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Research on the Influence of Electric Vehicle Integration in Island Microgrid, Vietnam

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***Abstract**: Vietnam's economy is developing strongly, and the demand for energy use will increase rapidly. The development of smart grids contributes significantly to the transition and sustainable development of energy from renewable energy sources to improve the quality of the national power supply and promote the sustainable use of electricity economically and efficiently. Thus, this is highly beneficial in reducing carbon emissions and other types of pollution. Besides, electrification in the transportation industry is developing rapidly, such as Electric Vehicles (EVs) and Metros in recent years. Integrating electric vehicles into the grid will enable two-way energy exchange, reactive power compensation and load balancing. However, the number of EVs participating in charging at a time will cause some conflicts, such as voltage and power loss at the nodes. Therefore, the balancing problem between load demand and generation source is a difficult task in planning operations. This paper presents a method to optimize island Microgrid (MG) operation with the participation of electric vehicles based on renewable energy sources. Optimization techniques in intelligent resource forecasting and management algorithms are built in MATLAB to achieve different requirements. The proposed Microgrid manages energy efficiency that adapts to the variability of Renewable Energy with improved efficiency.*

***Keywords**: Plug-in hybrid electric vehicles, Optimisation, vehicle-to-grid, Renewable energy, Vehicle to grid on MG.*

I. INTRODUCTION

Energy is always an indispensable development need and a hot topic worldwide. Fluctuations in energy prices caused economic recession and political instability in many countries worldwide. Energy from fossil fuels is the main source of energy that feeds global industry and is the fulcrum for the development of the modern world, accounting for 80% of total energy, with 27% coming from coal, and Renewable energy accounts for about 11% [1], [23] [2]. Over the past century, the massive use of fossil energy has emitted an enormous amount of greenhouse gases and caused global warming with unpredictable consequences for humanity. At the Global Conferences on Climate Change (COP), it was mentioned that exploiting renewable energy sources is an essential solution to diversifying energy sources for development, gradually replacing fossil fuels and fighting against fossil fuel's global climate change [3]. According to the International Renewable Energy Agency (IRENA) forecast, renewable energy can increase by 28% in 2030 and 66% in 2050 [4]. In addition, the share of renewable energy's contribution to the global energy sector could reach 57% in 2030 and 86% in 2050 (the current percentage is 26%). In the study [5], renewable energy investment has grown strongly globally, increasing by about 14.1% in 2016 and 29% in 2020. Renewable energy increased by about 9% in 2016 in the United States, accounting for 14% of electricity production. The proportion of wind and radiation energy electricity accounts for 5.2% and 0.8%, respectively. In recent years, electrification in transportation has been promoted and developed rapidly. Therefore, vehicles such as Electric vehicles and Metro are commonly used to help reduce CO_2 emissions into the environment. Besides, a large number of electric vehicles charging on the grid will sometimes affect the power quality and capacity of the generator. Many researchers worldwide are interested in electric vehicles' influence on the distribution grid. In the study [6], the effect of charging stations on highways was shown when electric vehicles were involved. The load demand increases at that time, affecting the system's reliability. In work [7], [8] indicate some bottlenecks on the medium-voltage grid, analyzing breakdowns caused by electric vehicle charging points. Severity depends on grid structure, EV penetration and charging station plan. The research [9] provides a method to build a random frame based on the point estimation method to help detect solar radiation prediction, battery temperature and plant service price. In the study [10] build a MG with an intelligent energy management system that schedules grid operations in real-time and a method of balancing energy between different. The algorithm can predict the mains with a relatively accurate hourly to reduce the risk in investments for distributed energy resources. Wind energy and radiation are two renewable energy sources known and exploited by humanity for a long time but have only been invested in research and development in recent decades. Although energy sources are inexhaustible and distributed everywhere on Earth, the potential for exploitation differs due to the uneven distribution in time and space. The world's islands have different possibilities for Wind and Solar energy. In Vietnam, in research [11] [25], it was proposed to build an MG model based on renewable energy sources of solar cells. At the same time, calculate investment costs and economic problems of operation. In the paper [12], an approach is developed when integrating EV chargers into the distribution grid, analyzing important parameters when EV impacts in Vietnam.

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However, the study of the impacts of electric vehicles on the MG on the islands in Vietnam is not yet widespread. Besides, these are famous tourist islands such as Cat Ba and Co To islands, with several tourists of about 2 million visitors a year. The increasing number of electric vehicles participating in traffic puts the power grid under tremendous pressure. This paper builds an MG model on an island in Vietnam and analyses the effects of electric vehicles and different types of charging stations on MATLAB software. Next, several algorithms to optimize grid operation are proposed to help reduce power loss. Voltage and frequency parameters are within the allowable range for the Vietnamese power grid. The rest of the paper is described as follows in Section II, building an MG model on Cat Ba Island, and Section III proposes an intelligent load and power management algorithm. Section IV is an analysis of different charging scenarios and impacts on the grid. The conclusions and future work are summarised in Section V.

II. STRUCTURE OF MICROGRID WITH ELECTRIC VEHICLE

A. Microgrid Definition

According to The Consortium for Electric Reliability Technology Solutions (CERTS) in the United States, an MG consists of essential components such as an electrical power supply and a portion of thermal energy to the load demand [11] [26]. In particular, the power source can be small turbines, solar panels, wind power, and battery storage systems. Energy sources are connected to the grid through circuit breakers and sustainably supply electricity with modern monitoring and control technology [12], [13]. Fig. 1 shows the MG model.

