SUSTAIN+

CInI
An Initiative of TATA TRUSTS

PROCESS DOCUMENTATION STUDY

COMMUNITY MANAGED DRINKING WATER SCHEMES

4th Wheel
Social Impact

DECEMBER 2022

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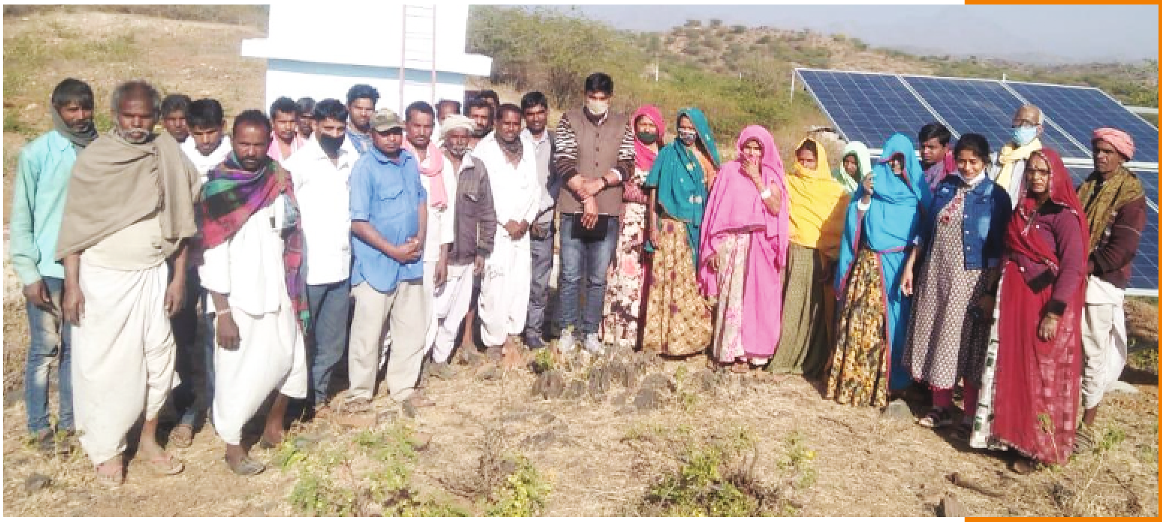
INTRODUCTION



1.1 BACKGROUND

Water, the backbone of human development and social advancement, is critical for survival of all living beings. Improved access to water supply, adequate sanitation infrastructure and good hygiene practices can improve human health. Water supply and sanitation pose one of the biggest development challenges, presently across the world and especially in India.

The World Bank reported that India has 18 percent of the world's population but only 4 percent of its water resources, making it among the most water-stressed in the world.[1] UNICEF estimates that waterborne diseases have an economic burden of approximately USD 600 million a year in India and that less than 50 percent of the population in India has access to safely managed drinking water.[2]

Based on the census 2011 data, approximately 17% of households in India are still fetching water from a distant source. The situation with regards to access to treated water can be gauged from the facts that; i) 50 % of HH receive less than prescribed 55 litres per capita day (lpcd), Rural household water is available only for 3-4 hrs; ii) Indian women spend approximately 4-5 hrs every day to fetch water from far off sources affecting their health and education; iii) >1.6Cr incidences of water borne diseases (e.g. cholera, typhoid) and ~2 Lakh deaths occur annually due to water borne diseases.

The Government is implementing water supply schemes where power is connected through power grids, which provides electricity connection for drinking water connections. Delays in implementation, irregular power supply specially during monsoons, and quality of infrastructure components have deterred availability of safe drinking water in communities.

CInI has partnered with Sustain Plus and government departments to ensure regular supply of drinking water at a household level through installation of solar pumps under these drinking water schemes. Support is offered by development of source (borewell/well), rising and distribution pipelines, storage provision, standposts, chlorination etc.

Two states in India, i.e.: Gujarat and Rajasthan have been reached as part of these efforts. The program in Gujarat is being implemented in Dahod district by Collectives for Integrated Livelihood Initiatives (CInI), while in Rajasthan it is being implemented in Sirohi and Pali districts by Centre for Microfinance (CmF).

GUJARAT

Dahod is mainly populated by tribal communities, and the population is scattered in the form of hamlets with clusters of 30- 40 households living together in a single hamlet. Some of these hamlets are situated in remote areas and are dependent on unreliable sources of water. Limkheda block in Dahod district receives low to moderate average rainfall annually and has a high surface run-off which leads to water scarcity in the summer season. Furthermore, the district also faces issues with quality of water due to more than permissible limits of fluoride contents.

Most villages and hamlets in the region were dependent on wells, hand pumps and borewells as the source of water. Due to scattered habitations, some community members needed to travel far to fetch water. This distance rose further during summer season as sources of water dried up. On average, time spent on fetching water took more than an hour. In some cases, the water supply system, if present, was connected to agriculture grid connection which resulted in irregular supply of water at odd timings.

RAJASTHAN

In Rajasthan, the project was implemented by Centre for Microfinance (CmF). The area of intervention was spread across Pali and Sirohi blocks within a forest cover marked by hilly terrain and dotted with scattered settlements. They were mainly inhabited by Grasiya and Bhil tribes who rate very poorly on key development indices. Low literacy levels and lack of awareness among them in addition to poor infrastructure for water supply characterised this context.

People mainly used handpumps and open wells, with most households required to travel more than 500 metres for fetching water, spending between 45 minutes to two hours in the process. A major part of these sources dried up during summers which led to acute water problems. Absence of regular power supply and months' long wait for getting a new electricity connection hindered water supply. In case of a malfunction, replacement took months and 6-12 hours power cuts were a regular occurrence. All of these issues were accounted for, and hence solar energy was adopted as a viable choice.

[1]World Water Day 2022: How India is addressing its water needs, World Bank. March 14, 2022. https://www.worldbank.org/en/country/india/brief/world-water-day-2022-how-india-is-addressing-its-water-needs

[2]Water, Sanitation and Hygiene. UNICEF. https://www.unicef.org/india/what-we-do/water-sanitation-hygiene. Waterlife: Improving Access to Safe Drinking Water in India. World Bank. https://documents1.worldbank.org/curated/en/586371495104964514/pdf/115133-WP-P152203-PUBLIC-17-5-2017-12-28-1-WaterlifeCaseApril.pdf.

1.2 COMMUNITY MANAGED DRINKING WATER SCHEME

The main objectives of the program was to address issues of safe drinking water access, capacitate communities to operate and maintain water supply systems and reduce operational and maintenance costs of accessing potable water. These in turn aimed to have community level impacts of reduced drudgery among women and improved health status.

