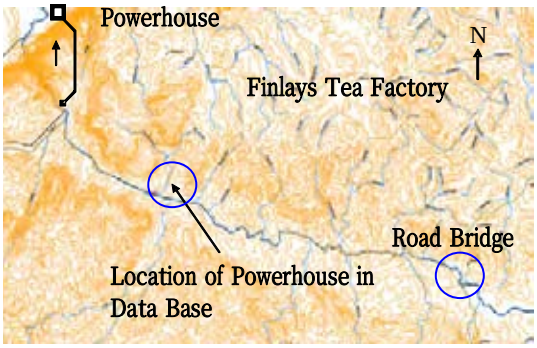
2. Uganda

Photo U-1 Small Hydro Potential Site in Mpanga River (2009/5/14)

Upstream View in Mpanga River (0.4 MW)

Downstream View in Mpanga River

Photo U-2 Small Hydro Potential Site in Muzizi River (2009/5/15)



Location Map (Head 385 m, 20 MW)

Road Bridge over Muzizi River

Photo U-3 Muzizi Finlays Tea Factory (Biomass Gasification Power Generation) (2009/5/15)

Tea Plantation and Workers Houses

Biomass Gasification Power Plant (205 kW)

Photo U-4 Small Hydro Potential Site in Kakala River (2009/5/15)

Upstream View (Head 175 m, Power 7.2 MW)

Downstream View of Kakala River

Photo U-5 Small Hydro Potential Site in Rwimi River (2009/5/15)

Upstream View of Rwimi River

Upstream View of Rwimi River at Road Bridge

Photo U-6 Small Hydro Potential Site in Mubuku River (2009/5/15)

Upstream View of Mubuku River (Two Existing and an Under Construction Power Stations)

Substation near Mubuku River

Photo U-7 Bugoye Small Hydropower Station under Construction in Mubuku River (2009/5/15)

Start in Jan. 2008 and Completion in Sept. 2009

Waterway along Contour Line

Pressure Pipe Line (Discharge $10m^3$/sec, Head 160 m)

Powerhouse (13 MW, 2 Units×6.5 MW)

Photo U-8 Mubuku I Power Station under Operation in Mubuku River (2009/5/15)

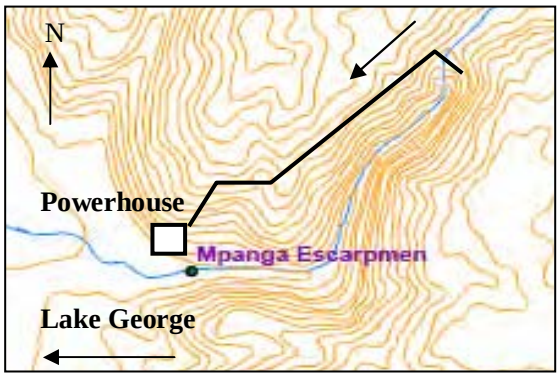
Steel Pipeline and Power Station (Kilembe Mines Ltd.)

Power 5.4 MW (3 Unites×1.8 MW)

Powerhouse

Discharged Water and Intake of Bugoye Power Station

Photo U-9 Mpamga Fall Hydropower Station under Construction in Mpanga River (2009/5/16)



Head 111 m, 18 MW

Lake George (Project Site 30 km far on the other side)

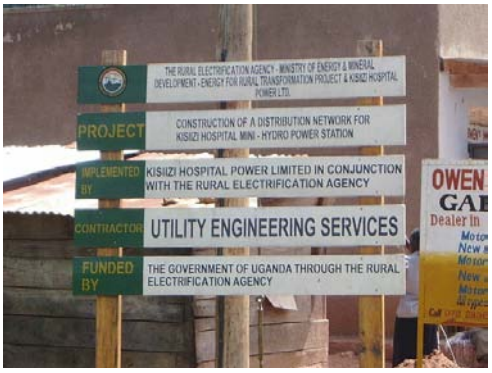
Photo U-10 Small Hydro Potential Site in Kyambure River(2009/5/16)

Kyambure Valley

Kyambure Valley

Photo U-11 Kisizi Hospital Small Hydropower Station and Mini-Grid Construction Project (2009/5/16)

Kisizi Hospital established in 1950s



Kisizi Hospital Power Ltd. in Conjunction with REA

Intake Weir of Power Station

Intake of Power Station

Two-Lane Waterway

New Powerhouse completed in Feb. 2009

Head 50 m, Discharge 1 to 1.5 m^3/sec, 300 kW

33 kV Transmission and 240 V Distribution Lines

Photo U-12 Bwindi Community Microhydropwer Scheme assisted by GTZ (2009/5/16)

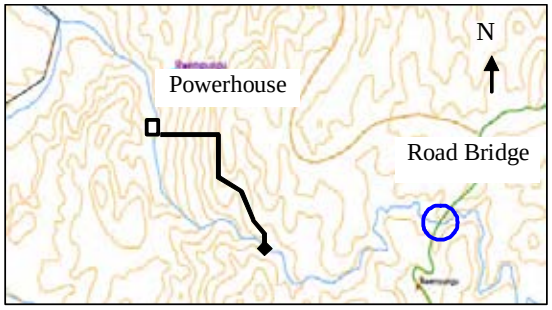
Targeted Completion in 2009

Waterway (0.8 m wide, 1 m deep)

Construction Site of Waterway and Powerhouse

Powerhouse under Construction (Head 40 m, 60 kW)

Photo U-13 Rwempungu Small Hydropower Potential Site in Nchwera River (2009/5/16)



