



Ethiopia's Energy Potential and Program

Girma Woldetinsae

Ministry of Mines and Energy,
Ethiopia

Contents

- Introduction
- Energy Potential
- National Energy Policy
- Fossil Fuels
- Geothermal
- Bio-Fuel
- Hydropower
- Solar
- Wind

Location of Ethiopia

Ethiopia is located in Eastern part of Africa

Population: ca. 80 Million

Area: 1,127,127 km²



Within Ethiopia there is a massive highland complex of mountains and dissected plateaus divided by the [Great Rift Valley](#), which runs generally southwest to northeast and is surrounded by lowlands, [steppes](#), or semi-desert. The great diversity of [terrain](#) determines wide variations in climate, soils, natural vegetation, and settlement patterns.

The normal rainy season is from mid-June to mid-September (longer in the southern highlands) preceded by intermittent showers from February or March; the remainder of the year is generally dry.

Ethiopia is an ecologically diverse country. [Lake Tana](#) in the north is the source of the [Blue Nile](#). Besides the aforementioned diverse physical features, Ethiopia is also endowed with canyons, gorges and rivers. The major river basins include the Abay (Blue Nile), Awash, Baro, Omo, Tekeze and Wabe Shebele.

Energy Potential

- Ethiopia has various energy resources
- The demand in the country is growing from time to time
- Hydropower is the main sources of energy in Ethiopia
- Energy coverage is estimated to be 41%
- Currently effort is being done to use energy mix

The Ethiopian National Energy Policy

Issued in 1994

Recognises the supply of household fuels.

Recognises the development of the energy sector in a coordinated manner that is benign to the environment.

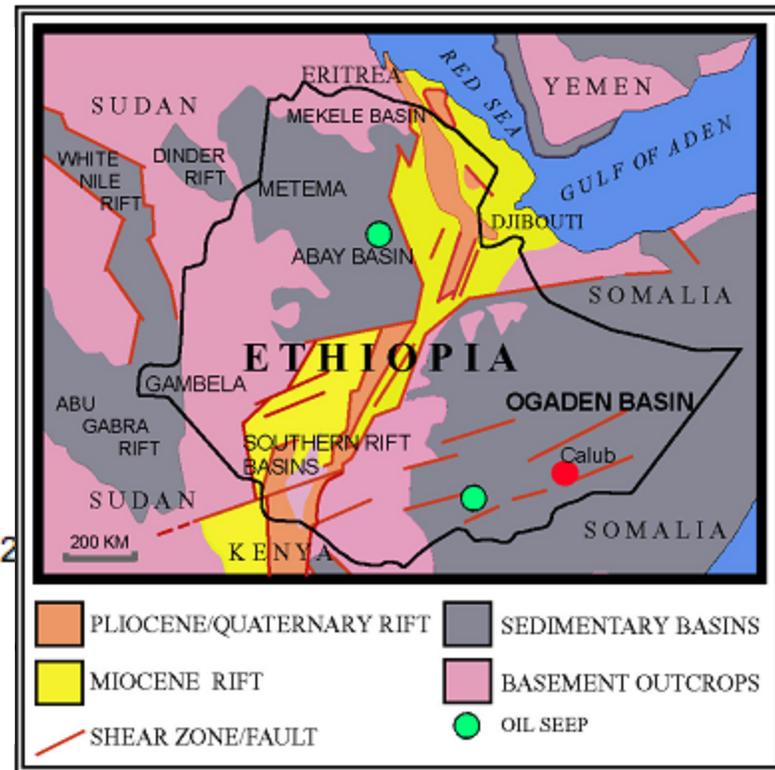
Gives high priority on hydropower development on least cost bases
Other resources will also developed on the basis of their economic viability.

Allowed the private sector participation,

It also gives emphasis for natural gas and oil exploration.

Fossil Fuels

- Petroleum
- Sedimentary Basins
- 6 Sedimentary basins
 - Abbay – 100,000 km²
 - Mekele – 8,000 km²
 - Metema – ~10,000 km²
 - Southern Rift - ~ 40,000 km²
 - Gambela - ~16,000 km²
 - Ogaden -350, 000 km²



- Other identified areas in different parts of the country
- Currently 17 COMPANIES ARE WORKING

Other Fossil Fuels

- Oil Shale
 - Identified in various places in the country
 - Dilbi
 - Yayu
 - Mush
 - NE of Mekele
 - An estimated reserve of 660 million to 1 billion tons
 - New areas are also reported recently



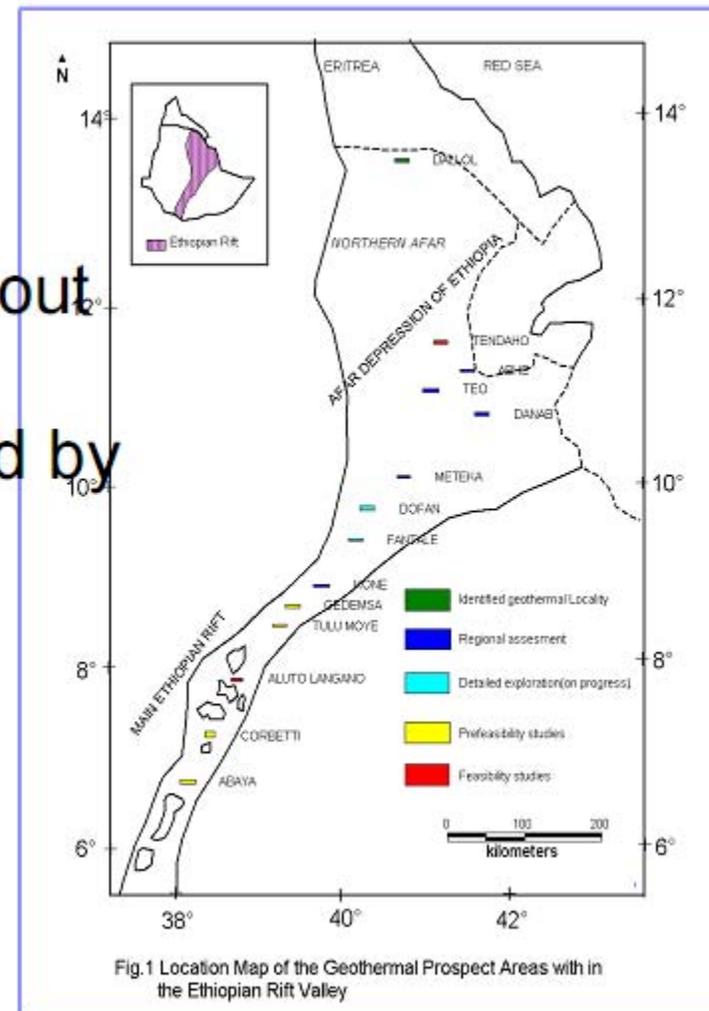
Other fossil fuel

- Coal
 - Dillbi
 - Yayu
 - Chida
 - Chilga
 - Mush valley
 - Wichale area
 - New areas recently reported also
- Estimated reserve > 500, 000,000 tons



