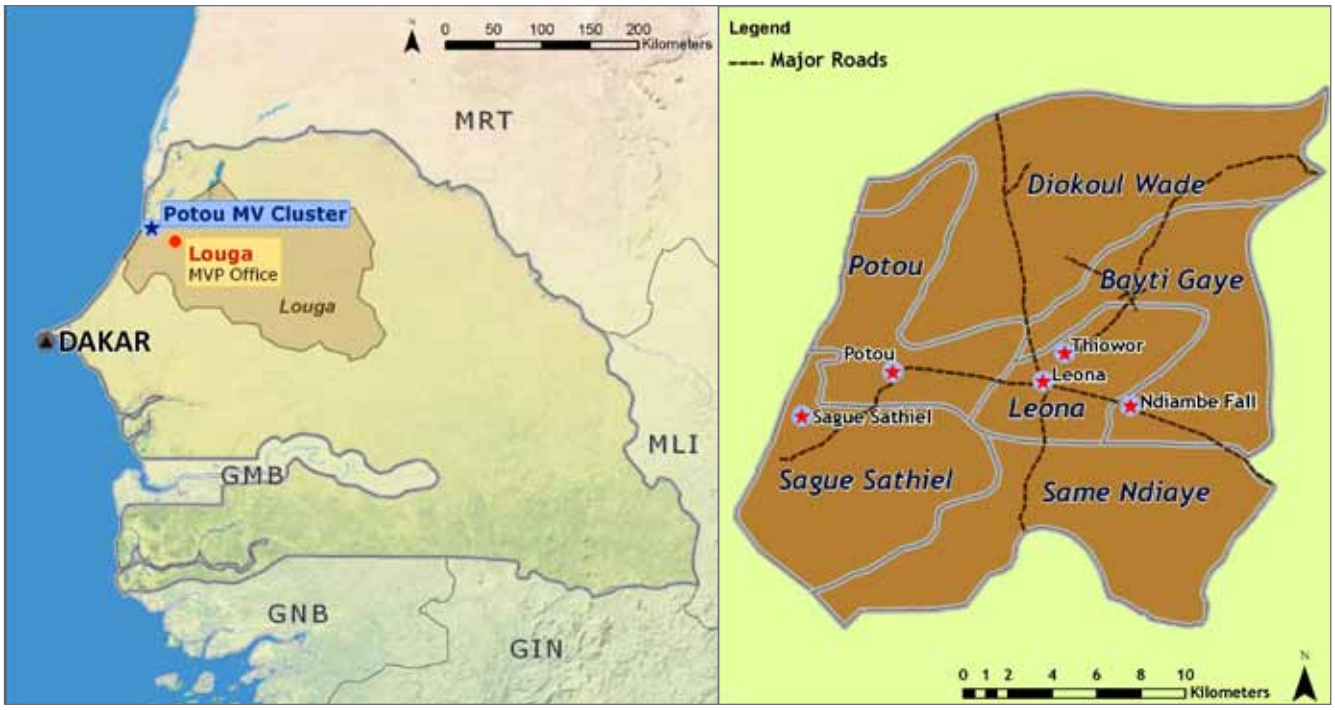
CHAPTER 7

Site Profile: Potou, Senegal



The Potou Millennium Village cluster is 415 square kilometers in size, with an estimated population of over 31,000 living in 106 mostly small and dispersed villages, many with fewer than 10 households. Prior to the MVP, modern energy was virtually nonexistent in the cluster Many villages also lacked access to transportation and water infrastructure.

Summary of Infrastructure Outcomes and Lessons Learned

1. Plans for comprehensive grid extension based on cost-sharing agreements between the MVP and the Senegalese government experienced major delays. Projects moved forward when funded separately, first by the government (three central villages) and later by MVP (six outlying villages).

2. In the short term, solar systems met the energy demands of off-grid institutions as clinics, health posts, schools and a fisheries post.

3. A solar lantern program provided basic electricity services to around five percent of off-grid households; supply chains must be strengthened for scalability.

4. Eighteen kilometers of all-weather roads were constructed to link the cluster to the region of Saint Louis, and connect Leona, headquarters of the rural community, with new local clinics.

5. The MVP provided five community vehicles to the rural council for public transport.

6. MVP collaborated with the government and private sector donors to create piped water systems with public taps that brought improved water sources closer to households than previous systems and open wells.

7. Two MVP-supported irrigation programs have helped to reduce farmers' labor costs, eliminate dependence on rainfall and boost agricultural production: a program of motor pumps sold in installments, and community gardens with irrigation.

