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Sizing and Analysis of Renewable Energy and Battery Systems in Residential Micro-grids

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Abstract: We present Solar Tune, a real-time scheduling technique with load tuning for sporadic tasks on solar energy powered multicore systems. The objective is to fully utilize the available solar energy while meeting the deadlines of tasks. Scheduling and power management method for multicore real-time embedded systems. This work mathematically proves that by allocating the new task to the core with the lowest utilization, we can achieve the lowest overall energy dissipation. Accelerated development of eco friendly technologies such as renewable energy, smart grids, and electric transportation will shape the future of electric power generation and supply. Accordingly, the power consumption characteristics of modern power systems are designed to be more flexible, which impact the system sizing. The model takes into account the intrinsic stochastic behavior of renewable energy and the uncertainty involving electric load prediction.

Keywords: Photovoltaic (PV), Direct Current (DC), Renewable Energy Sources (RESs).

I. INTRODUCTION

Renewable energy such as solar energy and wind energy is a clean alternative to fossil fuels. It exists perpetually and in abundant quantity in the environment. Today solar energy is not only being used to provide power to various low power embedded devices but it is also used to generate electricity to supplement local consumption in high performance computing systems. Photovoltaic (PV) cells can convert sunlight directly into direct current (DC) electricity. Different from the conventional setup which directly connects PV arrays to a computing system (DC load). This direct coupled PV system eliminates the battery and unnecessary power conversion devices and it has been successfully applied to many applications. The regeneration energy also called the green energy, has gained much importance nowadays. Green energy can be recycled, much like solar energy, water power, wind power, biomass energy, terrestrial heat, temperature difference of sea, sea waves, morning and evening tides, etc. [1,2]. Among the non-conventional, renewable energy sources, solar energy affords great potential for conversion into electric power, able to ensure an important part of the electrical energy needs of the planet. The conversion principle of solar light into Electricity, called Photo-Voltaic (PV) conversion, is not very new, but the efficiency improvement of the PV conversion equipment is still one of top priorities for many academic and/or industrial research groups all over the world. Among the proposed solutions for improving the efficiency of PV conversion, we can mention solar tracking [3]-[4], the optimization of solar cell configuration and geometry [5]-[6], new materials and technologies [7]-[8], etc.

The topic proposed in this paper refers to the solar tracking system that automatically adjusts the PV panel position based on the given tilt times with respect to the natural position of the Sun at different times of the day by means of a DC motor controlled by a intelligent microcontroller(AT89S52) that equipped with an algorithm to provide the tracking position using RTC(DS1307).From the experimental results, the proposed tracking system generates efficient energy compared to that of fixed system. Solar power is emerging as the number one competitive renewable energy resource, so to improve the utilization of solar energy resources, solar power monitoring systems is more important. Photovoltaic solar panels are increasing in popularity and users need accurate information of their solar energy installation. Currently, most residential solar panel systems only provide energy information on a monthly basis and do not allow individual panel monitoring. PV solar panel has at least 25 years warranty, whereas inverters only come with an 8-10 years warranty. That means that sometime in the 8-10 years range the inverter will die and the system will stop producing energy. With a monitoring system in place the installer or homeowner will know immediately that the system has been compromised. Otherwise it could be weeks or months before the home owner looks at their energy usage statement from their utility company and realizes that their solar electricity system is not longer producing energy. CONVENTIONAL power generation systems use fossil fuels as a primary source of electricity, yet these finite natural resources are known to be the dominant producers of greenhouse gases.

In order to reduce harmful emissions and meet the increased global electricity demand, renewable energy sources (RESs) are introduced as future replacements. The intensive research and development in this field has led to a huge growth in RES installations that are driven by cost decreases [1], [2]. However, the irregularity of RESs, and the limitations of available battery energy storage system (BESS) technologies prevent a high level of RES integration. Hybrid renewable energy systems (HRESs), comprising different renewable energy technologies in one design, are helpful since they provide a higher balance in energy supply as compared to a single-source system. Smart grids (SGs), which are perceived as next generation power systems, provide two-way communication channels between energy generation sources and end users [3], and allow the shift of demand to off-peaks or to renewable generation periods. This offers reduced operations and management costs for utilities, lower power costs for consumers, and ultimately, reduced emissions [4]. Furthermore, the recent increase in the use of electric vehicles (EVs) will increase electricity demands, but at the same time will increase energy demand flexibility by the control of EVs charge periods and other vehicle-to-grid applications [5], [6]. Due to these facts, the planning, operation, and management of future power systems will not be identical to those of conventional power systems, where all of the involved technologies should be considered in the design stage. The literature reporting the problem of sizing RESs, can be classified in two main categories.

