Feasibility analysis of renewable energy options for the union territory of Lakshadweep Islands

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Abstract: The power generation of most islands depends mainly on costly oil. Since the cost of energy is very high so these are the best test place for the implementation of the new technologies. We have considered the case of Lakshadweep Island which is one of a union territory of India. In Lakshadweep electricity is mainly generated from diesel generator sets. In this paper, an investigation has been made to find out total available potential of solar, wind and biomass in five islands of union territory of Lakshadweep. If we start generating up to the available potential then some islands will become renewable islands and this will increase the reliability, employment and decreases the cost of energy generation and pollution. Pearl and Logistic models have been used to find out the growth rate of SPV power generation. Using these models we find out that in how many years we will achieve the total available potential. After this, we have proposed a model of hybrid energy power generation for Kavaratti Island. The simulations and techno-economic evaluations have been done with the help of hybrid optimisation model for electric renewables software. Thousands of simulations have been carried out to achieve an optimal autonomous system configuration, in terms of system net present cost and cost of energy.

Keywords: feasibility analysis; biomass; renewable energy potential; technology diffusion; NPC; net present cost; COE; cost of energy.

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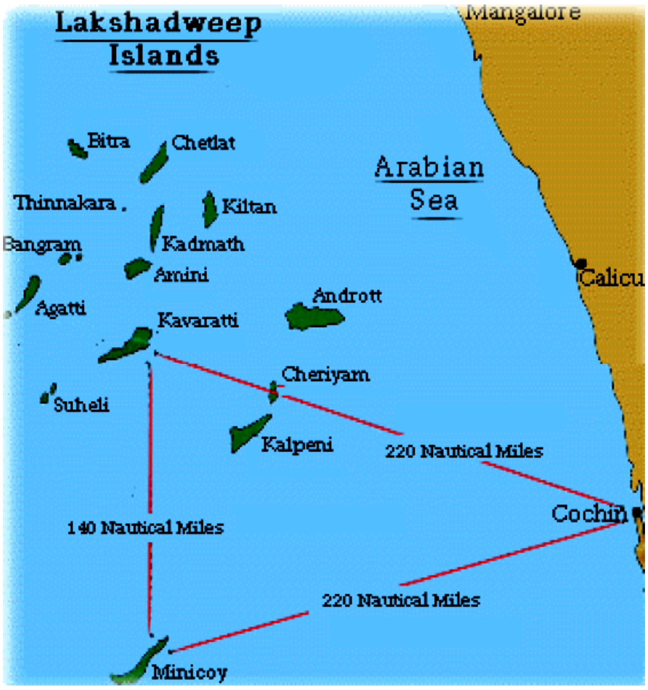
1 Introduction

The location of Union Territory of Lakshadweep (UTL) is in the Arabian Sea and it contains 36 small islands placed about 200–400 km from the South Indian western coastline latitude 81°15' N and 11°45' N and longitude 72°00' E and 74°00' E as shown in Figure 1. Population exists only in 10 Islands (Abid and Ansari, 2014). Only Androth and Kavaratti Islands have the area greater than 4 km^2 and the population more than 10,000 people and Kavaratti is the Capital of UTL. The climate of Lakshadweep is tropical and temperature ranges from 35°C to 22°C in summer and 32°C to 20°C in winter. The level of humidity is very high and ranges from 70–80% throughout the year. The rainfall is moderately around 1000 mm a year in the Island with mostly from the southwest rains (Ashraf et al., 2007). The structure and formation of Lakshadweep islands are the same and their tops are made up of coral reefs. The soil mainly contains coral limestone. The land has around 85% to 98% $CaCO_3$, which is not suitable for plantation (Ansari et al., 2016). Thus, these islands are not suitable for agricultural use. These islands suited only for coconut plantation and it is the main crop in the island. The unrealistic character of land setup in the islands previously was terminated in 1965 and landlords were changed to the occupant of the land. The major portion of the landholders (around 90%) at this time is less than 1.0 Hectare in size. It is very difficult for the administration to use these lands for other purposes because these lands belong to the local population (Kishore and Kishore, 2002).

The electricity generation from renewable energy sources is mainly from solar, wind and biomass energy. Other sources are also available like the thermal energy of the ocean but it is at immature levels and hence it cannot be applied commercially. Considering the energy demand and size of the islands, the Renewable Energy Source (RES) potential and its optimal use for five Islands namely Kavaratti, Kadmat, Kiltan, Androth and Agatti are investigated (Ansari et al., 2016).

Figure 1 Location of different Islands of UTL



2 Renewable energy potential in UTL

2.1 Potential solar energy

The average solar radiation over the islands is 4.032 kWh/m^2/day (Ashraf et al., 2007; Abid and Ansari, 2014). It shows vast potential available by the source. The lands have been taken on lease for 60 years fixed duration and SPV plants have been installed. To setup 100 kWp system those can operate 5–6 hours a day satisfactorily, 0.4 hectare land has been taken on lease and vacant for coconut trees (Cipriano, 2001). In 1970, the cost of PV Peak Watt was $100; during the 1980’s it decreased to $10 and at present, it is around $4 per peak watt installed. With bulk PV module production, progress in research and the development and the inclusion of governmental funding, the drops in price is expected which will boost the use of renewable energy resources (Albright, 2002; Ashraf et al., 2006a; Islam and Meade, 2006).

