

Powering Ethiopia Out of Poverty: Mersea Kidan

A Case for Diversified Electrical Energy Generation

Mersea Kidan

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Powering Ethiopia out of Poverty discusses the issue of energy use in Ethiopia. It shows projection of population and energy demand in Ethiopia for the coming twenty years. It also provides evidence that Combustible material is the primary source of Energy for Ethiopian households. It argues that Electricity needs to replace combustible materials as the primary source of energy. The paper summerizes by calling for diversification of sources of electric energy and the players in its generation, transmission and distribution.

Introduction

Ethiopia, even though a country with rich historical heritage, is one of the poorest countries of the world. The state of Ethiopia has survived centuries of natural and manmade challenges. Ethiopian people owned the only state that defended European aggressors and remained a free state in Africa. Even though Ethiopians enjoyed the freedom of having an own state while other African people languished under European colonization, they also missed the opportunity to get introduced to the fruits of the European civilization. When colonizers were building infrastructures like roads, Electric light and telecommunication in other African countries, Ethiopia was engaged in endless internal wars and with foreign aggressors. This history left Ethiopia to be one of the least developed countries in terms of infrastructure.

After the formation of Modern state at the beginning of 20th century, there were futile efforts to build the infrastructure of the country. But recent efforts by the current government seem to change that history of futility. Significant change is being registered both in the economic metrics and infrastructure.

In this paper, I will try to show that even though commendable efforts are being done to boost the country's energy production, they will not be sufficient to meet future demand. I first discuss the current energy use information, and then I will try to show the projection of both population and economy for the coming twenty years. Next I take an assumption of 11% growth in energy demand and show what it will be by 2030.

The main purpose of this paper is to argue that Electric energy should replace energy from combustible materials as the primary source of energy. Ethiopia needs to generate at least 165 Giga watts of electric power if it is to supply 50 % of the energy consumed by its people in a form of electric energy by 2030. I recommend use of diversified energy resources like coal, nuclear and bio-fuel as alternatives. I also recommend involving more players and technologies in the process of electric power generation, transmission, distribution and sale.

Current Energy use

According to a census report by CSA (Ethiopian Central Statistics Agency) the Ethiopian population size is 73,750,932. International Energy Agency (IEA) key indicator table shows that, in 2008, the total energy production of Ethiopia was 32 Million Tones Oil Equivalent. The energy consumption per Capita was 390 Kilograms Oil Equivalent. This number is expected to grow not only in an exponential rate but with a far faster rate than the GDP per Capita.

Ethiopia is far from having satisfied the current energy demand of its people. Taking a modest goal of 500Kg of Oil Equivalent consumption per Capita, Ethiopia needs to produce a total of 39 Million Tones Oil Equivalent (26% more than the current) Energy to fulfill that demand.

The 2008 energy balance table of Ethiopia at www.iea.com shows that of the 32million tones oil equivalent of energy consumed by Ethiopia in that year, 29million is generated from combustible and waste material. Most of the combustible renewable material that was used is wood in a form of charcoal or dry wood. Most Ethiopian households utilize

	Production in Kilo tones OE	Import in Kilo tones OE
Coal and Peat	0	0
Crude Oil	0	0
Oil Products	0	2,122
Gas	0	0
Nuclear	0	0
Hydro	283	0
Geothermal, Solar, etc..	12	0
Combustible and Waste	29,286	0
Total	29,581	2,122
Total		31703

Figure 1 Energy use by source

wood as a source of energy which they acquire in a traditional method. The

traditional method of collecting dry wood has been going on for millennia resulting in the depletion of the forest. Ethiopian Forest coverage which was 40% a century before has now plummeted to less than 3%.

The remaining energy was generated from Hydro dams (0.28 million tones oil equivalent) and Geothermal (0.12million tones oil equivalent) and the rest from other sources. In the same year Ethiopia imported a total of 2million tones of oil equivalent energy in the form of oil products. The table (Fig 1) summarizes Ethiopia's Energy use by energy source.

