Updated Rapid Assessment and Gap Analysis on Sustainable Energy for All (SE4All): The UN Secretary General Initiative

Federal Democratic Republic of Ethiopia
Ministry of Water, Irrigation and Energy

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Supported By:

ACKNOWLEDGEMENT

This updated version of the Rapid Assessment and Gap Analysis on the Sustainable Energy for All (SE4ALL): the UN secretary General Initiative, has been supported by the European Union (EU) Delegation to Ethiopia and is being based on the initial version dated June 2012 and supported by the UNDP.

This report provides an update in terms of the energy situation and plans within the Ethiopian energy sector, discusses the status with respect to the SE4All goals of: (a) ensuring universal access to modern energy services, (b) doubling the global rate of energy efficiency and (c) doubling the share of renewable energy in the energy mix, and the gaps and barriers to be addressed to implement the Initiative in Ethiopia.

The report has been prepared by the SE4All Team from the Ministry of Water, Irrigation and Energy with the participation of Michel Layec and Francis Xavier Ochieng, consultants financed by the EU Delegation to Ethiopia. It should be pointed out that attention has been paid to maintain the structure of the initial Assessment/Gap Analysis of June 2012.

It is my sincere hope that this document will prove useful not only for the development, monitoring and evaluation of the SE4ALL National Action Plan under preparation, but also to all the stakeholders and practitioners of Ethiopia's Energy Sector.

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ACRONYMS

CFL	Compact Florescent Lamp
CO_{2e}	Carbon dioxide equivalent
CRGE	Climate Resilient Green Economy
CSA	Central Statistical Agency
EEPCo	Ethiopian Electric Power Corporation
EEU	Ethiopian Electric Utility
EEPE	Ethiopian Electric Power
EPE	Ethiopian Petroleum Enterprise
ETB	Ethiopian Birr
EU	European Union
€	Euro
EUR	Euro
FiT	Feed in Tariff
FSS	Fuel Saving Stove (similar to ICS)
GDP	Gross Domestic product
GoE	Government of Ethiopia
GDP	Growth Domestic Product
GTP	Growth and Transformation Plan
GW	Giga Watt (10^9 Watt)
GWh	Giga Watt hour (10^9 Watt hour)
HICE	Household Income, Consumption and Expenditure Survey
ICS	Improved Cook Stove
ICT	Information and Communication Technology
IPP	Independent Power Producers
kg	Kilo gram (1,000 gram)
kWh	Kilo Watt hour (1,000 Watt hour)
LED	Light Emitting Diode

LPG	Liquefied Petroleum Gas
MHP	Micro hydro power (similar to SHP)
MJ	Mega Joule (one million Joule)
MOFED	Ministry of Finance and Economic Development
Mt	Million tonnes
MW	Mega Watt (one million [10^5] Watt)
MoWIE	Ministry of Water, Irrigation and Energy (previously MoWE)
MoWE	Ministry of Water and Energy
MW_p	Mega Watt Peak (one million Watt Peak)
NBE	National Bank of Ethiopia
PASDEP	Plan for Accelerated and Sustained Development to Eradicate Poverty
PJ	Peta Joule (10^{15} Joule)
PPA	Power Purchase Agreement
PV	Photovoltaic
R&D	Research and Development
REF	Rural Electrification Fund
RES	Renewable Energy Sources
SDPRP	Sustainable Development and Poverty Reduction Programme
SE4ALL	Sustainable Energy For All
SHP	Small Hydro power (Similar to MHP)
SME	Small and Medium Enterprise
SPM	Strategic Plan and Monitoring
SREP	Scaling up Renewable Energy Programme
SWH	Solar Water Heater
TCF	Tera Cubic Feet (10^{12} Cubic Feet)
TWh	Tera Watt hour (10^{12} Watt hour)
UEAP	Universal Electricity Access Program
UNDP	United Nations Development Programme
USD	United States Dollar

V	Volt
VDC	Volt Direct Current
WB	World Bank
WMS	Welfare Monitoring Survey

SECTION I: INTRODUCTION

1.1 COUNTRY OVERVIEW

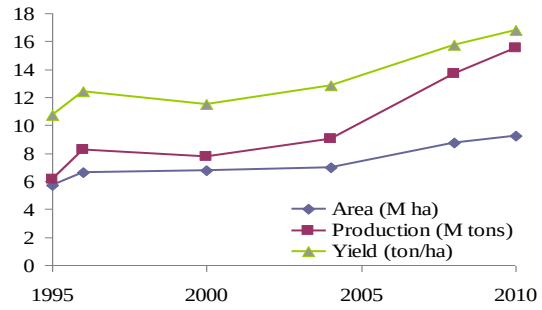
1.1.1 Basic socio-economic data

Ethiopia is a country of 85 million people (2012) living in an area of 1.1 million square kilometre. The population is growing at 2.3% annually and it is expected to reach 103 million by 2020 (CSA, 2011). Ethiopia has a predominantly agricultural economy and 84% of the population lives in rural areas directly or indirectly employed in agriculture and related activities. Ethiopia has a young population - two-thirds of the population is under 25 and a third of the population is between the ages of 15 and 35.

Agriculture is still the most important economic activity in Ethiopia accounting for 42% of the economy and employing 14.8 million households in the crop sub-sector alone.[1] The industry sector contributes 13% and the services sector 45% to total output. Annual real GDP growth has averaged 11% and per capita GDP 7.7% per year over the past six years. GDP per capita now stands at US$416 in 2011.[2] The current five year development plan, the Growth and Transformation Plan (2011-2015), projects 11% GDP growth for the remaining years of the plan.

Agricultural GDP, which has the most poverty alleviating impact, has grown 8.6% annually over the past five years. Food production has increased by 152% over the past fifteen years – this has direct and impact in improving food security, particularly in rural areas.

Area, production and yield for cereal crops in Ethiopia (1995 – 2010)



Yield for cereals has improved by 57% over the past fifteen years. This is compared to a 61% increase in the area cultivated and 152% increase in production.

Source: CSA, Agricultural Surveys, 1996-2010.

[1] NBE, Annual Report, 2009/2010 for GDP; CSA, Agricultural Sample Survey 2011 for agricultural households. http://nbebank.com/admin/filesystem/index.php?news=111; http://www.csa.gov.et/index.php?option=com_rubberdoc&view=category&id=79&Itemid=606

[2] Based on preliminary results for GDP growth in 2011 (11.2%) less the population growth rate of 2.6%

Poverty indicators have shown marked improvement over the past ten years – in the years from 1995 to 2011 poverty has declined by 36% nationally, 36% in rural areas, and 31% in urban areas.

					Change (%)	
Poverty head count	1995/96	1999/00	2004/05	2010/11	2004/05 over 1999/00	2010/11 over 2004/05
National	0.455	0.442	0.387	0.296	-12.4	-23.5
Rural	0.475	0.454	0.393	0.304	-13.4	-22.7
Urban	0.332	0.369	0.351	0.257	-4.7	-26.9

Source: MoFED, Ethiopia's Progress towards Eradicating Poverty, 2012.

1.2 ENERGY SITUATION

1.2.1 Energy supply

Ethiopia's domestic energy resources are predominantly renewable and consist of hydropower (45 GW), wind (1,350 GW), geothermal (5 GW), bioenergy (96 Mtons yield/y) and solar energy (5.5 kWh/m2.d).[3] Ethiopia also has known reserves of coal (260 million ton) and natural gas (4.7TCF). The country still relies heavily on bioenergy resources to meet energy demands. However, development of other renewable resources, principally geothermal and wind is now growing rapidly, and these are expected to supply a growing share of the energy demand in the future.

Ethiopia imports all its requirements for petroleum fuels and coal. Petroleum fuels are mainly used in the transport sector and as thermal fuel in the industry, service and residential sectors. Coal is used in the cement industry as fuel for kilns. The volume of petroleum imports has been growing rapidly (8% annually and higher) over the past ten years and has reached 2 million tons (US$1.1 billion) in 2011.

Power sector infrastructure development and services in Ethiopia have been mostly carried out through the state owned power company (Ethiopian Electric Power Corporation or EEPCO, which was split into 2 state own entities in December 2013). In 2012/2013 the power infrastructure consisted of: (a) 2,122 MW by 2012/2013 of installed generation capability from twelve hydro power plants, 1 small geothermal plant (7.3 MW) and several small thermal plants; (b) 12,494 km of transmission and 154,687 km of distribution lines by 2012/2013; and (c) about 2 million customers. Total power generation for 2012/2013 was 7,600 GWh and the consumption was distributed as follows among industrial (37%) customers, residential (37%) customer and commercial (26%) customers. Ethiopia presently exports power to Djibouti, and is building the regional transmission networks for additional exports to South Sudan and Kenya.

