# GREENING THE TEA INDUSTRY IN EAST AFRICA

# SMALL HYDRO POWER SCOPING STUDY

## KENYA

**15th March 2006**
**Final Report**

EATTA

UNEP

GEF

**IED REF : 05/020**


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# KENYA
# SCOPING STUDY

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# 1. BACKGROUND

## 1.1 PROJECT OBJECTIVES

- The specific objectives of "Greening the Tea Industry in East Africa" is to facilitate generation of electricity from decentralized hydropower, improve the reliability and quality of energy service, lower factory production costs and provide access to electricity for communities in proximity of tea factories and/or the proposed hydro power plants. The benefit to the global community will be reduced CO2 emissions compared to current practices.
- The project targets those tea production companies that have expressed an interest in the project and are members of the East African Tea Trade Association (EATTA).
- More specifically the project aims to reduce barriers related to financial weakness, lack of technical awareness and capacity as well as all obstacles related to power sector policy frameworks.
- The project will ear-mark six pilot projects for development in at least three of the eight EATTA member countries; these will be selected in countries wherein a high potential for replication exists.
- In the context of the project a total of 17 pre-feasibility studies will be carried out and in addition to these existing pre-feasibility or feasibility studies conducted by the tea companies themselves will be added to the list of potential sites.

## 1.2 INTRODUCTION TO THE SCOPING REPORT

- The objective of this scoping report is to provide the basis for understanding what the potential for hydro power development is in the proximity of tea factories, the interest expressed by the tea companies, present electrical practices, potential for replication, potential for rural electrification, $CO_2$ emission reduction and the existing know how and regulatory framework are for such projects to evolve.
- The scoping report will identify a range of potential hydro power sites in proximity of tea factories that could either supply electricity to the factory itself, thus replacing/reducing the need of power purchased from the utility and the use of diesel generators, a range of factories and rural communities in the surrounding areas.
- This report has been written by IED, Innovation Energie Développement, a French consultancy firm, and stems from an in country mission carried out by Mr Hugues Le Bars and Ms Lara Bertarelli in November/December 2005. Meetings with main stakeholders were conducted and site visits to Tea Companies/ Factories were conducted when these expressed interest in the project.

## 1.3 TEA PRODUCTION IN KENYA

- Tea was introduced in Kenya in 1903 by the white colonialists for experimental purposes. After 1915 and the land reforms producer groups developed in the mountainous areas of Kenya. The industrial scale tea development occurred in the fifties when the Kenyan government tried to promote small scale tea culture. Regulation was ensured by the State and this dynamic sector developed from 21 500 hectares in 1963 to 113 900 hectares in 1997.
- Today, the production of Tea in Kenya currently acts as the main export crop and overall represents about 80 %[1] of the total tea production in East Africa. In the world market, in 2002 Kenya was the third largest producer after India and Sri Lanka and second largest exporter of black tea after Sri Lanka. In 2001, the tea industry turnover was 474 million USD of which 437 million USD occurred from export earnings with the balance being the value of locally sold tea (Ref 1).

[1] **Market Report, Sale 44 – 7th and 8th November 2005**

- In 2004, total tea production in Kenya alone amounted to 324 608 tons. Currently the small scale growers under the umbrella of Kenya Tea Development Agency (KTDA) account for sixty percent of the total tea production while the multinational sector and large scale growers account for the remaining forty percent.
- Kenya tea has established a reputation world over for its high and consistent quality throughout the year. Production goes on all year round with two peak seasons of high crop between March and June and between October and December which coincide with the short and long rains respectively.
- Most Kenyan teas are manufactured using the Cut Tear and Curl (CTC) method of manufacture, although some factories also produce orthodox tea for export in middles eastern countries.

### 1.3.1 Threats to the Tea Industry in Kenya

- Several adverse forces presently threaten the tea industry. The first threat comes from the weak trend in the export price of tea. This export price problem is as a consequence of worldwide tea export increases which has occurred more rapidly than world consumption. The dollar price released for Kenya tea is at the same level as it was 10 years ago.
- The most worrying problem is the danger caused by the rising costs of production. This applies most forcibly to the estate sector where labor account for some two thirds of production costs ex-factory. The main problem arises from the pattern of wage awards imposed on the industry. Since 1990 the basic wage rate has risen 10 times; in fact since 1998 it has gone up by more than 50% (ref 1).
- The danger signals are evident: small producers have been resigning from the industry body in order to escape the statutory basic wage award. Kericho labour costs are twice those in Uganda. Daily rates are paid by smallholders growers in rural areas are half those offered in estates. Already some areas of low tea are seriously loss making and it will only be a matter of time before they are taken out of production.
- Investments in the sector are today focused on trying to significantly reduce production costs. Investments in hydro power wherein production costs are significantly lower than those by KPLC tariffs or diesel generator costs and a fast payback period are seen optimistically by the sector. Today for example some of the tea companies are investing into more energy efficient wood energy boilers.

### 1.3.2 Companies

- In Kenya there are a total of 15 tea companies and 91 tea factories who are members of EATTA. The companies can be classed into three types of players : (i) small holder tea cooperatives, Kenya Tea Development Agency (KTDA); (ii) large multinational companies; Unilever, EPK and James Finlay and (iii) private small estate holdings like Williamson, Nandi Hill, Sotik Highlands, Maramba etc.
- KTDA alone has 54 tea factories spread in 24 districts. The factories are owned by 380 000 growers. KTDA was responsible for 60 % of the tea production in 2002.
- The following table illustrates the factories owned by each Company and whether they responded positively to the project or not.

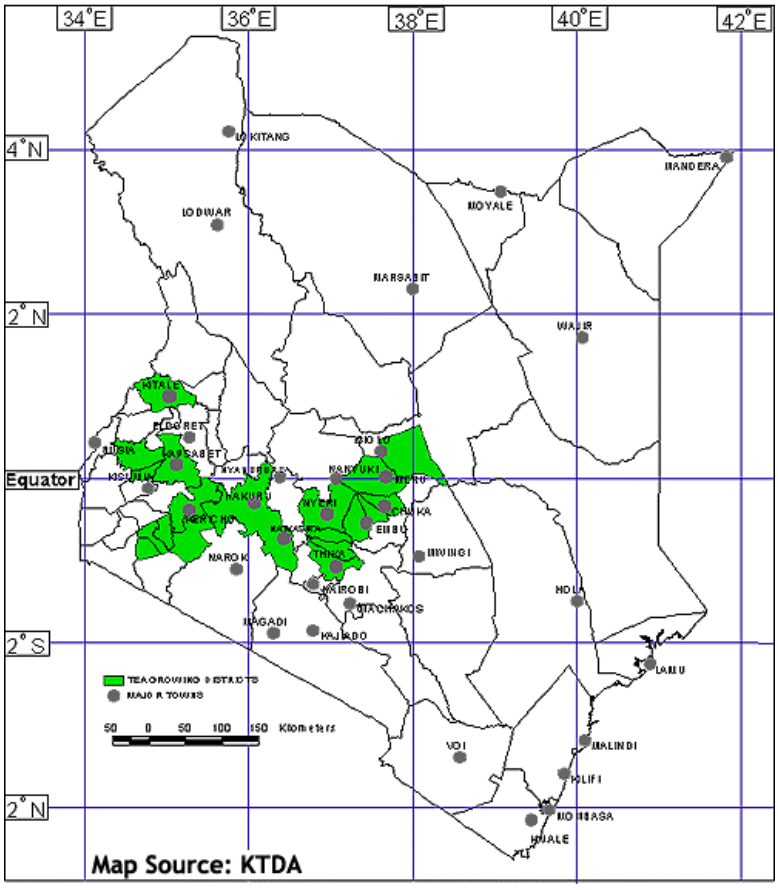
| Company | Location | Response to GTIEA Survey 2004 | Interest Expressed on Project |
|---|---|---|---|
| **KTDA (54)** | | | **Yes** |
| Chebut | Nandi Hills | Yes | |
| Chinga | Nyeri | Yes | |
| Gacharage | Maragwa | Yes | |
| Gachege | Thika | No | |
| Gathuthi | Nyeri | Yes | |
| Gatunguru | Muranga | No | |
| Gianchore | Nyamira | No | |
| Githambo | Muranga | Yes | |
| Githongo | Meru | Yes | |
| Gitugi | Nyeri | Yes | |
| Hyankoba | Kisii | No | |

| | | | |
|---|---|---|---|
| Ikumbi | Maragua | No | |
| Imenti | Meru | Yes | |
| Iriaini | Nyeri | Yes | |
| Kagwe | Thika | Yes | |
| Kambaa | Thika | Yes | |
| Kangaita | Kirinyaga | Yes | |
| Kanyenyaini | Muranga | Yes | |
| Kapkatet | Kericho | Yes | |
| Kapkoros | Kericho | No | |
| Kapset | Kericho | Yes | |
| Kathangariri | Embu | Yes | |
| Kebirigo | Nyamira | Yes | |
| Kiamokama | Kisii | Yes | |
| Kiegoi | Nyambene | Yes | |
| Kimunye | Kirinyaga | Yes | |
| Kinoro | Meru | No | |
| Kionyo | Meru | Yes | |
| Kiru | Muranga | No | |
| Litein | Kericho | Yes | |
| Makomboki | Maragua | No | |
| Mataara | Thika | No | |
| Michimikuru | Nyambene | No | |
| Mogogosiek | Kericho | Yes | |
| Momul | Kericho | No | |
| Mudete | Vihiga | Yes | |
| Mungania | Embu | No | |
| Mununga | Kirinyaga | No | |
| Ndima | Kirinyaga | Yes | |
| Nduti | Maragua | Yes | |
| Ngere | Thika | No | |
| Njunu | Thika | Yes | |
| Nyamache | Gucha | Yes | |
| Nyankoba | Kisii | No | |
| Nyansiongo | Nyamira | Yes | |
| Ogembo | Gucha | No | |
| Ragati | Nyeri | No | |
| Rukuriri | Embu | Yes | |
| Sanganyi | Nyamira | Yes | |
| Tegat | Kericho | Yes | |
| Theta | Thika | Yes | |
| Thumaita | Kirinyaga | No | |
| Tombe | Nyamira | No | |
| Weru | Meru | Yes | |
| **Unilever Tea Kenya Ltd (8)** | | | **Yes** |
| Chagaik | Kericho | Yes | |
| Tagabi | Kericho | Yes | |
| Kericho | Kericho | Yes | |
| Kimari | Kericho | Yes | |
| Kimugu | Kericho | Yes | |
| Koruma | Kericho | Yes | |
| Jamji | Kericho | Yes | |
| Mabroukie | Limuru | Yes | |
| **James Finlay Ltd (6)** | | | **No.** James Finlay has its own hydro programme with more than 2 MW installed. |
| Kymulot | Kericho | Yes | |
| Mara Mara | Kericho | Yes | |
| Changana | Kericho | Yes | |
| Kitumbe | Kericho | Yes | |
| Saosa | Kericho | Yes | |
| Chomogonday | Kericho | Yes | |

| | | | |
|---|---|---|---|
| **Eastern Produce Kenya Ltd (7)** | | | **Yes** |
| Savani | Nandi Hills | Yes | |
| Siret | Nandi Hills | Yes | |
| Kapsumbeiwa | Nandi Hills | Yes | |
| Kipkoimet | Nandi Hills | Yes | |
| Kibwari | Nandi Hills | Yes | |
| Kepchomo | Nandi Hills | Yes | |
| Chemomi | Nandi Hills | Yes | |
| **Williamson Tea Kenya (4)** | | | **Yes** |
| Changoi Tea Estate | Kericho | Yes | |
| Tinderet Tea Estate | Songhor | Yes | |
| Kapchorua Tea Estate | Nandi Hills | Yes | |
| Kaimosi Tea Estate | Kaimosi | Yes | |
| **Sotik Tea Co. (2)** | | | **Yes** |
| Aroket | Sotik | Yes | |
| Metarora | Sotik | Yes | |
| **Sotik Highlands (1)** | **Sotik** | **Yes** | **Yes** |
| **Kaisugu Limited (1)** | **Kericho** | **Yes** | **No response** |
| **Ngorongo Tea Factory Ltd (1)** | **SE Aberdares** | **No** | **No response** |
| **Karirana Tea Estates (1)** | **SE Aberdares** | **Yes** | **No response** |
| **Nandi Tea Estates (1)** | **Nandi Hills** | **Yes** | **Yes** |
| **Sasini Tea & Coffee Ltd (2)** | | | **No.** No potential perceived. |
| Keritor | Sotik | Yes | |
| Kipkebe | Sotik | Yes | |
| **Koisagat Tea Estate (1)** | **Nandi Hills** | **No** | **Yes** |
| **Kiptagich Tea Estate (1)** | | **No** | **No response** |
| **Maramba Factory Ltd (1)** | **SE Aberdares** | **Yes** | **No.** No potential perceived. |

