WASH Field Note FN/34/2020

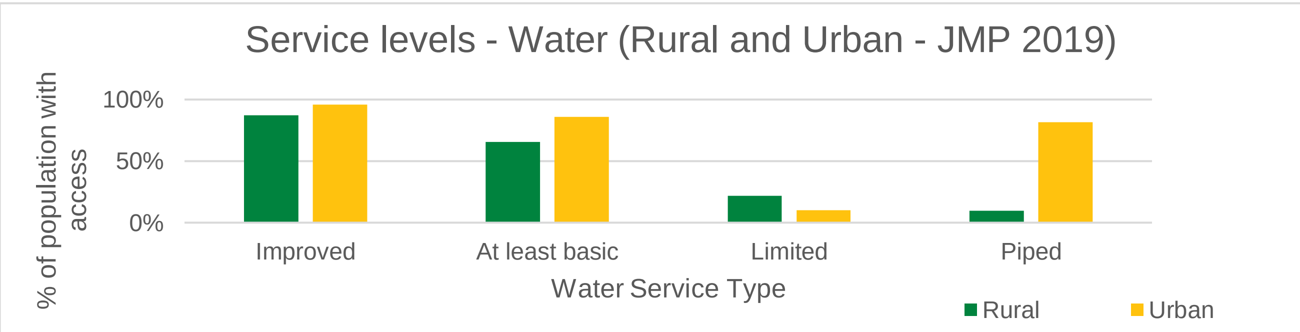
Scaling-Up Climate Resilient Sustainable Solar-Powered Systems for Institutions and Communities in Rural Malawi

SUMMARY

Ensuring sustainable access to safe water in rural communities in Malawi presents many challenges, particularly for schools and healthcare facilities, and is likely to become even more difficult with the increasing impact of climate change. To address these challenges, UNICEF has designed and implemented a programme which incorporates the risks associated with climate change and uses renewable energy to provide sustainable access to safe water for schools, healthcare facilities and communities in rural areas in Malawi. This approach has also been used as part of the recent Cyclone Idai emergency response to ensure safe water is available in the required quantities to internally displaced person (IDP) camps, schools, healthcare facilities and communities.

Introduction

According to the 2019 Joint Monitoring Programme[1] (JMP) data, 65.4 percent of the rural population in Malawi have access to at least a basic water supply service[2] and 9.6 percent have access to a piped system. This contrasts greatly with the situation in urban areas, where access to at least a basic water service and a piped water system are significantly higher at 85.8 and 81.5 percent, respectively.



[1] JMP, UNICEF-WHO, 2019

[2] Basic water service is defined as "Drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip, including queuing"

Sadly, the situation in schools in rural areas is even worse. According to the 2018 JMP data on WASH in Schools[3], 12.1 percent of schools in rural Malawi do not have a water service (no functional water source) while 25.6 percent of schools do not have a sanitation service (no functional toilets). For healthcare facilities, 1.1 percent of facilities do not have a water service, and 6.6 percent do not have a sanitation service.

Solar systems installed for the Joho water scheme in Machinga©*UNICEF/Malawi/2019/Ndayizeye*

In rural areas, most of the population and institutions depend upon groundwater for their water supply, which is mostly abstracted from boreholes (usually up to 45 meters) fitted with handpumps. Despite the number of people depending upon these systems, many of them are not working, with average rates of non-functionality reported to be 35-40%[4]. The reasons for such are many, including seasonal groundwater fluctuations[5]; mechanical breakdowns and limited capacities of village committees and districts to manage such systems. Another contributing factor is the vulnerability of the water sources to contamination after extreme weather events due to the poor siting of the system. When such systems are not operational, households are forced to collect water from rivers and lakes, which is often highly contaminated. As a result of the unreliable access to safe water and limited amounts available, which inhibit the practice of key hygiene behaviours, diarrheal diseases are one of the top three causes of under-five mortality[6].

To address the limited access to safe water services in communities, as well as schools and healthcare facilities which are sustainable and resilient to extreme weather events, UNICEF Malawi has integrated climate risk analyses together with use of renewable energy to design optimal water services and as a result, is promoting the use of solar powered deeper boreholes for multi-use systems in communities across Malawi.