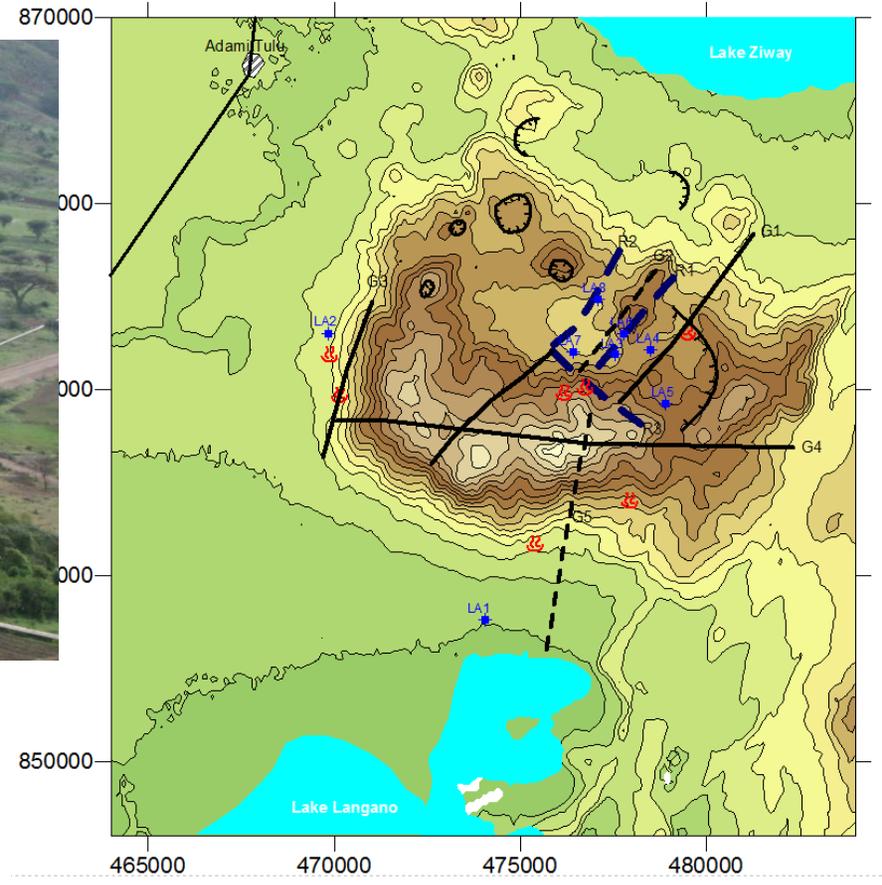
Geothermal

- Several areas along the Ethiopian Rift
- Estimated potential is about 5,000 MW
- Only two areas are tested by drilling
 - Langano- Aluto
 - Tendaho
- Other areas within the Ethiopian rift are only on prospect level.



Geothermal





Biofuel

- Coordinating office for investment Under MoME
- Licensing is handled in collaboration with
 - Ministry of Agriculture
 - Regional States
- ~200, 000 hectares of land licensed in the southern part of the country
- More land is available for investment

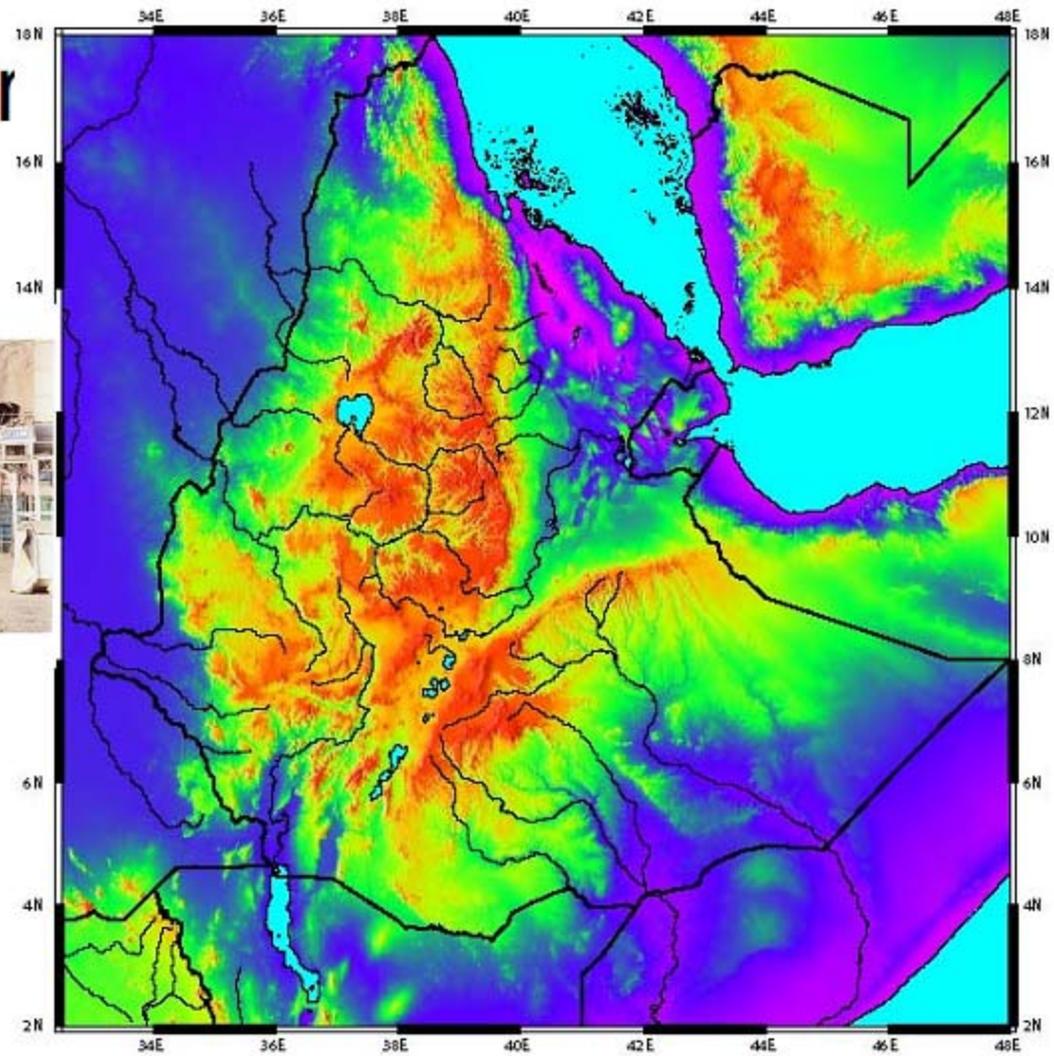
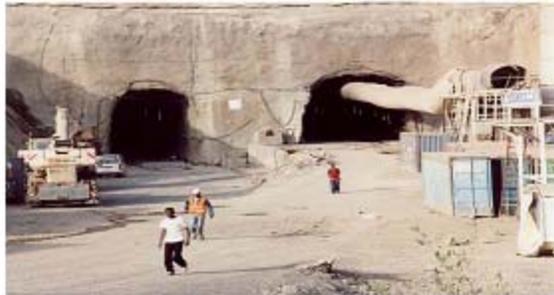
Ethanol Production From sugar Industries