The main drawback in these Islands for solar-based technology is that it requires an excess land area for installing solar panels (Menicou et al., 2015). The problem becomes worse when most land is covered by dense forest on the island. Since the main plantation is coconut tree which is around 10–15 metres height hence roof tops of the houses are also covered. This requires clearing of trees around PV array because shadowing of a small portion of the array even for a shorter duration causing overloading of DG sets (Surry, 1997; Purohit and Michaelowa, 2007). Considering the above problem and growth rate of the population only 2.0 Hectares of land is available in Kavaratti Island for future installation. 100 kW SPV Installation at Kavaratti Island is shown in Figure 2. The predicted annual potential of SPV energy for Kavaratti Island is 1210.96 MWh. Considering the efficiencies of current systems and using the radiation level of solar, the monthly SPV potential for five islands are shown in Table 1.

Figure 2 100 kW SPV Installation at Kavaratti Island

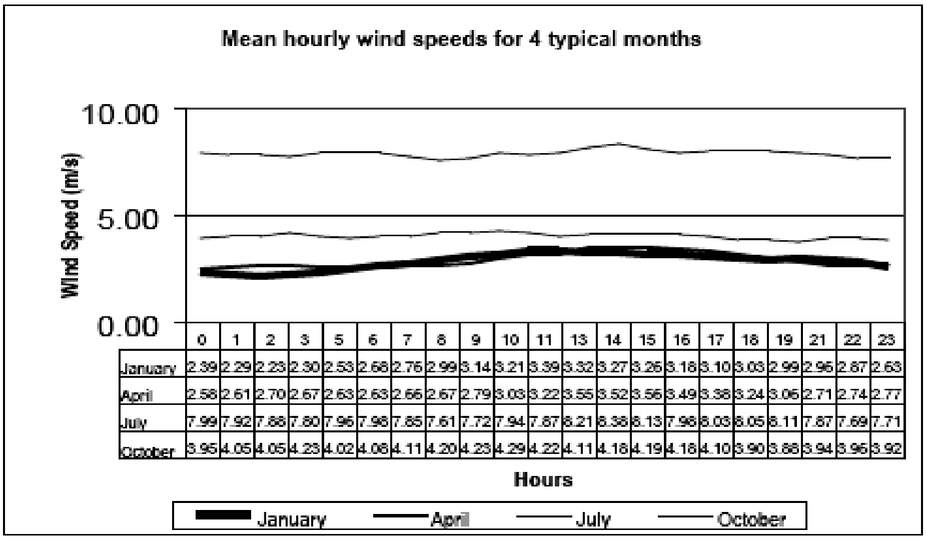
Table 1 Solar photo voltaic energy potential in kWh for five islands of UTL

Islands/Months	*Kavaratti*	*Kiltan*	*Kadmat*	*Agatti*	*Androth*
J	104,898.4	40,517.6	77,555.2	96,446.9	120,310
F	117,951.9	45,559.6	87,206.1	108,448.7	135,281.3
M	128,284.2	49,550.5	94,845.2	117,948.5	147,131.6
A	123,639.8	47,756.6	91,411.4	113,678.3	141,804.9
M	101,927.6	39,387.5	75,392.1	93,756.8	116,954.4
J	80,326.1	31,026.4	59,387.9	73,854.2	92,127.4
J	77,318.3	29,864.7	57,164.3	71,088.8	88,677.9
A	87,323.3	33,729.1	64,561.3	80,287.8	100,152.8
S	101,195.2	39,087.2	74,817.3	93,042.1	116,062.7
O	95,793.7	37,000.9	70,823.8	88,075.6	109,867.7
N	96,714.4	37,356.5	71,504.5	88,922.3	110,923.6
D	95,589.1	36,921.9	70,672.5	87,887.6	109,633.1
Total	1,210,962	467,758.6	89,5341.6	1,113,437.6	1,388,927.4

2.2 Wind energy potential

Among renewable energy sources, wind energy has a good potential apart from the solar PV system and that can be used for generation of electricity in the Lakshadweep Islands. Wind speed and solar radiation for the island depicts that the solar and wind resources complement each other. The matching behaviour of the month wise wind speed and solar fallout recommend that if we use a hybrid energy generation using wind, solar with DG sets then the reliability of the System will be very high (Ashraf et al., 2006b). The wind speed characteristics at UTL are shown in Figure 3. On the other hand, due to meagre transportation conveniences on the island, it is not allowed to unload more than 2 tons of machinery (Ashraf et al., 2008). Due to this condition on the heaviness the extreme capacity of a wind generator is limited to 80 kW; hence a large number of generators have to be connected. A wind farm requires a larger space which is a limitation again. One more significant issue is the must height, which requires being taller than the altitude of trees of coconut so that it can catch winds of adequate speed. Maintenance and operation of a wind generator was a major problem due to the unavailability of suppliers and manufacturers to provide servicing and spares. If we select wind generators on the basis of above facts then it should have less hub weight, the height of hub should be greater than 20 m and low maintenance (Duic and Carvalho, 2004). Furthermore, we can utilise wind power generation to its full capacity if the selected rated speed of wind generator is close to the average wind speed of the site where it has to be installed.

