Annual Report 2

August 2023 – July 2024

Assessing the Impact Pumps Solution for water services in rural Mali

Update: 09th April 2025

Contents

1- Tiefala village, Bougouni Area, Mali

1 Introduction

1.1 Reminder – Project Content

Project title: Assessing the Impact Pumps Solution for water services in rural Mali.
Expected number of beneficiaries: 10 000 people (500 people average per waterpoint)
Project's holder & partners: UDUMA as project lead, and Thermofluidics as partner.

Main objectives:

1) Testing the Impact Pumps Solution in terms of technicity, cost-effectiveness, reliability, adaptability and convenience including the first field trials of the new SolarPlex solar surface pumps;
2) Collecting reliable data for consistent comparative economic analysis.

Main activities and expected outcomes:

1) Introducing and piloting 20 new solar pumping technology (Impact Pumps) to assess the reliability and the cost reductions.
2) Undertaking a comparative economic analysis against existing approaches, with Thermofluidics support: light financial analysis of how solar pumping compares to handpumps (capex and opex, volumes of water sold, profitability, etc.) and how the Impact Pump compares to other solar pumps.
3) Organising training and public awareness activities for the local communities.

Project duration: 2022/08/01 – 2024/07/31
Contact: Mikael DUPUIS / m.dupuis@uduma.net
Date of the report: 9th April 2025

1.2 Progress: Project Completion

The project is now complete. The primary focus of this report is to summarise the comparative economic and performance analysis across the Impact Pumps Solution (IPS) compared to Alternate Solar Solutions (ASS) and Handpumps.

For completeness, since our last update, the following key activities have been completed with details provided in Appendix 1.

1. Finalization of the works and installation of the Impact Pumps Solution at the selected sites.
2. Monthly collection of technical and economic data from the field to prepare the comparative economic analysis between the Impact Pumps Solution and the manual and solar pumps typically used by Uduma.
3. Testing different sales models to address the low consumption recorded at most of the project sites.
4. Relocation of two impact pumps in other villages to address the very low consumption on initial villages.
5. Technical monitoring and evaluation of the installations.
6. Production of the comparative economic analysis.

The project was completed on July 31, without any significant delays.

2 Comparative Economic Analysis

The comparative economic analysis is divided into several key sections:

1. Capital Costs
2. Consumption
3. Service Events and Service Levels
4. Operating Costs
5. Turnover
6. Operating Profit
7. Conclusion

2.1 Capital Costs

2.1.1 Total CapEx

A summary of the CapEx costs of the different options is summarised in the table below.

Option	Hardware		Software
	Original Budget	Actual	Actual
Impact Pumps Solution (IPS)	$11,367	$11,409	$1,238
Alternate Solar Solution (ASS)	$18,346	$15,768	$1,949
Handpump	$2,700	$2,700	$1,200

Some notes on this data:

1. As reported in the project end of year 1 report and based on experience of Uduma and its contractors with 40 prior installation, Uduma estimated the CapEx figures for the Alternate Solar Solution (ASS) sites. Uduma also estimated the CapEx budget for the Handpump sites in scope.
2. The CapEx costs are divided into 'Hardware' and 'Software' , the latter includes site identification and awareness building only.
3. Actual ASS costs are based on those recorded by Uduma under this project, and were lower than budgeted because UDUMA negotiated better terms with the subcontractor. Uduma installed 10 piped water extensions with the additional budget.
4. Actual IPS costs were close to the budget and reflect the fact that:
   a. This was just a field trial of 20 site installations, a relatively low volume, IPS costs could potentially be further reduced with economies of scale. It should be highlighted that the IPS technology, installation and QA processes differ significantly from ASSs which local technicians are more familiar with. As such, this was a challenge that required substantial external training, support and follow-up during implementation.
   b. IPS CapEx included an additional 10% pumps in case these were required in the field trial.
   c. The IPS technical infrastructure design changed significantly from the pilot design in Kenya, so this was a first of its kind installation with that design. A number of improvement opportunities were identified in the overall design, procurement approach and QA processes which would benefit future installations.
5. The IPS Actual Hardware CapEx and Software CapEx was 28% and 36% lower, respectively, than that determined for the ASS.

6. As previously outlined by Uduma, the ASS and the IPS are considered comparable in terms of scope, reach and user base covered. However, for the purpose of this pilot, the design of infrastructure required for the ASS and IPS is different, which is explained further in the next sub-section 2.1.2.

