



**The Development of Technology Road Maps at subnational level:**

**KwaZulu-Natal, South Africa**

*...."striving to achieve an improved quality of life for all the residents and communities..."*



**The Development of Technology Road Maps**  
**at subnational level: KwaZulu-Natal,**  
**South Africa**

Report to the  
**Climate Technology Centre and Network**  
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## Acronyms

CoGTA	Cooperative Governance and Traditional Affairs
CTCN	Climate Technology Centre and Network
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DWS	Department of Water and Sanitation
EDTEA	Economic Development, Tourism and Environmental Affairs Department
KZN	KwaZulu-Natal province
NDE	Nationally Designated Entity
PV	Photovoltaic
UDP	UNEP DTU Partnership
SALGA	South African Local Government Association
SANEDI	South African National Energy Development Institute
TIKZN	Trade and Investment KwaZulu-Natal
TRM	Technology Road Map
TVET	Technical and Vocational Education and Training
UNFCCC	United Nations Framework Convention on Climate Change
WRC	Water Research Commission

## Executive summary

In 2010, the total greenhouse gas emissions for South Africa were estimated to be at 544 314 CO<sub>2</sub> eq (excluding the Forestry and Other Land Use<sup>4</sup>). According to the National Climate Change Response Policy (NCCRP, 2011), South Africa's emissions by years 2025 and 2030 will be in a range between 398 and 614 Mt CO<sub>2</sub>eq. As part of implementing the Nationally Determined Contribution (NDC) to overcome the challenges of ensuring a low emission climate resilient development path, South Africa identified its key priority sectors, including water and energy.<sup>5</sup>

South Africa has a high level of Renewable Energy potential and in the province of KwaZulu-Natal, the iLembe District Municipality has been nominated as the renewable energy hub. The impacts of climate change are increasing the frequency and duration of droughts in South Africa, thus leading to more shortages of potable water.

The iLembe District was one of the hardest hit by drought during 2015/16 and has a huge backlog of sanitation challenges and potable water shortages. Therefore, there is a need to ensure an optimal management of water resources, including the minimization of water losses. Consequently, there is a huge burden on the distribution of financial resources across the local municipalities, including the four local municipalities in iLembe district, being Mandeni, KwaDukuza, Maphumulo and Ndwedwe.

Climate change is a global problem influenced by an array of interrelated factors. It is also a local problem with serious impacts foreseen for South Africa, including the province of KwaZulu-Natal (KZN). Acknowledging the overall vulnerability of South Africa and the local vulnerabilities that vary among provinces, there is a need to conduct local level assessments of technology needs to overcome challenges experienced at a local level and ensuring a climate resilient low carbon development path. To address this need, the Department of Economic Development Tourism and Environmental Affairs (EDTEA) and the iLembe District Municipality in KwaZulu-Natal, have requested technical assistance from the Climate Technology Centre and Network (CTCN) to develop Technology Road Maps (TRMs) at subnational level. The TRMs, and the project concept notes developed from these, are expected to contribute to the local planning processes in iLembe for the water and energy sector, and will be given priority from the district in the efforts to enhance its low emission climate resilient development path.

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<sup>4</sup> GHG Inventory for South Africa 2000 - 2010

<sup>5</sup> South Africa's Intended Nationally Determined Contribution (INDC) to the UNFCCC

In February 2017, the CTCN, through the Council for Scientific and Industrial Research (CSIR) and UNEP DTU Partnership (UDP), started an activity to develop Technology Road Maps (TRMs) for iLembe district in Kwa-Zulu Natal, South Africa. During workshops, stakeholders selected three technologies for the water sector and three technologies for the energy sector. For the water sector, the TRMs cover technologies for (a) reducing system leakages, (b) irrigation efficiency and information systems, and (c) rainwater harvesting; and for the energy sector TRMs were developed for (a) household biogas, (b) solar photovoltaic street lighting and (c) Biodiesel. The development of the roadmaps involved one-on-one meetings with selected key stakeholders. Recommendations from stakeholders consulted during the development of these TRMs included, (a) as far as possible, technologies should be based on locally available material to reduce costs and maintenance, and (b) the district municipality should invest more in curbing theft and vandalism of the technology infrastructure to ensure the success of the technologies. During the engagements, it emerged that some of these technologies are already being implemented (in various combinations) at small scale in selected local municipalities in the iLembe District Municipality. For an example, the Water Research Commission (WRC) implemented a project in the Ndwedwe local municipality which included rainwater harvesting and the generation of methane from agricultural waste; the sludge in turn was used to make fertiliser for small scale farmers. Similar initiatives which included the installation of solar PV were implemented by the South African National Energy Development Institute (SANEDI) including the installation of the bio-digesters within the Ndwedwe area, target rural households. These roadmaps aim to pursue this work and reinforce ongoing efforts when started.

In 2014, the iLembe District Municipality held its second Climate Change Summit, and in this Summit a decision was taken to move the iLembe Community towards the Low carbon Society. Therefore, the objective of these TRMs is to support the iLembe District Municipality in making decisions about new projects to be implemented and ongoing projects to be scaled up for adaptation and mitigation interventions. The TRMs aim to support the decision-making process about the development of iLembe's Integrated Development Plan, especially the scaling up of energy efficiency projects and the implementation of the Regional Bulk Water Supply scheme to address sanitation backlogs and potable water supply. Recommendations from stakeholders consulted during the development of these TRMs included, a) as far as possible, technologies should be based on locally available material to reduce costs and maintenance, and b) the district municipality should invest more in curbing theft and vandalism of the technology infrastructure to ensure the success of the technologies.

**PART 1**  
**Introduction**

Climate change is a global problem influenced by an array of interrelated factors. It is also a local problem with serious impacts foreseen for South Africa, including the province of KwaZulu-Natal (KZN). Acknowledging the overall vulnerability of South Africa and the local vulnerabilities that vary among provinces, there is a need to conduct local level assessments of technology needs to overcome challenges experienced at a local level and ensuring a climate resilient low carbon development path. To address this need, the Department of Economic Development Tourism and Environmental Affairs (EDTEA) and the iLembe District Municipality in KwaZulu-Natal (Table 1.1), have requested technical assistance from the Climate Technology Centre and Network (CTCN) to develop Technology Road Maps (TRMs) at subnational level. The proponents of this technical assistance have narrowed the focus on the iLembe District Municipality, with future objectives being to replicate the outcomes to other district municipalities within the province of KwaZulu-Natal. Their view is that subsidy housing units and treatment works (both waterworks and wastewater works) in the iLembe district should be among the beneficiaries of these TRMs.

**Table 1.1** An overview of KwaZulu-Natal province<sup>6</sup>

<b>Population</b>	10.9 million People equivalent to 19.9% of the South African population. Children and young people from age 0-29 account for 64.1% of the population in the province.
<b>Districts</b>	10 Districts and 1 Metro
<b>Economic outlook</b>	The province is the second largest GDP contributor in the country with 16% in 2014.
<b>Income</b>	In 2014, 44.8% of households in the province were categorized as lower-(annual) income households (R0 – 54 000).
<b>Education and literacy</b>	Despite substantial improvements over the last 10 years, in 2014, an estimated 8.6% of the population in the province had not received any schooling and about 38.9 % had reached grade 7-11. Estimated literacy rate was 80.4% in 2014.
<b>Energy access</b>	The share of households with electrical connections in KwaZulu-Natal in 2014 reached 79.8%, which is lower than most provinces in the country. Due to the current prohibitive social-economic-political investment situation, the process of electrification of rural areas remains slow.
<b>Water and sanitation</b>	KwaZulu-Natal has one of the lowest proportions of households with access to piped potable water (71.6%) and hygienic toilets (70.9%).

As the first activity of this technical assistance, workshops on water and energy were held in KwaZulu-Natal in April 2017, where stakeholders prioritized key technologies for climate change adaptation in

<sup>6</sup> Source: KwaZulu-Natal Provincial Government, (2016)

the water sector, and for climate change mitigation aiming at reducing carbon emissions in the energy sector. As a result, three selected technologies for each of the sectors were:

Water sector (adaptation)

- (1) Reducing system leakages;
- (2) Irrigation efficiency and information systems.
- (3) Rainwater harvesting for storage (incl., from roads etc.), ponds and tanks;

Energy sector (mitigation)

- (1) Solar photovoltaic (PV);
- (2) Household biogas;
- (3) Biodiesel.

The iLembe District Municipality (3 260 km<sup>2</sup> or 3% of the KwaZulu-Natal geographical surface area) have four local municipalities: i.e. Mandeni, KwaDukuza, Maphumulo and Ndwedwe (Table 1.2). These municipalities have unique and common socio-economic challenges that the technologies should address with a focus on creating a better life for all communities and moving the iLembe Community towards a low carbon society as agreed during the 2014 Climate Change Summit. Many areas are difficult to access in order to deliver services efficiently because of the hilly topography of the rural areas.

**Table 1.2** An overview of the iLembe District<sup>7</sup>

<b>Vision</b>	<i>“By 2030 iLembe District Municipality will be a sustainable, people centred economic hub providing excellent services and quality of life”</i>
<b>Population</b>	The recent Community Survey (2016) results show that the population in iLembe District has grown to 657 612 people and has been growing at 1.7% per annum from 2011 to 2016.
<b>Local Municipalities within the iLembe District Municipality</b>	There are four local Municipalities within the District – i.e. KwaDukuza, Mandeni, Maphumulo and Ndwedwe. Unlike in the previous comparison of 2001 and 2011 results where Maphumulo and Ndwedwe rural municipalities of the district were seen to have a decrease in population, Ndwedwe is now experiencing an increase but Maphumulo remains on a downward trajectory. In three of the four local municipalities of iLembe, the overall growth rate has increased from 0.8% per annum to 1.7% per annum.

<sup>7</sup> Source: iLembe District Municipality’s Integrated Development Plan 2017-2022

<b>Regional Context</b>	The iLembe District Municipality is strategically located between the two primary development corridors of the province of KwaZulu-Natal, and also strategic gateway points into the continent which is Durban and Richards bay harbours. To the south of the district is the King Shaka international airport (KSIA) and the Dube Tradeport. The Aerotropolis, to which the KSIA will be the nucleus, extends well into the jurisdiction of the iLembe District, particularly Ndwedwe and KwaDukuza Local Municipalities. Whilst the majority of urban development occurs in Mandeni and KwaDukuza, the towns of Maphumulo and Ndwedwe have been gazetted as formalised towns, which are now serving as a catalyst for economic investment in these areas.
<b>Income</b>	In 2014, 44.8% of households in the province were categorized as lower-income households (R0 – R54 000).
<b>Education and literacy</b>	Despite substantial improvements over the last 10 years, in 2014, an estimated 8.6% of the population in the province had not received any schooling and about 38.9 % had reached grade 7-11. Estimated literacy rate was 80.4% in 2014.
<b>Age profile</b>	Within iLembe, 35.5% of the population is under the age of 15, KwaDukuza has the lowest percentage (29%) and Maphumulo has the highest percentage (40%) of the population less than 15 years. Throughout the district, it seems that all age groups under 65 years have decreased in percentage whilst the percentage of the age group of 65+ has risen. Compared to the other local municipalities in the district, KwaDukuza has the highest percentage of the working-class age group at 66.7% whilst Maphumulo has the lowest at 52.9%. The majority of people within the district are of working age, however the available employment opportunities are not adequate to absorb this high number.
<b>Educational profile</b>	Although the number of people with no schooling has declined in recent years, it remains high in Maphumulo, where 24% of the population have not received any schooling. However, the number of people with higher education has decreased further from 3.5% in 2001 to 3.1% in 2011 and now 1.83%, an alarming indicator of out-migration of highly skilled workers. The proportion of the iLembe population with matric decreased from 26.6% in 2011 to 18.39% in 2016, which is a dramatic drop and a cause for concern.
<b>Water and sanitation</b>	In 2003 the district became the Water Services Authority and Water Services Provider for the iLembe region and the Municipality's Water Services Development Plan (WSDP) was adopted in 2016. It is the role of the Technical Services Department to provide water and sanitation services throughout the district thereby eliminating backlogs.
<b>Energy</b>	<p>It should be noted that provision of electricity is a function of local municipalities and Eskom. It is estimated that 148 078 out of 191 369 households have a supply of electricity for cooking and other general household purposes.</p> <p>The iLembe District, specifically the IsiThebe Area under the Mandeni local municipality area, has been identified as the Renewable Energy hub, suggesting that there is huge opportunity energy growth in the iLembe Region.</p>
<b>Economic</b>	The KwaZulu-Natal' Provincial Growth and Development Strategy has identified the iLembe District Municipality as the renewable energy hub of

the province. The focus of this hub will be the manufacturing of renewable energy components, i.e. solar panels, solar geysers etc. The hub will not only cater to the domestic markets, but it will also focus on the international distribution of products.

In addition, as the iLembe District is plagued by a high rate of unemployment. The identification of the iLembe District as the Renewable Energy Hub and move towards a low carbon society will assist the District to deal first with the unemployment rate and secondly to grow a green economy by identify critical sectors for growing the economy which again is essential in the fight against unemployment and poverty.

The designation of the district as the renewable energy hub of the province is key in catalysing the transformation towards a green economy.

The purpose of these TRMs is to support the Province of KwaZulu-Natal in making decisions about technologies to be implemented as well as projects developed that are scaled up for adaptation and mitigation interventions. The main focus of this technical assistance will be at the iLembe district and the outcomes will be replicable to other districts within the KwaZulu-Natal Province and across the country. Such outcomes would also afford South Africa an opportunity to refine its approach in the implementation of the National Climate Change Response Policy (NCCRP, 2011) and the NDC. Provision of potable water and renewable energy are some of the key national priorities mentioned in those national policy documents. The NCCRP has two key objectives:

- To effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity.
- To make a fair contribution to the global effort to stabilise greenhouse gas (GHG) concentrations in the atmosphere within a time frame that enables environmentally sustainable socio-economic development.

It is worth acknowledging that there are stakeholders active on the ground implementing small-scale adaptation and mitigation projects in response to the challenges presented by climate change. These include, but not limited to the South African National Energy Development Institute (SANEDI) and the South African Local Government Association (SALGA) (e.g. biogas production, solar PV installation, rainwater harvesting, bio-fertilizer production); mobilization of financial resources for implementation of technologies in district municipalities (e.g. Trade and Investment KwaZulu-Natal (TIKZN)); biogas production, water harvesting for agricultural use, irrigation efficiency and the development of guidelines for safe use of harvested rain water [(e.g. Water Research Commission (WRC)]. These

climate response technologies should be catered comprehensively in the provincial as well as municipal policies such as the KwaZulu-Natal climate Change Implementation Plan, Indigent Policy, iLembe Regional Spatial Plan, iLembe Integrated Development Plan and the iLembe Regional Water and Sanitation Master Plan (in addition to national policies).

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### Approach

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For each priority sector, three technologies were selected through a multi-criteria analysis during stakeholder workshops in KwaZulu-Natal. The process included collecting information on barriers and measures that stakeholders have adopted to overcome those barriers. The next step was the development of a TRM for each technology. Information to develop these TRMs was gathered from available resources (e.g. WRC reports, internal district municipality reports, online literature, etc.) and one-on-one meetings with stakeholders such as the South African Nationally Designated Entity (NDE), SANEDI, WRC, EDTEA, iLembe district municipality officials, and TIKZN. Where available, information was collected for the following areas during the interviews:

- Actions and activities for the technology;
- Barriers and measures to overcome barriers;
- Source/s of funding for the technology implementation;
- Cost of technology;
- Success criteria;
- Indicators for monitoring and implementation.

During the consultation process, it emerged that some of these technologies are already being implemented (in various combinations) at small scale in selected local municipalities in the iLembe district municipality. Households were selected based on poverty-related criteria, and projects were then implemented by organisations such as SANEDI and WRC.

### Sector overview

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South Africa has a semi-arid climate with highly variable rainfall averaging at 495 mm per year; only 35% of the country receives 500 mm or more of rainfall and 21% receive less than 200 mm. About 65% of the country does not receive enough rainfall to engage successfully in rain-fed crop production.<sup>8</sup> The country's water sector is already under immense pressure with the current trend in population growth and citizens' water use behaviour. This pressure is worsened by the extended period of drought during 2015 and 2016<sup>9</sup>. Some local municipalities in the iLembe District were hardest hit by drought, and it was very costly for the iLembe District to provide potable water to these Municipalities, as more water tankers were required for water services within the iLembe Region.

Furthermore, as people were desperately searching for water, they also damaged the infrastructure in the process. This also led to loss of potable water (via leakages) and when the system (of water supply) was restored it encountered pipe bursts and other challenges which was always very difficult to detect and fix. This needed a certain type of technology that can be able to detect pipe leaks.

In a country where water is a scarce resource and rainfall and run-off rates are particularly low, it is necessary to consider other avenues to preserve this limited resource. Increasing average temperatures as a result of climate change will lead to higher evaporation rates from all bodies of water such as rivers, lakes and dams. The situation is expected to become worse for the interiors of the country, although prolonged drought spells have been recorded along the eastern seaboard of South Africa. In ensuring South Africa's water security, government and citizens will have to practice responsible and effective water use, by implementing technologies that conserve water and lessen the stress on this resource. Earlier in 2018, the city of Cape Town has introduced bylaws where each citizen is expected to use no more than 50 litres of water per day because reservoirs are drying up as a result of climate change.

The province of KwaZulu-Natal was declared a drought disaster area in 2014, and the drought conditions are still persisting in most parts of the province including the iLembe District Municipality<sup>10</sup>.

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<sup>8</sup> FAO. (2016). AQUASTAT - FAO's Information System on Water and Agriculture. Retrieved June 15, 2017, from [http://www.fao.org/nr/water/aquastat/countries\\_regions/ZAF/](http://www.fao.org/nr/water/aquastat/countries_regions/ZAF/)

<sup>9</sup> BusinessTech. (2015). Who is using all the water in South Africa? Retrieved June 15, 2017, from <https://businesstech.co.za/news/general/104441/who-is-using-all-the-water-in-south-africa/>

<sup>10</sup> iLembe District Municipality's Integrated Development Plan 2017 – 2022

According to climate projections from the CSIR, average temperatures are expected to increase in the near future, thus placing an extra burden on water resources because of accelerated evaporation rates from dams, rivers, etc. In other words, there is likely to be less drinking water in some areas of the province. Hence the technologies such as rainwater harvesting and reducing (water) systems leakages are important for implementation and scaling up.

