POWER AFRICA GEOTHERMAL ROADSHOW

Presented by
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Ethiopian Electric Power Strategy & Investment Head
SEP 28-Oct 3, 2014
ETHIOPIA

- Country in the horn of Africa
- Total area - 1.13 million square km
- 90 million inhabitants
- Population growth rate – 2.3% per year
- Average annual GDP growth rate ~ 10.7% for the last 10 yrs
Energy Resources

- Hydropower potential 45,000 MW
- Geothermal potential ~ 7,000 MW
- Solar energy potential 5.5 kWh /sq. m/day – annual average daily irradiation
- Average wind speed > 7 meter/second at 50 m above ground level – 1,350 GW
- Natural gas - 4 TCF (113 billion m³)
- Coal > 300 million tones.
- Oil shale – 253 million tones
Power sector Status

- Generation capacity in the grid – 2,268 MW
  - Hydro – 1,978 MW
  - Wind – 171 MW
  - Geothermal – 7.3 MW
  - Diesel – 112 MW
- HV transmission line length > 12,000 km
- MV & LV distribution line length – 157,000 km
- Customers ~ 2.1 million
- Access to electricity grid to Rural Towns and Villages – 54%
- Connected with Djibouti and Sudan at 230 kV and two Kenyan border towns the third one is on Process.
- Ethiopia-Kenya 500 KV HVDC transmission line construction will start in August.
- MOU is signed with Tanzania, Rwanda, South Sudan, Yemen and the second line to Djibouti
Electricity Demand

- Present Demand growth rate > 25%
- High demand growth, some factors
  - GDP growth of ~10.7%
  - Aggressive expansion of the grid to rural towns and villages raising access from 15% to 53% in 7 years.
  - Industrial consumption enhancement
  - Household energy consumption in major towns shift from wood-fuel and kerosene to electricity.
Growth and Transformation Plan (in 2015)

• Generation
  – Reach 10,000 MW
  – 90% from hydro, **10% from geothermal, wind and biomass renewable sources**

• Transmission
  – Reach a total of 17,000 km (400, 230, 132, KV AC and 500 kV HVDC)

• Distribution
  – Double line length to a total of 258,000 km.
major power sector developments

- Power plants completed in 2013
  + Ashegoda wind power – 120 MW
- Power plants under construction
  + Grand Ethiopian Renaissance Dam – 6,000MW
  + Gibe III – 1,870 MW
  + Genale Dawa III – 254 MW
  + Adama II – 153 MW
  + Solar power 300MW (US based company)
- Aluto Langano geothermal expansion – 75 MW
  + GoE, GoJ, WB, SREP
- Repi Waste-to-Energy power – 50 MW
Institutions AND REGULATORY FRAMEWORK

• Ministry of Water Irrigation and Energy (MoWIE) is the lead institution for the Energy Sector. It oversees three supervised institutions.
  – Ethiopian Electric Power (EEP)– generation, transmission, and grid based UEAP
  – Ethiopian Electric Utility (EEU) – distribution, sales
  – Ethiopian Energy Authority– regulatory body for electricity and energy efficiency

• Its responsibilities fall into three broad categories
  – resource assessment and development,
  – policy and regulatory, and
  – research and development
Institutions and regulatory framework

• The Ministry manages Directly
  – Energy Study and Development Follow-up
  – Hydropower study and Dam Administration
  – Alternative Energy Technology Promotion
    • Off-grid rural electrification program through Rural Electrification Fund
    • National biogas program
    • National improved cook stoves program
  – bio-fuel development coordination
  – Petroleum down stream operation regulation
Ethiopia Electricity Demand Forecast

A number of new type of consumers recently commenced or are under development identified:

1. New railway developments
2. Large new irrigation developments
3. New Industrial Developments
4. Large scale Dwelling house expansion Programs
5. Universal Electricity Access expansion Program
6. Electricity export consumers
1. Railway Demand Forecast Reference Scenario - Results

<table>
<thead>
<tr>
<th>year</th>
<th>Sales (GWh)</th>
<th>Gen. (GWh)</th>
<th>Peak (MW)</th>
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<tbody>
<tr>
<td>2015</td>
<td>404</td>
<td>513</td>
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<td>2020</td>
<td>1477</td>
<td>1711</td>
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<td>2037</td>
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2. Large new irrigation developments - Source Data

<table>
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<th>Sales (GWh)</th>
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New Industrial Demand - Results

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<th>Sales (GWh)</th>
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<td>2013</td>
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<td>3244</td>
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<tr>
<td>2015</td>
<td>5758</td>
<td>7326</td>
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Service Sector Demand Forecast

