UNITED REPUBLIC OF TANZANIA

NATIONAL ELECTRIFICATION PROGRAM PROSPECTUS



FINAL VERSION – JULY 2014

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ABBREVIATIONS

CHP	Combined Heat and Power
DP	Development Pole or development Centre
FiT	Feed in Tariff
GIS	Geographic Information System
IPD	Indicator of Potential Development
LCOE	Levelized Cost of Energy
LEC	Levelized Economic Cost
PoA	Program of Activity
SHS	Solar Home System
SMP	Solar Multifunctional Platform
SPP	Small Power Producer
SSHP	Small Scale Hydro Power
SWER	Single Wire Earth Return
SWS	Shield Wire System
ToR	Terms of Reference
EWURA	Energy and Water Utilities Regulatory Authority
GoT	Government of Tanzania
IED	Innovation Energie Développement
MEM	Ministry of Energy and Minerals
NBS	National Bureau of Statistics
NORAD	Norwegian Agency for Development Cooperation
NRECA	National Rural Electric Cooperative Association
REA	Rural Energy Agency
PSMP	Power Sector Master Plan
TANESCO	Tanzania Electric Supply Company Limited
SIDA	Swedish International Development Authority
TZS	Tanzanian Shilling
WB	World Bank

Units of Measure

GWh	Gigawatt hour = 1,000,000 kWh
HV	High Voltage (>33kV)
kV	Kilovolt
kVA	Kilovolt-Amps
kWh	Kilowatt hour
LV	Low Voltage
MV	Medium Voltage (11kV, 33 kV)
MW	Megawatt = 1,000 kW
MWkm	Value of MW x km. can be supplied through a given conductor
MWh	Megawatt hour = 1,000 kWh
TWh	Terawatt hour = 1,000,000,000 kWh

EXECUTIVE SUMMARY

1. Current Status of Electrification and Objectives

Tanzania's low electrification ratio is a barrier to economic development. At the end of 2013, about 18% of the households in Mainland Tanzania had been electrified. In urban areas, the percentage was about 45% and in rural areas somewhat below 6%.

Increasing access to electricity is a major objective for GoT. By 2015/16, 30% of the population shall have access to electricity, further increasing to 50% by 2020 and 75% by 2035. Foundations for the ambitious plan are in place.

- The existence of the Rural Energy Agency to facilitate and coordinate RE programs.
- An operational Rural Energy Fund with funds coming from levies, the Government's budget and donors.
- "Light-handed" regulation provides an enabling environment for the desired participation of private developers in rural electrification.

The 'National Electrification Program Prospectus' (Prospectus) aims at supporting the electrification policy by proposing a strategy for the period 2013 – 2022 which promises to considerably advance electrification in a cost-efficient way. The Prospectus indicates how the investments could be financed and determines the institutional, regulatory and capacity strengthening measures for the implementation.

The Prospectus encompasses urban and rural electrification. It covers electrification by connection to the main grid and by off-grid technologies where isolated mini-grids are supplied by renewable energy sources or hybrid systems. Distributed energy solutions, including micro grids, for remote low density areas are discussed. Investments in power plants which feed into the main grid and in transmission capacity are not taken into account.

2. On the Economics and Politics of Grid and Off-Grid Electrification

The Prospectus proposes to mainly electrify customers by connection to the main grid. There are both economic and political reasons for that strategy.

The economic reason is that grid connection is the least-cost electrification technology for settlements which meet the following conditions: (i) they are close to the main grid, (ii) they have a not-too-small population, and (iii) the customers to be electrified are not scattered over a large area but concentrated. Rules of thumb for the first two conditions are within 10 km of the main grid and having at least 500 inhabitants. Calculations of the levelized economic costs (LEC) of power supply show that the LEC of the proposed grid connection programs are (significantly) lower than those of off-grid technologies if these two conditions are met.

The result does not mean that off-grid electrification should not be undertaken. The grid connection plan of the Prospectus would electrify about 5,500 settlements until end of 2022, leaving more than 6,000 settlements as candidates for off-grid electrification or distributed technologies. Off-grid

electrification is strongly recommended for settlements which are too far from the grid to warrant grid connection but whose electrification promises substantial socio-economic benefits. The off-grid electrification costs would be high but the benefits would even be higher. The Prospectus estimates the potential for off-grid electrification by decentralized solutions with focus on small hydropower plants and small biomass-fuelled plants. The Prospectus further identifies off-grid projects which, in the consultant's view, deserve being given priority because of the size of the settlements.

In reality, economic criteria are not the only criteria determining which settlements should be electrified when by which technology. In Tanzania, the Government and many donors pursue the policy to connect all settlements in the vicinity of an MV line. The Prospectus accounts for that policy by electrifying all settlements which are within 10 km of the MV line and have more than 500 inhabitants at the time of electrification.

3. Low-Cost Network Design

Minimizing the costs of the electrical networks will be important as it will allow more rural access for a given budget. The Prospectus examined whether MV and LV networks can be constructed at lower costs compared to TANESCO's standards.

The review of TANESCO's design criteria showed that costs could be lowered between 8% and 37% by using more appropriate criteria. The current MV line span length of 110 to 120 m could, for example be increased to up to 200 m by increasing the length of the line cross-arms and adapting the wind criteria to the regional wind conditions.

A significant cost reduction could also be achieved by using **direct SWER without isolation transformer** for the electrification settlements with a projected low demand for power and where single-phase supply would be sufficient. Compared to 3-phase supply, direct SWER would reduce costs by 60 to 65%.

4. The Prospectus Approach and the Resulting Electrification Programs

4.1 Development Centre

The concept of "development centre" is at the heart of the Prospectus. A development centre is typically a settlement with a population of at least 1,500 inhabitants in 2012, with some existing social or administrative infrastructure (school, dispensary, police station, etc.), good access by roads and some business activities. Focusing on the electrification of such settlements promises to maximize the benefits of electrification. An "Indicator of Potential Development" (IPD) has been calculated for approximately 11,000 settlements from demographic and socio-economic data. The 10% of the settlements in a region which have the highest IPD values are the development centres in the Prospectus.

4.2 GIS Data Base and Electrification Programs Determined with the Data Base

The GIS data base includes the demographic and socio-economic data used to calculate the mentioned IPD values. The data base further contains TANESCO's existing and planned transmission

network, the main HV/MV substations, the location of the country's biomass resources and the location of potential sites for small hydro plants.

The GIS data base provided the input data for GEOSIM, the consultant's software. GEOSIM was used to determine the electrification program, the off-grid potential by using small hydro or small biomass-fuelled plants and the "priority" off-grid projects. Calculations made outside GEOSIM determined the number of customers who would be electrified by densification.

4.3 Electrification by densification

Densification is the connection of new customers to the distribution network in already electrified settlements. The distribution network may have to be extended to that end.

Densification has been TANESCO's main electrification activity since REA has been in charge of rural electrification. The densification potential is huge as only a portion of the potential customers in electrified settlements is connected. In Dar Es Salaam, for example, only about 60% of households were connected at the end of 2013 and the percentage was significantly lower in the other electrified towns. The Prospectus estimate is that in the period 2013 – 2022, about 160,000 new customers will on average be connected annually in the settlements which were already electrified at the end of 2012[1].

Densification costs are lower than the costs of the other electrification technologies but nevertheless substantial; on average 747 US$ per new connection.

4.4 Electrification by connection to the main MV grid

Four phases are distinguished regarding settlements to be electrified by connection to the rural MV backbone.

1. **Phase 1, referred to by REA as Turnkey II:** Electrification by grid extension of almost 1,500 settlements in the period 2013 – 2015. The list of settlements was obtained from REA.
   A request for turnkey electrification proposals was issued by REA in December 2012. The turnkey projects comprised 25 lots. 15 contracts were awarded in 2013 while 10 were not because of too high prices. The 10 were split into 20, re-tendered and contracts for these lots signed in early 2014. All construction works are expected to be finished by mid 2015.
2. **Phase 2, referred to by REA as Turnkey III:** Electrification by grid extension of settlements which are within 10 km of the 33-kV MV network which will exist at the end of 2015 (MV backbone). The connection is done by a 33-kV line if the settlement has more than 2,000 inhabitants. If it has more than 500 but less than 2,000 inhabitants, connection is done by SWER. Connections would be done in the period 2016 – 2019. The Turnkey III program would connect 177 development centres and 1,740 other settlements by three-phase lines and 1,256 settlements by SWER technology.
3. **Phase 3, part of Turnkey IV:** Electrification of 266 development centres by grid extension. The centres are within 40 km of the MV grid which is likely to exist by the end of 2019. If the line

[1] The Prospectus average of about 160,000 per year does not include settlements which will be electrified after 2012. The Prospectus assumes that densification will also take place in those settlements. A company which is awarded a main grid connection contract under the turnkey programs will connect the first wave of customers, estimated at about 30% of the population. After the assets have been transferred to TANESCO, the latter is expected to continue connecting customers. When including these customers, the annual average number of customers electrified by densification reaches 210,000 in the Prospectus. That is lower than TANESCO's target of 250,000 per year until 2017 but much higher than the number of approximately 140,000 whom TANESCO connected in 2013.

corridor of the backbone MV grid is not yet known, GEOSIM determines the 33-kV feeder line which connects the development centre to the rural MV backbone grid. The electrification of the development centres is assumed to occur in the years 2020 – 2022.

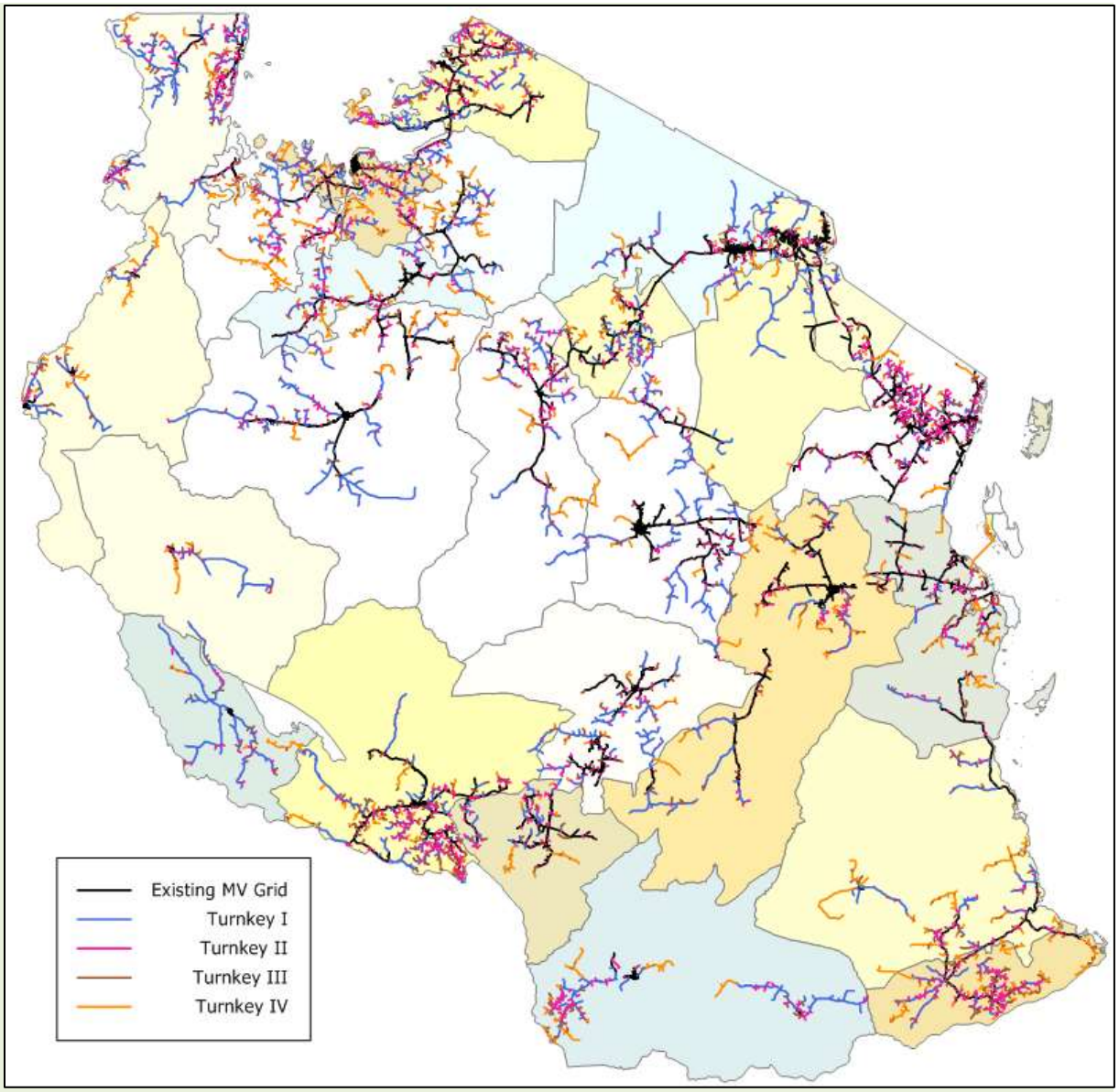
4. **Phase 4, part of Turnkey IV:** Electrification by grid extension of 780 settlements that are within 10 km of the feeder lines constructed in Phase 3. The connection is done by a 33-kV line for 506 settlements each of which has more than 2,000 inhabitants at the time of electrification. For 274 settlements which have more than 500 but less than 2,000 inhabitants, connection is done by SWER. Phase-4 electrification would take place in the period 2020 – 2022.

Under the turnkey scheme, contractors build MV extensions and LV distribution grids and connect the first wave of customers. All assets are transferred to TANESCO at the end of the construction works with no payment from TANESCO.

Another option that merits consideration under the Turnkey program would be to give private developers and community organizations the option of leasing MV and LV extensions for nominal leasing payments under long term concessions. This would effectively create small power distributors (SPDs), a business model that is now explicitly allowed under EWURA's new rules.

Figure 1 shows where the Turnkey Programs would be located.

Figure 1: Electrification by Grid Extension



4.5 Off-grid potential for small hydro plants and biomass-fuelled plants

To get an idea of the potential for off-grid electrification by small hydro plants or small biomass-fuelled plants (gasifiers or biogas digesters), the Prospectus determined how many settlements could be supplied by such technologies. The criteria were that the settlements are within 20 km of the energy resource, have at least 1,500 inhabitants and will not be reached by the ongoing Turnkey II Program.

The exercise identified 141 hydro sites which would supply 347 settlements and almost one million people. The sites are shown in Figure 2. At 88 sites, the capacity of the hydro plants is less than 1 MW. At 53 sites, the capacity is between 1 and 10 MW.

Figure 3 shows 310 settlements which could be electrified by small biomass-fuelled plants (gasifiers or biogas digesters). The total population of the 310 settlements exceeds one million inhabitants (2012 population). The installed capacity of the biomass-fuelled plants varies between 100 and 500 kW.

Site visits have to be conducted to confirm the feasibility of both the hydro and the biomass projects. Sustainability will require intensive on-the-job training in operation and maintenance.

Figure 2: Sites with small hydropower potential

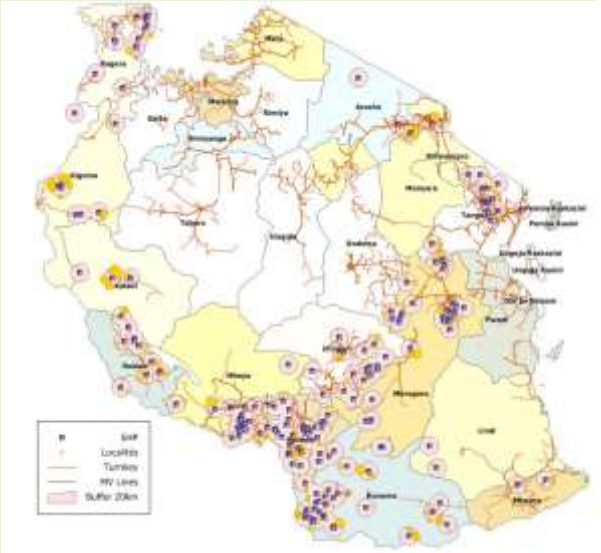
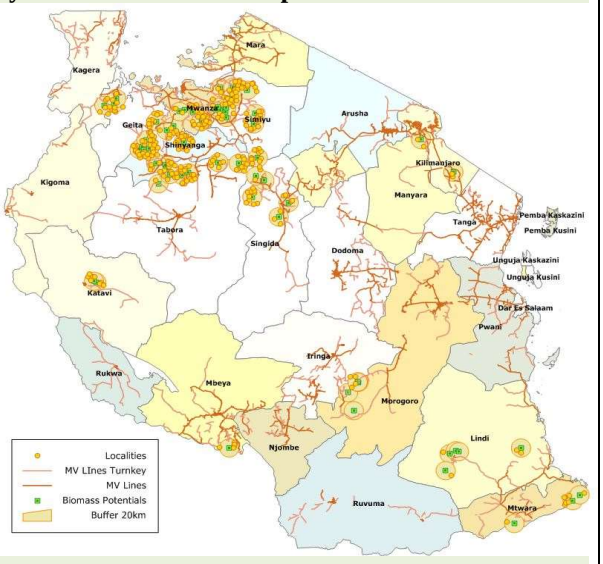


Figure 3: Sites with electricity production potential by small biomass-fuelled plants



4.6 "Priority" off-grid projects

While only 15 development centres would not be reached by Turnkey Programs until end of 2022, a large number (266) of the centres that would be reached would have to wait until at least 2020 before the grid will arrive - and longer should there be delays in the implementation of the Turnkey Programs. For many of these development centres, starting with off-grid supply before the main grid arrives promises to be attractive on economic grounds.

That has been taken into account in the Prospectus by identifying off-grid projects for 154 of the 266 development centres which would not be connected to the main grid before 2020. These projects could be called "priority projects" because of the size of the development centres. All centres supplied by hydro plants or gasifiers have at least 2,500 inhabitants and the centres supplied by diesel-PV systems at least 5,000 inhabitants in the electrification year[2].

Table 1: Off-grid projects for development centres not connected to the grid before 2020

Off-grid technology	Number of development centres	Number of customers in 2022	Investment costs in Million USD
Small Hydro Plants	19 *	40,436	28.3
Biomass Gasifiers	61	9,256	72.8

[2] Of the 266 development centers, 112 are not located near a hydro site or biomass area. Off-grid electrification by diesel-PV systems could be an option for these centres. That they are not among the priority projects is because they have less than 5,000 inhabitants.

Diesel-PV Hybrids	73	57,943	75.2
Total	**154**	**107,635**	**176.3**

* The 19 development centres would be supplied by 13 hydropower plants.

4.7 Distributed Technologies

Electrification is not limited to densification, grid connection or off-grid technologies but also realized by various other technologies which are commonly referred to as stand-alone or distributed technologies. Examples are solar home systems (SHS), solar lanterns, battery-charging stations, multifunctional platforms, and solar containers. The technologies are often considered as pre-electrification technologies, meaning that the people who use them continue waiting for the grid to come. In Tanzania, distributed technologies, in particular SHS and solar lanterns, have been installed through donor-funded programs in public infrastructure facilities (schools, dispensaries, etc.) and purchased by individuals on the market. An interesting business model is that of Off-Grid:Electric, a private company based in Arusha which is said to have installed more than 15,000 SHS in the Arusha and Moshi areas in slightly over one year. The company sells services rather than a product. Off-Grid:Electric installs the SHS at the customer. The SHS remains the property of Off-Grid:Electric. Customers buy services via mobile money. They are sent unlocking codes via their mobile phones to unlock the level of service they have paid for[3].

The use of distributed technologies will certainly continue to increase. They are in particular appropriate electrification technologies for areas with a low population density which usually includes the outskirts of an electrified settlement. It is, however, impossible to estimate how many people will be electrified by these technologies and that is why the Prospectus abstained from estimating numbers.

4.8 Status of electrification if the Prospectus is realized

Calculating the electrification ratio from the number of households which would be supplied by the interconnected grid and the priority off-grid projects yields for 2015 ratios 40% in urban areas, 7% in rural areas and 18% overall. At the end of 2020, the percentages would be 31% overall, 57% in urban areas and 20% in rural areas.

The values would be higher when also accounting for households using distributed technologies and for households which are supplied by not registered mini-grids established by religious institutions, communities, companies etc. The consultants guesstimate is that the overall electrification ratio would then not be far from 25% in 2015 and between 35% - 40% in 2020.

That is less than the Government's targets of 30% in 2015 and 50% in 2020. The Government's targets can only be achieved if another definition of electrification is used. The term "access to electricity" is normally used by the Government. While a definition is outstanding, the concept would increase the numbers considerably if it does not require that the household has access to electricity **in the house**. If access includes the possibility of using a near-by service outside the house which uses electricity (internet café, medicine stored in a refrigerator in a dispensary, neighbour's

[3] See http://www.aecfafrica.org/windows/react/projects/grid-electric-tanzania-limited.

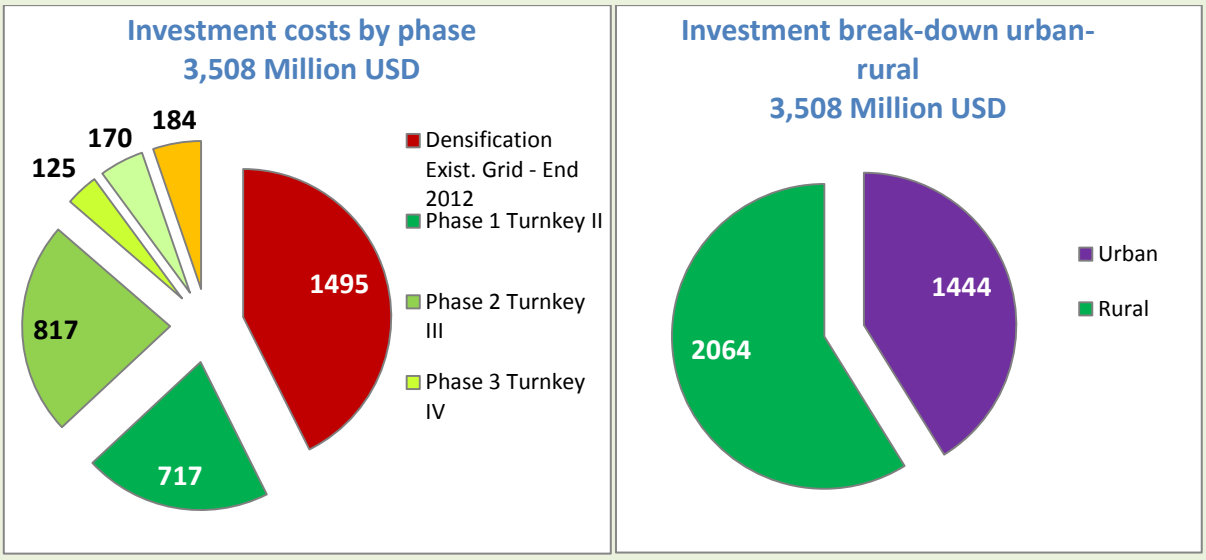
plug to charge a mobile phone, etc.) the Government's objectives could probably be reached if not exceeded.

5. Costs and Funding

5.1 Costs

Total investment costs in the period 2013 – 2022 would be in the order of 3.5 billion USD at 2013 prices. About 2.1 billion US$ would be needed for rural electrification and about 1.4 billion USD for urban electrification.

Figure 4: Total investment costs of the Prospectus Electrification Program excluding distributed technologies and preparation and supervision costs (Million US$ at 2013 prices)



The average annual amount is 350 million US$ with about 145 million USD for the electrification of urban areas and 205 Million USD for rural areas.

When adding 10 million for distributed technologies (solar home systems, solar lanterns, etc.) and 15% for preparatory[4] and supervision activities, the Prospectus will require **average annual costs of about 415 million USD**; 168 million USD thereof for urban areas and 247 million USD for rural areas. Financing costs and inflation would further increase the amount.

5.2 Funding

The review of various potential funding sources produced the scenario shown in Table 2.

The end-user contribution represents the connection fees which the customers pay under the current tariff scheme. Connection fees were significantly lowered in January 2013. For single-phase supply, customers in rural areas now pay 111 US$ and customers in urban areas 201 US$ which compares with costs of 350 US$. The lower connection fees have certainly contributed to the large increase in new connections from 103,000 in 2012 to about 140,000 in 2013. The consultant

[4] Feasibility studies, engineering and design, business plan, ESIA are estimated at 15% of the investment cost

recommends to continue charging the present fees but to recover the subsidized amount – in total about 700 Million USD in the period 2013 – 2022 - by a small monthly surcharge on the electricity bill. **Calculations show that a monthly surcharge of about 5 USD would recover the subsidized costs plus financing costs of 1% per month in 5 years.**

Table 2: Financing Scenario without accounting for Government's budget contributions and TANESCO's contributions

	Urban	Rural	Total
	(Million US$ per year at 2013 prices)		
I. Average annual cost in period 2013 - 2022	168	247	415
II. Average annual urban and "REA Cost"	126	289	415
III. Contribution of:			
- End-User (connection fees under present system)	36	54	89
- Levies injected into REF		85	85
- Donors - Contributions to REF		50	50
- Donors - Project approach		60	60
- Private Sector (off-grid and distributed technologies)		8	8
"Gap" (II - III)	**90**	**32**	**123**

Comments:

a) Costs include all costs except for financing costs and inflation

b) "REA Cost": all costs of densification in settlements which are electrified from 2013 onward allocated to rural. Urban costs reflect the costs of densification in settlements which were already electrified by end of 2012.

Levies comprise the Electricity Levy (3% of power purchase cost), the Pre-Destination Inspection Levy and the recently introduced Fuel Levy of 50 TZS per litre. The levies are transferred into the Rural Electrification Fund (REF).

The governments of Sweden and Norway are presently the only donors injecting into the REF. Discussions with other donors revealed that some may consider joining them but most will probably continue funding earmarked projects, referred to in the table as "Project Approach".

The private sector contribution represents about 30% of the investment and preparatory costs of off-grid projects. A higher contribution is considered unlikely.

Table 2 shows an average annual gap of 123 Million USD. The real gap would be significantly smaller because the table does not include the contribution of the Government and of TANESCO.

TANESCO's precarious finances have in the past prevented the company from making other than minor contributions to the financing of electrification projects. The ongoing reform program makes one expect that no major contributions will be made before the reforms have been implemented. But TANESCO informed the consultant that it will, to the extent possible, use bank loans to finance its electrification projects which, in terms of the Prospectus terminology, are densification projects in urban and rural areas. Some commercial banks are willing to lend to TANESCO without a Government guarantee.

The Government made significant contributions in the past. It provided the bulk of the funds for TANESCO's densification activities and injected millions of USD into the REF; in FY 2012/13 about 27 million USD and close to 50 million USD in FY 2013/14[5]. The Government will certainly continue supporting electrification activities from the budget. Rather than fixing in advance how much money will be made available from the budget for the REF, the budget support is expected to materialize "as needed", meaning that funds will mainly be made available when REA needs them to finance its electrification projects.

