Attachment O Materials of International Workshop

BURUNDI Renewable Energy, Current Situation, Opportunities and Challenges

Eng. Aloys NDUGARITSE, MSc
Rural Electrification Using Renewable Energy Meeting
Nairobi 2015, February ,02-06

A favorable geographical location

An economy **in growth**

- Burundi's economy is currently in growth. It wasn't until 2010 that the country returned to
- its pre-war level of GD P per capita (179 USD) and the GD P is growing regularly due to an economic growth rate close to 4 per cent in the last few years.
- Projections show a growth of about 10 per cent over the next years.

Energy Sector

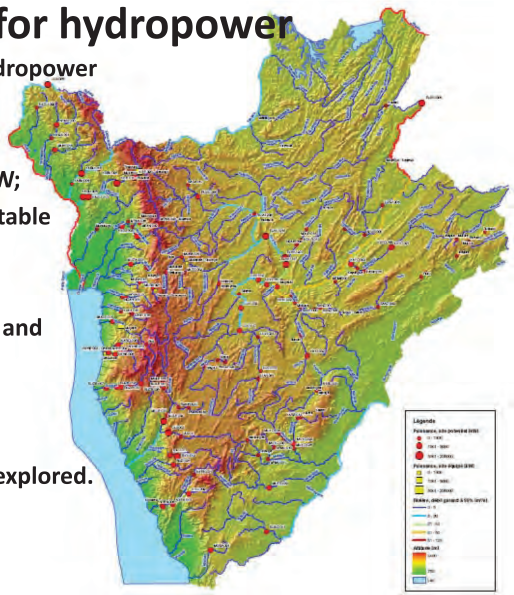
- **B**iomass: 94%
- **E**lectricity:3.5%
- **O**il: 2.5%
- **E**lectricity
- **H**ydro: 80%
- **T**hermal: 20%
- **H**ydro exploitable potential: 300 MW
- **H**ydro install capacity: 32.6 MW
- **T**hermal install capacity: 20.5 MW
- **C**onsumption capacity: 52 MW
- **I**mportation capacity: 15 MW from RDC and SINELAC
- **D**emand capacity: 72 MW
- **D**eficit capacity: 20 MW; Access rate=4.5% (urban); rural =1%

O1-1-1

Attachment O-1-1

Potential for hydropower

- A considerable potential for hydropower
- Potential evaluated at 1,700 MW; 300 MW were economically exploitable
- 156 potential hydropower sites and 29 existing sites .
- Fewer than 30 sites have been explored.



A potential for **solar energy**

- **2000 kWh/m^2/year**
- **Solar energy in Burundi, very interesting option.**
- **Photovoltaic technology**
  Thermal solutions.

- **Rural electrification by solar home systems**
- **Solar pumps**
- **Stand-alone photovoltaic generators**
- **Hybrid photovoltaic plants for remote areas**
- **Grid connected photovoltaic plants**

A **wind power potential ready for assessment**

- **No feasibility studies**
- **The wind power potential of Burundi is less than 4.8 m/s**
- **Favorable conditions at certain sites**
- **Wind power could be developed**

A geothermal potential to be evaluated

- **High-temperature aquifers (from 150 to 350 °C)** by a turbo generator
- **Burundi is located in the Great African Rift Valley**
- **A maximum of approximately 70 °C**

A substantial biomass potential to be evaluated

i. **Urban waste**.

- Electricity **by methanisation (biogaz)**
- **Peat**-based on electricity production
- The use of **sugar cane residues (bagasse)** to produce electricity
- **Methanisation requires the existence of a waste management system**.

ii. **Peat used Energy substitution**

iii. **Bagasse** : **The plant is a 2 x 2 MW** cogeneration unit.

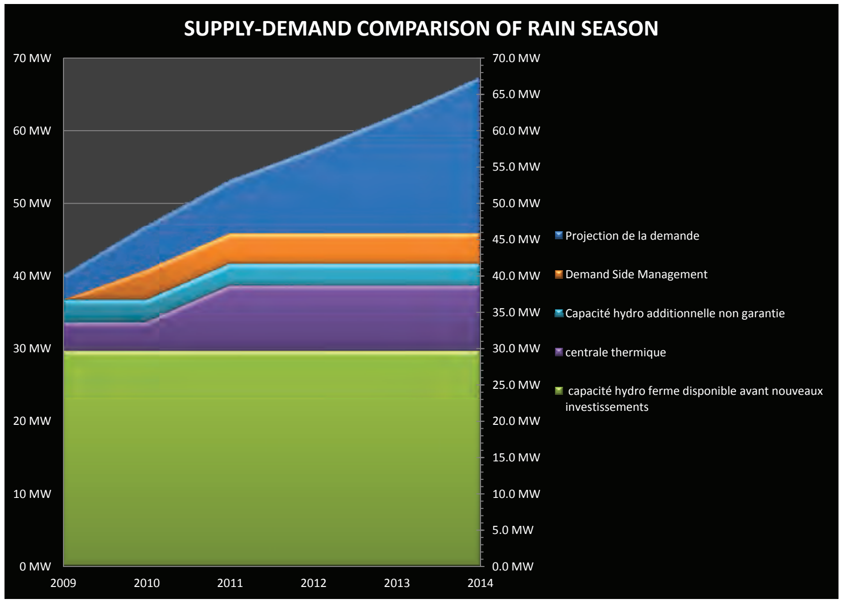
Private investors

- REGIDESO, National Utility.
- ABER, Rural Electrification.
- The new law opens for the state to entrust the provision of public and encourage private investment : IPPs, PPPs, PPAs, BOO (20 MW solar PV in project) to be considered.

- opportunities within the management of Burundi's local electrical infrastructures.

Costs and Tariff affordable

- Lower electricity costs, prices under control
- Due to Burundi's use of hydropower, its electrical production costs are among the lowest in the region.
- According to the World Bank, the average estimated production cost for most of the hydropower plants was approximately 0.04 USD /kWh in 2012,
- while the production costs for thermal power amounted to 0.3 USD/kWh for the plant in Bujumbura and 0.48 USD/kWh for diesel generators.
- The average production costs for the energy mix are consequently estimated at 0.062 USD/kWh for 2012.
- REGIDESO made two important price increases, at the end of 2011 and in March 2012.



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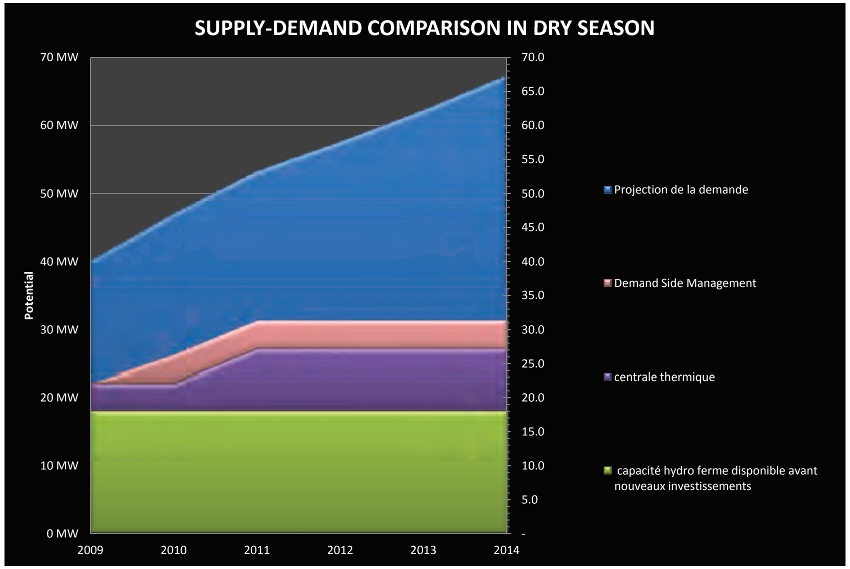
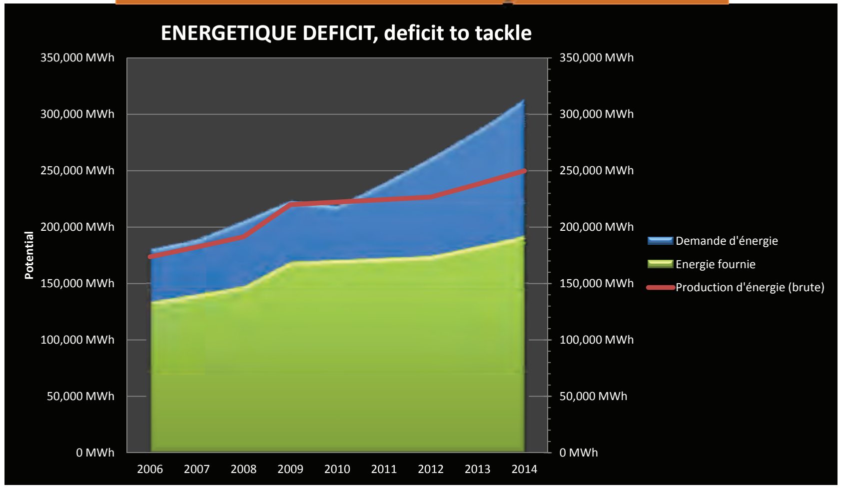
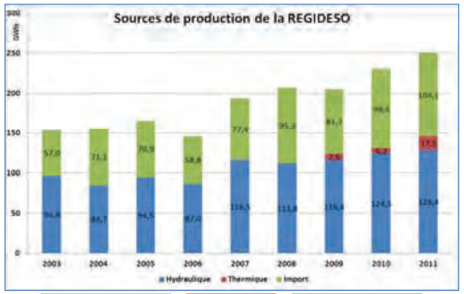


Demand > Offer ➔ Deficit

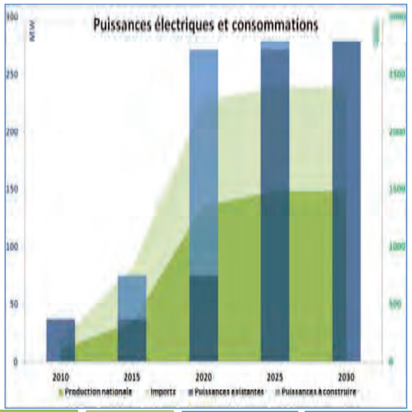


A deficit of 13 MW in rain season and 23 MW in dry season

hydro, thermal, importation



Importation | Thermique | Hydraulique



Production nationale | Imports | Capacité existante | Capacités à mettre en œuvre

Capacités existantes

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An electricity challenge to be faced

❖According to scenarios for economic growth, the energy needs would be approximately 100 MW in 2020, with industrial consumption at today's low levels. However, a number of industrial activities require additional

❖capacity estimated of at least 100 MW. Consequently, the energy demand would likely be of around 250 MW in 2020, excluding the energy needs of the nickel mines, which would need around 280 MW in peak hours.

❖ Furthermore, scenarios project regional integration of grids and substantial reliance on imports.

❖SE4ALL (Sustainable Energy For All) is an initiative launched to encourage stakeholders to make sustainable energy for all a reality by 2030.

Attachment O-1-1

An electricity challenge to be faced(continue

The initiative has three key objectives:

1. Ensure universal access to modern energy services;

2. Double the global rate of improvement in energy efficiency;

3. Double the share of renewable energy in the global energy mix;

SE4ALL funds are available for technical assistance, capacity building, project development and consultations within renewable energy and energy efficiency.

Opportunities

Solar energy

❖Photovoltaic solar energy or small hybrid thermal-photovoltaic power plants are suitable for the electrification of remote centres.

❖To develop the rural electrification of dispersed populations, supplying photovoltaic solar home systems could be a solution.

❖Finally all remote public or private infrastructure (health centre, schools, hotels, telecommunication towers) should be powered by solar energy through an extensive programme for decentralised electrification.

❖These projects could involve private investment and the delegation of public services.

Opportunities(continue)

❖Wind energy

❖The installation of wind turbines connected to the grid could be a solution if the wind conditions are satisfactory.

Geothermal energy

❖The conditions in the Rift Valley region are optimal for geothermal findings; the exploitation of these

❖resources by a geothermal power plant would be an additional asset in the energy mix. Such a project could

❖probably be done in the north-western part of the country, as a regional project carried out with Rwanda
and the Congo.

Opportunities(continue)

Biomass

❖Given that feasibility studies have demonstrated technical, economic, environmental and social viability, the installation of a peat power plant could be achieved relatively quickly.

❖The installation of a production plant based on waste through methanization, could, along with the implementation of a waste management system, become a reality in Bujumbura.

❖A cogeneration power station based on bagasse already exists at SOSUMO and could be improved and connected to the grid.

A favorable legal and regulatory framework

❖A liberalised electricity sector

Burundi has established a legislative and regulatory framework for structuring the energy sector and promoting participation of private investors.

❖Law No. I/014 of 1 August 2000 relates to the liberalization and regulation of the public services of water and electricity.

❖The production, transmission and distribution of electricity are all public services. These public services can be assigned in various ways (including leasing or concession) to public or private entities.

A favorable legal and regulatory framework(continue)

❖ Self-production (including production, transmission and distribution) are permitted for private use after authorizations are obtained.

❖ Creating transmission lines to serve third parties is allowed if public service does not yet exist where such arrangements are proposed.

❖ Self-producers can sell their surplus to public service managers through a price agreement.

❖ Similarly, the use of public transmission lines is possible through a price agreement.

❖The exporting of self-generated energy is allowed.
❖ In remote areas, private production, transmission and distribution is permitted.

A new legal framework favorable to private companies(continue)

❖Burundi's adhesion to the Treaty for the Establishment of the East African Community complies
❖Burundi to modify national laws to ensure the strict application of the rules of the treaty.
❖Burundi now belongs to a regional common market consisting of Kenya, Tanzania, Uganda, Rwanda
and Burundi, that is in favor of commercial trade between member states.
❖ The EAC allows for harmonization of customs tariffs and procedures within the community.

❖The Treaty is preparing the establishment of a common currency.

Legal Framework

❖Law No. 1/23 of 24 September2008 has defined all the tax benefits underway for investors in Burundi.
❖ The Investment Promotion Agency was created by presidential decree No. 1/177 of 19 October 2009.
❖ Its mission is to promote investment and exports, especially to inform, assist and support investors to obtain necessary documents and/or to ensure compliance with formalities required by law.
❖ The Agency also participates in the elaboration of reforms to improve the business climate.
❖ Finally, they advocate towards the public administration in cases of non-application or misapplication of laws
or regulations related to the promotion of investments and exports.
❖ Law No. 1/09 of 30 May 2011 changed the company laws in Burundi.
❖ This law defines the possible structures of companies, their organization and their management.

Legal Framework

❖The law identifies seven types of private companies: civil companies, simple partnerships, limited partnerships, limited liability companies, sole proprietorships, cooperative societies, and business corporations.

❖ In the context of regional integration in the East African Community, the law is under revision in order to harmonize it

❖with the laws of the four other member states.

Thank you for your attention!!

aloysndugaritse@yahoo.fr

A favorable legal and regulatory framework

- A liberalized electricity sector
- Burundi has established a legislative and regulatory framework for structuring the energy sector and promoting participation of private investors.
- Law No. I/014 of 1 August 2000 relates to the liberalization and regulation of the public services of
- water and electricity.
- • The production, transmission and distribution of electricity are all public services. These public services
- can be assigned in various ways (including leasing or concession) to public or private entities.
- • Self-production (including production, transmission and distribution) are permitted for private use after authorizations are obtained.
- • Creating transmission lines to serve third parties is allowed if public service does not yet exist where such arrangements are proposed.
- • Self-producers can sell their surplus to public service managers through a price agreement.
- • Similarly, the use of public transmission lines is possible through a price agreement.
- • The exporting of self-generated energy is allowed.
- • In remote areas, private production, transmission and distribution is permitted.

Legal&Regulatory instruments

- • A control and regulation entity was established by Decree No. 100/320 dated 22 December
- 2011. This entity, called the Control and Regulation Agency for the Water and Electricity Sectors in Burundi, has as main mandate to ensure the development of an orderly and profitable water and electricity sector in Burundi. It should control, regulate and monitor activities related to water and electricity in order to ensure compliance with contract conditions for delegation as well as specifications and additional clauses on the part of operators. It should also ensure the implementation, monitoring and application of tariffs in accordance with the pricing principles that have been established by regulation.

- • A rural electrification agency was established by Decree No. 100/318 dated 22 December 2011. The objective of this entity, called the Burundian Agency for Rural Electrification (ABER), is to develop and implement rural electrification projects and programmes, including small-scale hydropower, solar and wind energy, as well as other forms of energy that can improve electricity access for the rural population. The entity is currently under establishment.

. Decrees to promote self-production and re-sales of surpluses to the national distributor are being developed.

- • A law on PPP (Public Private Partnership) has been proposed by the government to the parliament and will soon be adopted. This law includes specific actions under the term called IPP (Independent Power Producer).

A new legal framework favorable to private companies

- Burundi made major reforms in 2011 to improve its business climate. Procedures for creating a business and obtaining construction permits have been substantially simplified, and measures to ensure better protection of investors have been adopted. Efforts carried out in 2012 to improve the business climate include seven indicators: creation of an enterprise, obtaining construction permits, access to electricity, transfer of property, paying taxes, cross border trading and resolving insolvency. These indicators are materialised through the simplification and significant reduction of costs, time and number of procedures.

- • Burundi's adhesion to the Treaty for the Establishment of the East African Community complies
- Burundi to modify national laws to ensure the strict application of the rules of the treaty. Burundi
- now belongs to a regional common market consisting of Kenya, Tanzania, Uganda, Rwanda
- and Burundi, that is in favor of commercial trade between member states. The EAC allows for
- harmonization of customs tariffs and procedures within the community. The Treaty is preparing the
- establishment of a common currency.

Legal Framework

- Law No. 1/24 dated 10 September 2008 has created a new investment code in Burundi with
- special provisions conducive to foreign investment.
- • The new Investment Code introduces the possibility of using international arbitration in order
- to resolve disputes between the government and investors. Section 13 of the Investment Code
- prohibits the nationalization and expropriation of investments or any measure of equivalent effect. In
- exceptional cases of expropriation for the public interest, the code guarantees investors a procedure
- that is in accordance with law and that is accompanied by fair ex ante compensation and appeal, and
- if necessary, to litigation and internal or international institutional arbitration.
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aloysndugaritse@yahoo.fr

RURAL ELECTRIFICATION USING RENEWABLE ENERGY

FEBRUARY 2, 2015

NAIROBI, KENYA

- Content
  1. Overview
     - Facts In Brief
     - Power Sector In Ethiopia
     - Renewable Energy Potential
  2. Current Situation
     - The Existing Power System
     - Under Construction
     - Generation Plan
     - Infrastructure development Vs Demand growth
  3. National Energy policy
  4. Technical Problem
  5. References

O1-2-1

Overview

Brief Facts about Ethiopia

- Ethiopia -landlocked country in the Horn of Africa.
- Total area -1.13 million square km.
- Population -87.9 million (2.57% growth per annum).
- GDP at market value ~ 30 Billion USD (11% growth per annum)

Attachment O-1-2

Overview Cont….

❖ Power Sector in Ethiopia

- There are two organs providing Electric Power Delivery Service . These are EEP and EEU.
- Ethiopian Electric Power (EEP): is engaged in the generation and transmission of electricity throughout Ethiopia.
- Ethiopian Electric Utility (EEU): is engaged in the distribution and sales of electricity in the country.
- Both are owned by the Government of Ethiopia (GOE) and are organized under the Ministry of Water, Irrigation and Energy (MOWIE) and are under the supervision of a common Management Board.

Overview Cont….

❖ Renewable Energy Potential

Hydropower

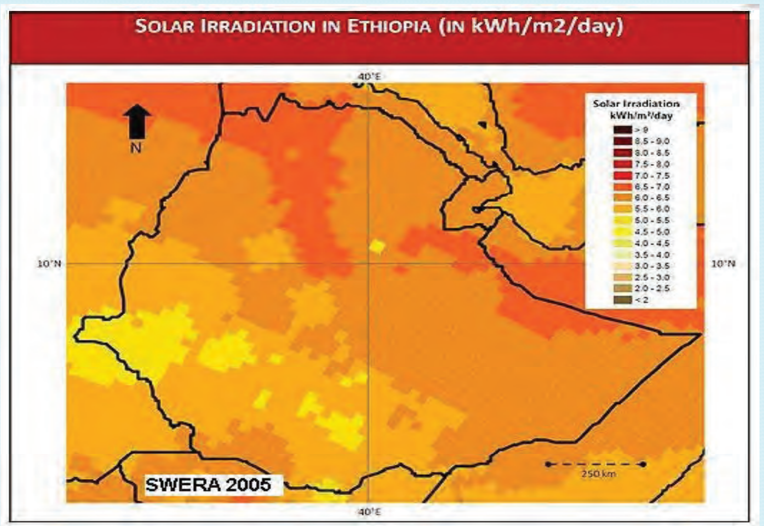
- Hydropower potential is estimated up to 45,000MW which is the 2nd highest in Africa.
- Ethiopia's terrain is advantageous for hydropower projects with 10 river basins, with adequate rainfall and is said to be the "Water Tower of Eastern Africa".
- Only 1,954MW of energy is exploited yet, which is not more than 4% of its potential.

Solar Energy

- Ethiopia receives a solar irradiation of 5000 – 7000 Wh/m² according to region and season and thus has great potential for the use of solar energy
- The average solar radiation is more or less uniform, around 5.2 kWh/m2/day.
- The values vary seasonally, from 4.55-5.55 kWh/m2/day and with location from 4.25 kWh/m2/day in the extreme western lowlands to 6.25 kWh/m2/day

Overview Cont..

Solar Energy Cont…



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Overview Cont…

Solar Energy cont…

- There is no solar power plant which feed the national grid yet in Ethiopia.
- UN organizations such as UNICEF and WHO are few examples that had supported projects that use PV based technologies (distance-education radios and vaccine fridges) in remote rural areas.
- **Ethiopian Telecommunications (Ethio. Telecom)** is the major user of PV solar in the country. uses PV solar to power its remote rural telecom installations and this application has grown several times in recent years.
- above 70,000 SHSs are disseminated in the country by the government and other organization.
- Installed capacity is approximately 7 MW with a majority in the **solar home system (SHS)**.