The first category includes integrating RESs into conventional power systems where the smart control of the electric load is not considered, and it has received the most attention in the available literature. Here, we include and review some of them [7]–[13]. For example, Alsayed et al. [7] presented a multi-criteria decision making algorithm for sizing a PV-wind system that satisfies a certain balance of economic, environmental, and social factors. Reference [10] also presented a multi-criteria sizing algorithm that was solved using a particle swarm optimization method. The sizing algorithm introduced in [13], adopted a novel power filter for limiting the fluctuation of renewable generation, and thus improve the stability of the electric grid. The second category pays attention to integrating RESs with SGs, where the potential role of EVs and other flexible electric loads for accommodating higher levels of renewables are highlighted. Some related literature is found in [14]–[19]. Reference [14] proposed a stochastic method, based on a Monte Carlo simulation and particle swarm optimization, for sizing a smart household energy system which takes into consideration the demand uncertainty. Another stochastic based optimization that accounts for load shifting is presented in [15]. Regarding the EV utilization in power system application, the effect of different EV control strategies in reducing surplus wind generation and harmful emissions was investigated [16]. A study investigating EV effect in high PV penetration scenarios is found in [17].

However, in the majority of the aforementioned studies, which were set for long-term evaluation, the energy management of the system is rule-based, i.e., it employs a predefined operation strategy, which means that it might not be optimal. On the other hand, the short-term scheduling of SG to achieve optimal control of energy dispatch and demand side management (DSM) in daily operation scenarios has been the main focus of [20]–[27]. In light of this, the current work introduces a reliable and efficient framework for optimizing HRES with BESS for supplying residential microgrids based on intelligent management. Fig. 1 shows a general block diagram of the proposed system. It utilizes PV and wind turbine (WT) generators as its renewable sources, a BESS, and a bi-directional inverter for converting energy from AC to DC (and vice versa). The electric demand features controllable and non-controllable loads. The novelty of this work lies in developing an integrated model that accounts for the different aspects and characteristics of energy consumption in modern power systems. More importantly, the load flexibility gained by using smart grid demand response programs, that enable the scheduling of high energy-consuming appliances such as washing machines, cloth driers, dish washers, and EVs in aims to benefit the users rather than treating them as randomly committed appliances. Therefore, it coincides with the principle of a smart grid operation. The model can be applied to large-scale design cases including numerous operation patterns, without imposing high computational burdens.

In order to estimate all electricity consumption aspects, TRNSYS software is used to simulate the dynamic thermal behavior of residential buildings, and predict the required electric energy for supplying the thermal load, which partly contributes to the non-controllable load of the residential community. Furthermore, the uncertainty in prediction of electric load and renewable energy resources are described by proper probability distribution functions (PDFs), and introduced into the optimization using scenario generation techniques. The optimization method employs mixed integer linear programming (MILP) since it can solve long term scheduling problems by satisfying all restrictions and guaranteeing the optimal power management of the microgrid, where other heuristic optimization methods combined with simple power management strategies might fail. The MILP model is generated for three years and solved using the high performance IBM ILOG CPLEX Optimization software that returns the decision variables: PV, WT, BESS, and inverter capacities, in addition to the hourly power dispatch decisions along the optimization horizon. The proposed optimization method can be used for planning new systems, or for upgrading systems already in operation to ensure that the growing electrical demand is efficiently served. Energy is vital for the progress of a nation and it has to be conserved in a most efficient manner. Not only the technologies should be developed to produce energy in a most environment-friendly manner from all varieties of fuels but also enough importance should be given to conserve the energy resources in the most efficient way. Energy is the ultimate factor responsible for both industrial and agricultural development.

The use of renewable energy technology to meet the energy demands has been steadily increasing for the past few years, however, the important drawbacks associated with renewable energy systems are their inability to guarantee reliability and they are lean in nature. Import of petroleum products constitutes a major drain on our foreign exchange reserve. Renewable sources are considered to be the better option to meet these challenges. It is obvious that the known resources of fossil fuels in the world are fast depleting. The importance of renewable energy sources was recognized in the early 18th century. During the past three decades, a significant effort has gone into the development, trial and induction of a variety of renewable energy technologies for the use in different sectors. Energy consumption has been growing rapidly in developing countries like India where, about 15% of the world's population live.

