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Distribution for One Communication Systems Based High Performance of Microgrid Control Systems

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Abstract

This paper aims to enhance the performance of Microgrid MG control systems using the proposed communication systems. The energy management of MG system is playing a great role in electrical system planning and design. The MG having distributed generators such as Photovoltaic generator, wind energy conversion systems, Energy storage system, diesel energy system, hydro turbine system, etc. is controlled to share the load energy among them economically and less pollutions. Distribution of the certain load among the energy sources of MG can be done quickly by using a communication system. The proposed communication system has two Arduino boards, two wireless modules with antenna modules, two monitors and a platform that used to collect sensors data in the cloud. The distributed generators in the present MG consists of Photovoltaic energy source, wind energy conversion system, and Energy storage system. While the load is home load. The Energy Management in the present study is done through Microgrid Energy Management center and using the data collected from sensors at power station and load center. The results sent to local controllers at each power station through wireless communication systems to control and achieve energy management. The digital and practical results prove the effectiveness the suggested wireless communication systems in sense of fast response and economically.

Keywords

MG control systems, Microgrid Energy Management System (EMS), wireless communication system.

1. Introduction

The Microgrids MGs have received an increasing interest due to their flexible and bringing a significant potential to promote and integrate renewable energy resources. Moreover, MGs can improve overall system reliability, efficiency, and performance. They can be used as an autonomous power source (islanding mode) in parallel with a main grid (grid connected mode), as well as during transition to islanding mode (on/off grid mode) [1-3]. The power electronics interface circuits (PEICs) called converters are connected between different MG components.Whereupon the

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Microgrid have two main configurations: AC and DC microgrids [4,5]. AC microgrids (ACMGs) are gaining in popularity due to their variety of applications. On the other hand, DC microgrids (DCMGs) provide DC power and are usually connected to a DC bus line [6]. In this case, an inverter (DC/AC) and a rectifier (AC/DC) are both required for bidirectional connection with ACMGs. ACMGs and DCMGs along with their respective PEICs still face numerous challenges such as efficient energy control and management [7-11].

The Microgrid Energy Management System (MG-EMS) is required to identify operation costs while taking into account the consumer power demand for each Distributed Energy Resource (DER) and Energy storage system (ESS) unit. As such, efficient algorithms are developed to optimize the use of individual DERs by minimizing an objective function while considering the system constraints such as load power balance, fuel cost, performance, specifications [12-20]. Real-Time Energy Management Systems (RT-EMSs) is described as one which controls an environment by receiving data, processing them, and returning the results sufficiently quickly to affect the environment at that time [21-22].

To improve the performance of RT-EMSs, a robust and reliable communication network is required to exchange the information and decision commands between the EMS, DERs, ESSs, local controllers, and PEIC in real time. The communication network should be flexible and expandable to provide a link with all the nodes within the MG location. For customer privacy and system security, a strong encryption algorithm should be used to secure the communication between different nodes and MG-EMS [23-24]. An advanced RE-EMS is proposed for MG application based on wired communication network in Ref. [25-26]. Wired communication systems do not have interference problems and their functions are not dependent on batteries, as wireless solutions often do. On the other hand, wireless communications have some advantages over wired technologies, such as low-cost infrastructure and ease of connection to difficult or unreachable areas. However, the nature of the transmission path may cause the signal to attenuate. Recently, different wireless communication technologies are available and utilized for smart MGs to meet certain requirements such as low cost, simple deployment, working in noisy and harsh environment and support large number of nodes to accommodate for all smart appliances, distributed energy resources and controllers. The Energy Management in the present study is done through Microgrid Energy Management center and using the data collected from sensors at power station and load center. The results sent to local controllers at each power station through wireless communication systems to control and achieve energy management. Computer simulation and practical results prove the effectiveness the suggested wireless communication systems in sense of fast response and economically.

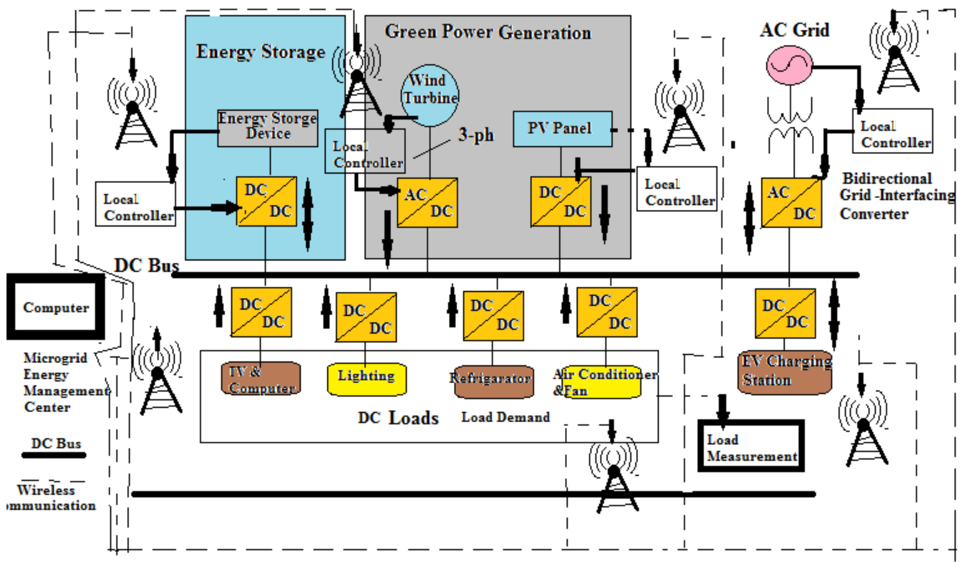

Figure (1) . The single line diagram of a typical Microgrid structure

2- Proposed Wireless Communication Systems

In our problem, the communication process takes place as follows.