- The main growing districts are situated in or around the highlands areas on both sides of the Great Rift Valley at heights from 1 500 to 2 700 meters above sea level.
- The main growing districts, as also illustrated in the map here, are:
  - Kericho
  - Bomet
  - Nandi Hills
  - Kiambu
  - Thika
  - Maragua
  - Muranga
  - Sotik
  - Kisii
  - Nyamira
  - Nyambene
  - Meru
  - Nyeri
  - Kerinyaga
  - Embu
  - Kakamega
  - Nakuru
  - Trans-nzoia

TEA GROWING DISTRICTS OF KENYA




- Interest in the project by tea companies has been gauged

by whether or not a response on the GTIEA questionnaire was obtained in 2004, response to communication mailouts and the level of feedback obtained during the field mission conducted between the 27th November and 4th December 2005 (see above table).

- In total, 69 tea factories responded to the GTIEA questionnaire, 8 companies out of the 15 expressed their keen interest in being involved in the project and five did not respond. The eight companies represent a total of 78 tea factories.
- With the exception of James Finlay, most of the companies who are not interested in being involved in the project perceive that there is no hydro potential in the vicinity of their tea factories.
- In the case of Sotik Tea company and Sotik Highlands, interest was clearly expressed by the Company to the Consultants, however due to the fact that 1:50 000 maps of the Sotik area illustrating contour lines are out of print and were not available at the Mapping Office, it was therefore not possible to identify the potential for hydro power in this tea growing area.

### 1.4 THE POWER SECTOR

- Hydropower is central to electricity provision in Kenya : over 60% of Kenya's electricity is generated by large hydropower plants. It should be however noted that drought prone countries, including Kenya have had drought induced power rationing in recent years. The share of hydro power in the power mix in the future is predicted to decrease.
- In 1997, Kenya's Electric Power Act allowed independent producers to supply electricity to the grid, but small decentralized schemes, such as micro hydropower, were not fully addressed. The New Energy Policy and the Energy Bill are very important documents that indicate the direction in which the Kenyan power sector is headed and will have important implications for SHP development in the country.
- Institutional and power sector reforms in Kenya have to a large extent contributed to the reduction in Ministry of Energy (MoE) direct control of the electricity industry. MoE activities are now more focused on policy formulation.
- About 55 % of the Generation falls under the responsibility of KenGen, the only state-owned company undertaking generation, whilst the Kenya Power and Lighting Company (KPLC) is responsible for transmission and distribution. Plans are underway to reduce Government's shares in KPLC to 30 % to reduce its majority share holding status. Recent sales of Government shares of KPLC have reduced government ownership to below 50 %. Although there is still some debate on the issue, KPLC can be legally considered to be a non-state controlled entity.
- An electricity regulatory board – ERB - has been set in place and the government is presently working on a programme to strengthen the institutional capacities in order to improve their operational and financial performance. It should be noted that the Ministry of Energy and the Electricity Regulatory Board have had experience with a "light-handed regulation" approach which has resulted in the waiving of license requirements for 2 decentralized micro-hydropower schemes in Central Province.
- The distribution of electricity outside the main towns has been undertaken by the Government of Kenya since the early 70's. A Rural Electrification Fund was created and fed jointly by the Government of Kenya, foreign loans and grants and KPLC participation. The REF is under the direct control of the Rural Electrification Steering Committee whose members are representatives from MOE and KPLC. KPLC executes the works and operates the schemes by the Government of Kenya. It should be noted that the Government only provides infrastructure through the Rural Electrification Fund. Electricity supply is the mandate of KPLC. However, financial losses incurred by KPLC in its supply of electricity to rural areas are reimbursed by the REF. This is, however, to change in the near future.
- Plans are underway to set up a Rural Electrification Authority to manage Rural Electrification. One of the REA objectives will be to explore other non-conventional alternatives to accelerate access to electricity, which will include small hydropower development, photovoltaic systems etc.
- As of June 2005, 6.8% of the rural population has access to electricity. The Government goal is to connect 150 000 urban consumers per year. The prohibitive costs of extending the national grid, at Kshs. 1.3 million per km (16,250 USD per km) will require other alternatives to be explored.
- Kenya has made significant progress in reflecting electricity tariffs to long run marginal cost restructuring the power sector opening the power generation market to private investment and reforming the sector's legal and regulatory environment. Specific progress achieved under the reform program includes:

a. Unbundling of power generation transmission and distribution activities on one hand and incorporation and commercialization on the other hand;
b. Entrance of IPPs;
c. Elimination of government subsidies to the sector with possibly the exception of those to rural electrification;
d. Amendment of the Electricity Act which ascended in 1998 to legislate private sector participation and the establishment of an independent regulator.

- Cost of electric power in Kenya is however high compared to regional competing nations in the COMESA region.

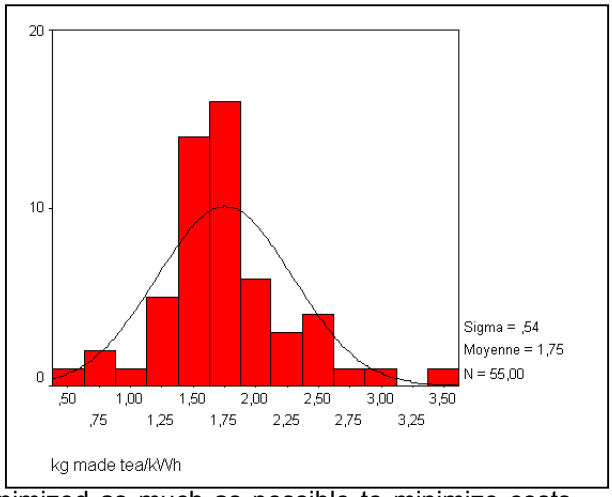
### 1.5 DEMOGRAPHY

- Tea production is labor intensive and accounts for 80 000 people working on the estate and about 3 million people earning their livelihood from the sector in direct and indirect employment. KTDA factories alone are operated/ owned by 380 000 growers.
- Tea growing and manufacturing are carried out in the rural areas thereby contributing significantly to rural industrialization and development. Tea Estates contribute significantly to the range of services available like schools and dispensaries and the standard of living, solid households and potable drinking water and community halls.
- Households in growing tea areas of Kenya tend to be of a highly dispersed nature with only a very few settlements.
- The population in tea growing areas is usually of a dispersed yet relative dense nature. People will tend to live in small plots of lands out of the estate scenario.
- Most tea estates, will also have labourer compounds wherein pluckers and estate workers reside. In most cases drinking water is supplied to the compounds and community halls, dispensaries and schools are also supplied with electricity. The majority of households do not have access to electricity, although a number do use car batteries.
- Some households, although a small percentage, will also reside in the few villages surrounding tea estates, these in most cases will be made up of a few shops, a posho mill and a school. The Tea factory in most cases will be located close to a town which will be electrified and that provides a range of services.

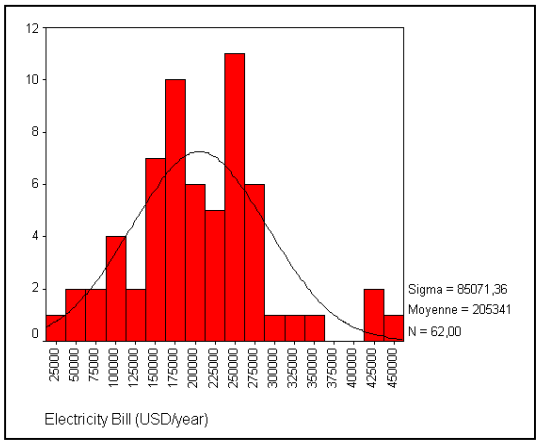
# 2. EXISTING ENERGY RESOURCES FOR TEA FACTORIES

- The basic processing of tealeaves undertaken at the tea factories requires significant amounts of electrical and thermal energy. Currently in most factories the electrical energy is sourced from often unreliable national grids or inefficient and highly polluting and greenhouse gas emitting diesel gensets. To meet the thermal needs Tea factories in Kenya rely mostly on fuelwood and in the case of KTDA also on furnace oil.
- All tea factories have generator sets that are in, 70% of tea factories, operation for up to 5 % of time, only 8% of tea factories have problems on the grid power for more than 10% of the time.
- All of the tea factories that responded to the GTIEA questionnaire are connected to KPLC, and therefore do not rely exclusively on the diesel generators.
- On average energy accounts for 0,10 USD/kg of made tea, electricity alone represents about 60 % of this value. Energy therefore represents about 6 % of the recent market value of Kenyan made tea (the latter indeed costs 1,54 USD/kg, as of November 2005).
- In addition to the real costs of purchasing or growing the range of fuels, there are losses which are accounted for in production quality when power outages or voltage drops are experienced. The main factor to maintain a high quality of Tea is that the green leaf needs to be processed within six hours of plucking.
- The quality of the power supply is closely dependent to the national distribution network layout and the distance between the tea factories and the power plants feeding the network.
- It is clear that Tea Factories are interested in diversifying their electrical supply so as to reduce costs and have a reliable power supply.
- The fuel budgets of tea factories are dependent on increasing international oil prices with negative implications on the competitiveness of the tea produce at the world market.

