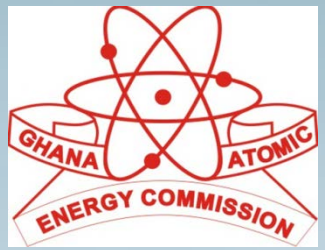
INPRO Dialogue Forum "Drivers and Impediments for Regional Cooperation on the Way to Sustainable Nuclear Energy Systems"



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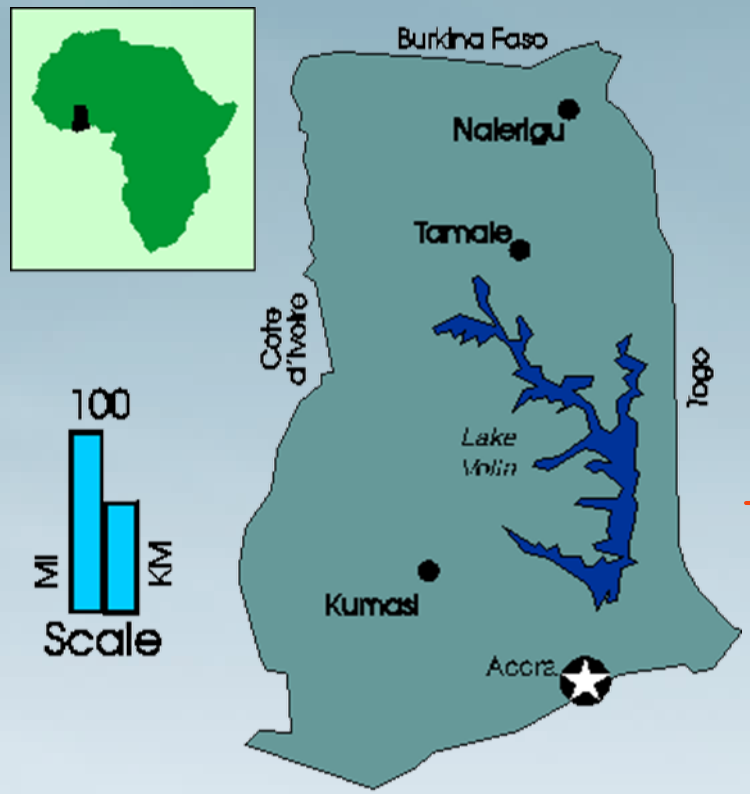
Ghana at a Glance



- Population: 23.800M (2009); 24million (2010)
- Average Annual Population Growth Rate: 1.7%
- GDP: 82.57 Billion USD
- GDP Per Capita: 3,256.85 USD
- GDP Real Growth Rate: 13.5% (2011)

Energy Planning 1/2

- An integrated approach was adopted for the analysis of future evolution of energy demand and supply capability at the national level using IAEA Energy Planning methodologies

