

Renewable Energy Integrated Smart Microgrid Scheduling for Electric Vehicles and Home Appliances

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ABSTRACT: Micro grids become more reliable, stable, and cost-effective by using EVs as electricity storage and renewable energy sources as distributed generators (DGs). Integration of renewable energy sources and electrical vehicles (EVs) reduces greenhouse gas emissions. In this paper, we propose a scheduling method using neural network to control the electricity consumption of home appliances and plug-in EVs. This reduces the electricity prices to customers. Finally, we compare the electricity consumption in scheduling done by neural network and electricity consumption obtained from a naive scheduling framework.

KEYWORDS: scheduling, neural networks, smart micro grids, V2G.

I. INTRODUCTION

Long distance transmission and distribution cause a substantial amount of power losses in the existing power grid. Almost 90% of the power outages are caused due to the failures on the transmission and distribution lines of grid. In world greenhouse gases 41% are emitted by Electric power generators, 23% by transportation system and 6% by residential houses. Smart grids will provide more electricity to meet rising demand, increase reliability and quality of power supplies, increase energy efficiency, able to integrate low carbon energy sources into power networks. A smarter grid will provide greater control over energy costs and a more reliable energy supply for consumers. Environmental benefits of a smarter grid include reduced peak demand, integration of more renewable power sources, and reduced CO₂ emissions and other pollutants. Smart grids possess demand response capacity to help balance electrical consumption with supply, as well as the potential to integrate new technologies to enable energy storage devices and the large-scale use of electric vehicles [1]. The performance of EV scheduling is done with load bidding that includes optimal EV charging results in maximum utilisation of wind and solar power and optimized discharge of EV results in minimum operational cost of microgrid. The expectations of charging power, battery capacity of EV are technical limits of charging power of battery and battery capacity and users. Due to the increase in load demand the utilisation of renewable energy has become more important [2]. The electrification of vehicle creates an impact on grid due high consumption of electricity. The charging and discharging of will change the load profile of electrical system. The load profile of the electrical system is flattened by the charging patterns of EV which is scheduled optimally. So that the operational cost and potential capital costs are minimized. The load profile is reshaped by intelligent scheduling of charging and discharging of EV. During the low demand condition EV is charged from the grid and it is discharged to grid during the high demand condition. Globally minimal total cost is provided by global optimal scheduling.

The information on the future base loads, charging periods of EV in future time of the day are required for global optimal scheduling and it is impractical [3]. Depending on the power level, timing, and duration of the EV connection to the grid, there could be a wide variety of impacts on grid constraints, capacity needs, fuel types used, and emissions generated. Some areas that could be more fully explored include: The relative emissions, gasoline use, electrical primary fuels use, and added generation needed to meet PHEV needs. The impact of alternative vehicle operation schemes (longer distance batteries, partial charging,) provided daytime charging, vehicle to grid generation. Transmission and distribution impacts from EV are options for utilities to modify customer

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behaviour, options for utilities and EV manufacturers to improve the vehicle/grid system and options for utilities to take advantage of PHEV characteristics to improve grid reliability[4]. The operation of electric power will become complex as the population of EV increases. The strategies of decentralisation permits the EV to choose their own charging pattern[5]. The decentralised EV charging protocol is used to shift the EV charging to off peak hours from peak hours. Different prices for different hours of the day are considered and peak hour load is minimised by imposing penalties on EV[6]. In V2G (vehicle-to-grid) operation, one million EVs with 16 kWh battery capacity can supply 2000 MW to the grid for a time period of up to two hours while discharging at a rate of 2 kWh. EVs may play a dual role in micro grids; they act as loads to the micro grid when plugged in for charging and as storage for electricity in the stationary state [7]. Along with charging infrastructure, investment required to develop intelligent IT infrastructure for smart charging of EVs and reliable services to home [8]. Currently, most of the home appliances consume electricity in a continuous fashion with tight scheduling [9]. Some of them consume electricity continuously while others operate in a distributed fashion with flexible scheduling [10].

Keys to achieve the Smart Grid are architecture communications and technology an integrated approach to deploy technology [11]. It should allow for efficient and economic development of new applications. The effective two-way communication, with all parts of the electric grid is essential to achieve the vision and to handle very large amounts of data points to glean information [12]. It utilizes technological enhancements in equipment and methodologies that are cost effective, innovative, interchangeable and reliable to provide the performance enhancing capabilities throughout the electric grid [13-14]. Our scheduling method results in the optimal use of electricity generated from renewable energy sources and minimize the amount of imported electricity from the grid. Consequently, it reduces the electricity price for the microgrid customers [15-16].

II. SYSTEM MODEL

A. PV SOURCE

The solar panel is connected to the smart microgrid. The output of the solar panel differs with the amount of solar radiation that incident on the panel and the angle of incidence. The number of PV cells decides the output power. The maximum power is produced during the maximum intensity of solar radiation. The solar radiation is less during the high cloud intensity. The output of the solar panel is given to the smart microgrid. The generated power from the solar panel is direct current. Hence the direct is inverted to alternating current by connecting an inverter between the solar panel and the microgrid.