- We use two Arduino boards, Two NRF24L01+PA+LNA Wireless Module 2.4 Ghz with Antenna modules , two monitors and a platform that lets you collect and store sensor data in the cloud, thingspeak in our case Potentiometers and LEDs are connected to one Arduino.
- We use three potentiometers representing the load, Solar1 capacity, Wind capacity, Battery and the Grid. The other Arduino is connected to a computer in which JADE code written in the Eclipse environment for Multi Agent requirement is present.

The values from each of these potentiometers are sensed by the first Arduino and sent to the web server through the NRF24L01+PA+LNA Wireless Module module

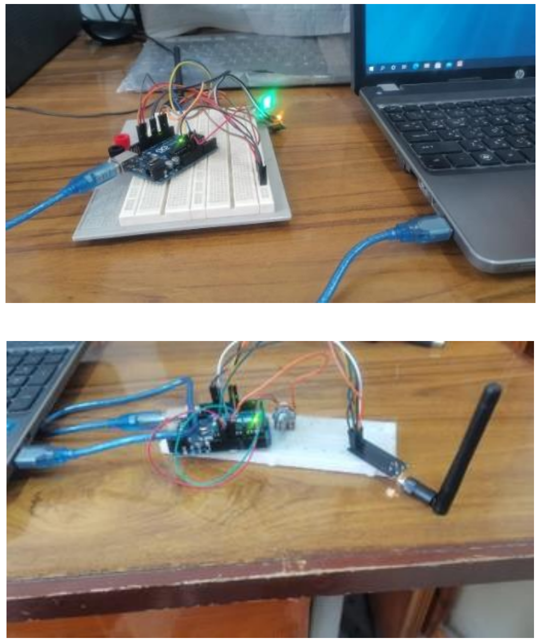

Figure 2: Demonstration Setup

As shown in Figure 2, the demonstration used two wireless NRF24L01 transceivers along with two micro-controllers: an Arduino Uno as the Local Controller at the microgrid, and an Arduino MEGA 2560 as the Master Controller at the Control Centre. To transmit the desired information from one microcontroller to another, the NRF24L01 transceiver with 2.4 GHz Radio Frequency (RF) is used. The transceiver uses Serial Peripheral Interface (SPI) to communicate with the microcontroller to transmit data

The NRF24L01 operates with baud rates from 250 kbps up to 2 Mbps and has 125 independently working channels. Each channel can have up to 6 addresses, or each unit can communicate with up to six other units at the same time. An Arduino microcontroller is used to build a bridge between the transmitter and user interface that converts the USB output to a SPI output.This system can be used as the communication approach for wireless control of the MG from the remote EMS; a scaled model is being prepared. The distance between the MG and the EMS can be in the range of 1 km.

3-Energy management system (EMS)

This section discusses the energy management strategy used in the proposed model. . The objective of the EMS is to supply the demand load from the DGs, ESS and . There are many input variables to the EMS, which include load demand, PV and wind turbine power output, system constraints, SOC of the battery, operational and maintenance cost of each DGs and ESS and the grid tariff as shown in Figure 3. The EMS receives its inputs and then determines the setting-point for the ESS and DGs .

4- Microgrid System Description and Model

The studied MG system as shown in fig.(1) has two lines, one solid for DC bus ,while the other

is dashed called wireless communication . The Power station includes Photovoltiac system PV, Wind turbine system WT and Energy Storage system ESS. Also there are load centers having home appliances. Moreover, There are AC grid and local controllers at each system components .Theses controllers have sensors to measure the state of power station under envormintal and load conditions and send these measured values through wireless communications to Energy management center having main computer which makes the energy management strategy. The results is sent via Wireless communication systems to Local controllers to control the Converters at each station.
Microgrid is an independent power grid composed of PV, wind power, battery storage system and load, which integrates power generation, transmission and distribution with flexible control and other characteristics. The power generation part of the micro-grid consists of distributed wind power and PV, while battery storage system is configured to suppress the volatility of wind–PV power output and load and match there al-time supply and demand within the microgrid system. We do not care whether it is a direct current(DC) or alternating current(AC)grid or a hybrid grid, it does not affect our analysis. We often need to consider PV ,wind, load and other factors for ES system capacity configuration ,and PSO needs to rely on mathematical models, so we analyze PV, wind and battery ES models in detail.

4.1 PV modeling

The output power of PV system changes with the weather conditions. The power generated from the PV arrays at hour t is calculated as follow [13]

$$P_{pv}(t) = A_{pv} * \eta_{pv} * G(t) \tag{1}$$

where η_{pv} is the PV panel reference efficiency, A_{pv} in m^2 is the solar array surface area, and G(t) is the solar irradiance in kw/m^2:

4.2 Wind power modeling

A simplified model of a wind turbine produces electrical power which has a linear relationship with the wind speed. When the wind speed reaches a nominal value, the wind turbine produces the nominal power. The wind turbine disconnects from the grid when the wind speed reaches the maximum wind value (cut-off speed). On the other hand, the wind turbine does not generate any power when the wind speed is equal or lower than the minimum wind value (cut-in speed) since it does not have enough power to overcome the friction of the turbine. The output power of wind generator is

$$P_w(t) = \begin{bmatrix} 0 & V \le V_{ci}\ , V \ge V_{co} \\ a * V^3(t) - b * P_{rate} & V_{ci} \le V < V_r \\ P_{rate} & V_r \le V < V_{co} \end{bmatrix} \tag{2}$$

Where P_{rate} is the rated output power, V_{ci} cut-in speed, V_{co} cut-off speed, V_r rated speed, V is the wind speed [m/s] and a, b are the fitting parameters of the wind turbine power curve which determine the rated output power of the generator. The output of the wind turbines depends on the wind speed forecasting.