2.1.2 Hardware CapEx

There are differences in the infrastructure design, capability and versatility between the IPS and ASS; some of which are reflected in the Hardware CapEx, and some are not. For example,

1. All ASS sites use metallic water towers raised to 4 meters above the ground, whereas the IPS sites met the requirements for using WRAS polyethylene tanks raised 3.5 metres above ground and larger borehole pipes.
    a. While this does save Hardware CapEx, the additional 0.5 metre tower height for all ASS sites was designed to allow for future gravity-fed piped delivery over distances of 200m to 400m to a community standpipe and payment mechanism being developed at present by Uduma[1].
    b. However, the IPS' patented pump distributes 1.8m^3/hour over 4km, which opens the possibility (to be tested) that future local piped delivery could be done without the need for higher tanks, depending on local requirements.
2. All IPS sites used the SolarPlex Extend solar pumps which include power control features to match them to each site's borehole yield, drawdown and demand profiles, meaning some sites required fewer PV panels, also reducing Hardware CapEx of the IPS. This feature also contributed to the decision to include a very low yielding borehole for solar deployment (see later discussions of Woroda).

2.1.3 Software CapEx

The Software Capex focused largely on two areas:

1. liaising with local government and regulators to obtain local site/tariff approval, and
2. identification of appropriate sites for deployment having communicated with the local community to ensure their engagement, buy-in, readiness/keenness for the solution, and preparedness to buy water at the volumes and prices contractually agreed between Uduma and local authorities.

The latter point proved to be a challenging aspect both for this project, and more broadly. Uduma used its experience and insights into the selection criteria for villages but predicting consumption accurately remains challenging (see analysis of reasons explored for low consumption).

2.2 Consumption

2.2.1 The Challenge

The expectation was that on average communities in Mali would consume 3 litres/person/day, equivalent to 45 m^3/month/site, or 30 m^3/day across each of the three groups of 20 sites, each group serving 10,000 people.

This expectation was not met for the majority of sites. To illustrate this, June 2024 is the dry season, and usually the peak month for consumption. The following number of sites exceeded the *average monthly* expectation of 45 m^3 consumption:

- IPS Sites – 6 of 20 sites (including all 4 wholesale tariffs – explained below)
- ASS Sites – 7 of 20 sites
- Handpumps – 11 out of 20 sites.

[1] Uduma anticipates investing CapEx of €2,780 per extension, retaining the existing 5,000 litre ASS tank, burying distribution pipes 200-400m and deploying a standpipe at the piped distribution point. Expected production capacity for ASS is between 10 and 12 m^3/day.

When identifying appropriate communities for deployment of a proposed solution, Uduma asks communities to evidence the desire for the solution. However, since water is perceived as a commodity, if lower cost options exist, even if water quality lower and risk to health is higher, communities will likely choose the lower cost option.

2.2.2 Potential Causes

Uduma and Thermofluidics, in consultation with experts including the Vitol Foundation, jointly investigated the potential drivers of low consumption at IPS sites, including:

1. population size,
2. existing infrastructure/alternate water source options,
3. site location and proximity to customer premises,
4. existence of household wells, and
5. time of year (rainy season vs dry season).

The only potential correlation between these drivers and low consumption was the presence of traditional wells in most villages, especially the small ones.

2.2.3 Solution – Wholesale Tariff

To help address low consumption at the IPS sites in particular, Uduma proposed a wholesale tariff to those villages, which is essentially a flat, pre-paid fee covering a period of time rather than a post-paid volumetric fee. This payment method had not been applied before with solar solutions, and is usually more associated with handpumps. The wholesale tariff was designed to leverage the reported ability of the IPS to produce (1) significant volumes of water each day, at (2) near zero marginal cost with (3) near zero impact on future maintenance costs. The objective for Uduma was to cover the OpEx and the CapManEx, while providing the best possible service to users.

The IPS design requirement was 5,000 litres per day. However, due to its capacity to provide over 18,000 litres per day, the IPS was able to provide significant more daily water production. Altogether, the design of the system and the capacity of the IPS made it possible to meet the increased consumption induced by the implementation of the wholesale tariff.

Communities on the wholesale tariff benefited from a significant increase in water volume, for a fee that was estimated to be 50% lower than the minimum government tariff. However, as the offer was pre-paid, it was theoretically supposed to increase Uduma's collection rates to 100%. However, in reality collection was challenging with teams being mobilized multiple times, generating extra expenses, to collect the fees.

The wholesale tariff showed how some communities prefer a fixed (known) fee for their water supply, rather than to pay "by the jerry can". This reflects the behavioural conditioning seen for payment at many handpump sites, with a key difference being that revenue leakage can be up to 50% on many handpump sites (see Wagner, J., Koehler, J., Dupuis, M. *et al.* « Is volumetric pricing for drinking water an effective revenue strategy in rural Mali? »).

2.2.4 Results

The following table shows the average monthly consumption in cubic metres across all project sites from September 2023 until July 2024, as well as showing the average monthly consumption over the entire period, and average daily consumption for the same period.

