendix 2) of the project document in Annex 1

Name: Mduduzi S. Dlamini

Title: Director

Name of Project Manager:

Duly authorized official of Executing Division

Date: 26/06/2020

Signature:

Signature:

Date:

MINISTRY OF COMMERCE, INDUSTRY & TRADE
PRINCIPAL SECRETARY
26 JUN 2020
P. O. BOX 451
Mbabane H100
SWAZILAND

REPORT OF PLANNED AND ACTUAL CO-FINANCE BY BUDGET LINE

Name:		MINISTRY OF HEALTH ESWATINI							
Project title:		GEF- Solar Chill Development,Testing and Technology Transfare							
Project number:		4682							
Project executing partner:		UNEP-Skat Foundation							
Project reporting period:		US$	US$	US$	US$	US$	US$	US$	US$
From:	2017	Prior Year	Cash Cofinance		In-kind Cofinance		Total for year		Cummulative
To:	2020	Actual Total	Planned	Actual	Planned	Actual	Planned	Actual	Actual Total
UNEP BUDGET LINE*		A	B	C	D	E	F=B+D	G=C+E	H=A+G
1100	**Project personnel**					5,273	-	**5,273**	**5,273**
1200	**Vehicle use (installation and assessment)**					12,295	-	**12,295**	**12,295**
1300	**Fuel (installation)**					16,607	-	**16,607**	**16,607**
1600	**Vehicle service**					429	-	**429**	**429**
2100	**Storage(equipment)**					2,571	-	**2,571**	**2,571**
2200	**Value added tax exemption**					47,135	-	**47,135**	**47,135**
2300	**Customs duty exemption**					62,864	-	**62,864**	**62,864**
3200	Group training (study tours, field trips, workshops, seminars, etc.)						-	-	-
3300	Meetings/conferences						-	-	-
4100	Expendable equipment						-	-	-
4200	Non-expendable equipment						-	-	-
4300	Premises (office rent, maintenance of premises, etc.)						-	-	-
5100	Operation and maintenance of equipment						-	-	-
5200	Reporting costs (publications, maps, newsletters, printing, etc.)						-	-	-
5300	Sundry (communications, postage,freight, clearance charges, etc.)						-	-	-
5400	Hospitality and entertainment						-	-	-
5500	Evaluation (consultants fees/travel/DSA, admin support,etc.)						-	-	-
TOTAL COSTS		-	-	-	-	**147,174**	-	**147,174**	**147,174**

* The actual expenditures should be reported in accordance with the specific budget lines of the approved budget (Appendix 2) of the project document in Annex 1

Name:	DR SIMON ZWANE	Title: PRINCIPAL SECRETARY	Name of Project Manager:
	Duly authorized official of Executing Division	Date: 13-08-2020	Signature:
Signature:			Date:

MINISTRY OF HEALTH
PRINCIPAL SECRETARY'S OFFICE
13 AUG 2020
P. O. BOX 5
MBABANE-H100
ESWATINI

Ministry of Commerce
Industry & Trade

P.O.Box 451
Mbabane
H100
Tel +268 2408 3204
Fax +268 2404 3055

SOLARCHILL B PERFORMANCE AND FEEDBACK REPORT PER EQUIPMENT

The Ministry of Commerce, Industry and Trade as Authority for all beneficiaries under Solarchill B can confirm that there were fifteen 15 Equipment and devices in total installed to beneficiaries businesses around the country on Inception of this project.

We can confirm that the Ministry had been monitoring and kept in touch through electronic communication with the beneficiaries since most of these areas are remote and not easily accessible by road. However we have been doing routine physical inspections for those which are easily accessible by road. Again we have done a quick check through electronic communication after receiving an invitation for this meeting with the consultant.

Thus we can give a brief report as per a shop as was installed in all 4 regions of the country

1. **AVUKILE AMAGEBA GENERAL DEALER** .The beneficiary for this shop is **Florence Sibiya** and was installed at Nsangwini in the Hhohho region. All set of devices for this one were imported from **Vest frost China**. This fridge is performing very well to date. The beneficiary engaged their technician trying to install lighting from the solar system but was unsuccessful. Her wish is to get a fridge with a much bigger capacity
2. **EMAZOMBA GROCERY.** The beneficiary for this one is **Simanga Ngozo** and was installed at Nkhaba eMajotini in the Hhohho region .All set of devices were sourced locally from **Palfridge Eswatini** .The solar panels for this one once fell due to heavy winds and the beneficiary did not report back to our Office since expenses for remounting were no longer to be encored by the project. So after remounting by themselves the fridge wasn't cooling much as before.
3. **BHOJANE SUPERMARKET**. The beneficiary for this shop is **Abraham Dlamini** and was installed at Nkhaba eMajotini in the Hhohho region.

ANNEX VI. BRIEF CV OF THE REVIEWER

Antoine Azar

Profession	Engineering Expert / Energy Efficiency Specialist / Sustainability Oriented
Nationality	Lebanon and Belgian
Country experience	• Europe: Germany, Netherlands, Belgium, Austria, Italy, Greece, • Africa: South Africa, Kenya, Burkina Faso, Cameroun, Mali, Senegal, Nigeria • Americas: USA, Peru, Colombia, Brazil, Argentina, Mexico, Chile, Guatemala • Asia: Pakistan, Thailand, Japan, Viet Nam, China, India, Uzbekistan • Middle East and North Africa: Lebanon, UAE, Turkey, Jordan, Egypt, Tunisia, Morocco • Oceania: Australia
Education	• Master Energy Engineer

Short biography

Mr Antoine Azar is an independent Engineering Expert / Energy Efficiency Specialist.

Key specialties and capabilities cover:

Project management of complex and strategic projects.
Strategy development, hands-on execution, and motivating teams to best practices. Selected assignments and experiences
Energy efficiency, emissions reduction, development of MEPS and energy labels, product development, and optimization of the Total Cost of Ownership (TCO).

Independent reviews:

- Midterm review of the UNEP's SolarChill project
- In support to the French FFEM, Antoine reviewed, evaluated, and supported more than 10 projects in Africa and Southeast Asia.

ANNEX VII. REVIEW TORS (WITHOUT ANNEXES)

TERMS OF REFERENCE

Terminal Review of the UNEP/GEF project

"SolarChill Development, Testing, and Technology Transfer Outreach" and "GEF ID 4682"

Section 1: PROJECT BACKGROUND AND OVERVIEW

(This section describes what is to be reviewed. Key parameters are: project timeframe, funding envelope, results framework and geographic scope)

1. Project General Information

Table 1. Project summary

UNEP Sub-programme:	Climate Change	UNEP Division/Branch:	Economy
Expected Accomplishment(s):		Programme of Work Output(s):	
SDG(s) and indicator(s)	SDG2: Zero Hunger SDG3: Good health and well being. SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all. 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix 7.2.1 Renewable energy share in the total final energy consumption		
GEF Core Indicator Targets (identify these for projects approved prior to GEF-7)			
Dates of previous project phases:	N/A	Status of future project phases:	N/A

FROM THE PROJECT'S PIR REPORT (use latest version) :

Project Title:	SolarChill Development, Testing, and Technology Transfer Outreach

Executing Agency:	SKAT Foundation

Project partners:	HEAT, Danish Technology Institute, Greenpeace International), UNICEF, GIZ, Technische Universität of Dresden, WHO

Geographical Scope:	Global

Participating Countries:	Colombia, Kenya and eSwatini

GEF project ID:	4682	Umoja number*13:	P1-33GFL-000949
Focal Area(s):	Climate Change Mitigation	GEF OP #:	
GEF Strategic Priority/Objective:	Climate Change To transfer and commercialize the SolarChill vaccine refrigerator (SolarChill A) and to begin the process of Transferring and commercializing the SolarChill household and light commercial refrigerator (SolarChill B).	GEF approval date*:	February 20, 2014
UNEP approval date:	June 03, 2016	Date of first disbursement*:	June 27, 2016
Actual start date14:	June 03, 2016	Planned duration:	30 months

[13] Fields with an * sign (in yellow) should be filled by the Fund Management Officer

[14] Only if different from first disbursement date, e.g., in cases were a long time elapsed between first disbursement and recruitment of project manager.

Intended completion date*:	March 31, 2018	Actual or Expected completion date:	September 30, 2021
Project Type:	Climate Change	GEF Allocation*:	2,712,150
PPG GEF cost*:	N/A	PPG co-financing*:	8,033,500
Expected MSP/FSP Co-financing*:	8,033,500	Total Cost*:	10,745,650
Mid-term Review/eval. (planned date):	October 2017	Terminal Review (planned date):	December 2018
Mid-term Review/eval. (actual date):	October 2018	No. of revisions*:	3
Date of last Steering Committee meeting:	September 2021	Date of last Revision*:	February 2, 2021
Disbursement as of 30 September 2021	2,589,221.98.	Date of planned financial closure*:	31 July 2023
Date of planned completion15*:	30 September 2021	Actual expenditures reported as of 30 September 2021 16:	2,642,692
Total co-financing realized as of 31 December [year]:	To be reported.	Actual expenditures entered in Umoja as of 31 December 2021	2,652,572
Leveraged financing:17			

2. Project Rationale18

348. In regions of the world without reliable electricity, preservation of temperature sensitive vaccines and food is problematic. Until recently, the market for vaccine refrigerators in remote areas without reliable electricity has been dominated by kerosene operated units. These refrigerators present a number of problems related to operating costs, effectiveness in maintaining appropriate temperatures,

[15] If there was a "Completion Revision" please use the date of the revision.
[16] Information to be provided by Executing Agency/Task Manager
[17] See above note on co-financing
[18] Grey =Info to be added

and environmental impact. In remote areas, obtaining kerosene on a timely and consistent basis has proven to be quite challenging and expensive.

349. In addition, fossil fuel (mostly kerosene but also propane gas or diesel) powered vaccine refrigerators result in greenhouse gas emissions through normal operation and emit toxic fumes that are dangerous to humans when in enclosed spaces. These refrigerators are also more susceptible to catching on fire as compared to electric and solar refrigerators. Finally, many solar vaccine refrigerators that are currently available on the market rely on lead acid batteries to store energy. These batteries are typically the weakest link in solar direct drive systems in developing countries because they break down frequently, especially in hot climates. Batteries are also vulnerable to theft and pose an environmental hazard upon disposal.

350. SolarChill is a technology- and product-centred initiative with the mission to create a refrigerator design that mitigates these problems. The SolarChill technology uses solar power to run a direct current (DC) hydrocarbon- based refrigerator compressor. Hydrocarbons, used as refrigerants, are safe for the ozone layer and for the climate. The compressor-driven refrigerant cycle freezes an ice bank in the walls of the SolarChill unit. The ice bank and thick insulation enables the unit to maintain the required temperature range for four to five days, even without any sunlight, thus batteries are not needed in the design.

351. SolarChill offers efficient use of limited solar energy and is free of emissions that may threaten human health or the environment.

352. There has not been a coordinated monitoring and review program of these units. Solar Chill A and B units have not undergone so far, a standardized field-testing procedure, to clearly demonstrate across different countries and climate zones, and across different brands that the technology is working in a technical reliable way. The aim of the Solar Chill consortium is to bring this technology to a breakthrough, that it finally reaches a much higher market penetration for the health market as well as for the domestic and small business market especially for off-grid areas. The proposed project will be a critical role to achieve these objectives and provide clear and transparent field test data, which then can be widely referenced. The aim will be foremost to demonstrate the feasibility in the target countries. Later, the reference data will be used by the Solar Chill consortium for outreach activities, primarily in developing countries, with the need for off-grid solutions mainly in the global sunbelt region. Further, the results from the field tests will be used to provide valuable feedback to Solar Chill producers both for enhancing the properties of Solar Chill A units and for the R&D and design of Solar Chill B units.

3. Project Results Framework

1. Project Objective: To transfer and commercialize the SolarChill vaccine refrigerator (SolarChill A) and to begin the process of transferring and commercializing the SolarChill household and light commercial refrigerator (SolarChill B).

2. The long-term aim of this project is to bring down costs of the technology, increase local manufacturing capacities, and stimulate consumer demand so the product can compete on price and performance with fossil fuel-driven refrigerators, even on the short-term horizon.

3. The project aims to accomplish: (a) the demonstration of the SolarChill vaccine refrigerator technology in Colombia, ESwatini, and Kenya; (b) collection and interpretation of relevant, reference-able technical data to demonstrate reliable and viable technical and commercial performance and to show that user acceptability is achieved; (c) completion of the development and field testing of the SolarChill food refrigerator; (d) dissemination of information about the technology on a country and regional level to industry leaders and policy makers; (e) web-based information sharing (through SolarChill website redesign); and (f) support to individual manufacturers (particularly in the targeting countries) in their efforts to market Solar Chill units and decrease the cost of the units through technical support on design, R&D and production know how. (g) supporting participating manufacturers in ESwatini and Colombia to fully deploy and enhance the technology and lower the costs over time to allow a sustainable production of Solar Chill A and Solar Chill B refrigerators (f) brokerage activities to increase the market penetration potential of particularly Solar Chill B units though connecting Solar Chill manufacturers with supporting financing intermediaries, particular micro-financing organizations . The manufacturers will be supported deploying both Solar Chill A and B technologies. In particular, the project will support to transfer the technology know how gained with Solar Chill A refrigerators to Solar Chill B refrigerators with a potentially much larger market and deployment scope.

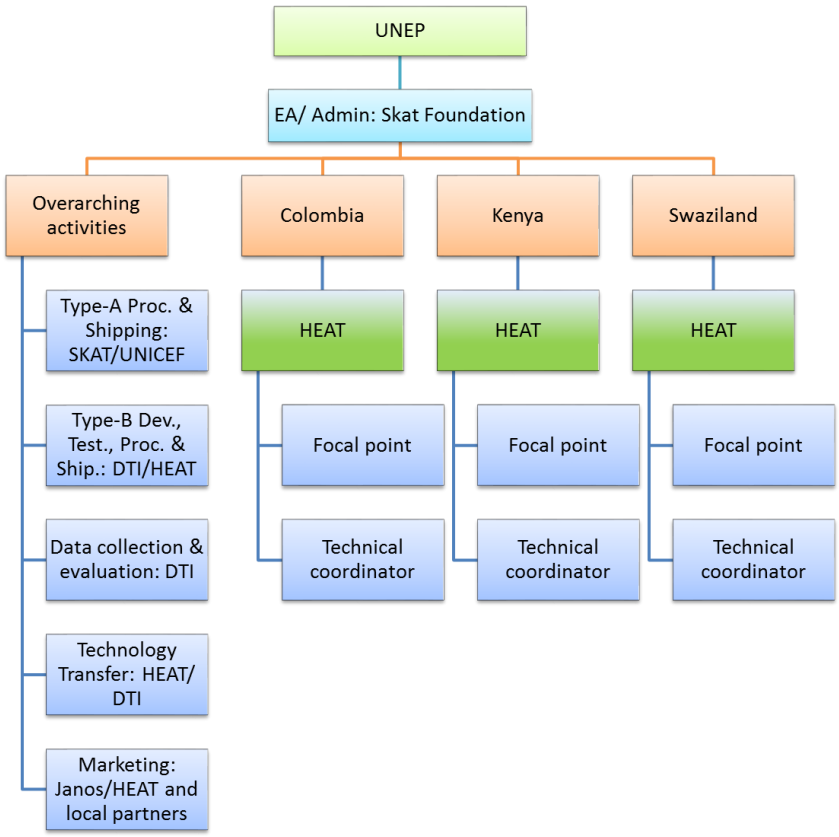
Project Component	Expected Outcomes	Expected Outputs
1. Procure, install 200 SolarChill A units in three countries (66 per country)*	Procure and install 200 SolarChill A units in three countries (66 per country)	Demonstration experience and cross-comparison of currently available SolarChill products (especially Solar Chill A units) under field conditions in representative health centres to ensure that safe vaccine storage conditions are met. Support participating manufacturers in the target countries in their efforts to market Solar Chill units and support their efforts to increase the costs competitiveness of the units
2. Laboratory testing of prototypes, procurement, and field testing of 15 (total of 45) SolarChill B units in each of the three countries*	Development by more than one manufacturer of SolarChill B and first-hand experience with SolarChill B in practical applications	-Testing results of SolarChill B under field conditions in a variety of small institutional and light commercial applications - Brokerage activities to connect financing organizations (micro-financing and venture capitalists) for increased market penetration.