4.3 Energy storage system modeling (Battery modeling)

There are many types of storage devices used in the power system. Electric storage systems include battery [15], super capacitor, flywheel [16], and superconducting magnetic energy storage (SMES) [17]. Depending on the application and the purpose for using the storage system the user decides which type of ESS can be deployed. ESS should be connected to a bidirectional battery charger to regulate the charging/discharging power of the ESS and to control the output voltage. In this paper, the battery storage system is used to give an optimal solution to the proposed model. The dynamic equation for the battery storage system is described as follows:

$$W_{ESS}(t) = W_{ESS}(t-1) + P_{charging} * \Delta t * \eta_{ch} - \frac{P_{discharging} * \Delta t}{\eta_{disch}} \quad (3)$$

Where $W_{ESS}(t)$ and W_{ESS} (t-1) are the stored energy in the battery at time (t) and (t-1). $P_{charging}$ and $P_{discharging}$ are the charging and discharging power, respectively, to the battery during a period (Δt). η_{ch} and η_{disch} are the charging/discharging efficiencies of the battery which are both set to be 0.9.

5. System constraints

There are many operational constraints that must be taken into consideration .Each DG and the proposed distribution network have technical power limits. These power limits control energy management problem. The system power limits are as follows:

5.1. Load power balance

The following equation illustrates the power flow relation at each time interval, where $\sum P_L(t)$ is the amount of load demand.

$$\sum P_L(t) - P_{pv}(t) - P_w(t) - P_{ESS}(t) - P_{gb}(t) + P_{gs}(t) = 0 \quad (2)$$

5.2 Source constraints

To keep the system stable, the DGs output power must be within suitable limits. Also, there are many constraints that must be taken into consideration to maintain the lifetime of the battery and prevent its damage. There is a limit on the amount of energy stored in the battery (presented as the state of charge (SOC)). The input/output power of the battery is limited by the maximum charging/discharging power [18].

$$P_{pv}^{min}(t) \le P_{pv}(t) \le P_{pv}^{max}(t) \quad (5)$$

$$P_{w}^{min}(t) \le P_{w}(t) \le P_{w}^{max}(t) \quad (6)$$

$$P_{ESS}^{min}(t) \le P_{ESS}(t) \le P_{ESS}^{max}(t) \quad (7)$$

$$SOC^{min}(t) \le SOC(t) \le SOC^{max}(t) \quad (8)$$

6. Simulation Results and Discussion

The proposed EMS scheme is implemented using MATLAB/Simulink by considering a certain day of 24 hours duration with variable load power requirement. . The hourly output power profile of the wind and PV system changes with the time of day as shown in Figures (3), (4) respectively. The profile of the load during one day is shown in Figure (5) .The limits and economic parameters of PV, WT and ESS are illustrated in Table [1]. The minimum, maximum and initial state of charge (SOC) of the ESS is supposed to be 10%, 90% and 50%, respectively. Table [2] illustrates the variation of the grid tariff**.** This section presents the results for the studied microgrid based on the proposed formulation . Firstly, The sensors in the Microgrid read the data of the load, PV, Wind, and ESS, then send through the wireless communication these data to the Computer center of EMS to process the data and the results are share of each power source for the load .These dispatching is sent to the local controllers at each source through wireless Communications.

Table [1]. Technical and economical parameters of DGS and ESS.

Type	PV	Pw	ESS
Lower Limit (kW)	0	0	-2
Upper Limit (kW)	25	20	2

Table [2] : Electricity time-of-use price periods

Time of hour	Off- peak 0-07	On – peak 07-11	Midum- peak 11-17	On- peak 17-19	Off- peak 19-24
Purchasing price ($/kW)	0.087	0.18	0.132	0.18	0.087
Sell price ($/kW	0.0435	0.09	0.066	0.09	0.0435