South Africa has developed policies on water management and has put together national programmes to reduce potable water losses. A number of policies listed in the Table 2.1 governs South Africa’s water sector. Furthermore, the Department of Water and Sanitation developed a Water Reconciliation Strategy for the KZN Coastal Metropolitan Area, which aimed to address pressing water security concerns in the area where water use exceeds the assured supply.<sup>11</sup>

**Table 2.1** Existing water legislation in South Africa<sup>12</sup>

<b>National</b>	
<b>National Water Act (Act 36 of 1998)</b>	Its purpose is to provide the framework to ensure that the nation’s water resources are protected, used, developed, conserved, managed and controlled in ways that take into account a number of factors such as <i>“meeting the basic human needs of present and future generations, promoting equitable access to water and preventing pollution and degradation of water resources”</i> . The Act also provided a framework for the establishment of suitable institutions.
<b>Water Services Act (Act 108 of 1997)</b>	It aims to assist municipalities to undertake their role as water services authorities, and to look after the interests of consumers. It also clarifies the role of other water services institutions, such as water services providers and water boards.
<b>Free Basic Water Policy (2001)</b>	The Free Basic Water policy targets the water needs of the most impoverished citizens by guaranteeing each household a free minimum quantity of potable water.
<b>White Paper on Water Services (2002)</b>	It aims to set out a more comprehensive policy approach to the management of the water services sector, ranging from small community water supply and sanitation schemes in remote rural areas to large regional schemes supplying water and wastewater services to people and industries in our largest urban areas.

Working with water boards, the national Department of Water and Sanitation initiated a “war on leaks” programme worth R3 billion in 2015 to curb water losses, which included training of plumbers. The South African Local Government Association (SALGA) is helping municipalities to develop

<sup>11</sup> Department of Water and Sanitation. (2011). *Strategy Steering Committee (SSC) for the Implementation and Maintenance of the Reconciliation Strategy - Progress report*.

<sup>12</sup> DWAf. (2004). Overview of the South African Water Sector. *National Water Resource Strategy, 1, 1–35*.

mechanisms of generating revenues from the supply of potable water. The water infrastructure in most parts of the country is outdated and poorly maintained, which leads to massive losses of potable water (i.e. non-revenue water) for the municipalities. Concerns about non-payment of plumbers (within the prescribed period of 30 days) and non-retention of trained learners remain ongoing challenges for municipalities.

Municipalities have their own policies and bylaws governing water management within their respective jurisdiction: i.e.

- Indigent Policy
- iLembe Regional Spatial Plan
- iLembe Regional Water and Sanitation Master Plan (2016)

Information from these TRMs will support the process of ensuring that the iLembe district municipality will have systems in place of *“managing water and that water loss through the iLembe water distribution systems is avoided<sup>13</sup>”*. Furthermore, the TRMs will support the development of the Regional Bulk Water supply scheme for the district. This water scheme is estimated at a total cost of R1, 283,580,681.00 and will be implemented in phases between 2017 and 2022.

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<sup>13</sup> Masupha Mathenjwa, iLembe district municipality, pers. comm. 2018

*Extract from the iLembe District Municipality Integrated Development Plan (2017 – 2022):*

“The following infrastructural characteristics, issues and challenges impact on the future development of the iLembe District and need to be taken forward in the IDP Process:

- The provision of basic infrastructure is hampered by the topographic constraints, low densities and low affordability levels, particularly in rural and traditional areas.
- Service infrastructure in iLembe’s urban areas needs upgrading and maintenance, however through grant funding from the Department of Water and Sanitation, particularly Municipal Water Infrastructure Grant (MWIG), the municipality is addressing this challenge.
- Rural areas are severely affected by a lack of basic services and continued service delivery backlogs.
- Bulk water supply is a major constraint that effects the entire District and in urgent need of attention.
- 22% of the population still does not have access to clean water and obtain water from rivers and streams. This poses a health risk with further implications regarding the provision of social services.
- 20% of the population still does not have access to basic sanitation.
- The urban areas have proper water borne sanitation systems, but the peri-urban and rural areas rely on pit latrines or no system at all. This places tremendous strain on the environment and poses a health risk.
- iLembe has been severely hampered by drought which has diminished the Municipality’s ability to provide water to all inhabitants.”

The measurable impacts of climate change will place more pressure on municipal authorities to supply communities with essential services. Hence for the 2016/17 financial year, “R200 million were allocated by the KwaZulu-Natal provincial government to undertake the following activities<sup>14</sup>:

- The drilling and equipping of 100 boreholes across the province;
- The procurement and installation of mobile packaged plants to support critical areas for each of the 14 Water Service Authorities;
- The procurement of water tankers to support firefighting in the province;
- The procurement and installation of raw water mass storage facilities to augment the water source for each of the 14 Water Service Authorities;

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<sup>14</sup> Extracted from the budget speech of MEC for finance, Ms. Belinda Scott: KZN provincial budget 2016/17 (MTEF Budget in the provincial legislature, 10 March 2016)

- The scooping of dams, as well as procuring winter fodder in areas which have insufficient grazing due to the drought;
- The Ventilated Improved Pit technology which responds to the minimum norms and standards;
- A large-scale rehabilitation programme of all pit latrine toilets and septic tanks in a desludging programme for various districts;
- A provision of infrastructure for the development and growth of the livestock industry, particularly in the communal areas. In this regard, 30 dip tanks will be constructed and 78 existing dip tanks rehabilitated, and a further 80 boreholes and 77 stock watering dams will be established.”

From the total budget allocation, iLembe district municipality received about R33 million, most of which was invested in communal UV resistant polyethylene storage tanks (Jojo tanks) and hiring of water tankers during the prolonged drought of 2015/2016<sup>15</sup>. For the 2017-22 period, the Regional Bulk Water Scheme<sup>16</sup> planned for the District are as follows:

- **The Ndulinde Sub-Regional Water Supply Scheme** fall within <sup>17</sup>wards 5, 6, 11, 12, 16 and 17 of Mandeni Local Municipality.
- **The Macambini Sub-Regional Water Supply Scheme** fall within wards 1, 2, 3, 8 and 9 of Mandeni Local Municipality.
- **The Inyoni Housing Bulk Water and Sanitation Project** falls within ward 10 of Mandeni Local Municipality.
- **The Lower Thukela Regional Bulk Water Scheme** is intended to serve the area of KwaDukuza with potable water supply.
- **The Groutville D Household Sanitation Project** is aimed at providing waterborne sanitation to Chris Hani, Lloyds, Ntshawini, Mnyundwini, Etsheni and Njekane areas within KwaDukuza Local Municipality.
- **The Southern Regional Bulk Water and Sanitation Project** is aimed at upgrading the existing bulk water and sanitation bulk and reticulation services to Nkobongo, Shayamoya, Shaka’s Head and Etete townships.
- **The proposed Umshwati Bulk Pipeline** will be implemented in partnership with Umgeni Water to augment the water supply to Ndwedwe Ozwathini area that is currently being served through borehole supply. These areas fall within wards 4, 5, 6, 8, and 9 of Ndwedwe Local Municipality.

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<sup>15</sup> Elias Bengu, KwaDukuza Local Municipality, personal communication, 2017

<sup>16</sup>Lembe District Municipality Integrated Development Plan 2017 - 2022

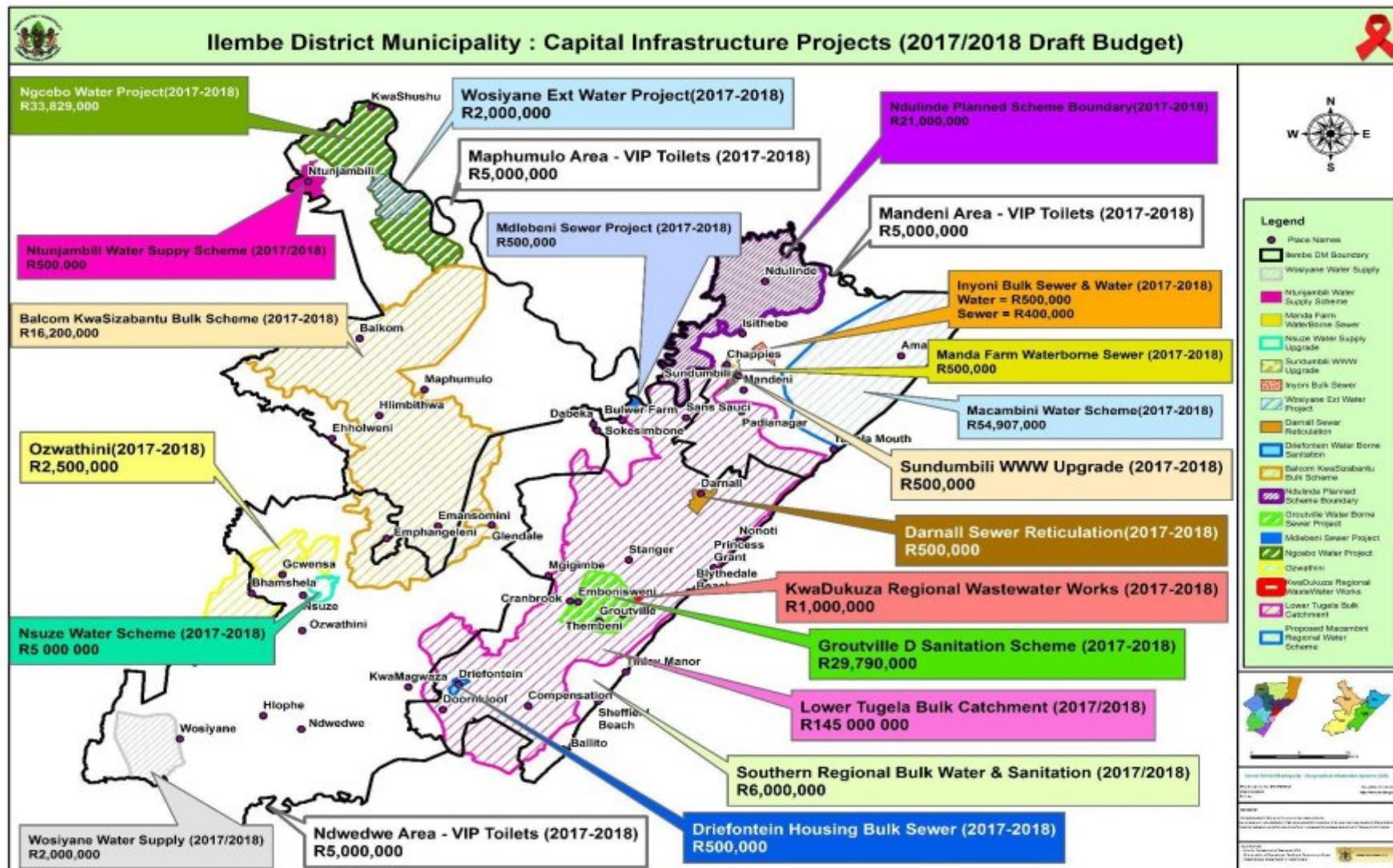
<sup>17</sup> NB: Residential areas in South Africa are either named or numbered. Each number refer to specific residential space/area.

- The Balcome/KwaSizabantu Sub-Regional Water Supply Scheme falls within Maphumulo Local Municipality of iLembe DM area. The water scheme will cover wards 3, 5 and 6 of Maphumulo Local Municipality with potable water supply at a level of house connections.
- The Maphumulo/KwaDukuza Sub Regional Water Scheme. The scheme is co funded by iLembe District Municipality and Umgeni Water, where Umgeni Water will focus on the implementation of the bulk system (including the dam) and iLembe District Municipality will focus on the reticulation networks up to yard connections. The scheme will cover wards 4, 7, 8, 9, 10 and 11 of Maphumulo Local Municipality and ward 1, 2, 3, 4 and 7 of Ndwedwe Local Municipality.

The improvement of the water infrastructure (e.g. building dams and drilling bore holes) to improve water supply and address the sanitation backlogs (Map 2.1) is part of the Regional Bulk Water Supply Scheme, a flagship programme for the iLembe district municipality. For the programme to succeed in service delivery to the people, it should be supported by cost effective technologies which take into account, locally available material as well as the impacts of climate change.

In terms of Research & Development in the sector, the Water Research Commission has published numerous reports, scientific papers, training manuals etc. These include, but not limited to:

- Water harvesting and conservation (WRC Report No. TT492) (comes in four volumes)
- Rainwater harvesting and conservation (RWH&C) from cropland and rangeland productivity in communal semi-arid areas of South Africa (WRC Report No. 1775/1/14);
- Sustainable techniques and practices for water harvesting and conservation and their effective application in resource-poor agricultural production through participatory adaptive research (WRC Report No. 1465/1/11);
- Sustainable techniques and their effective application in resource-poor agricultural production (WRC Project No. K5/1478/2) (comes in four volumes);
- Water resources management in rainwater harvesting: an integrated systems approach (WRC Report No. 1563/1/08).



Map 2.1: Source - Ilembe District Municipality Integrated Development Plan (2017 – 2022)

Map

## Technology Road Map for water efficiency and demand management 1: Reducing system leakages

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For this roadmap, ‘*real*’ water loss’ is defined as the amount of water lost between the supplier and the consumer. This loss occurs because of distribution network leakages, poor equipment maintenance and storage overflows. In addition, ‘*apparent*’ water losses as those due to inaccurate consumption measurements by the consumer or utility, and include imprecise metering, data errors and unauthorised consumption by a third party. An assessment of the distribution system may determine whether the water losses are ‘*real*’ or ‘*apparent*’ and consequently, the appropriate measures that need to be implemented to reduce the water loss. At present, the treatment works (both waterworks and wastewater works) in iLembe district municipality do not have an automated water supply/management system. It is therefore a challenge to quantify ‘*real*’ and ‘*apparent*’ water losses in the district.

To curb underground water leaks, the iLembe district municipality should invest in hydraulic leak detectors, which reduce the financial, labour and time costs for detecting leaks. Hydraulic processes have been used effectively to detect and locate leaks underground. These depend on pressure differences between the detector head and where the leak has occurred. For an example, for a Ferret® leak locator - a Ferret head, which is effectively a deflated balloon attached to a long cord, is placed inside a pipe, and allows water to get past it. Once the head is inflated with water, the pressure is higher than in water pipe so no water can pass. This creates a water-tight space for the Ferret head to then move through the pipe and towards the leak. The pressure powering the head will drop suddenly when the leak is detected and stop the device in its tracks. There are numerous portable leak detectors in the market, which may be suitable to the iLembe district municipality. However, a long-term solution could be the replacement of infrastructure: wider pipes made from material that is more durable.

Based on human population statistics, the current highest water demand in the iLembe District Municipality is from the KwaDukuza local municipality (58.42 ml/day); followed by Mandeni local municipality (29.83 ml/day); then Ndwedwe local municipality (15.26 ml/day); and finally Maphumulo local municipality (7.58 ml/day). During the 5 years of implementation of the Integrated Development Plan (2017 – 2022), the iLembe district municipality will roll out the Regional Bulk Water Supply Scheme<sup>18</sup>

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<sup>18</sup> A flagship programme for the water sector to address potable water supply and sanitation challenges in the district.

for the region. The scheme is intended to supply communities largely dependent of bore water holes and will also be a means of drought release and addressing the sanitation backlogs in the region.

The Water Research Commission<sup>19</sup> revealed that about R7.2 billion worth of potable water (i.e. 37% on average non-revenue water) is lost annually in South Africa due to (a) poor infrastructure maintenance, (b) illegal connections (including theft and vandalism) and (c) unaccounted water. A national “*war on leaks programme*” worth R3 billion was launched in 2015 by the Department of Water and Sanitation to train 15 000 plumbers. Proactive advocacy and communication networks between ward councillors and political leaders are needed to curb water loss as a result of system leaks, thus implementing the national programme at local level. For the four local municipalities (LM) falling under the iLembe district municipality, the following estimated figures were for a five-year period under the Bulk Water Supply Scheme were presented in Map 2.1.

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### Barriers and measures to overcome barriers

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#### **a) Human capital barriers**

Due to possible financial constraints, the district does not have adequate permanently employed personnel to attend to day-to-day community reports of water leaks (incl. administrators, technicians, plumbers, etc.). One of the temporary measures adopted by the district is the employment of interns working towards completion of their studies. This measure is short term and has the disadvantage of not building institutional memory for the responsible section within the district municipality. There is a need to develop an employment programme and also invest in training of personnel. Water losses due to non-attendance of reported faults within a reasonable time is further exacerbated by illegal connections, theft and vandalism of the water infrastructure. The prolonged drought conditions of 2015/16 contributed significantly to this problem. To address this barrier, the municipality upgraded the infrastructure from communal standpipes to individual yard connections per household. Community mobilization was also a significant measure in developing a sense of ownership in communities and reduced the occurrence of the incidents. To address human capital more effectively, the iLembe district municipality is building a work relationship with the Umfolozi TVET (technical and vocational education and training) college. This can go a long way in training plumbers.

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<sup>19</sup>The State of Non-Revenue Water in South Africa (Report No. TT 522/12)

#### **b) Technical/Technological barriers**

The district municipality does not have systems in place of managing water and reducing losses through the water distribution system. A measure to address this barrier is not made explicitly clear in the iLembe district municipality's Integrated Development Plan, which highlighted the Regional Bulk Water Scheme as a flagship programme for the district. There is also a lack of (underground) leak detectors because the equipment is expensive. Replacement costs for detector heads are high. There is a need to develop terms of reference for a scoping study on leak detectors for the district. Reducing leaks will assist the district in alleviating the sanitation backlog worsened by climate change water shortages during drought. Investment in human capital for the monitoring of the water supply/management systems will be crucial for the district to succeed in the reduction of water losses due to leaks in the system. Furthermore, the district does not have a water management system for water works and waste water treatment plant. Water management plans should therefore include the acquisition of this system quantify 'real' and 'apparent' water losses in the district.

#### **c) Environmental barriers**

Climate change induced drought contributed to water losses because dry old pipes filled with air would burst when resupplied with water. Although the extent of losses due to burst pipes has not been quantified/estimated, the incidents have been observed. Drought conditions also increased sanitation backlogs in the district and increased health risks to the affected communities. The municipality had to pay a lot of money for water tankers to transport water across the district. There is a need for the municipality to phase into their programmes the replacement of aging water infrastructure using more durable material.

#### **d) Economic barriers**

Most people in the iLembe district are poor and unemployed (Table 1.2). Paying for water services, which is a constitutional right, is therefore a significant constraint to the district municipality. The late payment of plumbers has also not been encouraging, in addition to the lack of incentives for curbing leaks. The district municipality has engaged in some community outreach programmes, but these need to be scaled up and regularized – a process that will need financial resources. The tender process of appointing service providers is often not seen as transparent. It is therefore quite important that the provincial budget speeches reflect the needs assessment of all districts and the criteria followed to appoint service providers.

### **e) Institutional barriers**

Although the district municipality is mandated to provide water to communities in iLembe, the responsibilities of local municipalities are not explicitly clear in the iLembe district municipality's Integrated Development Plan. The mandate/s for ensuring agricultural water security may be a barrier in a sense that two departments may claim responsibility; i.e. the national Department of Water and Sanitation and/or Department of Agriculture, Forestry and Fisheries. In this technical assistance, the district municipality has teamed up with the provincial government to overcome such constraints.

## **Beneficiaries and impacts**

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### **1. Local municipalities**

- Replace 50 leaking taps, inspection of 10km of pipes, install 10 detection heads, and install meters in 10 households in each municipality (40 households in total). Implementation in four municipalities [KwaDukuza, Maphumulo, Mandeni, and Ndwedwe].
- Management and reduction of debt to the district municipality, Umgeni water, etc.
- Effective management of water-borne diseases. Reduced chances of pathogens breeding by preventing water stagnation in public areas.
- Push-back of 'day zero' for pipes not to run dry.

