Power Generation through Hybrid Sources and Backward Compatibility

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Certificate

We accept the work contained in this report as a confirmation to the required standard for the partial fulfillment of the degree of BS (ETM).

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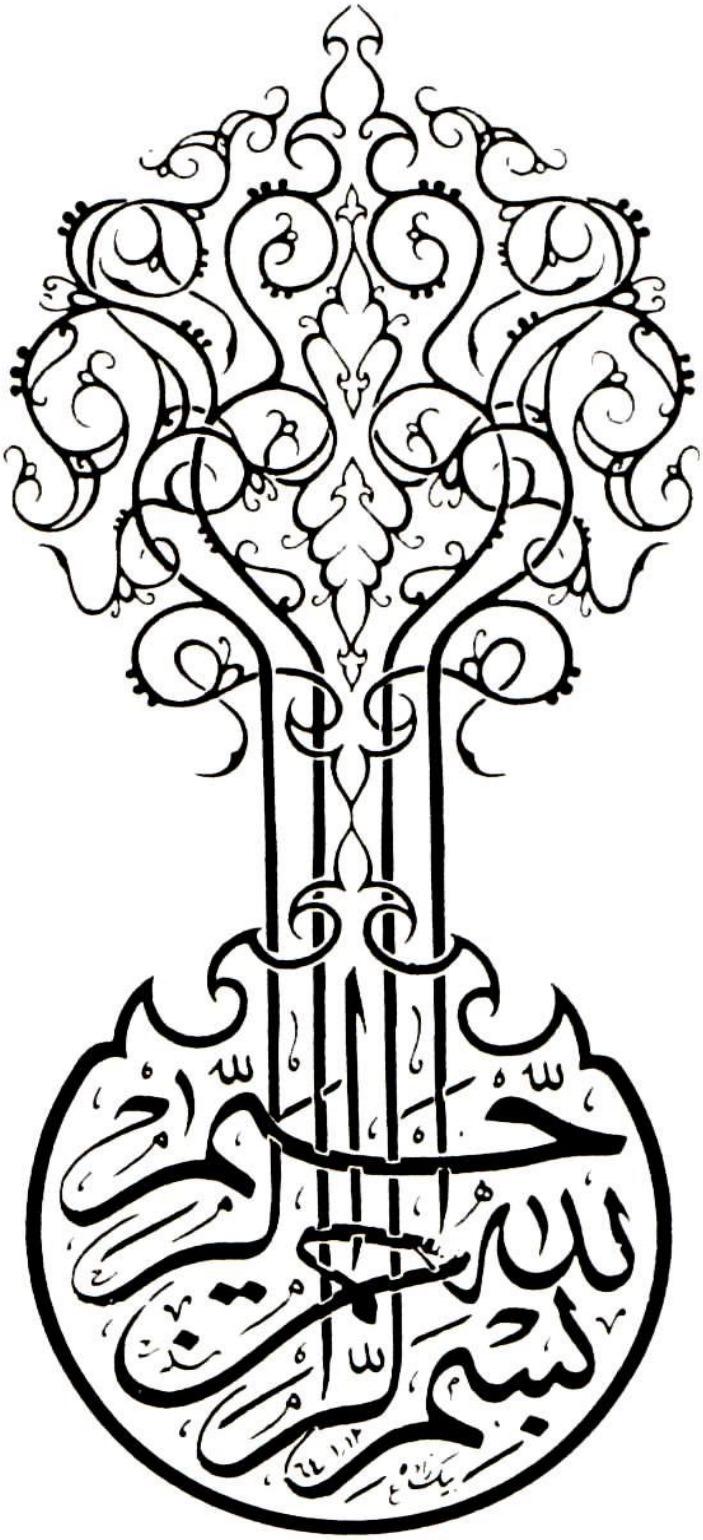
بسم الله الرحمن الرحیم

Dedication

We happily dedicate this project to our Parents, Friends and Teachers who supported us through every step and helped us to overcome all the difficulties that come in our way.

Acknowledgements

The first acknowledgement is to **ALLAH** Almighty who gave us strength to face all the challenges and difficulties that came our way while delivering this project.

We would also like to thank our supervisor **Dr Shagufta Henna** for providing us with valuable suggestions and supervision. It helped us a lot to complete our project successfully.

We are also thankful to our project coordinator **Ma'am Saima Jawad** for her help and guidance that helped us to complete our project on time and successfully.

We also appreciate our teahers, friends and class fellows for their suggestions and cooperation.

Abstract

Due to power shortage in the country and high billing rates there is a need to produce electricity that is cheaper and monetarily beneficent. Aim of this project is to design a system which can produce electricity and make it is easy to be used by the household user and if extra electricity is produced then it could be entered to the main grid and can get benefits from it. The system consists of automatic switch which will detect the production and requirement of power and will switch between sources accordingly. Power generation will be from Solar and Wind.

List of Topics

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Chapter # 1

INTRODUCTION

1.1 Project Overview:

This project is about generation of electricity for house hold use which can be extended up to industrial level also for example home owner or office worker needs electricity for daily use such as lightening and other electric appliances. The power generation is totally natural and ECO friendly as it uses wind and solar energy. This will also insure uninterrupted supply of electricity by switching between our generation, WAPDA and generator. It will help to face the energy crisis and lessen the load on the national grid.

Electricity is the flow of electrical energy. Everything is made up of atoms. Atoms are having a nucleus at center, containing protons and neutrons. In surrounding when there is an imbalance between protons and electrons, electrons from the orbits around it are released from the atom. This flow of electrons is called electrical current. Global Hydrology and Climate Centre, Benjamin Franklin was first who performed systematic and scientific study of lightning around the latter half of the 18th century. Previously, the other scientists have noted the similarity between laboratory sparks and lightning. Franklin for the first time conducted an experiment which proved that the lightning is of electrical nature.

Electricity production using solar energy and wind energy is not a very new thing it's been adopted since the man is looking for alternate energy sources for cheaper and clean sources. Few of the reuse able and eco-friendly energy sources are:

- Solar energy
- Wind energy
- Tidal energy
- Geothermal energy

Our country is blessed with all these type of energy sources but Solar is most common all around the country while wind is common around the coastal cities. Using these kinds of free energy sources we can generate enormous amount of electricity so that we can make ourselves easy from electricity shortage and huge billing.

The electricity crisis in the country is increasing day by day, that's why load shedding is increasing in hours daily. People are switching to other modes of power like generators and UPS etc. Maintain generator is also an issue as petrol and diesel prices are also much high. So we came up with an idea to combine different sources which produce cheap almost free electricity and which also is ECO friendly that doesn't produces noise and smoke etc. another feature of this project will be that if we are producing extra power then our requirements then we can enter the produced power that is extra to the national grid and can get monetarily benefits like the electricity meter will move in reverse and thus we would be compensated on billing. This method is expensive at installation but it will benefit the user in long run as it progresses.

Electricity runs everything in our daily life. Gas stations can't pump gas without electric power. Businesses have to close because their computers can't run without it. Industries would stop working without electricity. Our lives almost come like Stone Age without electricity.

Almost everything in our world today fully depends on the electricity to keep them running. In our homes, the things that we need and enjoy are plugged into a socket and require electricity. That's why backup electricity has become an important necessity and is no longer an enjoyable luxury.

Different energy sources can be used to generate electrical power which can run many devices like Computers, TV, machines, electric motors, mobile chargers and other electrical machinery. This energy can also be used for supplying electricity to schools, Mosques and streets which are located in rural areas. It would help

consumer to run appliances, outdoor and indoor lights. These power systems can also supply direct current and alternate current accordingly.