Location Map (2.3 MW)

Road Bridge over Nchwera River

Upstream View of Nchwera River

Downstream View of Nchwera River

Photo U-14 Small Hydropower Potential Sites in Foothills of Mt. Elegon (2009/5/21)

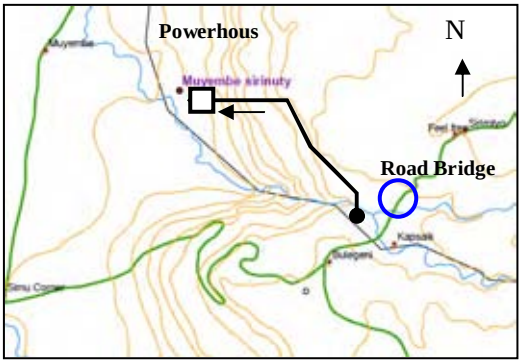
Second Fall from the Upstream in Sipi Falls

Third Fall from the Upstream in Sipi Falls

Fall upstream of Simu River

Automatic Water Level Gauging Station

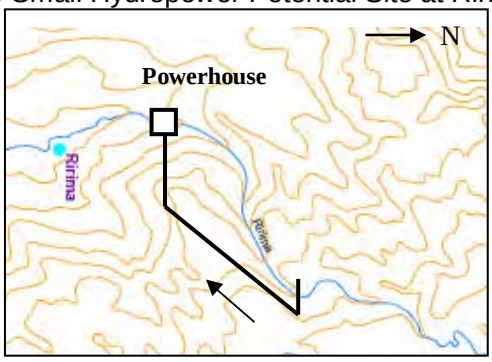
Photo U-15 Small Hydropower Potential Site at Muyembe in Foothills of Mt. Elegon (2009/5/21)



Location Map (Head 213 m, 5 MW)

Downstream View of MuyembeRiver at Road Bridge

Photo U-16 Small Hydropower Potential Site at Ririma in Foothills of Mt. Elegon (2009/5/22)



Location Map (Head 183 m, 2.5 MW)

Upstream View of Ririma River at Intake

Photo U-17 Owen Fall Power Station in Nile river (2009/5/23)

Owen Falls Dam (Nalubale Power Station, 180 MW)

Kiira Power Station (200 MW=4 Units×50 MW)

Photo U-18 Bujagali Hydropower Station Site Under Construction (2009/5/23)

Construction Works on Left Bank, Planned Completion in 2011

Construction of Powerhouse (5 Units x 50 MW, Photo by MEMD)

Photo U-19 Hydropower Potential Site at Karuma in Nile River (2009/6/3)

Karuma Fall (750 MW)

Downstream View of River (Waterway on Left Bank)

Photo U-20 Hydropower Potential Site at Ayago in Nile River (2009/6/4)

Ayago Fall (300 to 500 MW)

Downstream View of River (Waterway on Left Bank)

Photo U-21 Battery Charging Business for Mobile Telephones with PV (Photos by the Study Team for Public Facility Electrification)

PV Module for Battery Charging

Inverter

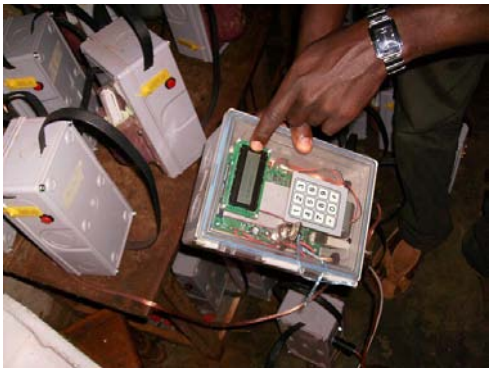
Batteries

Battery Charging Business for Mobile Telephones (Ush 300 to 500 per time)

Photo U-22 Battery Charging Business for Rechargeable Lanterns with PV (Photos by the Study Team for Public Facility Electrification)

Business at Three Locations with 100 Households each

2 Sets of PV Modules of 120 Wp



Charging Control made with Registered No. of Lanterns

Guarantee Money at USh 20,000 and Charging Fee at Ush 1,000 per time

Photo U-23 Sale Business of PV Facilities in Kampala (2009/5/7-8)

PV Module

Hearing at Sale Shop

PV Facilities

PV System made in Indonesia

Photo U-24 Status of PV Use (May 2009)

Health Center at Kanyabwanga in West Ankole District

Private House at Kagadi in Kabarole District

Hotel at Kyenjojo in Kabarole District

Hotel with 20 Sets of PV Modules of 80/85 W

Photo U-25 Cogeneration at Kakira Sugar Works Ltd. (2009/5/23)

Bagasse

Sugar Refining Plant

Steam Boiler

Steam Turbine and Generator of 16 MW

Photo U-26 Center for Research in Energy and Energy Conservation(CREEC) (2009/5/19)

Research of Biomass Gasification Plant

Research of Small Hydro Generator of 200W

Photo U-27 Hydraulic Turbine manufactured by Jincol Turbine Ltd. (Photo by Jincol Turbine Ltd.)

Turbines made in Switzerland (Left) and Uganda (Right)

Cross Flow Turbine (28 W)

Appendix 2

Supplement to Human Resource Development

Proceeding with human resource development for dissemination of renewable energy in private business is complemented as follows:

1. Strategic cultivation of entrepreneurs:

Renewable energy is a new technology which is not popular in Kenya and Uganda. It is necessary to create new business models and start up new business to disseminate such technology as a private business basis. The required human resource will consist of those who can start up businesses related to renewable energy, which are also the subject of target human resource development.