የሱካር ኢንዱስትሪ	1999	2000	2001	2002	2003	2004	2005
	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
ፊንጫ	8,000,000	8,448,000	11,009,000	13,834,000	16,585,000	18,515,000	21,221,000
መተሐራ	-----	-----	7,311,000	11,700,000	11,700,000	28,183,000	35,527,000
ወንጂ						15,428,000	20,728,000
ተንዳሆ				9,602,000	24,428,000	38,205,000	50,689,000
አጠቃላይ	8,000,000	8,448,000	18,320,000	35,136,000	52,713,000	100,331,000	128,165,000

ምንጭ:- የኢትዮጵያ ስካር ልማት ኤጀንሲ ፕሮግራም 1999 ዓ.ም.

Source : Ethiopian Sugar Industry Agency, 2009

Hydropower Potential



Hydropower



- Estimated potential ~ 45,000 MW
- Current Installed capacity > 2000 MW
- 2009/2010 => 3 Dams commissioned
 - Tekeze 300 MW
 - Gilgel Gibe II 420
 - Tana Beles 460
- Others under construction
 - Gilgel Gibe III
 - Gilgel Gibe IV
 - Chemoga Yada



Electrification status

- Number of electrified towns to date are only 2,800 from a total of about 7,000 rural towns/villages;
- Number of customers connected are about 1.4 million of which 40% of the customers are in the capital, Addis Ababa.
- Access to electricity is about 22%;
- Per-capita energy consumption is about 36kwh/year.
(500Kwh/yr is considered the average minimum level of consumption per- capita for reasonable quality of life)
- Much of the population lives in relative poverty and energy insecurity;
- Use of traditional fuels such as fire wood continues aggravating the soil erosion and habitat destruction.

- The government has launched a universal electricity access program (UEAP) to be implemented by EEPCO with the view to enhance the access to 50% within 5 years.
- UEAP plans to electrify 1,700 towns per annum within the coming years.
- the electrical energy demand growth in recent years have been very significant, for example from 2002 to 2006, the average annual energy demand growth witnessed was 13%, and an annual growth rate of 17% is expected at the end of this fiscal year.

Regional Interconnection

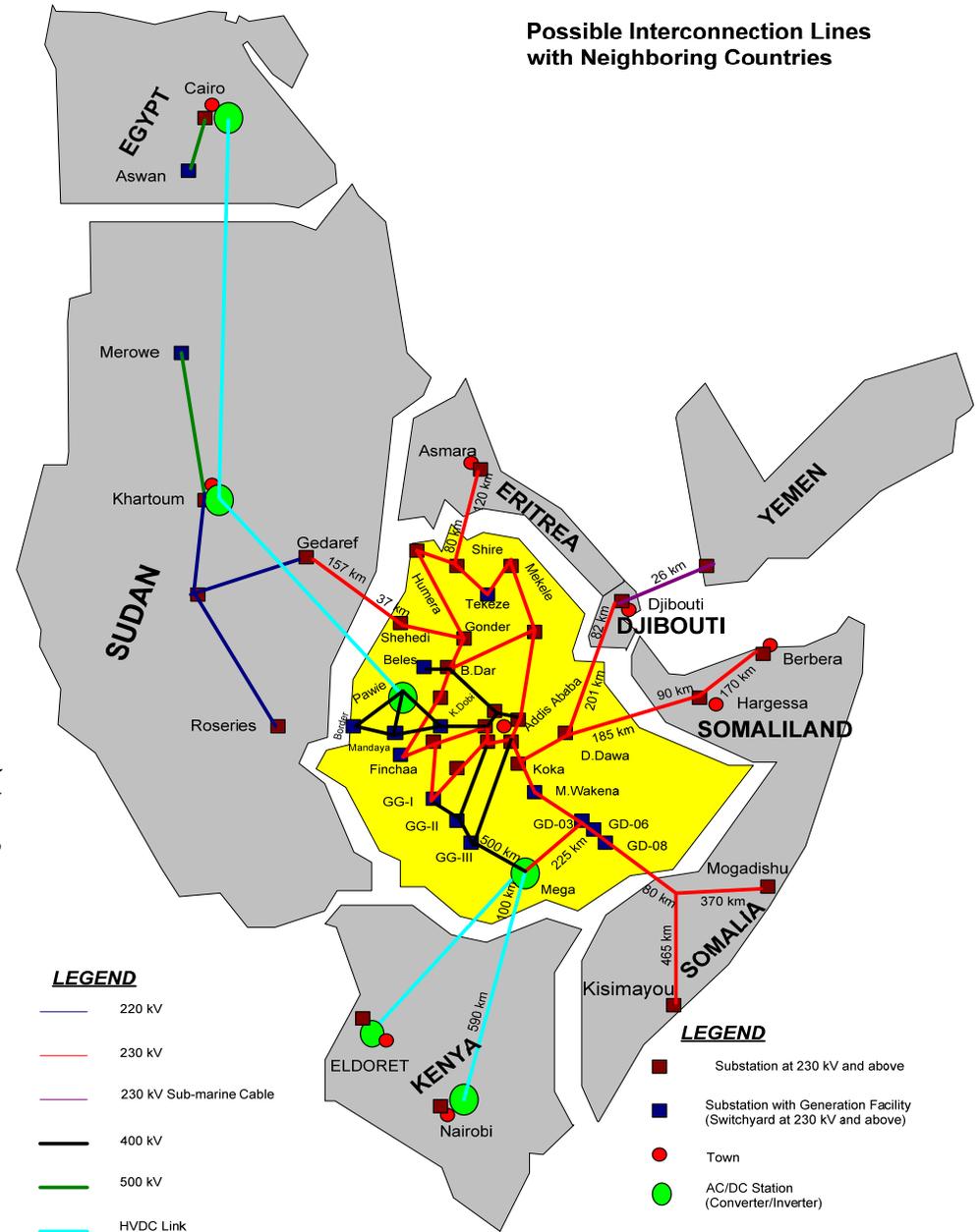
Eastern Nile Power Trade Program Study- phase I (Consultancy by EDF/Scott Wilson)-