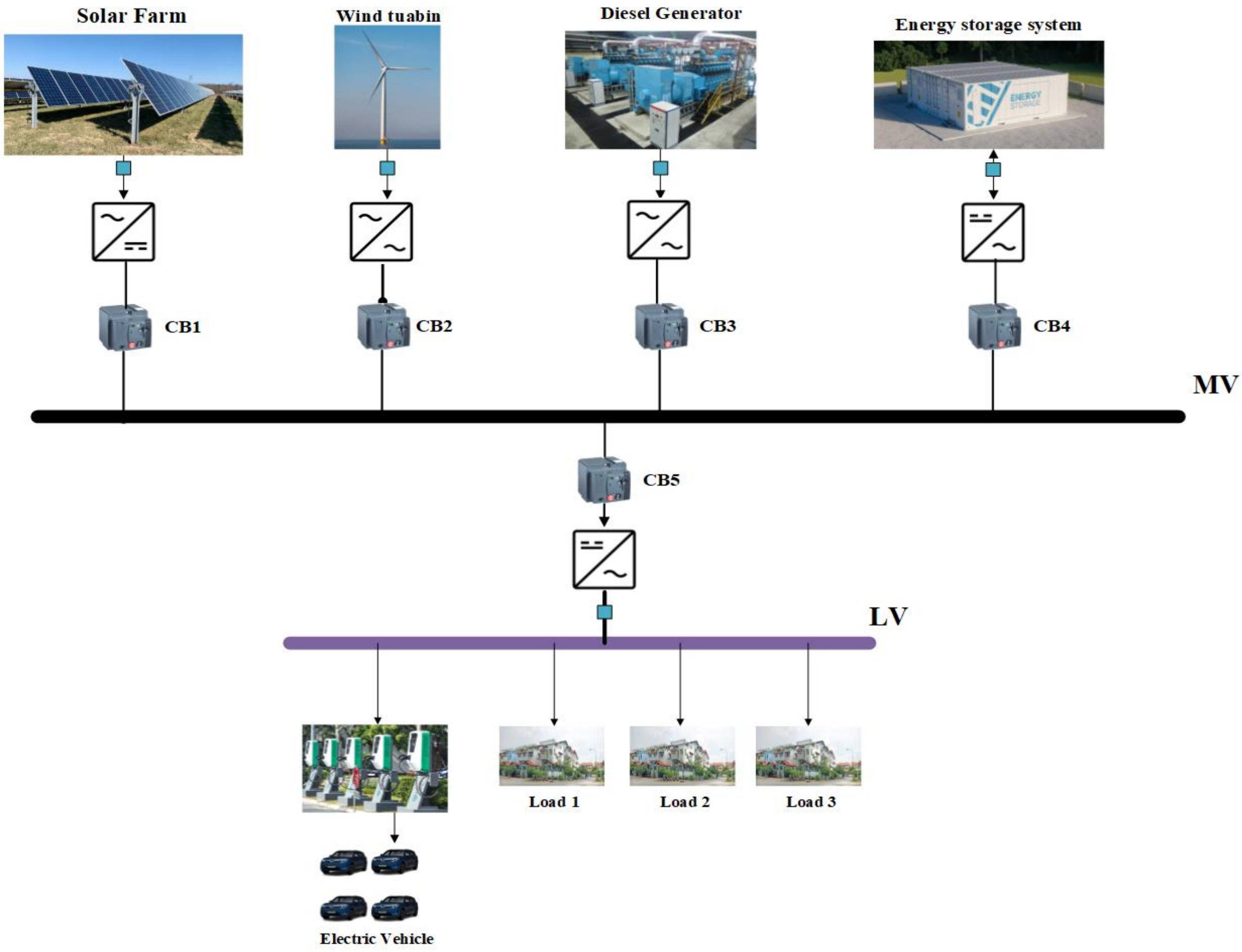

Fig. 1. Microgrid components

B. Wind Power

The relationship between wind speed (v_W) and turbine output power ($P(v_W)$) is nonlinear, with characteristic parameters including cut-in (v_i), cut-out (v_o) and rated Wind (v_r) speeds. Speed is calculated in about 24h, and this is essential data required when building a model. The capacity of the wind farm is modelled by the following [11], [14]:

$$P(v_W) = C_W \times \begin{cases} 0 & 0 \le v_W \le v_i \\ a + bv_w^3 & v_i \le v_W \le v_r \\ 1 & v_r \le v_W \le v_o \\ 0 & v_W \ge v_o \end{cases} \quad (1)$$

where parameters a, and b are given as follows:

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$$a = v_i^3 / (v_i^3 - v_r^3)$$
$$b = 1 / (v_r^3 - v_i^3) \quad (2)$$

Wind farm model with a capacity of 6MW. The overall wind speed is 15m/s, and the nominal wind speed is 13.5 m/s. The wind generator produces electricity at a voltage of 600 volts and a frequency of 50 Hz.

C. Solar Farm

The electricity generated from the PV farm relies on sunlight and converts it into electricity. PV power is proportional to solar radiation received by PV. The mathematical model of the solar plant is described as follows [14]:

$$P_s(t) = P_{s,r}.\eta_s.((E_s(t)/E_{stc}).(1+\alpha_s.(\tau_s(t)-\tau_{stc})) \quad (3)$$

where $P_{s,r}$ is rating of the PV panel, η_s is the efficiency of PV panel. $E_s(t)$ is solar radiation-induced, E_{stc} is the average radiation at standard test conditions and α_s is PV panel temperature coefficient. τ_s and τ_{tsc} are PV panel temperature and the average temperature of cells, respectively.

Solar panel farm with a total capacity of 4MW and built on three factors PV refinishing area, solar radiation, and panel efficiency. Solar radiation is taken in real-time, and shade is assumed at 11:30 for about 250s. The output voltage through the transformer is 25kV with a frequency of 50Hz. In addition, besides renewable energy sources, a small generator is built to help with the frequency deviation of the grid. The generator has a capacity of 10MW, a frequency of 50Hz and an output voltage of 25kV. This source of 24-hour maintenance makes up for the shortfall in capacity when renewable energy sources are affected. In the MG grid, Diesel generators are used to provide electricity, so limiting the amount of gas emitted into the environment is necessary. The formula for expressing emissions to the environment is as follows:

$$Em^{DG} = \sum_{t=1}^{T}\sum_{i=1}^{I} E_{CO_2}^{DG,i}.P_{DG}(i,t) \quad (4)$$

where $E_{CO_2}^{DG,i}$ is CO_2 emission rate of the DG i.

D. V2G Model

All residential, commercial, industrial and office buildings on the island are supposed to be equipped with smart grid technology and PEV charge/ discharge facilities. It is assumed that PEVs are parked at residential areas of the island from 17h00 to 6h00 and are parked at commercial, industrial and office areas of the island from 7h00 to 16h00. The V2G model is built in 5 different configurations. The VF9 electric vehicle tested in the model with a capacity of 92kWh and a quantity of 50 cars. In addition, the Vfe34 vehicle, with a total of 42kWh, is integrated into some residential areas. The following mathematical equation represents the electric vehicle model.

PEV Discharging mode [14], [16] [24]:

$$Cap_{BEV,t+1} = \max\left\{(Cap_{BEV,t} - \frac{\Delta t.P_{BEV,t}}{\eta_{Dis}}, Cap_{BEV,\min}\right\}; t = 1,...,NT$$
$$P_{BEV_{\min},t} \le P_{BEV,t} \le P_{BEV_{\max},t}; t = 1,...,NT \quad (5)$$

PEV Charging mode:

$$Cap_{BEV,t+1} = \min\{(Cap_{BEV,t} - \Delta t.P_{PEV,t}.\eta_{Ch}\}; t = 1,...,NT$$
$$P_{BEV_{\min},t} \le P_{BEV,t} \le P_{BEV_{\max},t}; t = 1,...,NT \quad (6)$$

where

$$P_{BEV_{\min},t} = \min\left\{\frac{P_{BEV,\max}.(Cap_{BEV,t} - Cap_{BEV_{\min}}).\eta_{Dis}}{\Delta t}\right\} \quad (7)$$
$$t = 1,...,NT$$

$$P_{BEV_{\max},t} = \max\left\{\frac{P_{BEV,\max}.(Cap_{BEV,t} - Cap_{BEV_{\max}})}{\Delta t.\eta_{Ch}}\right\} \quad (8)$$
$$t = 1,...,NT$$

where, $Cap_{BEV_{\max}}, Cap_{BEV_{\min}}$ Maximum and minimum capacity of BEV in kWh; $P_{BEV,t}$ Generated power of BEV in kW; $P_{BEV_{\max},t}, P_{BEV_{\min},t}$ Maximum discharging and charging rates of BEV in kW; $Cap_{BEV,t}$ Stored energy in BEV [14], [15], [16].