Since 2017, UNICEF Malawi has installed 45 solar powered water systems targeting schools and healthcare facilities, as well as nearby communities, reaching an estimated 135,000 people. Most recently during the Cyclone Idai floods response and recovery in early 2019, this approach was implemented as part of the emergency response at schools and healthcare facilities and communities which were used as temporary shelters, reaching a total of 60,000 people that were displaced during the cyclone and subsequent floods.

This Field Note analyses the key technical aspects of this approach, with a focus on the design, operation, maintenance and budgetary implications, and aims to share lessons learned on the use of this design and related technology.

Description of Intervention

Design of the programme

The primary aim of the programme was to increase the access of schools and healthcare facilities to resilient, sustainable and safe water systems, which would remain functional throughout the year, and could withstand extreme weather events.

[3] https://www.who.int/water_sanitation_health/publications/jmp-wash-in-schools-en.pdf?ua=1
[4] https://upgro.org/2018/09/28/an-analysis-of-hand-pump-boreholes-functionality-in-malawi/
[5] http://www.interaide.org/watsan/malawi/
[6] https://mwnation.com/dry-clinic-gets-sunshine/

Although the focus of the project was on schools and health care facilities, the water systems included a piped connection to the adjacent communities to improve their access to a sustainable and safe drinking water service, and to promote the ownership of the systems and thus, the sustainability of the systems over time.

Solar array for Chilala Water Scheme
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Selection of sites

This project constructed or rehabilitated the water supply for 45 solar-powered systems for permutations of schools, healthcare facilities and communities in 11 different districts, as follows:

- Health care facility and community water systems – 20 communities
- Primary school and community water systems – 17 communities
- Secondary school and community water systems – 3 communities
- Healthcare facilities, schools and communities – 2 communities
- Community water schemes – 3 communities

The selection of the schools and healthcare facilities was carried out in collaboration with the Ministry of Agriculture, Irrigation and Water Development; the Ministry of Education, Science and Technology; and the Ministry of Health.

Of the three secondary schools selected, two of the schools had no existing access to any water source, and while the third school had a borehole fitted with a handpump, it only functioned during the rainy season, when the water level in the borehole was higher.

For the selected primary schools, nine out of the 17 had no existing water source, and the remaining eight schools shared a borehole (fitted with a handpump) with the local community, leading to insufficient access due to the high demands of the community, and the distance.

For the healthcare facilities, although all of the facilities had existing water systems, none of the systems were functioning and water was collected from adjacent community sources. The existing systems were mainly comprised of gravity fed systems but the tanks had become clogged due to low maintenance, and had stopped working.

As some new water sources were required, a comprehensive hydrogeological investigation was undertaken which included geophysical surveys and qualitative field observations. The decision to convert the existing water sources to solar powered systems was taken after comprehensive analyses were carried out to assess the current and future yield of each source and any climate risks which could threaten water availability in the future. The assessments, which included step, constant rate and recovery tests, were undertaken to ensure that the yield was sufficient for a solar system and could be maintained in the future[7]. For the new water sources, an assessment of the flooding risks was carried out at the different sites, and sites chosen to minimize these risks were selected, while balancing the hydrogeological considerations. For the existing water sources, the risks of extreme weather events were also factored

[7] The duration of a step drawdown test was 6 hours (or until the drawdown stabilized). The constant rate test was performed for between 12 hours to 24 hours

into the design, and additional measures e.g. flood protection of the water source and equipment, incorporated, where necessary.

Child drinking water from one of the installed water points©*UNICEF/Malawi/2019*

Importantly, the assessment also looked at water quality, proximity to other boreholes, as well as any information on historical vandalism in the area. The information gathered during this assessment was included in the design parameters of the system including flood protection measures and safety measures to mitigate the risk of theft. The systems were designed for a minimum of 3,000 people.

The borehole depths ranged between 60 and 100 metres, with the lengths of distribution networks ranging from to 1,000 to 2,000 metres, with between five and 10 water points installed, with each water point installed with two taps.

