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# Reducing energy sector vulnerability to climate change and extreme events

Ephrem Shaul

*University of Addis Ababa*
*Addis Ababa*
*Ethiopia*

# Reducing Energy Sector Vulnerability to Climate Change and Extreme Events: Ethiopian Case

Ephrem Zewdu
e-mail: ephremz@hoarec.org

# Introduction

❖There is a clear consensus within the scientific community and the public that traditional fossil fuel based energy production systems are key contributors to global climate change.

❖However, the impacts of climate change and, in particular, weather variability on the energy production sector have been underestimated.

❖ Energy services are fundamental to social and economic development

# Cont..

❖In the ensuing decades, the global energy system will be confronted with fundamental challenge of growing world population and climate change.

❖population growth will mainly take place in counters that have limited access to clean energy, and less adaptive capacity to adverse impacts of climate change.

❖almost all population increase b/n 2000-2030 will occur in urban areas of the less developed regions (UN, 2001).

❖will increase both the “urban poor” and rural energy starving

❖Climate effects can have implications for energy production and use.

# Cont …

❖average warming can be expected to increase energy requirements for cooling (low lands of Ethiopia and Ethiopian Rift Valley areas)

❖Changes in precipitation could affect prospects for hydropower plants. (Ethiopia less adaptive capacity)

❖consider ways to adapt to possible adverse impacts and take advantage of possible positive impacts

❖adaptation prospects depend considerably on the availability of information about possible climate change effects to inform decisions about adaptive management.

# Ethiopian Energy Sector

## Selected indicators

❖Energy sources in Ethiopia includes : Biomass, natural gas, hydro, imported oil,

❖Electricity consumption per capita (kWh): 22.1 (2001) to 41.28 (2009);
➢ far lower than sub-Saharan Africa average excluding S.A 126 kWh

❖Electricity generation; installed capacity: 713 MW (2004) and will be 3,800 MW in (2012).

❖System loss (%): 22 (2001); 19.5 (2007)

❖Electrification Levels (%) (2005): National: 16, Rural: 07 ( 26 % for sub-Saharan Africa)

❖Biomass consumption as a percentage of total energy (%): 91

❖ Fossil fuel (petroleum products): 8% of primary energy in Ethiopia – but 50% of export earnings

(Wolde-Ghiorgis, 2003; Kebede, 2003; Teferra, 2002; AFREPREN, 2003; EIU, 2003; World Bank, 2000, WB 2003.)

# Cont..

❖ The consequences of dependence on traditional energy sources are alarming trends of deforestation and desertification in many parts of the country.

❖ The only significant sources of biomass fuels and tress are presently found in the south-western region of the country.

❖ Electricity generation Potential of Ethiopia (EEPCo)

Hydro > 45,000 MW (Abaye; Sheble; Omo; Tekeze, Awash, Baro, Genale and Merb )

Geothermal > 5,000 MW

Wind > 169 GW

Solar $10^6$ with average insolation of 5.5 $KWh/m^2$

# Cont..

❖ A stable supply of enough energy is a must for industrialization and middle income Ethiopia in 20-30 years.

❖At present EEPCo has increased installed generating capacity from 713 MW (2004) to 2,218MW by the end of year 2010. (but mainly dependent on Hydro) Fig 2;

# Cont..

❖The PASDEP target in the energy sector

➢ to increase production to 3,150 MW in 2012 & 5,300 MW in 2015. Table 1 & 2

➢ to increase the expansion grid to 13,054km

➢ improvement of efficiency on the existing energy resources, reducing energy loss from current 19.5% to 13.5%, international average.

❖Total estimated cost for five years is 51 bil Birr = 5.3 bil US $.