2. Human resource development of management and maintenance under planned economics:

The required characteristics of human resources to be developed may vary. Unlike the private business basis, the government or donor has responsibility for the establishment of renewable energy as a national plan, which decides capacity of facility and timing of installation such as planned economics. There is no necessity for entrepreneurship since the diffusion and expansion of renewable energy are done not by entrepreneurs in the case of private basis. Required human resources only consist of those who can manage and maintain the facility/equipment. Moreover, cultivation of human resources to be focused on such requirement is considered effective.

3. Cultivation of private sector's function utilized by the nation:

The reason in promoting renewable energy on private business basis is attributed to the significant financial burden to be borne by the nation and inefficiency under planned economics. The issues are caused if the nation is designated as the implementation body for promoting/expanding renewable energy. What the nation tries to utilize is private funds and the willingness and ability to create new business in self-directive manner. The latter is the exact characteristics of entrepreneur. Development of such functions and characteristics is effective at the stage of promoting/expanding renewable energy.

4. Entrepreneur and Engineer:

Human resource development targeting improvement of ability to start up new business is an effective strategy to promote/expand renewable energy, utilizing private sector's functions. Of course, technology is necessary to start and continue the business. However, entrepreneur and engineer do not need to be two different individuals. There are some cases that entrepreneur is an excellent engineer. Even in the case of training for cultivation of an engineer, that training should include the function to cultivate entrepreneurship.

5. The point of view of personnel to be cultivated by the training:

From the point of view of personnel to be cultivated, the most important is whether he/she can earn a living and engage into a professional work related to the skill and knowledge cultivated by the training. According to the interview at a course of renewable energy in Makerere University, most graduates are working in business not related to renewable energy since there is no work related to such discipline. Some of them are working for construction firms which build mobile phone stations. Although there is no problem in human resource development for any profession, it is unsatisfactory if the training for specific field will not lead to job opportunities. Creating job opportunities should be initiated prior to such training on specific fields.

Appendix 3

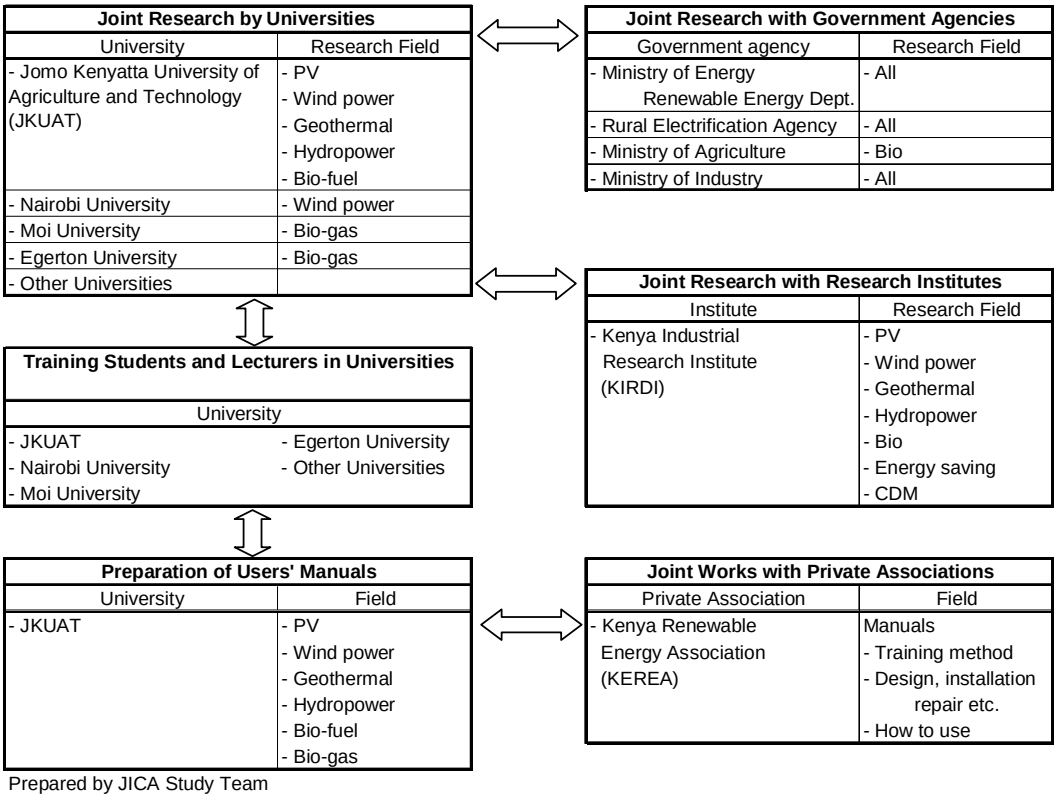
Support for Human Resources Development by Japan

1. Kenya

(1) Human Resources Development in Renewable Energy Field

Universities, government agencies, research institutes and private associations have been individually training personnel related to renewable energy. The Study Team proposes a comprehensive program to develop human resources for renewable energy as shown in **Figure 1-1**. This program consists of training of researchers and students in universities, staff of government agencies, research institutes and private associations, and preparation of lecturer's and user's manual for promotion of renewable energy.

This program aims at developing human resources by assigning the Jomo Kenyatta University of Agriculture and Technology (JKUAT) as a leader of program, to which Japan has been assisting since the 1980s. The cooperation between universities in Kenya and the Makerere University/the Center for Research in Energy and Energy Conservation (CREEC) in Uganda will also be effective in the human resources development.



