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Source Management and Load Shifting for Load Shedding Conditions

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ABSTRACT: This research paper investigates the use of Source extraction techniques to achieve load management in a hybrid energy system that integrates different energy sources, such as wind energy, solar energy, utility supply, and storage system. The primary objective of this study is to optimize the demand for energy by balancing supply and demand. In this paper the concept of source extraction refers to managing energy sources in order to ensure continuity of electricity supply. The LabVIEW software is used to implement load management and analyse their effectiveness in a sample hybrid energy system. Load management is the process of controlling various loads according to user priority. In this research paper source management and extraction is used for load shedding condition. The loads are segregated in Dispatchable and Un-dispatchable according to user priority. The system is implemented on a hybrid system. In this research paper the role of renewable energy sources is to optimize the demand. The renewable energy sources are utilized for implementing balance between source and load. The techniques have been applied on a sample system using LabVIEW software.

KEYWORDS: load management, load shedding, Renewable energy, Source extraction.

I. INTRODUCTION

The source management is an important aspect of energy management, especially in a scenario where demand for electricity exceeds the capacity of primary energy sources [1]. The research paper aims to achieve load management using source extraction for load shedding condition [2]. The load management is achieved by controlling the loads based on their priority, which is categorized in to dispatchable and un-dispatchable loads.

The system under test is a hybrid system. The primary goal of this system is to optimize the demand for energy and achieve a balance between the demand and supply of energy. The renewable energy sources are utilized to implement this balance [3, 4].

Load shedding is used to relieve stress on primary energy sources. That would be done by shifting a load from the LabVIEW software is used to implement the load management strategies in this research paper. LabVIEW is a powerful software tool that allows for the development of custom test and measurement systems, making it ideal for implementing load management strategies in a hybrid energy system.

II. LOAD MANAGEMENT TECHNIQUES

A. Load Shifting

Load shifting is an electricity load management technique in which load demand is shifted from peak energy hours to off-peak energy hours. This is achieved by using energy storage systems, such as batteries, to store excess energy generated during off-peak hours for use during peak hours [5, 6].

The idea behind load shifting is to make the most of renewable energy sources like wind and solar power, which may generate excess energy during off-peak hours when there is less demand. By storing this excess energy in batteries, we can use it during peak hours when there is more demand [7].

B. Flexible load shape

Flexible load shape is the ability to adjust its energy usage according to the availability of energy and the demand for energy. This flexibility allows the system to adapt to changing energy conditions, such as the availability of renewable energy sources like solar and wind power [8].

Flexible load shape can be achieved through various techniques, including load shifting, peak clipping, and valley filling. By shifting energy usage from peak hours to off-peak hours, we can adjust the load shape to match the availability of energy. For example, during times when solar or wind power is generating excess energy, we can use load shifting techniques to store this excess energy for use during peak hours when there is more demand. This allows us to balance out the load shape and make the most of renewable energy by sources. Flexible load shape is an important concept in energy management, as it allows us to make the most of renewable energy sources and reduce the strain on the energy grid during peak hours. By using a load shifting can achieve a more balanced and efficient energy system [9, 10].

III.BENEFITS AND BLOCK DIAGRAM OF DEMAND SIDEMANAGEMENT

A) Benefits of Source Extraction

- To utilize renewable energy sources (wind and solar) for optimizing the demand.
- To design and Implement Hybrid Energy System.
- To demonstrate the feasibility and effectiveness of the implemented system through experiment.
- To promote sustainable energy practices and reduce the carbon footprint.

B) For Utility

- It helps to reduce the market price for utility by freeing the utility from the expenses of building backup plants that are brought online to cope with the demand.
- It reduces the costs of managing the electricity grid.
- Availability of constant load on grid, so need of extrageneration.
- To reduce stress on primary energy Sources.

C) For Consumers

- Consumer can reduce their electricity bills by adjusting the timing and amount of electricity use.
- Consumer can control the loading by deciding their own priority.
- Active participation of consumer leads in saving.

