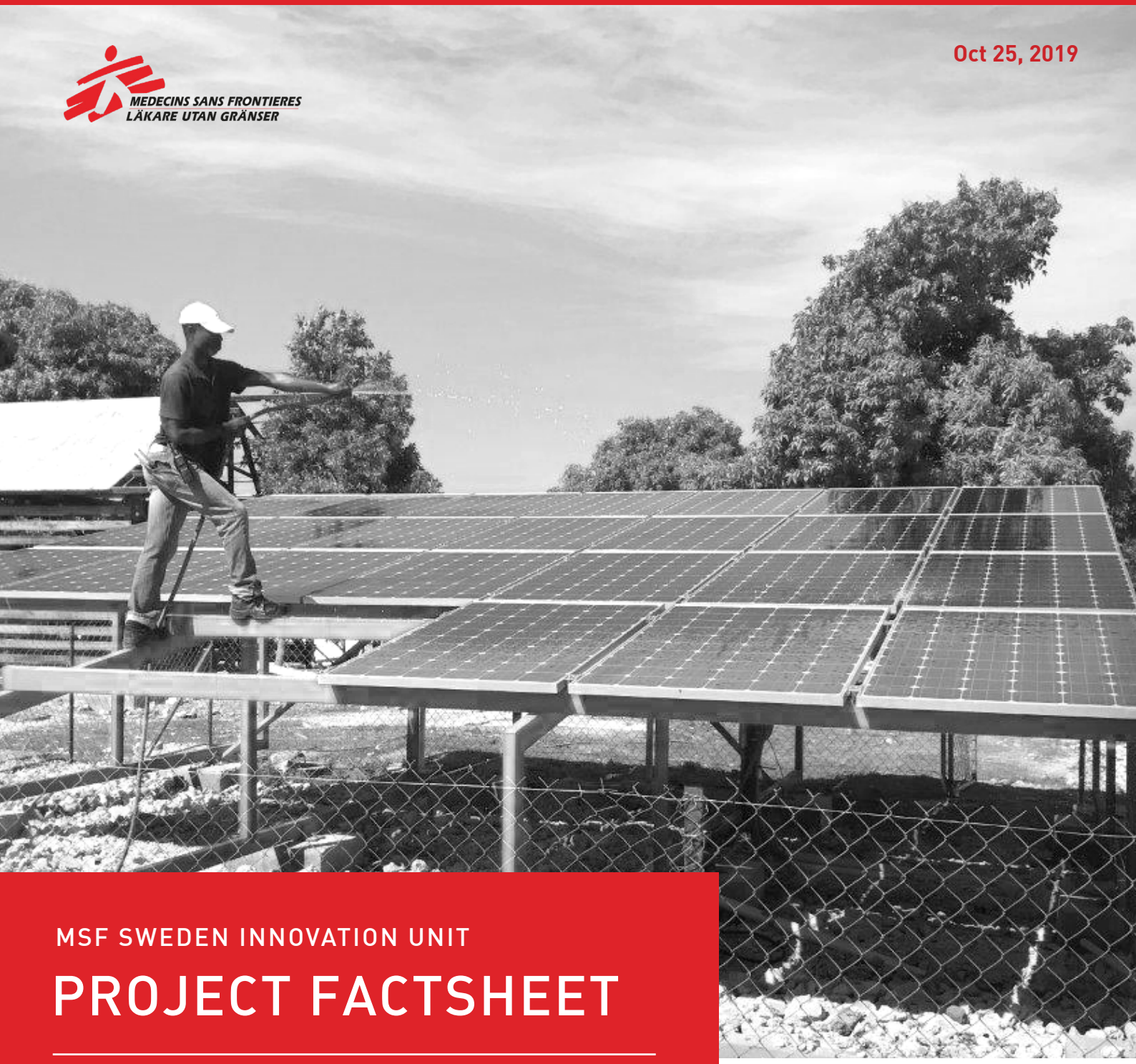
MEDECINS SANS FRONTIERES
LÄKARE UTAN GRÄNSER

Oct 25, 2019



MSF SWEDEN INNOVATION UNIT

PROJECT FACTSHEET

SOLAR AIR CONDITIONING

-Using the sun for cooling in MSF field projects

Table Of Content

This factsheet describes the innovation process and key learnings extracted from the Médecins Sans Frontières (MSF) Sweden Innovation Unit's Solar Air Conditioning Case. This case explores the potential exchange of a significant part of the diesel generator power used in MSF field projects for solar power contributing positive economic outcomes and maintained cooling efficiency for our medical facilities.