Attachment O-1-2

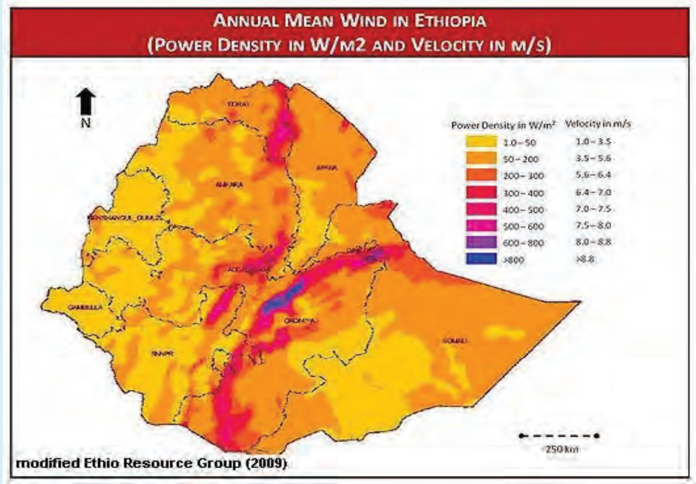
Overview Cont…

Wind Energy

- Ethiopia has good wind resources with velocities greater than 7 m/s.
- Its wind energy potential is estimated to be 1,350 GW.
- Wind energy is considered a promising complementation to hydropower, since the two resources unfold their potential anti-cyclic:-
  - in rainy seasons the hydropower potential is high whereas low winds prevail and
  - hydropower potential is low in the dry season whereas the wind potential is high.
- Only 171MW of energy is exploited yet which is insignificant compared to the countries potential.

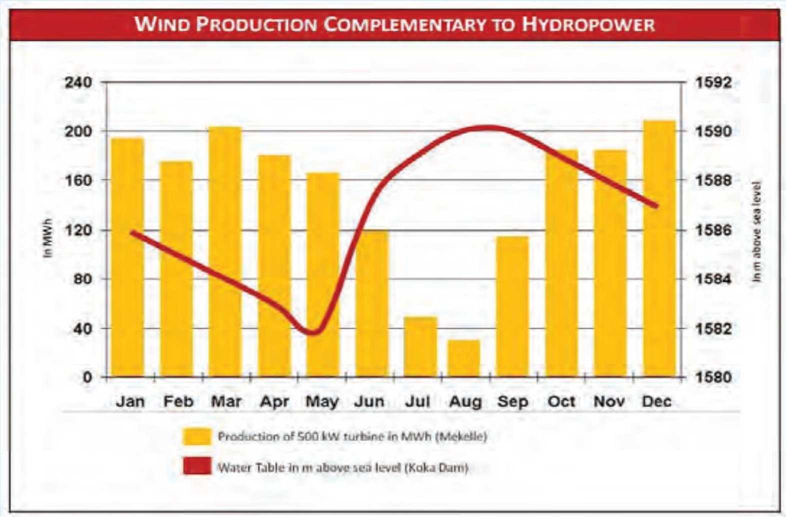
Overview Cont…

Wind Energy Cont…



Overview Cont…

Wind Energy Cont…



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Overview Cont…

Geothermal Energy

- Ethiopia has geothermal energy potential up to 10,000MW.
- Geothermal resources are primarily located in the Rift Valley area, where temperatures of 50 to 300°C prevail in a depth of 1,300 – 2,500 m.
- Only one 7.3 MW geothermal power plant has been commissioned so far, which started operating in 1998/1999 and still zero compared to the potential.

Attachment O-1-2

Overview Cont…

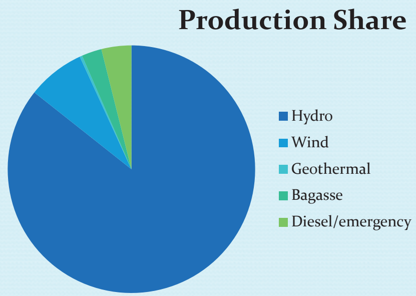
Biomass Energy

- According to estimates by **Woody Biomass Inventory and Strategic Planning Project (WBISPP)**, national woody biomass stock was 1,149 million tons with annual yield of 50 million tons in the year 2000. These figures exclude biomass fuels such as **branches/leaves/twigs (BLT)**, dead wood and homestead tree yields.
- Up to date, no grid-connected biomass power plants exist.
- But two sugar factories have however been using sugar cane bagasse for station supply and fed the surplus to the grid.
- The government implement around 8,013 Biogas plant for rural community at their vicinity within the 1st GTP Plan.
- In the next GTP period 20,000 biogas plant is planned.

Current Situation In Utilization of Renewable Energy

1) THE EXISTING POWER SYSTEM

- Grid accessible to 53 % of the population
- 2 million households connected to electricity
- Per capita electricity consumption 77 kWh/year
- System installed capacity ~ 2280 MW
- Hydropower (86%)
- Wind and Geothermal (7.5%)
- Bagasse (2.6%)
- Diesel stand by (3.9%)
- Thus considering stand by diesel, the Renewable Energy Share will be more than 96% . Otherwise 100% of the total utilization is RE.



Current Situation In Utilization of Renewable Energy Cont….

Existing Generation Installed Capacity…..

No.	Power Plants	Installed Capacity (MW)	Dependable Capacity (MW)	Average Energy (GWh)
1	Tis Abay I	11.3	0	2
2	Tis Abay II	73	0	10
3	Beles	460	460	2756
4	Koka	43.2	18.7	134
5	Awash II	32	12	185
6	Awash III	32	24	185
7	Finchaa including IVth Unit	134	128	617
8	Melka Wakena	153	114.5	557
9	Finchaa Amerti Neshe	98	98	246
10	Gilgel Gibe-I	192	184	885
11	Gelgel Gibe 2	420	420	2037
12	Tekeze	300	300	1404
13	Sor	5		
Hydro Total		**1953.5**	**1759.2**	**9018**

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Current Situation In Utilization of Renewable Energy Cont…

Existing Generation Installed Capacity……

No.	Power Plants	Installed Capacity (MW)	Dependable Capacity (MW)	Average Energy (GWh)
1	Aluto Langano	7.3	5	20
Geothermal Total		**7.3**	**5**	**20**
1	Adama I	51	17.85	156.4
2	Ashegoda	120	30	262.8
Wind Total		**171**	**47.85**	**419.2**
1	Wonji Sugar	30	16	77
2	Finchaa Sugar	30	10	48
Bagas Total		**60**	**26**	**125**
1	Awash 7kilo Diesel	35	0	0
2	Kaliti I Diesel (Containerized)	14	0	0
3	Dire Dawa Diesel	40	0	0
Emergency Diesel Total		**89**	**0**	**0**
Grand Total		***2280.8***	***1838.05***	***9582.2***

Attachment O-1-2

Current Situation In Utilization of Renewable Energy Cont…
Universal Electricity Access Status & Plan

State Government	Number or Planed Villages at the end of GTP -1	Access due to GTP-1 Accomplishment	GTP-2 Plan
Afar	228	75%	147
Amhara	2651	75%	1712
Benishanguls	231	75%	149
Diredawa	26	75%	16
Gambela	128	75%	83
Harari	19	75%	17
Oromia	3871	75%	2499
Somali	368	75%	238
SNNPR	2004	75%	1294
Tigray	636	75%	411
Total	10162	75%	6565

Current Situation In Utilization of Renewable Energy Cont…
Universal Electricity Access Status & Plan

- Achievement
  - More than 4,300 towns and villages are electrified at the end of 4th year of the GTP plan which leads the national electric access to 54%
  - Currently more than 3,000 towns and villages are on active construction stage.
- Growth and Transformation phase 2 Objectives.
  - 6565 villages and towns are planed during GTP -2 which leads the national electric access to 95%.
  - Having 16,727 villages and towns will leads the country electric access to 95%.

Universal Electricity Access Program
Micro enterprise participation on Concrete pole Production.

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UNDER CONSTRUCTION PROJECTS

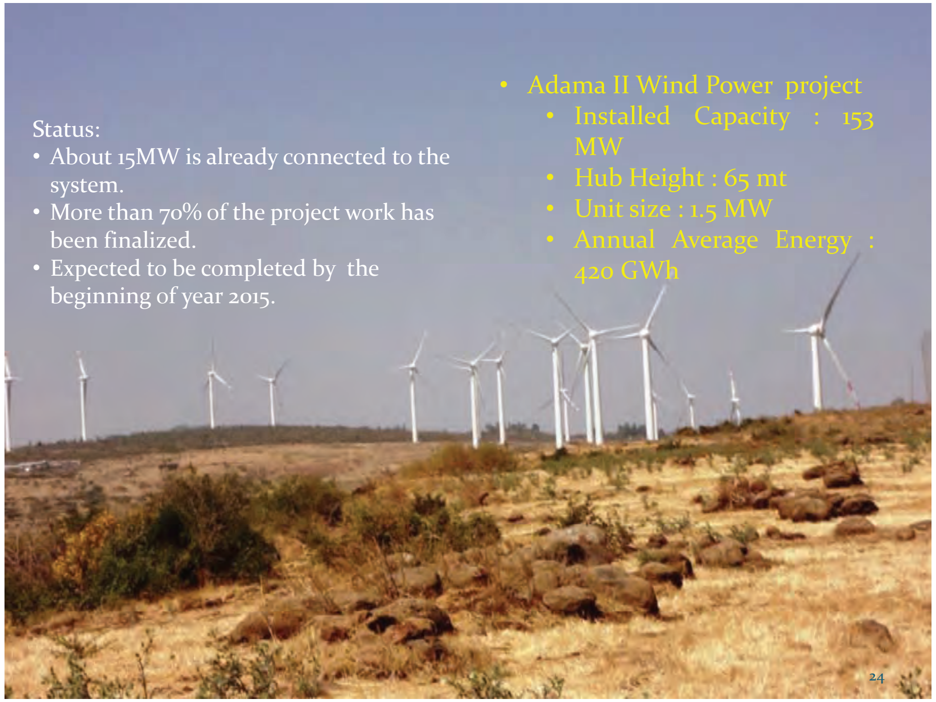
Attachment O-1-2

Genale Dawa III Hydro Power Project

Status:
- Currently 60% of the construction has been completed.
- The plant is expected to be completed at the beginning of year 2016.

Main features of the Project are

- Installed Power : 254MW
- Energy Production : 1695GWh
- 3 Francis units with 100MVA capacity
- Roller Compacted Concrete Dam with height of 110 m
- Reservoir Volume : 3.3 Billion Cubic Meter



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Attachment O-1-2

Generation Plan

Year	Cumilativel Plant (from Candidates)											Year
	Geothermal MW	Wind MW	Solar PV 300 MW	GT (gas) MW	CCGT (gas) MW	Diesels MW	WtE	Cogeneration	Biomass	Hydro	Total	
2012	0	0	0	0	0	0					0	2012
2013	0	0	0	0	0	0	0	0	0	0	0	2013
2014	7	171	0	0	0	112	0	16	0	1978	2284	2014
2015	7	324	0	0	0	112	0	146	0	1978	2567	2015
2016	7	624	300	0	0	112	50	328	60	4852	6333	2016
2017	7	924	300	0	0	112	50	408	120	4857	6778	2017
2018	277	1224	300	0	0	182	50	408	120	10107	12668	2018
2019	377	1224	300	0	0	532	50	448	120	10107	13158	2019
2020	577	1224	300	0	0	532	50	448	120	12521	15772	2020
2021	777	1224	300	0	0	532	50	448	120	14121	17572	2021
2022	877	1224	300	0	0	532	50	448	120	15056	18607	2022
2023	877	1224	300	0	0	532	50	448	120	17720	21271	2023
2024	877	1224	300	0	0	532	50	448	120	18944	22495	2024
2025	977	1224	300	140	420	532	50	448	120	18944	23155	2025
2026	1477	1224	300	140	420	532	50	448	120	18944	23655	2026
2027	1477	1224	300	140	420	532	50	448	120	18944	23655	2027
2028	2077	1224	300	140	420	532	50	448	120	18944	24255	2028
2029	2377	1224	300	280	840	532	50	448	120	18944	25115	2029
2030	2577	1224	300	280	1680	532	50	448	120	18944	26155	2030
2031	2877	1224	300	560	1680	532	50	448	120	18944	26735	2031
2032	3177	1824	300	560	2100	532	50	448	120	18944	28055	2032
2033	3477	1824	300	560	2520	532	50	448	120	18944	28775	2033
2034	3877	1824	300	560	2520	532	50	448	120	19944	30175	2034
2035	4277	1824	300	560	2940	532	50	448	120	19944	30995	2035
2036	4677	1824	300	700	2940	532	50	448	120	19944	31535	2036
2037	5077	1824	300	700	3360	532	50	448	120	19944	32355	2037

O1-2-7

Long term Generation Plan- Hydro

Name of Plant	Installed Capacity MW	Minimum Energy GWh	Average Energy GWh	Average Plant Factor	Total Cost million $	Planned Com. Date
Sor 2	5	42	39	0.88	22.3	2017
Geba 1 + Geba 2	372	1156	1709	0.53	772.1	2020
Genale 6	246	1388	1532	0.71	793.7	2020
Gibe IV	1472	4272	6146	0.48	3364.8	2020
Upper Dabus	326	1459	1460	0.51	848.1	2020
Karadobi	1600	6549	7857	0.56	3477.5	2021
Tams	1700	5296	5760	0.39	3241	2021
Beko Abo	935	6175	6632	0.81	1702.1	2022
Upper Mendaya	1700	7235	8582	0.58	3289.1	2023
Birbir R	467	2236	2724	0.67	1600.4	2023
Werabesa + Halele	436	1193	1973	0.52	1196.1	2024
Yeda 1 + Yeda 2	280	915	1089	0.44	729.2	2024
Baro 1 + Baro 2 + Genji	859	3150	3524	0.47	1793.6	2024
Genale 5	100	531	575	0.66	387.1	2025
Gibe V	660	1311	1905	0.33	1348	2025
Lower Didessa	550	811	976	0.2	804.9	2034
Tekeze II	450	2060	2721	0.69	2282	2034

Attachment O-1-2

Generation Plan- Geothermal

Year	Installed candidates (No / MW)		Size in year (MW)	Plant Location	EEPCO Region	MW
2018	2	200	200	Corbetti	SOUTHERN	200
2019	3	300	100	Corbetti	SOUTHERN	100
2020	5	500	200	Corbetti	SOUTHERN	200
2021	7	700	200	Aluto Langano	SOUTH EASTERN	200
2022	9	900	200	Tendaho	SEMERA	200
2023	9	900				
2024	9	900				
2025	12	1200	300	Tendaho	SEMERA	100
				Abaya	SOUTHERN	200
2026	16	1600	400	Tendaho	SEMERA	200
				Abaya	SOUTHERN	100
				Tulu Moye	SOUTH EASTERN	100
2027	16	1600				
2028	21	2100	500	Dofan Fantele	SEMERA	100
				Tulu Moye	SOUTH EASTERN	200
				Gedemsa	SOUTH EASTERN	200
2029	23	2300	200	Tendaho	SEMERA	200
2030	25	2500	200	Teo	SEMERA	200
2031	28	2800	300	Corbetti	SOUTHERN	300
2032	31	3100	300	Teo	SEMERA	100
				Gedemsa	SOUTH EASTERN	200
2033	34	3400	300	Aluto Langano	SOUTH EASTERN	200
				Dofan Fantele	SEMERA	100
2034	37	3700	300	Tulu Moye	SOUTH EASTERN	200
				Dofan Fantele	SEMERA	100
2035	42	4200	500	Corbetti	SOUTHERN	300
				Dofan Fantele	SEMERA	100
				Dallol	NORTHERN	100
2036	46	4600	400	Dallol	NORTHERN	100
				Teo	SEMERA	300
2037	50	5000	400	Teo	SEMERA	100
				Abhe	SEMERA	300
Totals			5000			5000
				Summary		
				Abaya	SOUTHERN	300
				Abhe	SEMERA	300
				Aluto Langano	SOUTH EASTERN	400
				Corbetti	SOUTHERN	1100
				Dallol	NORTHERN	200
				Dofan Fantele	SEMERA	400
				Gedemsa	SOUTH EASTERN	400
				Tendaho	SEMERA	700
				Teo	SEMERA	700
				Tulu Moye	SOUTH EASTERN	500
Plan IHLW84F4						5000

Generation Plan- Wind

Year	Installed candidate plant (No / MW)		Plant Location	EEPCO Region	Size of Plant (MW)
2016	1	300	Aysha area	EASTERN	300
2017	2	600	Assela area	SOUTH EASTERN	300
2018	3	900	Waldiya area	SEMERA	300
2019	3	900			
2020	3	900			
2021	3	900			
2022	3	900			
2023	3	900			
2024	3	900			
2025	3	900			
2026	3	900			
2027	3	900			
2028	3	900			
2029	3	900			
2030	4	1200	Aysha area	EASTERN	300
2031	4	1200			
2032	5	1500	Debre Birhan area	EASTERN A.A	300
2033	5	1500			
2034	5	1500			
2035	5	1500			
2036	5	1500			
2037	5	1500			
				Total	1500
			Summary		
			Waldiya area	NORTHERN	300
			Aysha area	EASTERN	600
			Debre Birhan area	EASTERN A.A	300
			Assela area	SOUTH EASTERN	300
			Adama area	SOUTH EASTERN	
Plan IHLW84F4					1500

Generation Plan- Solar

Year	Total candidate plant - MW	Total size (MW)	Plant Location	EEPCO Region	Size of Plant (MW)
2016	300	300	Semera area	SEMERA	100
			Hurso area	EASTERN	100
			Awash 7 Kilo area	SEMERA	100

Biomass Plants

Sugar (Bagasse) Plants

Name	Month	Year	Installed Capacity(MW)	Export Capacity(MW)	Export Energy(GWh)
Tendaho	5	2015	120	70	337
Beles 1	1	2015	30	20	96
Beles 2	1	2015	30	20	96
Beles 3	11	2016	30	20	96
Wolkayit	11	2016	133	82	395
Omo Kuraz 1	1	2015	60	20	96
Omo Kuraz 2	1	2016	60	40	193
Omo Kuraz 3	1	2016	60	40	193
Omo Kuraz 4	1	2017	60	40	193
Omo Kuraz 5	1	2017	60	40	193
Omo Kuraz 6	1	2019	60	40	193
Kessem	11	2014	26	16	77

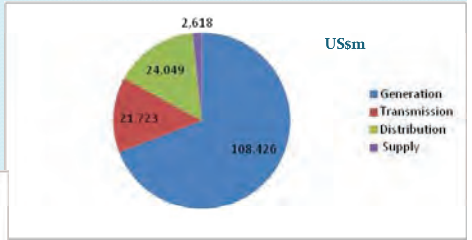
Woody Biomass Plants

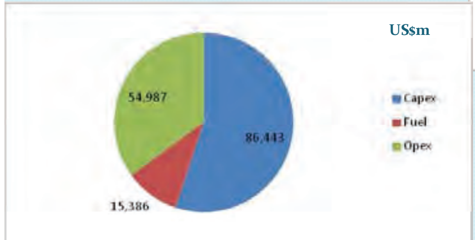
Name	Month	Year	Installed Capacity (MW)	Dependable Capacity (MW)	Energy (GWh)
Bamza	6	2016	120	60	289
Melkasadi	1	2016	137	60	32

Cost of Expansion Plan

- Total cost US$156bn over 25 years

Cost allocation:





Infrastructure development Vs Demand growth

Customer Categories

Ethiopia Electricity Demand Forecast

- Power Requiring
  1. New railway developments
  2. Large new irrigation developments
  3. New Industrial Developments
  4. Dwelling Houses Projects and Universal Electrification Program
  5. Service Sector
  6. Electricity Export

O1-2-9

Ethiopia Electricity Demand Forecast

1. Railway Demand Forecast

	Freight Rail Traffic (Kton)			Passenger Rail Numbers		
	Export	Import	Total	Domestic	Internationa	Total
2015	799	6 421	7 220	214 128	32 119	246 247
2020	1 538	11 316	12 855	344 745	57 712	396 457
2025	2 711	18 225	20 936	555 040	83 256	638 296
2030	4 778	29 352	34 130	893 615	134 042	1 027 657
2035	7 695	47 271	54 966	1 438 721	215 808	1 654 529

- Passenger and freight numbers for Addis Dewele route
- Passenger and freight numbers other planned routes

	Rail freight (kton)	Passenger numbers
2017	1 500	42 826
2022	3 150	103 424
2027	6 615	222 016
2032	13 892	446 808
2037	29 172	863 233

Attachment O-1-2

Total Railway Sales

Ethiopia Electricity Demand Forecast

Year	Sales (GWh)	Gen. (GWh)	Peak (MW)
2015	404	513	97
2016	633	783	147
2017	938	1131	211
2018	1062	1247	233
2019	1185	1374	256
202 0	1477	1711	319

Ethiopia Electricity Demand Forecast

2. Large new irrigation developments taking place

Region	Hectar Value	
	GTP1	After GTP1
SNNP	120,500	60,000
BENShangul	64,000	64,000
Gambela	1,510	107,304
Oromia	7,240	821,750
Somalia	60,000	918,250
Afar	40000	540,000
Tigray	16,000	18,000
Amhara	74,000	91,000
	383,250.0	2,620,304

Total Irrigation Sales

Ethiopia Electricity Demand Forecast

Year	Sales (GWh)	Generation (GWh)	Peak (MW)
2015	490	623	197
2016	879	1088	352
2017	1268	1528	496
2018	1662	1953	635
2019	2315	2685	875
2020	2967	3438	1123

O1-2-10

Ethiopia Electricity Demand Forecast

3. New Industrial Development in Ethiopia

- Programme driven by government establish industrial zones:
  - Industrial parks during Growth and Transformation Plan period planned at 1,130MW
  - After the GTP period Industrial park development planned at 1,200MW
- Applications for new industrial developments received:
  - Cement Factories 652 MW
  - Steel & Metals 741 MW
  - General industry 557 MW
  - Mining 100 MW
- Total Industrial installed capacity 4296 MW

Attachment O-1-2

Ethiopia Electricity Demand Forecast

Year	Sales (GWh)	Generation (GWh)	Peak (MW)
2013	2491	3244	447
2015	5758	7326	1007
2016	8178	10121	1390
2017	11185	13476	1849
2018	14094	16562	2271
2019	16261	18864	2586
2020	17916	20761	2845

Ethiopia Electricity Demand Forecast

Year	Sales (GWh)	Generation (GWh)	Peak (MW)
2013	1350	1758	304
2015	1736	2209	381
2016	1928	2386	410
2017	2143	2582	443
2018	2383	2800	480
2019	2646	3070	525
2020	2937	3403	582

Ethiopia Electricity Demand Forecast

Year	Sales (GWh)			Generation (GWh)	Peak (MW)
	Existing	UEAP	Total		
2013	2192	206	2398	3122	753
2015	2512	605	3118	3966	975
2016	2648	821	3469	4294	1000
2017	2761	1051	3813	4594	1139
2018	2853	1300	4153	4880	1216
2019	2926	1556	4482	5200	1302
2020	2982	1845	4827	5593	1410

Ethiopia Electricity Demand Forecast

- Export of power to Djibouti (60 MW) and Sudan (100 MW) has already begin
- Power Purchase Agreement with Kenya is signed and a 2000 MW transmission interconnection line is already under Construction.
- Power Purchase Agreement with Tanzania is going on for a 400MW Power Trade between the two countries.
- MOU for electricity sales to South Sudan, Yemen and Rwanda has already been signed.
- The power trade feasibility study between Ethiopia, Sudan and Egypt has been made and recommended a 3200MW transmission line.
- Burundi has expressed interest to import power from Ethiopia

Ethiopia Electricity Demand Forecast

Year	Total Energy GWh	Total Capacity MW
2015	2759	315
2016	2759	315
2017	8366	955
2018	8366	955
2019	9680	1105
2020	12075	1378

Ethiopia Electricity Demand Forecast

Maximum Demand (MW)

Year	Internal Demand (MW)	Export Demand (MW)	Total with Export (MW)
2015	2641	315	2956
2016	3335	315	3650
2017	4107	955	5062
2018	4795	955	5750
2019	5496	1105	6601
2020	6219	1378	7598

Energy (GWh)

Year	Internal Demand (GWh)	Export Demand (GWh)	Total with Export (GWh)
2015	14688	2759	17447
2016	18723	2759	21482
2017	23363	8366	31729
2018	27496	8366	35862
2019	31249	9680	40929
2020	34966	12075	47041

National Energy Policy

Energy Policy

The National Energy Policy

- Ensure a gradual shift from traditional energy to modern energy
- Ensure reliable supply of energy at affordable prices
- Streamline the development and utilization of energy resources
- Give priority to indigenous energy resources to attain self-sufficiency
- Increase energy efficiency
- Ensure environmental sustainability

Energy Policy

How to develop the energy sector

- Electric Power Generation Construction Programme
- Electricity transmission lines construction Programme
- Power Distribution and Expansion Programme
- Universal Electrification Access Programme (grid-based)
- Off-grid Rural Electrification
- National energy regulatory system for electricity and energy efficiency
- Alternative energy development and promotion
- Capacity building

Energy Policy

Main Energy Policy Goal

- The main energy policy goal is to ensure the availability, accessibility, affordability, safety and reliability of energy services to support accelerated and sustainable social and economic development and transformation of the country.

