Journal of Renewable Energy Science, Technology and Economics
ISSN 2395 – 2644 (print) Vol 1, Issue 1 - May 2015

Renewable energy: An assessment of public awareness
-- With special reference to Jorhat district of Assam

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Renewable source of energy has become increasingly important in the last few decades. Renewable energy is the energy derived from resources that are regenerative for all practical purposes and non- depleting besides environmental benign[1].Renewable energy is generally defined as energy that comes from resources such as sunlight, wind, water, tides and geothermal heat. Most renewable energy comes directly or indirectly from the sun. Sunlight or solar energy can be used directly for heating and lighting. Similarly hydel energy (rains), can be used to generate electricity. Besides, biomass, bio-fuel is the source of renewable energy and can be used to produce electricity, transportation fuel or chemicals[2]

Energy whether renewable or non-renewable is a part and parcel of human life. A country's economic position and well-being is determined by the per capita energy consumption level of that country. But non-renewable energy sources like coal, natural gas and oil resources are finite and hidden. Moreover the global oil market is currently very volatile. The world reserves of crude oil are uncertain. As a result searching for renewable energy sources are occurring allover the world. Renewable energy replaces conventional fuel in four distinct areas (i) electricity generation (ii) space heating (iii) motor fuel and (iv) rural energy. Among the above mentioned form of energy electricity is unarguably the most effective energy source for achieving development and for reducing poverty. It is widely used for both industrial and domestic purposes. But in India all the state electricity board suffers from the problem of high indebtedness and losses due to the subsidized power and resultant shortage of generating electricity[3].

Table 1 shows the anticipated power supply position in the country in general and North Eastern Region in particular.

Table 1: Anticipated power supply position in the country during 2014-15

	Energy				Peak			
State/ country	Requirement MU	Availability MU	Surplus/Deficit		Requirement MW	Availability MW	Surplus/Deficit	
				%				%
Arunachal Pradesh	793	637	-15.6	-19.7	140	134	-6	-4.3
Assam	**8765**	**5945**	**-2820**	**-32.2**	**1480**	**1001**	**-480**	**-32.4**
Manipur	727	753	26	3.6	150	136	-14	-9.3
Meghalaya	1996	2241	245	12.3	390	473	82	21.1
Mizoram	471	503	32	6.8	90	98	7	8.3
Nagaland	681	504	-177	-26	140	92	-48	-34
Tripura	1389	1664	275	19.8	310	298	-12	-3.8
Sikkim	557	872	315	56.6	131	149	18	13.7
Total(N.E.)	15380	13120	-2260	-14.7	2674	2364	-309	-11.5
Total(All India)	1048672	995157	-53515	-5.1	147815	788	-3027	-2.0

Source: www.cea.nic.in/reports/yearly/lgbr_report pdf

NE: North Eastern Region

It is found from the table that North Eastern Region faces more power shortage than all India level. In case of Assam the problem seems to be more acute as the state faces 32% power shortage. Moreover per capita energy consumption level in India is very less compared to developed countries. In the year 2010 per capita electricity consumption in USA was 13395 kwh whereas it was only 641kwh in India. On the other hand in Assam it was only153 kwh in the same year. The overall power supply position in Assam have not been satisfactory during the past several years. Table 2 expresses the per capita energy availability status in the Assam state from 2005-06 to 2009-10.

Table 2: Per Capita electrical energy availability status

Year	Gross electrical Energy availability (MU)	Projected population	Per capita availability status (Kwh)
1	2	3	4
2005-06	3267.87	28506000	115
2006-07	3344.30	28896000	116
2007-08	4013.62	29282000	137
2008-09	4270.00	29660000	144
2009-10	4590.00	30037000	153

Source: Economic survey, Assam, 2011-12

From the above discussion it is clear that per capita electricity consumption in Assam is very less in the past and at present. This low per capita consumption of electricity reflects both poor quality of life and low level of economic activities. 100 percent of the state's power generation is thermal. Yet many of the projects under implementation are hydel projects. But N E Region has a tremendous hydel potential and from this renewable source of energy NE including Assam should not be short of power in the near future[4]. So there is a need to aware and educate the people about the sources of renewable energy by which we can mitigate the deficiency of energy shortage now and in future.

Objectives: The basic objectives of this study will be

i) To study the main renewable energy sources of Assam.
ii) To asses the awareness of general public towards the use of renewable energy sources.
iii) To examine the behavioral aspect of general public to conserve energy.

Methodology: The study is based on both secondary and primary data. The sample will be designed in such a way that it will cover the general public of the society between the age group 14years to 60 years.

Table 3: Structure of the sample

Type of respondent	**No. of respondents**
School students (standard 10)	20
College students (Degree level)	20
Housewives (graduate)	20
Employees	20
Total	80

The above study was done in Jorhat district of Assam on Dec 2014. This district is chosen for our study as it is one of the highest literate district of Assam according to 2001 census. In order to assess the awareness level on renewable energy the respondents were randomly selected for our study.

Study area: Jorhat District, Assam, INDIA
Reference period: The month of December 2014.

Renewable energy sources of Assam :

Solar energy: Solar power is gradually being preferred across the globe to fight the growing menace of global warming and climatic change. The latitude and longitude of Assam is 24 degree 8 N to 28 degree 2 N and 89 degree42 E to 96 degree E. The mean average temperature in the state ranges from 22.5 degree to 24.5 degree centigrade. The climate of Assam ranges from a maximum of 29 degree C to a minimum of 16 degree centigrade.
The average solar radiation in Assam indicates that the state intercept only 36-38 percent of the astronomically possible sunshine during June August (FAO 1987). Though the average monthly sunshine hours are more from November to February (70 – 74 percent) the unit of radiation intercept is less due to fog in the morning during the period[5].Ministry of New and Renewable Energy (MNRE) had approved to convert Guwahati and Jorhat into solar cities as part of its initiatives to fight global warming.