### **2. All communities, particularly those in low cost subsidy housing projects:**

- Reduced potable water costs to municipalities.
- Possible increase in free water allocation.
- Water allocation to schools and communities to address the sanitation backlogs.

### **3. Private sector shall also benefit from the manufacturing, distribution and installation of site specific hydraulic leak detectors, considering the steep hilly topography on inland iLembe;**

- Job creation in the region.
- Setting up manufacturing and distribution plants for local and international markets.

### **4. Environmental benefits;**

- Reduction of soil erosion.
- Stabilisation of water tables.
- Reduced contamination of aquifers.

## Actions, activities (and timeframes)

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### Action 1: Planning

- Activity 1: Development of terms of reference for external contractual parties in the project (2 months)
- Activity 2: Identification of sites and assessment of technology requirements (3 months)

### Action 2: Implementation (installation)

- Activity 1: Procurement of equipment and inspection services (3 months)
- Activity 2: Installation of equipment (e.g. automated water supply/management system within the iLembe water plant) and inspection carried out (6 months)
- Activity 3: Provision of annual equipment maintenance (Ongoing)

### Action 3: Training and engagement of stakeholders

- Activity 1: Procurement of training services (2 months)
- Activity 2: Training of staff on the new devices to improve water meters reading (4 months)
- Activity 3: Training of locally based plumbers and artisans (6 months)
- Activity 4: Introduce employment programme (Ongoing)

### Action 4: Communication and outreach

- Activity 1: Terms of reference for outreach programme (2 months)
- Activity 2: Identification of agencies to implement outreach (2 months)
- Activity 3: Outreach implementation (awareness training for community) (Ongoing)

## Budget

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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 an 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 incur.

Action	Total Budget ZAR (R)	Total Budget USD @ 12.5
Action 1: Planning 1+2	20,454 + 45,510 = 65,964	5277
Action 2: Training and stakeholder engagement 3+4+5	20,454 + 262,820 = 283,274	22,662

Action 3: Implementation (installation) 6+7+8+9	21,120 + 73,344 + 56,320 + 70,400 = 221,184	17,695
Action 4: Communication and outreach 10+11+12	12,672 + 30,000 + 132,000 = 174,672	13,974
<b>Total</b>	<b>ZAR 745,094</b>	<b>USD 59,608*</b>

\* This does not include the costs of repairs since it cannot be estimated at this stage – it needs to be added on later

Overview of the reducing water system leakages TRM

<b>Sector</b>	Water						
<b>Sub- sector</b>	Reducing water systems leakages						
<b>Technology</b>	Automated water supply/management system and repair of water systems						
<b>Ambition</b>	Replace 50 leaking taps, inspection of 10km of pipes, install 10 detection heads, and install meters in 10 households in each municipality (40 households in total). Implementation in four municipalities [KwaDukuza, Maphumulo, Mandeni, and Ndwedwe]						
<b>Benefits</b>	1) Water availability for consumption 2) promotion of health and sanitation 3) savings for municipality to provide water						
<b>Action</b>	<b>Activities</b>	<b>Responsible body</b>	<b>Time frame<sup>20</sup></b>	<b>Risks &amp; Mitigation</b>	<b>Success Criteria</b>	<b>Indicators for monitoring and implementation</b>	<b>Budget (R)</b>
<b>1. Planning</b>	Development of terms of reference for external contractual parties in the project	Department of water works, 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.	20,454 WN 1
	Identification of sites and assessment of technology requirements	Department of water works, iLembe district municipality	3	Scale of repairs needed underestimated. Adequate site visits coupled with local consultations will ensure suitable sites are chosen and technology requirements are assessed properly.	---	Installation sites identified	45,510 WN 2
<b>ACTION 1 TOTAL</b>				<b>ZAR 65,964 / USD 5277</b>			
<b>2. Implementation (installation)</b>	Procurement of equipment and inspection services	Department of water works, iLembe municipality;	3	Equipment price is difficult to estimate without TORs and result of technology requirements assessment (i.e. current state of pipes or existing infrastructure).	---	All services required for inspection are procured	20,454 WN 3

<sup>20</sup> months

				This is a low risk activity. Following standard procurement procedures will ensure the right equipment is procured.			
	Installation of equipment and inspection	Department of water works, iLembe municipality; Private equipment suppliers	6	Additional structural changes required for installation.  More of the piping infrastructure might have to be replaced depending on results of the inspection. This is very likely and therefore should be budgeted for; however, inputs from private suppliers while identifying sites will bring to light an overall picture of specific installation requirements.	---	Equipment is installed and ready to use at all the identified sites.	262,820 WN 4
	Provision of annual equipment maintenance	Department of water works, iLembe municipality; Private equipment suppliers	Og	Local plumbers and artisans are uninterested or unable to offer adequate maintenance.  Planned training for local plumbers and artisans accompanied with employment programme.	At least 90% of trained artisans and plumbers can perform maintenance after training	Annual maintenance is performed as scheduled	0 See WN 5
<b>ACTION 2 TOTAL</b>				<b>ZAR 283,274 / USD 22,662</b>			
<b>3. Training and engagement of stakeholders</b>	Procurement of training services	Department of water works, iLembe municipality;	2	Inadequate procurement process and ineffective training. This risk will be mitigated by clearly defined TORs developed during the planning phase.		Training services required are procured	21,120 WN 6

	Training programme for staff to improve water meters reading	Department of water works, iLembe municipality; Private equipment suppliers	4	Inadequate or ineffective training.  This can pose substantial risk to the operation of the equipment. The training programme must be closely monitored by the iLembe municipality to ensure users are provided with adequate and effective training.	At least 90% of staff can perform the tasks on which they are trained on after training	Training module for staff is designed and implemented.	73,344 WN 7
	Training of locally based plumbers and artisans	Department of water works, iLembe municipality; Private suppliers who could provide the trainings	6	Local actors are uninterested in the training programme. The training will be part of a broader employment programme and should be coupled with adequate communication and incentivization.	At least 90% of trained artisans and plumbers can perform maintenance after training	Training module for plumbers and artisans is designed and implemented.	56,320 WN 8
	Introduce an employment programme	Department of water works, iLembe municipality; Local technical university	6 months to set it up Og <sup>21</sup>	The employment programme lacks support/funding and is not sustained over time. Well defined TORs for the program and alignment with national war on leaks programme objectives should ensure the relevance of the programme and mitigate these risks.	---	Employment programme is designed and implemented	70,400 WN 9
<b>ACTION 3 TOTAL</b>				<b>ZAR 221,184 / USD 17,695</b>			
<b>4. Communication &amp; Outreach</b>	Terms of reference for outreach programme	Department of water works, iLembe district municipality;	2	Comprehensiveness of the TORs  Consult experts to ensure all-encompassing TORs	At least 3 applicants to the bid.	Terms of reference for designing and implementing	12,672 WN 10

<sup>21</sup> Ongoing

						outreach programme developed and advertised.	
	Identification of agencies to implement outreach	Department of water works, iLembe municipality	2	Incompetent outreach agency.  Following standard service procurement procedures will ensure the right agencies are identified to design and implement the outreach programme.	--	Implementing agency meeting the selection criteria identified	30,000 WN 11
	Outreach implementation	Department of water works, iLembe municipality; Private equipment suppliers; NGOs; Local stakeholders; Local technical university	Og	Agencies do not implement the outreach activities effectively.  This can pose substantial risk to technology deployment in future. Outreach implementation must be closely monitored by the iLembe municipality to ensure wide range of users is covered with an effective programme. Part of this outreach programme would entail awareness raising activities in the communities regarding good practices and water usage.	Outreach programme reaches at least 300,000 people	Outreach programme successfully implemented	132,000 WN 12
<b>ACTION 4 TOTAL</b>				<b>ZAR 174,672 / USD 13,974</b>			
<b>TOTAL BUDGET</b>				<b>ZAR 745,094 / USD 59,608</b>			

Working notes (WN) on cost and savings assumptions

#	Cost Calculation	Assumptions	References
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1	<p>Number of persons: 5  Work Days: 3  Hourly wage:  30,000/(22*8)  Total hours: 5*3*8</p> <p><b>Total Activity budget ≈ 20454</b></p>	<p>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.</p> <p>Number of working days in a month 22.  Working hours per day 8.</p>	<p>Minimum wage rates for SA:  <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p>
2	<p>Number of persons: 4  Travel days: 2*4 = 8  Additional Staff Days = 2 * 4 = 8</p> <p>HR Expenses = (8/22) * 30,000 = 10,910</p> <p>Total trip Expenditure:  7900 * 4 = 31,600  Mapping Expenditure:  3000 approx.</p> <p><b>Total Activity budget ≈ 10910 + 31600 + 3000 = 45510</b></p>	<p>Site visits: 4  Total distance: 150 kms per trip (based on departure from iLembe to each municipality and around)  Fuel efficiency: 11km/l  Gasoline: 14 lit @ 50 = 700 per trip  Personnel: 3000 per trip</p> <p>DA: 397 +128 = 525 + Mark up 100% = 1050 per trip</p> <p>Trip expenditure = fuel + personnel + DA = 700 + 3000 + 4*1050 = 7900</p>	<p>Area of iLembe: 3269 sq. km.</p> <p>Cost of living numbers  <a href="https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa">https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa</a></p> <p>Daily Allowance  <a href="http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx">http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx</a></p>
3	<p>Number of persons: 5  Work Days: 5  Hourly wage:  30,000/(22*8)  Total hours: 5*1*8</p> <p><b>Total Activity budget ≈ 20,454</b></p>	<p>Includes tender floating time</p>	<p>Minimum wage rates for SA:  <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p>
4	<p>Total capital expenditure</p>	<p><u>Inspection of 10km pipes:</u>  approx. R 11000 per day (excl. VAT) + overnight stay for workers (5*1300) = R 61,500</p>	<p><b>Inspection of pipes:</b>  <a href="http://leakdetection.co.za/Cost-of-leak-detection/">http://leakdetection.co.za/Cost-of-leak-detection/</a></p>

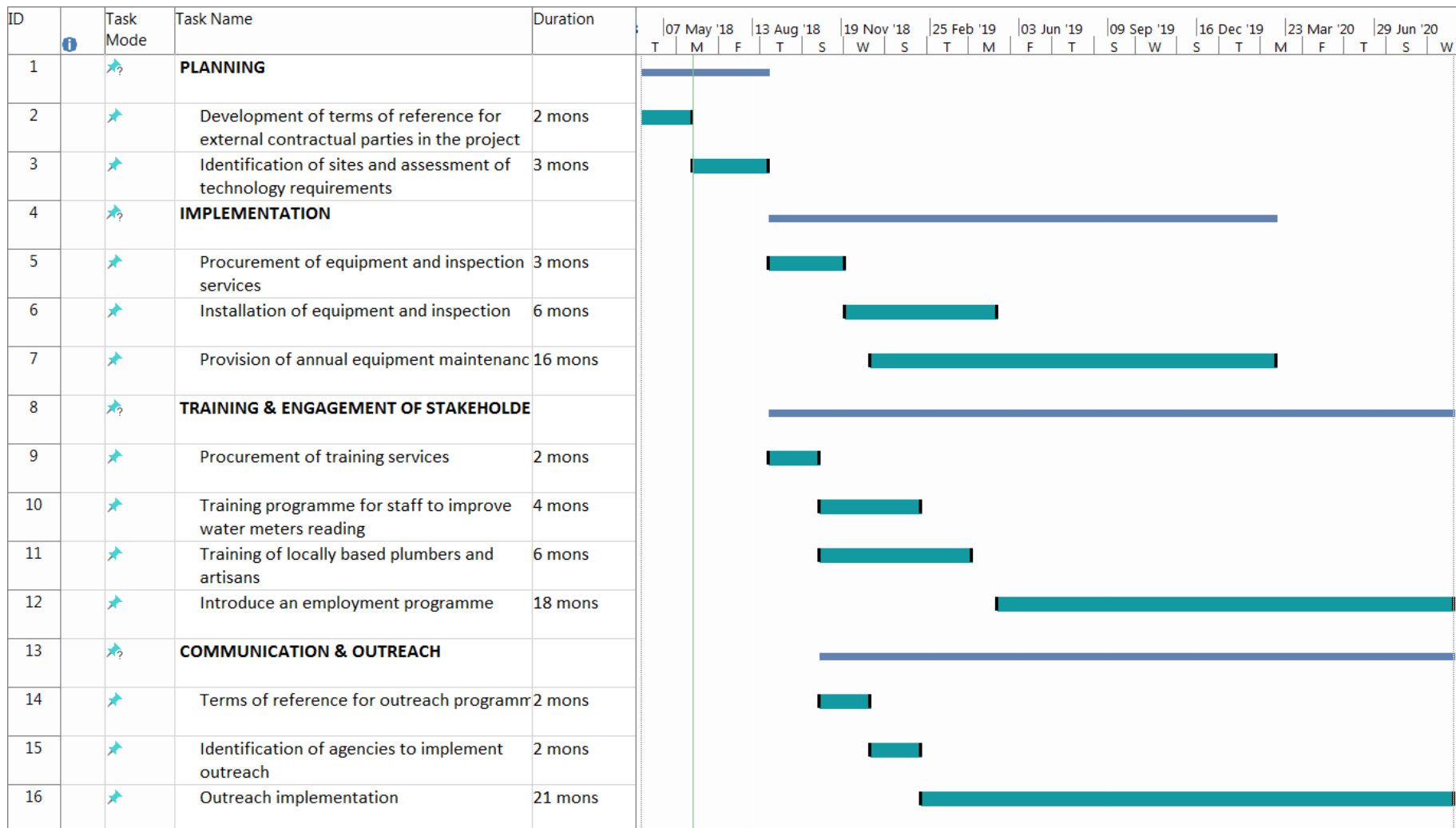
	<p><b>Inspection:</b> Number of days*11000+ Number of overnight stays*1300 = 61500</p> <p><b>Taps replacement:</b> 500 * 50 = 25000</p> <p><b>Detection heads:</b> Unknown number</p> <p><b>Meters:</b> 3000 * 40 = 120,000</p> <p><b>Additional staff time:</b> Number of persons: 2 Work Days: 20 (5 per municipality) Hourly wage: 30,000/(22*8) Total hours: 20*2*8</p> <p>Total cost ≈ 56,320</p> <p><b>Total Activity budget ≈ 262,820 (excluding detector heads and repairs costs)</b></p>	<p>The cost of repairs will have to be added but cannot be estimated without inspection.</p> <p><u>Taps (50):</u> depending on type of taps but for the sake of estimation we assume average price of 500R per piece.</p> <p><u>Detection heads:</u> Unknown at the moment</p> <p><u>Meters (40):</u> depending on the technology – but for the sake of estimating, we assume 3000 R per piece.</p> <p><u>Additional components:</u> <i>Automatization of the whole system could be considered and discussed at the procurement stage. This could entail modernization of hardware and software. To be defined by Municipality in collaboration with service and equipment providers.</i></p>	<p><b>Taps:</b> <a href="https://www.pricecheck.co.za/search?search=kitchen+taps">https://www.pricecheck.co.za/search?search=kitchen+taps</a></p> <p><b>Meters:</b> depends on the type. See for example: <a href="https://assuredautomation.com/WM/residential-water-meter-price-list.php">https://assuredautomation.com/WM/residential-water-meter-price-list.php</a></p> <p><b>Detection heads:</b></p>
5	No cost estimate. See WN 6 and WN 8	This activity should be considered as part of the employment programme and training to local plumbers and artisans, who will be called upon to provide maintenance.	

		Therefore, no cost estimates can be made separately for this component. The cost to the municipality will be detailed in WN 6 and WN 8 (procurement of training services and provision of trainings to local plumbers and artisans)	
6	<p>Number of persons: 3  Work Days: 5  Hourly wage:  30,000/(22*8)  Total hours: 3*5*8</p> <p><b>Total Activity budget ≈ 21,120</b></p>	<p>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.</p> <p>Number of working days in a month 22.  Working hours per day 8.</p>	<p>Minimum wage rates for SA:  <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p>
7	<p>Number of trainings in each municipality (one full day): 2 * 4 = 8  Room rental expenditure:  8 * 1500 = 12,000  Catering: 30 * 150 * 8 ≈ 36,000  Number of trainers: 2  Trainers time cost: 2 * 8 * 9 * [30000/(22*8)] = 25,344  Estimating 1 day prep time for training</p> <p><b>Total activity budget ≈ 73,344</b></p>	<p>Here it is assumed that the trainings would be given by the Department of Water works in collaboration with ILembe Municipality and limited involvement of private equipment suppliers.</p> <p>Training meetings held in each municipality: 2 per municipality  Room rental: 1500 per day  Catering for training day: 150 per person, estimate 30 people per training  Trainers: 30000/(22*8) = 170 per hour</p>	<p>Minimum wage rates for SA:  <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p> <p>Cost of living numbers  <a href="https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa">https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa</a></p>
8	<p>Number of persons: 2  Work Days: 20 (over six months)</p>	<p>Full cost estimates can only be done after having designed the training programme.  At this stage, it only includes staff time from the municipality to manage the training programme over a six month period.</p>	<p>Minimum wage rates for SA:  <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p>

	<p>Hourly wage: 30,000/(22*8) Total hours: 20*2*8</p> <p><b>Total Activity budget ≈ 56,320</b></p>	<p>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.</p> <p>Number of working days in a month 22. Working hours per day 8.</p>	
9	<p>Number of persons: 5 Work Days: 10 (over six months) Hourly wage: 30,000/(22*8) Total hours: 10*5*8</p> <p><b>Total Activity budget ≈ 70,400</b></p>	<p>At this stage, it only includes staff time from the municipality to design the employment programme and set it up in collaboration.</p> <p>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.</p> <p>Number of working days in a month 22. Working hours per day 8.</p>	<p>Minimum wage rates for SA: <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p>
10	<p>Number of persons: 3 Work Days: 3 Hourly wage: 30,000/(22*8) Total hours: 3*3*8</p> <p><b>Total Activity budget ≈ 12,672</b></p>	<p>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.</p> <p>Number of working days in a month 22. Working hours per day 8.</p>	<p>Minimum wage rates for SA: <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p>
11	<p>Number of persons: 2 Work days: 11 Number of Staff days=22 HR Expense=30,000</p> <p><b>Total Activity budget ≈ 30,000</b></p>	<p>Identification tasks include finalizing the proposals from shortlisted agencies including negotiations among key stakeholders for roles and responsibilities for implementation of outreach activities and expert consultations.</p>	

12	<p>Outreach budget – 132,000</p> <p><b>Total Activity budget ≈ 132,000</b></p>	<p>Depending on TORs</p> <p>The budget of the outreach programme will depend on the desired scale and intensity of activities within the outreach programme. This would typically depend on municipal finances. The Water Research Commission (WRC), which has committed to R880,000 finances for research and dissemination component to Vivendi’s water project in 2000.</p> <p>Since this project would be part of the broader national War on Leaks programme, we assume that the iLembe municipality would be willing to spend up to 15% of this amount in the current time for outreach and awareness activities. Part of this spending would go to setting up awareness raising activities in the communities regarding good practices and water usage.</p>	
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### Gantt chart for activities schedule



## Technology Road Map for water efficiency and demand management 2: Irrigation efficiency and information systems

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Water use in the South African agricultural sector accounts for the largest proportion of water allocation in the country. The population is dependent on the agricultural sector to ensure food security, poverty alleviation and job creation. However, inefficient water use for domestic and commercial irrigation is a common practice in South Africa. Incentives for saving water are almost non-existent. In order to achieve irrigation efficiency, the use of appropriate technologies that reduce losses from evaporation, deep drainage or surface run-off needs to be implemented. There are different types of irrigation efficiency techniques, and not all may be suitable to a particular site or crop species/variety.