There will, of course, be limits to the funds which the Government and TANESCO will contribute. The consultant's view is that while a contribution of about 120 million USD per year is not impossible, it will certainly be challenging. The consultant sees a more realistic chance to fill the gap if the proposed recovery of a significant portion of the subsidized connection costs is realized. That would reduce the gap to a level which is more likely to be closed by the Government and TANESCO.

6. Implementing the Prospectus

6.1 Electrification Policy – Main Grid Connection and Off-Grid Electrification

The Prospectus indicates which settlement should be electrified by connection to the main grid until the end of 2022. An improved data base may change the results a bit but will certainly not change them significantly. Settlements which are not on the list of "to be electrified by connection to the main grid" are candidates for off-grid electrification. The Prospectus also recommends the off-grid electrification of development centres that would be connected to the main grid but not before 2020. The projects are referred to as off-grid priority projects.

The policy recommendation is that the financial support for off-grid electrification projects should be made subject to the condition that the settlement is not on the list of settlements to be electrified by main grid connection or that it is on the list of off-grid priority projects.

6.2 Electrification Policy – Low-Cost Network Design

The Prospectus has identified low-cost network design technologies which would reduce costs significantly. **Low-cost network design should become a priority in project preparation.** As resistance from TANESCO must be expected due to low level of local expertise, the use of low-cost technologies will require Government support. It is recommended that the MEM demands REA and TANESCO to prepare electrification plans which explicitly indicate (i) how standards of existing technologies have been changed to reduce costs and what the resulting cost savings are and (ii) which electrification projects will use new technologies (for example, SWER or 2-phase MV) and what the resulting cost savings are. Some other recommendations to advance the use of low-cost technologies are made in chapter 7 (Accompanying Measures).

[5] The FY 2013/14 amount is a preliminary figure obtained from REA in early June 2014.

6.3 Appropriate institutional and organizational framework for rural electrification

The current set up with REA as facilitator and coordinator of rural electrification and turnkey-project manager should be kept. Strengthening measures which will be required for REA are described in the chapter on "Accompanying Measures".

A consequence of the significant increase of rural electrification will be that RE activities will become much more important for TANESCO. The activities will comprise the maintenance of the lines and substations, connection of customers (only a first wave of customers is connected under the turnkey contracts), extensions of the local LV network, installation of the logistics for pre-paid meters, etc. The most appropriate institutional set up to cope with the heavy increase in the workload remains to be determined. The establishment of an RE Department within TANESCO or the creation of an RE utility are among the possible solutions. The ongoing preparation of the power sector reform should address the issue.

6.4 Transparent process to determine electrification projects

It is not fully clear how the settlements to be electrified by grid connection have been determined so far. The consultant's understanding is that TANESCO makes a proposal which is then modified a bit by REA and the RE Board. The analysis of the settlements selected for the Turnkey II Program showed that few are far from the 33-kV grid (more than 20 km) or small (less than 1,000 inhabitants)[6]. It thus seems that economic and social development criteria dominated the selection. That said, the acceptance of the selection process would benefit from clearly defined criteria similar to those used in the Prospectus to identify development centres. REA's existing manual of procedures goes in that direction but needs some modifications.

6.5 Measures to create the required implementation capacity

Inviting foreign companies to participate in the construction of turnkey projects will be necessary to implement the large number of projects in time. That has already been the case in the Turnkey II Program where nine foreign companies were awarded 16 of the 35 lots.

A proposal to promote the involvement local companies in house wiring is based on the policy which Morocco used in its successful electrification program. Individuals and small local companies selling electrical equipment or doing electrical installation works were trained in how to do the house wiring. They received a certificate at the end of the training program and only certified companies were given the right for doing the house wiring at a fixed tariff.

6.6 Financial Support for Private Sector Participation

Three conditions are necessary to make the private sector participate in rural electrification:

a) A low risk of financial losses.
b) Providing access to loans.
c) Establishing a loan guarantee scheme.

Instruments which reduce the risk of financial losses are: funding a portion of the costs of preparatory works, providing subsidies for investment costs, the possibility to combine RE with sales

[6] See the Prospectus Report "Task 5 – Performance Metrics", April 2013, p.7-8.

under the FiT scheme, a regulation which includes a profit margin in the retail tariffs, and rules which provide off-grid developers with fair options when the main grid arrives. The instruments are in place in Tanzania. What remains to be improved is the lack of data on hydro and biomass sources and the shortage of capacity to prepare project proposals.

Providing access to loans is another necessary condition for private sector participation. The credit line facility provided under the TEDAP Project has proven an appropriate tool in that respect. The credit line facility needs to be increased as the present 23 million US$ facility may soon be depleted. The AFD established a 15 million US$ facility in mid-2013. Several donors are understood to sympathize with the idea to provide funds for a credit line facility but Government funding will most likely also be necessary.

A loan guarantee scheme is considered necessary as commercial banks which handle the credit line facility do not grant the loan without a guarantee and private developers have problems providing the guarantee.

Box 1: FiT Scheme and Rural Electrification

The FiT scheme aims at attracting private investors to set up small power plants (SPPs) using renewable energy carriers. The feed-in tariff applies to small power producers that are connected either to TANESCO's main grid or one of its 20+ existing isolated mini-grids. EWURA specifies FITs in both cases. The owner of the SPP has no obligation to electrify customers in the area where the plant is located if the capacity of the plant is below 1 MW. But he has that obligation if the capacity exceeds 1 MW. The Electricity Act 2008 says that "for the promotion of the National Energy Policy in relation to rural electrification, every licensee shall be required to supply electrical energy to the local communities where electrical supply installations are located or along transmission lines" (Section 39-(4) of the Act). For generation, distribution or supply activities with an installed capacity at a single site of more than 1 MW or a system demand supply exceeding 1 MW, the license is mandatory (Electricity Act 2008, Section 18-(2) and (3)). Therefore all rural generation licensees with a capacity over 1MW have an obligation to supply local communities, if any, in the vicinity of their plant or of their power evacuation line. The cost items which can be considered in the tariff which the owner of the SPP can charge the retail customers are fixed in Article 44 of "The Electricity (Development of Small Power Projects) Rules, 2013". The tariff explicitly allows a reasonable return on capital provided by the owner.

7. Accompanying Measures

7.1 Strengthening REA's Planning Capacity

REA's Planning and Database Management Division should be strengthened by recruiting one GIS expert with knowledge of GEOSIM or of another GIS-based planning software, one energy economist and one rural electrification planner. Among the tasks of the division should be the continuous updating and improvement of the GIS data base, the preparation of the list of settlements to be

electrified under the turnkey programs and assistance in the preparation of feasibility studies for off-grid electrification.

7.2 Measures Supporting Low-Cost Network Design

Low-cost network design should become a priority in project preparation. The assistance of an external expert is considered necessary to make REA propose changes of the network design criteria for rural electrification (MV span length, etc.) and TANESCO to accept them. The tasks of the expert would to determine the low-cost network-design, to indicate to REA and TANESCO the cost savings, to specify the low-cost network-design in the tender documents and to supervise initial installations made by construction companies.

Even more challenging will be the recommended use of SWER. The visit of a small team of REA and TANESCO staff of sites in South Africa or Namibia where electrification by SWER exists for years would certainly be useful. The visit should be followed by the implementation of the proposed pilot project. If the pilot project is successful, standard guidelines for specifications, preparation of bills of quantities and technical drawings should be established.

7.3 Non-Financial Measures Supporting Private Sector Participation

There should be a **one-stop shop** at REA which informs private developers about the available support for off-grid projects or electrification by distributed technologies and the procedures to be followed. The one-stop shop should offer assistance with the administrative procedures the developers have to follow to obtain the required permits and licenses.

Private sector participation would also be facilitated if **REA prepares projects for private developers.** The consultant recommends doing that for the identified priority off-grid projects for which proposals are not received from private developers. Project preparation means that feasibility and engineering studies are prepared. The studies are then made available to private developers in the context of a call for proposals.

There would be a two track approach for off grid electrification. Track 1 would be for priority off-grid projects for which REA would do the initial project preparation and then seek bids from private developers. Track 2 would be the present bottom-up approach where private developers are free to submit proposals for off-grid priority projects whenever they want. The evaluation of submitted proposals will, however, have to be changed in the medium term. The demanded subsidies may exceed the available subsidies. The introduction of off-grid ranking criteria would then become necessary. It is recommended that REA soon establishes a hierarchy of projects to be financed. Taking into account which projects should be given priority in funding will require to replace the current first-come-first-served procedure by the common evaluation of several proposals two or three times a year.

7.4 Tendering of Turnkey Programs

Tender documents for the Turnkey Programs should be technically more detailed to minimize the risk of misinterpretation by the contractors. That will require the assistance of external experts who are familiar with GIS based network design programs and the preparation of tender documents. REA should also consider the possibility of leasing a subset of the facilities built under the Turnkey

Programs to private developers who would then function as small power distributors (SPDs) These SPDs would buy power in bulk from TANESCO and resell it as retail. EWURA's second generation SPP and mini-grid rules explicitly provide for this type of business model (see Part VII).

7.5 Supervision of REF Funded Projects

The supervision of construction projects currently involves several parties: the Trust Agent supervising the commercial part of the contract, assisted in the technical by an engineering company with which the Trust Agent has an association agreement, TANESCO's engineers as representatives of the beneficiary and REA controlling the Trust Agent's supervision activities. Sharing the supervision work is certainly necessary but it is presently done without clear regulations on who conducts the supervision activities and without clear allocations of responsibilities. The consultant recommends changing that by adding to the Trust Agent a full-fledged 'Engineer' function in the FIDIC terms in charge of project supervision for REF/REA. The 'Engineer' shall be in charge of site supervision up to commissioning for all projects for which REF is the owner during the construction period. The 'Engineer' should be familiar with contract and procurement issues and have claims expertise.

7.6 Monitoring the impact of electrification

The ultimate objective of electrification is to advance socio-economic development and to reduce poverty. To what extent that has been achieved will require defining a set of indicators, fixing reporting requirements for the operator – which will normally be TANESCO for grid supply and private developers for off-grid supply - and conducting occasionally surveys. Detailed proposals can be found in the Task 5 Report (Performance Metrics) of the Prospectus Project. So far, no substantial monitoring has been done.

8. Rural Electrification Master Plan

The RE Master Plan is basically a follow-up program for electrification planning.

The RE Master Plan should improve the database of the Prospectus, specify on-grid and off-grid projects and make proposals regarding the set-up of RE in a reformed power sector. Among the detailed tasks should be:

- Improve the knowledge on the status of electrification in Mainland Tanzania: which settlements are electrified, by whom, what is the electrification ratio in electrified settlements, number of electricity users with stand-alone systems, development of the annual consumption of electricity users, quality of supply.
- Establish an improved database with emphasis on (i) renewable sources for electricity production and (ii) data to estimate the development potential of electrified settlements.
- Use the improved database to prepare a list of development centres for each region.
- Prepare the turnkey programs for on-grid electrification.
- Propose a list of off-grid projects for hydro sites, biomass-fuelled power plants and diesel-PV hybrid systems and determine an action program for the realization of the projects.
- Specify the role of stakeholders in RE in the reformed power sector.

1 Background and Objectives

Tanzania, with a population of about 43 million at the end of 2013, has been one of the African countries that have experienced significant economic growth over the last decade. Real GDP growth averaged close to 7% per year. Tanzania's progress has been made possible by stable political leadership and commitment to sound macro-economic and fiscal policies.

The country's medium-term objective as laid out in the **National Vision 2025** is to develop Tanzania from a least developing to a middle income country. A strong, competitive economy, an efficient public sector and sound environmental management shall provide income opportunities for the population thereby eradicating poverty which at present still affects about one third of households.

Reforms which will be necessary to that end shall be pushed by the **Big Results Now** initiative which uses new implementation methods and specified time frames to advance reforms in six priority areas.

It is not surprising that energy is among the priority areas. Tanzania's low level of electrification and the poor quality of electricity supply have been barriers to economic developments. If measured in the traditional way by the electrification ratio, about 18% of households had been electrified at the end of 2013 with a large difference between urban areas - on average about 45% - and rural areas - on average less than 6%. The Government's objective is that 30% of the population of the Mainland has access to electricity by end of 2015 and 50% by end of 2020.

The 'National Electrification Program Prospectus' is a planning exercise to identify the investments required to advance electrification, to indicate how the investments could be financed and to determine the institutional, regulatory and capacity strengthening measures for the implementation. The Prospectus encompasses urban and rural electrification. It covers electrification by grid extension, off-grid options where mini-grids are supplied by renewable energy sources, and distributed energy solutions for remote low density areas.

The Prospectus provides guidance and recommendations for the least-cost development of electrification. It does so by a transparent and rational approach. The Prospectus shall serve as the reference document for the Government, the Ministry of Energy and Minerals, REA, TANESCO and the Development Partners, when deciding on and coordinating electrification programs and associated activities.

The present report mainly summarizes what has been described in detail in other reports which were prepared as part of the Prospectus exercise :

Task 1 – GIS analysis of least cost access plan
Task 2 - Review of least cost bulk power generation and network expansion program
Task 3 - Readiness Assessment
Task 4 - Sector financing plan and gap analysis
Task 5 - Performance Metrics

The present report starts with a survey of the current situation and the planned developments and reforms of Tanzania's electricity sector. The methodology which has been used to determine the

Prospectus is described next, followed by the presentation of the resulting electrification programs, cost estimates and considerations on how the programs could be funded. The following chapters present the proposed implementation plan and accompanying measures. The report ends with recommendations for the preparation of a Rural Electrification Master Plan which is basically the follow-up program for electrification planning.

2 Current Situation of the Electricity Sector, Planned Developments and Reforms

2.1 Power Supply Infrastructure

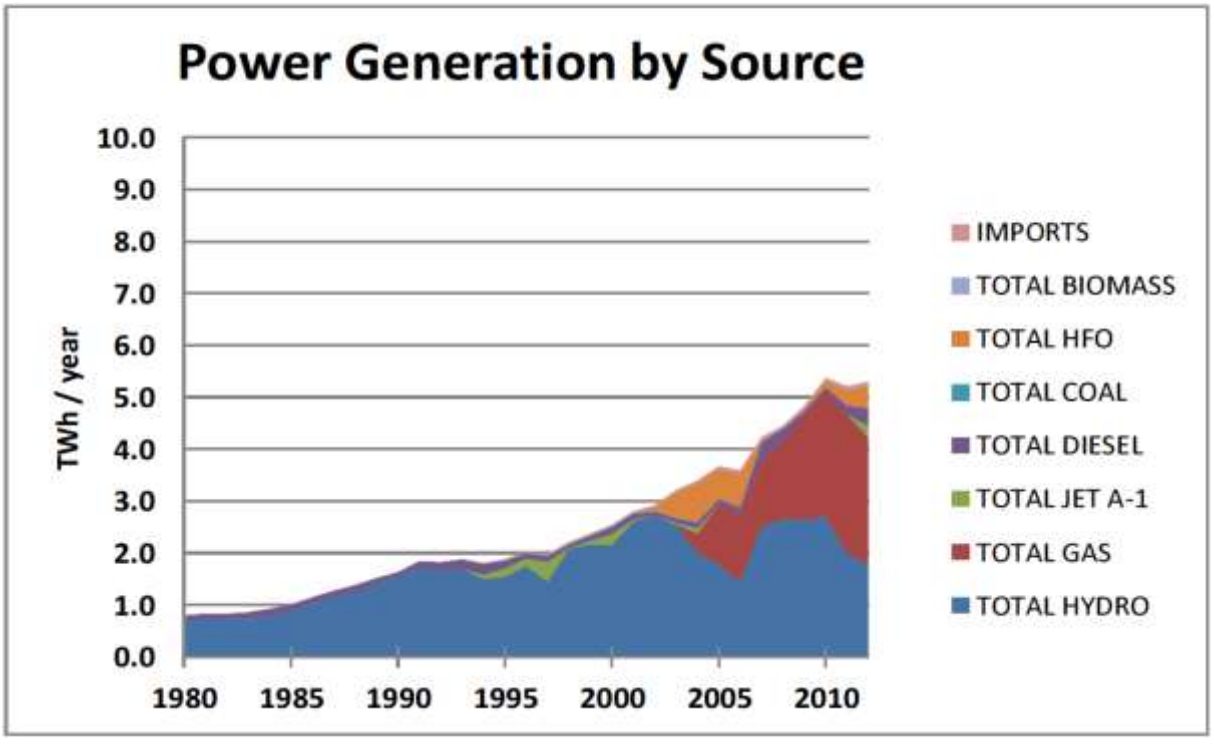
2.1.1 Generation

The installed generation capacity feeding into the interconnected grid stood at about 1,438 MW at the end of 2012. Thereof, 562 MW was hydro capacity consisting of six TANESCO-owned plants. Thermal capacity accounted for 876 MW with 501 MW gas-fired capacity and 375 MW diesel, HFO or Jet-A1 fuelled plants. Independent Power Producers (Songas and IPTL) owned 292 MW of the thermal capacity, private operators contracted under the Emergency Power Plan 325 MW and TANESCO 259 MW.

The available capacity was much lower with only 879 MW.

Figure 1 shows the development of generation and imports. Total generation and imports reached 5,741 GWh in 2012 with imports accounting for about 1%. TANESCO imports from Uganda up to 8 MW via a 132-kV line and from Zambia up to 5 MW via a 66-kV line.

Figure 1: Power generation in the period 1980 – 2012



Source: Pöyry, Joint Energy Sector Review 2012/13, Oct. 2013.

The generation shown in Figure 1 includes TANESCO's isolated power plants. The total capacity of these plants was about 77 MW at the end of 2012. Their generation only accounted for 3% of the total generation in 2012.

The generation includes plants selling power to TANESCO under the feed-in tariff (FiT). Their contribution was very small with less than 1% in 2012. The companies were: Tanwat (1.5 MW - sugar producer), TPC (5 MW - sugar producer), and Mwenga (3.5 MW - hydro plant). In 2013, Ngombeni Power, located on Mafia Island operating a biomass-fuelled plant, also started selling to TANESCO under the FiT scheme.

Figure 1 does not include the generation of small isolated plants owned by religious institutions, communities, companies, etc. Only anecdotal data are available on their electricity production which certainly was very small compared to the generation shown in the figure. It also shows that hydro generation dominated the market until 2005 before it has been severely affected by low rainfalls that prompted the Government to respond with the Emergency Power Plan. Under the plan, contracts were signed with private companies (Aggreko and Symbion) to produce substantial power from thermal plants, most of which are fuelled by petroleum products (HFO, diesel, Jet A-1). Costs considerably increased as a result.

The Emergency Power Plan has improved power supply – reducing the number and duration of power cuts – but the country is still suffering from a severe shortage of generation capacity.

The Government's target is to raise the installed capacity from 1,438 MW to 2,780 MW in 2015[8]. That shall predominantly be achieved by the installation of gas-fired capacity. A 532-km gas pipeline is expected to be available by end of 2014 which will bring low-cost gas from Songo-Songo and Mnazi Bay to the Kinyerezi power plants in Dar es Salaam. Kinyerezi I with a capacity of 150 MW (simple cycle) is under construction and should be finished before the end of 2014. The construction of Kinyerezi II with a capacity of 240 MW (combined cycle) is expected to start in 2014 and production by end of 2015. Other planned gas-fired power plants are Kinyerezi III (300 MW initially, ultimately 600 MW, simple cycle), Kinyerezi IV (450 MW, combined cycle), Kilwa (320 MW, simple cycle) and Mnazi Bay (300 MW). The planned commissioning dates of the plants are 2015 and 2016 and a significant portion of the production shall be exported. Coal-fired power plants and hydropower plants are planned, too, but will probably not be available in the near future.

2.1.2 Transmission

TANESCO fully owns the Tanzanian HV network. The existing transmission system includes the following lines and substations (TANESCO Oct.2013):

a) 220 kV lines: 18 lines (3,191 km)
b) 132 kV lines: 16 lines (2,213 km)
c) 66 kV lines: 5 lines (722 km)
d) 38 Grid Primary substations of 2,189 MVA

The planned transmission lines and their date of commissioning are:

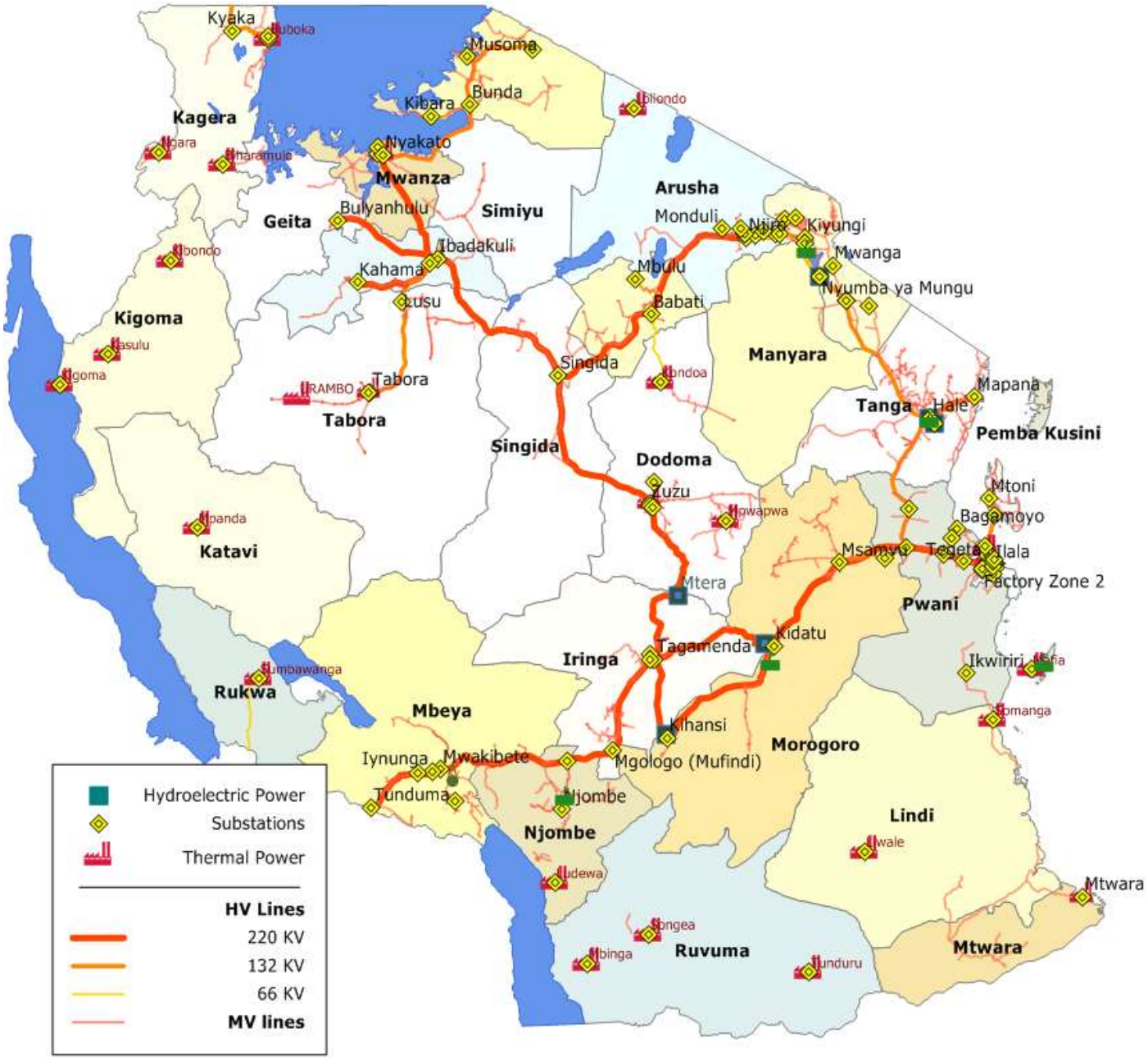
- 220kV Makambako – Songea (320km) – 2015
- 400kV Iringa – Shinyanga (648km) – 2015

[8] http://www.tzdpg.or.tz/fileadmin/documents/dpg_internal/dpg_main/DPG_Main_2013/DPG_Main_September_2013/Energy_NKRAs_Presentation_to_DPs.pdf

- 220kV Kiwira - Mbeya (100km) – 2016
- 400kV Singida – Arusha – Nairobi (577km) – 2016
- 400kV Kasama - Mbeya (220km) – 2016
- 400kV Mbeya – Iringa (280km) – 2016

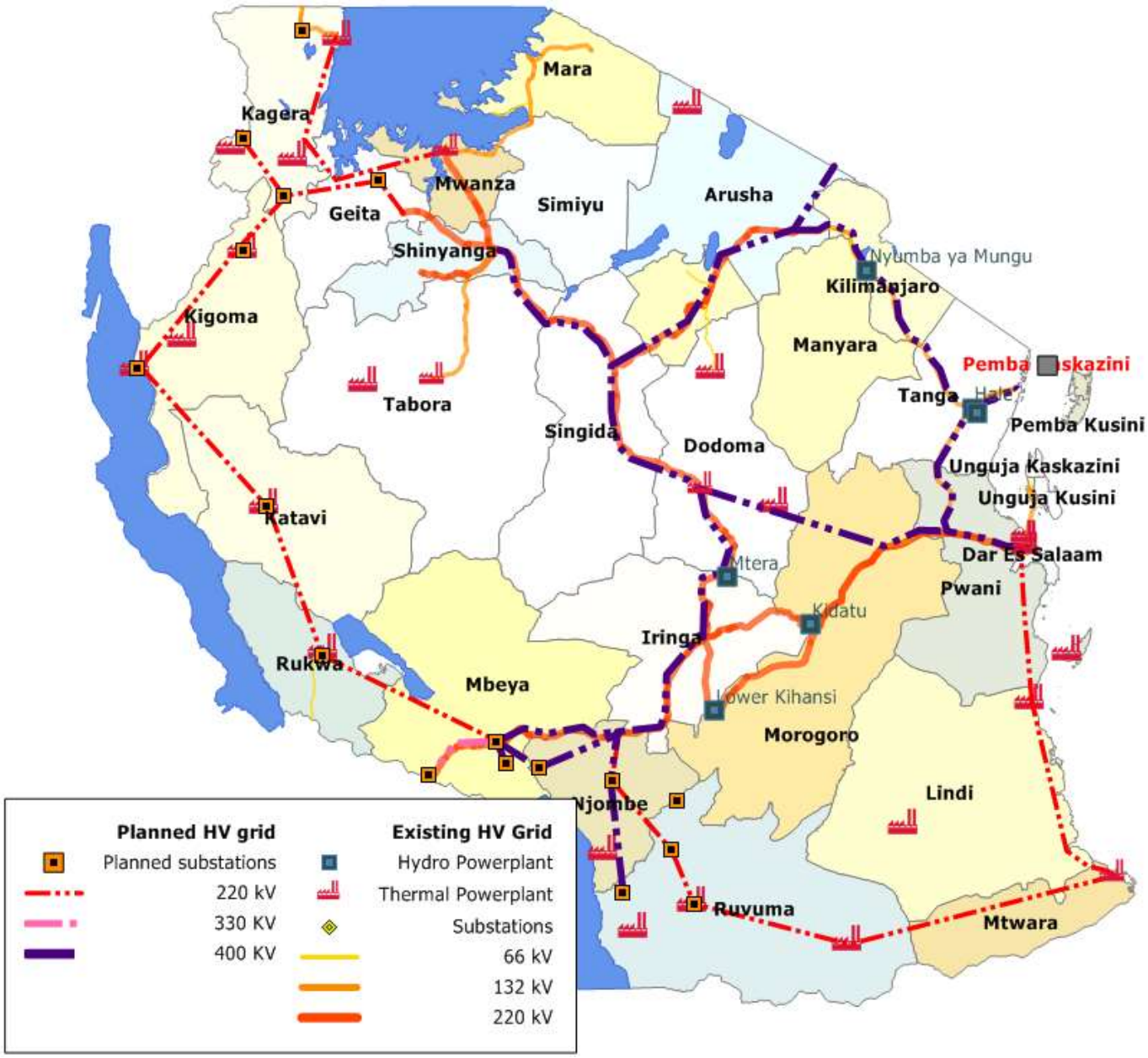
The existing and planned transmission network is shown below.

