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**Ministry of Electricity and Dams (SUDAN)**

# SUDAN

- Area: 1,886,068 km<sup>2</sup>
- Population: 30,894,000



# introduction

- The need for electricity in Sudan is increasing rapidly for both industrial and domestic sectors. A previous study, conducted with IAEA support assess the demand for energy and electricity in Sudan and concluded that considering the first nuclear power plant in Sudan is justifiable. So, IAEA and the Government of Sudan have jointly started Project SUD/0/011 to support Sudan to determine the optimal energy generation mix, including the nuclear power for electricity generation.



# Status and Prospects of a nuclear power programme in Sudan

- Feasibility Study for the nuclear program has been carried out by overseas consultancy firm incorporation with national team.
- The main outcome of the Feasibility Study is that introduction of nuclear power plant in Sudan electricity production and respectively construction of the first NPP in the country is *feasible and possible*. However it should be noted that introduction of nuclear power within Sudan energy production sector will require substantial efforts to address key issues relevant to the implementation of nuclear program in a country.



# Status and Prospects of a nuclear power programme in Sudan

- ❑ Site Survey/selection was Carried out by a Consultant firm and MED team.
- ❑ Nine potential sites were identified based on the IAEA Standards.
- ❑ MED is now preparing for the third phase: site characterizations to be carried out by an overseas contractor .



# Status and Prospects of a nuclear power programme in Sudan

- ❑ A national committee including members from relevant stakeholders participated in drafting the nuclear act (DNA) and complying with international instruments.
- ❑ Existing enacted legislations pertaining to NPP has been reviewed by the national committee to identify and harmonize possible areas of intersections with the DNA.
- ❑ existing enacted legislations studied so far were found to be in harmony with the DNA.



# Status and Prospects of a nuclear power programme in Sudan

- ❑ Nuclear related International instruments in which Sudan is Party/Signatory or considering to accede have been reviewed and reflected in the DNA.
- ❑ The DNA and the final report recommending the consideration of instruments in which Sudan is non-party , have been prepared and it will be channelled through the national legislative system very soon.



# Status and Prospects of a nuclear power programme in Sudan

- ❑ The first regulatory body was established in 1996 under SAEC's Act (SAEC Board).
- ❑ Regulations and codes of practices issued pursuant to the provisions of 1996 Act dealt with radiological safety.
- ❑ In 2010, the Minister of Science and Technology issued a decree that provided for the separation of the regulatory body (SNRRA) from the organizational structure of the SAEC i.e. the RB becomes semi autonomous.





# Status and Prospects of a nuclear power programme in Sudan

- ❑ The DNA called for the establishment of National Nuclear and Radiological Regulator (**NNRR**), it will be legally capacitated to issue all the necessary regulations and codes consistent with international standards for the management of nuclear and radiological activities.
- ❑ The existing regulatory authority (**SNRRA**) is working closely with other stakeholders such as SAEC & MED to develop nuclear regulatory infrastructure.
- ❑ **Human Resource Development Master Plan** under progress ,it will be completed in September this year and then will be implemented.