	Sep 23	Oct 23	Nov 23	Dec 23	Jan 24	Feb 24	Mar 24	Apr 24	May 24	Jun 24	Jul 24	Monthly Average	Daily average
IPS – All sites	1.0	1.4	3.0	1.9	5.5	7.0	11.8	21.0	34.2	58.8	19.4	15.0	0.5
ASS Sites	15.1	16.4	21.5	23.9	31.0	36.3	57.3	75.4	110.8	98.0	80.0	51.4	1.7

Handpumps Sites	74.5	102.9	80.2	77.2	102.5	110.2	118.5	87.8	149.0	108.2	56.5	97.0	3.2
IPS - Wholesale sites only									225.4	215.5	78.2	172.9	5.7

June 2024 was generally the peak consumption month across the project since sites had more time to be established, and it was the peak of the dry season. That month is therefore a helpful indicator of where the various approaches and payment options offered in the project got to by the end of the project and hopefully eliminates some of the early-stage transition effects in 2023 as people got used to the site being operational. The overall average consumption in cubic metres in June 2024 for each site type is summarised in the table below, along with the average consumption for top and bottom performing sites.

Site Type	**Average consumption in m³ in June 2024**			
	Top 25% sites	Bottom 50% sites	Bottom 25% sites	Overall Average
IPS – All Sites (Volumetric + Wholesale)	257	7	2.1	58
ASS Sites	361	12	3.5	98
Handpumps Sites	267	18	2.1	108
IPS – Wholesale Sites Only (4)				215

Some comments on consumption"

1. June 2024 was the highest consumption month for IPS sites in the project, coinciding with the peak dry season. The average consumption at pay per litre sites was 15 m^3/month whereas the average consumption at wholesale sites was 215 m^3/month – 14 times greater.

2. At Socourani consumption was 541 m^3 in June 2024. Cumulatively, in the 9 months before conversion from a volumetric to a wholesale fee, Socourani's consumption was 31.5m^3 – an average monthly consumption of 3.5m^3. The 155 time increase in consumption due to the wholesale fee is extraordinary. Socourani went from representing 0.12% of the total consumption across all 60 sites in April 2024, to 10.2% in June 2024.

3. Based on Uduma's experience, the initial low consumption at IPS sites reflects their commissioning during the rainy season, where consumption tails off significantly at all sites as rainwater collection and replenished and proximate traditional wells become attractive low-cost options.

2.3 Service Events and Service Levels

The IPS deployed was designed to address the root causes of service events, reflecting:

1. Thermofluidics' engineering insights from prior operations and overall design for Mali.
2. FMEA (Failure Mode and Effects Analysis) insights and related mitigating actions. The FMEA work was done at an earlier part of the project. It reflected Thermofluidics' insights and experience combined with Uduma's local knowledge and experience in Mali. Thus, it reflected the "best of both" partners on the project.
3. Uduma's context, including a desire to use existing parts where possible to limit inventories.

This approach worked well for most of the design. As a local operator working in rural areas, it is important for Uduma to 1) source as much as possible locally, 2) harmonize designs and materials across sites as much as possible. Conversely, Thermofluidics proposed alternative options it considered more reliable for taps, water meters and sensors, which differed from what Uduma typically uses and has stored in its inventory. Following extensive discussions, it was agreed that, as the customer, Uduma would deploy their preferred local equipment to all sites to support simplified existing inventory management and maintenance. Uduma and Thermofluidics consequently also agreed that any resulting service events related to that local equipment would be considered out of scope and excluded from any analysis.

For this study, we assume that:

1. A 'Service Level' reflects the proportion of days when the water service is available. It is calculated as a proportion of the total days when the service is available compared to the total days in the period the service is offered.
2. A 'Service Event' is an event where the water service becomes unavailable.
3. Service Events and related costs reflect the operating period at each site, which is then normalised since:
    a. Each site began operation at a different time, so normalising for the variable period of operation is considered a reasonable approach.
    b. If analysis and reporting is only done from a specific date, this would ignore commissioning challenges experienced prior to that date and where Service Events are often experienced. This would favourably distort the performance of ASS sites.
4. 'Technical Events' that did not impact the service have not been considered (e.g., the technical difficulties of the IPS in Woroda , which are discussed later).
5. 'Days Outage' is defined as the time between when the service was not available to end users to when it became available again.

Data was collected on Service Events and related costs throughout the project, which are summarised in the table below assuming 1 year site operation.

