INCLUDING SLACK BUS IN NEWTON RAPHSON METHOD FOR LOAD FLOW SOLUTION: A REVIEW

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Abstract : For power system operators, a load flow solution is a preordained tool for planning and operation power system. There are numerous methods available for the solution of load flow but Newton Raphson is used mainly among various methods of load flow solution techniques. Newton Raphson method for load flow is based on the assumption that out of the available generator buses, one bus will be kept out of operation and will be used in case of failure and power losses. In the Newton raphson iteration process this slack bus is not included and all the losses calculated at the end of an iteration are shifted to this slack bus because the system without losses is almost impossible. But in the case of Micro-grid system, which is a combination of mini power plants which include solar panel power generation, wind power generation, all other. In those small capacity power plants, there is no possibility of a separate bus which can take the burden of the failure and losses in the system. So there is a possible modified Newton Raphson method for having not any slack bus or including all the generator buses within the iteration. This method can be even applied to the large capacity power plant. This paper is a review of the change in Newton Rap son Method and compare result analysis of simple Newton Raphson Method and Modified Newton Raphson Method which has the addition of slack bus.

***Index Terms*–Slack bus, Micro-grid, Load flow.**

I. INTRODUCTION

Load flow is important for Power generation, Distribution and Balancing. In Load flow studies various methods exist including Newton Raphson, Fast Decoupled Newton Raphson and much other. Presence of Slack bus in load flow studies is major cover. But in micro-grid system of present technology, the slack bus existence is improbable. Because installing separate unit that will work when there is failure or loss in system will not be economical and reliable. But if slack bus is distributed in system then sustainable Power flow can be possible.

II. ASPECTS OF VARIOUS FACTORS

2.1 Concept of Slack bus

In traditional methods have substation as distributed generators, also the system has single slack bus. The whole load of loss is carried by slack bus, this is theoretical conception. But in real life there no such practical slack bus existence in the system. Even, in modern developing techniques the selection of Slack bus with the integration of network become more complex. As in modern technology the is trend and need of micro-grid, in which the slack bus which can be tolerate the load of loss and failure in systems might be impossible because the generation capacity of single unit or bus in micro-grid is not much high.

2.2 Requirement and function of Slack Bus

In a Power system there are mainly two types of buses in Practical life which include Generator bus (PV bus) and Load bus (PQ bus). But as discussed before for load flow solution slack bus is required to take the load of load and failure of any other bus in the system, which measure it would generate the power of same proportion as that of loss and failure in the system. So it can be counted that slack bus is generator bus.

2.3 Distributed Generator

Distributed generators can be classified into two types which include Non-participating Distributed generator (PQ model) and Participating Distribution generator (PV model). The PV buses can provide the real power generation in small Intensity in Renewable sourced power generation plant. But such small intensity generators are combined together to form a mini small grid system or micro-grid system. Therefore PV model bus generators are counted as Distributed Generators. In conventional power generation and distribution the utility grids are mainly located in Remote areas and power is being transferred through transmission tower, and then distributed as shown in figure 1, but in micro-grid there is concept of multiple Power generation sources near the energy consumers, which make it easy to control and tackle. These Multiple power generation sources are counted as Distributed generation, which is interconnected hub of Energy generation small power plant, large grids as well as consumers as shown in figure 2. India gets power generation of 77,641 MW annually from Distributed generation. Whereas USA amount is 742.316 TWh, china has 1,692,100 G Wh. Despite of these countries Iceland, Sweden, Costa Rica generate 100% energy from Distribution Generation.

2.4 Micro-grid

The micro-grid is bunch of Energy Distributed Generators, reticulate loads and Storage system, which can regulate the power instead of main power grid. The micro-grid is embrace on the notion of single unit Power system which is combination of large number of distribution generators. The power generation is mainly depend on the non Renewable energy source, which mainly counts, Thermal power plant, Nuc,,lear power plant and other but these plants somehow affect the environment. Moreover, because of some of the technical problems, like: long-distance transmission, transmission of power through high voltage medium, even transmission losses all these fact causes inconvenience in load flow. But, as already discussed micro-grid is embrace on distribution power generation which mainly contribute to green energy such as Wind, Solar and hydrogen based power plant. The integration of two or more such plants form Micro-grid. Also these micro-grid does not affect the environment to same extend as non- renewable sourced power plant affect.