D) Benefits of Renewable Energy Resources

- Available in abundant form.
- Free of cost, so no need to pay.
- No operationalcost(exceptwind),only maintenance cost
- Clean energy which doesn't produce greenhouse gas emission.

E) Objective of Research Paper

- To shift the load as per source priority.
- The availability of the source is required before supplying the load.

F) Block Diagram

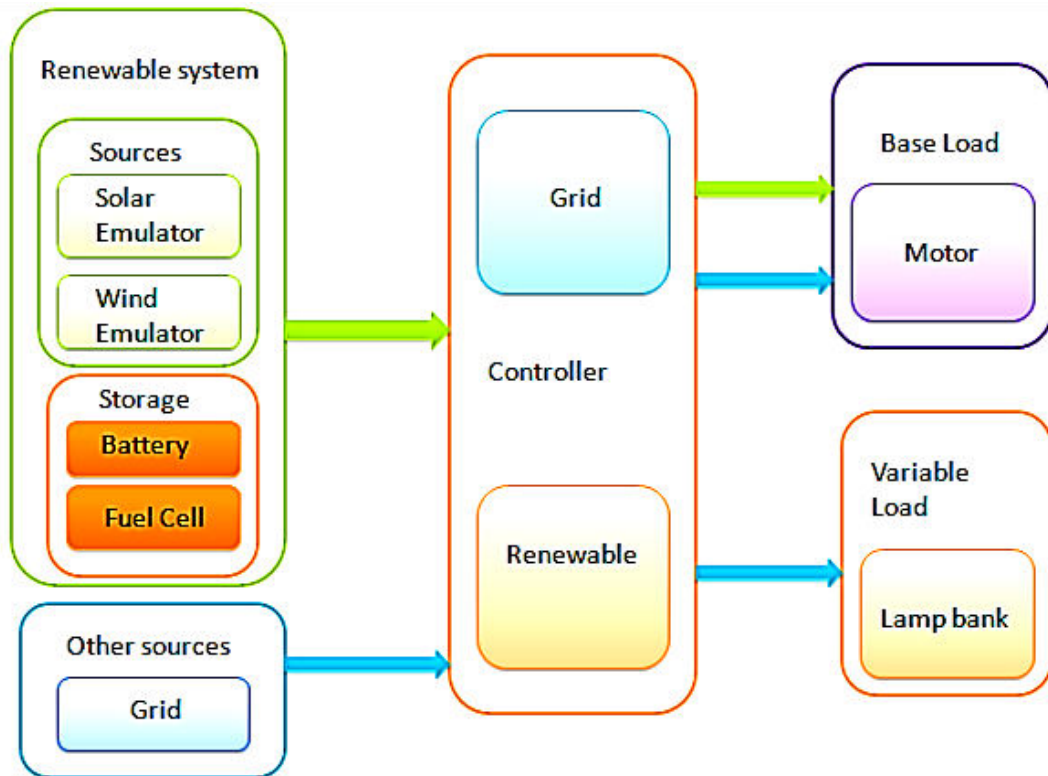


Fig.1: Block Diagram

IV. METHODOLOGY

The methodology involves a hardware and software-based approach that is applicable to real network systems including consumers and utility systems.

For implement of paper, simulation using Lab VIEW is used. Lab VIEW is a software program that allows for the creation of virtual instruments for various testing and measurement purposes. The Lab VIEW program design is used to create the necessary algorithms and control mechanisms required to manage the energy system. The Lab VIEW interface consists of two panels, namely the front panel and the block diagram. The front panel is used for all control and monitoring processes, while the block diagram is used for program design.

The process is performed on a test bench where all the sources are combined to form the test bench. This test bench is used to carry out the work, including testing and validation of the system. The test bench allows for the simulation of real-world conditions.

A) Hardware System

Paperwork is applicable to real network system including consumers and utility system.

