SET4food

SET4food project

The project: *Sustainable energy technologies for food utilization (SET4food)*

Duration: from 01/06/2014 to 31/12/2015 (19 months)

Implementing partners: COOPI – Cooperazione Internazionale, Politecnico di Milano and Fondazione Politecnico di Milano

Funding: co-funded by the European Commission's Humanitarian Aid and Civil Protection (ECHO), and the implementing partners

Objective: to enhance the response capacity of humanitarian actors in identifying and implementing efficient and sustainable energy technologies for food utilization

Main activities: all the activities aimed to contribute to make energy utilization in camps and informal settlements more efficient and sustainable. The project's beneficiaries were humanitarian actors – including both operators and organizations –, in order to make them more effective to support food security among displaced people, as refugees and internally displaced people. In practice, the objective was addressed with three groups of activities:

- **Practical tools** were developed, in order to support design and field implementation of humanitarian regarding energy-related issues;
- **Pilot projects** tested both the tools developed and innovative energy solutions. They collected useful indications and proposed recommendations to facilitate the successful implementation of new technologies and approaches in contexts of people displacement;
- **Training and dissemination activities** were implemented at different levels, in order to sensitize and build the capacity of humanitarian actors.



www.set4food.org

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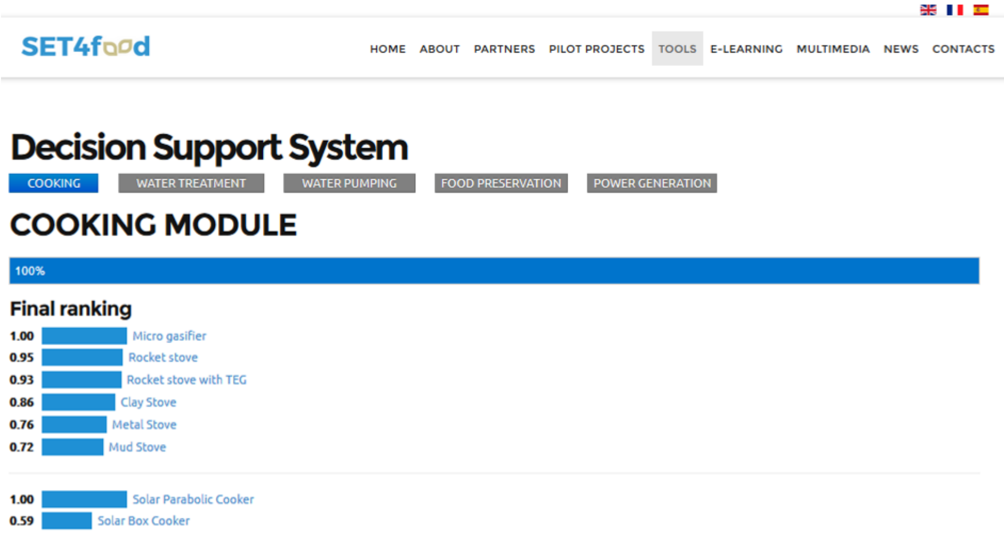
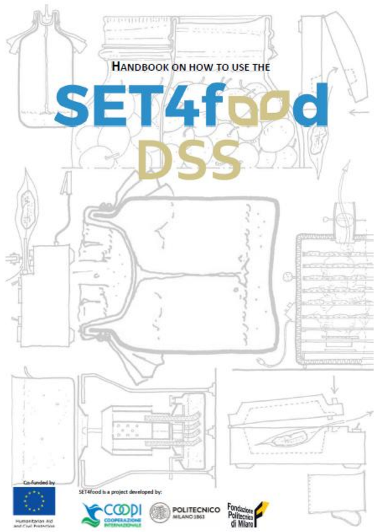
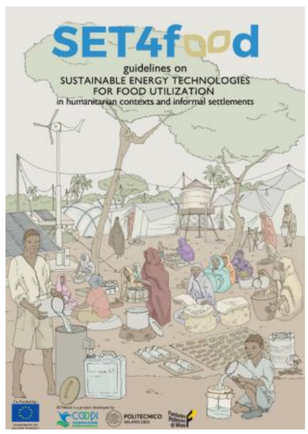
Tools for humanitarian actors

Decision support system (DSS) to identify potentially appropriate energy technologies for food utilization, given a certain context of people displacement. The five available modules deal with: 1) food cooking; 2) food preservation; 3) power generation; 4) water pumping; and 5) water treatment. A dedicated handbook facilitates the DSS use and its application in real cases. DSS and handbook are available in English, French and Spanish on www.set4food.org.

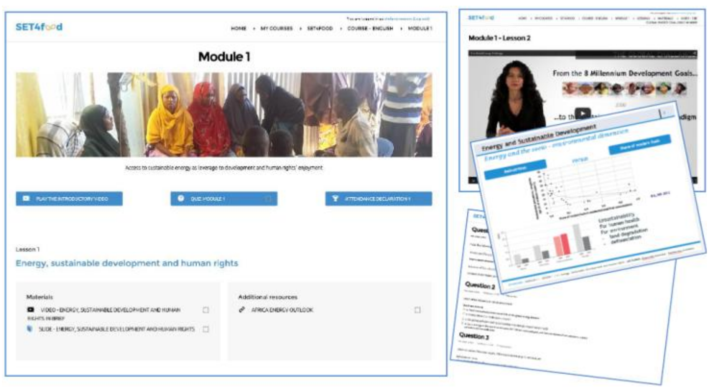




Guidelines on sustainable energy technologies for food utilization in humanitarian contexts and informal settlements. This publication introduces the topics considered by the DSS modules (i.e. food cooking, food preservation, power generation, water pumping, water treatment), and provide a general overview and a detailed description of all the technologies potentially of interested for humanitarian assistance. Technologies are described with technical sheets, references, examples of field application, and practical recommendations, and compared through a SWOT analysis. Practical examples of field innovation in humanitarian contexts are described, as well as recommendations and lessons learnt from the SET4food pilot projects. The guidelines are available in English, French and Spanish on www.set4food.org.



E-learning course about "Appropriate energy technologies for food utilization in refugee camps and informal settlements: overview, selection criteria and pilot case studies". It is composed of 5 modules with videos, slides, additional resources and quizzes. The course is available in English, French and Spanish on www.set4food.org.



