С Е К Ц І Я 1

АВТОМАТИЗОВАНІ СИСТЕМИ КЕРУВАННЯ ТА КОМП'ЮТЕРНО ІНТЕГРОВАНІ ТЕХНОЛОГІЇ

AUTOMATIC CONTROL SYSTEMS AND COMPUTER INTEGRATED TECHNOLOGIES

S E S S I O N 1

Розробка автоматичного контролера для мережі безперебійного електропостачання в Бангладеші

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Багато населених пунктів у Бангладеші досі не мають електропостачання. Енергетичні системи з відновлюваними джерелами енергії починають з'являтися, але у незначних масштабах.

Географічне положення країни є сприятливим для використання сонячних батарей та вітроенергетичних установок. Зазвичай у неелектрифікованих селах та віддалених районах є відкриті місцини для встановлення обладнання з метою одержання електроенергії.

У роботі запропоновано базовий дизайн, який може використовуватися у таких місцевостях для генерування та постачання електроенергії. Ця модель містить три складові: джерело електроенергії (сонячні батареї та вітроенергетичні установки), головний контролер (який включатиме установки для обробки та зберігання електроенергії, а також інші необхідні схеми) та обслуговувану територію (мережа та споживачі).

Наголос у роботі зроблено на будові контролера. Контролер складається з блоку обробки електроенергії (БОЕ), з'єднань з джерелами електроенергії та пристроями для її зберігання, інвертора та виводу на споживача. БОЕ відповідає за забезпечення необхідної напруги завдяки комбінації сонячних батарей, вітроустановок та акумуляторних батарей. БОЕ визначає, котре з джерел надає більше електроенергії, аналізує розбіжності та визначає оптимальне поєднання цих джерел з метою забезпечення потреб споживачів та підтримання заряду батарей.

Запропонована модель передбачена для забезпечення безперебійного живлення. Коли виробіток електроенергії від обох джерел перевищує потребу, і батареї є повністю заряджені, система вимикається, адже надлишкова електроенергія втрачається. Максимальний виробіток електроенергії в півтора рази перевищує поточну потребу мікрорайону, що дозволить вирішити питання забезпечення електроенергією у випадку його розбудови.

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Design of an Automatic Controller for Sustainable Grid Power Supply in Bangladesh

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This paper presents a proposed model of an automated controlling unit for distributing electricity generated from solar panels and windmills (hybrid connection) simultaneously to a small locality through a smart grid connection. The power sources will simultaneously provide electricity and will also store energy in a suitable storage medium (batteries). A central controller will distribute the collected power to the locality or store it as needed. The proposed model is suitable for tropical regions since both solar and wind energies are incorporated into the system. Since the geographical local of Bangladesh favors harvesting both these renewable sources of energy, this system can be ideal for places where electricity is still unknown.

Keywords – automatic, controller, solar, windmill, panel, grid, electricity.

I. Introduction

Bangladesh, being a developing country, is facing a major crisis in generating electricity. Although many areas are yet to be connected with the national grid, the generation is not sufficient to provide uninterrupted electricity to the areas currently connected to the grids.

But the geographic location of Bangladesh favors harvesting both solar and wind energy to benefit the generation of electricity. There are many places that are not yet connected to the grid and are extremely favorable for setting up solar panels and windmills. One such place is the St. Martin's Island, which is a major tourist area in Bangladesh.

This paper proposes a controller [1] for utilizing such abundant renewable energy. The controller is going to be responsible for supplying electricity from source to everyone in the locality. It will also charge up the battery units appropriately so that they can be used when the solar and wind energy are not giving sufficient output.

Fig. 1 shows the illustration of the whole system setup. There are two main sources for generating electricity – a field of windmills and arrays of solar panels. The electricity generated by the two sources goes to the "Main

Controller Center" which holds the automatic controller, storage units and the required circuits. The outlets from this center goes to the grid connection (not shown in the figure), which provides the locality with electricity. But the power requirement of all the households in the locality should be distributed in such a way so as not to put excess pressure on the sources. Also, in this model, both the windmills and the solar panels combined have approximately 1.5 times power output as that of the required amount by the locality. The power produced is excess so as to accommodate more load because it is natural that the demand of the locality will increase overtime.

Fig. 1. Proposed Model of the System

II. Functionality of the Controller

Fig. 2 shows the block diagram of the proposed controller. Each pairs of line denotes an input or an output. As it can be seen, the controller itself contains two major blocks inside – Power Processing Unit (PPU) and the Inverter.

The PPU controls the main flow of electricity from the sources to the storage medium (battery unit) and the locality (through inverter). The battery units are a collection of many 12v batteries connected in series. The internal circuitry of the PPU contains microcontrollers or microprocessors for data analysis and relays for routing the electricity to the required paths.

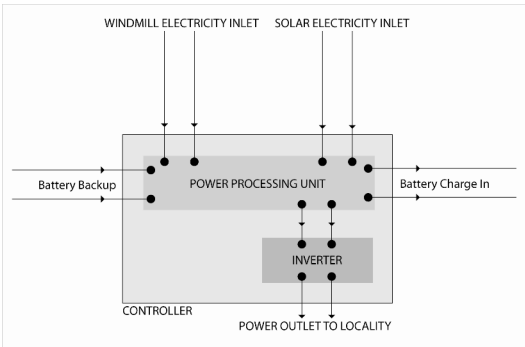

Fig. 2. Block Diagram of the Controller

The inverter converts the DC electricity (all the electricity generated by windmills and solar panels are usually DC) to AC for transferring it to the grid which will serve the locality.

The electricity generated by the energy sources are incorporated with the controller through the inlets (Windmill Electricity Inlet and Solar Electricity Inlet). Depending on the requirement of the locality there can be the following scenarios:

- Windmill generating more power than solar panels.
- Solar panels generating more power than windmill.
- Both solar panel grid and windmill grid are generating their full capacity power.
- Both solar panel grid and windmill grid combined are not generating sufficient amount of power output.

The PPU initially checks the status of power received from the sources. Considering the first and second scenario together, if the windmill grids are providing more power than the solar panel grids and vice versa, then the PPU will check the condition of the battery unit. If all the batteries are full, then the total output power goes directly to the grid through the inverter and any discrepancies are filled by the batteries. If all the batteries are not full and there is excess supply of power than demand, then the demand is met first and the excess power is used to charge the batteries.

Considering the third scenario where both the solar panels and the windmills are providing their full capacity power, it is obvious that the output power is more than the required demand; hence the PPU with check if any of the battery unit requires charging. If yes, then the excess power will be used to charge the battery while the locality is served simultaneously.

The fourth scenario where none of the solar panels or the windmills is providing any noteworthy output, then the whole locality will be served by the backup battery stack with small contribution from the sources.

One exception to all the scenarios can be if the sources are producing excess power than the locality demand and all the batteries are full, then the excess power will be wasted. Since this setup is for places where there is no connection of national grid, so it is not possible to backup the national grid with the excess output power.

Conclusion

This paper presented a model of an automatic control system for grid connection to a locality through renewable energy sources – windmills and solar panels. The proposed system can be improved substantially if the excess power can be utilized in some way when the demands are met and the storage units are full. Also more complicated grid network can be accommodated with more complicated Power Processing Unit. But this simple model can be very useful for rural areas of Bangladesh where grid electricity has not reached yet since Bangladesh's geographical location is a favorable place to harvest these two sources of energies.

References

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