E. Weather Conditions Influence

The generating capacity of Wind and solar energy depends on the weather [17]. Wind Energy is related to the wind speed to generate the maximum power source. Based on (1) showing the characteristic that depends on wind speed, building a wind turbine model in MATLAB, the authors have taken the wind speed of the day in real-time to simulate the generating capacity of the wind turbine. The chart of wind speed is shown below:

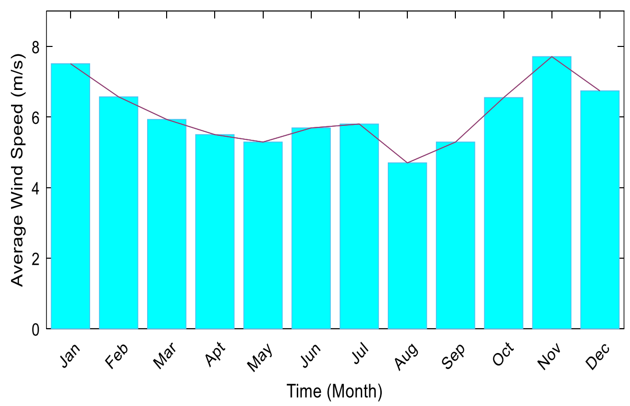

Fig. 2. Wind Speed

Solar farm capacity depends on solar radiation, temperature and shade factor. Use (2) to calculate the generating capacity of the solar farm in 24 hours. In addition, some conditions, such as PV dirtiness, significantly affect the ability. Similar to Wind, solar radiation is taken every day. In addition, the model can forecast the generation capacity of the solar farm on the following day.

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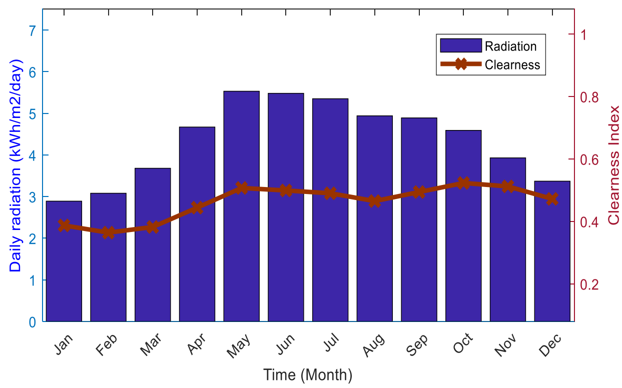
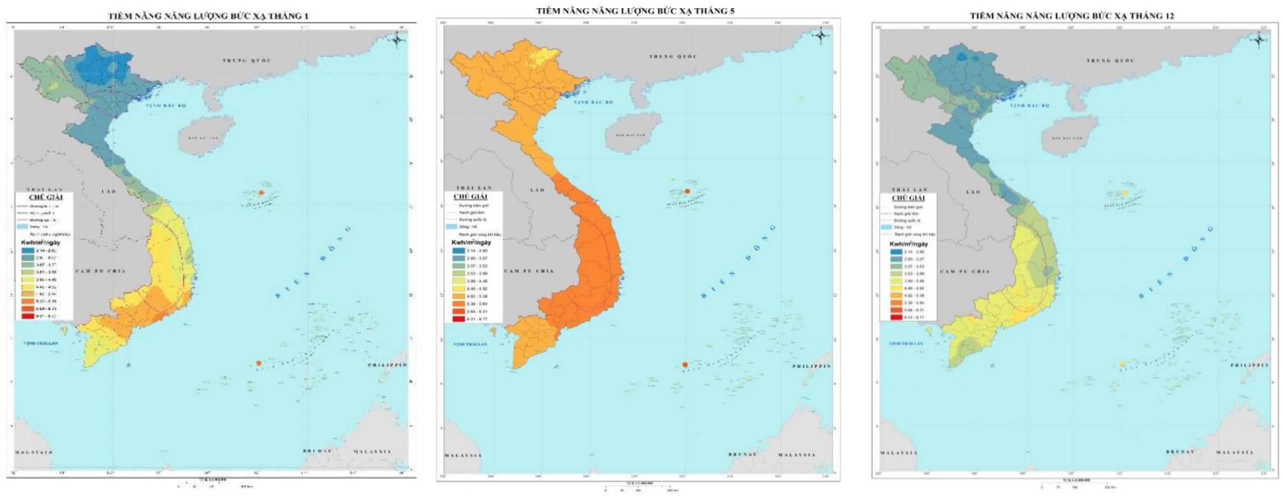


Fig. 3. Irradiance and Clearness Index

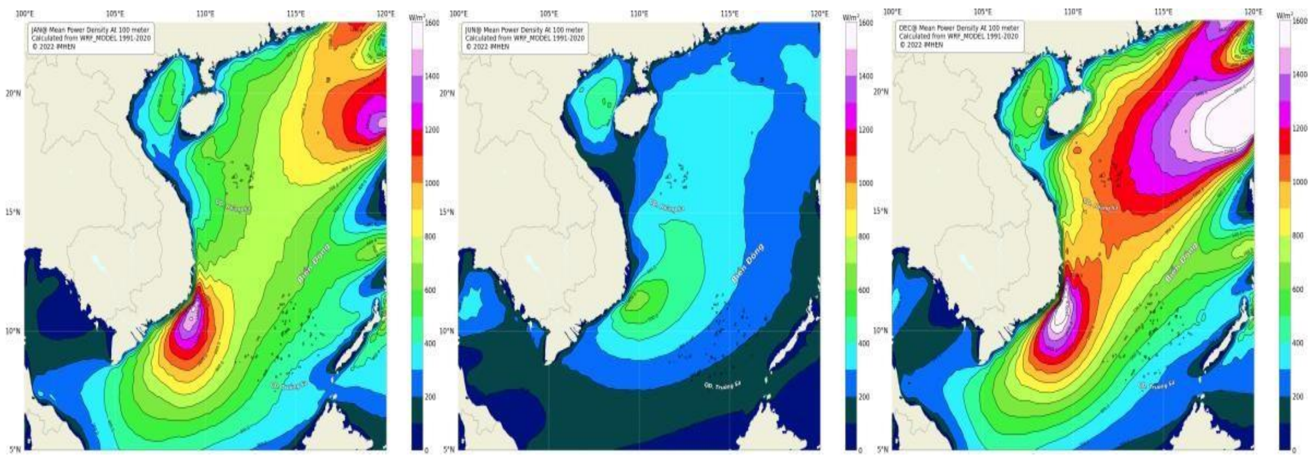
Monitoring data shows the total number of sunny hours in Vietnam is about 1857.0 hours/year, ranging from 1,653.0 -1,819.8 hours/year in the North and 2312.4 - 2502.6 hours/year in the South. In the Northern Delta region, the average Wind is about 3-5 m/s, but the coastal area of Nam Dinh and Ninh Binh provinces can reach 5-7 m/s (from January to July and from October to December).

Solar radiation and wind speed measured in typical months of the year are shown in Fig. 4 and Fig. 5. It can be seen that the two renewable energy sources can offset each other throughout the year. The map of Wind and solar energy in the East Sea of Vietnam in the period of 2022 is shown as follows:



(a) (b) (c)

Fig. 4. Radiation potential energy map (kWh/m2/day) for three months, according to observed (a) January; (b) May; (c) December



(a) (b) (c)

Fig. 5. The map of the average distribution of wind energy density (W/m2) of the months (a) January; (b) May; (c) December

III. MODEL DESIGN

A. Microgrid Model Design

The authors build the grid on MATLAB software from the MG component in section II. There are two medium voltage and low voltage grids in the MG grid. Solar farms and wind power are connected to the medium voltage grid through circuit breakers CB1 and CB2. Besides, the generating capacity of the diesel turbine is connected to the grid via CB3 with a rated capacity of 10MWA. An energy storage system about 2000kVA, is charged when the regenerative energy source is redundant. Loads include residential areas and industrial zones. In addition, the intended vehicle is integrated to test the load capacity of the grid. Fig. 6 shows a schematic diagram of the power grid.