The IEA key indicators table also provides Fuel consumption by economic sectors. It shows what portion of energy generated from each source is consumed by each sector. Much of the energy is consumed for residential purposes. The industrial & Service sectors consumed less than a percent of total energy. Other sectors like Agro forestry consume negligible amount of energy.

	Industry	Transport	Residential	Commercial & Public services	Agriculture/ Forestry	Non-specified	Non-energy use	Total
Coal & Peat	0	0	0	0	0	0	0	0
Crude Oil	0	0	0	0	0	0	0	0
Oil Products	512	1270	285	0	0	0	37	2105
Gas	0	0	0	0	0	0	0	0
Nuclear	0	0	0	0	0	0	0	0
Hydro	0	0	0	0	0	0	0	0
Geothermal, Solar, etc..	0	0	0	0	0	0	0	0
Combustible and Waste	0	0	27445	202	0	0	0	27647
Electricity	102	0	167	63	0	2	0	269
Heat	0	0	0	0	0	0	0	0
Total	614	1270	27830	265	0	2	37	30021

Figure 2 Energy share by sector

The chart below shows summarization of Energy use by economic sectors in 2008 based on data from IEA

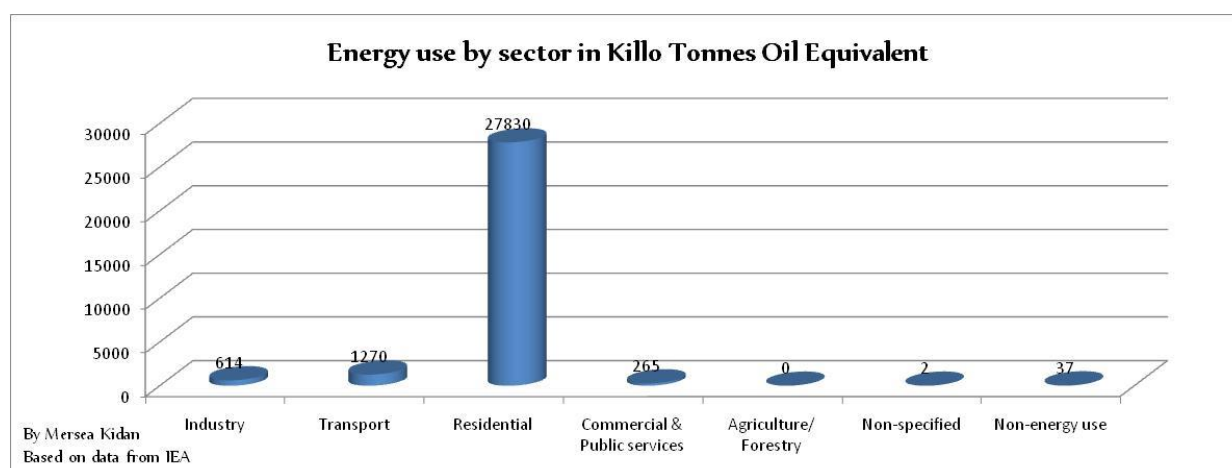


Figure 3 Energy use by sector

Population and economic projection

According to a census report by CSA (Ethiopian Central Statistics Agency) the Ethiopian population size is 73,750,932 and is expected to grow at a rate of 2.6% per annum. If the population growth continues with the same rate, then Ethiopian population will reach 133million by 2030.

According to [World Bank, World Development Indicators](#) Ethiopian Gross Domestic Product (GDP) in 2007 was \$19 billion. Ethiopia since then has been registering an average 11% GDP Growth. The newly ratified five year strategic plan (Growth & Transformation Plan GTP) by Ethiopian Government plans the GDP growth rate to be 11% at minimum and 15% at best for the coming five years. If we take the low case scenario, Ethiopia’s GDP will reach \$211billion in the year 2030.

