ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Special Issue 1, March 2017

Ant Colony Optimization of Charging Coordination of Electric Vehicles Considering Vehicle-to-Grid (V2G) Technology in Multi-Micro Grid Power System

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ABSTRACT: Electric vehicles are the reliable systems for making the pollution free environment and it can be implemented for vehicle to grid load dispatch. But the abandoned charging of these electric vehicles (EVs) can affect the safe and economic operation of power systems. The centralized EVs charging optimization methods require complete information of physical appliances and using habits, which will cause problems of high dimensionality. In this project, an ant colony optimization is proposed to realize the EVs charging coordination at the standalone grid, which can overcome the drawbacks of decentralized control method. In this work, the EV charging load model is developed in MATLAB simulink, and the charging management structure based on swarm intelligence is presented in terms of MATLAB scripts. The source such as solar and wind generated power as well as the EV aggregation are also considered in the algorithm. Finally, the charging coordination of 6 EVs with 300kWh capacity under multi micro grid is simulated to demonstrate the validity of the proposed method.

KEYWORDS: Electric Vehicles (EVs),Vehicle -to-grid (V2G),Ant Colony Optimization (ACO),Electric Vehicles Charging Coordination (EVCC).

I. INTRODUCTION

Renewable energy is energy that is comes from natural processes that are continuously replenished. This energy cannot exhaust and is constantly renewed. The use of renewable energy has many benefits, including a reduction in green house gas emissions, the diversification of energy provisions and a reduced dependency on fossil fuels. Although these technologies are improving in various aspects,the drawbacks associated with them,such as their intermittent nature and high capital cost.Hybrid renewable energy systems are considered to supply loads in the size of some watts up to some megawatts.A typical hybrid energy system consists of solar and wind energy sources.The wind energy conversion system(WECS)and the PV system in parallel in order to supply electric power to the load.Using a PV-Wind energy system substantially reduce the total life-cycle costs and make the utilization of renewable source more profitable compared with conventional electrical systems.

In present years,power and transport sectors have been experiencing new changes due to environmental concern and requirements for energy independence.The transport sector is suitable part of the electrification movement.By itself,the use of electric vehicles(EVs) will increase over the coming years[1],[2].Instead of fossil fuel energy,EVs use batteries to store the energy requiredfor the transportation.Dropping the dependency on Fossile fuel,these batteries are charged

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on an electric distribution system(EDS).If the charging of EVs is not controlled,the EDS can experience overloads,voltage limit violation and an excessive increase in power losses[3],[4].The EV charging coordination (EVCC) problem seek an optimal charging plan for the recharging of EV batteries in a exact time period.The optimal charging plan should maximize the energy and minimizes the power losses[5]-[10].In [5],A decentralized charging control algorthim was proposed to plan charging for large population of EVs.In Paper [12] The stochastics analysis of the APC regarding V2G frequency regulation for first time.The final goal is to find an optimal size to thin power capacity to aggregated and grid operator.In Paper [17]Simulating the foraging behaviour of ants in nature,ant ant colony optimization(ACO) algorthims are set of swarm intelligences algorthims at first developed to explain discrete optimization problems,such as travelling salesman problem.SamACO algorithm can deliver good performances for both unimodal and multimodal problems.In paper[18]Ant colony system has been developed to explain this NP-hard problem by incorporating anReducing horizon control(RHC) strategy.In this paper result RHS-ACS-ASS can not minimizes the computational burden but also improve solution accuracy, In paper [19]developed an aggregator for V2G Technology for frequency regulation regarding the optimal control strategy for the first time.Energy capacity is most considered factor.It could not applied not only the frequency but also other V2G technology application some modification.In[20]MRCPSPDCF is an important model for project management application and problems in NP-hard.Due to hard complexity.only few algorithm are obtainable for problem and it is not satify.ACO has been create to be good at solving graph-based search problem.apply ACO MRCPSPDCF is more uncertain duration and cost.