- The tools used for the study are:
  - (i) MAED model, used for energy and electricity demand analysis and projections from 2004 to 2030;
  - (ii) WASP IV model, used to determine the optimal long-term expansion of the electricity generating system; and
  - (iii) MESSAGE model for formulating alternative optimal energy supply strategies.
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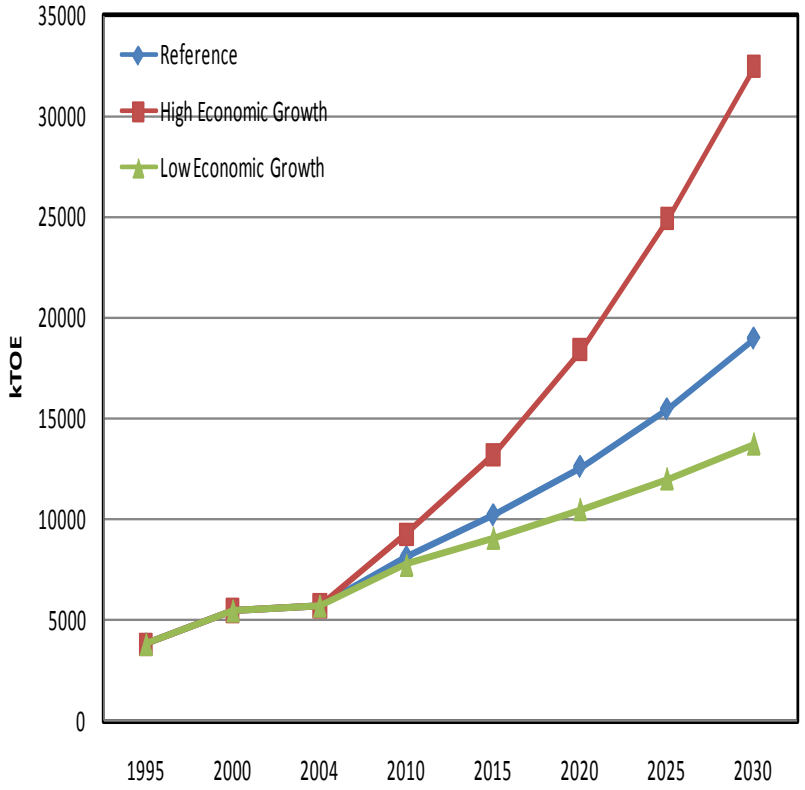
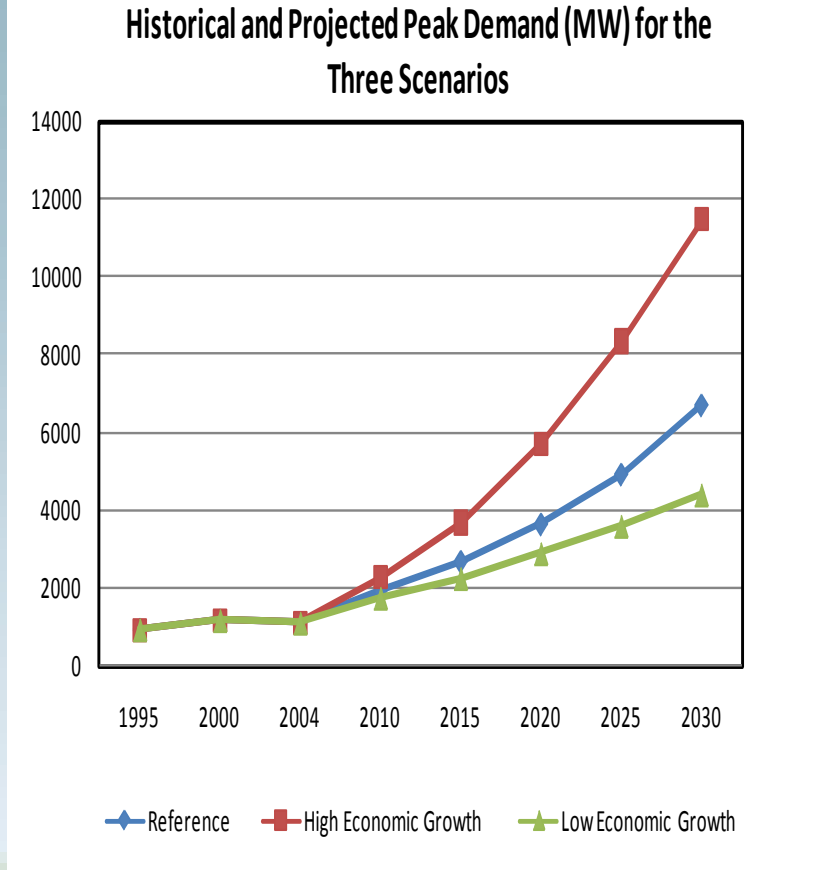
Energy Planning 2/2