Solar Water Heater, Solar cooker, Solar photovoltaic cell, Solar street light, solar stabs are becoming popular to reduce carbon emission in the environment. By using solar water heater we can get rid of carbon dioxide, nitrogen oxide, sulphur dioxide and other air pollution. When a solar water heater replaces an electric water heater the electricity displaced over 20 years represents more than 20 tons of avoided carbon dioxide emission alone [6].

Hydroelectric energy:
The hydroelectric potential available in the state is estimated at 12 million KW[7].But the state can able to harness only 2MW (as on 31/3/2001) from these huge stock. It is seen in the table that he total installed capacity of power is mainly thermal.

Table 4: Type of power supply in Assam as on 31/3/2001

Type of power supply	Installed capacity As on 31/3/2001 (MW)	Installed capacity As on 31/3/2001 (in percentage)
1	2	3
Thermal	620.70	99.68
Hydro	2.00	03.22
Total	622.70	100

Source: compiled by the author
The government of Assam has decided to encourage generation of power through small hydropower sources of energy and has framed a policy to achieve the objectives of self sufficiency in power. The identified potential at present for development of small hydropower projects is about 117 MW at about 88 identified locations [8]. According to Assam Power Project Development Company Ltd.(APPDCL) the hydel power

project under implementation in Assam include the 3MW Pahumara project ,the 4.7MW Bordikoria project, the 9 MW Disang project and the 3MW (each stage I&II) Kalanga Project [9].
From the year 1993-94 energy division division of ASTE Council started preliminary survey in Assam. The following table shows the SHP sites of Assam,

Table 5: The SHP sites of Assam

Name of the Project	Stream	District	Capacity
1	2	3	4
Kalmoni	Kalmoni	Kamrup	170 kw
Thiapani	Kopili	Kamrup	200kw
Nazirakhat	Motbhangadong	Kamrup	10kw
Barkasarang	Barkasarang	Kamrup	10kw
Amlong	Amlong	Karbi Anglong	100kw
Majar	Majar	Karbi Anglong	10kw
Longpai	Longpai	Karbi Anglong	20kw
Ganapati	Kopili	Kamrup	500kw

Source: http://asmenvis.nic.in/Database/Energy_858.aspx
The availability of energy of Assam depends on completion of the Mega power project i.e. Lower Subansiri Hydroelectric Power Project (LSHEP).The project was started in December 2007 and it targets to supply 2000 MW power in future. But construction of LSHEP involves many challenges. Unexpected geological condition at the Dam site led to landslide and slower tunnel excavation. By November 2007 the river was successfully diverted and in April 2008 the foundation was clear for construction. Moreover it was discovered that bedrock was reached 10metre (33ft) sooner than expected. This leads to an alteration in the Dam's design for stability. The re-design was completed in October 2008.As of November 2011 the Dam reached an elevation of 138m (453ft)just below the spillway elevation of145m(476ft). On 16December2011construction was halted by protest. The protest was done to reduce the ecosystem damage and loss of land. The centre recently held talks with anti Dam groups and formed 8 member expert panel to look into the safety and impact of Subansiri project.

Biomass energy:
In energy industry biomass refers to wood, straw, biological waste products that contained stored energy. The energy stored in biomass can be utilized by directly burning or feeding it into micro organism which in turn produce biogas, which is a form of natural gas. Direct burning is practiced by mankind for thousand of years for cooking and heating. But the process of direct burning is inefficient and causes emission of green house gases. Therefore more efficient methods like biomass gasification etc. are more widely used in decentralized power generation and remote area electrification. Biomass is utilized to produce bio-diesel, bio-ethanol and termed as first generation bio-fuel. On the other hand use of waste product to produce bio-fuel is termed as second generation bio fuel.

Biomass resources are abundantly available in the state. As the first phase of National Biomass Resource Assessment Programme (NBRAP) Assam Science Technology and environment Council (ASTEC) had

conducted this study in three blocks. During NBRAP third phase, ASTEC had conducted this study in five blocks of Assam. Later at the fourth phase of NBRAP this study had been conducted in five more blocks of Assam. As a whole in Assam a biomass assessment study has already been completed in 13 blocks and a number of pockets have been identified for remote village electrification. The Community Development Blocks where such studies have been done are as follows.

Table 6: Name of the selected blocks in Assam under NBRAP

Name of the Block	District	Remaks
1	2	3
Mayong	Morigoan	1st Phase
Margherita	Tinsukia	
Lowerpowa	Karimgang	
Sarukhetri	Borpeta	3rd Phase
Pubchaiduar	Sonitpur	
Jugijan	Nagoan	
Lahowal	Dibrugarh	
Katigaragh	Cachar	
Balijan	Goalpara	4th Phase
Patharkandi	Karimganj	
Bezera	Kamrup	
Lakuwa	Sibsagor	
Dhemaji	Dhemaji	

Source: compiled by the author from the website http://asmenvis.nic.in/Database/Energy_858.aspx

The potential for family type biogas plant was estimated as 307000 numbers till 31st March 2011. Out of this cumulative physical achievement was only 88324 numbers (28.77 percent) which indicates that achievement is far behind the targeted level.

Bio-diesel: Bio-diesel as an alternative source of energy has become increasingly popular all over the world . Jetropha curcas has been identified as the most suitable plant that can be used to produce bio-diesel. In India it is found in almost all states and it can be used as a live fence for protection of agricultural field from damage by livestock. Out of the various North eastern states Assam has the largest area under Jetropha cultivation (33,900 hectres)[10].In theyear 2007 Williamson Magor biofuel Ltd. has developed Jetropha Plantation over 51,000 hectrores of land. The company acquired a plot of land at Tezpur in Assam for setting up its factory. Since 2007 the company has developed plantation over an area of 1,32,000 hectres involving around 1,16.000 farmers in the country. Moreover extensive research has been going on in different academic institutions of Assam regarding development of bi-diesl.