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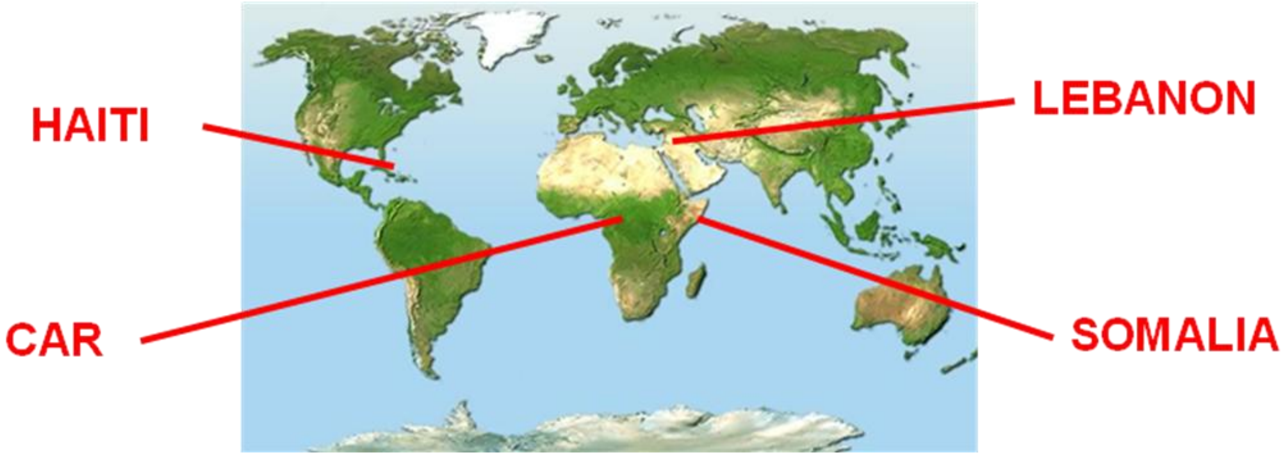
Pilot project activities

Pilot projects in different countries – Central African Republic, Haiti, Lebanon and Somalia – were implemented to test both the DSS logical framework, and innovative solutions for people displacement. Both refuges and IDPs, in both camps and informal settlements, were targeted.



Several innovative solutions were tested, including new energy technologies and approaches to make food utilization practices more sustainable, reliable and inclusive. Data were collected in order to identify both PROs and CONs of these solutions, and develop recommendation and useful indications for dissemination and scale-up. When applicable, some relevant parameters (e.g. reduction in fuel consumption or expenditure for water purification) were calculated to provide a benchmark.

Technical sheets of relevant innovative solutions implemented are attached. These solutions are:

- Pot-skirt for gas burner – implemented in Lebanon;
- Movable standalone electric system with thermoelectric fridge – implemented in Lebanon;
- Hybrid solar/wind power system with multi-compartment refrigerators – implemented in Lebanon;
- Improved cookstoves in rural and remote areas – implemented in Central African Republic;
- Locally-made solar refrigerator (SPARK model) – implemented in Haiti;
- Comparison of water filters for household water treatment and safe storage (HWTS) – implemented in Haiti.

The full list of technologies implemented is reported in the following table:

Country and beneficiaries	Municipality and type of settlement	Households (people) covered	Technologies
Lebanon **Syrian refugees**	**Kfarsaroun** (informal settlement) 13 households covered	13 (82)	13 **moveable standalone photovoltaic systems** in DC for indoor and outdoor lighting and to power 13 small **thermoelectric fridges** (20-25 litres each)
			12 **potskirts for gas burners**
			13 **water purification** systems with **UV lamps** integrated (Steripens)
	Deddeh (informal settlement) 100 hh covered (out of 149 hh with 670 people in the settlement)	100 (450)	One **hybrid solar/wind system** providing energy to **7 multi-compartment refrigerators equipped with eutectic plates** (each refrigerator with 8 compartments)
	Kfarsaroun (informal settlement) 16 hh, all covered	16 (82)	16 **vacuum sealers** with hand-pump and 30 bags each
		11 (60)	11 **micro-gasifiers** (ELSA cookstoves)
	Btouratij (informal settlement) 9 hh, all covered	9 (49)	9 **vacuum sealers** with hand-pump and 30 bags each
			9 **micro-gasifiers** (ELSA cookstoves)
Somalia **IDPs**	**Mogadishu,** **21 October camp** (camp) 315 hh covered (out of 900 hh in the camp)	75 (449)	3 **standalone photovoltaic systems** in DC for indoor and outdoor lighting and to power 3 **solar fridges** used in sharing mode (25 families each)
		180 (773)	99 **improved cookstoves** (1 locally-made and 2 commercial models): - 90 (30 per model) in sharing mode (2 families each) - 9 (3 per model) for demonstrative purposes
		60 (315)	60 **water purification systems** for household water treatment and safe storage (LifeStraw – Family 2.0; Tulip – Siphon)
Central African Republic **Congolese refugees**	**Zemio** (camp) 230 hh covered (out of 1251 hh in the camp)	88 (282)	2 **standalone photovoltaic systems (different PV technologies)** in AC for indoor and outdoor lighting and to power 4 **standard refrigerators** and 1 **freezer** used in sharing mode (totally 108 families = 100 beneficiaries + 8 in the management board)
		*	4 **locally-made root cellars** (using cold bricks produced by freezers)
			1 **improved smoking device** (adapted charcoal improved cookstove)
			1 improved locally-made **solar dryier**
		100 (320)	100 **improved cookstoves** (30 locally-made and 70 commercial) working with biomass (including firewood)
		30 (96)	30 **solar lanterns** (D.Light S2)
Haiti **IDPs**	**Port-au-Prince**, **St. Etienne 1 and 2** (camps) 24 hh covered (out of 202 hh in the camps)	24 (120)	3 **standalone photovoltaic systems** in DC to power 6 **locally-made fridges** (500 liters capacity) used in sharing mode (4 families each) – SPARK model
	Port-au-Prince, **Villambetta** (informal settlement) 217 hh, all covered	217 (1,085)	217 **water purification systems** for household water treatment and safe storage (LifeStraw – Family 2.0; LifeSaver – Jerrycan; Tulip – Table Top; Grifaid – Family Aquafilter; Sawyer – Point-One-Filter)
	TOTAL	**912 (4,103)**	

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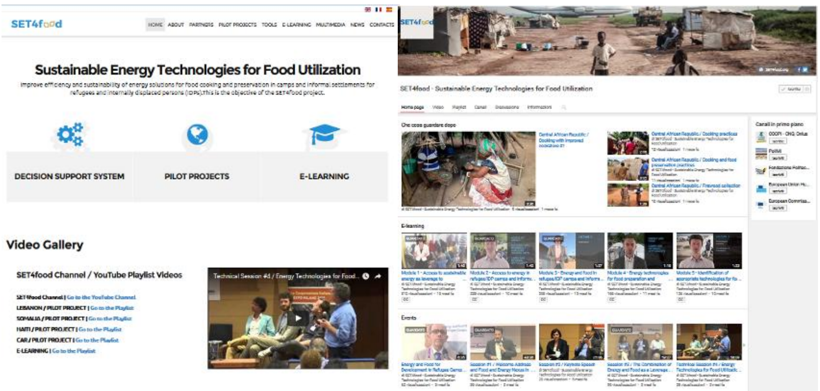
Training and dissemination activities

The SET4food website (link) and a dedicated Youtube channel (link) make all the materials produced easily available for all, including interviews, videos and recordings of public events. The website also introduces the SET4food project and provides a detailed description of the implementation of the pilot projects. It is in English, French and Spanish.



