THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Renewable Energy Management System in Home Appliances and Its Implementation in FPGA

A. Sathisshkumar
PG Scholar, Department of ECE, K.S. Rangasamy College of Technology, Thirucengode, Tamil Nadu, India
S. Jayamani
Assistant Professor, Department of ECE, K. S. Rangasamy College of Technology, Thirucengode, Tamil Nadu, India

Abstract:
Energy saving and renewable energy sources are considered as methods of solving home energy problem. Both energy consumption and generation should be simultaneously considered to save the energy cost. The energy management and communication unit is used to distribute the generated energy for home appliances based on the information transferred from the home server using the Zigbee transmitter and receiver and power line communication (PLC). The home server updates these information to internet server. Using web server all functions are controlled. In extension the photo sensor is to be used to track angular moment of the sun by using solar tracking system and this increase the power generation and result in decreasing the utilization of energy from power distribution and cost.

Keywords*: Zigbee, power line communication, renewable energy*

1. Introduction

In recent days, the usage of electronics is increased at a greater level. The usage of the current energy level is reduce in all areas. The energy consumption in home area are increased has more home appliances are installed. The energy saving and renewable energy method is used to solve the home energy problem. Both energy consumption and generation of the power usage stimulate the home energy cost to be saved. There are several method used in home energy management (HEMS) like PLC, zigbee and solar tracking system. The solar tracking system is used to generate the power in more level. The home energy power consumption based on the PLC is easy to access. A green house HEMS that monitors and controls the home appliance has to be proposed involves to achieve effiency. The solar and wind is used to generate power and is used in home appliances. A smart HEMS is used for both energy consumption and generation based on the zigbee and PLC. It based on the renewable energy gateway (REG). The home server is used to gather information from the both energy consumption and generation of the power through zigbee and PLC. These informations are updated in the internet. This paper focuses on the hardware implementation of a high performance field programmable gate array (FPGA) based on very high speed intergrated circuit hardware description language (VHDL).

2. Architecture of Home Energy Management System Using in Renewable Energy

2.1. System Architecture

A new architecture for energy efficiency in home appliance and energy management can achieve more energy for many appliances. A home has two parts concerning energy generation and consumption. The smart home appliance and light are used in the energy consumption. The renewable sources are sun and wind energy that is used to generate power.

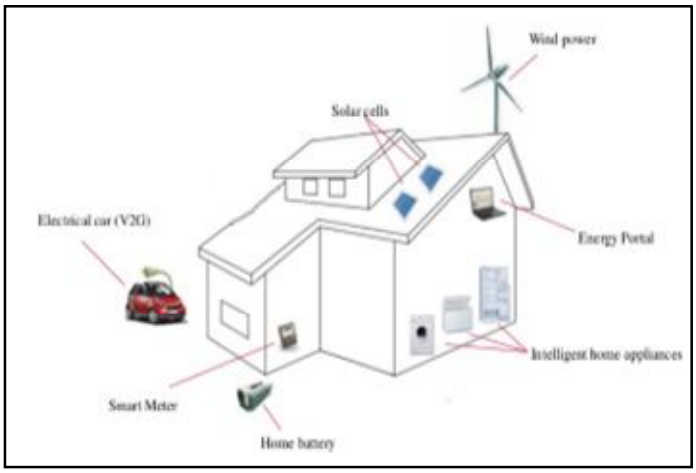

Figure 1: Architecture of home energy management system using in renewable energy

The consumed and generated energy is used to control the home server and monitor to reduce energy cost. In the energy consumption of home appliance and light which is used to monitor through the energy measurement and communication unit (EMCU) are installed at each and every outlet of appliances in the home.

The EMCU measure the energy consumption of home appliance and its information transfer the measured value to home server. The EMCU provides the information of the gathered data to the home server which is collected using zigbee. In the energy generation part solar and wind power monitors the REG. The solar power system comprises solar panel, PLC modem, inverter and REG. A PLC modem is attached the each solar panel of the system. The PLC helps to monitor the solar panel and transfer either information or data to the REG.