Tekeze Arc Dam, inaugurated in 2010, 300 MW

Gilgle Gibe II tunnel, hydropower, 420 MW

# Climate Change in Ethiopia

❖ $CO_2$ emission per capita calculated at 43 Kg – far less than the African average of about 1 ton and noting compared with the 20 ton per capita of the United sates or 10 ton in Germany. (Abebe Tadege, 2002)

❖ warming trend in the annual minimum temperature over the past 55 years. increasing by about 0.37 $^0$C every ten years. Fig 4

❖ The trend analysis of annual rainfall shows that rainfall remained more or less constant when averaged over the whole country (Figure 5). (NATIONAL METEOROLOGICAL AGENCY, 2007)

❖ Rainfall pattern has become erratic and unpredictable for local farmers

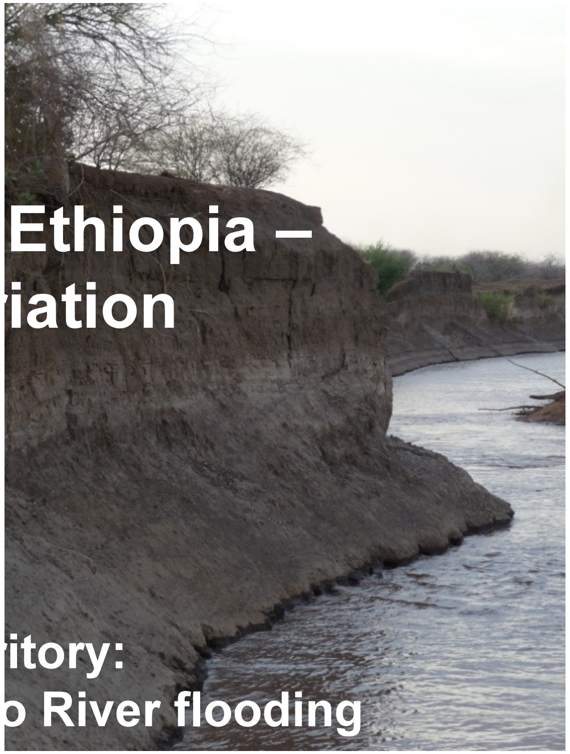
# Climate change

***"We still have the names of the months but they don´t say anything anymore!"***

**Nyangatom calendar:**

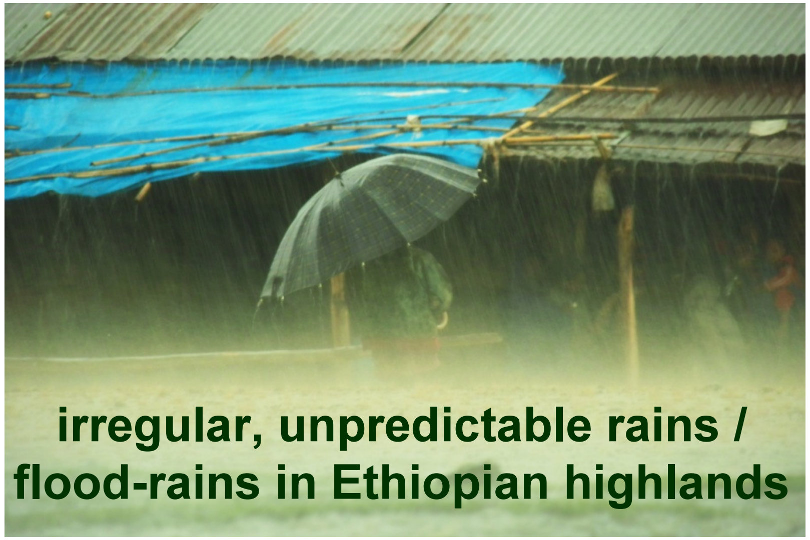
- **Lochoto** (March): "**muddy**"
- **Lotima** (April): "**growing of gras**"
- **Yelyel** (May): "**scattering of clouds**"

# Climate Change impacts in Ethiopia – features in regional variation



South Omo / Nyangatom territory:
failure of Belg-Rains – decrease of Omo River flooding

hail storms in Ethiopian highlands



irregular, unpredictable rains / flood-rains in Ethiopian highlands

# Projected climate change over Ethiopia

- For the IPCC mid-range (A1B) emission scenario, the mean annual temperature will increase in the range of 0.9 - 1.1 °C by 2030, in the range of 1.7 - 2.1 °C by 2050 and in the range of 2.7-3.4 °C by 2080 over Ethiopia (Figure 3) compared to the 1961-1990 normal. A small increase in annual precipitation is also expected over the country (Figure 4).