Site Type	No. of Service Events	Average Cost of Service Event (FCFA)	Total Cost of All Service Events (FCFA)	% of Total Cost of All Service Events	Days Outage	Service Level
Handpumps	4	82,064	328,257	32%	7	99.9%
ASS	2	225,000	450,000	68%	58	99.2%
IPS	0	0	0	0%	0	100%
Totals	**6**		**778,257**	**100%**		

Some key points regarding this data:

1. Two (2) Service Events were reported on 10% of the ASS sites, four (4) Service Events on 20% of the handpump sites, and no (0) Service Events at the IPS sites. The latter assumes the challenges at Woroda site were not a Service Event.
2. Average Cost of Service Event for the ASS includes a serious and unusual breakdown at one of the sites requiring the replacement of the complete pump. Similarly, the Average Cost of Service Event for handpump was heavily impacted by the replacement of a full pump body. Higher Service Event costs were naturally expected considering the operational lifespan of the equipment compared to the newly installed IPS, but not to such an extent.

3. Logistics of addressing a Service Event remains a challenge due to villages being in very remote areas that are sometimes not accessible or very difficult to access during the rainy season.
4. Uduma's service levels for handpumps are significantly better than the functionality levels reported more widely for (largely) community managed handpumps, which are typically 25% to 40% non-functional.

Challenges at Woroda

The Woroda site was atypical compared to the rest of the project, with a very low yielding borehole considered unviable for ASS. It was included in the project to explore the potential for the IPS to address the challenge of low-yielding boreholes.

Historically, only 150 people consumed 20m^3 of water per month at Woroda. What emerged during implementation is that the original borehole report was likely inaccurate in that it over-estimated the viable borehole yield and under-estimated the extent of drawdown[2]. For example, as part of our joint investigations, the borehole failed to recover its static water level overnight, despite very low consumption during the previous day.

An IPS installation was initially agreed based on the original borehole report, assuming it was accurate. Power settings on the IPS pump were significantly lowered to minimise abstraction rates to limit drawdown levels.

Whilst no Service Events were recorded at Woroda , Uduma and Thermofluidics worked together to understand a range of issues that emerged during commissioning:

1. Uduma thought was the pump malfunctioning, as air was being pumped on occasion. However, with remote support by the Thermofluidics technical team, it later emerged that the site was not fully commissioned in accordance with the installation guide, which may have caused some air ingress. This was corrected, but the problem persisted, suggesting the specific IPS may have had a fault.
2. The Uduma team reported that the IPS pump would stop before fully filling the water tank and thus not providing enough water for the village. The pump would not start automatically as expected, requiring manual restarting by a technician every morning. Although this did not impact water supply to users, it required significant intervention and follow-up from both teams, leading to higher costs. After the project was completed, the same IPS was relocated to another village. However, the issue persisted at the new site, making daily operations challenging due to the need for a manual restart of the pump every day.
3. Significant delays in obtaining video and photographic evidence from Mali, which reflects the challenging operational context for Uduma's teams in Mali.

2.4 Operating Costs

Comparing operating costs is challenging, especially when comparing infrastructure which was installed at different dates as older infrastructure tends to have higher maintenance costs. To manage this, only ASS sites

[2] The original Woroda borehole report shows a static water level of 7.78m, available flow of 1.2m^3/hour, transmissivity of 0.62 X 10^5 m^2/s, a 14m level drop in 1 hour abstracting 1.3m^3/hour, and a 14m level recovery in one hour. Given the issues experienced at Woroda, additional tests were done in July 2024 just before the end of the project to check the borehole report accuracy and basis for its inclusion in the project. That test showed a (6.22m lower) static level of 14m at 10.50am, indicating it had failed to recover overnight from low consumption the previous day. The test also revealed a drop in water level to 22.8m in 70 minutes, abstracting at only 1m^3/hour (not 1.2m^3/hour).

installed within the past year were considered. However, the handpumps are all considerably older and thus operating costs are expected to be higher.

Another challenge when it comes to comparing operating costs is consumption patterns. Historically, Uduma has noticed an increase in consumption with time, which would benefit ASS sites installed more than a year ago compared to the more recently installed IPS sites. However, since only ASS sites installed within the past year are considered, this advantage may not apply.

Considering the above, the operating costs over a 7-month period for maintaining each of the selected systems were captured by Uduma throughout the project and are summarised in the table below. It is important to note that:

1. The costs of the IPS wholesale tariff were analysed separately and based on 7-month data, which was pro-rated for the entire year.
2. Revenue related collection costs are for pay per litre collections, calculated as percentage of revenue collected. This cost is therefore zero for handpumps and IPS wholesale tariffs, as they are pre-paid access arrangements, not pay per litre.
3. An exchange rate of 509 FCFA per 1 USD was assumed.
4. The costs were allocated according to the approach detailed in Appendix 2.