Figure 2: Existing Transmission Network in Tanzania 2013



Source : IED-TANESCO

Figure 3: Planned Transmission Network in Tanzania 2014 – 2025



Source: PSMP 2013

2.1.3 MV and LV Network

The MV network consists of 11 kV and 33 kV lines and is mainly owned by TANESCO. At the end of 2013, there were 5,405 km of 11 kV lines, 17,733 km of 33 kV lines and 35,300 km of LV network. The 11kV lines are being progressively abandoned.

2.2 TANESCO's Financial Performance and Reform Plans

Table 1 shows that over the ten-year period 2003 – 2012, there was only a single year where TANESCO had made a profit before tax and only a single year where the operation had not been a loss-making exercise.

Table 1: Key Financial Indicators of TANESCO (Million US$)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Electricity Sales	159	173	196	185	234	310	313	324	344	519
Total cost of sales	183	244	250	290	308	307	326	342	475	735
thereof: Power purchase cost	68	114	156	187	195	162	141	147	218	334
Operating profit (loss)	(63)	(33)	(22)	(125)	(51)	2	(2)	(0)	(22)	(110)
Profit (loss) before tax	(214)	(104)	43	(125)	(54)	(18)	(36)	(31)	(48)	(142)
Average price paid (US cent/kWh)	6.83	7.02	7.47	6.69	7.35	9.18	9.00	7.91	8.61	11.68

Sources

2003 – 2009: Power Sector Reform and Regulation in Africa, p.30

2010 – 2012: 2010 - Audited Financial Statements 2011, p.23 and p.51.
2011 and 2012 - Audited Financial Statements 2012, p.25 and p.52.
Average annual exchange rate (TZS/USD): 2010 – 1440, 2011 – 1585, 2012 - 1581 (Source: http://fxtop.com)
Average price paid: revenues divided by sold kWh.

TANESCO's dire financial situation has been mainly due to that the company's supply costs exceeded the revenues. In recent years, reduced hydropower production and the generation of costly thermal power plants installed by private companies under the Emergency Power Plan resulted in high power production costs and made TANESCO request for several tariff increases. Higher tariffs which were granted by EWURA in early 2012 translated into an average increase of 40.3%. Tariffs were raised again by about 40% on average in January 2014. The new tariffs which became effective on January 1, 2014 shall remain valid until end of 2016. The tariff increase is considered a major step in improving TANESCO's finances and, in the wake, the company's performance.

Reform plans go beyond improving TANESCO's finances. At present, TANESCO is a state-owned vertically integrated production, transmission and distribution company. TANESCO is the System Operator and de facto Single Buyer of energy injected into the grid. This structure coupled with issues in the legal and regulatory framework is not considered adequate for an efficient electricity sector in which private companies would like to participate as power producer, distributor or in other functions. The Ministry of Energy and Minerals (MEM) has, therefore, recently decided to undertake a study to prepare the roadmap for the future sector reform. The "Big Results Now" Report which has been endorsed by the President can be said to anticipate results of the roadmap by proposing to split TANESCO into two or three companies and to create an independent System Operator by 2015/16.

2.3 Electrification: Status, Policy, Institutional Set-Up, Funding

2.3.1 Status of Electrification

Estimates of the status of electrification vary for two major reasons:

- The use of different definitions of electrification.
  In the traditional definition, referred to as the electrification ratio, a household is electrified if it is connected to a grid or has its own source of electricity generation. In the access definition, households which are not electrified as described above have access to electricity if they can use services, which require electricity, in the vicinity of their home. Examples are access to medicaments which need cold storage, access to the internet in internet shops, or access to the neighbour's plug to charge a mobile phone.

- Data availability.
  While TANESCO is the dominant supplier, it is not the only one. Communities, religious institutions, NGOs, and other companies are also suppliers and some electricity users have their own generation source. Only anecdotal data on non-TANESCO supply are available.

Even TANESCO's customer statistics do not give a precise picture of the number of households supplied by the company. A survey conducted by IED in 2012 found that one household meter supplied on average 1.25 households. The results of the Baseline Survey conducted by REA in 2011 also indicate that more households are supplied by TANESCO than officially recorded.

The definition and data availability issues are described in more detail in Annex 1. How the consultant's estimate has been obtained is also described there.

The consultant's estimate, using the traditional electrification ratio as measure, is that **about 18% of the Tanzanian households were electrified by end of 2013. In urban areas, the percentage was about 45% and in rural areas somewhat below 6%.**

2.3.2 Electrification Policy

2.3.2.1 Concentrating Rural Electrification Activities in the Rural Energy Agency

The Rural Energy Agency (REA) was established under Section 14 of the Rural Energy Act 2005. The Government created REA to have an agency which focuses on rural electrification. Beforehand, TANESCO was mainly in charge of RE and RE was not among the company's priority activities. Creating an agency in charge of RE is a sign of the importance that the Government attributes to RE.

2.3.2.2 Involvement of Private Sector and Communities desired

The Rural Energy Act 2005 relies on private and community involvement to provide modern energy services to rural areas. That is clearly expressed in the Principles of Rural Energy Development which state that:

"4(b) sustainable development shall be achieved when modern energy services in rural areas are promoted, facilitated and supported through private and community initiatives and involvement";

"4(c) the role of Government in rural energy service provision is that of a facilitator of activities and investments made by private and community entities".

In practice, the involvement of the private sector or communities is so far still limited and the focus not on rural electrification but on installing power plants which sell the production under the FiT scheme; see the following paragraph. While the main reason is probably lack of financial support, another important reason is that the private sector is in general risk averse and rural electrification is certainly not a low risk activity.

2.3.2.3 (Indirect) Involvement of the Private Sector via the Feed-in Tariff Scheme

The introduction of the FiT scheme has created private sector interest. By end of 2013, twelve FiT contracts had been signed for 50 MW of capacity. Hydro plants account for 33 MW thereof, biomass-fueled plants for 15 MW and a PV plant for 2 MW. Letters of Intent (LoIs) had been signed with eleven developers for 40 MW. Except for one 1-MW PV project, the LoI projects are all hydro projects.

The FiT scheme and rural electrification are, to a large extent, independent concepts. TANESCO as the buyer of the electricity produced under the FiT scheme is not obliged to use it for RE. The owner of the FiT plant is not obliged to do rural electrification if the plant has an installed capacity not exceeding 1 MW. The consultant's interpretation of the Electricity Act - see Box 1 – is that he has the obligation to supply the local community where the plant is located if the plant's capacity exceeds 1 MW. The interpretation has been contested during the final presentation of the Prospectus results in June 2014. Several attempts to clarify the issue have not produced a result.

Independent of whether the power producer has the obligation or not, supplying the local community may be of interest as it allows reducing risks. Important risks are that TANESCO does not pay or pays with substantial delay. The risk that TANESCO does not pay may be considered very low. But the risk that TANESCO pays with substantial delay cannot be ignored; the first FiT contracts were during several months not paid in time. Getting some income from retail customers in the surrounding rural area reduces the impact of late payments by TANESCO somewhat. To the consultant's knowledge, all existing plants which sell to TANESCO under the FiT scheme also supply other customers and most who intend to become producer under the FiT scheme, including those who use the matching grant for preparatory activities, are also planning to supply retail customers. Whether it is done or planned to reduce risks or for the (contested) legal obligation is not known.

The FiT scheme is also of benefit to developers who mainly want to provide people in rural areas with power supply. The optimal size of a hydro plant in terms of the lowest per-kWh-production-cost may exceed the demand in surrounding rural areas. Installing a smaller plant may not be financially feasible as the per-kWh-costs may not be affordable for the population. In that case, constructing the optimal-size-plant and selling the excess under the FiT scheme may be the solution. It thus not surprising, that many potential project developers who are currently preparing feasibility studies on small hydro plants, plan to combine the FiT scheme with the supply of rural customers.

2.3.3 Institutional Set-Up

2.3.3.1 Ministry of Energy and Minerals

The Tanzanian Minister of Energy is in charge of developing and reviewing government policies in the electricity supply industry. He takes all measures necessary to reorganize and restructure the industry with a view to attracting the private sector. Through REA, he prepares the Rural Electrification Plan and takes measures to promote rural electrification in accordance with the Rural Energy Act.

2.3.3.2 Rural Energy Agency

The Rural Energy Agency was established under Section 14 of the Rural Energy Act 2005 and became operational in 2006.

REA's task is to facilitate the provision of modern energy services in the rural areas of Mainland Tanzania. Regarding RE, the Agency does so in two ways:

(a) By providing technical assistance, research and development, training and other forms of capacity building to qualified developers prior to the realization of RE projects. The activities (technical assistance, training, etc.) are carried out by qualified experts.
(b) By providing subsidies for RE projects.

Though not explicitly mentioned in the Rural Energy Act, an important task of REA is to coordinate electrification initiatives. REA therefore serves as contact point for donors, private developers, non-governmental organizations, community-based organizations and others who intend to realize or support electrification projects.

2.3.3.3 The Regulator: Energy and Water Utility Regulatory Authority (EWURA)

In 2001, the Energy and Water Utilities Regulatory Authority Act (the EWURA Act) of 2001 was passed. EWURA became operational in 2006.

EWURA is responsible for the regulation of four sectors: electricity, petroleum, natural gas and water. EWURA's core functions are licensing or regulating access to the market, tariff setting and establishing and monitoring of technical standards that promote quality and reliability in electricity service provision.

EWURA has created incentives for direct and indirect participation of the private sector in rural electrification. An important incentive for direct involvement in the form of supplier of retail customers is the provision that **small power projects selling to retail customers can propose their own tariff**. The tariff regulation allows the operator to "… charge a tariff that, at a maximum, shall be limited to the sum of operating costs, depreciation on capital, whether supplied by the operator or others, debt payments, reserves to deal with emergency repairs and replacements, taxes, plus a

reasonable return on capital provided by the operator that reflects the risks faced by the operator."[9] The tariff has to be approved by EWURA.

Furthermore, **suppliers who conduct an off-grid distribution and supply activity of less than one Megawatt in a rural area are exempted from licensing requirements**[10]**.**

Incentives for indirect participation as power producer who sells to the grid operator are the **Standardized Small Power Purchase Agreements** (SPPA) for power generation projects with an installed capacity ranging between 100 kW and 10 MW and the **Standardized Small Power Producer Tariffs** (Feed-in-Tariffs) for the same range of projects. The Feed-in-Tariffs which were valid in 2012 and 2013 are shown below.

Table 2: Feed-in Tariffs in 2012 and 2013

FIRST SCHEDULE

Main Grid Connection Tariff

Description		2012 Tariff (TZS/kWh)	2013 Approved Tariff (TZS/kWh)	Percentage Increase
Standardized Small Power Purchase Tariff		152.54	174.89	15
Seasonally adjusted Standardized SPPT Payable in	Dry season	183.05	209.87	15
	Wet season	137.29	157.40	15

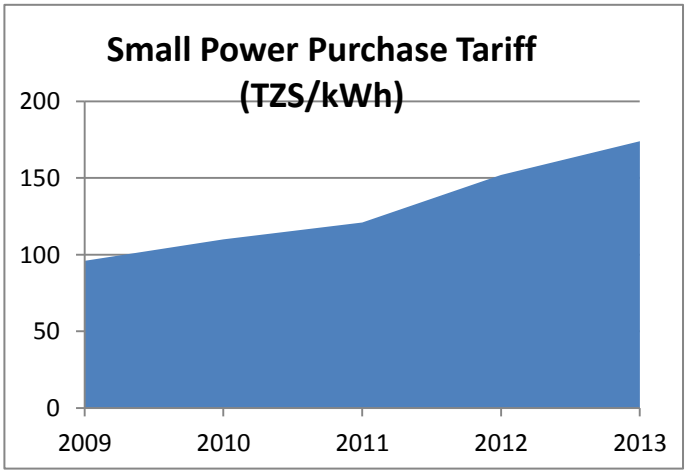
SECOND SCHEDULE

Mini Grid Connection Tariff

Description	2012 Tariff (TZS/kWh)	2013 Approved Tariff (TZS/kWh)	Percentage Increase
Standardized SPP Tariff	480.50	490.50	2

Evolution of Standardized Small Power Purchase Tariff for Main Grid Supply

Year	SSPP (TZS/kWh)	Increase (%)
2009	96.11	
2010	110.30	15
2011	121.13	10
2012	152.54	26
2013	174.89	15



[9] Part VIII of the Electricity (Development of Small Power Projects) Rules, 2013.

[10] Developers who only generate power in a rural area using a plant whose capacity does not exceed one MW are also exempted.

The Feed-in Tariffs are valid for installed capacities between 100 kW and 10 MW. The Feed-in-Tariff Scheme has some shortcomings which are currently addressed in a study which shall propose a new methodology on how to determine Feed-in-Tariffs[11]. The shortcomings are:

(i) that the tariffs are undifferentiated by renewable technologies;
(ii) that there is no guaranteed tariff over the long-term as the tariffs are adjusted annually by EWURA based on avoided and incremental costs - a floor price limits the FiT's downward variation, however.

Another previous shortcoming that it is not regulated what happens when the main grid arrives has been addressed by the new rules which were gazetted in April 2014.

The rules define a Small Power Project (SPP) as an entity that generates electricity and (1) sells the produced power at wholesale to a Distribution Network Operator (DNO) - which is TANESCO in the present system set up –, or (2) sells the produced power at retail directly to end customers, or (3) carries out some combination of the two. The rules say in Part VII that a SPP which is connected to an isolated grid can, when the main grid arrives, apply for the right:

(a) to sell to the Distribution Network Operator that is connected to the main grid and be paid the main-grid FiT,
(b) to become a Small Power Distributor who buys in bulk from the main grid and resells to retail customers,
(c) to carry out a combination of (a) and (b).

The owner of the SPP is also free to sell the assets when the main grid arrives.

Furthermore, to minimize the risk that the business model becomes obsolete when the main grid arrives, the developer who intends to set up a SPP which feeds into an isolated grid owned by the DNO shall be informed by the DNO of the planned date of interconnection with the main grid.

2.3.3.4 Institutions Charged with Environmental Issues

Two institutions are dealing with environmental issues: the National Environmental Management Council (NEMC) and the Division of Environment within the Vice President's Office (VPO).

NEMC has, among others, the mandate to review and monitor environmental impact assessments. NEMC is also responsible for environmental compliance and enforcement.

Among the mandates of the VPO is the preparation and issuance of guidelines for Environmental Impact Assessments. The VPO is also the Designated National Authority for the Clean Development

[11] See: http://cleanenergyblog.eversheds.com/all-briefings/africa-renewable-energy-feed-in-tariff-programme-for-tanzania/

Mechanism (CDM)[12]. In 2012, two rural electrification projects, the Mwenga Hydro Project and the Luiga Hydropower Project, had applied for carbon credits under the CDM facility. Mwenga's application was approved in mid-2013.

2.3.4 Funding Electrification

2.3.4.1 The Rural Energy Fund

The Rural Energy Fund (REF) was established by the Rural Energy Act 2005. The REF shall be the main vehicle for funding rural energy projects. The REF is managed by REA. The REF gets funds from the Government of Tanzania, donors, levies and interests earned.

Donors

Until the end of FY 2012/13 (July 2012 – June 2013), the government of Sweden through SIDA had been the only donor which injected funds into the REF. In FY 2013/14, the government of Norway joined SIDA. Other donors made significant contributions to RE by funding earmarked RE projects but have so far been reluctant to inject into the REF.

Levies

Electricity Levy: The Rural Energy Act 2005 defines the Electricity Levy as a percentage of electricity generation. As electricity generation is not a monetary value, the levy is in practice a percentage of the energy purchased by TANESCO's electricity consumers. The current percentage is 3% and the maximum percentage is fixed in the Rural Energy Act at 5%.

Pre-Destination Inspection Levy: The levy was introduced in 2011. The levy amounts to 0.04% of the fob-value of petroleum product imports.

Fuel Levy: The levy was introduced in 2013. The levy amounts to 50 TZS per litre.

The REF funds are used for:

- Grants towards the capital costs of projects implemented by private and public entities, co-operatives, and local community organizations.
- The provision of technical assistance, training and other forms of capacity building to qualified developers by qualified experts related to the planning and preparation of a project prior to an application for a grant.
- The provision of financial assistance. Co-financing investments in innovative pilot and demonstration projects and applications for renewable energy when development partners make special purpose funds available for that purpose.

[12] The study "Sustainable Energy Markets in Tanzania" (September 2012; prepared for SIDA by the Stockholm Environment Institute and renetech) mentions that "…there seems to be limited interest at the VPO to approve CDM projects" (p.24). The consultant got the same impression when discussing carbon credits with the VPO's office in June 2013. The "Sustainable Energy Markets" Report mentions that in August 2012, the CDM pipeline consisted of only 8 projects and only one of these, the Mtoni Landfill Gas Project, had been approved. The Mtoni Project stalled after the initial piping phase due to lack of gas.

A portion of the REF is also used to finance REA's activities.

Table 3 shows the receipts of the REF since FY 2007/8. The fiscal year starts on July 1 and ends on June 30 in the following year.

Table 3: Receipts of the Rural Energy Fund

Year	Government 1000 US$	Elec. Levy 1000 US$	PF Levy 1000 US$	SIDA 1000 US$	Interest 1000 US$	TOTAL 1000 US$
2007/08	9,528	-	-	-	28	9,556
2008/09	9,583	-	-	-	397	9,980
2009/10	16,035	6,012	-	-	523	22,570
2010/11	9,687	9,653	-	4,653	908	24,901
2011/12	37,382	6,979	3,431	10,353	2,157	60,303
2012/13	27,430	17,883	11,938	14,194	4,601	76,046

The Government has been the largest contributor accounting for 54% of the total funds injected up to and including FY 2012/13. The Electricity Levy and the Pre-Destination Inspection Levy contributed 27% and SIDA 14%.

Data on expenditures received from REA indicate that until the end of FY 2012/13, about 150 million US$ had been disbursed with about 85% thereof for electrification projects and a few other modern-energy-service-projects (briquetting, biogas, etc.) and 15% for REA's administrative costs. The total receipts of about 200 million US$ until the end of FY 2012/13 thus exceeded the total expenditures by approximately 50 million US$. That does not imply that REA had 50 Million US$ of excess cash. Payments for projects are made in several instalments and the "excess cash", which earns interest as can be seen from Table 3, is needed for future instalments. In FY 2013/14, for example, total payments made for the Turnkey II Program amounted to about 93 million US$, corresponding to 20% of the contract values.

Table 4 shows that until end of September 2013, funds for 149 projects had been disbursed by the Trust Agent, Tanzania Investment Bank. TIB is responsible for the disbursement of grant payments from the REF. The monitoring of the projects is done by the engineering company INTERFIN which has an association agreement with TIB. Out of the 149 projects, 92 were classified by TIB as completed. The Work Completion Report for some of the completed projects had not yet been submitted, however.

Table 4: REF disbursements until end of September 2013

Project	Number of projects	Disbursed until 30.9.2013 (Million TZS)
Grid extension projects	100	149,348
Biogas projects	6	400
Other bio-energy projects	4	62
Wind solar hybrid systems	3	147

Wind turbines	2	71
Wind mast installation	1	32
Hydro projects	2	68
Solar projects (mainly PV)	19	1,778
Compensation (property, way leave)	5	740
Feasibility studies	2	54
Diesel generators	5	11,580
TOTAL	**149**	**164,547**

The breakdown of the disbursed funds by type of project shows that by far the largest portion of the disbursed funds (91%) has been used for grid extension projects. The funds for grid extension projects were initially given to TANESCO which in turn commissioned construction companies with the works. Since 2012, the projects are tendered by REA and installed by construction companies under turn-key contracts. The projects are handed over to TANESCO when the work is finished.

TANESCO has been the dominant beneficiary of the disbursed REF funds. About 98% were directly or indirectly (turn-key grid extension projects) destined for TANESCO. Only the funds disbursed for renewable energy projects, with the exception of the wind mast installation, and the feasibility studies were benefitting private companies, NGOs, communities, religious institutions and others.

2.3.4.2 Donor Funding Outside the REF

Donors have substantially supported Tanzania's electricity sector in the past. Financial support in the form of grants or concessionary loans was mainly made available for generation, transmission and distribution infrastructure, including studies related to such investments. But the donors also funded electrification projects and associated activities (feasibility studies, capacity building, etc.). The consultant visited several donors and obtained some information on past, ongoing and planned activities in the electricity sector. The information, partly supplemented by information found in reviewed documents, is presented in Annex 2. The list of activities shown there is incomplete; both with respect to the list of donors and to the activities mentioned for the listed donors. The presentation illustrates nevertheless that Tanzania's electrification activities have in the past benefited substantially from donor support.

The following information on the TEDAP Project (Tanzania Energy Development and Access Expansion Project) is presented here because the project comes with facilities which are of particular interest for the desired private sector involvement.

The TEDAP Project provides funds for off-grid and renewable energy projects in the form of:

(i) **Matching grants** for pre-investment support (typically feasibility studies),
(ii) **Credit-line facility**,
(iii) **Performance grants** for connected customers in rural areas.

The TEDAP funds, managed by REA, are provided by the World Bank with co-financing from GEF and AFREA (Africa Renewable Energy Access Program).

Matching grants: Until mid 2014, 46 applications for matching grants had been received, 42 thereof for hydro projects. For 35 projects, a matching grant had been awarded and payments had been made for 30 project proposals. Matching grants finance up to 80% of the costs of pre-investment activities; predominantly feasibility studies and the Environmental and Social Impact Assessment (ESIA). The awarded matching grants finance on average 52% of the costs of the pre-investment activity. Not all feasibility studies will certainly result in the implementation of projects. But the large number indicates that there is great interest in setting up small hydro plants and suggests that a significant number of projects will be implemented - provided that financing can be arranged.

Credit line: Until mid 2014, the 23 million US$ credit line facility had been used by three companies – Mwenga, Andoya and Ngombeni. Mwenga installed a 3.5-MW hydro plant, Andoya a 1-MW hydro plant and Ngombeni a biomass-fuelled combustion plant on Mafia Island. All three projects are already operating. The total credit line amount used by these companies was 7.3 million US$. An application which had been received from Mapembasi (10 MW hydro plant) for about 10 million US$ was soon to be decided.

Under the credit line, private banks evaluate SPP projects using their own criteria and due diligence procedures. Once satisfied, they issue a loan and disburse funds to the project on an agreed upon schedule at an agreed upon interest rate, tenor, and terms. Banks are then able to refinance through the Credit Line to cover up to 85% of the total disbursed amount under 3 MW or up to 75% of the total disbursed amount from 3 MW to 10 MW with a maximum cap of $10 million USD per transaction. The creditor's default risk remains with the bank. Developers who use the credit line benefit from conditions which are better than the bank's normal conditions. The interest rate is the weighted average of the bank's rate (order of magnitude: 15%) and the credit-line rate (order of magnitude: 5% - 8%). The loan maturity is up to 15 years and the loan can come with a grace period of up to 5 years.

Performance grant: By mid 2014, six hydropower projects – Mwenga, Andoya, Mawengi, Lupali, Tulila and Isigula - had received payments from the performance grant of 500 US$ per connected customer. The performance grant is subject to the condition that the total amount does not exceed 80% of the distribution and connection costs.

2.3.4.3 TANESCO's Funding Contributions

Since the REF has been in place, TANESCO has stopped funding the connection of non-electrified villages to the MV grid. Since 2007, villages have been connected to the grid only if funding was provided by the REF or by donors.

TANESCO's funding of electrification investments has since been limited to the funding of densification investments where new customers are connected to already existing lines or where mainly only the LV grid is extended. TANESCO obtained the largest portion of the funds used for these investments from the Government. The amounts are not known but have certainly been important. Costs for the connection of the approximately 140,000 new customers in 2013 are estimated by the consultant at about 50 million US$.

3. Determination of Proposed Electrification Program

3.1 Survey of the planning process

The overall planning process aimed at answering the following questions:

- **Which settlements should be electrified until end of 2022 to best advance the socio-economic development within the regions?**

➔ *Identification of Development Centres at the regional level*

- **What will be the electricity demand in the identified Development Centres and nearby settlements?**

➔ *Assessment of consumption growth over the planning period*

- **Which technical options would be most appropriate to supply the Development Centres and nearby settlements?**

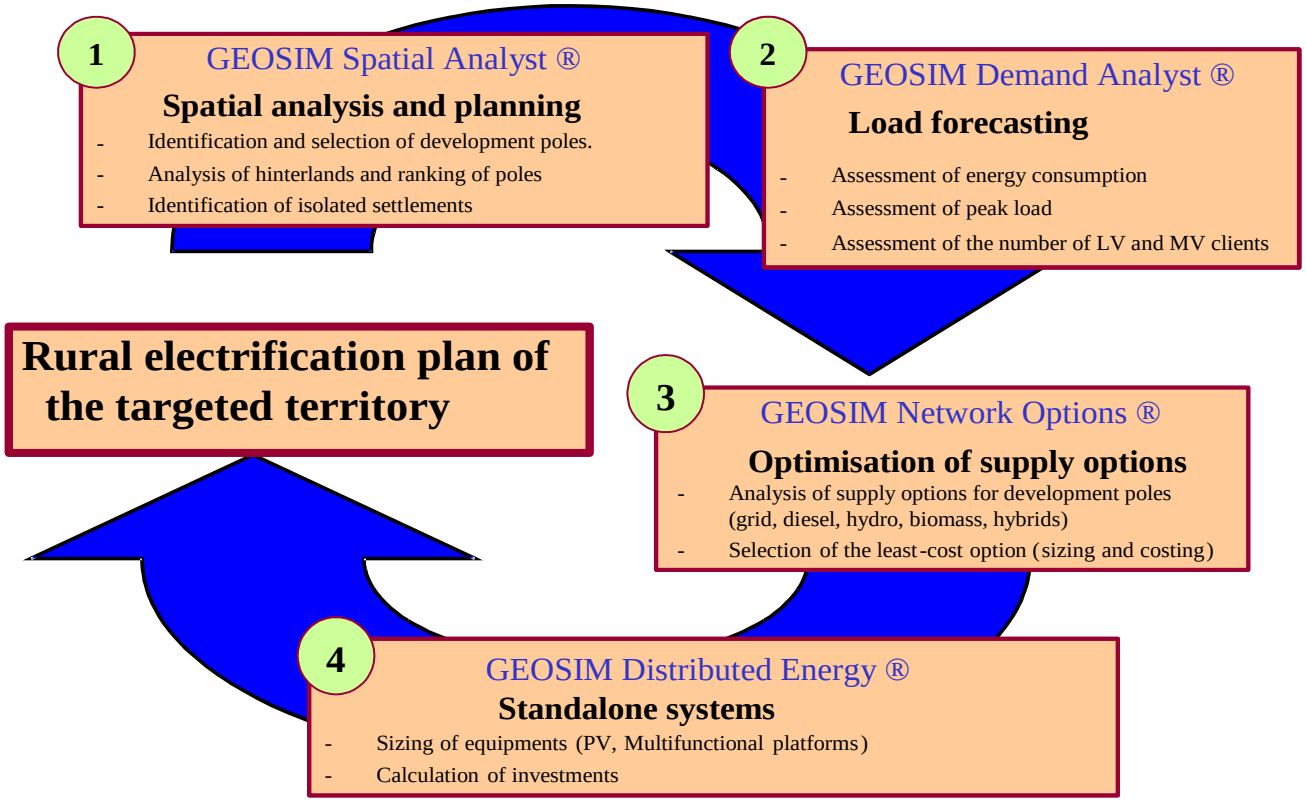
➔ I*dentification of supply options – connection to the main grid or off-grid electrification.*

The resulting electrification strategy strives to advance electrification with least-cost supply options while targeting areas where the impact of electrification on social and economic development is highest.