3. Information dissemination and technology transfer	Information regarding SolarChill more widely available; increased industry interest in SolarChill A and B production in Latin America and Africa	Marketing campaign, business plans, increased awareness and interest in SolarChill, and updated SolarChill website In cooperation with and contingent upon MLF and bilateral country program HCFC and HFC phase out activities, and contingent on manufacturers capacity to produce fluorocarbon- free refrigerators, facilitation of partnerships and licensing agreements, including assessment of potential partner companies by an unbiased engineer and business specialist.

4. Executing Arrangements

4. The project is implemented by UNEP and executed by SKAT as Executive Agency. Each country has a lead agent responsible for coordination and administration of activities, as well an in-country focal point and technical coordinator to lead in- country activities.

5. A series of activities, together with the responsible execution parties are listed on the left as 'overarching activities'. These are technical functions which will serve as inputs for work in all three countries.



6.

5. Project Cost and Financing

Project Component	Grant Type	Trust Fund	Grant Amount ($)	Confirmed Cofinancing ($)
1. Procure, install 200 SolarChill A units in three countries (66 per country)*	Inv	GEF	1,138,000	1,600,000 350,00019 675,0001 230,000
2. Laboratory testing of prototypes, procurement, and field testing of 15 (total of 45) SolarChill B units in each of the three countries*	Inv+TA	GEF	547,650	1,820,000 40,000 6,000 175,000

[19] Future GIZ cash contribution (unspent)

[1] Future GIZ cash contribution (unspent)

3. Information dissemination and technology transfer	TA	GEF	827,000	6,500 56,000
Subtotal			2,512,650	7,558,500
Project Management Cost (PMC)			199,500	475,000
Total project costs			2,712,150	8,033,500

Table on Expenditures Per Component

- Component/sub-component/output*	- Estimated cost at design**	- UNEP actual cost/ expenditure (USD)**	
- Component 1 / Outcome 1.1+1.2	- 2,442,650	-	
- Monitoring and review	- 70,000	- 21,196	
- Project Management***	- 199,500	-	
- Total	- 2,712,150	- 21,196	

6. Implementation Issues

7. [Record any important issues that have arisen in the implementation of the project including: important issues emerging from Mid-Term Review/ Mid-Term Review significant delays, changes in partners, implementing countries and/or results statements. Some of these issues may have been reported in the annual Project Implementation Review reports. Note the dates when such changes have been approved and who by]

8. Implementation Issues:

1. Challenges experienced by Palfridge to develop a Solarchill A prototype as per WHO standard requirements. One of the project objectives was that a unit would be developed, undergo independent testing and obtain WHO prequalification at DTI after which SolarChill A units would be produced and tested in the field. The time anticipated to achieve this objective was inadequate. The pandemic early 2020 added to this and caused further delays. Thus, the WHO prequalification at DTI was not completed before project closure. As a results, the SolarChill A units that were planned to be produced by Palfridge within the project period, were not produced by project end.
2. Frequent changes by the country representatives in the selection process of SolarChill A units during the procurement phase, caused delays.
3. The project funds were insufficient considering the market prices at project beginning and the respective costs for custom duties, transportation and installations. Thus, less SolarChill refrigerators were procured than originally planned.
4. While there were queries from Tanzania and Cameroon for technical guidance on SolarChill refrigerators, the project scope only foresaw supporting manufacturers in the project

countries Colombia, Eswatini and Kenya. This geographical restriction was a barrier for further outreach for the technology transfer.

5. Interruptions on business operations arising from the COVID 19 pandemic experienced by Palfridge and Colombia manufacturers in the development and testing of Solarchill vaccine and commercial prototypes.
6. Unanticipated issues occurred regarding the installation of the SolarChill units. Many of the locations where SolarChill units were installed, are very remote. Thus, the accessibility and bad road conditions were one factor that caused delays. Where SIM cards were used for monitoring purposes, recharging became a challenge.
7. Breakdown of Solarchill A units in the field. Some of these breakdowns were detected through remote monitoring, some others remained sometimes undetected for a certain period as the communication via e-mail and/or phone had been a challenge between remote clinics and the project team. Consequently, the project team had not always been informed timely. Once the project team was informed, the technical issue was communicated with the respective manufacturer yet as not all manufacturers have reliable technical service partners in the project countries repairs were often delayed if done at all.
8. Co-finance contributions by participating countries and their respective Ministry of Health (MoH) were not fully met.
9. During the technology transfer barriers were identified such as the reluctance of the manufacturers to share detailed technical information with the project team such as drawings of the SolarChill prototypes and internal business plans or information on costs for components.

Section 2. OBJECTIVE AND SCOPE OF THE REVIEW

(Apart from section 9, where you could insert up to 3 strategic questions that are in addition to the review criteria, this section is standard and does not need to be revised for each project)

7. Objective of the Review

9. In line with the UNEP Evaluation Policy[20] and the UNEP Programme Manual[21], the Terminal Review (TR) is undertaken at operational completion of the project to assess project performance (in terms of relevance, effectiveness and efficiency), and determine outcomes and impacts (actual and potential) stemming from the project, including their sustainability. The Review has two primary purposes: (i) to provide evidence of results to meet accountability requirements, and (ii) to promote operational improvement, learning and knowledge sharing through results and lessons learned among UNEP and [main project partners]. Therefore, the Review will identify lessons of operational relevance for future project formulation and implementation, especially for future phases of the project, where applicable.

8. Key Review principles

10. Review findings and judgements will be based on sound evidence and analysis, clearly documented in the Review Report. Information will be triangulated (i.e. verified from different sources) as far as possible, and when verification is not possible, the single source will be mentioned (whilst anonymity is still protected). Analysis leading to evaluative judgements should always be clearly spelled out.

11. The "Why?" Question. As this is a Terminal Review and a follow-up project is likely [or similar interventions are envisaged for the future], particular attention will be given to learning from the experience. Therefore, the "why?" question should be at the front of the consultant(s)' minds all through the review exercise

[20] https://www.unenvironment.org/about-un-environment/evaluation-office/policies-and-strategies

[21] https://wecollaborate.unep.org

and is supported by the use of a theory of change approach. This means that the consultant(s) need to go beyond the assessment of "what" the project performance was and make a serious effort to provide a deeper understanding of "why" the performance was as it was (i.e. what contributed to the achievement of the project's results). This should provide the basis for the lessons that can be drawn from the project.

Attribution, Contribution and Credible Association: In order to attribute any outcomes and impacts to a project intervention, one needs to consider the difference between what has happened with, and what would have happened without, the project (i.e. take account of changes over time and between contexts in order to isolate the effects of an intervention). This requires appropriate baseline data and the identification of a relevant counterfactual, both of which are frequently not available for reviews. Establishing the contribution made by a project in a complex change process relies heavily on prior intentionality (e.g. approved project design documentation, logical framework) and the articulation of causality (e.g. narrative and/or illustration of the Theory of Change). Robust evidence that a project was delivered as designed and that the expected causal pathways developed supports claims of contribution and this is strengthened where an alternative theory of change can be excluded. A credible association between the implementation of a project and observed positive effects can be made where a strong causal narrative, although not explicitly articulated, can be inferred by the chronological sequence of events, active involvement of key actors and engagement in critical processes.

12. Communicating Review Results. A key aim of the Review is to encourage reflection and learning by UNEP staff and key project stakeholders. The consultant should consider how reflection and learning can be promoted, both through the review process and in the communication of review findings and key lessons. Clear and concise writing is required on all review deliverables. Draft and final versions of the main Review Report will be shared with key stakeholders by the Task Manager. There may, however, be several intended audiences, each with different interests and needs regarding the report. The consultant will plan with the Task Manager which audiences to target and the easiest and clearest way to communicate the key review findings and lessons to them. This may include some, or all, of the following; a webinar, conference calls with relevant stakeholders, the preparation of a review brief or interactive presentation.

9. Key Strategic Questions

13. In addition to the review criteria outlined in Section 10 below, the Review will address the strategic questions22 listed below(no more than 3 questions are recommended). These are questions of interest to UNEP and to which the project is believed to be able to make a substantive contribution. Also included are five questions that are required when reporting in the GEF Portal and these must be addressed in the TR:

14. Q1: What alternative approaches would have been implemented to ensure Palfridge succeeded in developing a Solarchill Vaccine A refrigerator that passed the internal manufacturing testing protocol to enable it delivered for independent testing in DTI and obtain WHO prequalification?

15. Q2: What value has the field monitoring data collected under the project contributed to changes or improvement in production or business operations by the manufacturers based on the performance results of the units?

16. Q3: What has been the impact in the installation of Solarchill units in the various clinics and the future possibilities by the various ministries in procuring similar models for other facilities?

17. Q4: What future prospects exist in large scale production and commercialisation of the Solarchill B model units developed by participating manufacturers under the project

18.

19. Address the questions required for the GEF Portal in the appropriate parts of the report and provide a summary of the findings in the Conclusions section of the report:

20.

[22] The strategic questions should not duplicate questions that will be addressed under the standard review criteria described in section 10.

a) Under Monitoring and Reporting/Monitoring of Project Implementation:

21. What was the performance at the project's completion against Core Indicator Targets? (For projects approved prior to GEF-7, these indicators will be identified retrospectively and comments on performance provided23).

b) Under Factors Affecting Performance/Stakeholder Participation and Cooperation:

22. What were the progress, challenges and outcomes regarding engagement of stakeholders in the project/program as evolved from the time of the MTR? (This should be based on the description included in the Stakeholder Engagement Plan or equivalent documentation submitted at CEO Endorsement/Approval)

c) Under Factors Affecting Performance/Responsiveness to Human Rights and Gender Equality:
What were the completed gender-responsive measures and, if applicable, actual gender result areas? (This should be based on the documentation at CEO Endorsement/Approval, including gender-sensitive indicators contained in the project results framework or gender action plan or equivalent)

d) Under Factors Affecting Performance/Environmental and Social Safeguards:
What was the progress made in the implementation of the management measures against the Safeguards Plan submitted at CEO Approval? The risk classifications reported in the latest PIR report should be verified and the findings of the effectiveness of any measures or lessons learned taken to address identified risks assessed. (Any supporting documents gathered by the Consultant during this Review should be shared with the Task Manager for uploading in the GEF Portal)

e) Under Factors Affecting Performance/Communication and Public Awareness:
What were the challenges and outcomes regarding the project's completed Knowledge Management Approach, including: Knowledge and Learning Deliverables (e.g. website/platform development); Knowledge Products/Events; Communication Strategy; Lessons Learned and Good Practice; Adaptive Management Actions? (This should be based on the documentation approved at CEO Endorsement/Approval)

10. Review Criteria

23. All review criteria will be rated on a six-point scale. Sections A-I below, outline the scope of the review criteria. The set of review criteria are grouped in nine categories: (A) Strategic Relevance; (B) Quality of Project Design; (C) Nature of External Context; (D) Effectiveness, which comprises assessments of the availability of outputs, achievement of outcomes and likelihood of impact; (E) Financial Management; (F) Efficiency; (G) Monitoring and Reporting; (H) Sustainability; and (I) Factors Affecting Project Performance.

24. Annex 1 of these Terms of Reference provides a table with a list of various tools, templates and guidelines that can help Review Consultant(s) to follow a thorough review process that meets all of UNEP's needs.

A. Strategic Relevance

The Review will assess the extent to which the activity is suited to the priorities and policies of the donors, implementing regions/countries and the target beneficiaries. The Review will include an assessment of the project's relevance in relation to UNEP's mandate and its alignment with UNEP's policies and strategies at the time of project approval. Under strategic relevance an assessment of the complementarity of the project with other interventions addressing the needs of the same target groups will be made. This criterion comprises four elements:

[23] This does not apply to Enabling Activities

i. Alignment to the UNEP's Medium-Term Strategy24 (MTS), Programme of Work (POW) and Strategic Priorities

The Review should assess the project's alignment with the MTS and POW under which the project was approved and include, in its narrative, reflections on the scale and scope of any contributions made to the planned results reflected in the relevant MTS and POW. UNEP strategic priorities include the Bali Strategic Plan for Technology Support and Capacity Building25 (BSP) and South-South Cooperation (S-SC). The BSP relates to the capacity of governments to: comply with international agreements and obligations at the national level; promote, facilitate and finance environmentally sound technologies and to strengthen frameworks for developing coherent international environmental policies. S-SC is regarded as the exchange of resources, technology and knowledge between developing countries.

ii. Alignment to Donor/GEF/Partner Strategic Priorities

Donor strategic priorities will vary across interventions. The Review will assess the extent to which the project is suited to, or responding to, donor priorities. In some cases, alignment with donor priorities may be a fundamental part of project design and grant approval processes while in others, for example, instances of 'softly-earmarked' funding, such alignment may be more of an assumption that should be assessed.

iii. Relevance to Global, Regional, Sub-regional and National Environmental Priorities

The Review will assess the alignment of the project with global priorities such as the SDGs and Agenda 2030. The extent to which the intervention is suited, or responding to, the stated environmental concerns and needs of the countries, sub-regions or regions where it is being implemented will also be considered. Examples may include: UN Development Assistance Frameworks (UNDAF) or, national or sub-national development plans, poverty reduction strategies or Nationally Appropriate Mitigation Action (NAMA) plans or regional agreements etc. Within this section consideration will be given to whether the needs of all beneficiary groups are being met and reflects the current policy priority to leave no-one behind.

iv. Complementarity with Relevant Existing Interventions/Coherence26

An assessment will be made of how well the project, either at design stage or during the project inception or mobilization27, took account of ongoing and planned initiatives (under the same sub-programme, other UNEP sub-programmes, or being implemented by other agencies within the same country, sector or institution) that address similar needs of the same target groups. The Review will consider if the project team, in collaboration with Regional Offices and Sub-Programme Coordinators, made efforts to ensure their own intervention was complementary to other interventions, optimized any synergies and avoided duplication of effort. Examples may include work within UNDAFs or One UN programming. Linkages with other interventions should be described and instances where UNEP's comparative advantage has been particularly well applied should be highlighted.

Factors affecting this criterion may include:

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[24] UNEP's Medium Term Strategy (MTS) is a document that guides UNEP's programme planning over a four-year period. It identifies UNEP's thematic priorities, known as Sub-programmes (SP), and sets out the desired outcomes, known as Expected Accomplishments (EAs), of the Sub-programmes. https://www.unenvironment.org/about-un-environment/evaluation-office/our-evaluation-approach/un-environment-documents

[25] http://www.unep.fr/ozonaction/about/bsp.htm

[26] This sub-category is consistent with the new criterion of 'Coherence' introduced by the OECD-DAC in 2019.

[27] A project's inception or mobilization period is understood as the time between project approval and first disbursement. Complementarity during project implementation is considered under Efficiency, see below.

- Stakeholders' participation and cooperation
- Responsiveness to human rights and gender equity
- Country ownership and driven-ness

B. Quality of Project Design

25. The quality of project design is assessed using an agreed template during the review inception phase. Ratings are attributed to identified criteria and an overall Project Design Quality rating is established. The complete Project Design Quality template should be annexed in the Review Inception Report. Later, the overall Project Design Quality rating28 should be entered in the final review ratings table (as item B) in the Main Review Report and a summary of the project's strengths and weaknesses at design stage should be included within the body of the Main Review Report.

Factors affecting this criterion may include (at the design stage):

- Stakeholders participation and cooperation
- Responsiveness to human rights and gender equity

C. Nature of External Context

26. At review inception stage a rating is established for the project's external operating context (considering the prevalence of conflict, natural disasters and political upheaval29). This rating is entered in the final review ratings table as item C. Where a project has been rated as facing either an Unfavourable or Highly Unfavourable external operating context, and/or a negative external event has occurred during project implementation, the ratings for Effectiveness, Efficiency and/or Sustainability may be increased at the discretion of the Review Consultant and Task Manager together. A justification for such an increase must be given.