Energy in the Potou Cluster

GRID EXTENSION

In 2006, no households in Potou were connected to the national grid. Instead, the population relied on dry cell batteries, kerosene and candles for lighting, and lead acid vehicle batteries for higher electric loads, such as television. Occasionally, residents had solar systems at home, though these were often ineffective due to low quality equipment and installation. Mobile phone recharging was provided via pay-per-charge services in towns, powered by diesel generators.

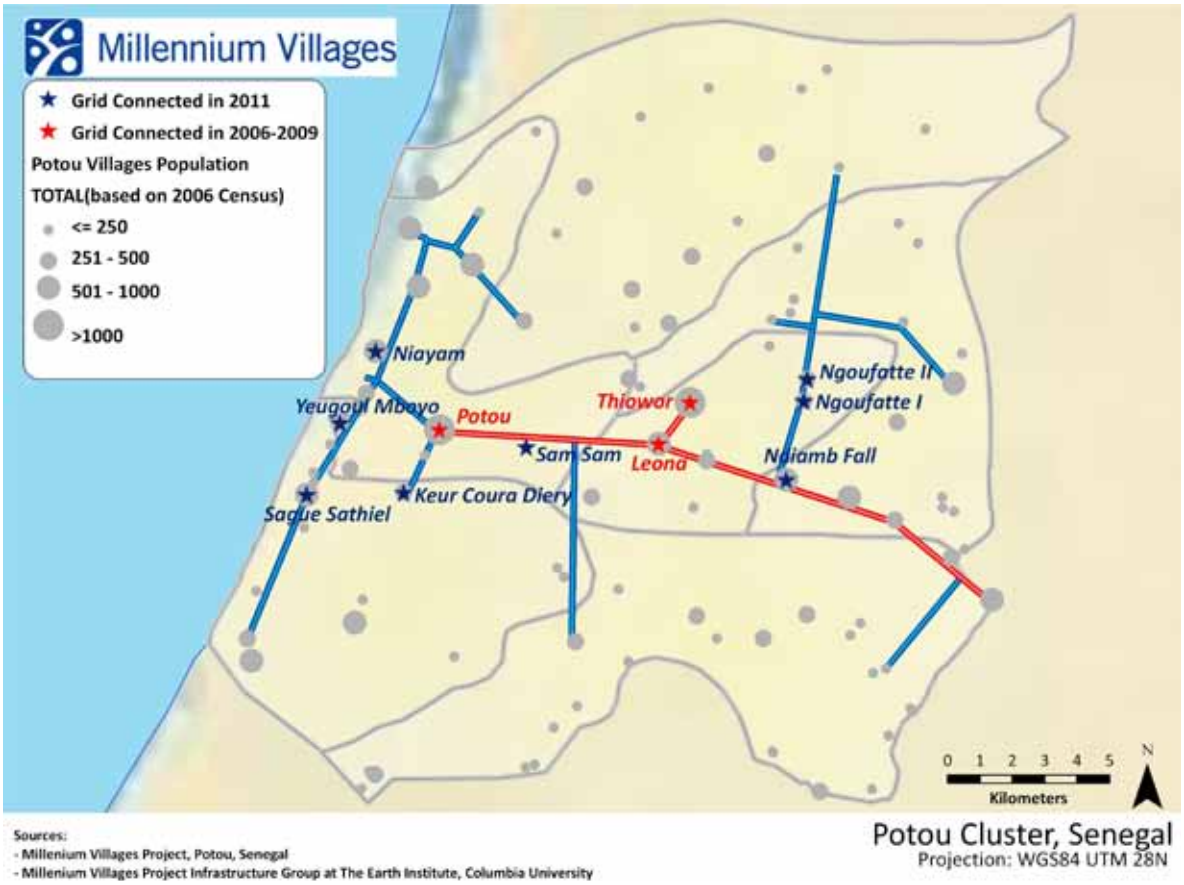
MVP Target:	Community-level electricity service to all markets and 50% of cluster population
Status at Project Launch: 0%	Grid had been extended to Potou and Leona, were not yet providing electricity
Outcome at 5th Year: 15% Grid Electrification	9 villages connected (3 by ASER; 6 by MVP) To date 475 household connections (15%)
MVP expenditures $334,000	75% of $445,143 allocated for connection of 7 villages
Partner / Government contribution: Information not available	The government contribution for initial electrification. The contribution for outlying villages is $1,030,000 (pending)

Early in the project's timeline (2006-09), three large and central villages—Potou, Leona, and Thiowor (map lines in red)—were connected with funding from the Senegalese Agency for Rural Electrification (ASER). This provided access for 30-40 percent of the cluster population and allowed for the electrification of institutions including health facilities, schools, and other government and community buildings in these towns. Rates of connection for households and businesses reached over 80 percent within two years. Alongside this electrification work, a comprehensive plan with cost-sharing provisions for 70 percent contribution by ASER and 30 percent by MVP to electrify around 20 additional villages was agreed upon with the government (map lines in blue). However, government funding for these outlying villages was substantially delayed, and in 2010, MVP agreed to independently fund the electrification of six of the original 20 outlying villages—Sague Sathiel, Ngoufatt 1&2, Keur Koura Diéri, Ndieumb Fall, Niayam and Yeuggoul Mboyo (map points in blue)—that were connected in 2011. ASER plans to connect the remaining villages in the future.