The electrification plan was mainly produced by **GEOSIM©**, a GIS-based software.

The planning process is illustrated below.

Figure 4: Illustration of the Planning Process



3.2 Data collection and GIS database compilation

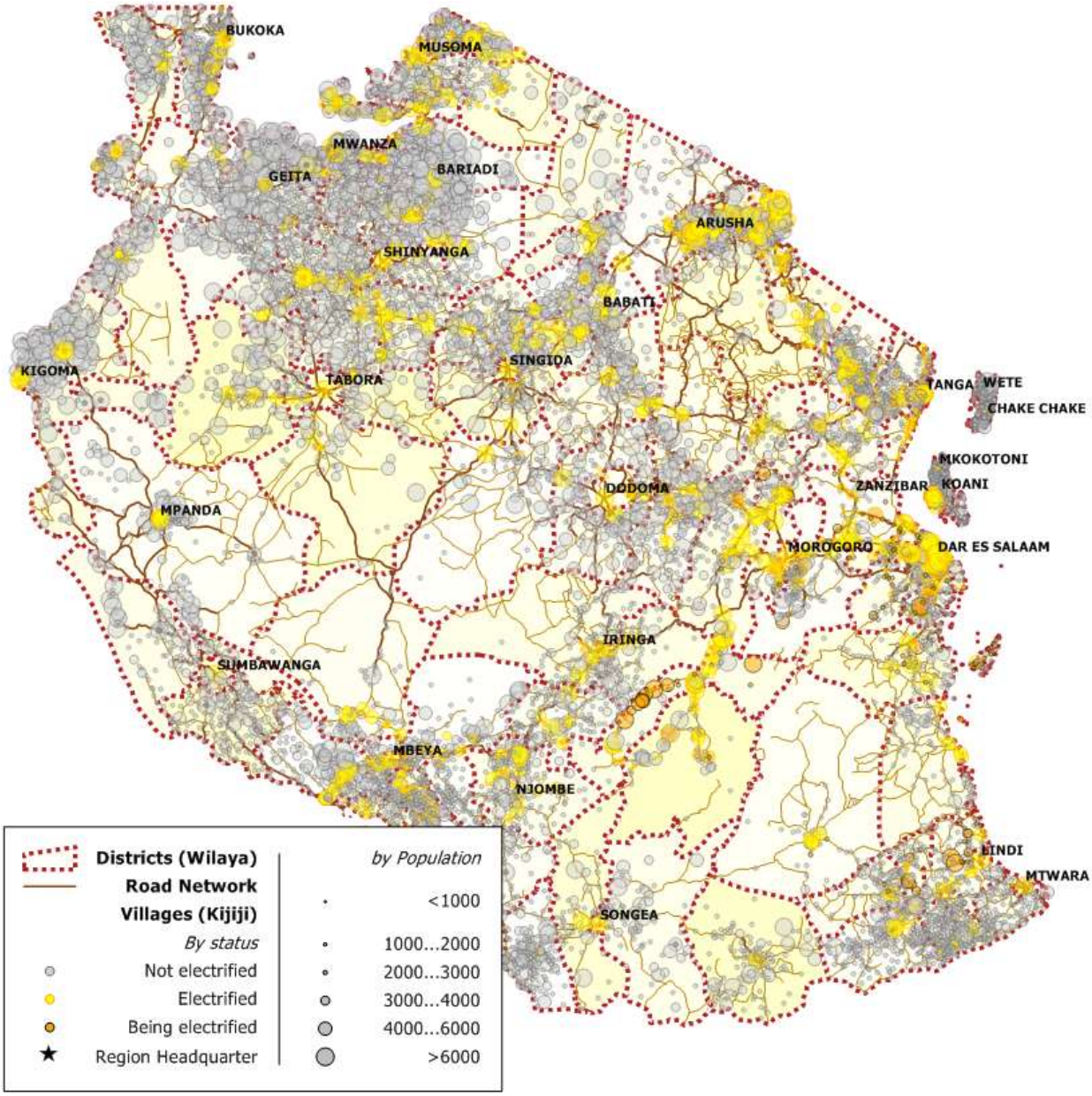
Table 5 shows the data which constitute the geospatial database and the input data for GEOSIM.

Table 5: List of collected data

Layer	Source	Data description
Administrative data		
Boundaries	Ministry of Lands and Housing, Internet	Country, regions, districts and wards boundaries
Villages	NBS, TANESCO, IED	Location and electrical status
Demographic data		
Population	NBS and IED (Projection)	All settlements (cities, towns, villages). Projection made by IED calculates with growth rates of 4.5% per year for Dar Es Salaam and 2.6% for other regions.
Households	NBS and IED (Projection)	All settlements (cities, towns, villages). Projection made by IED calculates with household size of 4.9 persons.
Energy sector		
HV lines	Google Earth/IED	Location
Substations	Google Earth/IED	Location
Power plants	Internet	Location and type
MV lines	REA, TANESCO, IED	Location
Transformers	TANESCO	Location and type
Existing SHP	REA	Location and characteristics
Hydro potential	TANESCO	Location
Agro industries	Minister for Industry	Location and characteristics
Biomass potential	GLOBCOVER	Land cover for Tanzania
Multi-sector data		
Health	MoHSW	Location and type
Education	MoEVT	Location and type
Police and rehab centre	REA, NBS	Location and type
Access to potable water	Internet	Location for only 13 districts in Tanzania
Markets	NBS	Location
Infrastructures		
Road network	Internet	Location and type
Airports	Internet	Location
Parks and reserves	University of Dar Es Salaam – GIS Dep.	Location and type
Railways	Internet	Location
Topography		
Rivers and lakes	Internet	Location
Hydro basins	Internet	Location

The projected population in the regions in 2013 and 2022 is shown in Annex 4. Figure 3.2 displays the distribution of the population in Tanzania in 2012. The map also indicates the electrification status of the settlements - separating between electrified settlements, ongoing or planned electrification, and non-electrified settlements.

Figure 5: Population distribution map in Tanzania (2012)



3.3 Development Centres

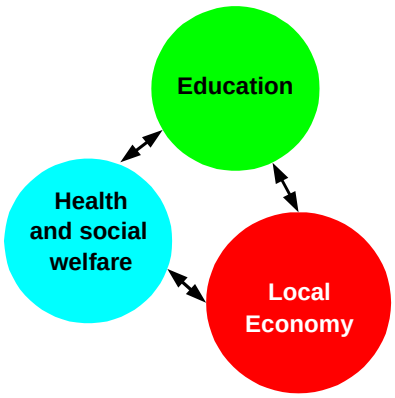
Spatial analysis allowed ranking settlements, which remain to be electrified, based on their estimated socio-economic development potential. The potential serves as indicator of the benefits of electrification.

The Prospectus identified in each of Tanzania's regions the settlements whose electrification, plus that of surrounding areas/villages, promises to provide the largest benefits. In total, about 12,248 settlements were evaluated.

The method draws its inspiration from the Human Development Index (HDI) developed by the UNDP. The idea is to calculate an index value which reflects the development potential of a settlement. The index, called the Indicator for Potential Development (IPD), is calculated from multi-sector data[15]. The index value varies between 0 (no potential for development) and 1 (highest potential).

The HDI evaluation uses three main components - health, education and economy - and so does the IPD. Each component had the same weight in the IPD. The score of each component is calculated from a set of subcomponents. For each subcomponent, categories are defined. The score of the subcomponent is given by the value of the valid category. The components, subcomponents and subcomponent categories used in the Prospectus are shown in Annex 1 together with the weights attributed to them. The IPD scoring system shown there was applied to each settlement.

Figure 5: Components of IPD



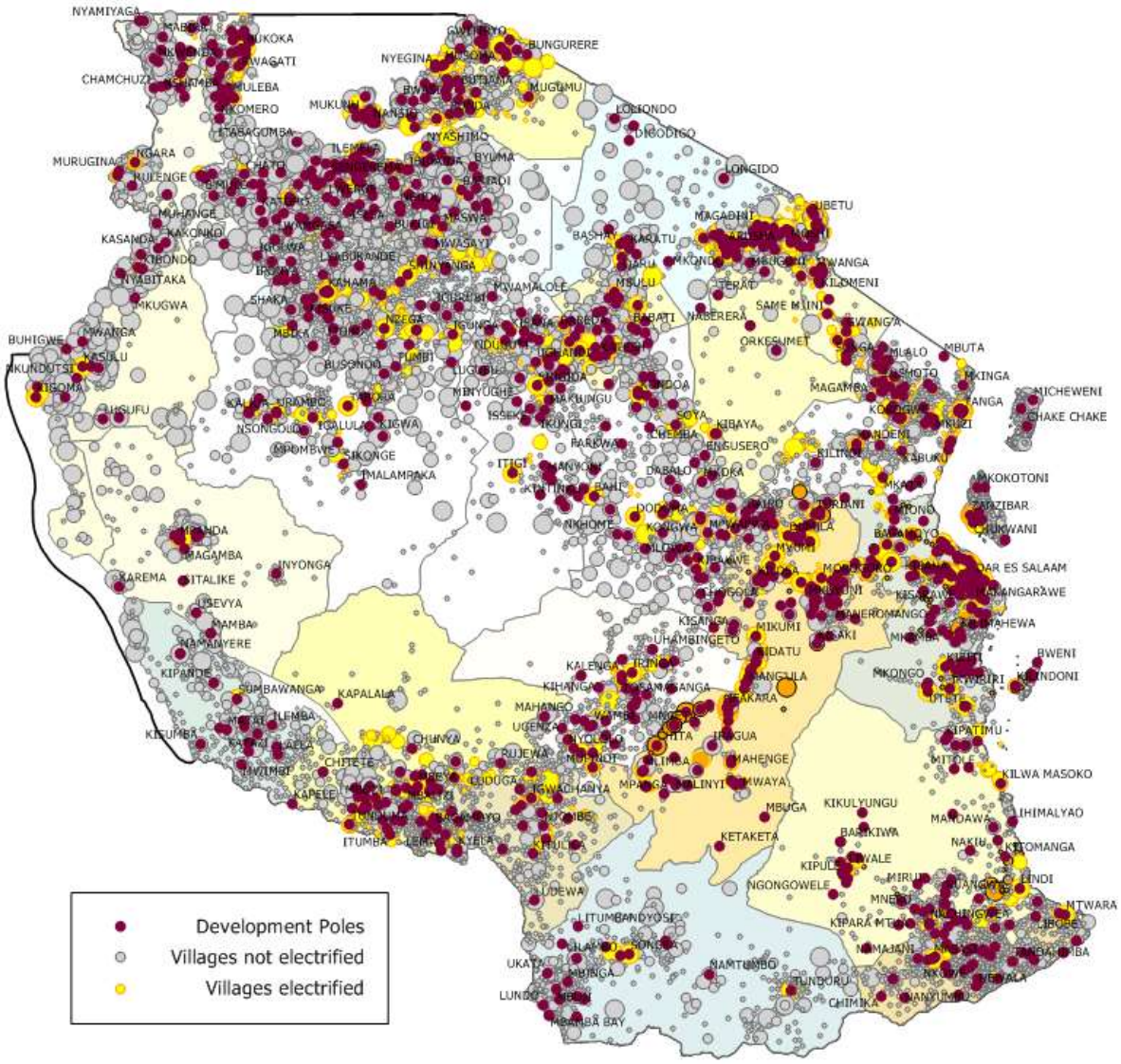
For each region, a rank order of the IPD score of examined settlements was established. The highest ranked settlements which equalled 10% of the total settlements in the region are referred to as **Development Centres** in the Prospectus. Table 6 shows the regional distribution. The total number of development centres is 1,192 and the number of not-yet-electrified centres 693. The Prospectus focuses on the electrification of the latter so as to maximize the benefits of the rural electrification. Proposed off-grid electrification projects are for development centres only. That the program for on-line electrification includes settlements which are not development centres – in fact, most settlements to be electrified by grid connection are not development centres – is due to the GoT's policy to connect all settlements to an MV line which are within 10 km of the line.

[15] Data from different sectors such as health, education, economy, transport

Table 6: Regional Distribution of Development Centres

	Total		Not Electrified	
Region	**Development Centres**	**Population in Development Centres in 2012**	**Development Centres**	**Population in Development Centres in 2012**
Arusha	46	249,378	15	47,956
Dar Es Salaam	82	869,431	13	93,311
Dodoma	53	571,126	40	171,537
Geita	37	205,704	34	198,472
Iringa	31	226,822	22	72,123
Kagera	63	310,900	47	161,457
Katavi	15	67,427	12	53,732
Kigoma	20	341,762	15	173,138
Kilimanjaro	57	340,182	13	39,836
Lindi	58	203,546	44	118,813
Manyara	39	205,034	20	98,106
Mara	44	267,359	24	76,316
Mbeya	59	481,285	39	119,431
Morogoro	133	894,458	77	334,751
Mtwara	38	199,042	32	76,151
Mwanza	88	341,292	45	161,035
Njombe	16	61,383	8	22,252
Pwani	85	338,150	50	135,676
Rukwa	16	188,067	15	61,272
Ruvuma	19	195,209	16	53,557
Shinyanga	26	242,569	13	46,213
Simiyu	28	127,138	24	108,445
Singida	42	252,482	32	98,307
Tabora	35	368,439	22	89,382
Tanga	62	256,685	21	79,401
TOTAL	**1192**	**7 804 870**	**693**	**2 690 670**

Figure 6: Map of Development Centres



3.4 Demand and Load Forecasting

The development of supplied customers in a grid connected settlement is assumed to proceed as follows:

Households: At the end of the first year, about 30% of the households in the settlement are connected to the distribution network. The ratio reaches 38.5% at the end of the second year. Thereafter, it increases at a fairly constant rate until the end of the fifth year when it reaches 49%. From then on, the electrification ratio increases by 1.5 percentage points per year.

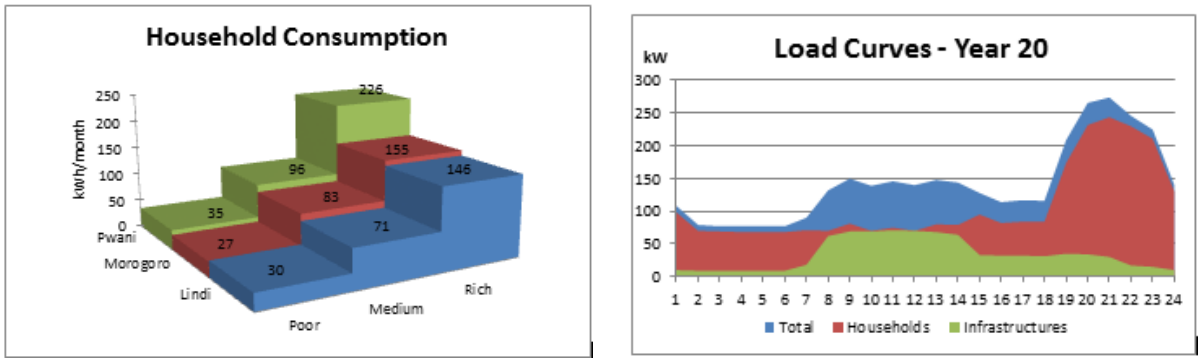
Other customers: The number of other customers depends on the size of the settlement. On average, other customers account for about 10% of total customers.

The initially installed distribution network is assumed to allow the connection of new customers until the end of the fifth year. Thereafter, the distribution network must be extended to connect new customers.

Load forecasts are based on the load profiles of end-users who had been contacted in surveys conducted as part of the IREP Project. Data of more than 5,000 end-users had been collected. In the Prospectus, end-user categories comprise poor, medium and rich households, businesses, small industries, public facilities etc.

Figure 8 shows an example of monthly household consumption and the daily load curve. The load curve has been used in the Prospectus to determine the capacity which has to be installed in off-grid projects.

Figure 7: Household Monthly Consumption and Daily Load Curve



3.5 Electrification Technologies

3.5.1 Examined Grid-Supply Technologies

Electrification by connecting customers to a distribution network is the main technology examined in the Prospectus. This is because electrifying customers in developments centres by distributed technologies does not make sense as it would only allow a very limited productive use of electricity. The following grid-supply technologies are examined in the Prospectus:

a) ongoing electrification in settlements which had already a distribution network at the end of 2012 – referred to as densification;
b) connection of a non-electrified settlement to the interconnected grid - referred to as grid extension;
c) installation of an isolated grid together with power generation facilities which feed into the isolated grid – referred to as off-grid electrification.

3.5.2 On the Economics of Main Grid Connection and Off-Grid

The annex to this chapter shows that the levelized economic costs of electrification by grid extension can be expected to be significantly lower than the costs of off-grid technologies. That result does not mean that off-grid technologies are not important. Off-grid electrification is strongly recommended for development centres which are too far from the grid to warrant grid connection. In such cases,

grid connection would be more costly than off-grid electrification and though the costs of the latter are high, they are justified as the benefits would even be higher[16]. In fact, the Prospectus even proposes to electrify a number of development centres by off-grid technologies within the period 2020 – 2022. An ongoing study will recommend options for the use of the off-grid assets once the grid has arrived.

3.5.3 Distributed Technologies

Electrification is not limited to grid-supply technologies. There are also stand-alone or distributed technologies such as solar home systems (SHS), solar lanterns, battery-charging stations, multifunctional platforms, and solar containers. These technologies are appropriate for users living in areas with a low population density; the areas usually include the outskirts of an electrified settlement. The technologies are often considered as pre-electrification technologies, meaning that people use them until the grid arrives.

In Tanzania, the use of SHS and solar lanterns has been promoted by several projects. The use of PV systems by schools and health facilities in rural areas is supported by grants from the World Bank under the "Lighting Rural Tanzania" Project. The project uses a competitive process to select private enterprises to deliver the PV systems. The use of PV systems in schools, health facilities and for water pumping was supported by grants from the REF. The EU provided grant funding for the promotion of SHS through associations and cooperatives in rural areas. The support of distributed technologies will certainly continue but it is impossible to estimate the number of people electrified by these technologies. The Prospectus Report "Prospectus - Task 1 - GIS analysis of least-cost access plan" described some distributed technologies but no attempt was made for the mentioned reasons to estimate the contribution to the electrification objectives.

3.6 Methodology used to determine the electrification of the examined grid-supply technologies

3.6.1 Densification

The Prospectus takes into account that the electrification in settlements, which were already supplied at the end of 2012, will continue. The densification program assumes that the electrification ratio increases by 1.5 percentage points every year. The number of newly connected households results from the development of the number of households and the assumed electrification ratio. The number of non-household customers has been estimated assuming that about 10% of the total customers are non-household customers.

3.6.2 Grid Extension

Connection to the grid is the least-cost electrification technology for areas which are not far from the grid and relatively densely populated. With one exception which is described below (Phase 3), the term "not far" has been defined as 10 km from the 33-kV grid. The density of settlements could not

[16] Source: Several studies have shown that the benefits of electrification are very high that they usually justify even the use of expensive technologies. An example is: ESMAP, Rural Electrification and Development in the Philippines: Measuring the Social and Economic Benefits, Report 255/02, May 2002.

be used as criterion as it could not be calculated from the available data. The Prospectus therefore used the population size. Settlements which have less than 500 inhabitants at the time when grid connection is considered have been excluded from grid extension.

GEOSIM©, a GIS-based simulation software, determined the settlements to be electrified by grid extension. The exercise has been based on TANESCO's transmission expansion plan. Four phases of electrification by grid extension have been considered:

5. **Phase 1, referred to by REA as Turnkey II:** Electrification by grid extension of almost 1,500 settlements in the period 2013 – 2015. The list of settlements was obtained from REA.

   A request for turnkey electrification proposals was issued by REA in December 2012. The turnkey projects comprised 25 lots. 15 contracts were awarded in 2013 while 10 were not because of too high prices. The 10 were split into 20, re-tendered and contracts for these lots signed in early 2014. All construction works are expected to be finished by mid-2015.

6. **Phase 2, referred to by REA as Turnkey III:** Electrification by grid extension of settlements which are within 10 km of the 33-kV MV network which will exist at the end of 2015 or is likely to be constructed until the end of 2019 (MV backbone). The MV rural backbone is supplied through existing HV/MV substations or existing isolated power plants that will be off-set by the development of the HV network. The connection is done by a 33-kV line if the settlement has more than 2,000 inhabitants. If it has more than 500 but less than 2,000 inhabitants, connection is done by SWER. Connections will be done in the period 2016 – 2019.

   The Turnkey III program would connect 177 development centres and 1,740 localities by three-phase lines and 1,256 settlements by SWER technology. The SWER technology is described in the Prospectus Report "Task 1: On-grid technologies catalogue" (April 2013).

7. **Phase 3, part of Turnkey IV:** Electrification by grid extension of development centres which are within 40 km of the MV grid is likely to exist by the end of 2019. If the line corridor of the backbone MV grid is not yet known, GEOSIM determines the 33-kV feeder line which connects the development centre to the rural MV backbone grid. The electrification of the development centres is assumed to occur in the years 2020 – 2022.

8. **Phase 4, part of Turnkey IV:** Electrification by grid extension of settlements that are within 10 km of the feeder lines constructed in Phase 3. The connection is done by a 33-kV line if the settlement has more than 2,000 inhabitants. If it has more than 500 but less than 2,000 inhabitants, connection is done by SWER. Phase-4 electrification would take place in the period 2020 – 2022.

   The Turnkey IV program would electrify 266 development centres (Phase 3) and 506 settlements (Phase 4) by 33-kV lines and 274 small settlements (Phase 4) by SWER technology.

3.6.3 Off-grid Electrification

Simulations were carried out with the GIS database to get an idea of the order of magnitude of a potential market for off-grid electrification using renewable energy resources for power production. For all localities with more than 1,500 inhabitants that will not be reached by the Turnkey II Program, it has been determined whether off-grid supply by small hydro plants or by biomass-fuelled plants could be attractive. The criterion was that the settlements are within 20 km of the hydro site or the biomass source respectively. The biomass-fuelled plants would mostly be gasifiers but may include biogas digesters that could be attractive in the sisal production areas. The results are shown in Chapter 4. In total, 347 villages have been identified as candidates for supply by small hydro plants and 310 villages as candidates for supply by biomass-fuelled plants.

Off-grid projects were determined for development centres that would not be reached by the interconnected grid before 2020. In total, 154 projects have been drafted, 18 with power supply coming from mini-hydro plants, 63 with power supply by rice-husk-fuelled gasifiers and 73 with power supply by diesel-PV hybrid systems. The latter are large development centres - more than 5,000 people in 2013 – with no hydro or biomass potential in the vicinity.

The 154 off-grid projects include 139 development centres that could be reached by the main grid in the period 2020 – 2022 (Phase 3 and Phase 4 of the grid extension program). Box 6.1 explains why the prior off-grid electrification is recommended.

Some technical and cost information on the examined off-grid generation technologies - small hydro plants, biomass-fuelled gasifiers, diesel-PV hybrid systems - are given in Annex 3.

Box 6.1: On the economics of electrifying priority development centers by off-grid technologies before connection to the main grid

Priority off-grid projects are off-grid electrification projects for developments centres which would be connected to the main grid between 2020 and 2022 if the electrification program were implemented as described in the Prospectus. The expression “priority development centre” shall indicate that the electrification of those settlement promises significant socio-economic development. The Prospectus did not compare the benefits with the costs to justify the recommended off-grid electrification prior to grid connection which could theoretically happen some years later. (The risk that some years become many years because of delays of the grid connection program is certainly not low.) But several studies indicate that the economic benefits of electrification are huge when including short, medium and long-term benefits*; in fact, so huge as to justify almost all projects and certainly the prior off-grid electrification of development centres.

Whether off-grid electrification is financially feasible for the developer if the main grid arrives some years later depends, among other, on the length of the period before the main grid arrives and the conditions which then apply. The regulation in place has been described in paragraph 2.3.3.3. The developer can then sell the production of the plant under the main grid FiT scheme, buy in bulk from the main grid and resell to his retail customers, carry out a combination of the two options or sell the assets. Only the financial analysis of each individual project can indicate whether off-grid electrification is financially feasible if the main grid arrives some years later.

* See for example: ESMAP, Rural Electrification and Development in the Philippines: Measuring the Social and Economic Benefits, Report 255/02, May 2002. The study estimates that "… the total benefit of providing electricity to a typical, non-electrified Philippine household would be $ 81 – 150 per month …" (page 3).

3.7 Low Cost Network Design

3.7.1 Approach

One component of the Prospectus explored the possibilities of minimising the costs of the electrical networks that have to be constructed. The objective was to determine whether there are MV and LV network designs that can be implemented at lower costs compared to those currently used. The reference is thus the current practice and the price of TANESCO's standard LV and MV networks.

The study used two approaches:

(1) Lower costs obtained from technologies different to those currently used. The examined new technologies are:
   - Two-phase MV systems
   - Single-phase MV systems
   - Shield Wire MV Supply systems, SWS
   - Use of LV single-phase electric motors

(2) Lower costs from the optimization of the presently used technologies. Optimizations means, in that context, changing mechanical dimensioning criteria (wind pressures, temperatures, safety factors and maximum conductor stress) and making maximum use of line elements.

3.7.2 New Network Technologies

- The **two-phase MV system** as recommended by NRECA has disadvantages in terms of capacity, voltage drops and additional costs to create a local third phase for using 3-phase electric motors. The potential cost savings do not compensate the disadvantages in areas with a certain economic development potential. Only when few large 3-phase customers exist in a deep-rural environment, could the two-phase MV system be attractive. In many cases, a light three-phase MV system with appropriate cable section would also be an alternative to the two-phase MV system.

- **Direct SWER without isolation transformer** is a single-phase option which is recommended as the most cost-effective option for areas with a projected low demand for power. Solutions with isolation transformer can be considered for clusters of settlement demanding a higher load due to higher level of activities and in order to balance load on the three-phase feeder line. But the basic rule shall be: when power demand exceeds what SWER can deliver, 3-phase electrification shall be preferred. This is generally the case when large 3-phase loads shall be supplied. In few cases, a two-phase solution can be economically considered.