In Proposed method,an Ant Colony Optimiztion technique(ACO) is to solve the optimal charging coordinaton of electric vehicles (EVs) in considering vehicles-to-grid(V2G) technology in a multi-micro grid.Solar and Wind Power plants are considered as a distributed generation(DG) and imbalance of the system circuits and loads are taken into account.The developed method defines an optimal charging schedule for the EVs.This charging schedules considers the EVs arrival and depature time and their arrival state of charge,all along with the energy giving of EVs able to with V2G technology.after all the charging coordination of 6EVs with 300kWh capacity under multi-micro grid is simulated to display the validity of the proposed method.The charging schedule obtained was compared in term of V2G and renewable generation scenarious,demonstrating the efficiency.

The paper is summarized as follows. The configuration of system is discussed in section II. Ant Colony Optimization Technique For the EV Charging Coordination Problem is given in section III. Simulation results are discussed in section IV. The conclusion of this paper is drawn in section V.

II. SYSTEM CONFIGURATION

The configuration represented as a multi-microgrid with the different renewable energy sources like solar and wind.The aggregated loads are represented as RL loads and the EV batteries are represented with the help of lead acid battery arrangements.The overall battery charging coordination is managed by the optimization technique called ant colony optimization algorithm.

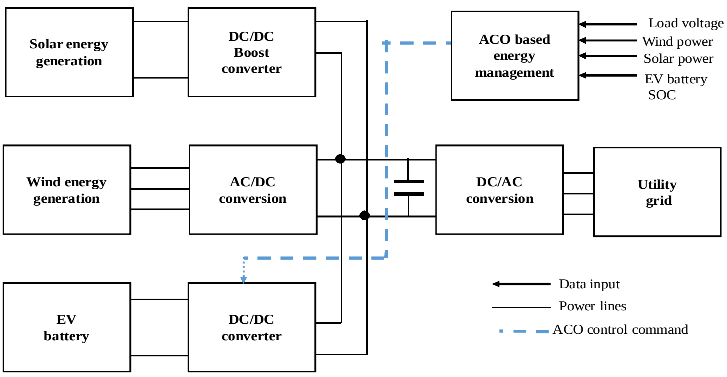

Fig.1. Overall block diagram of proposed system

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Fig 1.The solar and wind act as hybrid source as a distributed generation.The solar power plant model is designed with the help of solar cell equivalent circuit model block where the input is solar current and insolation. The block produces solar voltage and power as measured signal.the maximum power is track by MPPT. The P&O algorithm used in MPPT. The Main goal of P&O is to obtain the steady state operating point of PV system which utilizes the more energy.The control voltage source is providing the solar voltage into the boost converter.They boost up the voltage and the voltage is given to DC grid.The wind energy system having wind wind turbine,generator,interconnection and ontrol system.A wind turbine is a mechanism for converting the kinetic energy in wind into electric energy.Wind turbine are rotates with help of wind speed.Wind turbine can be able to with three phase generator.The Permanent synchoronous generator are used for stand alone wind power plant so it is suitable in this paper.it is given to rectifier(AC/DC) and then rectifier the voltage is given to grid.The EV battery are fully powered by electricity .Input power of EV is taken from hybrid system (solar and wind) is in grid.The EV battery storage system is designed with help of Lead-acid battery.Ev voltage is given to Buck-Boost converter.It do both charging and discharging work.The ant colony optimization technique is finding out the optimum charging level for the EV storage system in this work.

III. ANT COLONY OPTIMIZATION TECHNIQUE FOR THE EV CHARGING COORDINATION PROBLEM

A Ant Colony Optimization Technique model is to solve the EVCC problem considering EVs and EV-V2Gs. Ants start from their nest and find different paths to the food. In this context, the local information available to the ant is the path that it took to the destination. However a single ant is not alert of the complete topology of the environment. Ants thus communicate with each other by deposit traces of pheromone as they walk along their path. Subsequent ants that arrive in search of food, base their decisions of which path to take on the pheromone traces left in that locality by the previous ants .