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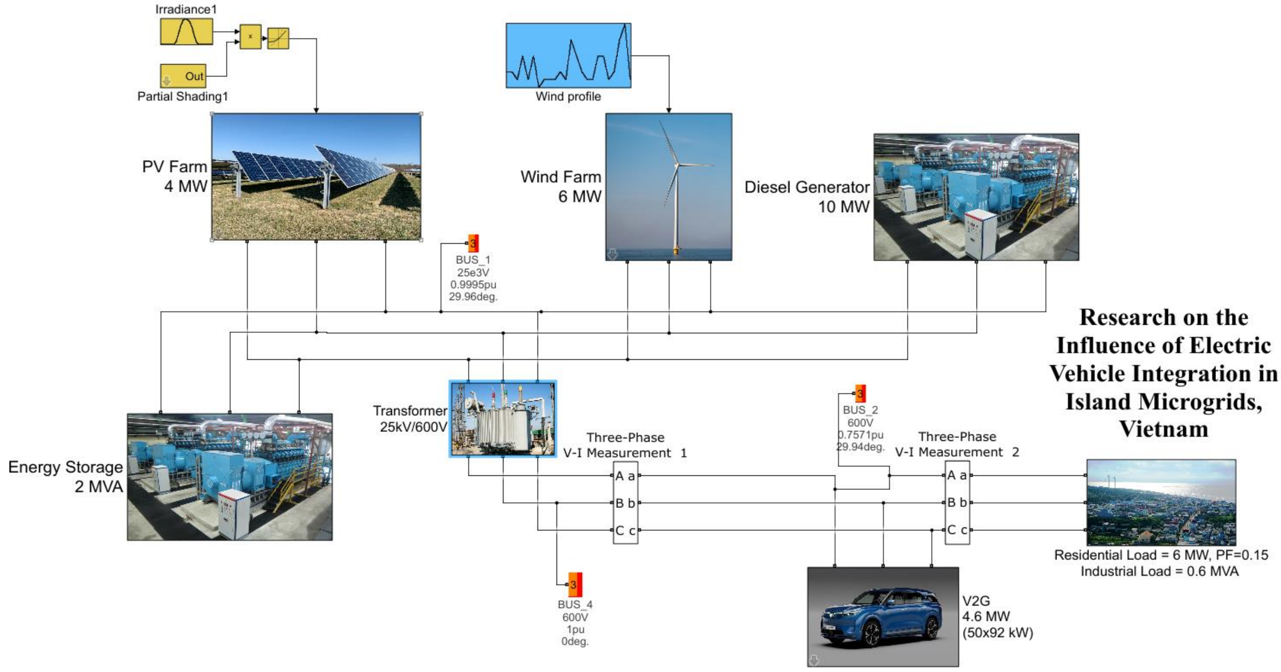

Fig. 6. Microgrid model in MATLAB

Next, the authors build two optimization algorithms in which algorithm 1 describes the ability to manage and forecast the power supply to the grid. Planning and managing the load is presented in algorithm 2.

B. Intelligent Power Management Algorithm 1

For optimized grid operation and cost savings, it is necessary to use optimization algorithms while theists design the grid. Electric vehicles joining the grid at any time, even during peak hours, affect the parameters of the grid. On the other hand, three typical parameters for the Vietnamese power grid are critical: voltage, frequency and voltage loss,

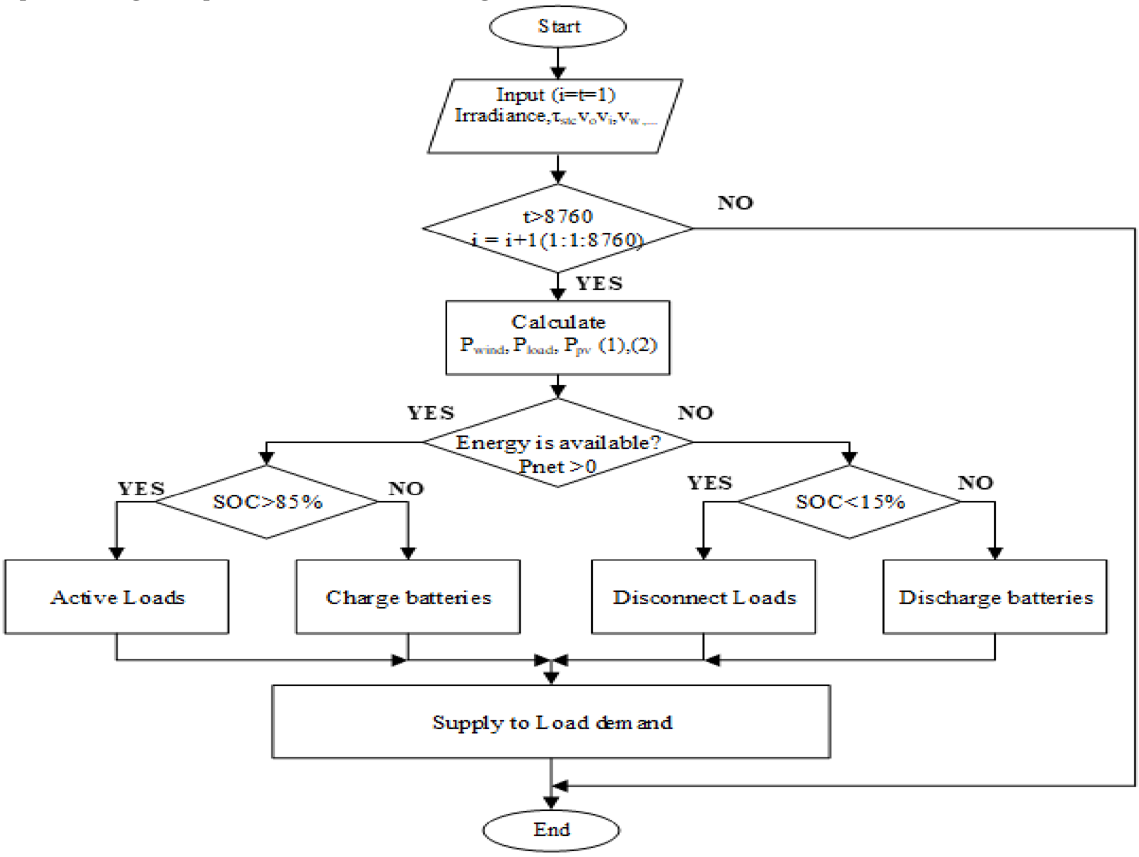

Fig. 7.Intelligent Power Management Algorithm

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The EMS algorithm is described as follows: voltage is maintained by supply by sources such as Solar Frame, Wind Power and storage battery. Initially, the algorithm receives input data such as irradiance and wind speed to calculate the capacity of the renewable energy source and then plans to mobilize power for the grid. In addition, battery storage is also involved when the time is insufficient to compensate for the lack of capacity.

The battery storage system is charged under low load demand (20% < SOC < 80%). The generated energy will be connected to the grid to supply the loads.