II. EXISTING SYSTEM

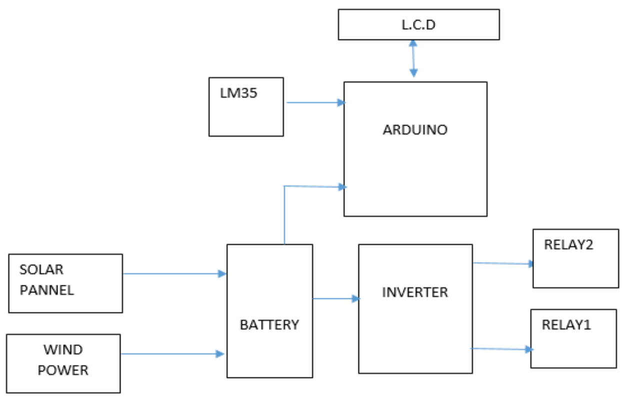

Fig.1 Block diagram.

The prototype of operated solar, wind tracking system using Arduino is shown in above fig.1. This project proposes a distributed hybrid power system which consists of solar power, wind power, battery storage and the load. To meet the electricity demand where the grid is unavailable, a distributed power generation strategy has been discussed. Different from the conventional solutions where the diesel is the sole source, the proposed approach utilizes the wind, solar as the main sources .With a reasonable capacity configuration, this proposed design highly increases the service time and reduces the dependence on traditional sources.

III. PROPOSED SYSTEM

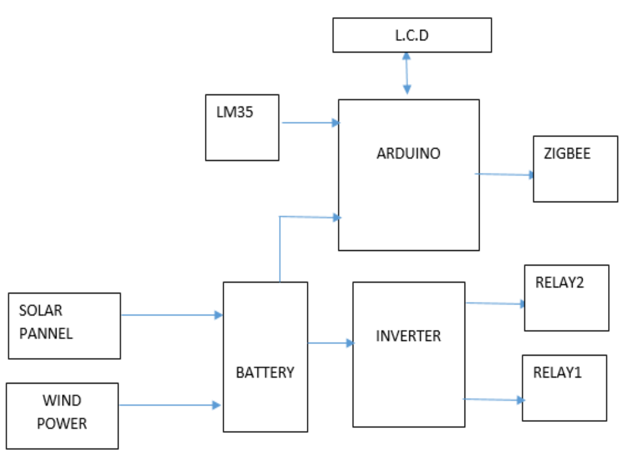

Fig.2 Block Diagram.

A. Renewable Energy Generation

The main drivers of the increased popularity in RE electricity generation by wind, solar, biomass, small hydro and hybrid are due to emergence of cleaner and sustainable energy technologies brought along with financial incentives, promotion mechanisms, economic and regulatory changes introduced in various countries. According to a study of (lEA, 2002), renewed interest in small scale electricity generation are: (i) development in distributed electricity generation technologies, (ii) difficulties in laying new transmission lines, (iii) demand of reliable electricity supply, (iv) climate change, and (v) liberalization of electric power market. In Europe and USA, distributed RES growth has been reported which are due to: (i) flexibility in deployment due to their small size, (ii) shorter lead time for installation and commissioning, operation and capacity expansion, (iii) cost effective source of electricity for peak load, (iv) minimal cost of transmission and distribution which could be as high as 40%, (iii) insurance against volatile prices of electricity, (iv) minimal transmission and distribution losses, and (v) effective use of locally available cheap primary RE sources such as biomass, biogas. landfill gas, etc. (Dondi et al, 2002; Pepermanns et al, 2005; Gulli, 2006).

In developing countries, apart from the merits mentioned above, another vital reason for promoting distributed RE generation is to provide access to electricity in isolated and remote regions (Sinha and Kandpal, 1991; Chaurey et al, 2004; Sihag et al, 2004). Extension of utility grid in inaccessible remote locations is economically unviable and in some cases physically difficult and unmanageable. Another important reason which makes RE famous is carbon dioxide emission from fossil fuel power generation and human search for cleaner energy. World carbon dioxide emissions are projected to rise from 29.0 billion metric tonne (bt) in 2006 to 33.1 billion bt in 2015 and 40.4 billion bt in 2030—an increase of 39% over the projection period. With strong economic growth and continued heavy reliance on fossil fuels expected for most nations other than Organization of Economic Cooperation and Development (OECD); much of the increase in carbon dioxide emissions is projected to occur among the developing, non-OECD nations according to International Energy Outlook (lEO, 2009). It has been reported in lEA 2006 report that RE sources is one of the largest contributors to global electricity production. They are accounted for 18% of production after 40% of coal and 19% of natural gas, but ahead of 16% of nuclear and 7% of oil. Nearly 90% of the electricity generated from RE came from hydro power plants followed by 6% combustible RE and waste.

A study on evaluation of suitability of different renewable energy sources to keep supply to a group of loads in rural area has been reported. For this purpose, a computer program with various subroutines has been developed for matching RE sources characteristics with rural loads profile cost effectively (Ijumba and Singh, 2004). A simple method of evaluating the existing renewable and non-RE technologies has been reported. The evaluation method is based on the weights given to the importance of six selection criteria: the economic viability; the conversion efficiency; the present level o\' the technological development; the environmental impacts; the after-production cleanup cost; the renewability and abundance of the source (Khoie, 2005).