Electricity Related Energy Policy Objectives include:

Policy Objective 1 – Provide adequate, reliable and affordable electricity supply to meet growing power demand for socio-economic development

Policy Instruments include:

- **Diversify energy generation mix** based on cost, efficiency, environmental considerations, appropriate technologies and competitiveness.
- **Encourage independent power producers**, small-scale private power producers and co-generators through creative incentive mechanisms.
- **Support local manufacturing of power generation, transmission and distribution equipment and materials.**

Energy Policy

Policy Objective 2 – Increase access to electricity services

Policy Instruments

- Expand grid-based Universal Electricity Access Program through public investment.
- Expand off-grid power supply to rural areas through creating incentive mechanisms to attract private investment.
- Design and implement appropriate support mechanisms to electricity contractors, small and micro enterprises (SMEs) and end-users to increase connectivity.
- Encourage the use of renewable energy for off-grid electricity supply

Energy Policy

Policy Objective 3 – Ensure continuous improvements in electric power efficiency and conservation

Policy Instruments Include:

- Introduce regulation and standards
- strengthen appropriate institutional capacity to implement energy efficiency and conservation measures.
- Promote electricity supply efficiency and conservation through effective support of training programs, information dissemination and continuous communication.

Energy Policy

Policy Objective 4 – Improve power sector governance

Policy Instruments
- Improve the government's capacity to institutionalize strong and efficient power system management structure and governance processes.
- Clarify the roles and functions of electric power governance institutions.
- Ensure accountability and transparency of operations of the institutions.
- Improve managerial and technical capacity of utilities.
- Establish and implement suitable electric power sector information, statistical and database system.

Energy Policy

Policy Objective 5 – Strengthen environmental and safety management practices

Policy Instruments
- Enforce environmental rules and regulations that reduce environmental pollution during power generation and transmission.
- Enact and enforce internationally acceptable safety standards.
- Integrate environmental and social impact assessment in all power system investment projects and environmental audits.
- Minimize siltation and deterioration of reservoirs of existing and new hydropower dam catchment areas through soil and watershed management practices.
- Maximize the use of financing facilities which encourage investments in renewable energy technologies.

Technical Problem.

Technical Problem

1. System energy loss which is more than 10%.
2. Solar equipment quality control.
3. Increase Energy efficiency and decrease Energy waste.
4. Access Road (Specially for construction of Biogas plant and connection to national grid)
5. Facilitating for proper and sustained mechanisms for data collection, analysis and knowledge management to establish the feasibility and market potentials of different RE applications.
6. •High investment cost of the biogas plant (increase in the price of construction materials)
7. • Inadequate promotion of the program
8. • Lack of credit service for biogas program

References

- Facts and Brief (Ethiopia Electric Power Corporation 2012/13)
- Ethiopia Electric Power Strategic planning and management.
- Federal Democratic Republic of Ethiopia Central Statistical Agency (August, 2013 Report).
- The Ethiopian Energy Policy .
- Energy Situation In Ethiopia.

REPUBLIC OF RWANDA

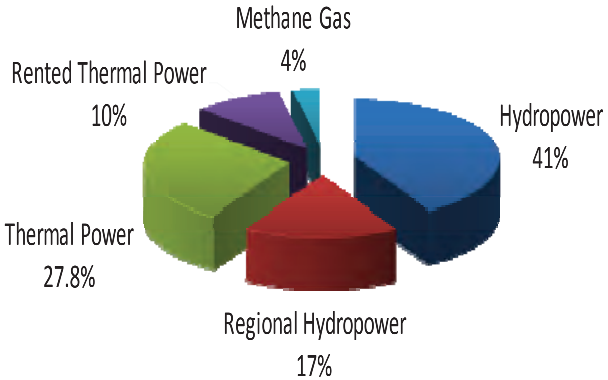
International Workshop on “RURAL ELECTRIFICATION USING RENEWABLE ENERGY”
2nd to 6th February, Nairobi.

By: Blaise MUNYEMANA MININFRA-Rwanda

Presentation Outline

- *Current situation*
- *Policy and Legal framework*
- *Technical Challenges*
- *Problems to be Solved*
- *Way forward*

Current Status



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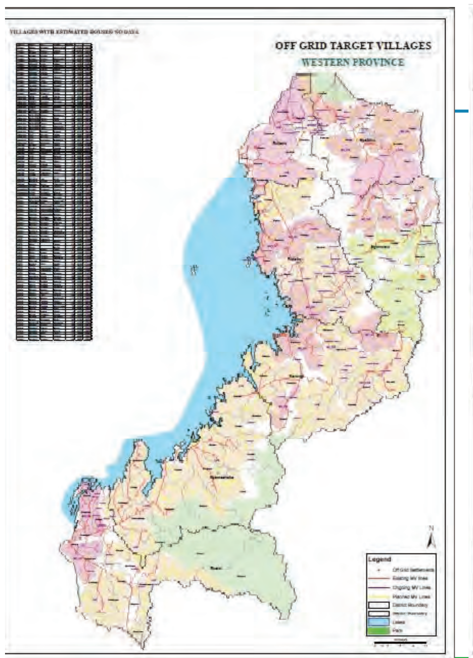
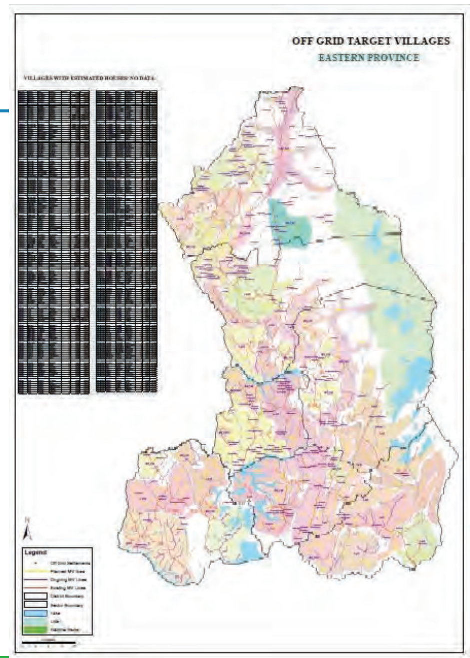
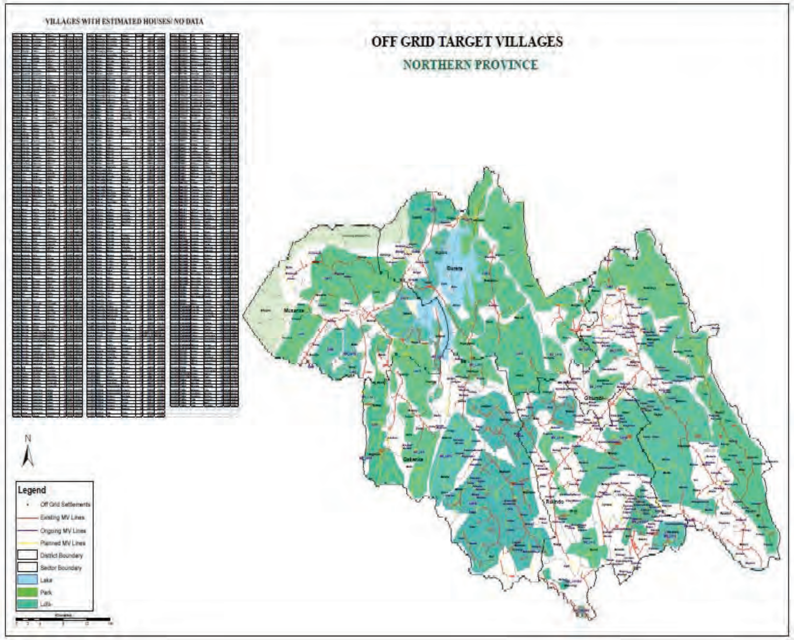
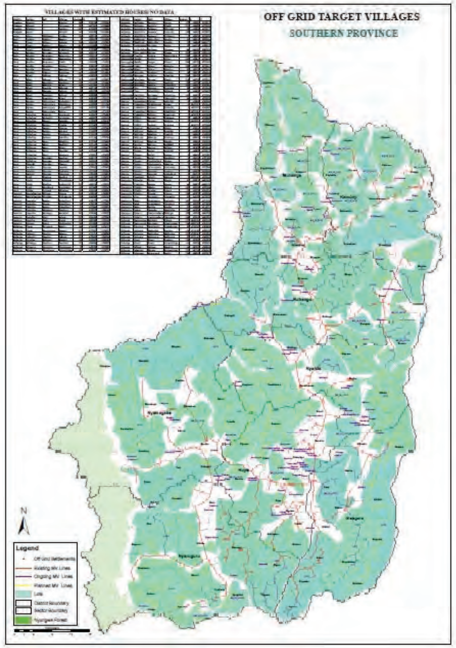




Attachment O-1-3





CURRENT SITUATION OF RURAL ELECTRIFICATION USING RENEWABLE ENERGY IN RWANDA

Objective 1: 100% access to electricity

Diversify our approach to delivering electricity access to include:

1. The option of off-grid solar and mini hydros for our rural population
2. Support for private sector development of mini-grids powered by Pico-hydro and Agri-waste

In addition to extending the grid throughout the country

Off-grid Electrification and Generation

Incentives:

- Recent tender for 20-30 micro-grids shows GoR commitment
- Results based financing for off-grid micro-hydro and solar launch in September 2014
- Simplified Licensing for Rural Electrification in existence and being reviewed

Way forward:

- Develop National Off-grid strategy
- Undertake pre-feasibility studies

Above policies will drive resettlement:

- Mini -grids along with the Biogas digesters program will help drive resettlement.
- Demonstrating they are aligned with a districts resettlement master plan will be a pre-condition of funding

- The EARP programme and resettlement plans will be aligned

Policy options presented:	$
Total	**637m**
100% electricity access	*612m*
*Disseminate **100,000** Digesters*	*19.7m*
Deliver 25 Micro Grids	*5.2m*

O1-3-2

CURRENT SITUATION

Hydro Power

Value of projects: Over USD 350m

Incentives:

- Over 333 Micro Hydropower sites have been identified
- Feasibility studies complete for over 49 sites
- REFIT Feed in tariff (from 50kW to 10MW)
- Standard PPA for small sites

Way Forward:

- Projects with feasibility studies to undergo competitive process on a periodic basis

Sample Opportunity: **Hydro Power Rollout Program**

Value of projects: USD 173m

Incentives:

- 10 hydropower sites with total installed capacity of 50MW
- 1 brown field ($22m), 9 green field ($160m) and 2 separate Dams at Rukarara ($13m)
- On green sites: 8 pre-feasibility studies complete, 4 further studies on-going.

Way forward:

- Competitive process for PPA.

Attachment O-1-3

Electricity Access for all: Possible Access solutions

Grid Access: Available to only around 22% of the population.

Cost: $470 / connection

Benefits: Will supply reliable high-voltage electricity required for heavy commercial and agricultural usage

Challenges: High levels of consumption required to recoup the government investment in the connection (circa 80 KWh / month)

Solar PV system: Can be installed anywhere in the country

Cost:

- Basic system - $80 (will power 2-lights and charge phone)
- Top of the range: $200 (includes remote switches, could also power a TV)

Benefits: Can be installed quickly anywhere;

Challenges: Unable to provide the power required for some economic uses for example refrigeration.

Mini-Grids: Small grids connecting multiple households to one generation source, typically hydro

Cost: $400-$800 / connection

Benefits: Can supply higher voltage power than home PV systems away from the Grid

Challenges: Costly to develop; require local maintenance and operation

OFF-GRID SOLAR ELECTRIFICATION PROJECTS:

IREAPPP 300 SCHOOLS SOLAR ELECTRIFICATION: 0.52 MW Supply and installation of photovoltaic solar PV equipment in 300 rural schools in 28 districts under the European Development fund. All of them have been fully completed and operational.

SOLAR PV IN 35 SECONDARY SCHOOLS IN 4 DISTRICTS (Kayonza (7), Huye (6), Nyaruguru (13) and Kirehe (9)-*funded by the Indian Government*) Installations completed in all 35 schools by "Clean Energy Technologies" and "Su-kam" (Indian).

(PIPELINE Projects) SOLAR HOME SYSTEMS IN 400 HOUSEHOLDS IN 4 DISTRICTS (Gisagara, Ruhango, Gatsibo & Gakenke with Support from Chinese government).

SOLAR ELECTRIFICATION OF GREEN VILLAGE: in Gicumbi District with 46Homes , 1school, 1Health center and a market.

MOBISOL: Currently in the Eastern province, has signed an agreement with REG with support from the EU Grant to electrify 49,000 Households and 1000 schools in the newly mapped areas for off-grid extension by 2018.

IGNITE SOLAR: Has signed an agreement with REG to electrify 1000 Households in 6monts to end by March 2015. So far 300 connections have been made. Upon successful completion of these, they shall sign an MoU to scale up the project to 250,000 – 1,000,000 Households.

Mini Grids

1. Site identification and encouraging resettlement:

- A study identifying all potential hydro sites has been completed which we shall be shared with the private sector and the districts.
- Districts will identify sites they wish to develop which will further their resettlement plans.
- RDB will then play a role in marketing these sites to private investors

2. Attracting and financing investment:

Incentivising the investment via Results Based Financing:

- To encourage the private sector a fund would pay private developers:
  - 30% of capital costs on construction to encourage development
  - A quarterly payment for 4-years for each consumer connected to the grid who is being serviced to incentivise continuous operation.

Local communities investment is essential and will be encouraged:

- Arrangements for local communities via funds to partner with private developers
- This will mitigate revenue collection risks for Private developers

Mini Grids:

3. Institutional and commercial arrangements:

- MININFRA plans to work with RURA: Charging and licencing arrangements.
  - Current view is a flat monthly fee of around RWF 3000 would cover the investment
- Arrangements for revenue collection vital:
  - Significant role for local district

4. Training

Once a district has decided to pursue a site REG will *train locals in construction*, *maintenance* and revenue collection

Central government to provide

Training and education

- Training to district level
- Mass public campaign on the benefits of micro-grids

Information:

- Detailed information on potential sites

Investment:

- Support identifying investors

Local government to provide

Training and education

- Avail people to train.

Site Selection:

- Select sites in line with resettlement plans

Finance:

- Raising finance to partner with private sector

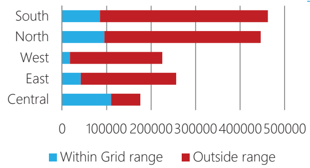
Objective 1: 100% access to electricity

Phase 1 Access will connect 33% of the population

	Household information		Current Access levels		Phase 1 Connections	
	Total hh (2012)	h.h. (2017)	%	Households	%	households
South	528619	607912	10%	50260	28%	145370
North	542630	624025	12%	65663	33%	177711
West	265688	305541	11%	29854	30%	80371
East	392949	451891	19%	74722	50%	195492
Central	294151	338274	47%	119498	55%	162518
Total	2024037	2327643	17%	340056	33%	**761463**

33% of the population will be connected by 2017 if we simply connect those currently within reach of the programme [1]

	Households not connected to grid in ph 1		
	Total	Within Grid range	Outside range
South	462542	85000	377542
North	446313	95000	351313
West	225171	17569	207602
East	256399	41800	214599
Central	175755	110000	65755
Total	1566180	349369	1216811
households	67%	15%	52%



67% of the population will still need Electricity Access….

Figures need validating in light of resettlement plans

[1] Based on 75% of households able to connect opting to do so

Policy

Policy Area	Key policy measures	Description
Electricity sub-sector		• The main policy objectives for the electricity sub-sector are to ensure sufficient, reliable, sustainable and more affordable power supply : • Transition to cost reflective tariffs: • Improve power quality and security by diversifying technologies and accelerating imports. • Increase proportion of cleaner energy through IPP investment streamlining
Rural Electrification/ Off-grid sub-sector		• Simplify licensing frameworks: • Introducing greater competition and flexibility in off-grid service provision through measures to simplify licensing and stimulate SPDs; • Pilot a PPP approach for increasing rural energy access. • **Ensure universal access to electricity in all schools and health clinics**

Electricity Access Sub-sector

Main NEP Directives	ESSP Objectives	Implementation
	EARP: For households too far away, and where more economical off-grid will be encouraged. Closely monitor resettlement progress.	Harmonize off-grid with 3 year plans
Introducing greater competition and flexibility in off-grid service provision through measures to simplify licensing and stimulate SPDs;	On-grid connections: 48% of households by 2018 (or 1,108,000 HH), with 389,00 connections from relocation and fill-ins.	Monitor resettlement and connection policy
	Off-grid connections: 22% of households by 2018. Develop off-grid strategy, develop innovative PPPs, study on phasing out kerosene subsidy	Develop and implement PPPs and strategy. Secure climate/RE finance
Pilot a PPP approach for increasing rural energy access.	Public services: 100% of schools and health centers connect	Analyze extension, develop FS for schools/ hospitals
Ensure universal access to electricity in all schools and health clinics	Small-scale off-grid distributors: Revision of simplified licensing framework and investigate possible inclusion under REFIT	RURA with MININFRA

O1-3-4

TECHNICAL PROBLEMS

- Low ability to pay for most people in the rural areas.
  - Between 50% and 80% of households have incomes of less than USD 1.25 per day.
- Market Failures especially with hydro-microgrids
- Not enough incentives to private investors to take up the renewable energy off-grid projects.
- Inadequate planning capacity to streamline the grid roll out plan with the off-grid renewable energy developments.
  - Economic analysis of renewable energy off-grid electricity provision. This is important in order to provide a comparison with on-grid economics to inform decisions about the speed of roll-out of grid vs. on-grid and the corresponding support/subsidy mechanisms.
- No robust rural electrification strategy yet available.

Attachment O-1-3

SOLAR PV

Benefits, Issues and interventions

Benefits

1. **Cost savings:** Cheaper system would save the average rural family around $60 per year.
2. **Health and safety benefits:** Eliminate fumes from candle and kerosene
3. **Economic Productivity and Educational benefits**
4. **Macro-economic benefits:** Solar systems could save up to $80m in kerosene imports over 5-years

The current market based approach is not working (less than 1000 units sold per month)

Market Problems	Policy Solutions
Quality Control	RSB to Develop Clear standards requirement for import
Consumer awareness	Large Scale Government Awareness programme: PV is as good as Grid for most
High Prices	Government programme installation and subsidisation
Limited Supply Chain	Government programme installation and subsidisation

MICRO-GRIDS

Benefits, Issues and interventions

Benefits

1. **High voltage power:** Can deliver high-voltage power away from the grid
2. **Will drive resettlement**
3. **Provides employment to the community**
4. **Significant potential with new and existing sites**

- 192 potential hydro sites have been identified in the Hydro Atlas.
- Several small community run grids exist

Market Problems	Policy Solutions
Lack of Awareness to the opportunity and potential sites	Promotion of the sector and documenting of potential sites
Difficulty raising Finance	Support the private sector via a results based finance approach
Institutional Framework and commercial arrangements	Work with Districts and RURA to establish fair arrangements which will attract private sector
Shortage of Skills	REG to deliver mass training programme

PROBLEMS TO BE SOLVED

- for mini-micro hydro (>50kW and <10MW), there is no institutional and regulatory framework for developing concession agreements.
- There is no financing mechanisms to provide incentives and attract the private sector for such business models.
- How to manage the transition from rural off-grid electrification to on-grid connection.

WAY FORWARD

- Consider NET METERING to allow solar home systems to export to grid during peak sunlight hours - look at impacts on the overall electricity system costs, as well as impacts on the incentives to individuals to install such systems (e.g. could cut down on their costs by removing the need for batteries)
- developing isolated mini-grid when renewable energy sources potentially exist (mini, micro or pico hydro, solar, biodigester or hybrid systems)
- Private sector engagement when economic conditions are met, i.e. affordable electricity tariff for the consumers and reasonable return on investment for the Private Investor is achievable.

My appreciation for the audience

Electrification Using Renewable Energy: Uganda's Experience

Benon Bena
Manager, Off-Grid Renewable Energy Development
Rural Electrification Agency-Uganda

Outline of the Presentation

- Background
- Electricity Sector
- Rural Electrification Strategy and Plan
- Policy framework
- Financial schemes
- Projects Implemented
- Proposed projects
- Conclusion

Background

- Uganda is located in East Africa
- It has an area of 241,000 sq km of which 43,900 sq km is covered with water bodies.
- 34% of the land is arable.
- Uganda's population is estimated at 34.9 million (2014) of which 82% reside in rural areas.
- The country has good hydro and solar resources

O1-4-1

The Electricity Sector

- The national electricity access is 14% while in the rural areas, access is only 7%.
- The electricity sector was unbundle into generation, transmission and distribution following the Electricity Act 1999.
- The generation companies sell electricity in bulk to transmission company which in turn sells it to distribution companies
- The Electricity Act 1999 also provide for the established of a Regulator and the Rural Electrification Agency (REA)
  – REA is responsible for promoting, supporting rural electrification programs in addition, RE below 20MW.