C. Load Management Algorithm 2 (LMA)

Three typical parameters for the Vietnamese power grid are critical: voltage, frequency and voltage loss, and power losses. Therefore, the grid should have optimal algorithms to meet this task. In addition, forecast the capability of generating sources such as solar cells and wind energy because this is an unstable energy source. Charging scenarios must calculate and coordinate the most suitable charging stations to avoid dissolving the MG system.

The capacity of the grid and the load demand must be within the limits of maximum generating capacity and minimum generating capacity. The load demand and the system losses must be within these limits [12], [18], [19]

$$P_{G,\min} \le P_{Load} + P_{Losses} \le P_{G,max} \qquad (9)$$

where $P_{G,\max}$ is the maximum generating capacity of MG; $P_{G,\min}$ is the maximum generating capacity of MG; and P_{Load} power consumption of load.

The power losses index ($P_{Losses}\%$) of the considered feeder is calculated using the following equation:

$$P_{Losses}(\%) = \frac{P_{Losses}(MW)}{P_{Load}(MW)}.100\% \qquad (10)$$

MG in Vietnam, the voltage performance indices ($\Delta V\%$) of the buses on the distribution grid are calculated using the following equation:

$$\Delta V\% = \frac{|V - V_N|}{V_N}.100\% \qquad (11)$$

where V_N is the nominal voltage of the feeder, V is the bus voltage. In the MG, the voltage across the nodes must remain within the upper allowable voltage limits and the lower allowable voltage limits as follows [12], [18]:

$$V_{B,\min} \le V_B \le V_{B,max} \qquad (12)$$

where V_B is the bus voltage, $V_{B,\min}, V_{B,\max}$ is the minimum and maximum allowable bus voltage, respectively.

The charging capacity of the EV must not exceed the maximum capacity of the charger. The battery is fully charged at the end of the cycle. The incoming energy equals the battery capacity $C_{\max}.x_n$. In case there is no PEV, the battery capacity is 0. Otherwise, it is 1 if there are EVs at nodes. The objective function is to reduce the power losses to a minimum with some constraints as follows:

$$\min \sum_{t=1}^{t_{\max}} \sum_{l=1}^{lines} R_l . I_{l,t}^2$$
$$s.t \begin{cases} \forall t, \forall n\{nodes\} : 0 \le P_{n,t} \le P_{\max} \\ \forall n\{nodes\} : \sum_{t=1}^{t_{\max}} P_{n,t} . \Delta t . x_n = C_{\max} \\ x_n \in \{0,1\} \end{cases} \qquad (12)$$

For optimization algorithm 2, the authors propose a real-time load management technique. The peak reduction and peak shift of load graph can be adjusted to improve voltage and power stability. The sole objective is to optimize costs and enhance MG stability. The proposed LMA technique is based on using the priority of EVs. During peak hours, low-priority EVs will be moved to off-peak hours. EV battery health and priority information is communicated to the monitoring centre when charging is plug-in. Algorithm 2 is described as follows:

Algorithm 2: Load Management

Input: Daily load profile, V_{node}, I_{line}, price profile, sub-intervals, EVs_priority, EVs_priority_List, Reference level.

1. If (EV priority level is high)
   Call Algorithm 1
   assume flat voltage profile.
   Calculate V_{node}, I_{line}, P_{losses} follow (10) and (11)
   Compare P_{losses} follow (9), (12)
   $P_{Load}^{LMA} = P_{Load}$
2. else
   Calculate optimal charging profile
   Calculate V_{node}, I_{line}, P_{losses} follow (10) and (11)
   /*EVs stop charging*/
3. $P_{Load}^{LMA} = P_{Load}(t+1)$
4. $EV\_priority = high$
5. $UpdateEV\_priority\_List$
6. Save Optimal charging profile.
7. Goto1

Output: */ Energy consumption of EVs*/
P_{Load}^{LMA} /*MG_power_load*/

IV. RESULT AND DISCUSSION

A. EVs Charging Scenario

In this part, the authors build scenarios to test how electric vehicles, when charging, will affect the grid. Vietnam divides the time of day into parts when using electricity as follows [20] [27]

- Peak hours: 9h30-11h30; 17h00-20h00.
- Off-peak hours: 22h00-04h00.
- Normal hours: 04h00-09h30; 11h30-17h00; 20h00-22h00.

The electricity price will change differently with each time frame, and the load graph will change.

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Therefore, it is necessary to consider charging electric vehicles at these time frames to avoid overloading the grid. The time frame chart is shown in Fig. 8.

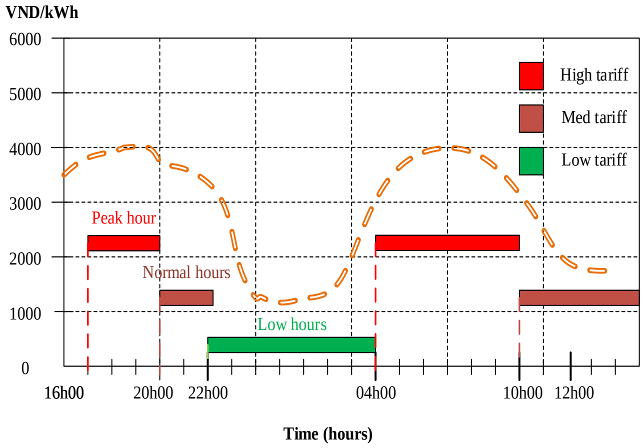


Fig. 8. Electricity price when charging EVs in time frames.

Some critical requirements for the MG grid when integrating EVs using the conditions of operation of the electrical distribution system in Vietnam's Circular No. 39/2015/TT-BCT, stipulating the electrical distribution system [12] and the Circular No. 30/2019/TT-BCT [21], [22].

Besides the rapid development of electric vehicles, charging stations are also being built and combined with gas stations in Vietnam. Depending on customers' needs, these charging stations are installed with different capacities according to the conditions of use. There are three types of Vinfast popular charging stations today: charge level 1, charge level 2, and charge level 3 [12].

- Charge Level 1: This charger is used in households and residential areas. The station is designed with an output with a capacity of 2.2kW. The charging time is about 19.4h, and the current is 10A with a voltage from 85-365VAC. This charger has a low investment cost and is easy to transport in any area.
- Charge Level 2: This is a DC fast charging station with 30kW used at rest stops and public parking areas. Short charging time from 40 minutes to 120 minutes for 80% battery. 3-phase charging station input voltage ranges from 304-465VAC.
- Charge Level 3: This is a 250kW DC super-fast charging station for commercial centres and public parking lots. The electric vehicle's DC power supply is directly supplied, the operating voltage is 400VAC, and the output voltage is about 200-1000VDC.

Table 1 shows the characteristics of the three charging levels.

Table- I: Three charging types of Electric Vehicles.

Parameters	Level 1	Level 2	Level 3
Operating Voltage	85-305V	304-465V	400V
Operating frequency	50Hz	50Hz	50Hz
Charger Speed	Slow	Fast	Rapid
Power	2.2kW	<60kW	250kW
Charging duration	19.4h	40-120 min	<30 min
The number of charging posts	1	2	1
Loacations	Home	Public, workplace	Public

Some requirements when integrating electric vehicles into the MG grid include power supply voltage, frequency and power loss. The MG operates on these requirements to keep the grid stable and reliable.