B. Wind Electric Generator System

A small wind energy generator (SWEG) system (up to 25 MW) for distributed system power supply consists of one or more nimibers of wind electric generator(s) each mounted on a separate tower at a suitable height, a wind turbine controller to convert ac output of wind electricity generator into dc electricity suitable for storage in batteries bank, an inverter and balance of system consisting of control panels, interconnecting cables, civil works, etc. (Patel, 1999; Manwell et al, 2002; Khan, 2006). Studies of simulations indicate that the energy capture of a wind turbine (WT) depends not only on the control stotegy but on the wind-speed and Rayleigh distribution. Studies on an oscillatory behavior have been observed with high wind speed and the conditions that can provoke oscillations in the power delivered by the SWEG (Carrillo, et al, 2004). It has been shown in the studies that oscillatory behavior of wind speed may be forecasted on short-term basis. The basis for this study is a set of measurements carried out during the installing of an isolated wind plant in the Canary Islands (Spain). The simulation leads to the conclusion that the hill-climbing method of control results in a greater annual energy-output (Arifujjaman, 2008). In another study the support vector machine regression algorithm has been suggested which provided accurate predictions of wind power and wind speed at 10-min intervals up to 1 h into the future, while the multilayer perception algorithm has been found accurate in predicting power over hour-long intervals up to 4 h ahead (Kusiak et al, 2009).

An SWEG significantly differs from large grid interactive wind electricity in many ways (Ackermann and Soder, 2002). The differences include:

- the coefficient of performance Cp of the SWEGs is significantly lower as compared to large wind turbines;
- most SWEGs are direct-driven, variable speed systems with permanent magnet (PM) generators;
- speed regulation in the SWEGs is mechanical which allows horizontal or vertical furling for controlling power at wind speeds higher than rated wind speed as against electronic regulation in large WT;
- the SWEGs are more expensive as compared to large WTs in terms of cost per kW; and
- back-up power supply is essential for an SWEG for making it a reliable distributed power supply source.

Analysis of the dynamics of a wind-turbine has been suggested using the RPM-Sim simulator (Renewable-energy Power-system Modular Simulator), which was developed at the NREL's National Wind Technology Center (Muljadi et al, 2000). Studies on the capital cost of SWEG projects and COE generated by such projects in the U.S. have been reported in the research papers (Forsyth et al, 2000; AWEA, 2005). Performance and techno-economic evaluation of SWEG system has been reported as an alternative energy source in Indian condition. In the case study, RETScreen software has been used to estimate WT power curve data, GHG emission reduction, annual saving, and other financial parameters (Afzal et al, 2007). Design of a low-cost micro-controller for a small induction-generator based grid-connected WT has been presented in a study. In which micro-controller PIC16F877 decides whether to disconnect the system fi-om the grid based on the power flow measurement between the WT and the utility grid (Ahshan etal, 2008). In another study the integration cost may be defined as the extra costs in the rest of the system when wind power is to be integrated with the situation without wind power. The result of the study depends on both parameters and the methods used. The methods, in order to get some understanding on the impact of different modeling have been suggested (Soder and Holttinen, 2008). Design optimization of wind power to be integrated with main grid has been reported in Thailand where low-medium-wind-speed profile is generally available, investigating the impact of the penetration level of wind power generation (Chompoo-inwai et al. 2008). As far as CO2 emission is concerned it has been shown in a study that CO2 emissions will be reduced 700-650 g C02/kWh wind produced.

The costs for COi abatement b\ increasing wind power capacity in Finland seem to be about 20 €/t CO2 for the tirst rWh of wind, and when the capacity is further increased the costs also raise gradual!} to 35 €/tonne of CO2 (tC02) for the seventh TWh of vv^ind. If the Finnish industry is able to maintain the current market aliares, the exports will be 0.8-1.2billion € in 2010 if the Finnish wind turbine manufacturers were able to get a global market share of 5%>. this would more than double the Finnish exports (Holttinen et al, 2002). Yang (2004) has outlined the impact of government policy and clean development mechanism (CDM) on wind power development in China. It has been concluded that CDM and government preferential policy on value added tax (VAT) would make wind power financially viable and popular in China. It would not be wrong if said, 'climate change drives WTs in China' (Yang, 2004). It has been reported in other paper also that SWEG systems provide electrical energy without GHG emission, therefore, the emission is mitigated (Afzal, et al, 2007).