Prepared by JICA Study Team

Figure 1-1 Program for Human Resources Development for Renewable Energy (1)

The target of the program for human resources development of universities and other organizations, cooperation between universities and other organizations, and the role of Japan in this program are described below.

1) Target of the program of universities and other organizations

Universities

The target of universities is that universities will become a center of familiarization of renewable

energy by extending the research and education field of universities to renewable energy field, and also to be a leader to familiarize renewable energy with joint research by government agencies and research institutes.

In addition to the above, the target of universities is to train students to contribute to development of renewable energy through the researches and education in the universities.

Government Agencies

Government agencies such as Ministry of Energy, Rural Electrification Authority (REA), Ministry of Agriculture and Ministry of Industrialization will carry out researches in the administrative field necessary to promote renewable energy in cooperation with universities.

Research Institutes

Research institutes such as Kenya Industrial Research Institute (KIRDI) will do research of basic technologies and practical realization of advanced technologies, and make demonstration experiment to promote renewable energy in cooperation with universities.

Private Associations

Private associations such as Kenya Renewable Energy Association (KEREA) which members are directly related with users of renewable energy in sale, construction and maintenance of renewable energy facilities, will prepare manuals of renewable energy facilities and lecture manuals for technicians and salespersons and transfer knowledge of renewable energy to them in cooperation with universities.

2) Cooperation between universities and other organizations

University

At present, universities are independently doing research PV, wind power, geothermal, hydropower, bio-fuel and so on. In this proposed program, JKUAT will do joint research of renewable energy with other universities as a leader of universities. Universities will do research basic technology and introduction to Kenya of advanced techniques developed in other countries. The program includes interchanges of researchers, lecturers and students between universities and adopt common curriculum in universities.

JKUAT will prepare and implement a middle term plan on research and education for next five years in cooperation with other universities. Universities lead by JKUAT will jointly get fund required for the research and human resources for development of renewable energy.

The universities will jointly research energy and economic policies required for administration with the government agencies. They will do joint research of basic technologies and practical realization of advanced technologies of renewable energy, and make demonstration experiment to promote renewable energy in cooperation with KIRDI. They also will prepare users manuals of renewable energy facilities and lecture manuals for technicians and salespersons together with KEREA.

Government Agencies

The government agencies will jointly research energy policies such as feed-in-tariff and tax

exemption to promote renewable energy in cooperation with universities.

Research Institutes

The research institutes will jointly research basic technologies and advanced technologies of renewable energy, and make demonstration of experiment to promote renewable energy in cooperation with universities. The institutes will research biomass production plant, biomass gasification plant, standardization and preparation of manuals of biomass utilization technology, commercialization of bio-diesel, manufacturing of small hydro turbines and so on.

Private Associations

The private associations will prepare manuals of design, installation and repair of renewable energy facilities for technicians and salespersons, and user's manual for end users based on the manuals for students and lecturers related with renewable energy prepared in the universities.

They will research effective method of lectures for technicians and salespersons and training of lecturers in cooperation with universities.

3) Role of Japan in the training program

The role of Japan in this training program is proposed as follows:

Universities

Japan will support universities by dispatching experts, providing financial assistance for training activities and supplying of materials, testing equipment and machines, and training in Japan and developing countries as mentioned below.

- Dispatch of Experts
  - ✓ Coordinators to assist universities in preparation, implementation and management of human resources development program
  - ✓ Education experts to assist universities in preparing curriculum related with education purpose, subjects, teaching method and so on
  - ✓ Lecturers, technical advisers and laboratory experts for renewable energy such as PV, wind power, geothermal, hydropower, biofuel, biomass gas, energy-saving and CDM
  - ✓ Experts to guide researchers in the fields of analysis of economical impact with renewable energy and legal system for promoting renewable energy
- Financial Assistance
  - ✓ Research cost
  - ✓ Scholarships to undergraduate and postgraduate students
  - ✓ Cost for experiments and material for experiments
  - ✓ Cost for construction or improvement of research facilities
  - ✓ Cost for presentation of research results
  - ✓ Cost for publication of reports, pamphlets and manuals
- Supply of Experimental Equipment and Materials
  - ✓ Research materials for renewable energy
  - ✓ Facilities to be used in classes for renewable energy
  - ✓ Experimental equipment and materials to be used in researches in universities

- ✓ Experimental equipment and materials for field tests

- Training in Japan and Developing Countries
  - ✓ Training for researchers and lecturers in universities in Japan
  - ✓ Training for lecturers and students in developing countries which have been utilizing renewable energies and can provide technical assistance by South-South Cooperation scheme

Government Agencies

- Dispatch of Experts
  - ✓ Coordinators to assist government agencies in preparing human resources development program
  - ✓ Education experts to assist government agencies in preparing curriculum for human resources development
  - ✓ Experts to guide government staff to make analysis of economical impact by projects with renewable energy and legal system for promoting renewable energy
- Training in Japan and Developing Countries
  - ✓ Training of the government staff on administration in Japan and developing countries which can provide technical assistance by South-South Cooperation scheme