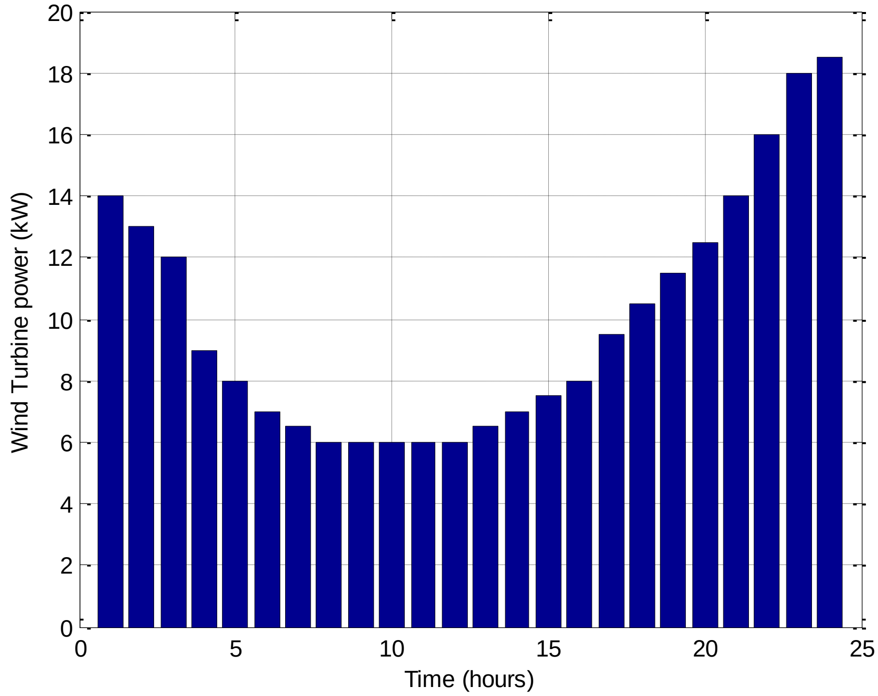

Fig.(3) Houry Wind turbine power at certain day

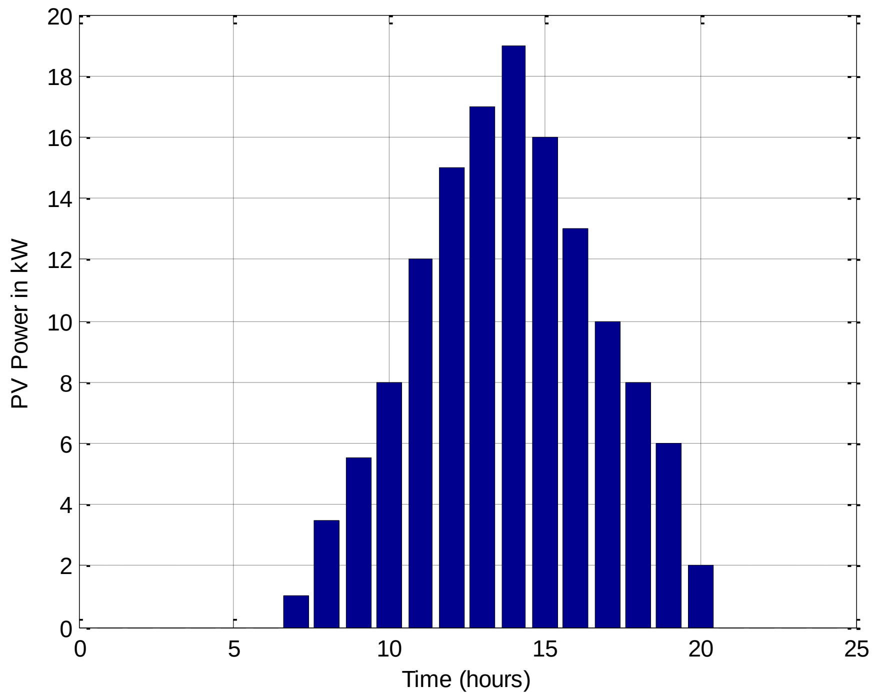

Fig.(4) Hourly Photovoltaic PV ower at certain day

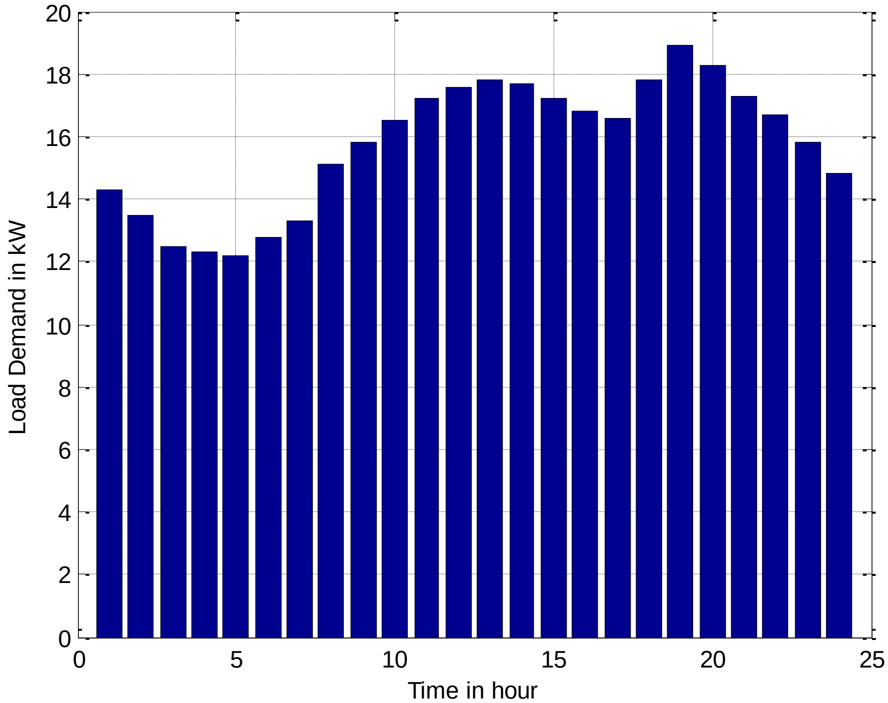

Figure (5): Hourly load demand during a day

6.1 Case Studies

In this section, two possible operation modes are described:

(1) Mode 1 'small-scale load': The DGs power is more than the demand in a specific hour and less in other hours of the day. So, the MG may sell or purchase power to/from the grid depending on the objectives of the operating strategy. The load in this mode consisted of a set of homes and the demand is shown in Figure (5)

(2) Mode 2 'large-scale load': The demand is constantly higher than the DGs power. thus, the shortage of the power demand can be bought from the grid and there will not be any power that can be sold to the grid. To apply this mode, it is assumed that another set of homes is coupled with the previous loads, which simply duplicates the load demand. To test the proposed model with these modes of operation there are three case studies that will be implemented:

6.1.1 Results for mode 1 'Small-Scale Load'

This mode will be discussed with the three cases to illustrate the advantages of the proposed strategy .