Vietnam's electricity system has a nominal frequency of 50 Hz. The requirements for operating the power grid with frequency are as follows:

- Normal operation mode: $49.8Hz \le f \le 50.2Hz$
- Unstable operation mode: $49.5Hz \le f \le 50.5Hz$

B. Simulation results

In this section, the authors simulate MG with EVs in MATLAB. There are two typical seasons of the year, winter and summer. During winter, wind power output increases significantly with high wind speed. On the contrary, in the summer, solar energy will generate much power when solar radiation is high. Wind Power's capacity depends on wind speed. With increased wind speed, the output power of wind power increases. On the contrary, the output power will decrease if the wind speed decreases. In addition, wind power capacity is 6MW, and the capacity fluctuation between summer and winter is different. During the period from 18h00 to 19h30, the peak time frame, the main energy source is a diesel turbine, about 83% of the total generating capacity of the grid. Meanwhile, solar cells and wind energy capacity are 0% and 14.5%, respectively. The period from 10h00 to 15h30 is when PV generates power to the grid. The primary energy source is the solar farm, which is about 46% of the total generating capacity of the grid. Meanwhile, diesel turbines and wind power energy is 47% and 7%, respectively. Finally, from 4h00 to 5h00, the lowest load demand is about 3.3MW. Besides, wind capacity is about 1.8MW, accounting for 54% of the total capacity of the whole grid. The ability of the MG grid, renewable energy sources is shown in the figure below.

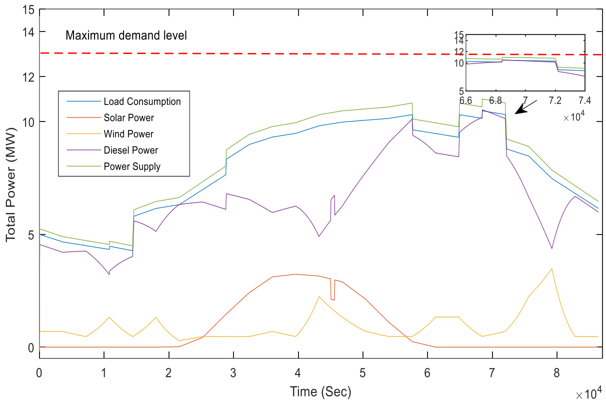


Fig. 9. The total capacity of load and Microgrid in summer

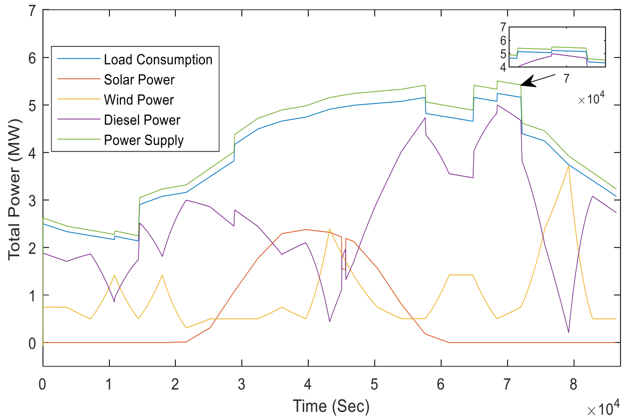
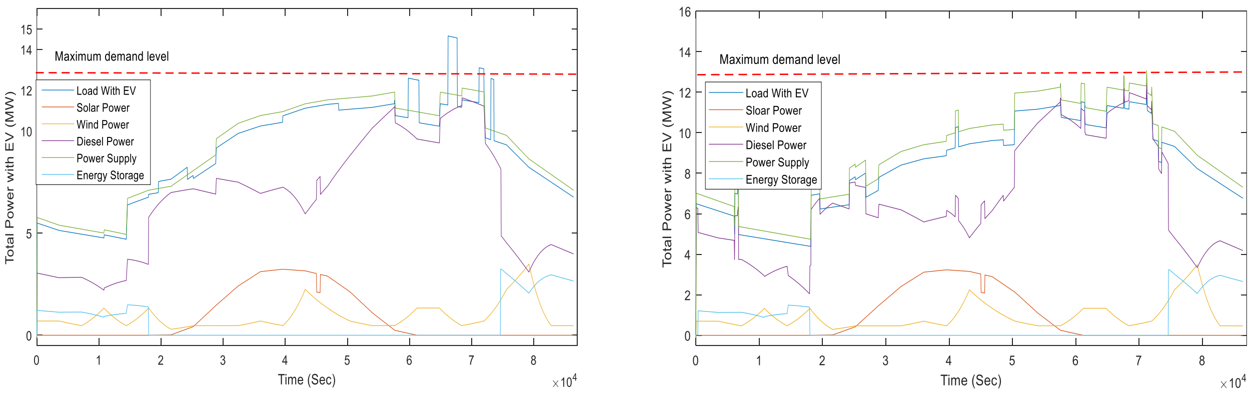


Fig. 10. The total capacity of load and Microgrid in winter

Similarly, the power consumption of the load in winter has decreased significantly. Besides, the power of solar farms generates about 2.5MW, and wind energy is about 4MW, accounting for 70% at peak hours. The load graph in winter is shown as shown in Fig. 10. Next, the EV component is considered when integrating into the MG system. From 17h00 to 19h00, the power consumption of the load is up to 14.5MW, which is when people come home from work and tend to charge their vehicles.

At this time, the capacity of Diesel generator has a maximum capacity of 89% of the total capacity of the grid. In addition, the Energy storage component is mobilized to compensate for power, accounting for about 0.19%. Fig. 11 shows the total power of the MG and the energy consumed by the load when there is a random charging EV. The total power of MG when algorithm 1 and algorithm 2 (LMA) are active. The power consumption of the load did not exceed the maximum capacity threshold of the MG grid.



(a) (b)

Fig. 11. The total power load consumption and power MG in Summer (a) Random 50%EV; (b) with 1, 2 Algorithm

In winter, the power consumption of the load decreases compared to summer, so the number of EVs participating in the grid and affecting the grid will be less. However, there is still an overload to the grid at some point. The number of EVs integrated randomly in the grid when algorithms 1 and 2 are applied. Thus, the total power load consumption does not exceed the capacity limit of the MG.

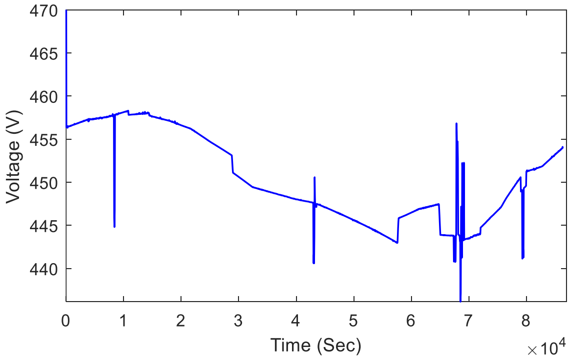


Fig. 12. Voltage measured of Wind Power.

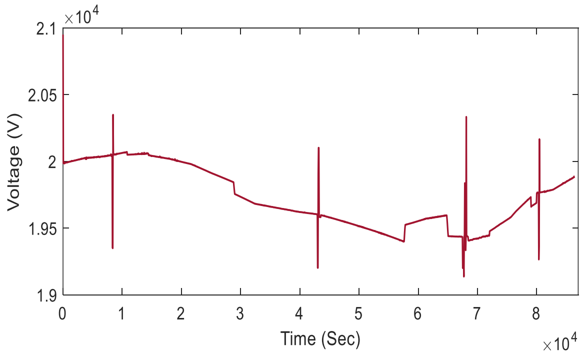


Fig. 13. Voltage measured of Solar Farm.

