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Overload Assessment of the Nigerian Power Systems Grid Network for Improved Performance and Efficiency

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ABSTRACT

Nigerian Power System grid network initially consisted of 25 buses and 7 generating stations, three of which are hydro, three thermal and one steam generating station. The hydro stations are located in Niger state and they are Kainji, Jebba and Shiroro while the thermal stations are located in River state (Afam) and Delta state (UGHELI) and the steam station located in SAPELE in Delta state. Electrical energy was supplied by the then National Electric Power Authority (N.E.P.A.) to consumers from these generating stations through transmission lines, to substations located at different areas around the country, as required by electricity consumers whose demand for electricity is far above generated capacity. The challenge is the inability of the utility company to simplify/automate the very vast network and ascertain the effects of system overload on the entire National Grid at various points in the network at a glance. This paper has examined critically these challenges on the Nigerian National Grid and has proposed options of overcoming them using NEPLAN which is a very user friendly planning and information system simulation software for electrical power systems analysis such as Load Flow, Fault level calculations, Transient stability, Voltage stability, and Motor starting.

Keywords: National grid; NEPLAN; P.H.C.N.; Consumers.

1.0. INTRODUCTION

A power system comprises of generation, transmission, distribution and utilization of electrical energy. Usually electrical energy is generated at a power station and is supplied to consumers through transmission lines. These generating stations vary considerably in their installed capacities and do not operate as isolated units but are interconnected to the national grid with a national control centre at Oshogbo in Osun state. The national grid consists of hundreds of kilometers of main transmission lines with a grid voltage of 330kV. The existing grid network before the contribution of the new lines consists of twenty five (25) buses and seven (7) generating stations three of which are hydro stations, three thermal stations and one steam station. The hydro stations are located in Niger state and they are Kainji, Jebba and Shiroro while the thermal stations are located in Rivers state (Afam) and Delta state (UGHELI) and the steam station located in SAPELE in Delta state.

2.0. BENEFITS.

Using NEPLAN simulation software for the overload assessment of Nigerian Power System enables the students/Engineers carry out (accurate) load flow analyses/solutions of a power system using Gauss Seidel, Newton Ralphson, Fast Decoupled, (etc) methods in a matter of minutes; The Nigerian national grid network can be seen at a glance; Effects of overloading/short circuit/faults in any part of the grid can be simulated, seen at a glance and remedied from the comfort of a computer system in a remote location; For future expansion, the effect of contributions of Independent Power

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Plants (IPPs) in the reduction of overload conditions can immediately be ascertained long before their generated power is injected into the national grid; Excellent long term electrical power consumption forecast is achievable using NEPLAN; The need of adequate compensating equipment and their locations can easily be determined; The entire power system can easily be automated. Etc.

2.1 CHALLENGES.

Till date, the Nigerian Power System is not fully automated thus, making it difficult to ascertain exactly overload condition of the entire National Grid at various points in the network at a glance.

3.0 RECOMMENDED SOLUTION.

The application of power systems simulation softwares such as NEPLAN, POWER WORLD, etc on the national grid in Nigeria can overcome the challenges currently being faced by the utility companies in the country. NEPLAN simulation software has been used for a demo design of the National Grid as can be seen as attached in fig.1.0 of the appendix. Running the load flow simulation of a section of the grid network gives the expected calculated parameters as shown in fig. 2.1. and the pictorial views of the grid clearly indicates overloaded sections of the network in red colour and equally make the lives of the servicing Engineer and Power Systems/Control Engineers easy on the network.

4.0 CONCLUSION

The effective use of power systems simulation softwares such as NEPLAN for the design and analysis of our national grid will:

- Allow the determination of the exact contributions of new generating/transmission stations and their effects on the already overloaded national grid before they are actually constructed.
- Enable Engineers give excellent long term electrical power consumption forecast (as present system overloads are clearly and accurately indicated).
- Ensure that overloaded lines and feeders are easily detected and corrected either by transferring loads to under – loaded lines/feeders or creating a new line/feeder entirely. (The effect of these actions can be simulated first on a computer system before practical implementation)
- Provide for adequate compensating equipment where necessary and their locations can easily be determined as in figs 2.0 and 2.1.

