

## Growth and Development of Entrepreneurship in Renewable Energy Sector of Nepal

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### Abstract

*This paper assesses the growth and development of entrepreneurship in a renewable energy sector of Nepal. The study adopts descriptive cum analytical research design. The required secondary data covering a period of 42 years of biogas sector, 25 years of solar sector, and 55 years of micro-hydro sector leading to a total of 122 observations were collected. They were related to energy mix, number of households, number of renewable energy systems installations, and renewable energy enterprises (REEs) for this study. This study has adopted percentage changes over the period, structure, pattern, and trends by development regions and periodic development plans for analyzing the data. The results show that manifold increase from 1992/93 to 2016/17 though the growth has slowed down in recent years. The results indicated that with the increase in GDP, population and number of households, there was an increase in the number of REEs, biogas companies, solar companies and micro-hydro construction companies. In addition, the results on number and capacity of renewable energy systems installed by development regions and by periodic development plans showed that the growth and development of renewable energy sector was encouraging throughout the country and over the period. This study is useful for renewable energy enterprises (REEs), development actors in the sector, academia, and policy makers. The study can be extended by incorporating other sectors of renewable energy such as, improved cooking stove, wind technology and biomass sectors to get greater insight into the results.*

**Keywords:** Biogas, entrepreneurship, growth and development, renewable energy enterprises, solar

### 1. Introduction

The entrepreneurship is regarded as the major contributor in building and sustaining economic growth. It is related to the process of generating new enterprise (Sharma, 2008). The entrepreneurial essence is seen as the engine of economic growth and development (Agarwal, 2003 and Sigdel, 2015). Entrepreneurship deals with opportunities over threats (Krueger, Reilly, & Carsrud, 2000). Wakkee *et al.* (2015) found that growth path used by small and medium enterprises (SMEs) is market penetration through increasing efficiency. Entrepreneurship though looks a simple term is highly encompassing. Entrepreneurship may generate thousands of new enterprises which can serve as the driving force for economic development in Nepal. The sustainable economic development depends upon goods and services produced in the country rather than remittances-based economy in Nepal. Due to acute unemployment situation in Nepal, about 1,800 youths have been departing abroad day by day for employment. The economy of the country has gone remittances-based economy. As a proportion of GDP, Nepal is the highest recipients of remittances (31.3 percent) in the world followed by Kyrgyzstan (30.4 percent) and Tajikistan (26.9 percent) in 2016 (Desilver, 2018). In these circumstances, entrepreneurship can generate employment locally and convert remittances-based economy into sustainable economy.

Furthermore, Pokharel (2006) highlighted the importance of renewable energy sector by indicating that sustainable development can be possible by creating enterprises on renewable energy technologies. The scheme like access to clean energy through rural

electrification scheme is considered as important especially for Nepal as it has created rural entrepreneurship, marketing innovations and social responsibility, with opportunities to develop other product/service areas powered by electricity (Pandey, 2009). AEPC (2011) revealed that 50 percent higher income to electrified households from small business while upon electrification, prospect of starting such business increases by 5 percent. Likewise, livestock income was higher by Rs. 2600 for electrified households compared to non-electrified households. According to AEPC/ESAP (2010), solar home system was likely to increase the probability of initiating small business by 3 percent. It also showed that the monthly income was 60 percent higher than the average income from small business for non-users of solar home system.

A study by Karki, Shrestha, Bajgain, and Sharma (2009) revealed that the role biogas for national development along with loan and subsidy for promotion of biogas in case of Nepal. The study showed that the subsidy scheme encouraged farmers to install biogas plants. Similarly, financing of the biogas plants is the most important part, since the decisions to invest in a new project necessitates its financing. Affordable financing is a key element in the promotion of biogas plants.

According to Ministry of Finance (MoF, 2016), Nepal's energy mix comprises firewood (50 percent) petroleum products (38 percent), cow dung (3 percent), renewable (3 percent), agricultural residues (2 percent), coal (2 percent) and electricity (2 percent). All commercial fossil fuels (mainly petroleum products and coal) are imported from abroad. Fuel imports absorb over one-fourth of Nepal's foreign exchange earnings (USAID SARI, 2012). Only about 2 percent energy need is fulfilled by electricity. Inconsistently, the recurrent nature of Nepali rivers and the vertical slope of the country's geography provide ideal conditions for the development of the largest hydropower projects in Nepal. It is estimated that Nepal has economically feasible hydropower projects having potential of nearly 83,000 MW (MoWR, 1997). However, Nepal currently has been able to exploit only about 847.68 MW against the current demand of 1,385 MW (MoF, 2016). Even though Nepal is importing 250 MW from India, there is huge gap between the energy demand and supply resulting in long hour-load shedding subsequently affecting the life of the people and the overall economy (MoF, 2016). Even in this situation there is a great discrepancy between urban and rural areas. There is 90 percent electrification in urban areas while it is only 5 percent in rural areas (USAID SARI, 2012).

