Feasibility Studies with the Aim of Developing
Bilateral Offset Credit Mechanism
FY 2011
(Studies for Project Exploration and Planning)

Geothermal Power Generation Project in the Great Rift Valley

New Energy and Industrial Technology Development Organization (NEDO)

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1.1 Outline of Studies for Project Exploration and Planning

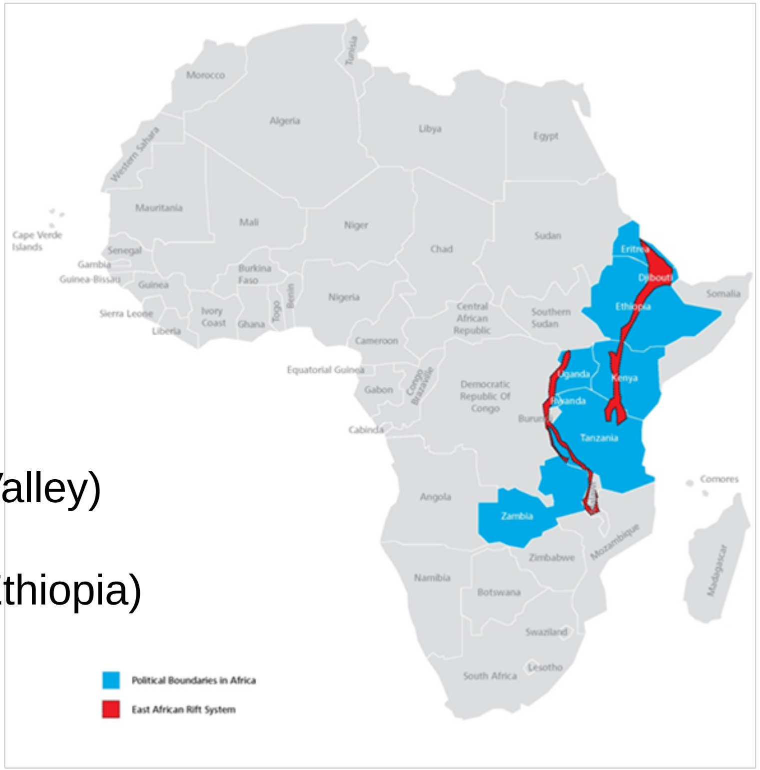
Purpose of Feasibility Studies (F/S)

- Conducting feasibility studies on geothermal power generation in the Great Rift Valley and developing methodologies for the measurement of GHG emission reduction.
- In addition, risks pertaining to geothermal development and possibility of financing are considered.

Studied Area

- 8 countries in the Great Rift Valley Area
  Djibouti, Ethiopia, Eritrea, Kenya, Rwanda, Tanzania, Uganda and Zambia
- Focusing particularly on Ethiopia, Djibouti and Rwanda

Map of countries researched in the Great Rift Valley



Applied Technologies

- Geothermal power generation

F/S Members

- Deloitte (Preliminary Research for the entire Great Rift Valley)
- Mitsubishi Heavy Industries (Djibouti)
- Marubeni Corporation & Mitsubishi Research Institute (Ethiopia)
- Sumitomo Corporation (Rwanda)

1.2 Great Rift Valley's Geothermal Perspectives

- In the Great Rift Valley region, demand for electricity has tremendously increased over the past years and the electrification rate is still low. Development of geothermal energy can serve as one of the significant solutions to the aforementioned problems.

- According to the Geothermal Energy Association (GEA), potential of geothermal energy in the Great Rift Valley is estimated at 14,000 MW.

- 163 MW of geothermal capacity in Kenya has already been installed and a 7.3 MW geothermal pilot plant in Ethiopia are already under operation.

- Although no other countries currently generate electricity using geothermal power, a majority of the countries are proceeding with preliminary exploration and appraisal drilling.