# Effects of climate change on energy production and use

- Seasonal and daily temperatures and precipitation changes affect the timing of peak electricity demands and the size of these peaks;

- Extended periods of drought lead to reduced water availability for hydropower generation;

- Changes in temperature and precipitation affect water availability for cooling power generators;

- Changes in cloud cover, temperature and pressure patterns directly affect wind and solar resources (affecting resource availability or productivity)

# Cont..

•Increased intensity and frequency of severe weather events impacts on energy infrastructure, power plants, transmission lines, refineries, oil and gas drilling platforms, pipelines and power lines resulting high energy prices;

•Increased intensity and frequency of severe weather events impact design and safety requirements of future energy infrastructure and other capital investments;

• Increased occurrence of blackouts may be observed as a result of higher electricity demand for cooling and refrigeration caused by higher temperatures.

# Effect of climate change on Ethiopian Energy sector

❖Changes in precipitation could affect prospects for hydropower, positively or negatively. (needs comprehensive assessment & documentation)

❖ new findings may lead to a change in perception and valuation of energy technology alternatives and energy policies and decision making processes of the country

**Effects of Climate Change on Future Ethiopian Hydropower**

❖Changes in precipitation could affect prospects for hydropower, positively or negatively.

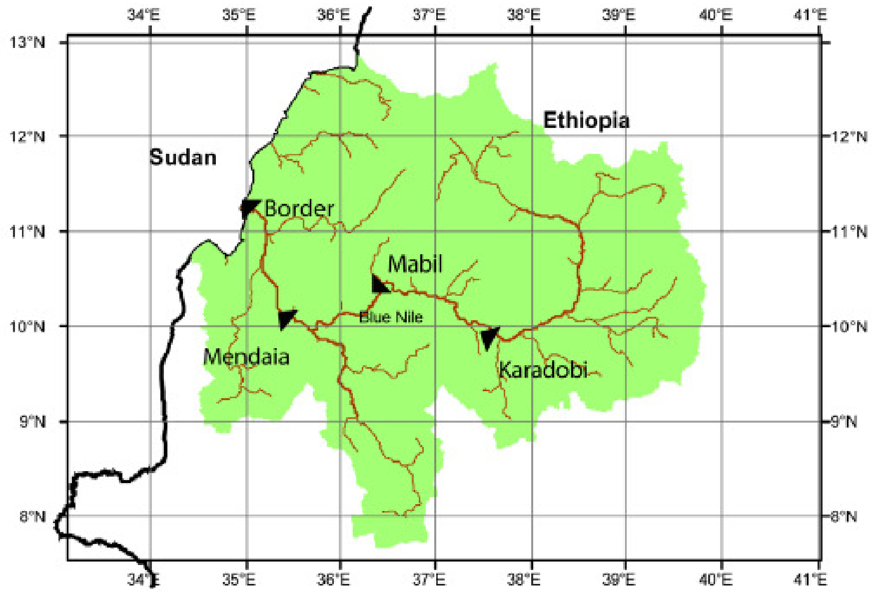



Fig. view of proposed hydroelectric dams along the Blue Nile River, as proposed by the United States Bureau of Reclamation.

➢ Drier than historically normal conditions appear to have a greater detrimental effect on overall benefit-cost ratios than positive effects expected under wetter than normal conditions. (Paul Block, Casey Brown, 2008)

# Making the energy sector resilient to climate change minimizing Damage

- To make energy systems "climate-proof " Adaptation and mitigation strategies must be assessed and incorporated in energy sector

- consider ways to adapt to possible adverse impacts and take advantage of possible positive impacts (detail scientific analysis in major basins of Ethiopia)

- Causes for vulnerability of Ethiopia to climate variability and change include high dependence on hydropower

- Role of protected areas ("avoiding the unmanageable") and ("managing the unavoidable").