Case 1) Purchasing electricity, without DGs and ESS;

In this case, the load is fully supplied from the utility grid. Where the DGs and ESS are disconnected from the utility grid. Fig.(6) shows the Microgrid Dispatching with Grid only and Without DGs and ESS. Table [3] gives the total cost of the purchased power from the grid according to the electricity time-of-use price periods. The load absorbs 359.1 kWh per day from the utility grid and the purchased cost is $32.7816 per day. Also, the reliability is missing in this case as if there is any fault in the utility grid, the load will be disconnected.

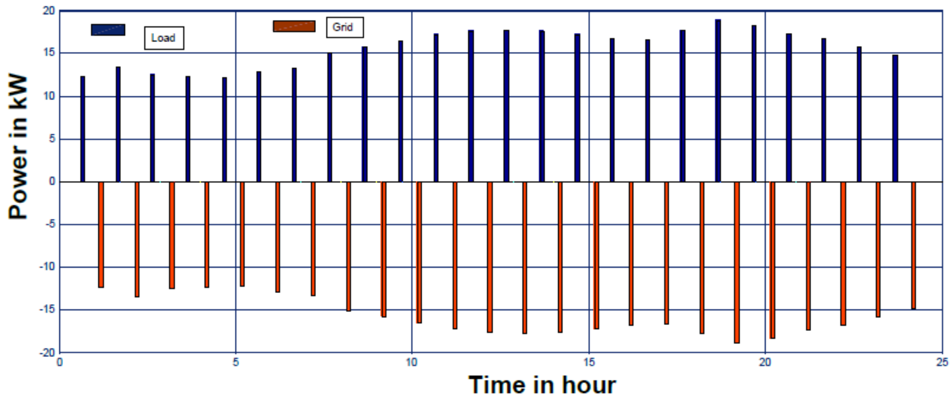

Fig.(6) Microgrid Dispatching without DGs and ESS and with Grid only

Case 2) Selling electricity, with DGs and ESS;

In this case, the DGs supply the load with the required power and store the surplus power in the ESS until it reaches the maximum capacity. If there is more power unexploited, it will be sold to the utility grid. Figure (7) illustrates the power flow as. shown in Table [3], the system costs are reduced by 92.5% so the daily saving is $30.32 per day; as it did not buy any power from the grid and the residual power stored in the ESS. The total cost, in this case, Figure (7) shows that the battery discharges when the DGs' power is lower than the load demand and charges when the DGs' power is higher than the load demand.

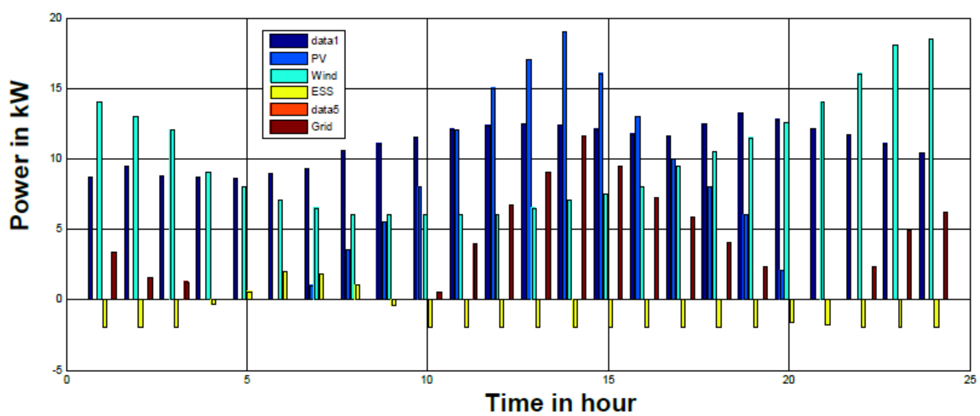

Fig.(7) Microgrid Dispatching with DGs and ESS and with Grid Selling Electricity

Table [3] Results of the studied cases

Case	Mode (1)					Mode (2)				
	Electricity trade					Electricity trade				
	Purchased kW	Sold kW	Purchased cost($)	Sell cost($)	Total cost ($)	Purch kW	Sold kW	Purch Cost ($)	Sell Cost($)	Total Cost($)

1	359.1	0	32.7816	0	32.7816	491.14	0	38.552	0	38.552
2	0	79.51	0	2.4587	2.4587	79.88	0	6.95	0	6.95
3	8.85	35.16	0.77	1.5295	-0.7595	35.62	8.67	35.62	0.3371	8.3329

Case 3) Purchasing electricity and selling electricity, with DGs and ESS;

This strategy allows the MG to acquire economic benefits by selling the electricity to the grid with high price and purchasing it with low price. Therefore, the buying cost is lower than the selling cost and the total cost is $-0.9532 per day as shown in Table [3]. Also, the purchased power from the grid (-20.6 kWh) is lower than the sold power to the utility grid (20.7 kWh). Table [4] shows that the battery charges in the off-peak price periods and discharges in the other hours of the day. This case study demonstrates a high potential savings for the total operating cost.

Table [4] : Daily dispatching of hourly Microgrid power for each source and total cost at Mode (1) case (3)