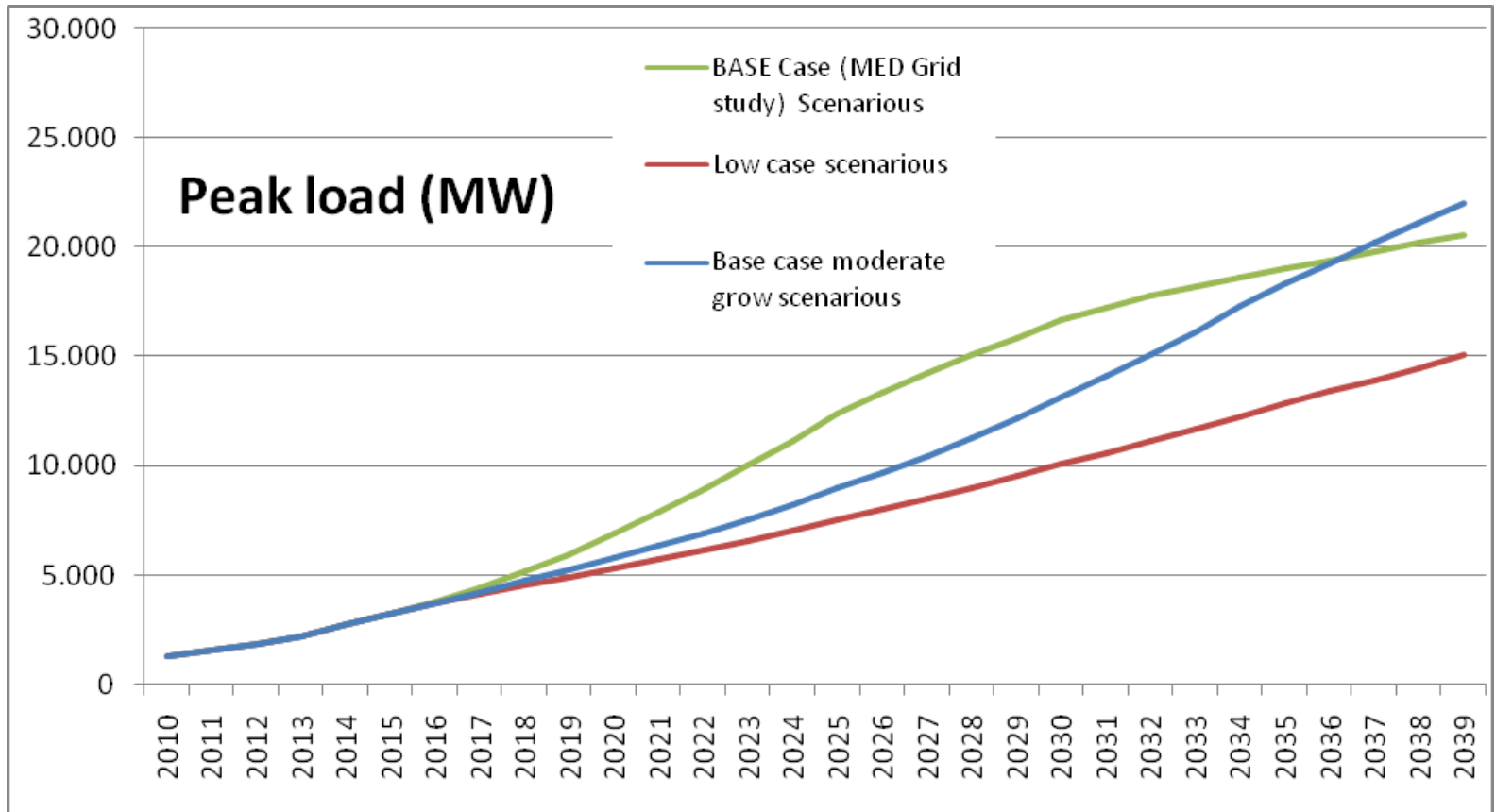


# driving forces

- ❑ Lack of oil resources due to separation of Southern Sudan after referendum in 2011 (70% of Oil Production forgone).
- ❑ Rapid increase in the demand in the last three decades.
- ❑ Nuclear power represent a cheap energy generation resource.
- ❑ deficiency of other resources such as hydro and renewable to cover the electricity demand expansion
- ❑ Necessity of diversification of energy supply options
- ❑ Reduction of CO<sub>2</sub> gases emissions
- ❑ Large territories of Sudan (low population density),
- ❑ Availability of cooling water .



# Sudan load forecast



## Impediments

- Public acceptance (Awareness)
- Long construction time and high construction costs due to additional safety requirements after Fukushima.
- Financing
- Lack of human resources in nuclear field
- Enhancement of Infrastructure especially electric grid and roads.





**Plan for NPP in Sudan  
between 2010 and 2039**



Year	Loss Of Load Probability %	TOTAL CAPACITY ADDED BY YEAR [MW]	Coal Fired Steam 400 MW	Coal Fired Steam 600 MW	NPP 1000 MW	NPP 600 MW	Gas Oil CCGT 500 MW	Gas Oil CCGT 200 MW	Natural Gas CCGT	Hydro candidate	NPP Total In year [MW]	NPP Additions by year [MW]
2010	0.00	0	0	0	0	0	0	0	0	0	0	0
2011	0.01	0	0	0	0	0	0	0	0	0	0	0
2012	0.66	0	0	0	0	0	0	0	0	0	0	0
2013	2.15	0	0	0	0	0	0	0	0	0	0	0
2014	0.51	666	0	0	0	0	1	1	0	0	0	0
2015	0.00	458	0	0	0	0	1	0	0	0	0	0
2016	0.00	648	0	0	0	0	0	0	0	1	0	0
2017	0.00	312	0	0	0	0	0	0	0	1	0	0
2018	0.00	760	2	0	0	0	0	0	0	0	0	0
<b>2019</b>	<b>0.00</b>	<b>1,170</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>600</b>	<b>600</b>
2020	0.00	897	1	0	0	0	0	0	0	2	600	0
2021	0.00	950	1	1	0	0	0	0	0	0	600	0
2022	0.00	570	0	1	0	0	0	0	0	0	600	0
<b>2023</b>	<b>0.00</b>	<b>1,380</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1,600</b>	<b>1000</b>
<b>2024</b>	<b>0.00</b>	<b>1,600</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3,200</b>	<b>1600</b>
2025	0.00	1,245	2	0	0	0	0	0	1	1	3,200	0
2026	0.00	950	1	1	0	0	0	0	0	0	3,200	0
2027	0.00	950	1	1	0	0	0	0	0	0	3,200	0
2028	0.00	918	0	0	0	0	1	0	1	0	3,200	0
<b>2029</b>	<b>0.00</b>	<b>1,600</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>4,800</b>	<b>1600</b>
2030	0.00	918	0	0	0	0	1	0	1	0	4,800	0
2031	0.00	570	0	1	0	0	0	0	0	0	4,800	0
2032	0.00	666	0	0	0	0	1	1	0	0	4,800	0
<b>2033</b>	<b>0.00</b>	<b>1,600</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>6,400</b>	<b>1600</b>
2034	0.00	0	0	0	0	0	0	0	0	0	6,400	0
2035	0.00	0	0	0	0	0	0	0	0	0	6,400	0
<b>2036</b>	<b>0.00</b>	<b>1,000</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>7,400</b>	<b>1000</b>
2037	0.00	0	0	0	0	0	0	0	0	0	7,400	0
<b>2038</b>	<b>0.00</b>	<b>600</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>8,000</b>	<b>600</b>
2039	0.00	0	0	0	0	0	0	0	0	0	8,000	0
<b>Total</b>		<b>20,428</b>	<b>9</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>2</b>	<b>3</b>	<b>5</b>	<b>8,000</b>	<b>8000</b>