1.2 Problem Description:

All around the world electricity is the most commonly used form of energy. It's a basic need for the economic development of a country and far an important standard of living. As a country's population increases and its economy grows, its demand for electrical energy also increases. If that demand is not fully met, a shortage in supply occurs. This shortage causes load shedding and power crisis.

Power Crisis in Pakistan is considered as one of the basic challenges to the country facing today. Electricity is vital necessity of our routine life and its short availability has badly affected the economic condition of country and overall living of people. Many have lost their jobs, businesses due to this crisis. Daily life of o common man has become immensely miserable. Pakistan is now a day facing up to 16 hours of electricity outage a day. It is expected to increase more if it is not solved with in proper time and resources.

The objective of this project is to study the nature and condition of this crisis and also to propose some short-term as well as long-term solutions.

There are three other major causes of the energy crises. They are

- Circular debt,
- Mismanagement of resources
- Corruption.

A handsome amount of electricity in Pakistan is producing by oil. Non-Payment to the oil companies results in the low supply which results in energy crisis. The power plants are not operating on their full capacity or they are closed. Everyone talks about the corruption done by the government officials, but no one ever talked about the corruption that is done by citizens who are perceived as innocent Pakistanis. At least 50% of People are either not paying the electricity bill or are bribing the officials to reduce the amount of the bill.

There is a huge repercussion of the energy crisis. Pakistan has been badly affected by the energy crisis. There was a common perception that only poor people in Pakistan suffer, but energy crisis has also hit the lives and business of the rich people. Students cannot concentrate on studies, because their attention is diverted to 12-hour load shedding. Industrialists and business men have started shifting their industries to Bangladesh as it is no longer possible for them to run their businesses in Pakistan. People belonging to the middle class are having great difficulty in finding the jobs because all the major businesses are either shutting down or making their employees redundant.

Both the government and the citizens should use electricity with care and denounce all those people who are involved in this corruption. Government should use its resources to punish all the culprits severely so that a precedent is set no one could ever dare to steal electricity.

1.3 Project Scope:

1.3.1 Objective:

To generate electricity through hybrid sources to produce cheap and clean electricity and also backward compatibility to the WAPDA grid for monetarily benefits.

1.3.2 Sub Objectives:

- To produce cheap and clean electricity for house hold use which can be extended up to industrial levels.
- To ensures the uninterrupted power supply using different sources.
- To enter the surplus electricity to the main grid and can earn money through it.

Chapter # 2

LITERATURE REVIEW

2.1 Literature Review

Hybrid energy sources are becoming popular among people because it is formed from many combined energy sources. The combination of two energy sources is a useful way of generating energy. The use of hybrid power generations came into shape because of increased prices of oil. The implementation of hybrid energy systems can useful the electric supply especially in remote areas. But it is a bit expensive and is difficult to combine few energy sources, but it is a expense at start. This initial expense would be more beneficial in remote areas; people living there would not face any power shortage crises.

Many renewable power sources have been processed for a better development in the last decades. So, their grouping would surely provide a better uninterruptible power system. Diverse renewable power sources would accompaniment each other. But, a lot of necessities have to be measured first. It is significant to recognize that all the factors that effects its performance, in order to get the finest of it. The main factors are locations, interval and requirements of the user. Location includes the information about the climate, main energy sources convenience and environmental situations. This data plays a key role in deciding that what kind of renewable power generators should be chosen. The swiftly growing costs of power line extensions and decreasing fossil fuels, along with the desire to lessen the carbon dioxide releases helped the development of hybrid power system appropriate for distant locations. Hybrid power systems are intended for the production and use of clean electrical power. It is independent of a large main centralized electricity grid and incorporate more than one type of power source. They can range in size from individual household power supplies to relatively large island grids. In general a hybrid system might contain alternating current (AC) fueled generators, an AC circulation system, renewable power sources, energy storage systems, power converting systems, fixed diesel system, rotary converters, dumped loads, load management options and a supervisory controled system.

2.2 Hybrid Power Energy:

S. Ashok (2009) from NITC in a research defined System: Hybrid energy system is including several (two or more) energy sources with appropriate energy conversion technology connected together to feed power to local load/grid.

2.3 Major features of Hybrid energy system:

NITC Research Review (2009) published that HES allow wide variety of primary energy sources, frequently renewable sources generation as the stand alone system for rural electrification where grid extension is not possible or uneconomic. Design and development of various HES components has more flexibility for future extension and growth. Device can be added as the need arises and assure the promising operation with existing system. If there is excess generation than demand, it can be feed in to grid which leads new revenue. The “whole” is worth more than the “parts”. Since many sources are involving in power generation, its stability, reliability and efficiency will be high. Running cost of thermal plant and atomic plant is high. Majority of the renewable source based electricity generation has minimum running cost also abundant in nature

2.4 Barriers:

Maximum power extraction: When different V-I characteristics voltages are connected together, one will be superior to other. In this circumstance, extracting maximum power is difficult for a constant load. Stochastic Nature of sources: These distributed sources are site specific and diluted. So, the design of power converters and controllers has to design to meet the requirement. Complexities in matching voltage and frequency level of both inverted DC sources like PV system, fuel cell, etc controlled AC sources like wind, hydro, etc. Because, these sources V-I characteristics depends on atmospheric condition, which is varying time to time. Forecasting of these sources is not accurate. Coordination: In order to get reliable power, these HES connected to utility grid. Often frequency mismatch arises between both systems. Hence it leads instability of the overall system.

2.5 Energy Conversion Technology:

Sun is the primary sources of all energies. It is available in many ways like oil, coal, wind, sunlight. We are generating electrical energy from these sources directly or indirectly. So far, there is no unique viable method is used for conversion and utilization.

2.6 Power Quality:

Variety of power electronics converters are involved in the power conditioning of hybrid energy system between sources to load. These power converters generate many harmonic components to the load which cause various disturbances to the load/power distribution

Chapter # 3

REQUIREMENT SPECIFICATIONS

3.1 Existing System:

Current situation in Pakistan is very bad and is in lot of crisis. People are switching to the alternate sources of energy. Our country is blessed with every kind of energy source and solar is one of them. Electricity generation through solar is not new and used extensively all over the world.

3.2 Proposed system:

The system we have designed is that using the free energy around us and convert that into electrical energy. The main aim is to get monetarily benefits from it. This will be done through the reverse meter that will move reverse when electricity pass through it and enter the main grid. This system also helps to ensure uninterrupted supply of power. The batteries will be charged and as soon the power cuts down it will automatically switch to the stored energy and in case the batteries also run short of power then it will switch to the other special feature that it will automatically starts the generator. We have combined the three sources altogether and will be used automatically according to the need and availability of them.
The solar will provide us enough power to operate the house and we had set our threshold of 2OO volts minimum. In case the voltage from the solar drops lower than that then it will switch to the Power supplied by WAPDA. The IC used will compare and measure the voltage level regularly. There is display unit which will tell us about the voltage generated and available to use.