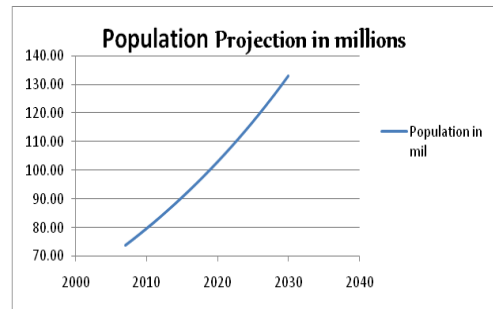


Figure 4 Population projection

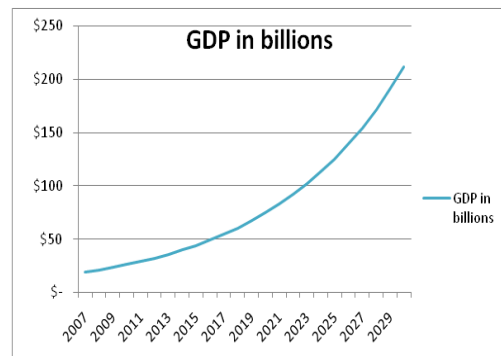


Figure 5 GDP Projection

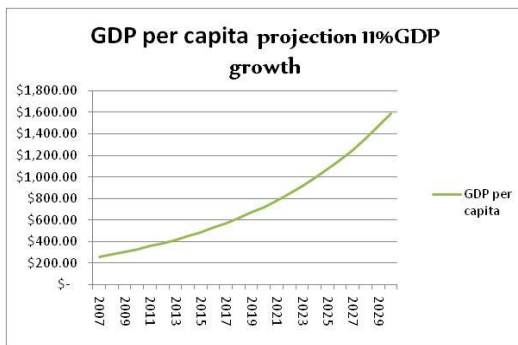


Figure 6 GDP per Capita projection

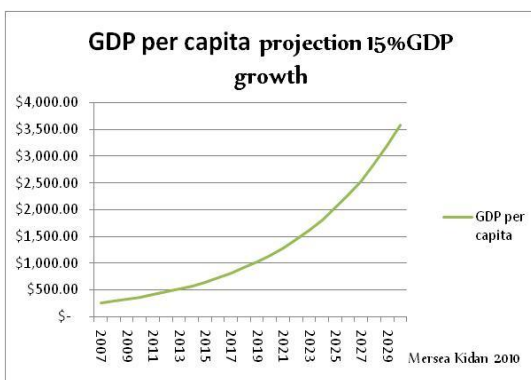


Figure 7 GDP per Capita Projection

Based on the projections on GDP and Population size, the GDP per capita will be \$1,588 by 2030. A per Capita GDP of \$1,588 is way smaller than the conventional income of middle income countries which ranges between \$4,000 and \$20,000. It is with this consideration that Ethiopian Government has set a stretched goal of 15% GDP Growth which will result in a GDP per Capita of \$3,585. Which consequently places the country among the middle income countries in the following few years. The two tables (Fig 6 & 7) show GDP per capita projections

based on 11% GDP growth and 15% GDP growth rates respectively.

Energy demand projection

The Growth and Transformation Strategic plan predicts that industry sector will grow in a

Economic Sector	2010	Plan (2011 - 2016)	
		Base Plan	Stretched Plan
Agriculture	6	8	14.9
Industry	10	20.1	21.4
Service	14.5	10.5	12.8
Total GDP	10.1	11	14.9

20%, Agriculture 8% and Service 10.5% rate for the coming five years assuming an 11% GDP growth rate. And for a 15% GDP growth rate the agriculture, industry and service sectors are expected to grow 14.9%, 21.4% and 12.8% respectively.