B) Simulation Using LabVIEW

The system works using program design in the lab view, in LabVIEW there are two panel(front panel and block diagram),from front panel all control and monitoring process carried out and in block diagram the program design work carried out.

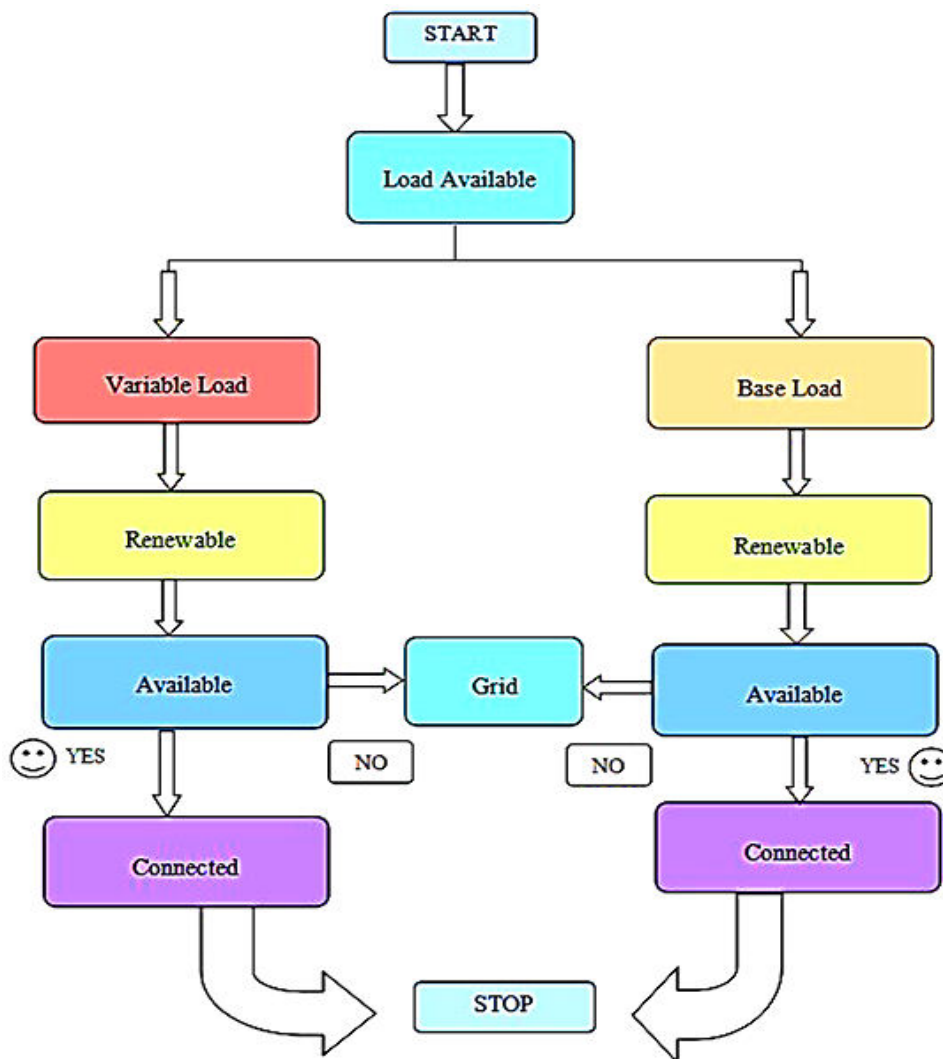


Fig.2: Flow Chart

C) Performed on test bench.

All sources are combined and formed the test bench, using this test bench extraction and management process is carried out.

V. SOFTWARE SYSTEM

In front panel all controls and indicators are placed in well manner. dis-patchable and un-dispatchable load are segregated separately. All source controls are placed in LHS top corner, and all load controls are placed beneath of it. Front panel is nothing but the graphical user interference from which all controlling and monitoring action carried out. The toggle switch is selected to control the sources and Boolean switches are selected to control the loading of dis-patchable and un-dispatchable load. when the Boolean switch of un-dispatchable load is pressed then that much amount of load shows the requirement of energy hence the available LED glows and that load get connected to the grid, so the LED of grid is also glows. The dis-patchable load is always connected to grid whenever requirement is occurred.