The solar energy inverter converts dc to ac power and stores in the battery. The solar inverter is connected to the REG through the serial communication line. The wind inverter converts wind power to ac power. It monitors and transfer the power to home appliance. The REG gathers the either information /data of solar and wind power. It transfers the gather data to the home server through ethernet and updates in the internet. Using internet updates the home server value and controls it.

2.2. Solar Tracking System

The development of the solar tracking system is used for the angular movement of the sun (with respect to the earth) and is used as photo sensor. The angular movement of the solar panel in accordance with input signal provided with a motor to drive the system (Right from minimum to maximum value of 180 degree angular movement of the sun). Using this method the panel have to collect maxmium solar energy at the time sunrise as well as sunset too.

Most of the solar energy in the form of light-rays would be collected in the photovoltaic cells mounted on solar panel, only when there is an angle of zero degree between the sun and the solar panel. So a track is develop to achieve the angular moment of the sun. Moving the solar panel from minimum (presale) to 180 degree angle with respect to the horizontal axis of the earth. For example, in the morning time the panel will be directed towards East and hence collect more light energy from the sun. During the sunset also, it collects sun light by moving the panel towards 180 degree. The position of the sun will be automatically sensed by using a set of photo detector sensors mounted in a semi-circular manner. The binary output from such arrangement will be generated in the one-hot coding manner, pertaining with the position of the sun. As per the input provided to the FPGA based control system, it makes angular rotation of the solar panel using stepper motor drive. A Finite State Machine (FSM) source code was developed for generating the stepper motor sequence.

2.3. Home server

The home server manage the EMCS inlet and outlet through the zigbee in control mode. The daa of energy consumption for home appliance and the light send their information update in the data base. The REG transfer the solar and wind energy to the inverter of the home server. Based on the performance of wind and solar energy the data is being updated. The transferred data store the information of the data base solar energy generation relate in the solar radiare and wind speed the based on the estimate energy generation the home server modifies the home derver is used reduce th energy cost. The home server the decide which operator is moved this to be data base operation.

The web server enables to access the home server and search the home energy information. The home energy information is control by the internet anytime and anywhere. The home server transfer the home energy information to the REMS the manage client to the server.

2.4. Energy Measurement and Communication Unit (EMCU)

In the energy consumption EMCU is used for measurement and communication. The measurement block is used measure the power energy and usage of power energy in home appliance. It uses an energy current transformer (CT) for measuring them. The CT measures the voltage and current in the usage of the home appliance. The energy and power is calculated in this process. The power is

defined to measure base of the phase differences between voltage and current. The measurement block includes the power control and electricity to connect the home appliance.
The data transfer is done data between the EMCU and home server. The zigbee is used to transfer the information to home server. The EMCU is communication block, controls the state of power control in response to the home server.

2.5. Renewable Energy Gateway and PLC Modem
In energy generation part, REG is used to connect the PLC modem , the solar and wind. The connection manags is the connection to the REG. The sensing agent measure the current and voltage of the solar panel. The PLC modem transfers the generated power data to the REG. The REG has three communication interface PLC for solar and wind. The connection manages to control the PLC modem update. The data is send to the home server.

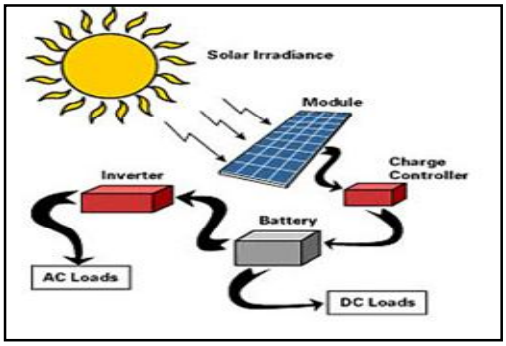

Figure 2: Power generation in solar panel

2.6. Remote Energy Management Server (REMS)
The home server transfers the home energy information of the home to the REMS. The client manager maintains the connection of the home server. The REMS gathers energy information from the clients home server and the provides the used energy of the home appliances and light. The generated energy information also transferred and is update to the internet.

