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Enhancement of Power Systems Stability Considering Nuclear Power Plants

by

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Abstract:

The nuclear power plants became the Best solution for satisfying the increased and Continuous demand for electric energy due to its very low running cost, its high capacity and supposed to be environmentally clean source of base load electrical generation .
For these reasons Egypt decides to begin its nuclear program .
Egyptian government signed a contract with Russian Rosatom company specialized in nuclear energy sector to establish EL-Dabaa nuclear power plant in Egypt which is located in Al-Dabaa City, The proposed El-Dabaa nuclear power plant would be consisted of four Reactor of Type VVER 1200 belongs to Generation III to provide the Egyptian unified Electric grid with total power 4800MW.
This nuclear power plant will operate as four stages, the first stage is to operate the first nuclear reactor to produce 1200-MW to the Egyptian grid in 2019. the second stage will produce 2400 MW will be in 2023. Then, the third stage will finish the construction of the third reactor and able to be in operation case to supply the total power of the plant to reach 3600-MW in 2026. Finally, the fourth stage will produce the proposed total power to reach 4800-MW in 2028.
This Paper discusses the impact of interconnecting between the electric power system of Egypt and EL-Dabaa nuclear power plant are studied and analyzed through simulation of both nuclear power plant and Egyptian electric transmission grid .
study for Egyptian unified power system, details for modeling of several elements, where the objective of this study is determining the optimal way for connecting between the proposed El-Dabaa NPP and the Egyptian power system .

Keywords:

NPP, VVER , ODEC , PSAT

1.*Introduction:*

The World Will need greatly increased Energy Supply in the FutureEspecially Cleanly - generated Electricity . Electricity demand is Increasing Twice as fast as overall Energy use and is Likely to rise by more than two - thirds by 2011 t0 2035 .
in 2012 ,42% of Primary Energy used was converted into Electricity .Nuclear Power Provides about 11% of The World's Electricity , and 21% of Electricity in OECD Countries .
All Major International Reports on Energy Future suggest an increasing role for Nuclear Power as an environmentally benign Way of Producing reliable electricity on alarge scale .
And this figure (1) explain World Electricity Consumption by Region and Figure (2) explain Numper of Reactors in the world now

