Reliability assessment in IGMS using NEPLAN software

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Abstract — The reliability of the transmission and distribution involves gathering outage data and evaluating system designs. The reliability of the T & D system is decrease due to deterioration of the apparatus due to their age. The reliability of the transmission and distribution system is related to reliability of the individual apparatus. The reliability is increased of the T & D system using different suitable maintenance. So some author proposed Intelligent Grid Management System which provide the suitable maintenance strategy and optimum power control. In this paper the reliability is estimated by the NEPLAN software.

Keywords: Reliability, Intelligent Grid Management System, T & D System, NEPLAN

I. INTRODUCTION

Various methods have been established to explain the reliability [8, 9]. The methods can be generally classified as:

1. Deterministic
2. Probabilistic or Stochastic

The typical norms that are used by deterministic methods to evaluate the reliability of the system are:

1. Planning generation capacity – the total installed size equals maximum demand plus a fixed percentage of the expected maximum demand in power system.
2. Operating capacity – the spinning capacity equals anticipated load demand plus a deputy equal to one or more largest units of the system.
3. Planning network capacity – to construct a minimum number of circuits on a load, the minimum number being dependent on the maximum demand of the group in the power system network.

Typical probabilistic aspects are:

1. System availability
2. Estimated unsupplied energy
3. Number of failure incidents
4. Number of hours of interruption
5. Excursions beyond set voltage limits
6. Excursions beyond set frequency limits

II. BASIC CONCEPT OF RELIABILITY

The term “system reliability” can be divided into the two basic concepts: System adequacy, System security

The concept of system adequacy is basically considered to be the existence of sufficient facilities within the system to satisfy the customer load demand and operation constraints. These facilities include those necessary to generate sufficient energy and the associated transmission and distribution system required to transport the energy to the actual consumer load points. Adequacy thus is considered to be associated with static conditions which do not include system disturbances.

Security, on the other hand, is considered to relate to the ability of the system to respond to disturbances arising within that system. Security is therefore related with the reaction of the power system to whatever disturbance is occurred, they are subjected. These are considered to include conditions local and extend effects and the loss of major generation and transmission facilities. The security concept relates to the transient actions of systems as they advance from one area and enter another area.

III. RELIABILITY INDICES

The adequacy assessment of a power system includes evaluation of convinced measure at one or more of the categorized levels [10, 12]. Each measure is related with a single reliability feature or a combination of certain reliability aspects. Such characteristics are system availability, estimated unsupplied energy, number of incidents, number of hours of interruption, etc. [12]. For example, some of the reliability measures are:

1. SAIFI – System Average Interruption Frequency Index

$$\text{SAIFI} = \frac{\text{Total number of customer interruptions}}{\text{total number of customer served}}$$

2. SAIDI – System Average Interruption Duration Index

$$\text{SAIDI} = \frac{\text{sum of customer interruption durations}}{\text{total number of customers}}$$

3. CAIFI – Customer Average Interruption Frequency Index

$$\text{CAIFI} = \frac{\text{total number of customer interruptions}}{\text{total number of customers affected}}$$

4. CAIDI – Customer Average Interruption Duration Index

$$\text{CAIDI} = \frac{\text{sum of customer interruption durations}}{\text{total number of customer interruptions}}$$

5. ASAI – Average Service Availability Index

$$\text{ASAI} = \frac{\text{customer hours of available service}}{\text{customer hours demanded}}$$

6. AENS – Average Energy Not Supplied

$$\text{AENS} = \frac{\text{the total Energy Not Supplied}}{\text{the number of customers at load point i}}$$

IV. INTELLIGENT GRID MANAGEMENT SYSTEM

The concept of Intelligent Grid Management was proposed to solve the reliability of system, economic aspects and aged equipment in modern transmission and distribution system. IGMS works on failure pattern of aged equipment which can be maintain by different maintenance strategies or procedures. The reliability of system is increases with the maintenance. In power system high reliability and power quality must be required. Reliability is decreased with age of apparatus or equipment. IGMS gives the planning of the maintenance and increased the life of the equipment using suitable maintenance with timing [1-6].