The ant-based charging plan algorithm mainly includes these steps as follows.

Step 1. Setting up the EVs' parameters. Including the EV number (ant population), the use habit of EV such as the plug-in and plug-off grid time (can help to get the usable charging time, assume that the car plug-in the grid when comes home and plug-off the grid when leaves home), the daily travel miles and the energy need when traveling 100KM (can help to compute the SOC of the battery), the charging efficiency, the rated charging power, and so forth.

Step 2. Initializing the pheromone. Compute the pheromone according to the day-ahead load forecast data of the transformer and other parameters using (1).

Step 3. Setting up the maximum iterations Nc max and the ant numbers$M$of each iteration. The fluctuation of the load curve is related to the$M$tightly.

Step 4. Loop for iterating in turn of the plug-in time of the EVs. Each ant decides the suitable charging time segment according to its parameters, and the pheromone of other ants is released.

Step 5. Compare the total load when the current EV_{load} added and the grid maximum load power, if load power surpass the grid power, exit the loop.

Step 6. Update the pheromone at the charging time segment for other EVs to use.

Step 7. Generate the charging scheduling of all EVs.

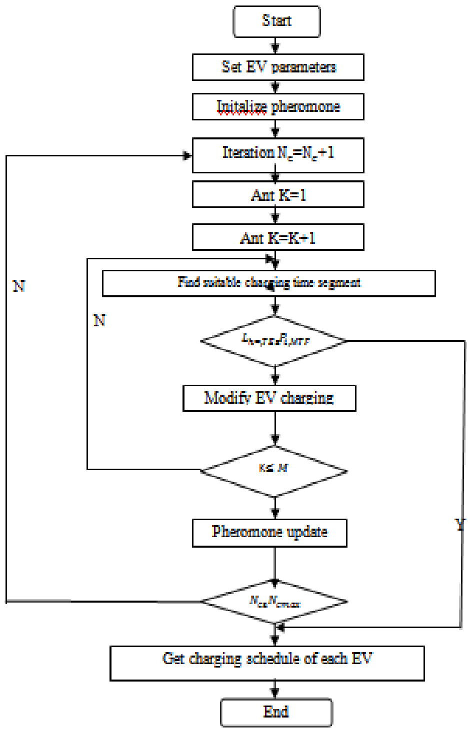

Fig 2.Flow chart of ant colony optimization.

As V2G technology on EVs is taken into description the solution must give an optimal schedule that determines when the EV batteries be required to be charged and when the EV-V2G must inject energy into the grid.The initial state of charge (SOC) of every vehicles known when the vehicles is plugged into the grid.The EV-V2G can be controlled in order to inject power into the grid according to their available energy.EV-V2G owners allow the EDS operator to utilize the energy stored in their vehicles. Vehicle-to-grid can be used with gridable vehicles, that is, plug-in electric vehicles (BEV and PHEV), with grid capacity. Since at any given time 95 percent of cars are parked, the batteries in electric vehicles could be used to let electricity flow from the car to the electric distribution network and back.

$$\min \sum_{f \in F} \sum_{t \in T} \alpha^{G}_{s,t} \Delta t (V^{re}_{s,f,t} I^{Gre}_{s,f,t} + V^{im}_{s,f,t} I^{Gim}_{s,f,t})$$

$$+ \sum_{n \in N} \sum_{t \in T} \alpha^{G}_{n,t} \Delta t P^{G}_{n,t} + \sum_{u \in E} \beta e E^{SH}_{U}$$

.

IV. RESULTS AND DISCUSSION

The integration of Standalone Microgrid that includes the renewable energy resources like Wind,PV and EVs. An Ant colony optimization technique is proposed to solve the optimal charging coordination of EVs in unbalanced EDS considering V2G technology in a multi-micro grid. Solar and wind power plants are considered as a Distributed generation(DG).