## Reactors type , type of a fuel cycle

- Sudan shall use PWR reactors.
- The open fuel cycle is going to be adopted, at least for the first NPP.
- Sudan strategy for ***back-end fuel cycle is sending*** the spent fuel to the supplier country.
- Sudan has no legal provisions governing transit or return of spent nuclear fuel and high level radioactive waste to other countries

The Criteria for selecting the reactor :

- ✓ Safety Considerations
- ✓ Proven technology
- ✓ High Reliability



## Sudan role in deployment of nuclear power plants by foreign suppliers

- While it is still subject to negotiations with vendor, the most suitable procurements strategy for the first NPP in Sudan will be super-turnkey contract. Hence the national participation will be quite limited.

Example:

- i. Construction materials supply e.g. cement.
- ii. Skilled personnel from conventional power plant , hydro plants and oil industry
- iii. Limited participation of national industry





- **The priorities for Sudan regarding nuclear energy system sustainability are:**
- **Economics**
- **Waste management**
- **Proliferation resistance**
- **Physical protection**
- **Environment**
- **Safety**
- **Infrastructure**



## **Sudan vision in *Energy independence and Security of supply* :**

### ***Security:***

- the ability of a nation to gather the energy resources needed to ensure its welfare.
- energy supply security is a matter of both domestic policy and international relations.
- including alternative supply options.
- the availability of domestic energy reserves and resources.
- the age of existing energy infrastructures (including regional and interregional interconnections), storage facilities, as well as future technology and energy trade options.

### ***Independency:***

- Diversity in energy resources to achieve the independency



## **Sudan existing and future cooperation with other countries in energy projects, nuclear and non-nuclear includes:**

- ❖ Transmission line interconnection between Sudan and Egypt , feasibility study has been carried out.
- ❖ Transmission line interconnection between Sudan and Ethiopia , the line is already energized.
- ❖ Chinese and Indian contractors are working in construction of thermal power plants (3x135 mw and 4x125 mw resp.)
- ❖ German and British consultancy firms supervise the construction of the above mentioned projects.





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## **The positive aspect of cooperation in nuclear and non-nuclear fields foreseen by Sudan are:**

- Capacity building
- Technology and know-how transfer
- Economical growth
- Reducing the cost of investment in human resources development
- Enhancement of national infrastructure e.g. national grid.
- Sharing of the experts in the nuclear field.
- Sharing of radioactive waste facilities.



## **Factors that motivate cooperation of Sudan with other countries in nuclear energy projects:**

- Provision of finance for the project.
- Opportunity for neighbour countries to use different energy resources efficiently.
- Human resources development.
- Filling the gaps in Human resources and Infrastructure.
- Utilizing the International experience in nuclear field
- Sharing of domestic and international industries in construction of NPP.



# **The factors affecting Sudan in selecting a vendor:**

- Sufficient Experience in nuclear field.
- Proven technology.
- Ease of Finance for large projects and financial stability of vendor
- Insurance of suitable technical and scientific support.





# **The indicators to measure benefits and disadvantages of cooperation with other countries in nuclear energy projects:**

- Technology transfer.
- Sustainable Technical support.
- Sustainable Solution for Waste storage .
- Solution for the gap in human resources.
- Minimizing electricity generation cost .





# Thank you for your attention