- Use of single-phase motors is required on SWER supply to provide the mechanical energy to run grain mills, grinders, large fans for drying activities and compressed air machine. Motor capacity up to 12 kW is available. An alternative to single-phase motors that is widely applied in Namibia is to install SWER converters (12.5 or 15 kW) thereby enabling the use of ordinary three-phase motors with the additional advantage of soft starting capabilities. The converter is priced at more or less USD 2,500. In Tanzania, single-phase motors or SWER converters are probably not in the market since the existing networks are generally 3-phase networks. Therefore it is recommended that information on productive use of SWER supply and requested technologies be included in REA extension activities. Securing the price difference should not be a barrier for the few users of larger single phase motors or SWER converters, concessional conditions could be offered, based on a subsidy paid by the REF. The total amount of needed subsidies will be lower than the benefits gained by constructing SWER lines.

- **Shield Wire System (SWS)** is an option of constructing new HV lines although it may also be possible to retrofit existing lines. The technology has proven its value for more than 20 years since first installed in Ghana. It is today implemented in a number of countries. The consultant recommends including SWS in the electrification toolbox.

- Properly dimensioned **3-phase MV lines** with adequate wire sections and optimised mechanical design will also contribute to reduce the cost of the rural power distribution.

3.7.3 Optimization of Existing Network Technologies

The usually applied TANESCO design criteria results in MV lines with span lengths of 110 to 120 m. But increasing the length of the line cross-arms or adapting the wind criteria to the regional conditions of the span length for a 33 KV line could increase the lengths of up to 200 m. The cost savings of optimizing the existing design could range from 8% to 37%, as illustrated in the table below.

Table 7: Cost savings from several line design optimization options
(savings in % of standard TANESCO 3-phase design)

Gain in 3-phase. Shifting 1.472 Pa to 600 Pa, short crossarm	11%	Climate criteria gains
Gain in 3-phase. Shifting 1.472 Pa to 300 Pa, short crossarm	13%	
Gain in 3-phase. Shifting 1.472 Pa to 600 Pa, long crossarm	26%	
Gain in 3-phase. Shifting 1.472 Pa to 600 Pa, long crossarm	32%	
Gain in 3-phase at 1.472 Pa long instead of short crossarm	8%	Optimisation gains
Gain in 3-phase at 600 Pa long instead of short crossarm	23%	
Gain in 3-phase at 300 Pa long instead of short crossarm	28%	
Gain in 3-phase. From shifting present 1.472 Pa and short crossarm to 300 Pa and long crossarm	**37%**	**Maximum combined climate criteria optimisation gain**

In order to secure a maximized use of the line elements and based on the review of different climate parameters, it is recommended to review the different criteria and develop simpler and region-differentiated criteria. It may also be beneficial to use lower wind pressures for LV than for MV.

3.7.4 Network technologies used in the Prospectus exercise

The network technologies used in the Prospectus are:

- The 3-phase MV line (wire: dog 100 mm2) mounted on wooden poles with cross arms at cost of 14,500 US$/km.
- The SWER line (wire: dog 50 mm2), also mounted on wooden poles and with rigid isolators at cost of 5,500 US$/km

The LV grids associated with these two options are:

- 3-phase LV grid with 3x50 mm2+25mm2 at cost of 10,500 US$/km
- Single-phase LV grid with 1x25 mm2 +16 mm2 at cost of 6,000 US$/km

4. Geospatial Roll-out of Electrification Program

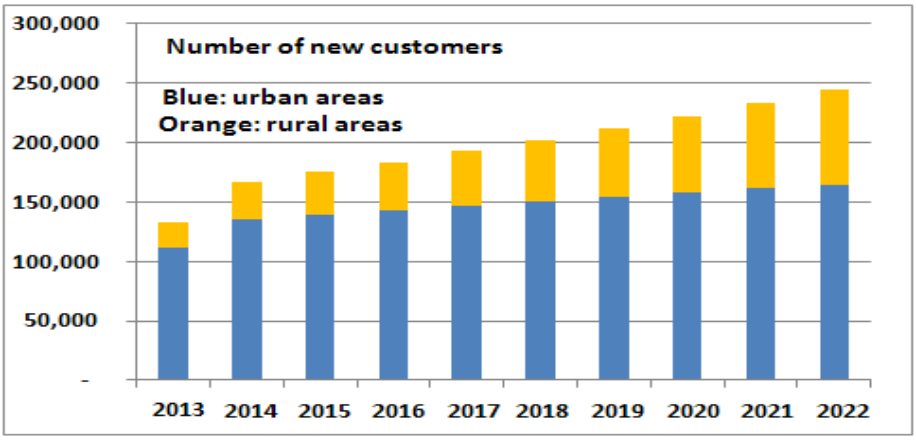
This chapter focuses on the results of the electrification program in terms of the number of settlements and customers that would be electrified by the program. The chapter includes the geographic presentation (i) of the areas that would be electrified by grid extension, (ii) of priority projects for off-grid electrification and (iii) of the potential sites for off-grid electrification by hydro plants and biomass plants.

4.1 Electrification by main grid supply - densification and grid extension

4.1.1 Densification of already electrified settlements

The densification program refers to the connection of customers who were not yet supplied by the existing distribution network in their settlement at the end of 2012. The electrification ratio in already electrified settlements is in general not high. At the end of 2013, TANESCO supplied on average less than 40% of the households in electrified settlements. The Prospectus estimate is that the annual number of newly supplied customers in these settlements will increase from about 170,000 in 2014 to almost 250,000 in 2022[17].

Figure 8: Development of new customers in settlements that were already electrified at the end of 2012



4.1.2 Grid Extension

As described in Chapter 3, electrification by grid extension would be realized by three turnkey programs:

- The already ongoing Turnkey II Program (2013 – 2015)
- The Turnkey III Program (2016 – 2019) that would electrify settlements within 10 km of the 33-kV MV network at the end of 2015 or is likely to be constructed until the end of 2019

[17] In 2013, TANESCO connected approximately 160,000 new customers by densification. The numbers shown in Figure 9 do not include settlements which will be electrified after 2012. The Prospectus takes into account that densification will also take place in those settlements. The numbers are included in the customer statistics on newly electrified settlements (grid extension and off-grid electrification).

- The Turnkey IV Program (2020 – 2022) that would electrify development centres which are within 40 km of the MV grid by the end of 2019. It would also electrify settlements that are within 10 km of the feeder lines to be constructed for the electrification of the development centres.

Table 8 summarizes the results of these programs.

Table 8: Electrification by grid extension

	Settlements reached by the grid	Thereof Development Centres	km of MV line	km of SWER line	Number of customers in 2022
Turnkey II	1,484	219	11,637		781,251
Turnkey III	2,996	177	4,413	2,733	1,086,759
Turnkey IV	1,046	266	5,441	793	280,887
Total	**5,526**	**662**	**21,491**	**3,526**	**2,148,897**

A total of 5,526 settlements would be reached by the turnkey programs; 662 thereof would be development centres. The regional distribution is shown in Table 9.

Table 9: Regional distribution of grid extension program

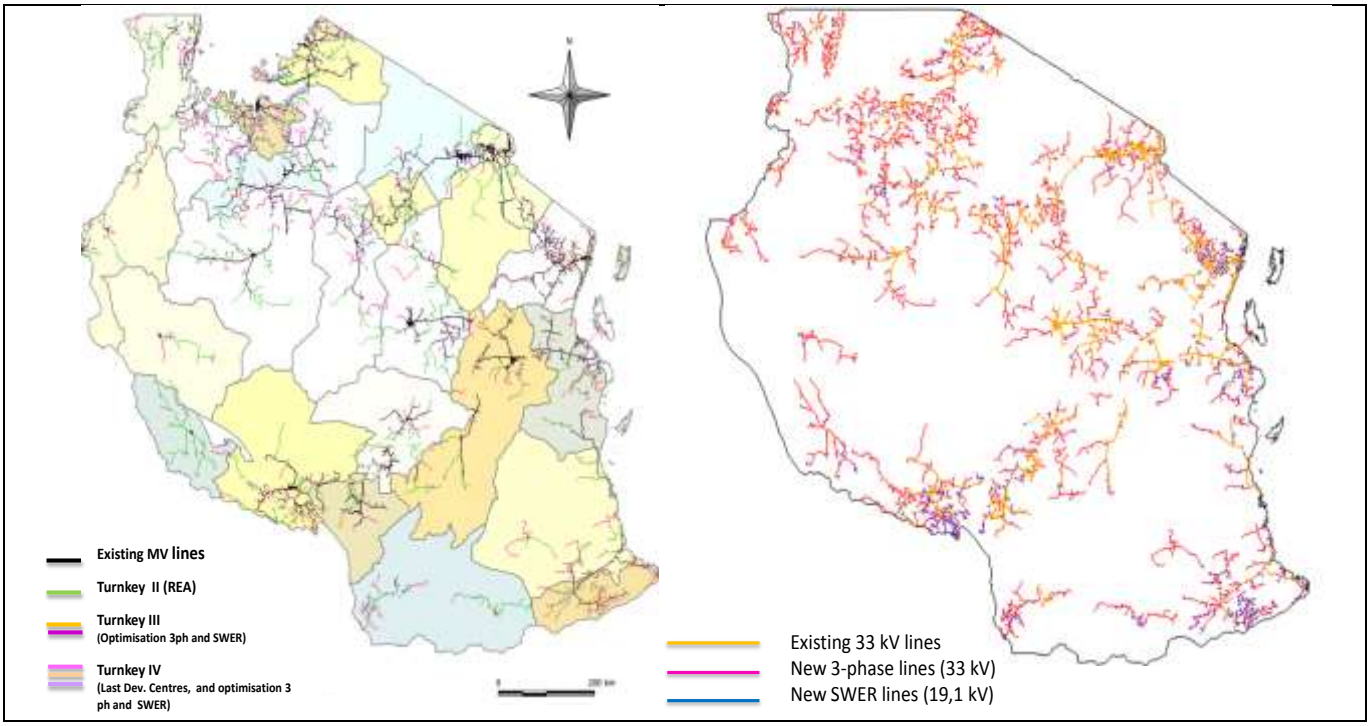
Name	Turnkey II (on going)		Turnkey III Optimisation				Turnkey IV Last Dev Centres			
Periode	2014-2015		2016-2019				2020-2022			
Supply type	3-phase supply		3-phase supply		SWER supply		3-phase supply		SWER Supply	
Region	Settlement	Thereof Develop-ment Centres	Settlement	Thereof Develop-ment Centres	Settlement	Thereof Develop-ment Centres	Settlement	Thereof Develop-ment Centres	Settlement	Thereof Develop-ment Centres
Arusha	32	3	60	3	15	1	20	5	2	0
Dodoma	98	18	81	15	35	0	21	7	10	0
Geita	32	7	72	5	23	0	67	22	15	0
Iringa	69	8	50	5	31	0	12	9	11	0
Kagera	143	19	147	12	42	4	42	10	6	0
Katavi	13	2	18	4	5	1	9	4	5	0
Kigoma	32	4	39	2	7	0	33	9	1	0
Kilimanjaro	37	3	64	6	34	1	9	3	3	0
Lindi	43	14	45	3	48	1	45	23	28	0
Manyara	53	9	56	2	12	0	21	9	2	0
Mara	122	11	130	10	54	0	23	3	6	0
Mbeya	116	11	133	11	200	4	41	12	25	0
Morogoro	71	30	82	16	69	4	54	25	15	0
Mtwara	44	6	101	6	123	6	45	14	43	0
Mwanza	92	11	146	19	54	3	67	12	6	0
Njombe	53	3	24	1	61	0	7	4	14	0
Pwani	41	12	40	8	86	4	31	21	17	0
Rukwa	58	12	18	0	23	0	7	3	7	0
Ruvuma	42	3	53	2	47	0	31	11	11	0
Shinyanga	33	4	55	2	31	1	28	6	16	0
Simiyu	59	4	55	3	4	0	56	17	3	0
Singida	56	8	71	2	30	0	49	21	7	0
Tabora	77	10	57	2	27	0	36	10	8	0
Tanga	68	7	143	7	195	1	18	6	13	0
Total	**1484**	**219**	**1740**	**146**	**1256**	**31**	**772**	**266**	**274**	**0**

The programs would supply about 2.1 million customers by the end of 2022.

Table 8 shows that SWER lines would account for 14% of the total grid length to be constructed. The SWER lines would supply 1,530 small settlements with an average population of 1,288 inhabitants in 2013 that will otherwise not be supplied.

At the end of the Turnkey IV Program, 15 development centres would still not be connected to the grid. One centre is in a vicinity of a potential hydro plant. The other 14 centres are located in remote and dry areas. They are considered candidates for off-grid electrification by diesel-PV hybrid systems. Figure 10 shows the areas which would be electrified by the turnkey programs.

Figure 9: Rural electrification through three grid extension programmes



4.2 Off-grid Electrification

4.2.1 Program for Development Centres

While only 15 development centres would not be reached by turn-key programs until end of 2022, a large number of the centres would have to wait several years before the arrival of the grid and even longer if there are implementation delays of the turnkey programs. For development centres which are in the vicinity of hydro or biomass resources, off-grid electrification prior to grid connection could be attractive. For centres in areas without hydro or biomass potential, off-grid electrification by diesel-PV hybrid systems could be an option[18].

That concern has been taken into account in the Prospectus by identifying off-grid projects for the 266 development centres which would not be connected to the main grid before 2020. Table 11 shows the 154 centres that have been identified. Many of these centres are potential candidates to hybrid PV-diesel system, but only the 59 having a population bigger than 5,000 inhabitants are considered as priority centres.

[18] It is at present not yet clear what happens when the grid arrives. A presently ongoing study is expected to propose several options. Among the options will probably be selling the power under the Feed-in Tariff Scheme or receiving compensation payments for the installed assets and, if desired, continuing as distribution company which purchases the power from the grid

Table 10: Off-grid projects for development centres not connected to the grid before 2020

Off-grid technology	Number of settlements	Number of customers in 2022	Investment costs in million US$
Small Hydro Plant	19 (13 hydro plants)	40,436	28.3
Gasifier	61	9,256	72.8
Diesel-PV Hybrid	73	57,943	75.2
Total	154	107,635	176.3

This off-grid program could be considered the priority off-grid program as it would electrify the largest development centres that will not be connected to the main grid before 2020. All centres which would be supplied by hydro plants or gasifiers presently have a population of at least 2,500 inhabitants; the centres supplied by diesel-PV systems have at least 5,000 inhabitants. The location of the development centres can be seen from Figures 11-14.

Figure 10: Hydro sites for prioritized development centres

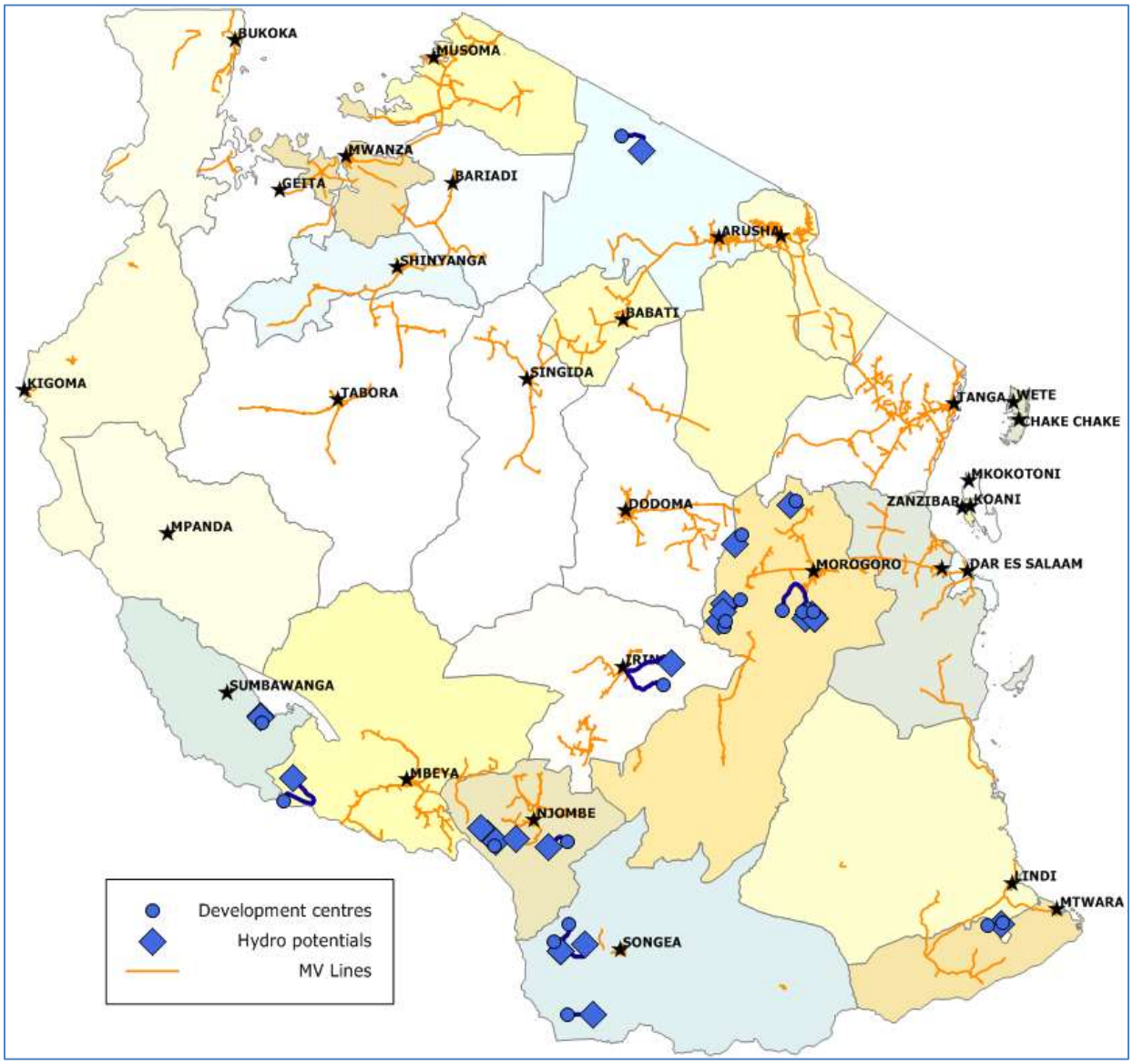


Figure 11: Biomass plant sites for prioritized development centres

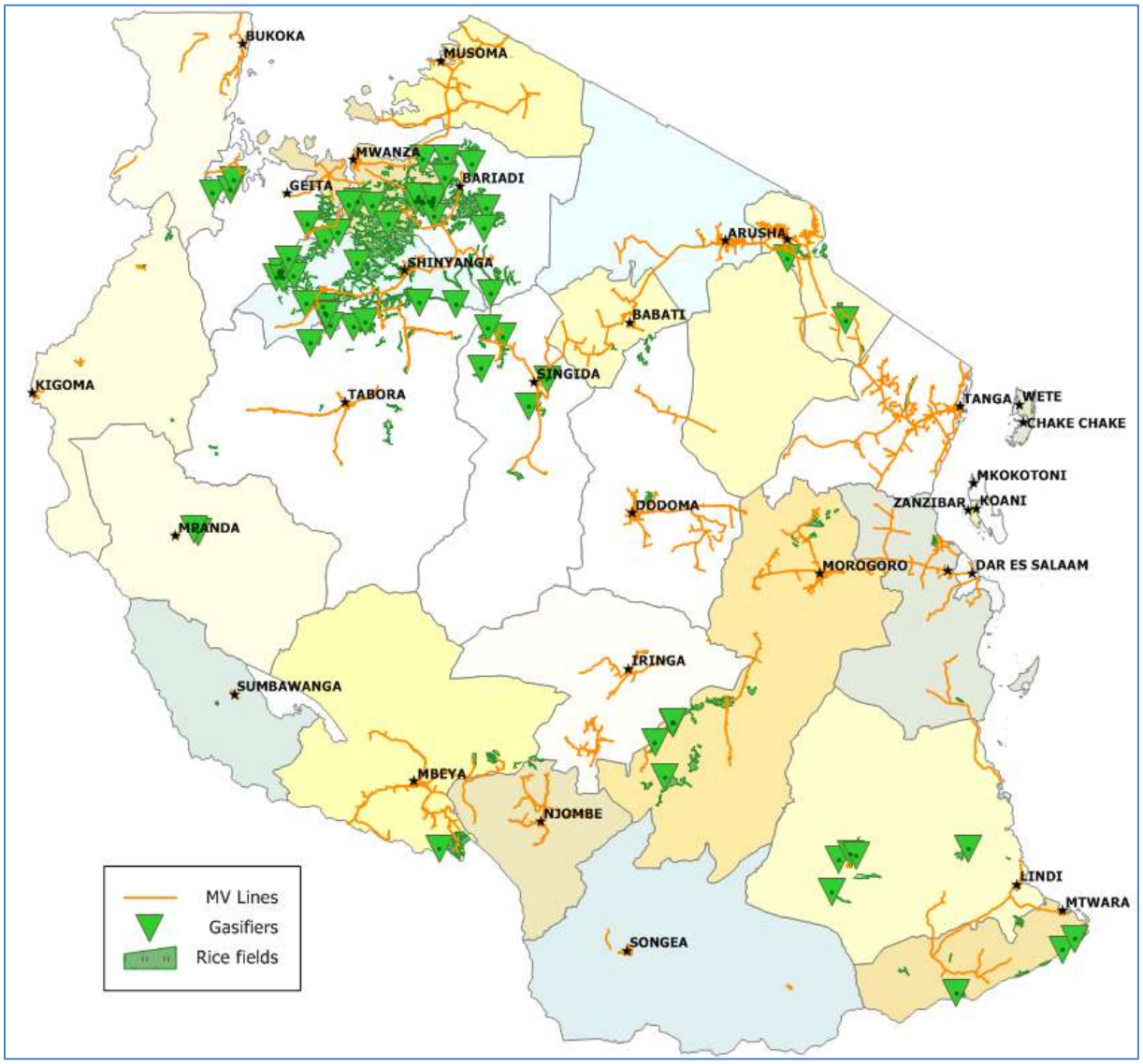


Figure 12: Location of diesel-PV systems for prioritized development centres

(grid connection could occur between 2020 and 2022)

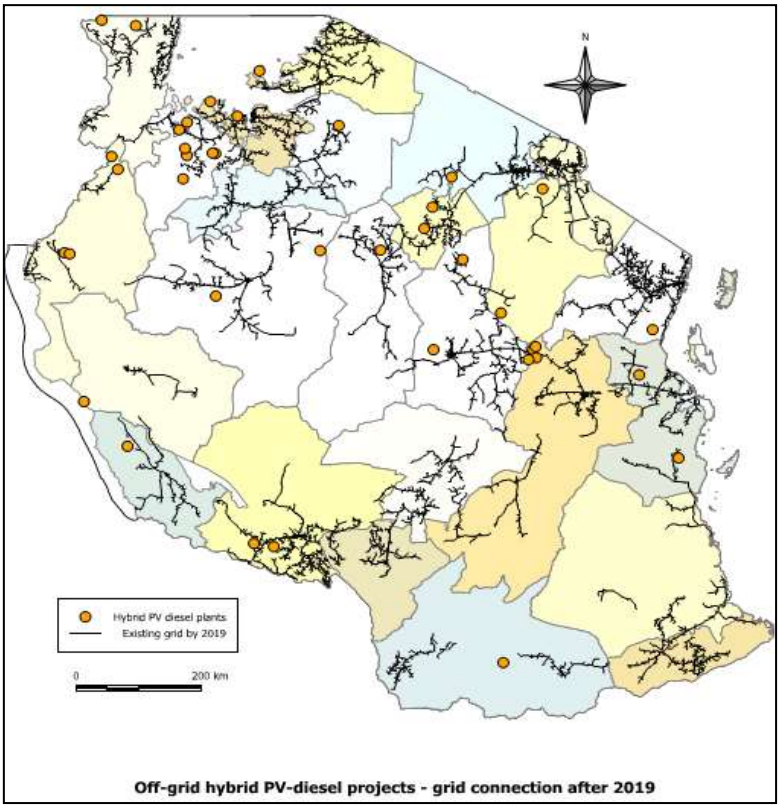
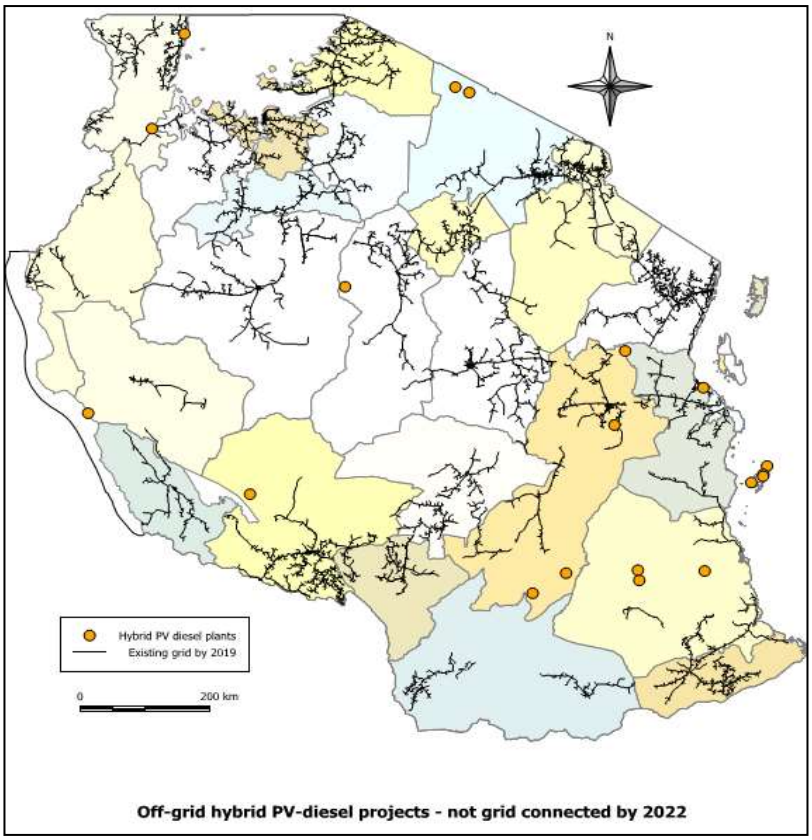


Figure 13: Location of diesel-PV systems for prioritized development centres (not grid connected before 2023)



4.2.2 Potential for off-grid electrification by hydro plants

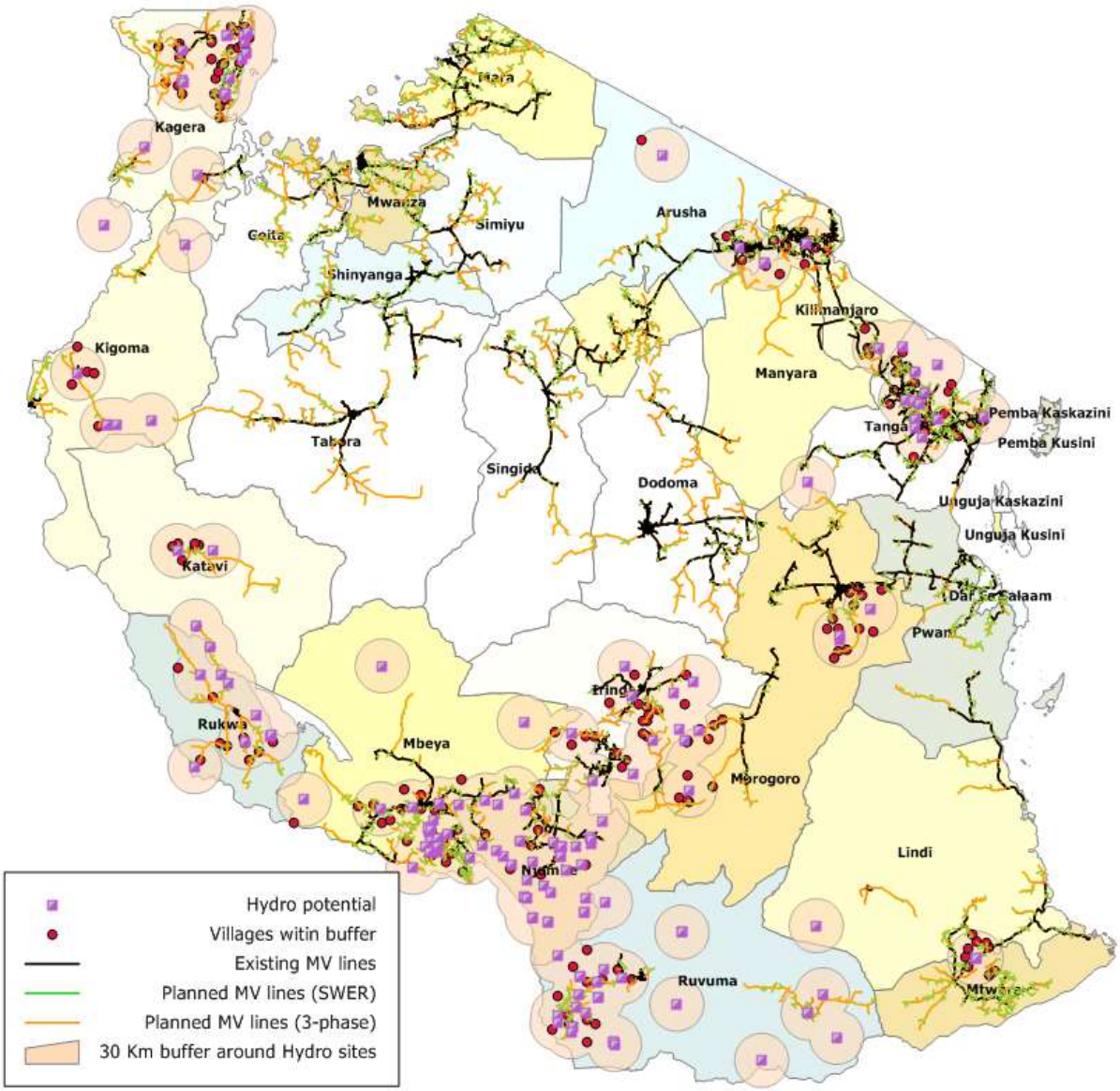
The potential for off-grid supply by hydro plants exceeds the 18 projects mentioned in Table 11. To get its order of magnitude, a simulation based on the GIS database identified all settlements with more than 1,500 inhabitants which will not be reached by the ongoing Turnkey II Program and which are within 20 km of a hydro resource.

