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Energy Crisis in Andaman and Nicobar Islands

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Abstract: Energy is considered as a crucial input parameter for day to day work and for economic development of a country. Per capita energy consumption is one of the key deciding factors of the level of well-being of any society for a country like India.. Energy is central to sustainable development and poverty reduction efforts. It affects all aspects of development - social, economic, and environmental - including livelihoods, access to water, agricultural productivity, health, population levels, education and gender-related issues. In Andaman and Nicobar Islands where 90 percent of the power is generated from diesel which costs Rs 12-14 per kWh unit, renewable are likely to be far more competitive, wind and small hydro will in fact be far cheaper than diesel-based power, we need to figure out if the island indeed has good potential for wind, solar, biomass and hydro, but then it is worth figuring this out soon. 250 kiloliters of diesel per day implies about Rs 450 crores of money down the drain every year, so allocating a few tens of crores to assess the potential of renewable and taking the first steps would make certain definite economic sense.. The Kalpong Project marks a major shift in the source of power generation at least in North and Middle Andaman. The renewable sources of energy will provide power at a cost many times cheaper in comparison to the present rates. In comparison to the our mainland the consumption of electric energy is more in magnitudes like in domestic consumption in Andaman it is 47.33% whereas in our main land it is only 22%,In commercial, here it is 26.32% where as there it is 8%. In the case of Agriculture sector in A&N islands it is only 0.45%where as there it is about 1.8%, at the last in Indsutry here it is, the power consumption is only of 5.47% whereas in mainland it about 15.78% , which makes a huge difference with the mainland in the year 2012. The cause may be over-consumption, aging infrastructure, choke point disruption or bottlenecks at oil refineries and port facilities that restrict fuel supply.

Keywords: Renewable sources of energy, kwh, Solar power, Ammonia Vapour, Temperature, OTEC, Per capita Consumption, etc

I. INTRODUCTION

The Andaman and Nicobar Islands have great maritime importance. During the British period political leaders considered dangerous to the interests of the Raj and other dreaded criminals were deported from mainland to the Cellular Jail- the Indian Bastille, situated on the sea coast of Atlanta Point in the North-Eastern part of Port Blair. Andaman & Nicobar predominantly depend on diesel for power generation; the island uses about 250 kiloliters of diesel every day for powering the population. [about 65 MW of power is generated everyday by diesel), so that puts the total installed capacity of electricity at about 70 MW. That gives a per capita installed capacity (taking the total population at 4 lacs) of 175 W, which is better than whole India’s per capita installed capacity of 125 W. Anyway, the point is the dependence on diesel over 90 percent; of power generation is diesel based. there is interesting potential in A&N for solar, wind, hydro, biomass and ocean power. Now, that’s cool. And while the caller complained that almost nothing had been in renewable, it appears that some work had indeed been done a total of 170 kW of solar PV had been established across 24 locations.[1].

Prior to Independence in 1932, a small steam driven reciprocating engine Direct Current (DC) generator of one hundred kW capacity was installed by the Britishers at Ross Island. After the departure of the Japanese occupation forces and British re-occupation in these islands in 1945, the power generation house was shifted from Ross Island to Atlanta Point, Port Blair and two 50 KW diesel engine driven DC generators were installed and commissioned. Only the bungalows and offices of the British were provided with electricity. After Indian Independence two steam turbine generating sets (Alternating current) of 550 KW each were commisioned in 1951 on the Chatham Island. The steam boilers were operating on wood waste & saw dust generated as by-products from the Chatham Saw Mill. Local mangrove wood available in plenty was also used as fuel.