D. Effectiveness

i. Availability of Outputs30

27. The Review will assess the project's success in producing the programmed outputs and making them available to the intended beneficiaries as well as its success in achieving milestones as per the project design document (ProDoc). Any formal modifications/revisions made during project implementation will be considered part of the project design. Where the project outputs are inappropriately or inaccurately stated in the ProDoc, reformulations may be necessary in the reconstruction of the Theory of Change (TOC). In such cases a table should be provided showing the original and the reformulation of the outputs for transparency. The availability of outputs will be assessed in terms of both quantity and quality, and the assessment will consider their ownership by, and usefulness to, intended beneficiaries and the timeliness of their provision. It is noted that emphasis is placed on the performance of those outputs that are most important to achieve outcomes. The Review will briefly explain the reasons behind the success or shortcomings of the project in delivering its programmed outputs available and meeting expected quality standards.

Factors affecting this criterion may include:

- Preparation and readiness

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[28] In some instances, based on data collected during the review process, the assessment of the project's design quality may change from Inception Report to Main Review Report.

[29] Note that 'political upheaval' does not include regular national election cycles, but unanticipated unrest or prolonged disruption. The potential delays or changes in political support that are often associated with the regular national election cycle should be part of the project's design and addressed through adaptive management of the project team. From March 2020 this should include the effects of COVID-19.

[30] Outputs are the availability (for intended beneficiaries/users) of new products and services and/or gains in knowledge, abilities and awareness of individuals or within institutions (UNEP, 2019).

- Quality of project management and supervision31

ii. Achievement of Project Outcomes32

28. The achievement of project outcomes is assessed as performance against the outcomes as defined in the reconstructed33 Theory of Change. These are outcomes that are intended to be achieved by the end of the project timeframe and within the project's resource envelope. Emphasis is placed on the achievement of project outcomes that are most important for attaining intermediate states. As with outputs, a table can be used to show where substantive amendments to the formulation of project outcomes is necessary to allow for an assessment of performance. The Review should report evidence of attribution between UNEP's intervention and the project outcomes. In cases of normative work or where several actors are collaborating to achieve common outcomes, evidence of the nature and magnitude of UNEP's 'substantive contribution' should be included and/or 'credible association' established between project efforts and the project outcomes realised.

Factors affecting this criterion may include:

- Quality of project management and supervision
- Stakeholders' participation and cooperation
- Responsiveness to human rights and gender equity
- Communication and public awareness

iii. Likelihood of Impact

29. Based on the articulation of long-lasting effects in the reconstructed TOC (i.e. from project outcomes, via intermediate states, to impact), the Review will assess the likelihood of the intended, positive impacts becoming a reality. Project objectives or goals should be incorporated in the TOC, possibly as intermediate states or long-lasting impacts. The Evaluation Office's approach to the use of TOC in project reviews is outlined in a guidance note and is supported by an excel-based flow chart, 'Likelihood of Impact Assessment Decision Tree'. Essentially the approach follows a 'likelihood tree' from project outcomes to impacts, taking account of whether the assumptions and drivers identified in the reconstructed TOC held. Any unintended positive effects should also be identified and their causal linkages to the intended impact described.

30. The Review will also consider the likelihood that the intervention may lead, or contribute to, unintended negative effects (e.g. will vulnerable groups such as those living with disabilities and/or women and children, be disproportionally affected by the project?). Some of these potential negative effects may have been identified in the project design as risks or as part of the analysis of Environmental and Social Safeguards.

31. The Review will consider the extent to which the project has played a catalytic role34 or has promoted scaling up and/or replication as part of its Theory of Change (either explicitly as in a project with a demonstration

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[31] For GEF funded projects 'project management and supervision' will refer to the project management performance of the Executing Agency and the technical backstopping provided by UNEP, as Implementing Agency.

[32] Outcomes are the use (i.e. uptake, adoption, application) of an output by intended beneficiaries, observed as changes in institutions or behavior, attitude or condition (UNEP, 2019)

[33] UNEP staff are currently required to submit a Theory of Change with all submitted project designs. The level of 'reconstruction' needed during a review will depend on the quality of this initial TOC, the time that has lapsed between project design and implementation (which may be related to securing and disbursing funds) and the level of any changes made to the project design. In the case of projects pre-dating 2013 the intervention logic is often represented in a logical framework and a TOC will need to be constructed in the inception stage of the review.

[34] The terms catalytic effect, scaling up and replication are inter-related and generally refer to extending the coverage or magnitude of the effects of a project. Catalytic effect is associated with triggering additional actions that are not directly funded by the project – these effects can be both concrete or less tangible, can be intentionally caused by the project or implied in the design and reflected in the TOC drivers, or can be unintentional and can rely on funding from another source or have no financial requirements. Scaling up and Replication require more intentionality for projects, or individual components and approaches, to be reproduced in other similar contexts. Scaling up suggests a substantive increase in the number of new beneficiaries reached/involved and may require adapted delivery mechanisms while Replication suggests the repetition of an approach or component at a similar scale but

component or implicitly as expressed in the drivers required to move to outcome levels) and as factors that are likely to contribute to greater or long lasting impact.

32. Ultimately UNEP and all its partners aim to bring about benefits to the environment and human well-being. Few projects are likely to have impact statements that reflect such long-lasting or broad-based changes. However, the Review will assess the likelihood of the project to make a substantive contribution to the long-lasting changes represented by the Sustainable Development Goals, and/or the intermediate-level results reflected in UNEP's Expected Accomplishments and the strategic priorities of funding partner(s).

Factors affecting this criterion may include:

- Quality of Project Management and Supervision (including adaptive management)
- Stakeholders participation and cooperation
- Responsiveness to human rights and gender equity
- Country ownership and driven-ness
- Communication and public awareness

E. Financial Management

Financial management will be assessed under three themes: adherence to UNEP's financial policies and procedures, completeness of financial information and communication between financial and project management staff. The Review will establish the actual spend across the life of the project of funds secured from all donors. This expenditure will be reported, where possible, at output/component level and will be compared with the approved budget. The Review will verify the application of proper financial management standards and adherence to UNEP's financial management policies. Any financial management issues that have affected the timely delivery of the project or the quality of its performance will be highlighted. The Review will record where standard financial documentation is missing, inaccurate, incomplete or unavailable in a timely manner. The Review will assess the level of communication between the Project Manager and the Fund Management Officer as it relates to the effective delivery of the planned project and the needs of a responsive, adaptive management approach.

Factors affecting this criterion may include:

- Preparation and readiness
- Quality of project management and supervision

F. Efficiency

33. Under the efficiency criterion the Review will assess the extent to which the project delivered maximum results from the given resources. This will include an assessment of the cost-effectiveness and timeliness of project execution.

34. Focusing on the translation of inputs into outputs, cost-effectiveness is the extent to which an intervention has achieved, or is expected to achieve, its results at the lowest possible cost. Timeliness refers to whether planned activities were delivered according to expected timeframes as well as whether events were sequenced efficiently. The Review will also assess to what extent any project extension could have been avoided through stronger project management and identify any negative impacts caused by project delays or extensions. The Review will describe any cost or time-saving measures put in place to maximise results within the secured budget and agreed project timeframe and consider whether the project was implemented in the most efficient way compared to alternative interventions or approaches.

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among different beneficiaries. Even with highly technical work, where scaling up or replication involves working with a new community, some consideration of the new context should take place and adjustments made as necessary.

35. The Review will give special attention to efforts made by the project teams during project implementation to make use of/build upon pre-existing institutions, agreements and partnerships, data sources, synergies and complementarities35 with other initiatives, programmes and projects etc. to increase project efficiency.

36. The factors underpinning the need for any project extensions will also be explored and discussed. Consultants should note that as management or project support costs cannot be increased in cases of 'no cost extensions', such extensions represent an increase in unstated costs to UNEP and Executing Agencies.

Factors affecting this criterion may include:

- Preparation and readiness (e.g. timeliness)
- Quality of project management and supervision
- Stakeholders participation and cooperation

G. Monitoring and Reporting

37. The Review will assess monitoring and reporting across three sub-categories: monitoring design and budgeting, monitoring implementation and project reporting.

i. Monitoring Design and Budgeting

38. Each project should be supported by a sound monitoring plan that is designed to track progress against SMART36 results towards the achievement of the project's outputs and outcomes, including at a level disaggregated by gender, marginalisation or vulnerability, including those living with disabilities. In particular, the Review will assess the relevance and appropriateness of the project indicators as well as the methods used for tracking progress against them as part of conscious results-based management. The Review will assess the quality of the design of the monitoring plan as well as the funds allocated for its implementation. The adequacy of resources for Mid-Term and Terminal Review should be discussed, where applicable.

ii. Monitoring of Project Implementation

39. The Review will assess whether the monitoring system was operational and facilitated the timely tracking of results and progress towards project objectives throughout the project implementation period. This assessment will include consideration of whether the project gathered relevant and good quality baseline data that is accurately and appropriately documented. This should include monitoring the representation and participation of disaggregated groups, including gendered, marginalised or vulnerable groups, such as those living with disabilities, in project activities. It will also consider the quality of the information generated by the monitoring system during project implementation and how it was used to adapt and improve project execution, achievement of outcomes and ensure sustainability. The Review should confirm that funds allocated for monitoring were used to support this activity.

The performance at project completion against Core Indicator Targets should be reviewed. For projects approved prior to GEF-7, these indicators will be identified retrospectively and comments on performance provided.

40.

iii. Project Reporting

41. UNEP has a centralised project information management system (Anubis) in which project managers upload six-monthly progress reports against agreed project milestones. This information will be provided to the Review Consultant(s) by the Task Manager. Some projects have additional requirements to report regularly to funding partners, which will be supplied by the project team (e.g. the Project Implementation Reviews and

[35] Complementarity with other interventions during project design, inception or mobilization is considered under Strategic Relevance above.

[36] SMART refers to results that are specific, measurable, achievable, relevant and time-oriented. Indicators help to make results measurable.

Tracking Tool for GEF-funded projects). The Review will assess the extent to which both UNEP and GEF reporting commitments have been fulfilled. Consideration will be given as to whether reporting has been carried out with respect to the effects of the initiative on disaggregated groups.

Factors affecting this criterion may include:

- Quality of project management and supervision
- Responsiveness to human rights and gender equity (e.g disaggregated indicators and data)

H. Sustainability

42. Sustainability37 is understood as the probability of the benefits derived from the achievement of project outcomes being maintained and developed after the close of the intervention. The Review will identify and assess the key conditions or factors that are likely to undermine or contribute to the endurance of achieved project outcomes (i.e. 'assumptions' and 'drivers'). Some factors of sustainability may be embedded in the project design and implementation approaches while others may be contextual circumstances or conditions that evolve over the life of the intervention. Where applicable an assessment of bio-physical factors that may affect the sustainability of direct outcomes may also be included.

i. Socio-political Sustainability

43. The Review will assess the extent to which social or political factors support the continuation and further development of the benefits derived from project outcomes. It will consider the level of ownership, interest and commitment among government and other stakeholders to take the project achievements forwards. In particular the Review will consider whether individual capacity development efforts are likely to be sustained.

ii. Financial Sustainability

44. Some project outcomes, once achieved, do not require further financial inputs, e.g. the adoption of a revised policy. However, in order to derive a benefit from this outcome further management action may still be needed e.g. to undertake actions to enforce the policy. Other project outcomes may be dependent on a continuous flow of action that needs to be resourced for them to be maintained, e.g. continuation of a new natural resource management approach. The Review will assess the extent to which project outcomes are dependent on future funding for the benefits they bring to be sustained. Secured future funding is only relevant to financial sustainability where the project outcomes have been extended into a future project phase. Even where future funding has been secured, the question still remains as to whether the project outcomes are financially sustainable.

iii. Institutional Sustainability

45. The Review will assess the extent to which the sustainability of project outcomes (especially those relating to policies and laws) is dependent on issues relating to institutional frameworks and governance. It will consider whether institutional achievements such as governance structures and processes, policies, sub-regional agreements, legal and accountability frameworks etc. are robust enough to continue delivering the benefits associated with the project outcomes after project closure. In particular, the Review will consider whether institutional capacity development efforts are likely to be sustained.

Factors affecting this criterion may include:

- Stakeholders participation and cooperation

[37] As used here, 'sustainability' means the long-term maintenance of outcomes and consequent impacts, whether environmental or not. This is distinct from the concept of sustainability in the terms 'environmental sustainability' or 'sustainable development', which imply 'not living beyond our means' or 'not diminishing global environmental benefits' (GEF STAP Paper, 2019, Achieving More Enduring Outcomes from GEF Investment)

- Responsiveness to human rights and gender equity (e.g. where interventions are not inclusive, their sustainability may be undermined)
- Communication and public awareness
- Country ownership and driven-ness

I. Factors Affecting Project Performance and Cross-Cutting Issues

(These factors are rated in the ratings table but are discussed within the Main Review Report as cross-cutting themes as appropriate under the other review criteria, above. If these issues have not been addressed under the Review Criteria above, then independent summaries of their status within the reviewed project should be given in this section)

i. Preparation and Readiness

46. This criterion focuses on the inception or mobilisation stage of the project (i.e. the time between project approval and first disbursement). The Review will assess whether appropriate measures were taken to either address weaknesses in the project design or respond to changes that took place between project approval, the securing of funds and project mobilisation. In particular the Review will consider the nature and quality of engagement with stakeholder groups by the project team, the confirmation of partner capacity and development of partnership agreements as well as initial staffing and financing arrangements. (Project preparation is included in the template for the assessment of Project Design Quality).

ii. Quality of Project Management and Supervision

47. For GEF funded projects 'project management and supervision' may refer to the project management performance of the Executing Agency and the technical backstopping and supervision provided by UNEP as Implementing Agency. The performance of parties playing different roles should be discussed and a rating provided for both types of supervision (UNEP/Implementing Agency; Partner/Executing Agency) and the overall rating for this sub-category established as a simple average of the two.

48. The Review will assess the effectiveness of project management with regard to: providing leadership towards achieving the planned outcomes; managing team structures; maintaining productive partner relationships (including Steering Groups etc.); maintaining project relevance within changing external and strategic contexts; communication and collaboration with UNEP colleagues; risk management; use of problem-solving; project adaptation and overall project execution. Evidence of adaptive management should be highlighted.

iii. Stakeholder Participation and Cooperation

49. Here the term 'stakeholder' should be considered in a broad sense, encompassing all project partners, duty bearers with a role in delivering project outputs, target users of project outputs and any other collaborating agents external to UNEP and the executing partner(s). The assessment will consider the quality and effectiveness of all forms of communication and consultation with stakeholders throughout the project life and the support given to maximise collaboration and coherence between various stakeholders, including sharing plans, pooling resources and exchanging learning and expertise. The inclusion and participation of all differentiated groups, including gender groups should be considered.

50. The progress, challenges and outcomes regarding engagement of stakeholders in the project/program occurring since the MTR should be reviewed. This should be based on the description included in the Stakeholder Engagement Plan or equivalent documentation submitted at CEO Endorsement/Approval.

iv. Responsiveness to Human Rights and Gender Equality

51. The Review will ascertain to what extent the project has applied the UN Common Understanding on the human rights-based approach (HRBA) and the UN Declaration on the Rights of Indigenous People. Within this

human rights context the Review will assess to what extent the intervention adheres to UNEP's Policy and Strategy for Gender Equality and the Environment38.

52. The report should present the extent to which the intervention, following an adequate gender analysis at design stage, has implemented the identified actions and/or applied adaptive management to ensure that Gender Equality and Human Rights are adequately taken into account. In particular the Review will consider to what extent project, implementation and monitoring have taken into consideration: (i) possible inequalities (especially those related to gender) in access to, and the control over, natural resources; (ii) specific vulnerabilities of disadvantaged groups (especially women, youth and children and those living with disabilities) to environmental degradation or disasters; and (iii) the role of disadvantaged groups (especially women, youth and children and those living with disabilities) in mitigating or adapting to environmental changes and engaging in environmental protection and rehabilitation.

53. The completed gender-responsive measures and, if applicable, actual gender result areas should be reviewed. This should be based on the documentation at CEO Endorsement/Approval, including gender-sensitive indicators contained in the project results framework or gender action plan or equivalent.

v. Environmental and Social Safeguards

UNEP projects address environmental and social safeguards primarily through the process of environmental and social screening at the project approval stage, risk assessment and management (avoidance, minimization, mitigation or, in exceptional cases, offsetting) of potential environmental and social risks and impacts associated with project and programme activities. The Review will confirm whether UNEP requirements39 were met to: review risk ratings on a regular basis; monitor project implementation for possible safeguard issues; respond (where relevant) to safeguard issues through risk avoidance, minimization, mitigation or offsetting and report on the implementation of safeguard management measures taken. UNEP requirements for proposed projects to be screened for any safeguarding issues; for sound environmental and social risk assessments to be conducted and initial risk ratings to be assigned are reviewed above under Quality of Project Design).

