Concept Note

Solar photovoltaic street lighting in iLembe District municipality, KwaZulu-Natal (South Africa)

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Introduction

The KwaDukuza Local Municipality (KDM, hereafter) is one of four local municipalities that comprise iLembe District Municipality, with a total surface area of 633 km^2. The population of KDM has grown by 37.8% from 167 805 in 2001 to 231 187 by the year 2011, according to the latest South African Census. During the peak holiday seasons the population in KDM may be as high as 320 000, as a result of incoming holiday makers. This highlights the need for safety, in order to contribute to the creation of conducive conditions for growing the tourism industry. Apart from this, street lightening also increases the possibility of socialization and enhances the potential of commercial activities. The project is envisaged to take a period of five years and will be divided into three broad outputs, namely:

1. The **scoping** in which, the areas for implementation and technical aspects will be identified
2. The **implementation** in which, actual implementation of the technology will take place.
3. The **communication and outreach**, in which entails documenting the process and the lessons learnt

Relationship to the country's sustainable development priorities

South Africa's Nationally Determined Contribution (NDC)[4] commits to making a contribution to substantial global emission reductions that are needed to keep the global temperature rise well below 2°C, and the peak, plateau and decline (PPD) trajectory range contributes at a national level to bending the curve of growing emissions – in the context of addressing poverty – and presents a trajectory that is consistent with a just transition to a low carbon future. This project relates closely with mitigation ambition of the country.

Whilst street lighting does not feature in the country's National Response policy[5], solar PV technology transfer features quite prominently in the context of the Renewable Energy Flagship Programme. The project will contribute to this programme. Also it is assumes that the actual

[4] https://www.environment.gov.za/sites/default/files/docs/sanational_determinedcontribution.pdf
[5] https://www.environment.gov.za/sites/default/files/legislations/national_climatechange_response_whitepaper.pdf

street lighting technology to be implemented is LED, thus the project will also contribute to the Energy Efficiency and Energy Demand Management Flagship Programme.

Barriers to dissemination and measures

A lot of solar PV technologies are consumer good technologies. For these technologies, the key barriers are around market awareness, financial resources, lack of credible companies, material costs, regulations that concern installation and thefts. The project concept note is focussed on solar street lighting, which does not have a market and it is a publically provided technology. The mantle of responsibility for this demonstration project of implementing solar PV street lighting is with the iLembe municipality. To develop fully viable business models for solar street lighting is difficult in the context of the district, which largely stems from the lack of direct revenues attributable to the technology for the intended beneficiaries.

Being non-market in nature and the municipality implementing the technology takes care of many barriers that individual users of consumer technologies in solar PVs face. Market awareness, for example, is no longer a key barrier when it comes to the implementation of solar street lighting. Dealing with lack of credible companies also becomes less risky considering the collective knowledge of municipal bodies is more than an individual consumers, they have standard tendering processes and they have greater negotiating power vis-à-vis an individual consumer. It is also important to note that although market awareness is not a key barrier in solar PV street lighting, the municipality may still want to use this demonstration project for outreach and communication to reach out to the intended beneficiaries. This will subsequently help in dealing with vandalism and theft of the public equipment and give a boost to consumer technologies in solar PVs. The financial barrier, however still exists for the municipal body. In the concept here, we present costs for the municipality if the project was to be completely financed by the municipality. This project concept note however can be further developed to explore external funding opportunities or to seek co-financing from the national government.

Preliminary Technology Targets and Ambition of Concept

According to South Africa's Greenhouse Gas (GHG) Mitigation Potential Analysis (2014), solar PVs is ranked number 14 among 172 technologies and its social and environmental benefits are widely acknowledged by the public bodies. According to the local mitigation potential analysis, 8,921; 20,977 and 54, 227 $ktCO_2e$ corresponding to the years 2020, 2030 and 2050, respectively can be achieved, if this technology is carefully included as a part of the municipality's integrated development plan (IDP). The technology is clearly lucrative for its mitigation potential.

