Background and objectives

Background

• With programming in over 160 countries, a number of solar solutions has been implemented in various which varying results and outcomes

• There is the need to know if such solutions can be scaled up and at what magnitude to contribute to achieving the SDGs

• Understand the context in which to implement them

Objectives

• To take stock of progress made so far by learning from in-country experiences (successes, challenges, and overall programme sustainability).

• To assess whether or not the systems are a viable method of accelerating the SDG for water.

• To give recommendations for future scale-up
**Methodology**

**Field assessment**

- Assessment took place in 4 countries (Nigeria, Mauritania, Uganda and Myanmar).

- Direct observations in 35 communities, plus 300 key informant interviews (Government, NGOs, private sector, WASH Committee and beneficiaries).

**Desk study and Literature reviews**

- Desk study and literature review of key documents on solar solutions to understand the drivers and levers that contribute to success or otherwise.

**Survey**

- Global survey carried out among UNICEF officer to identify and collect necessary information on solar pumping systems.
34 UNICEF Country Offices are currently implementing solar powered water supply programming.
Scope of UNICEF’s Global Solar Water Pumping System Programme

- Majority of systems are small in size (<2,000 beneficiaries), located in schools, communities and health care centres.

- Multi-village systems are also being piloted (e.g. Malawi).

- Programming aims to reach those with worst access, but also upgrade hand pumps and diesel systems.

- Mostly utilise a community-based management system – community responsible for all repairs following installation.
Solar Water Pumping Systems: The Technology

- Solar systems have been in mass production since 1983 – only recently that they’ve become affordable, efficient and versatile.

- “Climate Smart Investment”:
  - Generate no emissions (unlike diesel pumps).
  - Well suited to tropical climates and isolated off-grid communities.
  - For continuous supply of water, it’s important to have a water storage buffer or a backup battery system to pump when there is no sun rays.
Solar Water Pumping Systems: The Costs

Costs

• Price of solar powered systems, (especially solar panels) has decreased substantially in past 30 years.

• However, solar system components, on average are still 10-15% more expensive than other mechanized systems (grid or motorized).

• Significant price variations exist depending on local market conditions.

• However, over a 20 year period – a motorised pump costs around 5 times as much to maintain than a solar pump due to the cost of maintenance and fuel.
Results
## A Comparison of Water Supply Technologies

<table>
<thead>
<tr>
<th></th>
<th>Handpumps</th>
<th>Motorised pumps (diesel or other fuel)</th>
<th>Solar Powered Water Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial cost (per beneficiary)</strong></td>
<td>$10-20</td>
<td>$20-50 (varies according to context and size of system)</td>
<td>$10-90 (varies according to context and size of system)</td>
</tr>
<tr>
<td><strong>Pumping depth</strong></td>
<td>Up to 80m</td>
<td>Up to 600m¹</td>
<td>Up to 250m²</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>Simple</td>
<td>Moderate complexity</td>
<td>Moderate complexity</td>
</tr>
<tr>
<td><strong>User friendliness with beneficiaries and level of effort to keep it running</strong></td>
<td>Less popular – major effort required to collect water and breaks down regularly. Cheap to maintain.</td>
<td>Less popular – minimal effort required to collect water and breaks down regularly. Expensive to maintain.</td>
<td>More popular – minimal effort required to collect water and rarely breaks down. Cheap to maintain.</td>
</tr>
<tr>
<td><strong>Operating costs</strong></td>
<td>None</td>
<td>Significant day to day operating costs are required (cost of fuel and paying an operator)</td>
<td>None – unless system is manually operated³, in which case a part-time operator is necessary</td>
</tr>
<tr>
<td><strong>Durability</strong></td>
<td>Poor – breaks down frequently and requires regular maintenance. Average lifespan of 1-5 years.</td>
<td>Poor – breaks down frequently and regular maintenance is required. Average lifespan of 5-10 years.</td>
<td>High – rarely breaks down and little maintenance is required. Average lifespan of 10+ years.</td>
</tr>
<tr>
<td><strong>Pollution – environmental friendliness</strong></td>
<td>No greenhouse gas emissions</td>
<td>Significant greenhouse gas emissions</td>
<td>No greenhouse gas emissions</td>
</tr>
<tr>
<td><strong>Other considerations</strong></td>
<td>Only suitable for shallow water depths and requires time and physical labour (usually from women and children).</td>
<td>Noisy, heavily reliant on reliable fuel supply.</td>
<td>Requires consistent sun exposure throughout the year, reduced output when cloudy.</td>
</tr>
</tbody>
</table>

¹ Riser pipes are the limiting factor for the installation depth – more so than the power of the pump
² Example: Grundfos SQ Flex 1.2-3
³ Manually operated systems require an operator to switch the system off and on depending on how much water is available in the storage tank. Many of the newer systems now use automatic control panels in order to manage water flow, so operators are no longer required.
The Demand for Solar Water Supply Technology

- In the four countries studied, solar powered systems were found to be popular with communities, government and private sector partners.