3.3 Specifications:

3.3.1 Hardware Specifications:

Microprocessor PIC 16F877A
LCD
Bridge Rectifiers
Transformer
Fuse
Circuit Board
LEDs
Resisters
Diodes
Capacitors
Relays
Solar Panel
Electric Meter
Crystal Oscillator
Voltage Dependent Resister
ULN 2803APG

Chapter # 4

SYSTEM DESIGN

4.1 Block Diagram:

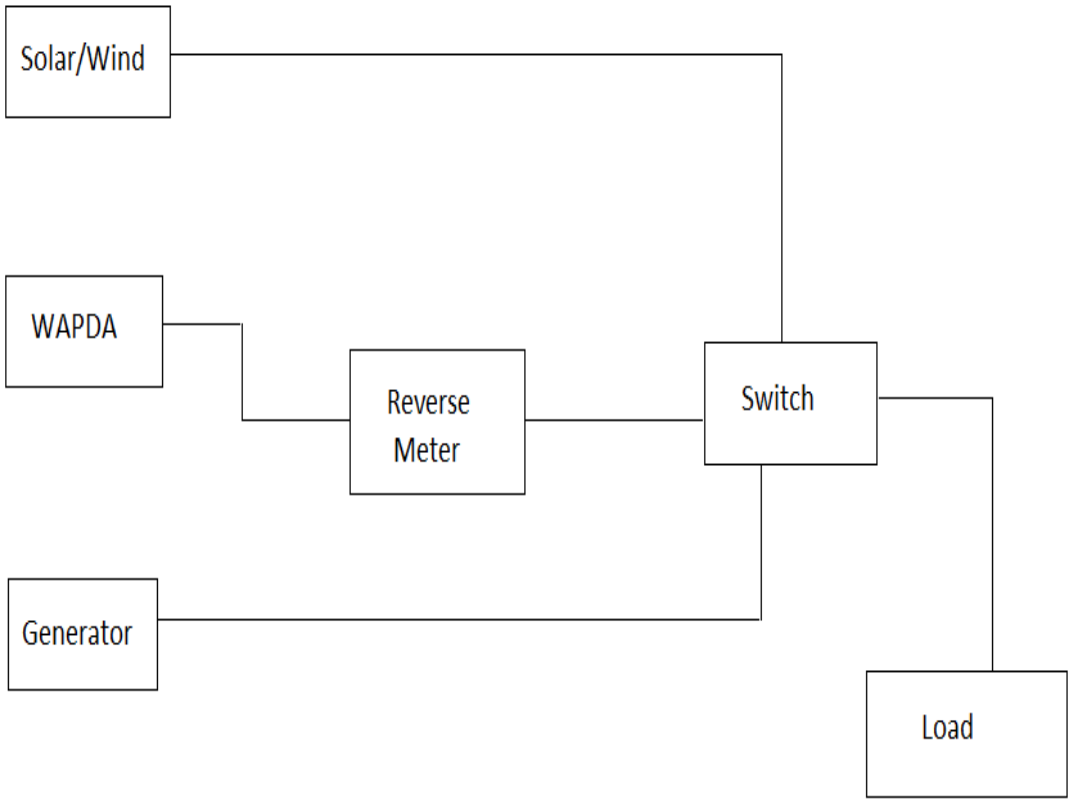

Figure 4.1

4.2 Components:

4.2.1 Microprocessor PIC 16F877A:

PIC 16F877A is used in this project as its programming is easy and it is more fast and reliable than 8051.

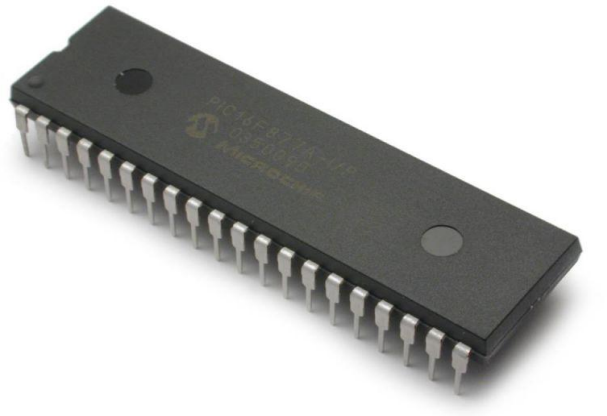

Figure 4.2 [1]

It has following properties:

- 40 pin device
- 5v power supply needed
- Operating frequency 20 MHz
- Flash memory 8k
- Data memory 368 bytes
- Built in analog to digital converter
- EEPROM memory 256 bytes
- 35 instruction set

4.2.2 Pin Configuration:

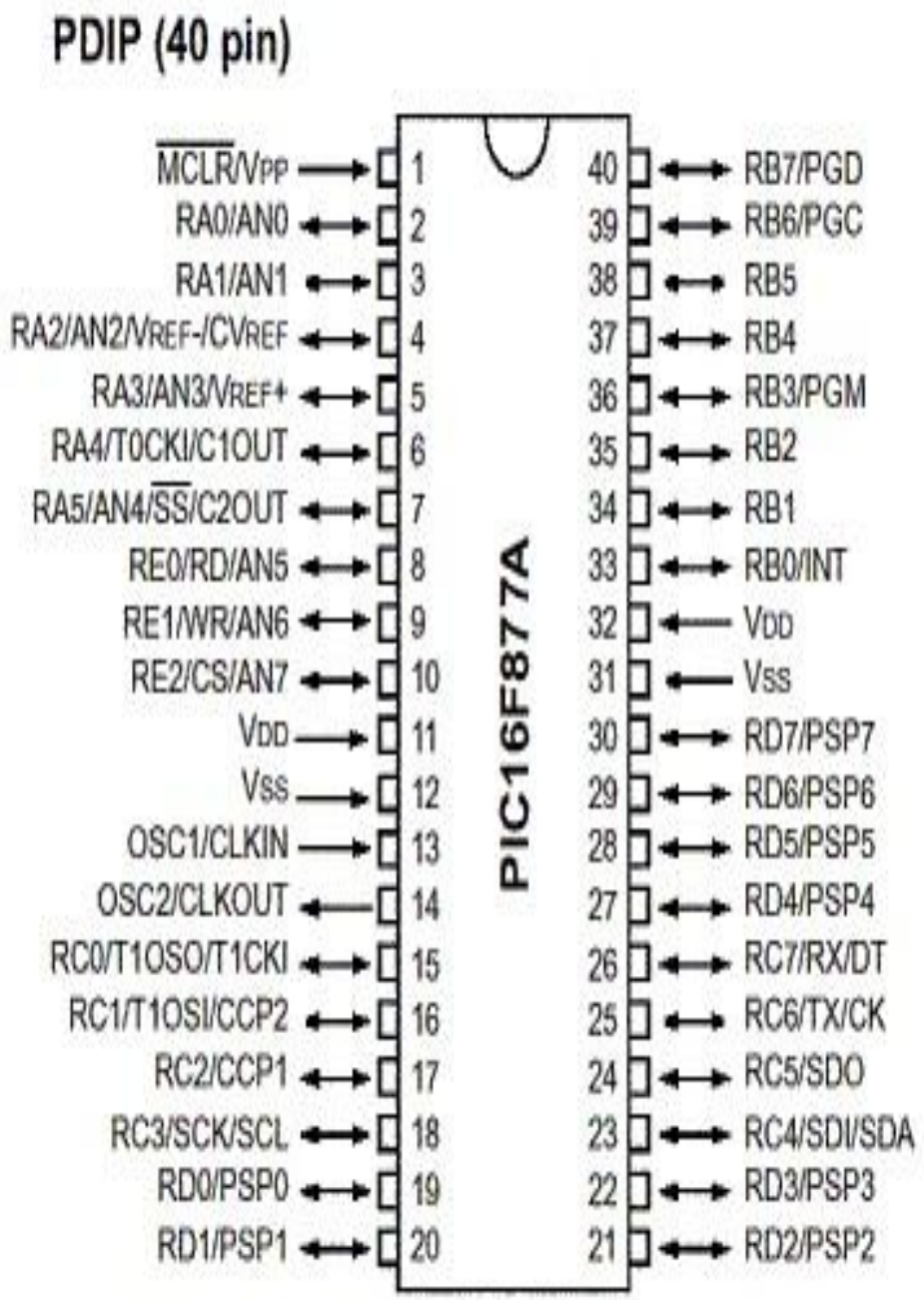

Figure 4.3 [2]

4.2.3 Rectifier:

Rectifier is a device which converts A.C current to D.C current through the process of Rectification.