As the national government has its focus on large-scale PV technology implementation, localized initiatives such as those of solar PV street lighting are helping balance the portfolio of activities. An assessment of social feasibility and demand shows that 62% of the KDM wards are in need for new street light installations, as identified in stakeholder consultations that were conducted to develop the municipality's IDP. In this demonstration project, the ambition is to work on a successful project implementation within the iLembe municipality and subsequently replication of this project throughout the province of KwaZulu-Natal with support from key stakeholders' i.e. the technical committee from the municipality, the energy agency, local bodies and private sector suppliers. The project's ambition is to install grid connected solar PV lighting for 5kms of street length in iLembe District with a key focus on KDM wards.

Project Concept

KDM comprises 27 wards, and 62% of which, according to the KDM IDP, are in need for new street light installation or maintenance of existing systems. This project will not address all these needs but will first prioritize areas in the municipality according to relevant stakeholder input and then address those areas that have been identified. The ambition of the project is to install grid connected solar PV street lighting for 5 kms of street length in iLembe district, specifically focussing on KDM local municipality. This implies installing 200 poles of solar PV lighting systems assuming a gap of 25m between each pair. The project is divided in three actions and several activities. The activities within the project are under three actions, namely scoping the project, implementation and communication.

Action 1: Scoping

The activities in this action focus on identifying the most suited technology for each section of the road length identified. The municipality will have to first identify members of the technical committee. The technical committee will have the primarily responsibility of overseeing the scoping and implementation project. The municipality will provide the committee with sufficient time to engage with technical experts if needed. Experts from technical institutes can be a part of the external steering committee group guiding the technical team. The technical team will identify and prioritize wards for implementation in consultation with local bodies. They will then identify location specific needs and consult the external steering committee to review the technical assessments. This will be used to prepare ToRs. The ToRs will invite bidders to come up with technology implementation plans with products that are suitable to meet the needs of the locations identified.

The output will include broad parameters for the installation of the technology. As a part of the scoping phase, technical terms of reference (ToRs) and procurement plan will be devised. A call for Expressions of Interests will be published; bidders shortlisted and proposal will be evaluated according to the ToRs. The ToRs will include a carefully considered and a structured approach to identify technology providers. Off-grid solutions are two to four times more expensive in comparison to grid-connected solutions. The technical team will also take into consideration the finer details of the technology in terms of future scope for upgradation and redesign, such as including battery backup capacity or add ons like dimming systems. The activities in this action include

- Constituting the technical committee
- Identification of sites
- Assessment of technology requirement for identified sites
- Development of terms of reference for external contractual parties in the project

In addition, it will be critical to understand areas where the intervention can be made, especially through the Housing project. There are other existing projects and it will be critical to understand Technologies used in these projects. There is an opportunity in Maphumulo, Ndwedwe (recently developing their towns) and Mandeni (as they are currently developing two housing projects)

Action 2: Implementation

The contracting agency will be identified. The technical experts will engage with the contracting agency to fine-tune the needs (if necessary), oversee the implementation process and monitor their progress over a period of time. Following the implementation, local bodies from the ward will make stakeholder committees comprising of the beneficiaries of the street lighting systems. The committee will provide maintenance feedback and support theft prevention. The budget also makes a small provision for training of the stakeholder committee for technology orientation and support in communicating maintenance needs to technology provider. The technology supplier will also ensure maintenance of the installed systems. In general, stationary batteries do not require a lot of maintenance; however, a regular check of electrolyte levels is advised. Local bodies will also facilitate to ensure protection from theft, which is a major technology transfer barrier. The activities under this action include:

- Procurement of equipment
- Installation of equipment
- Stakeholder committee formation and training
- Operations and maintenance

Action 3: Communication & Outreach

This action is a single activity action. Communication is primarily targeted at documenting the process and the success story. However, if not documented sufficiently, this information will not be useful for any future activities. Outreach component is limited in scope here considering the overall scale of the project. The activities of the outreach can be expanded in scope if the

municipality expands the programme beyond the scope of the current ambition. Communication and outreach activities will be carefully monitored by the iLembe municipality with a view of documenting the information in a manner that is appropriate for future use.

Outputs

Action 1: The pre-implementation phase activities of site and technology identification and development of terms of reference accomplished.

Action 2: Solar PV street lighting systems implemented at identified sites. Stakeholder committees for supporting on operations and maintenance in place.

Action 3: Lessons learned and technical experience gained documented.