The approach to grid electrification in Senegal is generally as follows. The Senegalese Agency for Rural Electrification (ASER) was created to achieve a rural electrification rate of 60 percent by 2022. To this end, villages near medium of low voltage grid networks are entitled to extensions, which are requested from the Director General of ASER. In response to a request, the agency does the following.

1. **Identification of potential beneficiary communities:** ASER locates the village and conducts a feasibility study, including all demands (residential, business, schools, clinics, etc.)

Figure 7.1: Potou Cluster Grid Extension (Grid lines in blue are estimated)



2. **Mobilization of funds:** Funds are mobilized through international partners (such as the World Bank, Millennium Promise, etc.), and the national government.

3. **Validation and call for tenders:** ASER calls for tenders, examines bids and makes its selection, which must be validated by the Directorate of Monitoring (DCM).

4. **Contracting:** ASER identifies potential electricity subscribers in the village (homes, businesses and public structures) and employs a contractor to make the connections.

5. **Operation of New Power line:** ASER instructs the local electricity provider to operate the new line. If the dealer does not exist, ASER convenes a Transient Delegate Manager (GTD) for this work. The operator applies a four-tiered ASER tariff structure—which includes three tiers of monthly flat-rate pricing, plus an additional fourth option for per kilowatt-hour pricing.

As of December 2010, more than 80 percent of households and businesses were connected in the first three villages to see grid extension (Potou, Leona, and Thiowor).

Interviews conducted in 2009 provide details on electricity use. Household demand varies by size, but the primary uses are typically evening lighting, cell phone charging, radio and television. Businesses report purchasing new appliances, expanding hours and services to customers and increased customer traffic leading to increased revenue following grid connection. Businesses previously relied on fuel-based energy, such as kerosene for lighting and LPG refrigerators for cold drinks. Following connection to the grid, the main

Table 7.1: Costs for grid power of monthly pricing structure (SENELEC, 2010)

Cost category	Businesses	Households
Connection Fee	22544 F CFA / $51.94	18320 F CFA / $42.21
Tier 1 (up to 50kWh)	1512 F CFA / $3.48	1512 F CFA / $3.48
Tier 2 (up to 500kWh)	1524 F CFA / $3.51	1524 F CFA / $3.51
Tier 3 (above 500kwh)	1534 F CFA / $3.53	1534 F CFA / $3.53

Table 7.2: Number of households and businesses connected by year 5 (2010 data)

	Households	Businesses	Total
Potou	196	123	319
Leona	76	30	106
Thiowor	172	13	185
Total	**444**	**166**	**610**

business use of electricity was nighttime lighting, which business owners say helps boost revenues. One sewing business reported staying open all night around major holidays thanks to increased demand.

Many shop owners in these grid-connected villages have purchased electric refrigerators and now sell cold yoghurt, soda and other local beverages, such as the popular hibiscus juice, in part to increase customer traffic. While some cell phone charging businesses existed before grid extension, competition has since increased, with businesses with new grid connections offering free phone charging in an effort to keep and attract customers. Some businesses offer charging of car batteries, which are carried home and used for electricity in off-grid households. A welding business may heavily rely on grid energy throughout the day. Seasonally, the demand for energy tends to rise during the hottest season of the year (May to September) and around major holidays. Prolonged power failure is rare in the cluster, but villagers report that short blackouts (10 minutes) are becoming increasingly frequent. The greater a business's reliance on grid energy, the greater the negative impact of electricity failures. For example, prolonged blackouts severely affect welding businesses.

At baseline, there were no public facilities with grid access. Today, five public buildings are electrified. Four are grid connected: the new Rural Council building in

Figure 7.2: Grid in Leona Market (left); Energy in use by a community tailor (right)

Figure 7.3: The grid electrified Rural Council Building (left); solar installation at Fishery Post (right)

Leona (completed in 2010), two community media centers and the Maison Familiale (community support center) in Potou. One office, the fisheries post in Niayam, had a 150 Wp system installed in 2008, which is used for lighting and one computer. Apart from the efforts of MVP and ASER, the international company Infraco is undertaking a study in the cluster for construction of a 50MW wind power generation project which will supply power to the national grid system under the auspices of the national power utility, Société Nationale d'Electricité du Sénégal (SENELEC).