❖ Managing natural ecosystems as carbon sinks and resources for adaptation is increasingly recognized as a necessary, efficient and relatively cost-effective strategy.

❖Semen mountain forest – Tekze dam, Gura Ferda and Godere forests for Baro and Gilo river catchments, Ormia and south-West forests -Geibe I, II, III Projects.

Montane Forest - Gura Ferda

Ethiopia's forest  for Local and Regional  hydroelectric project Implication

Marawi Dam in Sudan, (1.2GW)  on Nile River

Regional implication of Ethiopian Rivers

Aswan Dam, Egypt, Encarta picture

# Cont..

- Medium and long-term strategies must be developed to secure a diversified, decentralised, accessible and affordable modern energy system, more resilient to climate change

Diversification of Energy Matrix

- Geothermal Energy: I) lakeside areas, such as Alto-Langano, Corbetti and Abaya, ii) South Afar area, such as Tulu-Moye, Gedemsa, and Dofan, and iii) North Afar area, such as Tendaho and Dallol.

- Wind Power
- currently mainly limited to water pumping

However, Ashegoda Wind Power Project, the country's first wind farm, in Tigray State planned installed capacity of 120 MW.

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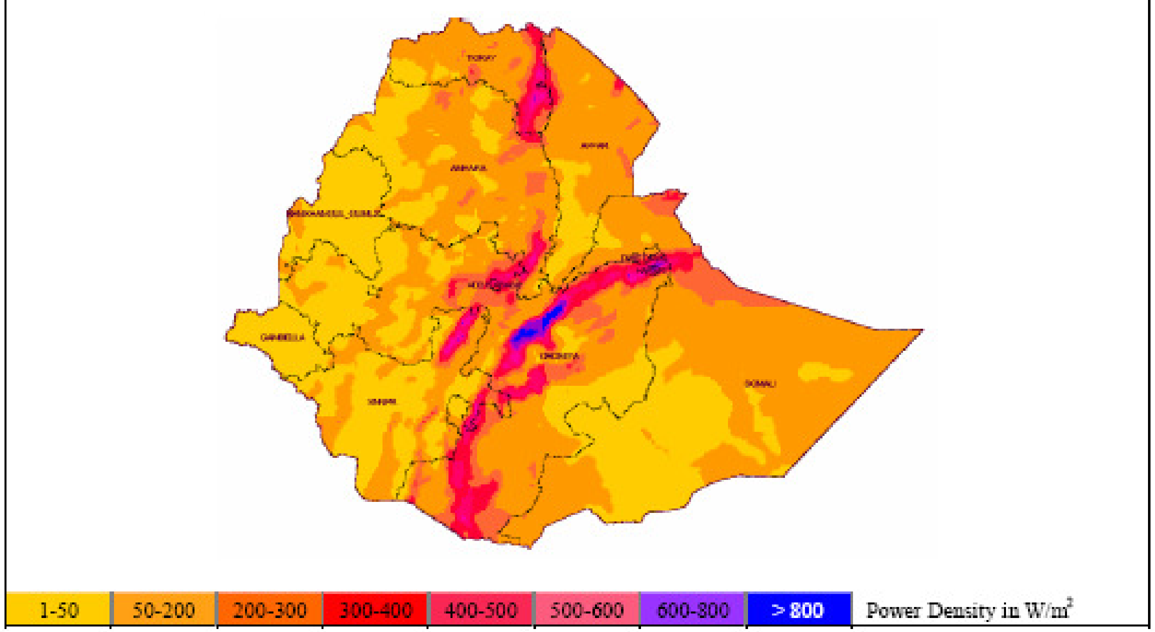
**Wind energy resources (SWERA, 2007)**