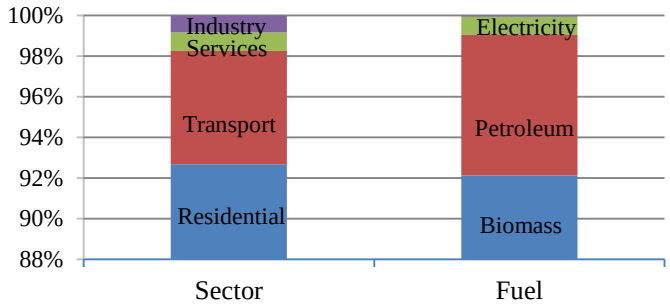
[3] Estimate for wind considers only areas that have excellent wind regimes, i.e. areas that have wind speeds higher than 7.5m/s at 50 meters above ground level.

1.2.2 Energy demand (overview of main consuming sectors, industry, residential, agriculture, transport)

Domestic energy consumption in Ethiopia was estimated at 1,300PJ in 2010. Per-capita consumption of energy consisted of 960 kg/year of bioenergy, 25 kg/year of petroleum, and 40 kWh/year of electricity.

The residential sector accounts for 93% of the total energy consumed in Ethiopia. The main energy requirements in the residential sector are for cooking and baking with bioenergy. The residential sector also consumes 37% of the total electricity supplied in Ethiopia.

Figure 1.1 Energy supply, 2010
Total energy supply = 1,300PJ



The transport sector is the second most important energy consuming sector. Inland transport in Ethiopia is almost exclusively by road using petroleum fuels. Energy demand for freight transport is estimated to account for two-thirds of the total transport energy requirements, the rest going for passenger transport (public and private).

Energy demand in the industry sector is growing rapidly but it is still small compared to other sectors. The industry sector consumes 37% of the electricity supplied (2.22 TWh) and a substantial amount of fossil fuels for thermal energy (in boilers and kilns). In recent years a growing amount of coal is being used replacing heavy fuel oils used in cement factories.

The services sector is composed of commercial services (hotels, restaurants, bakeries and others) and social services (health facilities, education facilities, water supply services, public lighting and others). In the services sector energy requirements are for lighting, thermal applications (cooking, baking, and boiling) and for electric appliances. In both commercial and social institutions (including universities) energy requirements for cooking (and baking) are substantial and the sector is an important contributor to bioenergy requirements.

Current development plans are expected to shift the characteristics of energy supply and use in Ethiopia. Supply side plans include increasing power supply capacity by four fold by 2015 and increasing production and use of liquid biofuels. On the demand side plans for introduction of extensive rail network, both inter city and intra city, will introduce demand for electricity from the transport sector while at the same time reducing petroleum fuel requirements for transport. Requirements for coal in the industry sector are expected to rise sharply because of plans to increase cement output ten times by 2015. Expansion of sugar production will increase bioenergy (ethanol) supply in Ethiopia.

1.2.3 Energy and economic development

The water and electricity sub-sector accounts for just 1% of national GDP (and 8% of industrial sector GDP) in Ethiopia. This, however, does not consider non-commercial energy and also petroleum and other fuels. A more indicative statistics would be household energy expenditures – in 2007 the estimate was that the average Ethiopian spent about 9% of its

income on energy and fuelwood and other cooking fuels accounted for 40% of this expense (CSA, 2007).[4]

The share of public spending on energy has increased significantly in recent years. There is clearly a growing realization of the importance of energy in the development agenda. During the 2006-2011 period investment in energy programs accounted for 20% of total investment while in the current planning period 2011-2015 (GTP) energy sector investment accounts for 45% of the total investment in the plan. The required investment for power projects alone in the current plan is US$6.5 billion.

Import of petroleum products and coal rose to around US$1.3 billion in 2010. This accounted for 16% of the total import value and 30% of total export income for the year. The relative burden of fuel imports from total export has declined in recent years because of substantial rise in export earnings (doubling between 2005 and 2010). The relative importance of fuel imports from total imports has also declined as other imports have risen more rapidly than fuel imports.

1.2.4 Energy strategy and relevant targets (access, capacity, generation, energy security)

The current five-year strategic plan of the Ministry of Water, Irrigation and Energy (MoWIE) sets the direction and targets for the energy for the period 2011-2015. This plan forms part of the national development plan called the Growth and Transformation Plan (GTP). The main actions and targets for the power sector include increasing generation capability for grid by four times (from 2GWs to 8 - 10GWs), doubling the length of the distribution network, and doubling the number of customers on the grid. The other major plans are to provide access to electricity to 3 million households and institutions through solar photovoltaic (PV) systems, disseminating 9 million improved cook stoves, and increasing production and use of liquid biofuels.

2010 & Targets	Unit	Base - 2010	Target - 2015
Power – on grid			
Installed power	MW	2,000	8,000
Distribution lines	Km	126,038	258,038
Transmission lines (66kV and above)	Km	11,537	17,053
Customers	No. (million)	2.0	4.0
Power – off grid			
Solar home and institutional systems	No. (million)	< 0.02	0.15
Solar lanterns	No. (million)	< 0.02	3.0
Other programs			
Solar thermal systems (cookers, heaters)	No.	NA	13,500
Liquid biofuel production	Liters (million/yr)	7.0	1,630
Clean cook stoves	No. (million)	7.0	16.00

Source: MWE, 2011. Strategic Plan of the Ministry of Water and Energy (in Amharic)

Another recent strategy that has relevance to the energy sector is the Climate Resilient Green Economy (CRGE) Strategy (2011). The greenhouse mitigation actions proposed in the CRGE strategy are mostly energy related including reduction of forest degradation through energy

[4] Central Statistical Agency (CSA), 2007. Household Income, Consumption and Expenditure (HICE) Survey 2004/5, Volume I, Analytical Report

efficient stoves and renewable fuels, displacing fossil fuels in transport by electricity through electric rail, and green power export to fossil fuel dominated power systems in neighbouring countries. The target for clean cooking is in fact the largest mitigation measure in the plan constituting 20% of the total greenhouse mitigation potential in 2030 (50 MtCO2e from 250 MtCO2e).

SECTION II: CURRENT SITUATION

2.1 ENERGY ACCESS

2.1.1 Overview and Assessment

Access to modern energy services improved in Ethiopia in the past seven years. About 7 million improved cookstoves have been disseminated to households and businesses since 2005, although only 4-5 millions are estimated in use. With the rural electrification project, accessibility to electricity services grew from about 15% in 2005 to about 53% by 2012/2013 with nearly all power generated from renewable resources. However, at the national level only about 18-20% (2011) of households used electricity in the household. For off-grid rural communities, the Rural Electrification Fund (REF) has been established to promote, disseminate and help finance isolated systems with renewable energy technologies.

Despite such efforts, much is yet to be done as the majority of the population particularly in rural areas is still dependent of costly and smoky fuels such as kerosene and firewood for lighting. For cooking households still depend on solid biomass fuels using inefficient open fire cooking methods with an estimated energy efficiency of 10%. Associated negative environmental, health and economic consequences of solid biomass usage on open fire are severe. Cognizant of this fact, the government of Ethiopia provided increased attention and resources for the energy sector development in its short and long term national strategic development plans.

2.1.2 Modern energy for thermal applications

Thermal energy needs in the households are mainly for cooking and water boiling for bathing. It accounts for the lion's share in the total national energy consumption. Drying food for longer preservation is also a common practice in the households. In agro-industries, thermal energy requirement is for process heating and drying in sugar, tea and tobacco industries. Thermal energy in industries is a major energy requirement - mostly met either with petroleum or electricity.

The energy sector in Ethiopia is characterised by the predominance of the household sector, accounting for 93% of gross energy consumption in 2009. Traditional biomass fuels including firewood, agri-residues, dung and charcoal account for 98.7% in the household energy supply while electricity and petroleum fuels account only for the remaining 1.3%[5]. Cooking is the main end-use in the households. Nearly all rural households and about 84% of urban households depend on solid biomass fuels for cooking[6]. Dependence on solid biomass fuels has generally increased over the years in the household sector. Comparison of household cooking fuel consumption patterns indicated that solid biomass fuels use increased from 78% in 2004 to 84% in 2011 in urban households. On the other hand, due to an increasing trend in kerosene price (currently USD 0.8 per liter), urban households decreased their dependence on kerosene for cooking. The number of urban households that use kerosene as major cooking fuel decreased from 14% in 2004 to 5% in 2011 by making a shift either to biomass (retail price of firewood USD 0.1 per kg, charcoal USD 0.34 per kg) or electricity (average domestic tariff of USD 0.028 per kWh; the tariff schedule provides for differential

[5] Ministry of Water and Energy, Energy Balance and Statistics for years 2005/06 to 2009/10, Augusts 2011, Addis Ababa, Ethiopia.