Energy and Construction for Health

The Potou health facilities offer a variety of services requiring power, including refrigeration for vaccines, a laboratory for conducting diagnostic tests for TB and malaria and lighting and fans for primary care and infant deliveries. At baseline, there were 19 health structures (one post and 18 dispensaries) in the cluster. Four of them received power via solar PV systems prior to MVP by Agence Française de Développement du Sénégal (AFDS).

Today, there are five health posts. Two of these (Léona and Potou) are connected to the grid. Three other health posts have solar installations provided by MVP, and each solar system includes three independent systems (with separate inverters and charge controllers) at a per system cost of F CFA 8,053,015 ($16,632). The three isolated systems prevent disruptions of basic clinic needs (lighting, computers, etc.), vaccine refrigeration and power to the staff quarters for lighting, charging cell phones as well basic entertainment options like television. These grid connections and solar systems provide 100 percent coverage of the infrastructure deemed necessary by the MVP health sector. In addition, seven out of 18 dispensaries have PV solar systems. The average cost of these systems, nearly $18 per peak watt, is higher than typical international market prices, and possibly slightly higher than prices in other countries in SSA.

MVP Target:	Electrify health facilities (selected by MVP health sector)
Status at Project Launch: 21%	Some health facilities by an outside organization (AFDS)
Outcome at 5th Year: 67%	12 facilities had power: 5 health posts (2 grid; 3 solar) & 7 dispensaries (3 solar by MVP; 4 solar by AFDS)
MVP expenditures: $58,000	Solar systems at 3 clinics and 3 dispensaries
Government contribution: $ 0	To date no funds have been provided by the government

Table 7.3: Health centers, electricity types and system capacity (figures in kW are for grid; figures in Wp are for solar)

Location	Health Facility Type	Energy Type (provider)	Maximum Power subscribed (Watts or peak Watts)	Cost per system	Unit Cost (US$/Wp)
Leona	Post	Grid	5.742kW	N/A	N/A
Potou	Post	Grid	5.742kW + 0.957kW	N/A	N/A
Sague Sathiel & Syer Peulh (2)	Post	solar (MVP)	225Wp + 300Wp + 300Wp	$16,632 each	$20.16
Samb	Post	Solar (MVP)	225Wp + 375Wp + 300Wp	$16,632	$20.16
Batlamine & Ndemba (2)	Case	solar (MVP)	225Wp	$3,000 each	$13.33
Wassoum Massal	Case	solar (MVP)	150Wp	$3,000	$20.00
Gabar, Keur Koura Dieri, Maka Tare, Santhiou Djadji (4)	Case	AFDS solar system	50Wp	Unknown, outside organization	Unknown
			Total:	**$58,896**	
			Average:	**$9,806**	**$17.85/Wp**

Figure 7.4: Construction and electrification for Potou cluster health facilities.

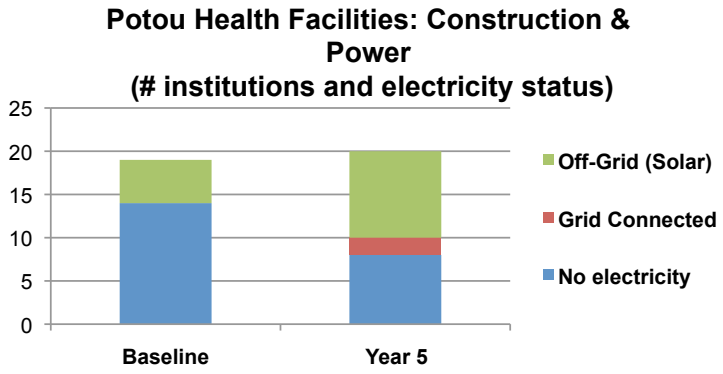


Figure 7.5: Solar Panels at a community clinic

In the long term, the site team is concerned that the bills for grid electricity at health posts in Potou and Leona may be too high and therefore unsustainable. For example, the health post in Leona reported having spent FCFA 362,760 ($725.52) for the two month period from February to March 2010. A more general estimate of yearly grid power costs for health posts is provided below.

Table 7.4: Estimated recurring costs for grid electricity at Potou cluster health facilities.