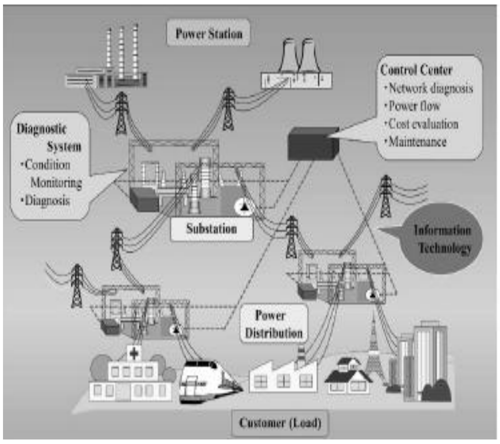

Fig. 1: The basic concept of Intelligent Grid Management System

IGMS (Intelligent Grid Management System) has proposed first time by Hiroki Koijima, Fumihri Endo, Masaki Kanamitsu, Naoki Hayakawa and Hitoshi Okubo Nagoya University, Japan [1]. IGMS was proposed to solve the issue of economic aspects, aged equipment, reliability and cost of the transmission and distribution system. The reliability and quality of the power system required because of the rise of a life level of the system. This problem can be solved by the Smart Grid. But the reliability of the aged equipment should not consider in the smart grid. The reliability of the equipment is affecting the whole system reliability. So the T & D system maintaining balance is required between cost and quality. Solve this problem the Intelligent Grid Management System was proposed by Nagoya University, Japan [1-6]. IGMS calculate the equipment failure impact on the total system and offers suitable operation and maintenance strategies which is mostly economically. The basic concept is shown in fig. 1.

The basic concept is also representing by the algorithm and flowchart which is discussed in next section. IGMS can analyse the individual equipment failure and condition as seen from the view point of the whole system and provides the most economically practical maintenance strategies and operation of the transmission and distribution.

The algorithm which is derived an optimum maintenance strategies and timing of the equipment in consideration of maintenance history [2]. The entire transmission and distribution system is scope evaluated in terms of T & D loss, Transmission and distribution system reliability, overload operation, outage cost [1, 3-6].

V. SIMULATION PROCEDURE AND FLOWCHART

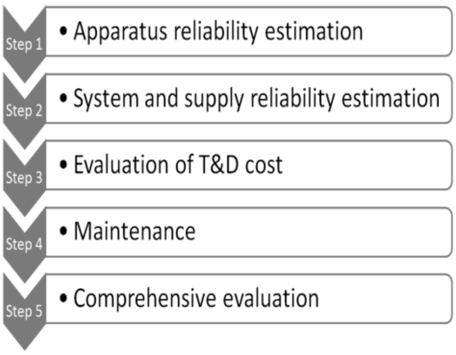

Fig. 2: Algorithms for Intelligent Grid Management System

The algorithm of Intelligent Grid Management System is shown in fig. 2. The algorithm consists of the following steps:

The flow chart for the optimization of cost and reliability in intelligent Grid Management System (IGMS) is shown in Fig.3

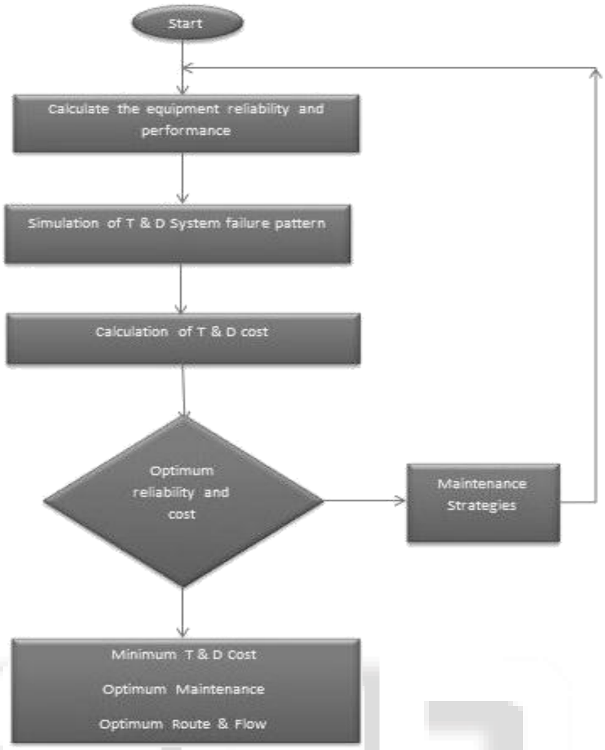

Fig. 3: Flow chart of Intelligent Grid Management System

VI. NEPLAN SOFTWARE

NEPLAN is software that used for analysis of electric power systems by BCP group in Switzerland [11]. The main features of the software include optimal power flow, transient- short circuit and reliability evaluation. NEPLAN can provide reliability indices for individual load points and the overall system [10-12]. The working of the NEPLAN software shown in simple diagram of Fig. 4

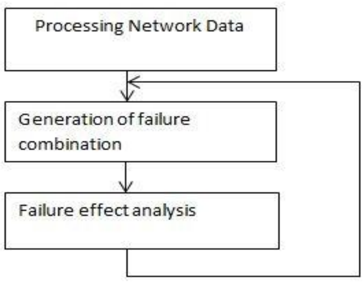

Fig. 4: Working of the NEPLAN

The first step is to analyse the network data for load flow analysis as well as the data for reliability evaluation. In the next step the program generates failure combinations. The failure combinations may be either individual failure or occurring at the same time multiple failures. The first order failures or individual failures consider a failure of only one component in the system. The second order or multiple failures consider simultaneous failure of two components in the system [10].