	Handpumps	ASS	IPS	Average	IPS Wholesale
Total Operating Costs	**$ 66.00**	**$ 121.00**	**$ 62.00**	**$ 83.00**	**$ 49.00**
Service event costs	$ 10.00	$ 6.00	$ -	$ 5.33	$ -
Labour (CZ)	*$ 2.00*	*$ 3.00*	*$ -*	*$ 1.67*	*$ -*
Parts	*$ 8.00*	*$ 3.00*	*$ -*	*$ 3.67*	*$ -*
Revenue collection costs	$ -	$ 49.00	$ 13.00	$ 20.67	$ -
Labour (fountain worker)	*$ -*	*$ 48.00*	*$ 13.00*	*$ 20.33*	*$ -*
O&M fees	*$ -*	*$ 1.00*	*$ -*	*$ 0.33*	*$ -*
Field management costs	$ 6.00	$ 15.00	$ 4.00	$ 8.33	$ 4.00
Royalty	*$ 5.00*	*$ 11.00*	*$ 3.00*	*$ 6.33*	*$ 3.00*
O&M fees	*$ 1.00*	*$ 4.00*	*$ 1.00*	*$ 2.00*	*$ 1.00*
Data collection costs	$ 42.00	$ 39.00	$ 38.00	$ 39.67	$ 38.00
Labour (CZ)	*$ 17.00*	*$ 19.00*	*$ 19.00*	*$ 18.33*	*$ 19.00*
Fuel (CZ)	*$ 24.00*	*$ 19.00*	*$ 18.00*	*$ 20.33*	*$ 18.00*
O&M fees	*$ 1.00*	*$ 1.00*	*$ 1.00*	*$ 1.00*	*$ 1.00*
Overhead costs	$ 8.00	$ 12.00	$ 7.00	$ 9.00	$ 7.00
Mission fee	*$ 1.00*	*$ 2.00*	*$ 1.00*	*$ 1.33*	*$ 1.00*
Water quality	*$ -*	*$ 1.00*	*$ -*	*$ 0.33*	*$ -*
Kizeo License	*$ 5.00*	*$ 6.00*	*$ 4.00*	*$ 5.00*	*$ 4.00*
Communication (CZ)	*$ 2.00*	*$ 3.00*	*$ 2.00*	*$ 2.33*	*$ 2.00*

Some important findings and notes include:

1. The Total Operating Costs for the IPS are 52% less than for ASS, and slightly less than those for handpumps (IPS at $62, ASS at $121 and Handpumps at $66, for the 7 months).
2. The IPS wholesale tariff model is 40% lower than those from ASS installations and 22% lower than the IPS pay-as-you-fetch model. It shows the benefit of combining zero service events for the IPS installations with limited revenue collection costs, given the fee for the wholesale tariff is pre-paid, all you can fetch.
3. One pump at an ASS site had a major breakdown requiring the replacement of the complete pump.

2.5 Turnover

The project gathered revenue or turnover information according to the definitions provided in Appendix 2. These are then aggregated by site type across 2023 and 2024. This allows the earlier period of operation to be differentiated from the last 7 months of operation. The turnover for the IPS wholesale tariff sites is presented separately as it contrasts significantly from the revenue at volumetric IPS sites.

	2023		2024	
Site Type	**Total Turnover (USD*)**	**Average Months of Operation**	**Total Turnover (USD)**	**Average Months of Operation**
IPS	7	4.5	91	7
ASS	264	8.5	377	7
Handpumps	194	8.9	151	7
Average	155	7.3	207	7
IPS – Wholesale Tariff Only	N/A	N/A	286	7**

** 1 USD = 590 FCFA*

*** pro-rated to 7 months from the annual fee*

Some additional notes on tariffs and revenue:

1. The Government of Mali's water tariff for pay-as-you fetch is equivalent to $0.87/m^3.
2. Socourani's agreed wholesale 12-month tariff was 250,000 FCFA (USD 424). Uduma originally proposed a higher fee of 350,000 FCFA as this is the minimum threshold for ASS sites to breakeven. However, following discussions with the village and due to the time limitations of the project, Uduma agreed a 28% discount.

   Socourani was one of the first villages to benefit from the new wholesale tariff and are unlikely to have expected that their daily consumption could increase by 155 times. This experience will support Uduma in securing a more viable tariff in future villages and confirms the need for deploying prepaid metres to ensure 100% of revenue is collected. Uduma is currently piloting this approach.

2.6 Operating Profit

Operating profit was calculated for 2024 by subtracting the total operating costs from turnover for each of the different site types. A table focused on the 7 months of operation in 2024 (Jan – Jul) summarises these results.