In response to the damage caused by Cyclone Idai in March 2019, an estimated 60,000 people sought shelter in 13 temporary IDP camps in schools, healthcare facilities and adjacent communities where UNICEF provided WASH support. However, the existing 13 boreholes were initially fitted with handpumps and were unable to meet the demands of such high numbers of people. To address this, UNICEF engaged private contractors to undertake yield and water quality assessments. Boreholes with sufficient yields, and with water which met the national drinking water quality standards, were rehabilitated and upgraded into solar powered water systems. These new systems increased the daily amounts of available water; reduced the time to collect water; increased the quantities collected, and enabled a transition to more sustainable approaches by reducing the dependence upon erratic and expensive water tankering operations. When families returned to their homes after the cyclone and the floods had receded, the upgraded school water systems continued to function for the schools, and were extended to the adjacent communities. Of the 13 systems, nine of these served schools and communities; one served a healthcare facility and adjacent community; two schemes served communities; and one water scheme served an orphanage and a community. The sharing of water systems between many communities and/or schools and healthcare facilities has had a positive impact upon the long term sustainability of the systems, and led to a more professional approach to operation and maintenance of the systems.

Implementation approach

In consultation with the Government of Malawi, it was agreed that UNICEF would prepare the bidding packages and release these on a Design and Build (DB) basis[8]. In advance of this, UNICEF issued a call for bids from interested companies to enter into a Long Term Arrangement (LTA) with UNICEF for the installation of solar powered water systems, to which 20 companies responded and five LTAs were awarded. The detailed design, civil works, supply and installation of the systems (and networks) for each site were all combined under the same package. This was done to ensure that the contractor was directly and clearly responsible for all the required provisions and to avoid any rebuttal of responsibilities, which can occur when packages of work are divided between different parties. In addition, the payment terms of the contract included provisions that ensured that payments were made only for successful boreholes, therefore transferring the risk of unsuccessful boreholes to the private contractors. This helped to ensure a high success rate (100 percent in alluvial formations) for the drilling and cost-effectiveness of the contract management. On the basis of the bidding, and as projects were funded, contracts were awarded to the five LTA holders on the basis of their performance and capacity. Since 2017, 18 lots have been awarded to five of the LTA holders. The Defect Liability Period for each system is 12 months, with 21 of the systems handed over to District Water Department, to date.

Although the bidding process was managed directly by UNICEF, the Government of Malawi were involved at all stages of the process and this programme was considered to be an opportunity (or trigger) for the technical staff of the three Ministries to explore the enormous potential of solar in rural areas across Malawi.

At all stages of the implementation, UNICEF provided technical oversight by reviewing and approving the designs according to specific conditions of each site, closely supervising the works (through the deployment of site monitors), certifying the works and providing overall technical and quality assurance.

Design of the system

Each system provides water for more than one single need; with most providing water to both an institution (school or healthcare facility) and a community; or to multiple institutions and a community.

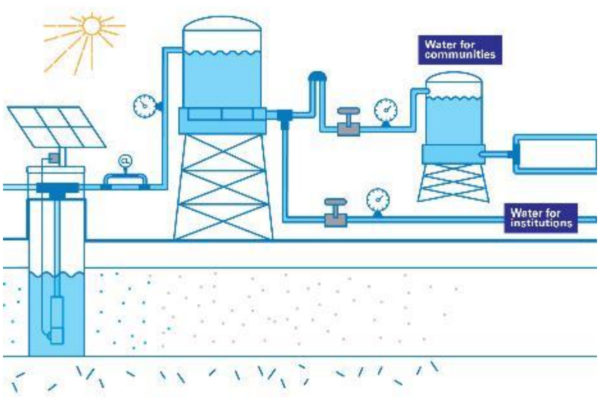

Figure 1 – simple representation of the reticulation system (in series)

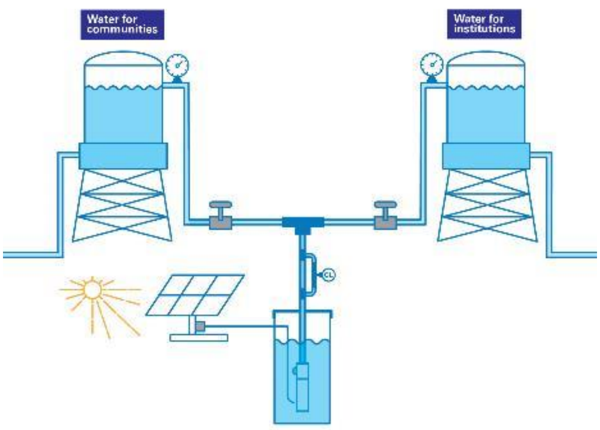

Figure 2 – simple representation of the reticulation system (in parallel)