[6] Ethiopian Welfare Monitoring Survey 2011, Summary Report, Central Statistical Agency, April 2012

tariffs varying with the level of consumption. Nevertheless, households do not make a total shift from one fuel to another. Because of unreliability of supply and fuel price fluctuation, fuel stacking is a common coping mechanism particularly in urban households.

Choice of cooking energy for households primarily depends on availability and affordability of fuels. In rural areas, solid biomass is the only available fuel, most of the time gathered by family members. Households in rural areas do not have much choice for modern fuels. For urban households, price of fuels is the determining factor. Even though electricity seems cheaper in Ethiopia, it is still unaffordable for the majority of households[7]. In 2011, of the 1.65 million households actually connected to the electricity grid, only about 18% of them use it for cooking[8].

Cooking situation in institutions (universities, hospitals, prisons, etc.) and businesses (hotels, restaurants, etc) is similar to that of the households. Like most households institutions and businesses use firewood with open hearth for cooking meals.

Solid biomass fuels are major sources of cooking fuel and will remain to be so in the foreseeable future particularly for rural households. Because of this, improved cookstove programs have been one of the major intervention areas in the household sector since early 1990s. A number of different type of stoves that are cleaner and energy efficient (on average a doubling of energy efficiency to 20%) have been developed and disseminated to urban and rural consumers including households and businesses. So far, over 9 - 10 million (by 2012/2013) improved biomass cookstoves of different types were distributed[9] of which 4.5 million were user-built firewood stoves. It is estimated that nationwide about 4-5 millions improved cookstoves are in used today, due to breakages, poor fit with cooking habits, etc. Today over 10 million households still don't have access to improved and clean cooking.

The National Cook Stove Program started in 1980 with the objective of disseminating at least two technologies per household (one for cooking and another for baking Besides it is planned to distribute nine million improved household cook stoves (ICS) by 2015 and distribute 30 million ICS by 2030

Biogas technology has also been promoted for cooking in rural households. Under the National Biogas Program, started in 2008, about 8,000 domestic biogas plants have been installed by 2012/2013. In these households about half of their cooking energy requirement is substituted by biogas. Even though the effort is not comparable to that of the number of households, institutional biogas plants have also been constructed in over 100 institutions.

Overall, thermal energy requirement in Ethiopia is mainly for cooking and the primary source of energy for this is traditional biomass fuels. This has resulted in over dependence on the biomass resources which led to an unsustainable supply of biomass fuels. The fraction of non-renewable biomass consumption for cooking for Ethiopia has been estimated at 81%[10].

[7] Average electricity tariff for domestic consumers is less than USD 0.05 per kilo watt hour.

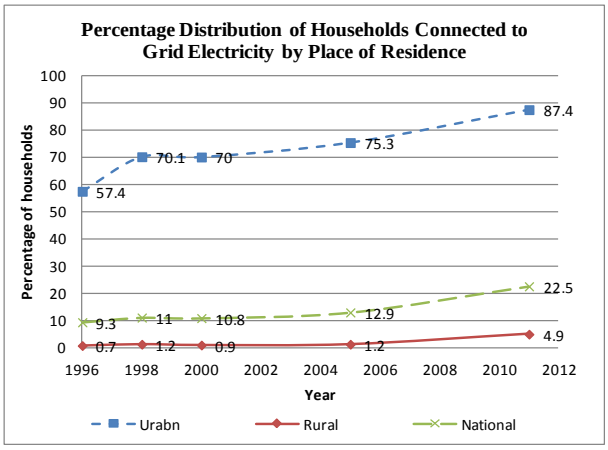
[8] EEPCO, Facts in Brief, 2010/11; CSA, WMS, 2012

[9] Ministry of Water and Energy, Strategic Planning and Management for years 2010 to 2015.

[10] Neil Bird, Dorian Frieden and Giuliana Zanchi, JOANNEUM RESEARCH Austria, A Methodology for Assessment of the fraction of Non-renewable Woodfuel Consumption Application to National and State Level in Ethiopia, World Vision Australia , 23 February 2009.

Being cognizant of this fact, the Ethiopian government and other stakeholders have made improved cookstoves dissemination one of their main national agenda. The current five-year plan of the government for the energy sector includes targets to disseminate biomass saving stoves, domestic biodigesters, biofuel stoves, and solar cookers.

2.1.3 Access to electricity



Electricity production, distribution and sale are up-to-now a de facto monopoly of the state-owned utility, Ethiopian Electric Power Corporation (in December 2013, EEPCo was split into two State-own utilities: EEPE for generation, transmission including exports, and system operations; and EEUo for distribution and commercial management; negotiations are underway with a large Independent Power Producer). Much smaller municipal, cooperative and power suppliers provide power to smaller towns and villages in areas outside the national grid. Until 2004, EEPCO's electricity production capacity had been very low (around 400 MW) and its annual electricity generation capacity was about 1.6 TWh, serving a total of about 740,000 customers. Since 2005, however, the situation has changed rapidly and significantly with large hydropower plants and transmission networks under construction.

To provide for the growing demand for electricity and to increase coverage to previously un-electrified towns and rural villages, the government devised a twin-track rural electrification strategy through a continuous expansion of the national grid and promotion of stand-alone and mini-grid systems. Under the Universal Electrification Access Program (UEAP) EEPCO expanded the national electricity grid to cover more urban and rural areas. For areas where expansion of the grid will not be economical in the mid to long term, the Rural Electrification Fund has been established to provide technical and financial support for installation of stand-alone systems through the participation of electricity cooperatives and the private sector. Since 2005 the generation capacity of EEPCO has been growing substantially with new power plants added into the system. In 2011, electricity production had grown nearly five times to 7,566 GWh by 2012/2013 with a total installed capacity of 2,177 MW.

Access to electricity has grown significantly over the last seven years with an average number of 210 thousand new customers connected to the grid annually. By mid 2012/2013, the number of customers connected to the grid was 2.03 million of which about 1.65 million were households. Between 2007 and 2011 the number of towns connected to the grid grew by more than three-fold from 1,620 to 5,866 increasing connectibility to electricity services to 53% [11]. Households get connection to the grid by either having direct electricity meter from the utility or through sharing meters from their connected neighbours. By mid 2011 about 22.5% of households were connected to the grid either through private meter (9.3%) or

[11] Ethiopian Electric Power Corporation, Facts in Brief, 2010/11

shared (13.2%) connection. Currently, electricity connection rate of households in urban areas is 87.4% while in rural areas it is only 4.9% [12]. Average electricity consumption has also increased by about 90% as annual per capita consumption in 2011 reached 48.2 kWh. This is a big progress but still is much lower than the Sub Saharan Africa (South Africa not included) countries average per capita consumption of 124 kWh[13].

Demand for electricity is continuously growing from the large suppressed demand both for domestic consumption and productive use in industries and businesses, and for exports. High domestic demand growth is however increasingly stressing the generation and the transmission and distribution networks leading to relatively high losses, decrease in the quality of service (interruptions, load shedding, voltage drops, etc.). In addition, with the power generation almost entirely depending on hydropower (99%), the risk of drought-related power outages is an important concern that should be addressed.

Under the off-grid component of the rural electrification program, several solar PV systems were installed to rural households and social institutions including rural health institutions and schools. Between 2005 and 2010, about 14,000 rural households and over 1,000 rural health institutions and schools were electrified with solar PV systems. Altogether, including systems installed by various players in the solar market, the total installed capacity for solar PV systems in Ethiopia is estimated at about 6.5 MW where the Telecom sector accounts for about 70%. Much of the remaining installed capacity, about 1.3 MW, of solar PV systems is for household use. Considering, an average system size of 30Wp, the total number of off-grid households that use solar home systems is estimated to be over 40,000.

2.1.4 Modern energy for productive uses

Modern energy requirement for productive use is primarily for powering small to large scale industries, water pumping for community and irrigation systems, processing of agricultural produce and other services in urban and rural areas. Despite the remarkable expansion of grid electricity, only 53% of the population has access to electricity services for productive uses. Currently, about 223,000 businesses and 20,000 industries are connected to the grid. However, even though they are very few and serve only a relatively small percentage of the population, municipal, private and cooperative electric power operators provide services such as grain milling and lighting to households and businesses in off grid areas. Energy services provided from these suppliers are characterized by poor quality of service and frequent outages due to precarious infrastructure. Services from such suppliers are usually more costly as supply of fossil liquid fuel for motors or generator sets, and technical skills for maintenance of systems are generally more expensive. One of the main reasons for such poor quality and unsustainable service from these systems is an improvised and below standard setup of the systems mainly arising from lack of finance and skilled technical capacity.