**Wind energy resource of Ethiopia**

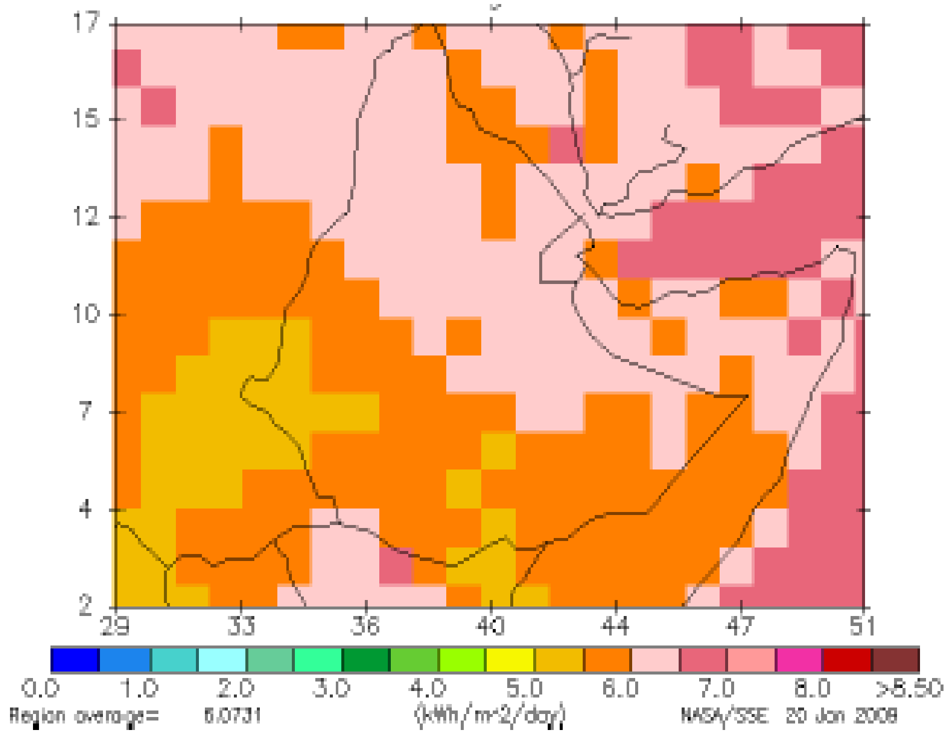
| Wind resource class | Wind class | Wind power density at 50magl W/m² | Wind speed at 50magl m/s | Area km² | Gross capacity [a] GW |
|---|---|---|---|---|---|
| Excellent | 7 | > 800 | > 8.8 | 1,392 | 7 |
| Excellent | 6 | 600 – 800 | 8.0 – 8.8 | 3,646 | 18 |
| Excellent | 5 | 500 – 600 | 7.5 – 8.0 | 6,454 | 32 |
| Good | 4 | 400 – 500 | 7.0 – 7.5 | 22,279 | 111 |
| Total (Good to Excellent) | | | | | 169 |

[a] Gross capacity is calculated assuming $5MW/km^2$.
*Source*: EREDPC/ERG, 2007.