Bio- ethanol: Bamboo is one of the major non edible biomass resources available abundantly in Assam and amongst the fastest growing plant. Numaligarh Refinery Limited (NRL) in Assam intends to explore the feasibility of setting up a bio- refinery in Assam to produce bio-ethanol using non –edible biomass

resources. On 11September 2014 NRL signed a memorandum of understanding (MoU) with a Finland based company M/S Chempolis Oy for carring out a feasibility study for production of ethanol from bamboo biomass.

Wind energy: Under a project sanctioned by MNES wind masts were installed in 30 sites in Assam. Data collection work under the project has been completed .The data collected is now being used for preparation of wind maps of Assam. The MNES sanctioned a wind monitoring project during 1995-96. Under this project sophisticated wind monitoring equipments were installed in five sites having good potential with an objective of assessing feasibility of putting up big energy big wind energy generators in these sites. Later in the year 1998-99 the MNES sanctioned a wind energy assessment project as attempt to enhance renewable energy sources in this area.

Table 7: Monthly wind speed at wind energy assessment project

Sites	**Monthly Wind Speed (KMPH)**
Telecom-tower, Guwahati	12.83
Muldam, N.C. Hills	17.2
Tolpoi, N.C. Hills	11.9
Khalimku, N.C. Hills	16.5
P-Leikul, N.C.Hills	17.1

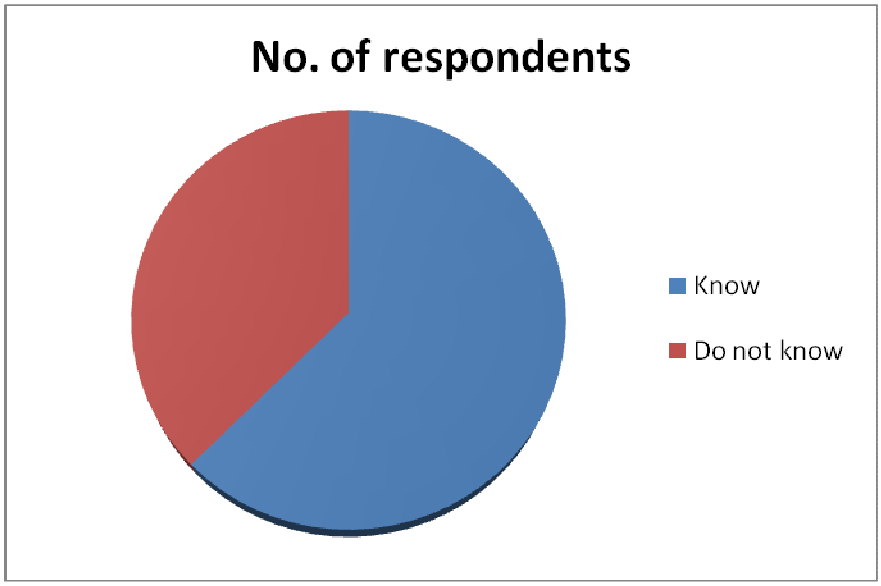
Another programme has been run by the MNES under which six wind generator cum battery charges of 1 KW capacity has been installed and commissioned at the six APRO Repeater stations viz Jalukbari, Bhubaneswari, Morianka (Kamrup District), Abhayapuri (Goalpara), Kamala Than (Nagaon) and Mahamaya peak (Karbi Anglong district). Besides a Wind Monitaring project at 25M Mast was sanctioned by the Ministry of Non-Conventional Energy Sources (MNES) at three locations, P-Leikul, Kalimkhu, and Tolopoi which is to be undertaken.

Findings: The study has attempted to identify the levels of public understanding and awareness of renewable energy sources. We purposefully took the literate section of our society as our sample to know the awareness level and behavioral pattern to conserve energy. For this purpose we framed a questionnaire to get the required data for the study. Their responses are analyzed below.

Findings on awareness of renewable energy

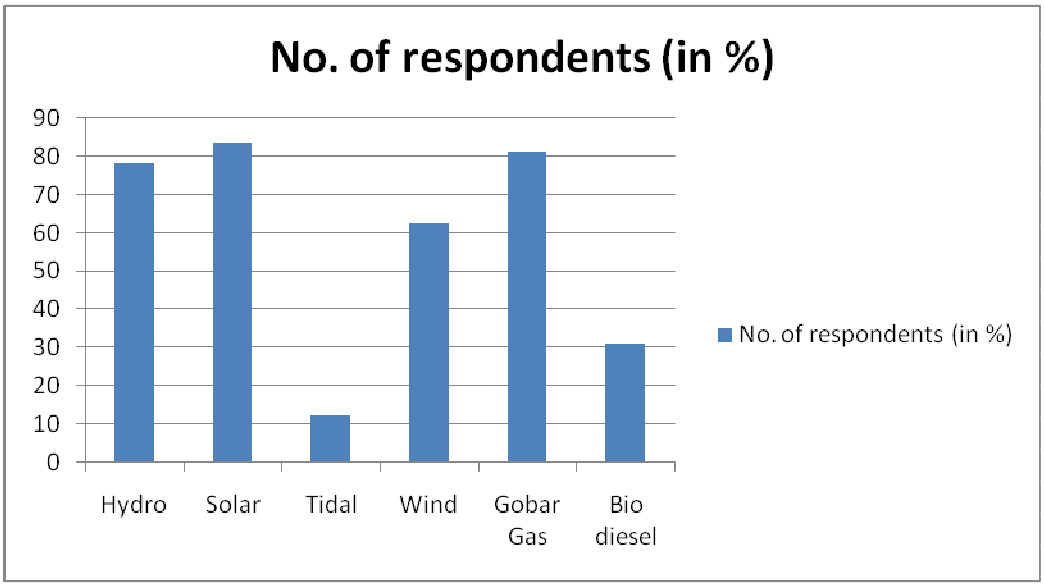
1. **Knowledge about the term renewable energy**: It was found that 62.5 percent respondents know the term renewable energy while 37.5 percent respondents do not know the meaning of the term.