Due to the geographical and topographical peculiarities of these islands, including separation by sea over great distances, there is no single power grid for all the electrified islands and instead separate power houses cater independently to the power requirements of separate Islands. At present there are 34 power houses with diesel generating sets of capacity ranging from 6KW to 250 KW and aggregate capacity of 68 MW. Round the clock power supply is available in South, Middle, North Andaman Islands, Neil Island Havelock Island, Long Island, Little Andaman Island, Car Nicobar Islands, Katchal Islands, Kamorta Islands, Campbell Bay and 16 Hrs power supply is provided in Chowra, Campion and Teressa Islands. M/s Suryachakra is operating a 20 MW DG Power House at south Andaman on PPA basis.

About 1133 Km of High Tension Lines, 2682 Km Low Tension Lines & 566 numbers of Distribution Transformers provide power supply to about 80990 consumers. The Annual per capita energy consumption of these islands is around 385 KWh as against the national average of 593 KWh due to every less industrial power requirement [2].

II. ENERGY RESOURCES

All the energy sources are divided into two groups- Renewable and Non- renewable (see fig.No1)..

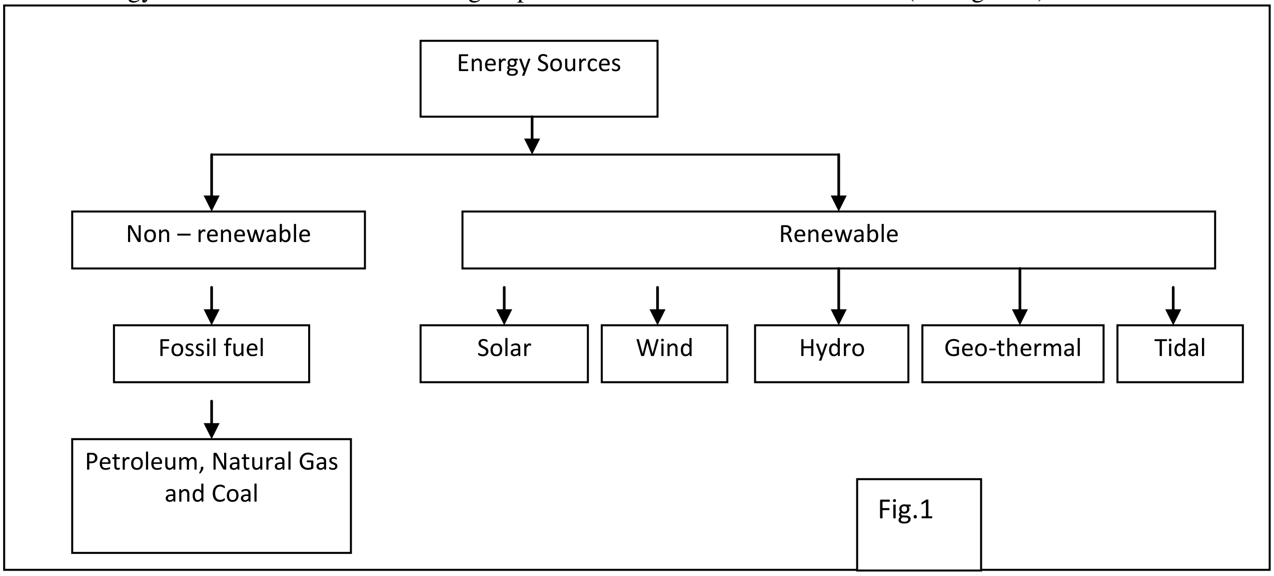

Fig.1

2.1 Factors for the Energy Crisis in Andaman

a) Migration of people from Pakistan through BanglashDesh to India Via West Bengal b) Purchase of Updated Ships and Boats from foreign Countries. c) Unturned Engines in Transports. d) Monopoly in the Manufacturing of Electric Power. e) Loss of Power through Transportation of Power through HighTension Lines. f) Energy crisis due to uneven supply of fuel for the production of Power in time. g) Large scale of theft of electricity: there is a large scale of that of electricity as clearly revealed by the growing difference between units generated. h) Wastage of energy by industrial sector: there is a huge wastage of energy by industry which consumes 30 % of the total electricity due to the less efficient system and other practices i) Over use of energy by transport sector: transport sector consume 28 % of the total energy. This over use of energy is due to the old and poorly tuned engines. j) Domestic wastage: Domestic wastage is about 45 % of the total electricity. Air conditioners and large scale illumination on different occasions. k) A crisis can develop due to industrial actions like union organized strikes and government embargoes. l) The cause may be over-consumption, aging infrastructure, choke point disruption or bottlenecks at oil refineries and port facilities that restrict fuel supply[3]. An emergency may emerge during unusually cold winters due to increased consumption of energy. m) Large fluctuations and manipulations in future derivatives can have a substantial impact on price. Large investment banks control 80% of oil derivatives as of May 2012, compared to 30% only a decade ago[4].

2.2 Hydro electric Project

This is one of the earliest known renewable energy sources. Hydro power is one of the best, cheapest, and cleanest sources of energy. The production of electricity using the energy of flow of water in rivers, small streams. The power plant with capacity greater than 25MW is called large hydel plant.
Theoretical formula for producing the power from a hydel project is as follows:

$$P=kdQgh$$

Where, P is the power in Watt, d is the density of water in kg/cubic meter, Q flow in cubic meter/sec, g is the acceleration due to gravity in m/second square, h in meter is the difference in height of the of the inlet and outlet water, and k is a dimensionless parameter whose value lie between 0 and 1; it determines the efficiency of the plant[5].

The Kalpong Hydro-Electric Power Project to the nation, the first ever in an island territory. The all-important power station, besides meeting the electricity needs, is destined to change the living standards of the people of North Andaman. The project generates about 14.83 million units of energy annually. This project provides 5.25 MW of additional capacity in the power system of North and Middle Andaman region. It will also partly operate as a base load station when the demand for power is at its peak. The capital, Port Blair, and its suburbs in South Andaman also depend on diesel generators for their electricity needs which run at a very high production cost of rupees nine per unit. On the other hand, the production cost of electricity from the Kalpong project is merely Rs. 1.89 per unit. Meanwhile, The solution to this problem perhaps lies in the optimum use of non-conventional energy sources such as solar, wind, tidal and bio-mass[6].

2.3 Solar and Solar Photovoltaic Energy systems:-

India is endowed with rich solar energy resource since it is located in the equatorial sun belt of the earth. Theoretically, India receives about 5000 trillion kWh solar radiations (power) with about 300 clear sunny days in a year. The daily average solar energy incident over India varies from 4 to 7 kWh/m^2 with about 2,300–3,200 sunshine hours per year[7]. Solar-powered devices are the most direct way to transform raw thermal energy into electricity. Installation of solar power plants require nearly 2.4 hectares (6 acres) land per MW capacity . 1.33 million MW capacity solar plants can be installed in India on its 1% land (32,000 square km). There are vast tracts of land suitable for solar power in all parts of India exceeding 8% of its total area which are unproductive barren and devoid of vegetation. 1% of 8294 sq.km vast land is 83 sq km , it has the capacity to generate .003MW of power, which could reduce consumption1-2 Rs per unit.
Part of waste lands (32,000 square km) when installed with solar power plants can produce 2000 billion Kwh of electricity (two times the total generation in the year 2013-14) with land productivity/yield of 1.5 million Rs per acre (6 Rs/kwh price). Moreover these solar power units are not dependent on supply of any raw material and are self productive.
In order to meet energy demand in remote and isolated islands where it was not feasible to establish DG power house solar photovoltaic energy system were establish at various location of these islands. A total of 35 Nos SP plants with aggregate capacity of 166.54 Kwp have been established at 24 different locations for providing 6 to 12 hrs of power supply for lighting homes and streets[8].
The theoretical equations for estimation of solar energy emitted from the surface of the sun.

$$T=\{S*r^2/\sigma R^2]^{1/4}$$

Where $S=1388 w/m^2$, $R=6.96*10^2$ m, $r=1.49*10$ 6 m , $\sigma=5.68*10^{-8}$, $T=5730$ K