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5.0 APPENDIX

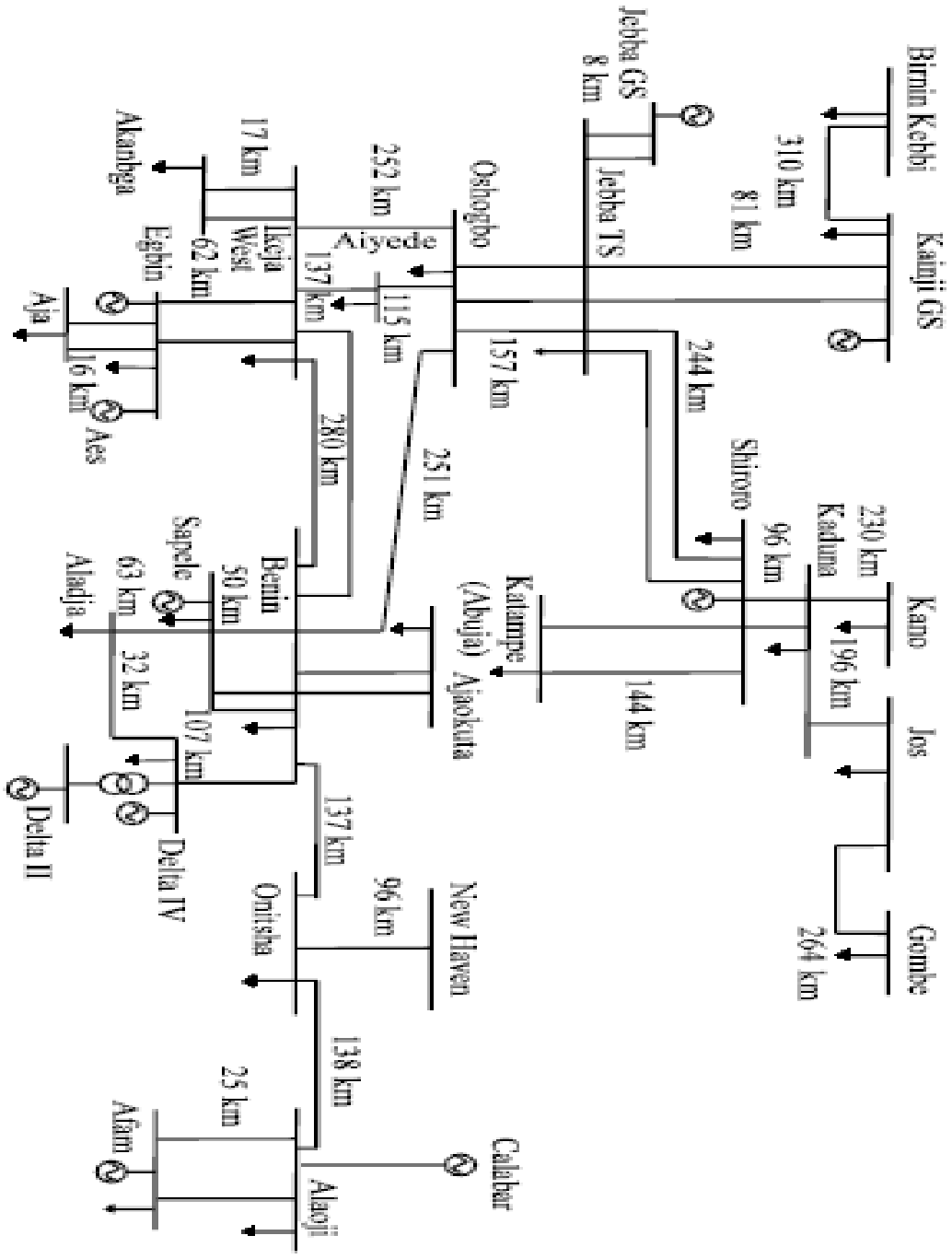

Fig 1.0 THE NIGERIAN 330KV TRANSMISSION GRID NETWORK

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Table 1.0. BUS IDENTIFICATION OF NIGERIAN 330KV GRID NETWORK