In the past seven years, access to modern energy services more than double mainly through the expansion of the national grid to previously unserved towns and rural villages. The off-grid strategy through dissemination of renewable energy resources has not been as effective, however. Since the establishment of the Rural Electrification Fund under the Ministry of Water and Energy in 2003, only less than 15 thousand households and social institutions got access to electricity mainly through solar PV systems. A lot more is expected in the future to

[12] CSA, Welfare Monitoring Survey, April 2012

[13] The World Bank, The State of the Power Sector in Sub Saharan Africa, 2009

enhance dissemination of off-grid standalone or mini-grid systems to reach the remaining unserved population as expansion of the national electricity grid further will be more costly and slower than it was in the first part of the program.

2.2 ENERGY EFFICIENCY

2.2.1 Overview and Assessment

Energy efficiency measures in Ethiopia have been mainly implemented for household cooking and lighting end-uses. Efforts to improve industrial energy efficiency have not been very successful mainly due to lack of technical skills to bring about the required outcome. Generally, in the national economy, the energy intensity per unit of GDP output has significantly decreased. This is primarily due to the high economic growth the country experienced in the past five to seven years.

2.2.2 Energy intensity of the national economy

Energy efficiency at national level has improved over the years in Ethiopia. In 2005, energy intensity for the aggregate national economy was 1.02 MJ per USD of GDP. With the rising economic growth in the last seven years, productivity has increased resulting in the fall in energy intensity. Between 2005 and 2010 the GDP grew almost three fold while the total primary energy supply has almost remained the same. In 2010, energy intensity for the aggregate national economy dropped to 0.26MJ per USD GDP.

Indicators	**Unit**	**2005/06**	**2009/10**
Exchange rate	(ETB/USD)	8.68	13
Population	(Million)	70	78.8
GDP per capita	(USD)	216.60	377.00
GDP	At current market price (Million ETB)	131,641.0	383,364.3
Total Primary Energy Supply	(Terra Joule)	1,151,300	1,274,443
Energy Intensity	(MJ/ETB)	8.75	3.32
	(MJ/USD)	1.01	0.26

Sources: Ministry of Water and Energy, Energy Balance, 2011

National Bank of Ethiopia for macroeconomic data

There is clearly a big potential for further improvement in energy efficiency in all sectors of the economy and society. Energy conversion technologies in the industrial sector have very low performance mainly due to aging equipment and lack of regular maintenance. Installation of efficient technologies and implementing power factor correction measures will reduce energy intensity in the industrial sector. EEPCO transmission and distribution losses can also be significantly reduced from the current 20-21%. Some attempts have been done in the past by the power utility to help industries improve the power factors. However, for want of technical skills relatively little was achieved.

Animate power is the main source of energy in the agricultural sector. This is also one of the reasons for low productivity in agriculture. With increased use of modern energy services for irrigation and other farm operations, productivity can be significantly increased resulting in further lowering energy intensity.

Over 90% of the energy source for the household and commercial sectors comes from traditional biomass fuels primarily for thermal applications. The potential for improvement of thermal conversion technologies in these sectors is quite high. Energy efficiency improvement opportunities in cooking and lighting equipments are high. As part of a demand side management effort, EEPCO distributed energy efficient light bulbs (Compact Florescent Lamps) to domestic consumers. The utility, as a result, claimed to have reduced the peak power demand significantly. In 2011, imports to the country of incandescent light bulbs was prohibited.

Between 2006 and 2010, Ethiopia has demonstrated its energy efficiency improvement by reducing energy intensity per GDP for aggregate national economy by 62%. There are however more energy efficiency improvement opportunities in all sectors in Ethiopia, for example through installation of energy efficient technologies both in the supply and demand sides, and increasing productivity by installing efficient management systems. At the same time, Ethiopia's rapid economic growth and transition to modern energy systems (ex. in agriculture, transport and commercial activities) and social demands will put pressure towards increasing energy intensity.

2.3 RENEWABLE ENERGY

2.3.1 Overview and Assessment

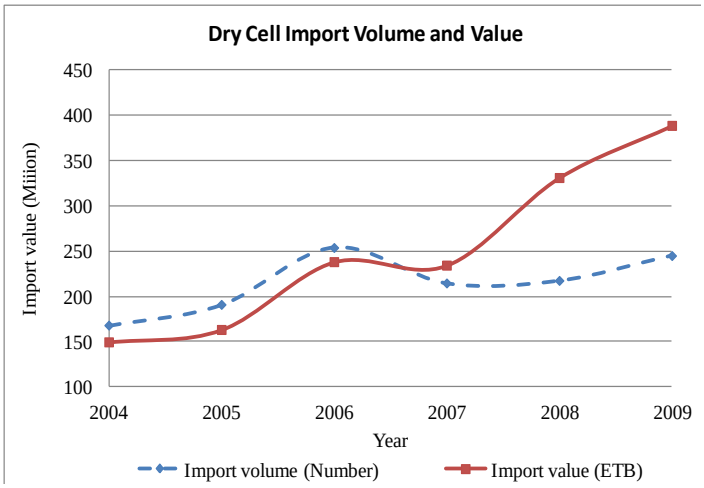
Renewable energy resources play a primary role in the national energy supply in Ethiopia. The power sector almost entirely depends on hydropower accounting for 94% of the installed capacity and over 99% of power generation. Future power sector development plans incorporate wind and geothermal energy to diversify the energy mix in power generation.

For thermal applications, particularly for household cooking energy, improved stoves (ICS) have been and will continue to be major area of intervention to improve the non-sustainable proportion of the biomass use in the sector. The government short and long term strategic plans provided due attention for development and dissemination of renewable energy resources and technologies such as solar PV systems (including for potable water and irrigation pumping), solar water heating, solar cooking, wind energy and micro hydropower for productive use both in off-grid and on-grid areas, biogas and biofuels based energy systems.

2.3.2 On-grid and off-grid renewable energy

Grid electricity in Ethiopia is almost entirely "green". In 2011, 99% of the total power generated to the national grid was from hydropower[14]. The remaining is from several relatively small thermal plants (diesels) which mostly serve as backup.

Off-grid power is mainly used for lighting and powering radio/cassette players in households and businesses. Except in very few cases, most the demand is met by dry cells. Use of automotive batteries (12 V DC) for powering radio/cassette players and more recently for lighting using 12V DC Compact Florescent Lamps (CFL) is increasing in rural towns and villages that are not very far away from the nearest connected towns. Use of dry cells and batteries is increasing in the country. Dry cells/ batteries import volume in 2009 was 215 million costing about ETB 388 million[15]. Import volume of dry cell between 2004 and 2009 increased by 45% while the price increased by 160%. This means that rural consumers that depend on dry cell and batteries for their electrical demands are paying a lot more than grid based consumers. Currently, about 16% of rural households and 2.8% of urban households use dry cells/batteries as major sources of lighting[16].



Several thousand diesel generators, mostly with small capacities ranging between 5 to 20 kW, are also used to supply electricity in off grid areas. They are mainly used by businesses or private electricity providers. Diesel generator sets are also used by businesses, industries and institutions in on-grid areas as backup during power outages. Actual number of generator sets and the proportion of their distribution in on-grid and off-grid are not known precisely. A study conducted in 2004 reported that about 41,000 generator sets for electricity generation were imported from 1994 to 2002. Import of generator sets was steadily growing and reached about 15,000 in 2002. The average annual import of generator sets in the country from 1994 to 2002 was 4,565. The study also estimated that about 70% of them were for off-grid[17]. Standalone generator sets still play a major role in providing electricity services to off-grid consumers as main source of electricity and to on-grid consumers as backups.

Adoption of Solar PV systems for households, businesses and institutions is continuously growing. Following the Lighting Africa promotion of low cost lighting services for rural consumers, over 70,000 solar lanterns (with 1 Watt-peak solar panel) have been imported for distribution in rural areas by private businesses in less than 12 months between 2011 and

[14] EEPCO, Facts in Brief 2010/11
[15] Dry cell import figures were obtained from Ethiopian Inland Revenues and Customs Authority.

[16] CSA, Welfare Monitoring Survey 2011, April 2012

[17] Ethiopian Electric Agency, The Ethiopian PV Commercialization Project, Mark Hankins and Melessaw Shanko, October 2004

2012[18]. There are over 40 micro and Pico hydropower schemes but only less than 10 of them are for electricity generation.

2.3.3 Use of renewable energy sources (RES) for thermal applications

Applicable renewable energy technologies for thermal applications such as cooking and heating, in the short term, are cookstoves, solar water heaters (SWH), solar cookers and dryers mainly for households and businesses, and biogas and biofuels systems.

For water heating in households and businesses, SWHs have been disseminated mainly through private sector initiatives. Total number of SWHs installed in the country until 2008 was estimated at about 5,000 units with numbers estimated to grow by 1,000 units per annum[19]. Based on this estimation, currently over 8,000 SWHs are estimated to have been installed. The market for SWHs is steadily growing despite low electricity tariff. On-going government housing program and real-estate development are market opportunities for SWHs. With supportive policies and regulations, SWHs can help reduce the peak load demand for electricity.