With the expansion of the industrial sector, which entails expansion of heavy duty manufacturing plants, the energy demand of the

Figure 8 growth by sector

sector is expected to grow in an exponential rate. In a similar fashion with the expansion of mechanized Agriculture which is currently driven by the soaring foreign direct investment on agriculture, the energy demand by the agricultural industry is expected to grow. The same principle applies for the service sector too.

For the lack of detailed studies, analyses and data sources, let us take an extremely conservative assumption that the energy demand will grow at the same rate as the GDP. Then, the energy demand by 2030 will be 251 Million Tons of Oil Equivalent and the per capita demand will reach 1,889 Kg Oil Equivalent. The two tables below show energy consumption projections with an assumption of 11% Energy demand growth.

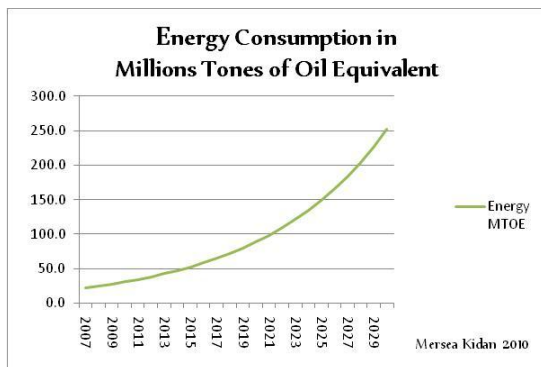


Figure 9 Energy Consumption projection

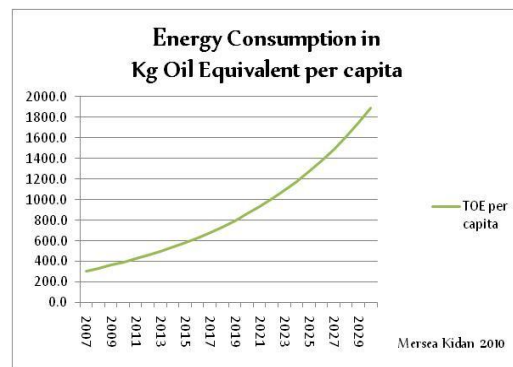


Figure 10 Energy Consumption projection per capita

The above two charts show how high the Energy demand will be even with the modest assumption that energy demand will grow at 11% rate. But it is inevitable that the energy demand will grow in a much higher rate due to the following reasons.

1. Population Growth
2. Economic growth
3. Living standard growth
4. Technological growth

The cumulative effect of the above four causes and others is going to entail a dramatically high demand of energy,

. In the Current energy use section above we have seen that much of the energy used in 2008 came from Combustible materials and Waste (92%). Very little amount of the energy consumed came from other sources like Electric generation (1%) or Oil products (7%).

What the chart reveals in Fig 11 shows is very important information. 99% of the energy Ethiopia consumes comes from sources that are going to be unavailable in the near future. 92% comes from Combustible materials which include Dry wood, dry animal dung, Charcoal (Carbonized wood) etc... Of these the only source that is renewable is dry cattle dung. Dry wood will soon be unavailable to households due to depletion of forests. The other source, Oil products (7%) is imported with expensive price which is expected to continue to soar. The price of oil has reached to a point only few portion of the people can buy it.