B. WIND TURBINE

A wind turbine is a rotating machine which converts the wind kinetic energy into mechanical energy. The speed of the wind changes frequently so that the wind speed at every hour is monitored. Wind power generation is very economical because of zero fuel cost. The wind turbines have a cut-in wind speed from 2 m/s to 5 m/s and cut-off wind speed from 15 m/s to 25 m/s. The speed of the wind below the cut-in wind speed the wind turbine does not produce power. The wind speed above the cut-off wind speed, the wind turbine generates the maximum power as the output. The power generated from the wind turbine is given to the smart microgrid. The output power from the wind turbine is direct current and varying. To make it constant output a rectifier is used. Then an inverter is connected between the rectifier circuit and the microgrid.

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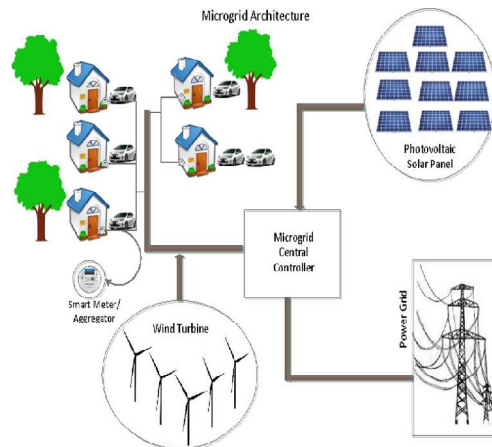


Fig .1 Microgrid Architecture

C. PHEV

Plug-in hybrid electric vehicles with renewable energy sources are becoming more popular. There are two ways of charging the plug-in hybrid electric vehicles. They are electric outlet plugging and onboard electricity generation. These vehicles can be operated at electric mode. PHEV is constructed with larger battery so as to drive at full power. It consumes high amount of power for charging its battery. This may cause the demand of electric power and creates an impact on distribution grid. PHEV is capable of charging the battery from energy generated during running time of the vehicle. In total consumption of electrical energy it becomes a part. To overcome these problems electric vehicles are charged directly from the grid and it supply power back to the grid during power demand. In this system PHEV is used as load as well as the source to the microgrid. The electric vehicle consumes power from the smart microgrid during low load demand period. Then it supplies the grid with power during high load demand period. The PHEV is connected to the microgrid through a bidirectional converter. During the PHEV charging it converts the ac power from the microgrid to charge the battery. Then it converts the dc power in battery of PHEV to ac power to supply power to the microgrid.

III. SMART MICROGRID AND SCHEDULING

Smart microgrid is an ideal way to utilise renewable energy sources in effective manner. It is the reduced scale of normal power grid equipped with a microcontroller so that it can operate independently. In this paper, scheduling is done with neural networks. The scheduling is done in the way to reduce the electricity consumption of the loads that are connected to the grid. During the half peak hours the demand of the electricity is low. At this time microgrid charges the PHEV. During the peak hours at high demand condition PHEV supplies power to the grid. Microgrid imports power from the neighbour grid during power shut shortage and exports power to the neighbouring grids. The scheduling is done to utilise the maximum amount of power from the renewable energy sources. The smart microgrid scheduled by neural network is more effective and economical than the regression algorithm scheduling. Finally, the scheduling by neural network is compared with the scheduling done by regression algorithm

IV. SIMULATION RESULTS

In this section, we simulate our proposed method, neural networks and compare the results with our optimal results with those obtained from regression algorithm scheduling. For simulation purpose we have taken data from small community residential subscribers. These data are prepared as energy data sheet which is used in the neural network for simulation. The fig.2 represents the load at the system with respect to time. The fig.3 represents the load forecasted by regression algorithm which used in naïve scheduling. The fig.4 represents the load forecasted by our proposed algorithm, neural network. Loads which are connected to the microgrid are now scheduled to minimise the electricity consumption. First, the neural network forecasts the load connected to the grid. Then it analyse the energy data sheet that we prepared with historical data. Finally it finds the data from the energy data sheet related to the present data

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obtained from the forecasting and schedules the load in the effective way to utilise the renewable energy and reduced energy consumption.