Cookstoves are major end use technologies in households and businesses. Solar cookers, biogas (which also produce fertilizer) and liquid biofuels (mainly bioethanol) have the potential to significantly substitute solid biomass use for household and commercial cooking.

2.3.4 Use of Renewable Energy Sources for productive activities

Renewable Energy Sources (RES) can be developed and utilized for productive uses in the agriculture, industry and business sectors. Solar and wind pumps are proven technologies for irrigation, community and livestock water supply. Micro hydropower resources provide wider access to electricity which can be used for grain milling, water pumping and social services in off-grid areas. Solar PV systems play important role increasing access to ICT.

Considering the ample availability of renewable energy resources, the efforts towards development and harnessing of these resources in Ethiopia have been very limited. The private sector should take a leading role in disseminating these technologies. Effective and sustained technical and political supports are however required in terms of technical capacity building and setting a level playing ground through supportive government policies and coherent regulations and standards.

Solar PV technologies were introduced over two decades ago. Market uptake to date is limited with only 6.5 MWp systems installed (of which the telecom sector accounting for nearly 70%). Micro hydropower has been a traditional grain milling technology in Ethiopia, but never really took off. Traditional water mills in rural areas have been quite common to provide grain milling services to off-grid rural communities. Few project based activities by non-governmental organizations have been introducing modern and efficient hydropower schemes for grain milling and electricity generation in rural areas. Currently, there about 40 modern micro hydropower schemes in the country that are used for productive activities in off-grid areas. Similarly, about 100 wind pumps mainly in the rift valley areas have been promoted.

[18] Consultation with major solar PV importers in Ethiopia

[19] GTZ, Ethiopia's Solar Energy Market, Target Market Analysis, November 2009.

2.3.5 Summary

Traditional biomass fuels are major sources of energy in Ethiopia. They are primarily used by households for cooking purposes. Access to modern energy services is limited to the urban population. The high dependency on traditional biomass has severe consequences on the environment, and the health and economy of both the nation and the people. Modern energy resources are required for realization of economic growth. The challenge is therefore to increase access to modern sustainable energy services while safeguarding the environment. In Ethiopia, the current and proposed solution is to develop and utilize renewable energy resources for domestic and productive use and promote energy efficiency technologies and management systems.

2.4 THE SE4ALL GOALS

The Sustainable Energy for All (SE4All) Initiative aims at three goals at the global level: (a) ensuring universal access to modern energy services, (b) doubling the global rate of energy efficiency; and (c) doubling the share of renewable energy in the energy mix.

2.4.1 Energy access

To improve access to modern energy services, the national short and long term plans focus on using renewable energy resources for on-grid and off-grid. The short term government plan is indicated in the Table below.

		2012/13 (Baseline)	**2015**
On-grid electricity	*Percent of population with access to electricity services*	53%	75%
	Number of households with meter connection to the grid	2.03 million	4 million
Off-grid electricity	*Solar Home Systems and Institutional PV*	23, 277[20]	153,000
	Solar Lanterns	Less than 20,000	3,000,000 (3 million households)
	Micro hydropower (One MHP assumed to serve 500 households)	47 (Serve 23,500 households)	112 (Additional 65 MHP to serve a total of 56,000 households)

2.4.2 Energy efficiency

Energy efficiency measures prioritized in the short term government plan are: cooking energy, charcoal production and electricity transmission and use. Cooking energy and charcoal production improvements can be effected through dissemination of energy efficient

[20] At least 10777 more were added for a total of 23277 by 2012/2013 (There may be more PV systems installed that are not accounted for in the statistics.)

cookstoves and charring kilns. In the power sector, power loss reduction in the transmission and distribution networks and inefficient lighting are major areas of intervention with regard to energy efficiency. By 2011/2012 about 11 million compact fluorescent lamps were already introduced to replace incandescent bulbs. In 2011, import of incandescent bulbs was prohibited.

		2012/13 (Baseline)	2015
Cooking efficiency	Through dissemination of energy efficient cookstoves	9 - 10 million	Additional 7.4 million
Power Transmission efficiency	Reduction of transmission loses	11.5%	6%
Efficient kilns for charcoal production		25	250
Energy efficient lamps		More than 11 million	Total replacement of incandescent lamps

2.4.3 Renewable energy

Renewable energy resources is playing and will continue to play a major role in providing clean energy both for electricity generation and for thermal applications. The short term government plan up to 2015 and the long term directions are indicated in the Table below.

Power sector development has been primarily through development of the hydro power potential of the country. Other renewables such as wind and geothermal will also have considerable contribution to the development of the power sector.

Technology	**2012/13 (Baseline)**	**2015**	**2030**[21]
Electricity from Hydro (MW)	1,978	10,641.6	22,000
Electricity from Wind (MW)	81	866	2,000
Electricity from Geothermal (MW)	7.3	77.3	1,000
Biomass (Bagasse)	0	103.5	103.5
Wind pumps (Number)	100	400	
Domestic biogas (Number)	6, 031	26,200	
Institutional biogas (Number)	100	1,100	
Liquid biofuel stoves (Number)	2,000	12,000	
Solar Cookers (Number)	Less than 1000	11,000	
Solar Water Heaters	7,000	15,500	

Source: SREP, SPM MWE,

[21] The forecast for 2030 is now under review and will most likely rise significantly.

Sustainably managed biomass is a "renewable" energy resource. In Ethiopia, however, the fraction of non-renewable biomass use for cooking is high. This could be mitigated by replacing traditional inefficient cookstoves in households and businesses by clean and more efficient ones and by providing substitute renewable energy fuels for cooking (biogas, biofuels, LPG for certain segments). On the supply side, intensive afforestation and reforestation programs could be carried out in parallel.

SECTION III: CHALLENGES AND OPPORTUNITIES FOR ACHIEVING THE SE4ALL GOALS

3.1 INSTITUTIONAL AND POLICY FRAMEWORK

3.1.1 Energy and Development Challenges

Development Challenges

Ethiopia is now implementing its third national development (poverty reduction) plan since 2000. The current plan: the Growth and Transformation Plan (GTP) covers the period 2011 to 2015. The earlier plans were PASDEP (2006-2010) and SDPRP (2001-2005).[22]The energy sector has been prominent in both the PASDEP and GTP where development of energy infrastructure accounted for 20% (Birr 46 billion or about USD 2.63 billion) and 45% (Birr 107billion or about USD 6.1 billion) of total investment in the plans respectively. The link between energy infrastructure development (particularly power infrastructure) appears is well understood and thus the priority.

Ethiopia has also recently issued a Climate Resilient Green Economy (CRGE) Strategy (MOFED, 2011). This strategy seeks to promote actions that will reduce the country's vulnerability to climate change and also to reduce emission of greenhouse gases. This strategy envisions Ethiopia leap-frogging to modern and efficient technologies and practices to achieve these goals. Energy related actions dominate the emission reduction plans among which are arresting deforestation and forest degradation through shift to clean cooking technologies, and increase in the supply and consumption of electricity for industrial, residential and transport uses.

For the energy sector the strategy brings to the forefront the following national development and energy security points: (a) dependence on fossil fuel imports vs. sufficient availability of domestic renewable energy to support economic development; (b) growing greenhouse gas emissions from fossil fuels and non-renewable biomass vs. clean renewable energy; and (c) power shortfalls and restriction of economic activity vs. reliable power availability, increased access in rural areas, and power export.

Institutions

The Ministry of Water, Irrigation and Energy (MoWIE) is the lead institution for the energy sector. Its responsibilities fall into three broad categories: resource assessment and development, policy and regulatory, and research and development. In the resource assessment and development area its fields of operation are mainly hydro, wind and solar energy resources.[23] It is responsible for energy policies and also for regulation of the power sector through the Ethiopian Energy Authority (under the oversight of the Minister of Energy). It also conducts research and development for renewables.

Ethiopia has a federal form of government with nine regional states and two city administrations. All states and cities have sector line agencies that function within the regions including agencies for the energy sector. The MoWIE provides capacity development and technical support to regional water and energy bureaus and agencies.

[22] Plan for Accelerated and Sustained Development to Eradicate Poverty (PASDEP) and Sustainable Development and Poverty Reduction Program (SDPRP).

[23] Exploration and development of fossil fuels and geothermal energy falls under the mandate of the Ministry of Mines.

Other ministries which have direct relevance to the energy sector include: the Ministry of Finance and Economic Development (MoFED) providing domestic and donors financing to the sector, the Ministry of Trade and the Ministry of Agriculture. The Ministry of Trade imports petroleum fuels through the Ethiopian Petroleum Enterprise (EPE) and also sets prices for petroleum fuels. The Ministry of Agriculture is responsible for forestry which is the energy source for the large segment of the population in Ethiopia.