Geothermal Energy Overview of 8 countries

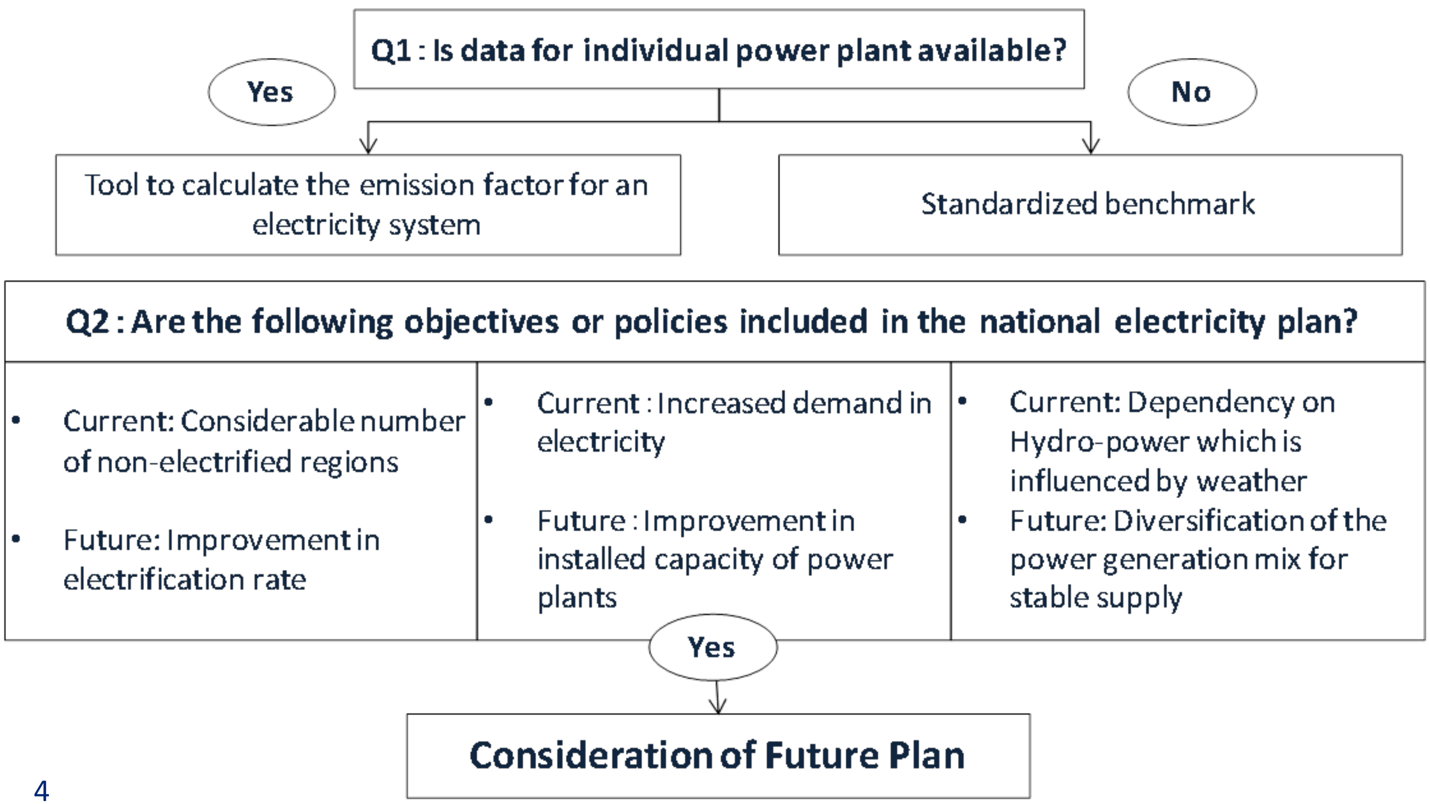
	Djibouti	Ethiopia	Rwanda	Kenya	Eretria	Tanzania	Uganda	Zambia
Geothermal Potential (MW)	230-860	5,000	>700	5,000	<100	150-650	450	-
Installed Capacity (MW)	0	7.3	0	163	0	0	0	0
Geothermal Power Under Development (MW)	-	75	-	280	-	-	-	-

1.3 Methodologies for measuring GHG emission reduction (part 1)

- It is inappropriate to simply apply the UNFCCC's ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" for registering CDM projects as it is challenging to obtain operational data for each power plant.

- Therefore, each methodology is considered for 4 cases in these studies based on the flow diagram below.

Classification of cases upon considering methodology



	Q1	Q2
Case 1	Yes	No
Case 2	Yes	Yes
Case 3	No	No
Case 4	No	Yes

1.4 Methodologies for measuring GHG emission reduction (part 2)

- Each methodology for 4 cases are explained as follows. Note that there are some conditions and exceptions applied for each methodology.