Average Price per KWh ($ includes taxes and service fees)	Average monthly energy use (kWh/month)	Projected Cost per Year ($)
$0.365	**626.215**	**$2,738**

Energy and Construction for Education

MVP Target:	Electricity service to education facilities as required by education sector.
Status at Project Launch: 0%	42 schools total, none with electricity
Outcome at 5th Year: 12%	50 schools total, 6 electrified: (2 grid; 3 solar PV; 1 both grid and solar)
MVP expenditures: $ 6,400	A small percentage of the overall grid extension costs, plus $6,400 for four solar systems
Government contribution: $0	No contribution

Schools in the Potou cluster are comprised of one or more brick structures with concrete floors and aluminum roofs, one or multiple classrooms and an office for staff and the headmaster. It is not uncommon for educational staff to use a classroom as living quarters after school hours. At baseline, there were 42 primary schools in the cluster, none of which had electricity. At year five, there are 50 in the cluster, six of which have been electrified: two are grid-connected, three have solar PV systems only, and one has both a grid and solar power. MVP installed 75 watt peak solar photovoltaic systems in four schools, at a cost of $1,600 per system, where they are used for classroom lighting and phone charging.

Since grid electricity has been recently extended to five other villages—Keur Koura Diery, Sague Sathiel, Niayam, Ngoufatt 1 & 2 and Ndieumb Fall—the opportunity exists to connect schools in these villages in the near future. Furthermore, if the Senegalese government's plans to electrify a further 14 villages is realized, grid electrification of the vast majority of schools will be possible. The MVP has also organized and trained a team of solar technicians affiliated with an energy cooperative (La Luminere Solaire) that can be called upon by the local rural council to perform maintenance, without the need for a contract with an external organization or MVP's technical expertise, as the current warrantees expire. Initially twelve, and later six more, volunteers received tools and training from MVP, as well as in Dakar and Louga, in matters including basic maintenance and trouble shooting.

Figure 7.6: Construction and electrification of Potou cluster schools

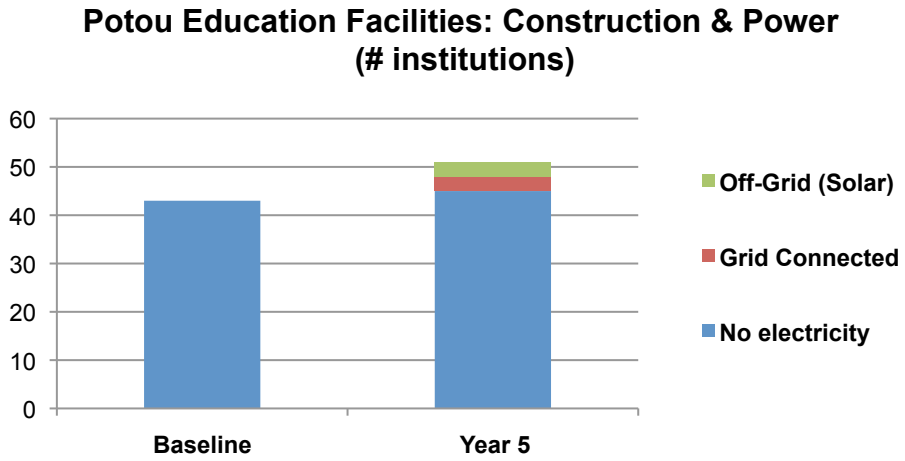


Table 7.5: Technical and cost details for electrification of Potou cluster schools

Location	Energy system Type	Electrified Classrooms (# of total or %)	Maximum Power subscribed (peak Watts)	Cost ($)	Unit Cost ($/Wp)
Leona	Grid	1 of 8	0.957	N/A	N/A
Potou	Grid	1 of 7	Unknown*	N/A	N/A
Batlamine, Gabar, Sague Sathiel	PV solar system	varies (50-100%)	75 Wp each	$ 1600 each	$ 21.33
Thiowor	Grid / PV	4 of 6	0.957/75Wp	$ 1600	$ 21.33
		Average	**75 Wp**	**$ 1600**	**$ 21.33**

Household Energy: Portable, Rechargeable, Solar-powered LED lanterns

MVP Target:	Initiate private-sector led sales of solar-powered LED lanterns within the cluster providing access to 50% of the cluster's off-grid population.
Status at Project Launch: 0% availability	No improved solar LED lanterns available in the cluster
Outcome at 5th Year: 5% coverage	168 lanterns sold since fall 2010, covering 5% of off-grid population
Cost summary: $ 56,500	$56,500 covered procurement of lanterns and a technical consultant to launch program

In late 2010, MVP initiated a program, assisted by solar lantern technical consultants, to sell improved LED solar lanterns in off-grid communities. This program follows a market-based model that relies on a local energy cooperative, La Lumière Solaire, for promotion and sales. To date, there have been 168 lanterns sold in the Potou cluster, covering five percent of the total off-grid households. However, the supply-chain for lantern products must be strengthened before the Potou lantern program will be sustainable or scalable. The team endeavored to simulate a full price build-up, though some important stages in the supply chain, such as the costs of overland transport and warehousing, are still unknown and will likely be important factors in affordability of lanterns sold in the villages. Similarly, preserving tax-free import into Senegal and sale at the local level will be important in keeping lanterns affordable to villagers. Supply chains must also flow in the other direction: Replacement parts and warranties have been an ongoing issue. Since warranties offered by lantern manufacturers cannot easily be fulfilled by distant suppliers, the site teams have been responsible for replacements of broken or faulty lantern products.