Implementation of the solar powered drinking water project was undertaken in 4 blocks *in Dahod district in Gujarat, and in Rajasthan reached communities in 1 block in Pali district and 4 blocks in Sirohi district.*

Table 1: Overall reach of project, across state, district, blocks

State	District	Block	Number of schemes	Number of beneficiaries (HHs)
Gujarat	Dahod	Dahod	5	206
		Limkheda	61	2275
		Dhanpur	7	321
		Singvad	7	438
Total			***80***	***3240***
Rajasthan	Pali	Bali	25	508
	Sirohi	Abu Road	13	198
		Pindwara	15	242
		Swaroopganj	13	309
Total			***67***	***1346***

All schemes were commissioned and completed in the past six years starting from 2016.

Table 2: Installation Timeline

Installation Timeline	Gujarat	Rajasthan
2016-2018	2	-
2019-2020	2	2
2021-Present	4	7

Pani Samitis manage the operation and maintenance of the solar-powered drinking water systems. The Solar pumps systems are currently under the Annual Maintenance period for 5 years from date of pump installation, for which services are provided by vendors.

Pani Samiti is a group of people from a single hamlet/village where a solar powered water supply scheme is functional. It is composed of local citizens who are also the beneficiaries of the water supply scheme. The idea behind the formation of Pani Samitis is to empower a community to manage implementation of water supply and enable them to operate and maintain the water supply system independently after initial installation and training. Formation of Pani Samiti is started once a habitation is finalised for programme implementation. This is done so that community members are involved in every process of programme implementation starting from identification of water source, finalising location for infrastructure development, discussion on location of solar panels and pumping machinery. Later, community members are trained on managing the system before total handover of responsibility for operation and maintenance.

1.3 STUDY DETAILS

CInI commissioned a process documentation of the drinking water programme to map the learnings and share the implementation process with a larger audience. The overall intent was to gain systematic knowledge of the interventions, bring forth insights about the processes and impacts, and offer best practice examples for other organisations and stakeholders in conceptualising, planning, and strategizing programmes in similar domains and geographies.

The specific objectives of the study were as follows:

- To outline key program stakeholders and establish areas of influence and levels of impact with regards to solar powered water supply systems.
- To capture the perceptions of stakeholders with changes and improvements owing to solar powered water supply systems.
- To evaluate, triangulate and validate impact achieved through discussions and consultations with stakeholders.
- To get reliable evidence and results for recommendations to strengthen design, implementation and program impacts.

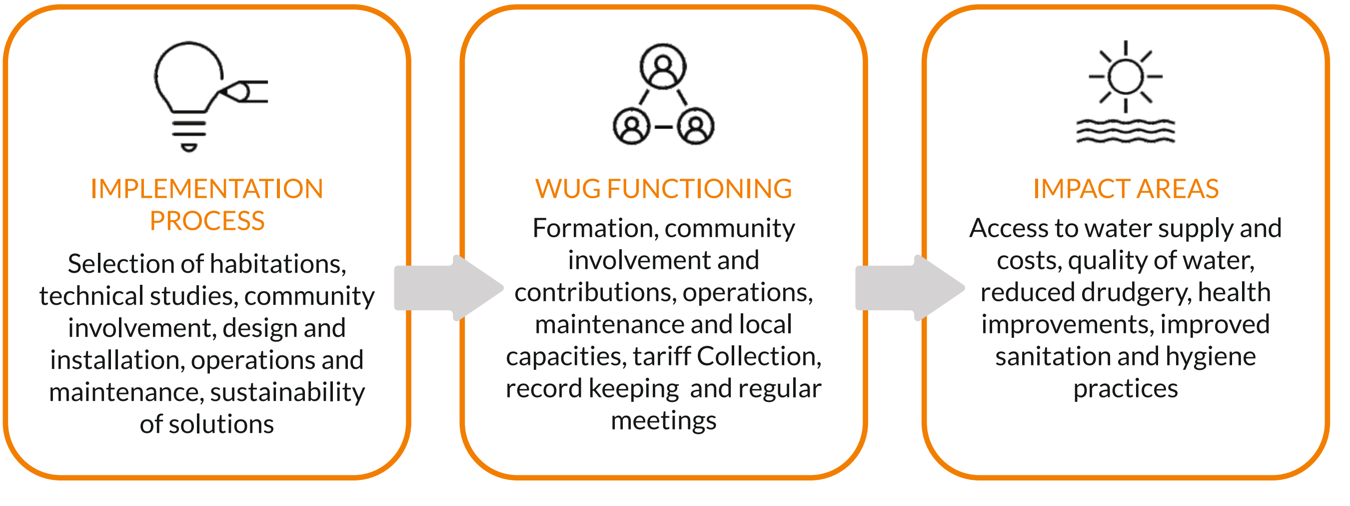
A purposive and comparative approach was taken towards identifying the hamlets to be reached in the study. For each state, specific criteria was used for sampling. In Gujarat, type of pumping (storage/direct), occurrence of water tariff collection, phase of intervention and innovations (chlorinator/bulk water metre) were variables of interest. In Rajasthan, hamlets were selected based on blocks, pump capacity, and population size.

The sampling was broadly classified into two kinds of villages: Intervention and Comparative. The study included 17 hamlets where CInI/CmF has implemented the solar power-based water supply program and 4 comparative hamlets (2 in each state) where communities received water via the electric grid or accessed water from the source. Selection of comparative villages considered geographical proximity to the intervention hamlets, type of source, number of households, and type of pumping (direct/storage).

96 respondents participated in the study. 34 Pani Samitis operators and leaders, 32 community members who were part of Pani Samitis, 13 Panchayati Raj Institution (PRI) members; along with 8 community members and 3 PRI members from comparative hamlets. Apart from interactions to gain contextual and basic insights from respective partners, interactions were held with a WASMO Engineer and a former PHED engineer who had consulted with the respective partners. The sample ensured a 50% gender representation across respondents. More Pani Samiti operators were male, while Pani Samiti leadership had a similar gender distribution. Livestock and agriculture were the most predominant occupations among all respondents.

The study adopted a qualitative approach to analyse three broad areas of enquiry. For each state, specific criteria was i.e.: 1) Process and implementation mechanisms to provide communities with water supply schemes, 2) Pani Samiti functioning to implement and sustain systems and 3) Areas of impact accrued owing to the systems (Fig. 1). Qualitative methods of process diagrams, process histories, case study development, most significant change and storytelling were used.

Figure 1: Areas of Enquiry



STUDY FINDINGS

2.1 IMPLEMENTATION PROCESSES

Scheme implementation consists of six key stages, spanning from selection of habitations, water user group formation, technical studies to inform design and installation of solutions, training community for ownership and maintenance post installation, facilitating operations and maintenance, to ensuring sustainability of schemes.