Overview of Methodology

Case 1

In general, values are calculated by applying Combined Margin (CM) accordingly to the UNFCCC's "Tool to calculate the emission factor for an electricity system (ver. 02)" for CDM projects.

Case 2

In general, the UNFCCC's "Tool to calculate the emission factor for an electricity system (ver. 02)" for CDM projects should be applied. However, the following conditions should also need to be applicable:

- ･Adjustment in BM (when there is discrepancy between past performance of power plants and the future plan)
- ･Adjustment in ratio of OM:BM (considering situation of demand increase of electricity, BM should be given more weight)

Case 3

In general, values are calculated by applying an emission factor accordingly to the UNFCCC's "Guidelines for the Establishment of Sector Specific Standardized Baselines" for CDM projects.

Case 4

In general, values are calculated accordingly to the UNFCCC's "Guidelines for the Establishment of Sector Specific Standardized Baselines" for CDM projects, but the following concepts should also be taken into account upon benchmarking a baseline.

1.5 Potential of Emission Reduction

- Based on the methodologies for GHG emission reduction, a total estimated emission reduction for each generator is calculated as per below.

Potential of Emission Reduction for each generator

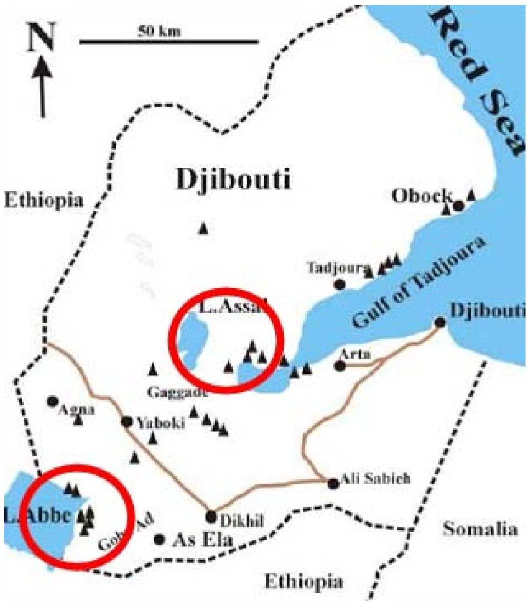
	Methodology applied	Generator Capacity (MW)	Total Estimated Emission Reduction (t-CO2/year)
Djibouti	Case 2	50	235,796
Ethiopia	Case 4	75	185,661
Rwanda	Case 2	75	376,840

2.1 Feasibility study for Project in Djibouti (Part 1)

Outline of F/S

- Conducting feasibility study mainly on the followings:
  - ➢ Analysis of Geothermal Resources
  - ➢ Preliminary Design of Power Plant
  - ➢ Estimation of Capital and Operating Cost
  - ➢ Calculation of amount of CO_2 Reduction and Credit
  - ➢ Study of application for BOCM

Map of Lake Assal and Lake Abbe



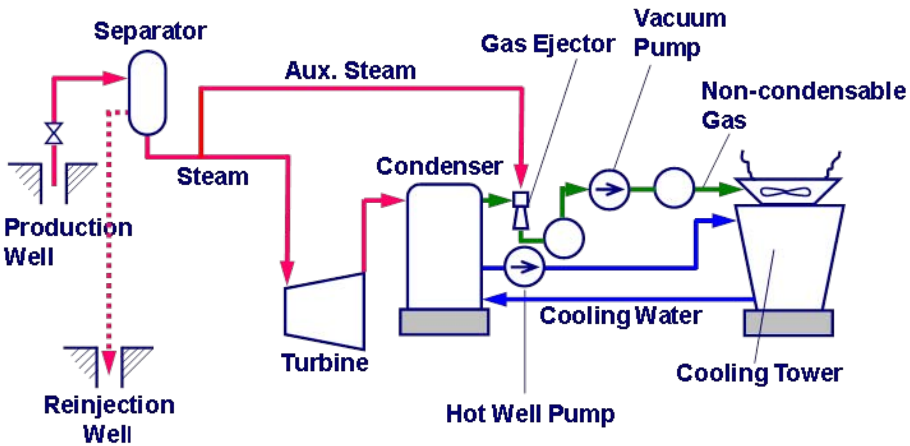
Studied Area

- Lake Assal
- Lake Abbe

Project Outcomes (Estimate)

- If a 50MW geothermal power plant is installed, CO_2 would be reduced by 236K tons per year.
- The project company (IPP) will enjoy $2.4Mil per year for 10 years. ($10/ton).