Technical workshops were carried out in the framework of Master courses in Development and Cooperation in Colombia, Italy, Kenya, Nepal and Palestine. These workshops were open also to humanitarian actors, academic staff, local authorities and private companies.

Public events were organized in Milan – during EXPO 2015 –, in Washington, and in Brussels.

Specific presentations were carried out for various humanitarian actors and institutions, as the global Food Security Cluster (gFSC), the Safe Access to Fuel and Energy Humanitarian Working Group (SAFE WG), UNHCR, and USAID. The SET4food project linked with the most relevant humanitarian actors and coordination mechanisms, promoting an effective and open process of knowledge sharing and collaboration.

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Pot skirt for gas burners

A pot skirt is a simple round piece of metal which is placed at the top of the combustion chamber where the flames are in contact with the bottom of the pot. It encloses the pot and forces the flame and hot gases to its sides. This model completely encloses the gas burner and the pot, is made of iron covered with insulating material (e.g. rock wool fixed with adhesive tape). Three perforated disks adapt the pot skirt to the pot. This solution is innovative because pot skirts are usually applied only to cookstoves fuelled with biomass (either firewood or charcoal). It is a **technology innovation**.

Location of implementation: Lebanon, Koura District, Kfarsaroun

Users: 13 households (82 people) of Syrian refugees living in an informal settlement

PROs: this pot skirt directs the flame and hot gases close to the pot, resulting in an improved heat transfer. Fuel consumption and emissions are reduced, especially cooking outdoor, as the flame is less affected by wind. The insulation prevent children from being burnt by touching either the burner or the pot. It is locally made with material and skills available almost everywhere.

CONs: refugees utilize burners and pots of different sizes, thus it is impossible to set a standard measure of the pot skirt. Therefore theoretically the distance between the pot and the pot skirt can be reduced, and the heat transfer improved.

COST: about 22 USD per pot-skirt.

Indicator	Value	Definition	Notes
Data coverage	38%	It indicates the percentage of households providing regular data throughout the monitoring period. Only data about this percentage are considered for indicators calculation	It can be considered a proxy of data representativeness
Technology acceptance	Good	Frequency of use of a certain technology, compared to the expected one, is used as a proxy for the evaluation of this indicator. The indicator assumes a value on a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data, but also other households may use the technology. It can be considered a proxy of technology effectiveness for a certain context
Appropriate usage	Good	It indicates if a certain technology is used according to the specifications, exploiting its potentialities in a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data. A low level of appropriate usage can be motivated by either little understanding of the technology or inadequate resources and conditions to fully use it. Under some conditions, this indicator can be a proxy of technology appropriateness

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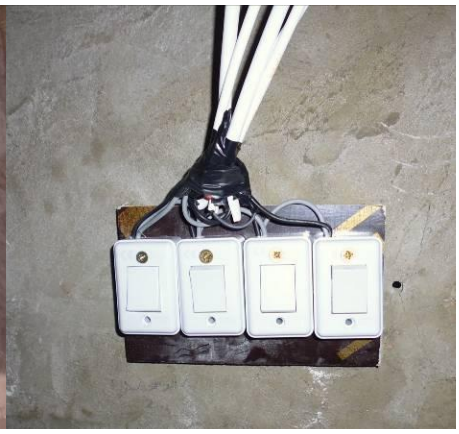
Movable standalone electric system with thermoelectric fridge

This solution is a very simple and **movable electrical system** – powered by sunlight – providing energy to 4 lights and a small thermoelectric refrigerator. It was installed by a local company with components already available on the Lebanese market. The electrical system is composed by **2 photovoltaic panels** (100 W each one), a **100Ah@12V battery**, charge controller and a fuse for system's and users' safety. Devices and fittings can be easily removed, transported and re-installed somewhere else. The system powers **4 LED lights** (5 W each one) for indoor and outdoor lights, and a **thermoelectric refrigerator** (like the ones in caravans or boats) with a 24 l capacity. It is a **technology innovation**.





Location of implementation: Lebanon, Koura District, Kfarsaroun

Users: 13 households (82 people) of Syrian refugees living in an informal settlement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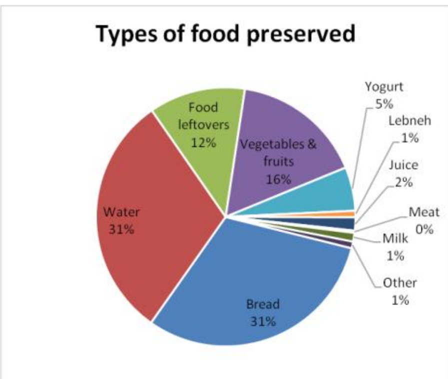
PROs: this system is easy-to-install, assembling simple items generally available on market. These devices are fixed with screws and bolts, thus are quite easy to remove, transported and re-installed in a different place. Both lights and thermoelectric refrigerators are not very energy-demanding and can be effectively used even with cloudy weather. Lights improve quality of life, increasing and supporting activities in the evening and night (e.g. study, breastfeeding, housekeeping), and giving an improved perception of safety. The refrigerator improves food preservation, saving money. Moreover, some households consider the food safer and healthier to consume.

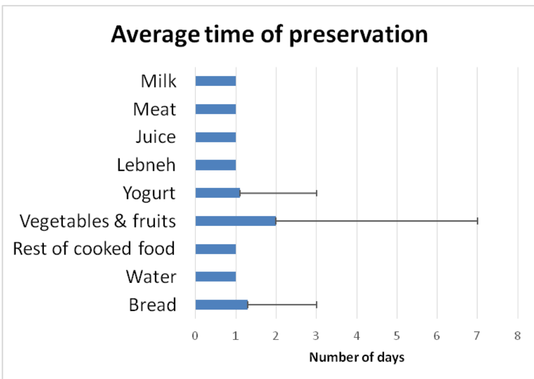
CONs: the system requires technical expertise for design, selection of components and installation. Electrical devices cannot be handled carelessly, and attention should be paid to operation and maintenance. Especially refrigerators should be protected from dust and misuses. Thermoelectric refrigerators have a limited refrigerating power, and cannot freeze.