➢Solar Energy (*Rural Electrification project)*

currently mainly used for telecom services and rarely for water heating

**Solar energy resources (NASA, 2005)**



# Cont..

- Electricity Loss

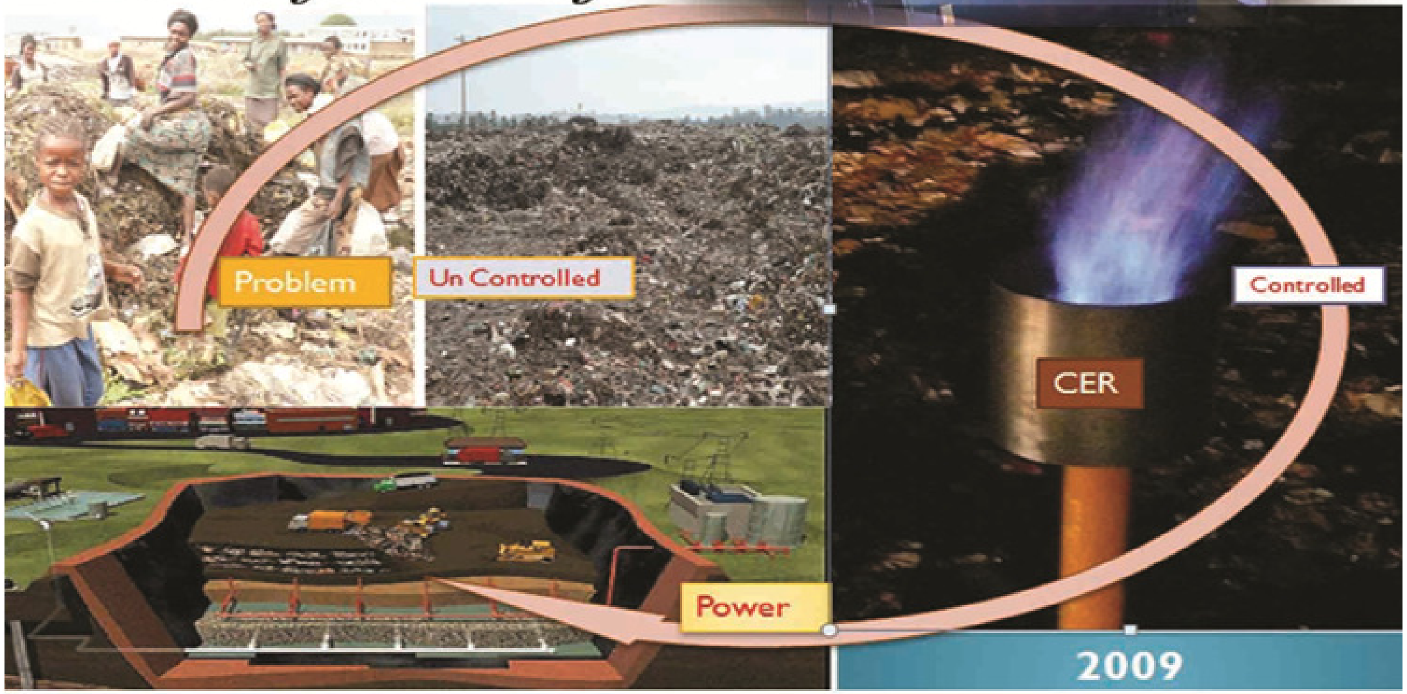
Improve energy efficiency as an essential adaptation measure

- Comprehensive assessment and documentation with quantitative analysis on energy projects of Ethiopia needs be done

- CDM (Clean Development Mechanism)