Figure 2: Implementation Process Overview

SELECTION OF HABITATIONS

Habitations are selected based on the existing power supply, availability of alternate sources, existing community institutions and capacities, demographic characteristics, existing water problems, and estimated financial costs.

TECHNICAL STUDIES

Multiple technical studies are carried out to gain clarity over the type of design and installation to be undertaken. These include water testing, yield tests, assessment of available water sources, DPR preparation, land distribution and topography, etc.

DESIGN AND INSTALLATION

Design of each installation is contextualized and tailored to local conditions.
Pump capacities, water sources, weather conditions, safety, purification measures, distance to source, and head loss provisions are considered for design and installation.

COMMUNITY OWNERSHIP

WUGs are formed for community members to independently operate and manage the scheme.
Capacity building and active functioning of WUGs is ensured through ommunity contributions at installation and in the form of regular tariffs, along with regular meetings.

OPERATIONS AND MAINTENANCE

Being in remote areas can also mean poor maintenance and operations support for solar solutions.
Operational issues like extreme weather events, long term maintenance and financial components (such as insurance and community ownership) are considered and addressed.

SELECTION OF HABITATIONS

In the sampled schemes, an array of reasons substantiated the case for implementation of the scheme. Most prominent problems related to unreliable power supply, high fluctuations in supplied power, lengthy and hectic process in procuring an electricity connection and financial burden in form of bills. Multiple factors have been considered in both locations while identifying habitations.

In Gujarat, three main criteria were used for selection of hamlets:

1. An existing active Pani Samiti exists since it is important for the subsequent handover of the scheme.
2. Irregular power supply in the hamlet for maximum utilisation of solar powered water pumping system and measuring impact.
3. Availability of an alternate source of water is necessary so that the primary source is not stressed and exploited.

"We were unable to get an electricity connection from the department. In a nearby hamlet, CInI was working on solar pumps so we reached out to them and after meetings a solar pump was installed in our hamlet,"
said Kiranbhai Chauhan, Pani Samiti operator from Suthar Jabhod scheme in Dahod, Gujarat.

"We could not get an electricity connection as it involved exorbitant funds. We were aware of the solar powered pumps and contacted Dharmesh bhai from CInI. After necessary meetings and surveys, we got solar pumps installed in our hamlet,"
said Pani Samiti leader Mayaben Solanki from Roz Haveli hamlet in Dahod, Gujarat.

In Rajasthan, three factors were accounted for:

1. Prioritising habitations with higher numbers of tribal and SC population. A benchmark set is 70% of the population should belong to SC/ST communities. This benchmark was followed in all the sampled schemes visited during the study. It was observed that the sampled habitations are dominantly populated by people from Scheduled Tribe belonging to the Grasiya Tribe, followed by people from Scheduled Castes and Other backward castes.
2. Selected habitations have severe water scarcity with no permanent source throughout the year and need to travel far and spend more time fetching water, getting poor quality water. All of the visited habitations in Rajasthan had this feature in common since the water source was unreliable and irregular.
3. Readiness among the community to contribute Rs 2000 as capital expenditure and take over responsibility of operation and maintenance in future. Except for one scheme implemented initially 5 years ago, all other habitations reported paying an amount of Rs 2000 per household as community capital contribution towards the scheme.

"CmF had been in touch with the gram panchayat which recommended our village for installation of a solar pump scheme as we faced difficulty with water availability. CmF explained the scheme to us and we saved money for over a year for community contribution,"
shared Pani Samiti operator Lala Natha from Thala Fali in Sirohi, Rajasthan.

"Electricity was unpredictable. It would come and go and would be available for 2-3 hours in the day. Transformer had also gotten burnt. Cmf had been working with this hamlet on the electricity scheme before, so then they came to us about solar,"
reported Pani Samiti operator Kani Bai from Dharohiya Fali from Pali, Rajasthan.

TECHNICAL STUDIES

Technical tests were the initial and integral step of the whole implementation process. It was the precursor to deciding further course of action. The following tests were conducted in every scheme before implementation.

Water Testing

Water available from the source was lab tested to get details about fluoride contents, quality of water and contamination if any. This helped in deciding whether the source is fit for consumption or not.

"CInI asked for a sample of water for a water test. We fetched a sample of water from the source and handed it over to CInI. They tested the water at a lab in Dahod and returned with the result that the water is potable,"
said Pani Samiti operator Bhabhor Dula Bhai from Rawali Dhulabhai Bariya hamlet in Dahod, Gujarat.

Yield Test

If the source available seems fit to be part of the scheme, a yield test is conducted to determine the quantity of water that can be yielded from the source and measured according to the needs of the Pani Samiti.

"CInI tested source water and a hydrologist from WASMO did the yield test for the source, borewell,"
said Bharatbhai from Palas hamlet in Dahod, Gujarat.

"Water testing of water from source, test for borewell potential as source, survey for constructing Ground Level Reservoir and laying pipeline was done. Women from the community contributed by doing the labour work as required,"
shared Pani Samiti operator Belaram from Grasiya ki Dhani from Pali in Rajasthan.

DESIGN AND INSTALLATION

For communities to fully benefit from solar powered water supply units, the design of each installation needed to be contextualised and accordingly tailored to local conditions. This includes making of Habitation Action Plans, preparation of scheme details and design (DPR), ascertaining financial estimates and deciding upon installation timelines.

Post selection of hamlets, implementation required source finalisation as an important factor to go ahead with the scheme. The two avenues for this aspect were either using existing sources like open wells or constructing a new source like borewell, or hand pump converted into borewell falling in line with the requirement. Majority of sampled hamlets already had a functional source of water in place which received a go ahead after necessary tests. A few hamlets where the existing source was unusable, a new source was constructed.

In Gujarat, all of the eight hamlets used an existing source of water. In Rajasthan, three schemes were implemented after constructing a new source and the rest used an existing source. Interestingly, these sites for source construction were privately owned in Rajasthan and owner community members came forward to donate the land for the greater benefit of the community. To avoid conflict in future, each one of them signed a No Objection Certificate and submitted it to the panchayat. In places where a new source was constructed, funds were either contributed by CmF/CInI or drawn from the panchayat or applicable government schemes, if any.

"After tests it was found that the borewell was dry so an existing handpump was converted into a borewell for use in water supply scheme,"
shared Pani Samiti operator Kiranbhai Chauhan from Suthar Jabhod in Dahod, Gujarat.

"Lasmobai and Sevaram, residents of the community, owned the land proposed for new source construction. Water testing occurred and then we had a meeting with the owners. They would also get water, so naturally they also agreed and a borewell was dug,"
said Pani Samiti leader Sitadevi from Obarla Fali in Sirohi, Rajasthan.