Hours	Load (kW)	PV (kW)	PW (kW)	Pgb (kW)	Pgs (kW)	ESS (kWh)	Total Cost($)
1	12.3	0	14	0	0	-1.7	0.123
2	13.5	0	13	0	0	0.5	0.135
3	12.5	0	12	0	0	0.5	0.125
4	12.3	0	9	-1.3	0	2.0	-0.0031
5	12.2	0	8	-2.2	0	2.0	-0.0914
6	12.8	0	7	-3.8	0	2.0	-0.2406
7	13.3	1	6.5	-3.8	0	2.0	-0.2356
8	15.1	3.5	6	-3.6	0	2.0	-0.1982
9	15.8	5.5	6	-2.3	0	2.0	-0.0651
10	16.5	8	6	-0.5	0	2.0	0.1165
11	17.2	12	6	0	0	-0.8	0.1720
12	17.6	15	6	0	1.4	-2.0	0.2509
13	17.8	17	6.5	0	3.7	-2.0	0.376
14	17.7	19	7	0	6.3	-2.0	0.5141
15	17.2	16	7.5	0	4.3	-2.0	0.4021
16	16.8	13	8	0	2.2	-2.0	0.2857
17	16.6	10	9.5	0	0.9	-2.0	0.2141
18	17.8	8	10.5	0	0	-0.7	0.1780
19	18.9	6	11.5	0	0	1.4	0.189
20	18.3	2	12.5	-1.8	0	2.0	0.0084
21	17.3	0	14	-1.3	0	2.0	0.0469
22	16.7	0	16	0	0	0.7	0.167
23	15.8	0	18	0	0.2	-2.0	0.1687
24	14.8	0	18.5	0	1.7	-2.0	0.2389
Sum	376.8	136	239	-20.6	20.7	1.9	2.8773 $

	kWh	kWh	kWh	kWh	kWh	kWh	

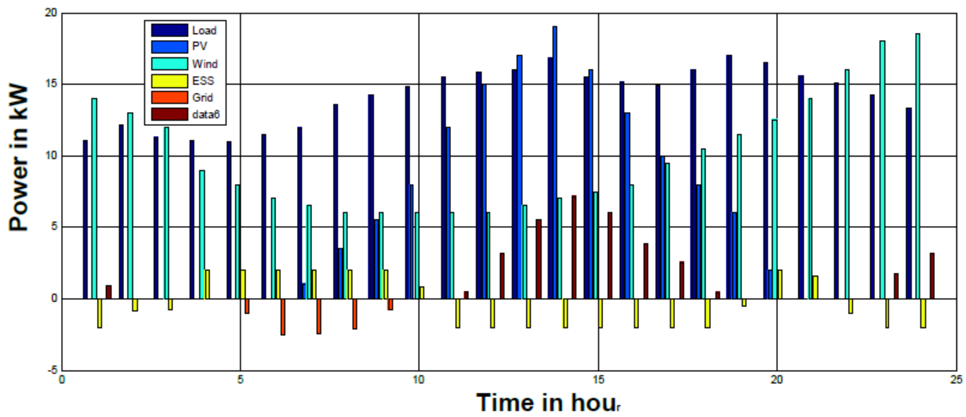

Fig. (8) Microgrid Dispatching for mode (1) case (3) for Microgrid Dispatching with DGs and ESS and with Grid Purchasing and Selling Electricity

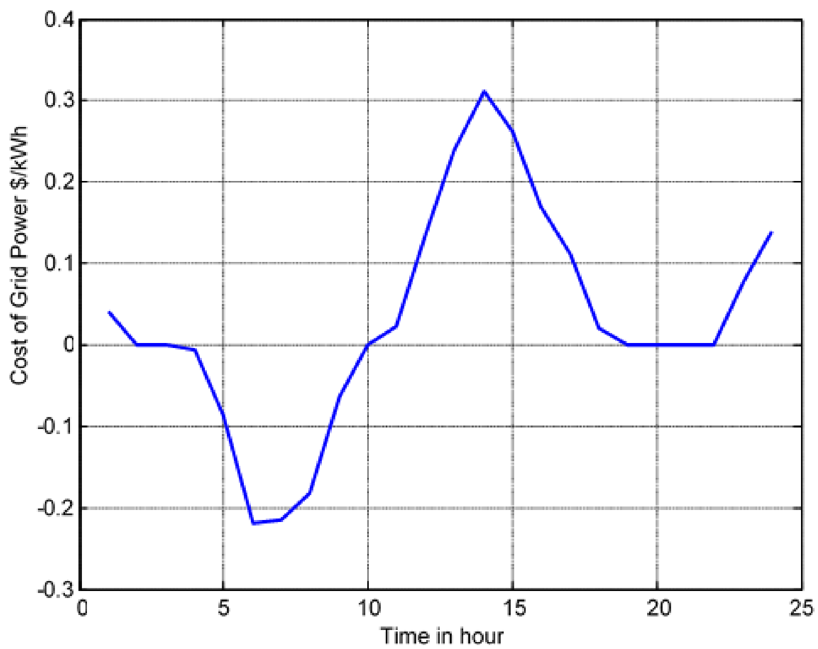

Fig. (9): Cost of Grid power (Selling and Purchasing Electricity) in $/kWh

6.1.2. Results for mode 2 'Large-Scale Load'

Case 1) purchasing electricity, without DGs and ESS;

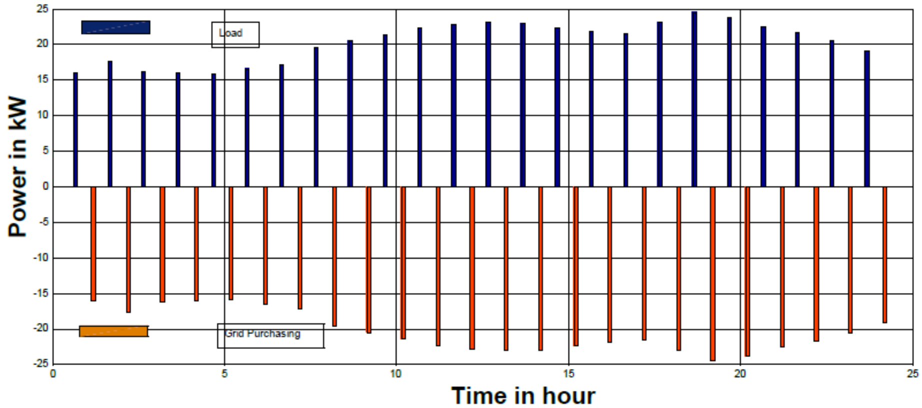

Fig.(10) Microgrid Dispatching without DGs and ESS and with Grid Purchasing for Mode 2 Large –Scale Load