Processing of a failure combination produces a value for the contribution of that combination to the reliability characteristics of the network, expressed as a probability. The contribution of this failure combination is added to Processing Network Data Generation of failure combinations Failure effect analysis the factors already identified, so that after processing all relevant failure combinations, a detailed picture is obtained of the interruptions occurring at each load node [12].

VII. SIMULATION

NEPLAN software is used for analyses the reliability indices of the transmission and distribution system [11]. Here a 5 buses system is used for the reliability of the system. The circuit diagram is shown in Fig. 5

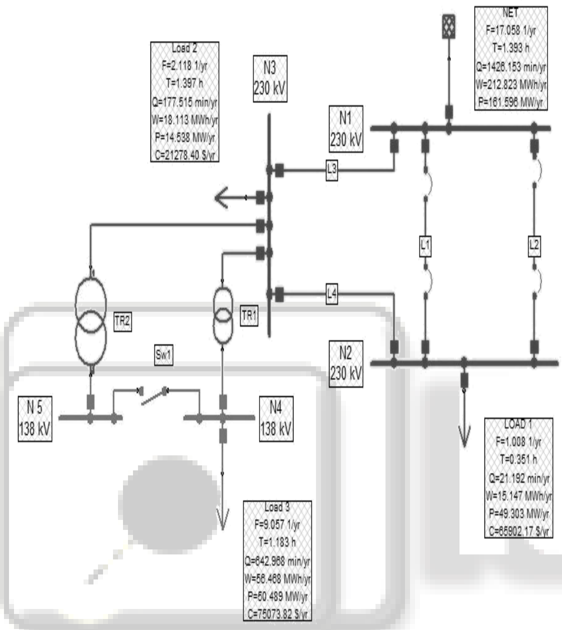

Fig. 5: buses systems which used in reliability analysis in NEPLAN software

VIII. OUTPUT RESULT OF NEPLAN

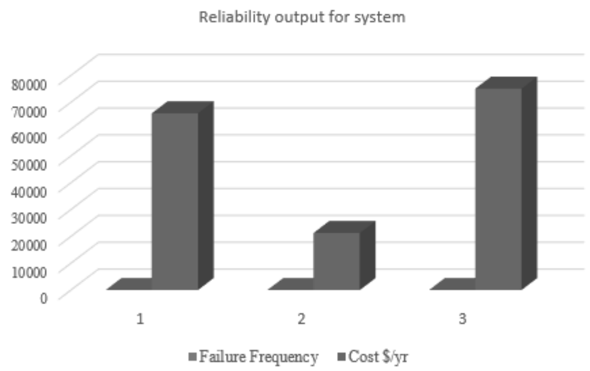

Fig. 6: Reliability output for system

Load point	Failure Frequency [1/*yr*]	Failure Duration [*h*]
Load 1	1.008	0.351
Load 2	2.118	1.397
Load 3	9.057	1.183

Table 1: Load point indices of reliability test

Load point	Failure freque ncy	Failure duration	Q= Min/yr	W= MWh/yr	P= MW/yr	Cos t = $/yr
Load 1	1.008	0.351	21.192	15.147	49.30	659 02
Load 2	2.118	1.397	177.515	18.113	14.53	212 78
Load 3	9.057	1.183	642.968	56.468	50.48	750 73

Table 2: Overall system indices of reliability test

IX. CONCLUSION

The reliability of the power system is vital for the secure power system. The reliability of the system is decreased with aged apparatus failure due to its deterioration. The reliability of the system is increased by the diagnosis of the equipment. The maintenance is done based on the historical data and condition assessment. For the reliability of the apparatus the failure rate should be calculated. The failure rate of the apparatus is estimated by age, health and condition of the apparatus. Then maintenance strategies applied on the apparatus in the system. The reliability can be calculated by deterministic and probabilistic method.
In this report the NEPLAN software is used for the estimate the reliability of the system. This software should work on the Markow model Probabilistic method. This software is directly calculated the SAIFI, SAIDI, CAIDI and CAIFI. The load scheduling, outage and overvoltage operation is directly calculated.

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