Various power system interconnection activities have been initiated with neighboring countries

The Ethiopia-Sudan and Ethiopia-Djibouti interconnections study phases have been completed and they are now at early construction phases.

After several high level negotiations, Ethiopia and Kenya have launched a feasibility study for the interconnection of the two countries power systems.

Beginning from November 2006, a study for the interconnection of Ethiopia, Sudan and Egypt has been undertaken through the Nile Basin Initiative (NBI).



Solar Energy Resource Potential

- SWERA solar resource data has been developed from Climatologically Solar Radiation (CSR) Model,
- Based on the model the following solar resource maps are prepared as an output covering the whole country
 - Average Direct Normal Irradiance (DNI) in kWh/m²/day at 40Km resolution
 - Average tilt (latitude Irradiance) in kWh/m²/day at 40km resolution
 - Average Direct Normal Irradiance (DNI) in kWh/m²/day at 10km resolution

Annual Average Direct Normal Irradiance in kWh/m²/day at 40km Resolution



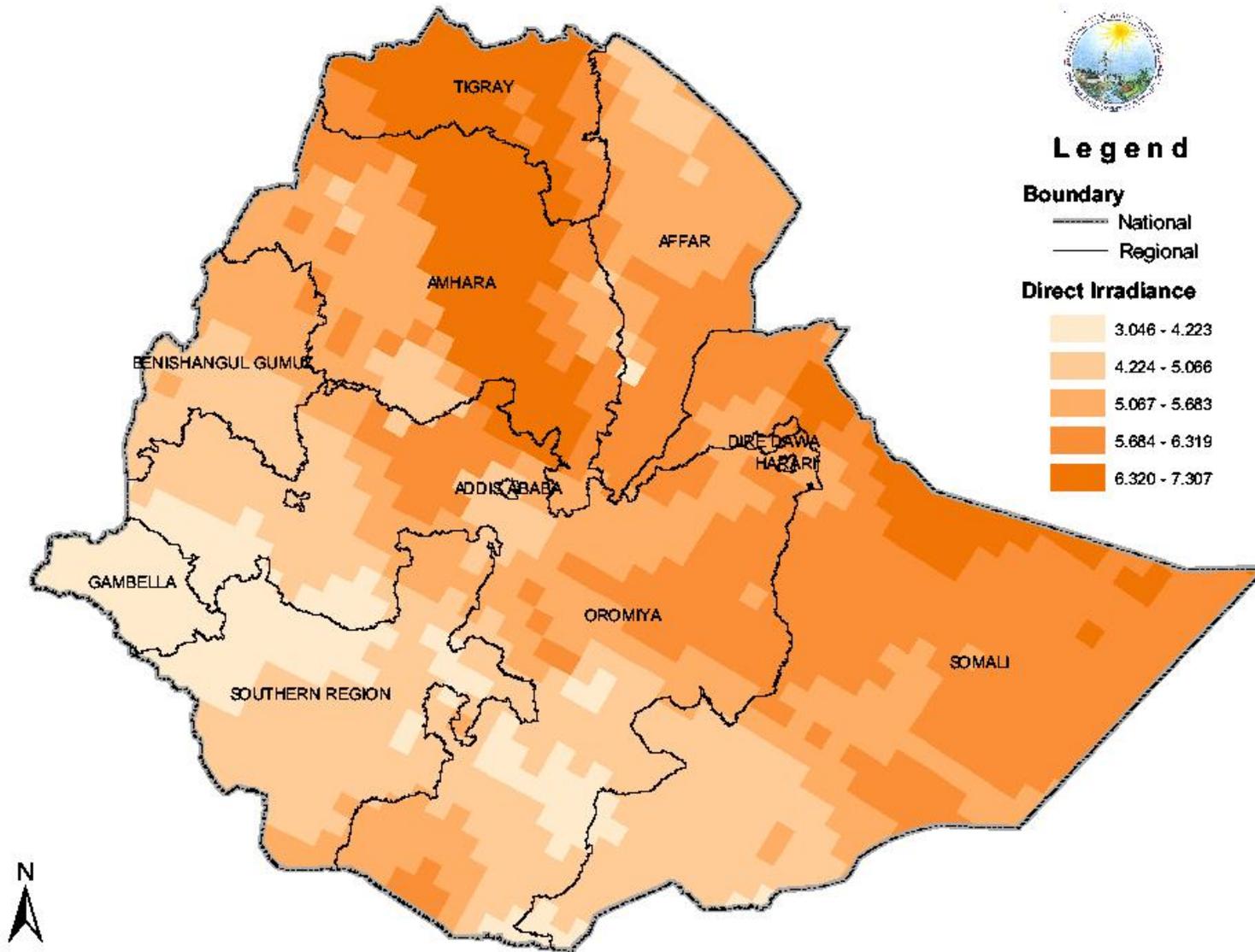
Legend

Boundary

- National
- Regional

Direct Irradiance

- 3.046 - 4.223
- 4.224 - 5.066
- 5.067 - 5.683
- 5.684 - 6.319
- 6.320 - 7.307