3.1.2 Thermal energy for households

Thermal energy demand in the residential sector (for cooking and baking food) is responsible for 90% of the total energy consumed in Ethiopia. This energy is mostly derived from solid biomass fuels (up to 95%) with the remaining coming from kerosene and electricity. Heavy reliance on solid biomass fuels has led to deforestation and forest degradation, emission of greenhouse gases, health impacts due to emission of air pollutants during cooking, and social and economic impacts due to the effort and expense required to collect and purchase fuels.

The impacts of over dependence on solid biomass fuels for cooking have long been understood and policies, strategies and plans have always tried to address them.

- The Energy Policy (current 2013 draft and 1994 Energy Policy) gives priority to the household sector and particularly to provision of sustainable energy for cooking. The Policy states the need to take measures to achieve gradual transition from traditional fuels to modern fuels to achieve a balance between the supply and demand for household energy. This was proposed to be achieved by increasing the supply of alternative fuels and promoting energy efficiency.

- The Environment Policy of Ethiopia (1997) also recognized the contribution of wood fuel supply on pressure on forest resources. It proposed similar measures as the energy policy (using alternative fuels) and to increase biomass energy supplies through in farm and homestead tree planting.

The strategies and plans for the sector focus on reducing the biomass energy consumed through the dissemination of improved biomass, other clean cooking stoves and some substitution (biogas, biofuels, etc.). The MoWIE plans to disseminate 9 million clean cook stoves mainly in rural areas by 2015. The Climate Resilient Green Economy (CRGE) strategy envisions significant reduction of forest degradation and emission of greenhouse gases through the improved cook stoves.

Biomass, LPG, kerosene and electricity are the fuels used for thermal energy in the household sector. Biomass is used both in rural and urban households; kerosene, LPG and electricity are used for cooking in urban areas. Biomass fuels are mainly freely collected in rural areas but purchased in urban areas.

3.1.3 Power sector

The power infrastructure in Ethiopia consists of about 2.2 GW of mostly hydrogeneration capability, with 7.6 TWh generated in 2012/2013 and electricity sales to 2 million customers.[24] The short term plan for the grid to 2015 is to quadruple generation capability to

[24] The total number of households that have access to electricity is about 4 million (twice the number of EEPCO customers). This is mainly due to the large number of meter sharing – almost 1 meter to 2 households.

10 GW and double the number of customers to 4 million (GTP, 2011). The off-grid plan is focused on increasing access through solar home and micro hydropower plants to more than 3 million households.

The Ministry of MoWIE is the overall overseer of the power sector including policies, strategies and plans for the power sector. The ministry oversees four electricity sector agencies/quasi-agencies:

- The Ethiopian Electric Power Enterprise - EEPE - for the construction and operations of the generating plants supplying the national interconnected system, of the transmission network, including the exports to neighbouring countries, and for overall planning and system management; and the Ethiopian Electric Utility – EEU – for the construction and management of the distribution system and commercial management). These two companies were previously forming the Ethiopian Electric Power Corporation (EEPCO.

- The Ethiopian Energy Authority (EEA) with new powers and duties announced in December 2013) which will serve as the power sector regulator with functions including licences/permits, Power Purchase Agreements and tariffs. The Authority is also responsible for energy efficiency and energy conservation in particular to set-up standards, carry-out testing and labelling of appliances, industrial and commercial audits.

- The Rural Electrification Fund (REF) was established in 2003 to accelerate the promotion of non-public sector driven off-grid power market in Ethiopia. The REF functions are carried out by a small project unit (RE Secretariat) under the MoWIE. Initially designed to be a technological neutral and private sector driven action it has later evolved as renewable energy focused and as an Electricity Service Cooperative (ESCO) and social institutions (schools and health posts) support fund. REF provided loans to ESCOs for investment in generation and distribution facilities more recently all funding has gone exclusively for solar PV systems to power social institutions and home systems for ESCOs.

The power market in Ethiopia is still nearly exclusively developed and managed by the public sector. Power generation for 2012 was 7.6TWh distributed among industrial (37%), residential (37%) and commercial (26%). Off-grid systems through non-public operates account for less than 1% of the total electricity supplied in Ethiopia. Supplies from these small systems are derived from solar home system, micro hydropower, and diesel generation sets.

Private sector engagement in the power sector through Independent Power Producers (IPPs) is possible although no project has gone to closure as yet; negotiations for a first and large IPP are however well underway). There have also been draft proposals circulated on Feed-in-Tariffs (FiT) for renewable energies, discussions on Auctions but no final decision has been made, impacting negatively on private sector commitments.

3.1.4 Modern energy for productive sectors

Energy demand in the productive sectors (agriculture and industry) is mostly for thermal and mechanical power. The small scale agriculture sub-sector in Ethiopia still relies mostly on human and animal power; the use of mechanized power for cultivation, irrigation and processing is, however, increasing for cash crops (mainly vegetables). The commercial agriculture sub-sector, which in Ethiopia is composed of sugar, cotton, tea, and tobacco, uses

mechanized power for cultivation and irrigation and thermal energy from biomass for processing.

Major short term plans to 2015 for the agriculture sector, that will have implication for energy demand and for co-generation, include increasing sugar production three-fold and expanding area under large scale commercial agriculture by 3 million ha. These plans will increase the demand for electricity from sugar industries and for petroleum fuels in new commercial farms. There are also opportunities to increase auto-generation and also export to the power grid from bagasse-based electricity generation from the sugar industries.

Industry sector demand for energy is for motive power and for thermal energy (for boilers, kilns). Motive power requirements are met from electricity while thermal energy requirements are met from fossil fuels. The industry consumed in 2011 37% of the total electricity supplied in Ethiopia; it is also a major consumer of petroleum fuels and coal for thermal energy for boilers and kilns (in cement factories). The short term projection is that the economy will grow by about 11% annually while the industrial GDP is expected to grow by 20% annually. Energy intensive industries with the highest growth will be cement, metal and sugar production.

The draft (2013) energy policy (replacing the 1994 Policy), the Growth and Transformation Plan (2011) and the CRGE (2011) all promote cleaner production and energy efficiency in industry.

Regarding the productive sectors, the Energy Policy intends to:

- Improve the efficiency of industrial equipment to conserve and reduce energy consumption.
- Energy demand in the agriculture sector will be met through locally-produced modern energy resources.

Regarding the productive sectors, the CRGE strategy (2011) intends to:

- Increase the competitiveness of the cement industry by reducing production cost and yield significant environmental and health benefits.
- Improve energy efficiency of the process and hence the cost of and emissions from cement production.
- Increase the pumice content leading to a decrease in both variable production costs and emissions.
- Increase the share of biomass in the mix of energy for production in cement factories, potentially decreasing costs and emissions.
- Increase the use of modern energy for irrigation, farming operations and livestock water supply to increase productivity in the agriculture sector.

3.1.5 National monitoring framework for SE4ALL Activities

As mentioned above, the three SE4ALL goals are: (a) ensuring universal access to modern energy services (covering electricity access, and modern and cleaner cooking solutions, (b) doubling the global rate of energy efficiency and (c) doubling the share of renewable energy in the global energy mix. Programs and tracking indicators that could be considered for these goals are as follows:

3.1.5.1 Program Opportunities

Thermal energy for households

- Access to energy efficient or renewable fuel technologies in households (proportion with such cook stoves)
- Reduction in the share of energy budget from total household budget
- Reduction of final energy intensity for cooking

Power sector

- Reduction of transmission and distribution losses in the power system
- Access to electricity by households (proportion of households with electricity connection)

Modern energy for productive sectors

- Reduction of energy intensity in cement manufacture
- Double the share of renewable energy for thermal energy in industry
- Commercial energy intensity for the agriculture sector

3.1.5.2 Tracking Progress

Data requirements to monitor these indicators may be divided into those that are: (a) readily available, for instance reduction of transmission and distribution losses on the power system; and those that are (b) more difficult to obtain, such as those that relate to access to modern energy services by households.

Thermal energy for households

- These indicators may be available from national census which is usually taken once in ten years. More frequent and specific data may be gathered by sample surveys from selected households in four or five years. The MoWIE could collaborate with the Central Statistical Agency (CSA) to prepare and conduct such surveys.

Power sector

- Some data on progress is available from the power utilities. Data regarding system losses is readily available. Regarding access to electricity by households, however, the power company holds data only on its customers, which do not account for households that share meters and also off-grid users supplied from other sources.

Modern energy for productive sectors

- Industry sector indicator data are available from standard annual industry performance and cost of inputs statistics. Such statistics are annually published by the CSA by industry groups. Specific data on individual industries can be collected by the MoWIE and the Ministry of Industry.

The MoWIE is in the process of developing a national energy database. The first phase of this project, which nears its end, was limited to collecting national level data from secondary

sources. This program could be extended to collect the required data for the SE4All tracking indicators. The MoWIE will need to coordinate the data collection effort among the relevant national and regional agencies. Support to capacity development will be required.