Introduction

This Solar AC Case project aimed to identify and test solar power solutions for cooling within MSF, reducing dependence on diesel powered generators and battery operations.

PROJECT

One of the largest consumers of fossil fuel within MSF field operations is air conditioning (AC). AC is medically essential for establishing controlled temperatures within pharmacies, operating theatres and laboratories, which can otherwise be challenging to provide in a reliable way. In addition, AC in MSF field offices and residences provide improved working and living conditions. Existing estimates suggest a **total fuel cost across MSF for AC of the order of €3 million/year**. In addition to the financial cost, AC also negatively contributes to global warming via approximately 6000 tons of CO_2 emissions, and to local pollution.

This Solar AC Case project aimed to identify and test solar power solutions for cooling within MSF, reducing dependence on diesel powered generators and battery operations.

MÉDECINS SANS FRONTIÈRES

Médecins Sans Frontières (MSF) is an international medical humanitarian organisation, and was established in 1971 in France with the aim to establish an independent organisation that focuses on delivering emergency medicine aid quickly, effectively and impartially.

Nowadays MSF operates all over the world and continues to be independent of both governments and institutions. This autonomy is used to provide help to people irrespective of gender, race, religion, creed or political convictions. MSF advocates for improved medical treatments and constantly looks for ways to improve its own practices.

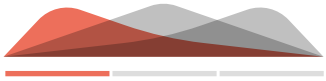
MSF SWEDEN INNOVATION UNIT

In the humanitarian sector, where responding quickly to rapidly emerging crisis situations is absolutely crucial, humanitarian organisations struggle to maintain a balance between addressing short-term needs and building the capability to meet long-term challenges. The MSF Sweden Innovation Unit (SIU) explores a human centered approach for promoting a culture of innovation within MSF, to more effectively co-create innovations that save lives and alleviate suffering.

For more information, visit msf-siu.org

01 Initiation

In December 2017 the MSF Sweden Innovation Unit and the MSF OCP (Operational Center Paris) jointly undertook the task of trying to find ways to power air conditioning with solar power in our field projects by applying for project approval and funding from the MSF Transformational Investment Capacity (TIC).



Step 1 of Innovation process
Initiation

Framing the challenge, performing research, analyzing insights, defining objectives

June, 2017
The MSF International Working Group (IWG) Energy identifies the need for solar powered air conditioning and contacts the MSF Sweden Innovation Unit for help with finalizing the research through a structured innovation project.

August, 2017
Initial needs assessment is performed through a questionnaire to the energy referents of all MSF Operational Centers (OCs).

December, 2017
A formal project proposal is submitted by OCP and SIU to the MSF Transformational Investment Capacity (TIC) to conduct a market landscape analysis, a use case scenario analysis for field projects, and first test pilot

May, 2018
Innovation project phase 1 launched as a TIC project with OCP funding and case management by SIU. Phase 1 is planned for 6 months – May to November.

June, 2018
Use case scenario analysis is started for three selected MSF OCP field projects. In parallel, the sourcing of monitoring equipment for the field projects is started.

June, 2018
A comprehensive international market landscape analysis of solar powered solutions for air conditioning is started.

01 Defining objectives

The energy referents in the different operational centres of MSF have sought to find a solar power solution to air conditioning needs for some time, since this is one of the largest consumers of diesel generator power in the field projects. Until now, only solar power systems with battery back-up have been available - something MSF could be improved on. With this, the project objective was defined as follows:

To identify potential solar aircon solutions – with no or minimal battery back-up need – that could be used in MSF operations with the aim to reduce costs, make operations more autonomous, and generally reduce the carbon footprint of MSF projects.

In addition, the following specific project objectives were formulated:
- To map and fully understand the needs and requirements for all use case scenarios: day, night or 24-7 use, i.e. OT, pharmacies, offices, ware-houses, etc.
- To perform a comprehensive market assessment of the available solutions and see how we could address the different use cases with existing off-the-shelf solutions/ products.
- To identify which use cases and existing solutions are closest to be matched for further development/implementation of solar aircon solutions.