Case 2) purchasing electricity, with DGs and ESS;

Table [5] : Daily dispatching of hourly Microgrid power for each source and total cost at Mode (2) case (2)

Hours	Load (kW)	PV (kW)	PW (kW)	Pgb (kW)	Pgs (kW)	ESS (kWh)	Total Cost($/kW)
1	15.99	0	14	0	0	1.99	0.1599
2	17.55	0	13	-2.55	0	2.0	-0.0719
3	16.25	0	12	-2.25	0	2.0	-0.0557
4	15.99	0	9	-4.99	0	2.0	-0.3241
5	15.86	0	8	-5.86	0	2.0	-0.4098
6	16.64	0	7	-7.64	0	2.0	-0.5747
7	17.29	1	6.5	-7.79	0	2.0	-0.5827
8	19.63	3.5	6	-8.13	0	2.0	-0.5923
9	20.54	5.5	6	-7.04	0	2.0	-0.4775
10	21.45	8	6	-5.45	0	2.0	-0.3141
11	22.36	12	6	-2.36	0	2.0	-0.0053
12	22.88	15	6	0	0	1.88	0.2288
13	23.14	17	6.5	0	0	-0.36	0.2314
14	24.31	19	7	0	0	-1.69	0.2431
15	22.36	16	7.5	0	0	-1.14	0.2236
16	21.84	13	8	0	0	0.84	0.2184
17	21.58	10	9.5	-0.08	0	2.0	0.208
18	23.14	8	10.5	-2.64	0	2.0	-0.0247
19	24.57	6	11.5	-5.07	0	2.0	-0.2461
20	23.79	2	12.5	-7.29	0	2.0	-0.4692
21	22.49	0	14	-6.49	0	2.0	-0.4046
22	21.71	0	16	-3.71	0	2.0	-0.1428
23	20.54	0	18	-0.54	0	2.0	0.153
24	19.24	0	18.5	0	0	0.74	0.1924

Case 3) purchasing electricity and selling electricity, with DGs and ESS;

As mentioned before, in case 1 the load is completely supplied by the utility grid. Also, in mode 2 the load is increased so the purchasing price is increased. In case2 and case 3, DGs and ESS are connected to the utility grid to supply the load. However, in each of the previous cases, the Microgrid MG can purchase power from the utility grid while in case 3 the MG can sell/buy power to/from the utility grid. In case 2, the ESS charge in the period (09:00–17:00) as in this period the generated power from the PV is at its maximum, while in the evening there is not enough irradiance to generate power from PV so the ESS discharges the stored power. Table[6] shows the power flow in the proposed MG in case 3. On the other hand, table[6] shows that in case 3, the MG will sell and buy power to/from the utility grid according to the electricity time-of-use price periods. Table [3] shows a comparison between the three case studies of two modes of operation in terms of minimum cost. From results, the case 3 is more effective than the other two cases. Where the previous analysis, and the aforementioned results indicate high potential savings for the total operating cost in the two modes of operations.

Table [6] : Daily dispatching of hourly Microgrid power for each source and total cost at Mode (2) case (3)

Hours	Load (kW)	PV (kW)	PW (kW)	Pgb (kW)	Pgs (kW)	ESS (kWh)	Total Cost($/kW)
1	14.7	0	14	0	0	0.76	0.1476
2	16.2	0	13	-1.2	0	2.0	0.0456
3	15.0	0	12	-1.0	0	2.0	0.053
4	14.76	0	9	-3.76	0	2.0	-0.2171
5	14.64	0	8	-4.64	0	2.0	-0.3037
6	15.36	0	7	-6.36	0	2.0	-0.4633
7	15.96	1	6.5	-6.46	0	2.0	-0.4670
8	18.12	3.5	6	-6.62	0	2.0	-0.4609
9	18.96	5.5	6	-5.46	0	2.0	-0.34
10	19.8	8	6	-3.8	0	2.0	-0.176
11	20.64	12	6	-0.64	0	2.0	0.1443
12	21.12	15	6	0	0	0.12	0.2112
13	21.36	17	6.5	0	0.14	-2.0	0.2211
14	22.44	19	7	0	1.56	-2.0	0.3079
15	20.64	16	7.5	0	0.86	-2.0	0.2524
16	20.16	13	8	0	0	-0.84	0.2016
17	19.92	10	9.5	0	0	0.42	0.1992
18	21.36	8	10.5	-0.86	0	2.0	0.1302
19	22.68	6	11.5	-3.18	0	2.0	-0.0817
20	21.96	2	12.5	-5.46	0	2.0	-0.3100
21	20.76	0	14	-4.76	0	2.0	-0.2541
22	20.04	0	16	-2.04	0	2.0	0.0025
23	18.96	0	18	0	0	0.96	0.1896
24	17.76	0	18.5	0	0	-0.74	0.1776

6.1.3: Practical Results

An Experimental set-up is installed using two Arduino boards, Two NRF24L01+PA+LNA Wireless Module 2.4 Ghz with Antenna modules , two monitors and a platform that lets you collect and store sensor data in the cloud, thing speak in our case Potentiometers and LEDs are connected to one Arduino. Two wireless NRF24L01 transceivers along with two micro-controllers: an Arduino Uno as the Local Controller at the microgrid, and an Arduino MEGA 2560 as the Master Controller at the Control Centre are built. To transmit the desired information from one microcontroller to another, the NRF24L01 transceiver with 2.4 GHz Radio Frequency (RF) is used. The transceiver uses Serial Peripheral Interface (SPI) to communicate with the microcontroller to transmit data. The NRF24L01 operates with baud rates from 250 kbps up to 2 Mbps and has 125 independently working channels. Each channel can have up to 6 addresses, or each unit can communicate with up to six other units at the same time. An Arduino microcontroller is used to build a bridge between the transmitter and user interface that converts the USB output to a SPI output. This system can be used as the communication approach for wireless control of the MG from the remote EMS; a scaled model is being prepared. The distance between the MG and the EMS can be in the range of 1 km. The practical results of microgrid energy management control at low load 37 kW and 51 kW are shown in fig.(11) and fig.(12).