Fig 1- Distribution of respondents according to their knowledge on renewable energy



2. **Knowledge about the sources of renewable energy**: to know the conception on renewable energy we had asked our respondents that what the sources of renewable energy are. 84 percent knows about solar energy, 81 percent knows about gobar gas, 78 percent knows about hydro energy and 62 percent knows about wind energy. But they are less aware about tidal, bio-diesel etc. It is found from our study that though some of the respondents were not familiar with the term renewable energy yet more than that (62.5%) knows the sources of renewable energy.

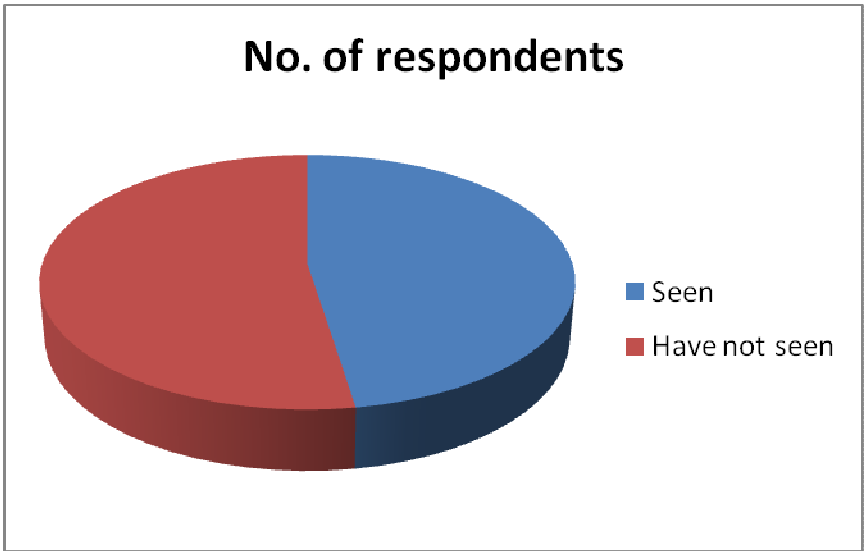
Fig 2- Number of respondents who have knowledge on different sources of energy (in %)



3. **Knowledge about renewable energy technology**: to know the level of awareness we asked them another question to the respondents "Have you seen any appliances of renewable energy

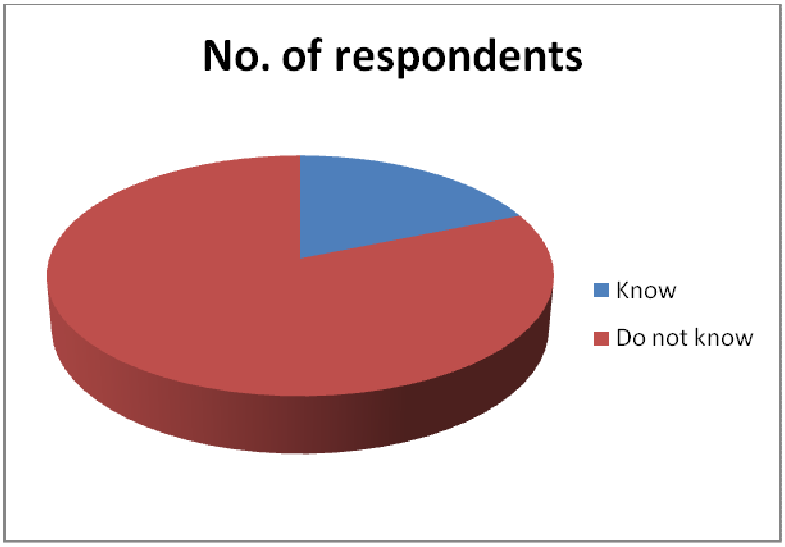
technology?". Out of total respondents 52 percent respondents have not seen any renewable energy technology. Only 48 percent said that they had seen appliances of renewable energy technology.

Fig 3- Respondents who have seen the appliances of Renewable energy



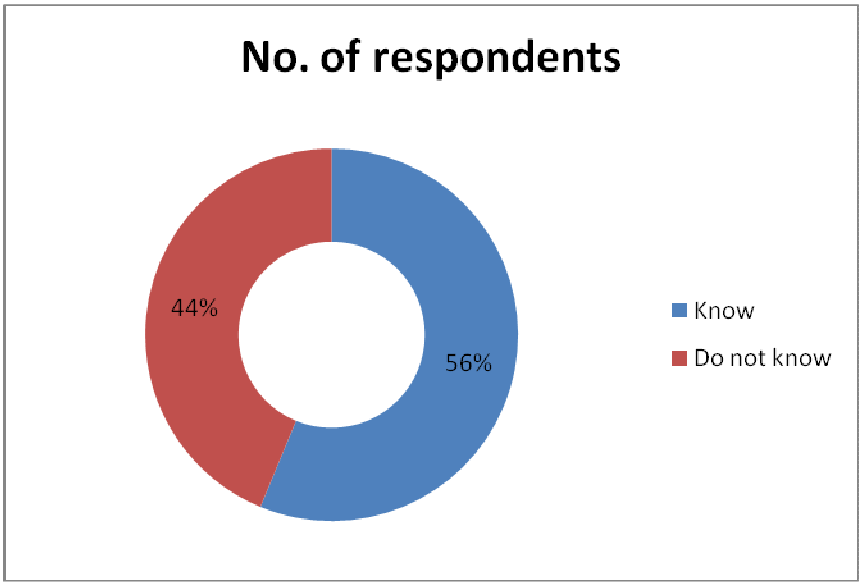
4. **Knowledge about the practical use of these technologies**: it was found that more than 81.25 percent respondents have no practical knowledge on these technologies. Only 18.75 percent respondents know the use of either solar or gobar gas technology.