COST: about 1,070 USD per electrical system.

Indicator	Value	Definition	Notes
Data coverage	38%	It indicates the percentage of households providing regular data throughout the monitoring period. Only data about this percentage are considered for indicators calculation	It can be considered a proxy of data representativeness
Technology acceptance	Middle	Frequency of use of a certain technology, compared to the expected one, is used as a proxy for the evaluation of this indicator. The indicator assumes a value on a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data, but also other households may use the technology. It can be considered a proxy of technology effectiveness for a certain context
Appropriate usage	Middle	It indicates if a certain technology is used according to the specifications, exploiting its potentialities in a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data. A low level of appropriate usage can be motivated by either little understanding of the technology or inadequate resources and conditions to fully use it. Under some conditions, this indicator can be a proxy of technology appropriateness

According to data collected, fridges were used to preserve especially some types of food, for a limited amount of time. It was mainly due to a limited food availability, but also a certain unfamiliarity with food refrigeration played a role. Indeed, potential of this technology was not fully exploited by the users.





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Hybrid solar/wind power system with multi-compartment refrigerators

This solution is a simple **microgrid** – powered by photovoltaic panels and a wind turbine – proving energy to 7 refrigerators, each of them with 8 lockable compartments. It was installed by a local company with components already available on the Lebanese market.

The **electrical system** is composed by **24 photovoltaic panels** (260 W each one, totally 6.2 kW), a **2.5 kW wind turbine**, a **40 kWh battery bank**, charge controllers, inverters, isolators, circuit breakers and other devices to protect the system's and users' safety. A real-time **monitoring system** collects data about power generation and consumption, and share them online through a dedicated web platform.

Every **refrigerator** has a total capacity of **700 l**, thus about 85 l per each of the **8 lockable compartments**. Every refrigerator was designed to have a power absorption of 350 W, and a maximum power consumption in standard testing conditions (STC) of 3,600 Wh/day. They were supposed to be equipped with eutectic plates for static cooling (i.e. to **keep the internal temperature constant for some hours in case of energy shortage**). Actually, these technical requirements could not be fully tested on the field.

This solution is innovative because: 1) the electrical system is completely based on renewable sources, combining the characteristic of both solar and wind energy; 2) refrigerators are design to work in hard conditions, including shortage of power; 3) refrigerators have compartments to guarantee a safe and personal use to a large number of households: they combine benefits of both a community installation and a device used at the household level; and 4) the entire system is tailored to successfully integrate the loads (i.e. refrigerators) with renewable energy sources, minimizing the drawbacks. It is a **technology innovation**.

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Location of implementation: Lebanon, Koura District, Deddeh, Waha Center.

Users: 100 households (450 people) of Syrian refugees living in a large informal settlement (149 households for a total of 670 people).

PROs: a household can benefit from **their own refrigeration space**, and other households can neither access nor see what it is stored. Despite the deterioration of Syrian dietary diversity at the household level due to the reduction of the value of food vouchers, **pregnant and lactating women** demonstrated to **improve dietary diversification** due to the use of refrigerators. The use of a micro-grid and a set of refrigerators in a **community-like approach** is particularly **efficient** from an energy point of view, and simplifies the operation and maintenance of the system, with only few simple operations required.

CONs: the system is owned by the refugee community – with formal supervision of the city Major –, thus a management committee is in charge of maintenance. Such a **community is not static**, because households in the informal settlement may change, affecting the system management. The system can **only partially cover people's energy needs**. In particular, the use of electricity has to be regulated and limited, in order to avoid any abuse and prevent refugees from provoking frequent system's collapses. Finally design and implementation of a similar system in a context of people displacement is pretty difficult, due to the lack of weather historical data, benchmarks and unstable conditions. Moreover, locally available material and expertise are not always available, and only partially reliable.

COST: 78,710 USD for the entire system.

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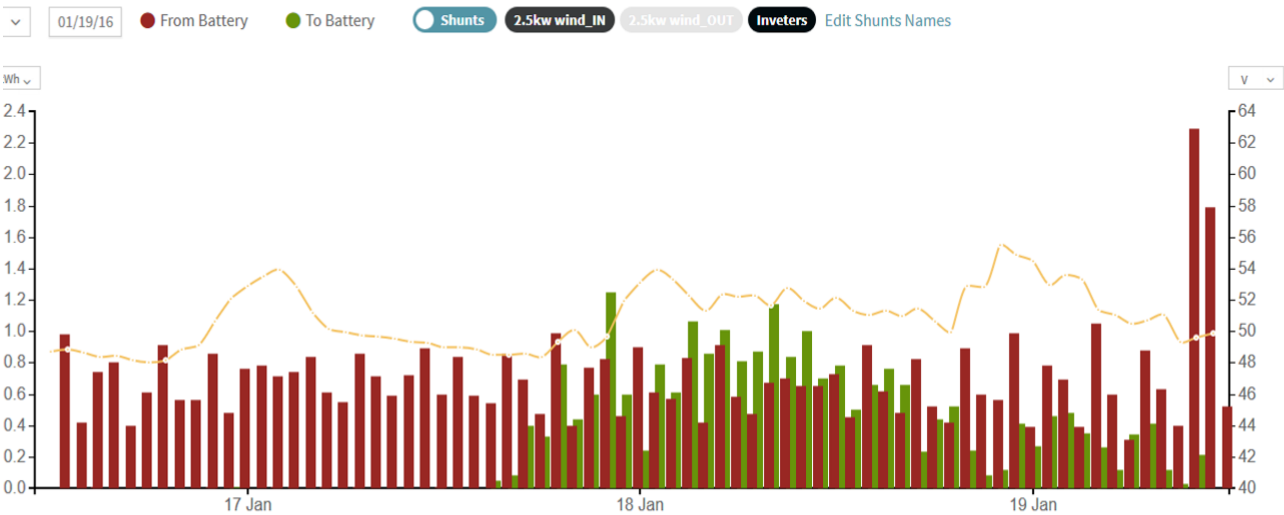
Indicator	Value	Definition	Notes
Data coverage	25%	It indicates the percentage of households providing regular data throughout the monitoring period. Only data about this percentage are considered for indicators calculation	It can be considered a proxy of data representativeness
Technology acceptance	Good	Frequency of use of a certain technology, compared to the expected one, is used as a proxy for the evaluation of this indicator. The indicator assumes a value on a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data, but also other households may use the technology. It can be considered a proxy of technology effectiveness for a certain context
Appropriate usage	Middle	It indicates if a certain technology is used according to the specifications, exploiting its potentialities in a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data. A low level of appropriate usage can be motivated by either little understanding of the technology or inadequate resources and conditions to fully use it. Under some conditions, this indicator can be a proxy of technology appropriateness

ELECTRICAL SYSTEM

The electrical system is able to cope with different situations, due to specific weather conditions or usage profiles of refrigerators. In particular, 3 typical scenarios are hereafter described, with the relative behaviour of the system.