Site Type	Turnover in 2024 (USD)	Total Operating Costs in 2024 (USD)	Operating Profit in 2024 (USD)	Operating Profit in 2024 as a % of Turnover
IPS	$ 91	$63	$28	31%
ASS	$377	$121	$256	68%
Handpumps	$151	$67	$84	56%
Average	$207	$83	$124	60%
IPS – Wholesale Tariff Only	$286*	$49	$237	83%

** pro-rated to 7 months from the annual fee*

2.7 Conclusion

The insights and lessons learned are considered significant and should benefit many in the context of changes underway in the water sector. The ability to track, analyse, and compare financial and operational performance of handpumps, ASS and IPS technologies provides valuable information for market adoption of IPS technology. This is relevant for all water service providers needing to provide solar solutions to customers, and provides valuable information on the technical infrastructure design, FMEA, CapEx, operating model options, revenue, operating costs, and service levels.

Below are the main conclusions of the study:

1. **Service Levels**: IPS offered a **100%** service level, compared to 99,2% for ASS and 99,9% for handpumps. However, this percentage difference is small, and it should be noted that in this assessment the ASS and handpumps sites consumed significantly more water than IPS sites, which results in a higher wear and tear.

It would be necessary to monitor the service level of IPS sites more closely over the long-term to better assess its durability and performance.

2. **Service Events**: IPS sites did **not have any service events within the project period** (apart from the technical issues encountered with the Woroda pump), whereas ASS and handpumps experienced several. This should be balanced with the fact that ASS sites are somewhat older installations than the IPS sites, and with much higher consumption rates.

3. **Turnover / Revenue**: An expectation of 3 litres per person per day consumption volume (and hence related revenue) was not realised across many of the three site types. Unfortunately, and within this context, consumption at IPS sites chosen by Uduma did not meet the expectations of Uduma or Thermofluidics. The most likely, albeit not proven, reason for this is the presence of unimproved alternative water points in all villages (traditional wells and rainwater collection).

   To address the above issue, a wholesale tariff model (i.e., flat fee) was agreed with IPS site villages, which significantly exceeded expectations. Consumption increased dramatically in those villages; notably a 15,500% increase at Socourani in June 2024 compared to average monthly use in the prior 9 months. Related revenue recovery rates theoretically increased to 100% as the tariff was pre-paid. Given Uduma's extensive experience with the wholesale model at handpumps, the option to scale this model up on a **larger scale** is being explored.

4. **Operating Cost**: IPS site operating costs were **significantly less** than ASS sites, reflecting lower levels of service events and increased reliability levels. However, this conclusion should be tempered by noting that, to improve project coordination the IPS sites were selected within the same intervention area, while the ASS and handpumps were much more spread out. This naturally lead to higher operating costs for personnel, fuel, per diems, etc.

5. **CapEx**: IPS sites have a lower CapEx than ASS sites. However, the differences in design between the two systems is the main factor explaining this difference, which is relatively minor.

   The table below summarizes the CapEx and OpEx, with the latter extrapolated on an annual basis. The potential impact of Inflation, interest, capital charges, and foreign exchange are not considered.

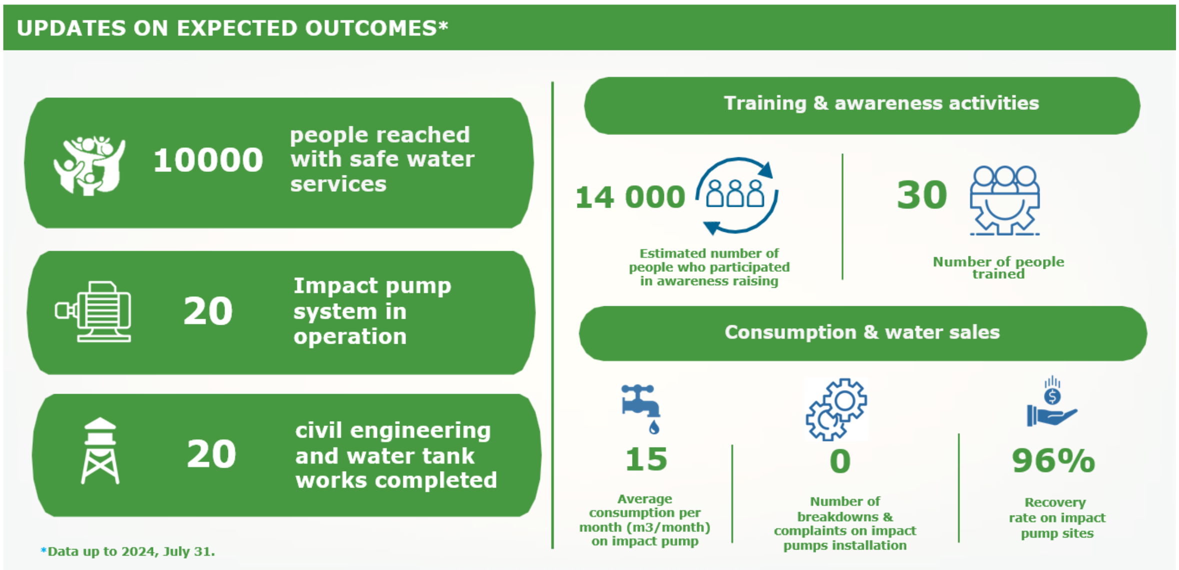
Site Type	CapEx	Annual OpEx
Impact Pumps Solution	$12,700	$108
Alternate Solar Solution	$17,700	$250
Handpump	$3,900	$111
IPS Wholesale Tariffs Only	$12,700	$84