Fig 4- Knowledge on the use of renewable energy technology



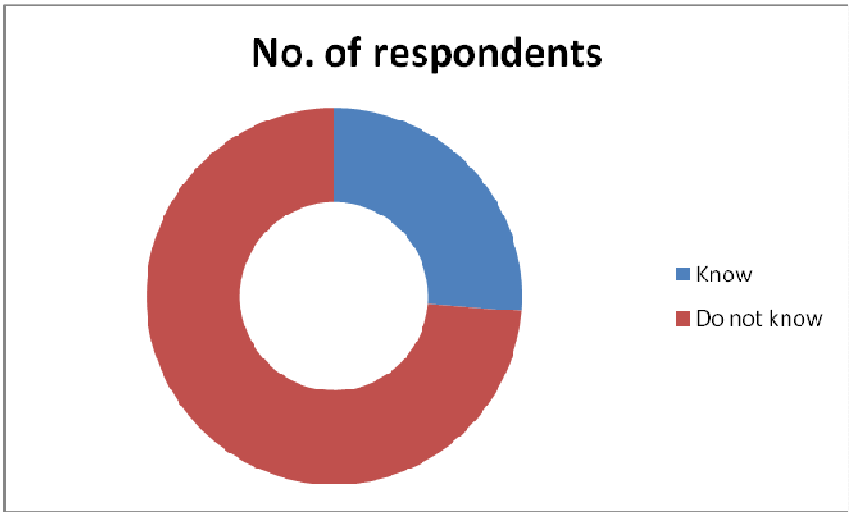
5. **Knowledge about the term bio-diesel**: the field study focused that 56 percent respondent had heard about the term bio diesel.

Fig 5- Knowledge on the term bio-diesel



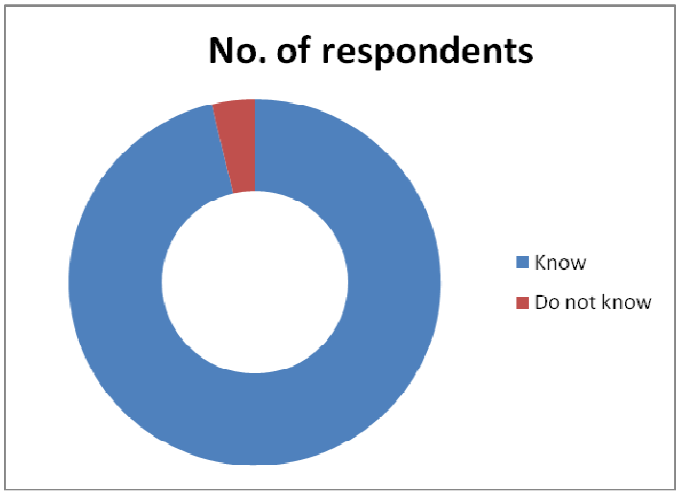
6. **Knowledge about the sources of bio-diesel**: To know the awareness level on this new source of energy respondents were further asked another question about the sources of bio diesel. Out of total respondents 25 percent respondents knows the sources of bio-diesel. Besides jetropha they expressed that sunflower and soyabean are the sources of bio-diesel.

Fig 6- Knowledge on the sources of bio-diesel



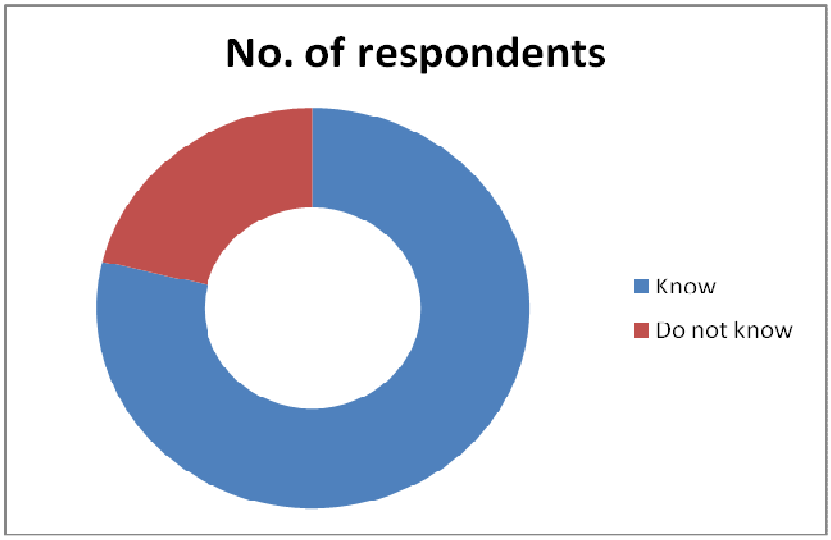
7. **Knowledge about the term bio-ethanol**: the entire respondent does not know the term bio-ethanol.
8. **Knowledge about the term Global Warming**: Almost 96 percent respondents know the term global warming.

Fig 7- Knowledge on Global Warming



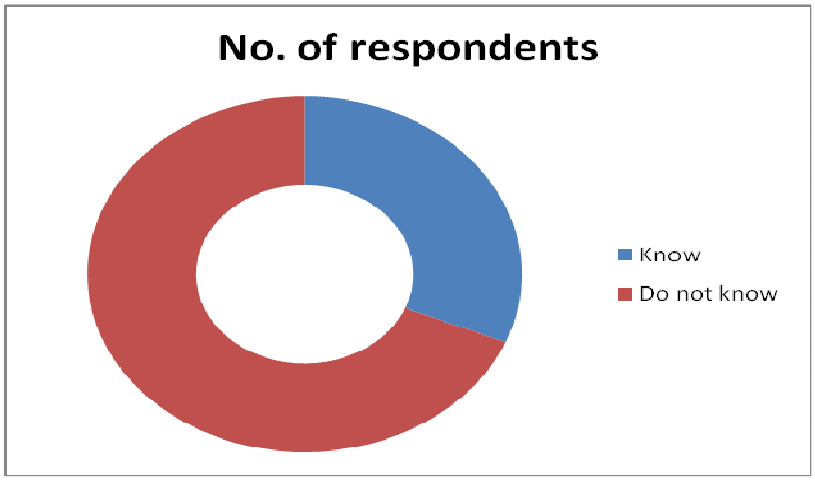
9. **Knowledge about the consequences pf global warming**: To know the level of awareness on global warming we had set another question in this regard. The question was "What are the consequences of global warming?". Out of total 77 respondents, who have knowledge about global warming, only 60 respondents know the consequences of global warming. They expressed that excess heat, melting the glacier, flood, draught, environmental sufferings, more ultra violet rays, temperature fluctuation, ecological imbalances, emission of carbon by machine and household equipments, green house effect, biodiversity degradation, rise in sea level , increase in temperature are the consequences of global warming.