Research Institutes

- Dispatch of Experts
  - ✓ Coordinators to assist research institutes in preparation, implementation and management of human resources development program
  - ✓ Technical advisers and field test experts for renewable energy such as PV, wind power, geothermal, hydropower, biofuel, biomass gas, energy-saving and CDM
- Financial Assistance
  - ✓ Research cost
  - ✓ Cost for experiments and material for experiments
  - ✓ Construction or improvement cost of research facilities
  - ✓ Cost for presentation of research results
  - ✓ Cost for publication of reports, pamphlets and manuals
- Supply of Experimental Equipment and Materials
  - ✓ Research materials for renewable energy
  - ✓ Experimental equipment and materials to be used in researches in the institues
  - ✓ Experimental equipment and materials for field tests
- Training in Japan and Developing Countries
  - ✓ Training for staff related with renewable energy in Japan
  - ✓ Training for staff related with renewable energy in developing countries which have been utilizing renewable energies and can provide technical assistance by South-South Cooperation scheme

Private Associations

- Dispatch of Experts
  - ✓ Experts to assist private associates in preparation, implementation and management of human resources development program
  - ✓ Education experts to assist institutes in planning of training program and preparing

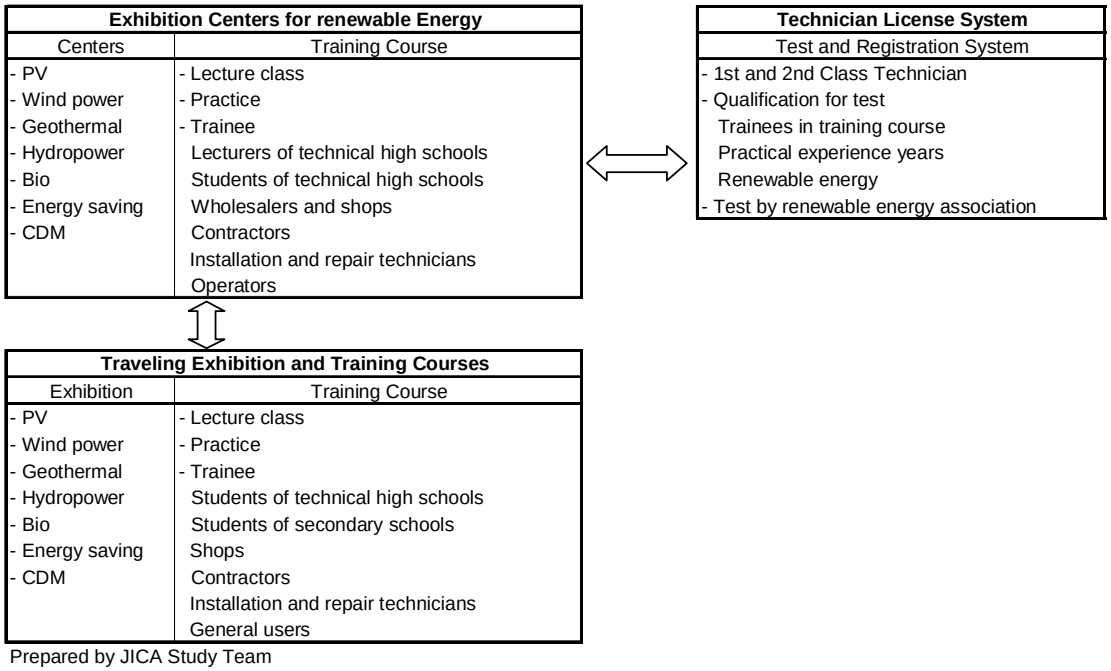
manuals of design, installation and repair of renewable energy facilities for technicians and salespersons, and user's manual for end users

- ✓ Technical advisers for renewable energy such as PV, wind power, hydropower, biofuel, biomass gas and energy-saving

- Financial Assistance
  - ✓ Training cost for technicians and salespersons
  - ✓ Printing cost for training text, pamphlets and manuals
- Supply of Experimental Equipment and Materials
  - ✓ Experimental equipment and materials to be used in the training
- Training in Japan and developing countries
  - ✓ Training for member of institutes and lecturers for the training in Japan
  - ✓ Training for member of institutes and lecturers for the training in developing countries which have been utilizing renewable energies and can provide technical assistance by South-South Cooperation scheme

The Study Team proposes constructing of exhibition centers, holding of short training courses and traveling exhibition, and establishing of license system as shown in **Figure 1-2.** The purpose of this proposal is to train technicians and salespersons regarding technical skills from design and installation to maintenance including repair of renewable energy facilities.

For this human resources development, the Study Team proposes that Japan provides technical assistance by dispatching experts, constructing exhibition centers, providing equipment and accessories for exhibition centers and traveling exhibition, and other related activities. KEREA may share expenses for the operation and maintenance of these activities because members of KEREA will get benefit from renewable energy business expanded by this program.



Prepared by JICA Study Team

Figure 1-2 Program for Human Resources Development for Renewable Energy (2)

(2) PV, Wind Power and Bio-Energy

The above program will be useful for the human resources development in PV, wind power and bio-energy fields since considerable human resources are required in these fields though special technology is not required comparing with the hydropower.

In addition to the program, it is important to train engineers and technicians through on-the-job training in projects of PV, wind power generation, bio-fuel and bio-mass gasification generation, cogeneration and so on.

(3) Small Hydropower

Various engineering fields such as civil and electrical works are required to plan, design, construct and operate hydropower stations. The Study Team proposes the following program for training of human resources for the development of small hydropower projects.

- **On-the-job-training of young engineers** - REA has a plan to conduct pre-feasibility and feasibility studies of small hydropower projects in the REA program. Young engineers of the government agencies and private consultants can participate in the studies and benefit from transfer of knowledge rendered by foreign experts during on-the-job-training in these studies.
- **Developing civil, mechanical and electrical engineers in JKUAT** - JKUAT will open comprehensive hydropower engineering course covering lectures, practices on desk and field to educate its civil, mechanical and electrical engineers in the program mentioned above.