Figure 7.7: solar lanterns for sale in Potou Market

Table 7.6: Potou lantern price build-up (in US$), with percentage of retail price added at each stage in the supply chain

	Nova S-201		Kiran		Notes
	Cost added	% of retail price	Cost added	% of retail price	
1. Price From Distributor	$34	87%	10.5	70%	
2. International Shipping	$1.58	4%	1.58	10.5%	Air shipping was relatively inexpensive due to the short distance (Gambia-Dakar).
3. Import Duties	$0	0%	$0	0%	Initial shipments were tax free; this will continue once the solar association is registered.
4. Warehousing / Distribution	$0	0%	$0	0%	Association members take this responsibility including financial obligation for any losses.
5. Overland Transport	$0	0%	$0	0%	Initially provided by MVP; needs to be determined for future shipments.
6. Retailer Margin	$3.42	9%	2.92	19.5%	$3: includes ~$1 for association fund & ~$2 for vendor (rounded to match local denominations)
7. Sales Tax	$0	0%	$0	0%	Sales will be tax free once association is registered with the local authorities.
Total	**$39**	**100%**	**$15**	**100%**	

Roads and Transport

MVP Target:	Fifty percent coverage of population with 2km of an all-weather road
Baseline Coverage: 30%	30% of the cluster population living within 2km of an all-weather road
Coverage After five Years 50%	MVP's construction of 18.4 km in targeted areas means that 49% of the population now live within 2km of an all-weather road
Cost summary: Total: $323,663	Total includes all three sections of roads at a unit cost of $17,590/km

Working with the Potou Cluster's governing body, the Rural Council, the MVP identified the need for improved transport routes to increase the mobility of people, facilitate timely access to rural health clinics and enable transport of agricultural products and finished goods to and from the community hub of Leona to markets throughout the greater St. Louis region. Using a community participatory approach, 18.4 kilometer of track was identified for construction. STTP (Societé de Transport et de Travaux Publics) was

Table 7.7: Cost and length of Potou cluster road projects

Road	Length (km)
Leona—Syer Fulani	8.6
Diokoul—Wade Ndialakhar	2.1
Mboltim—Diokoul Wade	7.7
Total Length	**18.4 km**
Total cost	**$323,663**
Cost per km	**$17,590**

Figure 7.8: Road construction in the Potou cluster

awarded $299,619 for road construction, and engineers with the Cabinet Polyconsult were awarded $24,045 to oversee the construction. The work commenced in October of 2009 and completed in March of 2011.

Field staff members report numerous beneficial impacts of the new transport routes. The roads allow for expedited travel via ambulance to all cluster health facilities and reduce the travel distance to the larger medical facilities of St. Louis by 70 kilometers. Businesses and producers may benefit from decreased time and costs of shipping to and from markets, reducing ice purchases by the fishing community and increasing prices received for fresher fish. In order to ensure that the transport routes remain passable, the Autonome des Travaux Routiers (AATR, or Autonomous Agency for Road Works) was approached and agreed to maintain the roads in the future. The government agency's mandate will ensure periodic reshaping, pothole elimination and the clearing of ditches and trenches. The Rural Council in the region has taken over the responsibility of applying for the maintenance to AATR on an annual basis.