Single Flash Cycle



Applied Technologies

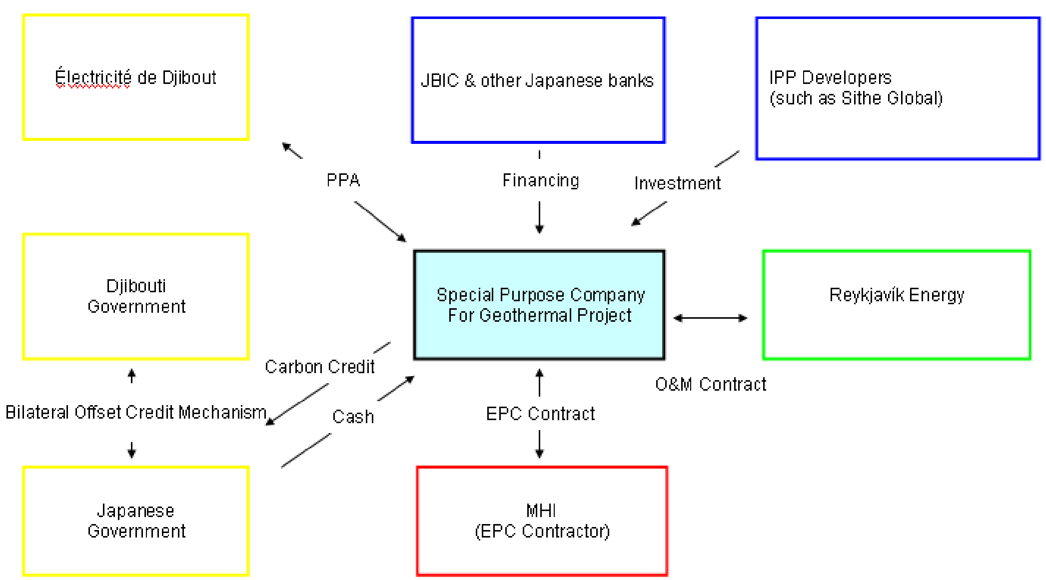
- Single Flash Cycle (50 MW x 1 Unit)

2.2 Feasibility study for Project in Djibouti (Part 2)

- The project is planned to be structured as the diagram below. A Special Purpose Company (SPC) would be established and the Mitsubishi Heavy Industries (MHI) would agree upon EPC contract to build a power plant. Financing, PPA and investment on the project would be arranged as below.

- The project is scheduled as below. If the project runs as it is initially planned, the results of drilling could be determined in April 2013.

Preliminary Scheme



Project Schedule

Time	Event
Mar, 2012	**World Bank Board Approval** **(to proceed with exploratory drilling)**
May, 2012	**Exploratory Drilling Tender**
Jul, 2012	**Start of Exploratory Drilling**
Feb, 2013	**Completion of Drilling and Flow Test for 3 Months**
Apr, 2013	**Test Results**

2.3 Issues/Limitations of CDM Methodology

- As the situation of electricity sector in Djibouti is unique, there are issues and limitations of simply applying the current methodology for registering CDM projects.

The current situation of electricity sector in Djibouti:

- The grid system consists only of two diesel power plants
- Dependence on imported fossil fuel
- Low electrification rate of 50%
- Commenced electricity import from Ethiopia in May, 2011
- Electricity demand will be doubled within the next 15 years

Issues/ Limitations of CDM Methodology:

- Only considers the existing grid systems, but not any future development plans
- In countries with low electrification rate, implementation of renewable energy project reduces the grid emission factor
- Difficulties with collecting detailed data on imported electricity

2.4 Emission Reduction Calculation Results (based on ACM0002)

- Amount of emission reduction from the project is calculated as the below.