Key Risks and Mitigation measures

Solar PV technology is a stable and established technology. Therefore, the risks around technology failure are low. However, the project's success is highly dependent on the choice of technology. There should ideally be a good match between the needs of the ward and the equipment provided. Many of the decision criteria in identifying the right technology will be technical in nature such as the height of the pole, appropriate distance between the two poles, need for battery back-up etc. the technical committee will be overseeing the entire project. The municipality will have to invest time in finding the right people to constitute this committee. It will be easy to mitigate this risk by ensuring that the technical committee from the municipality is competent in terms of their technology awareness and receives enough time to engage either with suppliers or with other technical experts to identify the most suitable technology options for implementation. As the scale of implementation is not large, the municipality does not have a significant stakes. However, the success of this demonstration project will pave way for future implementation in other wards, therefore it is important to take and make informed decisions.

In addition, another possible key risk can be a change in estimates of structural changes required for installation. While this risk cannot be completely mitigated, we have made a contingency provision in the budget allocation to ensure that there is provision for supporting these structural

changes needed, which are in addition to normal estimates, for implementing the technology. Other risks that the project faces include comprehensive TORs, expensive equipment and maintenance of the installations. These can be taken care of by ensuring that the technical committee prepares a detailed TOR (in consultation with experts as the need maybe) for identifying suppliers; follows standard procurement procedures to ensure the right equipment is procured at the best possible price and actively engages with local bodies to ensure that they facilitate maintenance of the street lighting equipment.

Opportunities

One of the biggest advantage of solar PVs is that it can find its applications in many forms of technologies. Their applications can range from having large-scale solar power plants to individual solar panels for household consumption. Improvements in technology, reduction in price of panels, efficient storage systems and over all enhancement in performance has made solar PVs a widely accepted renewable energy technology. In addition, they are also relevant for meeting the overall energy security goal of the country and transition towards becoming a low carbon economy.

This demonstration project focusses only on the KD Municipality wards and specifically on street lighting technology. There is an opportunity not just to disseminate the solar PV street lighting technology but also other solar PV based technologies that are consumer good technologies in nature where the users can experience direct benefits attributable to the technology. For such technologies, appropriate business models can be worked out to promote their dissemination. A successful demonstration project will also enable iLembe District Municipality continue its strong identity as the Renewable Energy Hub for the province.

Budget

The iLembe District Municipality has a mandate to provide water public utilities, which also includes the provision of street lighting. In this concept note, we do not make any provision for contribution from local communities or beneficiaries. This is because of the public good of the street lighting provision. In the long run, the municipality can consider part contributions from specific beneficiary groups like shopkeepers who can have more business due street lighting or

local communities who experience greater safety and increased tourism. The beneficiary contribution is primarily to encourage ownership and engagement from the beneficiaries and not targeted to cover full costs of the installations. Beneficiary contribution in the long run will prevent thefts and vandalism and also support regular maintenance if required. However, without demonstrating the benefits, beneficiaries' contribution will not be appealing to local communities. The details of cost assessment for every activity is presented (in local currency) in the concept table along with the working notes for each cost assessment. In the table below, we provide and action wise overview of the concept in the local currency and also in US dollars (1 USD = 12.5 ZAR). These costs are only presented from the municipality's perspective, therefore do not include the incidental costs that other stakeholders such as the end users occur. The total budget for the project is estimated to be approximately 340,000 USD assuming that all the expenses for the installation are borne by the municipality.

Action	**Total Budget ZAR**	**Total Budget USD @ 12.5**
Action 1: Scoping.	25455 + 25455 + 25455 + 25455 = 101,820	8,145.6
Action 2: Installation	4,040,000 + 21,400 + 40,455 = 4,101,855	328,148.4
Action 3: Communication	40,910	3,272.8
Total	**4,244,585**	**339,567**

Beneficiaries and Impacts

The project is estimated to benefit 231, 187 people of KD Municipality directly and indirectly. Of these, 0.43 %[6][7] are expected to be direct beneficiaries living in close proximity to the road length. This percentage is highly dependent on the population profile of the roads chosen. The immediate savings for the municipality will be in terms of provision of savings in electricity and over the technology life span, the operating expenses will be lower than conventional halogen street lighting systems. The project will have long-term impact on the following

Community Level Benefits:

[6] IDP 2017 http://www.mile.org.za/Intermediary%20Cities/Documents/KwaDukuza%20IDP%202012-17.pdf
[7] Assumed to be proportionate to the total road length of KD Municipality (i.e. 5km of the total 1154.6 km)

- Improved socialization possibilities
- Enhanced public safety

Benefits for the municipal corporation

- Reliable and stable provision of street lighting
- Long technology life
- Scope for dissemination of other PV technologies
- Reduced operating expenses over the period of technology life

Environmental Benefits

- Renewable energy supports the low carbon development strategy
- Reduced emissions

Economic Benefits

- Potential for local manufacturing and distribution
- Job creation in the region.