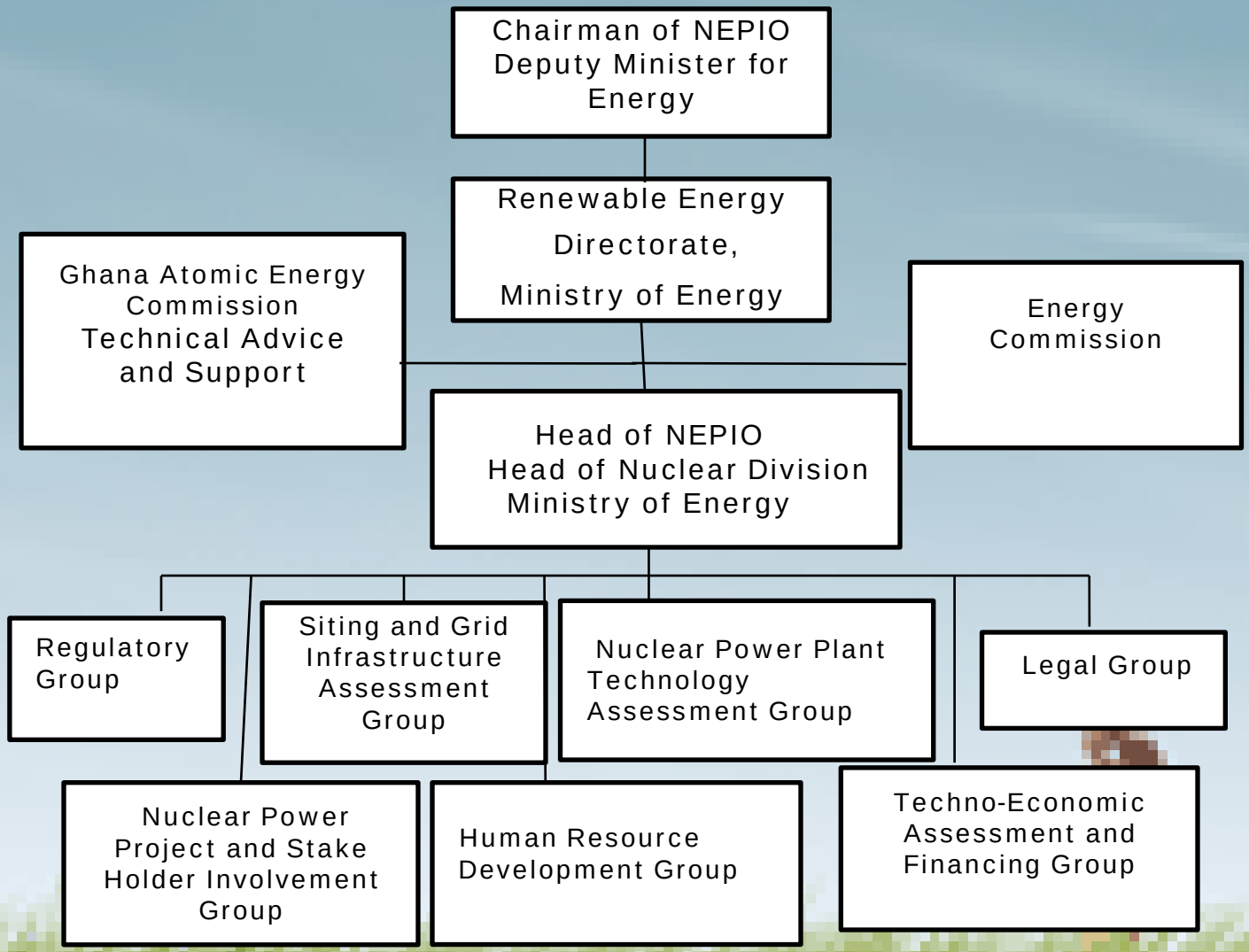
Status and Prospects of Nuclear Power in Ghana 1/2

- Ghana Government took a Cabinet decision in 2008 to build a nuclear power plant within a decade.
- Nuclear power was included in Ghana's energy policy as an option for meeting long term energy needs
- Human Resources Development: Establishment of School of Nuclear and Allied Sciences in 2006 and through IAEA "Sandwich" programmes
- Implementation of IAEA TC Projects on Nuclear Power Infrastructure development

