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AN OPTIMAL ANALYSIS OF POWER EVACUATION IN TIGA HYDRO POWER PLANT IN KANO STATE

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ABSTRACT

This report describes how an electric utility system is modeled by using load flow techniques to establish a validated power flow case suitable for simulating and evaluating alternative system scenarios. Details of the load flow model are supported by additional technical and descriptive information intended to correlate modeled electrical system parameters with the corresponding physical equipment that makes up the system. Pictures and technical specifications of system equipment from the utility, public, or vendor are provided to support this association for many system components. The report summarizes the load flow model construction, simulation, and validation and describes the general capabilities of an information query system designed to access load flow parameters and other electrical system information. Unlike the generators in large hydro power stations, which operate in voltage control mode, the generators in small hydro power stations (SHPs) are forced to operate in power factor control mode due to their limited reactive power support. In fixed power factor operation, smaller variations of voltage at the evacuation bus are managed by on load tap changing at the generator transformers. However, during large and frequent variations in voltage, such SHPs face difficulty in evacuating the power due to delayed response by the operators and inadequate tap settings of the generator transformers. In this thesis identification of power evacuation system performance for network will be carried out. The work will also study the existing and the proposed power evacuation system and carries out detail study of an existing transmission line and conduct detail study of power evacuation systems. The power evacuation studies will ultimately determine the transmission system capacity and availability of the transmission margin. Also for distribution system performance study, computer program (MATLAB) will be developed for calculation of transmission line performance and Load flow solutions for radial distribution network.

I INTRODUCTION

In a hydro power plant system, the energy present in water is converted into mechanical or electrical energy by the use of hydropower plant. Generic hydro power systems can be categorized in many different ways. Some of the methods of classification are based on how the electricity is generated by the plant, what kind of grid system is utilized for the distribution of electricity, the type of load capacity and the type of storage used by the system. Hydroelectric generating plants are generally located away from load centers. Accordingly power generated is stepped up to a suitable high voltage in step up substation at generating end and transmission lines laid for interconnection with the grid at a suitable point. The development of a hydro plant electrical single line diagram is the first task in the preliminary design of the plant. In evaluating a plant for good electrical system design, it is easy to discuss system design in terms of the plant's single line electrical diagram. A power station is where water flows though turbines using hydropower to generate Hydroelectricity. Power is captured from the gravitational force of water falling through penstocks to water turbines connected to generators. The amount of power available is a combination of height and flow. A wide range of Dams may be built to raise the water level, and create a lake for storing water. A power station (also referred to as a generating station, power plant, powerhouse, or generating plant) is an industrial facility for the generation of electric power. Most power stations contain one or more generators, a rotating machine that converts mechanical power into electrical power. The relative motion between a magnetic field and a conductor creates an electrical current. The energy source harnessed to turn the generator varies widely.As part of the effort of Kano state government towards solving the prolonging lack of electricity in the state, a 35MW small hydro Power project is recently awarded for the generation of power to supply the essential loads of the state. It is a well-known fact that Evacuation of small hydro power plant is a major challenge for independent power producers (IPP) in the field of power sector especially with stringent conditions of electric power regulating authorities. In this paper identification of power evacuation system performance for network will be carried out. The work will also study the existing and the proposed power evacuation system and carries out detail study of an existing transmission line and conduct detail study of power evacuation systems.

II MATERIAL AND METHODOLOGY

TIGA Hydro Power Project is a Surface Power Station comprising of two generating units of 1 X 8 MW & 1X2MW capacity. The station will generate power at 11kV and it will be stepped up to 33 kV through three

phase generator transformer. The step up transformer 11 kV / 33kV shall be connected to generator through XLPE cables. The LV terminals of Generator transformer will be connected to 11kV Indoor Switchgear Equipment. The offered system is a process control & visualization system that is specifically designed for hydroelectric power plants. The Unit Control Board for Unit 1 & 2 is integrated with digital governor for proper control of the machines in an optimal way. The purpose of this design memorandum is to elaborate the major basic parameters / guidelines considered for the design of Control system and digital Governor for the paper project.

Project Information:

Tiga Hydro Power Project is a Surface Power Station comprising of two generating units of 1 X 8MW & 1X2MW capacity.

Site Information:

Project Title: TIGA HPP (1 X 8 MW + 1 X 2MW)

Project Location: Kano, Nigeria.

Environmental Conditions:

Max. : 40^0C

Min : 11-14^0C

Max Relative Humidity: 80%

Altitude: 540m from MSL

Seismic Zone: Seismic hazard (PGA - (0.2 - 0.8 m/s) Richter scale magnitude 3, 0 - 3, 9

Electrical Network Data:

The equipment supplied will be designed to operate under the following electrical environment.

MV Network

Rated Voltage: 11kV (+/-10%)

Highest system Voltage: 12kV

Rated Frequency: 50Hz (+3%, -5%)

Auxiliary Power Supply

LV AC Power supply (If required)

Rated voltage : 415V, 3phase, 4 wire & 240V single phase.