Figure 3 Wind speed characteristics at UTL



	0	1	2	3	5	6	7	8	9	10	11	13	14	15	16	17	18	19	21	22	23
January	2.39	2.29	2.23	2.30	2.53	2.68	2.76	2.99	3.14	3.21	3.39	3.32	3.27	3.26	3.18	3.10	3.03	2.99	2.96	2.87	2.63
April	2.58	2.61	2.70	2.67	2.63	2.63	2.66	2.67	2.79	3.03	3.22	3.55	3.52	3.56	3.49	3.38	3.24	3.06	2.71	2.74	2.77
July	7.99	7.92	7.88	7.80	7.96	7.98	7.85	7.61	7.72	7.94	7.87	8.21	8.38	8.13	7.98	8.03	8.05	8.11	7.87	7.69	7.71
October	3.95	4.05	4.05	4.23	4.02	4.06	4.11	4.20	4.23	4.29	4.22	4.11	4.18	4.19	4.18	4.10	3.90	3.88	3.94	3.96	3.92

The gap between wind turbines is 3–5 rotor widths apart in the vertical path to the main winds and 5–9 rotor widths apart in the direction of main winds. The rotor diameters would be around 15–20 m for turbines rated up to 60–100 kW. The length of the coastline in Kavaratti Island is around 8 km on the western side (the island is straight in figure with its bigger axis of about 6 m in the north-south direction). It is counterfeit that only one-fourth of this length is used for installing wind turbines and hence the number of turbines (20 m diameter) is limited to 20 to 30. Correspondingly, the figures of turbines that can be installed in other islands have been calculated roughly which comes out to be 20 to 30 (Mackay and Probert, 1998).

Due to inadequate data, it is considered that the wind profile is same for all the islands and the slow wind speeds of Minicoy Island shown above have been used for investigation so as to be conservative in the assessment. Considering less number of turbines and taking the example of a French turbine-Vergent GEV 15/60 that fulfils the above norms and overcomes the drawback, the wind energy potential for five Islands of UTL are shown in Table 2.

Table 2 Wind energy potential in kWh for five islands of UTL

Islands/months	*Kavaratti*	*Kiltan*	*Kadmat*	*Agatti*	*Androth*
J	42,134.8	14,747.2	42,134.8	31,601.1	42,134.8
F	35,318.9	12,361.6	35,318.9	26,489.2	35,318.9
M	23,422	8,197.7	23,422	17,566.5	23,422
A	34,079.7	11,927.9	34,079.7	25,559.7	34,079.7
M	58,988.8	20,646.1	58,988.8	44,241.6	58,988.8
J	281,683.8	98,589.3	281,683.8	211,262.8	281,683.8
J	276,850.7	96,897.7	276,850.7	207,638	276,850.7
A	246,488.8	86,271.7	246,488.8	184,886.6	246,488.8
S	128,139.5	44,848.8	128,139.5	96,104.6	128,139.5
O	40,895.6	14,313.5	40,895.6	30,671.7	40,895.6
N	41,639.1	14,573.7	41,639.1	31,229.4	41,639.1
D	29,618.3	10,366.4	29,618.3	22,213.7	29,618.3
Total	1,239,260	433,742	1,239,260	929,465	1,239,260

2.3 Potential of biomass energy

Coconut is the main economic yield of the province with yearly production of around 283 million nuts during 2001–2011. Copra and husk are the products of coconut and dried husk is used for fibre manufacturing. The coconut produces a huge amount of unused dried husk, shells, leaves or cadjinsn and sawmills biomass whose dumping is a big environmental issue. The availability of biomass and the basis for proposing the 250kW gasifier at Kavaratti is given below (Ashraf et al., 2007; Abid and Ansari, 2014).

1.	No. of coconut trees at Kavaratti	120,000
2.	Average coconut per tree per year	40
3.	Total coconuts per year	4,800,000
4.	Total husk per year	4,800,000
5.	Available biomass from husk @ 0.32kg/husk (tons)	1536
6.	Total shells per year	4,800,000
7.	Available biomass from shells@ 0.075kg/shell (tons)	360
8.	Average leaves per tree per year	12
9.	Total number of leaves per year	1,440,000
10.	Available biomass from leaves per year @ 2.0kg/cadjin (tons)	2880
11.	Available biomass from sawmill (tons)	50
	Total available biomass (tons)	4776

The requirement of Biomass for a 250 kW gasifier up to 6000 hrs operation (considering 250 days per annum) 6000 hrs × 350 kg = 2,100 tons (43.5% of total availability).

The above calculation has been done with this consideration that the 250 kW gasifier requires biomass of 350 kg per hour which corresponds to1.4 kg/kW.

The Kavaratti is the capital of UTL and it has around 120,000 coconut trees. biomass from coconut plantation is shown in Figure 4. The calculated amount of biomass in Kavaratti Island consisting of leaves, shells, dried husk and sawmills is 4,776 tons (Purohit and Kandpal, 2004). Its disposal will be a great environmental issue if it is not properly utilised. By gasification of solid waste, we can solve the environmental issue to a great extent. The gasifier installed in West Bengal of rating 500 kW at Chhotanollakhali Island Sunderban uses the gas product of these solid wastes which replaces the 75% of diesel. At part load the emission increases significantly in diesel as well as in dual fuel mode. A biomass gasifier of rating 250 kW consumes biomass around 350 kg per hour. The potential of biomass energy calculated for five Islands is shown in Table 3.