Among others, there is scattered and sparse settlement pattern in Nepal having diversified structure of land from plains to high Himalayas. It means the supply of electricity is not feasible from national grid in some places. In these circumstances, the renewable energy is one of the feasible option to fulfil energy need gap of the country.

The above discussion shows that the studies dealing with the and development of entrepreneurship in renewable energy sector of Nepal are of greater significance. Thus, the purpose of this study is to assess the growth and development of entrepreneurship in renewable energy sector of Nepal. This study, therefore, deals with the following issues in the context of Nepalese renewable energy sector: What is the structure and pattern of growth and development of renewable energy sector? More specifically, what is the growth in the number of companies, number of systems installed, and capacity of systems installed in biogas, solar and micro hydro sectors across the developmental regions and the development plans?

## 2. Materials and Methods

The study adopts descriptive cum analytical research design. The study is based on fact finding operation searching for adequate information on the growth and development of entrepreneurship in the renewable energy sector of Nepal.

This study is based on the secondary data only. The required national level secondary data covering a period of 42 years of biogas sector, 25 years of solar sector, and 55 years of micro-hydro sector were collected for this study. The secondary data contained the information on growth and development of the renewable energy sector in Nepal. The secondary data on energy mix, number of households, number of renewable energy systems installations, renewable energy enterprises (REEs) and other related data were collected from the annual reports of Alternative Energy Promotion Centre (AEPC), Biogas Sector partnership Nepal (BSP-Nepal), Solar Electric Manufacturers’ Association, Nepal (SEMAN), Nepal Micro-hydro Power Development Association (NMHDA), Statistical Yearbook of Central Bureau of Statistics and Economic Survey of Nepal.

The national level secondary data were collected for biogas sector from 1975/76 to 2016/17, solar sector from 1992/93 to 2016/17 and micro-hydro sector from 1962/63 to 2016/17 as shown in Table 1. The study was based on 42 observations for biogas sector, 25 observations for solar sector and 55 observations for micro-hydro sector leading to a total of 122 observations for analysis of growth and development of the renewable energy sector by development regions and periodic development plans.

**Table 1:** Study period and number of observations for biogas, solar and micro-hydro sectors selected for the study

SN	Sectors	Study-period	Observations
1	Biogas Sector	1975/76 to 2016/17	42
2	Solar Sector	1992/93 to 2016/17	25
3	Micro-hydro Sector	1962/63 to 2016/17	55
Number of observations selected for the study			122

**Source:** NRREP Baseline Part B: Baseline of Renewable Energy Technology Installations in Nepal 2013, Alternative Energy Promotion Centre (AEPC), Ministry of Science, Technology and Environment, Government of Nepal; and Annual report of AEPC, various issues

This study has adopted percentage changes over the period, pattern, and trends to analyze growth and development of entrepreneurship in renewable energy sector of Nepal.

### 3. Results and Discussion

In this section, an attempt was made to analyze the growth and development of entrepreneurship in renewable energy sector of Nepal. Table 2 shows the structure and pattern of biogas companies, solar companies, micro-hydro construction companies, biogas systems installed, solar home systems installed, and micro-hydro systems installed in Nepal from 1992/93 to 2016/17.

As is evident, the number of biogas companies increased from one in 1992/93 to 16 in 1995/96 to 120 in 2016/17, the increase being 7.5 times over 1995/96. The percentage change in number of biogas companies over the last year fluctuated far and wide over a period of 1992/93 to 2016/17. Similarly, the number of solar companies increased from 11 in 2000/01 to 105 in 2016/17, the increase being 9.5 times. The percentage change in number of solar companies over the last year varied from zero to 69 percent. Likewise, the number of micro-hydro construction companies increased from 15 in 2000/01 to 78 in 2016/17, the increase being 5.2 times. The percentage change in the number of micro-hydro construction companies over the last year fluctuated far and wide over time.