Variation range: +10%, -10%

Rated Frequency: 50Hz (+3%, -5 %,)

Distribution: 3 phases + neutral

Earthing mode: Solidly Earthed

LV DC power supply

Rated Voltage: 110V

Variation Range: +10%, -10%

Earthing Mode: Isolated

III RESULT ANALYSIS AND DISCUSSION

The main focus of this paper is to ensure smooth evacuation of real power generated by Small Hydropower Plant (Tiga Independent Power Plant) units to the neighboring grid. While doing such research, the practical limitations faced by such units have been considered carefully in this work. Among few major issues, the two most important operational issues such as (i) Operation in constant power factor mode and (ii) Operation in voltage control mode have been well addressed in the project work. During the simulation of the study, it is observed that the existing control mechanisms of SHP units (i.e. exciter control) exhibit limited scope of real power evacuation to the grid. In order to overcome this difficulty, the authors have attempted the application of SVC control mechanism and the corresponding results are found to be very much satisfactory. From the above results it is inferred that the application of SVC control in SHP units could provide a viable option for ensuring smooth and secure evacuation of real power to the grid.

This work uses impedance to achieve the required accuracy starting with power flow analysis. Power flow analysis is a steady state analysis. It analyzes the response of a power system long time after switching occurs. Two variables are critical in power flow analysis. They are voltage magnitude and power angle. Before analyzing such variables, review of electrical quantities as complex number and per unit value is appropriate.

IV CONCLUSION

Kano state government changed its policy of power generation in order to overcome power crisis in the state and encourage private industries in this field. Kano state has many renewable energy resources across the state. Since the state fall under north-west region of the country where solar, wind and hydro are available. Tiga area has a high potential for hydro power generation. The state will benefits in many ways with an implementation of a mini hydropower project especially in means of improving infrastructure and the standard of living in the state.

Plant sizing, selection of electro-mechanical equipment was done in proper manner. Adequate protections for the network as well as for the generator and the personnel were accommodated. Control system for power flow and synchronizing were also accommodated as per the practical applications. Monitoring system give a better transparency on operation. Generator performances were tested even by modeling the system. Power line was design in such a way that to satisfy utility constrains and to minimize line losses. In overall this design comprised of a complete electrical system and it confirmed the performances of the project. The evacuation process of the project show the real work and the minimum power losses where shown. The study for the power generation project have been carried out considering the transmission lines that are available with the existing generations in kano state as well as transmission system that developed along with the independent power plant (tiga hydro power generation plant). Any change in the generation schedule of the project may affect the result. So the result of the above study would valid only with the generation scenario considered in the study.

V RECOMMENDATION

The Tiga Dam is in Kano State in the Northeast of Nigeria, constructed in 1971-1974. It is a major reservoir on the Kano River, the main tributary of the Hadejia River. The dam was built during the administration of Governor AuduBako in an attempt to improve food security through irrigation projects.[31] The dam covers an area of 178 square kilometres (69 sq mi) with maximum capacity of nearly 2,000,000 cubic meters (71,000,000 cu ft).[32] Water from the dam supplies the Kano River Irrigation Project as well as Kano City.[33]

Due to that condition if the government can improve the power plant, because tiga dam is the largest dam and the former administration of the state was proposed to build a power plant at a dam, the dam still have two extra canel that will use for power production. The site also has large area that if government can proposed the solar power plant can also been constructed there and connect it to the grid for the benefit of state indigenes.

REFERENCES

[1] A. Wijesinghe and L.L. Lai, *"Small hydro power plant analysis and development", development"*, 4th International Conference on Electric Utility Deregulation, Restructuring and Power Technologies, pp. 25-30, 2011.

[2] S.P. Adhau, R.M. Moharil, and P.G. Adhau, *"Mini-hydro power generation on existing irrigation projects: Case study of Indian sites"*, Renewable and Sustainable Energy Reviews, Volume 16, Issue 7, pp. 4785-4795, 2012.

[3] P. Oliver, *"Small hydro power: technology and current status",* Renewable and Sustainable Energy Reviews, Volume 6, Issue 6, pp. 537-556, 2002.

[4] M.H. Nazari and M. Ilic, *"Technical challenges in modernizing distribution electric poer systems with large number of distributed generators"*, IEEE Power Tech Conference, pp. 1-8, 2009.

[5] A.R. Wallace and A.E. Kiprakis, *"Reduction of Voltage Violations from Embedded Generators Connected to the Distribution Network by Intelligent Reactive Power Control",* Proc. 5th Int. Conf. on Power System Management and Control, pp. 210-215, 2002.

[6] D. Unger, L. Spitalny, J.M.A. Myrzik, *"Voltage control by small hydro power plants integrated into a virtual power plant"***,** IEEE EnergyTech-2012, pp. 1-6 , 2012.