2.5 Limitation of Finite Power generation in Micro-grid

Because of this finite power generation in Micro-grid plants, the basic concept of load flow i.e. considering one separate generator bus as slack bus will not be able to implement in such micro-grid systems. On this fact, if losses occure in such micro systems or any unit or bus fail mean while the operation. Then for supplying load of losses and shifting the load of failure bus to some another one will not be possible.

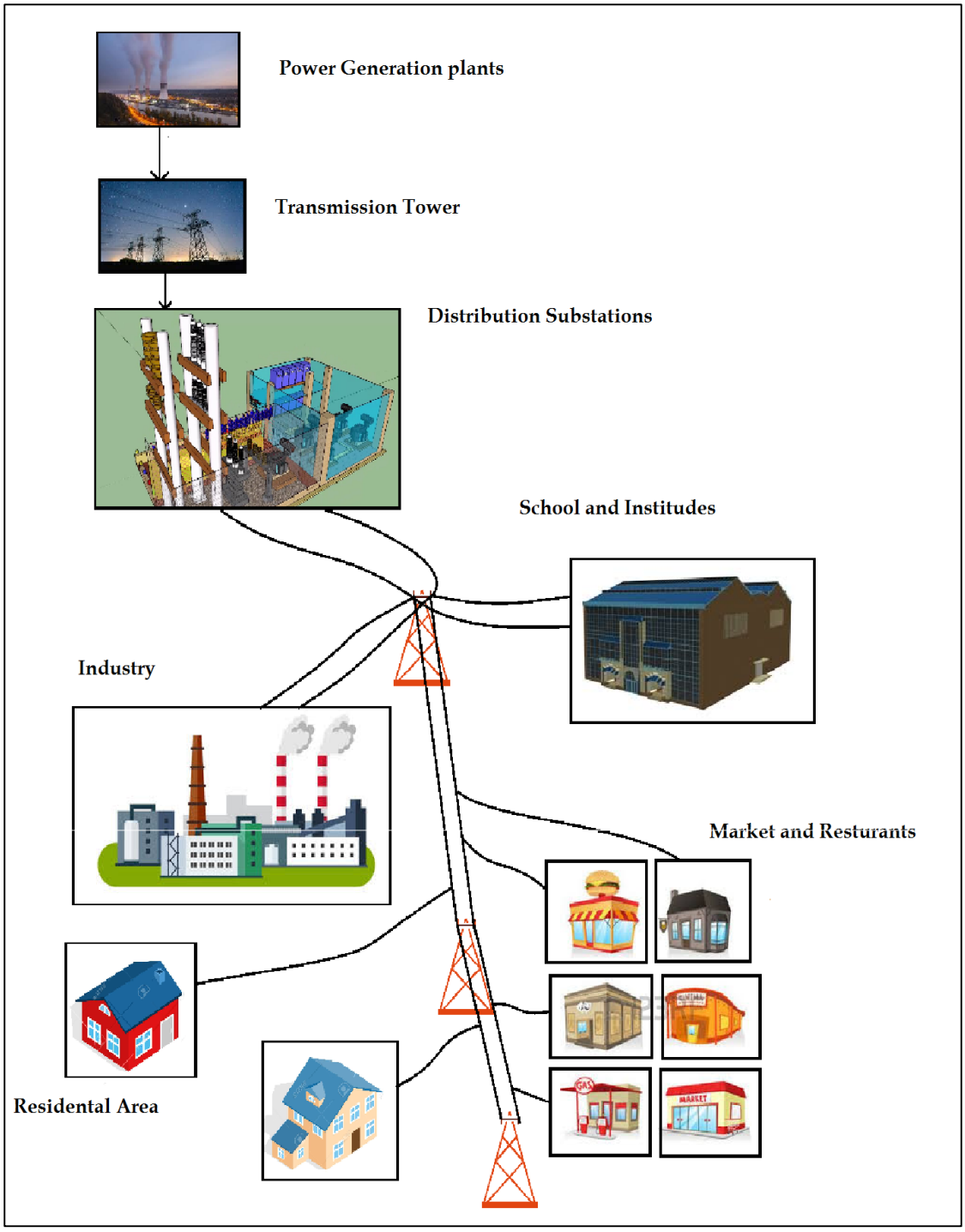


Fig. 1: traditional method of power generation and distribution

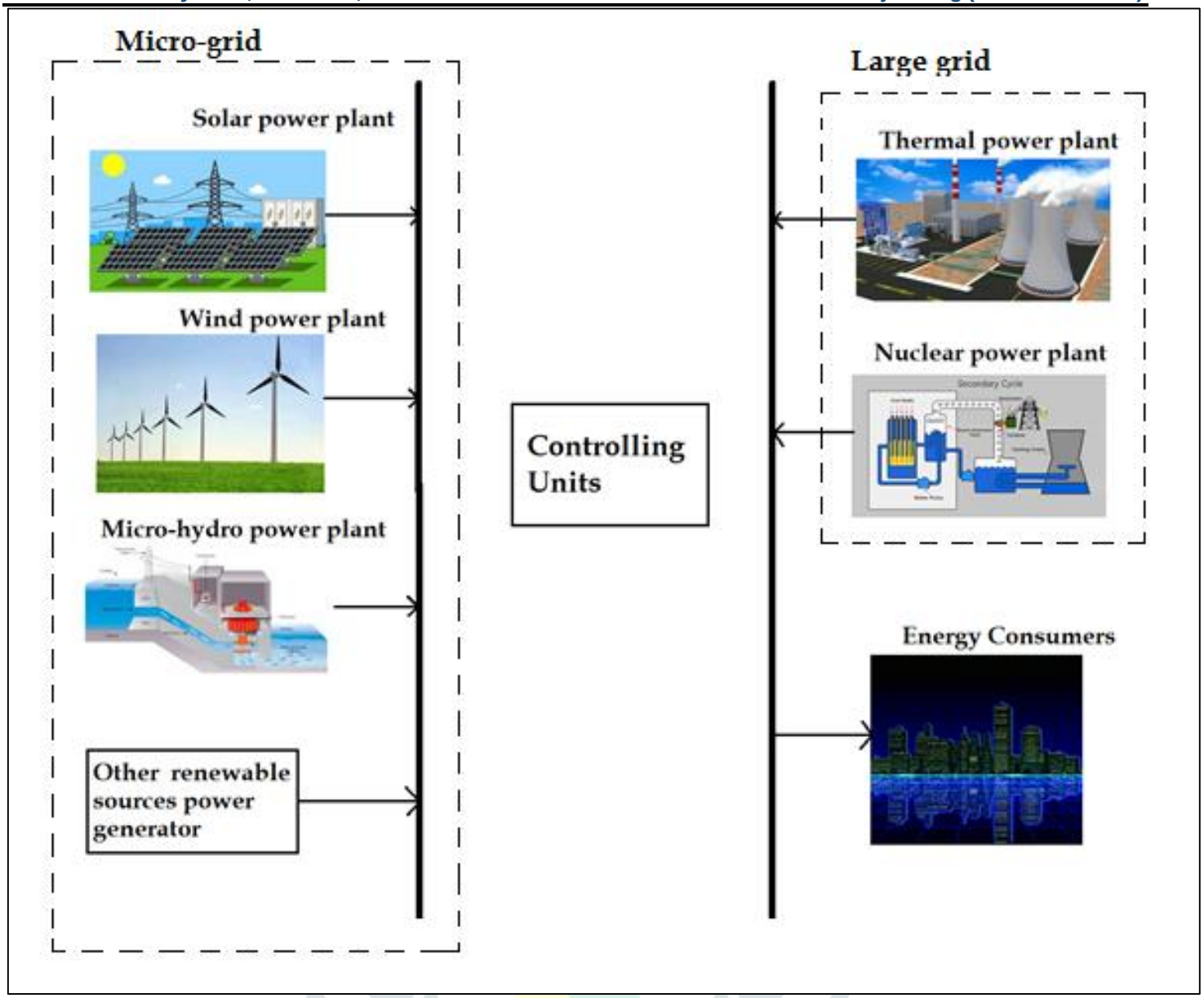


Fig 2: schematic modern power flow including large grid, micro-grid and consumers