Regional Summary of Annual Average Direct Normal Irradiance at 40km Resolution

REGION	Annual Direct Normal Irradiance (kWh/m ² /day)		
	Minimum	Maximum	Average
ADDIS ABABA	4.85	5.06	4.93
AFFAR	3.05	6.29	5.55
AMHARA	3.05	7.31	6.01
BENISHANGUL GUMUZ	4.12	5.73	5.02
DIRE DAWA	5.33	6.38	5.80
GAMBELLA	3.10	3.83	3.49
HARARI	5.30	5.84	5.61
OROMIYA	3.10	6.81	5.03
SOMALI	3.35	6.95	5.64
SOUTHERN REGION	3.10	5.67	4.50
TIGRAY	5.00	7.12	6.40

From the map and accompanying summary table it can be seen that Oromia, Tigray, Amhara and Somali regions have highest potential and Gambella and Southern regions have relatively lower potential.

Annual Average Solar Tilt Irradiance in kWh/m²/day at 40km Resolution



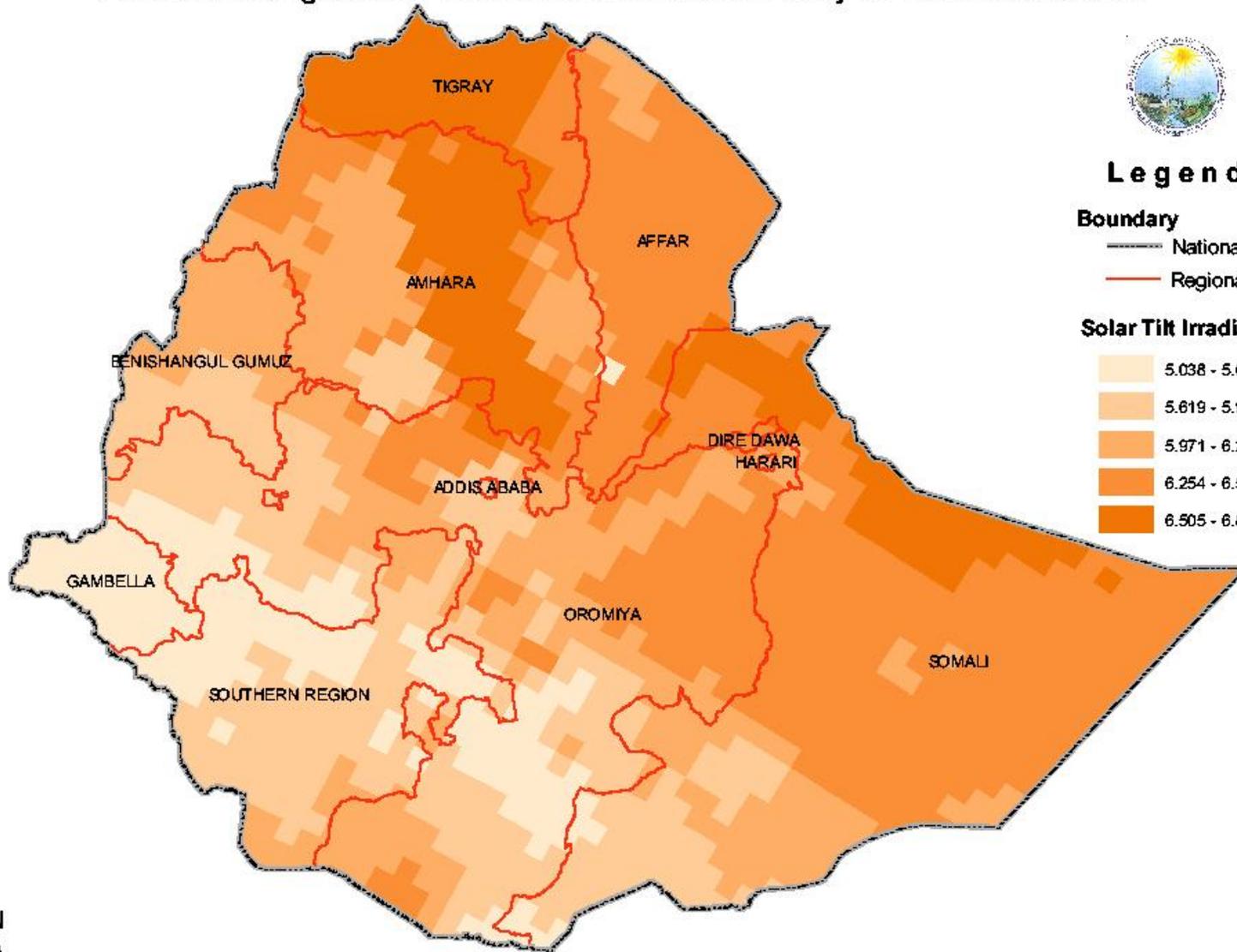
Legend

Boundary

- National
- Regional

Solar Tilt Irradiance

- 5.038 - 5.618
- 5.619 - 5.970
- 5.971 - 6.253
- 6.254 - 6.504
- 6.505 - 6.800



Annual Tilt Irradiance at 40km Resolution Summarized by Regions

REGION	Annual Tilt Irradiance (kWh/m ² /day)		
	Minimum	Maximum	Average
ADDIS ABABA	5.82	5.86	5.84
AFFAR	5.14	6.55	6.36
AMHARA	5.14	6.80	6.35
BENISHANGUL GUMUZ	5.65	6.29	6.00
DIRE DAWA	6.28	6.60	6.39
GAMBELLA	5.04	5.54	5.38
HARARI	6.15	6.35	6.25
OROMIYA	5.04	6.61	5.96
SOMALI	5.21	6.76	6.27
SOUTHERN REGION	5.04	6.24	5.73
TIGRAY	6.25	6.73	6.56