Sector	Renewable Energy / Electricity						
Sub- sector	Solar PVS						
Technology	Solar PV Street Lighting						
Ambition	Grid connected solar PV street lighting for 5 kms of street length in iLembe district.						
Benefits	1) Increase in public safety 2) Increase in possibility of commercial activities 3) Improvement in socialization						
Action	**Activities**	**Responsible body**	**Time frame[8]**	**Risks & Mitigation**	**Success Criteria**	**M&I Indicators**	**Budget R**
Scoping	Technical committee	iLembe Municipality; Electric Utility	2	The committee is competent. This can be a big risk, as the technical committee will be overseeing the entire project. The municipality will have to invest time in finding the right people to constitute this committee.	Well represented and technically sound committee overseeing project implementation	Technical committee to oversee the project is constituted	25,455 WN 1
	Identification of sites	Technical Committee; SALGA	2	Some important sites are not included in the shortlist. This is not a major risk considering that the implementation is in a smaller pool. Local consultations will ensure suitable sites are chosen	--	Installation sites identified	25,455 WN 1
	Assessment of technology requirement	Technical Committee; Suppliers; Electric Utility	2	Wrong equipment is chosen.	Technology meets the requirements of end of users	Type and quantity of equipment and	25,455 WN 1

[8] months

				Solar PV Street Lighting is a standard technology. The risk is more in matching the needs and technical aspects. Engagements with stakeholders and the private sector will mitigate the risk		accessories required is identified	
	Development of terms of reference for external contractual parties in the project	Technical Committee; iLembe Municipality	2	Comprehensiveness of the TORs Consult experts to ensure all-encompassing TORs	At least 3 applicants to the bid	Terms of reference for external contractual parties in the project developed and advertised.	25,455 WN 1
ACTION 1 TOTAL				***ZAR 101,820 / USD 8,145.6***			
Implementation	Procurement of equipment	Technical Committee; iLembe Municipality	3	Equipment is expensive. In general, depending upon the specifications, the technology can be expensive. Following standard procurement procedures will ensure the right equipment is procured at the best possible price.	--	All equipment and accessories required for installation are procured	4,040,000 WN 2
	Installation of equipment	Suppliers, Technical Committee; Local bodies; Electric Utility	4	Additional structural changes required for installation.	At least 60% saving in electricity consumption	Equipment is installed and operational at all the	21,400 WN 3

				As the total road length and the number of units to be installed is less, a contingency provision can be made to account for any structural changes needed.	At least 50% savings in the operations and maintenance during the technology lifespan	identified sites.	
	Stakeholder committee formation and training	Technical Committee; iLembe Municipality; Suppliers; Local bodies; NGOs; SALGA	2	Stakeholder committees are not very engaged about the process. Local bodies should ensure that active members are a part of the committee. The training should also include the larger benefits of having street lighting.	Stakeholder committee reports is aware of the technology benefits and of reporting mechanism for maintenance issues	A well represented stakeholder committee is formed and trained.	40,455 WN 4
	Operations and maintenance	Stakeholder Committee; Suppliers; Local bodies	*Og*[9]	Maintenance issues are not reported. Stakeholder committees will ensure maintenance needs are communicated to the suppliers. A provision of reporting maintenance issues through a hotline or any other relevant means should be included in the	Stakeholder committee reports at least 90% of maintenance issues to the technology provider.	--	0 WN 5

[9] Ongoing

				annual maintenance contract of suppliers.			
ACTION 2 TOTAL				***ZAR 4,101,855 / USD 328,148.4***			
Communication	Communication and outreach	Technical Committee; iLembe Municipality; Suppliers; Local bodies;	6	Communication and outreach is primarily targeted at documenting the process and the success story. However if not documented sufficiently, this information will not be useful for any future activities. Communication and outreach activities should be carefully monitored by the iLembe municipality with a view of documenting the information in a manner that is appropriate for future use.	The documentation is used as the basis for expansion of project implementation.	Lessons learned and technical experience gained documented.	40910 WN 6
ACTION 3 TOTAL				***ZAR 40,910 / USD 3,272.8***			
TOTAL BUDGET				***ZAR 4,244,585 / USD 339,567***			