III. POSSIBLE SOLUTION FOR SLACK BUS REQUIREMENT IN MICRO-GRID

If assumption is taken that function of slack bus will be shifted to all PV buses amiable in the system, then it could not be implement in mathematical modeling of simple Load flow method (Newton Raphson is taken as refermce in this paper for load flow solution). Because in simple load method, at the starting of iteration for calculating the losses, one bus is kept out of the iteration. So that all the losses calculated in iteration can be shifted to that bus. As shown in flow chart(Figure 3)

For slack black requirement in Mircro-grid, the method of load flow is needed to be modified with including all buses in the iteration and losses calculated will be shifted to all the possible buses as shown in modified Flow chart(Figure 4)

FIGURE 3: FLOW CHART OF SIMPLE LOAD FLOW METHOD

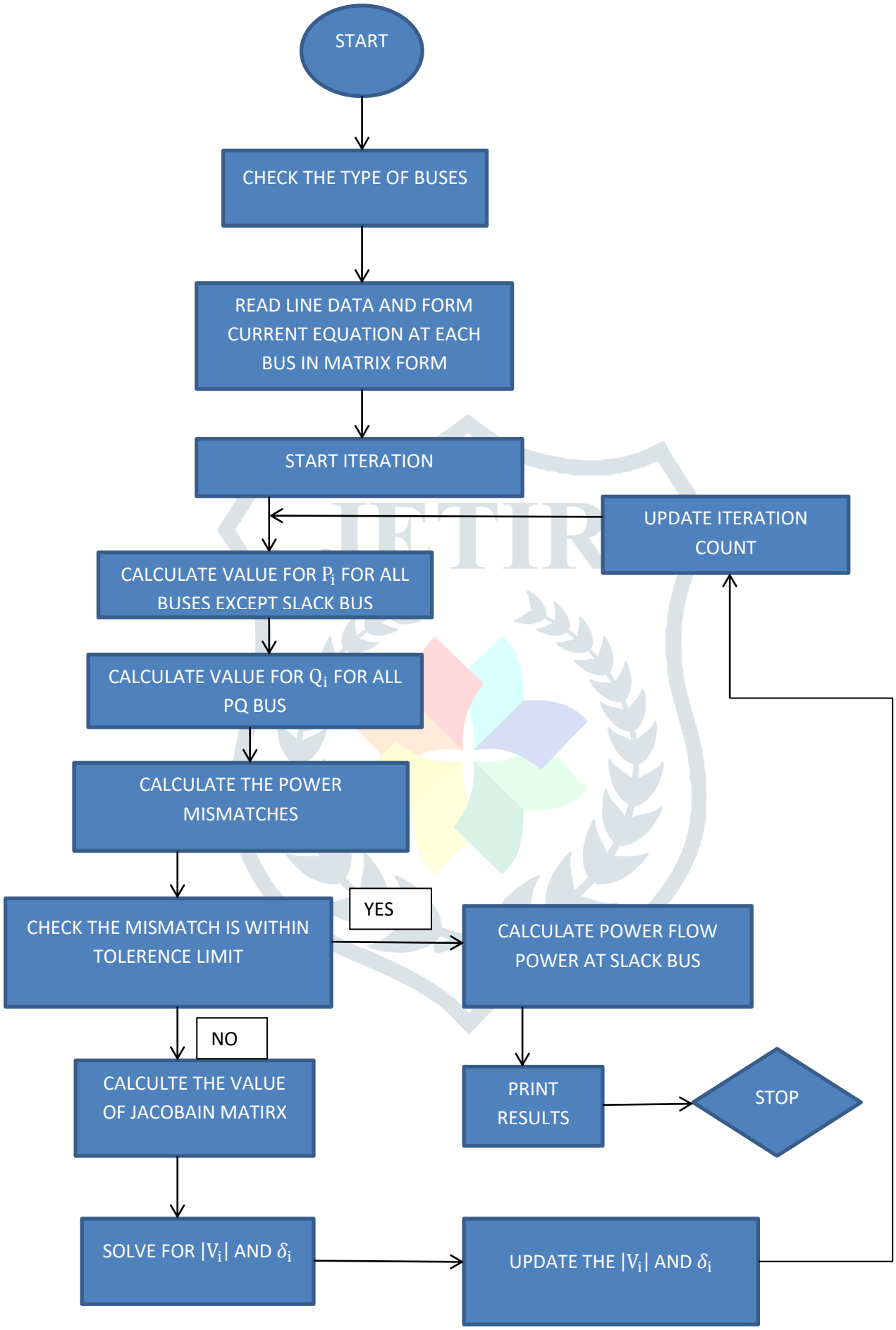
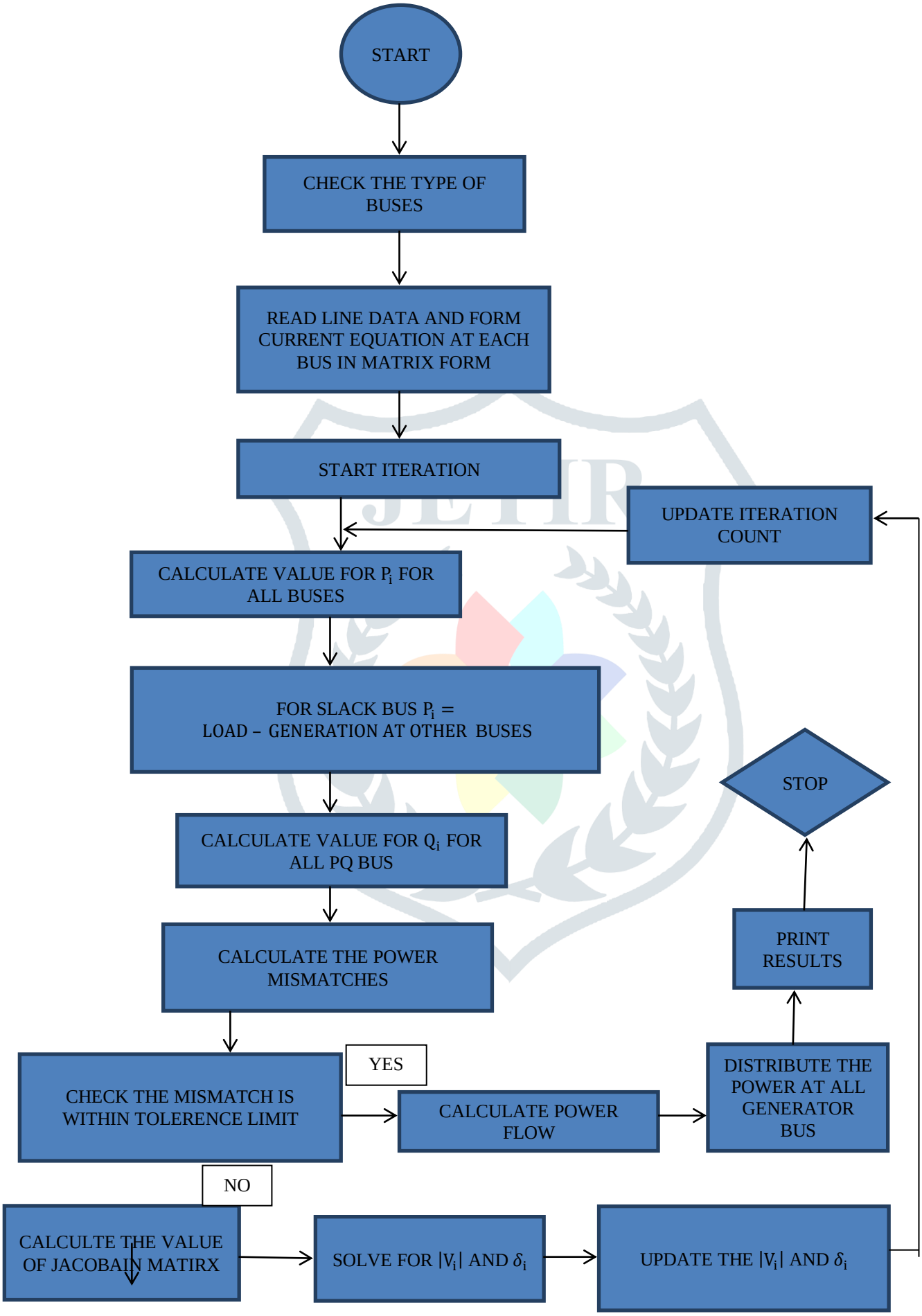