Table 3: Source of water used for scheme

State	Borewell	Open well
Gujarat	4	4
Rajasthan	3	6

Sources of water needed to be protected. In case of an open well, metal grills were installed on the opening to prevent contamination, and borewells were fenced to prevent intrusion.

Power yield of the solar panels and pump capacity had been determined as per unique characteristics of the target hamlets such as, population, household size and spread area, distance between source and households etc. The usual size of households in sampled hamlets ranged between 15 to 50. These schemes used 1 HP to 5 HP pumps powered by solar panels ranging from 2.5 KW to 5 KW. In Gujarat, the leading brand in sampled schemes was Shakti, followed by WOLT and DUKE. However, in Rajasthan, where the scheme was implemented earlier, Desire and Nimbus were associated as equipment vendors.

Natural and artificial threats were taken into consideration in terms of solar panel installation, as well as functional limitations of the machinery prior to installation. Every scheme visited as part of the study had placed solar panels away from locations of regular human activity. In case this was not possible, it was made sure that the solar panels were protected with fencing.

COMMUNITY OWNERSHIP

People from selected habitations were taken to visit a hamlet with active operation of a solar based water supply program for an exposure visit. Usually, exposure visits take place in nearby habitations with functional solar powered water supply schemes that share common culture and geographical characteristics. Exposure visits are not just limited to gaining knowledge about the solar scheme but have also proven to connect different communities living in the same village. When villagers would see the working of the scheme and easy access to water, doubled by similar community's endorsement of the program, it would boost their morale and confidence to try something like that in their own hamlet. In one such case from Rajasthan, members of the Dharohiya Fali hamlet were inspired by toilets they saw during an exposure visit and replicated it in their own hamlet.

"In a neighbouring hamlet, solar panels are functional for seven years. When we saw it, we were sure that this could put an end to our water problems."

The scheme was completed with support from CInI/CmF, community contribution, Panchayat or relevant government scheme funds. However, the financial avenues for the scheme were different in Gujarat and Rajasthan.

GUJARAT

In the case of Gujarat, excluding three hamlets, none of the eight other hamlets contributed monetarily for the construction of the scheme. In the other eight schemes, either the entire cost was covered under Sustain Plus or was partially funded by CInI and government agencies and authorities. For example, in Kali Pahani hamlet in Dahod, Gujarat, pipeline and taps were already constructed by NM Sadguru Foundation and the rest of equipment cost was borne by CInI.

RAJASTHAN

In the case of Rajasthan, the norm was to get a fixed amount as capital contribution from beneficiary households in the beginning. This norm started with a mandatory 10% contribution to the estimated cost but was later capped at INR. 2000 per household. All nine schemes sampled in Rajasthan were completed through financial contribution from CmF and capital contribution by the community. There was a standalone instance of a government body stepping in. In one case, at Grasiya ki Dhani hamlet, the panchayat contributed for the construction costs of a new borewell.

OPERATIONS AND MAINTENANCE

Issues were reported by a few hamlets in functioning of solar panels and pumping machinery. In addition to this, issues with water sources were also stated.

- Solar Panel: The problems reported by respondents across hamlets ranged from breaking of glass and fault in wiring. Another issue emerged was low utility during cloudy weather and monsoon.
- Pumping Equipment: There were instances of pump motor burning due to power fluctuations, loose wiring and leakage in inlet or outlet water pipes.
- Water Source: The only problem related to water source was drying of source in summer season due to lower levels of groundwater. Three hamlets in Rajasthan reported this issue.

Table 4: Total Pani Samitis reporting issues with the system

State	TOTAL Pani Samitis REPORTING ISSUES			
	Solar Panel	Pump Motor	Water Source	No issue
Gujarat	2	2	1	1
Rajasthan	2	4	4	2
Total	***4***	***6***	***5***	***3***

Communities in the intervention villages were trained with regards to maintenance of the scheme so that the supply system can be independently monitored, and minor troubleshooting can be done at local level. The general monitoring includes manual checks of the solar panel everyday by the operator and keeping an eye on pipelines for any fault. Mostly this is the responsibility of the operator, but other members also take stock of functioning in their personal capacity.

Resolution of more complex issues was addressed by vendors. CmF/CInI had already provided contact details of vendors to community members for quicker resolution. The general time frame for resolution was between one to two weeks. In all the cases where any expense was incurred, it was drawn from Pani Samiti savings. In exceptional cases, when the equipment was under warranty, the vendor covered the expenses. When asked if CiNi/CmF have been reachable and appropriately responsive to queries and complaints, all respondents replied in affirmative and showed satisfaction with these organisations' role.

Four hamlets in Gujarat reported that **solar systems gave low output during monsoon** and that affected the water supply. Similarly, five hamlets in Rajasthan reported the same problem.

2.2 PANI SAMITI FUNCTIONING

The purpose of forming Pani Samitis is to form a governing body at the local level, ensuring community buy-in and ownership into the scheme. Pani Samitis mostly consist of representatives from households within the hamlet and the community builds a consensus to appoint a leader and operator for the Pani Samiti functioning. Once the scheme is completed, these groups hold monthly meetings to ensure transparency and address grievances.

Figure 3: Pani Samiti Formation and Functioning

INVOLVEMENT WITH DESIGN & INSTALLATION

Extent of involvement with identification of pipeline routes, water sources, pumping machinery and monitoring of work execution

WATER DISTRIBUTION MECHANISM

Water distribution mechanisms in terms of water sharing, timings for households, resolution of community conflicts

TARIFFS, EXPENDITURES AND SAVINGS

Community contributions for installation and paying of regular tariffs; income levels, savings and expenditures incurred

RECORD KEEPING & MEETINGS

Records on water supply, tariff collection along with regularity of meetings and topics of discussion

WATER MONITORING & CONSERVATION

Water quality monitoring mechanisms and conservation efforts underway

Involvement with Design and Installation

Most Pani Samiti members cited involvement in source identification, offering suggestions during laying supply pipelines and construction, storage infrastructure and stand post outlet taps to ensure it caters to the needs of everyone. Overall, the community was involved by taking stock of the work and providing inputs to implementing agencies.

Many respondents shared that they contributed in the form of labour during infrastructure development. In Rajasthan, where capital contribution from the community was expected, labour contributions were adjusted against monetary contribution.

Water Distribution Mechanism

Water supply across the hamlet to each and every household is ensured through either of the three ways:

- Phased supply to one section of households at a time
- Multiple supply lines to maintain equity.
- Storage in a common tank to draw from

Distribution of water is managed by the community by applying basic civic sense. Respondents reported to have mutually decided supply timings and adopted a system. Generally, the solar pump would be switched on in the morning when there is sufficient sunlight available. In case of direct to household supply, it would be operated for a few hours (time depends upon the size of hamlet) till each household receives water. In case of a storage facility, the water would be first stored in a Ground Level Reservoir /High Ground Level Reservoir, then the supply would be turned on- phase wise or altogether at once.