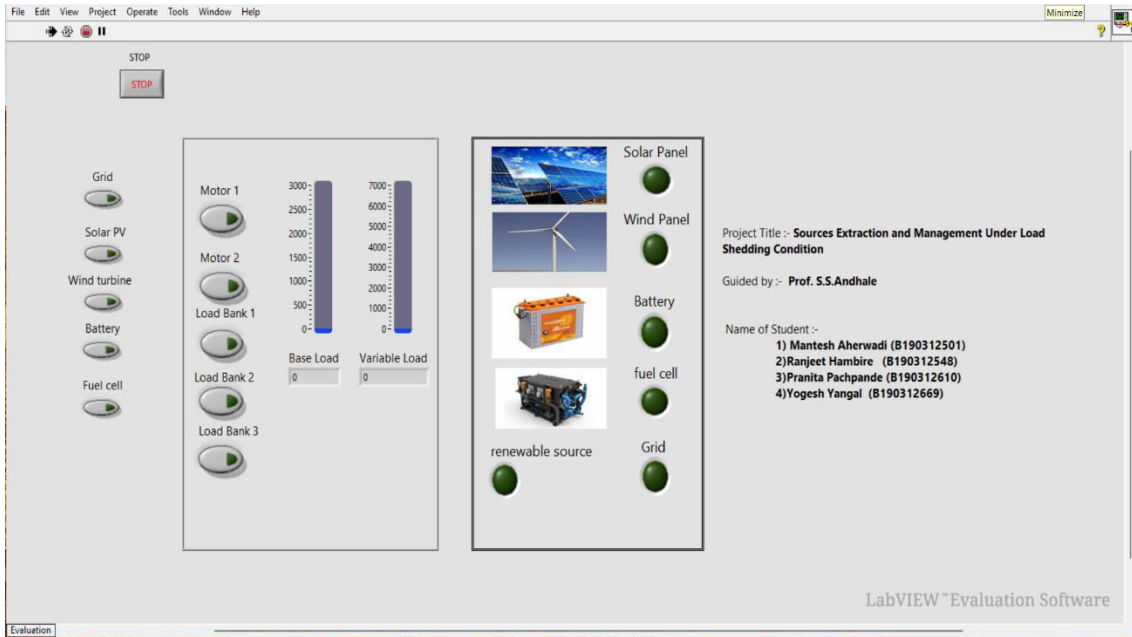


Fig. 3. Front panel

Whenever the un-dispatchable load required energy, its priority is renewable source, and second priority is grid. Again, in renewable resources priorities are decided based on unit cost, priority is given to the solar energy, second priority is given to the wind energy, third priority is given to the battery and last priority is given to the fuel cell.

