BRIEF OF THE KENYAN ENERGY SECTOR AND CURRENT STATUS OF NUCLEAR POWER PROGRAM

Presentation at the IAEA Meeting on Topical Issues in the Development Of Nuclear Power Infrastructure, 3-6 Feb. 2015 at IAEA Headquarters
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Kenya Nuclear Electricity Board (KNEB)
Presentation Outline

• Current power situation
• Vision 2030
• Future power demand
• Future power mix
• Nuclear as part of the mix
• Kenya’s nuclear power programme
• The Legal Frameworks
• Conclusions
Ministry of Energy & Petroleum (MoEP)

Generation function
- KenGen* (~80% Inst. Cap.)
- IPPs ** (~20% Inst. Cap.)
- UETCL Imports (<1%)
  - EPP * (140 MW)
  - Thermal (187 MW)
  - Geothermal (~50 MW)
  - Other IPPs expected
- Hydro (761 MW)
- Thermal (259 MW)
- Wind (5.3 MW)
- Geothermal (150 MW)

Transmission and Distribution function - KPLC

Energy Regulatory Commission (ERC) (regulating energy sector)

Rural Electrification Authority (REA)****

GDC KNEB KETRACO

100% Govt owned

70% GoK & 30% Public

POWER SUB-SECTOR INSTITUTIONAL FRAMEWORK TODAY
## Current Power Capacity in Kenya

<table>
<thead>
<tr>
<th>Sources (MW)</th>
<th>Installed Capacity (MW)</th>
<th>Capacity % Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>763.3</td>
<td>50%</td>
</tr>
<tr>
<td>Thermal</td>
<td>527.5</td>
<td>34%</td>
</tr>
<tr>
<td>Geothermal</td>
<td>198</td>
<td>13%</td>
</tr>
<tr>
<td>Cogeneration</td>
<td>26</td>
<td>2%</td>
</tr>
<tr>
<td>Wind</td>
<td>5.45</td>
<td>0.4%</td>
</tr>
<tr>
<td>Isolated grid</td>
<td>14.6</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,529</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Prevailing conditions in the power sector in Kenya

- Low electrification levels
- High electricity prices
- High system losses
- Persistent power interruptions
Time Series of Electricity Demand and GDP

Suppressed demand of approx. 150MW
Basic Vision for Energy

• **Available**
  ✓ Enough energy to meet current and future needs
  ✓ Security of supply

• **Affordable**
  ✓ Consumers can afford to pay for energy
  ✓ Energy companies can earn enough to stay in business

• **Acceptable**
  ✓ Environmentally compatible
  ✓ Public acceptance
POWER IS A KEY ENABLER FOR VISION 2030

Kenya Vision 2030
A globally competitive and prosperous nation with a high quality of life by 2030

Economic
To maintain a sustained economic growth of 10% p.a. over the next 25 years

Social
A just and cohesive society enjoying equitable social development in a clean and secure environment

Political
An issue-based, people-centered, result-oriented, and accountable democratic political system

Key Enabler:
A vibrant power sector that meets electricity required to drive flagship projects and programmes

A sustained economic growth of 10% per annum from year 2015
Kenya Vision 2030

• The Vision 2030 describes the way Kenya will be transformed from a low income agrarian economy into a newly industrialized middle income country, providing a high quality of life to all its citizens.

• This goal is based on three pillars - political stability, social development and economic growth.

• The economic objectives supporting the Vision 2030 require an annual GDP growth of at least 10%, to be reached by the year 2015.

• The Vision 2030 identifies energy and electricity as a key element of Kenya’s sustained economic growth and transformation.
Kenya Vision 2030

• Under Kenya Vision 2030, the country aims at enhancing and diversifying national power generation and supply by identifying new generation and supply sources.

• Nuclear energy has been identified as one of the sources of energy that would substantially address the prevailing energy deficit and accordingly established the Nuclear Electricity Project Committee.
Vision 2030 Flagship Projects with large energy requirements

- ICT Park
- Second container terminal and a free port at the Mombasa port
- Standard gauge railway (Juba-Lamu)
- Lamu port
- Special Economic Zones
- Iron and Steel smelting industry in Meru area
- Standard Gauge railway (Mombasa- Nairobi-Malaba, Kisumu)
- Light rail for Nairobi and suburbs
- Resort cities (Isiolo, Kilifi and Ukunda)
Peak Power Demand Projection for Kenya (MW)