3. Result and Discussions
The implemented result shows several developed components like solar tracking system, home servers, REMS, EMCU,PLC MODEM AND REG. These components were installed and operated, shows the miniaturized testing set that include a smart device, EMCU installed outlets. The prototype EMCU inserted between an AC power line, battery and their outlets measures and controls the electric power of the outlets. The three EMCUs are installed: one for light and mobile charge unit. These EMCUs transfer the measured data to the home server using data communication. The PLC is used for sensing and communication data to home server. The sensor part uses as the voltage divider to measure the current and voltage, current transformer, temperature sensor is used for measuring the atmospheric temperature value. The usage of the current value is as seen in the (3) input speed data causing the DAC output voltage change. Fig (4) it describe the energy usage of home application. Fig (5) Power usage of the kit. The control and maintain of usage of power in web server page is in fig (6) and fig (7).Fig (8) using RS 232 cable data is communicated to the desktop / laptop and is updated online. Overall hardware kit of renewable energy management system in home appliance fig (9).

Device Utilization Summary			
Logic Utilization	**Used**	**Available**	**Utilization**
Number of Slice Flip Flops	194	1,920	10%
Number of 4 input LUTs	281	1,920	14%
Number of occupied Slices	271	960	28%
Number of Slices containing only related logic	271	271	100%
Number of Slices containing unrelated logic	0	271	0%
Total Number 4 input LUTs	475	1,920	24%
Number used as logic	281		
Number used as a route-thru	194		
Number of bonded IOBs	21	108	19%
IOB Flip Flops	4		
Number of GCLKs	3	24	12%
Total equivalent gate count for design	4,563		
Additional JTAG gate count for IOBs	1,008		