## 2.1 ELECTRIC POWER




- The tea factories all rely on KPLC power for the majority of their power needs and on average for 7 % of the time on their diesel generators as a backup to KPLC power outages. For each ton of made tea a mean of 590 kWh are needed or equally for every electrical kWh used on average 1,75 kg of made tea are produced. About 60 USD/tonne of made tea will be paid for electricity alone.
- On average tea factories are paying 7,80 Ksh (0,11 USD/kWh) for every unit of KPLC power drawn, out of which 72% is the actual charge on the power and 28% is composed of fixed charges, taxes and levies, and 14 Ksh (0,19 USD) for every unit produced by their diesel generators. It is therefore not surprising that the use of diesel generators is minimized as much as possible to minimize costs. The overall average charge therefore for every kWh used amounts to roughly 0,15 USD/kWh per year. On average a factory would be looking into an electricity bill amounting to 205 000 USD per year.
- Expected national tariff increases will directly affect the risk of production costs for tea factories thus making interests in hydro investments even more pertinent. However, recently the Government have also given tea factories EPZ status, which say will lower tariffs.
- On average most of the tea factories will have two diesel generators of total capacity of around 1000 kVA, each at about 450 KVA, the backup capacity amounts to 0,30 KVA per tonne of made tea. The cost of running a diesel generator amounts to 0,19 USD/kWh[2].




- Power outages and voltage fluctuations from KPLC power are experienced on a daily basis by most of the tea factories in the wet season, low voltage is experienced in the evenings. It takes between 5 minutes to 5 hours for power to be restored after blackouts. Long blackouts occur monthly but short ones up to four times per week. For Kiegoi Tea Factory power failures are experienced on average 7 hours per month and low voltage experienced on average 32 hours per month. For eight KTDA tea factories studied under a previous IED study[3], tea factories experience on average power outages amounting to a yearly average of 25 hours per Month and these tend to occur during the most tea productive months of the year. On average these amount to 31 hours per month during this high productive season.
- Power is delivered at each of the connected Tea Factories by a 33/11 KV line. Once it reaches the Tea Factory a step down transformer converting the power to 240 kV is found. The Tea Factory distributes the power accordingly within its premises to the various load centers.
- Though most tea growing areas have a good hydro-power potential and some tea factories are already benefiting from this resource, there is still much that can be still be exploited.

### 2.1.1 Small hydro power plants

- A number of tea factories in Kenya, namely Unilever, James Finlays and Eastern Produce, already rely on hydro power for some or most of their electrical needs. Most of the hydro power plants were installed between 1928 and 1940, with a few installed in late 1980's and early 1990's. All are functioning since the time they were installed and have required very little maintenance.

[2] Assuming 1 litre of diesel generates 3,3 kWh.
[3] **Preasability Study: Small hydro development in tea catchment areas of Kenya**

- James Finlays has an installed capacity of 2.4 MW and Unilever with a total installed capacity of 2 MW is making savings of the order of 45 million KSh (625 000 USD) on electricity costs per year, in addition a 30 kW system coupled with a reciprocating water pump has been operating at Kimari Tea Factory since 1955. The 2 MW installed are shared between four sites of which three are interconnected to the Unilever internal distribution network.
- Unilever is looking into the expansion of their hydro power capacity with three more sites having been identified, totalling to 1 680 kW.
- A number of studies have been conducted by the tea factories but no realization has been put forward since the early 1990's due to the apparent high investment costs and the Tea Industry's present uncertainty of the future.

### 2.2 THERMAL POWER

- Tea factories either use wood fuel (self grown or purchased) and in the case of KTDA also furnace oil for heat applications. It is roughly estimated that for each 4 hectares of tea plantation approximately 1 hectare of woodlot is needed in order to cover the thermal power requirements of the tea processing plant. On average about 1,6 tonnes of wood are required for every tonne of made tea and the cost to the company amounts to about 20 USD/ tonne of wood. About 8,4 kWh of thermal equivalent per kg of made tea are needed.
- Most tea estates appear to have sufficient wood plantations to cover their own needs. On the other hand it appears that KTDA factories cooperatively owned by small holder tea farmers commonly are faced to meet (part of) their thermal needs by furnace oil.
- The consumption of furnace oil varies considerably from one KTDA tea factory to another, tea factories varying between one and two furnace oil boilers.
- The thermal energy requirements represent about 40% of the total energy costs incurred by the Tea Factories. Yet in terms of energy content, the thermal power needs represent 93%[4] of the total energy requirements of the production process.
- A number of tea factories already have nurseries for seedlings of fast growing tree varieties to be distributed to tea farmers and to be planted on marginal land (e.g. too steep for tea growing). In a number of cases wood fuel production is not adequate to cover the year round thermal energy needs of a factory and possibly sustainable production woodlots may have to be developed in addition. Fast as well as slow growing tree species should be considered in order to assure biodiverse plantations.
- A small survey conducted in collaboration with EATTA during the time of actual proposal preparation clearly showed that most tea factories do not depend on fossil fuel (furnace oil) to meet their thermal energy requirements.
- Depending on the actual location houses of tea farmers but also schools clinics etc. may or may not yet be electrified. While the tea factory will be the dominant productive use tea farmers and the communities could diversify their earnings through other activities. Depending on the area communities just around processing plants have remained unelectrified. It may possibly be an option to use such small hydro plants in addition to cover the demand of the tea factory itself as well as meet residential social and possibly even commercial demand for electric power in the tea farming area. This will make such a mini hydro5 option commercially socially and politically a very attractive option.

# 3. LOCAL RESOURCES FOR HYDRO POWER DEVELOPMENT

### 3.1 GEOGRAPHICAL AND PHYSICAL INFORMATION OF THE STUDIED ZONES

- Blessed with abundant rainfall, plenty of sunshine, and an acidic soil, Kenya's tea catchment area nurtures the country's main agricultural export : tea.
- The main growing districts are situated in or beside the highland areas on both sides of the Great Rift Valley, at heights of 1 500 to 2 700 meters above sea level.

[4] Assuming as above 1 litre of diesel is equivalent to 3,3 kWh and 1 litre of fuel oil is equivalent to 11,67 KWh.

***5*** The term "mini hydro" is here used for hydro applications with capacities between 100 and 1,000 kW

- An important fact to be noticed is that most of the tea catchments are close to large protected natural forests growing in the highlands and attracting precipitation. The rivers draining in the tea catchments have large watersheds that depend on these protected forests for smoothening the flow variations and importantly reducing the occurrence of floods.

### 3.1.1. The tea growing districts of West of Rift Valley

- The tea growing districts of the West of Rift Valley are located in Western Nyanza region, around the town of Kisumu and the Winam Gulf of Lake Victoria, between 20 and 100 km from its banks. The gentle rolling hills vary in altitude between 1 800 and 2 200 meters above sea level, close to protected forest areas, whose highest peaks are around 2 500 meters above sea level.
- Lake Victoria influences positively the climate of this tea production area, which can be divided in two zones :
- ***Nandi Hills zone*** on the Equator and above the Western Escarpment of the Rift Valley.
- ***Kericho - Sotik zone*** is divided from the Nandi Hills zone by the Kisumu Lumbwa plains, above which the soft tea hills rise slowly, southwards.

### 3.1.2. The tea growing districts of East of Rift Valley : Central Kenya

- Located in the Central region, North of Nairobi, the Aberdare range and Mount Kenya form an almost continuous barrier to the wet winds of the Indian Ocean, with summits ranging between 3 500 m to 5 200 m asl. The two mountainous areas are separated by the Nyeri lowland area (1 750 m asl). The tea growing districts of East of Rift Valley are located between 1 700 m and 2 500 m asl on the eastern slopes of Aberdare range, and the south eastern slopes of Mount Kenya.

***The Aberdare range***

- It is an isolated volcanic mountain chain that forms the eastern wall of the Rift Valley and runs about 100 kilometers north to south between Nairobi and Thomson Falls. Two peaks dominate the range : Ol Donya Lesatima (3 999 m) and Kinangop (3 906 m). They are separated by a long saddle of alpine moorland. The terrain is diverse with deep ravines that cut through the forested eastern and western slopes and there are many clear streams and waterfalls. The Aberdares are a water catchment area feeding two of Kenya's most important rivers : the Tana and Athi rivers and part of Central rift and Northern drainage basins.

***Mount Kenya's south eastern slopes***

- Mount Kenya (5 200 m) is a volcanic regular cone from which several rivers radiate in all directions. The south eastern slopes receive the largest rainfalls and give good possibilities to grow tea.

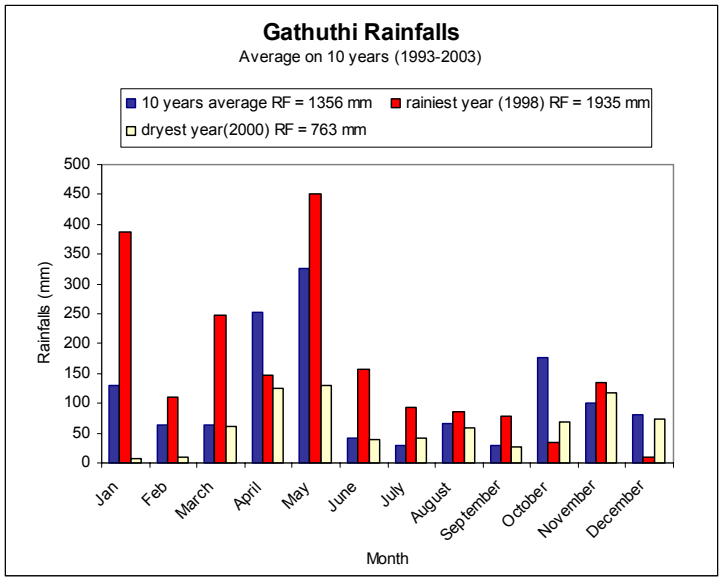
## 3.2 CLIMATE-PHYSIOGRAPHY

- Tea is grown in areas that receive the highest yearly precipitation and have moderate temperatures. Both heat and cold (frost) prohibit the growth of tea.
- In equatorial countries, the best climate conditions for tea growing are met when the following characteristics are respected during the longest period in the year :
    - sunny fresh mornings with temperatures between 10 and 25 C°
    - cloudy and rainy afternoons
    - annual rainfall between 1 500 and 3 000 mm per year
- These conditions are generally obtained at heights of 1 500 to 2 700 meters above sea level, in areas getting enough rain from wet winds. Kenya has several areas that benefit from seasonal monsoons and that meet the above conditions.
- Rainfall is so important for tea that most of the tea factories have their own rainfall meters and keep measurements over long periods of time.
- The hilly and mountainous areas of Kenya are rather wet, providing the right conditions for tea growth as well as sufficient water to assure local hydro potential.