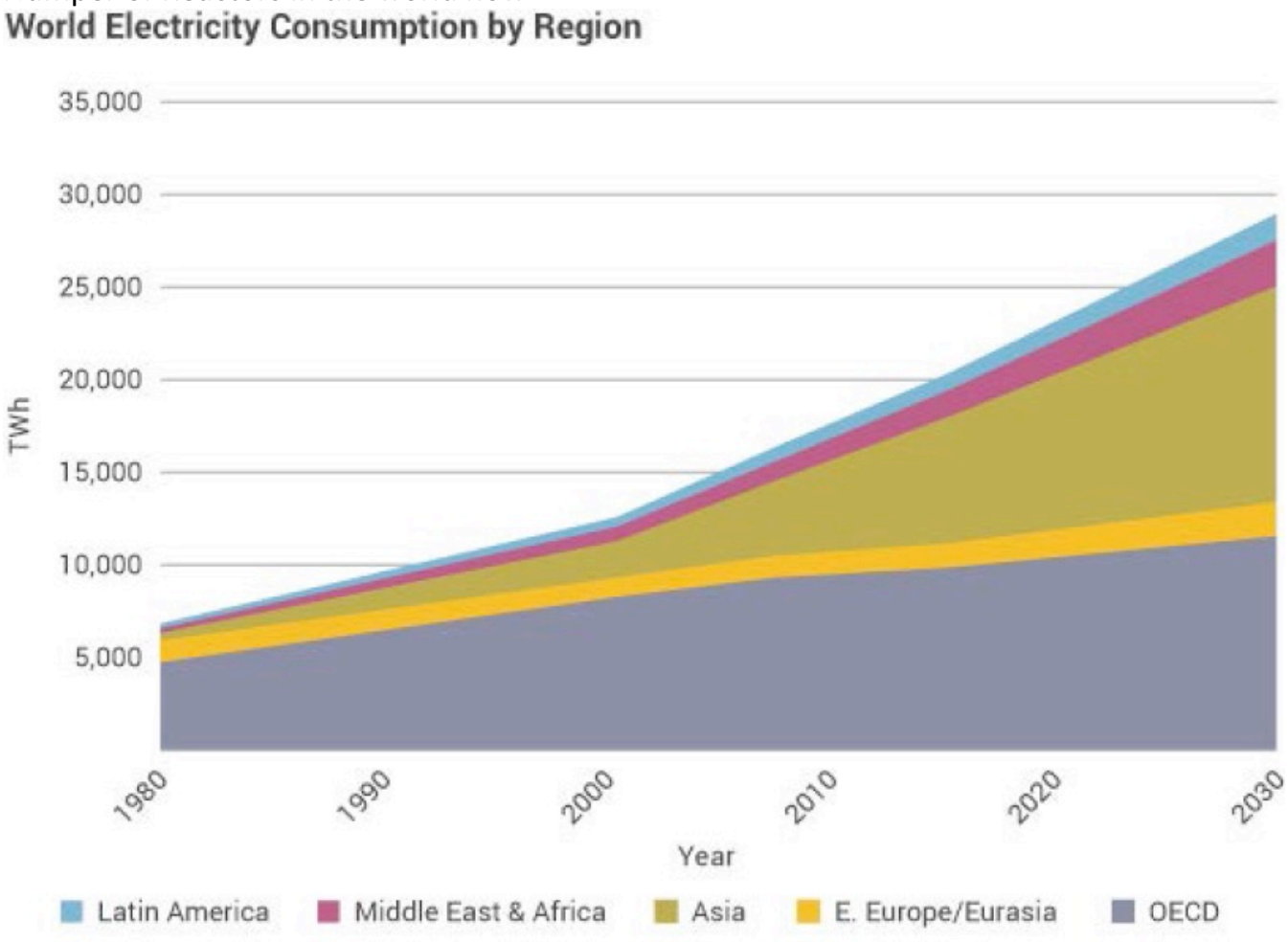

Figure 1 World Electricity consumption by Region.

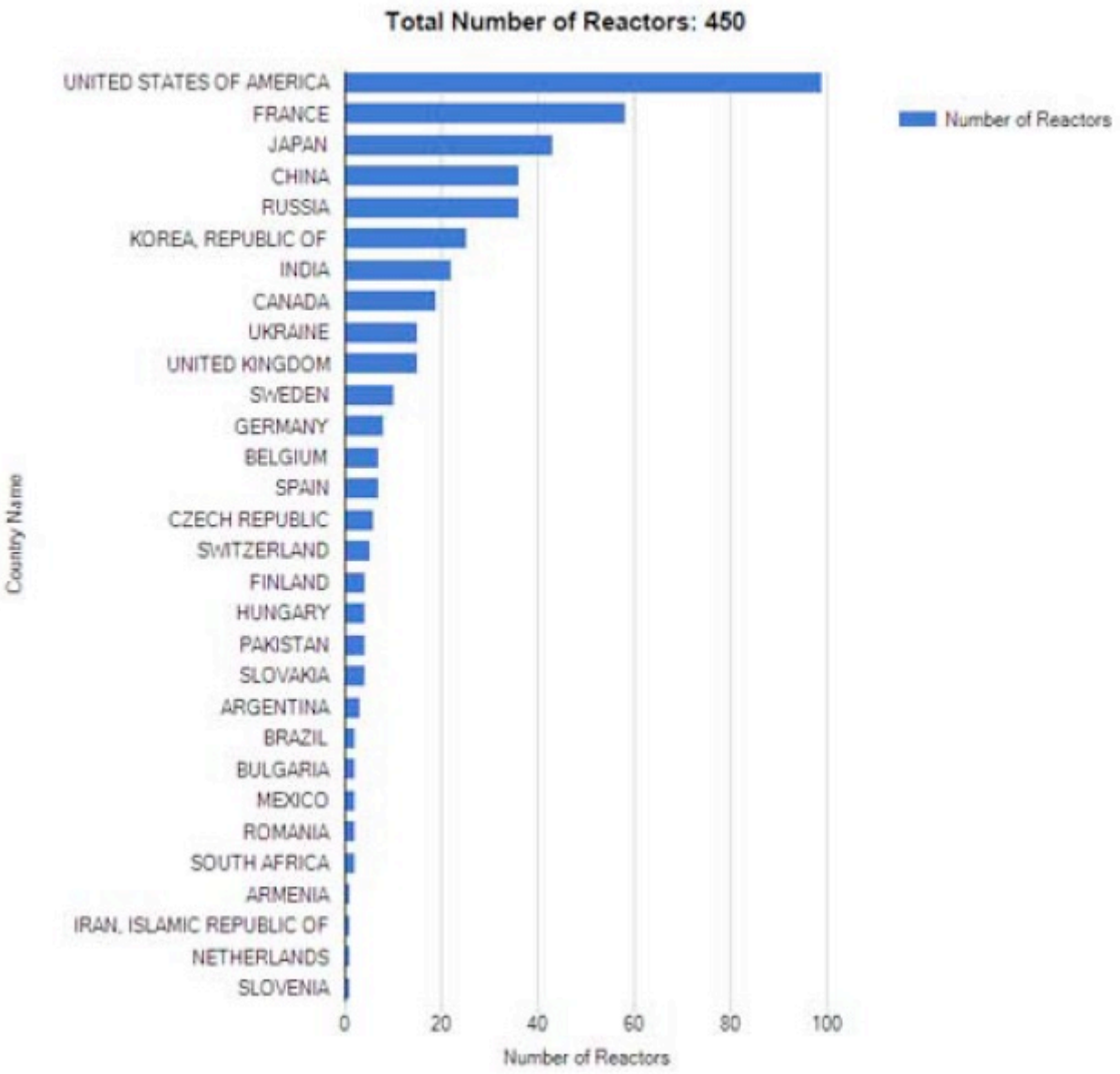

Figure 2 No. of Reactors in the World.

