d) Specific Measures for Solar Dryers

Economic and Financial Measures

i) Ensuring access to credit for consumers to obtain low interest loans

Non-financial measures

i) Formulation of enabling policies and legislation
ii) Strict enforcement of policies and legislation
iii) Development of requisite skills for solar dryer technology
iv) Provision of relevant information and awareness creation.

1.2 Action Plan for SHS

1.2.1 Solar Home Systems Technology

Kenya lies along the Equator. Solar energy resources are available in many areas of the country in quantities that are commercially viable. Solar Home Systems provide household lights, and electrical power for televisions, cassette players and small appliances. This forms the bulk market for photo-voltaics in Kenya.

A number of PV cells in a serial configuration is known as a solar module. When numerous solar modules are linked together in either a parallel or serial configuration they are known as a solar panel. Sunlight strikes the solar cells causing electrons in the cells to move in one direction producing direct current (DC). The electrons then flow through wires that connect the cells. Many solar cells are connected together to produce the voltage and current needed to power the inverter. The inverter is a solid-state electronic device that converts solar generated direct current into alternating current (AC) to power electrical equipment and appliances. AC is used in the home to provide light, power most appliances such radios, televisions and charge mobile phones. A SHS unit comprises solar panels, inverters, charge controllers, battery and compact fluorescent lights (CFLs).

An estimated 200,000 rural households in Kenya have solar home systems. This success has been largely due to private sector activity. Most units are in the power range of 10 to 100 Wp. However, still many rural households find it difficult to buy SHS due to their relatively high costs in unsubsidised market. High prices are due to the fact that the SHS parts and components are imported using hard currency whose exchange rate keeps on fluctuating due to instability of Kenya shilling. The high technology involved in SHS and raw materials required for SHS make SHS expensive. A complete SHS including wiring and installation charges amounts to about US$ 2,000. The price of compact fluorescent lights (CFLs) ranges between US$ 2.5 to US$ 5.6 (for 8- 20 watts).

The SHS technology has potential to provide electric power in the rural areas where about 95%of the population is not connected to the grid. There is a large potential (about 6,000,000 rural households) for its diffusion in the country. There is additional potential of SHS technology to provide electricity to the already grid connected households in both the urban and rural areas as a backup measure to ensure continuous power supply in view of frequent power outages. The uptake of SHS has been slow (see table 1.3) below due to various reasons such as relative high cost of the technology and low awareness on the potential socio-economic and environmental benefits of the technology among others.

Table 1.3: Trade and Production of SHS Parts and Components in Kenya: Mean (2004-2008)

Short Description	Units	Imports	Production	Consumption
Static converters [e.g. rectifiers and inductors and inverters for converting dc power to ac power]	Number	305,995	-	305,690
Photovoltaic system controller [charge controller for voltage not exceeding 100V]	Number	185,171	-	114,113
Photovoltaic cells, Modules and Panels	Number	118,322	-	112,908
Other lead-acid accumulators [Deep discharge (solar)]	Number	173,740	<50,000	1112,015

Source: Moses Ikiara, KIPPRA (2009)

SHS technology has potential to replace the use of polluting kerosene lamps and candles for lighting in rural households and therefore contribute to reduction of emissions of GHGs.

Economic, Social and health benefits include:

i) **Employment creation**. By targeting 3 million households with SHS by 2030, many jobs will be created for retailing, distribution, installation, maintenance and repair of SHS.

ii) **Reduces fire risks**. If kerosene lamps and candles are not handled properly especially by children, they have a likelihood of causing fires in grass thatched rural houses. The use of SHS will reduce such risks.

iii) **Good learning opportunities for students in the evenings**. Indoor use of SHS will increase the ability of school children to do their homework effectively leading to enhanced academic performance.

iv) **Improved health**. Traditionally families in rural areas use paraffin lamps and candles as source of light. These lamps/candles produce fumes which are harmful to human health.

Climate Change Mitigation Benefits

SHS will replace fossil fuel sources of energy such as kerosene lamps and candles which emit CO_2.

The mitigation potential is in the range of 1,000 ktCO_2 /year in2030 (Saidi et. al., 2012). Assuming that a rural household hason average two kerosene lamps/candles, SHS will replace use of 330,000 lamps/candles annually and 6,000,0000 lamps/candles by 2030.Given that a household consumes about one litre of kerosene for lighting/week, the country would save 8,580 tonnes/year of imported kerosene.

1.2.2 Targets for Technology Transfer and Diffusion

About 80% of the Kenyan population has no access to electricity from the grid (6 million).