We have used bridge rectifier in the project. Bridge rectifier consists of four diodes and it is a type of full-wave rectifier that converts both the negative and positive of AC voltages into the DC voltage. Bridge circuit is an arrangement of four or more diode which can provide the same polarity of output for the same input polarity. For the conversion of an alternating current input into a direct current output in a common application, it can also be known as bridge rectifier. By using the two-wires AC input, bridge rectifier provides a full-wave rectification, by resulting provided a two-wires DC output.

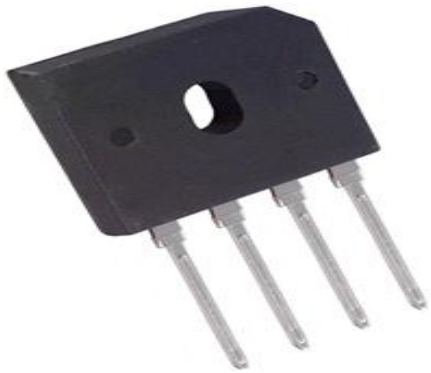

Figure 4.4 [3]

4.2.4 Transformer:

Transformer is an electrical device that transfers electrical energy from the one circuit to the other through induced coupled conductors and without changing the frequency. Changing electrical current in the primary winding creates a changing magnetic flux in the core of transformer and thus changing magnetic field through the secondary winding. The changing magnetic fields induce a changing electromotive force (EMF) or "voltage" in the secondary winding. That effect is known as mutual induction.

Figure 4.5 [4]

4.2.5 Fuse:

Fuse is an important component of electronic devices. It helps to stop the excessive flow of current or voltage to the circuit. It consist of a metal wire or strip joined between two electrical terminals.it melts when over amount of current passes through it thus saving the circuit ahead.

Figure 4.6 [5]

4.2.6 LED:

LED stands for Light Emitting Diode. They are semiconductor light sources used mostly for indication purpose but now also are used for lightening.

Figure 4.7 [6]

4.2.7 Resisters:

Resisters are used to control the current flowing in the circuits. They keep the current level to our requirement thus providing a safe and sound circuit.

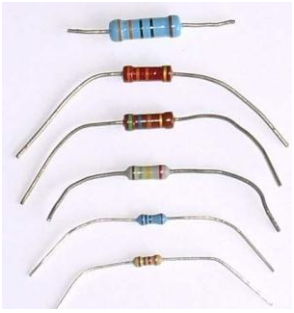

Figure 4.8 [7]

4.2.8 Capacitors:

Capacitors are normally used to save the charge but in electrical circuits its important role as D.C blocker is used. They ensure smooth A.C supply and block away any D.C component in it.

Figure 4.9 [8]

4.2.9 Solar Panels:

Solar panels are used to convert the Solar energy into electrical energy which will be used for operating the home appliances. Solar panels are rated by their DC output power under standard conditions, and normally range from 100 watts to 320 watts. The efficiency of a panel is determined by the area of panel given the same rated output - a 9% efficient 230 watt panel will have twice the area of a 17% efficient 230 watt panel. A single solar panel can produce only a limited amount of power; mostly multiple panels are used in applications.

Figure 4.10 [9]

4.2.10 ULN 2803APG:

It is high voltage and high current Darlington drivers having 8 NPN Darlington pairs. It has integral clamp diode for inductive loads. Its applications relay, hammer, lamp and display drivers.

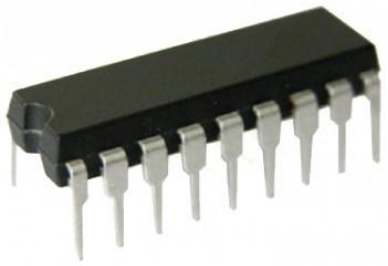

Figure 4.11 [10]

Chapter # 5

SYSTEM

IMPLEMENTATION

5.1 Hardware Implementation:

5.1.1 Switching panel:

This is the main switching circuit of the project which controls all the switching between the different power sources. It consists of step down transformers, bridge rectifier, PIC, relays and LCD.