3.2 PROGRAMS AND FINANCING

3.2.1 Thermal energy

One of the most critical energy sector issues at the moment is to ensure a sustainable and reliable cooking fuel to the household and commercial sectors. Firewood harvesting for cooking is unsustainable in Ethiopia at the current rate; the associated negative environmental and health impacts are immense. Studies indicated that if current trend of firewood management continued, the demand for firewood will rise by 65% deforesting an area of 9 million hectares of forestland between 2010 and 2030[25].

The Government of Ethiopia believes that wide scale dissemination of clean and energy efficient cookstoves and making substitute fuels from renewable energy sources available to consumers would curb the foreseen disaster. To this effect, the energy sector development program for 2010 to 2015 provided due consideration to cooking energy demand and planned to address issue by disseminating energy efficient cookstoves, introducing modern fuels such as biomass briquettes, sustainably produced charcoal, biogas and biofuels. Under this program, over 9 million cookstoves and several thousand solar water heaters will be disseminated until 2015 through the participation of the private sector.

To achieve the plan, strong private sector capacity and market development work will need be carried out in parallel. Capacity development programs will focus on domestic manufacturing and installation capabilities and access to capital. Strong promotional and market development program is also needed to build a sustainable commercialization network for renewable energy technologies. On the end-users side, financing schemes could be made available to improve the ability to pay for renewable energy technologies. The short term five year program will do market development for clean, renewable energy-based products and services in the household and commercial segments, by providing targeted capacity building and financing to small and medium-sized enterprises (SMEs). The program will build capacity and provide commercial financing that allow companies to develop a strong private sector that will provide high-quality modern energy services.

Parallel to the demand side management measures, supply enhancement has also got due attention. Strong focus is given to afforestation and reforestation measures to ensure environmental sustainability and enhance biomass fuel supply reliability. Since charcoal is one of the major cooking fuels in urban areas, dissemination of efficient kilns for charcoal production is included in the short term government plan.

3.2.2 Power sector

Ethiopia's vision to become a middle income country by 2025 cannot be realized without having adequate energy supply to power development plans and provide access to modern energy services. The country Electrification program aims to increase access to electricity services from the 41% in 2010 to 75% by 2015 through the expansion of the national grid to unserved rural areas. The number of customers that will be connected to the grid will double from the current 2 million to 4 million during the short term development period.

Despite the past achievement in increasing access to electricity and direct connection to the grid, and the ambitious future electrification plan, the large majority of the population will continue to rely on costly and polluting kerosene and firewood for their lighting requirements. Stand-alone and mini-grid based renewable energy technologies such as Solar

[25] Ethiopian Climate Resilient Green Economy, Green Economy Strategy, 2011

Home Systems (SHS) and micro hydropower plants are believed to play an important role to provide modern energy services to rural communities. The five-year government energy sector development plan, therefore, included such technologies as viable means of extending modern energy services to rural areas where the national electricity grid will not be a feasible option.

For the realization of the anticipated economic growth, the power sector should also be developed to ensure adequate supply of energy to the growing demand. Under the short term national development plan, energy infrastructure development program including expansion of the electricity grid and construction of a series of power plants were prominent accounting for about 40% of the total investment allocated for the period. By the end of the short term development period, the power sector is expected to have over 11,000 MW capacity all from renewable sources.

3.2.3 Modern energy for productive uses

Wider access to energy services is of significant importance for rural transformation. Small scale rural agro processing machinery and industries, water pumping for irrigation and ICT are some of rural based activities that require modern energy supply. Commercial dissemination of renewable energy technologies such as solar PV systems, wind pumps and others to households, businesses and social institutions is planned under the short term development plan.

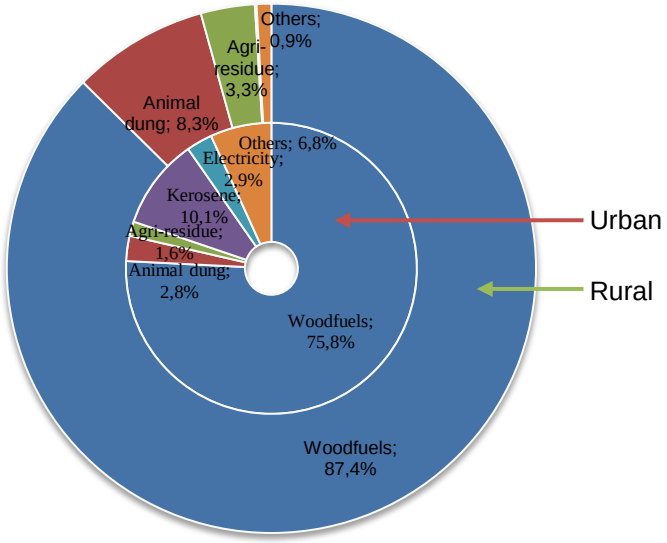
3.3 PRIVATE INVESTMENT AND ENABLING BUSINESS ENVIRONMENT

Private sector engagement in the energy sector in Ethiopia is so far mostly in (small) distributed and off-grid power applications and in the dissemination of improved efficiency cook stoves and similar technologies. These include provision of fuels and stoves for cooking for urban households and provision off-grid power alternatives such as PV systems in rural areas. The role of domestic private companies on large projects, such as generation and transmission projects for the power grid, is in sub-contracting construction works and manufacturing of some components.

3.3.1 Thermal energy for households

Thermal energy requirements in the household sector are mainly for cooking and baking. In urban areas mid and high income households also use thermal energy to heat water for bathing. Biomass energy is still the predominant source of thermal energy for cooking in both urban and rural areas. Statistics for 2011 from the CSA indicates that 99% of rural and 80% of urban households used biomass fuels for cooking.

Fuel used for cooking in the household sector, 2011 (CSA, 2012)



Thermal energy supply for households in rural areas is mostly still by users – i.e., households collect and transport their fuel requirements for cooking and baking. Very little of the supply in rural areas is commercial (purchased). There are essentially no intermediaries for fuel supply for thermal fuels in rural areas.

In urban areas the large share of the energy used for cooking and baking fuel supply is purchased. Biomass fuels are brought in by collectors and supply from urban peripheries (for wood) and further away (for charcoal). Kerosene is purchased from petroleum fuel distributors (international and domestic petroleum distribution companies) who purchase them from the sole importer of liquid petroleum fuels in Ethiopia – the state owned Ethiopian Petroleum Enterprise (EPE). LPG is imported and distributed by local companies. Electricity is supplied mainly by the state owned public utility, EEPCO.

Private sector involvement in the thermal energy supply chain for rural areas is very limited: mainly for provision of a small amount of purchased biomass fuels and also in the supply of improved biomass stoves. In urban areas, however, private sector role is significant and includes provision of supply of biomass fuels, kerosene and LPG, and supply of stoves for all types of fuels.

The major barrier for the private sector for thermal energy supply for the households is the size of the market. The market for fuels and stoves in Ethiopia is limited to urban areas – the vast majority of rural households still obtain their fuels and stoves freely. The main barriers that need to be dealt with to expand this market are outlined in the following table.

Institutional	– Improving but still limited capacity at the local district (Wreda) level for implementation – Shortcoming in coordination of actions among those concerned – Research and development shortcomings to continually lower costs of supply (fuels and stoves) to reduce barriers to acquiring improved fuels and stoves
Social	– Limited awareness of alternative means of thermal energy (fuels and

	stoves) in rural areas
	– Absence of standards and labels for stoves
Financial	– Limited financial capacity of uses; inaccessibility of user financing to increase access for improved technologies and to increase the market for the private sector – Constrained access to supplier financing to increase scale and improve mode of supply (fuels and stoves) – Potential sources of user and supplier finance (from carbon funds, for example) not exploited

3.3.2 Power sector

The state utility EEPCO (and the two newly created entities by splitting EEPCO) is responsible for virtually all power generated and distributed in Ethiopia (99% of the supply). EEPCO owns generation, transmission and distribution facilities and also provides customer service (i.e. it is a vertically integrated company). Private sector role in the EEPCO system is limited to design, construction and supply of system components. International companies provide design, construction and supply services for generation and transmission projects; local companies are involved in the construction of distribution facilities. Some local companies are also working with international companies as sub-contractors in generation and transmission projects.

There are no IPPs in the EEPCO system at present – all facilities are owned and operated by EEPCO - ; nnegotiations for a first IPP are now well underway after 3-3.5 years of discussions. Several international companies are expressing interest to develop geothermal and wind power plants as IPPs, but no private projects have yet been commissioned.

The off-grid market is small in Ethiopia constituting just one percent of the total power supplied. Off-grid systems in rural areas serve residential customers, commercial establishments, social institutions (water pumps, school services, and health facilities), churches and mosques, and telecom facilities. The potential to address this market with distributed renewable systems including PV and micro hydropower is high. Private companies provide engineering and system supply for off-grid systems.