***Central Kenya (East Aberdares and Mount Kenya)***

- In this area, rainfall is caused by orographic lifting of coastal air coming from the Indian Ocean, forced to elevate to higher altitudes by the almost continuous mountain range formed by the Aberdare Range and Mount Kenya. The rains are increased by the large protected forest covering the slopes of this chain.
- Mist and rain occur throughout much of the year, with precipitation varying from around 1 000 mm yearly on the north western slopes to as much as 3 000 mm in the south east. Heavy rainfall occurs throughout most of the year although there are two main rain seasons, from March

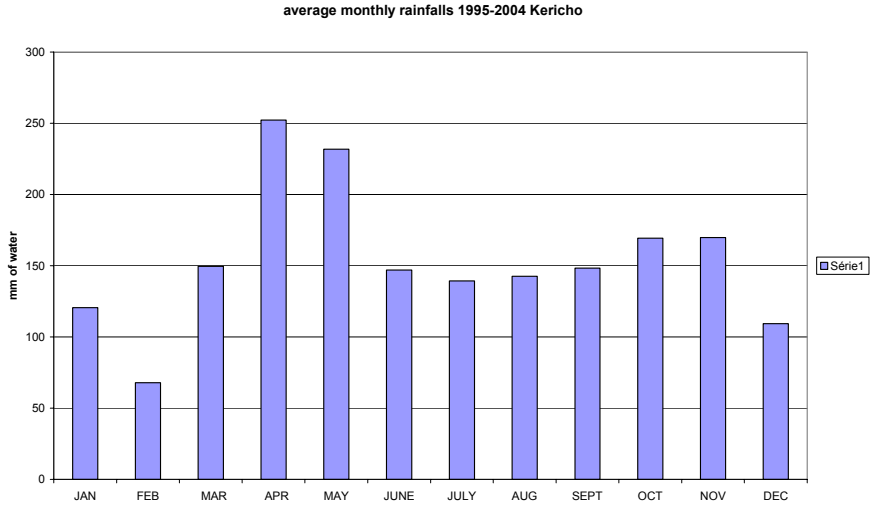
15th to May 30th (the “long rains”) and from October 15th to December (the “short rains”). It should also be noted that there are no real dry seasons wherein the flow to the rivers is significantly reduced. For instance in Gathuthi tea factory, the yearly rainfall average on the last 10 years was 1 357 mm per year with a maximum of 1 970 mm in 1998 and a minimum of 763 mm in 2000.




***The West of Rift Valley area : Nandi - Kericho - Sotik***

- The table below gives the average rainfall data of 14 tea estates of Unilever Kericho Division. It shows a more regular distribution of rain between months of the same year and between years.

| year | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 130 | 95 | 125 | 275 | 208 | 68 | 127 | 160 | 194 | 110 | 138 | 132 | 1 761 |
| 2003 | 61 | 25 | 123 | 281 | 342 | 157 | 148 | 173 | 165 | 162 | 96 | 101 | 1 835 |
| 2002 | 126 | 50 | 210 | 244 | 307 | 136 | 116 | 132 | 86 | 125 | 165 | 204 | 1 902 |
| 2001 | 305 | 45 | 145 | 278 | 231 | 234 | 182 | 103 | 181 | 188 | 164 | 26 | 2 081 |
| 2000 | 27 | 29 | 100 | 166 | 194 | 165 | 147 | 158 | 146 | 160 | 174 | 162 | 1 627 |
| 1999 | 128 | 22 | 282 | 206 | 208 | 123 | 113 | 171 | 150 | 179 | 106 | 61 | 1 749 |
| 1998 | 201 | 121 | 64 | 260 | 230 | 167 | 116 | 136 | 144 | 254 | 138 | 25 | 1 859 |
| 1997 | 82 | 2 | 75 | 322 | 120 | 119 | 154 | 148 | 30 | 214 | 359 | 243 | 1 867 |
| 1996 | 113 | 171 | 202 | 257 | 228 | 110 | 178 | 129 | 199 | 126 | 168 | 60 | 1 940 |
| 1995 | 34 | 119 | 169 | 234 | 249 | 190 | 112 | 116 | 189 | 175 | 189 | 80 | 1 856 |
| year | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | |
| mean | 121 | 68 | 150 | 252 | 232 | 147 | 139 | 143 | 148 | 169 | 170 | 109 | 1 848 |



## 3.3 GEOLOGY CONTEXT & SOILS

***Nandi Hills***

- The Nandi Hills form part of the Kapsabet Plateau area. Broadly the physiography of the area can be divided into a broad band of undulating hills of basement rocks in the West, the Uasin Gishu lava plateau to the northeast and the wooded highlands of Tinderet volcanic mass to the southeast.
- The tea-growing areas can be described as composed of low rolling hills of more or less granitized gneisses in the east with biotite gneisses to the west of the basement system.
- To the west the area is overlaid by an agglomerate of phonolitic, nephelinitic and melanephelinitic compositions with subsidiary tufts and lava flows.
- To the south is the Nyando escarpment with intrusive granites and tertiary basanites in the Mtetei Valley.

***Kericho Area***

- Physiographically the area consists of volcanic plateaus with dissected margins to the north, which lie the Kano Plains, and the Tinderet suite to the northeast. In the southern part the ground rises eastwards towards the Mau Ridge with hilly areas where the tea plantations are.
- The Kericho tea-growing areas are predominantly composed of Kericho Phonolytes (Losunguta type) with lower Miocene tufts agglomerates in containing biotite garnet etc towards the Kano Plains. Higher ground towards the Lumbwa area is occupied by more nepheline-rich volcanic extrusions and pyroclastics derived from activity in the Londiani area.

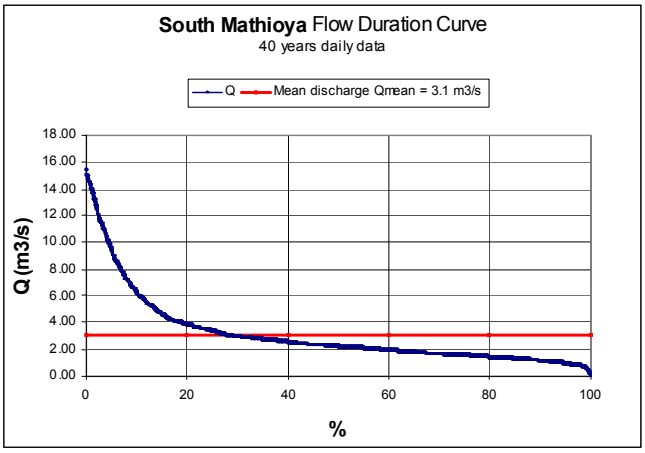
***Aberdares and Mount Kenya***

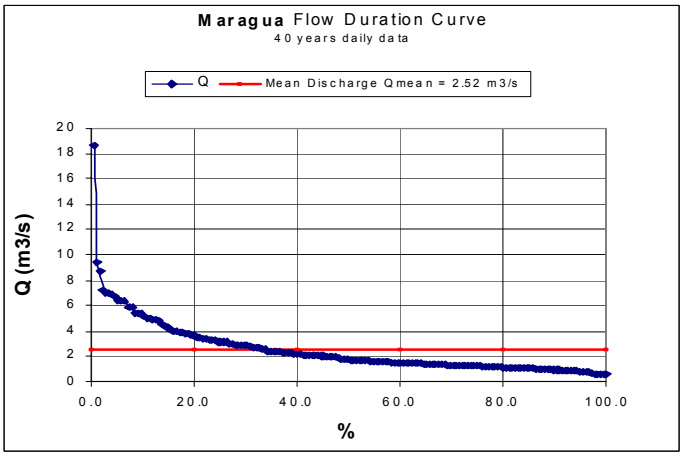
- Volcanic and mostly basaltic areas.

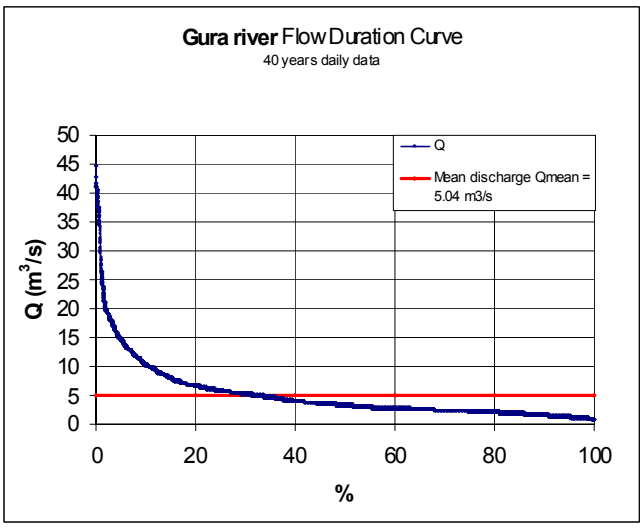
## 3.4 HYDROMETRY & HYDROLOGY

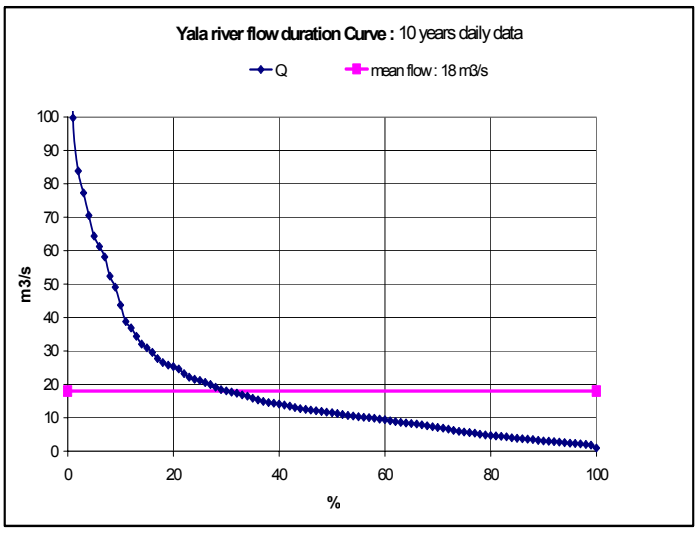
- Due to the decentralization of hydrology services, data collection was more difficult in 2005 than in 2004.

| | | | | | | Average flow | |
|---|---|---|---|---|---|---|---|
| **River** | **Area** | | | **Station N°** | **Water-shed area km²** | **m3/s** | **mm** |
| Gura | Aberdares | | | 4AD04 | 137 | 5,87 | |
| S. Mathyoya | Aberdares | | | 4BD06 | 51 | 3,10 | |
| Maragua | Aberdares | | | 4BE09 | 31 | 2,51 | |
| Itare | Kericho | S 0° 36,167' | E 35° 17,333' | 1JA01 | | | |
| Yala | Nandi Hills | N 0° 10,999 | E 34° 56,184 | 1FE02 | | 18,00 | |




- The above flow duration curves have similar curves, with mean flow value crosses the curve around the 30 % mark, and the flow reduces almost to 0. The monthly flow variations provide important characteristics of the rivers that allow for appropriate designs. The selection of sites for pilot projects should be centered around the availability of hydrological data that allow to characterize the flow of the river over time.

## 3.5 SITE ACCESSIBILITY

- The access roads to the tea factories are OK. Generally in tea growing areas the quality of the roads is better than in other rural areas. The accessibility to the SHPP site will be studied in detail for each case.

## 3.6 NATIONAL KNOW-HOW / CAPABILITY FOR SMALL HYDRO DEVELOPMENT

- There is an estimated 3 000 MW potential of small hydro in Kenya. Some tea companies and community groups are already operating such systems and the impacts are clear.
- Unilever, James Finlay and EPK have an aggregate installed capacity of 4,5 MW of hydro power. Much of these were installed in the late 1920's and 1930's and more recently in the 1980's and 1990's. Very little has been done in the past 10 years in terms of system installation, although the interest in exploiting other hydro sites is high.
- Recent studies conducted by the tea companies show that small hydro power development is economically feasible in Kenya, with a pay back period of around four to five years.
- This chapter provides some indications of the national know-how and technical capability in the fields of engineering, implementation, supervision, commissioning and maintenance of SHPP's in Kenya.