> *"Solar Panel is turned on at 10 AM to fill the GLR and turned off at 4 PM. There are two lines of water supply which is opened at 12 PM and other at 5 PM,"*
> *informed WUG operator Sawaram from Solanki Fali, Rajasthan.*

> *"Pump is switched on at 10 am every day. Over time we have learnt what is the water flow and timelines of water reaching every household storage tank and have accordingly started regulating. So, the farther off HH are supplied before and the near ones are done later. We coordinate on call for this. There are two supply lines, and the supply is done on alternate days,"*
> *shared Pani Samiti operator Gomaram from Huka Magri, Rajasthan.*

Only one hamlet in Gujarat reported to have witnessed fights in community over water issues whereas in Rajasthan two hamlets reported to have seen conflict related to water. The cause for such conflicts were mainly due to misuse of water by one household that resulted in irregular supply to another. Respondents from all hamlets shared that such conflicts within the community were solved through internal discussion and Pani Samiti meetings.

Tariffs, Expenditures and Savings

Each member household contributed a fixed tariff amount monthly for water supply facilities. The monthly tariff amount ranged between ₹50-100. This contribution created a fund for Pani Samiti savings. These are emergency funds are used towards water supply operation/maintenance, if needed. A Pani Samiti meeting was held to discuss a tariff amount on the basis of multiple factors like calculation of expenditure, financial capabilities of Pani Samiti members, number of contributing households and then following a standard budget mechanism taking all of these factors into account. CInI/Cmf were also involved in this process of determining the tariff by carrying out these activities with the communities.

Table 5: Tariff Structures

State	Total Pani Samitis	
	Up to ₹50	Between ₹50 and ₹100
Gujarat	3	5
Rajasthan	2	7
Total	***5***	***12***

13 of 17 Pani Samitis had income levels up to INR. 25000 since installation. Income of Water User Groups has been influenced by three factors:

1. Duration as a functional Pani Samiti
2. Expenditure incurred during this time.
3. Number of households and tariff collection

Table 6: Income Levels of Pani Samitis

State	Total Pani Samitis		
	Upto ₹25000	Between ₹25000 to One lakh	Above One lakh
Gujarat	5	2	1
Rajasthan	8	1	0
Total	***13***	***3***	***1***

In terms of expenditures, four hamlets in Gujarat and seven hamlets in Rajasthan reported to have spent money on repair and maintenance. This contribution created a fund for Pani Samiti savings. All operators in Gujarat are compensated monthly while in Rajasthan three out of nine were not compensated for operation duties. Average amount in Gujarat was INR 1037.5 and in Rajasthan it was INR 333.33. Lowest compensation recorded was INR. 100 and the highest was INR 1500 across Gujarat and Rajasthan. None of the Pani Samiti leaders received monetary compensation.

Record Keeping & Meetings

Record Keeping is registering information about various components of the water supply scheme with an aim to maintain transparency and accountability. Out of all the sampled hamlets in two states, Pani Samitis maintained *Meeting Notes* (all eight Pani Samitis in Gujarat make a meeting record for every meeting whereas in Rajasthan eight out of nine Pani Samitis follow this norm), *Operation and Maintenance Record* (0nly one Pani Samiti in Gujarat maintains these records while all nine Pani Samitis in Rajasthan keep this record), *Tariff Collection and Expenses* (all Pani Samitis across Gujarat and Rajasthan maintain this record), *Solar Panel/Tank Cleaning Record* (none of Pani Samitis in Gujarat keep this record while eight out of nine Pani Samitis in Rajasthan maintain this record) and *Pump Operation Logbook* (three Pani Samitis in Gujarat maintain this record whereas six Pani Samitis maintain the same record in Rajasthan).

As per recommendations made by CInI/CmF during Pani Samitis formation and subsequent training, it is imperative to hold Pani Samitis meetings from time to time and discuss functioning related issues there. This norm was found to be religiously followed by each and every hamlet sampled as part of the study so much so that there were penalties on members not attending meetings.

Pani Samiti meetings are held once every month on a fixed date in all the nine sampled hamlets of Rajasthan and seven hamlets of Gujarat. One Pani Samiti in Gujarat conducts meetings once in two months. Additional meetings are held in case of urgent requirements. Attendance percentage of these meetings have been reported to be between 70 to 100 percent across all the hamlets sampled in Gujarat and Rajasthan. These meetings are a platform for registering grievances and discuss topics that require input from each and every member of the Pani Samiti. Among the topics discussed are:

1. Water Supply Maintenance Issues
2. Collection of tariffs
3. Function related discussion
4. Record keeping

Operation and Maintenance

Maintenance of the solar panels involved regular cleaning to avoid dust and general upkeep, along with protection from damage to panels and wiring. All Pani Samitis from Gujarat and Rajasthan were following these norms as per training and cleaned the panels every week. Moreover, Pani Samitis constructed fencing around the panel location.

Water source maintenance involved cleanliness and ensuring timely chlorination of water. Also, in the case of an open well, it was observed that a boundary wall and a protective net has been installed. Four Pani Samitis in Gujarat suggested that they ensured no trash was thrown into the well and chlorination is done regularly. In Rajasthan, Pani Samitis maintained the water source by checking for mud blockage and cleaning (in case of open well) weed and other deposits.

Maintenance of the pumping systems included protection from theft, timely and safe operation and regular monitoring and upkeep. For maintenance of pipelines, it was ensured that no construction and excavation work is done without prior approval from Pani Samitis members so as to ensure the underground pipeline does not get damaged.

Generally, the maintenance of outlet taps is managed by the household(s) benefitting from it. General maintenance includes checking and fixing leakages and ensuring no water is wasted.

Solar powered systems in all the Pani Samitis have an insurance scheme, and most Pani Samiti members were aware of details.

Water Monitoring and Conservation

Six hamlets in Gujarat and 8 hamlets in Rajasthan reported to be using field testing kits to monitor water quality in their schemes. It was also observed in two hamlets, one in each state, that CiNi and CmF conducted periodic testing, mostly before and after monsoon.

Respondents from all the schemes said that they have encouraged judicious use of water and make sure water is not wasted. Additionally, four hamlets in Gujarat reported adoption of rainwater harvesting techniques meanwhile only two hamlets in Rajasthan concurred. One hamlet in Rajasthan shared plans of constructing a small pond to augment water.