Figure 4 Biomass from Coconut Plantation

Table 3 Biomass energy potential in kWh for five islands of UTL

Island	*Coconut harvested*	*Available Biomass from Husk (tons)*	*Available Biomass from candjin (tons)*	*Available Biomass from shells (tons)*	*Total Available Biomass (tons)*	*Approximate annual Electricity generation potential (kWh)*
Agatti	2,800,000	896	1,680	210	2,786	796,000
Androth	4,390,000	1,405	2,638	329	4,368	1,248,000
Kadmat	3,540,000	1,133	2,124	266	3,522	1,006,000
Kavaratti	3,800,000	1,216	2,280	285	3,781	1,080,000
Kiltan	1,770,000	566	1,062	133	1,761	503,000

3 Comparative analysis

Comparative analysis of renewable energy potential at different islands from different sources that is solar, wind and biomass is shown in Figures 5–9. Figure 5 shows the renewable energy potential of Kavaratti Island. Figure 6 shows the renewable energy potential of Kiltan Island. Figure 7 shows the renewable energy potential of Kadmat Island. Figure 8 shows the renewable energy potential of Agatti Island. Figure 9 shows the renewable energy potential of Androth Island. From these figures, it is clearly shown that at all five islands maximum potential of wind energy is available in the months of June and July and least potential of wind energy is available in the month of December. At all five islands maximum solar energy potential is available in the months of March and April and least solar energy potential is available in the months of June and July. Total biomass energy potential is divided equally for each month.