Figure 13 demonstrates the measured voltage of the Solar Farm in 24 hours. Sometimes, when there is a change in load switching, or a large number of electric vehicles participate, there will be fluctuations in the voltage of the power grid.

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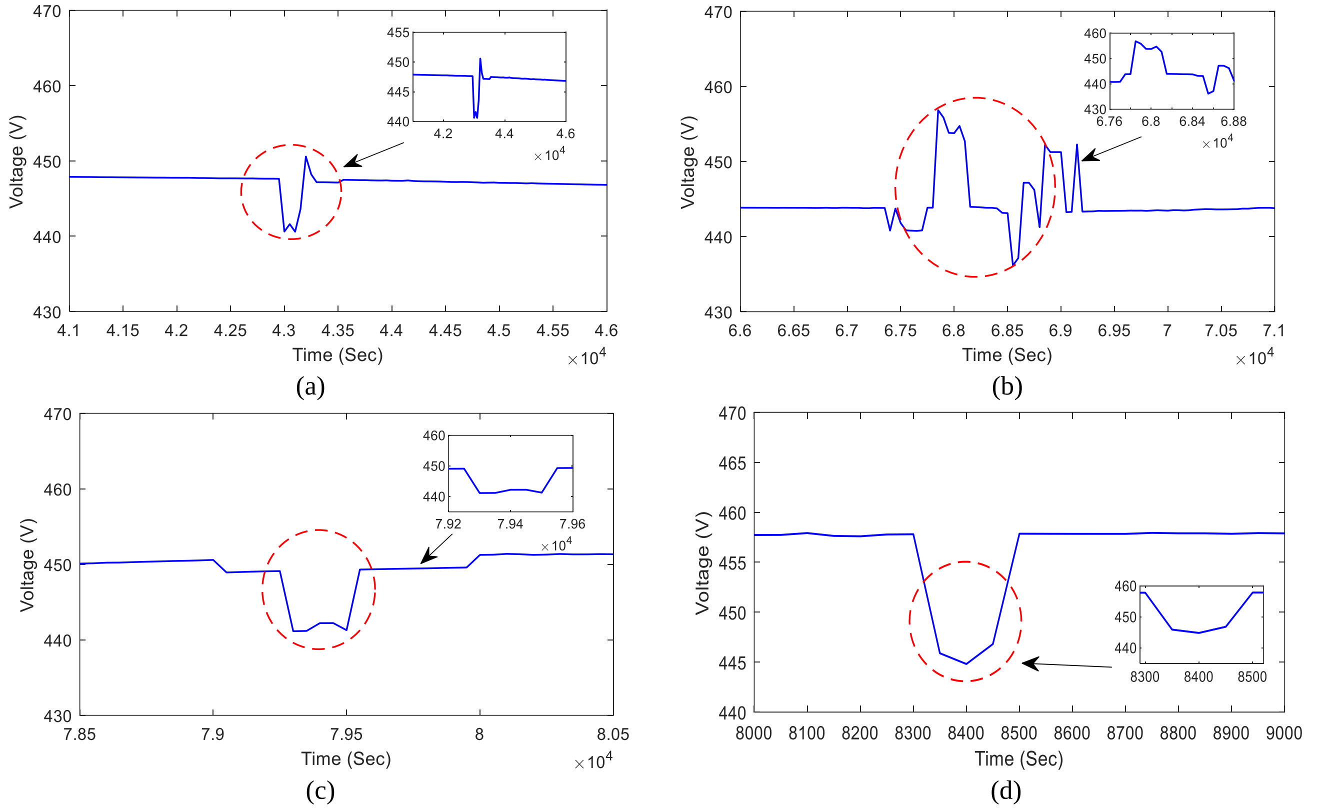


Fig. 14. Voltage measured of Solar Farm (a) from 11h30 to 13h30; (b) from 5h00 to 7h30; (c) between 21h00 and 22h30; (d) from 2h00 to 3h00

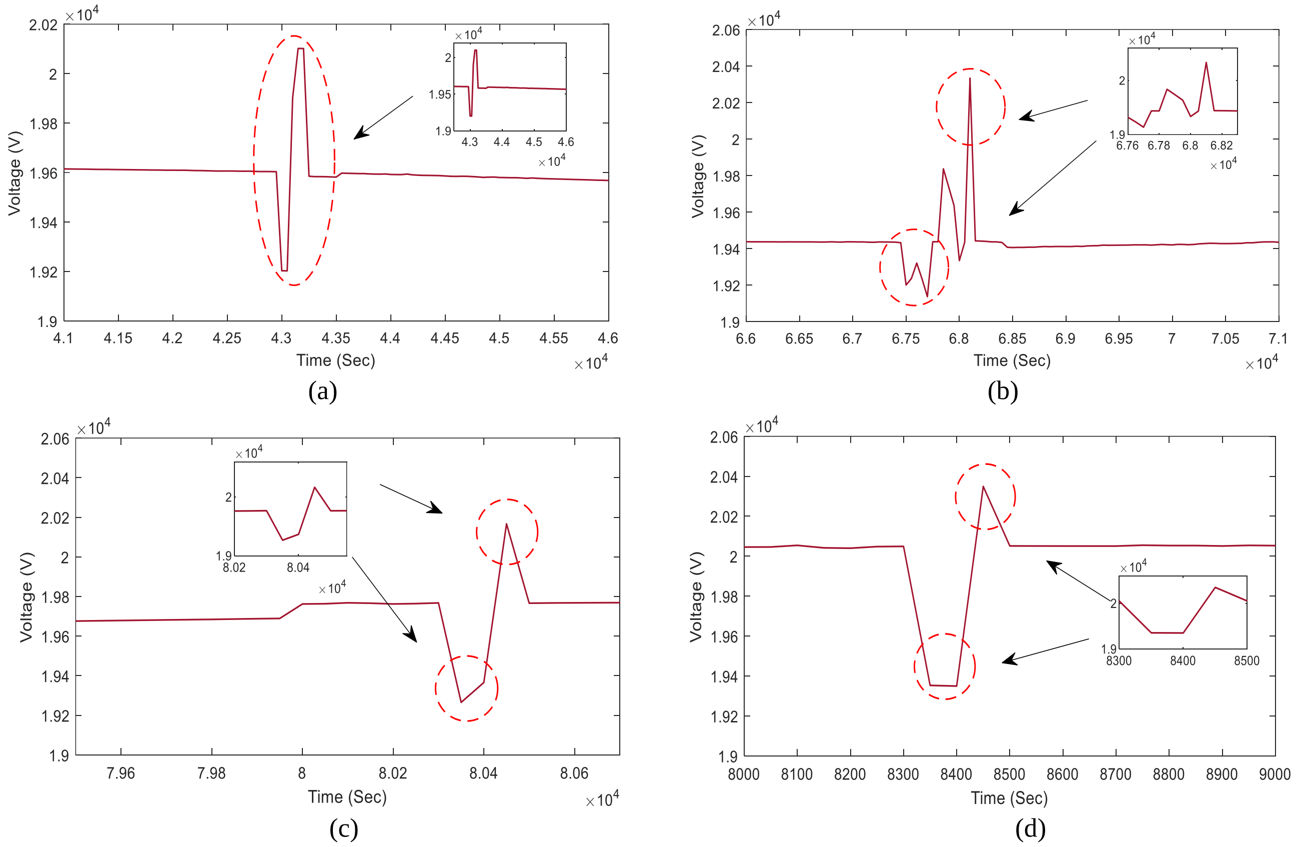
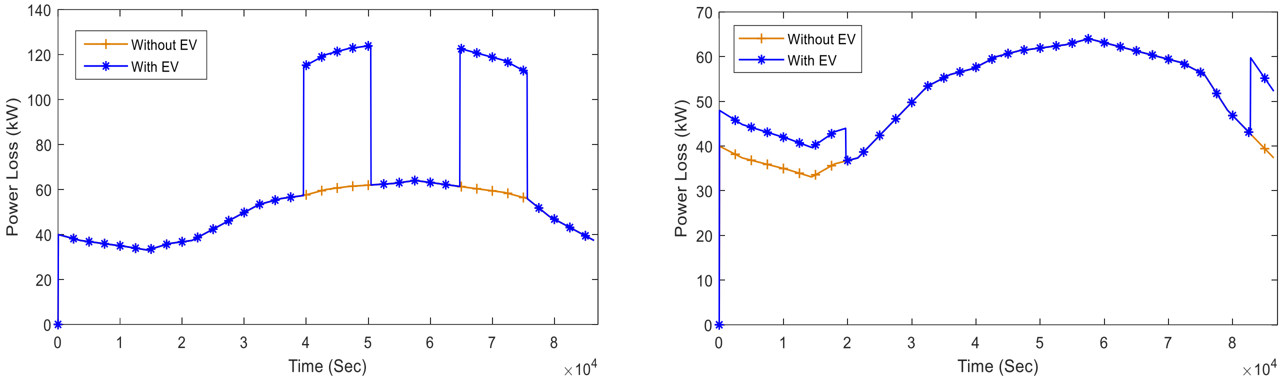