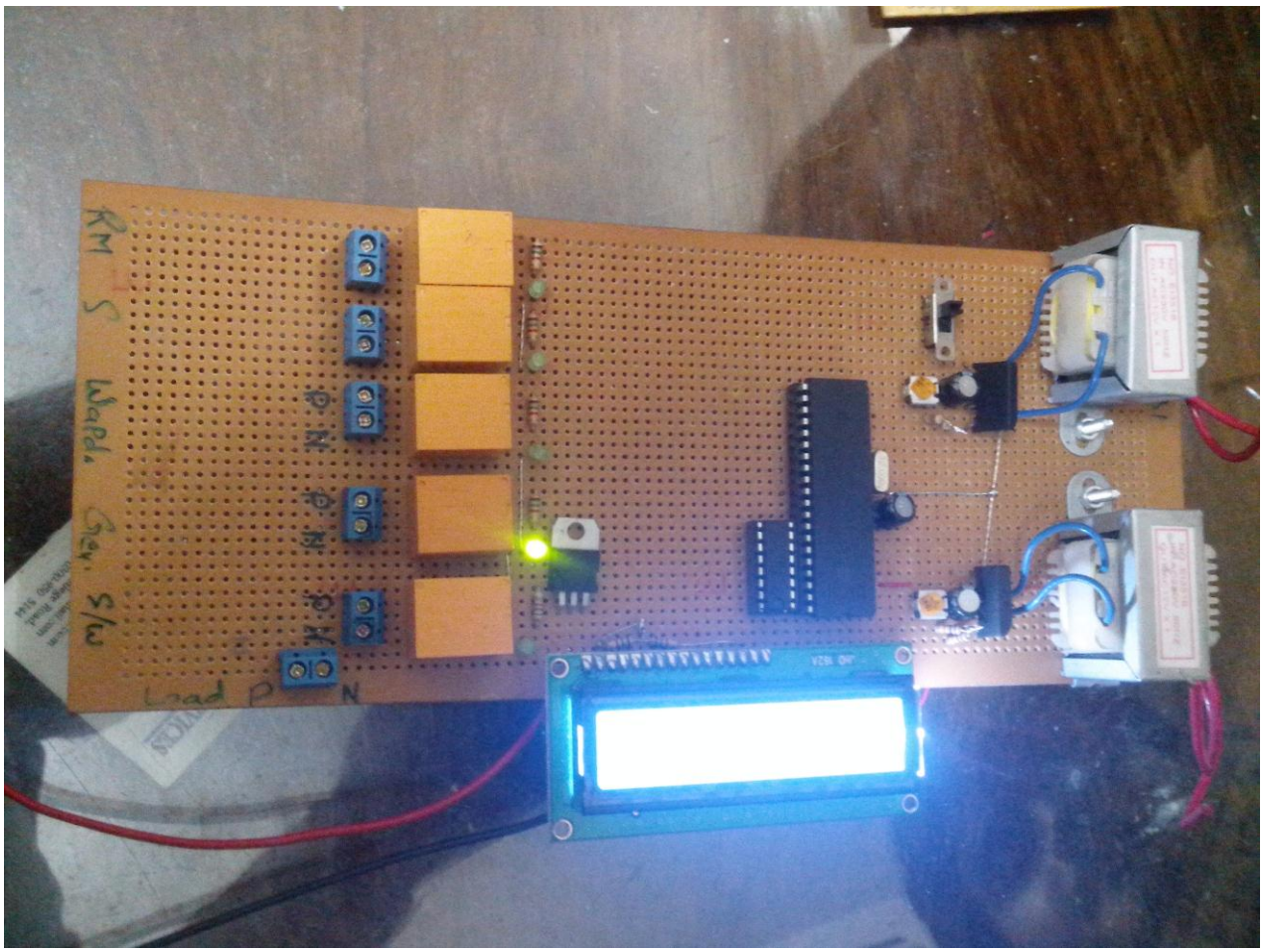

Figure 5.1

5.1.2 Output Relays:

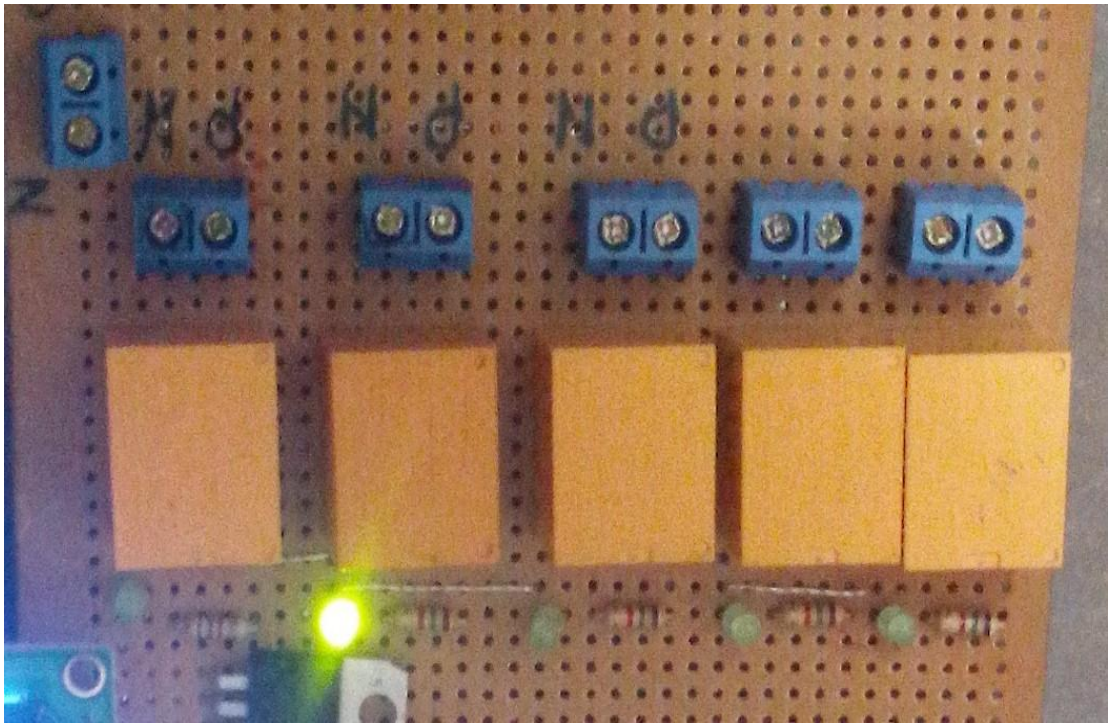

Figure 5.2

5.1.3 Bridge Rectifiers:

Figure 5.3

5.1.4 Display unit:

Figure 5.4

5.1.5 Resonant circuit:

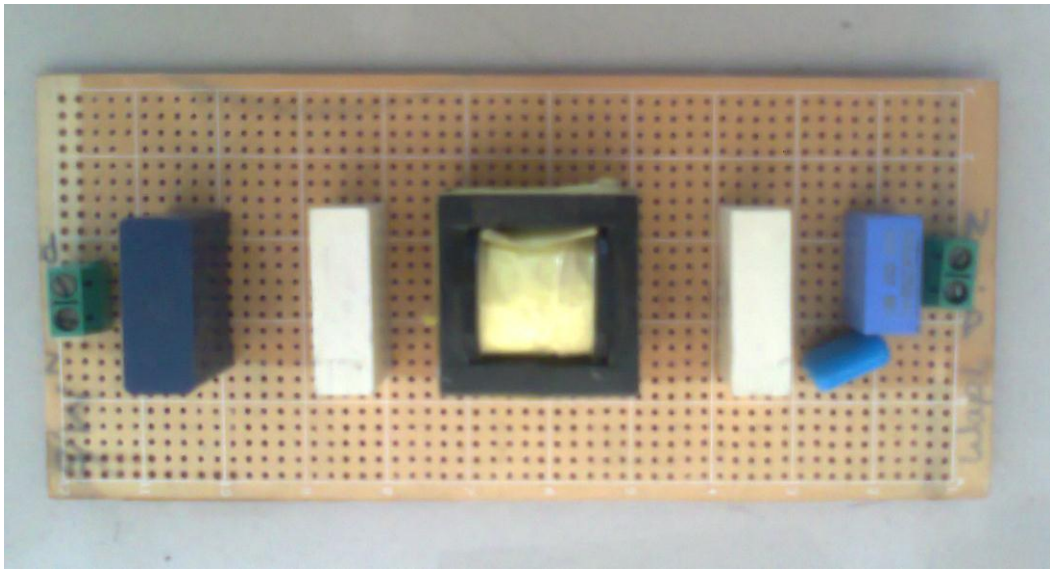

Figure 5.5

Chapter # 6

SYSTEM TESTING AND EVALUATION

Figures will show the Real time Output of the system.

6.1 Solar/Wind Energy Used:

When electricity generated through our solar energy is greater than 200 volts then the system will shift the load to solar power as shown in the figure below.

Figure 6.1

The microcontroller will send the command and the relay will be turned on which will complete the solar/wind circuit to the load as in the figure below. Glowing LED is indicating the point.

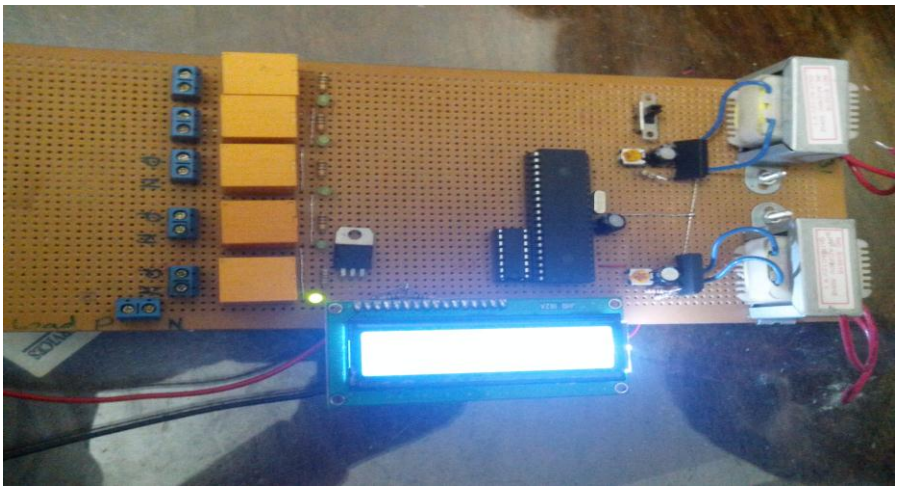

Figure 6.2

6.2 Power from WAPDA is used:

When voltage level from solar/wind drops then 200 volts the microcontroller senses it and sends the command and load is shifted to WAPDA power.

Figure 6.3

The relay which is connected to the WAPDA output is turned on thus completing the circuit.