BUS NO.	BUS NAME	BUS NO.	BUS NAME
1	Oshogbo	15	Aladja
2	Benin	16	Kano
3	Ike-West	17	SAP P/S
4	Ayede	18	AJA
5	Jos	19	Ajaokuta
6	Onitsha	20	New Haven
7	Akangba	21	Alaoji
8	Gombe	22	AFAM GS
9	Abuja	23	Jebba
10	Egbin-PS	24	Jebba GS
11	DELTA PS	25	Kainji GS
12	AES	26	B Kebbi
13	Okapi	27	Shiroro
14	Calabar	28	Kaduna

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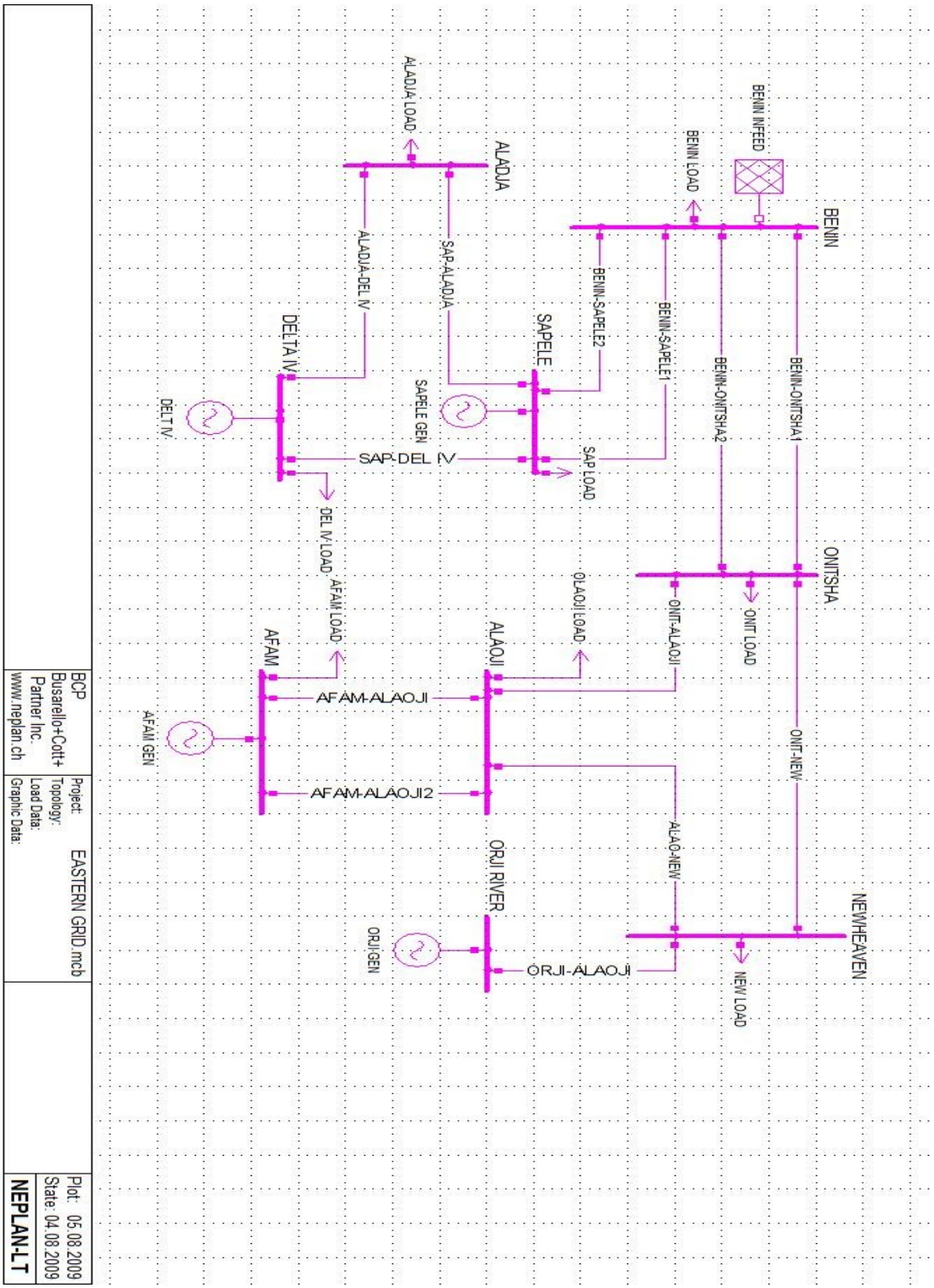