2.4 Energy from the sea - Ocean thermal, tidal and wave energy :-

Large amounts of solar energy are stored in the oceans and seas. On an average, the 60 million square kilometer of the tropical seas absorb solar radiation equivalent to the heat content of 245 billion barrels of oil. Scientists feel that if this energy can be tapped a large source of energy will be available to the tropical countries and to other countries as well. The process of harnessing this energy is called OTEC (ocean thermal energy conversion). It uses the temperature differences between the surface of the ocean and the depths of about 1000m to operate a heat engine, which produces electric power[9].
The process of harnessing the thermal energy of the sea is called OTEC . The Pressurized ammonia is vaporized in an evaporator through which warm sea water flows. The resulting vapour is expanded through a turbine to generate electricity with the help of a generator . The cold water is transported to the surface from depths and is used to condense ammonia vapour through condenser. The ammonia condensed is pumped back to the evaporator through pump. The MNES, New Delhi way back in 1997 was considering establishing a 1 MW Wave Plant at Mus break water. Car Nicobar for exploiting the wave energy potential at that location.

2.5 Wind Energy:-

Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. The earth’s surface is made of different types of land and water. These surfaces absorb sun’s heat at different rates, giving rise to the differences in temperature and subsequently to winds. During the day, the air above the land gets heated up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, the winds are reversed because the air cools more rapidly over land than over water. In the same way, the large atmospheric winds that circle the earth are created because the land near the earth's equator is heated more by the sun than the land near the North and South Poles. The power available from wind is proportional to cube of the wind's speed. So as the speed of the wind falls, the amount of energy that can be received from it falls very rapidly. On the other hand, as the wind speed rises, so the amount of energy in it rises very rapidly. However, productive wind speed ranges between 4 m/sec to 35 m/sec. The minimum prescribed speed for optimal performance of a wind mill is about 6 m/s. Wind power potential of a place is mostly assessed considering wind power density higher than 200 W/m^2 at 50 m height.

A simple equation for the Power in the Wind is described below. This equation describes as the power found in a column of wind of a specific size moving at a particular velocity.

$$P = 1/2\ \rho\ \prod\ r2\ V3$$

Where, P = Power in the Wind (watts), ρ = Density of the Air (kg/m3), r = Radius of your swept area (m2), V = Wind Velocity (m/s), and ∏ = 3.14

About 10 nos wind masts for studying the potential of wind were installed at different location during 1993-99 for installation of suitable capacities of wind battery chargers, wind pumps and wind generators. It is observed that only one location namely Keating Point at Mus, car Nicobar is having the required average win speed for installation of a wind electric generator[10].

2.6 Bio-Energy

Bio-energy is an important form of renewable energy that is stored in biological material like wood, wood-waste, manure, straw and other-products of agricultural processes. Bio-energy in these sources can be converted and used to generate heat or electricity, or to produce transport fuel. The source of bio-energy is organic material – which refers to biomass, An alternative name for biomass used to produce bio energy is a “feedstock.” The main categories of feedstock are: oil seed crops, grains, sugar crops, and agricultural residues, trees, grasses, and algae. For example, fats and oils from oil seed crops, such as soybeans, can be directly converted to biodiesel using the processes of hydro-treating[11-14].

The carbon content of vegetation is surprisingly constant across a wide variety of tissue types and species. Schlesinger (1991) noted that C content of biomass is almost always found to be between 45 and 50% (by oven-dry mass).In many applications, the carbon content of vegetation may be estimated by simply taking a fraction of the biomass, say

$$C = .457 * B$$

Where, C is carbon content by mass, and B is oven-dry biomass.

III. RESULT AND DISCUSSION

India is marching towards achieving a desirable status of a developed country with rapid strides. Ensuring uninterrupted supply of energy to support economic and commercial activities is essential for sustainable economic growth. In true sense, sustainable development should be widely spread in all three dimensions - social, economic, and environmental.