In 2015, the Water Research Commission (WRC) of South Africa, together with Isowat Consulting CC, developed *Irrigation Efficiency Training Material* detailing effective water management practices that can be applied by both irrigation water users and authorities. This step by step guide offers a path to improving the performance of irrigation infrastructure, using the water balance approach. The Department of Agriculture, Forestry and Fisheries (DAFF) developed the Irrigation Strategy for South Africa in 2015. The aim was to promote efficient utilisation of water resources for sustained food security and economic yields for subsistence farmers. That document outlined the institutional improvements and the investment in irrigation initiatives for success. For the purposes of irrigation, the sprinkler system, which simulates rainfall, is the most commonly used within the agricultural sector although it is a known fact that it wastes water due to evaporation, etc. This is the case for sugar cane plantations in the iLembe district, the primary cash crop for commercial and subsistence farmers.

Within the iLembe district municipality, the northern areas of Ndwedwe, the central corridor of Mandeni and KwaDukuza municipalities are the commercial farming hubs of the district. The commercial farming areas of KwaDukuza, Mandeni and Ndwedwe (31% of the iLembe District) are mainly under privately owned sugar cane plantations. Commercial agricultural activities take up the major portion of the district, substantially located in the flatter eastern parts of the district. Relatively minimal diversification has taken place and activities relate mainly to the growing of sugar cane. The majority of the agricultural developments in the western parts are traditional subsistence farming activities, with maize and other edible crops. These subsistence farmers could benefit from a drip irrigation system constructed from simple locally available material, and different systems can be designed based on financial resources available. Individual households can have small-scale drip

irrigation systems (e.g. using simple narrow tubes and soft drink bottles, as practiced in countries like India, for an example).

The drip irrigation system has gained momentum across a number of commercial farms in South Africa. Drip irrigation is well suited for areas that have or are expected to have limited or irregular water supply for agricultural use. The drip irrigation system uses less water than the sprinkler irrigation, since water can be distributed directly to the roots of the crops according to the plant requirements. Furthermore, this drip technology is not affected by wind or rain but the irrigation requirement (i.e. amount of water to be distributed), largely depends on the climate in which the crop is to be grown and should be calculated for each situation to ensure that the irrigation system is not under or over designed.

The key objective of implementing this technology is to improve the water efficiency within the agricultural sector (both subsistence and commercial) where drip irrigation is appropriate. The purpose of an irrigation system is to apply the desired amount of water, at the correct application rate and uniformly to the whole field, at the right time, with the least amount of non-beneficial water consumption (losses), and as economically as possible. To achieve this task, irrigation efficiency processes need to be adapted for local or district municipalities, to align more accurately with their individual development plans.

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### Barriers and measures to overcome barriers

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#### **a) Human capital barriers**

There is a lack of human capacity in the maintenance and operation of the technology. Further, this technology is perceived to affect mainly commercial farmers; hence there may be little interest by subsistence farmers in adopting it. Development of farmer education programmes as well as new water rights laws can help create incentive and influence the behaviour of farmers towards greater water-efficient management of irrigation systems<sup>22</sup>.

#### **b) Technical/Technological barriers**

Different crops will require different irrigation protocols. This may push up the costs of implementing the technology. In some rural communities, this would be a new technology and it would take time for communities to accept it. For some crops, irrigation protocols may need to be 'imported', and

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<sup>22</sup> Climate change adaptation technologies for water: A practitioner's guide to adaptation technologies for increased water sector resilience. Water Adaptation Technology Brief ([https://www.ctc-n.org/sites/www.ctc-n.org/files/.../improved\\_irrigation\\_efficiency.pdf](https://www.ctc-n.org/sites/www.ctc-n.org/files/.../improved_irrigation_efficiency.pdf))

there may not be locally available material to construct the technology system. Therefore, the district municipality should invest in developing irrigation protocols for the most commonly planted crops, to ensure food security during climate change. Diffusion of information may also be a constraint. Hence the need to invest in information sharing systems such workshops and radio programmes through solar powered radios for rural communities.

**c) Environmental barriers**

Conditions such as soil clay content, irregular rainfall or steep slopes can increase implementation and maintenance costs or affect drip system efficiency. Unexpected rainfall can affect drip systems either by flooding emitters, moving pipes, or affecting the flow of soil salt-content. Drip systems are also exposed to damage by rodents or other animals – where this is likely to be a challenge, communal or household vegetable gardens can be fenced off, and rodent traps (not poison), set in strategic locations. Furthermore, it can be difficult to combine drip irrigation with mechanised production as tractors and other farm machinery can damage pipes, tubes or emitters. Therefore, this technology may best be suited to conservation agriculture, where hand hoes are still being used. The hilly topography of the district could also present gravitational constraints to the flow of water. In certain cases, it would be necessary to redesign the farm weed control programme.

**d) Economic barriers**

The real costs of this technology may not be known until a localised study is undertaken to look into issues of design, operation and maintenance, crop irrigation protocols, markets and needs. Scoping studies are needed in the district to estimate the costs of the technology. The initial cost of drip irrigation systems can be higher than other systems, expensive but a phased approach can help manage the costs. Final costs will depend on terrain characteristics, soil structure, crops and water source. Financing for equipment may be available from financial institutions via leasing operations or direct credit.

**e) Institutional barriers**

The national Department of Water and Sanitation (DWS) and Department of Agriculture Forestry and Fisheries (DAFF) may find it their responsibility to influence the implementation and scaling up of the technology in the district. This may lead to conflicts and poor implementation if mandates are not addressed, from national, provincial and even local government. Within the district, clarity is needed on the source of water to be used as part of the technology; i.e. whether the water would be from the municipal water supply or from dams/wells, some of which are under tribal authority.

## Beneficiaries and impacts

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Drip irrigation is a versatile technology suitable for application in a wide range of contexts. It can be implemented at small or large scales and with low-cost or more sophisticated components. This technology can be employed in conjunction with other adaptation measures such as multi-cropping and fertiliser management. Promoting drip irrigation contributes to efficient water use, reduces requirements for fertilisers and increases soil productivity. It is particularly suitable in areas with permanent or seasonal water scarcity, since crop varieties to plant can also be adaptable to these conditions.

## Actions, Activities and (Timeframes)

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### **Action 1: Planning**

- Activity 1: Consultation with the individual farmers (or farmers' associations) to work together on the identification of technologies (drip irrigation) suitable for this purpose.
- Activity 2: Development of terms of reference for the development of drip irrigation protocols for specific crops (for commercial and subsistence farmers) (*3 months*)
- Activity 3: Assessment of site suitability for the technology (*3 months*)
- Activity 4: Training of farmers in the use and maintenance of the technology (based on WRC's *Irrigation Efficiency Training Material*) (*6 months*)

### **Action 2: Implementation**

- Activity 1: Procurement of equipment (*4 months*)
- Activity 2: Incentivisation of farmers based on needs assessment (*Ongoing*)
- Activity 3: Development of a youth training programme (*3 months*)

### **Action 3: Communication and outreach programme**

- Activity 1: Appointment of a professional agency (*2 months*)
- Activity 2: Roadshows and media press releases/statements (*Ongoing*)

### **Action 4: Research and Development**

- Activity 1: Engagement of experts/tertiary institutions to develop training modules (*Ongoing*)
- Activity 2: Training of municipal officials including extension officers (*6 months*)

## Budget

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The iLembe district municipality has a mandate to provide water to communities in the iLembe region. Estimated figures will be derived from a study on crop irrigation protocols based on the TOR informed by experts.

Overview of the irrigation efficiency and information systems TRM

<b>Sector:</b>	Water						
<b>Sub-sector</b>	Water Management						
<b>Technology</b>	Irrigation efficiency and information systems						
<b>Ambition</b>	Reduce wasting water during irrigation						
<b>Benefits</b>	1) Sustainable food production during drought; 2) Maintenance or even increase in current crop yields; 3) Reduction of soil erosion						
<b>Action</b>	<b>Activities</b>	<b>Responsible body</b>	<b>Time frame</b> 23	<b>Risks &amp; Mitigation</b>	<b>Success criteria</b>	<b>Indicators for monitoring and implementation</b>	<b>Budget (R)</b>
<b>Planning</b>	Development of terms of reference for the development of drip irrigation protocols for specific crops (for commercial and subsistence farmers)	Department of water works, iLembe district municipality	3	Crop dependence of drip irrigation protocols  Expert consultations to ensure comprehensive terms of reference	Funding to appoint a service provider secured  Crop specific irrigation protocols developed	TOR developed  Number of irrigation protocols	
	Assessment of site suitability for the technology	Farmers, private equipment suppliers, iLembe district municipality	3	Hilly landscape may reduce water flow  Expert consultations and to select suitable sites for water sources	Funding secured	Number of sites for technology deployment	

<sup>23</sup> Months

	Training of farmers in the use and maintenance of the technology (based on WRC's <i>Irrigation Efficiency Training Material</i> )	iLembe district municipality, Private equipment suppliers	6	Lack of interest from farmers, especially commercial farmers Promotion of water cost savings and equipment subsidy (incl. provision of loans and rental equipment)	Signed agreements	Number of farmers trained (subsistence and commercial)	
<b>Implementation</b>	Procurement of equipment	Farmers, private equipment suppliers, iLembe district municipality	4	Resistance of the technology by farmers  Partnerships between the municipality and the farmers' associations	Signed agreements	Number of (commercial) farmers adopting the technology	
	Incentivisation of farmers based on needs assessment	iLembe district municipality, private sector	Og <sup>24</sup>	Lack of funding allocation for the technology  Engagement of the private sector	Funding secured	Number of beneficiary farmers	
	Development of a youth training programme	iLembe district municipality	3 <sup>25</sup>	Lack of an employment programme for trained youth  This risk will be mitigated by clear and proper financial planning for the district	Funding secured	Number of youth employed	

<sup>24</sup> Ongoing

<sup>25</sup> Number of months to establish, ongoing thereafter

<b>Communication &amp; Outreach programme</b>	Appointment of a professional agency	iLembe district municipality	2	Lack of transparency in the appointment process  Proper procurement processes should mitigate the risk	Competent agency appointed	Number of communities and schools participating in the programme	
	Roadshows and media press releases/statements	iLembe district municipality	<i>Og</i>	Lack of interest and poor turnout  Community mobilisation	Funding secured	Number of events hosted	
<b>Research and Development</b>	Engagement of experts/tertiary institutions to develop training modules	iLembe district municipality, tertiary institutions in the area	<i>Og</i>	Lack of experts/ R&D capacity in the district  Further training of local tertiary educators by external experts	Experts head-hunted  Signed agreements	Number of fully fledged training programmes introduced in tertiary institutions	
	Training of municipal officials including extension officers	iLembe district municipality	6	Lack of interest by municipal officials  The activity should be part of the job description	Signed agreements  Training should contribute the NQF qualification	Number of officials trained annually	

## Technology Road Map for increased capture and storage of surface run-off: Rainwater harvesting for storage

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Rainwater harvesting for storage or *ex situ* water harvesting, refers to a varied collection of different techniques for the collection and storage of rainwater. Once harvested, the water can be used for a number of different purposes, which include the provision of drinking water, for livestock and irrigation, diversion of run-off water for infiltration in water scarce cropping areas, and refill of aquifers for ground water. Harvested rainwater is stored in natural or artificial reservoirs such as ponds and wells for domestic use or irrigation purposes. Rainwater is also often collected in small scale basins or from rooftops for smaller scale domestic uses.

This type of technology is often utilised in areas where rainfall is either variable or low to support crop production. Its success has also been witnessed in areas where potable drinking water sources are threatened. Rainwater harvesting can be used as a low cost adaptation mechanism at the farm level for increasing soil moisture, reducing soil temperature, and recharging groundwater and other water resources. *Ex situ* rainwater harvesting can reduce pressure on surrounding surface water and groundwater resources, as well as peak flows and flow durations.

Rainwater harvesting is an effective tool to alleviate stress on water resources by harvesting rainwater and storing it. The collection and storage of rainwater provides a convenient and reliable supply of water during seasonal dry periods and droughts. In areas where there are unpredictable weather patterns and water scarcity, this technology may insure availability of this resource. Extensive rainwater storage capacity can significantly reduce land erosion and flood inflow to major rivers. Rainwater collection can also contribute greatly to the stabilization of declining groundwater tables.

In South Africa, there is a small percentage of households that practice this type of technology. In most cases, rural and urban households are investing in UV resistant polyethylene storage tanks (commonly known as Jojo tanks; [www.jojotanks.co.za](http://www.jojotanks.co.za)) to harvest rainwater from their rooftops. Rainwater harvesting has the potential to improve food security for rural communities who have a high dependence on agriculture for food production and in doing so, also improve their livelihoods, as demonstrated by studies commissioned by the Water Research Commission (WRC) in KwaZulu-

Natal<sup>26</sup>. The WRC is developing guidelines to keep harvested free of pests and pathogens. With the increase in drought periods as a result of climate change, the cost of potable is increasing annually; and the quantity of drinking water will also be less from the municipal water supply.

### Barriers and measures to overcome barriers

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#### **a) Human capital barriers**

Lack of trained people on the operation and maintenance of RWH technology may reduce the efficiency of this technology. Furthermore, this technology requires community mobilisation as theft and vandalism of storage tanks and equipment may lead to conflicts. The communities will need time to adjust and accept this technology. Incentivisation or subsidisation of the equipment may assist in overcoming the barrier. Furthermore, the introduction of designer storage tanks may encourage high end households to also adopt the technology.

#### **b) Technical/Technological barriers**

The design of rooftops in some communities may not enable the technology to be implemented. For example, houses in rural communities have a round thatched roof without gutters to collect water. In such rural areas there is a need to provide guidelines on the construction, operation and maintenance of RWH. For agricultural purposes, the municipalities should assist communities with the construction of underground water storage facilities.

#### **c) Environmental barriers**

Water storage facilities carry the constraints of parasite/vector breeding, algal blooms and poor water quality. Furthermore, domestic RWH reduces storm water runoff and the recharge of ground water. This technology should be part of water management planning in the district municipality.

#### **d) Economic barriers**

Indigent households may not afford high quality UV resistant polyethylene storage tanks, including underground storage water tanks. The availability of water allows for crop production and crop diversity throughout the year as well as provides water for livestock and domestic use. This has economic benefits in terms of employment. It reduces travel time to remote water sources especially

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<sup>26</sup> Everson, C., Everson, T.M., Modi, A.T., Csiwila, D., Fanadzo, M., Naiken, V., Auerbach, R.M.B., Moodley, M., Mtshali, S.M., Dladla, R. 2011. *Sustainable Techniques and Practices for Water Harvesting and Conservation and their Effective Application in Resource –poor Agricultural Production through Participatory Adaptive Research*. WRC Report No. 1465/1/11. Pretoria: Water Research Commission.

in rural areas. The National Water Act (and other legal or regulatory provision) (see Table 2.1) need to cater comprehensively for RWH, especially if subsidies for households are to be given<sup>24</sup>. In urban centers, domestic RWH has an impact on water supply, hence management of the technology should be integrated in the management of water supply.

#### **e) Institutional barriers**

At national level, there are mandate matters on the recent policy of rainwater harvesting for households. Both the department of Water and Sanitation and the Department of Agriculture, Forestry and Fisheries consider it their responsibility<sup>27</sup>. There is a need for a structured dialogue between the authorities to facilitate the implementation of the technology, and its mainstreaming into the policy space.

### Beneficiaries and impacts

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1. Communities in low cost housing projects, plus 50 public schools (5000 L), 20 public offices (5000 L) and 25000 rural households (1000 L)
  - Reduced fresh water costs to municipalities.
  - Improved sanitation and health.
  - Food security from household or communal gardens through irrigation using harvested water.
  - NB: maintenance of the health/portability of the water should be regularly tested.
  
2. Reduction in water discharge to communities by the authorities:
  - Water discharge can be planned more efficiently.
  - The risk of emergency drought response which often requires hiring of water tankers can be significantly reduced.
  - Water stress relieve on municipal reservoirs.
  
3. Private sector shall also benefit from the manufacturing, distribution and installation of Jojo tanks for an example;
  - Job creation in the region.
  - Setting up manufacturing and distribution plants for local and international markets.

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<sup>27</sup> J Mwenge Kahinda, BBP Sejamoholo, AE Taigbenu, JR Boroto, ESB Lilie, M Taute and T Cousins. Water resources management in rainwater harvesting: an integrated systems approach. WRC Report No. 1563/1/08

4. Environmental benefits;
- Reduction of soil erosion.
  - Stabilisation of water tables.

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### Actions, activities (and timeframes)

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#### **Action 1: Installation of the equipment**

- Activity 1: Development of terms of reference for external contractual parties in the project (*2 months*)
- Activity 2: Identification of sites (*2 months*)
- Activity 3: Assessment of technology requirement (*2 months*)
- Activity 4: Procurement of equipment (*3 months*)
- Activity 5: Installation of equipment (*6 months*)
- Activity 6: Operations and maintenance (*ongoing*)

#### **Action 2: Training users**

- Activity 1: Training programme for users (*2 months*)
- Activity 2: Provision of annual equipment maintenance (*ongoing*)
- Activity 3: Helpline for user queries (*ongoing*)

#### **Action 3: Communication and outreach**

- Activity 1: Terms of reference for outreach programme (*2 months*)
- Activity 2: Identification of agencies to implement outreach (*2 months*)
- Activity 3: Outreach implementation (*ongoing*)

#### **Action 4: Promotion of local enterprises**

- Activity 1: Identification of potential manufacturers (*3 months*)
- Activity 2: Development of training modules relevant for manufacturers and workers disseminated through local technical university or industrial training institutes (*3 months*)
- Activity 3: Training of manufacturers (*ongoing*)
- Activity 4: Build a suppliers network (*ongoing*)
- Activity 5: Access to subsidized financing options from banks (*ongoing*)
- Activity 6: Access to subsidised excise duty for eco-friendly production (*ongoing*)

## Budget

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The iLembe District Municipality has a mandate to provide water to communities in the iLembe region. In this concept note, however we have used a 50:50 cost sharing mechanism between the municipal bodies and end users. This is to encourage ownership and engagement from the end users. 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 an 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 incur.