- UNICEF staff and implementing partners also favoured the use of solar powered systems in their programmes largely due to the low running costs and long-term durability.

![Graph showing percentage of responses on the opinion of solar water supply systems among different key informant groups.](image)
Operation and Maintenance

Durability

- Solar powered systems were found to be more durable than hand pumps and motorised systems where boreholes were well sited and systems were correctly installed and dimensioned.

- The majority of systems visited had never experienced a major malfunction.

- However, when break-downs did occur, issues tended to be minor but took a long time to fix, due to limited local capacity and difficulties in accessing spare parts.

**Functionality of solar pump since installation**
- Always functional: 36%
- Broken down once or more: 64%

**Most common causes of solar pump malfunction**
- Borehole ran dry: 20%
- Issues with wiring/electrical components: 25%
- Motor issues (e.g. silting up): 6%
- Vandalism/theft: 3%
- Lightening: 43%
Operation and Maintenance – Water supply

• The majority of systems were found to provide sufficient water for most of the year.

• However, 53% of systems experienced issues with seasonality (unable to provide sufficient water to meet demand for 1-7 days a year).
  
  • Improving dimensioning (e.g. storage) or reverting to a back-up generator when demand is very high is one way to overcome this issue.

• Only 6% of systems struggled to provide sufficient year round. This was found to be mostly due to poor dimensioning and/or borehole siting.

Is the water produced sufficient year round?

- Yes, all the time
- Mostly, but not for 1-7 days during the rainy season
- Mostly, but not for 1-7 days during the dry season
- No, we struggle year round
Operation and Maintenance

User Fee Management

• Following an initial 1-2-year warranty period, the community becomes responsible for managing and paying for repairs.

• 95% of systems either fully managed by the community or partially-managed in collaboration with the local government.

• In Myanmar, community contributed towards the cost of installation (up to 50%).

• Average costs per household varied with an average family in Myanmar paying $1.50 a month to around $4.50 (considered affordable for most families).

• On average around 5% of the population in each community could not afford to pay the fees for water, whatever the cost. Just 56% of communities were found to provide in-kind assistance to those in need.

• In just 33% of cases, WASH funds were held in an official bank account. Payment log books and receipts for users were provided in less than 20% of cases.

• Weak user fee collection mechanism in many cases meant savings were not always sufficient to cover high cost of repairs if needed.
Professionalization and Capacity

• The most common “severe” causes of malfunction were related to poor borehole siting and construction.

• UNICEF Somalia (2016) found that up to 29% of solar powered systems had problems with dry boreholes.

• Existing boreholes were often selected, without sufficient hydrogeological testing.

• UNICEF, NGO, and government staff at all levels lacked sufficient training in many cases.

• Operation and maintenance plans only existed in a few communities.

• Regularised system overhauls were rare occurrence; problems fixed as and when they occurred.

• Operation and maintenance guidance manuals not always easy to use locally
Enabling Environment

• Three of the four countries visited, Nigeria, Mauritania and Uganda, had solar pump technology explicitly mentioned in their national Water and Sanitation Strategy.

• In Mauritania, solar pump technology is a major priority for the government. It is used in 24% of Government-supported projects, with the aim of ensuring at least 40% of systems are solar-based by 2017.

• Government and private sector were found to favour larger, peri-rural communities with existing boreholes to upgrade. Less focus on smaller, isolated communities.

• In Mauritania, there were also reports of both private and public water supply providers cutting off water supply services for those who are unable to pay.
Conclusions

• Solar powered systems perform well in terms of flow rate and durability, where sunlight is plentiful, boreholes are well sited and systems are correctly dimensioned.

• Potential to ensure greater resilience in the poorest communities, leaving them less dependent on fuel supply, which can be easily disrupted and vulnerable to corruption.

• Opportunity to move up the water supply ladder and provide a higher level of service to communities in tropical regions, particularly in off-grid, rural communities.

• Effective collection of user fees (including provision for the poorest) is absolutely vital in order to ensure sufficient reserve fees to cover the high potential cost of break-downs.

• Significant investment is required in order to build both public and private sector capacities to successfully install and manage systems, strengthen markets and improve accountability.
Recommendations for Scaling up

• Improve system designing (dimensioning to match the environment and fully meet the needs of the population)

• Improve the collection and management of user fees at the community level – particularly in terms of accountability.

• Strengthen the monitoring, operation and maintenance of solar pump systems – including through improving certification, training and availability of official spare parts.

• Ensure solar systems are included in the enabling environments, policies and strategies

• Advocacy to be considered for solutions in hard to reach areas
Thank you