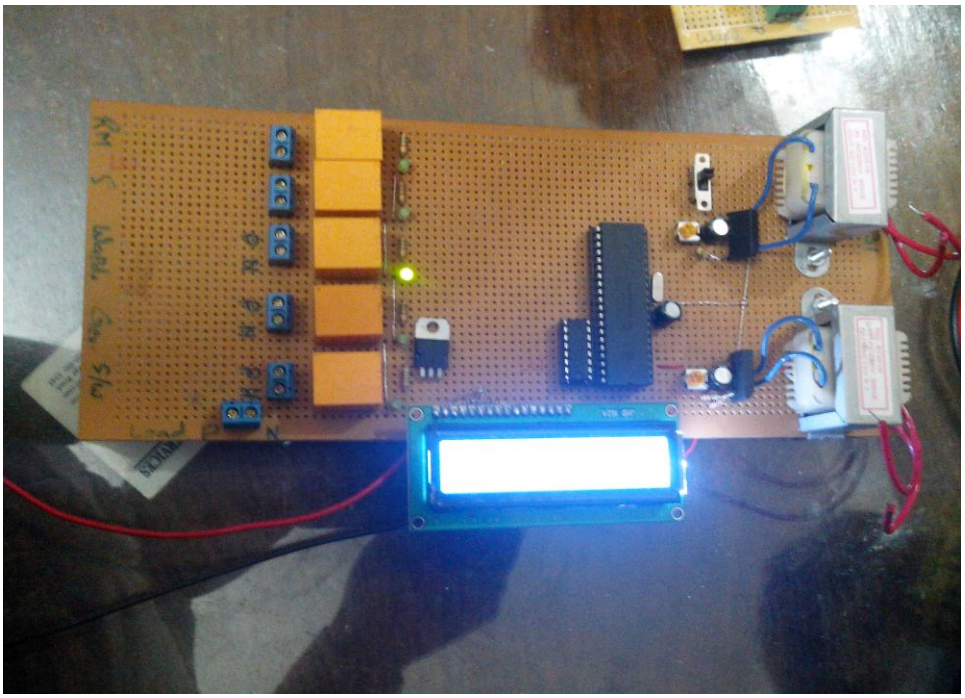

Figure 6.4

6.3 Power from Generater:

when the voltage levl fron solar/wind drops then 200 volts and wapda drops then 180 volts the microprocesser senses the drop and shift the loa dto generater. It sends the sulf comand to generater.

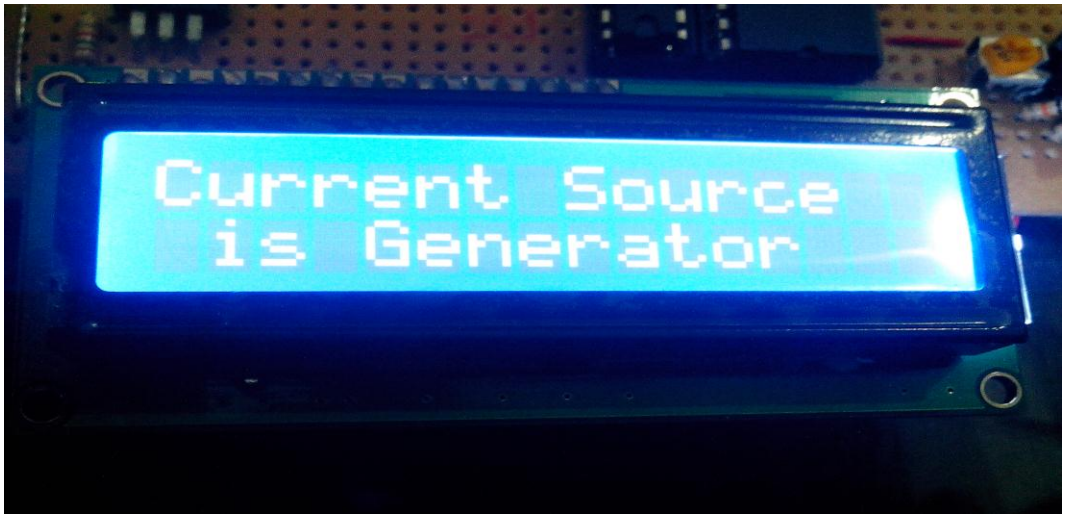

Figure 6.5

The relay connected to the generator circuit is turned on and load is shifted to it.

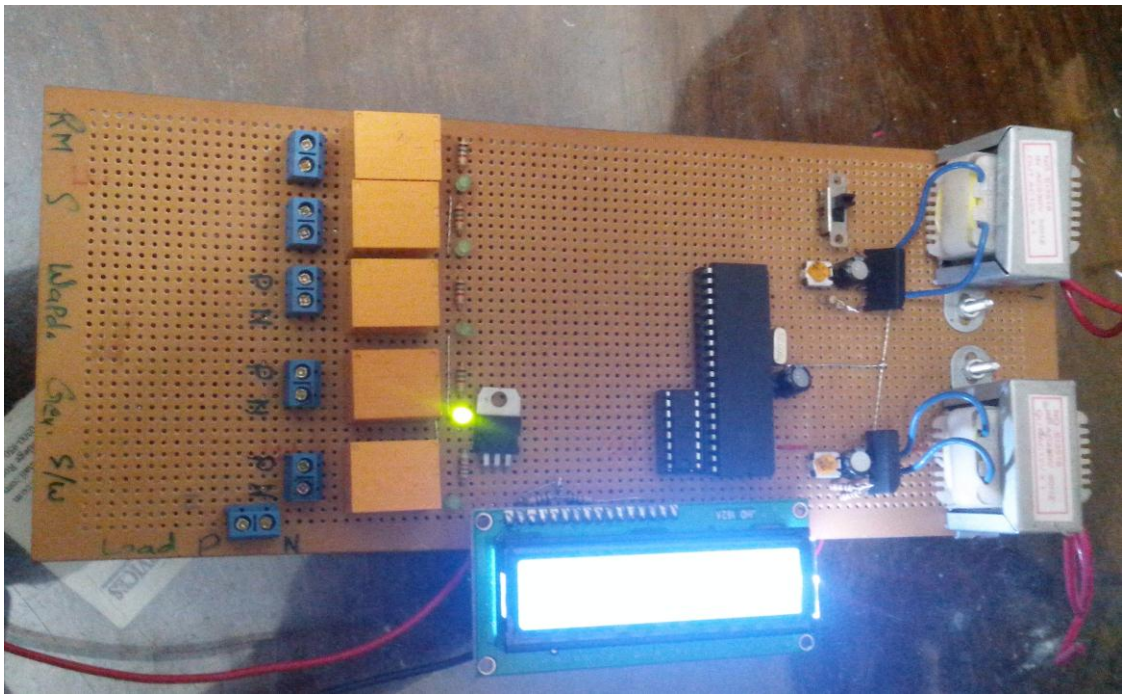

Figure 6.6

6.4 When Reverse Meter is on:

When we are not using the electricity produced by solar/wind we switch on the reverse meter. If the voltage is more than or equal to 220 volts then it will flow toward the reverse meter and enter the main grid.