Figure 5 Potential of renewable energy for Kavaratti Island

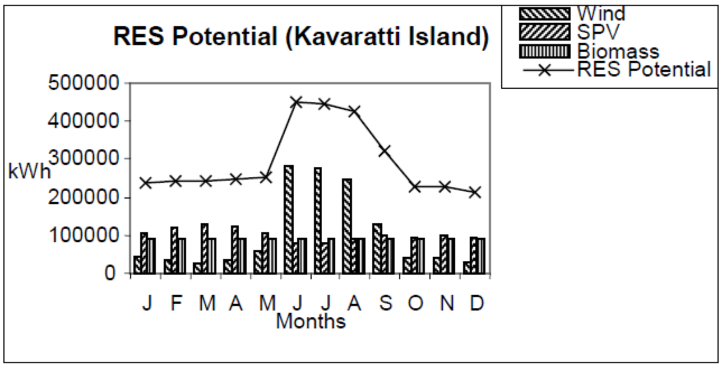


Figure 6 Potential of renewable energy for Kiltan Island

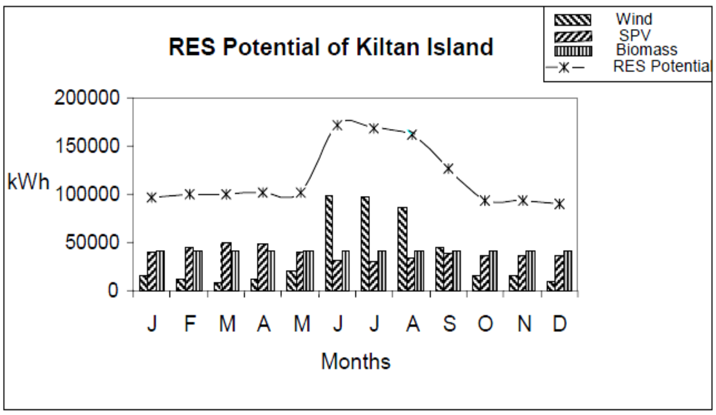


Figure 7 Potential of renewable energy for Kadmat Island

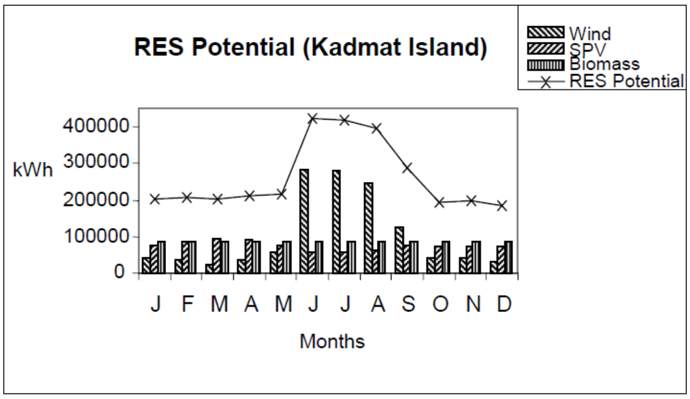


Figure 8 Potential of renewable energy for Agatti Island

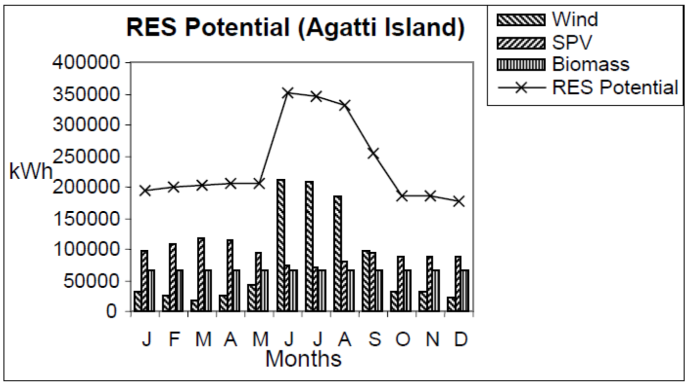
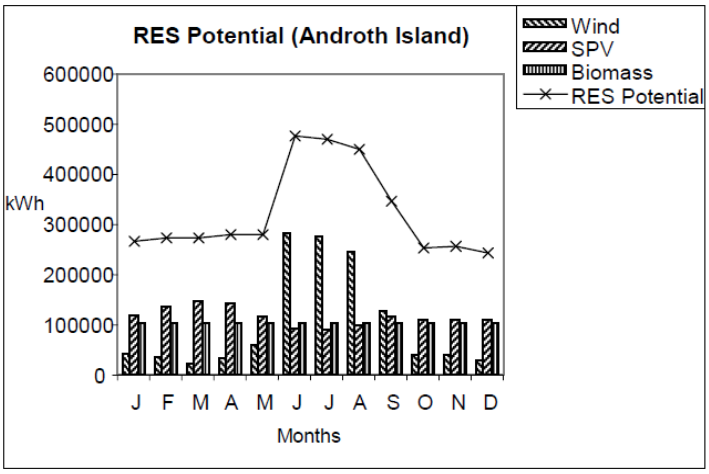


Figure 9 Potential of renewable energy for Androth Island



4 Technology diffusion models

4.1 Pearl model of technology diffusion

In this model, the cumulative number '$N(t)$' uses the given equations for the dissemination of the solar technology up to the *t*th year (with the coefficients *b* and *k* calculated from the previous data on the technology diffusion). The logistic dependability growth curve has an S-shaped curve and is given by Equation 1

$$N(t) = 1/\left(1 + be^{-kT_a}\right), b > 0, k > 0, T_a \geq 0 \tag{1}$$

The least squares estimators of the logistic growth curve parameters are:

$$\hat{b} = e^{\hat{b}_0} \tag{a}$$

$$\hat{k} = -\hat{b}_1 \tag{b}$$

where:

$$\hat{b}_1 = \sum_{i=0}^{N-1}(T_iY_i - N\overline{T}\overline{Y}) / \sum_{i=0}^{N-1}(T_i^2 - N\overline{T}^2) \tag{c}$$

$$\hat{b}_0 = \overline{Y} - \hat{b}_1\overline{T} \tag{d}$$

$$Y_i = \ln(1/R_i - 1) \tag{e}$$

$$\overline{Y} = 1/N.\sum_{i=0}^{N-1}Y_i \tag{f}$$

The results of Pearl model are shown in in Figure 10 and in Table 5.

Figure 10 Graph depicting the consumption of SPV power in UTL with respect to time using Pearl model

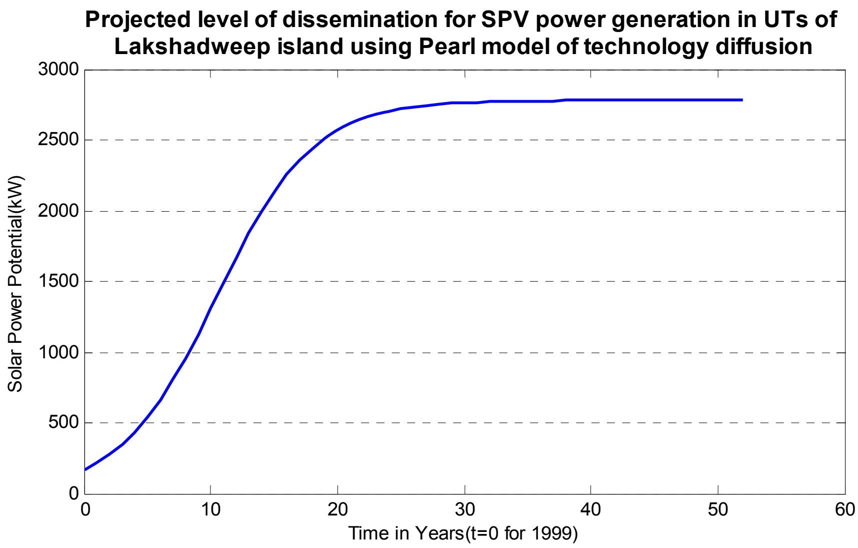


Table 4 Total yearly installed capacity of Solar Photo Voltaic Power Plant in the Islands of Lakshadweep (total SPV potential in UTL: 2780kW)

S.No.	*Year*	*Total capacity of plant (kW)*	*S.No.*	*Year*	*Total capacity of plant (kW)*
1	1999	35	11	2009	1,100
2	2000	235	12	2010	1,320
3	2001	235	13	2011	1,630
4	2002	685	14	2012	2,150
5	2003	685	15	2013	2,150
6	2004	835	16	2014	2,150
7	2005	900	17	2015	2,150
8	2006	900	18	2016	2,150
9	2007	900	19	2017	2,150
10	2008	900	20	2018	2,150

Table 5 Penetration of solar photovoltaic power in UTL with respect to time (Pearl Model)