About 165,000 SHS units annually are targeted for installation and rising to 3,000, 000 units by 2030. The target for SHS technology therefore is 50% of the 6 million households i.e. 3 million households by 2030. Other targets comprise mostly rural based institutions such as schools, hospitals, dispensaries, prisons and government offices.

Even households connected to the grid may wish to have a SHS as a power back-up for purpose of having a reliable power supply.

1.2.3 Barriers to the Technology's Diffusion

Barrier identification process was based on the following:

i) A desk study of policy papers and other pertinent documents
ii) Economic and other relevant assessments of the SHS
iii) Workshop by technology working groups and which included a brainstorming session. This workshop was held on 25th July 2012 at Laico Hotel, Nairobi (See Annex 2)
iv) Expert and stakeholder consultation (one on one basis)
v) Market mapping tool -consumer goods and capital goods. The elements in the market environment and the relation to the market chain were used to identify barriers for SHS.

1.2.3.1 Economic and Financial Barriers

The following are the economic and financial barriers to transfer and diffusion of SHS low carbon emission technology:

i) Solar Home Systems Require High Initial Investment Costs

SHS face several economic and financial barriers. These are barriers which make SHS to require high initial investment costs.

- **High cost of solar panels and batteries**

  Most of SHS parts and components such as solar photovoltaic cells, solar PV modules and panels, charge controllers, compact fluorescent lamps (CFLs) and solar batteries are imported. However, there is a local company in Kenya which also manufactures solar batteries including car batteries. High prices are due to the fact that the SHS parts and components are imported with hard currency whose exchange rate keeps on fluctuating due to instability of the Kenya shilling. High technology involved and raw materials required for SHS are also expensive. A complete SHS including wiring and installation charges amounts to about US$ 2,000. The price of CFLs ranges between US$ 2.5 to US$ 5.6 (8 -20 watts).

- **Lack of Subsidies**

  The government of Kenya does not provide subsidies for one to purchase a SHS. Due to relative high costs of SHS, this has made the SHS to be inaccessible to the rural poor households for who this technology is targeting.

- **High Costs of Installation, Repair and Maintenance**

  There are no institutions in the country providing focused and practical training courses on design, manufacturing/production of static converters, photovoltaic system controllers, photovoltaic cells and modules in the country. Technical colleges and other tertiary institutions offer general courses on electronics and electrical engineering. As a result, hands on skills are limited. Due to scarcity of trained local personnel to install, repair and maintain SHS, the costs of SHS are relatively high.

- **High Interest Rates**
  Financial institutions charge interest rates ranging between 15% and 30% for people wishing to get loans. The same interest rates are applicable to those wishing to access loans to purchase SHS**.**

1.2.3.2 Non-Financial Barriers

i) Inadequate information and Awareness

The majority of Kenyans living in rural areas have little information concerning the potential social, economic and environmental benefits of the SHS. Little information and awareness on SHS is due to the fact that neither the government nor the private sector has committed financial resources to use both the print and electronic media to provide information and awareness on the importance and potential benefits of SHS to the public at large**.**

ii) Theft of Solar Panels and Batteries

Many users of SHS have experienced frequent thefts of solar panels. This has tended to make potential users of SHS hesitant to acquire the technology.

iii) Inadequate Research and Development (R&D) and Unfocused Training

R&D targeting SHS is lacking. Due to lack of development of SHS technology in the country most of the SHS components are imported.

iv) Limited Number of Local Technical Trained Personnel (engineers and Technicians)

LocalUniversities and technical colleges in the country offer courses on electronics and electrical engineering. These courses are theoretical in nature and do not focus on practical aspects of the SHS technology such as design, manufacture and application of the technology. As a result, the country has limited number of trained technical personnel to install, repair and maintain SHS.

v) Few Distribution Networks

There are few distribution networks for SHS countrywide. As a result some customers have to travel long distances to access them besides incurring substantial costs on travel.

vi) Inadequate Enforcement of Standards for SHS

Due to inadequate legal and regulatory framework and corruption, low quality solar panels, batteries and compact fluorescent lights (CFLs) end up in the country. Low quality solar panels are unreliable and breakdown shortly after installation while low quality CFLs also last for a short duration after being installed. These low quality SHS products are sold at lower prices to unsuspecting customers