Status and Prospects of Nuclear Power in Ghana 2/2

- MoU signed between Ministry of Energy and ROSATOM (Russia) on NPP Infrastructure Development (June 2012)
- Seven technical groups have been formed and NEPIO instituted.
- The current major activity is site determination for nuclear plants.
- Other activities include techno-economic assessment, formulation of legal and regulatory framework and establishment of an independent regulatory authority

Structure of NEPIO

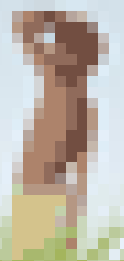


Driving Forces for Developing Nuclear Power Programme 1/2

- Energy security
  - reduce dependency on weather dependent hydro power and thermal plants which run on imported crude oil and gas
- Anticipated high Energy demand as a result of economic growth
  - Ghana's Electricity Demand is expected to rise to about 6000MW in 2020
  - Government policy to extend electricity to all parts of the country by the year 2020
  - Government policy to export electricity to the neighbouring states

Driving Forces for Developing Nuclear Power Programme 2/2

- Environmental protection
  - reduction in the emission of CO_2
  - reduction in the emission of gaseous pollutants
- Technology transfer



Impediments

- *Impediments are:*

  - Difficulties in funding nuclear power projects, which are highly capital intensive

  - Change of Governments, which slows down the continuation of on-going projects

  - Low level of industrialisation, causing almost all the power plant hardware to be imported including spare parts.

Nuclear power in 2030

- In 2030 Ghana's Energy capacity is expected to reach about 10,000MW
- Ghana is expected to have commissioned its first nuclear power plant by 2030 with capacity 600MW to 1000MW.
- Nuclear power is expected to play a significant role in Ghana's electricity generation.
- Within this period the reactor type is expected to be a light water type preferably a PWR or PHWR
- Type of fuel cycle being considered in this period is the one through cycle

Nuclear power in 2050

- By 2050 Ghana's system capacity is expected to be at least 25,000MW.
- Nuclear power is expected to be the main source of electricity due to the low availability of alternative sources such as gas and hydro.
- Though solar power systems are expected to play a significant role by this time due to technological advancement, it is very uncertain whether solar systems can be developed to run industries by the this time.
- It is expected that generation IV reactors will be added to the existing light water reactors. The reactor types include gas cooled reactors and fast reactors particularly breeder and burn reactors.

Reactor Technology Selection Criteria 1/2

- *The selection of reactors will be based on the following criteria:*

- Safety
  - The reactor should incorporate passive systems for its cooling and shutdown systems as much as possible

- Economics
  - The overall electricity generation cost should be competitive with other electricity generation options
  - The economics of the selected nuclear power technology should be as low as possible without compromising on safety

Reactor Technology Selection Criteria 2/2

- Technological Maturity
  - The technology should have gotten proving record of safe and reliable operation preferable not less than 10 years of proven experience.
  - Slight modifications of existing proven technologies is acceptable
  - This makes Gen IV reactors suitable for periods beyond 2030
- Grid Compatibility
  - The grid size makes SMRs more attractive in the 2030 period. Large reactors are however being considered as well due to on-going interconnections in the West Africa Power Pool

Supply of Nuclear Power Plant Equipment 1/2

- At the first instance it is expected that the first nuclear power plant will be built on turnkey basis. Local participation is expected to be low due to low level of experience.
- This situation is however expected to change when additional power plants are built.
- Local content with regard to participation by local industries is expected to increase.