<b>Action</b>	<b>Total Budget ZAR (R)</b>	<b>Total Budget USD @ 12.5</b>
Action 1: Installation of the equipment.	$20,445 + 29,710 + 20,445 + 42,741,500 + 34,800 + 0 = 42,846,900$	3,427,752
Action 2: Training users	$34,800 + 15,000 = 49,800$	3,984
Action 3: Communication and outreach	$20,455 + 30,000 + 220,000 = 270,455$	21,636
Action 4: Promotion of local enterprises	$30,000 + 90,000 + 30,000 + 60,000 = 210,000$	16,800
<b>Total</b>	<b>43,377,155</b>	<b>3,470,172</b>

### Overview of the rainwater harvesting TRM

<b>Sector</b>	Water						
<b>Sub- sector</b>	Rainwater harvesting						
<b>Technology</b>	Roof top rainwater harvesting						
<b>Ambition</b>	Roof top rainwater harvesting for 50 public schools (5000 L), 20 public offices (5000 L) and 25000 rural households (1000 L)						
<b>Benefits</b>	1) Water availability for consumption 2) promotion of health and sanitation 3) savings for municipality to provide water						
<b>Action</b>	<b>Activities</b>	<b>Responsible body</b>	<b>Time frame<sup>28</sup></b>	<b>Risks &amp; Mitigation</b>	<b>Success Criteria</b>	<b>Indicators for monitoring and implementation</b>	<b>Budget (R)</b>
<b>Installation</b>	Development of terms of reference for external contractual parties in the project	Department of Water Affairs and Sanitation, iLembe municipality; Water Research Commission; Finance department, iLembe District 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.	20445  WN 1
	Identification of sites	Department of Water Affairs and Sanitation, iLembe municipality, Water Research Commission;	2	Some important sites are not included in the shortlist.  This is not a major risk considering that the implementation is in a	--	Installation sites identified	29710  WN 2

<sup>28</sup> months

		Finance department, iLembe District Municipality; The South African Local Government Association (SALGA)		smaller pool. Local consultations will ensure suitable sites are chosen			
	Assessment of technology requirement	Department of Water Affairs and Sanitation, iLembe municipality; Water Research Commission; Finance department, iLembe District Municipality; SALGA	2	Wrong equipment is chosen.  As rainwater harvesting is an established technology, the risk of identifying wrong equipment is low. Consulting technical experts and private sector providers will mitigate the risk	Technology meets the requirements of end of users	Type and quantity of equipment and accessories required is identified	20445  WN 3
	Procurement of equipment	Department of Water Affairs and Sanitation, iLembe municipality; Private equipment suppliers; Finance department,	3	Equipment is expensive.  This is a low risk activity. Following standard procurement procedures will ensure the right equipment is procured. An effective cost sharing mechanism with the end users will also lower capital	--	All equipment and accessories required for installation are procured	42,741,500 WN 4

		iLembe District Municipality		expenditure for the municipality and create a sense of ownership among the users			
	Installation of equipment	Private equipment suppliers	6	<p>Additional structural changes required for installation.</p> <p>In general, piping infrastructure has to be installed. Some structural changes to harness water from rooftops may be needed. This risk is a low risk activity; however, inputs from private suppliers while identifying sites will bring to light an overall picture of specific installation requirements.</p>	At least 20% of annual water requirement per user met by RWH	Equipment is installed and ready to use at all the identified sites.	34,800 WN 5
	Operations and maintenance	End users	Og <sup>29</sup>	<p>Lack of proper O&amp;M can reduce the technology effectiveness and life span.</p> <p>Ensure that users get relevant training for operating and maintaining the equipment in the long run.</p>	At least 3/4 <sup>th</sup> of the users who can handle regular maintenance issues after the training.	--	0 WN 6

<sup>29</sup> Ongoing

					At least 90% of users can operate the equipment after training		
<b>ACTION 1 TOTAL</b>				<b>ZAR 42,846,900 / USD 3,427,752</b>			
<b>Training</b>	Training programme for users	Department of Water Affairs and Sanitation, iLembe municipality; Private equipment suppliers; Water Research Commission; Finance department, iLembe District Municipality; SALGA	2	Inadequate or ineffective training.  This can pose substantial risk to the operation of the equipment. The training programme must be closely monitored by the iLembe municipality to ensure users are provided with adequate and effective training.	At least 3/4 <sup>th</sup> of the users who can handle regular maintenance issues after the training  At least 90% of users can operate the equipment after training	Training module for end users is designed and implemented.	34,800 WN 7
	Provision of annual equipment maintenance		<i>Og</i>	Suppliers do not provide equipment maintenance service.  Procurement guidelines to include a provision of periodical equipment maintenance service from the suppliers.	End users availing this service are satisfied with the annual maintenance service	Option of annual equipment maintenance is provided to end users.	15,000 WN 8
	Helpline for user queries		<i>Og</i>	Suppliers do not provide a helpline for service queries.	End users availing this	A functional helpline is	

				Procurement guidelines to include a provision of helpline from the suppliers.	service are satisfied with services provided through the helpline	established for end users	
<b>ACTION 2 TOTAL</b>				<b>ZAR 49,800 / USD 3,984</b>			
<b>Communication &amp; Outreach</b>	Terms of reference for outreach programme	Department of Water Affairs and Sanitation, Local technical university; Finance department, iLembe District Municipality; SALGA	2	Comprehensiveness of the TORs  Consult experts to ensure all-encompassing TORs	At least 3 applicants to the bid.	Terms of reference for designing and implementing outreach programme developed and advertised.	20455 WN 9
	Identification of agencies to implement outreach	Department of Water Affairs and Sanitation, iLembe municipality; Finance department, iLembe District Municipality; SALGA	2	Incompetent outreach agency.  Following standard service procurement procedures will ensure the right agencies are identified to design and implement the outreach programme.	--	Implementing agency meeting the selection criteria identified	30,000 WN 10
	Outreach implementation	Department of Water Affairs and Sanitation,	<i>Og</i>	Agencies do not implement the outreach activities effectively	Outreach programme	Outreach programme successfully implemented	220,000 WN 11

		iLembe municipality; Private equipment suppliers; NGOs;  Local stakeholders; Local technical university; Water Research Commission; Finance department, iLembe District Municipality; SALGA		This can pose substantial risk to technology deployment in future. Outreach implementation must be closely monitored by the iLembe municipality to ensure wide range of users are covered with an effective programme	reaches at least 300,000 people		
<b>ACTION 3 TOTAL</b>				<b>ZAR 270,455 / USD 21,636</b>			
<b>Promotion of local enterprises</b>	Identification of potential manufacturers	iLembe municipality; NGOs; SALGA	3	Uninterested manufacturers identified.  An effective training programme will ensure that manufacturers are convinced about the financial viability of the technology. This will enhance their willingness to invest in local manufacturing facilities and include grass root	At least 50 manufacturers identified	List of potential manufacturers identified.	30,000 WN 12

				design innovations suited for the locality in their products. Local consultations will ensure grass root innovators are also included in training modules.			
	Development of training modules relevant for manufacturers and workers disseminated through local technical university or industrial training institutes	iLembe municipality; NGOs; Local industrial associations; Industrial training institute; Local technical university; SALGA	3	Ineffective training module.  The training module for workers involved either in the manufacturing or in repair and installation procedures is a standard low risk module and can be implemented by local industrial training institutes effectively. Training module for manufacturers will require a good balance between technical and economic aspects of manufacturing. Involving local technical university and local industrial associations can help design a comprehensive module.	--	Training modules for manufacturers and workers developed	90,000 WN 13
	Training of manufacturers	iLembe municipality; Local industrial	<i>Og</i>	Less attendees.	At least 2/3 <sup>rd</sup> of the manufacturers	Training modules are implemented	30,000 WN 14

		associations/ cooperation; Local industrial training institute		Active involvement from the iLembe municipality can ensure interested manufacturers and workers receive the training. The outreach programme for users will also indirectly promote local workers to enroll.	identified in the list undergo training	as per time schedule	
	Build a suppliers network	iLembe municipality; Local industrial associations/ cooperation	<i>Og</i>	Policy for subsidies on excise duty is created and implemented.	At least 90% of the existing suppliers join the network	A network of suppliers is created.	60,000 WN 15
	Access to subsidized financing options from banks	iLembe municipality; Local industrial associations/ cooperation; Banks	<i>Og</i>	Funding not secured.  The municipality will have to make provisions manufacturers to have access to subsidised loans for manufacturing either the entire equipment or spare parts. Prior applications for external funding or making a budget allocation for these subsidies will ensure easy finance access to manufacturers.	At least 50% of the local manufacturers entering venturing into the manufacture of RWH equipment and its accessories avail this policy	Policy for subsidized financing options is created and implemented.	WN 16

	Access to subsidised excise duty for eco-friendly production	Provincial Government; iLembe municipality; South African Revenue Service	<i>Og</i>	Funding not secured. The municipality will have to make provisions manufacturers to have access to excise duty rebates for having eco-friendly production. Prior applications for external funding or making a budget allocation for these subsidies while negotiating with the revenue services will make the equipment affordable thereby reduce the long-term capital cost burden on both the municipality and the users.	At least 50% of the local manufacturers entering venturing into the manufacture of RWH equipment and its accessories avail this policy	Policy for subsidies on excise duty is created and implemented.	WN 17
<b>ACTION 3 TOTAL</b>				<b>ZAR 210,000 / USD 16,800</b>			
<b>TOTAL BUDGET</b>				<b>ZAR 43,377,155 / USD 3,470,172</b>			

Working notes (WN) on cost and savings assumptions

#	Cost Calculation	Assumptions	References
1	Number of persons: 5 Work Days: 3 Number of Staff days=5*3 = 15	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.	Minimum wage rates for SA: <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a>

	<p>HR Expense=(15/22)*30,000</p> <p>Total Activity budget ≈ 20445</p>	<p>Number of working days in a month 22. Working hours per day 8.</p>	
2	<p>Number of persons: 4 * 2 Travel Days: 2*1 for site visit Additional Staff Days = 2*4 = 8 HR Expenses: = (8/22) * 30,000 = 10910</p> <p>Total Trip Expenditure = 7900*2 = 15,800</p> <p>Mapping Expenditure: 3,000 approx.</p> <p>Total Activity Budget = 10910 + 15,800 + 3000 ≈ 29,710</p>	<p>Site visits: 2 Total distance: 154 kms per trip (based on area of the district) Fuel efficiency: 11 km/l Gasoline: 14 lit @ 50 = 700 per trip Personnel = 3000 per trip</p> <p>DA: 397+128 =525 + Mark up 100% = 1050 per trip</p> <p>Trip Expenditure= Fuel + Personnel + DA = 700 + 3000 + 4*1050 = 7,900</p>	<p>Area of iLembe: 3269 sq. km.</p> <p>Cost of living numbers <a href="https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa">https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa</a></p> <p>Daily Allowance <a href="http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx">http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx</a></p>
3	<p>Number of persons: 5 Work Days: 3 Number of Staff days=5*3 = 15</p> <p>HR Expense=(15/22)*30,000</p>	<p>Includes tender floating time</p>	

	Total Activity budget ≈ 20445		
4	<p>Total capital expenditure</p> <p>Tanks: 70*4500+ 25000*2000 = 157,500 + 25,000,000 =50,315,000</p> <p>Incidental equipment cost for municipal bodies = 50% * 50,315,000 = 25,157,500 = 37500000</p> <p>Accessories: 70*1000 + 25000*700 =17,570,000 Incidental Accessories Cost = 8,785,000</p> <p>Plinth Construction: 70*1400 + 25000*700 = 17,598,000 Incidental Plinth construction cost = 50%*52240 = 8,799,000</p> <p>Total budget ≈ 85,483,000 End Users Budget: 42,741,500</p>	<p>Total Tanks requirement: 5000 L: 70 units (50 for schools + 20 for public institutions) @ 4500 each 1000 L: 25000 rural households @ 2000 each</p> <p>Accessories requirement (piping, gutter mesh, pre-filtration parts, first flush diverter etc.): 1000 per unit / 700 per unit</p> <p>Plinth construction: 1400 per unit / 700 per unit</p> <p>Municipal bodies to share these costs with end users at 50:50 ratio.</p>	<p>Tank Prices <a href="https://www.makro.co.za/sports-and-outdoor/water-storage-SHG/pg1">https://www.makro.co.za/sports-and-outdoor/water-storage-SHG/pg1</a></p>

	Municipal Budget: 42,741,500		
5	Activity Budget  6 trips = 6*5800 Total budget ≈ 34,800	<p>This activity is the primary responsibility of the equipment providers. The municipal officials to do pilot inspection. 6 visits over a period of 6 months by 2 officials.</p> <p>Site visits: 6 by two staff members Total distance: 154 kms per trip (based on area of the district) Fuel efficiency: 11 km/l Gasoline: 14 lit @ 50 = 700 per trip Personnel = 3000 per trip</p> <p>DA: 397+128 =525 + Mark up 100% = 1050 per trip</p> <p>Trip Expenditure= Fuel + Personnel + DA = 700 + 3000 + 2*1050 = 5800 per trip</p>	
6	Total budget ≈ 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 end users to ensure they are trained enough to operate and pursue regular maintenance of the equipment. This is included in the 'training' action.	
7	Activity Budget  6 trips = 6*5800	<p>Total Installations: 25,000 + 50 + 20 Half day on site training for users. For households this is to be done in batches of 50.</p>	

	<p>Total budget ≈ 34,800</p>	<p>For instructions i.e. schools and public bodies, this is to be done in batches of 10.</p> <p>Total Training: <math>(25000/50)+(50/10) + (20/10)</math> = 507</p> <p>Training material and implementation of training to be provided by equipment suppliers. The municipal body has monitoring and inspection task.</p> <p>It is assumed that 6 visits over a period of 2 months by 2 officials will suffice.</p> <p>Site visits: 6 by two staff members Total distance: 154 kms per trip (based on area of the district) Fuel efficiency: 11 km/l Gasoline: 14 lit @ 50 = 700 per trip Personnel = 3000 per trip</p> <p>DA: <math>397+128 =525 + \text{Mark up } 100\% = 1050</math> per trip</p> <p>Trip Expenditure= Fuel + Personnel + DA = <math>700 + 3000 + 2*1050</math> = 5800 per trip</p>	
8	<p>Number of Staff days=11</p> <p>HR Expense=<math>(11/22)*30,000</math></p>	<p>Provision of annual equipment maintenance and a helpline for user queries is a part of the arrangement with equipment suppliers. The expenses on behalf of the municipality are included in the staff hours spent in the</p>	

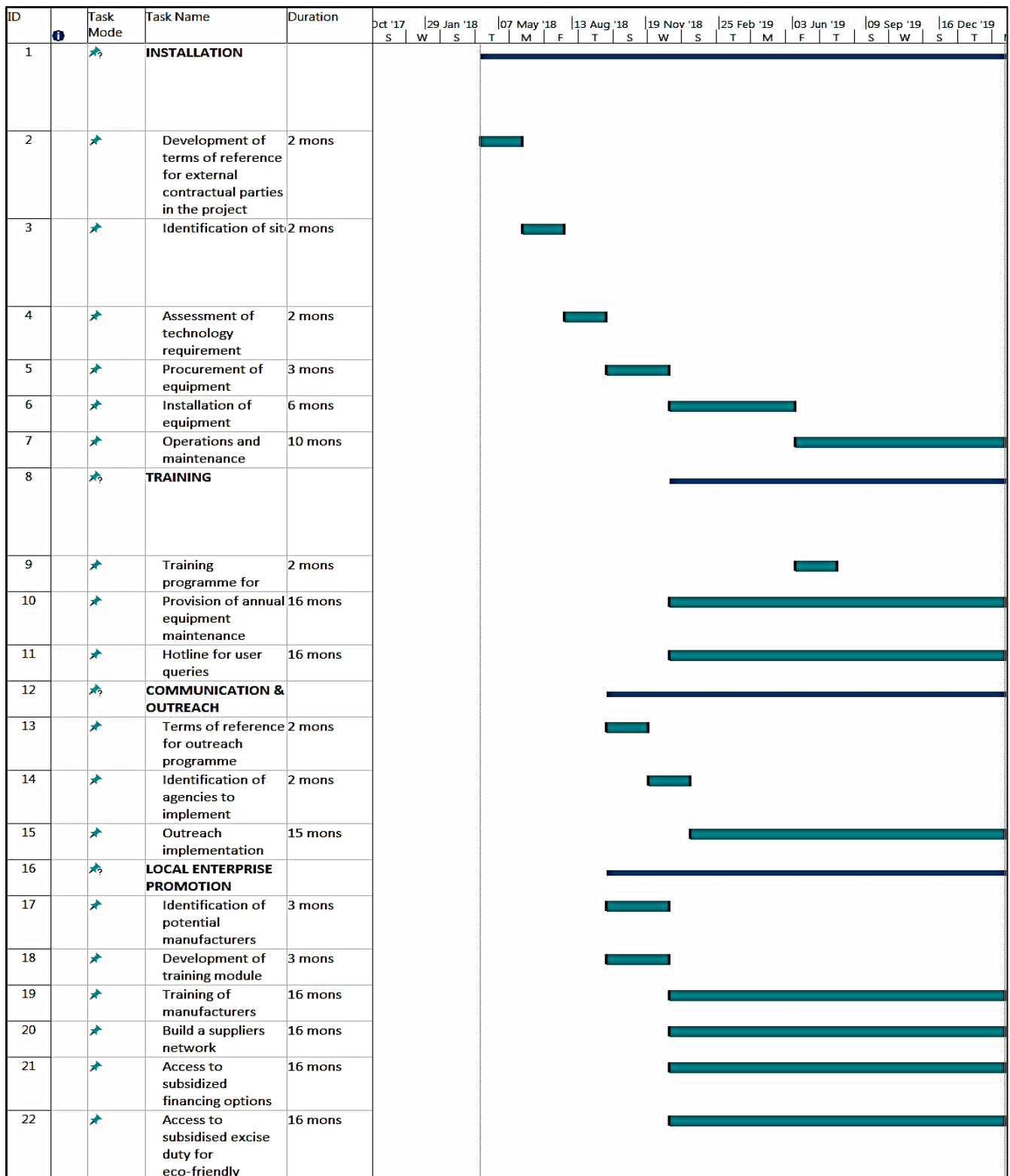
	Total Activity budget ≈ 15,000	development of terms of reference. A contingency expenditure of 11 staff days is kept here for receiving feedback on maintenance services/helpline from ward level representatives and NGOs.	
9	Number of persons: 5 Work Days: 3 Number of Staff days=5*3 = 15  HR Expense=(15/22)*30,000  Total Activity budget ≈ 20445	The assumptions here are same as those in WN 1/WN3 Includes tender floating time	
10	Number of Staff days=22  HR Expense=30,000  Total Activity budget ≈ 30,000	Identification tasks include finalizing the proposals from shortlisted agencies including negotiations among key stakeholders for roles and responsibilities for implementation of outreach activities and expert consultations.	
11	Outreach budget – 220,000  Total Activity budget ≈ 220,000	The budget of the outreach programme will depend on the desired scale and intensity of activities within the outreach programme. This would typically depend on municipal finances. The Water Research Commission (WRC), which has committed to R880,000 finances for research and dissemination component to Vivendi’s water project in 2000.	Durban Metro Water Case study <a href="https://www.wsp.org/sites/wsp.org/files/publications/af_durban.pdf">https://www.wsp.org/sites/wsp.org/files/publications/af_durban.pdf</a>

		We assume that the iLembe municipality would be willing to spend 25% of this amount in the current time for outreach and awareness activities.	
12	<p>Number of Staff days=22</p> <p>HR Expense=30,000</p> <p>Total Activity budget ≈ 30,000</p>	<p>Identification of potential manufacturers will primarily involve local bodies, industrial training institutes and other local organizations to identify grass root innovators and potential entrepreneurs.</p>	
13	<p>Number of Staff days=22</p> <p>HR Expense=30,000</p> <p>Days for technical support Days by Technical university to develop and implement training module – 22 days Expense=30,000</p> <p>Execution and implementation of Design Training for innovators – 22 Days Expense=30,000</p> <p>Total Activity budget ≈ 90,000</p>	<p>Training has two components:</p> <ol style="list-style-type: none"> <li>1) The local technical university will have include courses that incorporate training for installation and O&amp;M of the system.</li> <li>2) Design training making prototypes of grass root innovators production viable.</li> </ol> <p>Apart from this, there is administrative support from the municipal body to organize these trainings.</p>	

14	<p>Execution and implementation training for potential entrepreneurs. – 22 Days Expense=30,000</p> <p>Total Activity budget ≈ 30,000</p>	<p>Fundamentals of finance training from local university for potential entrepreneurs. This is to be primarily implemented by a local university with support from municipal body providing potential entrepreneurs training on financing alternatives and supporting them to establish themselves as local equipment or spare part suppliers.</p>	
15	<p>Execution and implementation training for potential entrepreneurs. – 44 Days Expense = 60,000</p> <p>Total Activity budget ≈ 60,000</p>	<p>Local suppliers' network can be facilitated in more than one ways and the budget depending upon the scope and size of the network. Since the implementation scope is limited to iLembe district, the municipal body can provide basic network support through directories, supplier website and providing exchange forums.</p>	
16	<p>Total Activity budget ≈ 0*</p>	<p>Municipal body can facilitate access to subsidized financing options in order to promote local manufacturing. As the scale and scope of manufacturing is not known, it is difficult to estimate the quantum of subsidy required. For now, the budget of this activity is assumed to 0.</p>	
17	<p>Total Activity budget ≈ 0*</p>	<p>Municipal body along with the revenue service and provincial government can provide excise duty subsidy for promoting local manufacturing. As the scale and scope of manufacturing is not known, it is difficult to estimate the quantum of</p>	

		subsidy required. For now, the budget of this activity is assumed to 0.	
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### Gantt chart for activities schedule<sup>30</sup>



### PART 3

<sup>30</sup> Monthly schedule for 21 months. The technology is expected to last 10 years with regular maintenance.