Years	*Consumption of power(SPV) (kW)*	*Years*	*Consumption of power(SPV) (kW)*	*Years*	*Consumption of power(SPV) (kW)*
1999	0168.0	2016	2,358.6	2033	2,774.3
2000	0214.6	2017	2,444.2	2034	2,775.6
2001	0272.8	2018	2,514.3	2035	2,776.6
2002	0344.6	2019	2,571.1	2036	2,777.4
2003	0432.0	2020	2,616.5	2037	2,778.0
2004	0536.8	2021	2,652.6	2038	2,778.5
2005	0659.7	2022	2,681.0	2039	2,778.8
2006	0800.9	2023	2,703.2	2040	2,779.1
2007	0958.5	2024	2,720.6	2041	2,779.3
2008	1,129.5	2025	2,734.1	2042	2,779.5
2009	1,309.0	2026	2,744.5	2043	2,779.6
2010	1,491.3	2027	2,752.7	2044	2,779.7
2011	1,670.2	2028	2,758.9	2045	2,779.8
2012	1,839.9	2029	2,763.8	2046	2,779.8
2013	1,995.8	2030	2,767.5	2047	2,779.9
2014	2,134.9	2031	2,770.4	2048	2,779.9
2015	2,255.8	2032	2772.6	2049	2,780.0

4.2 Logistic model of technology diffusion

The independent variable, X is related to the rolling mean of a dependent variable, $P(\bar{Y})$ by the Logistic curve. The formula depicting the above relationship is represented by any of the equation given below:

$$P = \frac{e^{a+bX}}{1+e^{a+bX}} \tag{2}$$

$$P = \frac{1}{1+e^{-(a+bX)}} \tag{3}$$

where 1 is the probability of *P*, *e* is the natural logarithm base (about 2.718) and '*a*' and '*b*' are the model parameters. When *X* is zero, the value of '*a*' yields *P* and '*b*' adjusts very quickly and with changing *X* a single unit probability changes (just as in ordinary linear regression we can have the unstandardised and standardised *b* weights in logistic regression).

Now taking log on both the sides of Equation 2 we have

$$\ln\left(\frac{P}{1-P}\right) = a + bX \tag{4}$$

The Equation 2 given above can also be written as:

$$N(t) = \left[\frac{e^{(a+bt)}}{1+e^{(a+bt)}}\right] \tag{5}$$

where *M* is the total potential and the dissemination of renewable energy technology up to a particular period (*t*th year) is given by a cumulative number *N*(*t*). *a* and *b* are the coefficients of regression which are to be determined by a log-log form of a linear regression of Equation 5 as given below.

$$\ln\left[\frac{\frac{N(t)}{M}}{1-\frac{N(t)}{M}}\right] = a + bt \tag{6}$$

A least squares regression estimate of the growth rate will be produced with Equation 6 when excel functions SLOPE and INTERCEPT applied to data array from Equation 6. The results of Logistic model are shown in Figure 11 and in Table 6.

Figure 11 Graph depicting the consumption of SPV potential in UTL time (Logistic model)

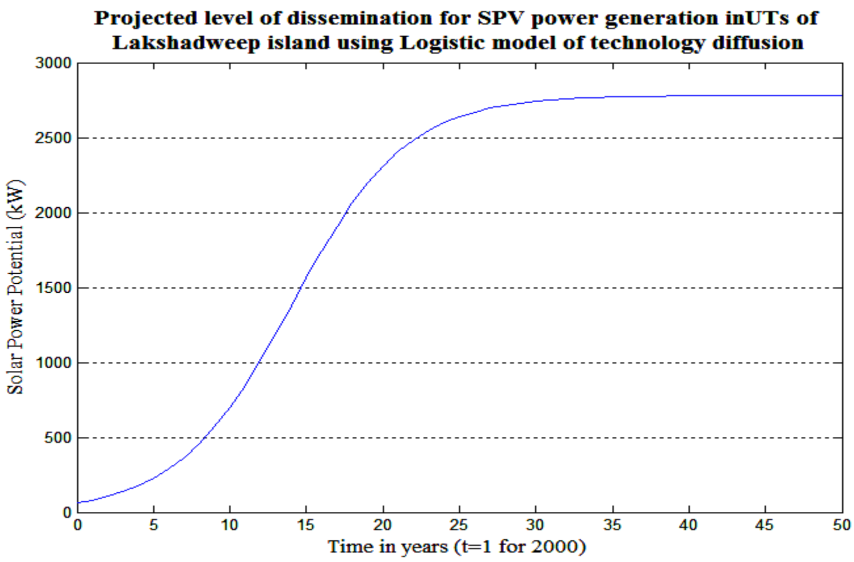


Table 6 Penetration of solar photovoltaic power in UTL with respect totime (Logistic Model)

Years	*Consumption of power (SPV) (kW)*	*Years*	*Consumption of power (SPV) (kW)*	*Years*	*Consumption of power (SPV) (kW)*
1999	62.9	2016	1,910.2	2033	2,766.7
2000	81.6	2017	2,061.8	2034	2,769.8
2001	105.7	2018	2,195.0	2035	2,772.2
2002	136.6	2019	2,309.2	2036	2,774.0
2003	175.9	2020	2,404.9	2037	2,775.4
2004	225.5	2021	2,483.6	2038	2,776.5
2005	287.6	2022	2,547.4	2039	2,777.3
2006	364.3	2023	2,598.5	2040	2,778.0
2007	457.8	2024	2,639.0	2041	2,778.4
2008	569.6	2025	2,670.8	2042	2,778.8
2009	700.5	2026	2,695.7	2043	2,779.1
2010	849.8	2027	2,715.0	2044	2,779.3
2011	1,015.5	2028	2,730.0	2045	2,779.5
2012	1,193.5	2029	2,741.6	2046	2,779.6
2013	1,378.3	2030	2,750.5	2047	2,779.7
2014	1,563.5	2031	2,757.4	2048	2,779.8
2015	1,742.7	2032	2,762.7	2049	2,779.8