In India the electric power production started with Coal, Diesel and Hydel power with the manufacturing capacities of 756, 98 and 508 MW respectively at the time of India’s independence whereas now these fuels are used to generate electric power at about 148478, 1200 and 40730 MW . Gas has been used to produce electric power from March-1966 at that time production magnitude was about 137 MW now it is 22,608 MW. The Nuclear energy is used to generate electric power in the year March 1974 and the magnitude was around 640MW now it is increased to 4780 MW(see table-1).

The total energy production since independence to march 2013 is raised from 4182 to 852,902 GWh and the per-capita consumption power has been increased from 16.3 to 917 kWh (see table-2).

A variety of power-generating systems are in operation in the Andaman and Nicobar A&N islands. Due to the physical separation of the islands across the Indian Ocean,most of the power-generating facilities operate independently. Because of the rural nature of the islands, solar, biomass, ocean, wind, and other renewable energy systems playa role in providing power to remote villages.There are 34 diesel-generator powerhouses scattered across the islands, providing a total capacity of about 40 MW. The generating stations produce 6 kW to 12.5 MW of power. There is also a 20-MW privately operated diesel power plant operating at BambooFlat, South Andaman Island.Since September 2001, the Kalpong Hydroelectric Power Project has provided 5.25 MW of additional capacity to the power grid of the North and Middle Andaman region. Diesel generator DG sets provided power to up to 92.5% of the population in the islands at South Andaman, Middle Andaman, Long Island, Neil Island, Havelock, LittleAndaman, Car Nicobar, Katchal, Kamorta, and Campbell Bay. At other locations, electric power is available for 5–16 hours per day through small DG powerhouses and solar PV power plants. Of 547 villages, 479 villages have electric power. This also describes the strategies to meet the necessary demand of power and steps taken to achieve sustainability. The Electricity Department is operating power generation, transmission and distribution systems & networks in these islands for providing electric power supply to the general public and various categories of consumers in different part of these islands(see table-3).

At about 1133 Km of High Tension Lines, 2682 Km Low Tension Lines & 566 numbers of Distribution Transformers provide power supply to about 80990 consumers. The Annual per capita energy consumption of these islands is around 385 KWh as against the national average of 593 KWh due to every less industrial power requirement. Energy Generation The total quantity of power generation in 1993-94 was 68.73 MU which increased 157.58 MU in 2003-04. It further increased to 200.92 MU in 2007- 08. The number of consumers also increased from 47170 during 1993-94 to 88990 in 2007-08.

Out of seven Union Territories , Andaman and Nicobar Island and Lakshadweep are only islands which are using Diesel as the only available source and are producing 60.05 MW and 9.97 MW of Electric power respectively, though these islands are surrounded its four sides with sea water and Andaman Nicobar island is one of the islands which is receiving maximum rain fall . In comparison to mainland the consumption of electric energy is more in magnitudes like in domestic consumption in Andaman it is 47.33% whereas in our main land it is only 22%,In commercial, here it

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Productive wind speed ranges between 4 m/sec to 35 m/sec. The minimum prescribed speed for optimal performance of a wind mill is about 6 m/s. Wind power potential of a place is mostly assessed considering wind power density higher than 200 W/m^2 at 50 m height. Andaman and Nicobar islands are left over with the open sea, hence it is receiving strong to mild winds throughout the year and the minimum height required to make a wind mill is only 50 m, whreras in this islands we do have saddle peak, it height is 732meters and Mount Thullier, its height is 642 meters from these two islands itself is sufficient to produce electricity. There are many possibilities , but the problem is with the Technology. (The production and distribution of electric power in this island is given in Table No.4)

Table 1.