Annual Average Direct Normal Irradiance in kWh/m²/day at 10km Resolution



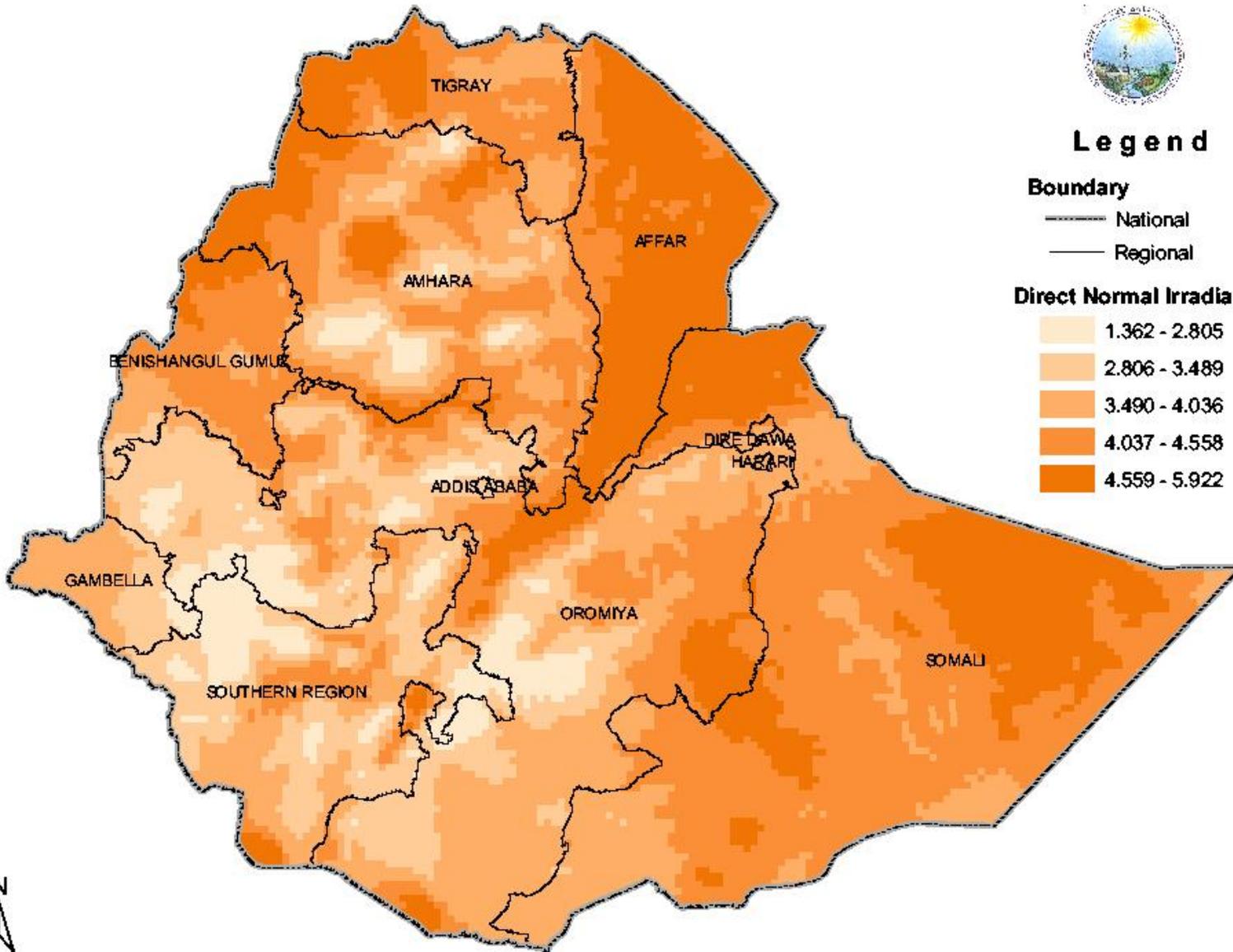
Legend

Boundary

- National
- Regional

Direct Normal Irradiance

- 1.362 - 2.805
- 2.806 - 3.489
- 3.490 - 4.036
- 4.037 - 4.558
- 4.559 - 5.922



Regional Summary of Annual Direct Normal Irradiance at 10km Resolution

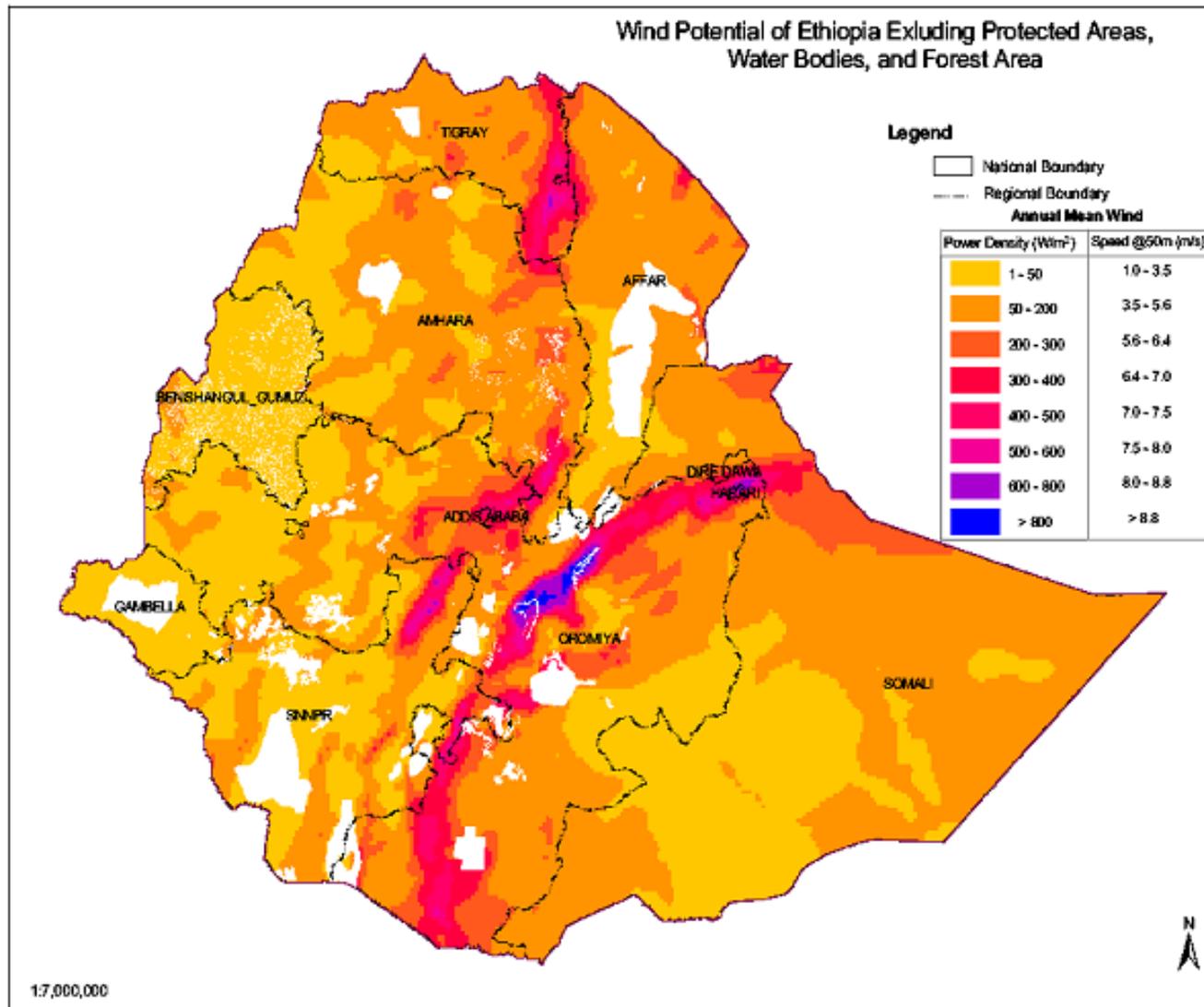
REGION	Annual Direct Normal Irradiance (kWh/m ² /day)		
	Minimum	Maximum	Average
ADDIS ABABA	2.84	3.79	3.36
AFAR	3.76	5.62	4.75
AMHARA	1.94	5.56	4.03
BENISHANGUL GUMUZ	2.92	4.76	4.17
DIRE DAWA	3.56	4.54	3.97
GAMBELLA	2.08	4.02	3.48
HARARI	3.65	4.01	3.84
OROMIYA	1.60	5.30	3.65
SOMALI	3.45	5.43	4.34
SOUTHERN REGION	1.36	5.92	3.33