Fig 8- Knowledge about the consequences of Global Warming



10. **Awareness on star rating of electrical goods**: To find out the awareness and understanding level on the renewable energy and to conserve energy the following question was asked to the respondent. The question was framed as "What the star rating of an electrical appliances indicates?" Only 31 percent of the whole sample knows that star rating of electrical goods indicates energy efficiency of the product.

Fig 10- Awareness on star rating of electrical goods



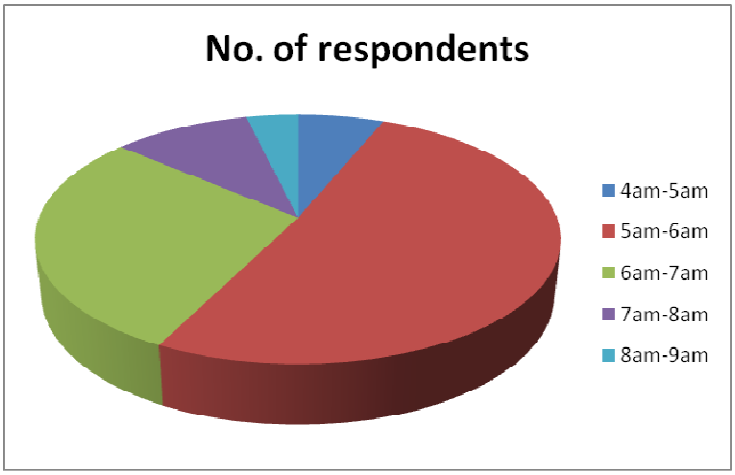
From the above analysis it is clear that awareness level among the respondent of general public is less. Out of ten parameters only six parameters show that awareness level of respondents on renewable energy is less. The following diagram depicts that the awareness level on renewable energy

Behavioral pattern of respondents to conserve energy:

Another objective of this paper is to find out the behavioral pattern of the respondent to conserve energy. For this purpose we have taken ten parameters. The findings are discussed below.

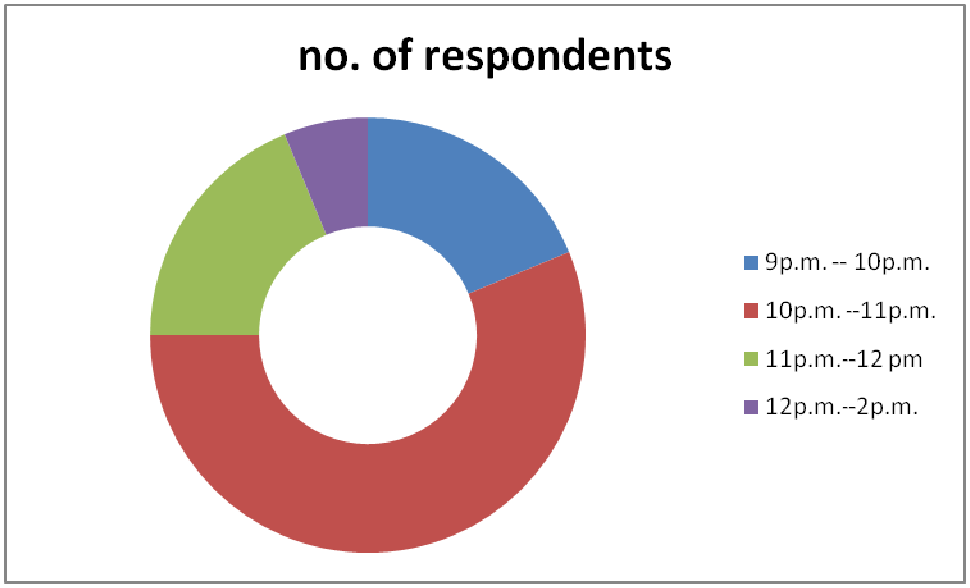
1) **Wake up time**: To know the behavioral pattern to conserve energy we want to study that the respondents use day time effectively or not. It is found that 56 percent respondent wake up in the morning before 6 a.m. As the study was done in winter season and particularly in the month of December so this behaviour of the respondent is determined as positive to conserve energy.

Fig 10- Distribution of respondents according to their wake up habit



2) **Bed time:** Similarly we try to find out how long in a day the energy is being used in the houses. It is found that 82 percent respondent go to bed after 10 p.m. On that ground energy (whether renewable or non-renewable) is very important for us.