### 3.6.1. Engineering and consultancy for Small Hydro Power Plants

- The following companies can provide engineering and consultancy services for SHPP, at the identification and feasibility stage including hydrology, topography and geology :
    - Rofe Kennard and Lapworth
    - Alane International Ltd
    - Gibb Africa
    - Howard Humphreys
    - Gath Consulting
    - HP Gauff
    - Cape Consult
- Among them some can provide detailed engineering including hydraulic design : weirs, small dams, canals and furrows, civil works, electrical works :
    - Gibb Africa
    - Rofe Kennard and Lapworth
    - Howard Humphreys
    - HP Gauff
- The same engineering company can also supply project management, supervision and commissioning assistance and services.
- Many of the tea companies are permanently thinking of ways to improve and maximize their manufacturing processes, so as to be able to compete effectively in the tea market. Tea companies generally have their own internal management and engineering capacities, and know where to get assistance if needed. However, as in other fields, the capacities of large international companies, family owned companies and KTDA companies are different.

### 3.6.2. Manufacturing of components

<u>Turbines :</u>

- There are no turbine manufacturers for micro hydro except for cross-flow turbines smaller than 30 kW.

<u>Metal works :</u>

- Penstocks, piping :
    - African Steel Pipes (ASP)
    - H. Young
    - Zakhem
- Iron carpentry, gates, others :
    - Tealand Engineering – (Based in Kericho)
    - Duplex Engineering (Based in Kericho)
    - Bridge Motors (Based in Kericho)
    - K K Engineering
    - Marshall Fowler
    - J F McCloy
    - CMC Engineering
    - Specialised Engineering

Electric components

- Cables
  - East African cables
  - Kenwestfal
- Electric switchboards and components
  - Doshi Electrical
  - Switchgear and Controls
  - Power Controls
  - Electric Link
  - A Baumann
  - Sitima Enterprises
- Transformers
  - Imported – But local dealers available.

### 3.6.3. Contractors

General contractors :

- **A** contractors will be needed for intakes, desilters, surge tanks – forebays, power houses and tailraces
- **B** or **C** contractors will be OK for canals (headrace), roads, bridges and basement of penstocks
- International :
  - Strabag
  - Sogea
  - Put Sarajevo
  - China Road and Bridges
  - SIETCO
- National :
  - H Young – Currently subcontractor to the Sondu Miriu Hydro Project 60MW
  - Mugoya Construction – Was a sub-contractor to the Turkwell hydro project 106MW
  - Kirinyaga - General civil works
  - SS Metha - General civil works
  - Kundan Singjh - General civil works
  - Issaco - General civil works
  - TM-AM - Group General civil works
  - Victory - General civil works
  - Associated - General civil works

Electric :

- National :
  - Power Technics
  - Specialised Power System
  - Power Engineering
  - M J Vejaria
  - Metha Electricals
- International :
  - ABB,
  - Siemens
  - Schneider Electric

### 3.6.4. Maintenance

- Tea companies have their own internal capacities for maintenance and repairs in the mechanical and electrical fields.
- They repair, modify and manufacture a good part of their machinery in the workshops of their factories.
- The rewinding of motors is often sub-contracted to different companies. Amongst them :
  - Automatic Controls
  - Sao Techno-Line

- M & R Electrodrives
- Electrical Rewinders Ltd

### 3.7. POTENTIAL SITES

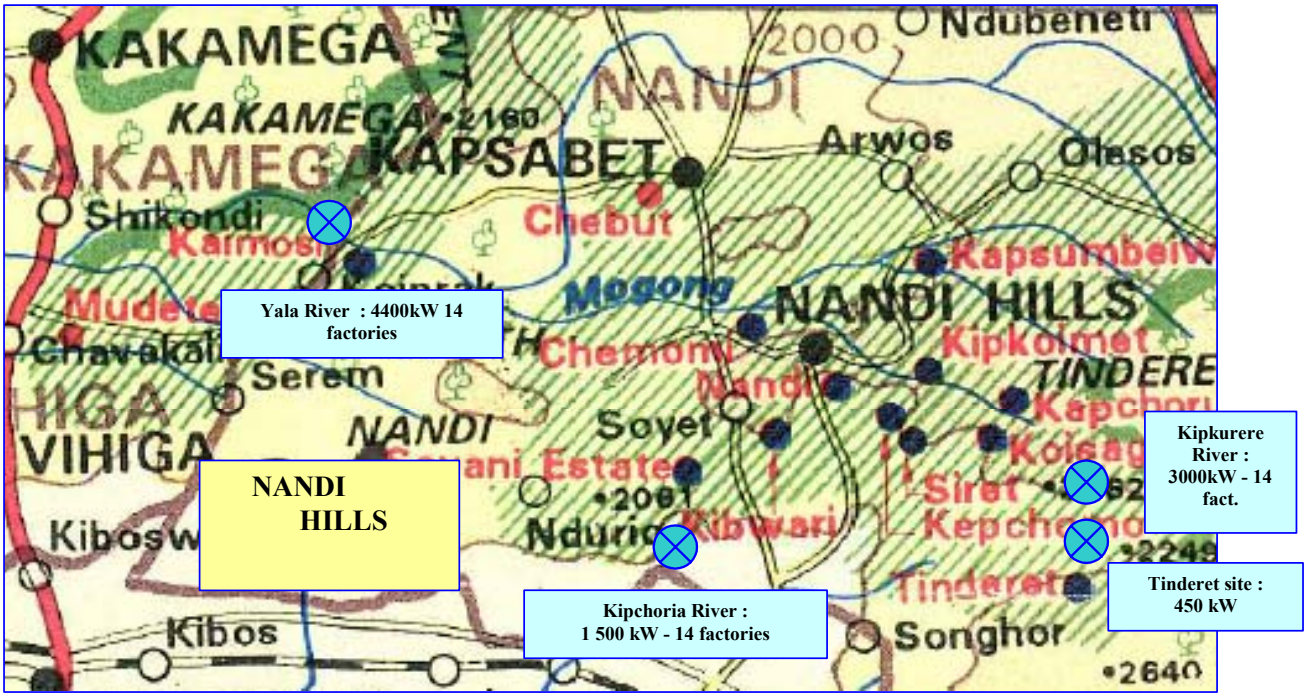
- A total of five sites were identified by the IED team in and around tea factories (within 15-20 km of the tea factory) on the basis of two main pre-conditions being satisfied:
  - Interest of the tea company in being involved in the project
  - Availability of 1:50 000 maps illustrating contour lines

| | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Map** | | 103/4 | 103/4 | 103/3 | 102/4 | 131/2 |
| **River** | | Kipkurere | Kasabe | Kipchoria | Yala | Itare |
| **Tea Factory** | | 14 factories | 14 factories | 14 factories | 14 factories | Kimari |
| | **unit** | Nandi Hills | Nandi Hills | Nandi Hills | Nandi Hills | Kericho |
| **mean flow** | | | | | | |
| watershed area | km² | 151 | 40 | 84 | | |
| annual precipitation | mm/a | 1400 | 1400 | 1400 | | |
| water losses | mm/a | 1100 | 1100 | 1100 | | |
| annual water volume | $m^3/a$ | 45 300 000 | 12 000 000 | 25 200 000 | | |
| average flow | $m^3/s$ | 1,436 | 0,381 | 0,799 | 12,000 | 5,000 |
| mean flow / km² | $m^3/s/km^2$ | 0,010 | 0,010 | 0,010 | | |
| **peak flow** | | | | | | |
| 100 y flood / km² | $m^3/s/km^2$ | 5,00 | 5,00 | 5,00 | | 5,00 |
| 100 years flood | $m^3/s$ | 755 | 200 | 420 | 500 | 100 |
| **weir** | | | | | | |
| ground level at intake | m | 2010 | 1860 | 1740 | 1640 | 1930 |
| normal level | m | 2012 | 1862 | 1742 | 1642 | 1932 |
| weir height | m | 5,50 | 4,50 | 4,50 | 4,50 | 4,50 |
| dam's length | m | 20 | 50 | 50 | 50 | 20 |
| water blade thick | m | 3 | 2 | 2 | 2 | 2 |
| spillway flow / m | $m^3/s$ | 11,508 | 6,264 | 6,264 | 6,264 | 6,264 |
| spillway length | m | 65,61 | 31,93 | 67,05 | 79,82 | 15,96 |
| **head** | | | | | | |
| tail race level | m | 1620 | 1640 | 1390 | 1530 | 1895 |
| static head | m | 392 | 222 | 352 | 112 | 37 |
| pressure losses | m | 14,46 | 10,91 | 18,84 | 7,85 | 4,55 |
| net head | m | 378 | 211 | 333 | 104 | 32 |
| **equipment** | | | | | | |
| total equipt flow | $m^3/s$ | 1,149 | 0,304 | 0,639 | 6,000 | 2,500 |
| installed power | kW | **3 037** | **450** | **1 491** | **4 374** | **568** |
| qy of turbines | u | 2 | 1 | 2 | 1 | 2 |
| flow / unit | $m^3/s$ | 0,57 | 0,30 | 0,32 | 6,00 | 1,25 |
| power / unit | kW | 1 518 | 450 | 745 | 4 374 | 284 |
| **productible** | **MWh** | **18 623** | **2 758** | **9 142** | **26 822** | **3 482** |

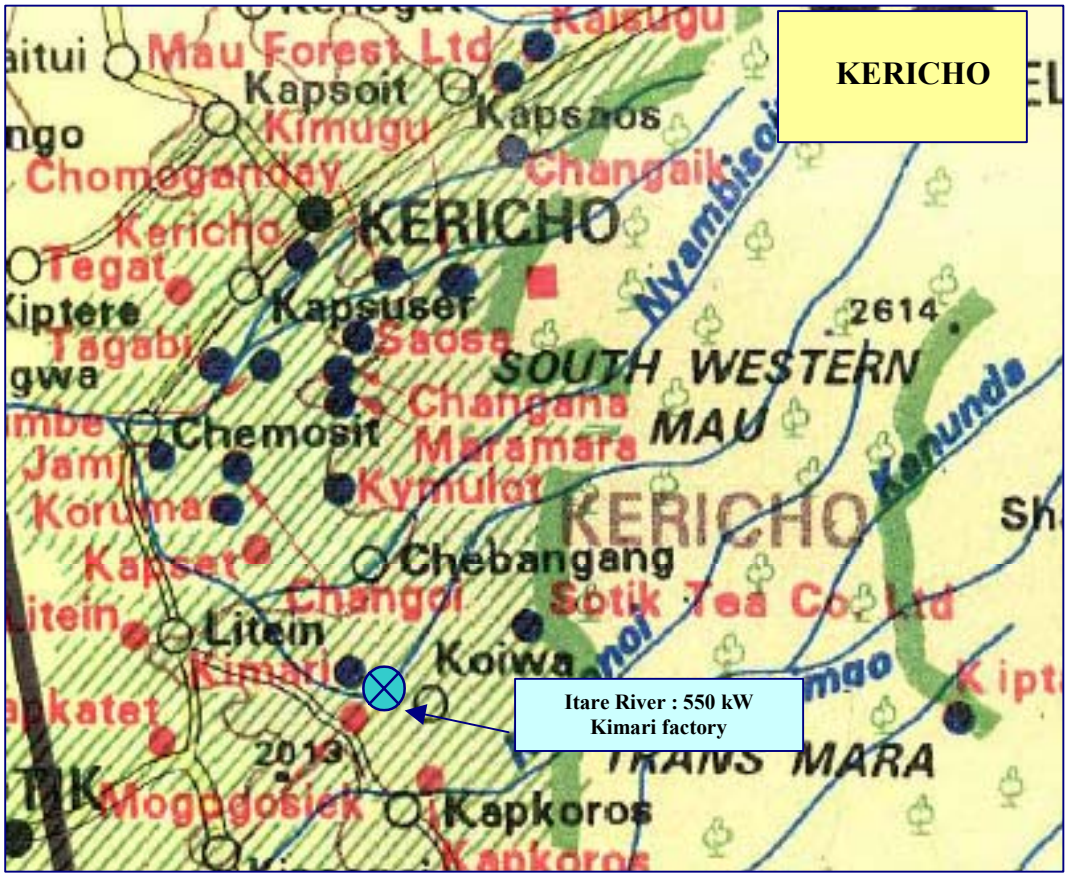
***Table of identified potential sites***

- Of these one, Kimari, has already been studied at pre-feasibility level by the tea company itself.
- The following maps illustrate the sites identified in relation to the tea factories in Nandi Hills and Kericho.