The Review will also consider the extent to which the management of the project minimised UNEP's environmental footprint.

Implementation of the management measures against the Safeguards Plan submitted at CEO Approval should be reviewed, the risk classifications verified and the findings of the effectiveness of any measures or lessons learned taken to address identified risks assessed. Any supporting documents gathered by the Consultant should be shared with the Task Manager.

vi. Country Ownership and Driven-ness

54. The Review will assess the quality and degree of engagement of government / public sector agencies in the project. While there is some overlap between Country Ownership and Institutional Sustainability, this criterion focuses primarily on the forward momentum of the intended projects results, i.e. either: a) moving forwards from outputs to project outcomes or b) moving forward from project outcomes towards intermediate

[38]The Evaluation Office notes that Gender Equality was first introduced in the UNEP Project Review Committee Checklist in 2010 and, therefore, provides a criterion rating on gender for projects approved from 2010 onwards. Equally, it is noted that policy documents, operational guidelines and other capacity building efforts have only been developed since then and have evolved over time. https://wedocs.unep.org/bitstream/handle/20.500.11822/7655/-Gender_equality_and_the_environment_Policy_and_strategy-2015Gender_equality_and_the_environment_policy_and_strategy.pdf.pdf?sequence=3&isAllowed=y

[39] For the review of project concepts and proposals, the Safeguard Risk Identification Form (SRIF) was introduced in 2019 and replaced the Environmental, Social and Economic Review note (ESERN), which had been in place since 2016. In GEF projects safeguards have been considered in project designs since 2011.

states. The Review will consider the involvement not only of those directly involved in project execution and those participating in technical or leadership groups, but also those official representatives whose cooperation is needed for change to be embedded in their respective institutions and offices (e.g. representatives from multiple sectors or relevant ministries beyond Ministry of Environment). This factor is concerned with the level of ownership generated by the project over outputs and outcomes and that is necessary for long term impact to be realised. Ownership should extend to all gender and marginalised groups.

vii. Communication and Public Awareness

55. The Review will assess the effectiveness of: a) communication of learning and experience sharing between project partners and interested groups arising from the project during its life and b) public awareness activities that were undertaken during the implementation of the project to influence attitudes or shape behaviour among wider communities and civil society at large. The Review should consider whether existing communication channels and networks were used effectively, including meeting the differentiated needs of gendered or marginalised groups, and whether any feedback channels were established. Where knowledge sharing platforms have been established under a project the Review will comment on the sustainability of the communication channel under either socio-political, institutional or financial sustainability, as appropriate

The project's completed Knowledge Management Approach, including: Knowledge and Learning Deliverables (e.g. website/platform development); Knowledge Products/Events; Communication Strategy; Lessons Learned and Good Practice; Adaptive Management Actions should be reviewed. This should be based on the documentation approved at CEO Endorsement/Approval.

Section 3. REVIEW APPROACH, METHODS AND DELIVERABLES

56. The Terminal Review will be an in-depth review using a participatory approach whereby key stakeholders are kept informed and consulted throughout the review process. Both quantitative and qualitative review methods will be used as appropriate to determine project achievements against the expected outputs, outcomes and impacts. It is highly recommended that the consultant(s) maintains close communication with the project team and promotes information exchange throughout the review implementation phase in order to increase their (and other stakeholder) ownership of the review findings. Where applicable, the consultant(s) should provide a geo-referenced map that demarcates the area covered by the project and, where possible, provide geo-reference photographs of key intervention sites (e.g. sites of habitat rehabilitation and protection, pollution treatment infrastructure, etc.)

57. The findings of the Review will be based on the following:

58. A desk review of:

- Relevant background documentation, inter alia CEO Endorsement Request Package
- Project design documents (including minutes of the project design review meeting at approval); Annual Work Plans and Budgets or equivalent, revisions to the project (Project Document Supplement), the logical framework and its budget;
- Project reports such as six-monthly progress and financial reports, progress reports from collaborating partners, meeting minutes, relevant correspondence and including the Project Implementation Reviews and Tracking Tool etc.;
- Project deliverables e.g website, field monitoring reports, technology transfer packet, prototype designs and assessments, laboratory testing results
- Mid-Term Review of the project
- Reviews of similar projects.

(a) Interviews (individual or in group) with:

- UNEP Task Manager (TM)

- Project Manager (PM)
- Project management team
- UNEP Fund Management Officer (FMO)
- Project partners, including and SKAT Foundation, UNICEF, Habitat, Energy Application & Technology (HEAT) and their national coordinators, Gesellschaft für Technische Zusammenarbeit (GIZ), Greenpeace International(Janos), Danish Technological Institute (DTI)
- Relevant resource persons
- Representatives from civil society and specialist groups (such as women's, farmers and trade associations etc).

(b) Surveys to be determined at inception phase
(c) Field visits – Travel to Eswatini and Colombia
(d) Other data collection tools, to be determined at inception phase

11. Review Deliverables and Review Procedures

59. The Review Consultant will prepare:

- Inception Report: (see Annex 1 for a list of all templates, tables and guidance notes) containing an assessment of project design quality, a draft reconstructed Theory of Change of the project, project stakeholder analysis, review framework and a tentative review schedule.
- Preliminary Findings Note: typically in the form of a PowerPoint presentation, the sharing of preliminary findings is intended to support the participation of the project team, act as a means to ensure all information sources have been accessed and provide an opportunity to verify emerging findings.
- Draft and Final Review Report: containing an executive summary that can act as a stand-alone document; detailed analysis of the review findings organised by review criteria and supported with evidence; lessons learned and recommendations and an annotated ratings table.

60. A Review Brief (a 2-page overview of the evaluand and review findings) for wider dissemination through the UNEP website may be required. This will be discussed with the Task Manager no later than during the finalization of the Inception Report.

61. Review of the Draft Review Report. The Review Consultant will submit a draft report to the Task Manager and revise the draft in response to their comments and suggestions. The Task Manager will then forward the revised draft report to other project stakeholders, for their review and comments. Stakeholders may provide feedback on any errors of fact and may highlight the significance of such errors in any conclusions as well as providing feedback on the proposed recommendations and lessons. Any comments or responses to draft reports will be sent to the Task Manager for consolidation. The Task Manager will provide all comments to the Review Consultant for consideration in preparing the final report, along with guidance on areas of contradiction or issues requiring an institutional response.

62. The final version of the Terminal Review report will be assessed for its quality by the UNEP Evaluation Office using a standard template and this assessment will be annexed to the final Terminal Review report.

63. At the end of the review process, the Task Manager will prepare a Recommendations Implementation Plan in the format of a table, to be completed and updated at regular intervals, and circulate the Lessons Learned.

12. The Review Consultant

64. The Review Consultant will work under the overall responsibility of the Senior Programme Assistant, Cicilia Magare in consultation with the Fund Management Officer Fatma Twahir.

65. The Review Consultant will liaise with the Senior Programme Assistant on any procedural and methodological matters related to the Review. It is, however, the consultant's individual responsibility (where

applicable) to arrange for their visas and immunizations as well as to plan meetings with stakeholders, organize online surveys, obtain documentary evidence and any other logistical matters related to the assignment. The UNEP Senior Programme Assistant and project team will, where possible, provide logistical support (introductions, meetings etc.) allowing the consultants to conduct the Review as efficiently and independently as possible.

The Review Consultant will be hired over a period of 8 months August 2022 to April February 2023and should have the following: a university degree in engineering, energy, technology or other relevant sciences area is required and an advanced degree in the same areas is desirable; experience in evaluating projects is required, , a broad understanding of Solar Refrigeration technology is required. English and French are the working languages of the United Nations Secretariat. For this consultancy, fluency in oral and written English is a requirement. The work will be home-based with field visits to the project countries.

66. The Review Consultant will be responsible, in close consultation with the Senior Programme Assistant, for overall quality of the review and timely delivery of its outputs, described above in Section 11 Review Deliverables, above. The Review Consultant will ensure that all review criteria and questions are adequately covered.

13. Schedule of the Review

67. The table below presents the tentative schedule for the Review.

Table 3. Tentative schedule for the Review

Milestone	Tentative Dates
Desk Review	24 August – 9 September 2022
Inception Report	15 September 2022
E-based meetings and discussions/surveys etc.	24 August – 15 September 2022
Review Mission (dates to be confirmed)	October 10 – 13/October 17 – 20
E-based meetings and discussions/surveys etc.	Ongoing
PowerPoint/presentation on preliminary findings and recommendations	18 November 2022
Draft Review Report to Task Manager (and Project Manager)	5 January 2023
Draft Review Report shared with wider group of stakeholders	2 February 2023
Final Review Report to Evaluation Office	2 February 2023
Final Review Report shared with all respondents	20 March 2023

14. Contractual Arrangements

68. The Review Consultant(s) will be selected and recruited by the Task Manager under an individual Special Service Agreement (SSA) on a “fees only” basis (see below). By signing the service contract with UNEP/UNON, the consultant certifies that they have not been associated with the design and implementation of the project

in any way which may jeopardize their independence and impartiality towards project achievements and project partner performance. In addition, they will not have any future interests (within six months after completion of the contract) with the project's executing or implementing units. All consultants are required to sigh the Code of Conduct Agreement Form.

69. Fees will be paid on an instalment basis, paid on acceptance and approval by the Task Manager of expected key deliverables. The schedule of payment is as follows:

70. Schedule of Payment:

71. Deliverable	72. Percentage Payment
73. Approval Inception Report	74. 30%
75. Approval Draft Final Review Report	76. 30%
77. Approval Final Main Review Report	78. 20%
79. Approval Final Main Review Report	80. 20%

81.

82. Fees only contracts: Where applicable, air tickets will be purchased by UNEP and 75% of the Daily Subsistence Allowance for each authorised travel mission will be paid up front. Local in-country travel will only be reimbursed where agreed in advance with the Task Manager and on the production of acceptable receipts. Terminal expenses and residual DSA entitlements (25%) will be paid after mission completion.

83. The consultant may be provided with access to UNEP's information management systems (e.g. PIMS, Anubis, SharePoint, etc.) and, if such access is granted, the consultants agree not to disclose information from that system to third parties beyond information required for, and included in, the Review Report.

84. In case the consultant is not able to provide the deliverables in accordance with these guidelines, and in line with the expected quality standards by UNEP, payment may be withheld at the discretion of the Head of Branch or Portfolio Manager until the consultants have improved the deliverables to meet UNEP's quality standards.

85. If the consultant fails to submit a satisfactory final product to the Project Manager in a timely manner, i.e. before the end date of their contract, UNEP reserves the right to employ additional human resources to finalize the report, and to reduce the consultant's fees by an amount equal to the additional costs borne by the project team to bring the report up to standard or completion.

ANNEX VIII. QUALITY ASSESSMENT OF THE REVIEW REPORT

Quality Assessment of the Terminal Review Report

Review Title: "Solarchill Development, Testing, and Technology Transfer Outreach" (GEF ID 4682)

Consultant: Antoine Azar

All UNEP Reviews are subject to a quality assessment by the UNEP Evaluation Office. This is an assessment of the quality of the review product (i.e. Main Review Report).

	UNEP Evaluation Office Comments	Final Report Rating
Report Quality Criteria		
Quality of the Executive Summary Purpose: acts as a stand alone and accurate summary of the main review product, especially for senior management. To include: • concise overview of the review object • clear summary of the review objectives and scope • overall review rating of the project and key features of performance (strengths and weaknesses) against exceptional criteria • reference to where the review ratings table can be found within the report • summary response to key strategic review questions • summary of the main findings of the exercise/synthesis of main conclusions • summary of lessons learned and recommendations.	Final report *(coverage/omissions)*: The Executive Summary fails to provide a concise overview of the review object (i.e. a project funded through a GEF grant of USD 2.7, with substantial in-kind Co-financing from GIZ, to a total of USD 5m – see Table 6 – and implemented by UNEP from 2016 – 2021 in three countries – Columbia, eSwatini and Kenya - with multiple executing partners). The project identification table does not include information on any previous or future phases of the project, which is important for the formulation of recommendations. Para 6, which asserts the reliability and sustainability of the technology lacks a reference to a published, peer-reviewed source to support this (para 101 mentions a 'coordinated monitoring and review programme' of the technology in 2013?). Para 9 is misleading in that this project has reached operational completion, so any learning can only be applied if there are future project phases. The status of para 12 is unclear. There is no concluding thought or finding to indicate the relevance of the information. Reference to where the review ratings table can be found within the report should have been included in the Executive Summary. Final report *(strengths/weaknesses)*: The Executive Summary presents detailed and useful project performance information but suffers from 1) mixing project description with review findings and 2) presenting further 'findings' under a misleading heading of 'Relevance'. The reader needs to read carefully to separate description from findings and would have been better served if	3.5

	the different elements had been and presented together. The 'project background' section is a mix of project description and review findings/verifications which is confusing for the reader. The review findings should have been integrated into the Conclusions for clarity. Similarly, the section 'C. Relevance' would have been better integrated into the Conclusions section to make its status as 'review findings' clear. The reader should be aware that this section is not a discussion of strategic relevance.	
Quality of the 'Introduction' Section Purpose: introduces/situates the evaluand in its institutional context, establishes its main parameters (time, value, results, geography) and the purpose of the review itself. To include: • institutional context of the project (sub-programme, Division, Branch etc) • date of PRC approval, project duration and start/end dates • number of project phases (where appropriate) • results frameworks to which it contributes (e.g. POW Direct Outcome) • coverage of the review (regions/countries where implemented) • implementing and funding partners • total secured budget • whether the project has been evaluated in the past (e.g. mid-term, external agency etc.) • concise statement of the purpose of the review and the key intended audience for the findings.	Final report *(coverage/omissions):* The report does not indicate how this project contributes to UNEP's Programme of Work (i.e. UNEP Subprogramme results etc) – even though para 88 states that the Reviewer reviewed the POW. It should have done so in both this section and in the Project Identification Table. There is also no clarification/confirmation of the number of past/future anticipated project phases, nor any mention of the Mid Term Review, which is indicated in the Project Identification Table to have been carried out in Oct 2018. Para 62. Refers to this project being launched in 2001, while this project was approved in 2016. The Project Identification Table should (as per UNEP's templates) have shown previous (or anticipated future) project phases. Para 64 Is a repeat of para 6 and should have been supported by a publication reference. Several paras in the Introduction have been directly copied into the Executive Summary and reflect the same weaknesses. Final report *(strengths/weaknesses):* The maps are too small to read as is and, when enlarged, are not clear or annotated enough to fulfill the intention in para 61 i.e. to indicate the sites where the SolarChill units were installed in the 3 countries. While the photographs are appreciated, they lack information on what they represent and, therefore, their relevance to this project.	3.5
Quality of the 'Review Methods' Section Purpose: provides reader with clear and comprehensive description of review methods, demonstrates the credibility of the findings and performance ratings. To include:	Final report *(coverage/omissions):* All elements covered, although the Mid Term Review is not mentioned. The selection of sites to visit was opportunistic (within easy reach) and the selection criteria for the 6 representative of end	4