Attachment O-1-4

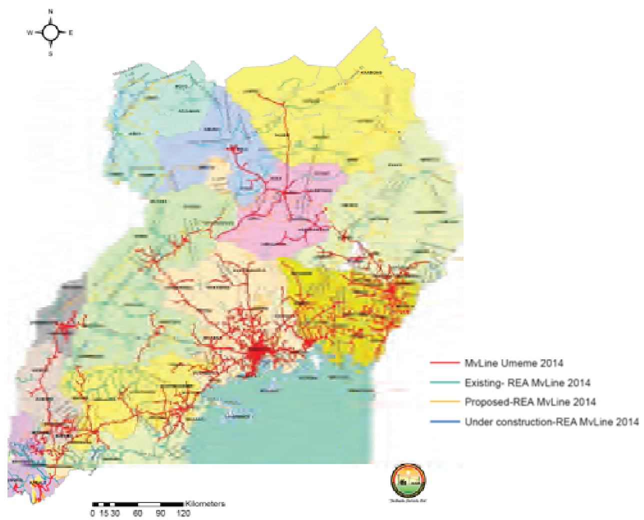
Rural Electrification Strategy & Plan 2013-2022

- In July 2013, the Government published a Rural Electrification Strategy and Plan (RESP) for period 2013-2022.
  - The primary objective of the Strategy is to achieve an accelerated pace of electricity access and service penetration to meet national development goals
  - The target is to achieve a rural electrification access of 26% by 2022, which translates to 1,415,000 new connections on grid and off-grid.
  - The strategy is also aimed at positioning the country to achieve the Government Vision of universal access by 2040
- The country has been divided into 13 service territories

Implementation of RE Strategy & Plan

- The Strategy is being implemented through a combination of approaches:
  - Grid extension in areas where the demand for electricity is high and the demand justifies the cost.
  - Mini-grids where the demand is not so high and the distance from the grid is long but the loads are fairly concentrated with potential for productive use of electricity such as trading centres including islands communities
  - PV standalone systems for isolated and dispersed households, businesses and social services facilities.

The Current Grid Map



Master plan

- REA has embarked on the master planning process to determine areas feasible for grid extension within the 10yr planning period and areas suitable for off-grid solutions
- The process will include development of detail construction plans with timelines.
- The islands on Lake Victoria are being considered for off-grid electrification using mini-grids
  - Survey is being undertaken to identify population centres and collect socio-economic data necessary to undertake pre-feasibility studies.

Policy Framework

- The policy provides for the development of mini-grids by the public, private including communities and through public-private-partnerships
- Some of the policy instruments available include:
  – Tax exemption of renewable energy generation equipment.
  – License exemption for off-grid projects with a capacity not exceeding 2MW.
  – Exemption from complying with all service standards applicable to the main grid
  – Light handed environmental regulation for small renewables energy projects

Financial Schemes

- There are a number of financial instruments available for developers of mini-grids in Uganda
  – Capital subsidies from REA covering the cost of the local distribution grid in order to buy down the end-user tariff
  – The liquidity insurance facility from Uganda Energy Credit Capitalization Company Ltd (UECCC) to enable Participating Financial Institutions (PFIs) extend the tenure of the loans.
  – Partial Risk Guarantee facility from UECCC available during the construction phase to cover for cost overruns of up to 15% of the total project cost. Any addition cost overrun up to 50% is finance 50:50 by both parties.
  – Bridge Financing Facility from UECCC to cover interest payments during the construction stage of a project, before it starts generating cash flows but payable after commissioning.
  – Transaction Advisory Services from UECCC

Projects Implemented

- The 3.5MW Nyagak mini-hydro located in north western Uganda supplies electricity to the district town.
  – Developed and operated by IPS. The project received a concessional loan and subsidy for REA
- The 374kW Kisiizi mini-hydro located in south western Uganda. It was upgraded from 64kW to 374KW. It supplies power to a hospital and the neighboring community.
  – It was developed and is operated by a church funded hospital. The project received a subsidy from REA
- The 64kW Bwindi micro-hydro located in south western Uganda supplies power to hospital and neighboring community.
  – It was developed by GIZ and is operated by the community.
- 40kW Suam Micro-hydro located in eastern Uganda supplies power to a community.
  – The project was developed by GIZ and is operated by the community

Projects Implemented Cont….

- Pamoja Energy Ltd has set-up two biomass gasification projects each with a capacity of 32kW.
- A 600kW PV diesel hybrid mini-grid set-up on Bugala Island by Kalangala Infrastructure services commissioned in Jan 2015.
- 5kW PV mini-grid in Kasese set-up by Remergy Energy A/S
- 22.5kW PV mini-grid set up by Kirchner Solar to power a telecom tower and a trading centre in Luwero

22.5kW PV System Installed by Kricher Solar in Uganda


Current Proposals

- REA has received proposals for the following off-grid projects:
  - Kirchner Solar Ltd to supply power to 30 villages with about 150 households and businesses using 22kW PV hybrid mini-grid.
  - REMERGY is planning to supply electricity to 3 villages in Kasese district using PV mini-grids.
  - Mandulis Energy Limited is setting two 32kW gasification using rice husks to power rice mills in northern Uganda and the neighboring community
  - Absolute Energy Ltd is plan to set up a 150kW PV mini-grid at Kitobo Island on Lake Victoria to supply over 400 households and businesses.
  - Energy for Development in collaboration with REA is setting a pilot 13kW pilot mini-grid to be operated by the community

Conclusion

- Due to the scattered nature of settlements in Uganda, mini-grids will play a major role in increasing electricity access in Uganda. Many people are migrating into trading centres which is providing opportunities for decentralized mini-grids.
- However, the potential will not be realized unless constraints are addressed:
  - The mindset of energy planners who view grid as the only approach to providing electricity.
    - Demonstrate that mini-grid can provide reliable electricity cost effectively.
  - Consolidate projects in a geographical area to benefit from economics of scale and reduce operational cost.
    - License projects covering the whole geographical area
  - Address the high upfront capital requirement, the resultant high end-user tariff and the ability of the rural communities to pay.
    - Provide subsidies and concessional financing to lower the end-user tariff.
  - Streamline and shorten the licensing regimes
    - Remove or reduce license fee for very small renewables.
  - Provide predictability of when the grid is likely to be extended to the area.
    - Develop rural electrification master plans that give timelines of when the grid is expected.
  - Improve regulation & incentives for connection of small renewables to the grid
    - Currently Uganda has a single buyer model. A need to allow embedded generation

THANK YOU

Contact:
Rural Electrification Agency
2nd Floor, House of Hope
Plot 10 Windsor Loop, Kololo, Kampala
Tel: +256 312 318100
Email: info@rea.or.ug or **bena@rea.or.ug**
www.rea.or.ug

International Workshop REA/JICA Project on Solar PV

Rural Electrification Authority
Hannington Gochi

INTRODUCTION

Purpose of Project on Solar PV

Overall Goal

Rural electrification models using renewable energy are disseminated to improve the quality of life of rural communities in Kenya.

Project Purpose

Rural electrification models using renewable energy are established.

Project Outputs

i) *A practical model for electrification of health service institutions in non-electrified areas using solar PV is developed through pilot projects.*

ii) *A practical model for electrification of schools in non-electrified areas using Solar PV is developed through pilot projects.*

iii) The capacity of REA and MOE&P to undertake projects using micro hydro power, biogas and wind technologies is enhanced.

iv) Necessary policy and institutional frameworks for spreading the models for rural electrification using renewable energy are recommended.

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Composition of the model

School Model

Technical Model:
- PV system for lighting
- PV system for charging services
- PV system for laptop

O&M Model:
- O&M structure
REA, MoE&P, MoEST, County Government)
- Role of institutions

FInancial Model:
- FInancial analysis of the pilot project
- Required PV system scale
- Initial cost
- O&M cost
- Available budget
-Income from charging service
- Cashflow projection

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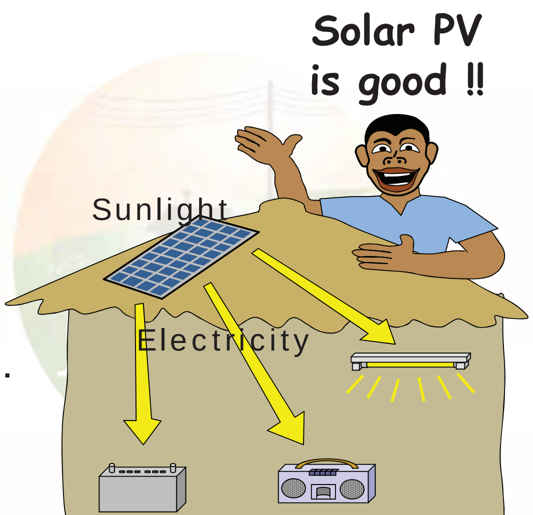
People enjoy solar PV right after the installation…



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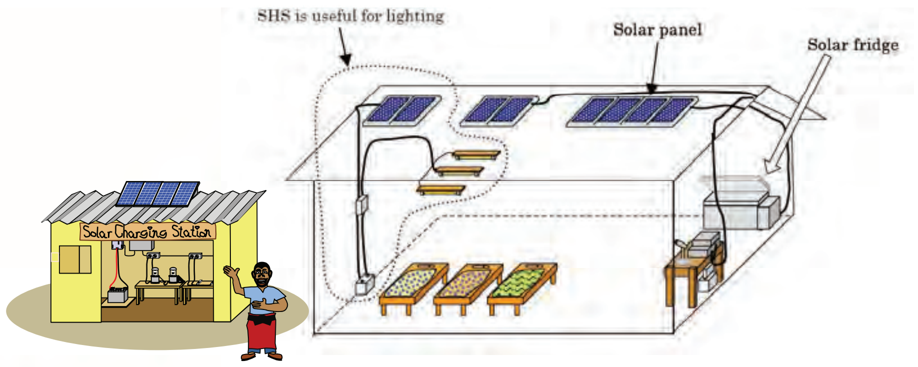
However…..

After around 5 years, he will facing a Problem..

No Budget for Battery Replacement……..

Concept of Pilot



Outline of Pilot (1)

- Install battery charging system for mobile phone, rechargeable lantern, hair clipper and other electrical equipments beside solar PV system for public facility to establish sustainable O&M structure.
- In total, ten (10) pilot plants were installed.

Outline of Pilot (2)

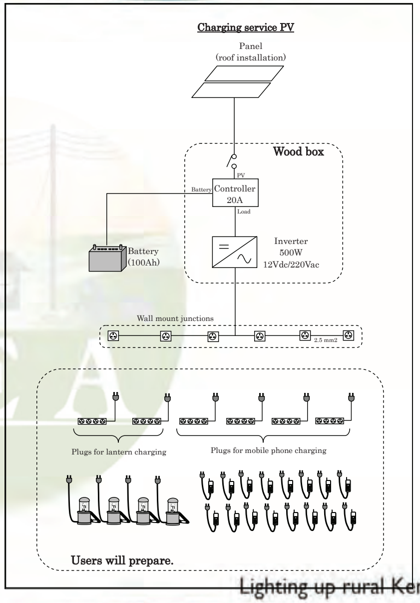
- Financial sustainability is one of the most important key issues because batteries of Solar PV system have to be replaced every 5 to 7 years.
- At the pilot facilities, battery charging services of mobile phone and other electrical apparatus were introduced to collect finance resources for the battery replacement.
- Financial management and trained book keeping skills.
- Operation of the pilot facilities were monitored by REA and the Project team.

Charging Facility (1)

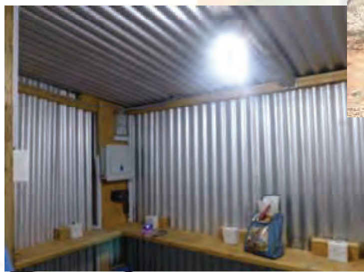
Charging station is not so large.

Operating by Technician.

Power outlets on the wall and a shelf are convenient for the operation.



Charging Facility (2)



Installed solar PV Capacity

LOT 1			LOT 2		
S. No.	Institutions	Total Installation Capacity (W)	S. No.	Institutions	Total Installation Capacity (W)
1	Iltumtum Pry School	3,360	1	Tuum Pry School	5,250
2	Olemoncho Pry School	2,640	2	Illaut Pry School	5,000
3	Ilkilnyeti Dispensary	1,680	3	Marti Pry School	6,750
4	Olkinyei Dispensary	800	4	Latakweny Dispensary	2,500
--	-----	---	5	Angata Nanyokei Dispensary	750
--	-----	---	6	South Horr Dispensary	500
Total		8,480	Total		20,750

Installation (1)

Installation (2)

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LED

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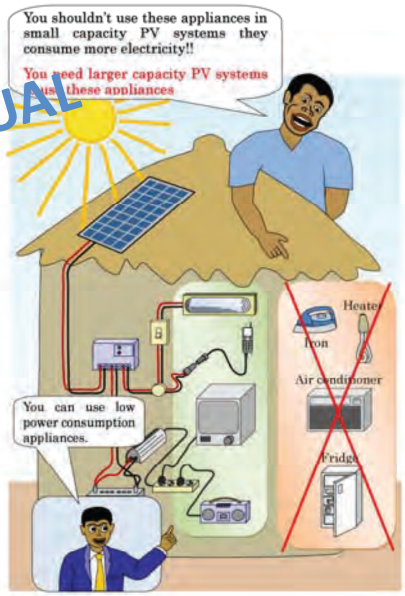

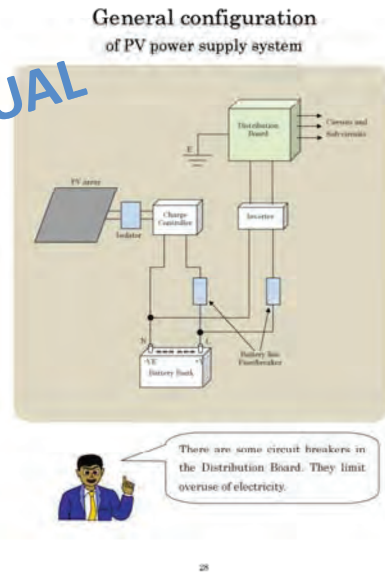

O2-1-4

Attachment O-2-1

Results of monitoring (1)

Public Facility	Monthly Average Income (Ksh./month)		
	Projection	Actual	Ratio
Lot 1			
Ilkilnyeti Dispensary	8,800	4,698	(53%)
Iltumtum Primary School	10,400	7,732	(74%)
Olkinyei Dispensary	13,200	303	(2%)
Olemoncho Primary School	10,400	1,480	(14%)
Lot 2			
Tuum Primary School	5,040	323	(6%)
South Horr Dispensary	2,640	1,116	(42%)
Illaut Primary School	4,320	437	(10%)
Latakweny Dispensary	2,640	653	(25%)
Marti Primary School	4,320	1,679	(39%)
Angata Nanyokei Dispensary	2,640	312	(12%)

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Results of monitoring (2)

- Income from Battery Charging Service was not enough for the Battery Replacement but for daily consumable equipment such as distilled water for battery, bulbs, etc.
- For Battery replacement, the other financial sources have to be prepared.

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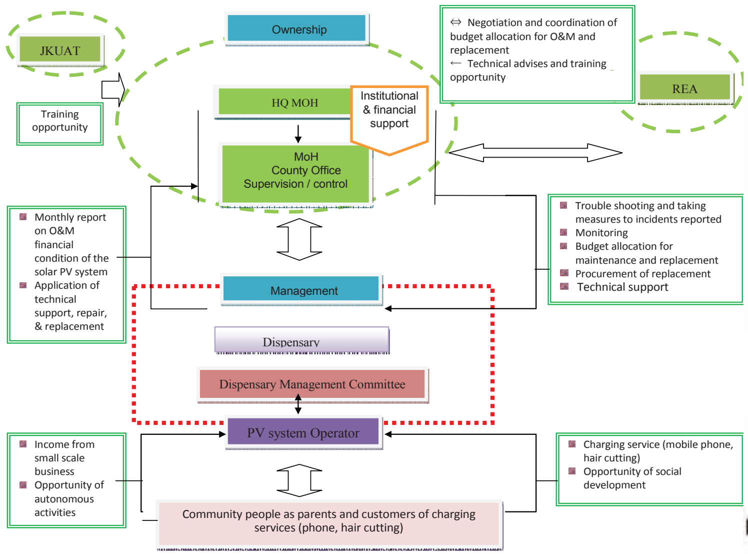
Operation and Management Model for Dispensary

Main Target area: Dispensaries in West Pokot, Samburu, Turkana, Marsabit, Isiolo, Mandela, Wajir, Garissa, Lamu and Tana River counties



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O&M Model

(1) County offices take responsibility. Prepare budget and human resources

(2) Facilities and MCs operate and maintain the system and manage the charging service, and they record and report the system condition and charging service to the relevant county offices.

(3) REA gives technical advises to the county heath and education offices.

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Guideline

Guideline for Solar PV in Health Service Institutions
Guideline for Solar PV in Schools

CHAPTER 1 INTRODUCTION
CHAPTER 2 SOLAR PV SYSTEM
CHAPTER 3 O&M AND MANAGEMENT
CHAPTER 4 FINANCIAL SYSTEM
CHAPTER 5 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS
Attachment 1 Solar PV Operation Manual
Attachment 2 Forms for O&M and Management
Attachment 3 Financial Management

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Thank You

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INTERNATIONAL WORKSHOP
On
Rural Electrification Using Renewable Energy

Guideline for Mini Hydropower (MHP) Development

Semekiah Ongong'a (Mr.)
Assistant Engineer of REA

3rd February 2015
Sarova Panafric Hotel, Nairobi
KENYA

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Contents

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1. Necessity of MHP Development

1. Use of Undeveloped Energy

- Potential hydro energy resources in the world is approximate 14 trillion kWh, 80% of these which are equivalent to energy demand of the whole world are not yet developed.
- About 2/3 of these undeveloped energy resource are located in the developing world.
- Development of these small hydros would support to deal with the global energy demand.

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1. Necessity of MHP Development (Cont.)

2. Geo-ecological Problem

- Global warming resulting from constant increase in greenhouse gases (CO_2, SO_x, NO_x)

3. Economic Development of Developing Countries

4. Local Energy Resource

5. Stabilization of Electricity Rates

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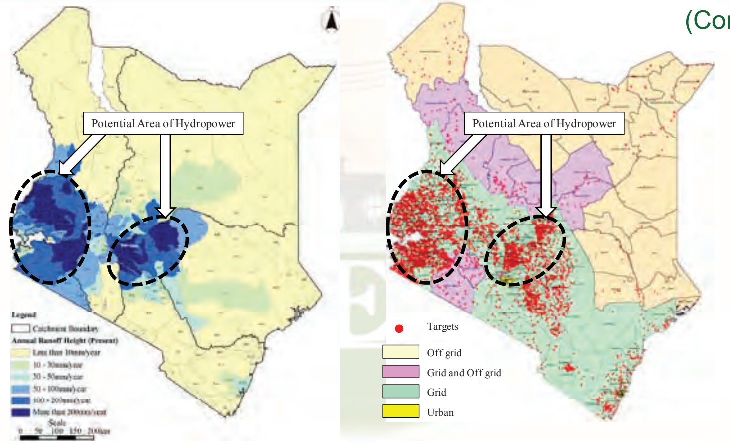
2. Overview of MHP Development in Kenya

- Total potential of small hydropower in Kenya is estimated to be 3,000 MW, out of which 30 MW has been developed.
- The potential area is limited in two water towers where receive annual rainfall of more than 1,500 mm.
  - The area around Mt. Kenya
  - The Western Kenya Region

2. Overview of MHP Development in Kenya

(Cont.)



Potential Area of Hydropower   Demarcation of Rural Electrification Method

Source: "Project on the Development of the National Water Master Plan 2030, Sector Report (B)" (JICA/2013), and "Rural Electrification Master Plan (REM 2009), Final Report Volume 1 – Main Report" (REA/2009).

3. Objective of MHP Guideline

- Working group of REA-JICA Project prepared guideline for MHP Development for REA personnel.
- The guideline describes how to implement MHP projects from project identification to O&M stage.
- Definitions in the guideline are made as follows:

➢ Micro hydro:	Less than 100 kW	Target of the guideline
➢ Mini hydro:	100 to 1,000 kW	(Target of the guideline)
➢ Small hydro:	1,000 to 10,000 kW	

4. Structure of MHP Guideline

1. General
   This chapter explains basics of hydropower generation and advantage & disadvantage of MHP.
2. Identification of the Project
   This chapter describes how to identify the potential MHP site and how to evaluate its potential & power demand using the existing data.
3. Investigation and Planning
   This chapter describes important points for survey including local community participation and social & technical investigations.
4. Basic Design
   This chapter describes the basic functions and hydraulic design of civil structure, estimation of basic technical features of electrical equipment & distribution facilities.

4. Structure of MHP Guideline (Cont.)

5. Economic and Financial Evaluation
   This chapter explains key indicators for the evaluation, and difference between economic evaluation & financial evaluation.
6. Environmental and Social Considerations
   This chapter explains standard procedures for obtaining the environmental license for all developments.
7. Construction Supervision
   This chapter explains procurement procedures of public works in Kenya and key points of construction supervision works by the Client.
8. Operation and Maintenance
   This chapter describes the importance of assistance of management board organized by the local community and key points of O&M works for MHP station and off-grid distribution system.

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5. Features of MHP Guideline

- There are many guidelines & manuals of MHP development in the world. The main features of this guideline are as follows:
- Application of Results of NWMP 2030
  The guideline provides fundamental discharge data in each sub-basin in Kenya from the National Water Master Plan 2030 (NWMP 2030) for preliminary evaluation.
- Application of Empirical Equations of Japan
  The guideline provides empirical equations in Japan for comparison of alternative layouts.

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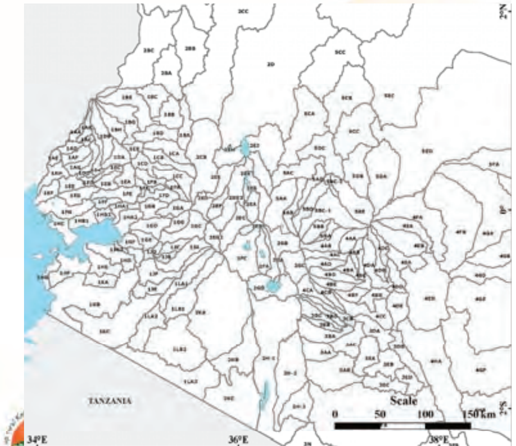
5. Features of MHP Guideline (Cont.)