The main barrier for private companies seeking to become IPPs for the grid is related to negotiating viable PPAs acceptable to both parties. In the off-grid area, the main constraint is the still limited size of the market due to several factors: institutional weaknesses in the public sector to systematically develop the market and scale-up the activities, dispersed demands, low level of awareness of potential customers to the off-grid options available, high up-front cost, and lack of sustainable business-models in the private sector.

Institutional	– Inadequate clarity of the grid vs. off-grid plan (to guide developers of off-grid systems) – No guarantees for compensation for investment for off-grid systems (when the grid displaces off-grid systems) – Non availability so far of Feed in Tariffs to promote IPPs on the grid – Market development for off-grid systems- the market is still small, capacity to promote off-grid solutions to customers is inadequate
Social	– Awareness for off-grid power options are low among potential users – Dispersed nature of rural settlements increases supply costs (for grid extension)

Financial	– Low tariffs (US$0.028/kWh on average for domestic customers) – therefore, unattractive for private investment in particular in rural areas – Low incomes and demands level in rural areas, low paying capacity of customers – limits the market for off-grid power systems – Investment finance difficult to acquire from domestic banks – Foreign currency availability may be constrained in certain years

3.3.3 Modern energy for productive sectors

Currently private sector role in the energy supply chain for the productive sectors is largely in the distribution of modern fuels (fuel and diesel oil) for thermal and mechanical applications, mainly for industry and commercial agriculture.

Cleaner production and energy management are not widely practiced in Ethiopia. Industry awareness and readiness to apply improved technologies is rather limited; private sector knowhow to support industry in implementation of such practices is also constrained.

Institutional	– Inadequate policies and regulations for industrial energy management - few industries practice modern energy management – Inadequate institutional capability in concerned ministries (Industry and Energy) to plan, promote and monitor energy management in industries – Limited industry awareness for improved energy management
Technical	– Very limited domestic capacity for design, plan and implement energy management practices in industries
Financial	– Lack of applicable financing model for energy management in industries (for example, cost and benefit sharing between industry and consulting implementing companies – ESCOs arrangement -)

3.4 SUMMARY OF THE MAIN GAPS AND BARRIERS FOR ACHIEVING THE SE4ALL GOALS

3.4.1 Thermal energy for households and other users

The main barriers towards better fuels and stoves for cooking in households (the main thermal application in the household sector) and in large institutions and private concerns in Ethiopia are:

a) Governance – Policies and strategies are generally supportive of clean energy for thermal uses in households. However, sector development support (in R&D, easing financing, standards for products and services, planning and coordination) is still inadequate to attend to the huge potential market, particularly in rural areas.

b) Supply chain – Rural households supply their own fuels and generally make their own stoves; urban households purchase both their fuels and stoves. Increasing access to better fuels and stoves to both rural and urban households as stipulated in existing plans (GTP, CRGE) calls for increasing financial and technical capacity of SMEs to provide improved technologies. Private sector SMEs, however, suffer from limited capital, technical and business capability to expand their businesses.

c) Households – Cleaner fuels and stoves are available to address the adverse social, economic and health impacts of current modes of thermal energy supply for households. However, access is constrained because of the limited financial ability of users as well as suppliers to address the market. These barriers will decline in the future as user incomes grow.

3.4.2 Power sector

Electricity supply in Ethiopia is dominated by the public sector. Private sector role is currently limited to some small off-grid activities. This is despite the fact that existing regulations allow for private investment in power production both on and off-grid.

a) Governance – According to potential private investors existing grid tariff (average of USc2.8/kWh currently) do not allow sufficient margins for return on investment; existing regulations also do not provide sufficient guarantees for investors in case of breach of contract by contracting parties (in particular EEPCO as the off-taker). In the off-grid market the view is that the market is too small and that geographic delineation is not clear between grid and off-grid areas to ensure sufficient time for investors to recoup their expenses.

b) Supply chain – A Feed in Tariff and associated regulations, which would have spell-out the off-take prices and guaranteed access to private investors to the grid, has not been yet adopted in Ethiopia.

c) End users – Low demand levels and users low paying capacity limit the extent and speed to grid expansion as well as deployment of off-grid technologies.

3.4.3 Modern energy for productive sectors

The agriculture sector in Ethiopia is still dominated by small holder farmers who mainly use human and animal power. Commercial agricultural activities are driven mainly by diesel powered machinery. The industrial sector consumes electricity, petroleum fuels and coal. Cleaner production and energy management have not been widely applied in Ethiopia.

a) Governance – Policies and regulations do not sufficiently address cleaner production and energy management in industry and other productive sectors of the economy. The promotion effort for these changes is insufficient.

b) Supply chain – Knowledge and resources to improve energy management in industries and other productive undertakings are not adequate in Ethiopia.

c) End users – Awareness of cleaner production and energy management is limited in industries. Where such awareness exists the resources required to improve processes is not readily available.

3.4.4 Energy Efficiency

Energy Efficiency activities are still very limited on the demand and the supply sides. In December 2013, the Ethiopian Energy Authority was created with inter alia the powers and duties to plan and implement energy efficiency/energy conservation programs and to act as the Electricity sector regulator.

a) Governance – Policies and regulations are currently very limited to effect energy efficiency in the various economic and social sectors; planning and implementation capacities and information, communication and raising customers and the citizenry awareness to the impacts and benefits of energy efficiency need also to be developed. Finally, energy prices and in particular electricity tariffs have important role to play to convey information about the private and societal costs and impacts.

b) Supply chain – Knowledge and resources to improve energy management in industry, commercial households and other productive undertakings using energy are not adequate in Ethiopia. The role and the requirements from the private sector (importers, suppliers, maintenance entities) need to be better delineated and capacity development programs need to financed and executed.

c) End users – Awareness of energy efficiency and the available options (appliances, equipment, maintenance and energy management) is limited in nearly all areas. Where such awareness exists the resources required to improve processes is not readily available.

3.4.5 Energy Sector Policy

A comprehensive energy sector policy (replacing the 1994 Policy) is under development and led by the MoWIE. This new policy, the enabling environment, and the new regulatory framework to be enacted and enforced by the Energy Authority, will all be critical in removing the main barriers and filling gaps, in particular for mobilizing the large amount of financing required by the sector and ensuring adequate governance, monitoring and evaluation and sustainability of the programs and activities.

3.4.6 Institutional and Human Capacities

Human and institutional capacities will need to be developed in the public and private sectors, and at the Federal and Regional Governments and City Administration levels to plan and implement the scale-up programs and to carry-out the monitoring and evaluation activities. This is a cross-cutting issue, impacting most of the activities at the decision-making and implementation levels.

3.4.7 Financing and Financial Sustainability

Substantial financial resources (from the Federal Budget and the Development Partners) have been and are currently allocated to the Energy sector. Meeting the SE4All Initiative's goals will require a significant scale-up of some activities and additional financing including from the private sector. Achieving medium and long term financial viability and sustainability will also depend amongst other things on the tariffing of the energy services and on the subsidy mechanisms. Diversifying to other renewable energies (such as geothermal, wind or solar for example) to mitigate risks and attracting private sector interest and financing will rest on a comprehensive and stable renewable energy tariff and subsidy policy.

3.4.8 Information, Communication and Awareness

One of the key barriers to be addressed relates to the insufficient information and communication towards all the participants of the various value chains. Addressing this constraint is critical for the scaling-up of activities for on-grid and off-grid electricity access, improved cooking solutions, improving energy efficiency, diversifying the renewable energy portfolio (such as increasing the contribution of geothermal, wind and solar to energy matrix. It would also need to target various audiences with varying areas of interest.

3.4.9 Conclusions

a) Recently published strategies and plans (GTP, CRGE, and sector strategic plans) provide the framework to address the shortcomings and constraints in the Ethiopian energy sector in particular access to modern and cleaner energy services, improvements in the sector performance and sustainability. Plans from other sectors are also be a good source for detailed planning for energy services to these sectors. Energy sector policies and regulations should be reviewed to achieve targets in the plans.

b) Policy and regulatory gaps in particular in areas such as private investment in the power sector or promotion of energy management in industry and commercial activities should be addressed. The private sector is important in the provision of services for small off-grid power systems and household fuels and technologies. Private sector role in larger programs (such as provision of power, services and products for large power projects) is currently rather limited, although increasing. Private companies are eager to engage in such larger projects but tariff levels and an unclear regulatory framework limits their engagement.

c) At the end user level, the main constraints appear to be: (i) the still limited awareness of better energy alternatives; (ii) low incomes and limited capacity to pay; (iii) dispersed settlement pattern, (iv) limited access to finance to adopt better systems; (v) ineffective value chains from imports, financing, installation to maintenance/after-sale service to financing; and; (vi) a clear and enforced set of regulations.

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