Figure 3: input speed data causing the DAC output voltage change

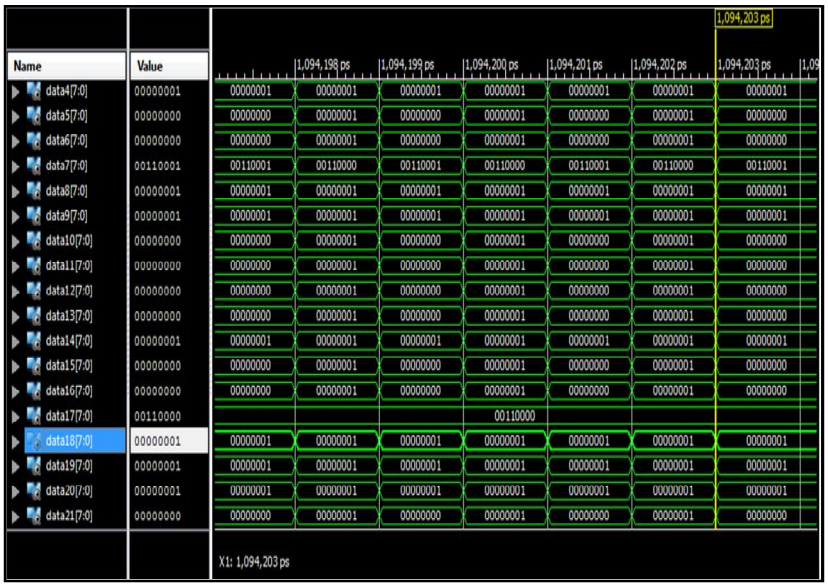

Figure 4: Output of home server

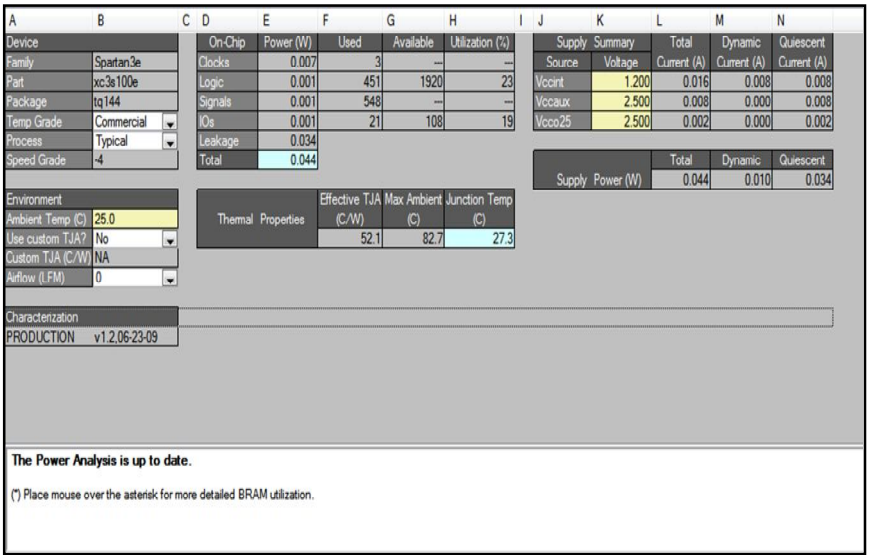

Figure 5: Power usage of the kit

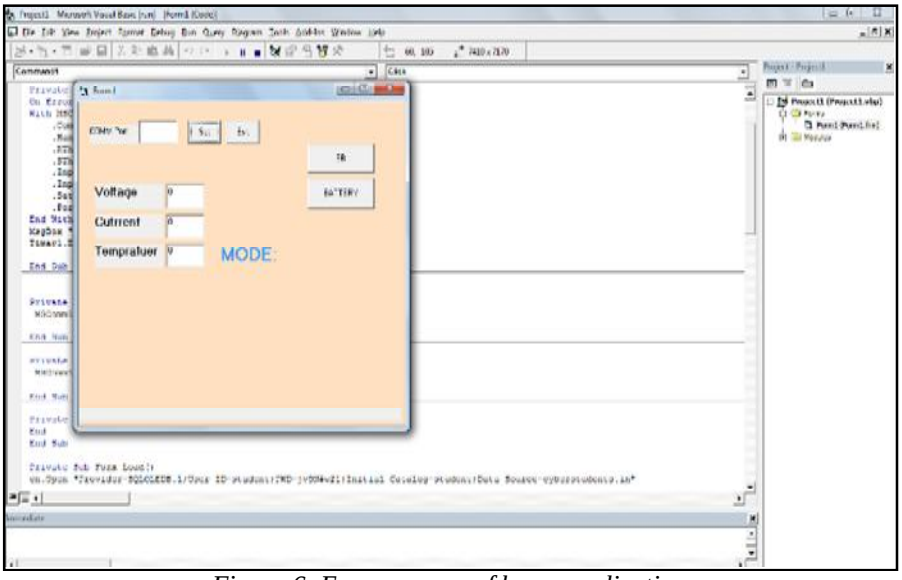

Figure 6: Energy usage of home application

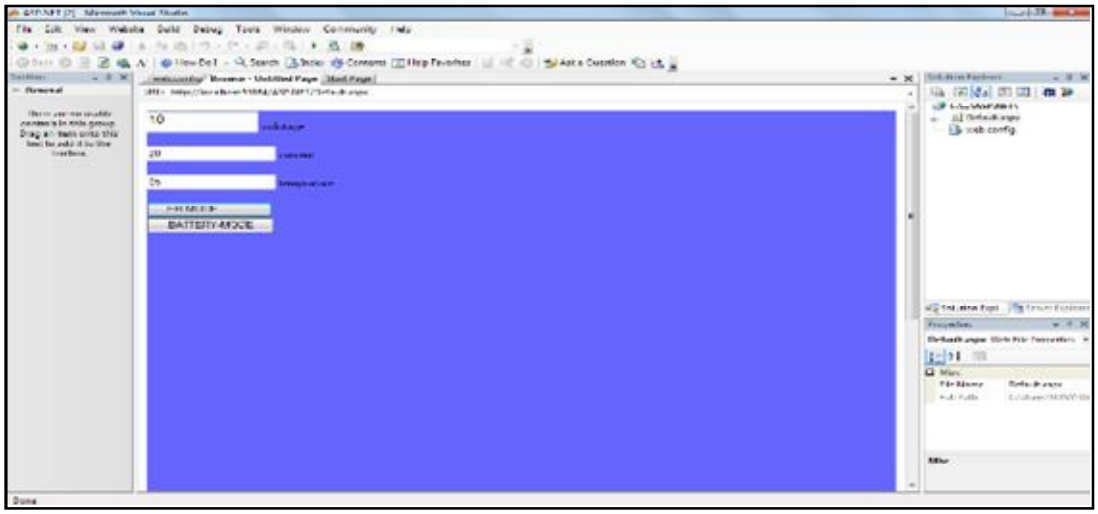

Figure 7: Usage of power in web server page

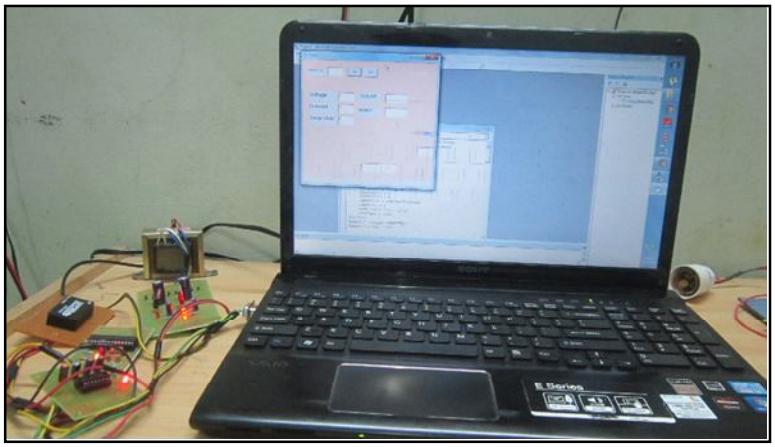

Figure 8: Using RS 232 cable connect to laptop/desktop

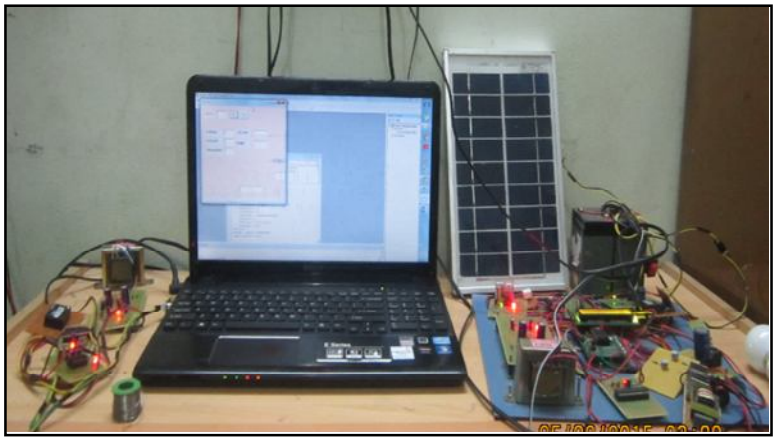

Figure 9: Overall connection of home appliance

4. Conclusion

The renewable energy sources are to be installed in residential area to save the energy cost, which it is important for both energy consumption and generation are simultaneously considered in HEMS. The smart HEMS architecture is considered for both consumption and generation. In the energy consumption, the EMCUs are installed in outlets and lights to measure the energy usages of home appliances. The Zigbee is used to transfer the gathered data to the home server. The home server figures out the home energy usage pattern. In the energy generation, PLC modems are installed in each solar panel to monitor its status and maintenance. Using the obtained energy information, the home server can control the home energy which is used to schedule and minimize the energy cost. The REMS provides the comparison and analysis for home energy usage and seems to be effective.