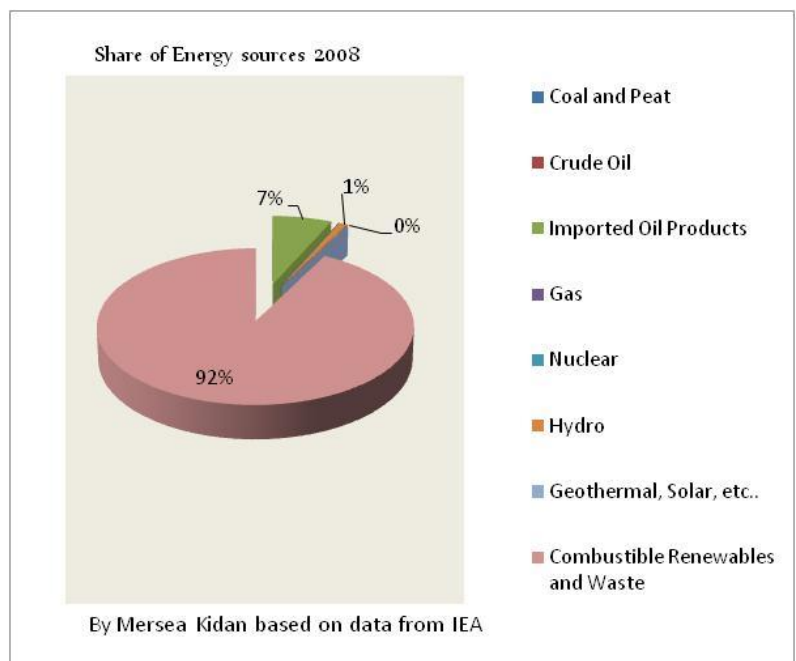


Figure 11 source of Energy

The fact that Ethiopian energy use depends on sources that would soon run out is very alarming and needs an aggressive mitigation initiative. Here I will try to show how electrical energy can replace combustible materials and oil as a primary energy source in Ethiopia. And that diverse electric energy generation methods should be considered.

Ethiopia needs to boost its electric energy generating capacity

1. To compensate for the energy from the running out combustible materials
2. To replace or augment oil as the source of energy primarily for transportation with the introduction of electric trains and other locomotives
3. Electrification of rural areas
4. To enable technology introduction and advancement
5. To cope up with future demand growth etc...

Let us take the first from the above listed reasons. If Ethiopia replaces 50% of the current energy consumption from combustible material by electric energy It would need to generate 170,000GWH (Giga Watt hours) of electrical energy or needs to have an additional generating capacity of 19,400MW. That is only to replace 50% of energy from combustible materials which is basically wood. This is to show the urgency of the issue.

Based on our projection, with an 11% growth rate, Ethiopia's total energy demand will be 250 million tones oil equivalent by 2030. Goals need to be set to have electric energy become the primary source of energy replacing combustible materials. If we take 50 % as a goal, the Energy demand will be 125 million tones oil equivalent per year. This is equal to 1.4petahours of electric energy per year, which, equals to a generating capacity of 165Gigawatt. This might sound a dubious number but it is a pragmatic challenge we are facing. Mothers and wives will soon run out of dry woods to cook with. Traditional Charcoal producers will soon run out of trees to make charcoals out of. We need to provide alternative source of energy. Compare 165Gigawatt with the generating capacity in 2010, 2000MegaWatt or 2 Giga watts. That shows how daunting the task of having adequate access of electricity to all Ethiopians will be. In order for Ethiopia to be able to provide half of the energy consumed by its people in a form of electricity, it needs to have a generating capacity of 165gigawatt by 2030.

The data, from Ethiopian lonely electric power provider company, shows that the country's renewable energy generating potential is about 60Gigawat. 45 Giga watt from Hydro power,

10 GigaWatt from wind and 5 Giga watt Geothermal. This shows that even if Ethiopia utilizes all its renewable energy resources, it cannot meet its own energy demand. So other energy generating alternatives need to be taken in to account.

Ethiopia needs to look in to every possible source to generate electric or other form of energy. Ethiopian Government seems to understand the seriousness of the situation and is doing a commendable job to generate as much energy as possible. But the challenge requires even more aggressive initiatives and efforts from every stake holder. All players need to understand the seriousness of the issue of depletion of Ethiopian forest and its consequences on every household. My strong recommendation is to diversify sources of electric energy generation and also diversify players in the supply chain of energy generation and distribution.