Back Ground of Nuclear Energy in Egypt :

Nuclear ambitions in Egypt date back to 1954. There are 2 nuclear research reactors in operation; 1st from Russia (1961) with (2 MW) and the 2nd from Argentina (1998) with 22 MW. Egypt realized the importance of nuclear power that could be used to secure the supply of electricity. Egypt was motivated to consider the introduction of nuclear power by the following factors:

- Steadily increasing demand for electricity,
- Egypt is not a rich country of indigenous fossil energy resources, and almost full utilized its hydropower resources,
- Instability in the prices of fossils energy resources,

- The expected spin-off effects of nuclear power that could support the development of the Egyptian industrial and scientific sectors,
- Nuclear energy is a technically and economically viable source of energy.

This figure shows electricity Generation in 2016,2017

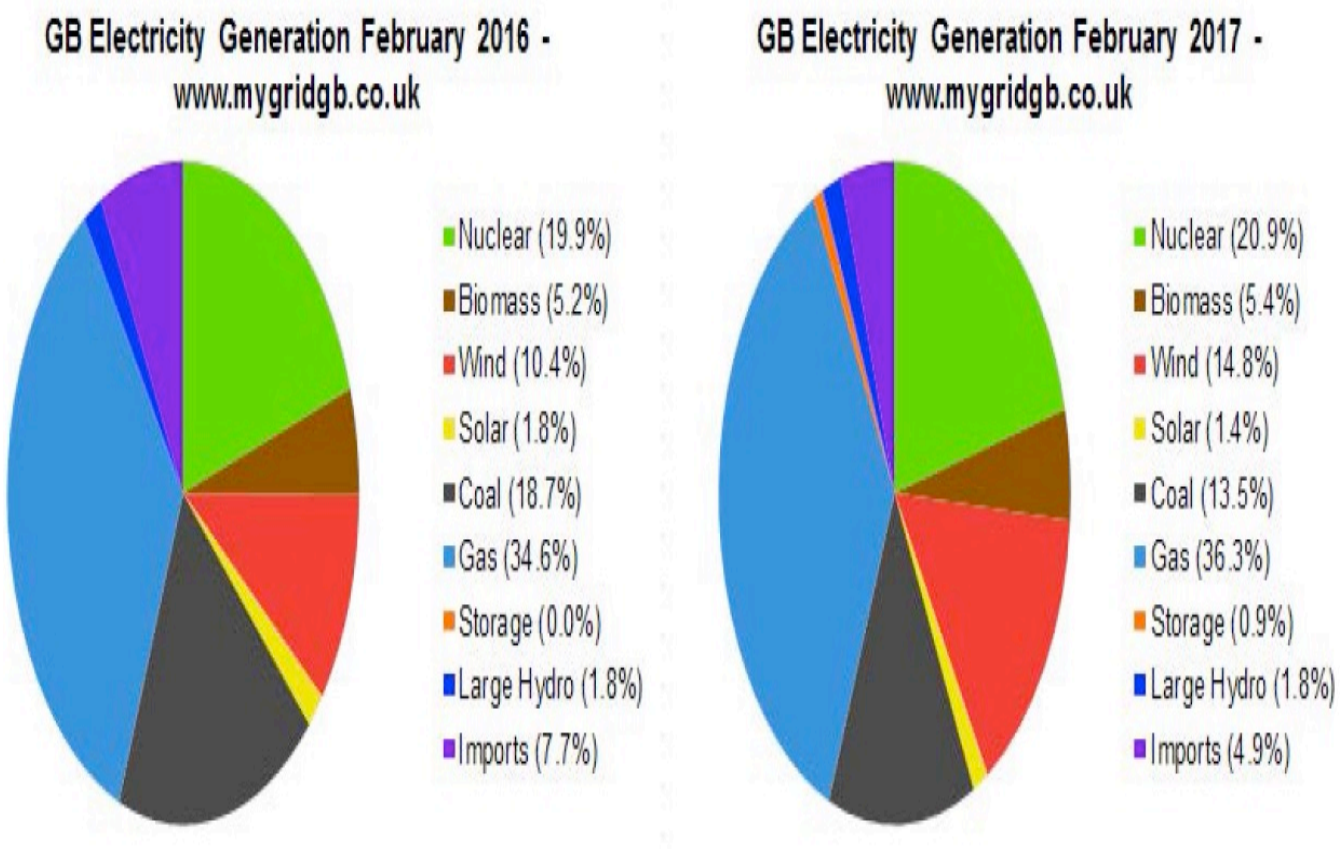

Figure 3 No. of Reactors in the World.