5. References

i. Young-Sung Son and Kyeong-Deok Moon, "Home energy management system based on power line communication," in Proc. IEEE International Conference on Consumer Electronics, Las Vegas, USA, pp.115-116, Jan. 2010.

ii. Young-Sung Son and Kyeong-Deok Moon, "Home energy management system based on power line communication," IEEE Trans. Consumer Electron., vol. 56, no. 3, pp. 1380-1386, Aug. 2010

iii. Jinsoo Han, Chang-Sic Choi, Wan-Ki Park, and Ilwoo Lee, "Green home energy management system through comparison of energy usage between the same kinds of home appliances," in Proc. IEEE International Symposium on Consumer Electronics, Singapore, pp. 1-4, Jun. 2011.

iv. Chia-Hung Lien, Hsien-Chung Chen, Ying-Wen Bai, and Ming-Bo Lin, "Power monitoring and control for electric home appliances based on power line communication," in Proc. IEEE International Instrumentation and Measurement Technology Conference, British Columbia, Canada, pp. 2179-2184, May 2008.

v. Saeed Jahdi and Loi Lei Lai, "Grid integration of wind-solar hybrid renewable using AC/DC converters as DG power sources," in Proc. World Congress Sustainable Technologies, London, UK, pp. 171-177, Nov. 2011.

vi. Hayato Yamauchi, Kosuke Uchida, and TomonobuSenjyu, "Advanced Smart Home," in Proc. IEEE International Conference on Harmonics and Quality of Power, Hong Kong, China, pp. 130-135, Jun. 2012

vii. NamsikRyu, Jae-Ho Jung, and YoungchaeJeong, "High-efficiency CMOS power amplifier using unevenbias for wireless LAN application," ETRI Journal, vol. 34, no. 6, pp. 885-891, Dec. 2012.

viii. C. Arm, S. Gyger, J. Masgonty, M. Morgan J. Nagel, C. Piguet, F. Rampogna, P. Volet, "Low-power 32-bit dual_MAC 120 uW/MHz 1.0V icyflex1 DSP/MCU core," IEEE Journal of Solid-State Circuits, vol. 44, no. 7, pp. 2055-2064, Jul. 2009.

ix. Hyoungsik Nam and HoonJeong, "Data supply voltage reduction scheme for low-power AMOLED displays," ETRI Journal, vol. 34, no. 5, pp. 727-733, Oct. 2012.

x. Hyunho Park and HyeongHo Lee, "Smart WLAN discovery for power saving of dual-mode terminals," ETRI Journal, vol.35, no.6, pp.1144- 1147, Dec. 2013.

xi. HyungSeok and Jiwon Yoon, "Hybrid distribution stochastic addressing scheme for ZigBee/IEEE 802.15.4 wireless sensor networks," ETRI Journal, vol. 33, no. 5, pp. 704-711, Oct. 2011.

xii. Jinsoo Han, Chang-Sic Choi, Wan-Ki Park, Ilwoo Lee, and Sang-Ha Kim, "PLC-Based Photovoltaic System Management for Smart Home Energy Management System," in Proc. IEEE International Conference on Consumer Electronics, Las Vegas, USA, pp. 542-543, Jan. 2014

xiii. P. K. Gaikwad "Development of FPGA based Prototype for Solar Tracker System" IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 1, Issue 4, Aug-Sept, 2013.