6. **Technical Monitoring:** The introduction of IPS technology posed significant challenges for local technicians as they were unfamiliar with it. Reliance on local resources alone proved insufficient, requiring extensive support from both Thermofluidics and Uduma teams to ensure successful implementation. On-the-ground support with IPS technical experts would have added value, but this was not feasible given the security situation in Mali. Additionally, the experience at the Woroda site highlighted further difficulties with very low consumption levels hindering the assessment of the technology's performance and its full capacity under 'normal conditions'. However, thanks to its large pumping capacity, the IPS was able to deliver peak consumption of up to 18,000 litres per day, while the initial design requirement was only 5,000 litres per day.

Overall Conclusion

The overall conclusion from the assessment is that the IPS demonstrates significant potential as a reliable (zero events) and adaptable solution for rural areas (effectively accommodating seasonal consumption variations). While CapEx analysis remains complex due to design and component differences, OpEx results promise substantial long-term benefits for operators. However, the limited project duration restricted the ability to conduct a comprehensive and reliable assessment of these figures over time, underscoring the need for an extended evaluation.

Both Uduma and Thermofluidics are very appreciative of the funding provided by the Vitol Foundation to undertake this project. Furthermore, Thermofluidics would like to take this opportunity to record its appreciation to Uduma for their significant, positive and resilient contribution to partnering to make this project a success under challenging local circumstances in Mali, which has enabled 10,000 more people to have access to reliable water.



3 Financial reporting

Please find attached to the financial reporting of the project.
All budget lines and categories were spent.

SIGNATURE

Date: 09/04/2025
Name: DUPUIS Mikael
Position: Deputy Director UDUMA

Appendix 1 – Summary of Additional Activities Undertaken

This appendix provides further information on some of the detailed activities undertaken since our last written report that have not already been covered in the main body of the report.

A1.1 Completion of works, installation, and technical monitoring

a) Installation update

In our last written report, one site had been installed and work to set up the remaining 19 sites was underway. The work proceeded smoothly, and all sites were launched between August 16 and September 8, 2023. Uduma's local team was able to complete the local installation activities successfully.

Please find below some pictures of installation sites and from the launching ceremonies with the local population:

For each installation, commissioning, maintenance, or other activity, UDUMA collected data with a dedicated application (Kizeo Form) and stored it centrally in the Kizeo database. This helped ensure that all the data relating to service, service events and related operating costs were available to underpin comparative economic analysis.

b) Technical monitoring at project sites:

Following the installations, Uduma assigned two agents to conduct monthly data collection at the Impact Pumps Solution sites, as planned. Their tasks included:

- Performing basic maintenance and upkeep (such as cleaning the screens, etc.).

- Retrieving data from the SIM card in the datalogger and sending it to the Thermofluidics team to verify the proper functioning of the different components of the Impact Pump Solution.
- Adjusting the pumps if necessary, and
- Recording consumption data (meter readings).

No major technical issues were encountered at the Impact Pumps Solution (IPS) sites.

A1.2 Training and awareness activities

UDUMA continued to perform awareness-building activities with the communities at each site. Activities included discussion and information sharing events with local authorities, local leaders, youth and women's associations, and any other key stakeholders. The purpose was to explain the service provided by UDUMA, inform people about the applicable tariffs, regular maintenance, etc. This approach enabled UDUMA to make each water point operational as quickly as possible and helped ensure acceptance by the beneficiary population. These activities took place in three stages: 1) before installation, 2) when the water point was "launched" and at its commissioning, and 3) afterwards, if necessary and depending on the needs.

As at the end of the project, awareness-building activities had been provided to over 14,000 people.

Appendix 2 – Financial and Service Event Detail

To enable a comparative economic analysis and a related service event analysis to be done on the project, Thermofluidics and Uduma agreed to track the following indicators. The table below provides information on key indicators, how they would be tracked, measured or estimated as well as the collection frequency. The approach benefited from being able to leverage Uduma's existing operational and financial systems.