2.3 AREAS OF IMPACT

Solar-powered water drinking schemes improved access to quality water, resulting in improved health, hygiene and sanitation outcomes for communities. Improved health outcomes can be attributed to reduced drudgery on the one hand, while on the other hand, they can be explained in terms of improved hygiene practices, reduced incidence of disease, and overall healthy development. This can be observed by looking at the before and after solar scenarios in the intervention hamlets while simultaneously comparing the scenarios with comparative hamlets.

Figure 4: Impact Outcomes

IMPROVED ACCESS TO WATER

Improved reliability of water supply systems, increased water availability across different seasons

REDUCED DRUDGERY

Reduction in drudgery in fetching water, time spent on collecting water and household chores.

INSTALLATION TIMELINES AND OPERATIONAL COSTS

Reduced installation timelines and ease of installation, costs associated with repair, maintenance and electricity bills, resolution of issues and timelines

IMPROVED WATER QUALITY

Systems and processes in places for regular source cleaning, chlorination, and water testing leading to improved water quality

IMPROVED HYGIENE, HEALTH AND SANITATION

Positive practices and behavior changes in terms of sanitation, handwashing, personal hygiene owing to water availability

Reduced Installation Timelines and Operational Costs

Solar pumps get installed between a few days to a month. Solar pump installation costs comparatively higher at an average of INR. 2,24,000 and much higher at an average of INR. 7,20,000 when considering all installation cost components. Costs also differ as per the capacity of the solar pumps.

In comparative villages with electricity grid connections, it usually takes more than 1.5-2 years from application to installation of electricity-based grid systems. Application process is tedious and also after completion of application power connections is delayed from the department. Many times, people own an agricultural power connection that makes them ineligible for another connection for water supply. Many times, the electricity connection could be illegal that causes loss to the electricity department and eventually to the government. For procuring an electricity connection, the applicant is required to pay around one to two lakhs in the form of security deposit. Actual installation costs of electricity are around INR. 1,04,000 on average for 21 households in Rajasthan. In Gujarat, installation costs differ from hamlet to hamlet and village to village because the cost of one system depends on the topography of the hamlet or village. If households are scattered, long pipelines are required or if congested short pipelines are required. Moreover, in some hamlets, there is a need to modify local resources such as borewells or wells. Once a detailed survey is conducted then the price quotation is decided. But on average it requires INR 3,00,000 to 4,00,000 to install a grid connection. The Government has now put a limit of INR. 1,00,000 for installation costs under JJM.

In intervention villages, reduced costs were seen in terms of electricity bill, purchasing water and repair and maintenance.

A remote settlement, Grasiya ki Dhani in Bali block, Rajasthan used an electric connection for water supply in the past. Later, solar panels were installed in the hamlet and respondents reported saving up to Rs. 20,000 per year due to issues related to electricity connection and still face problems with water supply. Today, community members are able to access enough water regularly and are able to maintain savings as well. Very few complaints were received in operations and functioning of the solar based water systems. This is very relevant for interior locations, where communities don't know how to address and repair transformers, and where local politics also occurs over electricity, owing to which grid connections lie defunct for a long time. Timeline for issue resolution ranges between a week to a month depending on the severity of the problem and nature of resolution, which needs local intervention or professional intervention. There has also been a focus on convergence and negotiation with vendors on providing timely and reliable post installation services which improves issue resolution processes.

In comparative villages with grid connections, communities pay a monthly tariff for the unreliable water supply. In addition, they also need to pay electricity bills which range around INR 6000 to 12000 annually.

Furthermore, in case of frequent malfunctions the expenditure only increases. Average repair costs were calculated at INR 5000 per annum for residents using electricity grid connections accounting for motor pump burn due to power fluctuations, cable damage, etc.
At many places electric connections had gotten discontinued since community members were not able to pay the bills, and community savings and funds had to be accumulated again. Since most of these villages are remote, repair and maintenance take weeks to a month. Irregular supply and power fluctuation render the supply line and pumping equipment damaged.

THEME: REDUCED COSTS AND INCREASED CONVENIENCE OF SOLAR BASED WATER SUPPLY SYSTEMS

Improved Access to Water

A key outcome has been the increased reliability of the water supply system. With solar powered pumps in place and supply mechanisms established, there is no more dependency on irregular power supply from electricity grids. One aspect of reliability comes from the fact that the system is managed by the community.

In the intervention villages, the water supply system is powered by solar panels and pumps and the operations are taken care of by community members.

It allows the community members to conveniently manage water supply on their own terms without any dependence on external factors like electricity supply. This makes the water supply system reliable. Generally, water supply timings were reported to be in the morning hours when people would need it for daily chores and due to availability of sunlight in these hours. The supply time was between 1-3 hours per day at a fixed time.

Whereas in comparison villages, with electricity powered water supply, respondents reported that water supply is unreliable and totally dependent on power availability.

In case of power cuts and irregular supply, there is no fixed mechanism and schedule for water supply.

In Gujarat, one out of the two comparative hamlets, Medi in Chilakota village, respondents shared that an electricity grid-based water supply system is in place. In case of non-functioning of the system, a handpump is the alternate source of water. The hamlet of Dungra Fali in Jada village has no water supply system and water needs to be collected directly from source.

In Rajasthan, in both the comparative hamlets i.e., Amli Village and Khakhra Fali in Thandi Beri panchayat, an electricity grid-based system is installed to draw water from an open well and pump it to a ground level reservoir. In Khakhra Fali, it takes two hours to fill the ground level reservoir, but the timings are not fixed due to irregular electricity supply. Whereas in Amli, water supply is done in a phased manner with each of the three phases receiving supply once in three days. Due to unavailability of a proper water supply system, source collection is a common option for respondents in these villages.

Before implementation of solar water schemes, scarcity of water was reported during summer owing to drying of source and groundwater depletion. Weather related drudgeries were observed. In monsoon communities were troubled with muddy routes and slippery trails, routes to the water source got blocked due to excessive rainfall and waterlogging in the fields; and in winter communities endured chilly weather on trips to get water.

"Before the scheme, during summers we would walk in the heat to the handpump with 3 containers. Due to scarcity, there were many people waiting to fill water and sometimes the handpump would go dry. In such a situation, we had to wait for around half an hour until it was recharged,"
Phuli Devi, Pani Samiti member from Obarla Fali told the enumerator.

"Summers is the worst time for water. Even kids were sent to fetch water on cycles. Women of the community would need to take breaks in the heat. Once, a woman from our community fainted while bringing back water and the pot of water was lost. She was sick yet had to go fill water the next day,"
Pani Samiti member Kimibai from Solanki Fali, Rajasthan shared her experience.

In intervention villages, the aspect of drudgery and time was reduced even in summer months and the supply worked well though it could be a little less as compared to other months.

