A new method to improve reliability of power grid by using plug in hybrid electric vehicles and distributed generation

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Abstract—New progress in the power system has opened a new era of electric grid operations, prompting smart approaches. Smart grids are mainly designed to integrate renewable energy sources into a more reliable and efficient system. The characteristics of energy storage systems may be useful in meeting these goals. One of these features is its ability to improve system reliability by allowing islands to perform much better. In this paper new method is presented to enhance the power system's reliability by using plug-in hybrid electric vehicles and distributed generation. This paper aims to find the best size of the parking lot for installation and loading to improve system reliability while keeping costs low. The general method for this paper is described in this section. A two-stage approach has been developed to minimize the objective function under study, which is paired with a genetic algorithm (GA). The discrete size of the Parking lots units and the discrete component of the load choice factors on each bus are represented by numerical variables in each solution.

Keywords- vehicle to grid, power system reliability, smart grid distributed generation.

I. Introduction

Power systems transition from a simple style to an unpredictable structure that effectively allows generators to connect directly to distribution systems. With its ability to properly execute islanding and penetrate renewable energy sources, the Energy Saving System (ESS) is a viable technology that can support smart grid disruptions. Other advantages of energy storage systems (ESSs) are demand-side management and strategies to improve power quality in distribution systems.

According to [1,2], distributed energy sources (DERs) can meet grid demands during planned and unplanned outages. As a result, successful islanded mode operations improve system resilience by eliminating load losses or lowering the amount of energy lost to unaffected consumers during service disruptions.

In [3,4] authors proposed using PHEV in the v2g mode to improve the power quality factors in distribution power network.

When a disruption occurs, island generation may help improve system resilience and allow the system to run in island mode if distributed energy sources are available. However, because the generated capacity of renewable sources, such as wind and photovoltaic panels (PV), is unpredictable, distributed units cannot depend completely on such resources to improve system reliability. They could also employ Electric vehicle parking lot (V2G) as a backup source in a network outage. The main challenge in introducing the concept of non-volatile distribution systems is the high cost of V2G-related installation and commissioning, which means that distribution units must calculate the optimal size of parking lot units to be installed to minimize installation and commissioning costs and maximize reliability-related improvements. In [5-8] the new method was proposed to improve under frequency load shedding in the power grid and [9] introduced a solution to coordinate zone 2 &3 of protection relays in the power grid by considering wind generation and series capacitors.

This paper looks at a value-based dependability approach to increase distribution system reliability from an economic standpoint. In practice, instead of obligatory requirements, production costs have used flexible goals as reliability criteria [10-12]. These targets are typically based on popular assessments of general consumption and customer tolerance levels concerning the number of power interruptions. However, the high expenses involved in the planning process mean that decisions should not be made based on the function of generic criteria in minimizing failure costs. It depends on customers.
To put it another way, obtaining these desired aims may raise the cost of public utilities much more than the costs that customers must pay during disruption. Reliability goals are costly in this scenario, and they are considered unnecessary due to the higher expenditures.

Furthermore, no incentive or penalty system mandates government spending to attain the required degree of reliability in many circumstances, despite certain customers being ready to pay more for higher reliability targets.

Willingness to pay (WTP) measures the value of dependability that public utilities may lose if they do not achieve the necessary degree of reliability for their customers. As a result, it's critical to explore optimization methods that consider economic concerns while determining the best investment strategy and level of reliability—improving the reliability of smart power distribution networks using the energy storage system. An economical proposed method in [17-19] would be beneficial to use in smart grids for reducing the cost of using renewable energy sources.

II. Problem-solving

The first step in determining the amount of power necessary from each parking lot unit allocated to feed the power. Demand for all potential island organizations needs a probabilistic study of the distribution system for each population generated by GA [13]. The following stage employs Monte Carlo Simulation (MCS) to assess the distribution system's reliability by calculating the unexpected supply of energy (EENS) and component cost indicators. Mathematics Relationships The following parts go over the problem in detail sections [14].

A. The first stage

The probabilistic model includes the random character of all Distributed generators and load demands in the initial stage. Fig (1&2) show an algorithm for detecting island and DG sizing. A sequential MCS is run for the system after the power requirements of each parking lot unit are determined. MCS' principal goal is to create a fictitious performance record for the system under investigation.

The study time (NY) has been translated into parts after the artificial study time (NY) has been generated for all components of the system (hours). The system is then recreated hour by hour for the whole period. The system mode is checked every hour to see if it is in common or island way. If the stored energy is sufficient and the power required is less than the rated parking lot power, each parking lot unit only gives the necessary power in island mode. The equation calculates the amount of energy stored in each parking lot unit every hour (1).

\[
E_{DG,i} = E_{DG,i-1} + P_{DG,i}^{sh} \times \eta_{DG} - P_{DG,i}^{dis}
\]

\[
0 \leq E_{DG,i} \leq E_{DG_i}
\]

\[
|S_{DG,i}| \leq S_{DG_i}
\]

in equation (1) (ch, dis) refers to charging and discharging, respectively. It also displays the parking lot output speed in its entirety. The equation (4) calculates each year's final costs.

\[
COST = \frac{1}{N} \sum_{y=1}^{N} \sum_{d=1}^{T_d} \sum_{i=1}^{d} CDFN(f_d) \times P_{SH,i,t} \times P_{DL,i,t}
\]
III. Case study

In order to simulate the proposed method a 33 bus IEEE system is applied [15]. The parameters relating to the system's reliability are also addressed in the reference [16].

There are two types of DGs for this system: photovoltaic distribute generation and wind.

A. Simulation results

This section presents the findings of the research, in which parking lot units are assigned to investigate all-island formation modes in order to increase system reliability. To study the influence of DG placement, DG1 and DG2 are connected to pins 33 and 18, respectively. Fig(3) shows the situation of installed DG (wind & PV) in the power network. Fig(4) shows the best parking lot locations and sizes, as well as load placement points. The new DG positions do not affect the sizes or locations of specialized parking lot units. These results, however, are system-dependent, thus they could vary nominal power levels by employing DGs or load points. Fig (4-6) shows different islanding scenarios.
B. The effects of a total constant factors

The influence of load break costs on the size and optimal placement of installed parking lot units, as well as load drop points when a fault appears, is examined in this scenario. A considerable number requires larger DS units of high-cost industry clients. Figures 7 and 8 show overall annual costs and the level of v2g reliability necessary for various scenarios.

CONCLUSION

A two-stage methodology for parking lot units in cost-effective distribution systems was examined in this paper to improve system reliability. The overall annual cost comprises installation and maintenance costs and fixed expenditures that have been reduced to establish the best mix of parking lot units and planned loads during probable occurrences. A probabilistic approach is used to compute the power requirements of specialized parking lot units, taking into account the random nature of all system components, including loads and all available DGs. A case study is presented, with two storage technologies contrasted to one that does not have parking lot. Because of their ability to produce successful island operations and minimize fixed costs suggests that integrating parking lot units with distribution systems reduces the annual expenditure on public utilities. As a result, improvements are more cost-effective. Finally, a sensitivity analysis examines the impact of actual costs on the outcomes.

REFERENCES