Sector overview

South Africa has a history, in as far as renewable energy policy is concerned, that dates back to 2003, which of course was developed in the backdrop of a general Energy Policy that was first published in 1998. The renewable energy ambition of the country is informed by this policy environment. At the time of writing this roadmap the South African government was in the process of updating the Integrated Resource Plan (2010) (Table 3.1).

**Table 3.1** Relevant energy policies and acts in South Africa

National	
<b>Energy Policy (1998)</b>	The objectives of the policy are to increase access to affordable energy services, improve energy governance, stimulating economic development, managing energy related environmental impacts and securing diversity. (Department of Minerals and Energy/Republic of South Africa & Department of Minerals and Energy of the Republic of South Africa, 2003; Thabethe, 2010)
<b>Renewable Energy Policy (2003)</b>	The general aim is to foster the uptake of renewable energy. (Department of Minerals and Energy/Republic of South Africa & Department of Minerals and Energy of the Republic of South Africa, 2003)
<b>National Energy Act (2008)</b>	The aim is to ensure that diverse energy resources are available, in sustainable quantities and at affordable prices, to the South African economy in support of economic growth and poverty alleviation. (Republic of South Africa, 2008)
<b>Integrated Resource Plan (2010)</b>	Medium to long-term plan to support the expansion of electricity supply including private and own generation and power purchases from regional projects. (Department of Energy, 2013)
<b>Renewable Energy Feed-in-Tariff Scheme (2009)</b>	First renewable energy feed-in-tariff (REFIT) in the country. It placed an obligation on the country's electricity public utility to purchase the output from qualifying renewable energy generators at pre-determined prices. Phase I of the scheme covered the following technologies: wind, small hydro, landfill gas methane and concentrated solar plant (CSP). For phase II, six new technologies were approved including: large-scale grid connected PV systems, solid biomass and biogas. The scheme does not include off-grid power generation.
<b>Renewable Energy Independent Power Producers Programme (REIPPP) (2011)</b>	In 2011, the Department for Energy switched " <i>from the REFIT scheme to a procurement process based on price competition</i> " called Renewable Energy Independent Power Producers Programme (REIPPP). ("IEA - South Africa," 2013)
Regional (SADC)	

National	
<b>Protocol on Energy (1996)</b>	Aims to promote the harmonious development of national energy policies and matters of common interest for the balanced and equitable development of energy throughout the SADC Region. ("Protocol on Energy in the Southern African development Community (SADC) Region," 2006)
<b>Regional Infrastructure Development Master Plan Energy Sector Plan (2012)</b>	Strategic framework guiding infrastructure development in Southern Africa covering six sectors: energy, transport, information and communications technology, meteorology, transboundary water resources, and tourism. (SADC, 2012)
<b>Various</b>	SADC Energy Cooperation Policy and Strategy (1996); SADC Energy Action Plan (1997); SADC Energy Activity Plan (2000). Establishment of the Southern African Power Pool (creation of common market for electricity in the region) and the Regional electricity Regulatory Association.

South Africa has a high level of Renewable Energy potential and presently has in place a target of 17 800 MW of Renewable Energy by 2030 under the Integrated Resources Plan (Table 3.1). In 2011, the Minister of Energy determined an initial 3 725 megawatts (MW) to be generated from Renewable Energy sources and pursuant to that has added a further 9 500MW through two new determinations bringing the total to 13 225 MW. The Independent Power Producer Procurement Programme (IPPPP) was designed to contribute towards the above-mentioned target and towards socio-economic and environmentally sustainable growth, and to stimulate the renewable industry in South Africa. The IPP Procurement Programme was launched by the Department of Energy in August 2011. Since the launch of the programme, the Department has procured 6 376 MW across 102 projects in the Large and Small Projects IPP Procurement Programme<sup>31</sup>.

In the IPP Procurement Programme, the Minister of Energy allocated an initial 100 MW of the 3725 MW to the procurement of small projects which has since been expanded to 400 MW which individually have a maximum contracted capacity of 5 MW. The projects with a generation capacity of not less than 1 MW and not more than 5 MW utilising the following technologies shall be considered as qualifying technologies for selection under this Small Projects IPP Procurement Programme:

- onshore wind
- solar photovoltaic
- biomass
- biogas
- landfill gas

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<sup>31</sup> <https://www.ipp-smallprojects.co.za/>

Transport accounts for about 13% of total national GHG emissions and 25% in the eThekweni community related GHG inventory<sup>32</sup>. The South African Second Communication to the UNFCCC notes that total emissions in the transport sector increased by 25% between the 1990 and 2000 GHG inventories. In general, this reflects increase economic activities and improved living standards. A 2012 Regulation (R. 671 of Petroleum Products Act, 2012) has introduced requirements for biomass blending in transport emissions to a minimum of 5% which will provide some level of reducing GHG emissions in this sector, whereby the number of private car owners is ever-increasing, in line with economic growth. This will remain at least until a formal public transport network such as the Integrated Rapid Public Transport Network (IRPTN) is in place and operating successfully throughout the KwaDukuza and greater iLembe region. Since there is no utility-level power generation in any of the local municipalities, and in the entire District, the most relevant direct energy-use emission sources in iLembe are likely to be from transport and commercial energy use<sup>33</sup>.

For the transport sector the mitigation abatement (i.e. actions taken to reduce greenhouse gas emissions) potential of biofuels is disaggregated into three subsectors, namely the road, rail aviation. These are outlines in the Table 3.2 below for 2020, 2030 and 2050, extracted from DEA (2014):

**Table 3.2** Mitigation potential analysis of biodiesel (Source DEA, 2014)

Subsector	2020		2030		2050	
	Abatement	MAC	Abatement	MAC	Abatement	MAC
Road	1,959	1,808	8,286	1,108	30,374	232
Rail	33	1,554	74	1,321	380	936
Aviation	212	1,131	571	632	969	-17

Abatement is measure in ktCO<sub>2</sub>e and marginal abatement costs (MAC) are measures in R/tCO<sub>2</sub>e

From the above table, it is clear that there is a: large potential for emissions reductions in the road subsector, and hence biofuels are considered as an attractive technology option. The above are national scenarios, but is clear that they can easily apply to the iLembe and the mode of transportation in the district is automobiles.

<sup>32</sup> DEA, 2014: *South Africa's Greenhouse Gas (GHG) Mitigation Potential Analysis*. Pretoria, Department of Environmental Affairs.

<sup>33</sup> KwaDukuza Municipality, 2013: *KwaDukuza Climate Change Strategy*, KwaDukuza

### **a) Human capital barriers**

The generation of bioenergy from ethanol is a highly scientific and requires specialised skills such as those acquired in chemical engineering programmes. This means that this technology does not have the capacity for creating jobs on a large scale and therefore might not be attractive to the District. It would however attract specialised skills to the region.

### **b) Technical/technological barriers**

The technology is expensive and technically involved. The latter suggests that it requires specialised skills. As there are limited expertise and experience in the District, this might be a significant technology transfer barrier. However as biodiesel initiative, investment into skills development could be encouraged and implemented.

### **c) Environmental barriers**

The process of distilling fermented corn or grain takes a long time and involves a lot of heat expenditure. The source of heat for distillation is mostly fossil fuel, and fossil fuels emit a lot of greenhouse gas, which is detrimental to the environment.

### **d) Economic barriers**

The energy content of the petrol is much higher than the one of bioethanol. Burning 1 litre of ethanol gives 34% less energy than burning the same amount of petrol. In other words, Bioethanol is not as efficient as petroleum. Its energy content is 70% of that of petrol. End users could end up paying more for more fuel to do the same work. So the use of bioethanol in public transportation will lead to increasing the price of the service. This disadvantage is major technology transfer barrier<sup>34</sup>

### **e) Institutional barriers**

There needs to be improved synergies between the sugar cane industry and iLembe. These are not non-existent because business activities in the District are governed by iLembe Chamber of Commerce, which is keen on getting biodiesel activities on line. There might also be administrative hurdles that would need to be removed, which are currently a hindrance at this stage. The issue biodiesel has been talked about for many years in the district, but there have been no activities to that effect yet.

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<sup>34</sup> <http://bioethanol-np.blogspot.com/p/advantages-of-bioethanol.html>

## Beneficiaries and impacts

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### 1. Local municipalities

- iLembe District Municipality would have an additional source of energy, thus improving the energy provision mix in the area.
- Waste management would also be improved. Since bio-diesel is produced from by-products of sugar cane production.
- Increasing energy security by producing and using biofuels locally, thus reducing the dependence on imported fossil oil;
- Less reliance on ESKOM for energy, thus reducing budgetary burdens on the District and its municipalities
- Saving foreign currency by displacing fossil oil imports;
- Earning foreign currency by producing biofuels for export.
- Diversifying the industrial sector.

### 2. Communities and industry

- Additional jobs would be created and specialised skills developed.
- The development of specialised skills in the District that would be useful when the technology is upscaled.
- Ethanol is a high-octane fuel that helps prevent engine knocking and generates more power in higher compression engines.

### 3. Environmental benefits

- GHG savings: most biofuels offer net GHG savings compared to fossil fuels, unless land area containing high carbon stocks (eg. rainforest, peatland) is cleared to make way for biofuel feedstock plantations. These GHG savings are achieved beyond the production stage.
- Ethanol adds oxygen to gasoline which helps reduce air pollution and harmful emissions in tailpipe exhaust.

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## Actions, activities (and timeframes)

### **Action 1: Capacity development on biofuels and barrier analysis**

- Activity 1: Capacitate District officials on the biofuel technology dynamics
- Activity 2: Develop ToR for identifying technology transfer barriers

- Activity 3: Funding resource mobilisation for barrier analysis project

**Action 1: Investment ready business case**

- Activity 1: Discussions with industry partners
- Activity 2: Develop technology choice information through analysis
- Activity 3: Develop investment ready business case
- Activity 4: Identification of investors

Overview of the household biodiesel (ethanol) TRM

<b>Sector</b>	<b>Energy</b>						
<b>Sub-sector</b>	Renewable Energy						
<b>Technology</b>	Biofuel (ethanol)						
<b>Ambition</b>	Fully development business cases for Darnall and Geldhow sugar mills – these projects should be investment-ready						
<b>Benefits</b>	Clean energy and the reduction of GHG emissions						
<b>Action</b>	<b>Activities to be implemented</b>	<b>Sources of funding</b>	<b>Responsible body and focal point</b>	<b>Time frame</b>	<b>Risks</b>	<b>Success criteria</b>	<b>Indicators for Monitoring of implementation</b>
<b>Action 1</b>	1.1: Capacitate District officials on the Biofuel technology dynamics	iLembe District Municipality	Market players/expects that can provide training	6 months	Unavailability of budget due to other priorities	Interest from the sugar industry	Number of capacitated officials in the technology
	1.2: Develop the ToRs for a project that will focus on identifying technology transfer barriers and seeking solutions to them.	In-house as this should be undertaken by District officials	iLembe District Municipality	9 months	Capacity to develop appropriate ToRs	ToRs published	ToRs document and advertisement
	1.3: Identify sources of funding to support the implementation of the project proposed in Activity 1.2	In-house as this should be undertaken by District officials	iLembe District Municipality	9 months	Lack of funding available	Funding identified and secured	Number if donors that have been identified.  Amount of funding secured in relation to the number of donors identified.

<b>Action 2</b>	2.1: Initiate discussions with Enterprise iLembe and industry players on how the outcomes of the scoping study could be taken forward.	In-house as this should be undertaken by District officials	iLembe District Municipality	12 months	Lack of interest in industry players  Some of the ethanol does not go to biodiesel product	Agreements and commitments from industry players should be secured	Signed agreements with industry players – not contracts but agreements etc.
	2.2 Develop technology choice information through analysis	In-house as this should be undertaken by District officials	In-house as this should be undertaken by District officials	12 months	Lack of capacity  Lack of internal funding	Analysis completed	Report on the analysis of technology options considered.
	2.3 Development of investment ready business cases – investment ready project proposals/business cases	In-house as this should be undertaken by District officials	In-house as this should be undertaken by District officials	12 months	Lack of capacity for the development of business cases – this is a well known gap in municipalities  Lack of internal funding  Lack of corporation	Completed business cases that have been evaluated and reviewed by business	Number of business cases completed

					from industry partners		
	2.4 Identification of investors through organisations such as CTI PFAN	In-house as this should be undertaken by District officials	In-house as this should be undertaken by District officials	12 months	Limited knowledge of the international investor landscape and climate finance	Number of investor identified, contacted and negotiated with	Level of investment secured in monetary terms.

Solar photovoltaic, or simply photovoltaic (PV), refers to the technology of using solar cells to convert solar radiation directly into electricity. A solar cell works based on the photovoltaic effect. R&D and practical experience with photovoltaics have led to the development of three generations of solar cells: Crystalline silicon based solar cells, thin film solar cells and third generation PV. Solar PV is very likely to play a significant role in climate change mitigation in the future. However, today, in spite of significant decreases in the cost for solar PV systems, a majority of PV deployment is still driven by substantial subsidy schemes, particularly feed-in tariffs.

There is an obvious, yet important, qualification to the discussion above on efficiency, which is that solar panels are limited to only produce electricity in periods of sunlight, either direct light or diffuse sunlight on overcast days. This means that solar cells, if used for remote/off-grid generation purposes, need to be implemented in conjunction with some kind of storage system such as a battery or as a hybrid system with some other type of generator. Where solar cells are grid connected this is less of a problem. They can be used during the day to reduce the local demand from the grid (or even to export back to the grid) and then at night, or during periods of low incident light, the grid can supply the necessary power. The former kind of application, as a remote or off-grid generator, is most commonly observed in developing countries and isolated areas, while grid-connected solar PV is more common in industrialized countries which have a wider reaching grid.

Grid connected solar PV also can have differences in the approach used depending on the way in which customers purchase the electricity. If the solar array is distributed, for example over a larger number of residential houses, then the single installations are operated by the consumer directly. The advantage of this to the consumer is that the cost of electricity, that the consumer must compete with, is the distributed cost, i.e. the cost to purchase power at the location of demand which is normally significantly higher than the actual levelised production cost of electricity (that doesn't account for transmission/distribution charges/losses and profit margins along the value chain). Solar installations can also be large and centralized but this demands that the power is sold into the common grid at market prices and must compete directly with other technologies (bearing in mind any subsidies that might be applicable for solar generation).

In terms of its social and environmental benefits, solar PV is ranked number 14 relative to other technologies in South Africa<sup>35</sup>, out of a total of 172, even though the prices of the technology are decreasing significantly in terms of the cost and implementability in South Africa it is ranked 98. According to the local mitigation potential analysis, 8,921, 20,977 and 54, 227 ktCO<sub>2</sub>e corresponding to the years 2020, 2030 and 2050, respectively can be achieved, thus rendering it attractive for climate change mitigation. Since national government focuses on large scale PV technology implementation, localized initiatives need to be induced via technical assistance to develop investment ready project proposal and linking these projects to international climate finance. The CTCN is suitably geared to facilitate this.

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### Barriers and measures to overcome the barriers

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Key barriers to technology transfer of solar PV technologies have been identified in the specified categories below:

#### **a) Human capital barriers**

The implementation of the technology requires specialised skills. Whilst the installation of PV systems would create jobs in the District, there will be a need for training technicians who will do the actual installation. This would delay the projects. This technology also requires high levels of maintenance, which includes regular reporting on a regular basis. Specialised skills are required for this purpose. There is lack of such skills in the District. To address this barrier, the municipality should link with the education sector in order to include information about the technologies in the Technology Education curriculum. Education about the technologies should not be limited to schools, community leaders (traditional or otherwise) should also be capacitated in this regard, through them communities can then be capacitated.

#### **b) Technical/technological barriers**

The first barrier is in the minds of PV manufacturers and integrators, most of whom are in the more affluent nations of the developed world, and who are used to marketing their products to wealthier customers in the developed world. Likewise, potential customers in the developing world are often not familiar with PV's and their advantages.

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<sup>35</sup> DEA, 2014: *South Africa's Greenhouse Gas (GHG) Mitigation Potential Analysis*. Pretoria, Department of Environmental Affairs.

### **c) Environmental barriers**

After use a technology needs to be decommissioned. Safe disposal of batteries and solar panels is difficult in the absence of efficient recycling processes. In its IDP the District has implemented many recycling projects. It is unlikely however that the recycling process that are currently in place are geared towards decommissioning technologies as PV. This has significant adverse environmental impacts. To address this problem, and to address this issue, the District should include recycling of technological waste in its IDP.