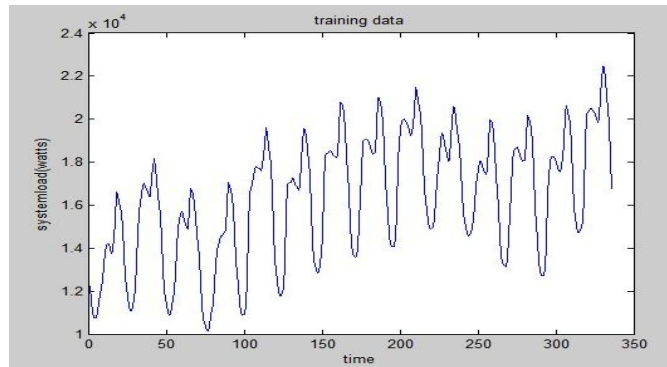


Fig.2 System load with time

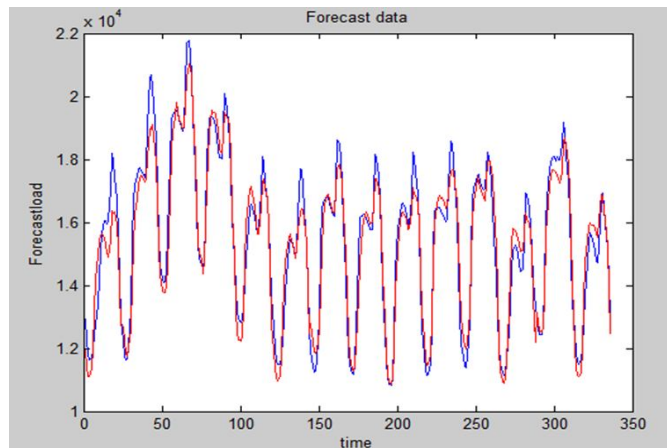


Fig.3 forecasted data by regression algorithm

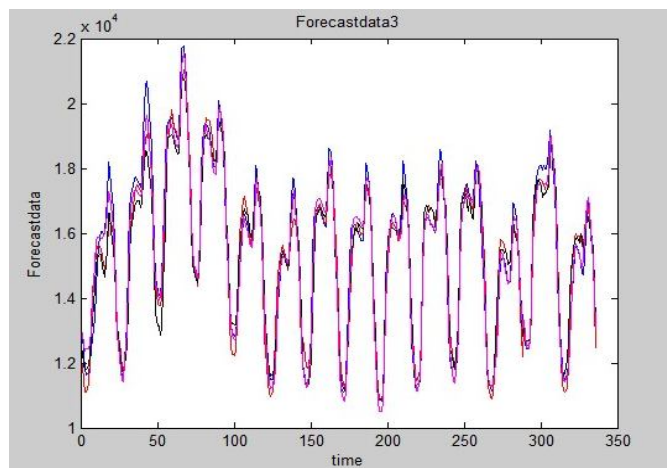


Fig.4Forecasted data by Neural networks

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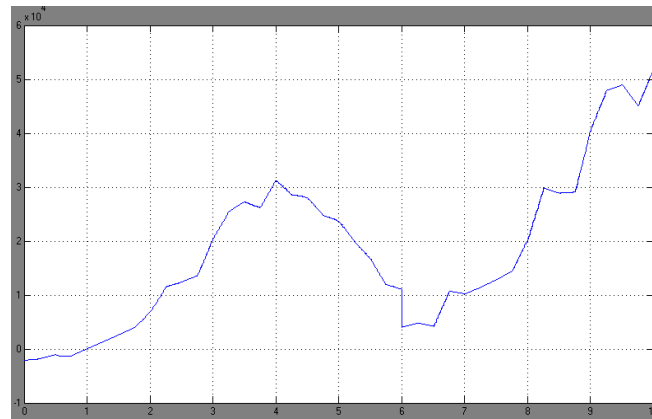


Fig.5 Energy consumption in scheduling by regression algorithm

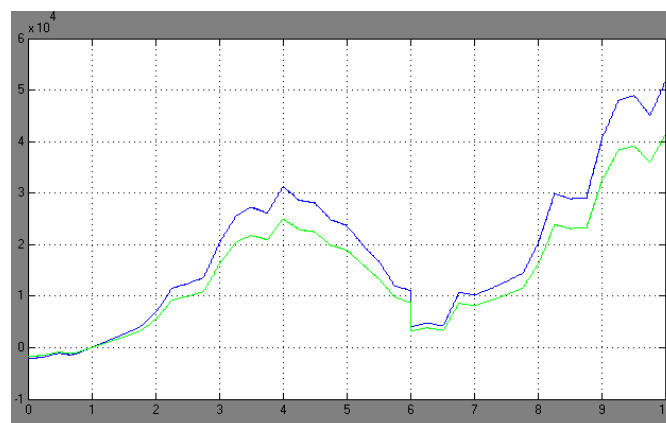


Fig.6 Energy consumption comparison in scheduling by regression algorithm and neural network

The fig.5 represents the energy consumed by load during the scheduling done by regression algorithm. The fig.6 represents the energy consumed by loads during the scheduling done by neural network. It shows that the energy consumed in scheduling done by neural network is less than the scheduling done by regression algorithm.

V. CONCLUSION

In this paper, we have proposed joint centralized optimal scheduling schemes for home appliances and EVs in a grid-connected microgrid powered by renewable energy sources. The microgrid uses EVs as electricity storage to improve the efficiency and reliability of the system. Neural network forecast and schedule the load from high demand periods to low demand periods accurately. Neural network technique is done scheduling in efficient manner than the regression algorithm method.

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