FIGURE 4: FLOW CHART OF MODIFIED LOAD FLOW METHOD FOR INCLUDING SLACK BUS IN ITERATION



The modified method had been implemented to the number of buses, the result would show that when the load of slack bus which is providing the losses supply would be distributed among the various generator buses then the losses will distribute according to generation capacity of generator, even the load will reduce more and more with the increase in the number of generator buses. For instance, if 4 generator buses system is considered the load will be distributed equally among those 4 buses according to their generation capacity.

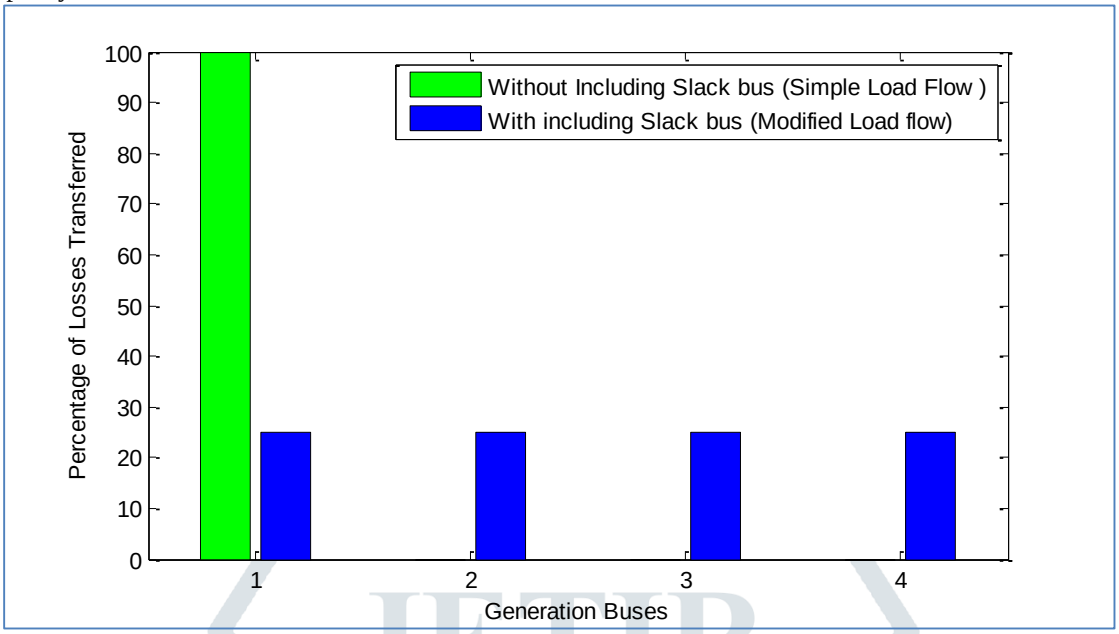


Fig. 5: data of losses shifted to slack bus and other generation buses

IV. CONCLUSION

The basic requirement for modification is mainly for micro-grid load flow stability and reliability. However the results shows that modification in simple load flow method by including slack bus in iteration and distributing the burden of losses on other buses, can reduced the losses in the system. Moreover low Power generation can satisfy the same amount of load, as that of system in which slack bus is kept out of iteration.

V. FUTURE DIRECTIONS

Since power generation from Non-Renewable energy source will not stay longer, therefore shifting dependence of renewable sources Power plant will be only option. So this method will help in finding load flow analysis.
This method has been implement on Newton Raphson Method only, but testing on other load flow method can also drive unexpected result.

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