Japan will dispatch Japanese hydropower engineers to provide lectures on civil, electrical, mechanical, transmission, construction and contract engineering courses. The lecturers shall be experts who have experiences on planning, design, construction, operation and contract management of hydropower project in developing countries.

The on-the-job-training in actual projects will be one of most effective methods for human resources development. The Study Team proposes a training program in which researchers and students construct a small hydropower station as a part of training for the human resources development supported by Japan. The project for the training is to construct a small hydropower station of several kW in installed capacity, which can be constructed by manpower without heavy construction equipment. The researchers and students will carry out pre-feasibility study, survey, design, construction, and operation and maintenance of the power station. They will get overall know-how for hydropower development and operation. It is possible the power station constructed in off-grid area will be handed over to the local community for utilizing it for rural electrification.

2. Uganda

(1) Human Resources Development in Renewable Energy Field

Universities, government agencies, research institutes and private associations have been individually training personnel related to renewable energy. The Study Team proposes a comprehensive program to develop human resources for renewable energy as shown in **Figure 2-1**. This program consists of training of researchers and students in universities, staff of government agencies, research institutes and private associations, and preparation of lecturer's and user's manual for promotion of renewable energy.

This program aims at developing human resources by assisting the Makerere University as a leader of program. The cooperation between universities in Uganda and the JKUAT in Kenya will also be effective in the human resources development.

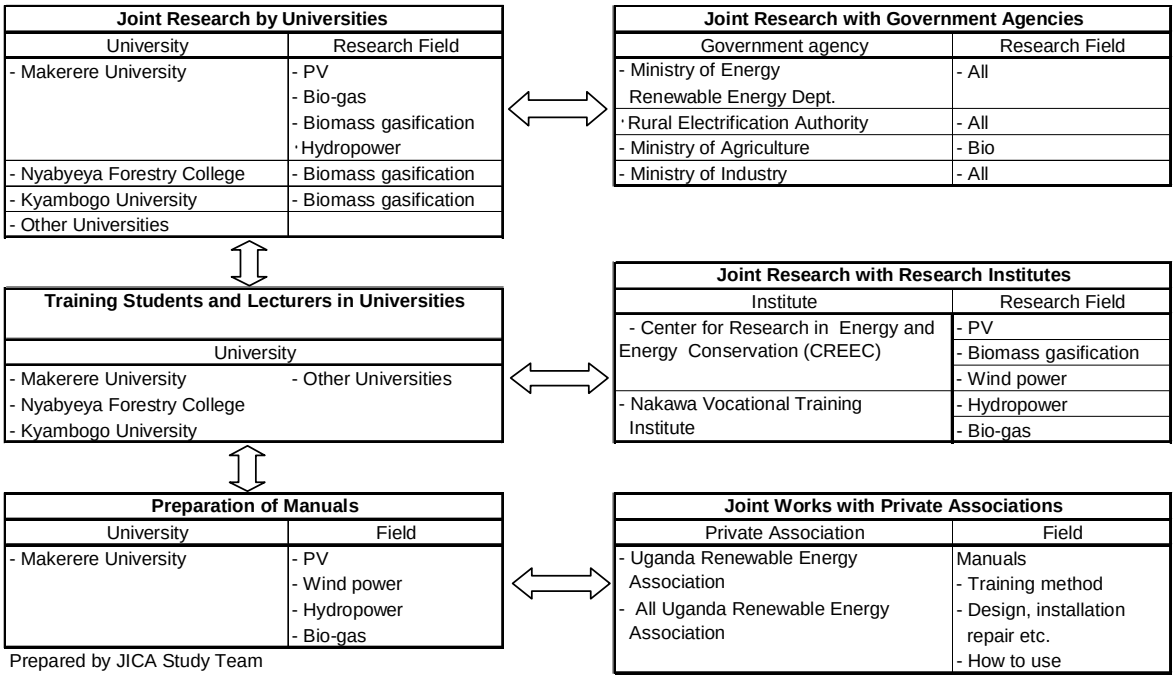


Figure 2-1 Program for Human Resources Development for Renewable Energy (1)

The target of the program for human resources development of universities and other organizations, cooperation between universities and other organizations, and the role of Japan in this program are described below.

1) Target of the program of universities and other organizations

Universities

The target of universities is that universities will become a center of familiarization of renewable energy by extending the research and education field of universities to renewable energy field, and also to be a leader to familiarize renewable energy with joint research by government agencies and research institutes.

In addition to the above, the target of universities is to train students to contribute to development of

renewable energy through the researches and education in the universities.

Government Agencies

Government agencies such as Ministry of Energy and Mineral Development, Rural Electrification Agency (REA), Ministry of Agriculture and Ministry of Finance, Planning and Economic Development will carry out researches in the administrative field necessary to promote renewable energy in cooperation with universities.

Research Institutes and Vocational Training Institutes

Research institutes such as CREEC will do research of basic technologies and practical realization of advanced technologies, and make demonstration experiment to promote renewable energy in cooperation with universities.

Training institutes such as Nakawa Training Institutes will research practical technology of renewable energy for promotion of renewable energy in cooperation with universities.

Private Associations

Private associations such as Uganda Renewable Energy Association and All Uganda Renewable Energy Association which members are directly related with users of renewable energy in sale, construction and maintenance of renewable energy facilities, will prepare manuals of renewable energy facilities and lecture manuals for technicians and salespersons and transfer knowledge of renewable energy to them in cooperation with universities.