1.1 *METHODOLOGY:*

In this paper "Power System Analysis Toolbox (PSAT) is SIMULINK toolbox of MATLAB Program for electric power systems analysis and control" was used to explain how the values were arrived at.
covers the model of the Egyptian unified power system to which the NPP will connect

DESCRIPTION, MODELLING, AND SIMULATION OF STUDY SYSTEM:

We use MATLAB Simulink to work this This model to Know the detailed configuration of the 500 KV of Electric Egyptian grid and in brief the 220 KV system around the suitable location of the first Egyptian NPP.
The suitable way for interconnecting between ElDabaa NPP and the Electric Egyptian grid is :
For 500KV System :

1- From Eldabaa to Elsaloom
2- From Eldabaa to sidi-krir

For 220 KV System :

1- From Eldabaa to Elomeed
2- From Eldabaa to Matrouh

This scenario of interconnection relies on three Ideas , the first idea is the reliability where the interconnecting will be on two levels 220KV and 500KV with double circuit on 500KV lines, the second idea is the security of operation of Nuclear Power Plant where this scenario takes into consideration the requirements of off-site supply that feeds the utilities or auxiliaries of NPP in case of any contingency for the NPP or its on-site supply for safe reactor shutdown , and the third idea is related to the economics of these infrastructure with respect to other ideas . For the 220KV system, there is an existing double circuit line between Omeed and Matroah. So it is of no use to build new lines, just one of the two circuits will be opened at the nearest point to ElDabaa and connected to ElDabaa station. This figure (3) explain Interconnection between Eldabaa and Electric Egyptian Grid . and Table (1) to explain data of suggested lines for 500KV, 220 KV of Eldabaa with Electric Grid .

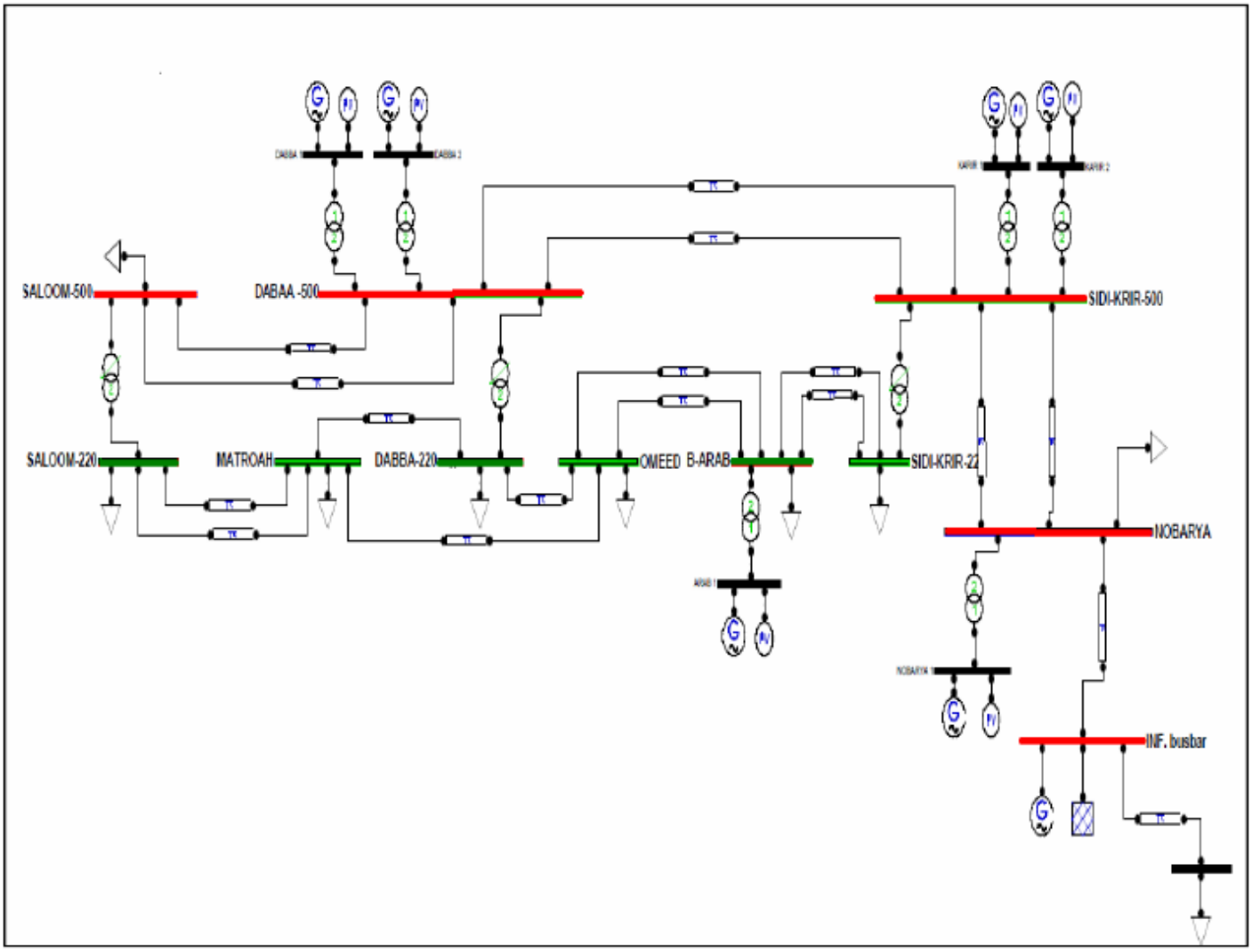

Figure 4 Interconnection between Eldabaa and Electric Egyptian grid .