*LFG (Land Fill Gas) Energy Plant six cities of Ethiopia*

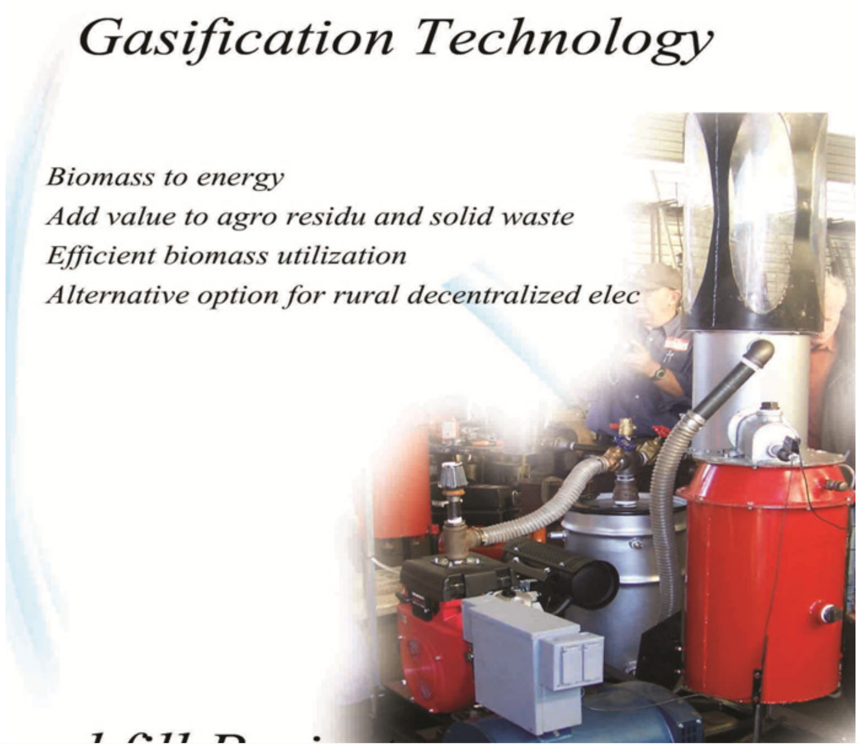
# Land fill Project




*Wast to energy*
*Clean City Development*
*Carbon creadit for the cities*
*Green house emission reduction*


Solar Cookit
Replace existing traditional
Bio mas use
Save Cooking time
Affordable
Fuel Saving Stove


Highly efficient
Modern
Displace Kerosene
Plant Oil Cooker

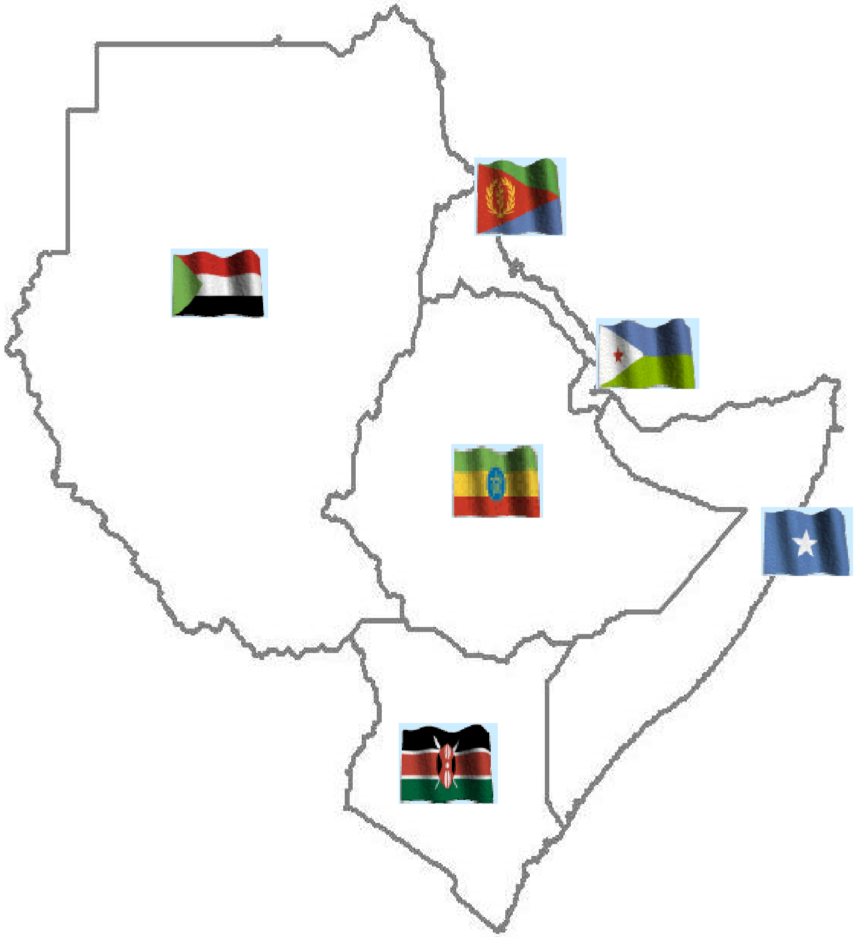

Gasification Technology
Biomass to energy
Add value to agro residu and solid waste
Efficient biomass utilization
Alternative option for rural decentralized elec

# Acknowledgment

- ICTP & IAEA

- Horn of Africa Regional Environment Centre/Network

objective to improve environmental *governance* and *management* in the Horn of Africa Region so that it can promote *sustainable development*, improve *livelihoods* and prevent *conflicts* over access to natural resources



# Thank you for kind attention