Diversify sources of electric energy

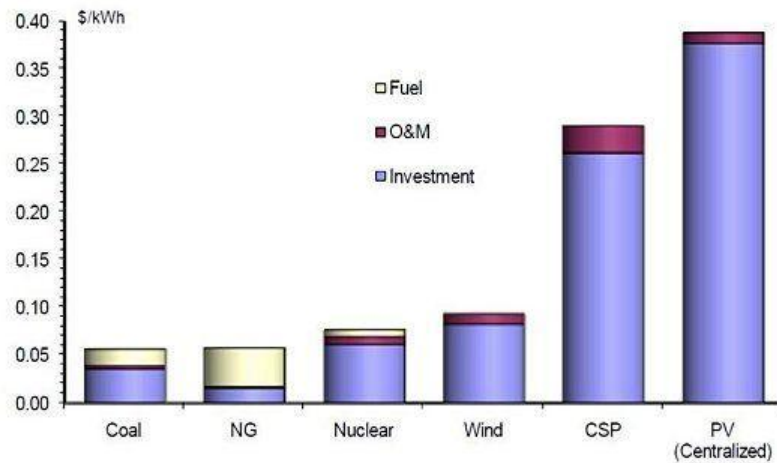
Whether it is because of pressure from donors and lenders or out of true commitment, Ethiopian government seems to focus on green energy generation. Based on that, the main focus has been on hydro power and to some extent wind energy generation. But as I have tried to show in the above discussion, even if Ethiopia makes use of all its hydro and wind energy potential, it cannot meet its future demand. So, further initiatives need to be taken to look for other alternatives. Those alternatives could be Nuclear energy, Coal, Bio-fuel, solar energy, Oil, Natural Gas etc....

It looks some sources of energy that could be cheaper to install and manage are being undermined due to their possible impact on climate. For example the idea of using coal for energy generation seems to be regarded as a taboo in the policy makers and EEPCO officials. But pragmatism needs to have its weight on their decisions. Green doesn't necessarily mean no carbon emission and that is not possible. But Ethiopia can have a net zero carbon emission. That is by saving more trees from being turned to charcoal. If more energy can be generated from coal and provided to households, trees would be saved from being cut for energy consumption. The use of dry wood and charcoal has been the main cause of deforestation which consequently contributes to the damage of both domestic and global climate.

Ethiopia, albeit, doesn't emit any significant amount of carbon to damage the environment; it is contributing to the exacerbation of global warming by depleting its forest. I believe that it

is better to emit minimum amount of carbon to generate energy that would save millions of trees which would suck the carbon from the environment in much higher volume.

The other energy source that seems to be feared by policy makers and EEPCO officials is



Source: Byrne et al, 2008. Data Sources(NEA/IEA 2005, Falk et al 2008, LAZARD 2008, ESMAP/World Bank 2008, IEA 2008)

Figure 12 Cost of electric energy

Nuclear energy. It is understood that generating nuclear energy is challenging for its multisided consequences (politically, economically, technologically and environmentally). But considering the alternatives at hand nuclear energy seems to be the inevitable alternative that all

growing economies and societies need to use as a source of energy. Nuclear energy generation, though perceived by many as an expensive alternative, the opposite is true. Even though it requires high installation cost, the production cost is cheaper compared to any of the other alternatives except coal and natural gas. The chart below shows the comparative cost of energy (\$ per kilowatt-hour) for different sources. It is understandable that the technology of nuclear energy is not cheap or easily accessible. But strategic efforts need to be done to accumulate the knowledge capital and expertise to harness the technology in the future.

While Ethiopia needs to harness all available resources to generate energy, adequate balance needs to be there to make sure that carbon emission is minimal. So all carbon free renewable energy technologies need to be researched and used. Among those is solar energy. The technological and economical feasibility studies indicate that solar energy is far from becoming feasible for precedence over other sources. But cost trends indicate that cost of solar energy is going down with improved technologies as fast as the price of energy is soaring. It is not going to be too long a time before solar energy becomes a feasible source of energy. So researches need to be done and the necessary knowledge and technological capital needs to be accumulated for future use.