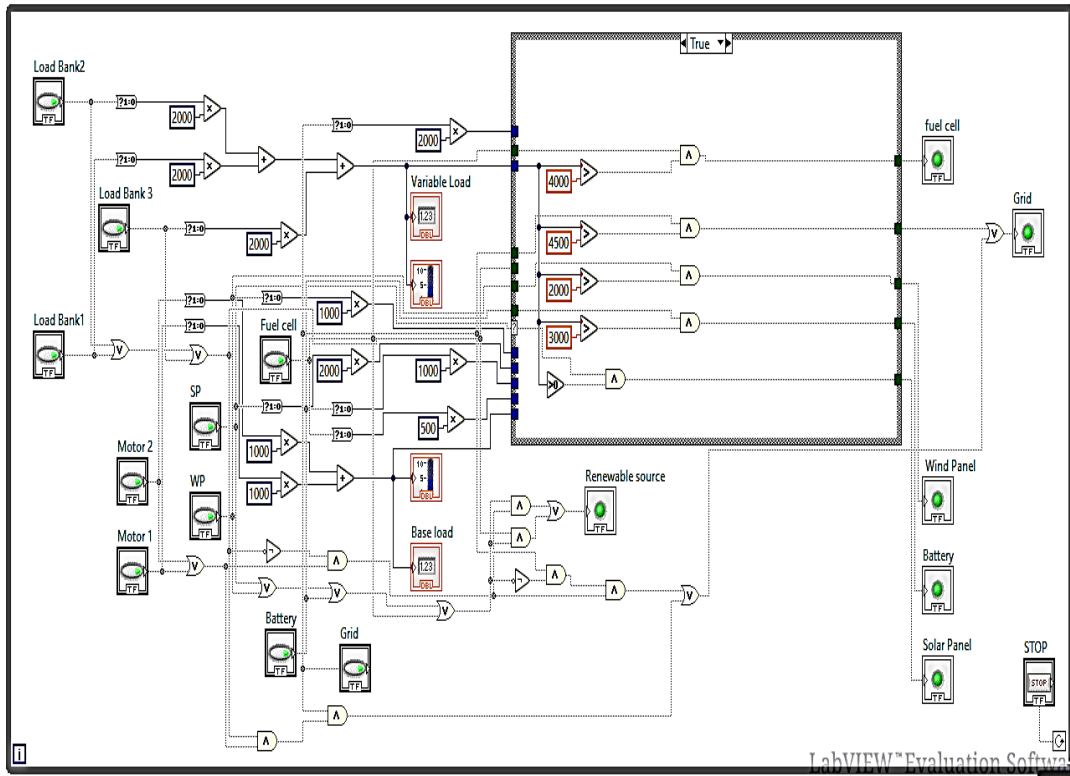


Fig. 4. Program on Lab VIEW



Table I. Parameters of Energy Sources

Energy sources	
Wind Turbine Emulator	1 kW, PMSG, 3 phase AC
PV Emulator	1 kW, 2 Channel
Fuel Cell	500 W, PEM type Fuel Cell
Battery	96V, 24 Ah
Grid	230 V, 50 Hz, 1-phase

A. Dispatchable Load

- **Induction Motor:**

Motor is an inductive type of load, which uses electrical energy and converts it into mechanical energy. It is a variable type of load because the current drawn from the motor depends on the loading of motor but in this case, we are considering it as constant load.

B. Un-Dispatchable Load

- **Induction Motor**

Motor is an inductive type of load, which uses electrical energy and converts it into mechanical energy. It is a variable type of load because the current drawn from the motor depends on the loading of motor but in this case, we are considering it as constant load.

- **Load Bank**

A load bank is a resistive type of load having a number of lamps connected in series and parallel combination. It is a variable type of load, by switching the lamp on and off the load can be varied.

Table II. Parameters of Dispatchable and Un-dispatchable Data

Dis-patchable data		Un-dispatchable data	
Inductionmotor	1 phase,230 V 50Hz,1HP, 2 nos.	Load bank	3 phase,230 V,50Hz,2 kW, 3 nos.

VI. RESULTS, DISCUSSION AND CONCLUSION

Table III. Load Distribution according to source

Base load (kW)	Variable load (KW)	Source Load Dependency
1	0	Grid / Renewable
2	0	Grid / Renewable
2	2	Grid + Solar
2	4	Grid + Solar + Wind+ Battery
2	6	Grid + Solar + Wind + Battery+ Fuel Cell