C. Photovoltaic System

PV technology for conversion of solar energy directly into electricity is used for number of applications including distributed electricity generation worldwide. A typical PV system for distributed power supply consists of a PV array with mechanical support, a power conditioning unit consisting of a charge controller and an inverter, storage batteries, and balance of system comprising of control panels, interconnecting cables, civil works etc. (Markvart, 1994; Bhattacharya, 1998; Khan, 2006). Output of the PV array is dc, whereas most of the electrical appliances operate with ac, hence needing inverter. Studies on techno-economics of solar PV based distributed electricity generation (Roy and Gupta, 1996; Chakarbarti and Chakarbarti, 2002; Chaurey et al, 2004,) have been reported that the COE firom PV is feasible as compared to grid extension option even in remote area. It becomes viable only if the grid is extended by about 20 km. A feasibility analysis of PV systems operation shedding and a comparative life cycle cost analysis of PV and DG set operation under Indian conditions have been reported (Koner and Dutta, 1998; Koner et al, 2000, Singh et al, 2005, Afzal et al, 2008). The feasibility of a standalone PV system has been compared with fossil fuel based DG set and it was found that PV projects are attractive for daily demand of up to 15 kWh (Koihe et al, 2002). An artificial neural network (ANN) approach may be implemented for forecasting the performance of electrical energy generated output from a cotmected solar PV system used in a remote area (Ashraf and Chandra, 2004).

An analog maximum power point tracker (MPPT) has been simulated and constructed, the algorithm of which is based on maximum power point voltage (MPPV), approximately a fixed percentage of the open circuit voltage of the PV panel. It has been observed that maximum power point (MPP) changing with atmospheric change and load conditions (Tariq and Asghar, 2005). The loss of power is quite high in rapidly changing atmospheric condition, because the controller has to search for new operating point more frequently (Tariq and Asghar, 2006a). Tariq and Asghar (2006b) have suggested use of a separately excited motor in place of a costly PM motor for water pumping system. Another simple and cheap analog MPPT has been proposed which improves performance of water pumping system under adverse insolation condition. Normally PM motors are connected directly with PV source to run water pumping system. It is not possible to have same characteristic of a motor and PV source under changing weather condition because the characteristic of PV source is nonlinear and highly dependant on the weather condition, resulting into underutilization of PV source most of the times (Tariq and Asghar, 2007). An on-line fuzzy logic-based dynamic search, detection and tracking controller has been developed also to ensure MPP operation imder excursions in solar insolation, ambient temperature and electric load variations (Altas and Sharaf, 2008).

A fuzzy algorithm has been used also to make decision so as to connect domestic apparatus on either the electrical grid or a PV panel (Salah et al, 2008). While modeling a PV system, regression techniques have been suggested to investigate the correlations between daily global solar radiation and sunshine duration for different climates in China (Lam et al, 2008). It has been suggested to use two commonly used tracking algorithms, namely. Perturb and Observation (P&O) algorithm and MPPV algorithm. A fast and accurate method has been implemented by using a novel hybrid-tracking algorithm (Tariq et al, 2009). A new technique MPPT has been reported which suggests the efficiency of the array may further be enhanced using new tracking methods of Pertiirb and Observe (P&O), Modified P&O (MP&O) and Estimate-Perturb-Perturb (EPP) methods (Ansari et al, 2009). These techniques have many drawbacks related to convergence speed, digital or analogue implementation, requirement of sensors, cost and range of effectiveness A paper has been reported on artificial intelligence-based fuzzy logic control scheme for the MPP tracking of a solar PV system under variable temperature and insolation conditions. A method has been suggested that a fuzzy logic controller (PLC) applied to a dc-dc converter device.

The results are found that the PLC exhibits a much better behavior (Ansari et al, 2010). It has been also reported that residential energy consumption varies tremendously across geographic regions due to disparities of access to different energy sources. Prices, climate, income, and urbanization level. It has been found in rural China that energy use patterns is a function of net income, rather than total expenditure, are morconsistent with the energy transition model (Jiang and O'Neill, 2004). Studies of some PV systems implemented for power supply of electricity in unelectrified remote areas in Sunderbans in the state of West Bengal and other places (Chakarbarti and Chakarbarti, 2002; Singh et al, 2005) and in the state of Rajasthan, India (MNES, 2005) have been reported. An energy analysis of a PV system for an academic institution of north Indian state of Uttar Pradesh has been reported. In this analysis, a load survey has been carried out to use as input to the RETScreen software to get estimated energy generated and the COE for one year besides providing estimate of collector area, total aimual estimated cost, total annual income, GHG emission reduction, carbon trading income due to GHG reduction, and cash flow etc. (Afzal et al, 2008). To improve the performance of a PV system, it has been suggested to use a transformer to provide galvanic isolation and groimding of the PV array in a PV-fed grid-connected inverter so that total harmonic distortion and dc component of the current supplied to the grid is low conforming to standards like IEEE 1547 (Patel and Agarwal, 2009). For the sake of protection while using a PV system a study has been assessed the protection against electric shock in a PV generator from the dc side of a PV installation by applying an "active" means. This has been conformed to International Electrotechnical Commission 60364, the international standard that provides guidelines for wiring in low-voltage electrical installations (Hernandez and Vidal, 2009)

IV. HARDWARE INTRODUCTION

A. Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. The Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

B. The Board Has The Following New Features

1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin, that is reserved for future purposes.

- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards as shown in Figs.3 and 4.

Arduino Pin Diagram:

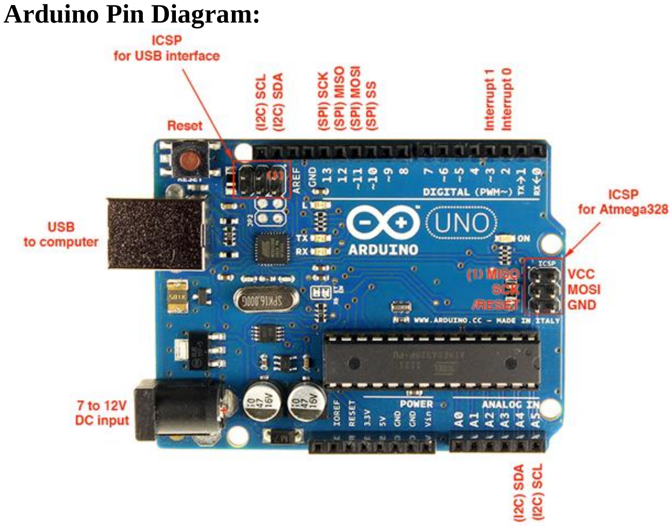

Fig.3. Aurdino Board.

Fig.4. Pin Description.

Power: The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

Memory: The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output: Each of the 14 digital pins on the Uno can be used as an input or output, using pinmode, digitalwrite , and digital read functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms.

Communication: The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

USB Overcurrent Protection: The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Automatic (Software) Reset: Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The

Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data. The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

Physical Characteristics: The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

C. 16x2 LCD Display

Liquid crystal displays (LCD's) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in liquid, but are grouped together in an ordered form similar to a crystal. The LCD's are lightweight with only a few millimetres thickness. Since the LCD's consume less power they are compatible with low power electronic circuits and can be powered for long durations as shown in Fig.5. The LCD's are used extensively in watches, calculators and measuring instruments is the simple seven-segment displays, having a limited amount of data. The following figure shows a general purpose alphanumeric LCD, with two lines of 16 characters:

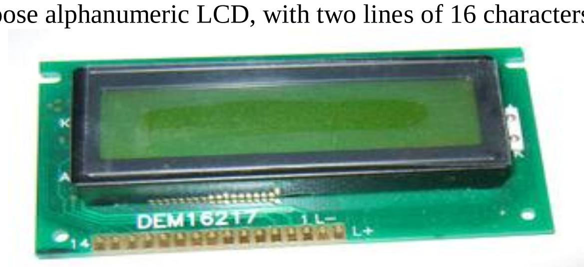

Fig.5. LCD.

D. Relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical as shown in Fig.6. The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

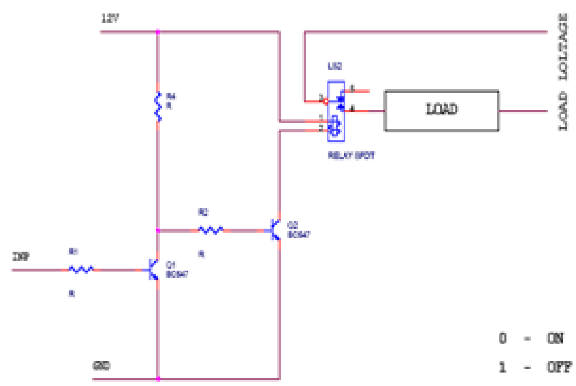

Fig.6. Spst relay.

Fig.7 relays.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay as shown in Fig.7. The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts as shown in Fig.8. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

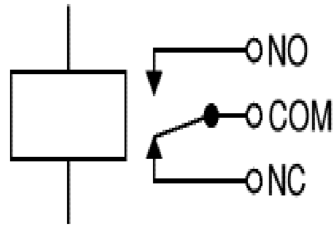

Fig.8. Relay internal diagram.

The relay's switch connections are usually labeled COM, NC and NO:

- COM = Common, always connect to this, it is the moving part of the switch.
- NC = Normally Closed, COM is connected to this when the relay coil is off.
- NO = Normally Open, COM is connected to this when the relay coil is on.