Scenario 1: the system is regularly powered. Electrical loads, that is the refrigerators (red lines), are between 0.5 and 2.4 kW (hourly average), with pretty low average values and peak values in particular moments of the day. Green lines indicate energy production from wind. Voltage of the battery bank (yellow) is higher during daytime – due to photovoltaic production – and has a discharge trend during the night. In windy days, such a discharge is not reported due to the wind contribution.



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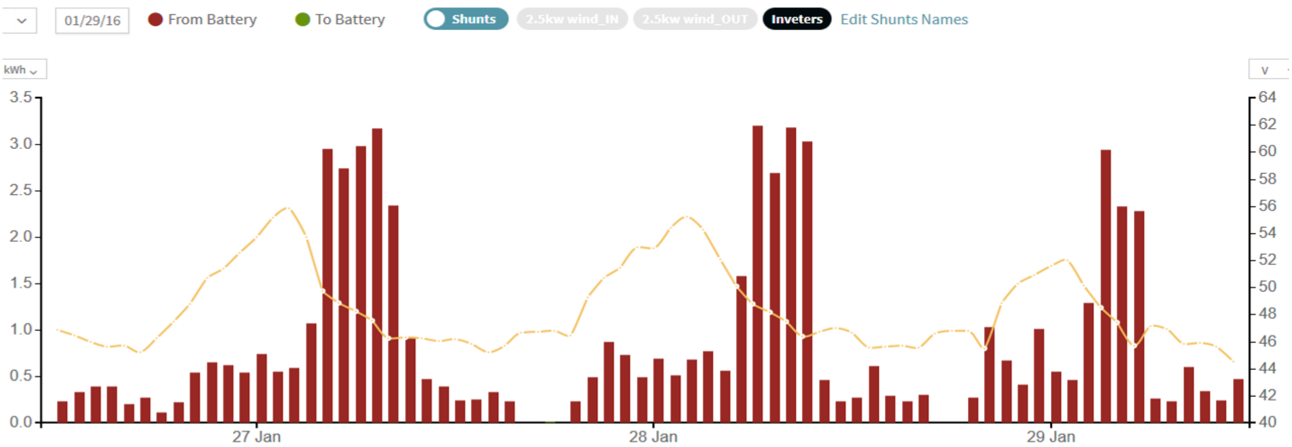
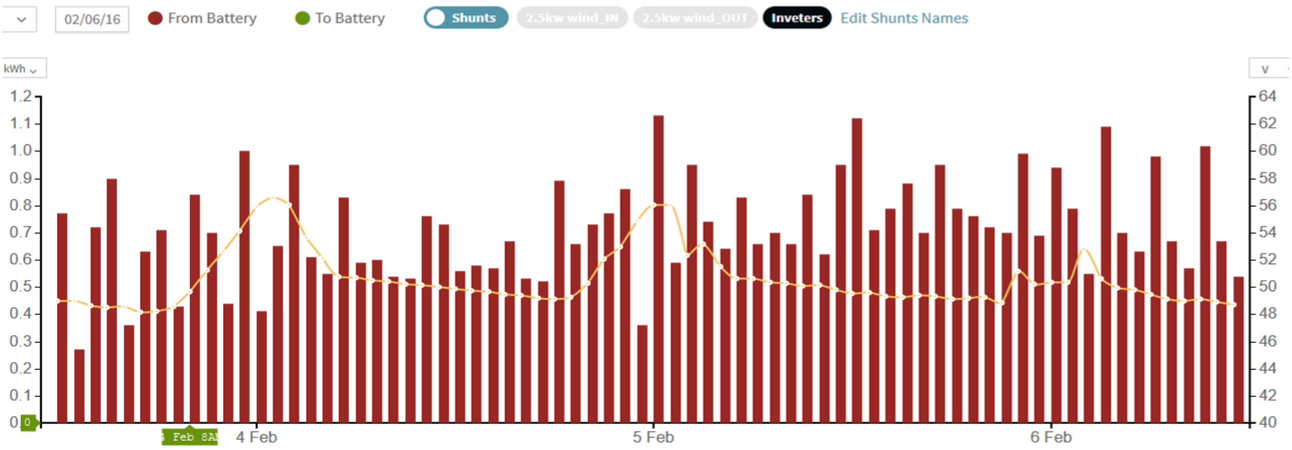
Scenario 2: electrical loads (red lines) are more energy demanding, with peak values of 3 kW. They are focused in the afternoon probably due to some unexpected loads (e.g. connection of other devices). Energy demand in this scenario is higher than the daily energy production. During the night, the battery bank achieves the minimum voltage drop limit, and automatically disconnects all the loads (refrigerators do not receive any energy). In early morning, when the sun starts shining, the loads are automatically connected again and work properly. Therefore, refrigerators are disconnected for some hours during the night. The impact on the refrigerators' internal temperature is limited, due to both the limitedness of power interruptions, and the contribution of the eutectic plates installed.



Scenario 3: electrical loads follow the predicted trend, with a quite regular energy demand and close to 0.8 – 1 kW. This energy profile is likely due to a normal use and operation of refrigerators. No power interruption is reported, that is the battery bank can manage the night energy demand with the energy stored during the day, as shown by the voltage trend (yellow line).