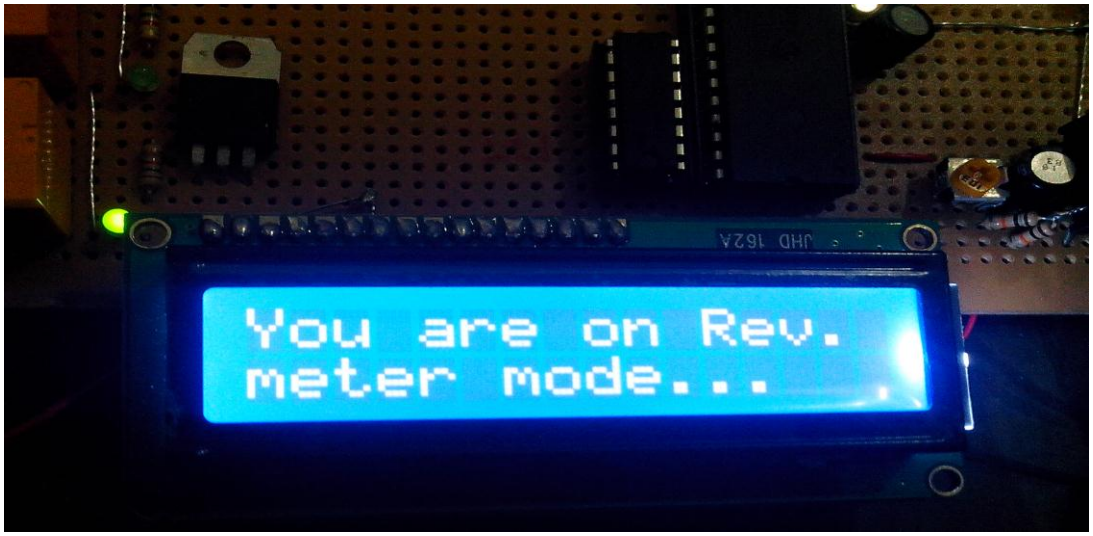

Figure 6.7

Output relay for the reverse meter will be switched on.

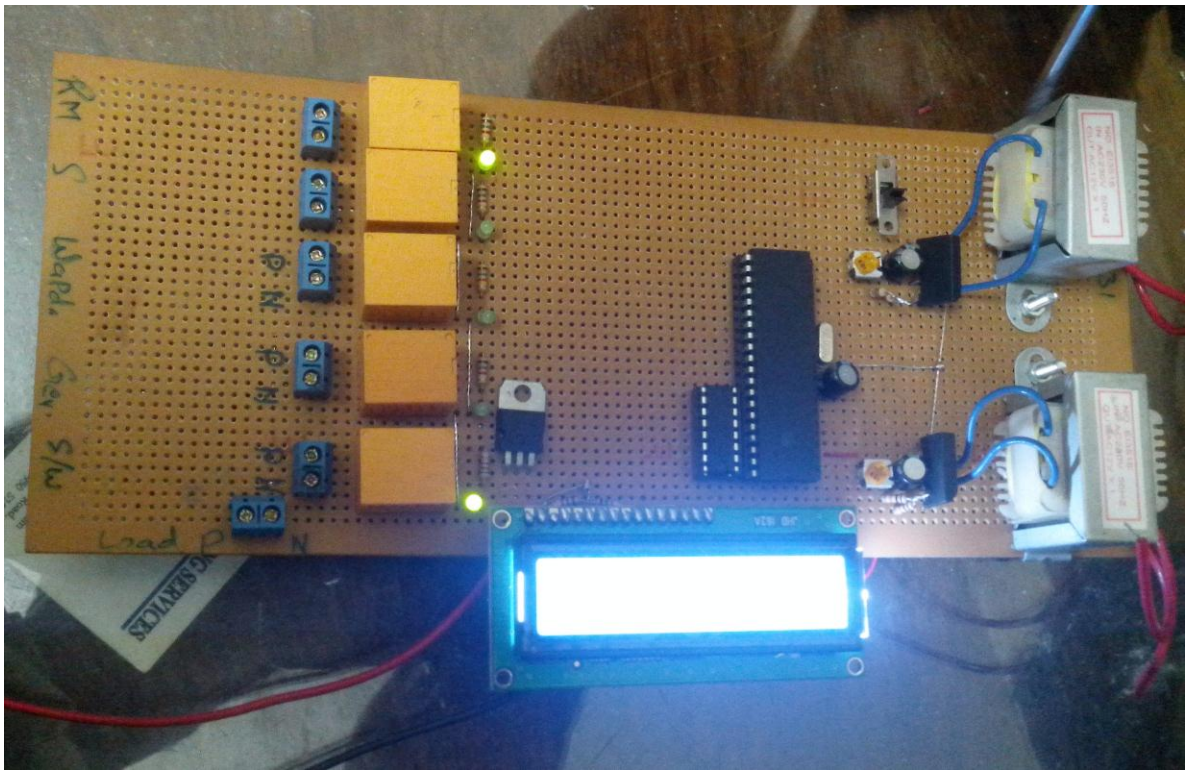

Figure 6.8

When the voltage drops then the 220 volt mark then it will not enter the main grid and will just charge the battries.

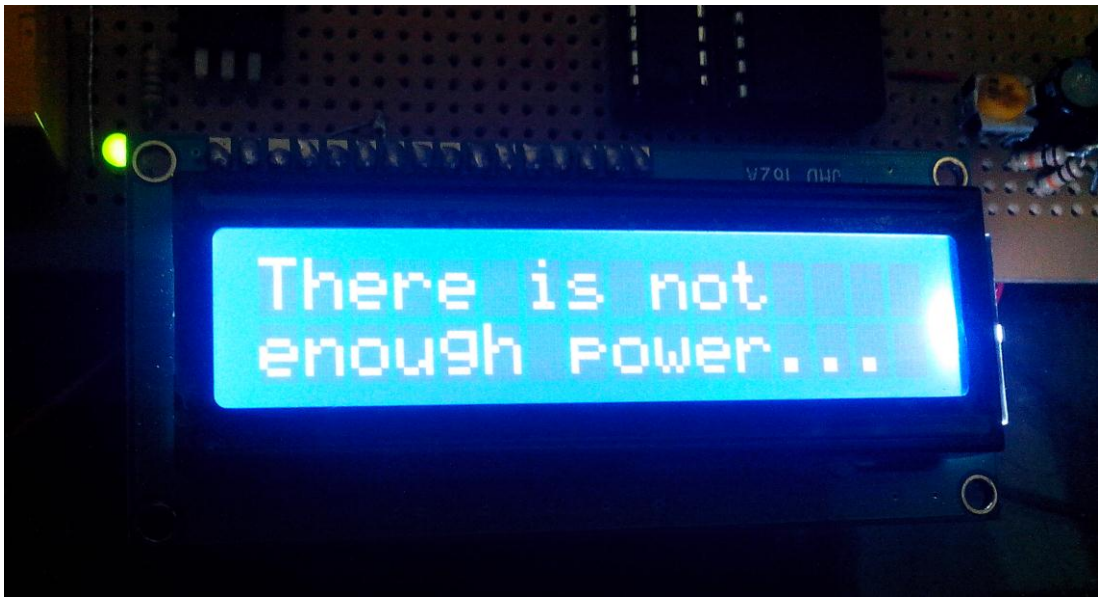

Figure 6.9

Chapter # 7

CONCLUSION

Our project was completed in different phases which were successfully finished and our project objectives were attained. This project was not just a degree requisite but it was great learning experience.

7.1 Project objectives:

- To produce cheap and clean electricity for house hold use which can be extended up to industrial levels.
- To ensures the uninterrupted power supply using different sources.
- To enter the surplus electricity to the main grid and can earn money through it.

7.2 Learning:

The first challenge that we had to face was the accusation of accurate working component required for the project. This constraint affected greatly in our project. For this reason we had to develop alternatives which can lead to similar results apart from this we also had to make different tradeoffs in designs which increased and tested our core technical knowledge and polished our designing skills.

The study and the research work that was carried out for this project gave us exposure to certain knowledgeable areas about which we did not know before. The key learning experience for us in this project was to absorb our research work, add our technical knowledge and bring our ideas into reality.