1.2.4 Action Plan for SHS

1.2.4.1 Proposal for Enabling Framework

In order to build on success of over 200,000 SHS installations country wide, and the proposed annual target aimed at installation of 165,000 SHS units per year, it is proposed that the Ministry of Energy and county governments in collaboration with the private sector, civil society, development partners and the beneficiaries of the SHS technology should support the following enabling framework:

i) The Energy Act 2006

The Energy Act (2006) established the Energy Regulatory Commission whose function among others is to enforce and review regulations, codes and standards for the energy sector. The Energy Act has substantially reformed the Energy Sector with an effective institutional, regulatory and legal framework. It is

proposed that the Act should be revised in order to give appropriate incentives for wide diffusion of SHS.

ii) Green Energy Fund

The government is in the process of setting up a Green Energy Fund Facility under the National Taskforce on Accelerated Development of Green Energy and whose purpose is to lend funds to viable renewable energy projects on concessional rates. This fund will be operationalized for the benefit of those wishing to access SHS technology and other green energy technologies.

iii) Kenya Anti-Corruption Commission

The government has established through an Act of Parliament the Kenya Anti-Corruption Commission to check corruption in all sectors of the economy. However, there has not been goodwill from authorities to ensure enforcement of the laws. The Anti Corruption Laws will be enforced in order to eradicate corruption and therefore ensure that only high quality SHS parts and components are sold in the country.

iv) The National Climate Change Response Strategy

The Government of Kenya has formulated a National Climate Change Response Strategy whose objectives include conducting periodic climate change threat and risk assessments at national and local levels; developing a national capacity building framework in strategic climate change areas; identifying specific research and development needs to address climate change; and opportunities for technology development, absorption and diffusion among others.The action plan needs to be implemented as soon as possible in order to support climate change programmes at the county level.

1.2.4.2 Proposed Measures

Identification of measures process was based on the following:

i) TNA consultants own experience
ii) Workshop by technology working groups and which included a brainstorming session. This workshop was held on 25th July 2012 at Laico Hotel, Nairobi (See Annex 2)
iii) Market Mapping Tool
iv) Logical problem analysis (objective tree)

The following measures for diffusion of SHS technology are being proposed.

a) Economic and Financial Measures

Affordable SHS will become affordable through a combination of both economic and financial measures and non- financial measures. These measures are discussed below.

i) Low Costs for solar panels and batteries

Low costs for SHS parts and components will be realized by encouraging the private sector to establish industries to locally manufacture and assemble SHS parts and components such as solar panels, inverters, lighting kits and charge controllers.

ii) Provision of Subsidies

The current cost of SHS technology is beyond the financial reach of the common man in rural areas. The county governments, Ministry of Energy, NGOs, development partners, private sector will consider providing subsidies to the poor households wishing to buy SHS in order to make them affordable.

iii) Low Interest Rates

The Ministry of Energy in collaboration with the development partners and local financial institutions will establish a revolving fund whereby potential users of SHS could borrow at low interest rates to access SHS. The low interest will be meant for managing the fund. Potential borrowers from this fund will be encouraged to form groups. These groups will guarantee loans borrowed by their individual members.

As an example of the aforesaid, the government is in the process of setting up a Green Energy Fund Facility under the National Taskforce on Accelerated Development of Green Energy and whose purpose is to lend funds to viable renewable energy projects on concessional rates.

b) Non-Economic Measures

i) Adequate Information and Awareness on SHS

Information and awareness campaigns will be launched by the private sector in collaboration with county government and NGOs to sensitize the communities on the SHS technology. Funding for this measure will be provided by county governments, private sector, NGOs and development partners.

ii) Provide Security for Solar Panels and Batteries

Most of people who steal solar panels and batteries do so because they are poor and unemployed. Public education and awareness creation, community policing and empowering the youth to access different sources of livelihoods are some of the methods that will be employed in order to make SHS secure.

iii) Enhanced R&D

R&D activities for SHS technology will be addressed through– legal, institutional, policy, regulatory and technical components and where absent will also be enhanced. Funding for R&D activities will be provided by the private sector, county governments, Ministry of Energy, NGOs and development partners.

iv) Provision of Critical Mass of Local Trained Personnel (technical manpower)

Critical mass of trained technical personnel will be achieved through increased local training and technology transfer for imported SHS equipment. Local village polytechnics and technical colleges in collaboration with private and public R&D institutions will be empowered to offer courses on design, production and application of SHS. As a result, the country will have a critical pool of trained technical personnel to assemble, install, repair and maintain SHS in the country.

v) Increase Distribution Networks

In order to increase diffusion of SHS in the country, SHS distributors will be encouraged to increase their distribution networks by making sure that these products are available within the mobility range of potential customers, typically less than 20km from the customers home. This will be done by the private sector.

vi) Enforcement of SHS Standards

The Kenya Bureau of Standards in collaboration with the customs section of the Kenya Revenue Authority will ensure enforcement of existing national standards for SHS.