Line code	From	TO	Voltage (kv)	No. of cts.	Length (km)	R pu/km	X pu/km	B pu/km
T.L1	ElDabaa	ElSaloum	500	2	325	1.00E-05	1.23E-04	9.10E-03
T.L2	ElDabaa	Sidi-Krir	500	2	122	1.00E-05	1.23E-04	9.10E-03
T.L3	ElDabaa	El-Omid	220	1	71	2.77E-04	2.143E-03	4.798E-03
T.L4	ElDabaa	Matroah	220	1	111	1.77E-04	1.367E-03	3.060E-03

Table 1 : Data of suggested lines of 500KV ,220KV System of Eldabaa with Electric Grid .

Cases Study :

The electric power system will be subjected to some disturbances to analyze and monitor the behavior of the NPP under these disturbances and so, the impact of this behavior on the electric power system performance where some disturbances may cause one or more units in the NPP to be dropped .

Firstly : Fault at bus Eldabaa 500KV accompanied by outage T.L 1 :

A three-phase short circuit fault is applied to the bus of El Dabaa-500 and accompanied by outage for (T.L1) between Dabaa and Saloum. The supposition of this case that there is time lag between the circuit breakers of T.L1 and T.L2 and sothat there is an outage for T.L1 only. It is explained from the following figures from figure (4.1),figure (4.2) .

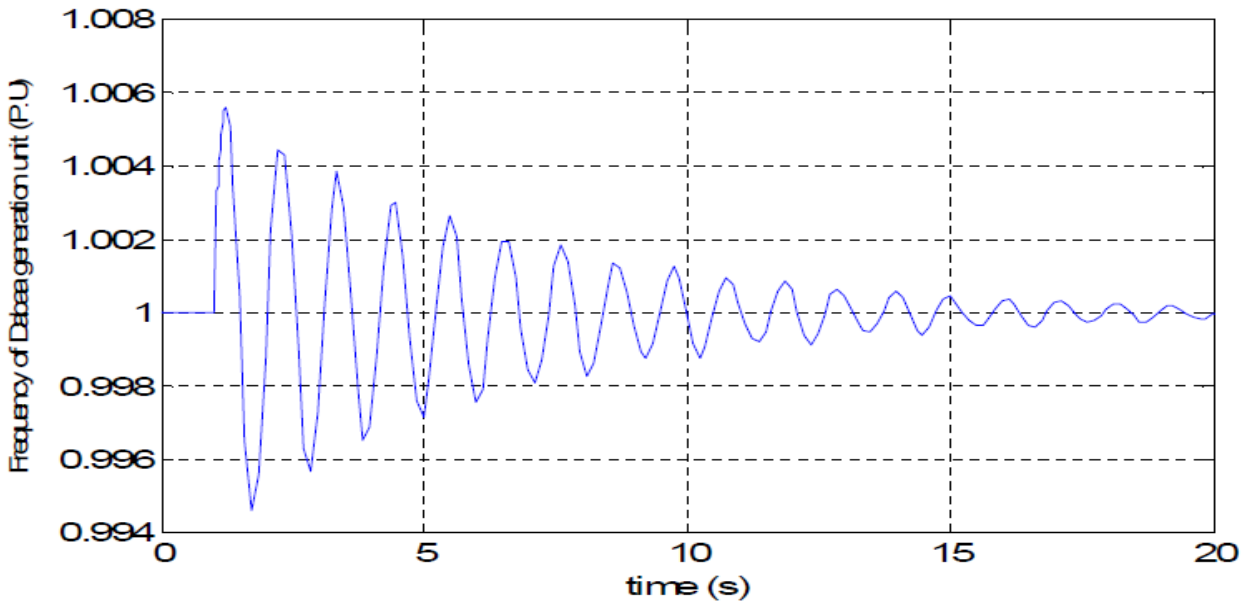

Fig. (5.1) Frequency of ElDabaa generation unit for fault at Dabaa-500 KV and (T.L1) outage .