But in case of drying of the source, the water supply ceased. In intervention villages, no instances of purchasing water were reported. Respondents from these hamlets shared that water had to be bought sometimes before the implementation of the scheme but after implementation buying water is no longer necessary, even during high demand due to social functions as solar based water supply system cater to increased demand as well.

THEME: WATER ACCESS AND IMPROVED LIVING STANDARDS

Communities in comparative villages faced severe water scarcity in summer and owing to unreliable water supply and dependence on source collection, faced weather-related drudgeries.

In Gujarat, no respondents from two comparative hamlets reported purchasing water for drinking and domestic purposes. Whereas in Rajasthan, respondents from both the sampled hamlets said they have purchased water for drinking and domestic purposes. The expenses for this water supply were borne by the panchayat. In Khakra Fali hamlet in Thandi Beri, irregular power supply often forced people to buy water while in Amli village, lack of water source during summer was the cause to order water tankers. Respondents reported that they spent INR 500 for a 7000-litre tanker ordered four times throughout the summer season.

Improved Quality of Water

Most respondents either opined that water quality was better than before or said that quality was never an issue and maintained that there has been no change in quality of water.

Table 7: Perception on change in quality of water in intervention villages

State	Better than before	No Change
Gujarat	4	4
Rajasthan	7	2
Total	***11***	***6***

In the intervention villages, there was an improvement in quality of water owing to purification guidelines followed during the implementation of the scheme and during operations. As a rule, chlorination of water was observed in all the intervention schemes by Pani Samiti operators or members at regular intervals. Another reason, as stated by respondents, is the mandatory water testing done by implementing agencies before scheme implementation and after that at regular intervals, mostly pre and post monsoon. Addition of chlorine has been observed as the preferred method of purification in the intervention schemes. This is done either at the source itself or at the storage tank or privately in households.

In the comparison hamlets, quality of water was assessed by asking residents about the smell, taste and colour of water.

Water quality was reported and recorded on these parameters.

In Gujarat, respondents from Dungra Fali in Jada Village reported that water available is discoloured whereas no respondent complained about water quality in Medi hamlet in Chilakota village.

In Rajasthan, respondents from Amli village reported that the water available through hand pump has bad taste and smell besides being discoloured. However, they did not report any issue with water quality provided by the panchayat through a Ground Level Reservoir. On the other hand, water in Khakra Fali in Thandi Beri village was reported to be potable.

THEME: WATER QUALITY

Reduced Drudgery

Drudgery relates to travelling long distances to fetch water, compounded by long wait times. Doorstep water supply has significantly reduced challenges faced in accessing water among communities.

"Earlier we needed to allocate time specifically for fetching water and accounting multiple trips around 4-5 hours were spent just sourcing water. Now with this water supply system, we can fill and store water for a day's use in just 20 minutes and that too without having to walk far,"
shared Pani Samiti member Kimibai from Solanki Fali in Rajasthan.

"Before the scheme, we walked to a nearby open well which was the source of water for multiple villages in the vicinity so that would cause a crowd. The whole process would take up to an hour or more. As of now, we can conveniently fill water during the one-hour supply time. I would say we can save around an hour daily now,"
shared Pani Samiti member Budhliben from Palas in Gujarat.

"Kids can also fill water now. We women don't need to make 2- 3 trips per day. Before, we would be going to fill water all the time. We would get up in the morning and go fill water after morning chores. Then we would fill the tiffin and go to work. If needed, we would go and fill water again before going to work. We would have to go and fill water in the dark in the evening again, once back from work"
shared WUG Leader Sita Devi from Obarla Fali in Rajasthan.

"Chores would be planned around procuring water, and we would cook food later. There are so many things to do, get firewood, cook, etc. Moreover, water is needed not just for family members, but also for animals. We would not get any rest. Now, there is no tension to go and get water for family and animals."
shared Pani Samiti Leader Methibai from Ubiya Fali in Rajasthan.

"Now all the water fills in 15 minutes. When the solar panel was not installed, it would take us an hour to fetch water for one trip. The other chores in the house would get affected."
shared Kusumba of Suthar Fali in Gujarat.

In the intervention villages, all respondents reported that time spent in fetching water has been reduced.

It had been cut down by a minimum of 30 minutes to one hour. Earlier, fetching water was done over multiple trips that would require several hours in a day. This implies the saving of time to get water. Not only were multiple trips required in a day to fetch water, but several aspects also such as multiple hamlets using a single source of water contributing to increased time to draw water, women needing to carry the water-filled containers over distances, getting water for the household human members and animals contributed to further efforts for women to procure water. Drudgery would also mean that villagers had to plan their other chores accordingly. Now, they have enough time to attend to other important tasks.

In comparative villages with an electricity-based water supply system, irregularity in power supply has reinforced the drudgery aspect despite having a facility for easy water access.

In comparative villages with electricity-based supply or no water supply system, drudgery is still a prevalent problem as respondents reported having to walk to the source for collecting water.

In Gujarat, respondents from Medi hamlet reported an increase in drudgery in case of irregular power supply as they need to walk to collect water from a hand pump or go to a nearby village.

In Rajasthan, respondents from Khakhra Fali in Thandi Beri shared that water availability is entirely dependent on electricity supply which is not fixed. Operator needs to travel to and from hamlet to source if power goes out in between. It usually takes 10 minutes to fill water when uninterrupted power supply is available. When there is a bigger fault in the electricity supply which takes days to get repaired, residents have no choice but to walk to other sources located at a distance. handpump, well or even to a neighbouring hamlet. Thus, drudgery comes into play despite having a water supply system.

THEME: DRUDGERY

"Fetching water from open well is tiresome. It takes more than 30 minutes just on a single trip. We need to go on 10 such trips in a day,"
said Arvindbhai from Dungra Fali, Comparative Village

Improved Hygiene, Health and Sanitation

Water availability can be directly linked to health and sanitation outcomes like increased toilet use, personal hygiene behaviours and improved menstrual hygiene.

"Before, less water was available. As a result, we would need to go to the toilet in the open. Now that we have enough water, we are able to use the toilets and use an adequate amount of water"
shared WUG Member Mansigh Bhai Bamaniya, from Kheriya Fali in Gujarat.

"We would have to walk long distances during our periods, in pain. Plus, there would not be enough water to wash. Now none of these problems are there"
shared WUG Member Sarikaben from Dungra Faliya in Gujarat.

"We used to get waterborne diseases before. We used to only be able to clean the toilet once in 15 days. Now the incidence of diseases has reduced. We clean the toilet once a week now"
shared Bhabhor Dhulabhai Kalu from Rawali dhulabhai bariya faliyu in Gujarat.