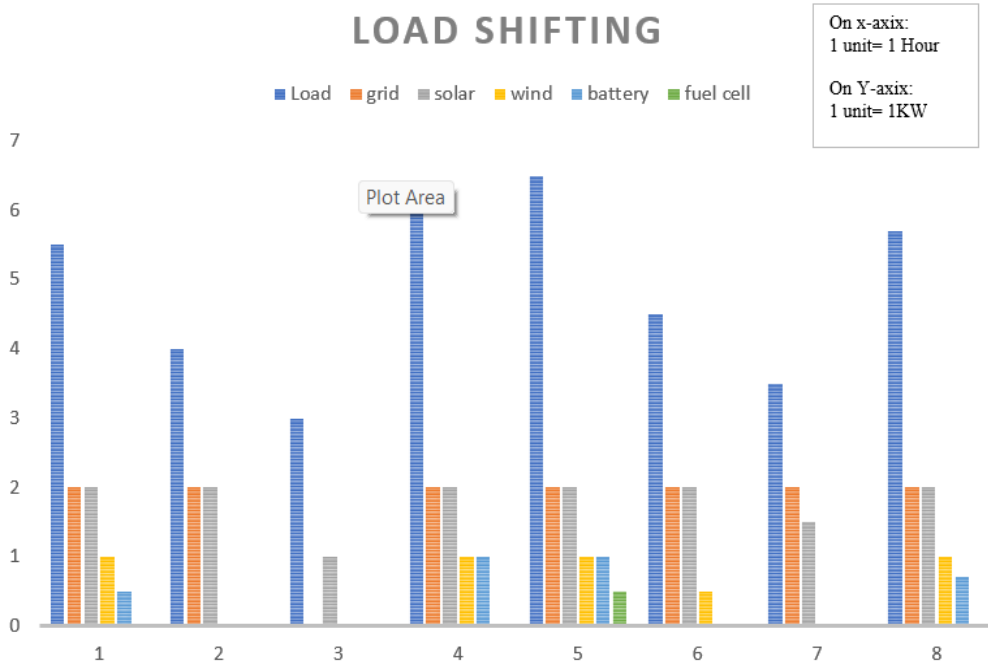


Fig. 5. Load Distribution for time with respect to change in source dependency

Table IV. Load Shifting as per Assumed Capacity

Time (hr.)	Total Load (kW)	Grid (KW)	Solar PV (KW)	Wind Emulator (KW)	Battery (KW)	Fuel cell (KW)
1	3.5	2	1.5	-	-	-
2	5	2	2	1	-	-
3	4.4	2	2	0.4	-	-
4	6.5	2	2	1	1	0.5
5	5	2	2	1	-	-
6	5.5	2	2	1	0.5	-
7	6.5	2	2	1	1	0.5
8	6	2	2	1	1	-
9	5.8	2	2	1	0.8	-
10	4.5	2	2	0.5	-	-

A) Simulation Case

1. One Motor and One Load Bank are Turned ON:

When one motor (1KW) and one load bank (2KW) are turned ON, the motor load which is dispatchable is directly connected to grid as shown in above figure. The dispatchable load must be fulfilled irrespective of availability of renewable sources. As shown in panel, as all renewable sources are available the un-dispatchable (load bank) load is shifted to Solar panel. This shifting is done on priorities which are based on unit cost. Priority is given to solar energy, second priority is given to wind energy, third priority is given to the battery and last priority is given to the fuel cell.