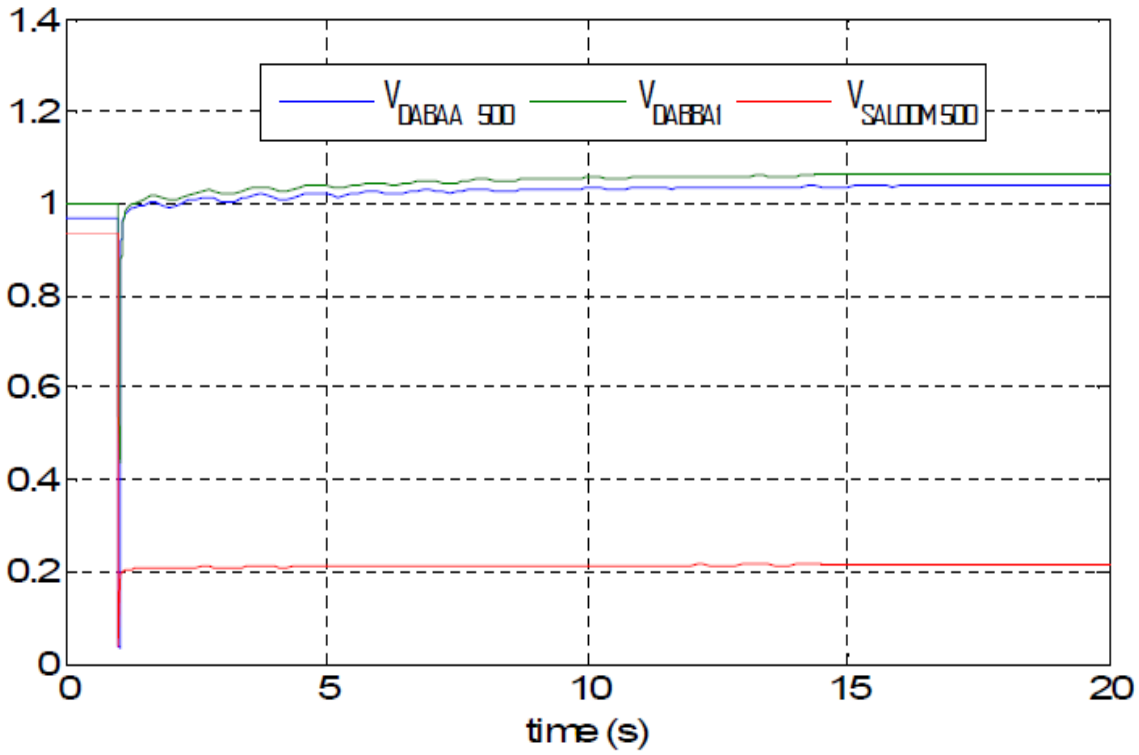

Fig. (5.2) Voltages buses for fault at ElDabaa 500 KV and (T.L1) outage.

Secondly : Fault at bus Eldabaa 500KV accompanied by outage T.L 2 :

A three-phase short circuit fault is applied to the bus of El Dabaa-500KV and accompanied by outage for (T.L2) between Dabaa and Sidi-Krir. The supposition of this case that there is time lag between the circuit breakers of T.L1 and T.L2 and sothat there is an outage for T.L2 only. It is explained from the following figures from figure (4.3),figure (4.4)

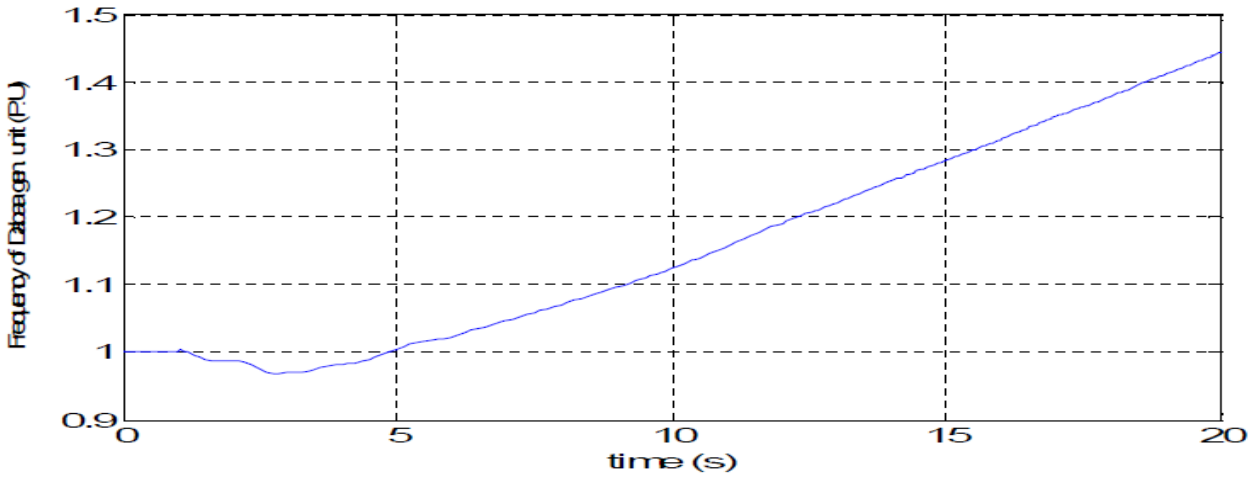

Fig. (4.3) Frequency of ElDabaa generation unit for fault at Dabaa-500 KV and

(T.L2) outage .