5 Proposed hybrid model fo Kavaratti Island

5.1 Kavaratti Island profile

Kavaratti Island is the capital of the Union Territory of Lakshadweep. This island is situated at a distance of 404 km from Kochi and is located between Androth Island on the east and Agatti Island on the west. It lies between 10°32' and 10°35' N latitude and 72°35' and 72°40' E longitude, having an area of 4.22 square km. The maximum length of the island is 5.8 km and the width is 1.6 km with a lagoon having a length of about 6 km (Ansari et al., 2016).

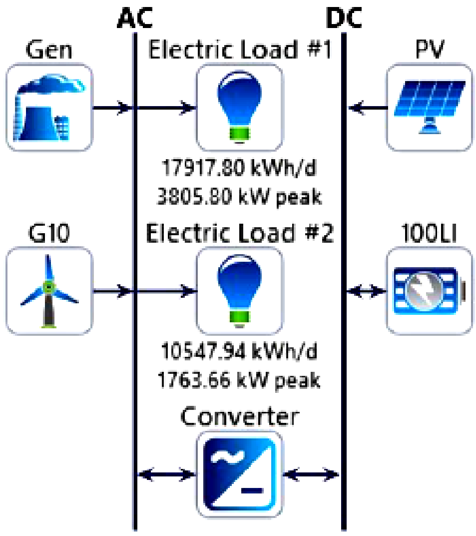
5.2 HOMER software

HOMER is a software tool used to analyse and design the hybrid energy system. The main three tasks which are performed by HOMER are simulations, optimisations and sensitivity analyses (Ma et al., 2014, 2015). HOMER models the performance of different integrated energy systems to investigate their techno-economic and environmental feasibility in the simulation process. While, in the process of optimisation, simulation of several system configurations is done to obtain the best optimal results that satisfying the technical constraints with lowest net present cost and cost of energy (Aziz et al., 2018).

5.3 System architecture

In Kavaratti Island, most of the energy is used to meet the domestic and industrial load only. Hence, I will consider only these two types of load in HOMER for simulation and optimisation. The proposed model shown in Figure 12 consists of diesel generators, wind turbines, solar PV, batteries, converters and loads.

Figure 12 Proposed system model



The annual energy consumptions of Kavaratti Island by the domestic and industrial load are 6.54MU and 3.85MU respectively in 2016. These data are provided by Government of India and Administration of UT of Lakshadweep. These data have been converted into daily energy consumption as 17917.8 kWh/day for domestic load and 10547.94 kWh/day for the industrial load. These daily data have been used by the HOMER for simulation and optimisation.

5.4 HOMER results

Total net present cost: $32,627,000.00

Levelised cost of energy ($/kWh): 0.246

6 Result and discussion

Table 1 shows solar photovoltaic energy potential in kWh for five islands of UTL that is for Kavaratti, Kitlan, kadmath, Agatti and Androth. From Table 1, it clear that maximum solar photovoltaic energy potential is available at Kavaratti Island and minimum solar photovoltaic energy potential is available at Kiltan Island. From Table 1, it is also clear that maximum solar potential is available in the month of March and April and minimum potential is available in the month of June and July.

Table 2 shows wind energy potential in kWh for five islands of UTL that for Kavaratti, Kiltan, Kadmath, Agatti and Androth. From Table 2, it is shown that the maximum wind energy potential is available in Kavaratti, Kadmat and Androth Islands and is available in the month of June and July and minimum wind energy potential is available in Kiltan Island and is available in the month of December.

Table 3 shows the biomass energy potential in kWh for five islands of UTL that is for Kavaratti, Kitlan, kadmath, Agatti and Androth. From Table 3, it is clear that maximum biomass energy potential is available in Androth Island and minimum biomass energy potential is available in Kiltan Island.

Table 4 shows the total yearly installed capacity of solar photovoltaic power plant in the Lakshadweep Islands considering only five islands mentioned above. Table 5 and Table 6 give the dissemination of SPV power generation in UTL with respect to time using Pearl Model and Logistic model, respectively. These tables show the growth rate of SPV power generation.

Figure 13 shows the optimisation and sensitivity results from HOMER. HOMER simulates the proposed model for thousands of combinations and gives the optimal result. The optimal solution given by HOMER includes PV, diesel generators, battery storage and converters. For this combination, the net present cost (NPC) is $32,627,000.00 and cost of energy (COE) is $0.246 which is minimum. For sensitivity analysis, I have considered fuel rate in dollars ($) and wind speed in m/s as variables. The above NPC and COE have been calculated for diesel rate $1 and wind speed 5.21m/s. Figure 14 and Table 7 shows the cost summary of NPC that includes capital cost, operating cost, replacement cost, salvage value and cost of resources. Out of these, capital cost is maximum and it is $22,000,000.00 which includes capital cost of Gen sets ($620,000), capital cost of Li-Ion batteries ($10,800,000.00), capital cost of PV ($9,640,000.00) and capital cost of converters ($1,010,000.00).