"We would wash hands less frequently, and not with soap. The bathing frequency was lower before- old people would bathe once in 5 days. Women would bathe once in 2-3 days. Men would bathe every day. Everybody would need to go to the well to bathe, otherwise women would need to get water home to bathe. If men and women went at the same time, women would have to wait for men to be done. Now everyone can bathe everyday"
shared WUG Member Mashu Devki from Kagdara Fali in Rajasthan.

"Incidence of water-related diseases has declined, especially those such as Blue baby and diarrhoea. Women would even lose babies, or infertility would occur. Ensuring this access to water was necessary"
shared Ratharam Suthar, ex- PHED Engineer and former CmF Consultant in Rajasthan.

In intervention villages, availability of water directly impacts use of toilets for the basic reason: having enough water to drink now water could be spared for using toilets.

Similarly, with more water being available, people can engage in handwashing and bathing more often and washing clothes more than before. Menstrual hygiene improved for women who have adequate water to wash themselves or are able to wash their menstrual clothes more frequently. Respondents from six hamlets in Gujarat reported that there has been a decrease in the number of waterborne diseases among residents in their respective habitations after the scheme has been put in place. Similarly, in Rajasthan, four hamlets have reported less waterborne diseases. Apart from these outcomes, residents pointed out that there has been an increase in cleanliness at home and toilets which has kept probable illnesses at bay. There were cases of natural chemical or bacterial contamination of water reported that caused stomach pain, knee aches and kidney problems.

In comparative hamlets, respondents reported waterborne diseases as common among their population, especially in Dungra Faliya in Gujarat. Furthermore, they added that water scarcity discouraged regular cleaning and use of toilets among people in the hamlet. The presence of electricity-based or manual access to water mainly entailed drudgery-related challenges and long timelines to fetch water explained by the unavailability/unpredictability of any water supply system and distance between habitation and water source.

THEME: HEALTH AND HYGIENE OUTCOMES

"We have to go to fetch water from the open wells, and that is difficult for us. It takes 30 minutes to fetch water for 1 trip and we have to make 10 trips in a day"
shared Arvindbhai Ratanshingh Mavi from Dungra Faliya in Gujarat.

"It takes half an hour for me to fill the tank, half an hour for the water to reach the homes. Sometimes, if the light goes out, I have to wait, or make multiple trips. Depending on electricity, it could be 3-4 trips or 1 trip in a day"
shared Operator Poonaram Kanaram from Khakra Fali, an electricity-based scheme in Rajasthan.

"We use water from the handpump, and people fall ill with fever, cold, cough, jaundice, vomiting. This especially occurs after the summer season; it occurs in the monsoon season"
shared Kantaben Lakhmanbhai Mavi from Dungra Faliya in Gujarat.

"We get water from the hand pump to use in the toilet. It takes times to get that water, so we are not able to clean it properly. We only clean it once a week. Plus, sometimes due to shortage of water, we go to the toilet in the open"
shared Arvindbhai Ratanshingh Mavi from Dungra Faliya in Gujarat.

03

RECOMMENDATIONS AND CONCLUSIONS

Results and evidence suggests that solar based drinking water systems serve as a reliable source for water access among communities. To further strengthen efforts and works toward long sustainability of impacts, the following recommendations are proposed.

An overview of a comparison between solar powered drinking water systems with electricity grid and off grid systems, can be viewed here:

RELIABLE POWER THROUGH SOLAR SYSTEMS: COMPARISON WITH ELECTRICITY GRID AND OFF-GRID SYSTEMS.

1. SCOPE FOR ALTERNATIVE USE OF SOLAR PUMPS

Use of excess power generated, and development of solar mini grids has tremendous potential to save electricity costs and earn sustainable incomes in rural areas. Drawing inspiration from a case study of a hamlet where excess power from the solar panels were used to operate a grain grinding machine, respondents across Gujarat and Maharashtra suggested that additional power could be used for household use as well as to promote local micro entrepreneurship. This could be done through solar power-based livelihood solutions such as sewing machines, looms, milking machines, printer and photocopy machines, flour milling machines, milk chillers, cold storage units, carpentry tools, welding machines, and others.

2. ALTERNATE SOURCE OF WATER

One of the prerequisite conditions to begin with the scheme has been identification of an alternate source of water in the selected hamlets. As per observation, the visited hamlets had multiple sources of water but not all of these sources were reliable throughout the year. These sources were handpumps, open well, rivulets etc. but solar- powered yield of water tends to get affected due to cloudy weather. Since water sources dry up during summers, it is important for solar based drinking water systems to identify and ensure alternate sources of water.

Alternative waters are sustainable sources of water, not supplied from fresh surface water or groundwater, that offset the demand for freshwater. Alternative water can serve as a vital water supply in support of water resilience by providing diverse water sources. Examples of alternative water sources include harvested rainwater from roofs, harvested stormwater, reclaimed wastewater, graywater, and additional alternative water sources like atmospheric water generation, discharged water from water purification processes, etc.

3. ENSURING OPTIMUM USAGE OF WATER GIVEN INCREASED AVAILABILITY

Ensuring access to water is imperative, given the remote locations of numerous hamlets. However, simultaneously ensuring that water is used optimally rather than wasted is the need, given declining water levels and unpredictable rainfall patterns in these contexts. Multiple respondents did articulate that at a hamlet-level, communication was undertaken with any persons who would waste water. However, ensuring persistence of this practice is necessary. For instance, as has been already taken up by CmF in Rajasthan, water security plans are being drawn up in concomitance with community members. Activities have included discussions on depth of water levels and yields, tracing these over the years, along with irrigation patterns. Not only does this serve to deepen the gravity surrounding water crises by building awareness among community members, but it could also ensure the consistent and good practice of careful usage of water.

Remote monitoring and management is a game changer for ensuring availability of potable water in remote village locations. Water Resource Monitoring Systems and app-based digitised platforms for testing water quality for standard safety parameters, have been launched under the flagship Jal Jeevan Mission, and should be promoted through this program. Local communities and Pani Samiti members should be trained to lead water-quality surveillance and undertake water quality testing using field test kits.

4. SUGGESTIONS FOR FUTURE IMPLEMENTATION OF THE SCHEME

Every hamlet sampled and visited for the scheme had suggestions and recommendations for improving the existing scheme in their habitations and for other hamlets to be covered in future. These included:

1. Protection of solar panels: Solar panels cannot be placed very close to homes since this increases the likelihood of damage, while placing them too far away prevents them from being monitored. Solar panel installations should include fencing and regular physical monitoring of the panels.

2. Storage facility for water supplied in cases where the supply is directed from source to outlet taps. This helps get water at odd timings in emergency situations.

3. Villages with solar powered drinking water systems should serve as model schemes and organise exposure visits for other similar hamlets to get motivated to adopt such systems.

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