The exercise produced 347 settlements as candidates for off-grid electrification by hydro plants (they include the 18 settlements mentioned in Table 11). The 347 settlements would be supplied by 141 hydro sites. About 950,000 people could be reached if the plants were installed. Total investment costs are estimated at 267 million US$. Small systems with an installed capacity of less than 10 MW would cost 96 million US$ and large systems 171 million US$ (53 million US$ for the distribution grid and 118 million US$ for the hydro plant). The development of some hydro sites, in particular the sites with an installable capacity of more than 10 MW, may require that a portion of the production can be sold under the FiT scheme as the demand of the rural customers is much lower than the production potential.

Table 12 shows the distribution of the 347 settlements over the regions. The settlements are, of course, concentrated in the regions which are endowed with substantial hydro potential.

Figure 15 shows the 141 hydro sites. The hydro capacity of all sites is less than 10 MW which qualifies them as small hydro plants under the current regulation. This means that they could also sell all or part of the production to the main grid under the FiT Scheme – provided that the main grid has arrived. More than 88 sites have a capacity of less than 1 MW and 53 sites have a capacity between 1 and 10 MW.

Figure 14: Sites with small hydropower potential



Being connected to the main grid will be an advantage for a hydropower plant because:

- The optimal size of a hydro plant in terms of costs per kW installed often exceeds the electricity demand in the vicinity of the plant. When connected to the main grid, the excess production can be sold under the FiT Scheme.

- It can use the national grid as back-up in case of water shortage or peak time thereby saving expensive diesel consumption during these periods.

Table 11: Regional distribution of settlements that could be supplied by small hydro plants

Region	Number of settlements	Total population in 2012	Average population
Arusha	6	19,659	3,277
Dodoma	4	8,728	2,182
Iringa	80	185,742	2,322
Kagera	15	37,097	2,473
Kigoma	14	62,817	4,487
Kilimanjaro	1	5,574	5,574
Lindi	5	10,571	2,114
Manyara	2	39,794	19,897
Mbeya	26	69,197	2,661
Morogoro	45	113,797	2,529
Mtwara	7	15,611	2,230
Rukwa	50	150,394	3,008
Ruvuma	72	185,001	2,569
Tanga	20	47,367	2,368
Total	**347**	**951,349**	**2,742**
Thereof with existing social infrastructures	*162*	*451,199*	*2,785*

4.2.3 Potential for off-grid electrification by biomass plants

The exercise described above was also done for settlements that can be potentially supplied by biomass plants; mostly gasifiers but also biogas digesters, particularly in the sisal production areas. The criteria have been that the settlements have more than 1,500 inhabitants and are within 20 km of the biomass source.

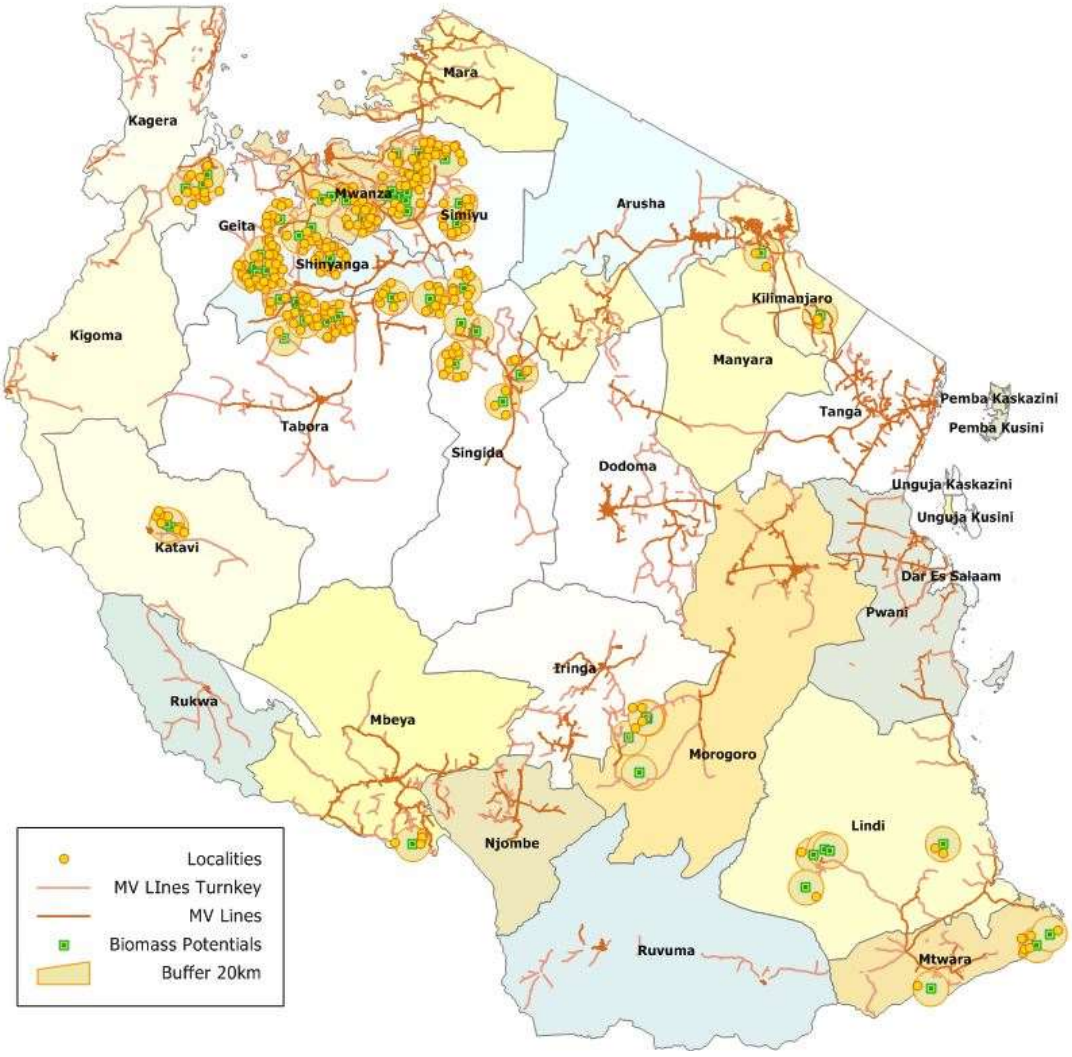
The exercise produced 310 settlements as potential candidates for off-grid electrification by biomass plants. The regional distribution is shown in Table 13. The total population of the 310 settlements is about one million inhabitants (2012 population).

Table 12: Regional distribution of settlements that could be supplied by biomass plants

Region	Number of settlements	Total Population in 2012	Average population size
Iringa	2	3,931	1,966
Kagera	15	53,622	3,575
Kilimanjaro	2	3,385	1,693
Lindi	4	10,182	2,546
Manyara	2	8,183	4,092
Mbeya	6	16,327	2,721
Morogoro	2	9,347	4,674
Mtwara	8	16,104	2,013
Mwanza	55	172,485	3,136

Rukwa	9	47,950	5,328
Shinyanga	145	487,994	3,365
Singida	20	62,726	3,136
Tabora	40	113,676	2,842
Total	**310**	**1,005,912**	**3,245**
Thereof with existing social infrastructures	139	448,529	3,227

Figure 15: Sites with electricity production potential by biomass plants

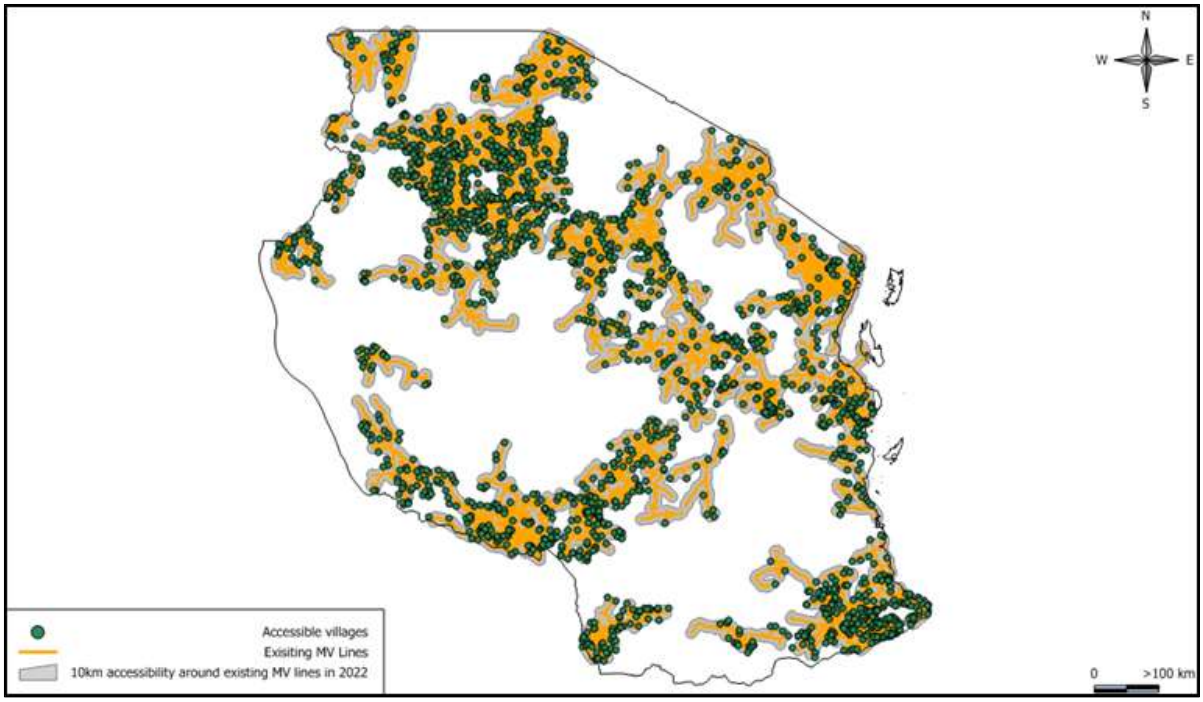


4.2.4 Potential for off-grid electrification by diesel-PV systems

The electrification programs described above (densification, grid extension, off-grid priority projects), would make about 50% of the population get access to electricity by 2022. About 3,400 settlements with 10.5 million inhabitants in 2013 would remain without access if stand-alone systems or other distributed technology options are not considered.

A 10 km electrification buffer around the grid would reach about 1,950 localities (5.5 million inhabitants in 2013) of the 3,400 settlements; see Figure 17. That could become another turnkey program after 2022.

Figure 16: Settlements within the 10 km buffer of the MV grid which is projected to exist in 2022



The approximately 1,450 localities (5.1 million inhabitants in 2013) which would be outside the extended grid buffer should be considered at the present time as deep rural areas. Among those, 416 are settlements with a population of more than 2,000 inhabitants and with some social infrastructure like schools and dispensaries; see Table 14. Some even have a hospital or a secondary school.

Table 13: Other settlements without access by 2022 with at least education and health care infrastructures

Size	Number	Population in 2013	Average population
2,000-5,000 inhabitants	317	1,034,138	3,262
5,000-10,000 inhabitants	88	566,880	6,442
>10,000 inhabitants	11	136,016	12,365
Total	**416**	**1,737,034**	**4,176**

For some of these localities, the supply of diesel oil is quite expensive due to the additional transport cost and unreliability during the rainy season, making hybrid diesel-PV systems cheaper than pure diesel supply. In that case hybrid diesel-PV systems could be considered.

Pre-electrification solutions based on solar solutions can be offered. A more detailed screening of these localities should be carried out when the REA GIS database have been completed for the rural areas. This list could constitute the background document for PV priority programmes such as SHS, micro PV power plants or solar mini-grids. In areas with wind resources, wind chargers could complement solar energy.

4.3 Development of Electrification Ratio

Calculating the electrification ratio from the number of households which would be supplied by the interconnected grid and the priority off-grid projects yields for 2015 ratios 40% in urban areas, 7% in rural areas and 18% overall. At the end of 2020, the percentages would be 31% overall, 57% in urban areas and 20% in rural areas.

The values would be higher when also accounting for households using distributed technologies and for households which are supplied by not registered mini-grids established by religious institutions, communities, companies etc. The consultants guesstimate is that the overall electrification ratio would then not be far from 25% in 2015 and between 35% - 40% in 2020.

That is less than the Government's targets of 30% in 2015 and 50% in 2020. The Government's targets can only be achieved if another definition of electrification is used. The term "access to electricity" is normally used by the Government. While a definition is outstanding, the concept would increase the numbers considerably if it does not require that the household has access to electricity **in the house**. If access includes the possibility of using a near-by service outside the house which uses electricity (internet café, medicine stored in a refrigerator in a dispensary, neighbor's plug to charge a mobile phone, etc.) the Government's objectives could probably be reached if not exceeded.

5. Costs and Funding of the Prospectus Electrification Program

5.1 Costs

Densification costs

The investment costs are based on the hypothesis that network extensions are required to connect new customers. While that may overestimate the costs in the near-term because some customers can be connected to existing LV lines, it is a reasonable assumption for the medium and long term. Network extension costs assume that 1 km of LV line is needed for 30 additional registered customers. LV line costs are 10,500 US$/km or 6,000 US$/km in case the line is a SWER line. For non-SWER lines, 20% of the LV costs are added to account for MV line extensions.

Densification costs also include the customer connection costs. These are composed of the costs of the service line from the distribution line to the premise, the costs of one or two additional poles if required (more than 30m away from the distribution line) and the costs of the LUKU meter (prepaid meter). Customer connection costs are shown in Annex 5.

Phase 1 – Phase 4 costs include:

- The cost of connecting the settlement to the MV backbone grid. In Phase 1 and 3, all settlements are connected by three-phase lines (14,500 US$/km). In Phase 2 and Phase 4, that applies to settlements with more than 2,000 inhabitants in 2012 while small settlements are connected by SWER lines (5,500 US$/km).
- The cost of setting up the initial distribution network: LV/MV lines, transformers; SWER lines for small settlements in Phase 2 and 4. Costs depend on the number of customers – 30 registered customers per km of LV line - and the demand for electricity.
- The cost of network extensions. Network extensions start five years after the initial network was constructed.
- Customer connection costs.

Off-grid costs include:

- The costs of the power plants.
- In the case of hydro plants: the costs of network needed to transport the power to the supplied settlements.
- The costs of the initial distribution network.
- The customer connection costs.

The costs of the off-grid program shown in Table 15 are the costs of electrifying 154 developments centres which will not be reached by the interconnected grid before 2020. Electrification is done by hydro plants (18 settlements), rice-husk-fuelled gasifiers (63) or diesel-PV hybrid systems (73) which then feed into local grids. While these projects promise to be attractive for private sector participation because of their size and the availability of renewable energy sources in the area, many other (small) off-grid projects could emerge. The off-grid costs shown in Table 15 therefore do not claim covering the costs all off-grid projects that may be implemented until end of 2022.

Table 14: Annual investment costs of the Prospectus Electrification Program

Year	Densificat.	Phase 1	Phase 2	Phase 3	Phase 4	Off-Grid	Total
	exist. grids	TURNKEY II	TURNKEY III	TURNKEY IV			
	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$
2013	100.3	113.1	-	-	-	-	**213.4**
2014	126.2	190.9	-	-	-	-	**317.0**
2015	132.7	264.8	-	-	-	37.4	**434.9**
2016	139.4	20.5	120.0	-	-	34.8	**314.9**
2017	146.5	21.1	149.2	-	-	35.7	**352.5**
2018	153.9	21.2	172.2	-	-	37.0	**384.3**
2019	161.6	21.3	274.2	-	-	31.4	**488.3**
2020	169.6	20.6	33.8	30.7	43.1	2.8	**300.7**
2021	178.0	21.6	33.7	46.1	53.2	2.7	**335.2**
2022	186.7	21.8	33.7	48.2	73.4	2.5	**366.2**
Total	**1 494.8**	**716.9**	**816.8**	**125.0**	**169.7**	**184.3**	**3 507.4**
Urban	**1 095.2**	**136.9**	**129.3**	**24.4**	**28.1**	**30.1**	**1 443.9**
Rural	**399.6**	**580.0**	**687.4**	**100.6**	**141.6**	**154.2**	**2 063.5**

Total investment costs in the period 2013 – 2022 would be in the order of 3.5 billion US$ at 2013 prices. About 2.1 billion US$ would be needed for rural electrification and about 1.4 billion US$ for urban electrification.

The average annual amount is considered more meaningful as it is known that plans are never realized as planned. The average annual amount is 350 million US$ with about 145 million US$ for the electrification of urban areas and 205 million US$ for rural areas.

The investment costs shown in Table 15 do not include the costs of distributed technologies (solar home systems, solar lanterns, etc.). A rough estimate of the average annual costs for these technologies is 10 million US$. The largest portion of the costs would be for rural areas.

The costs for preparatory works (feasibility studies, engineering studies, etc.), administrative tasks and supervision are also not included in the table. These ancillary costs are estimated at 15% of the investment costs. Adding the ancillary costs and accounting for the costs of distributed technologies yields **average annual costs of about 415 million US$**; about 168 million US$ for urban areas and 247 million US$ for rural areas.

Financing costs and inflation would further increase the amount.

5.2 Funding Considerations

5.2.1 Reflections on the Contribution of Customers to the Customer Connection Costs

Table 16 is a slightly different presentation of the costs shown in Table 15. The difference is that the customer connection costs are shown separately. They account for the largest portion of the total cost and are the only costs where the customers pay some of the costs through the connection fees.

Table 15: Annual investment costs separating between customer connection costs and other costs

Year	Densificat.	Phase 1	Phase 2	Phase 3	Phase 4	Off-Grid	Customer	Total
	exist. grids	TURNKEY II	TURNKEY III	TURNKEY IV			Con. Cost	
	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$
2013	49.7	76.4	-	-	-	-	87.3	**213.4**
2014	62.3	130.3	-	-	-	-	124.4	**317.0**
2015	65.5	179.1	-	-	-	31.4	158.9	**434.9**
2016	68.7	-	73.5	-	-	28.9	143.8	**314.9**
2017	72.1	-	84.3	-	-	29.2	166.9	**352.5**
2018	75.6	2.1	101.2	-	-	29.8	175.5	**384.3**
2019	79.3	5.4	147.4	-	-	24.5	231.8	**488.3**
2020	83.1	9.7	-	21.9	25.8	0.0	160.0	**300.7**
2021	87.1	10.2	2.4	33.7	32.1	0.0	169.7	**335.2**
2022	91.3	10.3	5.3	41.5	41.8	0.0	176.1	**366.2**
Total	**734.7**	**423.6**	**414.1**	**97.1**	**99.7**	**143.9**	**1,594.3**	**3,507.5**
Urban	**548.9**	**84.7**	**71.1**	**19.4**	**17.9**	**24.1**	**677.9**	**1,443.9**
Rural	**185.9**	**338.9**	**343.1**	**77.7**	**81.8**	**119.8**	**916.4**	**2,063.5**

In Tanzania, connection fees must be paid in three subsequent monthly instalments and the customer is only connected once the last instalment has been received. High connection fees have been a significant barrier for many potential customers. The drastic reduction of the connection fees which became effective in January 2013 has made a significant contribution to the increase in the number of new connections from 103,000 in 2012 to more than 160,000 in 2013. The drastic reduction has not been made possible by lower costs but by higher subsidies. Annex 5 shows that most of the connection fees currently paid by the customers are much lower than the costs. Only 3-phase customers who need one or two poles are paying more than the cost estimate.

Table 17 shows the subsidized amounts[19] which illustrates that **on average, 51% of the costs in rural areas are subsidized and 35% of the costs in urban areas.** The high subsidies raise the question whether end-users could pay more for the connection costs.

The consultant agrees with the finding of the recent subsidy study[20] that a higher contribution would be possible by allowing customers to pay (a portion of) the connection costs through several monthly

[19] The "profit" made from the few customers who pay more than the costs have been taken into account. Without the profit, the subsidies would be slightly higher.

instalments. The consultant's recommendation is to continue charging customers the present up-front connection fees but to recover the subsidized costs through a surcharge on the monthly bill over a period of several years.

Table 16: Customer connection costs, costs paid by customers and subsidized costs

	URBAN AREAS			RURAL AREAS			TOTAL
Year	Customer connect. cost	Customer payment	Subsidies	Customer connect. cost	Customer payment	Subsidies	Subsidies
	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$	Mio. US$
2013	48.27	31.48	16.79	39.04	19.84	19.19	35.98
2014	61.42	40.05	21.37	62.95	31.95	31.00	52.36
2015	68.15	44.43	23.72	90.75	45.93	44.81	68.53
2016	64.39	41.98	22.40	79.37	38.53	40.84	63.24
2017	68.58	44.75	23.83	98.36	47.93	50.43	74.26
2018	70.41	45.87	24.54	105.10	50.30	54.80	79.34
2019	80.49	52.50	27.99	151.27	73.75	77.52	105.51
2020	69.97	45.63	24.34	90.08	44.02	46.06	70.40
2021	72.26	47.12	25.14	97.40	47.78	49.62	74.76
2022	73.97	48.25	25.72	102.12	50.33	51.79	77.52
Total	**677.89**	**442.05**	**235.84**	**916.44**	**450.36**	**466.07**	**701.91**

The following example demonstrates what the surcharge could be. If the connection costs are 350 US$ and up-front fees are 111 US$, a monthly surcharge of 8,500 TZS (≈ 5.3 US$) paid over 5 years would recover the remaining costs of 239 US$ plus financing costs calculated with a monthly interest rate of 1% (annual rate 12.7%).

In a survey conducted by the above mentioned subsidy study, 8,500 TZS was the amount that two-thirds of the customers who were not connected said they would, on average, be willing to pay monthly for getting connected. The customers assumed that they would not have to pay up-front fees. Having to pay up-front fees could have lowered the monthly amount they were willing to pay but, if so, probably not significantly.

Recovering subsidized costs via a monthly surcharge is certainly politically difficult given that tariffs were only recently increased by about 40%. But even if the surcharge were only introduced in 2015 and only half of the subsidized costs were recovered, the amount would be substantial.

These are the other countries that demonstrate that cost recovery is possible:

- In **Morocco**, end-users paid about 300 US$ during the electrification campaign. The amount could alternatively be paid in monthly instalments of about 5 US$ over a period of 7 years.

- In **Rwanda**, customers pay about US$ 100 for the connection. The amount is close to what single-phase customers in rural areas nowadays pay in Tanzania (111 US$). The Rwandan

[20] CRISIL, Millennium Challenge Account Tanzania, Consulting Services for Electricity Scale-up and Subsidy Policy Study, Final Report, January 2013

customers in rural areas can pay the amount in three instalments over one year. All customers permanently pay in addition about 0.83 US$ per month (≈ 1330 TZS) for the installed prepayment meter.

5.2.2 Review of potential local and foreign funding sources

Excluding the connection fees paid by end-users, the costs to be financed, including preparatory but excluding financial cost, administrative and supervision costs, average 325 million US$ per year, with 125 million US$ for urban areas and 200 million US$ for rural areas.

In reality, the electrification of the urban areas of Phases 1 – 4 and of the off-grid program will be part of REA's responsibilities. Only the densification of the already electrified urban areas is excluded from REA's responsibility. That would yield an average annual investment cost of about 100 million US$ for urban areas and 225 million US$ for rural areas. Possible funding sources for these costs are examined in this chapter.

Local sources	Foreign sources
1. Government	8. Donors
2. TANESCO	9. Carbon Credit
3. Levies	
4. Local Banks	
5. Pension Funds	
6. Communities	
7. Private Sector	

5.2.2.1 Government

The Ministry of Finance and the Ministry of Energy and Minerals confirmed during discussions with the consultant that the Government is committed to increase the access to electricity. The recent introduction of the Fuel Levy is proof of the commitment. But fixed amounts will not be budgeted for electrification. If need arises because the available funds from levies and donors are not sufficient to make contracted payments, the Government will make the needed funds available.