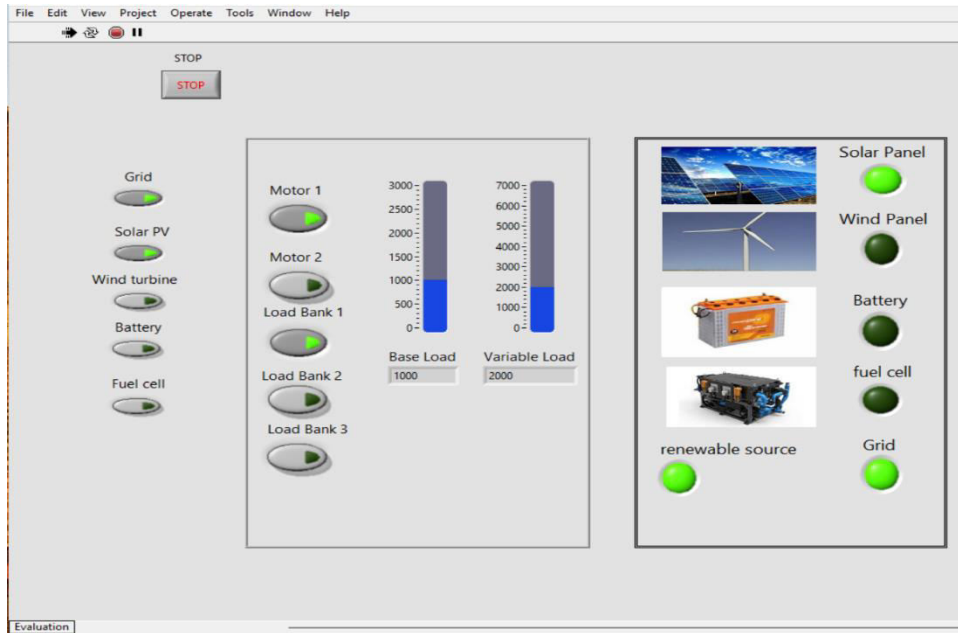


Fig. 6. One Motor and One Load Bank are Turned ON

2. One Motor and Two Load Bank are Turned ON:

When one motor (1 kW) and two load banks (each – 2 kW) are turned ON, the motor load which is dispatchable is directly connected to grid as shown in above figure. As shown in panel solar (2 kW), wind (1 kW) and battery (1 kW) contribute together to fulfill the un-dispatchable load demand of 4 kW.



Fig. 7. One Motor and Two Load Bank are Turned ON

3. Two Motor and Three Load Bank are Turned ON:

When two motors (1KW) and three load banks (each - 2KW) are turned ON, motor load which is dispatchable is directly connected to grid as shown in above figure. As shown in panel solar (2KW), wind (1KW) and battery (1KW) contribute together to fulfill the un-dispatchable load demand of 6KW. Addition to above fuel cell (0.5 KW) will also contribute to fulfill the demand of load bank (6KW).

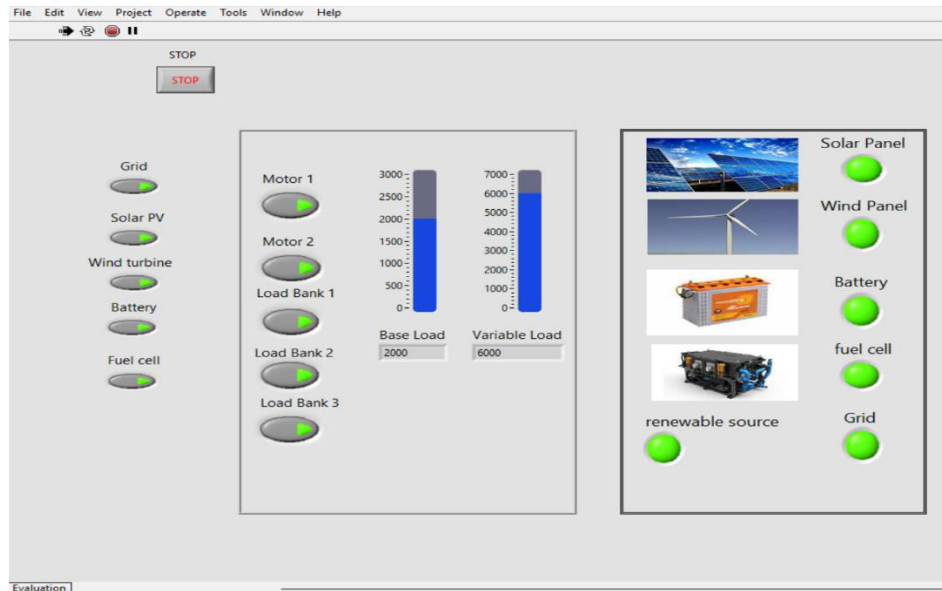


Fig. 8. Two Motor and Three Load Bank are Turned ON

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