[8] The bidding materials can be shared with interested Country Offices

To ensure that there is sufficient water for the institutions, the system was designed with two independent water storage systems, separating out the institutions from the communities. Depending on the specific characteristics of each site, two different pumping options have been implemented, either by pumping directly to the higher of the two tanks (for schools or healthcare facilities) with water then flowing to the lower tank (for communities) using gravity (as given in Figure 1); or pumping to the two separate tanks at the same time, in parallel, with the first option preferred where possible (as given in Figure 2).

The pumps which were selected had a wide voltage range (from 30 volts to 300 volts) and were designed using average daily sums of photo-voltaic (PV) electricity output for the least favourable month of the year in terms of solar energy, to optimise the functionality of the system even during very long or prolonged cloudy days. Furthermore, the systems were equipped with a change-over switch which allows the connection of a generator at any time, if installed and required (the installed pumps can run on both DC power and AC power).

The systems were initially designed with two storage tanks, each tank of 10,000 litres capacity. As the tanks fill, there is a continuous outflow to the network. The tank size was estimated based on the anticipated water needs at night and for periods of cloud cover. However, even during cloudy days, the system will continue to operate (even with a minimum solar energy) due to the selected pumps (helical pumps with wide voltage range). It should be noted that the new LTA will include other types of pumps and increased storage capacity for future projects.

The design of the solar components, together with the hydraulic analysis, consisted of the selection of the pump, sizing of the PV array and sizing of the cabling. Using the results of the pumping tests to determine the safe yield and dynamic head of the boreholes, an online software was used to size the solar systems including the selection of the pump.

To determine the size and number of the solar PV array, a design factor of 1.6 was applied to account for the local temperature and irradiance conditions as well as power losses in the system. This helped to ensure that the solar pump performs throughout the year even during the least favourable months, regardless of variations in solar radiation.

The sizing of the power cable was determined as per international standards, to maintain the voltage drop within 5 percent. An important consideration was to avoid high costs associated with large diameter cables. Depending upon the specific site characteristics, the most cost-effective solution can be adopted without compromising the power input to the pump.

The average amount of time required for the design, testing, construction (for new sources), rehabilitation (where necessary) and the installation of the PV system and distribution network was three months.

Operation and management of the systems

One of the key factors in the non-functionality of the original systems was the poor and limited maintenance of the systems, as well as seasonal changes in the water levels. The poor maintenance of the water tanks led to regular blockages which stopped the systems working. To minimize the risk of this happening to these systems, a number of measures have been undertaken including:

- The extension of the water network to the communities to help instil a sense of responsibility of the community towards the system when receiving a higher level of service
- The separation of the water storage system for the institutions from the communities – this minimised the risks of overuse by the communities at the expense of the institutions
- Water Management Committees (WMCs) were established and trained, and were placed under the supervision of the school or healthcare facility management. Initially, the establishment and training of the committees was carried out by the

government district with financial support from UNICEF. However, this approach has been recently revised to ensure a more structured support to WMCs. This revision has been implemented to ensure:

i) the basic technical training on regular operation and maintenance duties of the water committees is delivered by the particular contractor which installed the system, as part of their contractual obligations[9]
ii) the committees were properly trained in the management aspects of the system including fee collection – the Water User Association[10] was engaged to support this important training
iii) improved supply chain for spare parts and technical assistance for maintenance (with the involvement of the local private sector through a "hotline" system).

UNICEF is in the process of rolling out the new capacity building package aimed at promoting professionalised structures for rural water systems.

The collection of funds for the ongoing operation and maintenance of the systems has been managed to date through the village structures. These funds have covered costs associated with engaging a Watchman as well as minor repairs such as replacement of taps. Funds for the schools and healthcare facilities are generated through periodic contributions (in principle, schools and healthcare facilities are cross-subsidized by villages).

The local authorities were engaged in community mobilization and the siting of the water infrastructure to minimise the risk of land conflicts. Initially, it was considered to include a contribution of local materials (e.g. sand or labour for trench excavation) but this was not pursued due to concerns over possible delays and any issues with specification variance.