<Baseline Emissions>

$$BE_y = EG_{PJ,y} \times EF_{grid,CM,y}$$

BE_y	Baseline emissions in year *y*	267,618	tCO_2/year
$EG_{PJ,y}$	Net electricity supplied to the grid by the project in year *y*	366,600	MWh
$EF_{grid,CM,y}$	CO_2 emission factor for grid connected power generation in year *y*	0.73	tCO_2/MWh

<Project Emissions>

$$PE_y = PE_{FF,y} + PE_{GP,y} \quad PE_{GP,y} = (w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}) \times M_{steam,y}$$

PE_y	Project emissions in year *y*	31,821.67	tCO_2/year
$PE_{FF,y}$	Project emissions from fossil fuel consumption in year *y*	0	tCO_2/year
$PE_{GP,y}$	Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year *y*	31,821.67	tCO_2/year
$w_{steam,CO2,y}$	Average mass fraction of carbon dioxide in the produced steam in year *y*	0.001299	%
$w_{steam,CH4,y}$	Average mass fraction of methane in the produced steam in year *y*	1.2×10^{-6}	%
GWP_{CH4}		21	-
$M_{steam,y}$		24,030,432	t stream/year

<Emission Reductions>

$$ER_y = BE_y - PE_y$$

ER_y	Emission reductions in year *y*	**235,796**	tCO_2/year

2.5 Consideration of MRV for BOCM

- The below shows proposed MRV overview for the Bilateral Offset Credit Mechanism (BOCM).

	Key points of proposed MRV for BOCM
M	• Consideration of the “Suppressed Demand” case; reduction of future emissions due to the expected demand increase • Determination of standardized baseline by the host country • Preparation of positive list of certain types of technologies/ measures by the host country for the establishing of projects’ additionality
R	• Reporting before (project plan) and after (monitoring results) the project implementation is desirable • Flexible reporting style with minimum requirements (e.g. like ISO14064, and the GHG protocol to a certain extent)
V	• Validation/ verification by a certified third party (e.g. ISO14065) • Place stronger emphasis on verification

3.1 Feasibility study for Project in Ethiopia (Part 1)

Outline of F/S

- Conducting feasibility study mainly on the followings:
  - ➢ Since financial arrangement is main issue to implement the project, F/S considers appropriate financial schemes including Japanese ODA and additional benefit of emission credit.
  - ➢ Since Ethiopia is excluded from the benefits of CDM, F/S proposes the new options for methodology/MRV which will be optimized to Ethiopia

Studied Area

- Aluto-Langano

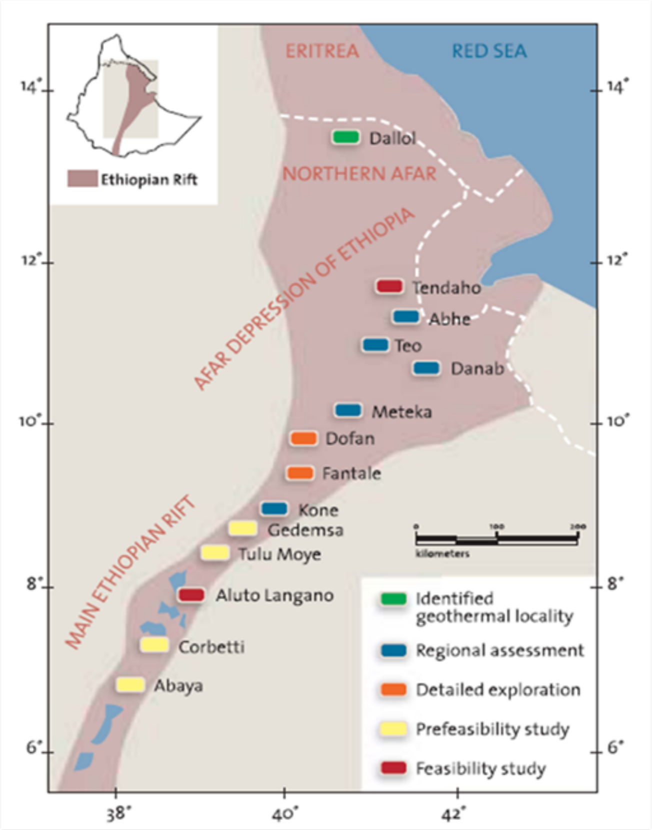
Project Outcomes (Estimate)

- If a 75MW geothermal power plant is installed, CO_2 would be reduced by 194K tons per year.