Working notes on cost and savings assumptions:

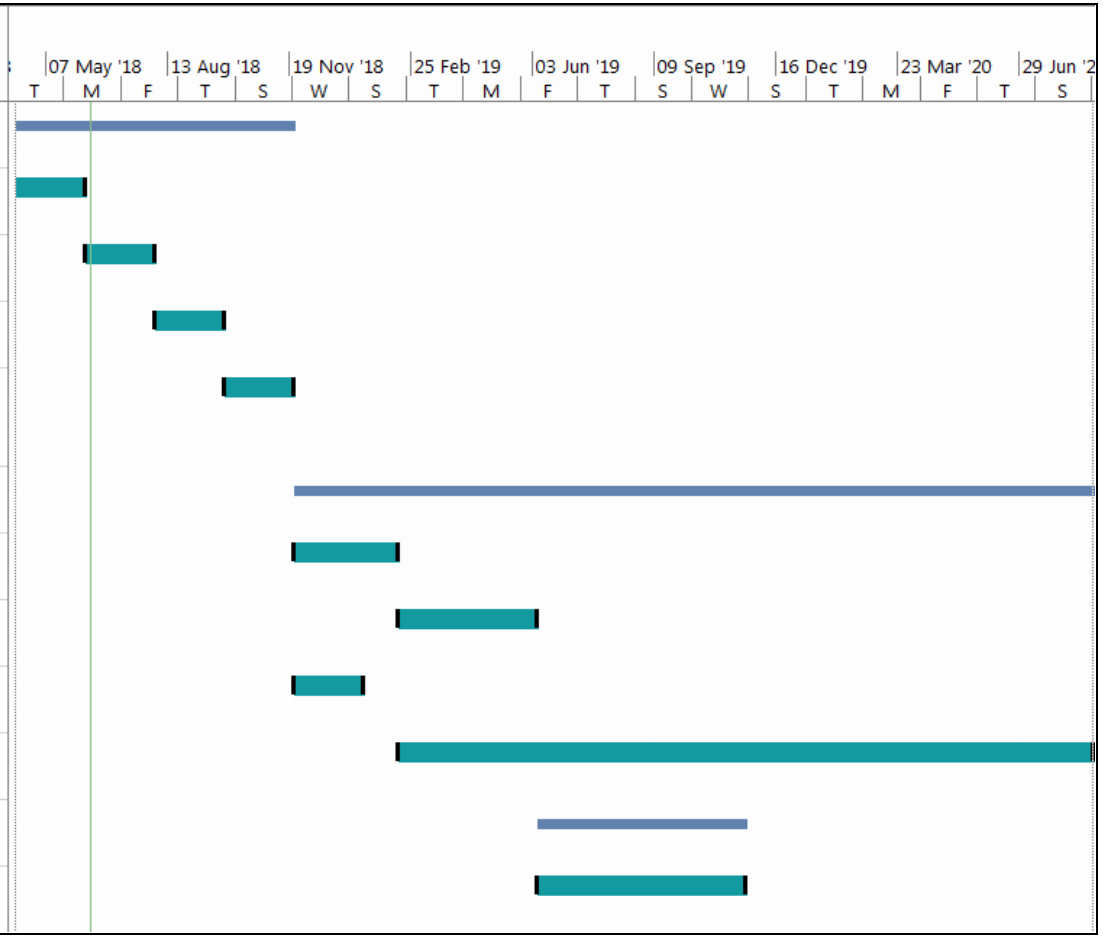
#	Cost Calculation	Assumptions	References
1	Number of persons: 5 Work Days: 3 Number of Staff days=5*3 = 15 HR Expense=(15/22)*30,000 Stakeholder engagement = 5000 Total Activity budget ≈ 20445 + 5000 = 25455	Minimum wage rate is 2933 per month for workers (rounded to 3000). It is assumed that the average minimum wage for experience iLembe municipality staff is 10 times this rate i.e. 30,000 p.m. Number of working days in a month 22. Working hours per day 8. In general, we assume that activities 1, 2, 3 and 4 have the same amount of work load. The estimates. A provision of 20,000 R is made for engaging with stakeholders wherever necessary i.e. 5000 for each activity.	Minimum wage rates for SA: https://mywage.co.za/main/salary/minimum-wages
2	Number of poles assuming a gap of 25m = 5000m/25 = 200 poles Cost of each pole including installation = 20,000 For 200 poles= 4,000,000 Provision for structural changes (1%)= 40,000 Total Activity = 4,000,000 + 40,000 =4,040,000	The cost of poles includes all incidental costs that are required to install the pole. The cost numbers are from a street light project in Zimbabwe. Actual numbers can be determined only when specific technical requirements are spelled out from the committee. A 1% provision of total capital costs is made to look into specific site structural changes that are required. It assumed that staff hours necessary for the execution of procurement process are included in the first four activities.	Pole cost from case example in Zimbabwe https://onlinelibrary.wiley.com/doi/pdf/10.1002/wene.218 Other relevant references for costs: http://repositorio.ul.pt/bitstream/10451/12388/1/ulfc110307_tm_Rita_Almeida.pdf http://ir.knust.edu.gh/bitstream/123456789/7720/1/PETER%20ACHEAMPONG.pdf https://www.engoplanet.com/single-