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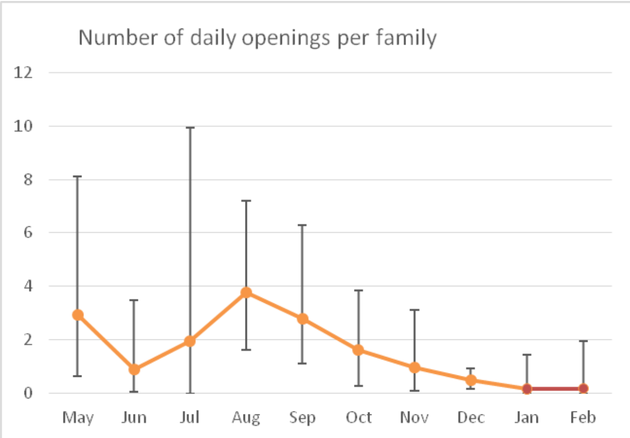
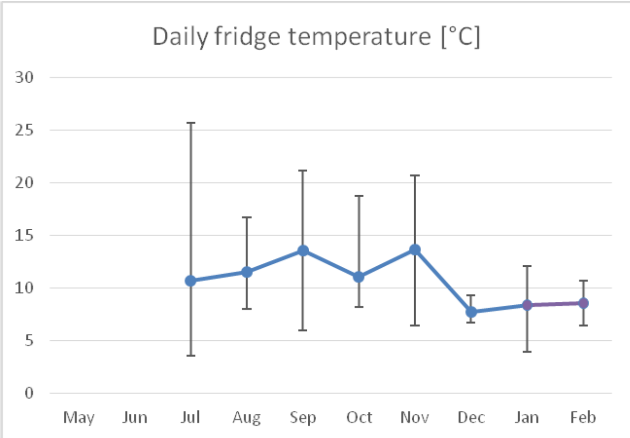
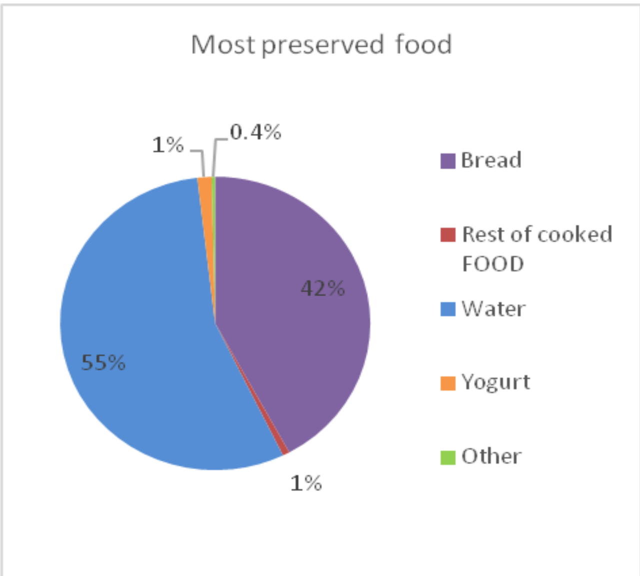
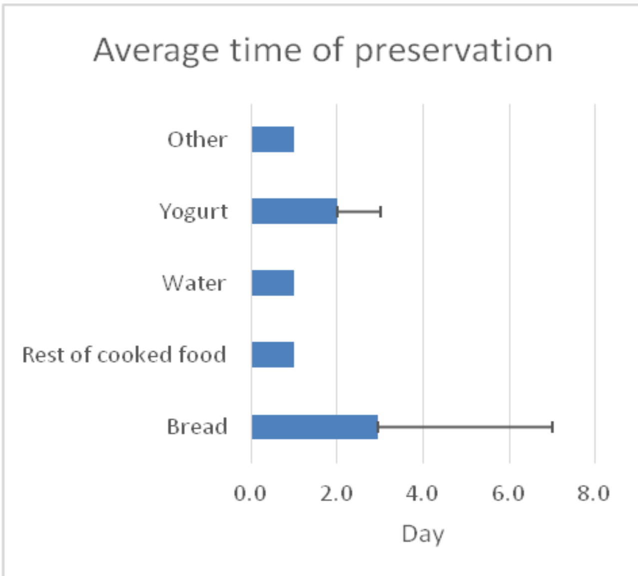
REFRIGERATORS





Note: the system was upgraded in December 2015, increasing both power generation (i.e. the number of solar panels) and power storage (i.e. the number of batteries). The final setup is the one previously described. The upgrade was motivated by the fact that some components were probably not as efficient as expected, and local conditions – especially the temperature in summer – and the refugees' pattern of use were particularly stressful for the system. The upgrade allowed the system to improve its performance and effectively cope with particular situations (e.g. high peak loads, high temperature), as confirmed in the following months (i.e. January and February 2016). However, the system should be tested in hard weather conditions – especially in summer – to get further indications. Finally, the system was not designed for other purposes (e.g. lighting and to power other devices), thus unexpected uses are particularly stressful for the system and endanger its operation. Unexpected uses were reported during the monitoring period.





Note: These charts refer to the period before the system upgrade. In this period, refrigerators' internal temperature was not as low as expected, thus majority of households were used to preserve only water and bread. In particular, cold water was particularly requested and appreciated during the summer.

Outcome on nutrition

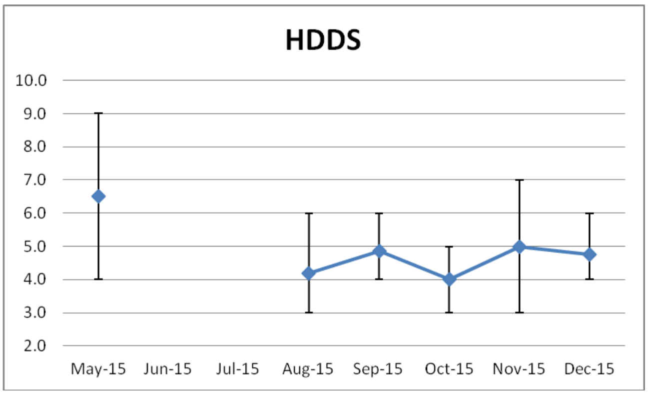
Dietary diversity was assessed as proxy of the outcome of the use of refrigerators on people's nutritional intake. In the monitored period, the household dietary diversity score (HDDS) – that indicates the diversity of food items consumed by all the household members at home – decreased due to the reduction of the value of food vouchers distributed to Syrian refugees. In the same period, the women dietary diversity score (WDDS) – that indicates the diversity of food items consumed by pregnant and lactating women – seems to show an increasing trend. This is confirmed by the ladies, which reported that refrigerators allow them to store food for a longer period in a safer and healthier way. Also food leftovers can be preserved, and are generally consumed later on by women at home and children, improving their dietary diversification. It is interesting to notice that such an improvement was not perceived, in particular because the focus is on the household, and because of the worsening due to reduced purchasing power. Finally, some households reported that the use of refrigerators changed composition and frequency of grocery shopping, and it had a positive impact on family expenditures.