Security of the systems: key considerations

At the early stage of the project, three solar pumps were stolen from systems installed in Blantyre district. As a response, a number of modifications were made and as a result, the risk of theft of pumps has reduced significantly with no other incidents reported. Initiatives undertaken to minimise the risk of theft included:

- the solar panels were fenced and the support structures were elevated to a height of approximately 4 meters above ground
- bolts were welded to attach the solar panels onto the steel support structure
- the manhole for the pump was welded to the well head cover
- angle-shaped iron bars were welded along the perimeter of the solar panels to the steel framework to ensure robust anchoring
- the solar panels and control rooms were sited within the premises of schools and healthcare facilities to increase safety of operations and prevent possible vandalism and misuse of electric parts.

Life cycle cost analysis

The potential of scaling-up solar powered water systems in rural areas across Malawi is dependent upon their reliability, in addition to the operational costs. To demonstrate the differences between the costs of a solar system to the two other most common alternatives (diesel generator powered network and boreholes fitted with handpumps), a life cycle analysis was undertaken. This analysis was undertaken with the following assumptions:

- Each option should meet the desired water demand for 25 years[11] and serve a population of

[9] This is in line with the BCBT approach (Build, Capacity Building and Transfer) adopted by UNICEF Ethiopia within the ONEWASH Plus Programme.

[10] Water Users Associations (WUAs) are established by the current sector proclamation and meant to function as decentralized technical and operational branches of nearby Municipal Water Utilities. Given their capacities and support by the central utilities, WUAs will be key bodies in providing the proper skills transfer to water committees.

[11] The design period of a borehole fitted with hand pump is 15 years, this has been extended to 25 years with provision for

3,000 users (considered to be the average size of a rural village including one school and one health facility[12])

- The per capita daily water consumption for rural water supply is considered to be 15 litres (equating to 45 m^3/day for 3,000 people)
- The capital costs for civil works and pipe networks for solar and diesel generator powered water systems are considered to be the same
- The discount factor varies depending upon the government policy and macro-economic conditions – this was taken as 14 percent in the case of Malawi[13].

Based on the above assumptions, the life cycle costs for each water supply system are given in Table 1 below.

Type of water system	Total life cycle cost
Solar Powered Water System	59,206,262 MWK ($80,553)
12 Boreholes fitted with hand pumps[14]	80,670,670 MWK ($109,756)
Diesel Generator Powered Water System	169,395,802 MWK ($230,470)

Table 1: Life cycle cost for different water systems

On the basis of the calculations, the costs to produce one cubic meter of water[15] were calculated as:

Type of water system	Cost per cubic meter of water
Solar Powered Water System	$ 0.20
Borehole fitted with hand pumps[14]	$ 0.27
Diesel Generator Powered Water System	$ 0.56

Table 2: Cost per cubic meter of water

This analysis shows that although the initial capital costs for solar are more expensive than the other two options, solar power is significantly more cost effective in the longer term. Although the initial capital investment for diesel generator systems is lower, the higher operation and maintenance costs result in a higher whole life cycle cost, as shown in the following chart.

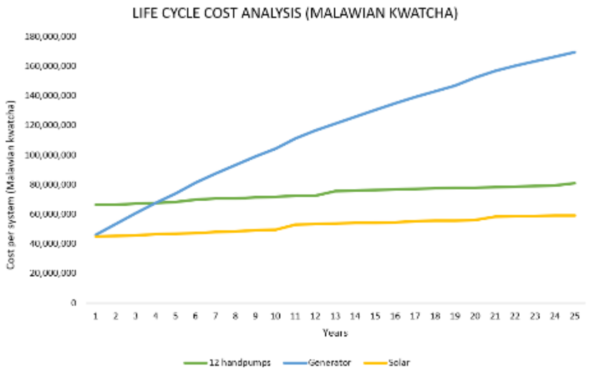

Figure 2: Graphic representation of the life cycle cost analysis

The small costs to maintain the solar system have been managed to date by the community through monthly contributions, with the amounts differing between the sites.