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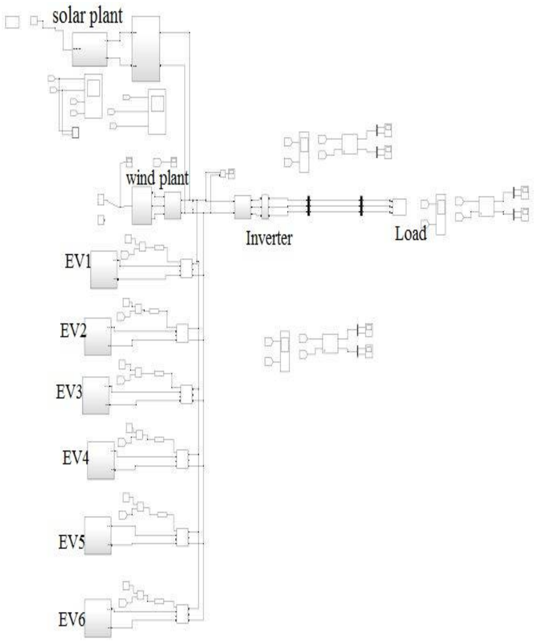

Fig.3: Simulink Model of Proposed system

Figure 4 Shows the voltage ,current and power waveforms obtained at the pv panel terminal respectively.

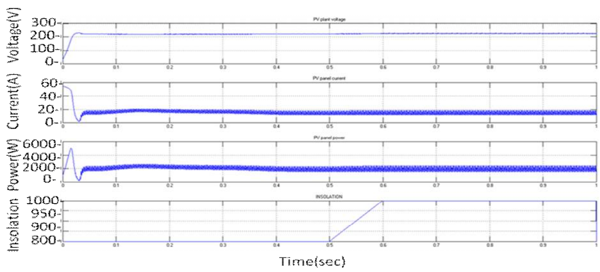

Fig4:Voltage , current and power pv panel output

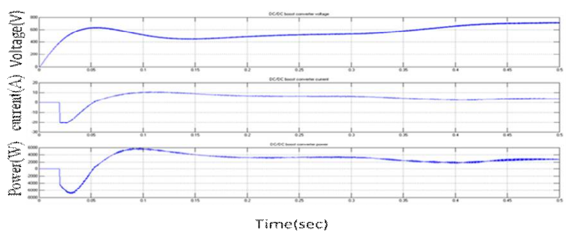

Fig 5:Voltage Wave form of DC-DC Boost Converter.

The Figure 5 shows the voltage waveforms generated by the Boost Converter.

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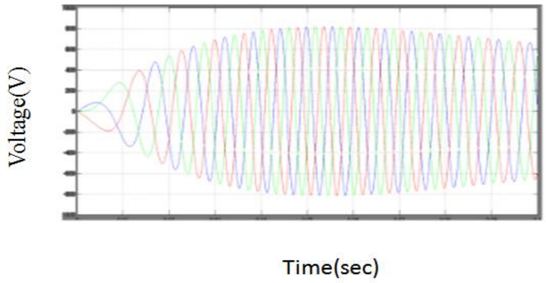
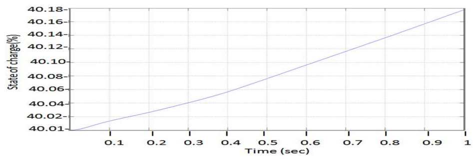
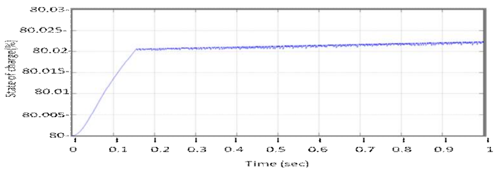


Fig 6: Voltage Waveform Wind Power Plant

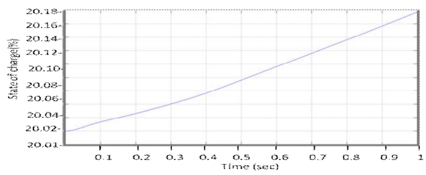
The figure 6 shows the Wave form of voltage generated by Wind power plant.