TIGRAY	2.79	5.13	4.33

The Solar Resource Potential can be used for the following applications

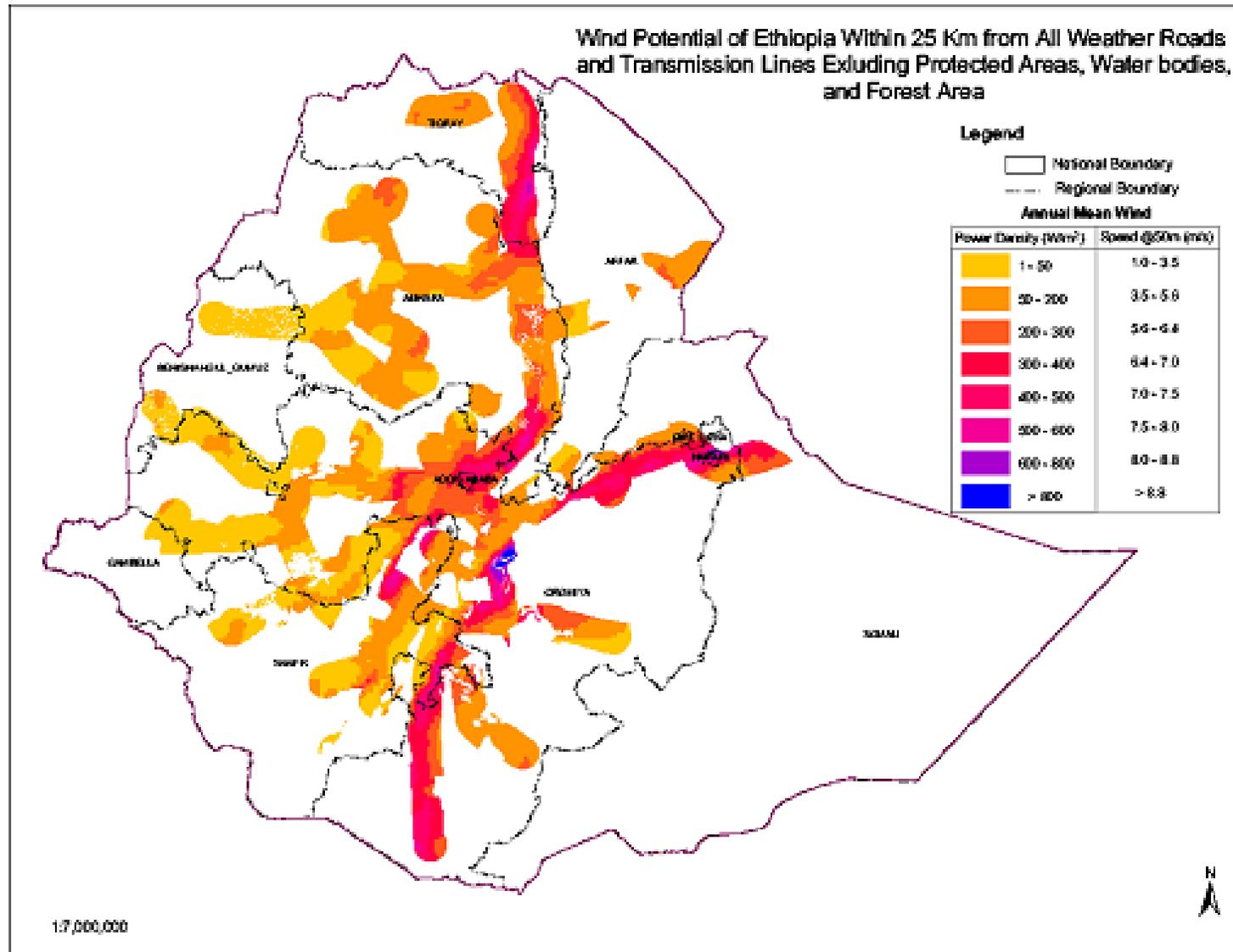
- **Grid Based Applications**
 - Central Generation (PV Power Plants)
 - Building Integrated PV (BIPV)/ Dispersed Systems
- **Off-grid Applications (Small Decentralized Systems)**
 - Solar Home Systems (SHS)/ Scattered Systems
 - Potential for Health Institutions
 - Potential for Rural Schools
 - Religious Institutions
 - Water pumping
 - For domestic use
 - For livestock
- **Potential for Solar Water Heating (SWH)**
 - SWH for Domestic Applications
 - SWH for Commercial (Business and Institutional Applications)
 - SWH for Industrial Applications