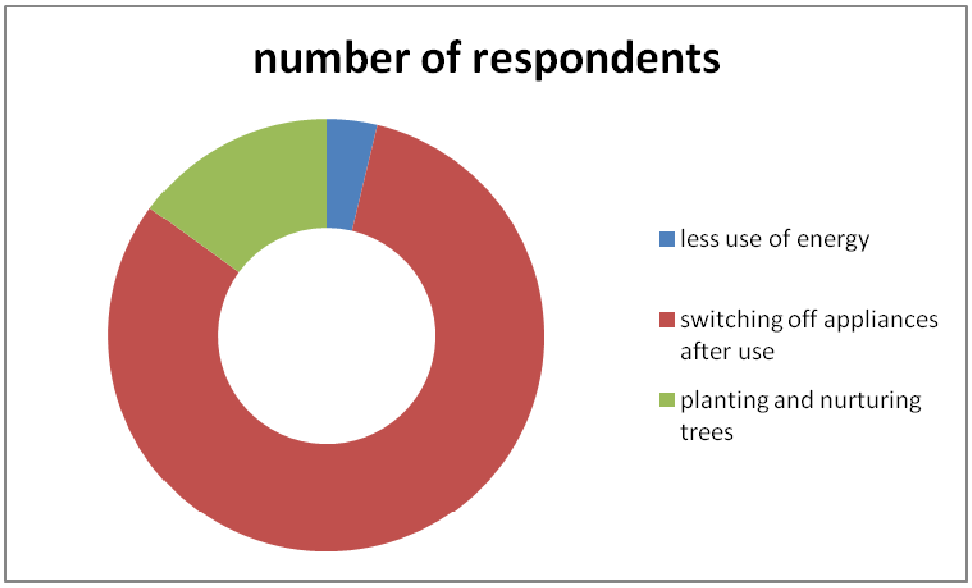
Fig.11: Distribution of respondents according to their bed time habit



Moreover 18 percent respondents go to bed after 11 a.m. It is proved that nowadays bed time of a family is determined not on climate but on other factors.

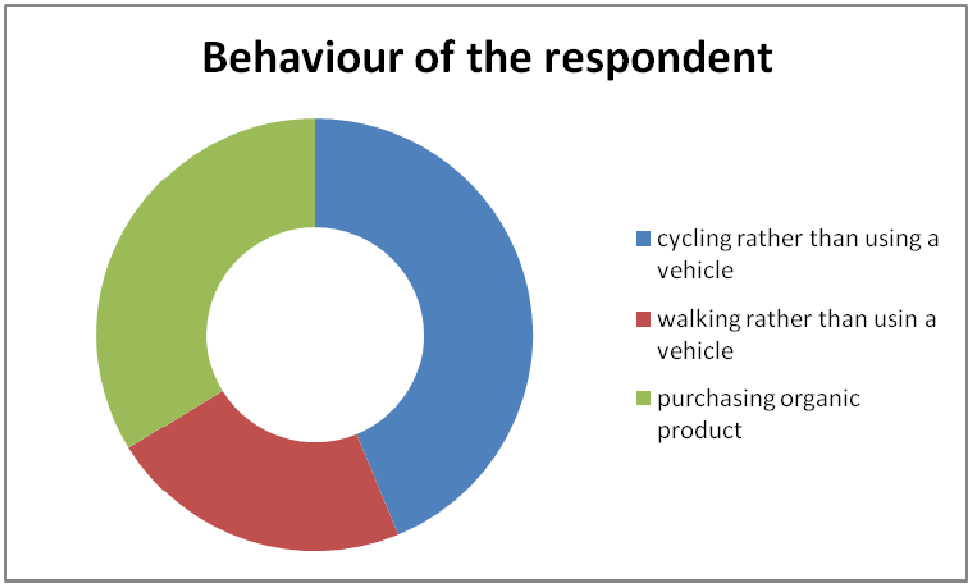
3) **Behavioural pattern that is most important to save energy:** We also enquired the respondents about the behaviour which is most important to save energy. For this purpose the following question was asked. “Which is the most important behavior to save energy? a) Less use of energy b) switching off appliances after use c) planting and nurturing trees” 81.25 percent respondents said that switching off the appliances after use is the best process to save energy. 15 percent respondents opined that planting and nurturing trees is most important to reduce the excess heat of the temperature. The remaining 3.75 percent said that less use of energy is important to save energy.

Fig.12: Behaviour pattern of the respondents which is most important to save energy



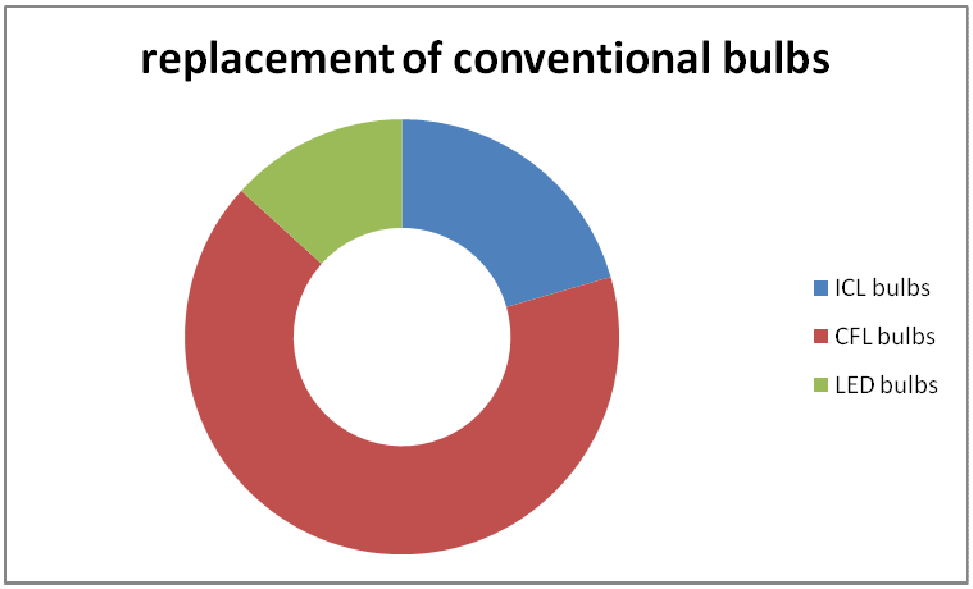
4) **Behavioural of the respondent to save energy:** Motor vehicles are the most important means of transportation for modern life style. So a question on the following options to save energy was asked a) cycling rather than using a vehicle b) walking rather than using a vehicle c) purchasing organic product. About 43.75 percent respondents said that they use cycle to save both money and energy. Similarly 21.25 percent respondents disclosed that they try to save money and energy by walking. The remaining 35 percent respondent said that due to scarcity of time they have no option of cycling or walking. As an effort to save energy they give preferences to purchase organic product.