• description of review data collection methods and information sources • justification for methods used (e.g. qualitative/ quantitative; electronic/face-to-face) • number and type of respondents *(see table template)* • selection criteria used to identify respondents, case studies or sites/countries visited • strategies used to increase stakeholder engagement and consultation • methods to include the voices/experiences of different and potentially excluded groups (e.g. vulnerable, gender, marginalised etc) • details of how data were verified (e.g. triangulation, review by stakeholders etc.) • methods used to analyse data (scoring, coding, thematic analysis etc) • review limitations (e.g. low/ imbalanced response rates across different groups; gaps in documentation; language barriers etc) • ethics and human rights issues should be highlighted including: how anonymity and confidentiality were protected. Is there an ethics statement? E.g. *'Throughout the* review *process and in the compilation of the Final Review Report efforts have been made to represent the views of both mainstream and more marginalised groups. All efforts to provide respondents with anonymity have been made.*	users of SC-A and SC-B are not given. Other project and partner representatives are said to be weighted towards those who have been with the project the longest but further details are not provided. Final report *(strengths/weaknesses):* Given the central role played by demonstration and testing of technologies in this project (see paras 102/3), the Reviewer should have described how the project's test data were reviewed and analysed/verified. The Evaluation Office notes that, due to the lack of local support, remote test locations were not visited during the missions in the two project countries visited (eSwatini and Colombia).	
Quality of the 'Project' Section Purpose: describes and verifies key dimensions of the evaluand relevant to assessing its performance. To include: • *Context:* overview of the main issue that the project is trying to address, its root causes and consequences on the environment and human well-being (i.e. synopsis of the problem and situational analyses) • *Results framework*: summary of the project's results hierarchy as stated in the ProDoc (or as officially revised) • *Stakeholders:* description of groups of targeted stakeholders organised according to relevant common characteristics • *Project implementation structure and partners:* description of the implementation structure with diagram and a list of key project partners • *Changes in design during implementation:* any key events that affected the project's scope or parameters should be described in brief in chronological order • *Project financing:* completed tables of: (a) budget at design and expenditure by components (b) planned and actual sources of funding/co-financing	Final report *(coverage/omissions):* Complete section, although under Stakeholders, the government authorities in Colombia are not listed (para. 110). Final report *(strengths/weaknesses):* The reformulation/reconstruction of the project's results, which intended to 'make the expected outputs more concrete' (para 108 and Table 3) does not bring the level of results definition and standardized that is expected to support an assessment of the project's performance. Specifically, at this stage in the report, there are no clear outcome (uptake) and output (provision) statements that make the project's expected results clear and evaluable. Moreover, result statements presented in Table 3 are not aligned with those in the ToC section. The table setting out the project extensions is clear and helpful, although if the reasons for extension had been included it would have been more useful.	3

	Table 6 and 8 contain contradictory information vis-à-vis GIZ co-finance. It is recorded as both cash (c. USD 5m in Table 6) and in-kind (Table 8). Table 9 shows inaccuracy in the aggregation of the performance ratings of the sub-categories. Table 9 shows HS ratings for each of Adherence, Completeness and Communication but aggregates this to a Satisfactory rating. However, in Table 14, the final summary of performance ratings, all sub-categories are recorded at the S level. Furthermore, Table 9 (Financial Management) should have been presented in the Review findings section of the report on 'Financial Management'.	
Quality of the Theory of Change Purpose: to set out the TOC at Review in diagrammatic and narrative forms to support consistent project performance; to articulate the causal pathways with drivers and assumptions and justify any reconstruction necessary to assess the project's performance. To include: • description of how the *TOC at Review*[40] was designed (who was involved etc) • confirmation/reconstruction of results in accordance with UNEP definitions • articulation of causal pathways • identification of drivers and assumptions • identification of key actors in the change process • summary of the reconstruction/results re-formulation in tabular form. *The two results hierarchies (original/formal revision and reconstructed) should be presented as a two-column table to show clearly that, although wording and placement may have changed, the results 'goal posts' have not been 'moved'.* This table may have initially been presented in the Inception Report and should appear somewhere in the Main Review report.	Final report *(coverage/omissions):* Final report *(strengths/weaknesses)*: The Evaluation Office notes that the project did not have a ToC diagram and that the reviewer reconstructed the ToC as part of the terminal review. Moreover, the Evaluation Office notes considerable inconsistency between what presented in the following tables and the rToC diagram (Figure 5): • Table 3: 'Planned and reformulated project outputs and outcomes'. • Table 10: 'Project framework at inception'. • Table 11: 'Justification for Reformulation of Results Statements' Tables 3, 10 and 11 should have set out clearly how the TOC was reconstructed based on a reasonable and transparent adjustment of the project's results framework at design, such that the project's performance at all results levels can be reliably assessed and in accordance with UNEP's/standard results definitions. Of particular concern is that a) the project outcome statement in Table 11 is not consistent with the 4 outcomes identified in the TOC and b) neither the single outcome in Table 11 nor the 4 outcomes in the TOC can be clearly derived from the 3 outcomes statements in the CEO Endorsement (Table B) and last PIR report (Table in section 3.1, 2022). As the UNEP assessment of project performance is heavily weighted towards the sustainable achievement of project outcomes, the Evaluation Office finds that the reconstructed TOC alone does not serve as an appropriate framework against which the project's	2

[40] During the Inception Phase of the review process a *TOC at Review Inception* is created based on the information contained in the approved project documents (these may include either logical framework or a TOC or narrative descriptions), formal revisions and annual reports etc. During the review process this TOC is revised based on changes made during project intervention and becomes the *TOC at Evaluation*.

	performance can be clearly assessed. **Therefore, the Evaluation Office has referred to the formulation of results in the PIR 2022, including the indicators and targets, to validate the Reviewer's assessment of Effectiveness and Sustainability.** The Review report does, however, provide a clear description of 3 causal pathways that reflect the expected effects of the project.	
Quality of Key Findings within the Report Presentation of evidence: nature of evidence should be clear (interview, document, survey, observation, online resources etc) and evidence should be explicitly triangulated unless noted as having a single source. Consistency within the report: all parts of the report should form consistent support for findings and performance ratings, which should be in line with UNEP's Criteria Ratings Matrix. Findings Statements (where applicable): The frame of reference for a finding should be an individual review criterion or a strategic question from the TOR. **A finding should go beyond description and uses analysis to provide insights that aid learning specific to the evaluand.** In some cases a findings statement may articulate a key element that has determined the performance rating of a criterion. Findings will frequently provide insight into 'how' and/or 'why' questions.	Final report *(coverage/omissions):* Final report *(strengths/weaknesses):* There are inconsistencies within the report, specifically in relation to the nature of the GIZ contribution (cash or in kind) and, importantly, in the reconstruction of the TOC. Although the report does not contain specifically labelled 'Findings Statements' it does provide considerable feedback and insights into the challenges faced by the project and verifies its achievements.	4
Quality of 'Strategic Relevance' Section Purpose: to present evidence and analysis of project strategic relevance with respect to UNEP, partner and geographic policies and strategies at the time of project approval. To include: Assessment of the evaluand's relevance vis-à-vis: • Alignment to the UNEP Medium Term Strategy (MTS), Programme of Work (POW) and Strategic Priorities • Alignment to Donor/GEF/Partners Strategic Priorities • Relevance to Regional, Sub-regional and National Environmental Priorities • Complementarity with Existing Interventions: complementarity of the project at design (or during inception/mobilisation[41]), with other interventions addressing the needs of the same target groups.	Final report *(coverage/omissions):* ***Alignment to UNEP's Medium-Term Strategy (MTS), Programme of Work (POW) and Strategic Priorities:*** The report does not indicate how this project contributes to UNEP's Programme of Work (i.e. UNEP Subprogramme results etc). Also, para. 140-142 refer to the project alignment/contribution to the national priorities of the three countries and the SDGs. This should have been included in the other sub-criteria of Strategic Relevance. Final report *(strengths/weaknesses):*	4.5

[41] A project's inception or mobilization period is understood as the time between project approval and first disbursement. Complementarity during project implementation is considered under Efficiency, see below.

Quality of the 'Quality of Project Design' Section Purpose: to present a summary of the strengths and weaknesses of the project design, on the basis that the detailed assessment was presented in the Inception Report.	Final report *(coverage/omissions)*: Project strengths and weaknesses are summarized. The quality of project design table is provided as an Annex (H). Final report *(strengths/weaknesses)*: The section is adequately addressed.	5
Quality of the 'Nature of the External Context' Section Purpose: to describe and recognise, when appropriate, key external features of the project's implementing context that limited the project's performance (e.g. conflict, natural disaster, political upheaval[42]), and how they affected performance. While additional details of the implementing context may be informative, this section should clearly record whether or not a major and unexpected disrupting event took place during the project's life in the implementing sites.	Final report *(coverage/omissions)*: Final report *(strengths/weaknesses)*: Para. 162 states that "The second extension to 17 January 2020, meant that the last part of the project happened during the pandemic". The Evaluation Office revised the text as, based on what indicated in Table 5 (Revisions and extension dates), the second extension was until 17 January 2021. Moreover, para. 162 states that "The initial timeline was 03 June 2016 – 31 March 2018, well before the Covid-19 pandemic". The first two project extensions were granted before COVID-19 was declared a pandemic by WHO in March 2020. Therefore, COVID-19 is considered to have partially affected the project implementation. The Rating of 'Nature of the External Context' is adjusted to 'Moderately Unfavourable'.	4.5
Quality of 'Effectiveness' Section **(i) Availability of Outputs:** Purpose: to present a well-reasoned, complete and evidence-based assessment of the outputs made available to the intended beneficiaries. To include: • a convincing, evidence-supported and clear presentation of the outputs made available by the project compared to its approved plans and budget • assessment of the nature and scale of outputs versus the project indicators and targets • assessment of the timeliness, quality and utility of outputs to intended beneficiaries • identification of positive or negative effects of the project on disadvantaged groups, including those with specific needs due to gender, vulnerability or marginalisation (e.g. through disability).	Final report *(coverage/omissions)*: A table with the output statements, their indicators and respective baselines and targets should have been provided. Final report *(strengths/weaknesses)*: The report does not provide a detailed assessment of project performance against a consistent set of outputs. Essentially, this project aimed to deliver a reliable and convincing 'proof of concept', disseminate the test results that prove the concept and engage a range of 'brokerage' agents in taking up the technology. **The Evaluation Office has referred to the formulation of results in the PIR 2022, including the indicators and targets, and considered these against the Criteria Ratings Matrix to validate the**	2.5

[42] Note that 'political upheaval' does not include regular national election cycles, but unanticipated unrest or prolonged disruption. The potential delays or changes in political support that are often associated with the regular national election cycle should be part of the project's design and addressed through adaptive management of the project team.

	Reviewer's assessment of Effectiveness and Sustainability. For a Satisfactory rating 81-99% of outputs should have been delivered with quality and in good time and those most important to achieve outcome level results, with good levels of ownership. At output level the field testing of SC-A and SC-B units is critical. The project achieved 56% of its target for SC-A (113 units against a target of 200) and 86% of its target for SC-B (39 against a target of 45). However, a) the reasons for not reaching the targets were largely outside the control of the project and b) the number of units was still substantial enough to form a testing and learning basis for the proof of concept. Paras 288 and 289 note the limited number of units that provided data. In addition, as stated in para 231, the test data was largely qualitative rather than quantitative because manufacturers were reluctant to share hard data. This is a significantly limiting factor to the utility of the output level achievements. However, the process of delivering this project was rich and did generate a great deal of solid learning that forms the basis for further action. The Evaluation Office validates the performance rating of outputs at the Satisfactory level.	
ii) Achievement of Project Outcomes: Purpose: to present a well-reasoned, complete and evidence-based assessment of the uptake, adoption and/or implementation of outputs by the intended beneficiaries. This may include behaviour changes at an individual or collective level. To include: • a convincing and evidence-supported analysis of the uptake of outputs by intended beneficiaries • assessment of the nature, depth and scale of outcomes versus the project indicators and targets • discussion of the contribution, credible association and/or attribution of outcome level changes to the work of the project itself • any constraints to attributing effects to the projects' work • identification of positive or negative effects of the project on disadvantaged groups, including those with specific needs due to gender, vulnerability or marginalisation (e.g. through disability).	Final report *(coverage/omissions):* The section on the achievement of project outcomes repeats to a certain extent what already presented/discussed in the previous pages 47-49 of the Effectiveness section. Final report *(strengths/weaknesses):* The report does not provide a detailed assessment of project performance against a consistent set of outcomes (i.e. 1 outcome in Table 11, 4 outcomes in the TOC and 3 different outcomes in the PIR and CEO Endorsement). Essentially, this project aimed to achieve commitments and take-up among a range of agents across the public and private sectors. **The Evaluation Office has referred to the formulation of results in the PIR 2022, including the indicators and targets, and considered these against the Criteria Ratings Matrix to validate the Reviewer's assessment of Effectiveness and Sustainability.** For a Moderately Satisfactory rating those outcomes most important for the achievement of intermediate states, along with the key assumptions and drivers, must be achieved. In this instance there is evidence of project take-up in	2.5

	specific instances and amongst some players but this take-up is not consistent across all target groups and some limitations/challenges remain that interrupt the intended causal pathways. The Evaluation Office validates the performance rating at the outcome level as Moderately Satisfactory.	
(iii) Likelihood of Impact: Purpose: to present an integrated analysis, guided by the causal pathways represented by the TOC, of all evidence relating to likelihood of impact, including an assessment of the extent to which drivers and assumptions necessary for change to happen, were seen to be holding. To include: • an explanation of how causal pathways emerged and change processes can be shown • an explanation of the roles played by key actors and change agents • explicit discussion of how drivers and assumptions played out • identification of any unintended negative effects of the project, especially on disadvantaged groups, including those with specific needs due to gender, vulnerability or marginalisation (e.g. through disability).	Final report *(coverage/omissions):* The section lacks an analysis of the elements supposed to be discussed in this section, i.e., likelihood of impact based on the casual pathways represented in the rToC; whether drivers and assumptions (identified in the rToC) hold; unintended negative effects of the project; explanation of the roles played by key actors and change agents. Final report *(strengths/weaknesses):* While the Reviewer has not covered all elements as expected by the Evaluation Office, a clear argument of the achievements and limitations of the project, as they relate to long-lasting change, is set out.	4
Quality of 'Financial Management' Section Purpose: to present an integrated analysis of all dimensions evaluated under financial management and include a completed 'financial management' table (may be annexed). Consider how well the report addresses the following: • *adherence* to UNEP's financial policies and procedures • *completeness* of financial information, including the actual project costs (total and per activity) and actual co-financing used • *communication* between financial and project management staff	Final report *(coverage/omissions):* As mentioned above, Table 9 should have been included in this section. Final report *(strengths/weaknesses):* This section raises no particular issue with regards to adherence to policies, completeness of financial information and communication between financial and project staff. The Evaluation Office notes what indicated in para. 223, namely, that during the project implementation part of the budget was moved from Component 3 (Outreach) towards Component 2 (SC-B). The Evaluation Office notes that the ratings of the three Financial Management sub-criteria presented in table 9 are not consistent with what was presented in the narrative section (page 52-54) and in Table 14 (Summary of project findings and ratings).	4
Quality of 'Efficiency' Section Purpose: to present an integrated analysis of all dimensions evaluated under efficiency (i.e. the primary categories of cost-effectiveness and timeliness). To include: • time-saving measures put in place to maximise results within the secured budget and agreed project timeframe • discussion of making use, during project implementation, of/building on pre-existing	Final report *(coverage/omissions):* A discussion on how the project could have benefitted from pre-existing initiatives and projects is presented. Final report *(strengths/weaknesses):* The section discusses the timeliness of project execution. Overall, the project had three no-cost extensions which extended the project duration by	5

institutions, agreements and partnerships, data sources, synergies and complementarities with other initiatives, programmes and projects etc. • implications of any delays and no cost extensions • the extent to which the management of the project minimised UNEP's environmental footprint.	33 months, to September 2021, which is double of the time originally intended for the project implementation.	
Quality of 'Monitoring and Reporting' Section Purpose: to present well-reasoned, complete and evidence-based assessment of the evaluand's monitoring and reporting. Consider how well the report addresses the following: • quality of the monitoring design and budgeting *(including SMART results with measurable indicators, resources for MTE/R etc.)* • quality of monitoring of project implementation *(including use of monitoring data for adaptive management)* • quality of project reporting *(e.g. PIMS and donor reports)* \	Final report *(coverage/omissions):* Final report *(strengths/weaknesses):* **Monitoring Design and Budgeting:** This section should have discussed the quality of the design of the monitoring plan as well as the funds allocated for its implementation. Moreover, it should have discussed the relevance and appropriateness of the project indicators as well as the methods used for tracking progress against them. Instead, this section focused on the change in the budget lines, which was already discussed in the financial management section. Even though not mentioned in this section, the monitoring plan is presented as an Annex (G). For each indicator, the plan indicates the data collection frequency, responsibility, means of verification and budget. However, the latter does not seem appropriate. The Evaluation Office notes that a MTR was budgeted for and carried out although the Review Report does not reference it much. **Monitoring of Project Implementation** This section should have discussed to what extent the monitoring system was operational and facilitated the timely tracking of results and progress towards projects objectives throughout the project implementation period. Also, whether the project gathered relevant and good quality baseline data that is accurately and appropriately documented. Moreover, it should have assessed the quality of the information generated by the monitoring system during project implementation and how it was used to adapt and improve project execution, achievement of outcomes and ensure sustainability. Instead, this section simply states that the "The half year reports, and the PIR reports give a very good sense of what happened in the project, the problems encountered, and the measures taken". There is no discussion of the role played by the MTR in terms of adapted management and no evidence provided on monitoring having been undertaken. **Project Reporting:**	2