Water and Sanitation

PIPED WATER

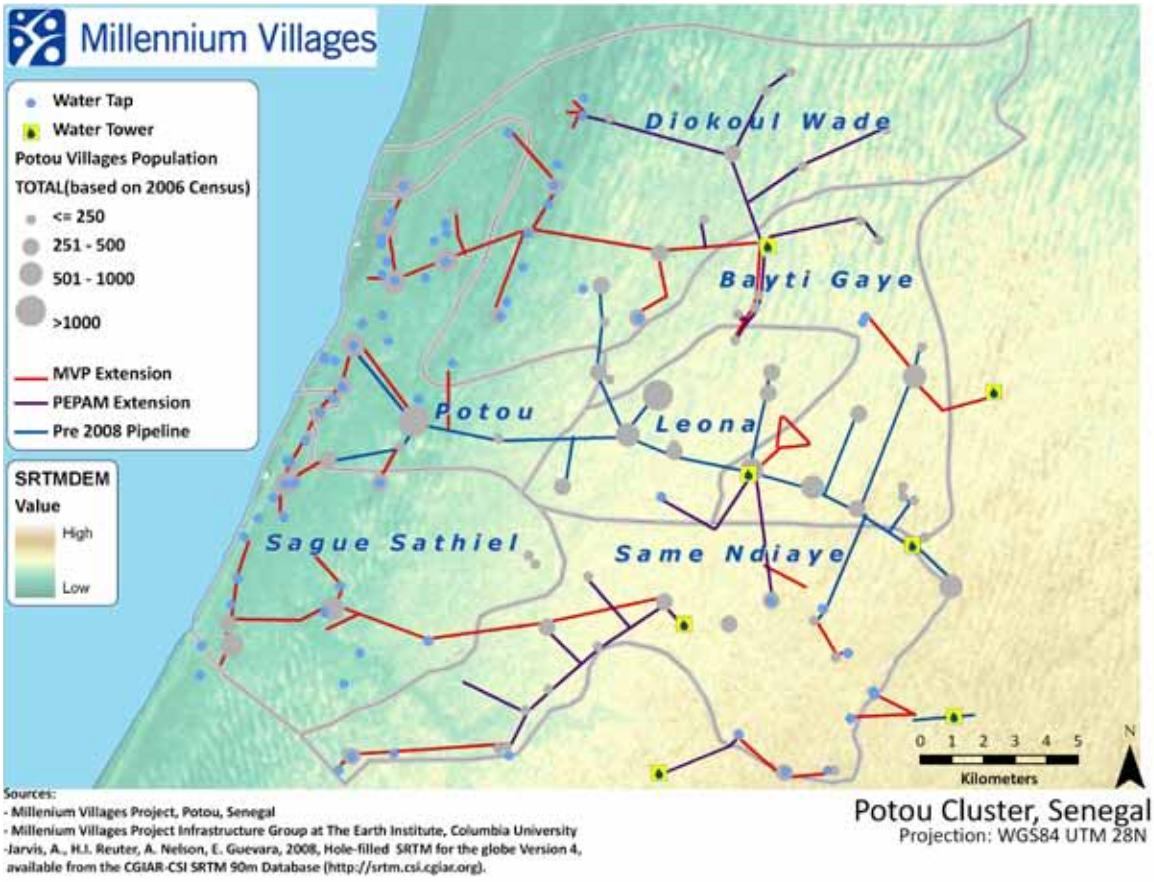
MVP Target:	100% population using an improved drinking water source, year-round: during both wet and dry seasons
Status at Project Launch: 20% coverage	20% of population had access to improved drinking water source at baseline
Outcome at 5th Year: 78% coverage	70km piped water extensions (MVP) and 30km (government) provided an additional 58% with access to improved drinking water
Cost summary: Total: $ 340,000	Total represents MVP costs for installation only of 70 km pipe ($4857/km); this excludes value of pipe donated by JM Eagle ($498,780)

At baseline, only 20 percent of the population of Potou was using improved drinking water sources year-round. However, the Senegal site is unique among MVP sites in that much of the required water supply infrastructure and management capacity needed for comprehensive coverage was already in place before the MVP. At baseline, Senegalese government agencies such as Direction de l'Hydraulique Rurale (DHR), and programs such as PEPAM, (Programme Eau Potable et Assainissement du Millénaire / Water and Sanitation Program for the Millennium) had already installed an extensive piped water distribution system (>70 kilometers, with more than 40 public taps), six mechanized boreholes equipped with diesel generators and submersible electric pumps (>40 cubic meters / hour) and seven elevated reinforced concrete water towers (100-200 cubic meters). Notably, one of the previously equipped boreholes in the project zone had never been put to use because the previous World Bank project had run out of funds before installing the complementary distribution network. Borehole users associations (ASUFORs) were already formed, trained and functioning for the six boreholes in the project zone, and the DHR was actively engaged in the oversight of these committees.

Building upon these resources, MVP undertook improved piping interventions to bring cleaner drinking water to 100 percent of the Potou cluster population by establishing public taps closer to households than previous systems and existing open wells. A collaborative approach between MVP, government (PEPAM) and outside donors (JM Eagle) ensured cost-effectiveness by building upon unfinished projects in the cluster and utilizing established capacities at the community and government levels to reduce the costs of technical design and implementation and ensure sustained local management.