Circuit Description: This circuit is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay. The relay ON and OFF is controlled by the pair of switching transistors (BC 547). The relay is connected in the Q2 transistor collector terminal. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and Normally open (NO). The relay common pin is connected to supply voltage. The normally open (NO) pin connected to load. When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the Q2 transistor. So the relay is turned OFF state. When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and relay is turned ON. Hence the common terminal and NO terminal of relay are shorted. Now load gets the supply voltage through relay.

E. Temperature Sensor

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in oC). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 oC temperature rise in still air as shown in Fig.9.The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every oC rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ oC.

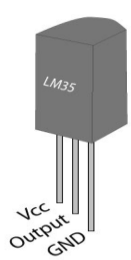

Fig.9. Pin Diagram.

In general, a temperature sensor is a device which is designed specifically to measure the hotness or coldness of an object.LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C).With LM35,the temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 °C temperature rise in still air. The operating temperature range is from -55°C to 150°C.The LM35’s low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It has find its applications on power supplies, battery management, appliances, etc.click here for datasheet. The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C).It can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C.

The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The LM35 comes in many different packages such as TO-92 plastic transistor-like package,T0-46 metal can transistor-like package,8-lead surface mount SO-8 small outline package. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ˚ Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4˚C at room temperature and ±3⁄4˚C over a full −55 to +150˚C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35’s low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1˚C in still air. The LM35 is rated to operate over a −55˚ to +150˚C temperature range, while the LM35C is rated for a −40˚ to +110˚C range (−10˚ with improved accuracy). The LM35 series is available pack aged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

Solar Panel: Solar power is energy captured from the sun. The tremendous energy discharged by the sun each day is harnessed using various solar technologies available today. Solar energy systems can be either active or passive. Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones are available, based on thin-film cells. The cells must be connected electrically in series, one to another. Externally, most of photovoltaic modules use MC4 connectors type to facilitate easy weatherproof connections to the rest of the system as shown in Fig.10.

Fig.10 Solar Panel.

F. Wind Energy

Wind energy has been used for pumping water and milling grain for hundreds of years. More recently, wind energy has also been used for electricity generation. Developing countries can take advantage of wind power on a small scale, both for irrigation (wind pumps) and for generation of electricity (wind generators).

G. DC Motor

Although motor gives 60 RPM at 12V but motor runs smoothly from 4V to 12V and gives wide range of RPM, and torque, 60RPM Centre Shaft Economy Series DC Motor is high quality low cost DC geared motor as shown in Fig.11.

Specifications Of DC Motor:

DC supply: 4 to 12V
RPM: 60 at 12V
Total length: 46mm
Motor diameter: 36mm
Motor length: 25mm
Brush type: Precious metal
Gear head diameter: 37mm
Gear head length: 21mm
Output shaft: Centered
Shaft diameter: 6mm
Shaft length: 22mm
Gear assembly: Spur
Motor weight: 105gms

Fig.11 DC Motor.

Introduction to Micro vision Keil (IDE): Keil is a cross compiler. So first we have to understand the concept of compilers and cross compilers. After then we shall learn how to work with keil.

Concept of Compiler: Compilers are programs used to convert a High Level Language to object code. Desktop compilers produce an output object code for the underlying microprocessor, but not for other microprocessors. I.E the programs written in one of the HLL like ‘C’ will compile the code to run on the system for a particular processor like x86 (underlying microprocessor in the computer). For example compilers for Dos platform is different from the Compilers for Unix platform So if one wants to define a compiler then compiler is a program that translates source code into object code. The compiler derives its name from the way it works, looking at the entire piece of source code and collecting and reorganizing the instruction. See there is a bit little difference between compiler and an interpreter. Interpreter just interprets whole program at a time while compiler analyzes and execute each line of source code in succession, without looking at the entire program. The advantage of interpreters is that they can execute a program immediately. Secondly programs produced by compilers run much faster than the same programs executed by an interpreter. However compilers require some time before an executable program emerges. Now as compilers translate source code into object code, which is unique for each type of computer, many compilers are available for the same language.

Concept Of Cross Compiler: A cross compiler is similar to the compilers but we write a program for the target processor (like 8051 and its derivatives) on the host processors (like computer of x86) It means being in one environment you are writing a code for another environment is called cross development. And the compiler used for cross development is called cross compiler. So the definition of cross compiler is a compiler that runs on one computer but produces object code for a different type of computer. Cross compilers are used to generate software that can run on computers with a new architecture or on special-purpose devices that cannot host their own compilers. Cross compilers are very popular for embedded development, where the target probably couldn't run a compiler. Typically an embedded platform has restricted RAM, no hard disk, and limited I/O capability.