***Map of selected sites for Nandi Hills area***




***Map of selected sites for Kericho area :***



### 3.8. FIRST CONCLUSIONS

- Several SHPP supplying tea factories are already operating in Kenya. Amongst them :
  - Unilever sites in Kericho, amounting to an installed capacity of 2 MW.
  - James Finlay sites in Kericho, amounting to an installed capacity of 2,4 MW.
  - EPK site in Nandi Hills supplying Savani factory with 120 kW, built in 1932 on Kipchoria river.
- Some pre-feasibility studies supplying power tea factories in Kenya have been conducted, including:
  - 5 pre-feasibility studies conducted by IED in 2004 in north east Aberdare, to supply 8 KTDA factories.
  - Orina & Partners study for one site on Mjembe falls to supply Kyono factory (KTDA), on the Eastern slopes of Mount Kenya.
  - Rofe Kennard and Lapworth study for one site on Itare river to supply Kimari factory (Unilever), in Kericho area.
- In addition, identification studies have been done in Nandi Hills for EPK in 1994, showing that the best case should be to extend the Kipchoria river site, using all the possible head.
- The above documents show :
  - The existing SHPP sites owned by tea companies are cost effective and their maintenance is within the capacities of tea factories technical teams.
  - EPK and Unilever, who are already operating SHPP sites, are interested in increasing their hydro-power capacity.
  - The 3 areas surveyed by IED (North East Aberdares, Nandi Hills and Kericho) show good potentials. Sotik, Mount Kenya and south east Aberdare areas probably have good potential too.
  - Nandi Hills and Kericho areas were surveyed by IED in December 2005.
  - In Nandi Hills 3 sites are able supply almost all the electric power needs of the 14 factories of this area, including power supply to employees of the factories :

| River | unit | Kipkurere | Kipchoria | Yala | Total |
|---|---|---|---|---|---|
| **Net Head** | **m** | 378 | 333 | 104 | |
| **Total equipment flow** | **m3/s** | 1,149 | 0,639 | 6,000 | |
| **Installed Capacity** | **kW** | 3 037 | 1 491 | 4 374 | **8 902** |

  - In Kericho, 1 site is interesting and could be developed quickly, because technical studies are already made. It is on Itare river, for Kimari site, with :
    - net head : 32 m; total equipment flow : 2 500 m3/s ; and installed power : 568 kW.
  - A pre-feasibility study of the Yala site could illustrate that the site could be greater than what have been quoted above.

# 4. GENERAL DESCRIPTION OF THE DEMAND

### 4.6. TEA FACTORIES

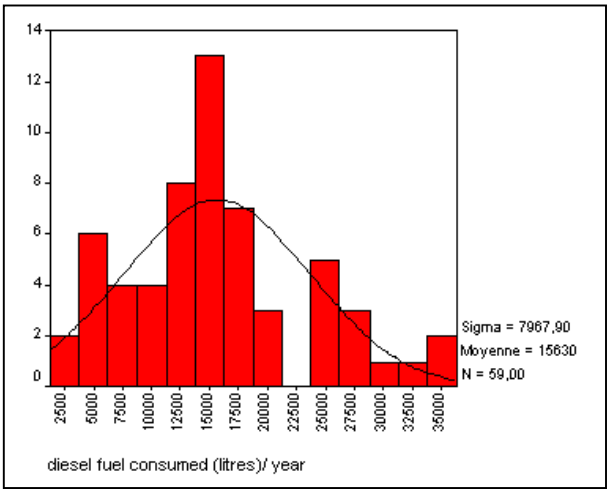
- Converting tea factories to (mainly) operate on hydro should start with a careful analysis of power requirements and actual consumption. It goes without saying that large amounts of thermal energy and electrical power are needed to produce Black Tea – on average 9 kWh (thermal and electrical) are needed to produce one kg of made tea.
- The thermal energy requirements represent about 93% of the total energy demand of a tea factory. Although the electrical demands are significantly less than the thermal requirements in energy terms, the costs incurred are much higher.
- The annual electricity bill to the utility per factory comes to an average of 200 000 USD per year and in addition about 15 000 USD per year are spent on diesel fuel, although obviously this

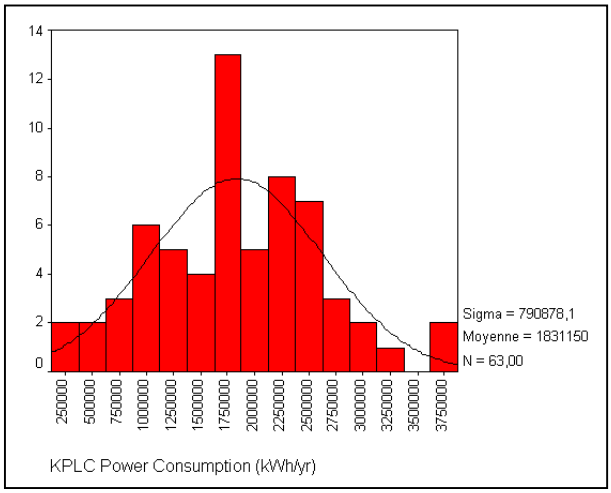
will vary between tea factories depending on their capacity of production, generator efficiency and the level of power outages experienced.

- On average 15 000 litres of diesel (equivalent to 50 MWh), 1 800 MWh KPLC power, 5 400 tonnes of wood, and 560 000 litres of furnace oil are consumed per year per factory[6]. This is equivalent to 590 kWh/ton of made tea (570 kWh/ton KPLC Power and 20 kWh/ton from the diesel generators) and 1,6 tonnes of wood per ton of made tea.
- Monthly consumption varies considerably depending on the tea production, which consequently depends on the level of rainfall or irrigation. Typically, the operation has two clear seasons: high productive seasons from October to January and from April to May. During high productive seasons the factory works over 24 hours, 6 days a week.

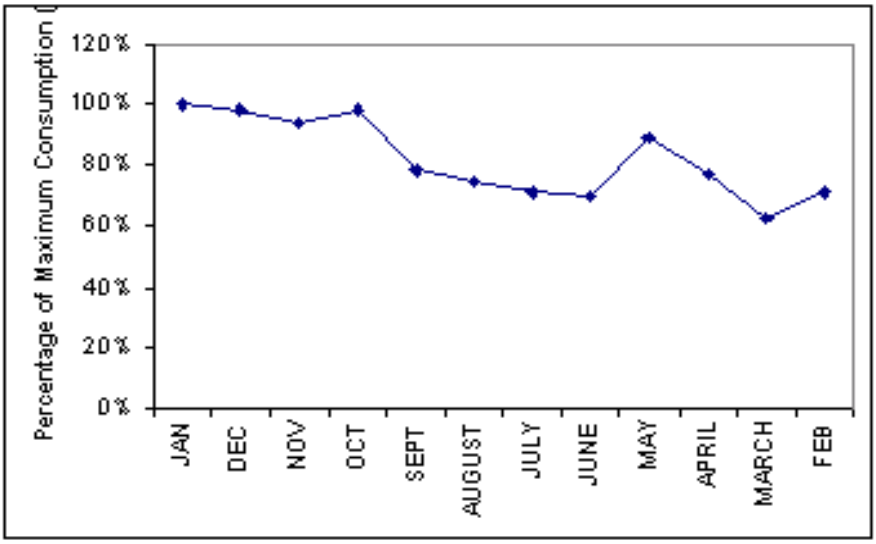
### 4.6.1. Electric power requirements

- For the electrical requirements of the tea factory, power is purchased from either the utility and generated inhouse as a backup during power failures.
- Tea factories only use their backup diesel generator only during power outages, use of their diesel generators is minimized as much as possible so to avoid incurring generation costs of up to 0,19 USD/kWh.
- The annual KPLC power diesel consumption is shown in the figures here. Most of the tea factories draw up to 1 000 KVA from the utility and equally have a genset installed capacity of 1 000 KVA, each generator at about 450 kVA.




- The monthly power consumption is correlated to made tea production, downstream, and to rainfall and irrigation data, upstream.
- As can be seen in the following graph the power consumption patterns drop between June to September and March, with peak consumption between October and December and April, May. The graph provides the relative monthly power consumption as a percentage over the maximum consumption. This represents a mean of 27 tea factories' monthly consumption figures.

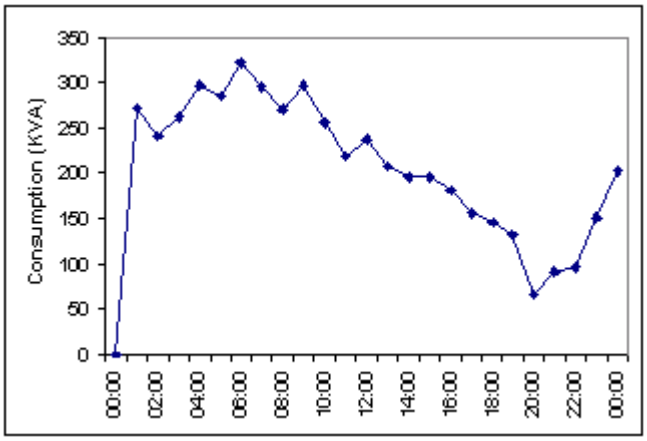



- The peak consumption at any

[6] Furnace oil consumption is noted only in KTDA factories. Consumption varies considerably from factory to the next.

given time, on average, amounts to 450 kVA. Although this will greatly variate from one tea factory to the next.

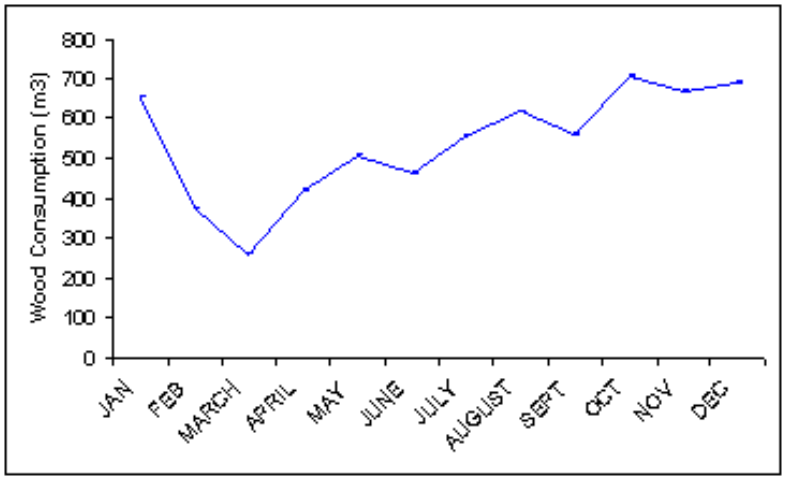
- The following figure provides an example of the variation of a daily load curve for a typical factory.