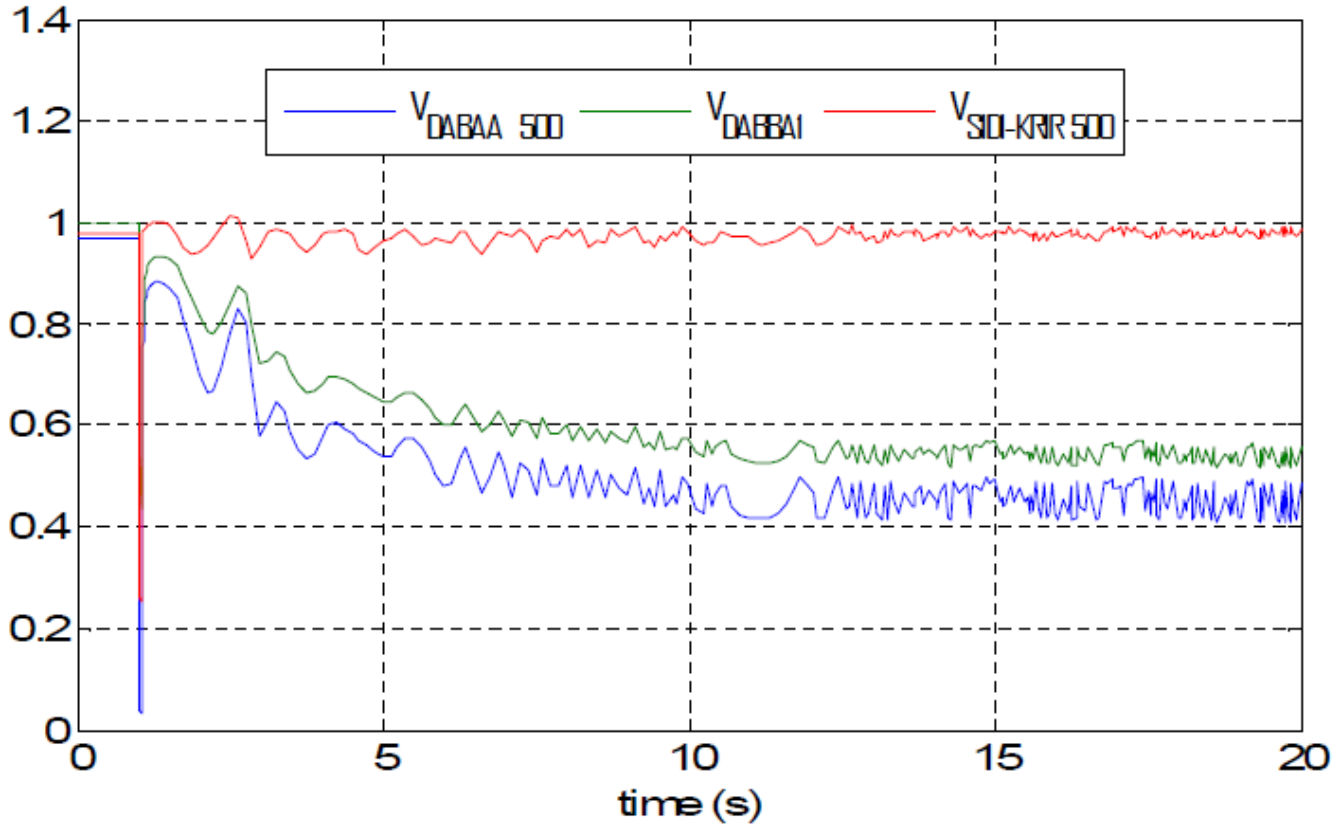

Fig. (5.4) Voltages buses for fault at ElDabaa 500 KV and (T.L1) outage.

Thirdly : Fault at bus Eldabaa 500KV accompanied by outage(T.L1, T.L 2):

A three-phase short circuit fault is applied to the bus of E l Dabaa-500KV and accompanied by outage for (T.L1,T.L2) between Dabaa and Sidi-Krir. The supposition of this case that there is no time lag between the circuit breakers of T.L1 and T.L2 and so that there is an outage for (T.L1,T.L2) together. It is explained from the following figures from figur(4.5),figure(4.6)