The project plan included a field test of available off-the-shelf solutions

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02 Perform research

During this point in the case development, the team identified requirements and use cases, for solar power cooling solutions through the expertise of the energy referents of all operational sections of MSF. Existing projects were used to collect initial data on cooling needs as well as energy consumption for conventional generator powered ACs.

The Case team performed an extensive international landscape analysis of solar power air conditioning technologies and products available on the market, currently under development, as well as those in earlier research stages.

In parallel, a monitoring program for use case scenarios was planned for three OCP field projects, one in Haiti, one in Nigeria and one in Iraq. The monitoring equipment to be used for monitoring solar irradiance, indoor and outdoor temperatures and power use of conventional generator powered air conditioners – remotely via internet connections – was identified through a market search and sourced at an early project stage. Unfortunately, this equipment eventually did not prove functional in field conditions and the monitoring in three projects had to be aborted. As a learning in response to this another monitoring system is currently (July 2019) being finalized as a part of the Haiti project

03 Analyse insights

- Multiple brands of "hybrid" ACs were found to be available in the market that were designed for solar power input supplemented by grid (or generator) power. None of these solutions were from major AC brands.
- From this identified long-list, two suppliers were identified as the most promising. Both units were purchased and, interestingly, it became apparent that there was almost identical hardware in both indicating that they were from the same manufacturer. These would potentially fulfill the "daytime only" use case with solar power only and the "24 hour" use case with generator backup.
- More advanced systems incorporating thermal cold storage (the freezing of water to ice with solar power or using other phase-change materials or PCM) for night-time cooling needs were also found. However, none of these options were readily available to implement in phase 1 of the project. These solutions are currently a more nascent research or testing stage, gradually moving closer to being available in the market.
- Systems for more advanced control of multiple "normal" ACs - to match power consumption with available solar power input - were also researched. Such systems may be available in the relatively near future.

02 Development

Following an extensive market analysis the conclusion is reached that the most feasible technique at the time of assessment was solar PV electrically powered aircon equipment, potentially with thermal storage. The team installed the test aircons in parallel with the existing aircons to be able to switch over if there would be any problems and mitigate against risk during testing.

Step 2 of Innovation process
Development

Generating and screening ideas, creating and testing concepts and prototypes

- **July, 2018**
  Version one air conditioners ordered to be used in the field tests in addition to monitoring equipment for the use case scenario monitoring and field tests.
- **August, 2018**
  First delivery of solar air conditioners to MSF Logistique in Merignac from Superen, China.
- **August, 2018**
  MSF OCP Drouillard Hospital for burn wounds in Haiti is selected as field test location. Field test dates are set to mid-October until mid-December.
- **August, 2018**
  OCB expresses interest in installing solar air conditioning in safe-room in South Sudan.
- **September, 2018**
  Project extension to January 2019 is granted due to an over-optimistic initial time plan.
- **September, 2018**
  Monitoring equipment for use case and field test monitoring received from manufacturer. Pre-testing in Merignac reveals challenges and the third use case study (Iraq) is abandoned.
- **September, 2018**
  The planned field test of thermal cold storage cooling systems abandoned for project phase 1 due to too low technology readiness level for field project contexts in combination with limited project time.

01 Generating ideas

There are three main use case scenarios that frequently require air conditioning in MSF field projects:

1. Continuous (24-hour): Operating theatres, intensive care units and other critical medical wards, pharmacies and laboratories require prolonged AC with high risk impact if the system was to fail

2. Daytime: Consultation rooms, offices and medical wards in places with moderate night-time temperatures require shorter term AC with medium risk association in case of system failure

3. Night-time: Residences of MSF staff demand overnight AC with lower risk association in case of system failure

With the equipment identified being readily available, the Case team determined that the first two use cases would be prime for intervention using:

- Solar photovoltaic (PV) direct powered ACs + generator/grid power backup
- PV direct powered (only) ACs

For use case 2 (daytime usage), the match was hypothesised to be close to perfect with solar power available for most of the working day. For case 1 (24-hour use), it was concluded that test-beds would still rely on diesel generators in most projects but could cut the generator load significantly during daytime - which are typically the peak load hours for generator use. For the third use case (nighttime use), the only solution currently available is PV powered ACs with battery backup, which is not ideal due to high battery capacity needs and limited battery durability.