For completion of this project team work was vital this particular experience of working in team was great learning which will help us in our future professional life.

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4. 1Pinout Description Table:

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	13	14	30	I	ST/CMOS(4)	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	14	15	31	O	—	Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
$\overline{MCLR}$/VPP/THV	1	2	18	I/P	ST	Master clear (reset) input or programming voltage input or high voltage test mode control. This pin is an active low reset to the device.
						PORTA is a bi-directional I/O port.
RA0/AN0	2	3	19	I/O	TTL	RA0 can also be analog input0
RA1/AN1	3	4	20	I/O	TTL	RA1 can also be analog input1
RA2/AN2/VREF-	4	5	21	I/O	TTL	RA2 can also be analog input2 or negative analog reference voltage
RA3/AN3/VREF+	5	6	22	I/O	TTL	RA3 can also be analog input3 or positive analog reference voltage
RA4/T0CKI	6	7	23	I/O	ST	RA4 can also be the clock input to the Timer0 timer/counter. Output is open drain type.
RA5/$\overline{SS}$/AN4	7	8	24	I/O	TTL	RA5 can also be analog input4 or the slave select for the synchronous serial port.
						PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	I/O	TTL/ST(1)	RB0 can also be the external interrupt pin.
RB1	34	37	9	I/O	TTL	
RB2	35	38	10	I/O	TTL	
RB3/PGM	36	39	11	I/O	TTL	RB3 can also be the low voltage programming input
RB4	37	41	14	I/O	TTL	Interrupt on change pin.
RB5	38	42	15	I/O	TTL	Interrupt on change pin.
RB6/PGC	39	43	16	I/O	TTL/ST(2)	Interrupt on change pin or In-Circuit Debugger pin. Serial programming clock.
RB7/PGD	40	44	17	I/O	TTL/ST(2)	Interrupt on change pin or In-Circuit Debugger pin. Serial programming data.

Continued:

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
						PORTC is a bi-directional I/O port.
RC0/T1OSO/T1CKI	15	16	32	I/O	ST	RC0 can also be the Timer1 oscillator output or a Timer1 clock input.
RC1/T1OSI/CCP2	16	18	35	I/O	ST	RC1 can also be the Timer1 oscillator input or Capture2 input/Compare2 output/PWM2 output.
RC2/CCP1	17	19	36	I/O	ST	RC2 can also be the Capture1 input/Compare1 output/ PWM1 output.
RC3/SCK/SCL	18	20	37	I/O	ST	RC3 can also be the synchronous serial clock input/ output for both SPI and I^2C modes.
RC4/SDI/SDA	23	25	42	I/O	ST	RC4 can also be the SPI Data In (SPI mode) or data I/O (I^2C mode).
RC5/SDO	24	26	43	I/O	ST	RC5 can also be the SPI Data Out (SPI mode).
RC6/TX/CK	25	27	44	I/O	ST	RC6 can also be the USART Asynchronous Transmit or Synchronous Clock.
RC7/RX/DT	26	29	1	I/O	ST	RC7 can also be the USART Asynchronous Receive or Synchronous Data.
						PORTD is a bi-directional I/O port or parallel slave port when interfacing to a microprocessor bus.
RD0/PSP0	19	21	38	I/O	ST/TTL(3)	
RD1/PSP1	20	22	39	I/O	ST/TTL(3)	
RD2/PSP2	21	23	40	I/O	ST/TTL(3)	
RD3/PSP3	22	24	41	I/O	ST/TTL(3)	
RD4/PSP4	27	30	2	I/O	ST/TTL(3)	
RD5/PSP5	28	31	3	I/O	ST/TTL(3)	
RD6/PSP6	29	32	4	I/O	ST/TTL(3)	
RD7/PSP7	30	33	5	I/O	ST/TTL(3)	
						PORTE is a bi-directional I/O port.
RE0/$\overline{RD}$/AN5	8	9	25	I/O	ST/TTL(3)	RE0 can also be read control for the parallel slave port, or analog input5.
RE1/$\overline{WR}$/AN6	9	10	26	I/O	ST/TTL(3)	RE1 can also be write control for the parallel slave port, or analog input6.
RE2/$\overline{CS}$/AN7	10	11	27	I/O	ST/TTL(3)	RE2 can also be select control for the parallel slave port, or analog input7.
VSS	12,31	13,34	6,29	P	—	Ground reference for logic and I/O pins.
VDD	11,32	12,35	7,28	P	—	Positive supply for logic and I/O pins.

4.2 Data Sheet for ULN 28O3APG

Electrical Characteristics (Ta = 25°C)

Characteristic		Symbol	Test Cir-Cuit	Test Condition		Min	Typ.	Max	Unit
Output leakage current		I_{CEX}	1	V_{CE} = 50 V	Ta = 25°C	—	—	50	μA
				V_{CE} = 50 V	Ta = 85°C	—	—	100	
	ULN2804A			V_{CE} = 50 V	V_{IN} = 1 V	—	—	500	
Collector-emitter saturation voltage		VCE (sat)	2	I_{OUT} = 350 mA, I_{IN} = 500 μA		—	1.3	1.6	V
				I_{OUT} = 200 mA, I_{IN} = 350 μA		—	1.1	1.3	
				I_{OUT} = 100 mA, I_{IN} = 250 μA		—	0.9	1.1	
Input current	ULN2803A	$I_{IN (ON)}$	2	V_{IN} = 3.85 V		—	0.93	1.35	mA
	ULN2804A			V_{IN} = 5 V		—	0.35	0.5	
				V_{IN} = 12 V		—	1.0	1.45	
		$I_{IN (OFF)}$	4	I_{OUT} = 500 μA, Ta = 85°C		50	65	—	μA
Input voltage (Output on)	ULN2803A	$V_{IN (ON)}$	5	V_{CE} = 2 V, I_{OUT} = 200 mA		—	—	2.4	V
				V_{CE} = 2 V, I_{OUT} = 250 mA		—	—	2.7	
				V_{CE} = 2 V, I_{OUT} = 300 mA		—	—	3.0	
	ULN2804A			V_{CE} = 2 V, I_{OUT} = 125 mA		—	—	5.0	
				V_{CE} = 2 V, I_{OUT} = 200 mA		—	—	6.0	
				V_{CE} = 2 V, I_{OUT} = 275 mA		—	—	7.0	
				V_{CE} = 2 V, I_{OUT} = 350 mA		—	—	8.0	
DC current transfer ratio		h_{FE}	2	V_{CE} = 2 V, I_{OUT} = 350 mA		1000	—	—	
Clamp diode reverse current		I_R	6	Ta = 25°C	(Note)	—	—	50	μA
				Ta = 85°C	(Note)	—	—	100	
Clamp diode forward voltage		V_F	7	I_F = 350 mA		—	—	2.0	V
Input capacitance		C_{IN}	—			—	15	—	pF
Turn-on delay		t_{ON}	8	R_L = 125 Ω, V_{OUT} = 50 V		—	0.1	—	μs
Turn-off delay		t_{OFF}		R_L = 125 Ω, V_{OUT} = 50 V		—	0.2	—	

Note: $V_R = V_R$ (max)

APPENDICES

User Manual Guide:

The project consists of two parts one is the switching part ant other that is connected to the meter.

The project is almost automatic. You just have to install at first then it will work automatically. Switching between sources and turning on of generator will be self-controlled.

Switching on of reverse meter is manual. When you have to leave the house or you know that no more power will be consumed then just turn on the reverse meter and it will start sending the surplus amount of energy into main grid.

Pre cautions:

As it is working on electricity so it has to be handled with care and proper insulation.