- Adoption of Results of NWMP 2030



- Monthly mean discharges in each sub-basin were simulated in NWMP 2030.
- Estimation of the discharge at the candidate site in proportion to the areas of catchment
- Preparation the flow duration curve
- Defined dependable discharge within 90 to 95% of reliable discharge.

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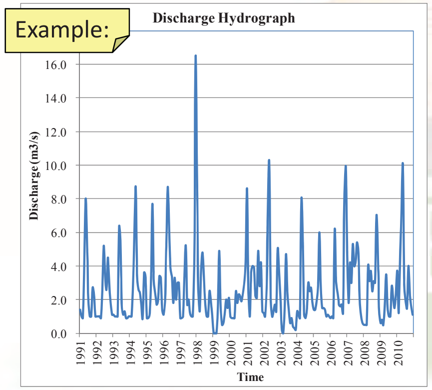
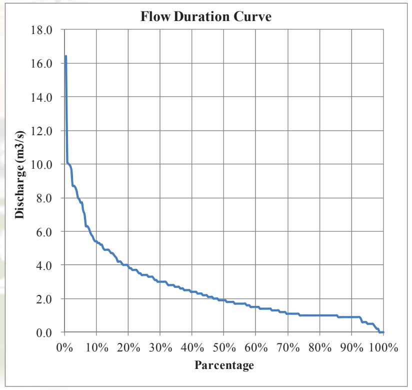
5. Features of MHP Guideline (Cont.)

- Adoption of Results of NWMP 2030





This is applicable for preliminary study only.

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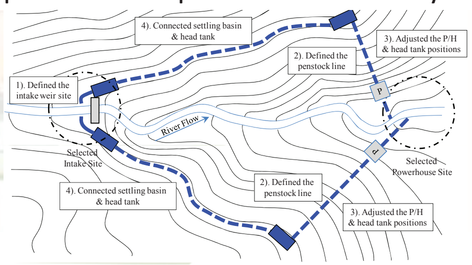
5. Features of MHP Guideline (Cont.)

- Adoption of Empirical Equations in Japan

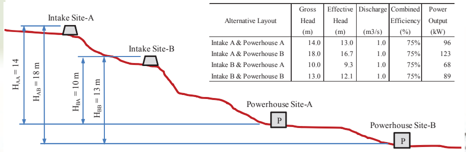
In general, there are many alternative approaches, such as location of intake weir, route of power canal, location of power house, etc.

Therefore, alternative study is required to identify the optimum development plan.

Sample Procedure of Preparation of the Alternative Layout



Sample of Alternative Layout



Alternative Layout	Gross Head (m)	Effective Head (m)	Discharge (m3/s)	Combined Efficiency (%)	Power Output (kW)
Intake A & Powerhouse A	14.0	13.0	1.0	75%	96
Intake A & Powerhouse B	18.0	16.7	1.0	75%	123
Intake B & Powerhouse A	10.0	9.3	1.0	75%	68
Intake B & Powerhouse B	13.0	12.1	1.0	75%	89

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5. Features of MHP Guideline (Cont.)

- Adoption of Empirical Equations of Japan

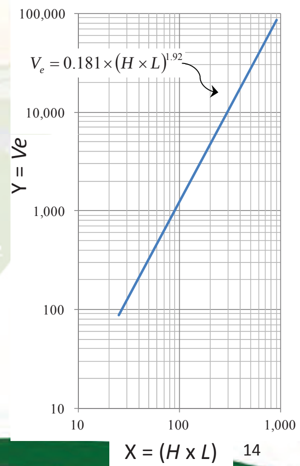
The empirical equations show statistical correlations between work quantity & major structural dimensions.

For example, excavation volume of intake weir is easily obtained by estimation of weir height (H) and weir crest length (L).

Therefore, alternative study is easy to conduct.

However, this is also applicable for preliminary study only.

Example: Excavation volume of weir



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6. Technical Recommendations

1. Integrated Master Plan & Specification Standard
   REA actively involves the following on-going activities by MOE&P:
   - Preparation of integrated master plan on rural electrification, and
   - Formulation of "Guideline Specification Standard for Development of Micro/Small Hydropower"
2. Selection of Target Area for MHP Planning
   REA selects several target areas to be electrified by MHP for the concentrated MHP planning.
3. Execution of Pilot Project by Direct Management
   REA implements specified MHP projects in the direct management as on-the-job training for REA personnel.
4. Role-sharing Arrangement in O&M Stage
   REA starts coordination with relevant agencies to discuss and arrange the role-sharing in O&M stage of MHP.

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END

Thank you for your kind attention.

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PROJECT FOR ESTABLISHMENT OF RURAL ELECTRIFICATION MODEL USING RENEWABLE ENERGY

INTERNATIONAL WORKSHOP HELD AT PANAFRIC HOTEL

3rd FEB 2015

Objectives

- Objective of international Workshop:
  - To share experience on renewable energy from invited countries and other experts from the country.

INTRODUCTION

- Biomass is the organic material which is utilized as energy. Material source is mainly agricultural, industrial and human waste.
- Biogas is the fuel gas that is produced by the anaerobic fermentation of organic material by methane producing bacteria. This process is determined by several conditions.
- Design of the various digester sizes has always been left at the discretion of a particular contractor. Now there will be a reference manual for the design and maintenance of the biogas system.
- The guideline manual developed by JICA expert team will be used in the planning, design, procurement and monitoring of the biogas system.

Guideline Contents

Part-1 Guideline for Biogas Generation System Planning

Summary of Basic Planning

- Basic planning is conducted to figure out the scale of system, overall demand, possible energy supply and the initial cost of the project.
- Project objective, availability of feedstock, amount of biogas production, benefit from fuel or electricity saving, demand assessment, determination of the system layout, design and cost estimation are done.
- Available feedstock is calculated to determine the amount gas expected daily.

Summary of Basic Planning CONT…….

- Amount of biogas production in m³ per kg of feedstock is calculated. The value is variable according to weight and feeding conditions.
- Amount of fuel wood or other fuel saved by biogas and the amount of energy generated by the produced biogas system is calculated.
- System layout is site specific and depends on the general slope and effluent management plan.

Part-1: 4.2 Energy production and demand Amount of biogas production-- Human

Description	Value	Unit
Amount of biogas production [1]	0.02-0.028	m^3/person/day
Size of digester	0.1	m^3/person
Substrate	3.3-4.9	L/person/day
faeces	0.25-0.4	kg/person/day
urine	1-1.5	L/person/day
flushing water	2-3	L/person/day

1) Biogas as an alternative to fuelwood for a household in Uleppi sub-country in Uganda

$$V_h = 0.024N_h \times O \times D \times R$$

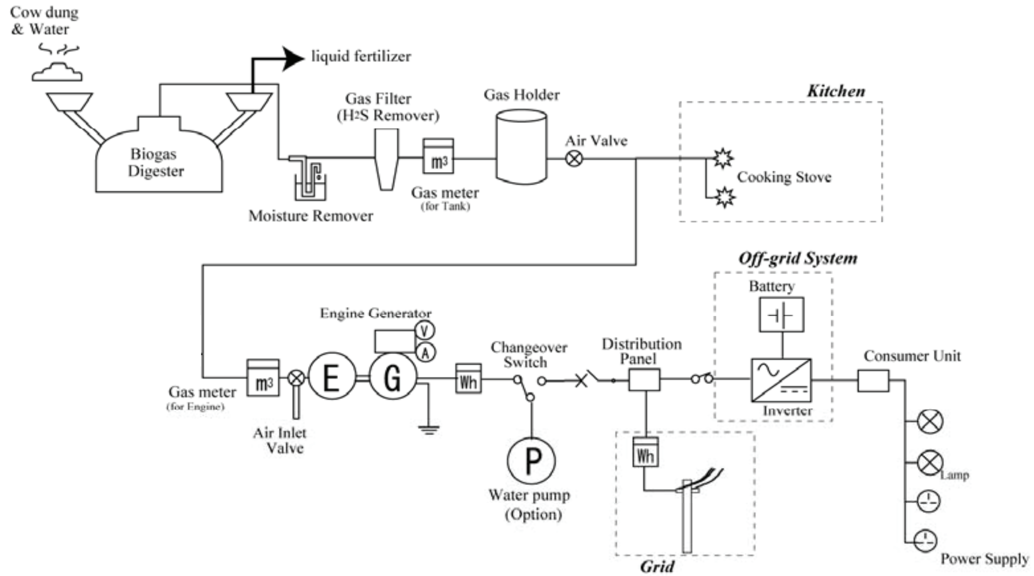
Where, V_h: Volume of biogas production from human waste (m^3/year)
N_h: Number of persons utilizing toilets connected to the digester at the facility
O: Body weight ratio, average weight of persons/average weight of adults
D: Number of regular days (= 365 – number of long holidays))
R: Toilet usage ratio (percentage of toilet use connected to the digester)

Example:
0.024 m^3/person/day x 1000 students x 0.8 x (365-92) x 0.75 x= 3931 m^3/year

BASIC PLANNING CONT…………..

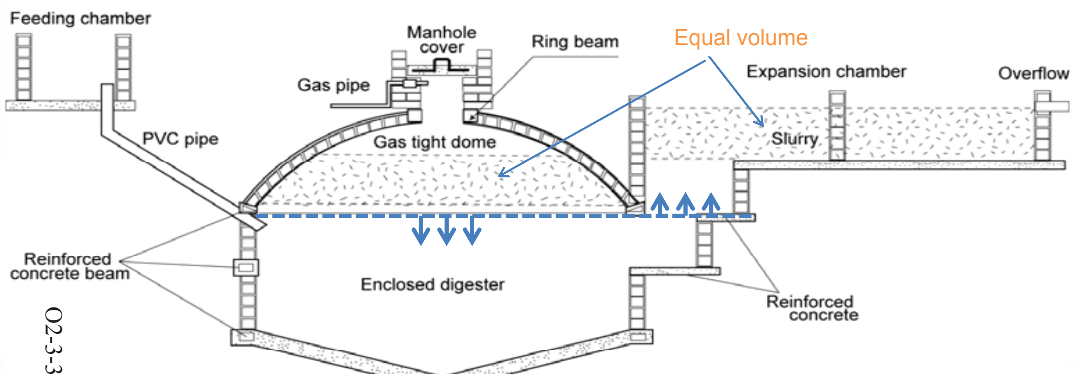
- Design: determination of the digester size and the type to be used in a particular area. Gas line length, biogas engine (electricity) and stove (thermal) application.
- Cost estimation: includes labour transportation, material, administration, testing and commissioning, user training and documentation.
- Financial and Economic evaluation is also calculated.

Part-1: 5.1 Biogas Generation System



Part-1: 5.2.3 Design of Biogas Digester

AKUT Type Digester, Biogas Construction Manual, prepared by GmbH, and PSDA
- Cone bottom shape digester with feeding chamber and expansion chamber
- For toilet connected digester, inlet and outlet pipe is connected to sewer line
- Durable, strong with reinforced concrete slab and bean
- Drawings are available



Source: AKUT Type Digester, Biogas Construction Manual, PSDA/GIZ

O2-3-3

Part-1 Guideline for Biogas Generation System Planning

Attachment O-2-3

PROCUREMENT

- Procurement is done in accordance with the Public Procurement and Disposal Act 2006. The method consists mainly of open tender.
- The bidding document is prepared by the procuring entity (Rural Electrification Authority). All eligible bidders obtain it from the company website and submit the duly filled document to the offices.
- The bids are subjected to an evaluation process, and the successful bidders are awarded contracts to carry out the project.
- REA supervisors monitor the construction of the project and the commissioning activity.
- Contractors maintain during the liability period then the project is handed over.

Part-2 User Guideline for Biogas Generation Operation

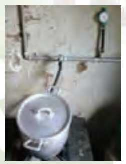
Part2: 3. Operation and Maintenance

-Daily operation : water& urine mixing

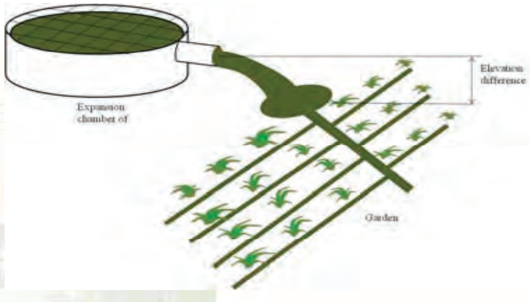
Item	Dry cow	Lactating caw
Body Weight (kg)	612 ±70	614 ±47
Water intake (kg/day)	28.0 ± 9.1	98.4 ±14.9
Urine amount (kg/day)	10.8 ±4.9	21.9 ±7.5

- Biogas pressure measurement

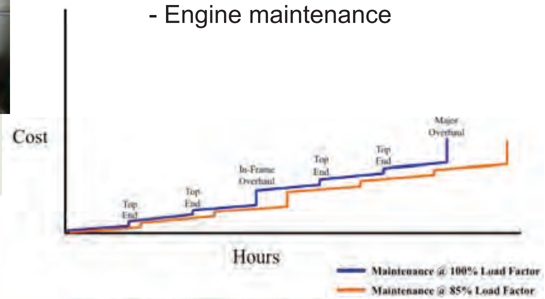
Digestor Size m^3	Dung/day kg	Nos of Cow	Gas production m^3	Max Pressure (cm) (mbar)
8	100	5	3	94
12	150	7	4.5	97
16	200	9	6	105
24	300	13	9	115
32	400	17	12	125
48	600	25	18	125
59	740	31	22	127
71	900	38	28	133
80	1100	46	34	135
124	1500	63	46	140



- Utilization of effluent



- Engine maintenance



O2-3-4

Part-3 Guideline for Monitoring and Evaluation

Attachment O-2-3

Part-3: 1. Monitoring

Item	Unit	Description	Frequency
Biogas Production amount	m^3	Biogas production amount. Measured by gas flow meter.	Every day
Generated Energy	kWh	Energy amount generated by biogas generator. Measured by energy meter.	Every day
Energy Output	kW	Power output by biogas generator. Measured by biogas generator indication.	Every day
Temperature	ºC	Ambient temperature. Complementary information to assess gas production efficiency.	Every day
pH	-	Potential of hydrogen. This is the indication of acidity and alkalinity condition inside a biogas digester and slurry. Optimal pH is 7-8.5.	Occasional monitoring
Methane concentration	%	Percentage of Methane in biogas. This is the indication of biogas production.	Occasional monitoring
ORP	mV	Oxidation Redox Potential. This is the indication of anaerobic condition of biogas digester.	Occasional monitoring
Biogas analysis (detailed)	-	Gas is sampled and sent to a laboratory. Concentration of components is analyzed by gas chromatography (CH_4, CO_2, O_2, N_2, H_2. etc.)	When required for study and R&D purpose

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Part-3: 2. Evaluation

- To analyze system efficiency
- To obtain lessons and learn from them for implementation of similar projects in future
- To provide advice for better and more efficient operation
- Especially for public projects, it is necessary to present data and analysis results to justify the project according to accountability requirements.

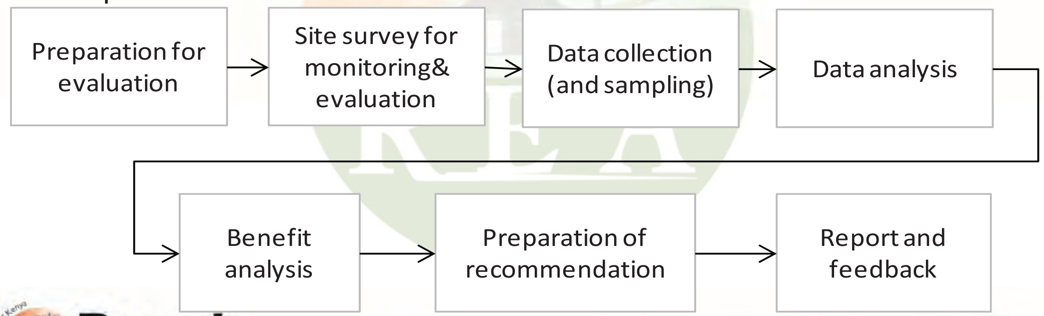

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Illustration of Pre-Feasibility study

- Nyeri high school is located in Nyeri county. Approximate population of 1500, 10 cows and 15pigs.
- Electricity consumption 1.5 mil KSh/year and fuel wood is 0.8mil Ksh/Yr.
- Preliminary design is as follows:

Description	Qty	Unit	Remarks
Nos of cows	17		to be increased from 10 nos
Digester size	32	m3	
Assumed feedstock input	400	kg/day	
Possible gas production	12	m3/day	
Generated energy	12	kWh	1kWh/m3
Electric energy demand	8.5	kWh	Light, 59 nos of 36W, 4hrs

Description	Value	Unit
Utilization ratio	**0.54**	
Boarding toilet usage ratio	0.67	
Student/adult weight	0.80	
Nos of student utilizing dorm toilet	950	nos
Converted nos of person for biogas	509	nos
Digester volume	**60**	**m3**
Gasproduction amount	**15.3**	**m3/day**

O-2-3-5

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Cost Comparison between installation system with generator and without

Item	Nyeri High School with Generator			Nyeri High School without generator		
	Qty	unit	KSh	Qty	unit	KSh
Biogas Digester for Toilet	60	m3	413,720	60	m3	413,720
Biogas Digeter for Cow Shed	32	m3	340,444	32	m3	340,444
Excavation and civil works	1	lot	188,830	1	lot	188,830
Additional toilet facility with septic tank						
Gas holding steel tank and connection valve	2	nos	100,800	2	nos	100,800
Bigoas flow meter	2	nos	73,000	2	nos	73,000
PVC gas bag	1	nos	411,000	1	nos	411,000
Biogas generator	7	kVA	240,000		kVA	
Energy meter	1	nos	50,000		nos	
Distribution board, switch gear	1	nos	150,500		nos	
Biogas filter and solenoid valve	1	nos	106,500	1	nos	106,500
Cable work	1	lot	200,000		lot	
Pipe work	1	lot	250,000	1	lot	250,000
Fence and safety arrangement	1	lot	118,000	1	lot	118,000
Subtotal			2,642,794			2,002,294
Detailed design and drawing	1	lot	246,000	1	lot	186,380
Testing, commissioning, training	1	lot	363,500	1	lot	275,403
Total Cost			3,252,294			2,464,077
Total Cost adjusted with Inflation 2010/13	4.91%/	Ksh	3,755,264	4.91%/	Ksh	2,845,149

Attachment O-2-3

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REA's Biogas projects

- ✓REA has successfully completed a biogas project in Mangu high school. Generating electricity from the biogas obtained which is used to pump water.
- ✓Isinya biogas will undergo rehabilitation to begin functioning.
- ✓Feasibility plan for construction of another facility in Nyeri high school is underway.

Conclusion

The development of a guideline manual in biogas generation is a big step towards the development and promotion of the technology.

REA is conducting Pre-F/S, Feasibility Study, project implementation for biogas generation system. The experience and lessons learned can be shared for promotion of biogas in Africa.

THANK YOU

Simple Pre-Feasibility Study
on
Wind Power Development in Baragoi

Rural Electrification Authority
Hannington Gochi

INTRODUCTION

1.1 Purpose of Simple Pre-F/S

A. Wind - diesel power plants can be used for power supply in autonomous systems where a connection to the national grid is either impossible or too expensive due to long transmission line.

B. The most important purpose of a Wind -Diesel Hybrid system is to reduce the consumption of diesel fuel. In general, isolated diesel power stations are located in remote areas, and transportation and oil storage costs can therefore be reduced.

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1.2 Location and Topography

Location:

Samburu County is located in Rift Valley.

Baragoi is located around 100 km from Maralal, in Samburu County.

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Baragoi Diesel Power Station

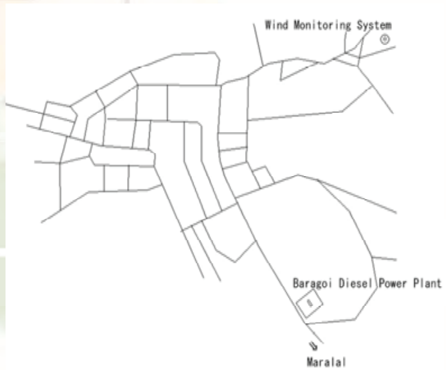
Location:

N 1.46’44’’,

E 36.47’26’’

Altitude:

1280 meters above sea level.



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(Diesel Generator)

(Transformer)

(Control Unit)

(Fuel Tank)

1.3 Climate

Semi-arid

Temperature:

Averaging between 25°C during the coldest months (June and July) and 33°C during the hottest months (January to March).

Rainfall:

Total annual precipitation averages 700mm. April and November being the wettest months while the driest months are between July and September.