	There is no mention of the fact that project reporting was carried out with respect to the effects of the initiative on disaggregated groups.	
Quality of 'Sustainability' Section Purpose: to present an integrated analysis of all dimensions evaluated under sustainability (i.e. the endurance of benefits achieved at outcome level). Consider how well the report addresses the following: • socio-political sustainability • financial sustainability • institutional sustainability	Final report *(coverage/omissions):* Final report *(strengths/weaknesses):* **Socio-political Sustainability:** The Review should have assessed the extent to which social or political factors support the continuation and further development of project outcomes. In particular, assessing the level of ownership, interest and commitment among government and other stakeholders to take the project achievements forwards. However, the section on socio-political sustainability simply mentions some of the benefits of the SC-A and SC-B refrigerators that were installed in the project countries, with no discussion of the aspects mentioned above. **Financial Sustainability:** The reviewer should have assessed the extent to which project outcomes are dependent on future funding. No such assessment is presented in this section, other than a few considerations on the price level of SolarChill technology. **Institutional Sustainability:** The Review should have assessed the extent to which the sustainability of project outcomes (especially those relating to policies and laws) is dependent on issues relating to institutional frameworks and governance. In particular, whether institutional capacity development efforts are likely to be sustained. Instead, this section simply reports that: "Upon project closure, extensive documentation packages, handover letters have been prepared. The goods purchased in the project have been handed over as well as documentation and results of the field tests. This gave the possibility to end-users (e.g., ministries of health and different NGOs and international organizations) to select best quality and performing units." There is no assessment of the robustness of the institutional achievements.	2
Quality of Factors Affecting Performance Section Purpose: These factors are not always discussed in stand-alone sections and may be integrated in the other performance criteria as appropriate. However, if not addressed substantively in this section, a cross reference must be given to where the topic is addressed and that entry must be sufficient to justify the performance rating for these factors.	Final report *(coverage/omissions):* An assessment of factors affecting performance is presented as a stand-alone section within the report. Final report *(strengths/weaknesses):*	4.5

Consider how well the review report, either in this section or in cross-referenced sections, covers the following cross-cutting themes: • preparation and readiness • quality of project management and supervision[43] • stakeholder participation and co-operation • responsiveness to human rights and gender equality • environmental and social safeguards • country ownership and driven-ness • communication and public awareness	**Quality of project management and supervision:** A more detailed analysis of the project management performance of the Executing Agency and the technical backstopping and supervision provided by UNEP as Implementing Agency would have been appreciated.	
Quality of the Conclusions Section **(i) Conclusions Narrative:** Purpose: to present summative statements reflecting on prominent aspects of the performance of the evaluand as a whole, they should be derived from the synthesized analysis of evidence gathered during the review process. To include: • compelling narrative providing an integrated summary of the strengths and weakness in overall performance (achievements and limitations) of the project • clear and succinct response to the key strategic questions • human rights and gender dimensions of the intervention should be discussed explicitly (e.g. how these dimensions were considered, addressed or impacted on)	Final report *(coverage/omissions):* Key strategic questions are addressed in this section. Final report *(strengths/weaknesses):* The section highlights some of the project findings/achievements/challenges, strengths and weaknesses of the project.	4.5
ii) Utility of the Lessons: Purpose: to present both positive and negative lessons that have potential for wider application and use (replication and generalization) Consider how well the lessons achieve the following: • are rooted in real project experiences (i.e. derived from explicit review findings or from problems encountered and mistakes made that should be avoided in the future) • briefly describe the context from which they are derived and those contexts in which they may be useful • do not duplicate recommendations	Final report *(coverage/omissions):* The review identified three lessons learned, which are rooted in project experiences/challenges encountered during the implementation. Final report *(strengths/weaknesses):* However, The Evaluation Office notes that the three lessons learned duplicate the first three recommendations.	4.5
(iii) Utility and Actionability of the Recommendations: Purpose: to present proposals for specific action to be taken by identified people/position-holders to resolve concrete problems affecting the project or the sustainability of its results. Consider how well the lessons achieve the	Final report *(coverage/omissions):* No recommendation provided relating to strengthening the human rights or gender dimension.	2

[43] In some cases 'project management and supervision' will refer to the supervision and guidance provided by UNEP to implementing partners and national governments while in others, specifically for GEF funded projects, it will refer to the project management performance of the executing agency and the technical backstopping provided by UNEP. This includes providing the answers to the questions on Core Indicator Targets, stakeholder engagement, gender responsiveness, safeguards and knowledge management, required for the GEF portal.

following: • are feasible to implement within the timeframe and resources available (including local capacities) and specific in terms of who would do what and when • include at least one recommendation relating to strengthening the human rights and gender dimensions of UNEP interventions • represent a measurable performance target in order to monitor and assess compliance with the recommendations. NOTES: **(i)** In cases where the recommendation is addressed to a third party, compliance can only be monitored and assessed where a contractual/legal agreement remains in place. Without such an agreement, the recommendation should be formulated to say that UNEP project staff should pass on the recommendation to the relevant third party in an effective or substantive manner. The effective transmission by UNEP of the recommendation will then be monitored for compliance. **(ii)** Where a new project phase is already under discussion or in preparation with the same third party, a recommendation can be made to address the issue in the next phase.	Final report *(strengths/weaknesses)*: The first three recommendations represent lessons learned, and in fact duplicate the lessons learned identified. These are not immediately actionable by project stakeholders and do not represent a measurable performance target. The 4th recommendation "*See reduction of costs as a relevant factor in UNEP projects as lower costs facilitates the introduction of new technologies*" is generic and does not have a measurable performance target. Recommendation 5 reads as "*Foresee an Initial Project Review*" by an independent expert for future projects. The Evaluation Office notes that all UNEP projects are reviewed by experts before being implemented as part of the Project Review Committee. Also, this recommendation does not have a measurable performance target, whereas the proposed implementation timeframe of two month is not aligned with the nature of the recommendation.	
Quality of Report Structure and Presentation **(i) Structure and completeness of the report:** To what extent does the report follow the Evaluation Office structure and formatting guidelines? Are all requested Annexes included and complete?	Final report *(coverage/omissions)*: The report is complete and follows the Evaluation Office guidelines. All the required Annexes are included in the report. Final report *(strengths/weaknesses)*: While the report follows the Evaluation Office guidelines in terms of structure, the reconstruction of the TOC does not play the central role expected in the performance assessment process because of inconsistency in the presentation of results across Tables 3, 10, 11 and the TOC itself. The lack of a systematic presentation of evidence against the project's output and outcome level results is also a limiting factor.	4
(ii) Writing and formatting: Consider whether the report is well written (clear English language and grammar) with language that is adequate in quality and tone for an official document? Do visual aids, such as maps and graphs convey key information?	Final report *(coverage/omissions)*: Final report *(strengths/weaknesses)*: The report is clear and tone adequate. A few typos were identified. The font used in the report was not always consistent. Location maps are too small and out of focus to be read and the photos are not labelled.	4.5
OVERALL REPORT QUALITY RATING		**3.6**

A number rating 1-6 is used for each criterion: Highly Satisfactory = 6, Satisfactory = 5, Moderately Satisfactory = 4, Moderately Unsatisfactory = 3, Unsatisfactory = 2, Highly Unsatisfactory = 1. The overall quality of the review report is calculated by taking the mean score of all rated quality criteria.

ANNEX IX. PORTAL INPUTS (FOR GEF PROJECTS ONLY)

The following table contains text to be uploaded to the GEF Portal. **It will be drawn from the Review Report, either as copied or summarised text.** In each case, references should be provided for the paragraphs and pages of the report from which the responses have been copied or summarised.

Table II: GEF portal inputs

Question: What was the performance at the project's completion against Core Indicator Targets? (For projects approved prior to GEF-7[44], these indicators will be identified retrospectively and comments on performance provided[45]).
Response: *(Might be drawn from Monitoring and Reporting section)* **Monitoring Design and Budgeting (MS)** This is considered moderately satisfactory. The budget lines have been changed significantly in three revisions. The motivations have not been clarified to the reviewer and cannot be found in the given documents. As mentioned in paragraph 124, the UMOJA financial reporting system and the spreadsheet templates did not foresee a financial reporting per outcome. As a consequence, the arguments for change in budget lines can be found in the spreadsheets, but no overall argumentation is given, neither in the spreadsheet nor in the accompanying documents of the revisions. This is not so much a short-coming in the project, but the result of the way the financial reporting was organised. Meanwhile, this issue has been resolved. Interestingly the third component received 55% less funding then initially foreseen, and this third component did not lead to fully satisfactory outcomes, as Palfridge being the only manufacturer aiming to produce SolarChill A units, failed to do so within the extended timeline of the SolarChill project. The Colombian manufacturers did start the development of SC-A but did not find compressors and PV panels for an acceptable price, so the development was stopped. That being said, and from the meeting with Palfridge, it was mentioned that the request to Palfridge was to "produce a SC-A unit" instead of to "develop a SC-A unit". An approach that limited Palfridge's R&D work. **Monitoring of Project Implementation (S)** This is rated as satisfactory, form the provided documents. The half year reports, and the PIR reports give a very good sense of what happened in the project, the problems encountered and the corrective measures taken. **Project Reporting (S)** Rated as satisfactory. An extensive set of reports has been published on the website www.solarchill.org. One relevant report on the field test has been sent to the reviewer separately and was not available on the website. There are Annual, half year and expenditure reports and

[44] The GEF is currently operating under the seventh replenishment period of the GEF Trust Fund covering the period July 1, 2018 to June 30, 2022. The GEF Portal Reporting Guide for FY20 Reporting Process indicates that GEF-6 projects that have yet to map existing indicators to GEF-7 Core Indicators need to do so at MTR stage or (if already there) at the time of the TE. .(i.e. not GEF projects approved before GEF-6)

[45] This is not applicable for Enabling Activities

inception report that were not to be uploaded on the website. There are however no reports from monthly meetings available to the reviewer, nor any Steering Committee meetings.

Question: What were the progress, challenges and outcomes regarding engagement of stakeholders in the project/program as evolved from the time of the MTR? *(This should be based on the description included in the Stakeholder Engagement Plan or equivalent documentation submitted at CEO Endorsement/Approval)*

Response: *(Might be drawn from Factors Affecting Performance section)*

Stakeholders Participation and Cooperation

According to the interviewed stakeholders and the countries' missions performed by the reviewer (e.g., meetings with ministries, project partners other national organizations, etc.), the cooperation between the project and the national partners was good apart from some issues in Kenya.

Local technicians received basic trainings for equipment servicing.

Manufactures proved to be less motivated to share knowledge with the project, but overall, the participation was good.

Agreed co-financing from the different national partners were satisfactory apart from in Kenya where promised import duty exemption were refused and the project team had to replace the planned models with less expensive ones to cover the import duties and taxes.

Stakeholders Participation and Cooperation is rated Moderately Satisfactory (MS).

Question: What were the completed gender-responsive measures and, if applicable, actual gender result areas? *(This should be based on the documentation at CEO Endorsement/Approval, including gender-sensitive indicators contained in the project results framework or gender action plan or equivalent)*

The nature of the project did not leave much room for mainstreaming human rights and gender equity in the implementation and in the results of the project.

There was no specific plan or action on human rights and gender equality but arguably women benefit from better health care for their children and reduced travel time and frequency to the medical clinics, as they tend to be in charge of taking care of them.

Participation of women and men in project activities was conditional on their roles in the respective ministries / institutions. The reviewer noticed a fair (around 50%) gender representation at the multiple meetings during the country visits in Colombia and eSwatini.

Finally, the nature of the project outputs and outcome is gender neutral.

Responsiveness to Human Rights and Gender Equality is rated Satisfactory (S).

Question: What was the progress made in the implementation of the management measures against the Safeguards Plan submitted at CEO Approval? The risk classifications reported in the latest PIR report should be verified and the findings of the effectiveness of any measures or lessons learned taken to address identified risks assessed. *(Any supporting documents gathered by the Consultant during this review should be shared with the Task Manager for uploading in the GEF Portal)*

Response: *(Might be drawn from Factors Affecting Performance section)*

Some risks weren't identified in the project plan such as high upfront price, lack of after sales clear agreement and spare parts availability in the countries, lack of support from some local authorities, etc. and the pandemic risk (COVID-19) created multiple delays in equipment's servicing and data collection. These risks (apart from the COVI-19 pandemic) were identified during midterm review but not solved satisfactorily. For instance, the high up-front cost has not evolved between the MTR and the final project review.

Question: What were the challenges and outcomes regarding the project's completed Knowledge Management Approach, including: Knowledge and Learning Deliverables (e.g. website/platform development); Knowledge Products/Events; Communication Strategy; Lessons Learned and Good Practice; Adaptive Management Actions? *(This should be based on the documentation approved at CEO Endorsement/Approval)*

Response: *(Might be drawn from Factors Affecting Performance section)*

Technology transfer (MS)

The technology transfer has not resulted in a new certified SolarChill A product. Local manufacturers such as Palfridge in eSwatini as well as Interhospitalaría, MartinKas, and Fricon in Colombia became SolarChill project partners. Yet only Palfridge came close but did not manage to meet the WHO criteria, at the DTI laboratory, for their SC-A unit.

Concerning SolarChill-B, Palfridge developed a model and field tested 40 units in eSwatini with positive feedback from end-users (e.g., availability of cold drinks and temperature sensitive goods such as cheese and milk, reduced electrical bill). On the other hand, the small internal volume of the SC-B units was highlighted as a limitation factor.

Question: What are the main findings of the evaluation?

Response:

The project delivered on field testing of solar-powered vaccine coolers without batteries (SC-A) and provided data and confidential feedback to manufacturers of these equipment. The numbers deployed are 113 of the 200 planned or 57%. 65 of the 113 provided quantitative data or 33% of the planned number.

The project did not deliver fully on the planned field testing of solar-powered coolers without batteries for household and commercial applications. 40 of the planned 45 were installed (89%). Of these, only one location reported temperature measurement data. The qualitative data, through questionnaires, do give a positive overall view on the SC-B technology.

The technology transfer package towards manufactures produced one outcome: a report. In terms of knowledge transfer, the work from HEAT and GIZ in the field has certainly contributed to the knowledge transfer to manufacturers in eSwatini and Columbia allowing manufacturers to improve the quality and performance of their units.

The feedback from the field was quite positive for both SC-A and SC-B as these units improved the healthcare situation especially in remote non electrified areas (SC-A) and it improved the incomes (higher sales) of small businesses and reduced their electrical bills (SC-B).