Fig. 15. Voltage measured of Solar Farm (a) from 11h30 to 13h30; (b) from 5h00 to 7h30; (c) between 21h00 and 22h30; (d) from 2h00 to 3h00

Fig. 14a shows a voltage deviation of wind power about 0.28% between 3h00 and 5h00. Especially in Figure 14b shows between 17h00 and 19h00, the voltage drop increased to 5.43%, exceeding the allowable limit of the power grid. In addition, Fig. 14c and Fig. 14d, between 21h and 22h30 and 2h00 to 3h00, detail transient components with magnitude amplitude deviations of 0.218% and 0.213%.

Fig.15a shows the voltage deviation of the solar farm in the period from 3h00 to 5h00, about 1.77%. Fig. 15b shows that the voltage drop during peak hours from 17h00 to 19h00 is 4.62% when people have a high demand for equipment. Besides, the figures of 2.33% and 2.12% correspond to the voltage deviation in the hours from 21h to 22h30 and 3h00 to 4h30.



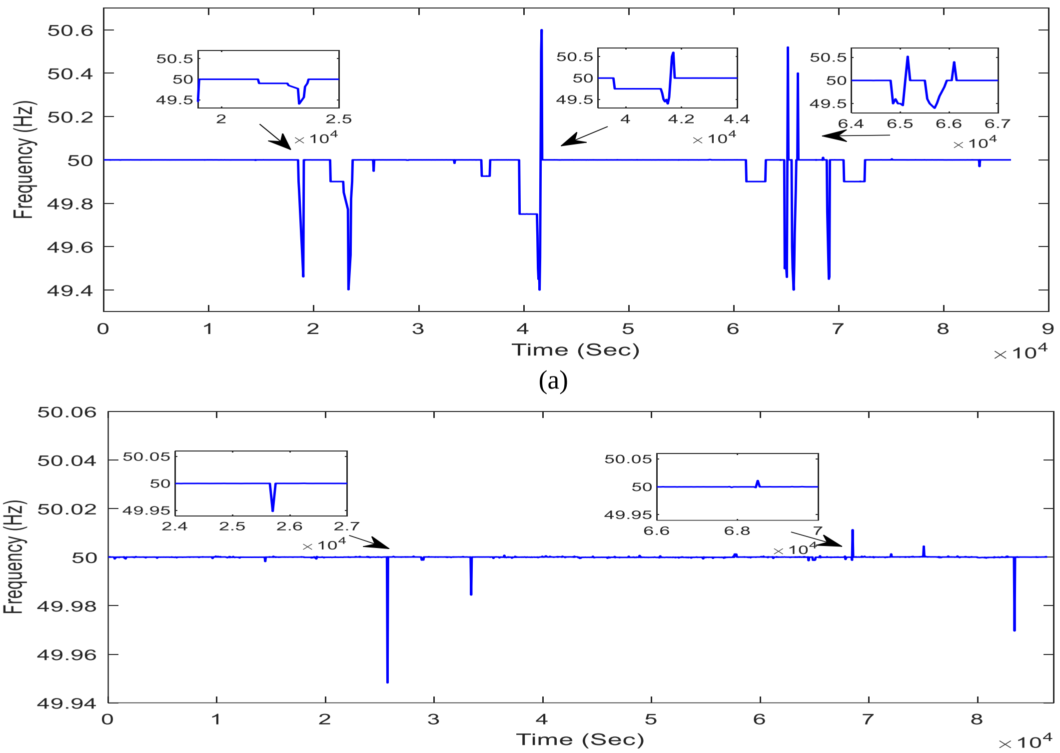
(a) (b)

Fig. 16. Power losses in MG (a) with random EVs; (b) with MLA Algorithm

Fig. 16.a depicts the power loss of the power grid in the period from 11h00 to 12h30 and from 18h00 to 19h30, the maximum power loss is about 120kW. In addition, Fig. 16b shows power deviation with intelligent power and load management algorithms. The power loss of the grid has been reduced to about 60kW.

Finally, when integrating EVs into the grid, frequency is considered.

Fig.17 illustrates the effect of EV on the grid frequency. Between 5h and 6h30, the grid frequency drops to 49.4Hz, and the frequency difference is about 1.2%. Similarly, the period from 18h00 to 19h00 frequency is down to about 49.48Hz and up to about 50.45Hz. Meanwhile, figure 17. shows the results when using the LMA algorithm in tram control. The results show that the frequency in about 24h is within the allowable value of the power grid



(a)

(b)

Fig. 17. Frequency of the MG when integrating EVs (a) with random EVs; (b) with LMA Algorithm

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V. CONCLUSION

In this paper, the island Microgrids model in Vietnam has been built with renewable energy sources. In addition, they are integrating grid-connected Electric Vehicles to evaluate the technical criteria of the MG grid according to national standards. The simulation results show that when the EV is combined, the voltage at the nodes decreases beyond the allowable limit and the power loss increases. Using two power optimization algorithms and load management helped overcome high EV penetration. Wind speed variation and radiative variation related to the grid's operating capacity were analyzed, and it was determined that the proposed design of V2G and the MG efficiently regulate all the parameters. In the future, with many optimization algorithms applied to operate integrated grid EVs, it will help improve the efficiency of energy sources through which loads can be managed. The proposed method needs to be tested with large-scale island grids in Vietnam.

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Ethical Approval and Consent to Participate	No, this article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	All authors having equal contribution for this article.

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