Fig. 13: behaviour that are followed by the respondent to save energy



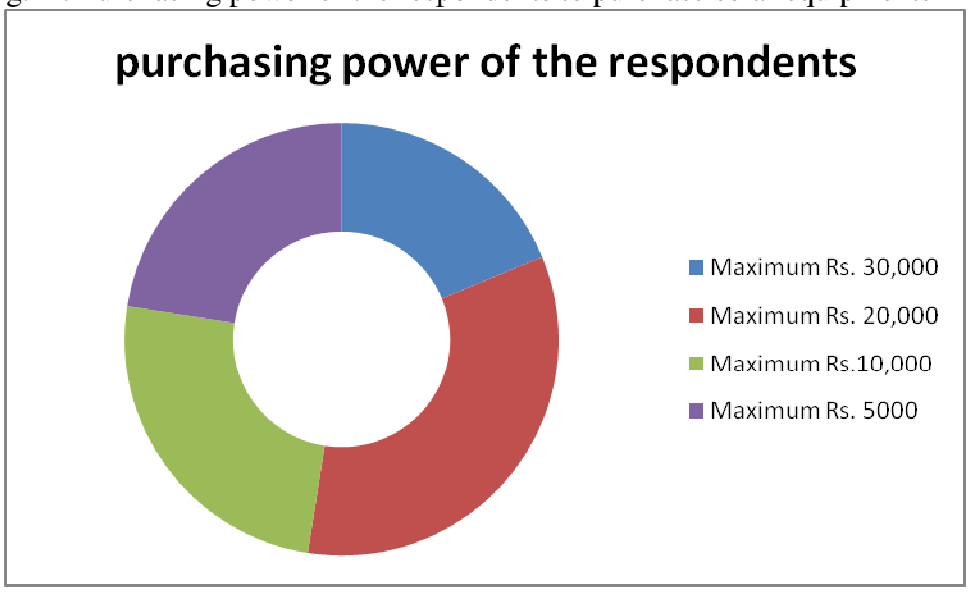
5) **Conservation of energy by replacing conventional (ICL) bulbs:** The questionnaire was framed in such a way so that we can get information on replacement of ICL bulbs with CFL/LED bulbs in respondent's house. It is found that 80 percent conventional bulbs were replaced by CFL/LED bulbs. It indicates that the respondent's family has a positive outlook in case of replacement of old more energy consuming bulbs.

Fig 14: Replacement of conventional bulbs



6) **Replacement of conventional ceiling fan:**Only 3.75 percent respondents replaced their conventional ceiling fan with energy efficiency (star rating)ceiling fan.
7) **Replacement of conventional tube light:** Only 2.5 percent respondents replaced their T12/T8 tube light with T5 tube light.
8) **Maintenance of temperature of AC:** 38 percent respondents know that maintaining temperature of AC at 25 degree centigrade will lead to least energy consumption. But no one tries to do so.
9) **Benefit of installation of Renewable energy technology**: 65 percent respondent perceived that installation of renewable energy technology in their houses will definitely reduce their electricity bill.
10) **Purchasing power:** More than 50 percent respondents opined that they can able to purchase solar equipments if the capital cost is at a range of Rs 20,000 to Rs 30,000. The details about the purchasing power of the sample are given below.

Fig.14: Purchasing power of the respondents to purchase solar equipments



From the above analysis it is found that out of 10 parameters taken for our study 6 parameters indicates positive behaviour of the respondent to conserve energy. Therefore it can be concluded that the public of the study area have a positive outlook to conserve energy.

Suggestions:

1. There is feasibility for harnessing solar power in Assam. Both the state and central government should formulate a policy to encourage setting up of small rooftop solar power plant to reduce the dependency on non renewable energy sources.
2. Assam possesses immense potential for development of power sector based on hydel power. Government should encourage to establish small hydro power through public private stackholders.
3. The government should introduce some hydropower policy which will promote private participation in development of small hydro projects through certain attractive incentives.
4. Biomass resources are abundantly available in the state. Residue from agriculture, forestry and plantations are the main source of biomass material in the state. So Government should formulate a policy to use these resources.
5. The climate of Assam is suitable for Jetropha cultivation. In remote areas waste land can be used for Jetropha cultivation.
6. Government and non Government organizations (NGOs) may organize awareness programme for the public both in rural and urban areas. These organizations may arrange different programmes such as cultural programmes, sensitization programme to use renewable energy technologies, demonstration of solar equipments, awareness programme on global warming and bio-diversity, pollution etc. Side by side statutory provision may be made for entrusting such responsibility to the retired persons (government service holder) of that locality.

Conclusion:

Assam faces more power shortages than all India level. The state has the potentiality to implement solar power plant to reduce the dependency on non-renewable energy resources. Similarly the hydroelectric potential available in the state is estimated at 12 million kw. Besides MNES has installed wind masts in 30 sites of Assam. As an effort to produce bio-diesel, Williamson Magor Bio-fuel Ltd has planted Jetropha curicus over 51000 hectres of land. Moreover NRL in Assam signed a memorandum of understanding with a foreign company for carrying out a feasibility study for production of ethanol from bamboo biomass. So it is seen that efforts were made to explore renewable energy sources in Assam.

Though efforts were made in government sector to use renewable energy resources yet it is found from our study that general public are less aware about this burning issue. This study reveals that the more than half of the respondents has the capacity to purchase solar equipment (at a cost of Rs.20,000—Rs. 30,000) yet none of them installed solar equipments in their houses. This indicates that solar equipment suppliers are not interested in this area. The important aspect of the study is that respondents have a positive behavior to conserve energy. So awareness camps should be organized by both government and private investor so that public can use renewable energy sources as a supplementary source of energy in urban areas and primary source of energy in remote areas. Then dependency on non-renewable sector can be minimized. Decentralized energy system based on renewable energy is the only alternative to our energy shortage problem. Renewable energy sources will provide solutions to our energy problems and side by side it will fight the growing menace of global warming and climatic change.

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