2.1 Socio - Economic Conditions

<u>Samburu North Sub-County</u>

Population: 59,801 (2009 census)

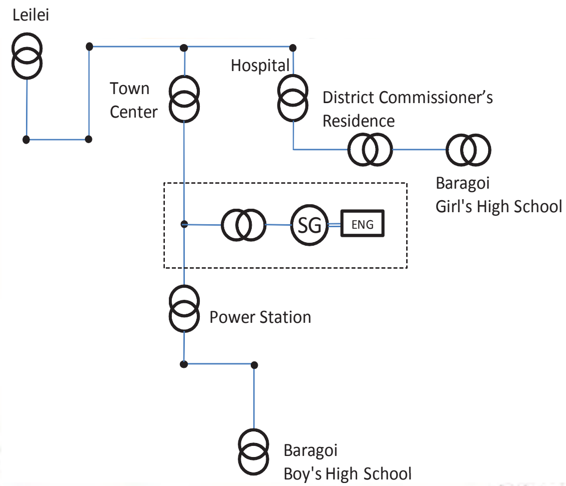
Households: 11,699 (2009 census)

<u>Baragoi town</u>

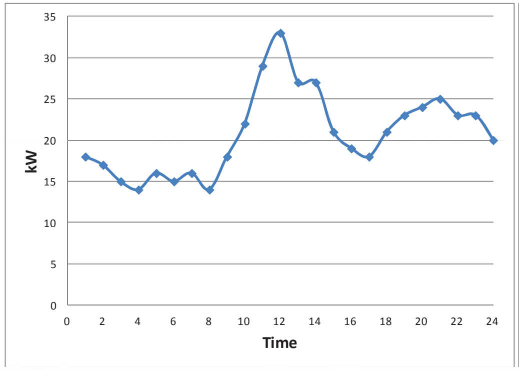
Population: 4,694 (2009 census)

Households: 924 (2009 census)

2.2 Power Demand



Power Demand of Baragoi Diesel Power Station



Time	kW
1	18
2	17
3	15
4	14
5	16
6	15
7	16
8	14
9	18
10	22
11	29
12	33
13	27
14	27
15	21
16	19
17	18
18	21
19	23
20	24
21	25
22	23
23	23
24	20

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3 WIND ANALYSIS

3.1 Wind Monitoring

Monitoring Height: 20m, 40m
Anemometer, Wind vane

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Monthly Average Wind Speed

Year	Month	average wind speed (m/s)		max. wind speed (m/s)	
		20m a.g.l.	40m a.g.l.	20m a.g.l.	40m a.g.l.
2010	Sep	4.4	5.1	14.2	14.8
	Oct	4.7	5.6	15.9	17.3
	Nov	3.4	5.1	16.7	17.6
	Dec	5.1	6.0	17.3	20.6
2011	Jan	5.3	6.1	17.4	17.8
	Feb	5.0	5.8	17.2	18.7
	Mar	5.1	6.1	20.1	22.0
	Apr	5.0	6.1	26.2	26.4
	May	4.0	5.0	18.1	20.0
	Jun	3.6	4.2	12.8	14.3
	Jul	3.8	4.4	13.6	14.2
	Aug	3.8	4.4	13.5	15.2
Average		4.4	5.3	16.9	18.2

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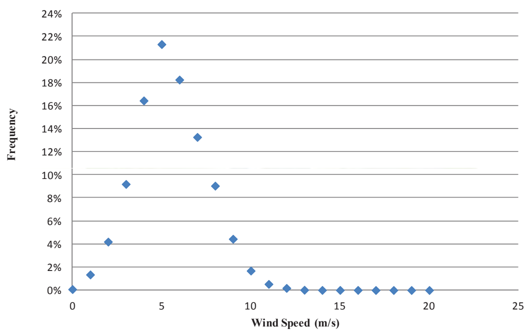
Table 2 Wind Speed Frequency

Wind Class	Range of Wind Speed (m/s)	No. of Data (40m a.g.l)	Frequency (40m a.g.l.)	No. of Data (20m a.g.l.)	Frequency (20m a.g.l.)
0	0<V<0.5	37	0.1%	46	0.1%
1	0.5<=V<1.5	641	1.3%	233	0.5%
2	1.5<=V<2.5	1997	4.2%	4352	9.1%
3	2.5<=V<3.5	4376	9.2%	8133	17.1%
4	3.5<=V<4.5	7821	16.4%	11242	23.6%
5	4.5<=V<5.5	10146	21.3%	9448	19.9%
6	5.5<=V<6.5	8682	18.2%	6614	13.9%
7	6.5<=V<7.5	6315	13.3%	4287	9.0%
8	7.5<=V<8.5	4304	9.0%	2172	4.6%
9	8.5<=V<9.5	2114	4.4%	812	1.7%
10	9.5<=V<10.5	801	1.7%	204	0.4%
11	10.5<=V<11.5	251	0.5%	35	0.1%
12	11.5<=V<12.5	85	0.2%	7	0.0%
13	12.5<=V<13.5	10	0.0%	3	0.0%
14	13.5<=V<14.5	3	0.0%	0	0.0%
15	14.5<=V<15.5	2	0.0%	0	0.0%
16	15.5<=V<16.5	3	0.0%	0	0.0%
17	16.5<=V<17.5	0	0.0%	0	0.0%
18	17.5<=V<18.5	0	0.0%	0	0.0%
19	18.5<=V<19.5	0	0.0%	0	0.0%
20	19.5<=V<20.5	0	0.0%	0	0.0%
		47588	100%	47588	100%

pared by JET & REA

Over 15% of wind speed frequency was recorded between 4m/s and 6m/s. Around 69% of wind speeds were recorded at 4.5 m/s and higher.

Wind Speed Frequency



Prepared by JET & REA

Figure .6 Wind Speed Frequency

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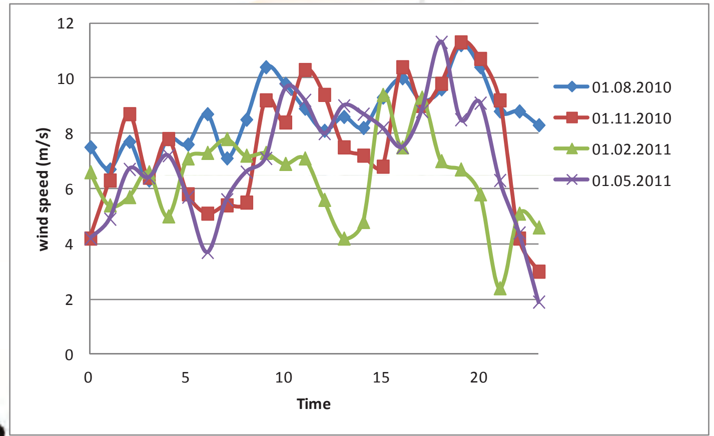
Diurnal Wind Speed



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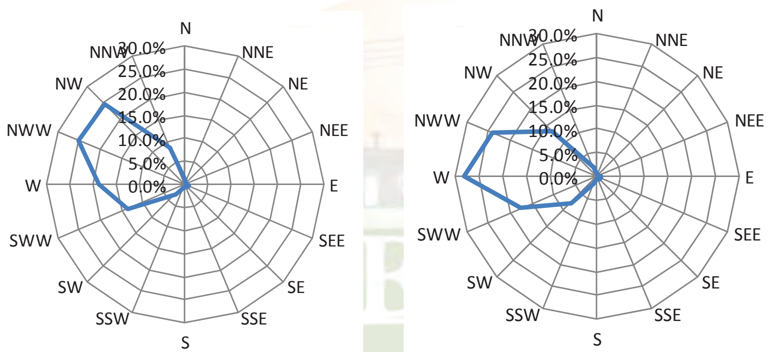
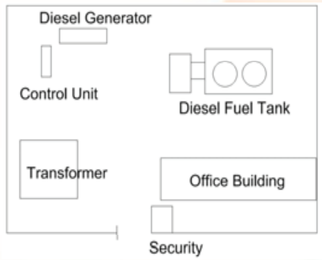
Wind Direction



Wind axis is defined as the direction of the prevailing wind and the two immediate directions on both sides, and the symmetric directions of these three directions. In total, 6 of the 16 azimuth angles are designated as the wind axis. In the case of Baragoi, more than 70% of wind direction is in the wind axis.

4 PRELIMINARY DESIGN AND COST ESTIMATE

4.1 Baragoi Diesel Power Station



(Diesel Generator)

(Transformer)

(Control Unit)

(Fuel Tank)

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4.2 Proposed Wind-Diesel Hybrid System

Table 3 Estimation of Energy Output from Wind

Wind Speed Bin (m/s)	Power (kW)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.3	0.03	0.03	0.03	0.03	0.05	0.07	0.06	0.06	0.05	0.04	0.02	0.03	0.04
5	0.8	0.16	0.13	0.13	0.14	0.18	0.20	0.21	0.21	0.23	0.18	0.15	0.15	0.17
6	1.7	0.32	0.27	0.27	0.34	0.32	0.21	0.27	0.25	0.31	0.35	0.38	0.33	0.30
7	2.6	0.43	0.41	0.43	0.45	0.33	0.12	0.14	0.18	0.25	0.35	0.51	0.44	0.34
8	3.7	0.46	0.44	0.53	0.47	0.23	0.05	0.07	0.08	0.23	0.34	0.60	0.43	0.33
9	4.9	0.34	0.27	0.47	0.37	0.09	0.01	0.00	0.02	0.12	0.23	0.33	0.29	0.22
10	6.2	0.19	0.23	0.19	0.19	0.01	0.00	0.00	0.00	0.02	0.10	0.15	0.14	0.10
11	7.5	0.07	0.10	0.06	0.07	0.01	0.00	0.00	0.00	0.00	0.02	0.05	0.09	0.04
12	8.0	0.04	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.01
13	8.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	7.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2.05	1.92	2.13	2.07	1.21	0.66	0.75	0.80	1.22	1.61	2.22	1.95	1.56

Power (kW)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Net kW	2.05	1.92	2.13	2.07	1.21	0.66	0.75	0.80	1.22	1.61	2.22	1.95	1.56
kW	1.58	1.48	1.64	1.59	0.93	0.51	0.58	0.61	0.94	1.24	1.71	1.50	1.20
Daily (kWh/day)	37.9	35.6	39.4	38.3	22.3	12.2	13.9	14.7	22.5	29.8	41.1	36.1	28.8
Monthly(kWh/Mo)	1,173	997	1,220	1,148	691	366	432	457	674	923	1,232	1,118	10,512

Air density (monitored)	1.05
Air density (std.)	1.226
Air density Ratio	86%
Safety Margin	10%

Prepared by JET & REA

Capacity Factor = 1.2 / 7.5 = 16.0%

4.3 Selection of Wind Turbine

- Penetration ratio can be designed to be less than 15% by installing two wind turbines of 7.5 kW.
- Annual Energy Penetration = 10,512 × 2 / 182,500 = 11.52 %

Benefit from wind turbine installation

Generation capacity of the wind turbine	15	kW
Capacity factor (Wind)	16.0%	
Operation hour per day	24	Hours
Operation day per year	360	days
Annual power generation (Wind)	20,736	kWh/Y
Life time of the wind turbine	20	Years
OM cost of the generation system (% of the investment)	2.0%	
Diesel fuel cost per litter	105.0	kSh/litter
Fuel consumption	0.67	litter/kWh
Fuel cost per kWh	70.35	kSh/kWh

Benefit (Replaced Diesel Cost) 1,458,778 kSh/Y

Capacity Factor vs. EIRR

Baragoi Pre-F/S:
Capacity Factor: 16%, EIRR = 10.0%

Capacity Factor	EIRR
15%	8.8%
20%	14.5%
25%	19.6%

Consideration

- For a wind project, most important pre-condition is to select a sufficiently windy place.
- Capacity factor needs to be at least over 20%. The benefits from wind will be improved by selecting a site with higher wind potential.
- Optimization of Installed capacity of diesel generator at Baragoi Diesel Power Station should be considered as it is not appropriate for the current power demand

Thank You

Access to Cleaner Energy

Developing & Under-developed Market

Arvind Garimella

Overview

- Lessons from solar lighting project in
  - Africa and
  - India
- Challenges
- Takeaways

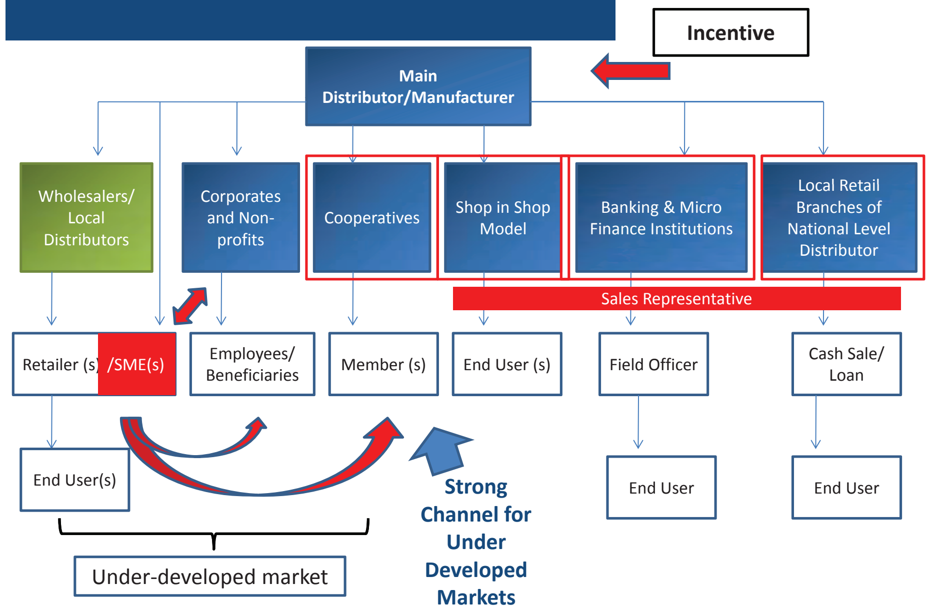
DFID-TERI Africa

The DFID-TERI Partnership Project is a collaborative action research, aiming to pilot scalable business models for provision of clean cooking and lighting solutions for poor households in Africa, especially in Kenya and Ethiopia. This is being achieved through;

- Review of existing technological solutions and delivery models and identification of barriers to the promotion of clean energy (lighting& cooking) options in sub-Saharan Africa;
- Sharing lessons and best practices from the Indian context in the area of policy, regulation, financing, technology and delivery models; and
- Demonstration of the techno-social viability of the decentralized cooking and solar home lighting applications through innovative business models and financing options to bring improved quality of life to the rural households in the region.

O3-1

National Level Distributors



Attachment O-3

Incentive as a Trigger. **Ethiopia**

- Development of last mile SME
  - Wholesale price to last mile
  - Products on credit to SME
  - Training on technical aspects
  - Training on marketing and promotion

Financial Products
- Installment purchase
- Deposit and order
- Bulk / Institutional orders

New Promotion Activities
- Market day sales
- Village level
- Brand building using tee shirts
- Cross selling products

New Partnerships
- Cooperatives
- Private enterprises
- SME network expansion in the form of village level agents
- Energy bureau officers

Incentive as a Trigger. **Ethiopia**

- Incentive at National Distributor Level
  - Scaling up in to new areas.
  - Feedback from last mile SME
  - Introducing new products through opinion leader channel

Capacity building
- Training and capacitation of staff in technical and marketing.
- Training to last mile SME on technical and marketing.

Marketing
- Local language customized marketing in radio, newspapers, flier and banners.
- New channel of distribution to introduce products and customize products to user needs. This is the opinion leader channel.

Sharing incentive
- Sharing incentive with cooperatives.
- Credit sale to last mile SME
- Whole sale price offered to SME.

Incentive as a Trigger. **Kenya**

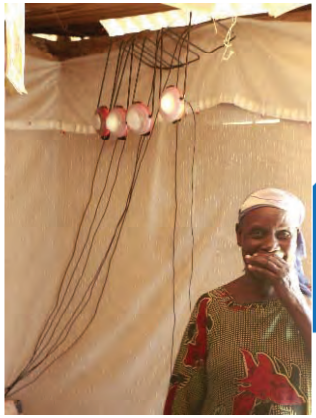
- Incentive at National Distributor Level

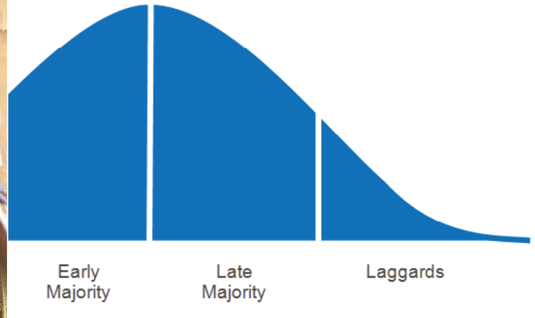
Capacity building and New Resources
- Training and capacitation of staff in technical and marketing.
- Inception or Stregthening of the direct sales representatives.

Marketing
- Local language customized marketing in radio, newspapers, flier and banners.
- Bring a consumer get air time.
- Replace old product with new product.
- Making promotional videos and using advertisement spaces provided by Banks.

New Fiancial Products and Package Deals
- Using bank kiosks as retail outlets and comissioning these kiosk agents through partial incentve.
- Warranty registration through SMS. Development of ICT systems for consumer information gathering & analysis.
- Establishing new partnership by sharing incentive: Banks, MFIs, Bank Kiosks, Space in supermarkets.

Last Mile SME





Lighting a Billion Lives (LaBL)

Commitment at the
Clinton Global Initiative
2007

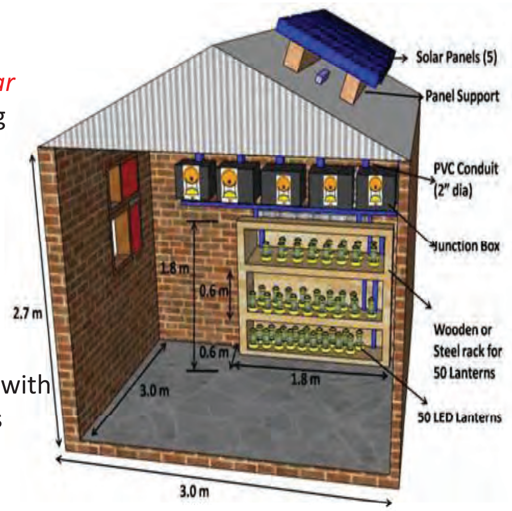
Official Launch by then
Hon'ble Prime Minister of India
2008

We commit to enable a billion lives
to access light from solar technologies

Lighting a Billion Lives

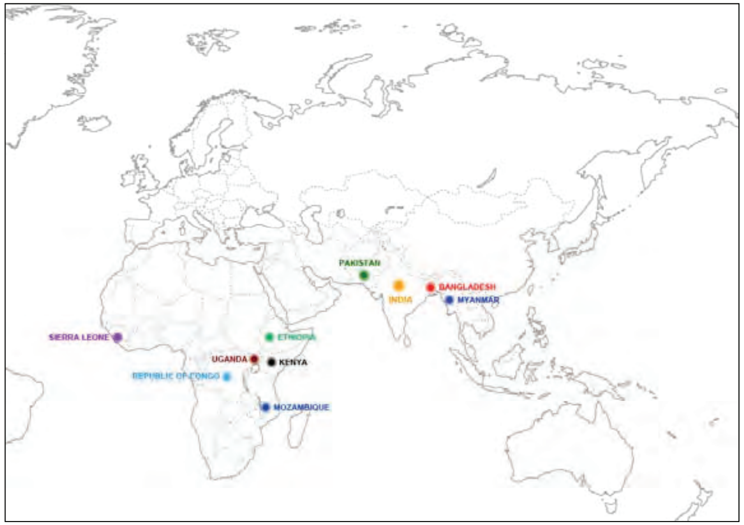
Lighting a Billion Lives initiative *facilitates setting up of micro solar utilities*, which offer clean lighting solutions to energy poor villages

- Provides reliable and clean illumination
- Replaces the use of polluting kerosene as a lighting fuel
- Catalyzes rural solar market
- Equips local human resources with technical and managerial skills



Source: TERI , 2012

Global Presence



Technologies

SOLAR CHARGING STATIONS	SOLAR MICRO GRIDS
INTEGRATED DOMESTIC ENERGY SYSTEMS	SOLAR HOME LIGHTING SYSTEMS

Solar Charging Station (SCS)

Features of SCS

- Consists of Solar panels, junction boxes and lanterns (for typical SCS consist of 5x 50Wp panel, 5 JB with 10 ports each to charge total 50 lanterns)
- Managed by a local entrepreneur
- Lanterns are brought to the station by the user every morning for recharging
- The entrepreneur rents out the recharged lanterns, every evening in lieu of a nominal fee, which are used for illuminating homes and small businesses

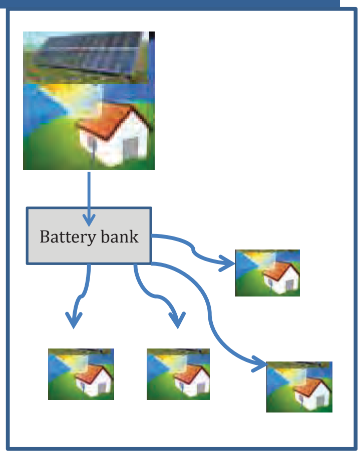
Source: TERI , 2012

Lanterns usage

Source: TERI , 2012

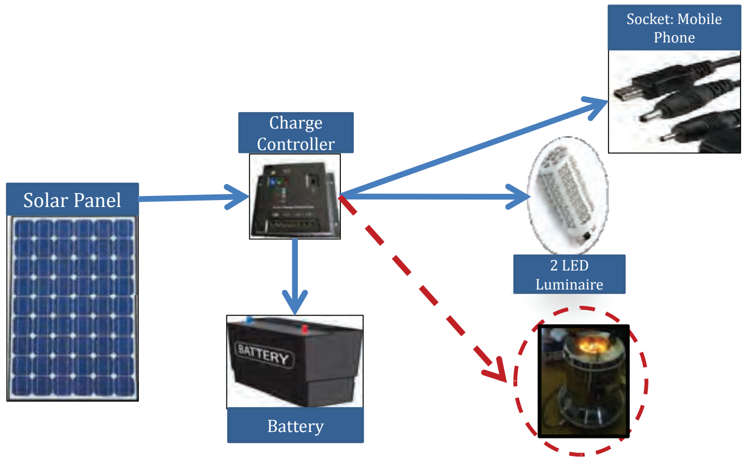
Solar Micro Grid (SMG)

- The SMG is also local entrepreneur driven and comprises of PV panels (e.g. 250 Wp) installed in modular units with required storage allowing generation capacity to scale up easily to meet demand
- DC electricity is distributed over a short distance from the battery banks to cluster of households within the village
- Each household can light up fixed LED lamps for 4-5 hours each night points
- Each household is provided with two 3 Watt LED lamps & facility to charge mobile phone

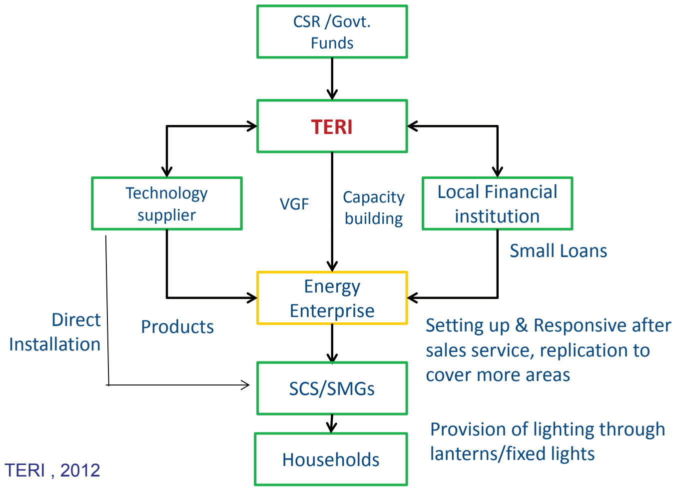


Integrated Domestic Energy System (IDES)

IDES provides access to basic energy from a solar module (20 Wp; 20 Ah battery) for lighting (2 lights of 2-3 Watt each), charging mobile phone and for operating a forced draft improved biomass cook-stove.



What does TERI do?