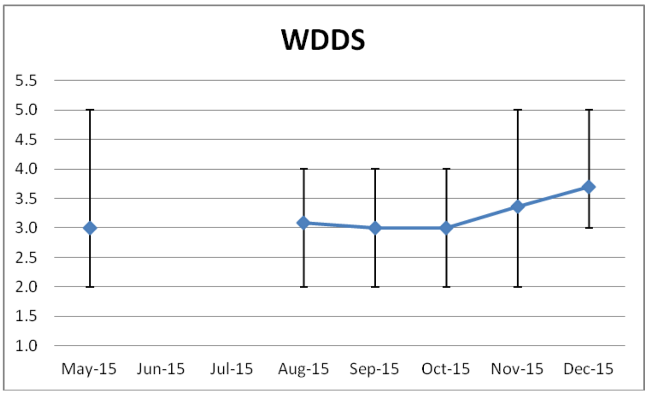
Household dietary diversity score (HDDS)

From	19/05/2015	To	18/12/2015
min	4	min	4
max	9	max	6
average	**6.5**	**average**	**4.8**

Women dietary diversity score (WDDS)

From	19/05/2015	To	18/12/2015
min	2	min	3
max	5	max	5
average	**3.0**	**average**	**3.7**





Remark: HDSS and WDDS are differently calculated. Error bars show the maximum and minimum scores reported.

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Improved cookstoves in rural and remote areas

Improved cookstoves (ICSs) are devices able to improve combustion, resulting in fuel saving, reduced emissions of harmful gases and sometimes shortened cooking time. Consequently, also CO2 emissions are reduced. Several models are available and vary according to location, use (e.g. household, large facility as schools or hospitals) and fuel they are designed for. Theoretically, they can be manufactured almost everywhere, due to the fact that they can be made of various materials. Unfortunately, in rural and remote areas, especially in unstable countries, material and skill required are generally missing. In the Congolese refugee camp of Zemio, in Central African Republic (CAR), two models were distributed and tested: a model of ICS produced by a world-famous brand – imported from Kenya – and a locally-made ICS produced in Bangui, the CAR capital city. This solution is a field testing of **technology innovation**.

Location of implementation: Central African Republic, Haut-Mbomou prefecture, Zemio refugee camp

Users: 100 households (320 people) of Congolese refugees

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PROs: both the models were introduced very easily and were very appreciated. People immediately perceived the reduction of fuel consumption, and consequently time for wood collection and/or money for those used to pay for it.

CONs: beneficiaries initially considered the locally-made model more robust, but later they changed their mind due to the experience. Indeed, people perception and experience are very important for a successful introduction and an effective use of ICSs. Logistical aspects were particularly complicated due to the lack of a local dealer and very poor infrastructures available in CAR. Import, custom clearance and shipping were a serious challenge.

COST: about 174 USD per imported cookstove (including shipping up to Bangui), 20 USD for cookstoves made in Bangui. Shipping to Zemio is excluded.

Indicator	Value	Definition	Notes
Data coverage	40%	It indicates the percentage of households providing regular data throughout the monitoring period. Only data about this percentage are considered for indicators calculation	It can be considered a proxy of data representativeness
Technology acceptance	Good	Frequency of use of a certain technology, compared to the expected one, is used as a proxy for the evaluation of this indicator. The indicator assumes a value on a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data, but also other households may use the technology. It can be considered a proxy of technology effectiveness for a certain context
Appropriate usage	Good	It indicates if a certain technology is used according to the specifications, exploiting its potentialities in a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data. A low level of appropriate usage can be motivated by either little understanding of the technology or inadequate resources and conditions to fully use it. Under some conditions, this indicator can be a proxy of technology appropriateness

Daily household fuel consumption			Daily household time for wood collection			Daily household total Cost of wood		
3-stone fire [kg/d]	**ICS [kg/d]**	**Variation**	**3-stone fire [min/d]**	**ICS [min/d]**	**Variation**	**3-stone fire [USD/d]**	**ICS [USD]**	**Variation**
13.2	5.4	- 58.8%	100	46	- 53.6%	0.33	0.24	- 28.7%

Note: fuel consumption strongly depends on cooking practices, including the use of the cookstove. Beneficiaries declared that imported ICSs had better performances, while collected data indicated that local ICSs consumed a slightly smaller amount of fuel. However, beneficiaries agreed on a strongly reduced fuel consumption of both the models compared to 3-stone fire.

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Locally-made solar refrigerator (SPARK model)

The Solar Photovoltaic Adaptable Refrigeration Kit (SPARK) was designed by Politecnico di Milano to allow communities to assemble refrigerators using local materials. The electric and mechanical parts, that is a compressor (with a thermostat), a roll-bond evaporator pre-charged with refrigerant, and plug-in connectors for the refrigerant circuit, are provided in a compact kit that can be shipped almost everywhere. On the other hand, photovoltaic panels can be locally purchased, and the body is locally constructed. For pilot testing in Haiti, a carpenter was hired to build the refrigerator body – made of plywood –, providing internal insulation with an aluminium foil and polystyrene (insulating glue was not available). A metallic cage divided the refrigerated room in compartments, to facilitate the use by different households. Theoretically this refrigerator could work without any battery, however one was included because it was the first field testing of the SPARK (another field test was taking place in Cameroon). In total, 6 refrigerators were assembled, each of them composed of 2 kits, with a photovoltaic panel (250 W), a battery (100Ah@12V) and a charge controller. Each refrigerator has a 500 liters capacity and 4 lockable compartments (one per family). Small buildings were built to house two refrigerators, and make it easy and safe to access for the households. This solution is a **technology innovation**.

Location of implementation: Haiti, Port-au-Prince, St. Etienne 1 and St. Etienne 2 IDP camps

Users: 24 households (120 people) of IDPs

www.set4food.org

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PROs: households can benefit of their own refrigerated room. Design is flexible, scalable and can be tailored on material available and needs. Refrigerators are independent from energy supply from the grid or generators and theoretically long-lasting. Some households thought about the possibility to start new income generating activities, and majority of them perceived nutritional improvements of their diet due to the introduction of the fridge.

CONs: local carpenter was not expert in the manufacture of such a kind of structures, thus production took time and supervision. Different materials could potentially be used, including secondary material, but some items were hard to find in Port-au-Prince (e.g. for insulation). One of the filters presented some technical problems, probably due to the electrical devices, resulting in a temperature higher than expected. Each fridge is owned by a group of households, but singularly used by each of them: a specific management has to be tailored on the households involved. Some of the households do not regularly have food leftovers or extra food to preserve. Others took some time before starting using the refrigerator.

COST: about 2,467 USD per refrigerator + 1,818 per small building (housing two refrigerators).