To date, MVP has installed 70 kilometers of pipeline and PEPAM has installed approximately 30 kilometers. The pipeline provides 13,500 people with improved water sources with 85 public taps in 63 villages at an average of 220 meters from the household, increasing improved drinking water coverage from 56 percent to 99.5 percent in those villages, and to 78 percent for the cluster overall. When broken down by cost component, unit costs for water delivery are overwhelmingly spent on diesel fuel for pumps.

Figure 7.9: Map of Potou cluster piped water projects



Installation proceeded under the supervision of PEPAM, the MVP and The Earth Institute, in close collaboration with the village chiefs and councils. Efforts were made to minimize the travel distance for water users and the average distance from household to public taps. For 997 households, this was found to be a significantly shorter distance than that to previous piped installations and existing open wells. Along the new network, 80 percent of the households were within 400 meters of a public tap.

In addition to the public taps, 11 communal animal troughs, each designed to serve several villages, were also constructed. Site selection was coordinated with the Livestock Association of the CR-Léona and a contractor who chose sites that were within 100 meters of the main pipeline and near access corridors to minimize costs and allow animals without negatively impacting adjacent fields.

Table 7.8: Unit cost breakdown for piped water in two Potou cluster projects

Cost Component	Cost per Unit of Water Delivered (Average, $/m3)	Percent of Total Costs (%)
Diesel Fuel	0.28	71
Management	0.06	15
Maintenance	0.03	7
Other	0.16	6
TOTAL	**$ 0.54**	**100%**

Irrigation

Agriculture is the most important economic sector in the Potou cluster, and farmers are highly dependent on inconsistent rainfall during a three-month season, allowing only one crop per year. Farmers typically hired a seasonal manual laborer who drew water from a well and carried it in buckets, in exchange for food and lodging for the season. After harvest, the farmer sold his proceeds, subtracted costs (such as fertilizer) and split the income evenly with his seasonal worker. Two irrigation projects were undertaken in the cluster with the broad objectives of increasing farmers' incomes by reducing seasonal labor costs, eliminating dependence on rainfall and boosting agricultural production and diversifying crops.

MVP Target:	Support irrigation and water pumping for agriculture according to site-specific needs and opportunities
Status at Project Launch: N/A	Unknown, no survey data compiled concerning pumps at baseline
Potou MVP objective:	Provide 500 individual farmers with pumps
Outcome at 5th Year:	45 farmers in 16 villages have received pumps.
Cost summary:	$21,222

One MVP irrigation intervention is to provide motor-pumps on credit in Niayes, the traditional horticultural zone of the Potou cluster. To date, 45 farmers in 16 villages have received motor pumps courtesy of a revolving fund, originally with 35 pumps, established with an initial investment from MVP and now managed by a local financial institution (FI). The farmers, organized in a cooperative, obtain the motor pumps from the local FI; they are to be repaid in three years with a seven percent annual interest rate. The interest earned is split evenly between the lender and the cooperative. This repayment schedule was designed with the seasonal nature of farmers' revenue in mind, and to ensure that they are not financially burdened. Payment is made directly to the FI, which returns the money to the revolving fund, which is then used to purchase additional motor-pumps, which will be loaned to other farmers in the cluster.

Figure 7.10: Irrigation pump, provided through revolving fund initiated by MVP

The motor-pumps (Yamaha YP20 or YP10) are diesel-powered and both cost approximately 268,000 CFA ($617). These models were chosen by the MVP site team because of their performance and fuel consumption. A single pump can irrigate an average rate of 0.22 ha/hr while consuming 11.47 mm/day of water and consuming fuel at a rate of 1.69 l/h. For manual labor, the average rate of irrigation is only five percent of this (0.011 ha/hr), while it consumes a comparable amount of water (11.72 mm/day). Also as part of the motor pump program, a farmer can buy an irrigation kit.

The pumps have had an immediate impact on the agricultural practice, making it faster, cheaper and less risky. Farmers no longer depend on rain or the availability of seasonal workers and can have four farming campaigns per year, doubling farmers' incomes. Many farmers reported that they have increased their land plots because the motor-pumps allow them to irrigate more land with less effort and time. To date, the systems have low maintenance costs and the users are generally very satisfied.

In a second intervention, irrigation is being promoted in Dieri, the drier part of the Potou cluster and specialized in rain fed agriculture, to diversify crop production and reduce climate related risks. Six village or community gardens measuring between 0.5 ha and four ha are already functional, and there are plans to establish over a dozen more. Three of these gardens are connected to the piped water network and pay fees to the ASUFORs. The three others use water from a hand-dug well -- two with windmill pumps (repaired by MVP) and the third with a solar pump (installed by MVP). ■