2) Cooperation between universities and other organizations

University

At present, universities are independently doing research PV, wind power, geothermal, hydropower, bio-fuel and so on. In this proposed program, Makerere University will do joint research of renewable energy with other universities as a leader of universities. Universities will do research basic technology and introduction to Uganda of advanced techniques developed in other countries. The program includes interchanges of researchers, lecturers and students between universities and adopt common curriculum in universities.

Makerere University will prepare and implement a middle term plan on research and education for next five years in cooperation with other universities. Universities lead by Makerere University will jointly get fund required for the research and human resources for development of renewable energy.

The universities will jointly research energy and economic policies required for administration with the government agencies. They will do joint research of basic technologies and practical realization of advanced technologies of renewable energy, and make demonstration experiment to promote renewable energy in cooperation with CREEC. They also will prepare users manuals of renewable energy facilities and lecture manuals for technicians and salespersons together with Uganda Renewable Energy Association and All Uganda Renewable Energy Association.

Government Agencies

The government agencies will jointly research energy policies such as feed-in-tariff and tax

exemption to promote renewable energy in cooperation with universities.

Research Institutes and Training Institutes

The research institutes will jointly research basic technologies and advanced technologies of renewable energy, and make demonstration of experiment to promote renewable energy in cooperation with universities. The institutes will research biomass production plant, biomass gasification plant, standardization and preparation of manuals of biomass utilization technology, commercialization of bio-diesel, manufacturing of small hydro turbines and so on.

The training institutes will research practical technologies of renewable energy and their application in cooperation with universities. Because trainees in the training institutes are technicians, research of practical and wide-use technologies will be preferable then special ones.

Private Associations

The private associations will prepare manuals of design, installation and repair of renewable energy facilities for technicians and salespersons, and user's manual for end users based on the manuals for students and lecturers related with renewable energy prepared in the universities.

They will research effective method of lectures for technicians and salespersons and training of lecturers in cooperation with universities.

3) Role of Japan in the training program

The role of Japan in this training program is proposed as follows:

Universities

Japan will support universities by dispatching experts, providing financial assistance for training activities and supplying of materials, testing equipment and machines, and training in Japan and developing countries as mentioned below.

- Dispatch of Experts
  - ✓ Coordinators to assist universities in preparation, implementation and management of human resources development program
  - ✓ Education experts to assist universities in preparing curriculum related with education purpose, subjects, teaching method and so on
  - ✓ Lecturers, technical advisers and laboratory experts for renewable energy such as PV, wind power, geothermal, hydropower, biofuel, biomass gas, energy-saving and CDM
  - ✓ Experts to guide researchers in the fields of analysis of economical impact with renewable energy and legal system for promoting renewable energy
- Financial Assistance
  - ✓ Research cost
  - ✓ Scholarships to undergraduate and postgraduate students
  - ✓ Cost for experiments and material for experiments
  - ✓ Cost for construction or improvement of research facilities
  - ✓ Cost for presentation of research results
  - ✓ Cost for publication of reports, pamphlets and manuals
- Supply of Experimental Equipment and Materials

- ✓ Research materials for renewable energy
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- ✓ Experimental equipment and materials to be used in researches in universities
- ✓ Experimental equipment and materials for field tests

- Training in Japan and Developing Countries
  - ✓ Training for researchers and lecturers in universities in Japan
  - ✓ Training for lecturers and students in developing countries which have been utilizing renewable energies and can provide technical assistance by South-South Cooperation scheme

Government Agencies

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Research Institutes

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Training Institutes

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- Training in Japan and Developing Countries
  - ✓ Training for staff related with renewable energy in Japan
  - ✓ Training for staff and trainees related with renewable energy in developing countries which have been utilizing renewable energies and can provide technical assistance by South-South Cooperation scheme