Growth of installed Capacity in India[5]

Thermal (MW)					Nuclear (MW)	Renewable (MW)			Total (MW)	% Growth (on yearly basis)
Installed Capacity as on	Coal	Gas	Diesel	Sub-Total Thermal		Hydro	Other Renew-able	Sub-Total Renew able		
31-Dec-1947	756	-	98	854	-	508	-	508	1362	-
31-Dec-1950	1004	-	149	1153	-	560	-	560	1713	8.59%
31-Mar-1956	1597	-	228	1825	-	1061	-	1061	2886	13.04%
31-Mar-1961	2436	-	300	2736	-	1917	-	1917	4653	12.25%
31-Mar-1966	4417	137	352	4903	-	4124	-	4124	9027	18.80%
31-Mar-1974	8652	165	341	9058	640	6966	-	6966	16664	10.58%
31-Mar-1979	14875	168	164	15207	640	10833	-	10833	26680	12.02%
31-Mar-1985	26311	542	177	27030	1095	14460	-	14460	42585	9.94%
31-Mar-1990	41236	2343	165	43764	1565	18307	-	18307	63636	9.89%
31-Mar-1997	54154	6562	294	61010	2225	21658	902	22560	85795	4.94%
31-Mar-2002	62131	11163	1135	74429	2720	26269	1628	27897	105046	4.49%
31-Mar-2007	71121	13693	1202	86015	3900	34654	7760	42414	132329	5.19%
31-Mar-2012	112022	18381	1200	131603	4780	38990	24503	63493	199877	9.00%
30-Jun-2014	148478	22608	1200	172286	4780	40730	31692	72422	249488	10.35%

Table -2

Growth of Electricity consumption in India[5] in % of Total.

Consumption as on	Total (in GWh)	Domestic	Comme rcial	Industrial	Traction	Agri-culture	Misc	Per-Capita Consumption (in KWh)
31-Dec-1947	4,182	10.11%	4.26%	70.78%	6.62%	2.99%	5.24%	16.3
31-Dec-1950	5610	9.36%	5.51%	72.32%	5.49%	2.89%	4.44%	18.2
31-mar-1956	10150	9.20%	5.38%	74.03%	3.99%	3.11%	4.29%	30.9
31-mar-1961	16804	8.88%	5.05%	74.67%	2.70%	4.96%	3.75%	45.9
31-mar-1966	30455	7.73%	5.42%	74.19%	3.47%	6.21%	2.97%	73.9
31-mar-1974	55557	8.36%	5.38%	68.02%	2.76%	11.36%	4.13%	126.2
31-mar-1979	84005	9.02%	5.15%	64.81%	2.60%	14.32%	4.10%	171.6
31-mar-1985	124569	12.45%	5.57%	59.02%	2.31%	16.83%	3.83%	228.7
31-mar-1990	195098	15.16%	4.89%	51.45%	2.09%	22.58%	3.83%	329.2
31-mar-1997	315294	17.53%	5.56%	44.17%	2.09%	26.65%	4.01%	464.6
31-mar-2002	374670	21.27%	6.44%	42.57%	2.16%	21.80%	5.75%	671.9
31-mar-2007	525672	21.12%	7.65%	45.89%	2.05%	18.84%	4.45%	559.2
31-mar-2012	785194	22.00%	8.00%	45.00%	2.00%	18.00%	5.00%	883.6
31-mar-2013	852902	21.79%	8.33%	44.87%	1.81%	17.95%	5.25%	917.2

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Table:3

Union – Territory wise installed capacity										
	Thermal (MW)				Nuclear (MW)	Renewable (MW)			Total (MW)	% of National Installed Capacity
Union Territory	Coal	Gas	Diesel	Sub-Total Thermal		Hydro	Other Renew able	Sub-Total Renewable		
Delhi	4556.37	2116.01	-	6672.38	122.08	690.33	16.00	706.33	7500.79	3.21%
Chandigarh	32.54	15.32	-	47.86	8.84	52.88	-	52.88	109.58	0.05%
Puducherry	230.09	32.50	-	262.59	19.28	-	-	-	281.87	0.12%
Andaman & Nicobar	-	-	60.05	60.05	-	-	10.35	10.35	70.40	0.03%
Lakshadeep	-	-	9.97	9.97	-	-	-	-	9.97	0.00%
Dadra & Nagar Haveli	1622.35	196.91	-	1819.26	228.14	-	-	-	2047.40	0.88%
Daman & Diu	36.71	4.20	-	40.91	7.38	-	-	-	48.29	0.02%