Contribution of Geothermal Power Generation

- Ensure a stable electricity supply and fill a gap of electricity shortage in Ethiopia.
- Archive significant GHG emission reduction compared to fossil fuel power generation
- Save cost of importing fossil fuel (e.g. Diesel)

Geothermal Resources Exploration and Development in Ethiopia



Reference: "Strategy for Geothermal Resource Exploration and Development in Ethiopia" 「Geosciences」Mar 2006

3.2 Feasibility study for Project in Ethiopia (Part 2)

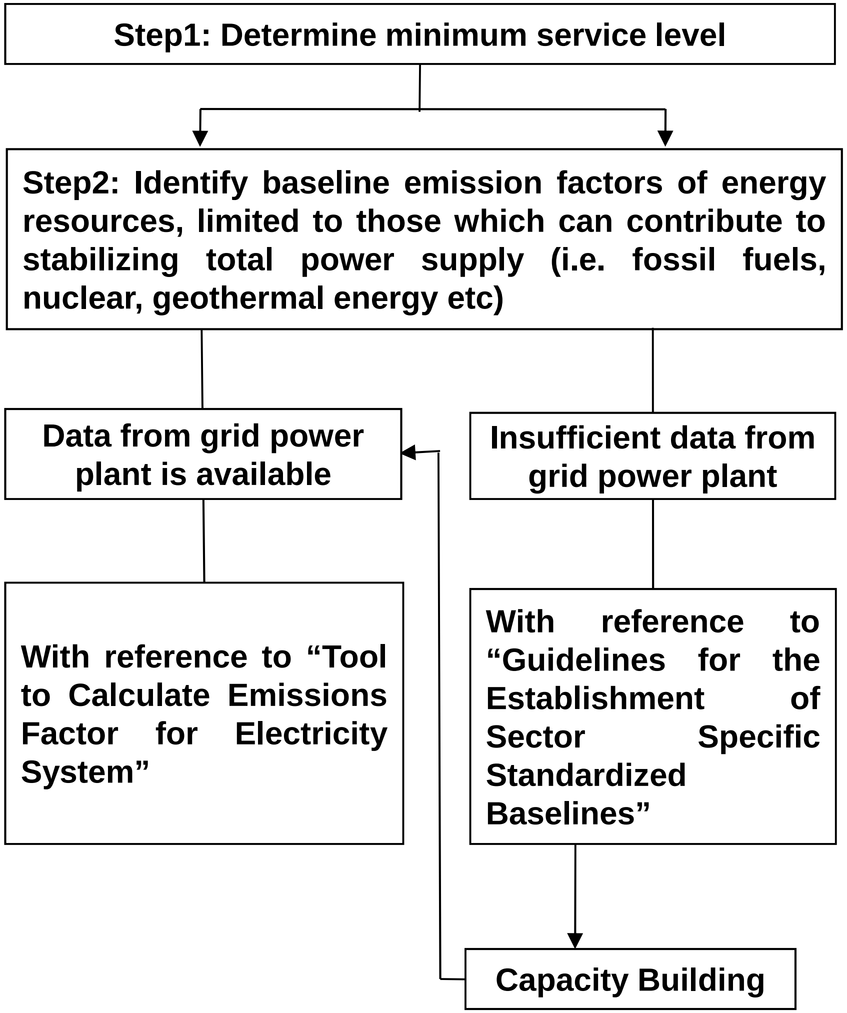
Estimation of Emission Reductions

- Diesel is chosen as baseline technology
  - ➢ No sufficient data to calculate grid emission
  - ➢ Of all available energy sources, diesel and geothermal energy help stabilize power supply
  - ➢ Initial investment and advanced technological capability required to develop geothermal plants.
- Emission reductions: 185,661 t-CO_2

Economic Evaluation

- Project Financial Internal Rate of Return (Phase-III)
  - ➢ Revenue obtained from bilateral offset credit: 7.38%
  - ➢ Without revenue from bilateral offset credit: 6.89%
- Prospect for financial arrangements
  - ➢ Funding from SREP program (Scaling Up Renewable Energy `Program in Low Income Countries)
  - ➢ Grants from other MDGs (Multilateral Development Bank)
  - ➢ Financial aid from Japanese government such as yen-loan.

Method for calculating baseline emission factors for a country with insufficient electricity supply and more than 50% hydro power_



4.1 Feasibility study for Project in Rwanda

Outline of F/S

- Conducting feasibility study mainly on the followings:
  - Possibility of development for geothermal power project
  - Calculation of CO_2 reduction amount
  - Research on current grid condition
  - Appropriate plan for transmission lines and substations in connection with geothermal power development.