Figure 13 HOMER sensitivity and optimisation result

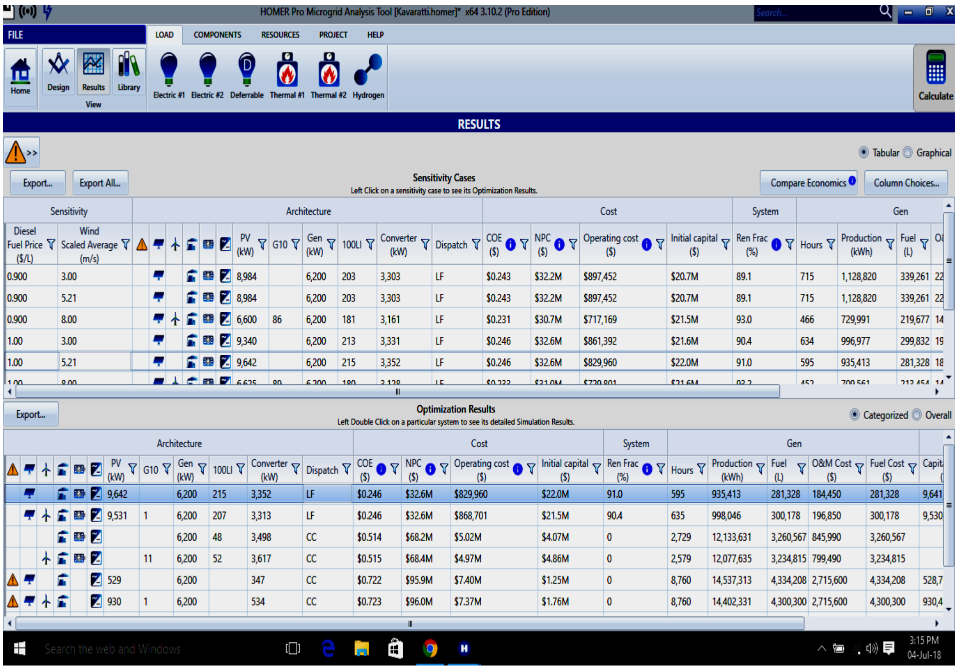


Figure 14 Cost summary

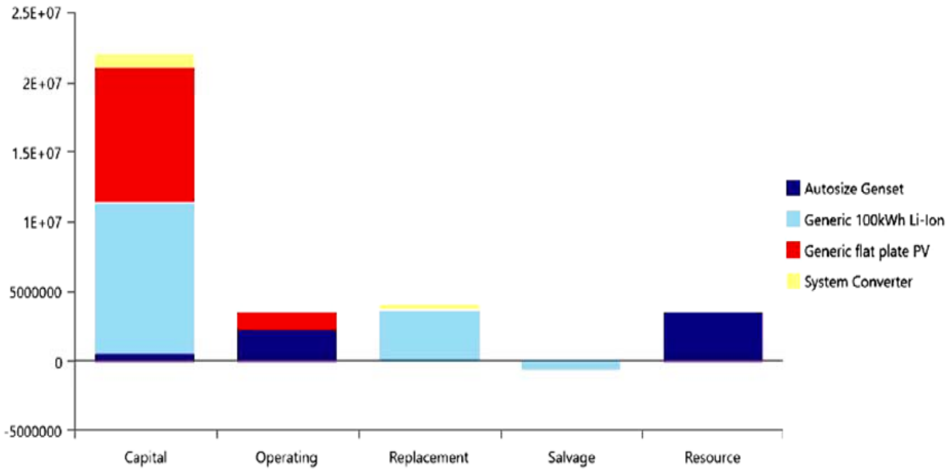


Table 7 Net present costs

Name	Capital	Operating	Replacement	Salvage	Resource	Total
Autosize Genset	$620,000	$2.36M	$0.00	-$1,204	$3.60M	$6.57M
Generic 100kWh Li-Ion	$10.8M	$27,484	$3.65M	-$598,137	$0.00	$13.8M
Generic flat plate PV	$9.64M	$1.23M	$0.00	$0.00	$0.00	$10.9M
System Converter	$1.01M	$0.00	$419,641	-$78,109	$0.00	$1.35M
System	$22.0M	$3.62M	$4.07M	-$677,450	$3.60M	$32.6M

7 Conclusion

From the above investigations, it is clear that the union territory of Lakshadweep Island has the vast potential of solar, wind and biomass energy. Till now the energy generation from these renewable energy sources is very less but if we start generating up to or very close to the available renewable energy potential then the use of diesel will be reduced to a great extent which reduces the cost of energy generation and carbon emission. In this work two models, Pearl and Logistic have been used to determine the projected level of dissemination for SPV power generation in Union Territory of Lakshadweep Island. Using these models of technology diffusion, it is observed that the total available potential will be achieved in around the next 25 years. HOMER software has been used for optimisation and sensitivity analysis of the proposed model. From the study of Lakshadweep Island, a hybrid energy system consisting of solar PV, diesel generators for emergency power supply and batteries for the backup will provide 24-hour electric supply to every household in the island at the unit cost of $0.246/kWh. The result also showed that the proposed hybrid power system with battery storage is a practical and cost-effective solution for this island.

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