02

Development

Step 2 of Innovation process
Development

Generating and screening ideas, creating and testing concepts and prototypes

- **October, 2018**
  Delivery of the second brand of solar air conditioners to MSFL from Hotspot Energy, USA.
- **October, 2018**
  Field test period in Haiti started with installation of monitoring equipment for use cases with existing air conditioners (generator powered).
- **November, 2018**
  Solar power system and solar powered air conditioners are installed.
- **Dec, 2018 - Jan, 2019**
  Test program run for solar air conditioners. Monitoring equipment excluded from test after malfunction identified and new system is sourced for later installation. Use case monitoring in second project (Nigeria) is also abandoned. Promising function of solar AC units proven for initial period.
- **March, 2019**
  New power consumption monitoring equipment installed for the tested solar units in addition to conventional air conditioners in Haiti. Continued follow-up for the hotter summer season planned.
- **July, 2019**
  New temperature monitoring equipment installed in Haiti.
- **August, 2019**
  New temperature monitoring equipment installed in Haiti.

03 Testing phase

In the selected Haitian test site, Drouillard Hospital, the Case team installed three hybrid air conditioning units, two of which were connected to direct solar power only. These were installed in consultation rooms in the Outpatient Department as per case scenario 1. The third was installed in the operating theater (OT) and was, in addition to solar PV power, also connected to the generator power.

For comparative purposes, the team also installed two battery powered (solar PV power charged batteries) ACs in the residential section of the hospital compound. All installed units are 12,000 Btu/h (3kW) in cooling capacity, which is the standard basic unit capacity in most of our field projects. Each unit was installed with a solar power array of 8 PV panels with a nominal maximum power output of 275W each. This is intentionally a somewhat oversized solar PV array in order to be able to cover also for partly cloudy conditions and early morning and late afternoon lower solar power intensity.

The initial development test phase 1 of the project was only 2 months long - from finished installation in December 2018 to end of January 2019. The case manager, Per-Erik Eriksson, was on location until late December, after which the monitoring was done remotely. During this period, the project team verified the function of all test ACs for the different use cases. However, due to December and January typically being a cooler period of the year in Haiti the remote monitoring equipment proved faulty. With this realisation the decision was taken to extend the verification period over the hot season 2019 (June-August).

Following this the hybrid ACs, with PV power only and with generator backup respectively, worked without interruption for over 9 months. The direct solar powered units supply the cooling needed for the two consultation rooms from around 8.00 in the morning until around 17.00 in the afternoon, i.e. during all working hours for this use case. The hybrid unit in the operating theater also supplied most of the required cooling during the day. However, when dealing with larger test spaces and buildings where insulation is less robust, the generator back-up power is occasionally required during cloudy periods - in addition to evenings, nights and early mornings. This indicates the challenge with the hybrid solar/generator solution, as they are likely to create high load peaks for the generator at these times if many ACs are connected like that in the same site. The hybrid type of AC, but with direct solar PV power only, is therefore primarily recommended for implementation in further field projects.

The two battery powered ACs for use case 3 (night residential usage) performed reasonably well as far as the actual AC units were concerned. However, it was proven that large battery banks would be required unless very strict usage hours are observed. These are therefore not recommended for further implementation in field projects.

03

Implementation

The project results have been widely disseminated in OCP as well as throughout the energy referents of all sections of MSF. The results of the initial tests and longer term performance insights have also been presented through two short videos in addition to a presentation at the MSF Scientific Days 2019. This has resulted in significant movement-wide interest.