Fig 2.0 NEPLAN - EASTERN GRID NETWORK

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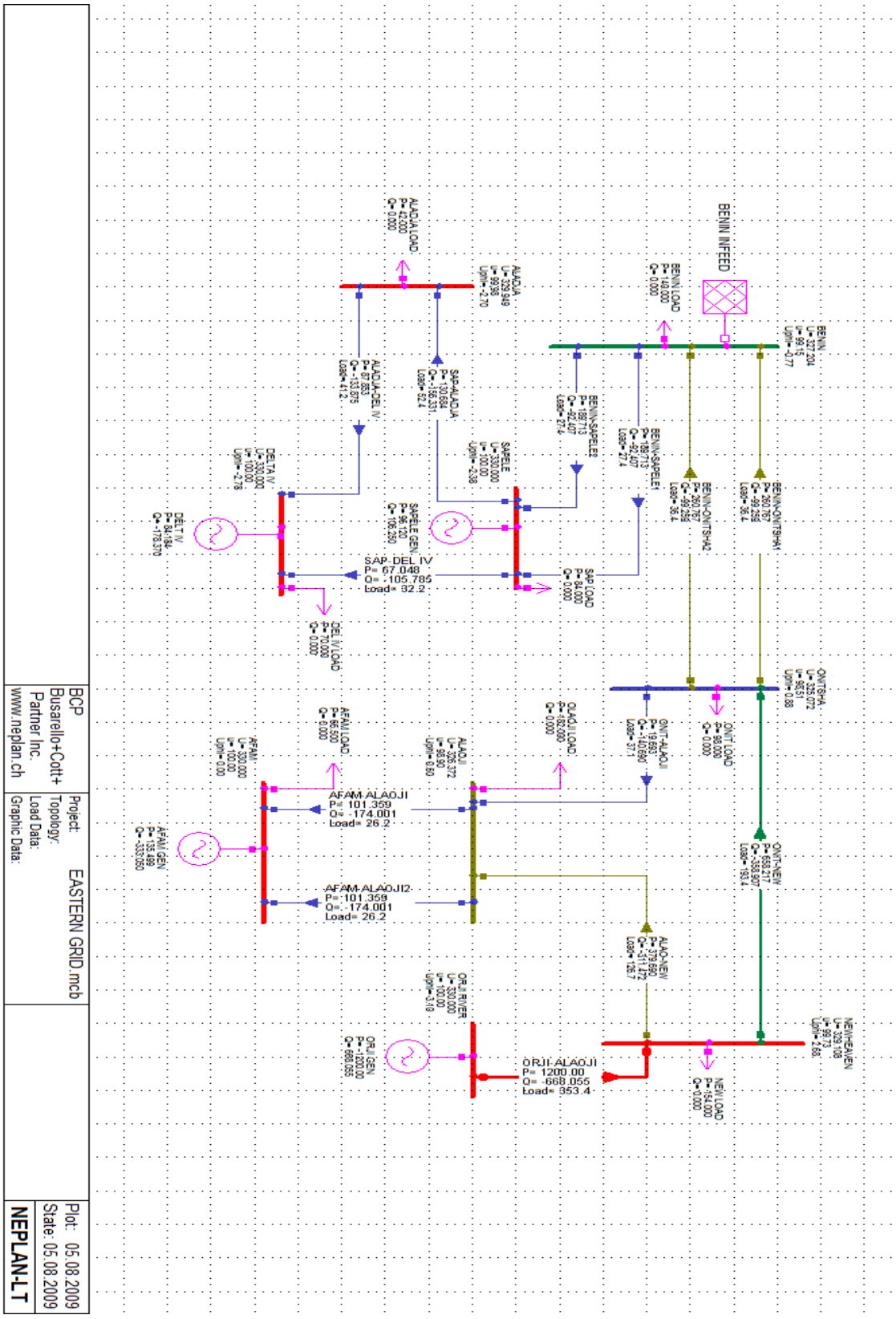

Fig 2.1 NEPLAN - EASTERN GRID NETWORK WITH LOAD FLOW SIMULATION
(Colours indicate network condition. E.g. colour red indicates overloaded feeders/Lines.)

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