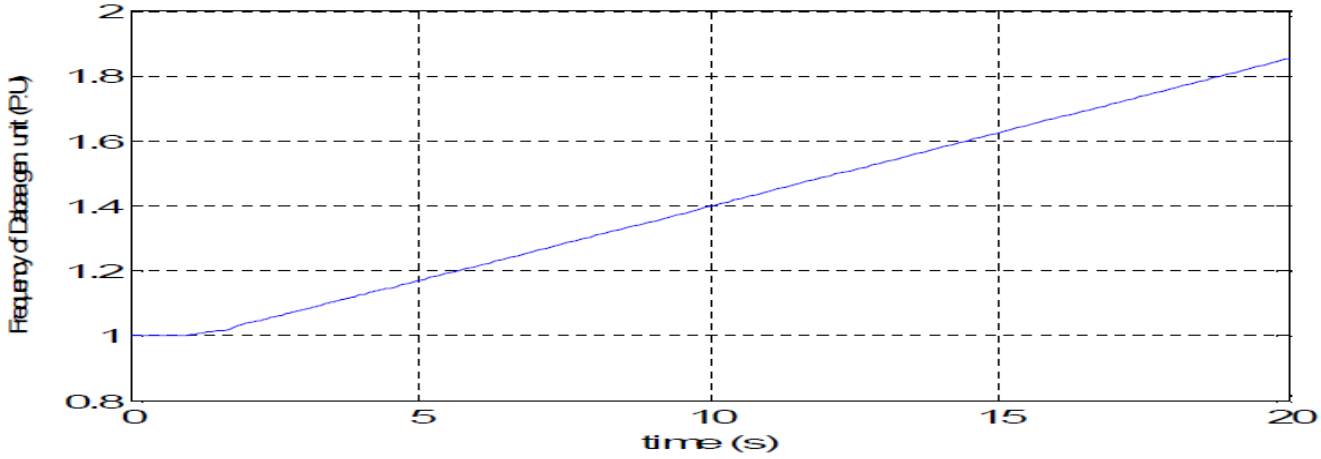

Fig. (5.5) Frequency of ElDabaa generation unit for fault at Dabaa-500 KV and (T.L1,t.L2) outage .

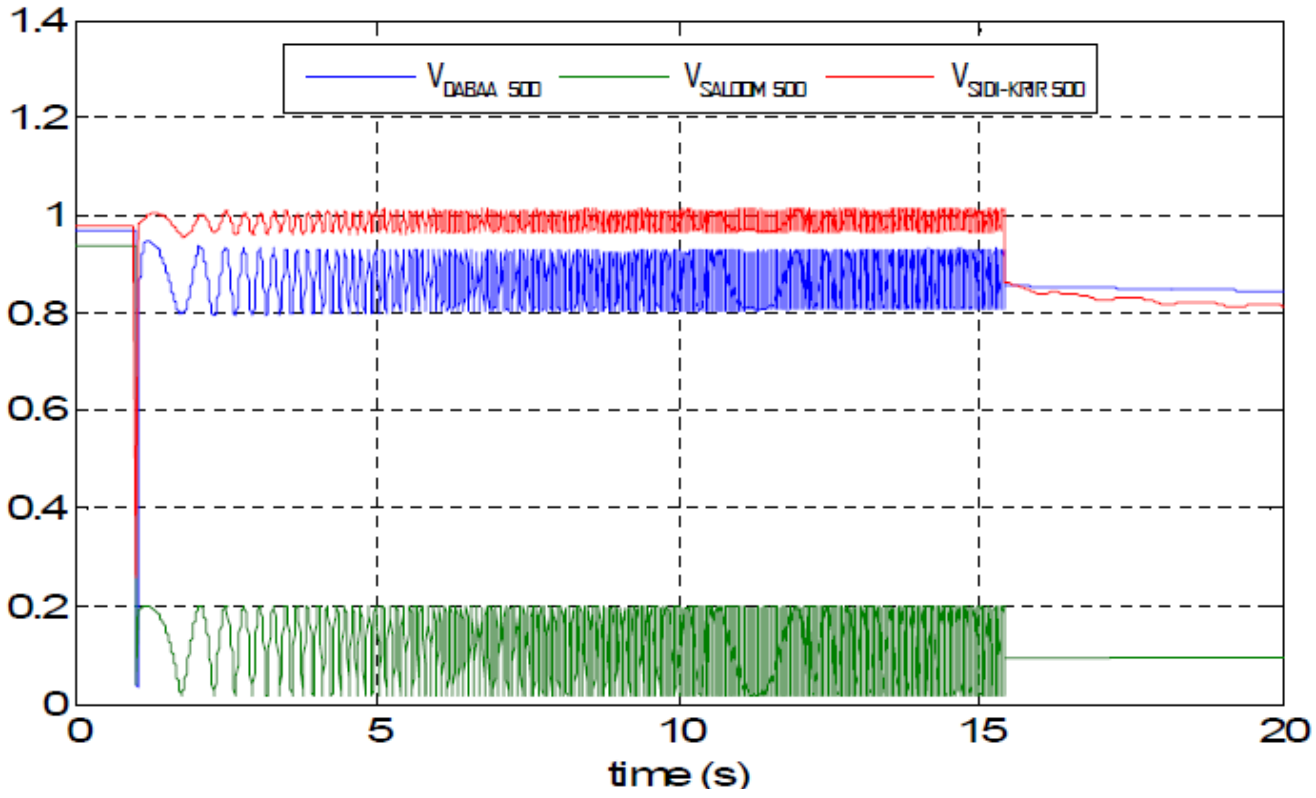

Fig. (5.6) Voltages buses for fault at ElDabaa 500 KV and (T.L1,T.L2) outage .

Conclusion :

1. The proposed NPP which is planned to be constructed in E l Dabaa is the optimal solution to solve the problems of continuous demand on electric energy in Egypt and the most suitable reactor for the first nuclear project in Egypt is

(VVER1200).

2. Studying the Egyptian unified power system explain that it is an safe, efficient, secure and reliable power system and its impacts on the performance of proposed NPP are accepted .

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