			post/2017/08/21/How-to-design-and-calculate-Solar-Street-Light-system https://www.researchgate.net/profile/Sreedevi_Nair2/publication/299453235_Economic_Feasibility_of_Solar_Powered_Street_light_using_high_powered_LED-A_Case_Study/links/56f8e6e208ae38d710a26d34/Economic-Feasibility-of-Solar-Powered-Street-light-using-high-powered-LED-A-Case-Study.pdf https://deepblue.lib.umich.edu/bitstream/handle/2027.42/99562/GlobalBrightLights%20FInal%202013.pdf?sequence=1
3	4 Trips = 4 * 5350 Total Activity budget = 21400	This activity is the primarily responsibility of the suppliers. The Technical committee will have site visits to monitor the progress of the implementation. The Technical Committee members will do 4 site inspections in a period of 4 months. Site visits: 4 by two staff members Total distance: 55 kms per trip Fuel efficiency: 11 km/l Gasoline: 5 lit @ 50 = 250 per trip	Area of iLembe: 3269 sq. km. Cost of living numbers https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa

		Personnel = 3000 per trip DA: 397+128 =525 + Mark up 100% = 1050 per trip Trip Expenditure= Fuel + Personnel + DA = 250 + 3000 + 2*1050 = 5350 per trip	Daily Allowance http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx
4	Number of persons: 5 Work Days: 3 Number of Staff days=5*3 = 15 HR Expense=(15/22)*30,000 =20455 Training for stakeholder committee = 20,000 Total Activity budget ≈ 20445 + 20000 = 40455	We assume that the staffing costs for pursuing this activity are the same as in WN1 i.e. 20455. In addition, a provision of 20,000 for organizing a short training session for the stakeholder committee is made.	
5	0	As this is an activity where end users are to take action. The incidental costs for the municipality are therefore assumed to 0. The municipality will organize training for the stakeholder committee the costs for which are included in the working note.	
6	Number of persons: 5 * 2 (Municipality and Tech Committee) Work Days: 3 * 2 Number of Staff days=5*3 * 2 = 30 HR Expense=(30/22)*30,000 = 40910	Communication and outreach is primarily targeted at documenting the process and the success story. This is an internal activity to be pursued by the municipality and the technical committee. The staff time budgeted for this is twice as much as in WN 1.	

Gantt chart for activities schedule[10]

ID	Task Mo	Task Name	Duration
1		**SCOPING**	
2		Technical committee formation	2 mons
3		Identification of sites	2 mons
4		Assessment of technology requirement	2 mons
5		Development of terms of reference for external contractual parties in the	2 mons
6		**IMPLEMENTATION**	
7		Procurement of equipment	3 mons
8		Installation of equipment	4 mons
9		User committee formation and training	2 mons
10		Operations and maintenance	20 mons
11		**COMMUNICATION**	
12		Communication and outreach	6 mons



[10] Monthly schedule for 25 months. The technology is expected to last at least 10 years with regular maintenance