[7] K. Dielmann, A.V. Velden, *"Virtual power plants (VPP) - a new perspective for energy generation?"*, Modern Techniques and Technologies, Proceedings of the 9th International Scientific and Practical Conference of Students, Post-graduates and Young Scientists, pp. 18 - 20, 2003

[8] R. Claudia and B. Maciel, *"A Comparison of Voltage Stability Indices",* IEEE MELECON, pp. 1007-1010, 2006.

[9] IEEE Committee Report, *"Voltage Stability of Power Systems: Concepts, Analytical Tools and Industry Experience",* IEEE, Vol.PES-93TH0358-2-PWR, 1990.

[10] J.C. Chow, R. Fischl, and H. Yan, *"On the Evaluation of Voltage Collapse Criteria"*, IEEE Trans. on Power Apparatus and Systems, Vol. PWRS-5, pp. 612-620, 1990.

[11] Claudio Canizares, *"Voltage Stability Assessment: Concepts, Practices and Tools",* IEEE/PES Power System Stability Subcommittee Special Publication, 2000

[12] R. Raghunatha, R. Ramanujam, K. Parthasarathy and D. Thukaram, *"A new and fast technique for voltage stability analysis of a grid network using system voltage space",* IJ Electrical Power and Energy Systems, Vol.20(5), pp. 337-344, 1998.

[13] P. Kessel and H. Glavitch, *"Estimating the Voltage Stability of a Power System",* IEEE Trans. on Power Delivery, Vol. 1, No. 3, pp.346-354, 1986.

[14] I. Herbert and H. Takashi, *"A real-time PMU data and neural network approach to analyze voltage stability",* International Conference on Advanced Power System Automation and Protection, vol.2, pp. 1263-1267, 20112.

[15] N.G. Hingorani and L. Gyugyi, *"Understanding FACTS: Concepts and technology of flexible ac transmission systems",* IEEE Press, NY, 2000.

[16] B.S. Pali, S. Bhowmick, and N. Kumar, *"Power flow models of static VAR compensator and static synchronous compensator"*, 5th IEEE Power India Conference, pp. 1-5, 2012.

[17] D. Thukaram and L. Abraham, *"Selection of Static VAR compensator location and size for system voltage stability improvement"*, Electric Power Systems Research, Vol.54, Issue 2, pp. 139-150, 2000.

[18] Bhattarai, D. N. (2005*). Hydropower Development in Nepal: A study of Demand for Electricity and Financial Requirement up to 2030.*Devi KumariBhattarai

[19] *Power system analysis & control* by NPTEL lecturers

[20]. *Load flow analysis report* by MPREC.

[21]. M.J.Katira, K.B.Porate*"Load Flow Analysis of 132 / 11 kV Distribution Sub Station using Static Var Compensator for Voltage Enhancement – A Case Study"*

[22]. William D. Stevenson's, Jr. Elements of *Power System Analysis'* Tata McGraw-Hill New Delhi.

[23]. Professor G.A. Evdokunin, chairman *"Efficiency of Power Transmission Lines with Increased Surge Impedance Loading (ISIL) In Long Distance Energy Transfer"* department of electrical networks & systems Saint Petersburg state technical university, Russia November 9, 2000

[24]. Ms. DeepikaTiwari, Student M.Tech. Final, Prof. S.K.Bajpai, HOD Electrical Engg.*"Determination of Techno-Commercially viable Power Evacuation Scheme for 1200MW Malwa Thermal Power station of M.P"* GGITS, Jabalpur 2011.

[25]. H.S. Hippert, C.E. Pedreira, and R. Castro, *"Neural networks forshort-term load forecasting: A review and evaluation,"* IEEE Trans

[26]. D.P.Kothari, I.J. Nagrath*'Modern Power System Analysis'* Tata McGraw –Hill India.

[27]. G. W. Stagg. And Ahmed El- Abid*"Computer Methods in Power System Analysis",*McGrawHill, India.

[28]. M.P.Selvan and K.S.Swarup, *"Distribution System Load Flow using Object-Oriented Methodology",* 2004, int. Conf. on Power system technology-POWERCON 2004, Singapore, 21-24 Nov.2004.

[29]. Professor G.A. Evdokunin, chairman *"Efficiency of Power Transmission Lines with Increased Surge Impedance Loading (ISIL) In Long Distance Energy Transfer"* department of electrical networks & systems Saint Petersburg state technical university, Russia November 9, 2000

[30]. Jaigad Power Transco Limited *"Detailed project report for 400 kV (quad) double circuit power Transmission lines for evacuation of power from Jaigad power project phase-I (1200 MW)".*

[31]. UjududShariff (17 March 2009). *"Food Security and Kano Irrigation Project"*.Daily Trust.Retrieved 2010-05-16.

[32] Barau, AliyuSalisu (2007) *The Great Attractions of Kano. Research and Documentation Directorate Government House Kano*

[33] Edward B Barbier (November 7, 2002). *"Upstream Dams and Downstream Water Allocation - The Case of the Hadejia'Jama'are Floodplain, Northern Nigeria"* (PDF). Department of Economics and Finance, University of Wyoming. Retrieved 2009-10-01