Indicator	High-level Description	Proposed approach	Measurable indicator	Data Collection Frequency
Service levels	Information on the opening and closing of sites	UDUMA collects data on when users cannot access water at a site i.e., site downtime. This reflects site-specific trouble ticket information (start and end date/times). UDUMA's systems and operations vary depending on the type of service provided. To convert therefore downtime into a service level is challenging.	Service Continuity: Number of days the site is closed/month	Monthly data collection and reporting
Faults/Trouble tickets	Number of faults/trouble tickets and nature of the issue	If a technical problem occurs on a site, a trouble ticket is raised. When the fault is fixed, the trouble ticket is closed. A trouble ticket is site-specific and also records whether water was accessible by end users or not, as described above, along with date and time information. The trouble ticked is recorded by the area manager and put on UDUMA's Access database.	#Trouble tickets and associated information recorded when issues are reported	Monthly data collection and reporting
Operating Costs	The costs and related activities involved in fixing a fault would be captured and relate to a specific fault on a specific site. This would include time (cost), materials, transport/fuel.	It is proposed that UDUMA analyse the periodic costs recorded by commune alongside the related trouble tickets in that commune to estimate the repair-related costs for handpumps, solar solutions and Impact Pumps Solutions.	#breakdowns (by type) estimated average cost of the repair	Monthly data collection and reporting
Revenues	Revenues generated by site, volumes purchased and collection recovery levels	UDUMA plan to gather and analyse revenues by site, Jerry Can volumes purchase and collection recovery levels, by 2 weekly period for the project.	Revenues generated/month/site Volumes or flat-fee purchase/month. Collection recovery levels/month	Monthly data collection and reporting

Furthermore, the detailed basis for charges applied to the project were consistent with the following methodology. This reflected Uduma's methodology for cost allocation feasible with its systems.

	ZONE HEAD (CZ)	FONTAINIERS	INCOME	OTHERS	TURNOVER
Basic file	Payment status of zone heads	Payment status of Fontainiers	Operating accounts	Field management and Thermofluidic report	Thermofluidic report (Revenue Template)
The charges	**Data collection:** the number of data taken for PEA is two (2) times per month and for PMH one (1) time per month. The unit price for taking data is 1,100 FCFA per take.**The cout data collection by water point**is calculated on the basis of the number of data taken multiple by 1,100 FCFA and divided by the number of water points in the municipality.	**Fountain workers remuneration:** Amount of remuneration is 15% of sales (CA). Rate applied to collections	X	**OM fees on recipe:** The OM fee is equal to 1% of the sale (CA)	X
	Repair : The amount of repair is 3,000 FCFA per Intervention	**OM fees:**the OM fee is equal to 2% of the amount of remuneration	X	**Royalty:** the amount of the Royalty is 3% of sales	X
	Communication (Credit): The credit amount is 3,500 FCFA per month. For the amount of credit per water point the calculation is made on the basis of 3,500 FCFA divided by the number of water points per municipality.	X	X	**Kizeo License:**The cout of kizeo is 10 euros per CZ or 6570F, to get the cost of kizeo per water point you must divide the kizeo license cost (6570) by the number of water points managed by the CZ	X
	OM fees: The OM fee is 2% of the total remuneration (Communication + Repair + Data collection + Fuel)	X	X	**Spare part** :actual cost of parts	X
	Fuel : the amount of fuel is calculated based on the distances traveled (per km). To calculate the amount for a single water point, the fuel allocation divides by the number of water points	X	X	X	X
Products	X	X	**Sale of water/PEA** : The sale of water on PEA is based on the volume consumed. One (1)m3 is equal to 500 FCFA	X	**CA/PEA:** The volume consumed Multiple by 500 FCFA
	X	X	**Water sale/PMH:**Water consumption on PMH does not depend on volume but on the payment of a lump sum of 15,000 FCFA per month. UDUMA grants a discount of 2,500 FCFA when municipalities pay for 6 months or 1 year of consumption, or 12,500 FCFA in this case	X	**AC/TDC:**Payment of a lump sum of 15,000 FCFA per month, a reduction of 2,500 FCFA/month when municipalities pay for 6 months or 1 year of consumption, i.e. 12,500 FCFA per month in this case

Appendix 3 – Uduma Site Selection

To carry out a comparative study with the 20 Impact Pumps Solution sites, Uduma selected 20 Alternate Solar Solution sites (ASS) and 20 Handpump sites.

In the map below, the location of these 60 sites is shown where:
- the sites where Impact Pumps were installed.
- the sites Uduma chose to carry out the comparative analysis with the Impact Pumps Solution are shown by type (Handpumps (Manual pumps) or Solar-powered systems (ASS)).

The round-trip distances for all 20 sites across each of the three site types are considered comparable.