Source: TERI , 2012

Key Features

Quality products

Quality installations

Technician/ Operator training

Responsive after sales support

User satisfaction

Financing

Capital cost (USD per household)

- Solar Charging Station (SCS) ~ 45 (One portable lantern)
- Solar Home Lighting System (SHLS) ~ 95 (2 lights + mobile charging)
- Solar Micro Grid (SMG) ~ 70 (2 lights + mobile charging)

Financing

- Mix of grant, debt and equity (pro-poor PPP)
- Grant ranges from 30 to 80% (depending on socio-economics/geography)

Tariff (per connection)

- Solar Charging Station (SCS) ~ 5 to 8 cents
- Solar Micro Grid (SMG) ~ 8 cents
- Solar Home Lighting System (SHLS) ~ 8 – 25 cents per month for each household as a service charge

Innovations/Success factors in LaBL

Institutional Innovations

- Fee for Service models – to reach the last mile
- Expanding TERI's presence with the support of grassroots partner organization
- Creation of an "Energy Enterprises" – after sales service network for responsive repair services by local youths

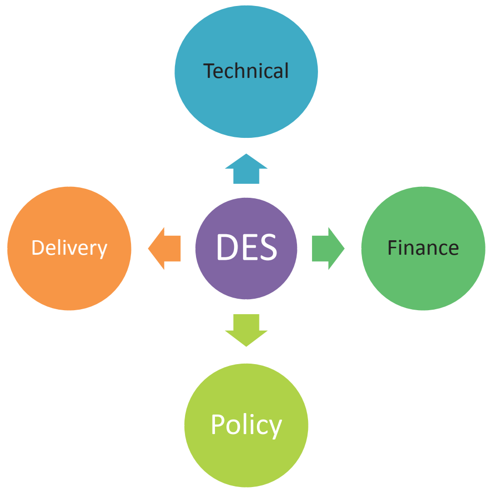
Technological Innovations

- Suite of technological options – SCS, SMG, SHS, IDES
- Continuous technical improvements in solar lighting designs with reputed technology partners, driving down cost, improving efficiency and quality

Financial Innovations

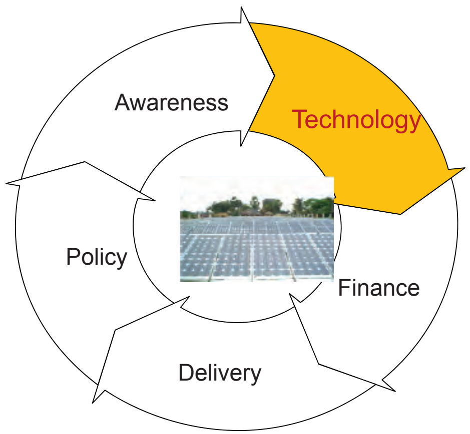
- Graduating from initial grant-based model to a mix of equity, grant and debt based model
- Co-financing with community involvement
- Leveraged government funding
- Leveraged CSR funding

Challenges in Solar Light dissemination



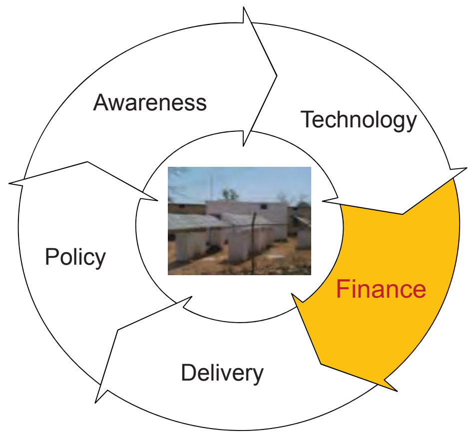
Overcoming challenges ……

Technology ……



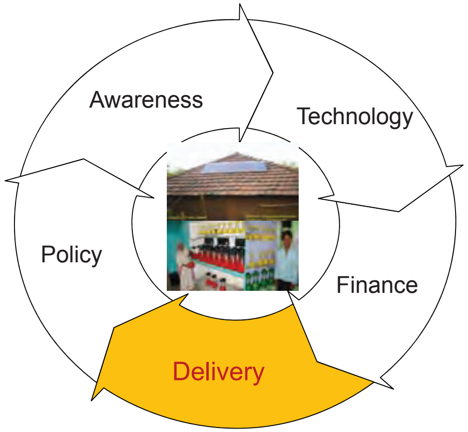
- Untested products/ Absence of benchmarks/standards
- Quality of service
- Limited local technical capacity
- Battery technology still vulnerable (over drawl by most consumers)
- Suite of technology designs/ models; E.g. hybrid models
- New research & pilots by Private sector with enabling policies & mandate by Govt

Financing ……



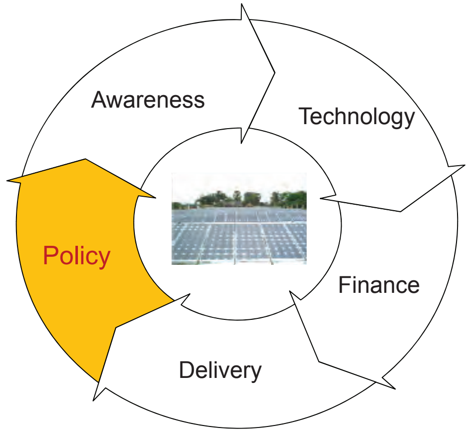
- Financial mechanisms are not in line with income level of poor HHs (the section w/o electricity access)
- Debt financing from banks difficult due to higher perceived financial & technology risks in rural setup
- Improved & affordable access to capital with flexibility along entire value chain/Priority sector lending
- Viability gap funding / Risk guarantee fund
- Low cost fund and Mix of Grant: Debt: Equity

Institutions/delivery ……



- Absence of organized/ structured delivery model in most cases (e.g. involving Utility etc.)
- Lack of standard process and metrics for scaling up
- Last mile access for products and (spares)
- Single Window model vis-à-vis Two Window model
- Reducing costs…New operating models
- Build scale/bundling to cut costs & ensure bankability

Policy……



- Dissemination suffers from uncertainty in political framework conditions
- Cross- subsidy in grid electrified villages/ Regulatory uncertainty
- **Strong political will**

Takeaways

- Service delivery models to be structured considering the uniqueness of the region within which the plant is to be installed -*Today off-grid, grid-connected tomorrow*
- Contrary to prescribed models of off-grid electrification, *top-down approach/organized structure* seems to be working better than community model
- Designing variable tariff structures considering both *ability to pay as well as operational expenses*
- Strong regulatory & policy regime supports development of projects – *Viability gap funding/Results based aid*
- Need to *build local capacity and adopt clustering* for effective maintenance & viability of operation

Assante

Thank You

JICA's Cooperation for Rural Electrification by Renewable Energy

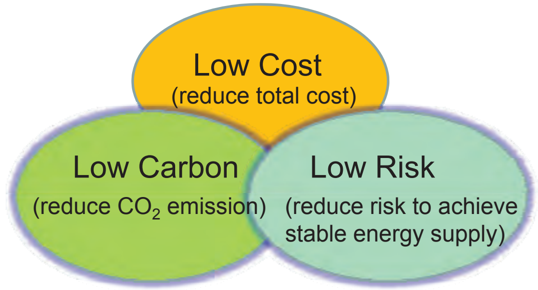
Tadayuki OGAWA
JICA Senior Advisor

3rd February, 2015

JICA's Cooperation in Energy Sector

1. Realize low-carbon societies and sustainable development

3L Policy by JICA



Contribute to achieve sustainable economic growth in accordance with 3L energy supply.

JICA's Cooperation in Energy Sector

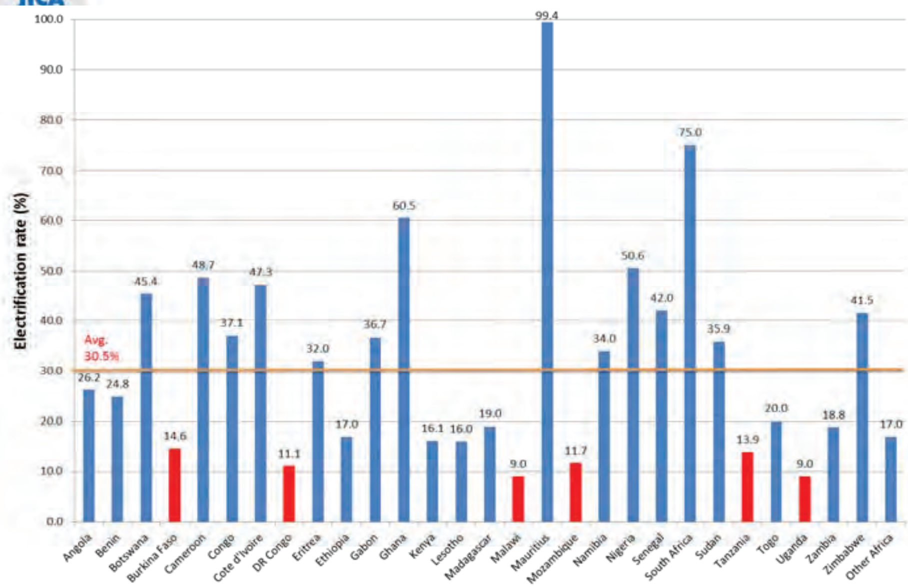
2. Make the best use of Japan's strength

(1) Promoting technologies such as;

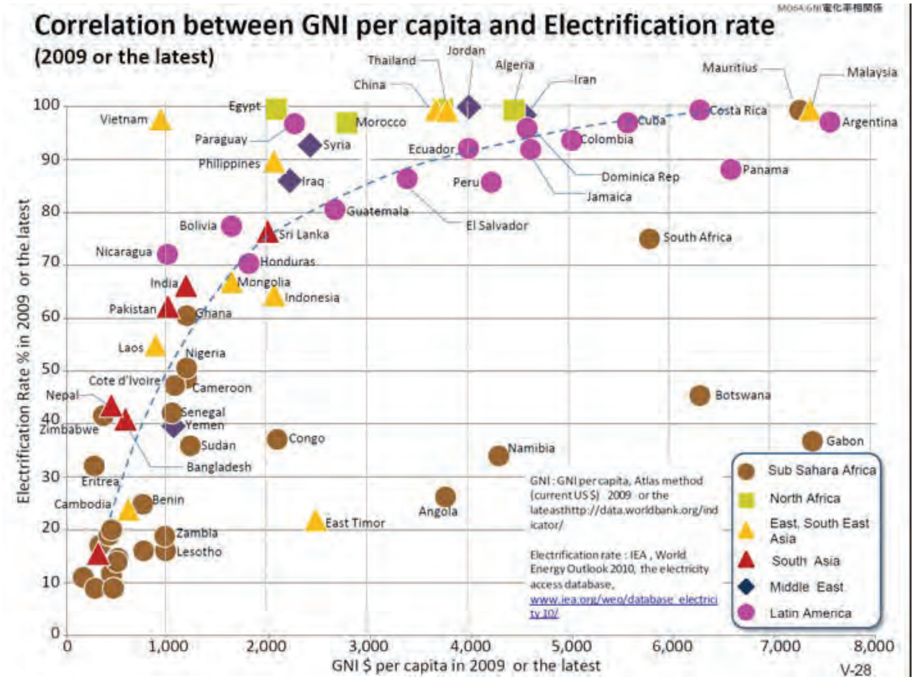
- Thermal power generation (gas combined cycle, Ultra Super Critical (USC) coal fired, etc.)
- Highly-efficient and advanced power transmission & distribution system
- Renewable energy (especially geothermal power)
- Energy efficiency & conservation

(2) Higher priority on expansion & reinforcement of national grid system

Electrification rate in Africa



(Source: IEA World Energy Outlook 2011)



Reference material by Mr. Yoshino

Common barriers

1. Higher unit cost of power supply

- Low population density, dispersed location of customers
- Smaller power consumption (usually less than 30kWh/month)
- Less productive use of power (e.g. agricultural or commercial facilities)
- Less competition among contractors

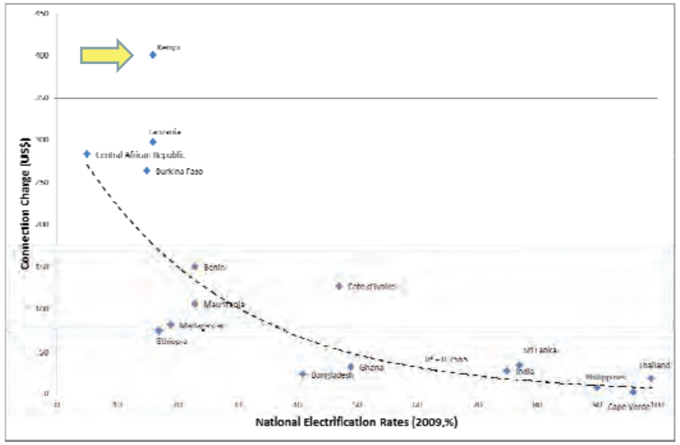
Unit cost per customer, per kWh supply, per km of grid extension are generally much higher than urban area.

2. Lower ability to pay by rural residents

- No periodical income (barter economy, agricultural income, etc.)
- Connection charge (required to pay considerable amount at once)
- Monthly tariff payment (required to pay periodically)

Even if communities are connected with grid, considerable share of households cannot afford to apply for service.

Connection charge and electrification rates



- High connection charges have a dampening effect on electrification rates.
- Connection charges in Sub-Saharan African countries are the highest level in the world.

Common barriers

3. Absence of an appropriate incentive system

- Tariffs and subsidies are not designed to ensure full cost recovery of the investment in rural electrification.
- Tariffs are often too low for well-off in urban area.
- Cross-subsidies are not focused in rural poor.

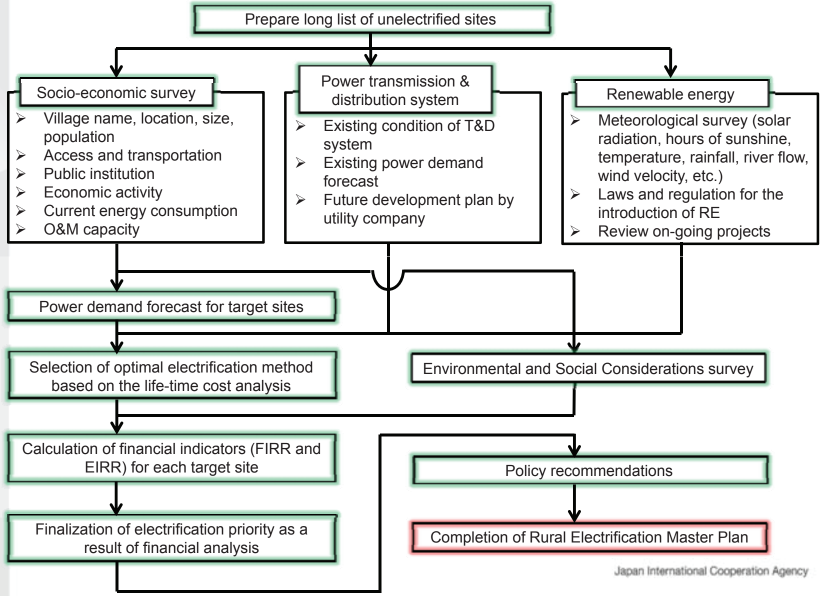
Utilities and other service providers are not willing to invest in rural electrification.

4. Weak capacity of organization concerned

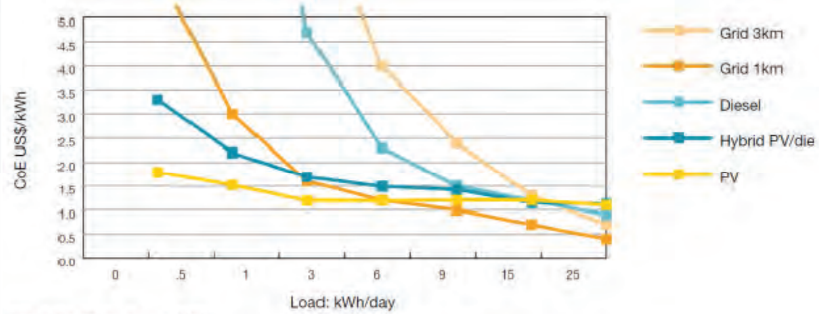
- Budgets and staffs for related Ministries (or REA) are not enough.
- Both technical and managerial capacity are required.
- Political interference due to lack of fair and transparent criteria
- In case of off-grid electrification, capacity building for community organization is critical for the sustainable O&M.

Usually, the capacity of both central and local government need to be developed to implement rural electrification.

Rural Electrification Master Plan



Options for Rural Electrification



Source: Authors' calculations, 2010.
*6% DR; 20 yer life; diesel US$1.1/litre delivered; grid extension at US$15,000/km; grid elect US$0.22/kWh

It is necessary to compare life-cycle cost (not only initial cost) of each available option for rural electrification.

Expanding application of PV systems

	1980-2000	2000-2010	2010- onwards
High Income Countries (EU, Japan, etc.)	• Roof-top grid-connected PV system for household • Off-grid PV system for limited usage (lighthouse, remote areas)	• Medium scale (10-100kW) grid-connected PV system for public and business facilities • Mega-solar system	• Wide-spread dissemination of roof-top PV system for households • Mega-solar system supported by FIT • Smart technology in combination with storage system
Middle Income Countries	• Solar Home System (SHS) for rural electrification • Battery Charging Station (BCS) • PV-diesel mini grid • PV water pump • PV street light • PV navigation light	• Roof-top grid-connected PV system for household	• Grid-connected PV for public facilities • Micro-grid system for island nations • Mega-solar system (Middle East, North Africa, South Asia, etc.)
Least Developed Countries		• Mobile phone and lantern charging business	• Pico solar products (solar lantern, solar kit) in Africa, South Asia

Public → Private

Possible benefit to introduce PV system in developing countries

(1) Diversifying energy resources

It might be possible to mitigate risk against price escalation of imported fossil fuel by diversifying energy resources, especially where power generation is heavily dependent on diesel engine generators.

(2) Extending minimum energy without grid supply

Off-grid PV system can be a solution to provide minimum requirement of energy where grid power supply is not expected in the medium-term perspective.

(3) Mitigation against climate change

Life-cycle GHG emission can be reduced compared with thermal power generation, as small as 4% g-CO2/kWh of coal-fired power plant.

Common issues to introduce PV system in developing countries

(1) Consistency with related policy and plan

In order to introduce PV system for rural electrification, it is necessary to confirm the consistency with related policy and plan (e.g. rural electrification master plan, grid extension plan) .

(2) Establishment of appropriate O&M system

For the purpose of sustainable operation of PV system, appropriate O&M system needs to be established to provide periodical maintenance service, payment collection, trouble shooting, etc. For off-grid PV systems, the amount of payment by users should be determined in consideration of the replacement cost of storage battery and other BOS.

(3) Capacity development

Basic technical training is needed for engineers and technicians in charge of O&M of PV system. Also, more upstream and comprehensive training for policy and institutional arrangement for the introduction of PV system is effective for government officers and utility staff.

(4) Ensuring quality of equipment and installation work

A lot of equipment for PV system is imported from various regions and manufacturers. Therefore, it is difficult to ensure necessary quality of the equipment. To ensure the quality of installation works, national qualification for the installation of PV system is introduced in some countries.

Typical cooperation by JICA

(1) Technical cooperation for rural electrification

As a measure to promote rural electrification, master plan study, feasibility study, and capacity building to introduce off-grid PV system (e.g. Solar Home System (SHS), Battery Charging Station (BCS), PV for public facilities) were implemented.

(2) Programme grant aid for environment and climate change

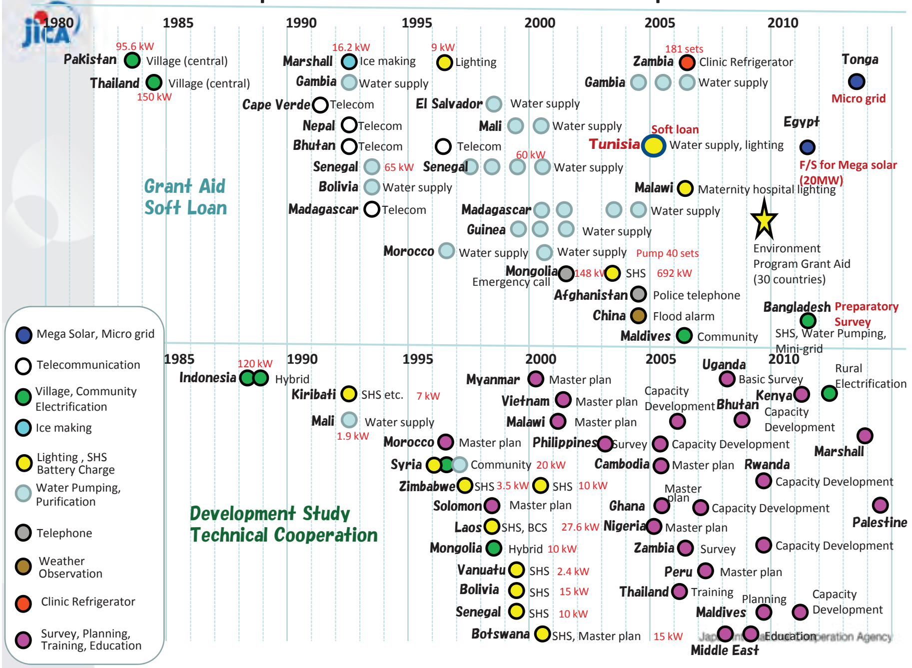
Grid-connected PV systems were introduced at public facilities such as government office, airport, and university. In addition to the procurement & installation of equipment, on-site technical training was conducted as a soft-component (TA) to establish appropriate O&M system.

(3) Mega solar PV system

Feasibility study for mega solar PV system was implemented to promote large-scale PV power plant for the purpose of diversifying generation sources.

Japan International Cooperation Agency

Past Experience of Technical & Financial Cooperation



Development needs for PV

(1) Planning strategy and institutional development (policy, law, and regulation) for the introduction of PV system

1) Grid-connected system: analysis on the maximum capacity of PV system to be interconnected, possible impact on existing grid

2) Off-grid system: development of O&M capacity to ensure the sustainable usage of PV system

(2) Assistance for the planning / designing of particular PV system

(3) Support for establishing certification system of PV components and national qualification system for engineers & technicians to install PV system

(4) Others

Electrification for rural households to utilize minimum lightings, PV vaccine refrigerator, PV water pump, etc. are often requested in rural areas without grid supply based on the particular conditions at sites.

Japan International Cooperation Agency

Solar Home System in Bhutan

- Longer life lighting and smaller PV capacity by the introduction of LED instead of CFL.
- Introduction of maintenance free battery to prevent from refilling wrong water.

Water Pump in Senegal

- Unlike other off-grid PV system, it is not necessary to install storage battery. Thus it can be operated successfully if there exists appropriate O&M system.
- There have been many technical problems for DC-AC inverters.
- Other troubles expected are theft of PV modules, breakdown of pump due to sand coming out of well water.