Code can be edited and compiled on a fast host machine (such as a PC or Unix workstation) and the resulting executable code can then be downloaded to the target to be tested. Cross compilers are beneficial whenever the host machine has more resources (memory, disk, I/O etc) than the target. Keil C Compiler is one such compiler that supports a huge number of host and target combinations. It supports as a target to 8 bit microcontrollers like Atmel and Motorola etc.

There are several advantages of using cross compiler. Some of them are described as follows

- By using this compilers not only can development of complex embedded systems be completed in a fraction of the time, but reliability is improved, and maintenance is easy.
- Knowledge of the processor instruction set is not required.
- A rudimentary knowledge of the 8051's memory architecture is desirable but not necessary.
- Register allocation and addressing mode details are managed by the compiler.
- The ability to combine variable selection with specific operations improves program readability.
- Keywords and operational functions that more nearly resemble the human thought process can be used.
- Program development and debugging times are dramatically reduced when compared to assembly language programming.
- The library files that are supplied provide many standard routines (such as formatted output, data conversions, and floating-point arithmetic) that may be incorporated into your application.
- Existing routine can be reused in new programs by utilizing the modular programming techniques available with C.
- The C language is very portable and very popular. C compilers are available for almost all target systems. Existing software investments can be quickly and easily converted from or adapted to other processors or environments.

Now after going through the concept of compiler and cross compilers lets we start with Keil C cross compiler.

H. KEIL C Cross Compiler

Keil is a German based Software development company. It provides several development tools like

- IDE (Integrated Development environment)
- Project Manager
- Simulator
- Debugger
- C Cross Compiler , Cross Assembler, Locator/Linker

Keil Software provides you with software development tools for the 8051 family of microcontrollers. With these tools, you can generate embedded applications for the multitude of 8051 derivatives. Keil provides following tools for 8051 development

- C51 Optimizing C Cross Compiler,
- A51 Macro Assembler,
- 8051 Utilities (linker, object file converter, library manager),
- Source-Level Debugger/Simulator,
- µVision for Windows Integrated Development Environment.
- The keil 8051 tool kit includes three main tools, assembler, compiler and linker.
- An assembler is used to assemble your 8051 assembly program
- A compiler is used to compile your C source code into an object file
- A linker is used to create an absolute object module suitable for your in-circuit emulator.
- 8051 project development cycle:-
- these are the steps to develop 8051 project using keil
- Create source files in C or assembly.
- Compile or assemble source files.
- Correct errors in source files.
- Link object files from compiler and assembler.
- Test linked application.

Software: The Arduino Software (IDE) allows you to write programs and upload them to your board. In the Arduino Software page you will find two options:

- If you have a reliable Internet connection, you should use the online IDE (Arduino Web Editor). It will allow you to save your sketches in the cloud, having them available from any device and backed up. You will always have the most up-to-date version of the IDE without the need to install updates or community generated libraries.
- If you would rather work offline, you should use the latest version of the desktop IDE.

V. RESULTS

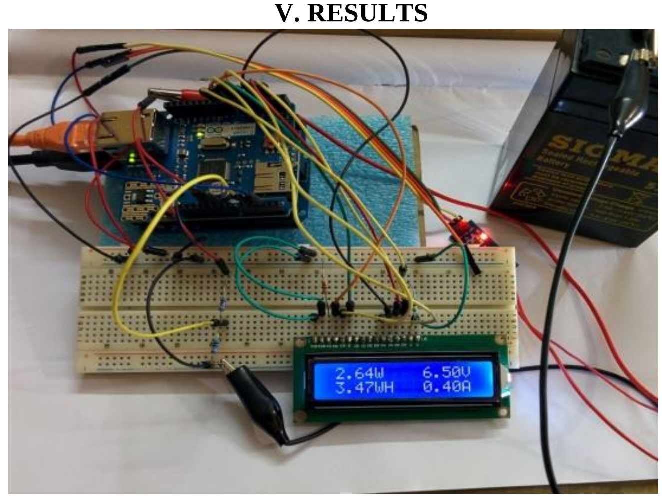

Fig.12.

VI. CONCLUSION AND FUTURESCOPE

The utilization of renewable resources is greatly demanding in the world. The world facing the problem of global scarcity of electricity and pollution can be easily overcome with renewable energies. The presented paper is based on the different researches on the utilization of the natural resources like solar and wind. The combination of solar and wind hybrid system is also presented in the paper. Overall the aim of the research study to utilised the presented literature for developing the proposed research work.

Future Scope: In the future, this technique is used for other multi core architectures and proposes scheduling techniques to other different task models and planned to implement the proposed approach in Hardware and verify our approach on a direct coupled solar energy powered embedded system.

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