### **d) Economic barriers**

Lack of financing options can be a significant for off grid PV systems. To identify international sources of funding for technology transfer projects will be a challenge because of the return on investment. A viable option is a concerted effort by the municipality to develop technology transfer projects that can be linked to international funding agencies via the Climate Technology Centre and Network as this initiative would encourage off grid electricity connections and supplies for the rural poor. Municipal revenue is tied to electric sales, Note that in iLembe District municipality only Kwa Dukuza Local Municipality has this capability, but the rest of the municipalities (i.e. Mandeni, Ndwedwe and Maphumulo) will follow suit in due course.

### **e) Institutional barriers**

The provision of energy is the responsibility of KwaDukuza Local Municipality and for off grid PV systems, the local municipality would require support from the District, whose priorities might not include PV street lighting as an option. If there is no supports system from higher government layers or structures, then the installation on the ground would be stalled o difficult. To remove the barrier the District's policies should be aligned with the provincial and national ones to render efforts more streamlined.

## **Beneficiaries and impacts**

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1. Local municipalities
  - Less reliance on ESKOM for the provision of street lighting in the local municipalities
  - Improved savings in the long run.
2. All communities
  - Improved safety and security
  - Job creation
  - Specialised skills developed

### 3. Private sector

- Opportunities for technology suppliers
- Opportunities for technology localisation
- Safety and security of business in the local municipalities due to improved criminal prevention mechanisms or process.

### 4. Environmental benefits

- Reduction of GHG concentrations

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#### Actions, activities (and Timeframes)

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The iLembe IDP for the 2017 – 2022 period has been put in place and therein, the District has resolved to participate in all climate change events at the provincial, national and international levels. As a response to the IDP, the following key actions for the period 2017 – 2022 have been identified:

#### **Action 1: Installation**

- Activity 1: Establish the technical committee (*2 months*)
- Activity 2: Identification of sites (*2 months*)
- Activity 3: Assessment of technology requirements (*2 months*)
- Activity 4: Development of terms of reference for external (*2 months*)

#### **Action 2: Implementation and communication**

- Activity 1: Procurement of equipment (*3 months*)
- Activity 2: Installation of equipment (*4 months*)
- Activity 3: User committee formation and training (*2 months*)
- Activity 4: Operations and maintenance (*on going*)
- Activity 5: Communication and outreach (*2 months*)

The iLembe district municipality has a mandate to provide electricity to communities in the iLembe region. In the table below, we provide an 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 incur. 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.

<b>Action</b>	<b>Total Budget ZAR</b>	<b>Total Budget USD @ 12.5</b>
Action 1: Scoping.	25455 + 25455 + 25455 + 25455 = 101820	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
<b>Total</b>	<b>4,244,585</b>	<b>339,567</b>

Overview of the solar photovoltaic TRM applied to street lighting

<b>Sector</b>	Renewable Energy / Electricity						
<b>Sub- sector</b>	Solar PVS						
<b>Technology</b>	Solar PV Street Lighting						
<b>Ambition</b>	Grid connected solar PV street lighting for 5 kms of street length in iLembe district.						
<b>Benefits</b>	1) Increase public safety 2) Increase possibility of commercial activities 3) Improve socialization						
<b>Action</b>	<b>Activities</b>	<b>Responsible body</b>	<b>Time frame<sup>36</sup></b>	<b>Risks &amp; Mitigation</b>	<b>Success Criteria</b>	<b>M&amp;I Indicators</b>	<b>Budget R</b>
<b>Installation</b>	Technical committee	iLembe Municipality	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.	A competent technical committee characterised by a diverse but relevant skill set	ToRs of the technical committee and the committee is operational  Evidence of meetings provided.	25,455 WN 1
	Identification of sites	Technical Committee	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	Efficient process for identification of sites in place and operational	Number of sites identified and characterised	25,455 WN 1
	Assessment of technology requirements	Technical Committee; Suppliers	2	Wrong equipment is chosen.	Clear criteria for assessment of	Technology requirement assessment	25,455 WN 1

<sup>36</sup> months

				Solar PV Street Lighting is a standard technology. The risk is more is matching the needs and technical aspects. Engagements with stakeholders and the private sector will mitigate the risk	technology requirement	accepted by stakeholders	
	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	TORs accepted by stakeholders	Published TORs	25,455 WN 1
<b>ACTION 1 TOTAL</b>				<b>R101, 820.00/ \$ 8, 145.60</b>			
<b>Implementation &amp; Communication</b>	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.	iLembe municipality procurement procedures adhered to.	Number of procured technology components	4,040,000 WN 2
	Installation of equipment	Suppliers, Technical Committee; Local bodies	4	Additional structural changes required for installation.  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.	Equipment installation procedures verified	Number of components of the equipment installed	21,400 WN 3

	User committee formation and training	Technical Committee; iLembe Municipality; Suppliers; Local bodies	2	User 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.	Proper engagement with user committee  Properly trained user committee	Fully established user committee	40,455 WN 4
	Operations and maintenance	User Committee; Suppliers; Local bodies	Og <sup>37</sup>	Maintenance issues are not reported.  User 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 annual maintenance contract of suppliers.	Standard operating procedures (SoPs) developed	Material outlining SoPs accepted by the stakeholders	0 WN 5
	Communication and outreach	Technical Committee; iLembe Municipality; Suppliers; Local bodies;	2	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.	An operational outreach programme	Number of communities impacted by the outreach	40, 910 WN 6

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<sup>37</sup> Ongoing

				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.				
<b>ACTION 2 TOTAL</b>					<b>R 4, 142, 765.00/\$ 331, 421.20</b>			
<b>TOTAL</b>					<b>R 4, 244, 585.00/R 339, 566.80</b>			

Working notes (WN) on cost and savings assumptions

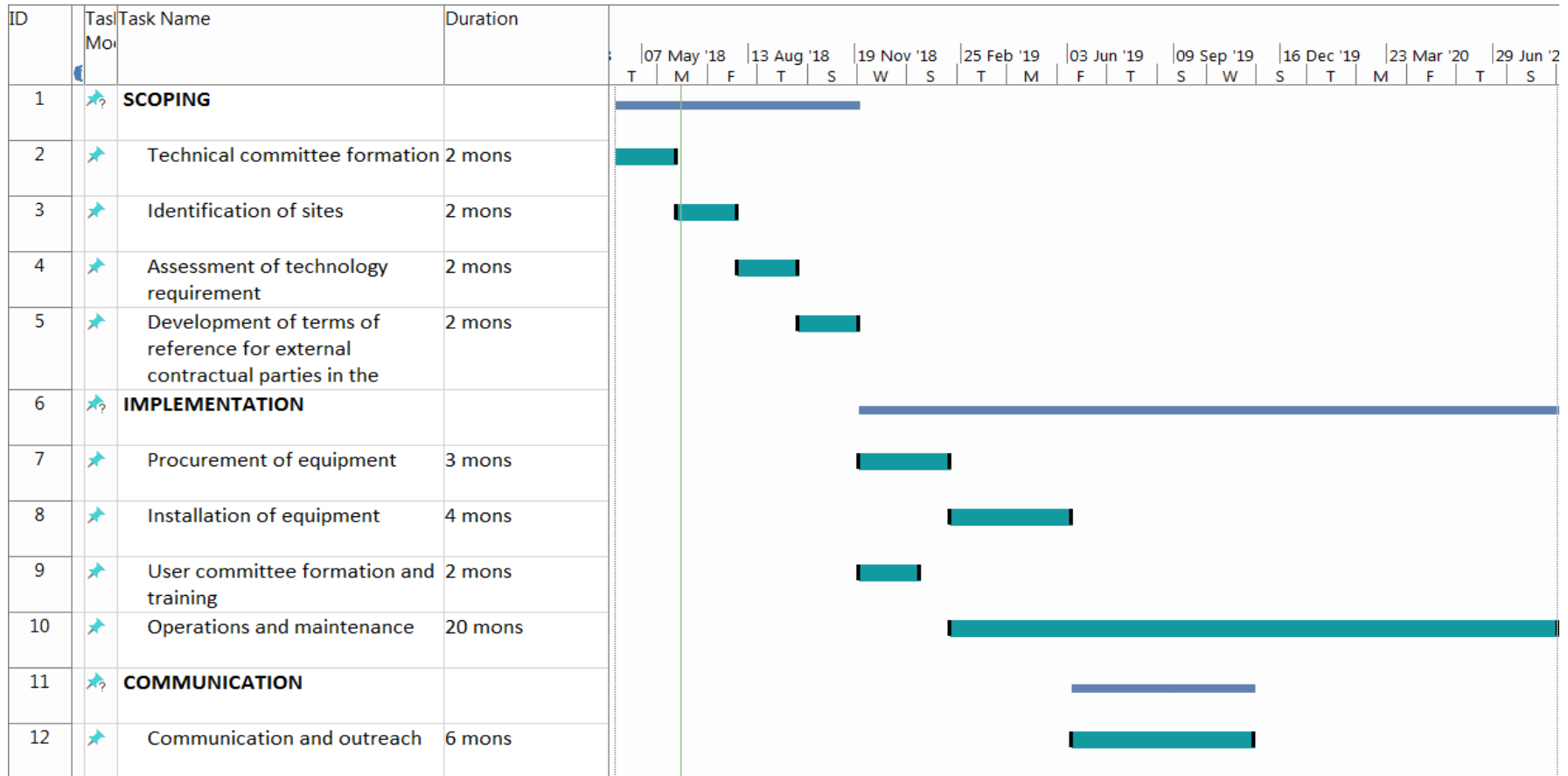
#	Cost Calculation	Assumptions	References
1	<p>Number of persons: 5  Work Days: 3  Number of Staff days=5*3 = 15</p> <p>HR Expense=(15/22)*30,000</p> <p>Stakeholder engagement = 5000</p> <p>Total Activity budget ≈ 20445 + 5000 = 25455</p>	<p>Minimum wage rate is 2933 per month for workers (rounded to 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.</p> <p>Number of working days in a month 22.  Working hours per day 8.</p> <p>In general, we assume that activities 1, 2, 3 and 4 have the same amount of work load. The estimates.</p> <p>A provision of 20,000 R is made for engaging with stakeholders wherever necessary i.e. 5000 for each activity.</p>	<p>Minimum wage rates for SA:  <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p>

2	<p>Number of poles assuming a gap of 25m = <math>5000\text{m}/25 = 200</math> poles</p> <p>Cost of each pole including installation = 20,000</p> <p>For 200 poles= 4,000,000</p> <p>Provision for structural changes (1%)= 40,000</p> <p>Total Activity = 4,000,000 + 40,000 =4,040,000</p>	<p>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.</p> <p>A 1% provision of total capital costs is made to look into specific site structural changes that are required.</p> <p>It assumed that staff hours necessary for the execution of procurement process are included in the first four activities.</p>	<p>Pole cost from case example in Zimbabwe</p> <p><a href="https://onlinelibrary.wiley.com/doi/pdf/10.1002/wene.218">https://onlinelibrary.wiley.com/doi/pdf/10.1002/wene.218</a></p> <p>Other relevant references for costs:</p> <p><a href="http://repositorio.ul.pt/bitstream/10451/12388/1/ulfc110307_tm_Rita_Almeida.pdf">http://repositorio.ul.pt/bitstream/10451/12388/1/ulfc110307_tm_Rita_Almeida.pdf</a></p> <p><a href="http://ir.knust.edu.gh/bitstream/123456789/7720/1/PETER%20ACHEAMPONG.pdf">http://ir.knust.edu.gh/bitstream/123456789/7720/1/PETER%20ACHEAMPONG.pdf</a></p> <p><a href="https://www.engoplanet.com/single-post/2017/08/21/How-to-design-and-calculate-Solar-Street-Light-system">https://www.engoplanet.com/single-post/2017/08/21/How-to-design-and-calculate-Solar-Street-Light-system</a></p> <p><a href="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://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</a></p> <p><a href="https://deepblue.lib.umich.edu/bitstream/handle/2027.42/99562/GlobalBrightLights%20Final%202013.pdf?sequence=1">https://deepblue.lib.umich.edu/bitstream/handle/2027.42/99562/GlobalBrightLights%20Final%202013.pdf?sequence=1</a></p>
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3	<p>4 Trips = 4 * 5350</p> <p>Total Activity budget = 21400</p>	<p>This activity is the primarily responsibility of the suppliers. The Technical committee will have site visits to monitor the progress of the implementation.</p> <p>The Technical Committee members will do 4 site inspections in a period of 4 months.</p> <p>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  Personnel = 3000 per trip</p> <p>DA: 397+128 =525 + Mark up 100% = 1050 per trip</p> <p>Trip Expenditure= Fuel + Personnel + DA  = 250 + 3000 + 2*1050  = 5350 per trip</p>	<p>Area of iLembe: 3269 sq. km.</p> <p>Cost of living numbers  <a href="https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa">https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa</a></p> <p>Daily Allowance  <a href="http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx">http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx</a></p>
4	<p>Number of persons: 5  Work Days: 3  Number of Staff days=5*3 = 15</p> <p>HR Expense=(15/22)*30,000  =20455  Training for user committee = 20,000</p> <p>Total Activity budget ≈ 20445 + 20000 = 40455</p>	<p>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 user committee is made.</p>	
5	0	<p>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 user committee the costs for which are included in the working note.</p>	

6	<p>Number of persons: <math>5 * 2</math> (Municipality and Tech Committee)  Work Days: <math>3 * 2</math>  Number of Staff days=<math>5*3 * 2 = 30</math></p> <p>HR Expense=<math>(30/22)*30,000</math>  = 40910</p>	<p>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.</p>	
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Gantt chart for activities schedule



Biogas is a gaseous mixture generated during anaerobic digestion processes using waste water, solid waste (e.g. at landfills), organic waste, e.g. animal manure, and other sources of biomass<sup>38</sup>. Anaerobic digestion is the biological degradation of biomass in oxygen-free conditions. In the absence of oxygen, anaerobic bacteria will ferment biodegradable matter into methane (40-70%), carbon dioxide (30-60%), hydrogen (0-1%) and hydrogen sulphide (0-3%), a mixture called biogas. Biogas is formed solely through the activity of bacteria. Although the process itself generates heat, additional heat is required to maintain the ideal process temperature of at least 35°C. In comparison, the methane component of natural gas could amount to over 80%. In nature, biogas is generated at the bottom of stagnated ponds, lakes, swamps or in the digestive system of animals<sup>39</sup>.

Biogas can be produced on a very small scale for household use, mainly for cooking and water heating or on larger industrial scale, where it can either be burnt in power generation devices for on-site (co)generation, or upgraded to natural gas standards for injection into the natural gas network as bio methane or for use directly as gaseous biofuel in gas engine-based captive fleets such as buses.

The household feedstock, e.g. animal dung or sewage, is converted to slurry with up to 95% water, and – for small-scale applications – fed into a purpose-built digester. Digesters come in many forms and sizes, which may range from 1 m<sup>3</sup> for a small household unit to some 10 m<sup>3</sup> for a typical farm plant and more than 1,000 m<sup>3</sup> for a large installation (Larkin et al., 2004). Biogas production in such cases can be both continuous and in batches with digestion taking place for a period from ten days to a few weeks.

A small domestic biogas system will typically consist of the following components:

- Manure collection: raw, liquid, slurry, semi-solid and solid manure can all be used for biogas production.
- Anaerobic digester: The digester is the component of the manure management system that optimizes naturally occurring anaerobic bacteria to decompose and treat the manure while producing biogas.
- Effluent storage: The products of the anaerobic digestion of manure in digesters are biogas and effluent. The effluent is a stabilized organic solution that has value as a fertilizer and other

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<sup>38</sup> Welink, J.-H., Dumont, M. and Kwant, K., 2007. Groen gas: gas van aardgaskwaliteit uit biomassa: update van de studie uit 2004, SenterNovem, pp. 34.

<sup>39</sup> Jepma, C.J. and Nakicenovic, N. (2006): Sustainable Development and the Role of Gas, EDReC/IIASA/IGU.

potential uses. Waste storage facilities are required to store treated effluent because the nutrients in the effluent cannot be applied to land and crops year round.

- Gas handling: piping; gas pump or blower; gas meter; pressure regulator; and condensate drain(s).
- Gas use: a cooker or boiler<sup>40</sup>.

For applications on a larger scale, feed stocks such as sewage sludge from waste water treatment plants, wet agricultural residues and the organic fraction of municipal solid waste (MSW) can be collected and used. Biogas can be used for all applications designed for natural gas, given a certain upgrading of its quality<sup>41</sup>. Upgrading can be done to a level compatible with natural gas ('green gas') by cleaning (removal of H<sub>2</sub>S, ammonia and some hydrocarbons from the biogas) and by increasing the methane share (by removing the CO<sub>2</sub>)<sup>42</sup>. Beneficiation of biogas can take different forms, from producing heat, electricity and combined heat and power (CHP), to the production of transport fuel. The digester effluent resulting from biogas production can be used as a fertilizer. All these different forms contribute to diversifying the South African energy mix, which is currently dominated by local coal and (predominantly) imported transport fuels<sup>43</sup>.

The idea of this roadmap is the upscaling and replication of the work that has already been conducted by the South African National Energy Development Institute (SANEDI) in collaboration with Khanyisa Projects in iLembe District's Ndwedwe region. The purpose of the iLembe Rural Biogas programme was to pilot biogas as a possible energy solution for rural areas and twenty six biogas digesters were installed for rural homesteads. The focus will therefore on upscaling small scale (< 30kW, GIZ and SABIA, 2016) projects for self-consumption requiring 0.1 – 2 tons of municipal solid waste (MSW), manure of sewage (typically feedstock not human). MSW would typically comprise of garbage including organic matter collected from households, retail stores and commercial processes, typically sent to landfill. As estimated by industry stakeholders (GIZ and SABIA, 2016) small (< 30kW) and rural (<10kW) scale has the potential of more about 1100 projects in 5 years. These are national estimates and therefore could be used to estimate the potential for these small scale projects in iLembe.

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<sup>40</sup> EPA, 2010: AgSTAR Handbook: A Manual for Developing Biogas Systems at Commercial Farms in the United States, available online at [http://www.epa.gov/agstar/pdf/handbook/full\\_pdf.pdf](http://www.epa.gov/agstar/pdf/handbook/full_pdf.pdf)

<sup>41</sup> IEA Bioenergy Task 37 (2005): Biogas Production and Utilization, available online at <http://www.iea-biogas.net/Dokumente/Brochure%20final.pdf>

<sup>42</sup> Welink, J-H., Dumont, M. and Kwant, K., 2007. Groen gas: gas van aardgaskwaliteit uit biomassa: update van de studie uit 2004, SenterNovem, pp. 34.

<sup>43</sup> DEA, 2007: *Biogas report: Facilitation of large scale uptake of alternative transport fuels in South Africa – The case for biogas*. . Pretoria, Department of Environmental Affairs.

Most of the barriers discussed here apply to most developing countries<sup>44</sup>, including South Africa.

### **a) Human capital barriers**

A shortage of construction and maintenance skills, which affects many developing countries, is a key reason why not all of the installed biogas plants in South Africa are actually in use. The discrepancy of training men when women are responsible for maintaining the biogas system results in a lack of effective knowledge, reducing the number of plants in use. Thus, cultural and social customs should be taken into account with the transfer of knowledge. In addition, building technical capacities in remote areas is key to expanding biogas use for cooking.