The number of biogas systems installed increased from 3,318 in 1992/93 to 31,765 in 2013/14 which declined to 15,707 in 2016/17, the decrease being about 2 times. Similarly, the number of solar home systems installed increased from 8 in 1992/93 to 103,271 in 2014/15 which declined to 9,291 in 2016/17. Likewise, capacity of solar home systems installed increased from 272 in 1992/93 to 2,026,000 in 2012/13 which declined to 143,300 in 2016/17. As regards the number of micro-hydro systems installed, it increased from 3 in

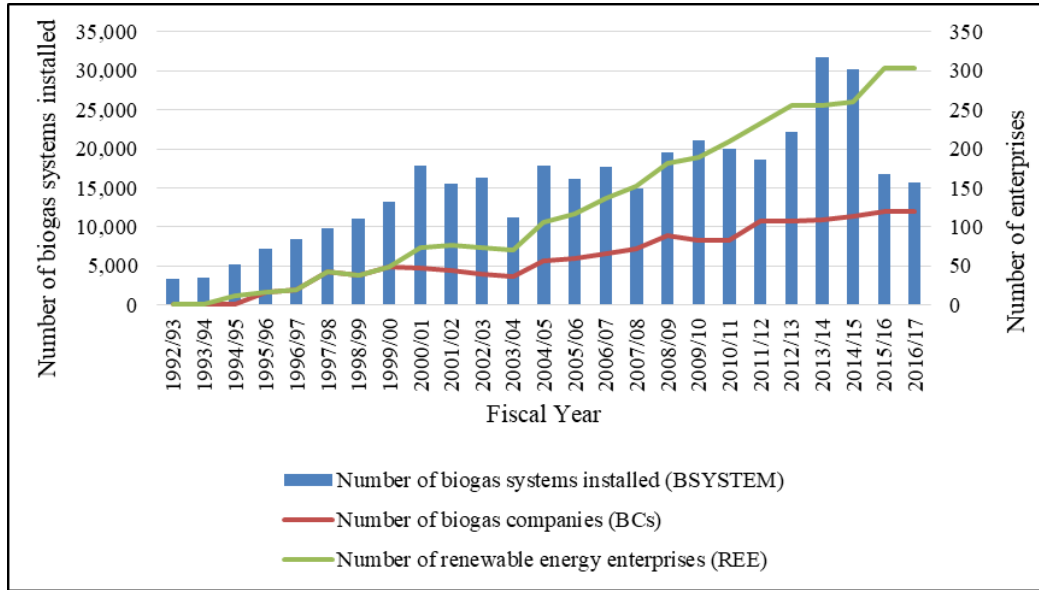
1992/93 to 253 in 2013/14 which declined to 75 in 2016/17. On capacity of micro-hydro systems installed, it increased from 27 in 1992/93 to 7,492 in 2011/12 which declined to 957 in 2016/17. The percentage change in number of biogas systems installed, number of solar home systems installed, capacity of solar home systems installed, number of micro-hydro systems installed, and capacity of micro-hydro systems installed over the last year fluctuated far and wide over a period.

**Table 2:** Number of biogas companies, number of solar companies, number of micro-hydro construction companies, number of biogas systems installed, number and capacity of solar home systems installed, number and capacity of micro-hydro systems installed from 1992/93 to 2016/17 with percentage change over the last year