Map of Studied Areas

Reference: National Online Project (edited by investigation team)

Studied Area

- Karisimbi
- Gisenyi
- Kinigi
- Bugarama

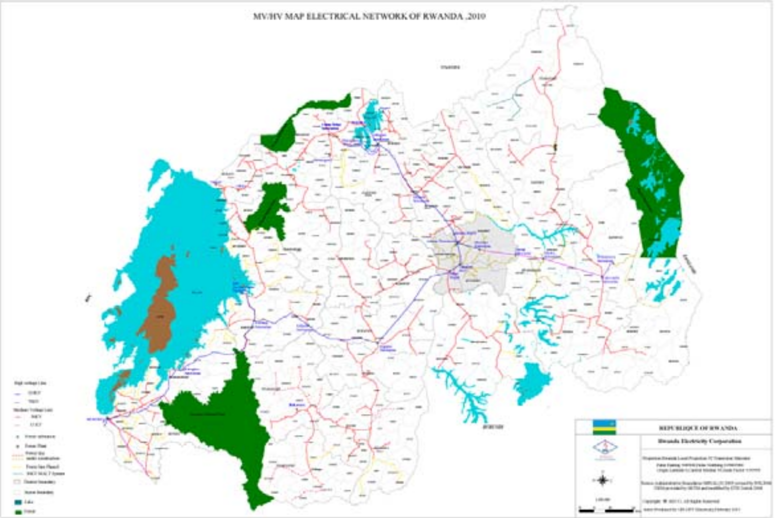
Project Outcomes (Estimate)

- If a 310MW geothermal power plant is installed, CO_2 would be reduced by 1.5 million tons per year.
- In order to develop such plant under the Electricity Development Strategy by the MINIFRA, technical and financial supports from abroad are necessary due to risks associated with geothermal development and enormous cost.

4.2 Grid Structure and Plan for Interconnection in Rwanda

Current grid condition in Rwanda

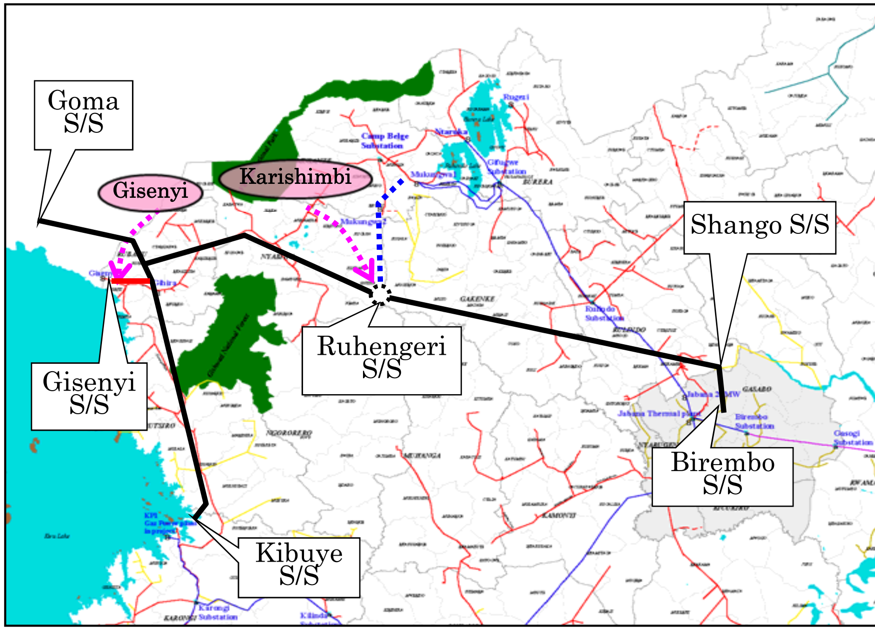
- Main network system of Rwanda is consisting of high voltage (HV) network by 110 kV and 70 kV, and medium voltage (MV) network by 30 kV and 15 kV.
- 110 kV network is operated in the northern and the southern transmission line separately due to the unstable network in southern area.



Reference: EWSA annual report 2010

Plan for Interconnection

- In order to provide electricity generated by Karisimbi and Gisenyi geothermal power plants, it is necessary to construct new and higher voltage (i.e.220kV) transmission line.
- Moreover, the above should be connected to the transmission line which will be constructed between Lake Kivu and Kigali city by the Electricity Development Plan of the MININFA.



Reference: "Feasibility Study for 220 kV Overhead Transmission Line Kibuye-Gisenyi-Goma and Gisenyi-Birembo (Kigari)" by Fichtner