The other alternative is bio-fuel. Ethiopian government is constructing factories that produce ethanol out of molasses. Molasses is a waste of sugar production from sugarcane. Also other efforts are being done to produce fuel out of plants. One example is production of bio-fuel from jatropha. ECOENERGY a private company is investing on jatropha fuel production. This is an effort that should get full support from the government. The challenge in using bio-fuel as a source of energy is its possible competition for land and resources with food grains. All necessary economical and legal protection measures need to be taken to make sure that the production of bio-fuel does not encroach the production of edible crops and plants.

Involve all stakeholders (Diversify Players)

For the past half a century, Ethiopian Electric Power Corporation has been the single player in the power generation sector. This institution has gone through numerous structural changes since its establishment in 1956. Nevertheless It has remained to be the sole generator, transmitter and distributor since. Though the restructuring in 1997 was anticipated to allow involvement of private companies in the sector, the change was only to separate the regulatory and operation bodies. Both bodies still remain under the control of the executive branch of government.

The Government needs to stand up to its promise and actually implement separation between the corporation and the regulatory body.

All the necessary policy and structural frameworks need to be worked out to involve the private sector in the energy sector. It is known that the government has a strong stand against allowing foreign companies in the sector. But I cannot see any reason for the government to deny Ethiopian companies the right to involve in the sector. The opposite is what the government should do. It needs to give incentives so that private companies participate in generating, distributing or selling electric power. The model of the banking industry is a good benchmark. The government does not need to privatize EEPCO but encourage domestic private companies to participate in the sector. Private Banks have flourished while the government kept its ownership of the major banks in the country. Similarly Government can keep owning EEPCO but allow other companies to participate in the energy industry.

The other stakeholders that need to be involved in the sector are research centers, communities, financial institutions and cooperatives. These institutions can play a significant role if all the necessary incentives are provided. A hybrid system of both Macro and micro

power generation should be encouraged. Regulatory, technological, financial and other resources need to be provided to generate energy from small dams, wind turbines, solar panels and other generators in a micro level. A combination of centralized grid systems and micro-grid systems need to be developed to promote domestic power generation and distribution.

Summary

Ethiopia's energy consumption in 2007 was 21 million tones oil equivalent. 92 percent of that energy comes from combustible materials. Much of the combustible materials is dry wood in one or another form. Ethiopian forest which is the source of dry wood has been depleted to the level where it can no more deliver to the dry wood demand. So alternative source of energy needs to be provided for households or the situation will get worse if it can get any worse than now at all. Besides, population is expected to reach 133million by 2030 and the economy is expected to grow in an average of 11%. If these two projections hold true, the energy demand of the country is expected to grow in a fast rate. Taking a modest projection of 11% the total energy demand of the country will reach 250 million kilo grams oil equivalent.

If Ethiopia is to supply its people with alternative energy source, it is electricity that is feasible. Recent technological advancements are showing that most technologies are opting for electricity as a source of energy for their products. So, the need to generate more electricity is inevitable. If Ethiopia is to supply 50% of its peoples' energy consumption in a form of electricity, then it needs 165 Giga watts of generating capacity. It is impossible to generate that much of energy only from renewable resources. Hence, all potential resources need to be considered. Coal, Nuclear and Bio-fuel need to be considered as alternatives. As a matter of fact use of Nuclear technology is an inevitable task if Ethiopia is to generate such amount of energy. The technological, knowledge and institutional infrastructures need to be built to cultivate these alternative technologies.

It is not only diversified resources that would result in success of providing the needed energy but also diversified players and technologies that can deliver the result. All stakeholders like private companies, research institutions and communities need to play their role if future energy demands are to be fulfilled. Also diverse technologies like multiple Grid systems, multi tier generating systems and others need to be considered.

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