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<th>Sales (GWh)</th>
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<td>2015</td>
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### Domestic Demand Forecast - Results

<table>
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<tr>
<th>Year</th>
<th>Sales (GWh)</th>
<th>Gen. (GWh)</th>
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<td>Existing</td>
<td>UEAP</td>
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<td>2037</td>
<td>3151</td>
<td>14485</td>
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### 2012 Internal Demand Composition

- Irr.: 0%
- St. Ligh: 1%
- Rail: 0%
- Dom.: 36%
- Com.: 24%

### 2037 Internal Demand Composition

- Irr.: 14%
- Rail: 8%
- Dom.: 18%
- Com.: 14%
- Ind.: 45%
• The electricity supply system in Ethiopia is hydro-dominated. Currently some 95% of the country’s installed capacity comes from hydro-power plants.

• Geothermal energy is typically considered as a clean, renewable and environmentally friendly source of energy which can be used as a stable and reliable source of base load electric power and due to the assumed high geothermal resources in Ethiopia becomes an important option for diversification of power generation.

• This is reflected in the recently developed Power System Expansion Master Plan which envisages an increase of geothermal capacity from currently 7 MW (Aluto Langano pilot plant) to 5,000 MW in 2037 (or 15.5% of the total installed capacity). It is expected that the majority of the additions of the geothermal capacities will take place in the years following 2025.
Generation Planning

Typical Time line

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<tr>
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<td>Drilling (production &amp; reinjection)</td>
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<td>Financial closure - start of EPC</td>
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<td>Steamfield</td>
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<tr>
<td>Power Plant</td>
<td>6</td>
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<tr>
<td>COD (Commercial Operation date)</td>
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<td>Commercial Operation - Generation</td>
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<td>Costs spread % of investment</td>
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</table>

Sites considered in priority for development
Geothermal Prospects

- 23 prospects (JICA MP Study Sites)
- 10,000 MW Potential

Various stages
- One pilot plant in one prospect
- Two prospects tested by drilling
- The rest under surface investigation

Source: Jica Team
• Exploration began in 1969 (UNDP & EG)

• 18 Geothermal Prospect areas were identified for Electricity generation in the whole ERV (covers 13% of the country)

• The resource is also for direct uses (agriculture, agro-industry etc)
• About 250 Km S of AA

• Detailed Geoscientific including 8 TG wells

• Max. Temp = 250 ºC

• Drilling is justified to define the extension of reservoir

• Surface and near surface exploration are recommended before drilling

• 132 KV TL passes within 15 Km of the Prospect

• The first 20 MW will be Generated in 2015

• Feasibility study has been done for 132 KV and 230 Kv Transmission line to evacuate 500 MW
• The USAID through the Power Africa Initiative is coordinating closely with the WBG in preparing a regional geothermal development strategy focusing mainly on East African Rift Valley countries.
• It is expected that this joint support to the EEP will help GoE realize private sector investment in its geothermal sector development effectively.
• It is highly unlikely that sufficient funding can be made available by the Government of Ethiopia even taking into account that donor funding may be available for geothermal energy. Good point that the investment requires more than 20 Billion USD in todays money.
- Institutional set up
## Summary Findings – SWOB Analysis of Geothermal Sector in Ethiopia

### Strengths

- Private sector investment in mining and electricity generation are allowed
- Fiscals incentives are available for electricity generation comparable with other countries
- No restrictions to private investment in geothermal energy generation
- Initial geotechnical investigations for 13 fields are available or ongoing,
- Detailed investigation (exploration, temperature gradient drilling or test-drilling) are ongoing or planned on other 9 fields for 2014/2015.

### Weaknesses

- Little experience with development of geothermal resources
- Skills and professional capacity not sufficiently developed
- Commercial and legal skills are required in addition to technical skills

### Opportunities

- Strongly increasing electricity demand
- Electricity generation from geothermal energy as base load plants provides energy security, system stability and independence from international fuel price fluctuation
- High estimated geothermal potential
- High enthalpy geothermal resources
- Land ownership is with the GOE, which enables easier access for private developers
- Underway Geothermal master plan study
- Undergoing Geothermal policy and institutional set up study

### Barriers

- No policy supporting geothermal development
- Co-ordination between sector institutions missing
- Geothermal legal and regulatory framework not adequately developed to promote geothermal development and to attract private investment
- No procedures for private sector investment
- Basic documentation for private investment missing (Project Agreements, Pricing)