Source: Least Cost Power Development Plan 2011/2031
## Load Forecast Synthesis

<table>
<thead>
<tr>
<th>Year</th>
<th>Peak (MW)</th>
<th>Installed Capacity (MW)</th>
<th>Reserve Margins</th>
<th>Energy (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>1,520</td>
<td>1,531</td>
<td>0.7%</td>
<td>9,084</td>
</tr>
<tr>
<td>2018</td>
<td>3,751</td>
<td>5,077</td>
<td>35%</td>
<td>22,685</td>
</tr>
<tr>
<td>2031</td>
<td>16,905</td>
<td>21,599</td>
<td>28%</td>
<td>103,518</td>
</tr>
<tr>
<td>Average Yearly growth rate</td>
<td>13.5%</td>
<td></td>
<td></td>
<td>13.6%</td>
</tr>
</tbody>
</table>
# Future Power Supply Options - 2031 Installed Capacity

<table>
<thead>
<tr>
<th>Technology</th>
<th>Capacity (MW)</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal</td>
<td>5,530</td>
<td>26</td>
</tr>
<tr>
<td>Nuclear</td>
<td>4,000</td>
<td>19</td>
</tr>
<tr>
<td>Coal</td>
<td>2,720</td>
<td>13</td>
</tr>
<tr>
<td>GT-NG</td>
<td>2,340</td>
<td>11</td>
</tr>
<tr>
<td>MSD</td>
<td>1,955</td>
<td>9</td>
</tr>
<tr>
<td>Import</td>
<td>2,000</td>
<td>9</td>
</tr>
<tr>
<td>Wind</td>
<td>2,036</td>
<td>9</td>
</tr>
<tr>
<td>Hydro</td>
<td>1,039</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21,620</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Projected Power Generation Mix - 2031


Installed Capacity (MW): 0, 2,000, 4,000, 6,000, 8,000, 10,000, 12,000, 14,000, 16,000, 18,000, 20,000, 22,000, 24,000, 25,000

Legend:
- Wind
- Hydro
- Coal
- Geot
- GT-NG
- GT-KERO
- Cogn
- Import
- MSD
- Nucl
Why Nuclear for Kenya?
1. Sharp increase in energy consumption – high power demand

2. Nuclear shall provide stability in supply

3. Adequate capacity for ambitious economic development programme

4. Nuclear provides efficient and reliable power

5. Lower cost of power - an economic alternative to fossil fuels

6. Nuclear power is adequate, environmentally friendly and clean

7. Availability of nuclear global peer review and support

8. Nuclear technology is mature and proven
Introduction of KNEB

- NEPC was established by The Government vide The Kenya Gazette Notice on the 19th November 2010
- NEPC’s mandate is to drive the nuclear energy roadmap for Kenya.
- NEPC is tasked with spearheading and fast tracking development of nuclear electricity in order to enhance the production of affordable and reliable electricity generation process.
- NEPC established a Secretariat that carries out the day to day activities of the institution
1. Extensive civic education, regarding nuclear electricity power *lobby support from key stakeholders e.g COTU), (FKE), KAM and the civil society;
2. Ensure that all terms and conditions of the IAEA, necessary for approval for the construction of nuclear electric power plants are met;
3. Prepare and endorse, a detailed road map for the realization of the terms and conditions indicating the milestones and time lines for approval by the international Atomic Energy Agency;
4. Oversee the implementation of the IAEA approved road map including the preparation of a comprehensive legal and regulatory framework;
5. Review and approve a capacity building plan targeting young Kenyans
6. Identify appropriate sites for construction of a nuclear power plant along Kenya’s coastal shoreline taking into consideration environmental and social impact considerations;
7. Develop a collaborative program with academic institutions and other organizations within and outside Kenya, for nuclear power research and development;
8. Develop a well-stocked library on nuclear electricity production;
Kenya’s Nuclear Power Programme

- Kenya has been a member of the International Atomic Energy Agency (IAEA) since 1965. The IAE is a United Nations (UN) institution that encourages and assists in research, development and practical application of atomic energy for peaceful uses throughout the world.
- Kenya’s decision to embark on a nuclear programme is based upon a commitment to use nuclear power for peaceful purposes, in a safe and secure manner.
- To attain nuclear status, Kenya shall be guided by The IAEA Milestone approach. The IAEA milestones framework provides a guide in the development of Kenya’s nuclear infrastructure that will ensure that the country meets its objectives.
The success of a NP programme depends upon considering all of the issues in an integrated manner.

<table>
<thead>
<tr>
<th>National Position</th>
<th>Legislative Framework</th>
<th>Radiation Protection</th>
<th>Human Resources Development</th>
<th>Environmental Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear Safety</td>
<td>Funding and Financing</td>
<td>Nuclear Fuel Cycle</td>
<td>Emergency preparedness</td>
<td>Stakeholder Involvement</td>
</tr>
<tr>
<td>Safeguards</td>
<td>Radioactive Waste</td>
<td>Regulatory Framework</td>
<td>Electrical Grid Planning</td>
<td>Site and Supporting Facilities</td>
</tr>
<tr>
<td>Management</td>
<td>Procurement</td>
<td>Industrial Involvement</td>
<td>Security and Physical Protection</td>
<td></td>
</tr>
</tbody>
</table>
Comparison of future power supply options costs (LCOE Ksh/kWh) - Kenyan case