Street Light in Nigeria

- O&M system by communities shall be established because PV systems are owned by the whole community (eg. Replacement of battery, lighting fixture)
- Lifetime of storage batteries tends to be shorter because they are exposed to high temperature environment.
- Introduction of LED light shall be considered to prolong the battery's lifetime and reduce the capacity of PV system.

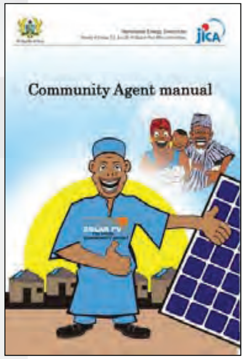
Vaccine Refrigerator in Nigeria

- Coordination with Ministry of Health is important in addition to concerned authorities of energy and rural electrification.
- Only certified equipment by WHO should be introduced for the appropriate temperature control of vaccine (NO general purpose fridge).
- Comparison of life-cycle cost with kerosene and LPG is necessary.

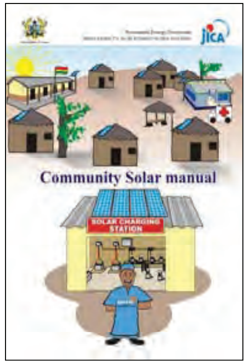
Community Solar System in Ghana

- Mobile phones, solar lanterns, and car batteries can be charged.
- The income from a charging station is used for the O&M of the whole PV system.
- Socio-economic survey is a must to confirm the availability of existing competitors, their charging fee, etc.

Sample Training Materials



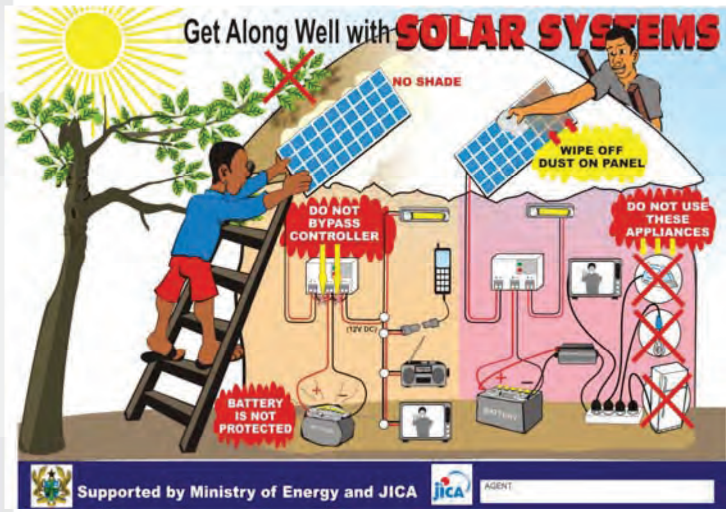
Community Agent Manual



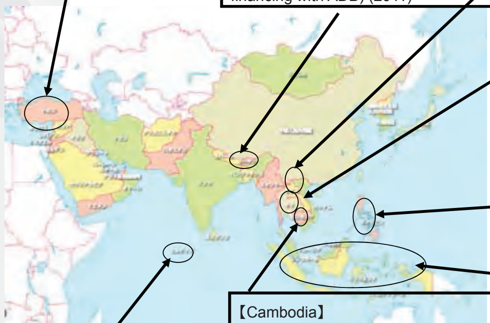
Community Solar Manual

Training of Technicians at Community

User Awareness Raising



JICA Renewable Projects（Asia）



【Turkey】
●The Study on Optimal Power Generation for Peak Demand (2010-2011)

【Bhutan】
●The Integrated Master Plan Study for Dzongkhag-wise Electrification (2003-2005)
●Rural Electrification Project (Co-financing with ADB) (2011)

【Laos】
●Mini-Hydropower Development Project (Grant Aid) (2013)

【Thailand】
●Innovation on Production and Automotive Utilization of Biofuels from Non-Food Biomass (SATREP) (2010-2015)
●Development of New Biodiesel Synthesis (SATREP) (2011- 2015)

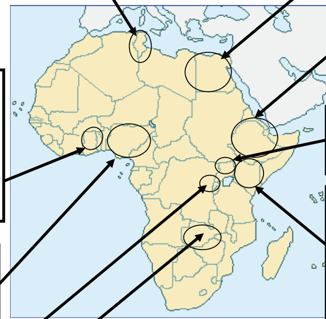
【Philippines】
●Sustainable Improvement of Renewable Energy Development in Village Electrification (2004-2009)
●Mini-Hydropower Development Project in the Province of Ifugao (Grant Aid) (2013)

【Indonesia】
●Master Plan Study for Geothermal Power Development in the Republic of Indonesia (2006-2007)
●Lumut Balai Geothermal Power Plant (Loan Aid) (2010)
●Capacity Development for Enhancement of the Geothermal Development (2010-1013)

【Maldives】
●The Project for Clean Energy Promotion in Male (2008-2009)

【Cambodia】
●The Project of Operation and Maintenance of Rural Electrification on Micro-hydropower in Mondul Kiri (Grant Aid) (2006)
●The Project for Construction and Rehabilitation of Small Hydropower Plants in Rattanakiri Province (Grant Aid) (2013)

JICA Renewable Projects（Africa）



【Egypt】
●Gulf of El Zayt Wind Power Plant Project（Loan Aid）(2010)
●Kuraymat Integrated Solar Combined Cycle Power Plant Project (Co-financing with GEF)（2006)

【Tunisia】
●Photovoltaic Rural Electrification and Water Supply Project（Loan Aid）(2005)

【Ethiopia】
●The Project for Formulating Master Plan on Development of Geothermal Energy in Ethiopia (2013-2014)

【Uganda】
●Project for Master Plan Study on Hydropower Development (2009-2011)

【Ghana】
●The Project on Human Resource Development for dissemination PV systems (2007-2011)
●MP Study on rural electrification by renewable energy resources in the northern part of the Republic of Ghana (2004-2005)

【Kenya】
●Olkaria 1 Unit 4 and 5 Geothermal Power Project (Loan Aid) (2010)
●Project for Establishment of Rural Electrification Model Using Renewable Energy (2011-2015)
●Project for Capacity Development for Promoting Rural Electrification Using Renewable Energy (2011-2015)

【Nigeria】
●MP Study for utilization of solar energy (2005-2007)

【Rwanda】
●The Project for Preparation of Electricity Development Plan for Sustainable Geothermal Energy Development (2013-2014)

【Zambia】
●The Study for Development of the Rural Electrification (2006-2008)
●Increased Access to Electricity Services Project (Loan Aid) (2009)

【Malawi】
●MP Study for Rural Electrification (2001-2003)
●Technical Cooperation Project for Rural Electrification (2006-2009)

JICA Renewable Energy Projects (Latin America)

【El Salvador】
●Renewable Energy Master Plan Study (2011)

【Guatemala】
● Promotion of Productive Activities in Three Villages of Northern Region using Clean Energy (2011-2014)

【Bolivia】
●Preparation Project for Laguna Colorada Geothermal Power Plant Construction Project (2011-2013)

【Peru】
●Master Plan for Rural Electrification through Renewable Energy (2006-2007)
●Master Plan for Development of Geothermal Energy in Peru (2010-2011)

Sample Case of Cooperation (Geothermal)

- Ring of Fire（Asia and Pacific）: Indonesia, Philippines, Peru, Bolivia, Nicaragua, Costa Rica
- Great Lift Valley（Africa）: Kenya, Ethiopia

Geothermal Development in Indonesia

3,900MW to be developed during 2010-2014
Master plan to promote Geothermal Development, identified sites with priority Loan Support for Geothermal Projects (Lahendong, Uruberu, Kamojang)
Support for Human Resources and Institutional Development

Geothermal Power Plant

Sample Case of Cooperation (Wind)

Large-scale Wind Power Generation Project at Targeted Area with Stable Wind Speed and Direction

Zafarana Wind Power Generation Plant in Egypt

Yen Loan Project (13.5 Billion Yen)
Construction of 120MW Wind Power Generation Plant in Zafarana Area along Suezu Bay (220km South East from Cairo)
Contribution to Power Supply increasing, Fossil Fuel saving, GHG reduction (250,000 t/year)
Average Wind Speed 8-10m/s

First CDM Project in Japan ODA

Sample Case of Cooperation (Mini Hydro)

Mini Hydro Power Generation (Grant Aid) at Targeted Area with Stable Hydro potential and Proper Operation & Maintenance

Ifugao Province Mini Hydro Power Generation Project in Philippines

Construction of 800kW Mini Hydro Power Generation using Domestic Renewable Energy in Ifugao Province Northern part of Luzon Island
Contribution to Energy Diversity and GHG reduction
Contribution to Regional economic development and Environmental protection of Ifugao Rice Terraces, a UNESCO World Heritage Site, utilizing revenue from sales of electric power

Mini Hydro Power Generation

Sample Case of Cooperation (Solar PV)

<u>Programme grant aid for environment and climate change</u>

- Installation of Grid-connected PV system to public facilities, such as airport, government buildings, hospitals, etc. (total 30 countries by JICA)
- Grid-connected PV system – enables to operate without batteries and under existing power system
- Expected to lead the introduction of similar system by the recipient government

Public School (Maldives)

Social Center (Maldives)

Sample Case of Cooperation (Solar PV)

International Airport (Palau)

National Hospital (Marshall Islands)

Breakdown of installation under programme grant aid for environment and climate change

Project site	Nos. of installation	Country
①University, laboratory	12	Djibouti, Tajikistan, Belize, Ghana, Federated States of Micronesia, East Timor, Gabon, Bolivia, Egypt, Kazakhstan, Georgia, Moldova
② Public office (Presidential office, Min. of Foreign Affairs, Min. of Education, power company, water supply utility, etc.)	8	Maldives (3)、Pakistan, Cambodia, Federated States of Micronesia, East Timor, Gabon
③ Airport	7	Palau, Afghanistan, Laos, Malawi, Bolivia, Georgia, Lesotho
④ Hospital	4	Tajikistan, Marshall Islands, Yemen, Burundi
⑤ Water supply facility (treatment plant, etc.)	3	Nepal, Cambodia, Nigeria
⑥ Others (major road, power station, primary school, agricultural processing complex, solar home system, etc.)	8	Mongolia, Syria, Uruguay, Maldives (2), East Timor, Palestine, Tonga
Total	42	30 countries

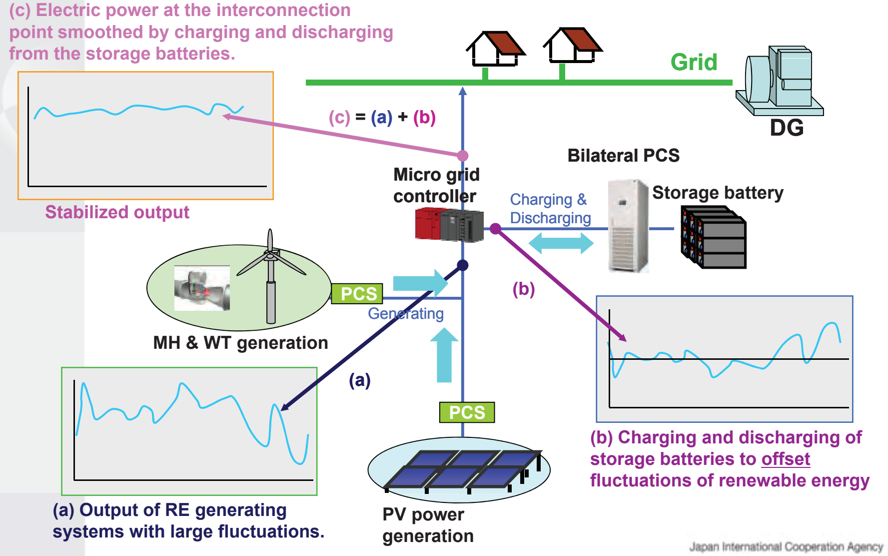
Impact of introducing grid-connected PV system by JICA

They have expedited to introduce grid-connected PV system in each country where off-grid PV systems had been predominantly installed.

(1) They were the first experience in most countries (about 70%).
(2) They could reduce the barrier of institutional arrangements (e.g. power purchase, grid-interconnection code)
(3) Technical assistance has been conducted for sustainable O&M system.
- Group training in Japan
- Soft-component under the project

(4) They could raise the awareness of general public as the project sites are visible (airport, presidential office, etc.)

General Function of Micro grid system



Sample Case of Cooperation (Solar PV + Micro Grid system)


PV array (1000kW)


Micro Grid Controller


Li-ion capacitor (10kWh, 2units)

(Photos: courtesy by Tonga Power Ltd., Yachiyo Engineering Co., Ltd. and Fuji Electric Co., Ltd.)

Penetration of PV power is expected to increase more than 50% during low demand period.

Sample Case of Cooperation (Solar PV) - Technical Cooperation in Philippine -

- Technical training for the off-grid PV system has been provided to engineers & technicians in Department of Energy.
- Practical capacity development by repeating lecture and hands-on training
- Certified engineers with certain level of skills have been dispatched as experts in other countries (Bhutan, Zambia) in similar JICA projects.

Group trainings for solar PV

Training course	Duration	Implementing organization	Feature of training
Solar power generation technology	2.5 months	Osaka City University	Focus on technical training for solar home system
Solar power generation technology (B)	2 months+	Kitakyushu International Techno-cooperative Association (KITA)	Technical training for off-grid PV and grid-connected PV system
Training for Planners to the Promotion of Photovoltaic Power Generation (A) (Main target: grid-connected PV system)	1 month	Kansai Economic Federation / Pacific Resource Exchange Center (PREX)	Convey Japan's experience for introduction of PV system, and deliberate their own policy of introducing PV.
Training for Planners to the Promotion of Photovoltaic Power Generation (C)	1 month	Okinawa Enetech	Technical training for PV - diesel hybrid system

Training for Planners to the Promotion of Photovoltaic Power Generation

- Trainees visit related companies (manufacturers, utility, installation, etc.) and public authorities concerned to convey their needs.
- This will result in establishing partnership between Japan and participating countries.
- Introducing Japan's products and technology
- Group discussion and preparation of wrap-up report

Cooperation policy by JICA

(1) Alternative energy source for diesel power generation in island countries

Introduction of grid-connected PV system can be considered in case fuel consumption of generators can be reduced considerably, and tariff level is high enough to recover O&M cost of the PV system.

(2) Mega-solar power plant

Development of large-scale power plant (PV or CSP) can be considered where higher solar insolation can be expected. Mitigation of the impact on grid-interconnection could be the potential target for cooperation.

Cooperation policy by JICA

(3) Human resource development under group training in Japan

Engineers and officers in charge are invited to participate in technical & planners training. Those training courses are designed to introduce PV system in a sustainable manner, in addition to keep utilizing the existing system.

(4) Rural electrification

After technical & financial comparison with grid electrification and other off-grid energy sources, introduction of PV system can be considered.

Possible tools of cooperation would be two-step loan, assistance through private firms (BOP business, small & medium scale enterprise, etc.), etc. and group training as mentioned above.

Project for Establishment of Rural Electrification Model Using Renewable Energy

Venue: Panafric Hotel, Nairobi

Date	3rd February 2015
Type Of Meeting	International Workshop on Rural Electrification with Renewable Energy

MEMOS OF DISCUSSION

1. Morning First Session

Eng. Kamweru, REA made opening remarks with welcoming participant and summarizing importance of rural electrification and renewable energy. Dr. Dei, JET, introduced project activities and familiarized participants. Mr. Ogawa, JICA, explained JICA's Cooperation for Rural Electrification with explanation of rural electrification situation together with economic growth in the world. Mr. Ndugartitse from Ministry of Energy and Mines, Burundi, presented summarized paper of Burundi Renewable Energy, Current Situation, Opportunities and Challenges

After above presentations, following discussions were held:

The participant inquired Burundi guest about Feed-in-tariff in Burundi. He replied that power purchase agreement determines tariff with respective conditions of the power generation projects.

The participant from Green Africa Foundation asked JICA that although Angola has large economy but the electrification ratio is low, despite that increase of economy promotes Rural Electrification. JICA pointed that the domestic resources in the country have not well utilized for the development.

EAPP Chair inquired to Burundi guest if Burundi has intention of investment for geothermal or hydro while current installed capacity is about 50 MW, and asked if they still want to import power. Burundi guest replied that they are officially importing from Ethiopia and Uganda, and import capacity will be increased but import power increases tariff. He added that Burundi have strategy of developing 20 MW from Indian investment and 50 MW from complex partners such as WB.

The participant from Univ. of Nairobi REA asked if there will be the universal solutions. REA replied that business point of view and national development is different and each has different plan. JICA mentioned that JICA WB, and donors have been supporting energy sector development at the county level, and they have donor's meeting to coordinate to avoid duplication. JICA also added that in this project, REA will disseminate the model and introduce guidelines. Such outcome should be shared among donors too.

2. Morning Second Session

In the second morning session, the presentations from greater East African countries were held. The guests from Ethiopia, Mr. Girma, from Rwanda, Mr. Munyemana, and from Uganda, Mr. Bena presented their papers.

The participant from Univ. of Nairobi asked to Rwanda and Uganda guests about the situation for training. Uganda guest replied that they have research and training center and university for Engineering at higher level. For lower level, there is technical institution to train the technicians electrical works, and they have the module of solar design and sizing. He also mentioned that before Uganda emphasized grid electrification and rural connections in 2001 were only 1%, and now Uganda has national targets as explained. Rwanda guest replied that central government provides trainers training and local authorities also have training capacity. He explained that in Rwanda national capacity building initiative for graduates and industry sector is available.

3. Afternoon Session

In the afternoon session, the representative from REA, Kenya Mr. Gochi presented for PV and wind, Ms. Kelly for biogas, and Mr. On'gonga for MHP. Also, Mr. Garimella, from TERI, India presented about TERI's activity.

The Participant mentioned about low sustainability of rural electrification by PV. REA replied that for rural school electrification projects, qualification is being conducted in tendering and tender document makes importance on quality. REA also explained that Energy Act 2020 enhanced solar installation quality and competence.

The Participant pointed that no actual example was given in biomass and wind, and inquired if. REA visited site and give advises. REA replied that as for Biomass, two biogas projects were implemented, and REA explained the cases of Mangu and Isinya for rehabilitation.

The Participant mentioned about Pre-F/S wind Baragoi project and asked if wind has mechanical problem and how to cope with in case of Baragoi. REA replied that all necessary information is in the Guideline, which is distributed in CD.

The Participant asked about Biogas guideline, how long it can be used, and pointed that new biogas standard at the final stage of preparation. REA replied that the Guideline was developed with validation procedure and the feedback was incorporated. REA also mentioned that the Guideline will continue to be updated when new technology comes online.

4. Discussion Session

Plenary discussion on rural electrification using renewable energy in greater East African countries is held with Participants with the panelist representing REA in Kenya, JICA, and TERI.

The Participant pointed that Rwanda has similar policy with Kenya and they have 100% electrification target for schools, health centers, and public institutions, and inquired how to deal with O&M sustainability.

Rwanda guest answered that electrified schools are encouraged and have obligates to ensure maintain once they have receive electricity, and the contractor has 1 year maintenance obligation. He also explained that schools have mandate to carry out maintenance. Ministry of Health and local government have similar policy and they secure budget for maintenance. The Participant asked if they do not have income generation by charging service. Rwanda answered that for school, they have to raise fund.

The Participant inquired how Rwanda increased electrification from about 15% in 2011 and will achieve 100% electrification by 2020. Rwanda guest replied that EARP (Electricity Access Roll out Program) increased all plans with development partners and donors. EARP grid extension will electrify 40% by 2017-18, and 70% by 2020. The remaining electrification will be achieved by off-grid applications. For that, whole country was mapped and different resources are available. Private investors will have sufficient incentive. RE strategy enhanced such aspect.

The Participant inquired Ethiopia that how the private sector is assisted. Ethiopia guest replied that policy provide support and incentive for private sector. SHS and biogas alternative energy support is provided under ministry.

Kisumu County Chief officer questioned about renewable energy options including domestic biogas. A participant mentioned about TERI business model and inquired if REA looks for business model for hydro and biogas. REA replied that REA will not implement private household level biogas but will provide technical assistance to village or community. Information will be given. REA also mentioned that renewable energy is expensive and capital intensive for business is tricky, thus REA will not go down to business model for small renewable energies. REA encourage institution manager for project participation.

Kisum County Chief Officer also asked if REA reviewed water issues and climate change. REA replied about micro hydro 3000 MW figure is from MoE&P and MoE&P has updated hydro potential information. As for environmental assessment, REA replied that the guideline introduces the requirement of NEMA.

The final comments of Panelists were as follows.

Burundi: Rural Electrification has problems that extension of grid is not possible for long line in terms of economics. Priority is put on private investment.

Ethiopia: Ethiopia has municipal waste energy program by 2020. Kenya interconnects with Ethiopia. The Power generated in Olkaria by KenGen will go into Ethiopian line. Interconnection benefits to share resources. Maintenance is also needed.

Uganda: We will achieve 2040 target. We started renewable energy program from 2002 till now and we are electrifying 7-800,000. Demand is still increasing. Fast implementation is required. Rural access program is constructed with infrastructure development such as road. Small and micro enterprise was formed and they took contract for low-medium voltage line construction. In addition, Uganda has vision of 5000 MW development, which is quite ambitious. Our least cost option is hydropower and 3 projects are under construction (600 MW Karuma under construction, 600 MW Ayago, and one more). For below 20 MW, we have FIT 9-10 cents/kWh, and 170 MW is under Tendering. Procurement of 20 MW PV was finished and will be commissioned in 10 months.

Rwanda: Methane is not very common and has some challenges. Construction management is also challenging. 50 MW methane gas to power plant will be started by 2018. It will be the pioneer. For capacity building, Rwanda has National Capacity building Secretariat, which is in operation

TERI: Rural household affordability for renewable energy is already there. Lower price of Lighting Africa will help. But they do not care about certificates for quality. For marketing in villages, at present there is no household profiling. Household cash flows should be assessed such as harvesting season for marketing. Which product is suitable for which household should be suggested.

JICA: As for issue of penetration of renewable energies, islands countries have rapid increase of renewable energies, which affects operation of utility company. In case of Japan, after 2012, FIT large scale Mega-solar caused confusion and some utilities companies refused to accept mega-solar. Small nations will face this issue due to increasing renewable of energy. It may need to consider to limit the level of introduction of renewable energies.

Dr. Dei, JET: From 2012, we worked with REA. REA is very busy and difficult to share the time. However, they tried to understand and today they showed good presentation. We are happy. We created guidelines for technologies with cooperation of REA. We expect REA staff grow strong. Thank you for three years.

Way Forward

As the last session, Mr. Rogoncho, Design Department of REA, closed the session with mentioning about importance of human development, financing for energy development, public private sector partnership, interchange programs, and technology transfer for rural electrification using renewable energy.