The Government's future contribution to the REF will then mainly depend on REA's implementation capacity. That said, there are certainly limits to what the Government can contribute. Up to and including FY 2012/13, the maximum annual contribution to the REF was 37 million US$ and the average 18 million US$. In future, higher contributions than 37 million US$ are not unlikely because the recent 40% tariff increase and the soon-to-start replacement of high cost emergency power production by lower cost gas-fired production will decrease the subsidies which TANESCO needs. The planned power sector reforms are expected to be costly and to temporarily offset a high portion of the saved subsidies but one can reasonably assume that the Government will contribute significantly more than in the past. Whether it will be 50 million US$ - REA told the consultant that close to 50 million US$ were obtained in FY 2013/14 – or a higher or lower amount cannot be said, however.

5.2.2.2 TANESCO (will be changed)

In past, TANESCO's financial contributions to electrification consisted in financing densification investments – connecting customers to an existing distribution network or extending the existing network and then connecting new customers. The funds for these investments mainly came from the Government.

The recent (January 2014) 40% tariff increase will improve TANESCO's finances and so will the soon-to-come replacement of expensive emergency power by gas-fired power plants. But it will be a long way before the company will have sound finances which enable it to finance a significant portion of densification investments from its own funds. Funds will therefore have to come from the Government and from loans made available by commercial banks. TANESCO informed the consultant in mid-2014 that in at least the near-term, it intends to mainly use commercial loans for densification investments. Commercial banks are said to be willing to lend to TANESCO and some without a Government guarantee. An estimate of the amount that TANESCO can borrow from commercial banks was not given, however.

5.2.2.3 Levies

Levies are reliable and predictable funding sources. In FY 2012/13, the Electricity Levy and the Pre-destination Inspection Levy accounted for 39% of total receipts. The recent introduction of a Fuel Levy of 50 TZS per litre can be expected to make levies the largest contributor to the REF.

The annual funds mobilized by the Fuel Levy alone are estimated to be between 50 and 60 million US$. The recent 40% tariff increase and the continuously increasing electricity consumption should make the Electricity Levy contribute at least 25 million US$ per year. Adding 10 million US$ from the Pre-destination Inspection Levy yields 85 million US$ as conservative estimate.

5.2.2.4 Banking Sector

Banks will almost certainly not be investors in RE. The question is whether banks will provide loans for RE, in particular to private investors in off-grid electrification. Long-term loans with favourable interest rates would be necessary.

Providing long-term loans is difficult for local banks because they mainly depend on customer deposits to fund their lending. Customer deposits are short-term liabilities. The banks need access to long-term financing to provide loans for electrification projects. The consultant considers pension funds and life insurance companies as potential long-term funding sources. Government guarantees or guarantees from other highly rated institutions (donors) will certainly also be necessary to make banks offer long-term loans to investors in RE. The investors are unlikely to provide sufficient guarantees while non-recourse financing where the off-grid system provides the guarantee is also not on the menu for the time being.

High interest rates are another hurdle. Interest rates are high because inflation is high – in the first three months of 2013, the annual rate of inflation (National Consumer Price Index) was in the order of 10% and the risk of losses is high. Based on discussions with the CRDB Bank and the Tanzania Investment Bank, the loan interest rate would be in the order of 20% unless a sovereign guarantee is provided.

Support will certainly be needed to make banks provide loans with a long maturity and an interest rate which does not jeopardize the RE project's financial viability. The credit line facility which has been described in paragraph 2.3.4.2 does that. The private companies which so far used the facility obtained loans with 10 years maturity, two years grace period and interest rates of about 13%. The "normal" interest would have been about 20%.

5.2.2.5 Pension Funds

Pension funds have huge asset values. In mid-2009, the asset values of four of the six funds stood at 1.7 billion US$. The funds were invested in treasury bills (25%), bank deposits (24%), loans[21] (24%), real estate (13%), equities (11%) and corporate bonds (3%)[22].

Pension funds look into other investment possibilities and the consultant recommends discussing with them the possibility of investments into RE. Direct investments may not be allowed under the regulatory regime and if they are, liquidity considerations or rate-of-return expectations will probably be important barriers. A more realistic possibility is seen in that pension funds provide long-term loans to commercial banks for funding RE projects.

5.2.2.6 Local Governments

Local governments are allowed to raise certain revenues from a variety of taxes, levies and fees. The UNCDF Report "Financing Local Infrastructure: Part One Report – The Tanzania Environmental Scan", November 2009, lists on page 25 the taxes, levies and fees that were in place in 2009. They do not include fees for electrification. Theoretically, such fees could be introduced. It would require including them on the authorized list which, in turn, would require changes in the Urban Authorities (Rating) Act and the Local Government Finances Act.

The consultant attributes a low probability to the possibility that local governments decide to introduce taxes, levies or fees for electrification. The local population is poor which makes the introduction of local taxes, levies or fees generally difficult and the collection of revenues has been weak. In FY 2006/7, the collection of local revenues accounted for only 7% of total revenues. Introducing a tax, levy or fee to finance electrification investments may meet more resistance than usual as the investment would certainly not benefit the entire population.

Local governments are more likely to use the matching grant for preparatory works (feasibility study, design study, etc.) and the REF to finance the investment costs. The contribution of local governments to the investment costs of electrification projects will be limited to in-kind contributions in the form of making sites available for installing electrical equipment.

[21] TANESCO's financial statements show that pension funds have already provided loans to TANESCO. The outstanding loan amount at the end of 2011 was 61,000 Million TZS (about 38 million US$).

[22] Source: 6th International Policy and Research Conference on Social Security, The role of pension funds as institutional investors in Tanzania: Challenges and opportunities. Paper presented by Elias E.M. Baruti, The Local Authorities Pension Fund.

5.2.2.7 Private Sector

The desired private sector involvement in RE is not limited to private companies or individuals but includes all entities other than TANESCO. Communities, NGOs and religious institutions are in that sense part of the private sector.

Private sector involvement in rural electrification exists in all African countries. Mali and Senegal are probably the countries with the highest rate of private sector participation as investors and operators. In Mali, more than 100 small towns and villages are supplied by private companies under concession contracts. Power production is mainly done by diesel generators. About 15 villages are supplied by PV systems in the form of PV supplied mini-grids or solar home systems. Projects that will operate diesel-PV hybrid systems are under construction. Senegal has cut the country into 10 regions. In each region, one private company shall be awarded a concession for rural power supply. At present, 6 concessions have been awarded. The predominant supply technology is connection to the grid of the national utility.

In Tanzania, religious institutions are probably so far the main private sector entities doing rural electrification. Their investments were predominantly funded by religious institutions in Europe and the US, foreign governments and bilateral and multilateral donors. There also exist community-managed projects. A well-known project is the 300-kW Mawengi hydro plant, managed by the Lumama Electric Cooperative with still ongoing technical support by the Italian NGO, ACRA. At the end of 2013, the project supplied about 680 end-users. The project has been entirely financed by grants provided by the EU and Italian institutions. The community's contribution consisted in the release of land for the electrical infrastructure.

The engagement of private companies in the literal sense started with the construction of the 3.5 MW Mwenga hydro powerplant. The plant is owned by Mwenga Hydro Limited, an affiliate of Rift Valley Energy. Power production started in September 2012. Initially, the produced power was sold entirely to TANESCO under the feed-in-tariff scheme. The plan is that in the long run 80% of the production is sold to TANESCO and 10% shall be sold to Mufindi Tea Company Ltd., an affiliate of Rift Valley Corporation. The tea producer was connected to the plant in mid-2013. Another 10% is planned to be sold to rural customers. At the end of 2013, more than 800 customers had been connected. The construction of the distribution network, consisting of 28.5 km of 400 V lines, is still ongoing at the time of this writing (March 2014). The total number of rural customers is estimated at about 3,000, comprising of 2,600 households, 165 shops, 20 schools, 13 clinics/dispensaries, 1 hospital and more than 100 small and medium enterprises.

Until November 2013, 28 matching grants had been awarded by REA, 26 thereof for feasibility studies of hydropower projects which attest of the private sector's interest in RE projects. The matching grants finance on average about 80% of the pre-investment costs.

Making a study, of course, does not mean that the planned project will be realized. Even if the study indicates that the project is feasible, the project will not be realized unless two conditions are fulfilled:

1. **Private sector projects will need substantial subsidies.**
   The experience made in other countries suggests that 50% - 80% of the investment costs will have to be subsidized[23]. Subsidies are necessary because cash-flow problems pose a risk to make the project non feasible. The logic is as follows: The private sector can normally only finance a small portion by equity. Financing the remaining sum entirely by loans would incur high debt service payments (repayment of principal plus interests) during the loan repayment period. The debt service and O&M costs would exceed the sales receipts. That is also true if the customers are charged "high" tariffs. Tariffs may be higher than TANESCO's but there are limits to what customers can afford and these limits are usually such that the tariffs do not produce sales receipts which allow paying for debt service and the O&M costs during the loan repayment period. It is definitely true if commercial loans are used (short repayment period, high interest rate) but normally also if concessionary loans are obtained (longer repayment period, lower interest rate). Reducing debt service is thus required which means that the loan amount must be reduced which, in turn, means that grant funding must be made available.

2. **Private sector projects need access to favourable loans.**

   Access to loans is difficult for the private sector because of lack of adequate collateral. Setting up a partial guarantee scheme would be very useful.

   Favourable loan conditions in the form of a long repayment period, a grace period which covers at least the first year of operation, and a low interest rate are needed to provide a reasonable rate of return to the investor at affordable tariffs. Without favourable loan conditions, there is also the risk that the above mentioned cash-flow problems arise.

The support needed to make the private sector become directly involved in RE covers the following fields:

- Preparation of feasibility, engineering, design and other studies
- Obtaining the required rights and permits
- Subsidies for investment costs -at least 50%
- Access to loans which mainly means help with the provision of the guarantee
- Favourable loan conditions: a grace period which covers at least the first year of operation, 10 years loan reimbursement period, and an interest rate which does not exceed the rate of treasury bills
- A tariff formula which allows to automatically pass through costs which are beyond the control of the private operator (e.g. fuel prices or foreign exchange variations)

A one-stop shop at REA is highly recommended to assist interested parties with the administrative procedures to be undertaken. The one-stop shop should:
(i) inform interested parties which studies, permits, licenses etc. are required,
(ii) inform which documents have to be presented to which authority,

[23] The investment costs of the Mwenga hydro project were subsidized at about 60%. The project received a grant from the EU which financed almost 50% of the costs of the hydro plant and the performance grant of 500 US$ per customer for about 2,600 customers.

(iii) assist, if desired, interested parties when discussing contentious issues with the relevant authorities.

Information on (i) and (ii) can be made available on a website or through leaflets but it is strongly recommended to give interested parties access to a person to discuss whatever they like to discuss. Administrative procedures are never self-explanatory and support in how to interpret certain clauses is usually greatly appreciated and useful for progressing[24] [25].

Regarding the financial contribution of the private sector to the investment costs, the consultant considers 30% a realistic estimate.

5.2.2.8 Foreign donors

Bilateral and multilateral donors have in the past made substantial contributions to electrification projects and associated activities (feasibility studies, capacity building, etc). The support mainly came in the form of grants or concessionary loans. An incomplete list is shown in Annex 2.

Donors can be expected to continue supporting Tanzania's electrification program. The SREP Report mentions that 1 billion US$ has been committed by donors to the energy sector until 2016/17 with approximately 350 million US$ for renewable energy projects[26]. Regarding electrification projects and associated activities, only some anecdotal information is available.

The government of Sweden will probably continue to provide funds for the REF. Whether the annual amount will exceed the 15 million US$ injected in FY 2012/13 and perhaps even double was not clear at the end of 2013. In addition, SIDA will finance the 220-kV Makambako – Songea line and rural electrification projects for villages which are near the line.

The government of Norway will inject about 25 million US$ into the REF in both FY 2013/14 and FY 2014/15. The funding could continue thereafter provided that certain conditions will be met and a number of milestones reached.

The **SREP** (Scaling-Up Renewable Energy Program) for Tanzania has two major components: Geothermal Power Development Project and Renewable Energy for Rural Electrification Project (RERE). The planned budget for the RERE is about **182 million US$**. The break-down shows that 134 million US$ are foreseen for investments in mini and micro-grids, 28 million US$ for investments in stand-alone PV systems, almost 11 million US$ for a risk mitigation facility and 7 million US$ for transaction advisory services. The remaining amount of about 3 million US$ is for project preparation grants, capacity building and program management. Funding shall come from the World Bank (50 million US$, grant), development partners (47 million US$), the private sector (30 million US$), commercial banks (28 million US$), SREP (25 million US$) and the Government of Tanzania[27]. Only

[24] The Mwenga hydro project made the experience that the relevant authorities seldom knew what had to be done exactly to meet the conditions they were in charge of. The lack of know-how, which may have been due to that Mwenga was the first real private sector developer, delayed the project by at least one year. Obtaining water rights and the approval of the environmental impact assessment were said to be major hurdles.

[25] In Mali's rural electrification program, some candidates had a misconception of what output-based subsidies mean. They believed that they would obtain the subsidies after contract signature. A few projects had to be cancelled after contract signature for that reason.

[26] Source: SREP, Investment Plan for Tanzania, May 2013, p.17 (funding) and p.39 (use).

[27] Source: SREP, Investment Plan for Tanzania, May 2013, p.77.

the World Bank and the SREP funds (75 million US$ in total) are so far considered as being almost secured. The SREP is expected to start disbursements in early 2015 and to make the last disbursements between 2019 and 2021.

AFD: Rural electrification projects will continue to benefit from the AFD's recently (mid 2013) established 15 million Euros credit-line facility for renewable and rural projects.

KfW has committed to provide a 5 million Euros grant for funding rural electrification projects along the 220 kV Geita – Nakasani line (on-line electrification).

DFID is preparing a 20 million £ green mini-grid facility.

The **EU** is expected to continue supporting rural electrification projects under the 11th EDF. The total amount for the 5-year period 2015 – 2020 could reach 150 million Euros. More than 90 million Euros should be dedicated for grid extension in 2 phases. About 40 m€ package is planned to finance a turnkey project in the coming year. The injection of part of the remaining funds (about 50 m€) into the REF has not been excluded in a second phase.

JICA: Electrification projects will benefit from the training provided for TANESCO's technicians and engineers working with distribution and substation facilities.

One result of the anecdotal information is that in the short term, only the governments of Sweden and Norway will probably inject into the REF. Other donors will use a project-oriented approach where earmarked projects or supporting activities are funded.

In the medium and long term, the contributions of donors will certainly depend on the performance of the RE program and thus largely on REA's performance as the authority in charge of RE. A sound program should be based on a transparent and rational approach with measurable performance indicators. The consultant would also expect that in the long term, donors will not finance much more than the country. Central government funds, TANESCO's funding, and levies would count as the country's contribution.

A scenario of the funding which donors may make available for electrification projects is presented in paragraph 5.3.

5.2.2.9 Carbon credits

An incentive to reduce CO2 emissions is provided in the form of carbon credits. Carbon credits can be obtained under the Clean Development Mechanism (CDM) of the Kyoto Protocol, under Programs of Activities (PoAs) or under the Gold Standard. They can be sold in voluntary or compliance market. Carbon credits could be obtained for electrification projects which use renewable energy sources for power generation. In the Prospectus, that applies to off-grid projects and distributed technologies.

CDM Mechanism

The foundations for obtaining carbon credits through the CDM mechanism are in place. Tanzania was one of the first countries in Africa to establish a Designated National Authority for the CDM in 2004. The process to obtain carbon credits from CDM is laborious, time consuming and costly. For a small

project, application costs and annual monitoring costs usually exceed the value of the carbon credits[28].

Until end of 2012, two rural electrification projects, the 3.5-MW Mwenga Hydro Project and the 3-MW Luiga Hydropower Project, had applied for carbon credits under the CDM facility. Mwenga's application was approved in mid-2013.

Programs of Activities

PoAs are an innovative facility under the CDM. PoAs are handling large numbers of emission reducing activities that can earn carbon credits. Individually, these activities would be too small to apply the often costly carbon credit certification processes. PoAs do not require that all individual activities are known or identified at the moment the PoA is registered. Once the PoA is registered, activities can be included periodically as the program grows provided that the technology type of the project is included in the registered PoA. The time needed for a project to be included is then shortened to a period of weeks which compares with years under the regular CDM project-approval cycle[29]. For Tanzania, PoAs are interesting because off-grid projects will generally be small. The planned installed capacity of 14 of the hydropower projects was less than 2 MW and of nine projects less than 1 MW. Under the regular CDM process, the costs incurred with the registration of small projects almost certainly exceed the carbon credits. Bundling the projects in a PoA will not reduce the total application costs but lead to drastically lower costs per project.

Internet research showed that there is one registered PoA in Tanzania (solar-wave water purification) and one ongoing PoA validation (Lift-off Project; the project aims at replacing kerosene lamps with solar LED lamps)[30].

Gold Standard

The Gold Standard is an independent standard for certifying GHG emission reductions. Certification is done by the Gold Standard Foundation, a Swiss based non-profit organization. Gold Standard is the only standard that operates in both the compliance and voluntary markets, covering individual projects as well as PoAs. Developers can pursue registration of their project as a voluntary emission reduction project following the Gold Standard guidance only, or use the Gold Standard to certify credits generated under the CDM.

Registering a PoA under the Gold Standard requires conducting more elaborate stakeholder consultations under the CDM. A Gold Standard PoA must work with local communities, NGOs and government officials to conduct local stakeholder consultations to assess the potential environmental and social impacts of a program, ensuring the delivery of verified sustainable development benefits and also proactively seek feedback on the design of the PoA. The benefit is that Gold Standard certification usually leads to higher carbon credits in the voluntary market.

[28] What is a "small project" depends on the carbon credit. A rule of thumb is that the installed capacity of the project should be at least 1 MW in order that the project is not a small project.

[29] PoA registration also takes a long time; on average more than a year (Workshop on PoA under the CDM; May 2011). But once the PoA is registered, including projects goes fast.

[30] See http://cdm.unfccc.int/ProgrammeOfActivities/registered.html and http://cdm.unfccc.int/stakeholder/roundtable/08/AENOR_PoAs.pdf

Internet research showed that one project in Tanzania had applied for Gold Standard certification in 2011. The project aims at providing energy efficient cooking stoves in Arusha and Tanga. The stoves halve the amount of wood required. The project is realized by the UK-based company co2balance. The company expects to earn over 800,000 Gold Standard voluntary carbon credits from 2012 to 2019[31].

Outlook

Several facilities exist to obtain carbon credits but only very few projects have so far applied for carbon credits.

The presently low carbon prices of less than 5 Euros per ton of CO2 equivalent[32] provide little incentives to embark on the time-consuming and costly process of obtaining carbon credits. But prices could increase and even small contributions could help financing the ambitious electrification program. The consultant recommends charging an existing agency with the task to organize registration under the PoA facility. Most off-grid rural electrification projects will be too small to warrant registration under CDM but bundling them under the PoA facility and selling the carbon credits in the voluntary market seems to be worthwhile.

The following financing scenario does not consider revenues from carbon credits as they would be small compared to those of other financing sources.

5.3 Summary

Table 18 presents a financing scenario which is based on the information presented above.

The presentation of the "average annual REA cost" is made to reflect the institutional set-up in Tanzania. When using demographic criteria (size of population) or infrastructure criteria (existing social and administrative infrastructure), some costs of the Phase 1 – Phase 4 program and of the off-grid program would be classified as urban electrification costs; see, for example, Table 15. But except for the densification costs of already electrified urban areas, that is unlikely being the case in Tanzania. Electrification is REA's mandate and the urban settlements which will be electrified in the future will fall under REA's mandate. Furthermore, funding which the donors provide for electrification projects does not normally separate between urban and rural electrification. Distributing the donors' funds between these categories could thus only be done arbitrarily. The redistribution of some costs from urban to rural areas does not change the total costs and, consequently, not the financing scenario.

[31] See http://www.co2balance.com/news/tanzanian-gold-on-the-way/

[32] Prices depend on the type of project (hydro, biomass, geothermal, afforestation, energy efficiency etc.) and the market (voluntary market, compliance market). The statement that prices are "less than 5 Euros per ton of CO2 equivalent" gives an idea of the order of magnitude but is not valid for each project/market.

Table 17: Financing Scenario without accounting contributions from the Government and from TANESCO

	Urban	Rural	Total
	(Million US$ per year at 2013 prices)		
I. Average annual cost in period 2013 - 2022	168	247	415
II. Average annual urban and "REA Cost"	126	289	415
III. Contribution of:			
- End-User (connection fees under present system)	36	54	89
- Levies injected into REF		85	85
- Donors - Contributions to REF		50	50
- Donors - Project approach		60	60
- Private Sector (off-grid and distributed technologies)		8	8
"Gap" (II - III)	**90**	**32**	**123**

Comments:

c) Costs include all costs except for financing costs and inflation

"REA Cost": all costs of densification in settlements which are electrified from 2013 onward allocated to rural. Urban costs reflect the costs of densification in settlements which were already electrified by end of 2012.

The scenario shows an average annual "gap" of 123 million US$. Provided that the contributions of the financing sources listed in the table are valid, the real gap would be significantly smaller because the table does not include:

(i) the annual contribution of the Government to the REF,
(ii) the annual financing of densification investments by the Government,
(iii) the contribution of TANESCO

As has been mentioned in paragraph 5.2.2.1, the Government is expected to continue supporting electrification from the budget. The contributions will not be in the form of firm commitments but will be made when need arises. That applies to both injections into the REF and to the financing of densification investments (urban and rural) from the budget.

To close the rural gap, "only" 32 million US$ would be needed. Given the Government's injections into the REF in recent years, one is tempted to say that 32 million US$ can certainly be expected from the Government. But that viewpoint ignores that the urban gap of 90 million US$ must also be financed. The amount is needed to connect customers in areas which are already electrified – with few exceptions, these areas are urban areas – but where typically only between 20% and 60% of the population is presently connected to the distribution grid. TANESCO can certainly not fund the investments from its own sources and the consultant considers it highly unlikely that banks will

provide TANESCO every year with 90 million US$ for densification investments. The Government will certainly have to fund a high portion of the amount.

Summarizing, the electrification program of the Prospectus is certainly ambitious on financing grounds. The main financing risk is not seen in the rural electrification program but in the densification program. The present policy and the donors focus on rural electrification because rural areas are far behind urban areas when it comes to having access to electricity. That makes on expect that the rural electrification program outlined in the Prospectus can be financed; at least when not including densification investments in rural areas but limiting connections to the first wave of customers (typically about 30% of the population). The consultant sees the main challenge in financing the densification program outlined in the Prospectus. The program would mainly increase the electrification ratio in already electrified urban areas. The consultant would not be surprised if only a downsized version of that program will be realized and if the densification in rural areas which will be electrified in future advances slower than projected.

That the electrification program of the Prospectus is ambitious on financing grounds follows when comparing with program with those that have been realized in other countries. Morocco is probably the outstanding champion in Africa when it comes to advancing electrification. In 1995, Morocco's electrification ratio stood at 18%; in 2008, at 95%. The average annual investment costs, excluding densification investments, amounted to about 230 million US$ at today's prices. The corresponding costs of the Prospectus are 280 million US$ per year (excluding densification costs but including preparatory, administrative and supervision costs). More details on Morocco's electrification program and how it was financed are presented in Annex 6.

6 Implementation Plan

6.1 Electrification Policy – Main Grid Connection and Off-Grid Electrification

The Prospectus prepares an electrification strategy with a GIS-based software which accounts for the development impact of electrification. It takes into account the transmission expansion plan and uses low-cost network design technologies. The resulting strategy puts emphasis on electrification by grid connection – in 2022, about 72% of the population will live in areas covered by the main grid - but leaves a huge potential for off-grid electrification.

Implementing the Prospectus does not mean that the electrification plans which come with the Prospectus should exactly be realized as described. The electrification plans will certainly be subject to some changes caused, for example, by an improved data base or financing or implementation constraints. But the result which settlements should be electrified by grid connection until end of 2022 is not likely to change significantly. Settlements which are not in the grid-connection areas are candidates for off-grid electrification. In addition, development centres which would not be connected to the main grid before 2020 are also considered candidates for prior off-grid electrification. The development centres are referred to as priority off-grid projects in the Prospectus.

The policy recommendation is that financial support for off-grid electrification should be made subject to the condition that the settlement is not in an area which will be reached by the main grid until end of 2022 or that it is on the list of priority off-grid projects.

6.2 Institutional and organizational framework for rural electrification

With one exception, the institutional and organizational set up is considered adequate for the Government's plans to substantially increase access to electricity. Shortcomings rather exist at the operational level. Decisions which have to be made at the policy level to rectify the shortcomings are presented in this chapter. Measures which can be taken without decisions at the policy level are described in the chapter on "Accompanying Measures".

The exception concerns TANESCO. A consequence of the significant increase of rural electrification will be that RE activities will become much more important for TANESCO. The activities will comprise the maintenance of the lines and substations, connection of customers (only a first wave of customers is connected under the turnkey contracts), extensions of the local LV network, installation of the logistics for pre-paid meters, control of pre-paid meters, etc. TANESCO certainly needs more personnel to cope with the high increase in the workload. But organizational or even institutional changes will be required as well. Options are:

(1) The creation of a rural electrification business entity in TANESCO with separate accounts.
(2) The creation of private distribution companies which buy in bulk from TANESCO and assume all functions of a distribution company; see 6.5.2.
(3) The outsourcing of the distribution activities to private companies under a management contract.
(4) The creation of a separate rural utility.

The ongoing preparation of the power sector reform should recommend the most appropriate option.

Involving private companies under a management contract could be the least attractive option. The experience made with such contracts in other countries – the contracts normally covered distribution and generation - is anything but encouraging. Maintenance and repair have been controversial issues which often led to the cancellation of contracts. Normal maintenance has to be paid by the management company whereas major repair works have to be paid by the owner of the assets. When the management company claimed that major repair works have to be carried out, the owner sometimes claimed that negligence of normal maintenance has been the reason for the repair works. The controversies usually focused on generation assets. The risk of controversies is certainly lower if only distribution assets are concerned but whether it is low is not known.

6.3 Electrification Policy – Low-Cost Network Design

The Prospectus has identified low-cost network design technologies which would reduce costs significantly. **Low-cost network design should become a priority in project preparation.** As resistance from TANESCO must be expected, the use of low-cost technologies will require Government support. It is recommended that the MEM demands REA and TANESCO to prepare electrification plans which explicitly indicate (i) how standards of existing technologies have been improved or changed to reduce costs and what are the resulting cost savings and (ii) which electrification projects will use new technologies (for example, SWER or 2-phase MV) and what are the resulting cost savings. Some other recommendations to advance the use of low-cost technologies are made in the following paragraph (Accompanying Measures).