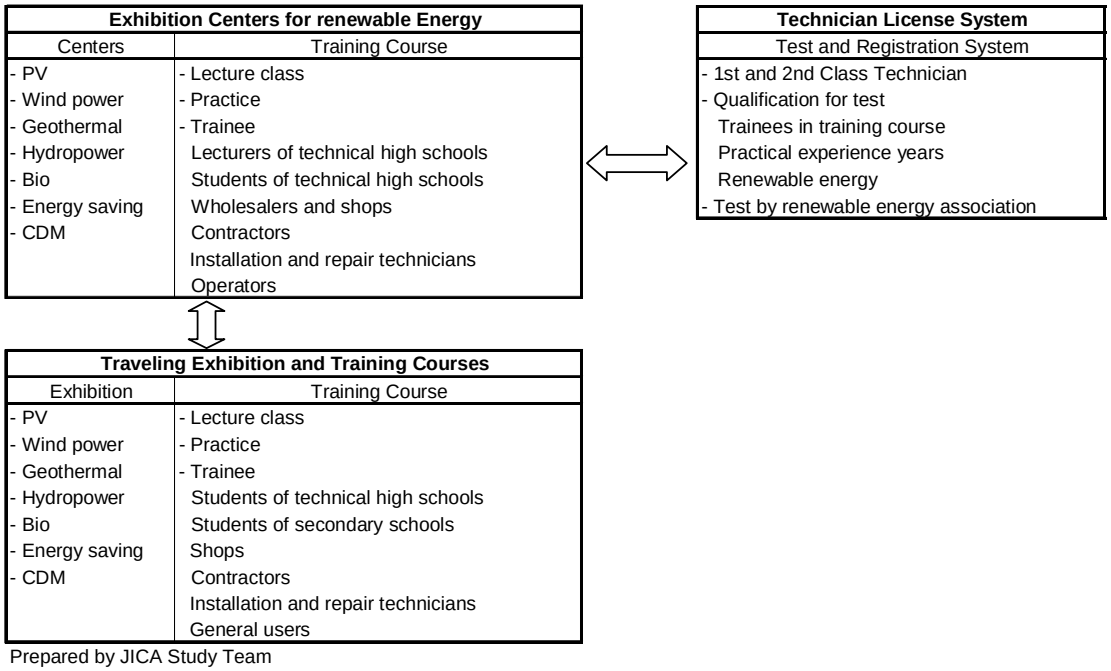
Private Associations

- Dispatch of Experts
  - ✓ Experts to assist private associates in preparation, implementation and management of human resources development program
  - ✓ Education experts to assist institutes in planning of training program and preparing manuals of design, installation and repair of renewable energy facilities for technicians and salespersons, and user's manual for end users
  - ✓ Technical advisers for renewable energy such as PV, wind power, hydropower, biofuel, biomass gas and energy-saving
- Financial Assistance
  - ✓ Training cost for technicians and salespersons
  - ✓ Printing cost for training text, pamphlets and manuals
- Supply of Experimental Equipment and Materials
  - ✓ Experimental equipment and materials to be used in the training
- Training in Japan and developing countries
  - ✓ Training for member of institutes and lecturers for the training in Japan
  - ✓ Training for member of institutes and lecturers for the training in developing countries which have been utilizing renewable energies and can provide technical assistance by South-South Cooperation scheme

The Study Team proposes constructing of exhibition centers, holding of short training courses and traveling exhibition, and establishing of license system as shown in **Figure 2-2.** The purpose of this proposal is to train technicians and salespersons regarding technical skills from design and installation to maintenance including repair of renewable energy facilities.

For this human resources development, the Study Team proposes that Japan provides technical assistance by dispatching experts, constructing exhibition centers, providing equipment and

accessories for exhibition centers and traveling exhibition, and other related activities. Uganda Renewable Energy Association and/or the All Uganda Renewable Energy Association may share expenses for the operation and maintenance of these activities because members of the associations will get benefit from renewable energy business expanded by this program.



Prepared by JICA Study Team

Figure 2-2 Program for Human Resources Development for Renewable Energy (2)

(2) PV, Wind Power and Bio-Energy

The above program will be useful for the human resources development in PV, wind power and bio-energy fields since considerable human resources are required in these fields though special technology is not required comparing with the hydropower.

In addition to the program, it is important to train engineers and technicians through on-the-job training in projects of PV, wind power generation, bio-fuel and bio-mass gasification generation, cogeneration and so on.

(3) Small Hydropower

Various engineering fields such as civil and electrical works are required to plan, design, construct and operate hydropower stations. The Study Team proposes the following program for training of human resources for the development of small hydropower projects.

- **On-the-job-training of young engineers** - The New and Renewable Source of Energy Section of Ministry of Energy and Mineral Development will conduct pre-feasibility and feasibility studies of small hydropower projects. Young engineers of the government agencies and private consultants can participate in the studies and benefit from transfer of knowledge rendered by foreign experts during on-the-job-training in these studies.
- **Developing civil, mechanical and electrical engineers in Makerere University** - **Makerere University** will open comprehensive hydropower engineering course covering lectures, practices on desk and field to educate its civil, mechanical and electrical engineers

in the program mentioned above.

Japan will dispatch Japanese hydropower engineers to provide lectures on civil, electrical, mechanical, transmission, construction and contract engineering courses. The lecturers shall be experts who have experiences on planning, design, construction, operation and contract management of hydropower project in developing countries.

The on-the-job-training in actual projects will be one of most effective methods for human resources development. The Study Team proposes a training program in which researchers and students construct a small hydropower station as a part of training for the human resources development supported by Japan. The project for the training is to construct a small hydropower station of several kW in installed capacity, which can be constructed by manpower without heavy construction equipment. The researchers and students will carry out pre-feasibility study, survey, design, construction, and operation and maintenance of the power station. They will get overall know-how for hydropower development and operation. It is possible the power station constructed in off-grid area will be handed over to the local community for utilizing it for rural electrification.

Appendix 4

Characteristics of Large Capacity Capacitor

Large capacity capacitor has the following characteristics:

Lead Acid Battery	Large Capacity Capacitor
Volatile	Non-volatile
High self discharge	Low self discharge
High de-rating	Very low de-rating
Temperature highly affects storage capacity	Temperature has minimal effects on storage capacity
Small working temperature range (most manufacturers recommend 15 to 35 deg. C for best performance)	Large working temperature range (-20 to +60 deg. C)
Requires long time to get full capacity	High rate of charging is possible
Low life cycle (frequent replacement). At room temperature 500 to 1800 cycles, 80% max. discharge for deep cycle battery. (In case of improved car battery for PV, 50% max. discharge)	High life cycle (no frequent replacement). At 60 deg. C around 6,000 cycles, 80% discharge.
Low initial cost	High initial cost
Frequent maintenance required	No frequent maintenance required
After longevity, collection and appropriate processing are necessary. (As for the abandonment of lead and sulfuric acid, the negative environmental impact is considerable. Appropriate processing is necessary.)	Low impact to the environment because main substance is carbon.

Large capacity capacitor is superior to lead acid battery except in terms of initial cost.