Outcomes

As the systems have been operating for less than two years, longer term impacts have not been identified however, monitoring visits and feedback from the community have indicated that:

- On average for each system, 1,242 students and 4,000 people benefit from the new/rehabilitated water systems

replacement of spare parts including a complete new Afridev pump

[12] To match the required users number, 12 borehole fitted with handpumps (each one serving an average population of 250 people) have been considered in the analysis

[13] source, World Bank: World development indicators, 2016

[14] 12 boreholes are taken as the equivalent of one motorised/solar system, based on the national standard of 250 people per handpump

[15] For easy reference the total water production estimated at the end of the life cycle is 410,625 cubic meters, assuming a daily production of 45 cubic meters of water

- Water collection times (both walking and queuing times) have reduced due to fact that there are now multiple water points
- Larger volumes of water can now be collected due to the shorter walking distances and reduced queueing time (an important step up the water ladder from improved to basic service) which can greatly improve the hygienic condition of the household, as well as other economic opportunities available
- Reduced absenteeism in school
- Improved health of the students
- The systems replacing the diesel-powered systems reduce the amount of emissions produced. Using a 5 KVA (4 KW) diesel-powered water system as an example, the annual carbon dioxide emission would be reduced by 45.5 tons per year, for one system alone. This is in addition to the reduced fuel required to travel to the nearest market to purchase fuel for the generators.

Water point at Nankwali primary school in Mangochi
©UNICEF/Malawi/2019/Ndayizeye

effective step towards addressing major challenges which are faced by both communities and institutions. To date, the main learning points have been:

***How solar powered water system have revitalized life in the school and surrounding community (*Nangondo school in Machinga District)** - *(extracted and condensed from a local newspaper article)*
"The school premises are now tidy. The toilets are cleaned three times a day and floors mopped every day," says 15-year-old Junior Milli who is in Standard 8. He can recall when he and many of his friends would frequently suffer from diarrhoea and miss classes because they drank from unsafe water sources and lacked water for handwashing after using the toilet. The school now has a safe water source and a new handwashing facility that enables children to wash their hands after toilet use.

Previously, the lack of water at school affected girls' class attendance even more than boys. Fifteen-year-old Getrude Madinga, who was preparing for her primary school leaving examinations, says the lack of water affected girls' menstrual hygiene. "We were just staying home and skipping classes during that time of the month. The installation of this solar powered water system has changed all that. There is a steady supply of water both at school and home" says Madinga. She says she and many other girls now look forward to coming to school and attending lessons in well cleaned classrooms and toilets that smell so well.

Ensuring access to water in schools is critical for girls to help them manage their menstruation hygienically, safely and with dignity.

Lessons Learned

By introducing the solar powered water systems to rural settings, UNICEF Malawi has demonstrated that investing in climate resilient services that are sustainable and use renewable energy is a cost-

- Solar powered water systems are more cost effective when looking at a life cycle approach and accelerate access to a higher level of water service
- Storing water instead of solar energy avoids the need (and associated costs) to install inverters or

batteries, when the storage capacity is sufficient. This makes the solar system simpler and reduces the initial capital and maintenance costs

- Although the technical requirements for the day to day operation and maintenance of the solar powered schemes are minimal, it is critical to support the development of professionalised management structures. Technical backup support from nearby water utilities, through Water Users Associations (WUAs) is under development, in addition to a supply chain for spare parts and water treatment chemicals. This approach would allow more reliable and cost efficient operation and maintenance systems, whereby communities will still maintain the ownership of the schemes and collect fees to cover operational costs, and the WUAs provide the required managerial and technical support
- To increase the impact and to maximize the use of the water produced, in certain schemes additional water points were constructed to support small scale irrigation schemes (up to one hectare) for backyard gardening in schools or nutrition/healthcare facilities
- When estimating the water demand, the reliability of water points in neighbouring communities also needs to be factored in, as well as future projections of declining water levels and increased competition for water. The drying of shallow water sources in neighbouring villages led to the solar systems acting as ‘magnets' as they were often the only functional water sources in an area, particularly during the dry months. This caused an increase in the water demand in many of the systems during the dry months, however, in one site in particular, the water levels were lowered due to the additional water demand. To address this, another borehole was drilled and the network was extended.

Next Steps

In general, the schemes have served the targeted institutions and communities well, with pump performance and water levels well within the design, with only one system encountering challenges due to excessive demand, as outlined above.