### **b) Technology barriers**

The technology is not complicated and there is already quite a lot of project management experience with the implementation technology in the Ndwedwe local municipality. Therefore knowledge of the technology itself is not a barrier.

### **c) Environmental barriers**

The site-specific issues that have limited the scope of biogas technology in sub-Saharan Africa include the availability of water and organic materials for effective bio-digester operation. Bio-digesters typically require water and waste to be mixed in an equal ratio (Surendra et al., 2014). Mengjie (2002) and Ng'wandu et al. (2009) have recommended the use of greywater for feeding a domestic bio-digester, but excluding greywater contaminated with detergents or chemical cleaning products to avoid destroying microbial activity in the bio-digester. In South Africa, greywater generated per household is approximately 75% of the household water consumption

### **d) Economic barriers**

Financial expertise often is lacking to appropriately value the revenue streams that a domestic biogas plant for cooking will generate, making it hard to obtain loans for such facilities. An effective approach to overcome this barrier could be training courses for loan officers to better evaluate the impact of technology uptake on income flow. The Inter-American Development Bank has a programme in Colombia which teaches loan officers to properly evaluate the value of energy efficiency projects,

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<sup>44</sup> [http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Dec/IRENA\\_Biogas\\_for\\_domestic\\_cooking\\_2017.pdf](http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Dec/IRENA_Biogas_for_domestic_cooking_2017.pdf)

including the expected return on investment which could be used to increase the cash flow and corresponding loan collateral value.

The private sector has a key role in promoting renewable energy and making the biogas sector commercially sustainable and market oriented. The national policy should be developed in such a way that it attracts more private companies to participate in the biogas sector. In addition, one of the major barriers for the widespread dissemination of domestic biogas technology is the high installation, operating and maintenance (IOM) costs, which puts it out of financial reach of many rural households.

#### **e) Institutional barriers**

An existing renewable energy policy can assist in breaking the barriers for the wide-scale dissemination of biogas technology. Policy should guide the stakeholders and suppliers to maintain quality of product and services.

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#### Beneficiaries and impacts<sup>45</sup>

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1. Local municipalities
  - Biogas improves health of rural low-income households by providing a cleaner cooking fuel and a waste handling solution thus avoiding health problems improved savings in the long run.
2. All communities
  - Bio-slurry/digestate when used as a fertilizer enhances physical, chemical, and biological attributes of the soil and increases crop productivity when applied to the land
  - Job creation and the development of new skills in the community.
3. Private sector
  - Opportunities for technology suppliers and building suppliers
  - Opportunities for technology localisation
4. Environmental benefits
  - Reduction in greenhouse gas (GHG) emissions by displacing the burning of fuelwood and paraffin in inefficient cook stoves with biogas. Biogas technology could potentially reduce global anthropogenic methane emissions by around 4%.

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<sup>45</sup> Msibi SS and Kornelius. (2017): Potential for domestic biogas as household energy supply in South Africa Journal of Energy in Southern Africa 28(2): 1–13

- Reduction in deforestation associated with the dependency of rural areas on fuelwood as the main source of energy. Global deforestation is responsible for 17–25% of all anthropogenic GHG emissions and a contributor to soil erosion resulting in vulnerability to the effects of droughts and floods.

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### Actions, activities (and timeframes)

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#### **Action 1: Planning**

- Activity 1: Development of terms of reference for external contractual parties in the project (*2 months*)
- Activity 2: Identification of sites (*2 months*)
- Activity 3: Assessment of technology requirement (*2 months*)

#### **Action 2: Training and stakeholder engagement**

- Activity 1: Training programme for local community (*2 months*)
- Activity 2: Operations and maintenance (*Ongoing*)

#### **Action 3: Implementation (installation)**

- Activity 1: Procurement of equipment (*2 months*)
- Activity 2: Installation of equipment (*6 months*)
- Activity 3: Provision of annual equipment maintenance (*Ongoing*)
- Activity 4: Helpline for user queries (*Ongoing*)

#### **Action 4: Communication and outreach**

- Activity 1: Terms of reference for outreach (*1 month*)
- Activity 2: Identification of agency to implement outreach (*1 month*)
- Activity 3: Outreach implementation (*Ongoing*)

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### Budget

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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 an 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 incur.

<b>Action</b>	<b>Total Budget ZAR</b>	<b>Total Budget USD @ 12.5</b>
Action 1: Planning	20,454 + 49,063 + 20,454 = 89,971	7198
Action 2: Training and stakeholder engagement	88,363 = 88,363	7069
Action 3: Implementation (installation)	6,000,000 + 15,000 = 6,015,000	481,200
Action 4: Communication and outreach	12,272 + 30,000 + 132,000 = 174,272	13,942
<b>Total</b>	<b>6,367,606</b>	<b>509,409</b>

## Overview of the household biogas TRM

<b>Sector</b>	Energy						
<b>Sub- sector</b>	Energy generation						
<b>Technology</b>	Biogas (household)						
<b>Ambition</b>	40 biogas digesters installed in each of the three selected municipalities (Maphumulo, Mandeni, and Ndwedwe). Total: 120.						
<b>Benefits</b>	1) Improved health and sanitation 2) Reduced deforestation and emissions reduction 3) Savings and energy security increased						
<b>Action</b>	<b>Activities</b>	<b>Responsible body</b>	<b>Time frame<sup>46</sup></b>	<b>Risks &amp; Mitigation</b>	<b>Success Criteria</b>	<b>M&amp;I Indicators</b>	<b>Budget R</b>
<b>1. Planning</b>	Development of terms of reference for external contractual parties in the project	SANEDI, 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.	20,454  WN 1
	Identification of sites	SANEDI, iLembe municipality	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	---	Installation sites identified	49,063 WN 2

<sup>46</sup> months

				ensure suitable sites are chosen.			
	Assessment of technology requirement	SANEDI, iLembe municipality	2	Wrong equipment is chosen.  As biogas digester is an established technology, the risk of identifying wrong equipment is low. Consulting technical experts and private sector providers will mitigate the risk	Technology meets the requirements of end users	Type and quantity of equipment and accessories required is identified	20,454  WN 3
<b>ACTION 1 TOTAL</b>				<b>ZAR 89,971 / USD 7198</b>			
<b>2. Training and stakeholder engagement</b>	Training programme for local community	SANEDI, iLembe municipality; Private equipment suppliers	2	Inadequate or ineffective training.  This can pose substantial risk to the operation of the equipment. The training programme must be closely monitored by the iLembe municipality to ensure users are provided with adequate and effective training.	---	Training module for local community is designed and implemented.	88,363 WN 4

	Operations and maintenance	End users	Og <sup>47</sup>	Lack of proper O&M can reduce the technology effectiveness and life span.  Ensure that users get relevant training for operating and maintaining the equipment in the long run	At least 90% of users can operate the equipment after training  At least 3/4 <sup>th</sup> of the users who can handle regular maintenance issues after the training.	---	0 WN 5
<b>ACTION 2 TOTAL</b>				<b>ZAR 88,363 / 7069 USD</b>			
<b>3. Implementation (installation)</b>	Procurement of equipment	SANEDI, iLembe municipality; Private equipment suppliers	2	Equipment is expensive.  This is a low risk activity. Following standard procurement procedures will ensure the right equipment is procured.	---	All equipment and accessories required for installation are procured	6,000,000 R WN 6
	Installation of equipment	Private equipment suppliers	6	Additional structural changes required for installation.	---	Equipment is installed and ready to use at all the	Included in procurement costs WN 6

<sup>47</sup> Ongoing

				In general, biogas digesters are not complex structures. However, installation will need to follow certain requirements to ensure sanitation. This risk is a low risk activity; however, inputs from private suppliers while identifying sites will bring to light an overall picture of specific installation requirements.		identified sites.	
	Provision of annual equipment maintenance	SANEDI, iLembe municipality;  Private equipment suppliers	<i>Og</i>	Suppliers do not provide equipment maintenance service.  Procurement guidelines to include a provision of periodical equipment maintenance service from the suppliers.	End users availing this service are satisfied with the annual maintenance service	Option of annual equipment maintenance is provided to end users.	15,000 WN 7

	Helpline for user queries		<i>Og</i>	Suppliers do not provide a helpline for service queries.  Procurement guidelines to include a provision of helpline from the suppliers.	End users availing this service are satisfied with services provided through the helpline	A functional helpline is established for end users	
<b>ACTION 3 TOTAL</b>				<b>ZAR 6,015,000 / USD 481,200</b>			
<b>4. Communication &amp; Outreach</b>	Terms of reference for outreach programme	SANEDI, iLembe municipality; Local technical university	1	Comprehensiveness of the TORs  Consult experts to ensure all-encompassing TORs	At least 3 applicants to the bid.	Terms of reference for designing and implementing outreach programme developed and advertised.	12,272 WN 8
	Identification of agencies to implement outreach	SANEDI, iLembe municipality	1	Inadequate outreach agency.  Following standard service procurement procedures will ensure the right agencies are identified to design and implement the outreach programme.	---	Implementing agency meeting the selection criteria identified	30,000 WN 9
	Outreach implementation	SANEDI, iLembe municipality; Private equipment	<i>Og</i>	Agencies do not implement the outreach activities effectively	Outreach programme reaches at least 300,000 people	Outreach programme successfully implemented	132,000 WN 10

		suppliers; NGOs; Local stakeholders; Local technical university		This can pose substantial risk to technology deployment in future. Outreach implementation must be closely monitored by the iLembe municipality to ensure wide range of users are covered with an effective programme			
<b>ACTION 4 TOTAL</b>				<b>ZAR 174,272 / USD 13,942</b>			
<b>TOTAL BUDGET</b>				<b>ZAR 6,367,606 / USD 509,409</b>			

Working notes (WN) on cost and savings assumptions

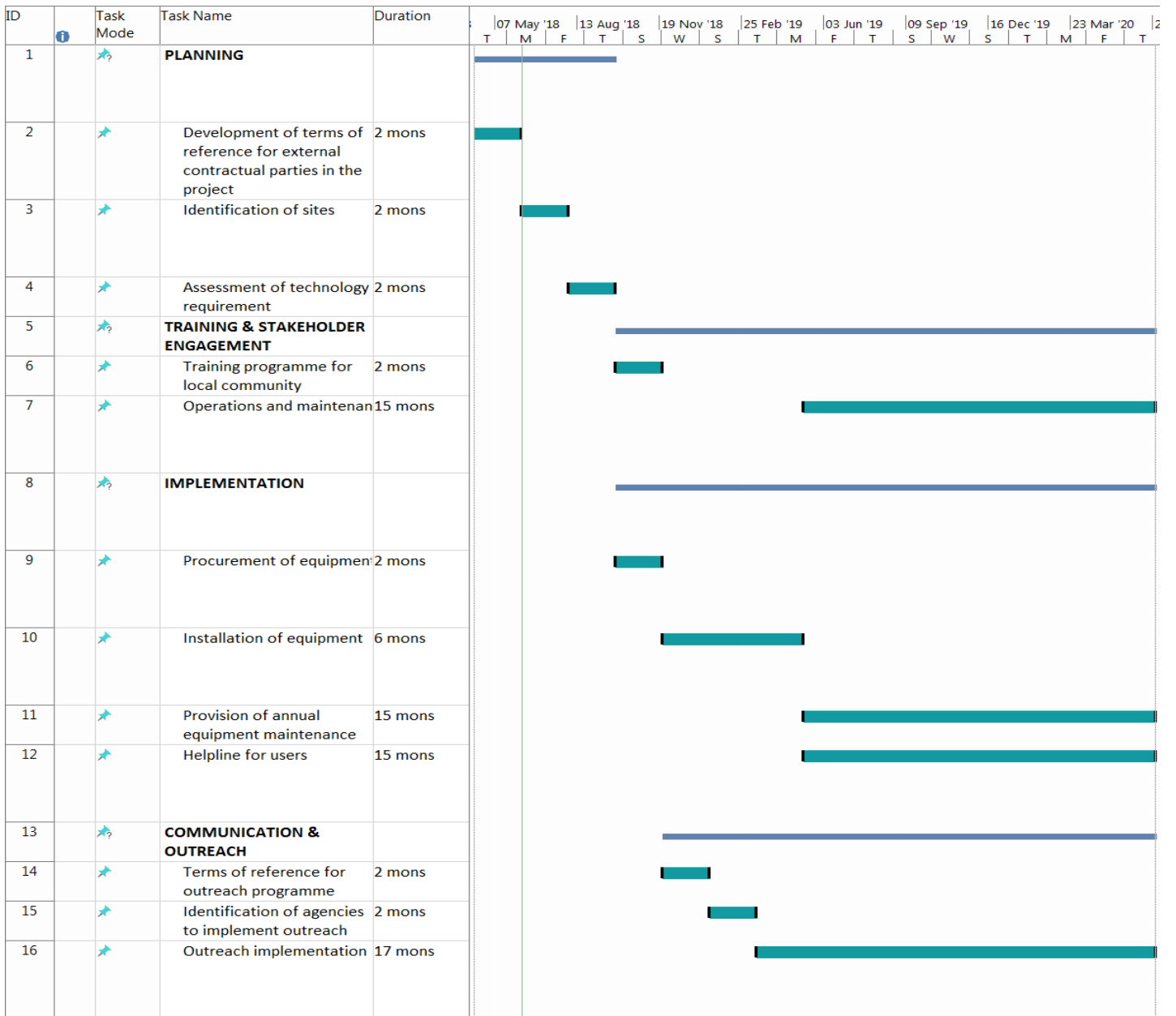
#	Cost Calculation	Assumptions	References
1	Number of persons: 5 Work Days: 3 Hourly wage: 30,000/(22*8) Total hours: 5*3*8  Total Activity budget ≈ R20454	Minimum wage rate is 2933 per month for workers (rounded to 3000). It is assumed that the average minimum wage for experience iLembe municipality 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.	Minimum wage rates for SA: <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a>
2	Number of persons: 2 * 3 = 6 Travel days: 2*3 = 6 Additional Staff Days = 2 *3*2 = 12	Site visits: 3 Total distance: 125 kms per trip (based on departure from iLembe to each municipality) Fuel efficiency: 11km/l Gasoline: 12 lit @ 50 = 600 per trip	Area of iLembe: 3269 sq. km.  Cost of living numbers

	<p>HR Expenses = <math>(12/22) * 30,000 = 16,363</math></p> <p>Total trip Expenditure:  <math>9900 * 3 = 29,700</math>  Mapping Expenditure: 3000 approx.</p> <p>Total Activity budget <math>\approx 16,363 + 29,700 + 3000 = R49,063</math></p>	<p>Personnel: 3000 per trip</p> <p>DA: <math>397 + 128 = 525 + \text{Mark up } 100\% = 1050</math> per trip</p> <p>Trip expenditure = fuel + personnel + DA = <math>600 + 3000 + 6 * 1050 = 9900</math></p>	<p><a href="https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa">https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa</a></p> <p>Daily Allowance  <a href="http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx">http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx</a></p>
3	<p>Number of persons: 5  Work Days: 3  Number of staff days = <math>5 * 3 = 15</math></p> <p>HR Expense = <math>(15/22) * 30,000</math></p> <p>Total Activity budget <math>\approx R20454</math></p>	<p>Includes tender floating time</p>	
4	<p>Number of trainings in each community (one full day): <math>2 * 3 = 6</math>  Room rental expenditure: <math>6 * 1500 = 9000</math>  Catering: <math>70 * 6 \approx 63,000</math>  Number of trainers: 2  Trainers cost: <math>2 * 6 * 30000 / (22 * 8) = 16,363</math></p> <p>Total activity budget <math>\approx R88,363</math></p>	<p>Training meetings held in each municipality: 2  Room rental: 1500 per day  Catering for training day: 150 per person, estimate 70 people per training  Trainers: <math>30000 / (22 * 8) = 170</math> per hour</p>	<p>Minimum wage rates for SA:  <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a></p> <p>Cost of living numbers  <a href="https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa">https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa</a></p>
5	<p>Total budget <math>\approx 0</math></p>	<p>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 end users to ensure they are trained enough to</p>	

		operate and pursue regular maintenance of the equipment. This is included in the 'training' action.	
6	Total capital expenditure  Tanks: $120 \times 45000 = 5,400,000$  Total Activity budget $\approx 5,400,000$ R	Total digester requirement: 120 units (40 per municipality) If concrete domestic digester are chosen, at 45,000 per unit.	Digester Prices <a href="http://www.biogassa.co.za/index.php/products/domestic-digesters">http://www.biogassa.co.za/index.php/products/domestic-digesters</a>
7	Number of Staff days=11  HR Expense= $(11/22) \times 30,000$  Total Activity budget $\approx$ R15,000	Provision of annual equipment maintenance and a helpline for user queries is a part of the arrangement with equipment suppliers. The expenses on behalf of the municipality are included in the staff hours spent in the development of terms of reference. A contingency expenditure of 11 staff days is kept here for receiving feedback on maintenance services/helpline from ward level representatives and NGOs.	
8	Number of persons: 3 Work Days: 3 Hourly wage: $30,000 / (22 \times 8)$ Total hours: $5 \times 3 \times 8$  Total Activity budget $\approx$ R12272	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.	Minimum wage rates for SA: <a href="https://mywage.co.za/main/salary/minimum-wages">https://mywage.co.za/main/salary/minimum-wages</a>
9	Number of Staff days=22  HR Expense=R30,000  Total Activity budget $\approx$ R30,000	Identification tasks include finalizing the proposals from shortlisted agencies including negotiations among key stakeholders for roles and responsibilities for implementation of outreach activities and expert consultations.	
10	Outreach budget – 132,000  Total Activity budget $\approx$ R132,000	Depending on TORs The budget of the outreach programme will depend on the desired scale and intensity of activities within the	Durban Metro Water Case study <a href="https://www.wsp.org/sites/wsp.org/files/publications/af_durban.pdf">https://www.wsp.org/sites/wsp.org/files/publications/af_durban.pdf</a>

		<p>outreach programme. This would typically depend on municipal finances. The Water Research Commission (WRC), which has committed to R880,000 finances for research and dissemination component to Vivendi's water project in 2000.</p> <p>Since this project would be a follow-up to the pilot biogas project, we assume that the iLembe municipality would be willing to spend up to 15% of this amount in the current time for outreach and awareness activities.</p>	
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## Gantt chart for activities schedule



## Appendix 1

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### Stakeholders interviewed during the development of the TRMs

- **Aurelie Ferrie:** South African Local Government Association
- **Nicole Algio:** South African National Energy Development Institute
- **David Mahuma:** South African National Energy Development Institute
- **Sudhir Pillay:** Water Research Commission
- **Sylvester Mpandeni:** Water Research Commission
- **Henry Roman:** National Designated Entity-RSA
- **Nisaar Mohammed:** Trade and Investment KwaZulu-Natal
- **Nhlakanipho Biyela:** KwaDukuza Local Municipality
- **Masupha Mathenjwa:** iLembe District Municipality
- **Ntokozo Ngubo:** Provincial Department of Economic Development Tourism and Environmental Affairs (EDTA)
- **Raymond Ganesh:** KwaDukuza Local Municipality