ANNEX X. REVIEW FRAMEWORK MATRIX

Strategic Relevance	• To what extent the project is aligned with UNEP MTS, POW and GEF Strategic Priorities? • To what extent the project is aligned to Donor/GEF/Partners Strategic Priorities? • Relevance to Global Regional, Sub-regional and National Priorities? • Complementarity with Existing Interventions and Coherence?	• **Review of MTS, POW; GEF programming directions; UNEP organizational documents; Project Document, CEO Endorsement request.** • **Strategies and policies for related sectors. Interviews with related staff.**
Effectiveness	• What are the key achievements of project components as per project design? • To what extent did the project achieve the direct defined outcomes per project design or beyond? • What impact has been achieved or is likely to be achieved within the project timelines and beyond?	• **Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners** • **Interviews with project teams and project stakeholders.** • **Field visits to project countries**
Financial Management	• To what extent the project adheres to UNEP's Financial Policies and Procedures? • To what extent the financial information are complete and comprehensive? • What financial controls are in place? • Where there any project revisions? • Was there adaptive management on project budget revision in relation to project workplans? • Have financial internal and external reporting been met? • How was the communication between the project management teams	• **Review of Half Year Progress Reports, PIRs, financial reports, budget revisions,.** • **Interviews with the Project Management and finance teams**
Efficiency	• **How efficient was the achievement of various project components?** • **Did the project experience delays and what were the adaptative measures put in place?**	• **Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners** • **Interviews with project teams and project stakeholders.** • **Field visits to project countries**

Monitoring and reporting	• To what extent the project's monitoring, design, and budgeting was optimum? • How well the project monitoring facilitated the project's tracking and implementation? • How complete was the project Reporting against established reporting modalities? • How effective was the project steering committee in the strategic execution of the project?	• Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners • Interviews with project teams and project stakeholders. • Field visits to project countries
Sustainability	• To what extent the project achieved an institutional sustainability in the three countries? • To what extent the project achieved a socio-political sustainability? • What institutional arrangements were put in place by the project team for continued sustainability of the project outcomes? • Was there an exit strategy for continued sustainability of the project outcomes?	• Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners • Interviews with project teams and project stakeholders. Field visits to project countries
Factors Affecting Performance and Cross-Cutting Issues		
Preparation and Readiness	• What constraints did the project experience at inception? • What steps if any were put in place to address them?	• Review of project periodic substantive reports (Inception Report, PIRs and Half Year Progress Reports). Periodic meeting reports by project partners • Interviews with project teams and project stakeholders. • Field visits to project countries
Quality of Project Implementation and Execution	• Did the project implementation adhere to the Project design defined in the project document? • Was there adaptive management to any implementation/executive challenges?	• Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners • Interviews with project teams and project stakeholders. • Field visits to project countries
Stakeholders' participation and cooperation	• To what extent stakeholders were actively participating in the project's implementation? What efforts they made to achieve the project's outcomes? • How involved were the national governments in the project execution in the different countries?	• Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners • Interviews with project teams and project stakeholders. • Field visits to project countries
Responsiveness to Human Rights and Gender Equity	• How explicit was gender mainstreaming in the project implementation? • How gender sensitive were the project?	• Review of project prodoc, CEO ER, PIR and progress reports, and MTR. • Interviews and consultations.

Environmental and Social safeguards	• To what extent the project adhered to UNEP's social and environmental safeguards? • Were environmental risks identified in the project design and execution? How were they addressed?	• Review of Project Document • Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners • Interviews with project teams and project stakeholders. • Field visits to project countries
Country ownership and drivenness	• What was the level of participation of ministries, governments, and agencies in project activities? • How did the countries demonstrate leadership? (strategic guidance*, co-financing, etc.).* • How active were the national teams in the periodic meetings?	• Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners • Interviews with project teams and project stakeholders. • Field visits to project countries
Communication and public awareness	• Was there a project communication plan? • What communication channels the project activated for knowledge sharing?	• Review of project periodic substantive reports (PIRs and Half Year Progress Reports). Periodic meeting reports by project partners • Interviews with project teams and project stakeholders. • Field visits to project countries

ANNEX XI. ANNEXES ADDED BY THE CONSULTANT

ANNEX A: PROJECT RESULTS FRAMEWORK (from the Project Document)

Description	Indicators	Source of verification	Assumptions
Promote, demonstrate, and deploy low-carbon technologies.	Greenhouse gas (GHG) emissions reduction potential.	GHG emissions reduction estimates.	This project will project, not measure, GHG emissions reductions.
Reduce carbon emissions through off-grid efficiency gains.	Addition or substitution of SolarChill units for fuel-driven units.	SolarChill consortium.	Off-grid efficiencies gains using solar instead of fossil fuel powered.
Increased availability and use of WHO PQS prequalified SolarChill refrigerators.	Number of WHO PQS prequalified SolarChill A refrigerators and available brands.	WHO PQS.	Increased availability of WHO PQS SolarChill A refrigerators will increase accessibility and introduction of SolarChill. Increasing introduction of off-grid efficiency products will lead to reduction in carbon emissions.
Increased availability and use of SolarChill B food refrigerators (for domestic and small-scale businesses)	Number of marketed SolarChill B refrigerators and available brands.	SolarChill consortium.	Increased availability of qualified SolarChill B refrigerators will increase accessibility and introduction of SolarChill. Increasing introduction of off-grid efficiency products will lead to reduction in carbon emissions.
Increased awareness of benefits of SolarChill technology from an environmental and health perspective.	Number of individuals recognizing the benefits of SolarChill.	Number of views of SolarChill website. Questionnaire tracking	Recognition of benefits of SolarChill technology will promote the use of SolarChill and reduce GHG emissions. Annual Interviews will be carried out with

Description	Indicators	Source of verification	Assumptions
			all relevant stakeholders (ministries, health facilities, domestic manufacturers, distributors) with the same questionnaire. The interviews and questionnaire will be designed to appropriately monitor the progress of the project with regards to its objectives and measuring the awareness.
Brokerage and linkage activities between manufacturers and whole sellers in the countries and financing organisations (micro-financing)	Appropriate linking parties identified, and contacts established; One partnership established;	Engagement from financing organization confirmed;	Existing financing (micro-financing) organization in at least one of the three target countries exists and shows interest to get engaged
Deployment and testing of SolarChill units according to project components with resulting GHG emission reductions.	Number of units of SC-A and SC-B installed and being tested.	Monitoring of the local partners	Every unit installed avoids installation of a kerosene unit (GHG abatement) allows avoidance of corresponding additional fuel combustions. Therefore, every unit installed results in corresponding GHG abatement.
Accurate site selection for testing & evaluating SolarChill A.	Site compliance to SolarChill A requirement.	SolarChill consortium technical experts.	Solar equipment site selection protocols have been validated by industry experts.
SolarChill installation and monitoring protocol and training program for local technicians.	Training protocols available.	SolarChill consortium technical experts.	MOH will contribute to the appropriateness of the training protocols and format for training.
Accurate site selection for testing and evaluating SolarChill B.	Site compliance to SolarChill B requirements.	SolarChill consortium technical experts.	Solar equipment site selection protocols have been validated by industry experts.
Consolidate SolarChill external Communication.	Communication and marketing materials available	SolarChill consortium.	Obtaining buy-in of external communication messages

Description	Indicators	Source of verification	Assumptions
	and accessible.		will strengthen the overall SolarChill category.
Engage in technology transfer discussions.	Number of companies engaged in discussion about technology transfer.	SolarChill consortium, Ministry of Industry (MOI) and Ministry of Environment (MOE).	Given the timeframe and investment required for conversion of a manufacturing line, it is anticipated that companies interested in technology transfer will not be able to fully adopt the technology within the scope of this project.
National institutional/sectoral and policy compliance.	Number of national policies in place to mitigate climate change through the introduction of solar refrigeration or other means.	SolarChill consortium, MOI, MOE, MOH.	Adoption of new policies or strengthening of existing policies will help to encourage installation of additional SolarChill units and incentivize local or regional manufacturers to transition to CFC-free refrigerants and insulation. Note that the policies to be followed are driven by the Montreal Protocol and HC conversions-HPMP strengthening enforcement is an extension of the work is driven by UNEP co-financing. This activity therefore is not part of the project specific outputs or indicators and therefore does not appear in Annex G.
	Foster project institutional arrangements.	Number of collaborating institutions involved in the project.	SolarChill consortium, MOI, MOE, MOH.	Aligning objectives of SolarChill with other organizations will help to ensure the project goals are achieved and sustainable.
Activities	Dissemination of tools and training for site selection review and approval for SolarChill refrigerators.	Number of MOH staff trained.	SolarChill consortium technical experts.	N/A.
	Confirm potential SolarChill A sites in	Baseline information and	SolarChill consortium	N/A.

	each country.	results from solar site assessment of facilities.	technical experts.	
	Prepare an overview of procurement costs, including import and customs considerations for use in the implementation phase.	Purchase orders available.	UNICEF Supply Division.	SolarChill A units are all WHO PQS prequalified. UNICEF tenders offer the lowest market price for refrigerators, PV panels, and installation equipment.
	Procure and ship selected SolarChill A units to Colombia, Kenya, and ESwatini.	Refrigerators purchased and delivered to countries.	UNICEF Supply Division.	N/A.
	In collaboration with country MOH and/or local contractors, distribute SolarChill A units.	SolarChill A units arrive to designated sites.	MOH and country coordinators.	If appropriate, MOH will distribute units to facilities, contributing to in-kind co-financing.
	Creation of tools and training for installation of SolarChill refrigerators.	Number of MOH staff trained.	SolarChill consortium technical experts.	Some countries prefer to have a private company install and repair units. MOH training will ensure back-up experts are available. If SolarChill B units are installed by a different set of technicians, those individuals will be included in this initial training.
	Creation of tools and training for maintenance and repair of SolarChill refrigerators.	Number of MOH staff trained.	SolarChill consortium technical experts.	Some countries prefer to have a private company install and repair units. MOH training will ensure back-up experts are available. If SolarChill B units are installed by a different set of technicians, those individuals

				will be included in this initial training.
	Creation of tools and training for monitoring and reporting of SolarChill refrigerator performance.	Number of MOH staff trained.	SolarChill consortium technical experts.	Some countries prefer to have a private company install and repair units. MOH training will ensure back-up experts are available. If SolarChill B units are installed by a different set of technicians, those individuals will be included in this initial training.
	Confirm potential SolarChill B sites in each country.	Baseline information and results from solar site	SolarChill consortium technical experts.	The same solar assessment will be performed for SolarChill B as that outlined for SolarChill A.
	Document the criteria for how SolarChill B units must perform in lab tests and during field testing	Testing protocol available.	SolarChill consortium technical experts.	Manufacturers that have expressed interest in developing SolarChill B units will agree with these test specifications

	Collect design and test information from SolarChill B candidate manufacturers (Liebherr, Bosch, The Fridge Factory, Vestfrost).	Refrigerator specification and test results available.	SolarChill consortium (DTI).	SolarChill B units that meet test requirements will be available for purchase.
	Coordinate the procurement of SolarChill B units to Colombia, Kenya, and ESwatini.	Refrigerators purchased and delivered to countries.	SolarChill consortium (DTI).	SolarChill B units meeting performance criteria will be affordable and available for sale.
	In collaboration with country MOH	SolarChill B units arrive to	MOH and country	Technicians trained upon the arrival of SolarChill A

	and/or local contractor, distribute SolarChill B units.	designated sites.	coordinators.	for installation, repair, and monitoring, and will also be available to install SolarChill B units.
	Complete optimization of The Fridge Factory SolarChill A and obtain WHO prequalification.	WHO prequalification.	WHO PQS.	N/A.
	Support R&D transfer from SolarChill A to B (with enhanced critical features, in particular 72-hour autonomy without battery) with participating manufacturers in project countries	SolarChill B available for sale.	The Fridge Factory, Technical Experts. Vestfrost, Bosch, True Energy, and other qualifying solar refrigerator manufacturers. Participating manufacturers in Colombia;	Partnership with local manufacturers in Colombia will be sought for the development of SolarChill A and/ or B units. It is assumed that R&D and local manufacturing is required to tailor the products to local and regional needs (i.e., for technical specifications such as autonomy and ambient temperatures); lower production capabilities will allow to lower the costs of the units significantly over time.
	Develop a SolarChill business case for manufacturing. Support partnering local manufacturers to assess regional sales markets including Kenya, Colombia, and Southern Africa; support manufacturers to lower costs (design and sourcing);	Business case available.	SolarChill consortium/ Tech Experts. Local	The business case will include information on markets, marketing; for manufacturing it will include a strategy on lowering costs for imported / externally sourced materials and lowering costs for improved designs; It is assumed that costs for critical components for the solar units such as PV panels and vacuum panel (for insulation and autonomy at high ambient temperature), direct current compressor can be significantly reduced over time.
	Contact refrigerator manufacturers to assess their initial interest in	Identification of additional technology transfer partners.	SolarChill consortium.	If a new manufacturer can deliver SolarChill B units for field testing within this project, this will be

	SolarChill and explore ways in which the project can support their interest in the implementation phase.			pursued.
	In the context of each country, track the national institutions related to and influencing this project and summarize their role, if any, in the GEF project.	Number of national policies in place to mitigate climate change through the introduction of solar refrigeration or other means.	SolarChill consortium, MOI, MOE, MOH.	Adoption of new policies or strengthening of existing policies will help to encourage installation of additional SolarChill units and incent local or regional manufacturers to transition to CFC-free refrigerants and insulation.
	In the global context (outside the context of project countries) track the institutions related to and influencing this project and summarize their role or effect on this project.	Number of global policies in place to mitigate climate change through the introduction of solar refrigeration or other means.	SolarChill consortium, MOI, MOE, MOH.	Adoption of new policies or strengthening of existing policies will help to encourage installation of additional SolarChill units and incentivise local or regional manufacturers to transition to CFC-free refrigerants and insulation.

	Estimate the demand and supply potential for SolarChill A and B refrigerators, globally and in the project's three initial countries.	SolarChill market demand estimates.	SolarChill consortium.	SolarChill A and B units will continue to be most appropriate in areas of unreliable access to grid electricity.
	Calculate potential indirect emissions reductions from the project.	Baseline and end estimates of direct and indirect emission reductions from the project.	SolarChill consortium.	Measurement of the emissions may not be feasible given the small scale and short timeframe of this project.

	Measure direct and indirect emission reductions from the project.	Baseline and end estimates of direct and indirect emission reductions from the project.	SolarChill consortium.	Measurement of the emissions may not be feasible given the small scale and short timeframe of this project.
	Update and advance the SolarChill website and associated marketing materials.	Revised website and marketing materials available.	SolarChill consortium.	N/A.
	Create and execute a communication and advocacy plan for SolarChill A and B.	Advocacy plan available.	SolarChill consortium.	N/A.
	In collaboration with the project's advisory committee, identify, hire, and execute a contract, if needed, with a country program coordinator (CPC) and associated technical staff. The CPC may be a staff member from the MOH or may be an independent contractor capable of dedicating the time to oversee this project effectively.	Hired country program coordinator.	SolarChill consortium.	Associated technical staff will be based on in-kind government time commitments.
	Summarize national- and donor-funded activities contributing to the objectives of this project during project implementation.	Description of the activities, how they supported the project, when they took place, and how much they cost.	SolarChill consortium.	N/A.