Table-4

Power generating capacity in Andaman and Nicobar Islands		
No. Of Diesel Power Houses	35	6 KWh to 5000KWh
Hydro Power Station	01	5.25 MW
Power Transformer	27	44.77MVA
Distribution Transformers	436	50.609MVA
Consumers	700300	
Street Light	11000	
Percapita Consumption	250KWh	350KWh(National Level)
Villages	547	
Electrified Villages	479	
Villages covering 92.4%	311	24 h supply
Villages covering 2%	39	5-16 h supply
Villages covering 0.8%	18	5-12 h supply
Villages covering 2.3%	111	Street lights
Total Utilization	97.5%	Through all the Devices

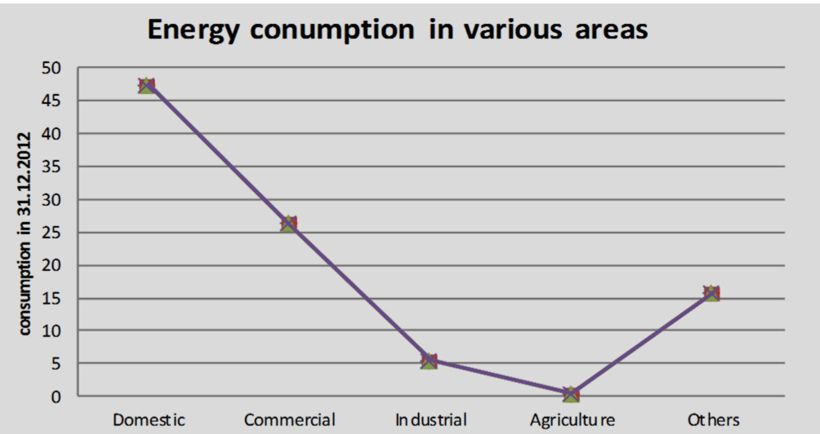

Fig. 2

IV. CONCLUSION

In a land where 90 percent of power is generated from diesel (which anyway costs Rs 12-14 per unit), renewable are likely to be far more competitive – wind and small hydro will in fact be far cheaper than diesel-based power. We need to figure out if the island indeed has good potential for wind, solar, biomass and hydro, but then it is worth figuring this out soon. 250 kiloliters of diesel per day implies about Rs 450 crores of money down the drain every year, so allocating a few tens of crores to assess the potential of renewable and taking the first steps appears to me to make definite economic sense. , The solution to this problem perhaps lies in the optimum use of non-conventional energy sources such as solar, wind, tidal and bio-mass. . Kalpong project, solar panels and windmills will light and delight to a large number of houses besides irrigation facilities in areas it is meant to serve. The Hon,ble goveror of Andaman directed the Electricity to use LED bulbs in all the Govt Buildings to save the power lose and to protect the Non-conventional sources of energy that are being used in Andaman and he also directed to disconnect the electric supply where AC are running in the peak hours. The solution to this problem perhaps lies in the optimum use of non-conventional energy sources such as solar, wind, tidal and bio-mass. . Kalpong project, solar panels and windmills will light and delight to a large number of houses besides irrigation facilities in areas it is meant to serve. At the last, The advanced scientific and technology mechanisms may be adopted to utilize the abundance renewable sources of energy which is cheaply available in Andaman will reduce the cost many times cheaper in comparison to the present rates . Hence forth, the ultimate goal of reduction of per-capita consumption rate would come to true.

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