<table>
<thead>
<tr>
<th>Option</th>
<th>LCOE (Ksh/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal</td>
<td>6.9</td>
</tr>
<tr>
<td>Wind</td>
<td>9.2</td>
</tr>
<tr>
<td>Nuclear</td>
<td>10.2</td>
</tr>
<tr>
<td>GT - Natural Gas</td>
<td>11.3</td>
</tr>
<tr>
<td>Coal</td>
<td>12.7</td>
</tr>
<tr>
<td>Gas Turbine - Natural Gas</td>
<td>15.1</td>
</tr>
<tr>
<td>Medium Speed Diesel</td>
<td>21.7</td>
</tr>
<tr>
<td>Gas Turbine - Kerosene</td>
<td>30.2</td>
</tr>
</tbody>
</table>
KNEB Current focus

1. **Pre-feasibility study for Kenya’s nuclear power programme**

   The objective of the study is to assess the current status of development of the national infrastructure against the guidelines recommended by IAEA and to propose measures for further development when the comprehensive report on Self Assessment of Kenya’s Nuclear Infrastructure Status is adopted

   - Target implementation period is one year
   - A team of assessors from various organizations have been appointed to work with the secretariat
   - PFS budget and activities developed and approved
   - The 19 infrastructure issues have been clustered and work has commenced on each of the issues
Achievements in Kenya’s nuclear programme

1. Extensive public awareness plan prepared
2. Preparation of a detailed road map for setting up a NPP
3. Preparatory work towards development of a comprehensive legal and regulatory framework
4. Review of The Energy Policy and Bill to incorporate nuclear power as one of the sources of power in Kenya
5. Development of a NCST Policy and a Draft Atomic Energy Bill
6. Review of the Environmental Management & Coordination Act (EMCA)
Achievements in Kenya’s nuclear programme

7. Development of a Capacity Building Programme for Kenya

- 30 students sponsored by GoK for Masters in Nuclear science at the University of Nairobi
- 13 Kenyan students currently studying at The Korea Institute of Nuclear Graduate School (KINGS) under sponsorship by both Govts of Korea and Kenya. Additional students under consideration for the 2013 program
- MoUs with various countries currently under review for collaboration on nuclear issues including capacity building

8. The IAEA Technical Cooperation Project (TCP) titled ‘Building Capacity for the Implementation of a Nuclear Power Programme’ currently under implementation – 49 Kenyans underwent a one month training in June/July 2012/13 on various aspects of nuclear power in Texas A&M University, USA on this programme
Organizations engaged in Kenya’s nuclear programme

- Collaboration of other organizations in Kenya with KNEB on the nuclear programme is in one of the following ways:
  - Membership in the KNEB Committee that gives direction to all the organization’s activities
  - Incorporation in the pre-feasibility study – institutions have nominated specialists in various fields to compose a team of assessors for the pre-feasibility study. This team guides the Secretariat in their respective specializations
  - Collaboration programmes defined in MoU’s
Institutions in collaboration with NEPC

- Ministry of Higher Education Science and Technology
- National Security Intelligence Service (NSIS)
- Energy Regulatory Commission
- Kenya Electricity Generating Company (KenGen)
- Kenya Power & Lighting Company (KPLC)
- Kenya Electricity Transmission Company (KETRACo)
- Kenya Industrial Research and Development Institute
- Central Organization of Trade Unions
- Kenya Bureau of Standards
- Ministry of State for National Development and Vision 2030
- Ministry of Environment and Mineral Resources
- University of Nairobi
- Other Universities, Research Institutions locally and internationally
Countries in Active Collaboration with Kenya on the Nuclear Programme

1. South Korea
2. France
3. USA
4. Ghana
5. South Africa
6. China
International Legal Framework

Kenya has been a member of the IAEA since 1965 and has signed and ratified 10 Treaties including:

i. The Nuclear Non-Proliferation Treaty (NPT)

ii. Comprehensive Safeguards Agreement (CSA)

iii. Additional Protocol under the Nuclear non-proliferation Treaty (NPT)

iv. The Small Quantities Protocol under the nuclear non-proliferation Treaty

v. The Convention on Physical Protection of Nuclear Materials (CPPNM)

vi. CPPNM amendment to the physical protection of nuclear materials (CPPNME)

vii. Revised Supplementary Agreement concerning the provision of Technical assistance by IAEA – Article XI

viii. The African Cooperative Agreement for Research Development
Conclusions

- Given our current energy mix and the high demand vis-a-vis supply of the same, Kenya does not enjoy the luxury of an alternative to nuclear application for peaceful purposes in the generation of electricity. It is a NATIONAL IMPERATIVE.

- The Government of Kenya is committed to ensuring safe, reliable and low priced electricity. Nuclear has been adopted as one of the competitive options for the future power supply.
THANK YOU