	Hold country program advisory committee meetings in recipient countries.	Outline project activities and timing, and develop an organogram and decision-making flow	SolarChill consortium.	Participants may include MOH, MOE, MOI, and interested NGOs.
	Report in-kind contributions with each country.	Document $225,000 (USD) per country or agreed upon amount over 3 years.	SolarChill consortium.	N/A
	Track co-financing of partners, Governments, and existing and potential manufacturing partners.	Document SolarChill consortium and government funding commitments	SolarChill consortium/ SKAT.	Cash and in-kind contributions are included.
	Carry out the administrative/executive agency functions, including financial reporting functions, as specified in the contract with UNEP.	Project funds disseminated and tracked.	SolarChill consortium (SKAT).	GIZ to provide international coordination amongst SolarChill partners
	Manage and disburse the GEF funds by subcontracting SolarChill consortium member organization, country program executing agencies, and consultants.	Project funds disseminated and tracked.	SolarChill consortium (SKAT).	N/A

ANNEX G - M&E BUDGET AND WORK PLAN (from the Project document)

Objective / Outcome [1]	Outcome / objective level indicator [2]	Baseline Conditions [3]	Mid-point Target [4]	End of Project Target	Means of Verification [5]	Monitoring / sampling (frequency / size) [6]	Location / Group	Responsibility	Time frame [7]	Budget (Object of expenditure & cost) [8]
Procure, install and monitor 200 SolarChill A units (=vaccine coolers) in three countries	Field demonstration and cross-comparison of currently available SolarChill A products to ensure that safe vaccine storage conditions are met.	Vestfrost units installed in Colombia and Kenya.	200 SolarChill A units installed and monitored across the three countries. (Preferably from different suppliers).	Performance records of at least 1 year from different brands of SolarChill A units.	SolarChill consortium and MOH	Quarterly or semi-annually (depending on equipment and existing protocols)	Colombia, Kenya, ESwatini	SolarChill consortium technical experts	Q4Y1	1,113,000
Site selection for SolarChill A will follow project established and WHO endorsed guidelines. These guidelines	Mid-term and End of project review (UNEP)			Final report			Global		Q1Y3 - Q2Y3	25,000

Objective / Outcome [1]	Outcome / objective level indicator [2]	Baseline Conditions [3]	Mid-point Target [4]	End of Project Target	Means of Verification [5]	Monitoring / sampling (frequency / size) [6]	Location / Group	Responsibility	Time frame [7]	Budget (Object of expenditure & cost) [8]
stipulate that sites must meet the solar radiation, environmental conditions, clearance for solar panel installation, and healthcare catchment population size required by the solar direct drive refrigerator chosen. Project										

Objective / Outcome [1]	Outcome / objective level indicator [2]	Baseline Conditions [3]	Mid-point Target [4]	End of Project Target	Means of Verification [5]	Monitoring / sampling (frequency / size) [6]	Location / Group	Responsibility	Time frame [7]	Budget (Object of expenditure & cost) [8]
review										
Procurement, install and monitor of 45 SolarChill B units in the 3 countries Site selection for SolarChill B will follow project established guidelines. These guidelines stipulate that sites must meet the solar	Field demonstration of SolarChill B in a variety of small institutional and light commercial applications. Mid-term and end of Project Review (UNEP); Linkage of manufacturers, wholesalers, and financing (micro-financing organisations	No available SolarChill B units.	45 SolarChill B units installed and promotion of SolarChill B marketing / financing	First performance records of SolarChill B units from different suppliers. Final report Links between manufacturers, wholesalers and financing organisations established	SolarChill consortium and MOE	Quarterly or semi-annually (depending on equipment and existing protocols)	Colombia, Kenya, ESwatini Global	SolarChill consortium technical experts	Q4Y2 Q1Y3 - Q2Y3	522,650 25,000

Objective / Outcome [1]	Outcome / objective level indicator [2]	Baseline Conditions [3]	Mid-point Target [4]	End of Project Target	Means of Verification [5]	Monitoring / sampling (frequency / size) [6]	Location / Group	Responsibility	Time frame [7]	Budget (Object of expenditure & cost) [8]
radiation, environmental conditions, clearance for solar panel installation, and demand utilization for a solar direct drive refrigerator. Project review	)									
Increased awareness of the availability of SolarChill	Advocacy campaign, business plan, increase in	Minimal visits to website and demand of	Increase in visits to website; Tracking of awareness, usage,	Annual Questionnaires/ Interviews with key stakehol	SolarChill consortium and manufactures	Semi-annually	Global	SolarChill consortium	Q1Y1 - Q2Y3	

Objective / Outcome [1]	Outcome / objective level indicator [2]	Baseline Conditions [3]	Mid-point Target [4]	End of Project Target	Means of Verification [5]	Monitoring / sampling (frequency / size) [6]	Location / Group	Responsibility	Time frame [7]	Budget (Object of expenditure & cost) [8]
products and their technological, performance, cost and environmental benefits. benefits.	global demand for SolarChill units.	~1000 units per year; Low awareness among key stakeholders on the technology, availability, usage, and access (including finance) of SolarChill Units	knowledge of SolarChill technology, access, financing, sourcing	ders; Evaluation and tracking of progress. information material available and shared with stakeholders worldwide						807,000
Engage in technology transfer with refrigerator production	Preparation of a tech transfer packet. Engage local	One manufacture r	Discussions with 1-3 manufacturers	At least one additional manufacturer from a development country	SolarChill consortium	Semi-annually	Colombia, ESwatini	SolarChill consortium, Ministry of Industry (MOI), of Environmen	Q2Y1 - Q2Y3	

Objective / Outcome [1]	Outcome / objective level indicator [2]	Baseline Conditions [3]	Mid-point Target [4]	End of Project Target	Means of Verification [5]	Monitoring / sampling (frequency / size) [6]	Location / Group	Responsibility	Time frame [7]	Budget (Object of expenditure & cost) [8]
companies in Colombia that have converted to HC production lines as well as those willing to do so. Project review	manufacturers to adopt advanced Type B technology. Mid-term and End of project review (UNEP)			adopts SolarChill Type- A technology. At least one manufacturer is enabled to adopt SC Type-B technology. Final report			Global	t (MOE) (mostly Colombia)	Q1Y3 - Q2Y3	20,000
Project management	Coordinate and track finances and administratio	Initial project budget	Expenses and co-financing commitment	Total expenses and co-financing commitment	GEF	Quarterly statements	Global	SolarChill consortium, MOI, MOE, MOH	Q1Y1 to Q2Y3	199,500

Objective / Outcome [1]	Outcome / objective level indicator [2]	Baseline Conditions [3]	Mid-point Target [4]	End of Project Target	Means of Verification [5]	Monitoring / sampling (frequency / size) [6]	Location / Group	Responsibility	Time frame [7]	Budget (Object of expenditure & cost) [8]
	n of grant.		s	s						

Annex H - Review of quality of project design

A.	Operating Context		YES/NO	Comments/Implications for the review design
1	Does the project document identify any unusually challenging operational factors that are likely to negatively affect project performance?	i)Ongoing/high likelihood of conflict?	No	Of minor importance
		ii)Ongoing/high likelihood of natural disaster?	No	Of minor importance
		iii)Ongoing/high likelihood of change in national government?	No	Changes in national governments impacted the project, given the initial project was planned to run for 30 months and in the end took twice that time. For instance…
B.	Project Preparation		YES/NO	Comments/Implications for the review design
2	Does the project document entail clear and adequate situation analyses?		Yes	Some risks and gaps have not been identified in the Project Document e.g., risk related to hi upfront price, procurement process should have included after sales service and spare parts, field test criteria, etc.
3	Does the project document include a clear and adequate stakeholder analysis, including by gender/minority groupings or Indigenous peoples?		No	The project document sees the parties involved in the project as stakeholders, not the end users. Gender is marginally mentioned. Nothing on minority groups.

4	If yes to Q4: Does the project document provide a description of stakeholder consultation during project design process? (If yes, were any key groups overlooked: government, private sector, civil society, and those who will potentially be negatively affected)			Manufacturer and suppliers of SC technology were overlooked in the project document. They have been involved at the procurement phase.
5	Does the project document identify concerns with respect to human rights, including in relation to differentiated gender needs and sustainable development? (e.g., integrated approach to human/natural systems; gender perspectives, rights of indigenous people)	i)Sustainable development in terms of integrated approach to human/natural systems	No	The tables have been filled in, but human rights are not addressed in the text of the project document.
		ii)Gender	No	Gender is marginally mentioned.
		iii)Indigenous peoples	No	Nothing on minority groups.
C.	Strategic Relevance		YES/NO	Comments/Implications for the review design
6	Is the project document clear in terms of its alignment and relevance to:	i) UNEP MTS and PoW	Yes	The project document refers to older UNEP documents on strategic priorities, logically.
		ii) UNEP/GEF/Donor strategic priorities (incl. Bali Strategic Plan and South-South Cooperation)	Yes	
		iii) Regional, sub-regional and national environmental priorities?	No	
		iv) Complementarity with other interventions	No	

D.	Intended Results and Causality		YES/NO	Comments/Implications for the review design
7	Are the causal pathways from project outputs (availability of goods and services to intended beneficiaries) through outcomes (changes in stakeholder behaviour) towards impacts (long-lasting, collective change of state) clearly and convincingly described in either the logframe or the ToC? (NOTE if there is no TOC in the project design documents a reconstructed TOC at Review Inception will be needed)		Yes	There is no TOC, but Annexe A contains a “Project results framework”. The descriptions are meticulously done, but looking at the remarks from the mid-term review, the assumptions have a tendency of being oversimplifications.
8	Are impact drivers and assumptions clearly described for each key causal pathway?		Yes	Oversimplification of the causal pathway.
9	Are the roles of key actors and stakeholders clearly described for each key causal pathway?		Yes	The roles and responsibilities are described in Annex H of the ProDoc. See also Annex I.
10	Are the outcomes realistic with respect to the timeframe and scale of the intervention?		NO	The answer is NO with the original project’s time frame of 30 month (e.g., without the 36-month extension).
E.	Logical Framework and Monitoring		YES/NO	Comments/Implications for the review design
11	Does the logical framework:	i) Capture the key elements of the Theory of Change/ intervention logic for the project?	Yes	There is no TOC, but Annexe A contains a “Project results framework”.
		ii)Have appropriate and ‘SMART’ results at output level?	Yes	Section A.5.2 of the ProDoc

		ii)Have appropriate and 'SMART' results at outcome level?	Yes	Section A.5.2 of the ProDoc
12	Is there baseline information in relation to key performance indicators?		No	The baseline is described in words, hardly in numbers and assuming little to no activity outside/before the project. The assumptions on the energy use in the baseline (fossil fuel generator coupled to refrigerator) are not based on data. The review of the SolarChill refrigerators needs to be done against data on the baseline.
13	Has the desired level of achievement (targets) been specified for indicators of outputs and outcomes?		Yes	The ProDoc contains mid-points and end terms targets in its Annex G.
14	Are the milestones in the monitoring plan appropriate and sufficient to track progress and foster management towards outputs and outcomes?		Yes	Numbers for the outputs in the projects + future penetration levels have been given (see also Annex H of the ProDoc).
15	Have responsibilities for monitoring activities been made clear?		Yes	They can be found in the Annex G and Annex H of the ProDoc.
16	Has a budget been allocated for monitoring project progress?		Yes	See Annex G of the ProDoc.
17	Is the workplan clear, adequate, and realistic? (e.g., Adequate time between capacity building and take up etc)		No	Timewise, the original workplan wasn't realistic as the project has been extended three times beyond the original 30-month duration. Also, the ProDoc does not show a logical pathway to achieve cost reduction of SC technology leading to the desired market penetration of SC. See Annex G of the ProDoc.

F.	Governance and Supervision Arrangements		YES/NO	Comments/Implications for the review design
18	Is the project governance and supervision model comprehensive, clear, and appropriate? (Steering Committee, partner consultations, etc.)		No	The allocation of responsibilities is clear (Annex H and Annex I of the ProDoc). The role and actions (annual meetings, budget approval, activities approval, etc.) of the steering committee is explained on page 65 of the ProDoc. However, the governance has not been adequate. Only two half year report in a project running for , see paragraph 241.
19	Are roles and responsibilities within UNEP clearly defined? (If there are no stated responsibilities for UNEP Regional Offices, note where Regional Offices should be consulted prior to, and during, the Review)		No	No such responsibilities were described in the ProDoc.
G.	Partnerships		YES/NO	Comments/Implications for the review design
20	Have the capacities of partners been assessed? (CHECK if partner capacity was assessed during inception/mobilisation where partners were either not known or changed after project design approval)		Yes	
21	Are the roles and responsibilities of external partners properly specified and appropriate to their capacities?		Yes	Roles and responsibilities have been clearly allocated, but it appears that some responsibilities are spread between two or three partners for one activity (e.g., in column 9 of Annex G, the project management is the responsibility of MOI, MOE and MOH). This might affect the execution effectiveness of the project (to be investigated during the review).

H.	Learning, Communication and Outreach		YES/NO	Comments/Implications for the review design
22	Does the project have a clear and adequate knowledge management approach?		No	At the project inception it was unclear how the knowledge transfer would take place. But later, the SC website has been developed and papers have been published, etc.
23	Has the project identified appropriate methods for communication with key stakeholders during the project life? (If yes, do the plans build on an analysis of existing communication channels and networks used by key stakeholders?)		Yes	Communication with stakeholders took place via bi-annual progress updates, audits, PIR annual document, the SC website, the mid-term review, etc.
24	Are plans in place for dissemination of results and lesson sharing at the end of the project? If yes, do they build on an analysis of existing communication channels and networks?		Yes	The SC website and published papers are the means for results dissemination. Training materials are also published on the SC website. The Terminal report will be distributed to all stakeholders and published on the GEF website for access to external parties. The website should be updated to correctly present the current state of the project e.g., finalized project. Also, the history section does not go later than 2018 which do not show the recent results of the project. The question: is Greenpeace international still managing the website? (To be verified during the review).
I.	Financial Planning / Budgeting		YES/NO	Comments/Implications for the review design
25	Are the budgets / financial planning adequate at design stage? (Coherence of the budget,		Yes	The co-financing numbers add up correctly (even though they were not realised as such).

	do figures add up etc.)			
26	Is the resource mobilization strategy reasonable/realistic? (If it is over-ambitious it may undermine the delivery of the project outcomes or if under-ambitious it may lead to repeated no cost extensions)		No	The project was extended three times without cost extension. Hence the resource mobilization strategy seems to be under-ambitious. The review should also verify if co-financing budgets (cash and in-kind) have been received by the project.
J	Efficiency		YES/NO	Comments/Implications for the review design
27	Has the project been appropriately designed in relation to the duration and/or levels of secured funding?		No	From duration point of view, the project was clearly underestimated (the duration has been extended three times). The planned co-finance was not realised in practice.
28	Does the project design make use of / build upon pre-existing institutions, agreements and partnerships, data sources, synergies and complementarities with other initiatives, programmes, and projects etc. to increase project efficiency?		No	Previous field data did not exist when the project was planned in the early 2000's but field teste data existed for SC technology prior to the start of the project. Partnership with WHO and UNICEF were relevant for their experience in the health care field.
29	Does the project document refer to any value for money strategies (i.e., increasing economy, efficiency and/or cost-effectiveness)?		No	The ProDoc describes the unit cost reduction potential, but only by referring to external factors. The decrease of the cost of the units was foreseen through technical support on design, R&D and production know how. Also, the project design shows attention for financing, not commercial cost reduction.

30	Has the project been extended beyond its original end date? (If yes, explore the reasons for delays and no-cost extensions during the Review)		Yes	Delays in equipment supplies and installations, COVID-19 pandemic, challenges with data collection (e.g., network coverage), delays at customs, etc. Other reasons will be explored during the terminal review, also by using the PIR reports and other documentation.
K.	Risk identification and Social Safeguards		YES/NO	Comments/Implications for the review design
31	Are risks appropriately identified in both the ToC/logic framework and the risk table? (If no, include key assumptions in reconstructed ToC at Review Inception)		No	The risks table (table 11) in the ProDoc is clear. Nonetheless, some risks weren't identified (high upfront price, lack of after sales clear agreement and spare parts availability, lack of support from some local authorities, etc.) and the pandemic risk (COVID-19).
32	Are potentially negative environmental, economic, and social impacts of the project identified and is the mitigation strategy adequate? (Consider unintended impacts)		Yes	All these potential impacts have been listed in the ProDoc. No major negative impact has been identified.
33	Does the project have adequate mechanisms to reduce its negative environmental footprint? (Including in relation to project management and work implemented by UNEP partners)		No	Most of the work was planned to and has been done remotely, thus reducing travel. Yet, there is no explicit mechanism to reduce its' negative environmental footprint
L.	Sustainability / Replication and Catalytic Effects		YES/NO	Comments/Implications for the review design
34	Did the design address any/all the following: socio-political, financial, institutional, and environmental sustainability issues?		Yes	Environmental sustainability is addressed through the emissions reduction calculation and the no-use of lead batteries. The GEF secretariat raised the question about the

				financial sustainability of the project (Annex B). Apart from that, there are no details about the other issues.
35	Was there a credible sustainability strategy and/or appropriate exit strategy at design stage?		No	At the design stage there was no clear and sustainable project's exit strategy. The field units were handed to relevant ministries. Communication on the handover process is mentioned in respective Advisory Report prepared by HEAT, but there are no further details.
36	Does the project design present strategies to promote/support scaling up, replication and/or catalytic action? (If yes, capture this feature in the reconstructed TOC at Review Inception)		Yes	The Project Framework contains the component Information dissemination and technology transfer. Apart from the outreach activities, there are no clear catalytic action nor replication efforts, neither are there related activities for after the project end.
M.	Identified Project Design Weaknesses/Gaps		YES/NO	Comments/Implications for the review design
37	Were there any major issues not flagged by PRC?		No	
38	What were the main issues raised by PRC that were not addressed?			For example, the high upfront cost of the SC units and the project replication in other countries/regions.
N	UNEP Gender Marker Score	SCORE		Comments
39	What is the Gender Marker Score applied by UNEP during project approval? (This applies for projects approved from 2017 onwards)	N/A	N/A	