6.4 Transparent process to determine grid-connection projects

It is not fully clear how the settlements to be electrified by grid connection have been determined so far. The consultant's understanding is that TANESCO makes a proposal to a planning commission composed of representatives from the MEM, REA and TANESCO. Taking into account possible amendments made by the commission, REA prepares a list to be approved by the REF Board. The final proposal is presented to the Parliament in order to get a formal approval for funding. While economic and social development criteria certainly play a role in the selection, some political meddling is said to also influence the result[34]. To minimize political meddling, the process should be based on clearly defined criteria similar to those used in the Prospectus to identify development centres (see Annex 4). REA's existing manual of procedures goes in that direction but needs some modifications. The proposed list of settlements should be prepared by REA in collaboration with TANESCO but with REA taking the lead. The proposed list which is submitted to the REF Board for decision should indicate for each settlement how many points it has obtained for each criterion. The Board may drop settlements from the list and include others but changes should be limited to 5% and the reasons for changes should be given. Upon request, the proposed list and the approved list should be made available to donors who contribute to the funding of the projects.

[34] That does not refer to the Government's policy to electrify district headquarters. District headquarters are development centers and would be selected by any reasonable method.

6.5 Support for Private Sector Participation

6.5.1 Financial support and guarantees

Three conditions are necessary to make the private sector participate in rural electrification:

d) A low risk of financial losses.
e) Providing access to loans.
f) Establishing a loan guarantee scheme.

Instruments which **reduce the risk of financial losses a**re:

- funding a portion of the costs of preparatory works,
- providing subsidies for investment costs,
- the possibility to combine RE with sales under the SSPPA scheme,
- a regulation which includes a profit margin in the retail tariffs.

The instruments are in place in Tanzania but important details remain to be improved:

(1) There are insufficient data on hydro and biomass sources.
That could end soon as a hydro resources assessment, financed by the WB, is currently ongoing and biomass and wind resource assessments are understood being under preparation.
(2) Private developers often don't have the capacity to prepare proper project proposals including business plans. The number of consultants in Tanzania which have the capacity seems to be small.
(3) Feed-in tariffs should be made dependent on the technology.
(4) It remains to be determined what will be the options for private developers of off-grid systems when the main grid arrives.

The last two-mentioned points require changes at the regulatory level. It is understood that a currently ongoing study is addressing the issues. The relationship between the Feed-in-Tariff Scheme and rural electrification is described below in Box 1.

Providing access to loans is another necessary condition for private sector participation. The credit line facility provided under the TEDAP Project has proven an appropriate tool in that respect. The credit line facility needs to be increased substantially as the present 23 million US$ facility is almost depleted. The AfD established a 15 million US$ facility in mid-2013 and several donors are understood to sympathize with the idea to provide funds for a credit line facility. But Government funding will most likely also be necessary.

The existing credit line facility and ones planned by donors are linked to the use of renewable energy technologies. That is not considered an obstacle as the off-grid projects proposed so far by private developers all envisage the use of renewable energy sources.

A loan guarantee scheme is considered necessary as commercial banks which handle the credit line facility do not grant the loan without a guarantee and private developers have problems providing the guarantee. **It is highly recommended that the Government sets up a loan guarantee scheme**[35]**.**

[35] The World Bank has set up a loan guarantee scheme for electric cooperatives in the Philippines. The scheme guarantees the reimbursement of 80% of the loan. The scheme has been highly successful.

Box 6.1: FiT Scheme and Rural Electrification

The FiT scheme aims at attracting private investors to set up small power plants using renewable energy carriers. The feed-in tariff for sales to the main grid operator is fixed by EWURA. The owner of the SPP has no obligation to electrify customers in the area where the plant is located if the capacity of the plant is below 1 MW. But he has that obligation if the capacity exceeds 1 MW. The Electricity Act 2008 says that "for the promotion of the National Energy Policy in relation to rural electrification, every licensee shall be required to supply electrical energy to the local communities where electrical supply installations are located or along transmission lines" (Section 39-(4) of the Act). For generation, distribution or supply activities with an installed capacity at a single site of more than 1 MW or a system demand supply exceeding 1 MW, the license is mandatory (Electricity Act 2008, Section 18-(2) and (3)). Therefore all rural generation licensees with a capacity over 1MW have an obligation to supply local communities, if any, in the vicinity of their plant or of their power evacuation line. The cost items which can be considered in the tariff which the owner of the SPP can charge the retail customers are fixed in Article 44 of "The Electricity (Development of Small Power Projects) Rules, 2013". The tariff explicitly allows a reasonable return on capital provided by the owner.

6.5.2 Creating the regulatory framework for private distributors

An issue which requires regulatory activities is the establishment of a model for developers who are interested in developing and operating a portion of the rural grid with supply coming from TANESCO or another power producer than the private developer. The operational activities of the developers would be that of a distribution company: connecting customers, line extensions, maintenance of assets, billing and collection, etc. One private developer, Armstone Ltd., has already expressed interest in such a model. The model exists in Senegal in the form a large concessions and in Mali in the form of small (village type) concessions.

6.5.3 Partnership opportunities

A new type of public-private-partnership projects could arise from a model proposed by CEFA, an Italian NGO, which has already built three hydro-based RE schemes: A private developer installs and operates a power plant and constructs the MV lines which connect the plant with rural settlements in the vicinity of the plant. An NGO with a sound knowledge of rural economies constructs and operates the local distribution networks and assists the population with the development of the rural economy.

Private companies are usually not much interested in the distribution activities associated with rural electrification. They are more interested in constructing and operating a plant which sells under the FiT scheme to the main grid operator. But they have the obligation to supply rural customers in the vicinity of the plant if the capacity of the plant exceeds 1 MW (see Box 6.1). In the CEFA model, the private company would be relieved from the distribution activities which would be assumed by an NGO. In addition to obtaining access to electricity, the rural population benefits from the NGO's

know-how of rural economies. The NGO advises the population in how to improve the productivity of existing activities and points to new income earning activities. The NGO expands the distribution network in line with the needs of the rural economy. The rural customers pay the NGO for the electricity service and the NGO pays the operator of the power plant. The rules for fixing the wholesale price for power sales to the NGO remain to be determined by EWURA.

CEFA expects the explicit combination of power distribution with rural development to provide more subsidies, or at least better financing conditions, for the distribution component.

6.6 Need for developing capacity and skills for the rural electricity sector

The implementation of the electrification program requires many more engineers, technicians and craftsmen than Tanzania has at present. There is an urgent need to set up schemes which provide the needed skills.

TANESCO has been without training facility during the past 10 years. The capacity of the new Technical Training School (TTS) is limited to 200 craftsmen, 180 technicians and engineers. The TTS consists of few class rooms in the centre of Dar and a training field with equipment to train the installation and maintenance of electrical network up to 33 kV.

The enhanced cooperation between TTS and the Vocational Education and Training Authority, VETA, should be considered and supported to provide sufficient training capacity in the future.

TANESCO does not provide a reservoir of human resources as the recruitment of new engineers and managers was limited during the past 10 years. A 'successor' training programme was added in recent years to the training programmes carried out at the TTS for 200 engineers and managers. The successor programme aims at acquiring skills through active coaching by seniors (mentors).

Regarding house wiring, the consultant recommends considering the Moroccan approach where training was organized by ONE, the national utility, on how to do proper house wiring. The training was offered to local companies as well as individuals, including students who had finished engineering studies. The participants received a certificate at the end of the training program and only certified individuals or companies were allowed doing the house wiring at a fixed tariff. Training in energy efficiency was also provided, enabling the participants to recommend energy efficient solutions to end-users.

7. Accompanying Measures

This chapter focuses on practical measures which should be undertaken for the efficient implementation of the electrification program outlined in the Prospectus.

7.1 Recommended Strengthening and Supporting Measures for REA

7.1.1 Strengthening the Planning and Database Management Division

The identification of electrification projects, which was done in the Prospectus, should be carried out by the **Planning and Database Management Division** (PPMD)**.** The PPMD should therefore be strengthened by recruiting one GIS expert with knowledge of GEOSIM or another GIS-based planning software, one energy economist and an energy economist and planner with a solid background in rural electrification. The proposed strengthening of the PPMD will aim at achieving a more efficient and transparent selection of priority localities (both on grid and off grid) based on socio-economic characteristics, on assessment of financial viability and prioritisation and on a realistic budget.

Among the tasks of the division should be:

(1) Continuous updating and improvement of the GIS data base.
(2) Preparation of the list of settlements to be electrified under turnkey programs which would start two years later. The list should be prepared in collaboration with TANESCO but with REA in the driver chair.
(3) Identification of priority off-grid projects. The first step should be to improve the data base used by the Prospectus to identify priority projects. The step should be followed by visits of the most promising priority projects in terms of the socio-economic development potential.
(4) Management of feasibility and engineering studies for selected priority off-grid projects. The PPMD should prepare a proposal on the projects to be selected. After approval of the REF Board, the PPMD should recruit external consultants who carry out the feasibility and engineering studies.
(5) Identification of PV programmes for social and administrative infrastructure facilities (schools, dispensaries, administrative buildings, etc.).
(6) Preparation of budget estimates (investment cost and operational budget).

7.1.2 Recommendation to help REA cope with project proposals submitted by private developers

Project proposals are received (i) in the form of requests for matching grants for preparatory works for planned projects and (ii) in the form of requests for subsidies if the developer has decided to realize the planned project. The following statements apply to both forms of project proposals.

Proposals for off-grid projects and projects for distributed technologies can at present be submitted at any time by the developer. They are appraised individually and continuously which creates relatively high transaction costs. It is an appropriate procedure to start receiving proposals from private developers but a more structured approach seems necessary in the medium term.

If funds to subsidize off-grid projects or projects for distributed technologies are limited, a project hierarchy should be established and potential developers informed which projects would be given priority in funding. The projected number of customers supplied at the end of the first year of

operation and the investment cost per customer could be among the criteria used in establishing the hierarchy.

A large number of project proposals would exceed REA's capacity to handle the proposals. It is, therefore, recommended that REA sign framework contracts with consultants for the appraisal of both off-grid proposals and proposals submitted for distributed technologies. Only consultants who have participated in training courses organized by REA should qualify for framework contracts.

Evaluating a large number of proposals continuously would make it difficult to account for the funding hierarchy and also incur high transaction costs for the consultants. It is, therefore, recommended to only appraise project proposals two or three times a year if the number of submitted proposals exceeds a threshold which remains to be fixed. Proposals could be continued being received at any time but the developers would be informed that the project proposals would only be evaluated at pre-fixed dates.

The procedure described in 7.1.1, that REA has feasibility and engineering studies prepared by consultants for selected priority projects, would be followed by calls for proposals. The deadline for submission should be coordinated with the above mentioned proposal evaluation dates.

7.1.3 Upgrading and Strengthening the Procurement Management Unit

The work load of the Procurement Management Unit (PMU) will increase considerably if the proposed RE program is implemented. While the recommended assistance by engineering companies in the preparation of tender documents for larger grid extension turn-key projects will ease the burden, strengthening the PMU will be necessary. The Prospectus Team shares the view expressed in the report "Review of Organizational Structure" prepared by Ernst and Young that the PMU should be upgraded to a division and its staff increased by two officers.

7.1.4 Upgrading the Legal Affairs Office

The Legal Affairs office should be upgraded to a division to give it the same importance in the organizational hierarchy of the agency as the proposed Procurement Division with which it has to work closely together in tender preparation, tender evaluation and contract award. When there are disputes between the contractor and REA, Legal Affairs has to propose solutions to REA's management.

7.1.5 Support for Preparation of Tender Documents

The preparation of tender documents is the responsibility of the PMU. Until now, the tender documents for the turnkey packages are not based on detailed design. The approximate route of the MV lines is determined from GPS points. The bill of quantities for the distribution systems contains the estimated number and capacity of transformers and the estimated length of LV lines. Delays which some projects experienced were due to that the electrification required another dimensioning of the system than drafted in the tender document. Delays also occurred because the contractor had to do the detailed mapping of all localities and the drawing of the LV networks. In order to minimize the risk of delays and of conflicting interpretations of the tender documents, it is recommended to

prepare tender documents which are more detailed and more precise. That will require using an integrated GIS-based grid design programme. Better tender documents which include the detailed design and routing of the MV and LV lines would also advance the ESIA study. Obtaining the environmental clearance has often delayed project implementation.

For large grid extension turnkey projects, the consultant recommends that REA appoints power engineering companies specialised in detailed project design using a GIS-based grid design programme to prepare the tender documents. These companies would also assist the PMU in the evaluation of proposals.

For other projects the consultant recommends than REA sign framework contracts with consultants for the preparation of tender documents and with preferably experience in the evaluation of technical proposals. Only consultants who have participated in relevant training courses organized by REA should qualify for framework contracts.

7.1.6 Project Supervision during the Construction Phase

The supervision of construction works currently involves several parties: the Trust Agent (TA) supervises the commercial part of the contract; an engineering bureau with which the TA has an association agreement does the supervision of the technical components; installed facilities which will be transferred to TANESCO are in addition examined by TANESCO's engineers before the transfer, and REA occasionally participates in supervision activities. The Trust Agent's involvement in the supervision of construction works derives from the agent's responsibility for the disbursement of the grants provided by the REF. Disbursements can only be made if conditions are fulfilled. Progress of construction works and proper execution are part of the conditions. As the Trust Agent, which is presently the Tanzania Investment Bank (TIB), does not have the technical competence to judge the quality and progress of construction works, an associated engineering company does that job.

It is not clear which authority the parties have under the present arrangement. What happens, for example, if the engineering company working for the Trust Agent has accepted the construction but TANESCO or REA do not? There is a need to establish clear lines of authority. That will become even more important if international contractors get involved in construction works.

The consultant's recommendation is to give the Trust Agent a full-fledged 'Engineer role in FIDIC terms'[36]. The agent's primary task is the disbursement of the grants provided by the REF. At the present, the Trust Agent is already involved in the supervision of construction works but the arrangement lacks rigour and could create legal problems should there be disputes between the contractor and REA or TANESCO. The proposed 'Engineer role in FIDIC terms' would avoid that. The contract which the REF has with the Trust Agent expires in summer 2014. The renewal of the contract will be subject to a national tender process. That provides the opportunity to revise the status of the Trust Agent by giving it the 'Engineer role in FIDIC terms'. TANESCO's engineers will

[36] FIDIC is an international contract framework with a very well developed legal and arbitration framework establishing rules between the employer (the owner of the project), the engineer (consultant in charge for supervision of project implementation) and the contractor (building the infrastructure). The engineer is the authority in charge to deal with all technical and contractual matters with the contractor on behalf of the employer. Generally dispute and arbitration take place between the employer/engineer and the contactor. But if the engineer fails in his duties, there are also arbitration opportunities between the employer and the engineer.

continue examining the construction works before the take-over. REA's role would be the control of the performance of the 'Engineer'. In order for REA to do that as required its supervision staff should be increased by two or three engineers.

An alternative arrangement which could be considered is the creation of a Rural Electrification Project Management Unit reporting to REA and partly staffed with REA experts. The unit will provide services for the preparation of tender documents and supervise the implementation of large grid extension turn-key projects. The unit would in that respect assume the Trust Agent's 'Engineer role in FIDIC terms. The unit could have regional offices to facilitate the supervision of the contractors – the offices could be either permanent if activities justify this over time, or established for the duration of the construction period.

7.1.7 Project Monitoring in the Operation Phase

Donors normally end the monitoring of output-based funded projects when the funds have been spent. Electricity supply usually only begins thereafter. It is important that REA monitors the achievement of the electrification objectives as it will help to identify potential weaknesses in the design or execution of the electrification program and allow making necessary corrections.

Performance indicators should measure the achievement of the electrification objectives. The ultimate objective is socio-economic development and poverty reduction. Other important objectives whose achievement should be monitored are:

- access to electricity,
- customers' overall satisfaction with electricity supply,
- affordability of electricity supply and connection costs,
- technical and non-technical losses,
- power supply quality

Indicators are presented in the Prospectus Report "Task 5 – Performance Metrics, April 2013".

Basic data on electrification schemes (number of customers per tariff categories, kWh sold, peak load, basic information on the grid and the quality of the supply) should be provided by TANESCO or the private developer on an annual basis. The information could be completed by surveys of some electrified settlements. They surveys should be conducted by REA about one year after the start of electrification and again two or three years later. A proposal regarding the number of entities to be surveyed within a selected settlement is presented below.

Table 18: Proposed size of surveys for monitoring purposes

End-User	Number of end-users to be covered by the survey
Households	5%. A minimum of 10 households in settlements where there are less than 200 household customers.
Small businesses	About 15%. A minimum of 10 customers in settlements where there are less than 70 small business customers
Social and public services	About 15%. A minimum of 10 customers in settlements where there are less than 70 social and public service customers
Large electricity consumers	All. A large electricity consumer accounts for at least 5% of total electricity consumption.

7.2 Non-Financial Measures to Facilitate Private Sector Participation

7.2.1 Creation of a One-Stop Shop at REA for Private Developers

Getting all the information what must be done to participate as private developer in RE, which support is offered and the possibility of having to cope with partly cumbersome administrative procedures are barriers of entry for private developers. To reduce these barriers, there should be a **one-stop shop** at REA which informs private developers about the available (financial) support for off-grid projects or electrification by disseminated technologies and the procedures to be followed. The one-stop shop should offer assistance with the administrative procedures the developers have to follow to obtain the required permits and licenses.

7.2.2 Preparation of Off-Grid Projects by REA

Private sector participation would also be facilitated if **REA prepares projects for private developers.** The consultant recommends doing that for the priority off-grid projects which would reach the largest number of customers and for which proposals are not received from private developers. Project preparation means that feasibility and engineering studies are prepared which will require site visits. The studies should then be made available to private developers in the context of a call for proposals.

7.2.3 Receipt and Evaluation of Proposals

Project proposals prepared by private developers should continue being received whenever they are submitted. Whether this policy incurs higher costs for REA than the receipt at pre-fixed dates depends on when the proposals are evaluated. The evaluation must not take place continuously but can be limited to certain periods. In fact, that is recommended should there be so many proposals that the requested grants exceed the available sum. The proposals should then be ranked based on criteria which remain to be determined and only the highest ranked proposals should receive grant funding. The number of rural customers that would be supplied by the project at the end the first year after the start of operation and the investment costs per customer should be among the criteria.

7.3 Low-Cost Network Design

Low-cost network design should become a priority in project preparation as it would reduce costs considerably.

7.3.1 Optimization of Existing Network Technologies

As resistance from TANESCO must be expected, the assistance of an external expert is considered necessary to make REA propose changes of the network design criteria for rural electrification (MV span length, wind speed criteria, etc.) and TANESCO to accept them. The tasks of the expert would be to determine the low-cost network-design, to indicate to REA and TANESCO the cost savings, to specify the low-cost network-design in the tender documents and to supervise initial installations made by construction companies.

7.3.2 SWER and Other New Technologies

Using the SWER technology is only recommended for areas where the projected demand will be low and where in particular the use of electricity for production purposes is likely to be limited. The productive use of electricity normally requires 3-phase supply while the proposed SWER technology would come with single-phase supply. If it is likely that only few motors will be used in the area, financial support should be offered for the purchase of single-phase motors or three-phase converters.

While the conditions for using SWER seem to considerably limit its use, the experience made in several countries (among others South Africa, Namibia, Tunisia, Mozambique, Laos, New Zealand, Australia, Canada, Brazil, Upper Midwest USA) shows that there are more areas than commonly believed. The consultant recommends that the introduction of SWER in Tanzania should start with the visit of a small team of REA and TANESCO staff of sites in South Africa or Namibia where electrification by SWER exists for years. The visit should be followed by the implementation of the proposed pilot project in Tanzania. The targeted area is located in Pwani region, about 90 km from Dar es Salaam in Kisarawe district in the vicinity of Msanga. About 16,000 inhabitants or about 3,000 households could be supplied by the project. The pilot project will combine both SWER technologies; direct SWER and SWER with an isolation transformer for the most populated areas. The pilot project should be evaluated with the assistance of foreign experts who are familiar with the SWER technology. The evaluation should produce guidelines for specifications, bills of quantities and technical drawings which could then be used by REA's PPDM division for future projects. The evaluation should be followed by a training program for REA, TANESCO and engineering companies.

Another new technology which has been proposed by NRECA for Tanzania is the **two-phase MV system.** While the Prospectus consultant has some doubts on its attractiveness, the consultant recommends installing a pilot project and judging the attractiveness based on the performance of the pilot project.

8. Recommendations for Rural Electrification Master Plan

8.1 Introduction

In spite of past and ongoing reform efforts, Tanzania remains one of the poorest countries in the world. About 80% of the population is living in rural areas where access to quality services and goods pale in comparison to urban areas. That also applies to energy services. While about 45% of the population in urban areas has access to electricity at the end of 2013, less than 6% had so in rural areas.

The Electricity Act of 2008 says in Article 37 (Rural Electrification) "*The Minister shall, in consultation with the Rural Energy Agency and the Authority, prepare a Rural Electrification Plan and Strategies for Mainland Tanzania and periodically amend and update such plan*" including the following tasks : "

a/ expansion of the main grid in rural areas, and
b/ development of off grid electricity supply systems in rural areas, including new and renewable energy systems
"

Regarding the Monitoring and evaluation, the Act says in Article 38:

"*The Minister shall, in consultation with the Rural Energy Agency and the Authority, cause to establish and maintained a rural electrification database for Mainland Tanzania to assist in the monitoring of progress and establishment of the targets of rural electrification*"

which literally give to REA the responsibility for projects follow up. The use of a specific electrification database is consequently specified and should be included in any future rural electrification master plan.

8.2 Rural Electrification Planning Activities in the Recent Past

The last Tanzanian **Rural Electrification Master Plan** completed in 2005-2006 and financed by AfDB offered an analysis of rural areas, giving an overview of the electrification status, the energy resources and the technology available at an aggregated level (region and district). The master plan included few pre-feasibility studies for the development of RE projects. Project proposals which were made for regions or sometimes districts were too generic to be of value for project developers.

The **Integrated Rural Electrification Planning** (IREP), financed by the EU Energy Facility with co-financing from REA, which was carried out in 2011 – 2012 used a geospatial planning method. Licenses of the database and the geospatial software GEOSIM were deployed at REA, EWURA, TANESCO and MEM. Staff of these organizations was trained for six weeks in the use of the tools. Resource assessments were carried out in 6 regions with emphasis on hydro and biomass potentials. The GIS database, including besides the results of the resource assessments data which allowed calculating the development potential of settlements (see Annex 3) was consolidated for six targeted regions (Pwani, Morogoro, Tanga, Lindi, Dodoma and Iringa). For these regions, more than 60 pre-feasibility studies were prepared. In 2012 and 2013, REA financed data collection activities, including energy demand surveys, in other regions.

A **hydro resources assessment,** financed by the WB, is currently ongoing. **Biomass and wind resource assessments** are under preparation and could be carried out next year.

8.3 Objectives

The Master Plan should prepare rural electrification plans which give priority to the electrification of rural areas where the electrification promises to substantially advance the economic development of the areas. For the impact-maximization plans, least-cost electrification technologies should be determined by examining the costs of electrification by grid connection and off-grid solutions. The Master Plan should indicate how the plan should be implemented, giving due consideration to the planned power sector reforms.

8.4 Recommendations

Rural Electrification Planning Methodology emphasizing the socio-economic impact of electricity services

The primary objective should be impact maximization rather than cost minimization. It is recommended that impact maximization starts with the analysis of the socio-economic development in settlements which are already electrified. The analysis is expected to indicate which factors are important and how they influence the development. Based on the analysis, the variables used to estimate the impact of electrification on socio-economic development should be determined and the calculation of the impact index from the variables.

The Government of Tanzania's **National Vision 2025** for poverty eradication and sustainable development should be reviewed in this context. The Master Plan should indicate how it would support the objectives mentioned in the National Vision 2025.

Geospatial Least-Cost Electrification Rollout Plan

A geospatial database and software should be used to prepare the Master Plan. The use of these tools requires:

- The creation of a GIS-based spatial planning platform with geo-referenced data layers which cover both grid extension and off-grid applications by region.
- Data collection and analysis for establishing the digitized data layers for the spatial planning platform. The data include population settlements and their density patterns, locations of infrastructure priority facilities (schools, health facilities, mosques, administrative buildings, etc.), digitized representation of existing networks and lines, availability of renewable energy resources, and network performance characteristics at each sub-location.

The database and the tools would then be used to provide the following output:

- Projections of electricity connections and electricity demand for the population with no or inadequate electricity services at a disaggregated level (by district and province at a minimum; by township if possible).
- Comparison of different technologies and electricity supply options (technical and economic viability). Cost comparison and estimates of total electrification costs (investment and O&M costs) at each sub-location. Cost comparison should include the comparison of electrification by

grid extensions or off-grid applications for settlements for which it is not obvious that one of options is the least-cost option.

The analysis of grid extensions should include sub-transmission assets, power supply delivery points (substations) on the main grid system, medium voltage network extensions, low voltage reticulation and connection rollouts. The analysis must be coordinated with the power sector master plan that is under preparation.

Off-grid applications should cover the expansion of existing isolated networks and the development of new mini and micro-grids and their power supply sources (small hydro plants, small biomass-fuelled plant, diesel-PV or wind-diesel hybrid systems,.

Distributed technologies using renewable energy sources as much as possible (SHS, solar lanterns) should be foreseen for locations for which grid connection of off-grid projects are not economically viable.

- Sensitivity of the plan to key variables such as connection charges, supply cost per kWh, use of low-cost network designs, financing costs, etc.

Strengthening National Rural Electrification planning expertise toward sustainable planning through training and the use of specialized planning tools

The objective of the training activities is to enable the agencies in charge of RE to prepare subsequent master plans themselves.

The data base of a master plan should be almost permanently improved and updated and the Master Plan updated annually. That will require familiarity with the tools, the data base and the methodology. The training in the form of brief courses and on-the-job training shall provide that know-how.

Rollout program and pre-feasibility studies portfolio

A broad and comprehensive strategy for rural electrification should be developed, drawing from the experience of national institutions and capitalizing on past initiatives, tools and databases. The strategy should tackle technical, financial and organizational challenges and particularly strive to reach national electrification targets as quickly as possible, using least-cost options while targeting areas where the impact of rural electrification on social and economic development is highest.

The strategy should be supported by a concrete 5-year plan which describes the projects to be implemented, indicates the electrification technologies to be used (grid connection, off-grid and source of supply, distributed technologies), presents the implementation plan (role of stakeholders taking into account the planned power sector reforms), provides cost estimates and a tentative financing plan.

For the most important projects from a socio-economic development point of view which are foreseen for off-grid technologies, pre-feasibility studies should be prepared.

8.5 Implementation

In order to fulfil to legal obligation from the Government with delegation to REA, various solutions can be foreseen once the hydro potential assessment is completed:

a) **Update of the existing database and extend the regional planning done through the IREP** for 6 regions to the remaining regions of Tanzania mainland using tools and data already collected.(http://www.irep.rea.go.tz)

REA already got capacity building and adequate tools for building this planning department and even started data collection for more than 16 additional regions.

Capacity building would still be needed focusing on the new REA's planning division and update of the existing regional planning should also be performed in order to take into account the latest grid extensions. (Turnkey)

b) Prepare a new **Rural Electrification Plan and Strategies for Mainland Tanzania** which should comply to the above recommendations including database creation and capacity building for REA and following the requirements specified in the Electricity Act (2008)