Step 3 of Innovation process
Implementation

Detailed implementation and design of solutions in the field, scaling up and diffusion

- **January, 2019**
  Innovation project phase 1 completed and reported to OCP and TIC. Tested equipment sufficiently proven for a recommendation for wider implementation across MSF however previously planned phase 2 not deemed feasible at this point in time. Additional 24 units of the Superen Hybrid air conditioner are ordered by MSFL to be available for field project orders.
- **February, 2019**
  OCA plans to implement the solar hybrid air conditioners in four field projects.
- **March, 2019**
  Project results presented to the MSF IWG Energy. Significant interest express for further implementation from all OC energy referents.
- **May, 2019**
  Project presented at the MSF Scientific Days in London and video result summary published on MSF web channels.
- **June - August, 2019**
  Larger scale implementation phase of the project discussed for e.g. pharmacies.
- Project Completion

Current Status and Next Steps

Following the successful verification of the function of the hybrid solar AC, MSF Logistique (MSFL) ordered 24 further units to have in stock for field project orders. The first of these units are currently being shipped to OCA field projects. Simultaneously, OCP are investigating the possibility of implementing the technology in a pharmacy in South Sudan.

The next phase of the project (not yet initiated) will involve testing further use cases, supporting wider implementation and dissemination of learnings, as well as continuous monitoring of the Haiti installations to provide data for an entire annual cycle. The Case team also plan to develop tools for sizing of the equipment kits (AC units as well as PV panel arrays etc.) for various climate conditions and use cases. This continued investigation is also intended to provide added guidance on return-on-investment for various contexts.

Lessons Learnt

- The hybrid AC systems tested – with PV power only as well as with generator backup – were found suitable for field hospital conditions, both with respect to installation and economy (return on investment). Following the successful test results, they are already being implemented more widely within MSF and can be ordered from MSF Logistique.

- The epidemiological impact of an air conditioner is independent of its power source it will be the same. However, it is important to keep in mind that when installing aircons and insulating the rooms, care must be taken to also have proper ventilation so that air is renewed to keep a good air quality, as well as maintaining the units (cleaning according to the contamination risks of the room).

Acknowledgements

This project was made possible by the contributions of Case Leader Per-Erik Eriksson, the Case Owner Alfredo Gonzalez (OCP energy referent) and SIU Innovation Lead Marpe Tanaka. Special thanks are also to MSF Logistique for assisting the procurement of test equipment and arranging for further ordering processes within the movement.

Finally, sincere thanks are expressed to the personnel of the MSF Douillard Hospital for burn wounds in Haiti (OCP) for hosting the field tests and putting up with all the extra work and effort that results in.

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Our Approach

The SIU takes a human-centered design approach. This means taking the wishes and requirements from the potential users by involving them directly in the design process. In doing this, the product is more likely to fit the needs and wishes of the end-users and the processes in which it has to work.

INNOVATION PROCESS

The MSF SIU uses a three-phase innovation process of initiation, development and implementation. Although these phases principally follow each other, they also often overlap. It is important to highlight that an innovation process is not a linear one, but one that requires iterations in which steps are repeated to improve the product. Iterations improve the design solution to ensure it fits the scenario in which it has to be used.

INITIATION

Framing the challenge, performing research, analyzing insights, designing objectives

DEVELOPMENT

Generating and screening ideas, creating and testing concepts and prototypes

IMPLEMENTATION

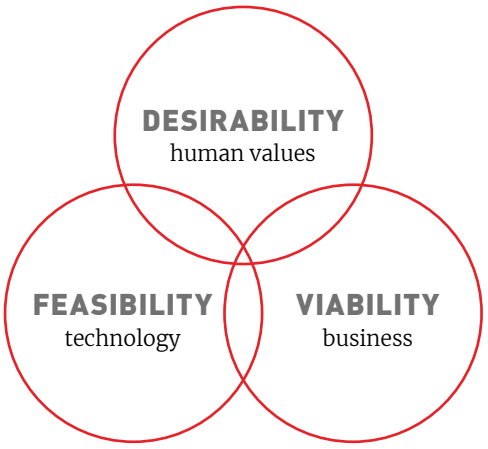
Detailed implementation and design of solutions in the field, scaling up and diffusion

COLLABORATION

Many innovation processes are conducted collaboratively. This is done to balance desirability, viability and feasibility, which increases the value of the design solution, as it will be:

- a desirable solution the user really needs.
- a feasible solution that is (technically) possible.
- a profitable solution with a sustainable business model.

This is one of the reasons why the MSF Sweden Innovation Unit operates on a collaborative and open basis. We believe that external actors have value to add through their expertise and aim to harness this added value throughout the design process.



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