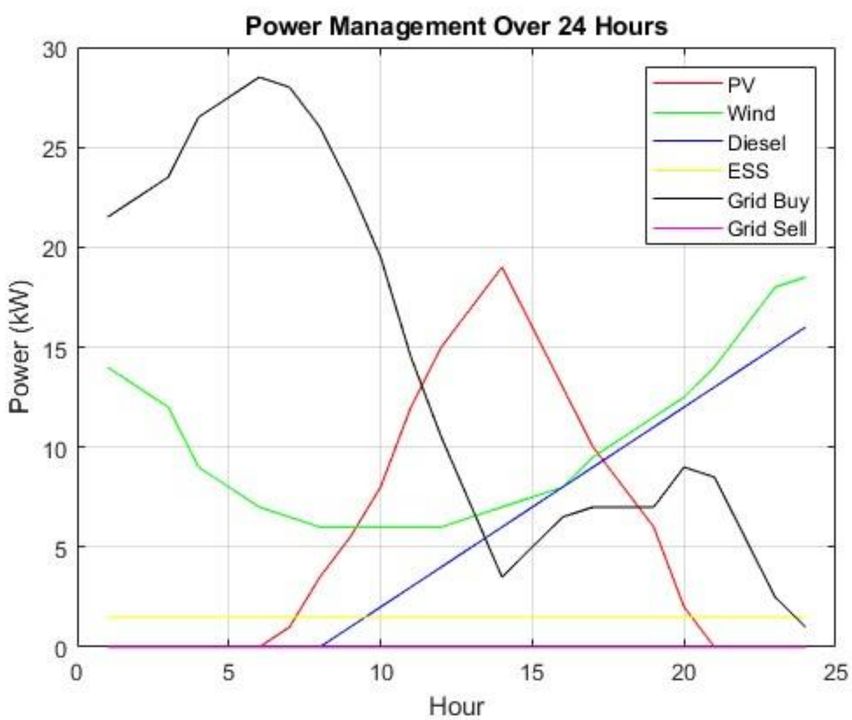

Fig.(11) : Practical Microgrid Dispatching using PV, Wind Energy, ESS and Grid connected for 37kW load

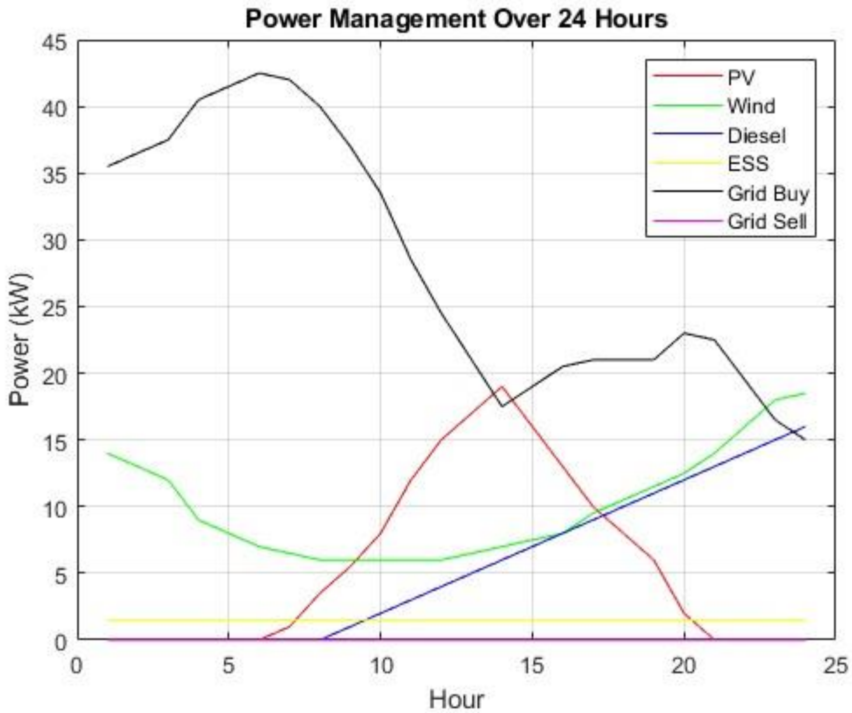

Fig.(12) : Practical Microgrid Dispatching using PV, Wind Energy, ESS and Grid connected for 51kW load

7. Conclusion

The present paper has designed a communications system to improve the Microgrid energy control with Distributed generator such as battery energy storage, Photovoltaic generator PV and, Wind turbine energy conversion system WG. The Microgrid was connected to Main Grid . The Object of communication system was to collect datac from the field of PV , WG , Battery and Load demand . These data have been sent and then processed in main computer for Microgrid energy control software under the distributed generator constraints. The results of Energy control have been sent through Wireless communications systems to the Local Controller at each Microgrid source to get the output power from them. The Proposed System is simulated in MATLAB Package and the results show the powerful of the communications system in sense of fast response and high performance and reliability of the Microgrid operation.

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