Indicator	Value	Definition	Notes
Data coverage	100%	It indicates the percentage of households providing regular data throughout the monitoring period. Only data about this percentage are considered for indicators calculation	It can be considered a proxy of data representativeness
Technology acceptance	Good	Frequency of use of a certain technology, compared to the expected one, is used as a proxy for the evaluation of this indicator. The indicator assumes a value on a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data, but also other households may use the technology. It can be considered a proxy of technology effectiveness for a certain context
Appropriate usage	Middle	It indicates if a certain technology is used according to the specifications, exploiting its potentialities in a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data. A low level of appropriate usage can be motivated by either little understanding of the technology or inadequate resources and conditions to fully use it. Under some conditions, this indicator can be a proxy of technology appropriateness

Refrigerator temperature: 6-10 °C

Food usually preserved: vegetables (e.g. carrots, onions, potatoes, sweet potatoes, tomatoes, egg plants, cabbage, leek, sweet pepper), fruits (e.g. papaya, oranges, shadek – a sort of local grapefruit), water and juice.

Bright spots:

- Ms. Anne (fancy name), one of the beneficiaries, started using part of her compartment to improve her business. In particular every day she was used to buy two packets of sausage and 3 kg of ice to conserve them, and sell them in the community. She was also used to buy pieces of bread and sell them with spread mamba (Haitian peanut butter). After the introduction of the refrigerator, she stopped buying ice, and could purchase more bread, expanding her second business. She started earning some extra money, and studying how the business could be expanded.
- Ms. Jane (fancy name) started her own private garden thanks to a project implemented by a different NGO. She could produce different varieties of leaf vegetables, as spinach. The introduction of the refrigerator allows her to preserve such vegetables better and for a longer period.

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Comparison of water filters for household water treatment and safe storage (HWTS)

5 different models of water filters were tested on the field with households of internally displaced people (IDPs). All of them can guarantee water treatment at the household level – that is at the point-of-use – and the minimization of the risk of recontamination: treated water is either safely stored in a sealed tank or ready for immediate consumption. The filters tested are produced by world-famous brands, and meet the highest standards of water purification. Some were already available on the field – due to the presence of local dealers -, while the others were imported. All the suppliers provided a certain warranty, material for initial capacity building and post-sale support, at least remotely. Households gave their opinion on the effectiveness, practicality and convenience of the filters from their own point of view, thus considering specific local conditions and different patterns of use. This intervention was a field testing of **technology innovation**.

Product	Molecular weight cut-off (MWCO)	Tank for raw water	Tank for treated water	Cost (USD)	Procurement	Picture
Saywer PointONE Filter with bucket adapter kit LINK	100 nm (0.1 μm)	Yes (not included)	Yes (not included, usually not considered)	103 (buckets and support stand included)	Locally available	
LifeStraw Family 2.0 LINK	20 nm (0.02 μm)	Yes	Yes	75	Locally available	
Grifaid Family Aquafilter LINK	10 nm (0.01 μm)	Yes (not included)	No (treatment immediately before the use)	54 (bucce included)	Imported	
Tulip Table Top LINK	Ceramic filter (diatomaceous earth treated with nanosilver)	Yes	Yes	20	Locally available	
LIFESAVER Jerrycan LINK	15 nm (0.015 μm)	Yes	No (treatment immediately before the use)	94.20	Imported	

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Location of implementation: Haiti, Port-au-Prince, Villambetta IDP informal settlement

Users: 217 households (1.085 people) of IDPs

PROs: in general, these filters are particularly easy to use, and appreciated by people. People do not have to buy drinking water – whose quality is sometimes disputable –, but they simply filter raw water, usually far cheaper. This practice results in money and time savings. Indeed, beneficiaries had to purchase drinking water in a different place than raw water, availability is more limited, and queue is quite long. In short time people perceive health benefits, resulting in a reduction of water-borne diseases. Moreover water flavour usually improved – as reported by more than 90% of the households -, due to the lack of chlorine residue and/or the filtration process, facilitating the use of the filters. Operation and maintenance are very limited and, if well-done, the filters have a long life span. In Haiti about 40% of the households shared filtered water with friends and relatives for free, therefore the actual number of users was more than 1,400.

CONs: despite the simplicity, operation and maintenance have to be carried out regularly. In order to have a good use of the filters, capacity building and regular follow-up visits directly in beneficiaries' home are recommended. Cartridges have to be replaced and affordability of spare parts is an issue. For local people is pretty impossible to benefit from post-sale support from suppliers of imported filters.

Product	Remarks from beneficiaries
Saywer PointONE	It was particularly appreciated due to speed of filtration, storage capacity and simplicity of operation and maintenance. Beneficiaries lost syringes for filter cleaning (backwashing)
LifeStraw Family 2.0	Some beneficiaries find the cleaning procedures (backwashing) complicated
Grifaid Family Aquafilter	Few filters had a breakage in the filtering media and were replaced by the supplier (without additional cost). Some beneficiaries did not understand well the use of the filter and others complained about the need of pumping to filter water
Tulip Table Top	Some breakages were experienced, due to a certain material fragility. Local supplier replaced damaged parts, excluding those attributed to accidental falls
LIFESAVER Jerrycan	It was very well accepted due to the simplicity of use and the large storage capacity

Indicator	Value	Definition	Notes
Data coverage	37%	It indicates the percentage of households providing regular data throughout the monitoring period. Only data about this percentage are considered for indicators calculation	It can be considered a proxy of data representativeness
Technology acceptance	Good	Frequency of use of a certain technology, compared to the expected one, is used as a proxy for the evaluation of this indicator. The indicator assumes a value on a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data, but also other households may use the technology. It can be considered a proxy of technology effectiveness for a certain context
Appropriate usage	Good	It indicates if a certain technology is used according to the specifications, exploiting its potentialities in a three-level scale (Low/none; Middle; Good)	This indicator is calculated on households providing adequate data. A low level of appropriate usage can be motivated by either little understanding of the technology or inadequate resources and conditions to fully use it. Under some conditions, this indicator can be a proxy of technology appropriateness

	Daily household potable water consumption (drinking & food) [l/d]	**Variation**	**Average household daily expenditure for potable water (drinking & food) [USD/d]**	**Variation**
Before filter distribution	14.12 (2.82 per person)		0.37 (0.07 per person)	
After filter distribution	19.31 (3.86 per person)	+ 37%	0.16 (0.03 per person)	- 58%

Before filter distribution, water for drinking & food was completely purchased. The quality of this water was higher of the water for other uses. Only few houses temporarily benefitted of some water treatment programs promoted by the National Water and Sanitation Company (DINEPA). After filter distribution, water for drinking & food was composed of water of high quality (7%) and water of low quality purified by the filter (93%). Water of high quality and low quality cost about 0.026 and 0.007 USD/l, respectively.

On average, **daily household raw water consumption** (non-drinking & food use) was **108 l/d** (21.5 per person) – the same **before and after filter distribution**.