Supply of Nuclear Power Plant Equipment 2/2

Time Frame	Type of Local Activity
2015-2025	Manufacture of materials for civil works such as cement, iron rods, paints, plastic components, electrical cables, etc.
2025-2035	Manufacture of some reactor parts such as pipes, valves, some electronic components, switches etc.
2035-2045	Manufacture some components of reactor equipment, instrumentation and control equipment, turbine equipment and electricity generation equipment
2045 - beyond	Manufacture of almost all components of reactor equipment, instrumentation and control equipment, turbine equipment and electricity generation equipment

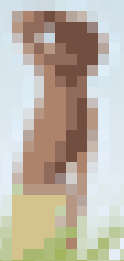
Backend Nuclear Fuel Cycle

- The plan for nuclear fuel cycle is currently based on the once-through cycle.
- Spent fuel will be stored at interim disposal sites while final disposal repository is determined
- The possibility of sending the spent fuel to the supplier of fuel will be explored
- The utilisation of advanced fuel cycle schemes such as partitioning transmutation through accelerator driven system shall be explored.

Backend Nuclear Fuel Cycle 2/2

- Ghana currently has a nuclear bill which prohibits the acceptance and disposal of nuclear waste from another country

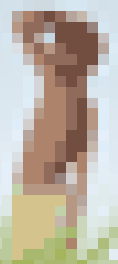
- (..more information can be obtained from Nuclear Bill and International Laws signed by Ghana….)



Sustainable Energy Development

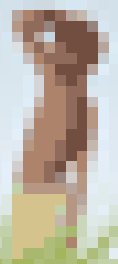
- Ghana undertook an IAEA project on planning for sustainable development from 2006 to 2008.

- There is also currently an on going AFRA projects on local and regional energy modelling using the MESSAGE model.



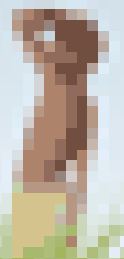
Sustainability of Nuclear Power

- The sustainability of *nuclear* power is ranked in the following order of importance
- Safety
- Economics
- Waste management
- Environment
- Physical protection
- Infrastructure
- Proliferation resistance



Energy Security 1/2

- The main factor that is hindering energy security is the low oil and gas reserves and exhausted hydro sources
- The country has to import oil and gas from neighbouring Nigeria to run its thermal electricity generation plants
- This has threatened the energy security of the country



Energy Security 2/2

- *Factors that influence energy security are:*
  - Availability of fuel
  - Availability of plant hardware and spare parts
  - Availability of imported electricity from neighbouring states through the interconnections being made in the West Africa Power Pool Project

Sub-regional Energy Cooperation 1/2

- *The major energy cooperation in the sub -region are:*

  - Transmission of electricity among member states through the West Africa Power Pool Project

  - Interconnections are actively on going and Ghana is expected to play active role in supplying electricity to the neighbouring state due to its good electricity infrastructure. Major Driving factors are:

    ✓Economic: – Ghana gains foreign exchange through export

    ✓Regional cooperation: – other countries will get cheaper source of power from Ghana instead of depending on more expensive crude oil and diesel power systems for electricity generation

Nuclear power is expected to play a crucial role in this power export project

Sub-regional Energy Cooperation 2/2

- Supply of gas from Nigeria to Ghana and neighbouring states through the West Africa Gas Pipeline Project

- This project is facing problem of unreliable supply of gas from Nigeria leading to power shortages in Ghana

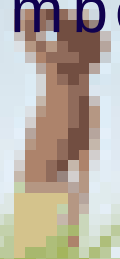
- The main factors are:
  - Technical: - Intermittent compressible flow of gas
  - Economical: - Interest in Nigeria gas by some European countries
  - Socio-political: - concerns in Nigeria that the gas should be used to meet growing local energy demand

Nuclear Power Cooperation with Neighbouring States

- The main factors that will enhance nuclear power cooperation with neighbouring states is the West Africa power pool project
- The main militating factor will be:
- Low access to credit by some states
- Political instability in some neighbouring states
- Lack of adequate infrastructure and nuclear power regulatory authorities
- Lack of requisite manpower to manage nuclear power project

Indicators for Nuclear Cooperation

- Development of Regional Nuclear power office for ECOWAS as it is in the case of renewable energy
- Signing of cooperative agreements by member states
- Establishment of local infrastructure for nuclear power such as an independent regulatory body by ECOWAS member states



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