NB : consumption patterns are factory specific and quite sensitive; any pre-feasibility study will therefore closely assess the actual load duration curves of each tea factory that is studied.

### 4.6.2. Thermal power requirements

- All of the Tea Factories rely on wood for meeting their thermal requirements and KTDA factories in addition also use furnace oil. On average for every ton of made tea produced two tons of wood are needed. The lower the value the more efficient the boilers. Presently tea factories are investing in the replacement of old boilers with new efficient ones.
- Boilers tend to be rated at 10 bars and a steam capacity between 3 and 5 tons/steam per hour.
- The following graph provides the average wood consumption per month for seven tea factories in Nandi Hills. Wood consumption is at its lowest between February and April. The consumption can have important variations according to temperature levels. The variation in its consumption is also dependent on the amount of green leaf production.




- The wood used is in most cases eucalyptus and is in mostly grown by the estates themselves.
- The thermal requirements of tea factories significantly outweigh the electrical needs. At a calorific value of 19 MJ per kg of wood, the equivalent electrical requirements amount to 5,28 kWh/kg of wood and at 42 MJ for every litre of furnace oil, the equivalent electricity outputs amount to 11,67 kWh. On average therefore a tea factory will be consuming a total of 30 GWh, electrical equivalent, per year to meet its thermal needs, representing about 93 % of the total energy needs of the factory.

### 4.6.3. Interest of the tea factories in SHP development

- The interest of the various companies in Kenya was gauged through mainly their responsiveness to the GTIEA questionnaire, communication via e-mail and also phone calls, and response to our site visits. It can be generally said that the majority of tea factories contacted in Kenya have been extremely enthusiastic and interested in participating in the project. With about 95 tea factories and 15 companies in Kenya, IED has tried to ensure that the project has

encompassed as many of these as possible. Field missions were carried out in tea factory intense areas like Eastern Aberdares, Nandi Hills and Kericho.

- It is thought that the replication of hydro power plant development, given the feedback from tea factories, will not be a problem in Kenya.

### 4.7. SETTLEMENTS IN TEA CATCHMENT AREAS

- The majority of settlements in and around large tea estates tend to be quite small providing the essential needs : a shop, a bar, a posho mill and sometimes a school. These in most cases tend to be unelectrified. The tendency is that where tea factories rely on small holders for green leaf the number of villages is higher. In large estates these settlements are replaced by more concentrated labour camps on the estates themselves. Amenities include drinking water taps, community halls, dispensaries and schools.
- Out of the estate type scenario, the majority of the population lives in isolated households. Due to the costs involved in connecting each individual household the priority for electrification should focus on settlements as potential centres for development.
- Most tea estates are however served by one large town which provides a range of amenities. These towns usually tend to be electrified.
- The table below provides the number of settlements within a 10km radius of three tea factories.
- The demand for individual settlements will be reviewed in the pre-feasibility studies.
- The energy demand for a range of relevant activities is provided in the following table:

| Activity | Installed Capacity (W) | Consumption (kWh/month) |
|---|---|---|
| pumping - 100 households | 500 * | 106 |
| public lighting - 100 households | 200* | 49 |
| mills , oil presses, coffee processing | 2040 | 310 |
| mechanics, welding, etc. | 1000 | 236 |
| arts & crafts | 100 | 32 |
| drink houses /restaurant | 790 | 274 |
| shops | 36 | 53 |
| schools | 153 | 161 |
| health centres | 2500 | 1209 |
| worship areas | 200 | 58 |
| administrative centres | 100 | 27 |

*** for 100 Households**

### 4.8. HOUSEHOLDS

- The majority of households are dispersed in nature with the exception of labour compounds within tea estates. Power to these are today not provided with the exception of community halls. Power is however supplied to households of Senior and Management Staff.
- The average monthly Consumption levels is given below for households belonging to three income brackets.

| | Energy Demand (kWh/month) |
|---|---|
| Low Income Households | 15 |
| Medium Income Households | 23 |
| High Income Households | 41 |

# 5. REGULATORY FRAMEWORK

- The New Energy Policy and the Energy Bill are very important documents that indicate the direction in which the Kenyan power sector is headed. The Energy Bill is at an advanced stage and, once ratified in Parliament, will dramatically transform the power sector. This Draft National Energy Policy of 2004 is clear on encouraging mini hydro and private sector involvement:
    - Rural Energy: The government will encourage and promote private sector initiatives in entering the renewable energy market. The government recognizes the side of development partners in finding specific programs and will continue to seek their support especially in areas less attractive to the private sector. Furthermore the government will allocate resources to complement self-help groups and private sector efforts in rural energy supplies.
    - Legal and Regulatory framework: Specifies ERB to license electric power producers with ERB as a one stop office for facilitating permits and licenses; enabling renewable energy systems and not exceeding 3 MW to operate in any area without license irrespective of any other existing distribution license. The National Energy Policy would make it mandatory for a licensed public electricity supplier operating in an area where power generation is being undertaken by parties other than those with agreements or arrangements with such public electricity suppliers to buy such power on terms approved by ERB (note: obviously the project will have a role to play in discussions with ERB).
    - Note (March 2005): The newly published Sessional Paper on Energy spells and Kenya's new energy policies: Whereas before the limit was set at 1mw (and obligatory hybrid-a reflection of a national lack of confidence is renewable energy technologies) the new threshold is set as a ceiling of 3MW and below (and not hybrid) for power generation that has no large needs to be licensed by the Ministry of Energy. Provided tariffs are approved by the Energy Regulatory Board Large power producers can now access customers directly. For hydro projects clearing from the water authority and environmental Management Agency (Environmental Impact assessment and regular audits) remain compulsory. Environmental safety Standards for transmission are under preparation whereas before it was required to follow KPLC prudent practices now a new grid code allows for independent mini grids.
    - Other Renewables: The government recognizes that most of the renewable energy sources; solar, wind, small hydro, co-generation, biogas and municipal waste energy have potential for the creation of opportunities and employment generation. In order to encourage private sector participation in harnessing these sources of energy the government will therefore pursue the following policy strategies:
        - Collection of hydrological data and undertaking of pre-feasibility and feasibility studies on small hydro;
        - Packaging and dissemination of information on renewable energy systems to create investor and consumer awareness and community based pilot projects;
        - Review of Electric Power Act 1997 to facilitate rural electrification based on supply on a limited scale using renewable energy technologies;
        - Allowing duty free importation of renewable energy hardware as to promote widespread usage;
        - Provision of tax incentive to both users and producers of renewable energy technologies and related accessories based on the degree of maturity and market presentation;
        - Encouraging financial institutions to provide credit facilities for up to a maximum period of 7 years to consumers and entrepreneurs through fiscal incentives;
        - Enforcing protection of the catchment areas.

- Recent developments in the policy/regulatory sector are positive steps towards the development of small hydro power, namely:
    - The above policy document takes into account small hydropower as an option to provide off-grid rural electrification
    - A new energy bill that will provide better legal framework for the development of the energy sector will soon be tabled in parliament.
    - The Govt. has constituted a Ministerial Advisory Committee on Micro Hydropower to advice on the technical issues related to their development.
    - The Electricity Regulatory Board is currently working on a report that will propose more rules and regulations that may be needed to govern the development of these systems.
    - Registration to IN-SHP approved.
    - Government is seeking funds for pre-feasibility studies.

### 5.6. KEY INSTITUTIONS AND ACTORS

- Key institutions in Kenya include:
    - Ministry of energy and mines
        - Energy Policy formulation and development
    - Kenya Power & Lighting Company
        - National utility responsible for Electric power transmission and distribution and management of national electricity grid
    - Kenya Energy Generation Company (KenGen)
        - National utility responsible for 55 % of the electric power generation and responsible for management
    - Electricity Regulatory Board (ERB)
        - Regulation of electric power sub-sector
    - Independent Power Producers (IPPs)
        - Electricity Generation and sale to the national grid
    - Ministry of water resources
    - Ministry of the environment

### 5.7. POLICIES AND PRACTICES OF PPAS BETWEEN UTILITIES AND IPPS IN THE POWER SECTOR

- Independent power producers are now able to officially generate power.

### 5.8. LICENCES AND AUTHORISATIONS FOR INDEPENDENT HYDROPOWER DEVELOPMENT AND DISTRIBUTION

- Licenses include :
    - Generation License, obtained from the Ministry of Energy
    - Distribution License, obtained from the Ministry of Energy
    - Water rights, obtained from the Ministry of Water Resources
    - Environmental Impact Assessment, Ministry of the Environment
- If the sale of power to the utility is envisaged :
    - Case by case negotiation on power purchase agreement.
- Ensure generation and distribution standards are followed.
- Licenses required are addressed in the Electricity Act as, in most cases, generation, transmission and distribution licenses are required. What is useful to point out is that the Ministry of Energy and the Electricity Regulatory Board have had experience with a “light-handed regulation” approach which has resulted in the waiving of license requirements for 2 decentralised micro-hydropower schemes in Central Province.

### 5.9. CUSTOMS TAXES LEVIES AND ROYALTIES FOR HYDROPOWER DEVELOPMENT

- Tax exemption for three years
- Hydro power import at 5% tax
- There is no indication of any taxes or levies for individual generation in the current Electricity Act.

# 6. STRATEGY FOR SHP DEVELOPMENT

## 6.6. SWOT ANALYSIS BARRIERS IDENTIFICATION

| Strengths | Weaknesses |
|---|---|
| • Hydro potential in tea growing areas is a good match.<br>• Potential for replication is high, considering the overall number of tea factories and the interest in the project voiced by the tea companies.<br>• Access to financing not seen as a problem.<br>• Utility tariff is high for Tea Factories, rated at 0,11 USD/kWh.<br>• One pre-feasibility study has already been conducted by Unilever . Low hanging fruit?<br>• Tea companies are willing to cooperate and join forces in a potential SHP development if benefits shared.<br>• A national EATTA organism exists that facilitates coordination.<br>• KTDA factories use furnace oil to meet their thermal needs, if ever enough power were made available there could be an interesting potential for CO2 reductions – although the viability of changing to sustainably forested wood should also be considered.<br>• Tea Factory technical know-how very strong.<br>• The majority of tea factories are confident about hydro and most know how to maintain the systems. A total of 4,5 MW have been installed by tea factories themselves since the early 1930's. | • Identifying potential operators besides the tea companies themselves may be difficult.<br>• Tea Companies not interested in carrying the cost of the rural electrification component. In addition the Tea Company is not directly interested in acting as an operator for the whole area – it would prefer selling wholesale electricity at a transformer to an operator who would then take care of it from there.<br>• When substituting the electrical needs, the potential for CO2 savings are limited to replacing diesel fuel – 15 000 litres per year equivalent to 75 tonnes of CO2 savings.<br>• Power in Kenya is mostly hydro based, meaning low CO2 savings. Although the future energy mix of the country will most likely have a larger share from fossil fuels.<br>• Regulatory framework not fully mature, not many projects of this size have been developed before across technologies by IPP's. However it is possible to generate power for ones own consumption.<br>• No legal framework allowing a number of Tea companies to join forces and establish an IPP or to generate power for their own internal use.<br>• Power wheeling not practised.<br>• Overall reluctance by the utility when discussing potential IPP projects or generation for self-use.<br>• Rural Electrification Agency not up and running.<br>• Potential for rural electrification in tea catchment areas low due to disperse nature of the population and relatively few settlements in proximity of the hydro sites.<br>• Standards in private distribution network, and distribution network serving multiple clients. |
| **Opportunities** | **Threats** |
| • A dynamic hydro power sector.<br>• Rural electrification to settlements. | • Tea Industry facing hard times due to low market costs coupled with increasing production costs, and low rainfall season.<br>• Existing Regulatory framework may not concede projects wherein a number of tea companies come together to produce and share power amongst themselves, to go through.<br>• Threat to the GTIEA project is the introduction of EPZ status to tea factories as this plans to lower KPLC tariffs, which will make the financial attractiveness of a SHP less interesting.<br>• Climate change, especially in respect to rainfall patterns. |

## 6.7. BUSINESS MODEL RECOMMENDATIONS

• The business model for projects wherein the SHP sites identified will meet the demand of one tea factory alone will be simpler in that the most efficient business model will be the Tea factory itself investing in and operating the project. The complexity in terms of regulatory limitations will begin when multiple companies will want to develop a joint SHP, such a site has been

proposed under this work. A joint venture between stakeholders who will "share" the benefits is difficult to create in Kenya.