As a result of the success of the programme, this long-term approach has been included in UNICEF Malawi’s new Country Programme 2019–2023, and enormous efforts will be made to mobilise resources to significantly scale-up the approach as a model of water services that are sustainable and resilient to climate change and offer cost effective options for rural settings.

Array of solar panels at Mphuzi Primary School, Dedza District. ©UNICEF/Malawi/2019/Ndayizeye

The main next steps are anticipated to be:

- To maximise the learning from the installed systems, UNICEF will continue to undertake monitoring visits (with the Government) to identify improvements to the design, technology and service delivery models – currently these visits are undertaken at least once every two months
- To fully understand the impact of the systems, data on attendance and the health status of the students will be collected to identify any changes
- Options to install a remote monitoring system are being investigated (to measure yield, pumped amounts, as well as water levels and key water quality parameters)

- The support to the committees from the WUAs will be scaled up, and the quality and timeliness of the support monitored. It is expected that this support will be rolled out in two phases:
    a) The private contractors will work on the design, build and operate approach (a similar approach was developed for Ethiopia), where the contractor would continue to provide back-up support to ensure the required maintenance took place during (and possibly beyond) the defect liability period while also empowering/building the capacity of the local water operators (committee and WUA) on technical operations.
    b) The Water User Associations (decentralized branches of water boards/utilities) will be involved to provide the required managerial support to operate group solar powered water systems in the same district (cluster systems). The WUAs will benefit from the technical training of the contractors (as above) as well as from specific support (management, fees collection, community mobilization, etc) from UNICEF through NGOs.
- UNICEF is planning to install a complete package of WASH facilities in the schools and healthcare facilities (latrines, incinerators etc to identify any changes) in the schools and healthcare facilities where these are deemed to be insufficient, when funding is available.

POSITIVE FACTS

- *Reasonably low CAPEX*
- *Low OPEX*
- *Limited maintenance required*
- *Improved service levels*
- *Keep it simple: store water not energy!*

References

WHO-UNICEF 2019. WASH in Health Care Facilities: Global Baseline Report 2019. Joint Monitoring Programme (JMP) of WHO and UNICEF. Geneva (here)

WHO-UNICEF 2018. Drinking Water, Sanitation and Hygiene in Schools: Global Baseline Report 2018. Joint Monitoring Programme (JMP) of WHO and UNICEF. Geneva (here)

An Analysis of Hand Pump Boreholes Functionality in Malawi 2018 (here)

Photo Credits

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About the Series

UNICEF's water, sanitation and hygiene (WASH) country teams work inclusively with governments, civil society partners and donors, to improve WASH services for children and adolescents, and the families and caregivers who support them. UNICEF works in over 100 countries worldwide to improve water and sanitation services, as well as basic hygiene practices. This publication is part of the UNICEF WASH Learning Series, designed to contribute to knowledge of good practice across UNICEF's WASH programming. In this series:

Discussion Papers explore the significance of new and emerging topics with limited evidence or understanding, and the options for action and further exploration.

Fact Sheets summarize the most important knowledge on a topic in few pages in the form of graphics, tables and bullet points, serving as a briefing for staff on a topical issue.

Field Notes share innovations in UNICEF's WASH programming, detailing its experiences implementing these innovations in the field.

Guidelines describe a specific methodology for WASH programming, research or evaluation, drawing on substantive evidence, and based on UNICEF's and partners' experiences in the field.

Reference Guides present systematic reviews on topics with a developed evidence base or they compile different case studies to indicate the range of experience associated with a specific topic.

Technical Papers present the result of more in-depth research and evaluations, advancing WASH knowledge and theory of change on a key topic.

WASH Diaries explore the personal dimensions of users of WASH services, and remind us why a good standard of water, sanitation and hygiene is important for all to enjoy. Through personal reflections, this series also offers an opportunity for tapping into the rich reservoir of tacit knowledge of UNICEF's WASH staff in bringing results for children.

WASH Results show with solid evidence how UNICEF is achieving the goals outlined in Country Programme Documents, Regional Organizational Management Plans, and the Global Strategic Plan or WASH Strategy, and contributes to our understanding of the WASH theory of change or theory of action.

Readers are encouraged to quote from this publication but UNICEF requests due acknowledgement. You can learn more about UNICEF's work on WASH here: https://www.unicef.org/wash/

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