The proposed action plan for SHS is shown below in table 1.4.

Table 1.4: Technology Action Plan: Solar Home Systems

Name of Measure	Why measure is needed	Main actors	Time-frame	Cost	Justification	Indicators of success	Risks
Provision of subsidies	Relative high cost of SHS	Ministry of Finance; county governments, local banks; and development partners	5-10 years	KShs.240 million. Funding will be provided through county governments, development partners, NGOs and PPPs.	Target per county is 625 households. Proposed subsidy per household is KShs. 16,000. Total subsidy is KShs. 16,000x625x24=KShs. 240,000,000	Adequate subsidies such as soft loans; revolving funds (Green Energy Fund) for SHS in place	Support from government; development partners; PPPs and NGOs
Enforcement of national standards for SHS	Currently low quality SHS are being imported into the country through the backdoor. Solar panels and lighting kits break down frequently requiring high maintenance costs	KEPSA; Kenya Bureau of Standard and immigration section of the Kenya Revenue Authority (KRA)	0-5 years	Kshs.1,000,000 funding will be provided through the Kenya Bureau of Standards	The officers from Kenya Bureau of Standards and Kenya Revenue Authority are already in place.	Enhanced and enforced standards for SHS in place	Lack of collaboration between Kenya Bureau of Standards and the immigration section of KRA

Name of Measure	Why measure is needed	Main actors	Time-frame	Cost	Justification	Indicators of success	Risks
Information and awareness campaigns will be launched to sensitize the rural households on the SHS technology	In most rural areas, there is generally inadequate information and awareness on SHS technology. This is evidenced by the fact despite many socio-economic and environmental benefits associated with use of SHS, many rural households (over 6 million) continue to use highly polluting fossil fuel based energy for lighting kerosene lamps and candles.	County governments, PPPs; KEPSA ; media; and NGOs	0-5 years	KShs. 23.5 Million. Funding will be provided by county governments, NGOs, private sector, development partners and by ministry of energy	Since there are 47 counties in Kenya, KShs. 500,000 will be allocated per county for information and awareness campaigns	Information and awareness campaigns conducted	Lack of interest from NGOs and industry
Provision of critical mass of technical man-power. This will be facilitated through increased local training; technology transfer for imported SHS equipment with support of local technical training colleges and R&D institutions	To increase technical capacity of personnel involved in installation, repair and maintenance of SHS. There are only five companies in Kenya involved in Solar PV market. Many of these companies are involved in importation and wholesale aspects of the technology while only one deals specifically with retailing of SHS.	County governments; PPPs; NGOs	0-5 years	Kshs. 47 million. PPPs, NGOs and development partners	KShs. 1,000,000 will be availed per county for capacity building	Trained man power in place	Lack of funding

Name of Measure	Why measure is needed	Main actors	Time-frame	Cost	Justification	Indicators of success	Risks
Research and Development. R&D activities for SHS will be enhanced. Issues such as – legal, institutional, policy and regulatory and technical components and where absent will also be addressed and enhanced.	Both the R&D institutions; academia; and the private sector are not providing funding to support focused R&D targeting SHS technology	County governments R&D institutions; Ministry of Enery; NGOs; and private sector	5-10 years	KShs. 470 million. The funding will be given by counties from current allocations, PPPS, development partners and NGOs. Part of government R&D funding will be directed to support R&D on SHS technology.	KShs. 10 million per County	Provision of funds for R&D on SHS technology in place	Lack of funding
Adequate distribution networks. Distribution networks will be increased such that SHS customers travel less than 20 Km to access them.	Potential buyers of SHS technology have to travel long distances and incurring substantial travelling costs before they can access SHS technology	Private sector	0-5 years	KShs. 47 million. County governments, NGOs, development partners and PPPs will provide the funding	At KShs. 1 million per county.	Distribution net-works within reasonable reach	
Provision of security for solar panels and batteries. This will be achieved through public education, awareness campaigns, community policing and improvement of livelihoods by agro-processing activities for value addition. These activities will create employment in the rural areas.	Theft of solar panels and batteries	NGOs, media; public and local administration, local business men; PPPs and development partners	0-5 years	KShs. 47 million. The county governments; Ministry of Industrialisation; Ministry of Higher Education, Science and Technology and the community will provide the required funding.	At KShs. 1 million per county.	Public education and awareness campaigns conducted and community policing in place	Lack of funding