- With regards to the rural electrification component most of the Tea Factories are reluctant in getting involved because selling power is not their core business; there are high risks involved and in addition most of the people residing in close proximity to the Tea Factories will be directly or indirectly reliant on the tea factories economy – this may incur awkwardness in collecting payments or dealing with payment defaults etc.
- A third option is a combination of the above, wherein the Tea Factory operates and invests in the SHP, uses electricity for its own consumption and the remaining power is sold at wholesale quantities to a range of clients or to the utility. A PPA will have to be agreed with the various customers; being other tea factories and an operator in charge of distributing electricity to rural areas or the utility. The community itself may be interested in acting as an operator for administering the distribution of power to rural communities.
- A fourth actor as already mentioned above is KPLC. The electricity generated could be sold directly to KPLC through a PPA, or their network could be utilized through a power wheeling agreement (PWA) from the SHP to the tea factories – although this is not allowed in Kenya.

### 6.8. MAKING FINANCING AVAILABLE FOR HYDRO POWER INVESTMENT

- In Kenya, the financial institutions contributing to the energy sector are/could be:
  1 World Bank;
  2 International Monitory Fund;
  3 African Development Bank;
  4 European Union Investment Bank;
  5 TRIODOS Bank
  6 Ethical Investment Banks/ Funds
  7 East African Development Bank (EADB);
  8 Rural Electrification Fund
  9 EUEI
- Commercial loans for such projects can be accessed.
- The tea industry has access to loans and has good relationships with their banking institutions. Tea factories will make investments if return on investments are attractive, low payback period and lower production costs per kWh generated compared to KPLC power. Tea factories require access to soft loans for part of the capital, up to 50% on investment.
- Factories can obtain offshore loans for a period of 5-8 years at an interest rate of 4-6 %.

### 6.9. IMPROVING TECHNICAL CAPACITY IN-COUNTRY FOR SMALL HYDRO DEVELOPMENT

- Not many developments of this size have yet been developed in Kenya. It is thought that much is yet to be done to increase the national capacity in hydro power development., even though the in house technical know-how of tea factories is very high.

### 6.10. SUBSIDIES AND SUPPORT AVAILABLE FOR PRIVATE SECTOR RURAL ELECTRIFICAITON

- Exemptions can be sought wherein a project has a social dimension.
- A Rural Electrification Fund has been existing since the 1970's, this fund is administered by the Rural Electrification Committee and in the future a rural electrification agency will be put in place.

# 7. CONCLUSIONS

- The potential for replication in Kenya is considered high with 8 companies having expressed direct interest and these representing about 80 tea factories in total.
- A number of tea companies are already operating SHP plants in the country and these are interested in expanding their hydro share. Financial packages that make the capital investment more manageable will be readily accepted by Tea Companies.
- Existing plants and recent studies that have been conducted in the country show that SHP are cost effective and have interesting pay back periods of four / five years.

- The maintenance needs of the system can be easily covered by the internal capacities of the company.
- In terms of regulatory aspects, attention should be set on what legal modalities are needed for setting up an entity representing a number of tea companies that can generate and distribute power amongst themselves.
- The IED team identified a total of 5 potential sites, two of these will be considered at pre-feasibility level:

| Hydro site or river name | Net head (m) | Equipt flow ($m^3/s$) | Installed power (kW) | Tea company | Tea factories |
|---|---|---|---|---|---|
| Kipkurere (Nandi Hills) | 378 | 1,149 | 3 030 | EPK, Williamson, Nandi Tea Estates, Koisagat | **EPK :** Savani, Kapsumbeiwa, Kipkoimet, Kepchomo, Chemomi, Siret, Kibwari, **Willimason :** Tinderet, Kapchorua, Kamoisi, **Nandi Tea Estates :** Nandi, **Koisagat :** Koisagat |
| Kipchoria (Nandi Hills) | 333 | 0,639 | 1 500 | EPK, Williamson, Nandi Tea Estates, Koisagat | |

- All together, 4 companies will be covered by the new pre-feasibilities: Eastern Produce Kenya, Williamson, Nandi Tea Estates and Koisagat.
- Covering 12 tea factories: Savani, Kapsumbeiwa, Kipkoimet, Kepchomo, Chemomi, Siret, Kibwari, Tinderet, Kapchorua, Kamoisi, Nandi and Koisagat.
- The SHP plant will envisage to provide power to multiple tea factories. The Kipchoria scheme represents an extension project of an existing hydro scheme supplying Savani Tea Factory.
- These two sites were selected on the basis of a selection matrix developed by IED in consultation with EATTA, UNEP and AFREPREN.
- The matrix is constructed on three main axis which recapture the overall objectives of the GTIEA project, as shown in the table below.
    1. Potential for replication: the potential for replication of the SHP in the country has to be high. The higher the number of tea factories and tea companies in a given country the higher the potential for replication. This criteria is measured at the national level.
    2. Attractiveness of the site : the attractiveness of developing the site will depend on the individual sites' attractiveness which will take into account the topography, hydrology and access of the site; the reliance on diesel generators due to the quality of power and thirdly on the potential for savings measured by the utility tariffs and diesel costs.
    3. Enabling environment : this is measured by three main criteria, the motivation of the tea company in developing the project; the perceived ease in access of financing from the tea factory and thirdly at the national level the maturity of the regulatory framework and whether this allows for the setting up of IPP or self-generation of power, or generation of power for a group of beneficiaries etc., power wheeling etc.
- A point system is attributed to each category on the basis of national level and site specific characteristics for each project. Overall the attractiveness of the project has more points followed by the enabling environment and potential for replication.

| | | | | MAXIMUM POINTS |
|---|---|---|---|---|
| 1 | **Potential for replication** | **25%** | N° of EATTA tea factories in the country | 20% |
| | | | N° of companies in the country (if many; high potential) | 5% |
| 2 | **Attractiveness** | **40%** | Hydrology and topography potential | 15% |
| | | | Quality of power: if poor quality or if not connected to the Grid: high potential | 15% |
| | | | Cost cutting potential: if price of power is high or if operates on Diesel: high potential | 10% |
| 3 | **Enabling environment** | **35%** | Interest expressed by Tea factories | 10% |
| | | | Regulatory framework (if easy for independent producer: high potential) | 15% |
| | | | Availability of financing | 10% |
| | | | **TOTAL POINTS** | **100%** |

- It should be noted that these 2 new pre-feasibility studies will be added to the pool of pre-feasibilities that have already been prepared by the tea companies themselves and by IED in the context of another contract with KTDA. These include:

| Site Name / River | Installed Capacity (kW) | Tea Company | Tea Factory |
|---|---|---|---|
| Kamari (Kericho) | 568 | Unilever | Kamari |
| Tagabi (Kericho) | 800 | Unilever | Unilever Internal Distribution Grid supplying 6 Tea Factories |
| Gura (NE Aberdares) | 2 775 | KTDA | Gathuthi, Gitugi, Iriaini, Chinga |
| North Mathioya 1 (NE Aberdares) | 2 010 | KTDA | Kanyenyaini, Kiru, Gatunguru, Githambo |
| North Mathioya 2 (NE Aberdares) | 1 540 | KTDA | Kanyenyaini, Kiru, Gatunguru, Githambo |
| North Mathioya 3 (NE Aberdares) | 1 960 | KTDA | Kanyenyaini, Kiru, Gatunguru, Githambo |
| South Mathioya (NE Aberdares) | 1 570 | KTDA | Kanyenyaini, Kiru, Gatunguru, Githambo |
| Maragua (NE Aberdares) | 1 970 | KTDA | Kanyenyaini, Kiru, Gatunguru, Githambo |

- A total of six pre-feasibility studies will be selected out of the full list of pre-feasibility studies (that is those conducted by IED plus those conducted by the tea companies themselves) to benefit first-hand of a more detailed feasibility study, technical assistance and a financial package being prepared. It should also be noted that all projects, (other than the six selected pilot projects) can benefit from the financial package being put in place.

# Appendix A: List of people met

| Company | Contact Telephone | E-Mail | Contact | Position |
|---|---|---|---|---|
| Eastern Produce Kenya Ltd | 020 4440399/4440115-9 | c.ballard@nandi.easternproduce.co.ke | Chris Ballard | General Manager, Engineering |
| Eastern Produce Kenya Ltd | 020 4440399/4440115-9 | | Warren | Health & Safety Officer |
| Koisagat Tea Estate Ltd 1 | 020 242024/318451 | parkside@wananchi.com | Lawrence Karanja | Director |
| Koisagat Tea Estate Ltd 1 | 0722 334 174 | | EK Wanjoih | Tea Factory Manager |
| Nandi Tea Estates Ltd | 0733 632043 | nanditea@africaonline.co.ke | Isac Zang | Engineer |
| Unilever Tea Kenya Ltd | 052 20146-9 | Norman.Kelly@unilever.com | Norman Kelly | Operations and Development Director |
| Unilever Tea Kenya Ltd | 052 20146-9 | martin.ogada@Unilever.com | Eng. Martin Ogada | Company Electrical Engineer |
| Unilever Tea Kenya Ltd | 0722 428927 | anthony.biegon@unileve.com | Anthony Biegon | Kimari TF Manager |
| Unilever Tea Kenya Ltd | 052 20146-9 | | Peter Sielle | Kimari TF Production Manager |
| Williamson Tea Kenya Ltd | 020 2710740/1 | gwkenya@williamson.co.ke | Zabron Mugo | Group Engineer |
| Williamson Tea Kenya Ltd | 020 2710740 | nigel@williamson.co.ke | Nigel Sandys Lumsdaine | Managing Director |
| KPLC | 0733 895015 | | Mr Anangwe | |
| KPLC | | | Mr Kinyra | Drawing Office |

# Appendix B: References

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