(a)



(b)



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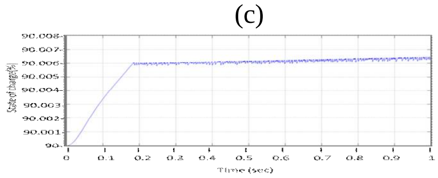

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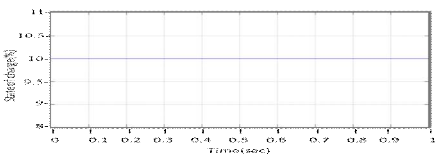

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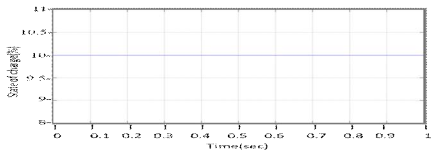

(f)

Fig.7: State of charge of (a)EV1,(b)EV2(c),EV3,(d)EV4,(e)EV5,(f)EV6

Figure 7 shows the stste of charge of EV system 6EVs with 300kWh capacity.

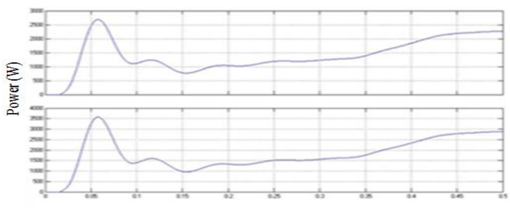

Fig.8: Grid real and reactive power

Figure 8: Shows the real and reactive power of the charging coordination of Ant colony the ACO.

TABLE 1 SHOWS THE DESIGN OF SOLAR PANEL

Parameter	Value
Short circuit current	35.4250A
Open circuit voltage	144.3V
Current at P_{max}	30.2250A
Voltage at P_{max}	111.8Vs
Insolation	1000W/m^2
Maximum power	5KW

The table 1 shows the parameter of the solar panel .

TABLE 2 SHOWS THE DESIGN OF WIND TURBINE

Parameters	Value
Nominal mechanical output power	3 MW
Base power of the electrical generator	400VA
Base wind speed	12m/s
Maximum power at base wind speed (p.u of nominal mechanical power)	0.8

The Table 2 shows the Design of wind system. In this system pitch angle controller control the wind flow around the wind turbine blade,thereby controlling the torque experted on the turbine shaft.If the wind speed is less than the rated wind speed of the turbine,the pitch angle is kept constant at its optimum value.Turbine shadft is used to couple the wind turbine and Permanent Magnet Synchronous Generator.

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TABLE 3 :DESIGN PARAMETERS FOR EV BATTERY STORAGE SYSTEM

Parameter	Value
Type of battery	Lead Acid
Nominal voltage	5000V
Rated capacity	10 Ah
Energy capacity	50 kWh

Table 3 Shows the design of Ev.The EV battery storage system is designed with the help of Lead-Acid battery battery.The energy capacity is 50kWh.

V. CONCLUSION

An optimization technique based technique was presented to solve the optimal charging coordination of electrical vehicles (EV) in an multi micro grid electrical distribution systems (MMG-EDS) considering vehicle-to-grid (V2G) technology. The proposed method can be used to define optimal charging schedules in order to avoid operational concerns associated with uncontrolled EV recharging. The methodology was proven to efficiently handle EV load imbalance; randomness in EVs' state of charge. For every scenario, the methodology found charging coordination with no load shedding. In addition, the charging schedules satisfied operational constraints, taking into account the imbalance of the system circuits and loads; they also achieved a better economical operation of the EDS. These results show the methodology to be very useful, as it defines each step to be implemented and gives a broad view of the state of the EDS throughout the whole time period. The methodology also offers great adaptability for incorporating new loads, e.g. EV plugs for recharge. Also, from the tests carried out, it can be concluded that the utilization of V2G in EDS is economically unsound, because the impact on the battery lifetime outstrips the economic improvement shown by this technology.

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