Wind

- Potential
- Here are two projects
 - Ashegoda
 - Adama



A GIS map showing Geographic Distribution of Wind Resources

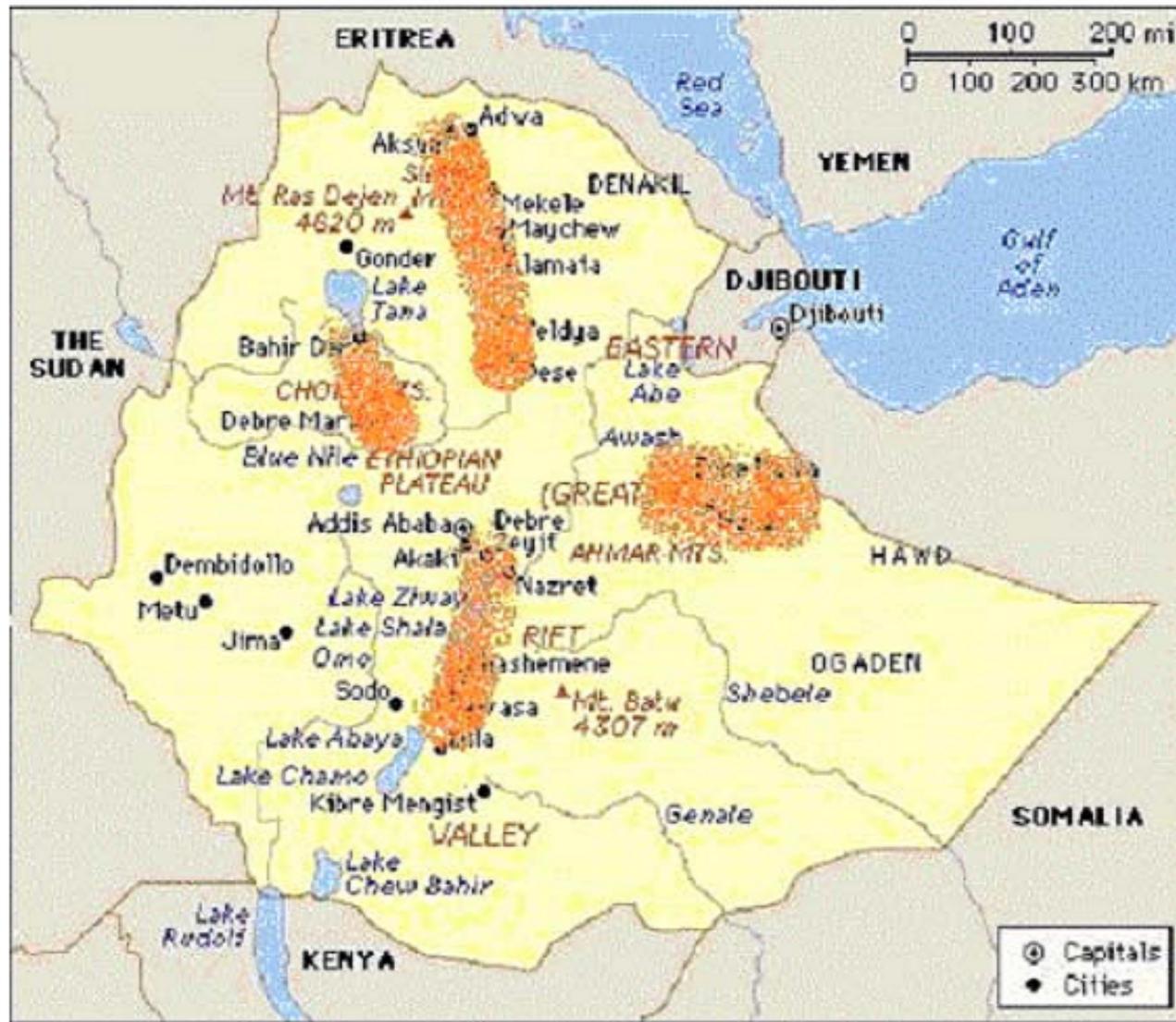


Geographic Distribution of Wind Resources for Grid based Generation

Region	Wind Resource Category and Land Area Under Category (km ²)				
	Class 4	Class 5	Class 6	Class 7	Total
Addis Ababa	207	--	--	--	207
Afar	12	--	--	--	12
Amhara	1614	328	--	--	1942
Benshangul	--	--	--	--	--
Dire Dawa	--	--	--	--	--
Gambela	--	--	--	--	--
Harar	109	108	143	--	360
Oromiya	9074	1726	754	401	11955
SNNPR	1589	819	10	--	2418
Somali	271	19	--	--	290
Tigray	2299	729	77	--	3105
Total	15175	3729	985	401	20290

Regional distribution of Wind Resources for Grid based wind Generation

Four Major areas for Wind Energy



Others

- Biomass Energy Strategy
- Improved stoves program (Household energy Intervention)
- Biogas program
- Rural Electrification Fund
- Energy efficiency and reduction of wastage (e.g. CFL
- Energy performance labelling

Institutions Involved in the Energy sector

- Ethiopian Electric Power Corporation (Development)
- Ethiopian Renewable Energy Development Centre
- Ethiopian Energy Agency (regulation)
- Geothermal Resource exploration and assessment
- Bio-fuel Development and coordination
- Research and Development Directorate
- Petroleum operations and Regulation Department

Private Sector:

Solar Energy for Ethiopia (Stiftung SolarEnergie)

Access to Modern Energy Service:GTZ- Dutch Program

JB World, Electric world, Solarman...