Fiscal year	Biogas companies		Solar companies		Micro-hydro construction companies		Biogas systems installed		Solar home systems installed				Micro-hydro systems installed			
	Number	% change over the last year	Number	% change over the last year	Number	% change over the last year	Number	% change over the last year	Number	% change over the last year	Capacity in Wp	% change over the last year	Number	% change over the last year	Capacity in kW	% change over the last year
1992/93	1	-	-	-	-	-	3,318	-	8	-	272	-	3	-	27	-
1993/94	1	-	-	-	-	-	3,506	6	89	1,013	3,276	1,104	84	2,700	226	737
1994/95	1	-	-	-	-	-	5,117	46	36	(60)	1,247	(62)	128	52	316	40
1995/96	16	1,500	-	-	-	-	7,157	40	149	314	4,898	293	144	13	378	20
1996/97	19	19	-	-	-	-	8,387	17	562	277	20,398	316	100	(31)	406	7
1997/98	42	121	-	-	-	-	9,869	18	736	31	27,612	35	125	25	616	52
1998/99	38	(10)	-	-	-	-	11,052	12	1,899	158	68,410	148	148	18	613	(1)
1999/00	49	29	-	-	-	-	13,265	20	8,279	336	316,540	363	152	3	933	52
2000/01	47	(4)	11	-	15	-	17,857	35	6,211	(25)	242,064	(24)	86	(43)	972	4
2001/02	44	(6)	11	-	21	40	15,527	(13)	13,745	121	543,486	125	95	10	505	(48)
2002/03	39	(11)	13	18	21	-	16,340	5	18,482	34	650,669	20	133	40	934	85
2003/04	37	(5)	13	-	20	(5)	11,259	(31)	15,106	(18)	411,095	(37)	101	(24)	562	(40)
2004/05	57	54	22	69	27	35	17,803	58	17,887	18	462,679	13	86	(15)	762	36
2005/06	60	5	29	32	28	4	16,118	(9)	6,788	(62)	175,052	(62)	88	2	994	30
2006/07	66	10	34	17	37	32	17,663	10	10,806	59	296,393	69	168	91	2,081	109
2007/08	72	9	38	12	42	14	14,884	(16)	38,375	255	888,334	200	118	(30)	2,091	1
2008/09	89	24	50	32	42	-	19,479	31	53,662	40	1,250,799	41	96	(19)	1,525	(27)
2009/10	83	(7)	64	28	42	-	21,158	9	57,058	6	1,285,476	3	177	84	1,938	27
2010/11	82	(1)	69	8	58	38	20,055	(5)	34,219	(40)	796,606	(38)	243	37	3,161	63
2011/12	107	31	69	-	57	(2)	18,584	(7)	45,752	34	990,494	24	172	(29)	7,492	137
2012/13	108	1	69	-	78	37	22,112	19	91,879	101	2,026,000	105	133	(23)	3,239	(57)
2013/14	109	1	69	-	78	-	31,765	44	87,038	(5)	1,342,836	(34)	253	90	4,046	25
2014/15	113	4	69	-	78	-	30,196	(5)	103,271	19	1,593,281	19	126	(50)	3,346	(17)
2015/16	120	6	105	52	78	-	16,706	(45)	56,770	(45)	875,855	(45)	155	23	1,910	(43)
2016/17	120	-	105	-	78	-	15,707	(6)	9,291	(84)	143,300	(84)	75	(52)	957	(50)

Source: Appendix-1.

Figure 1 presents growth in number of biogas systems installed number of biogas companies and number of REEs in Nepal from 1992/93 to 2016/17.

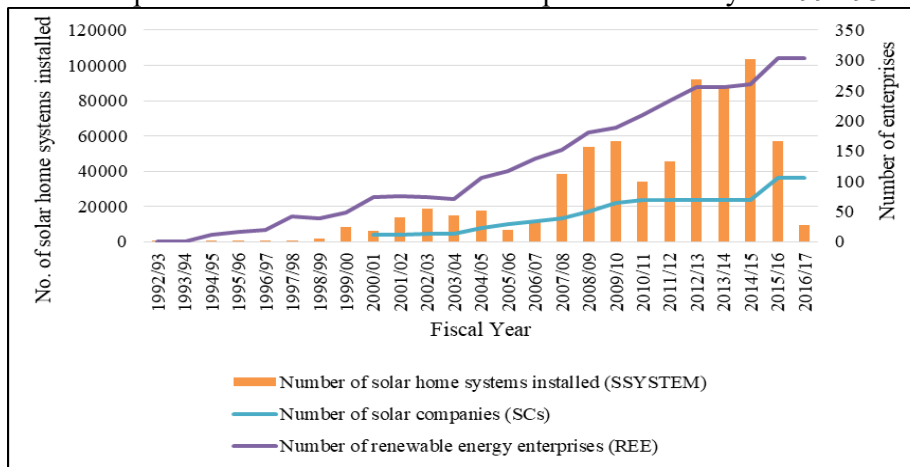


**Figure 1:** Growth in number of biogas system installed along with number of biogas companies and number of REEs in Nepal from 1992/93 to 2016/17

**Source:** Appendix-1.

It shows an increase in number of biogas systems installed in Nepal till 2013/14 after which it all went on declining as well as a manifold increase in number of biogas companies and number of REEs from 1992/93 to 2016/17 though the growth has slowed down in recent years.

Figure 2 shows growth in number of solar home systems installed number of solar home companies and number of REEs in Nepal from fiscal year 1992/93 to 2016/17.

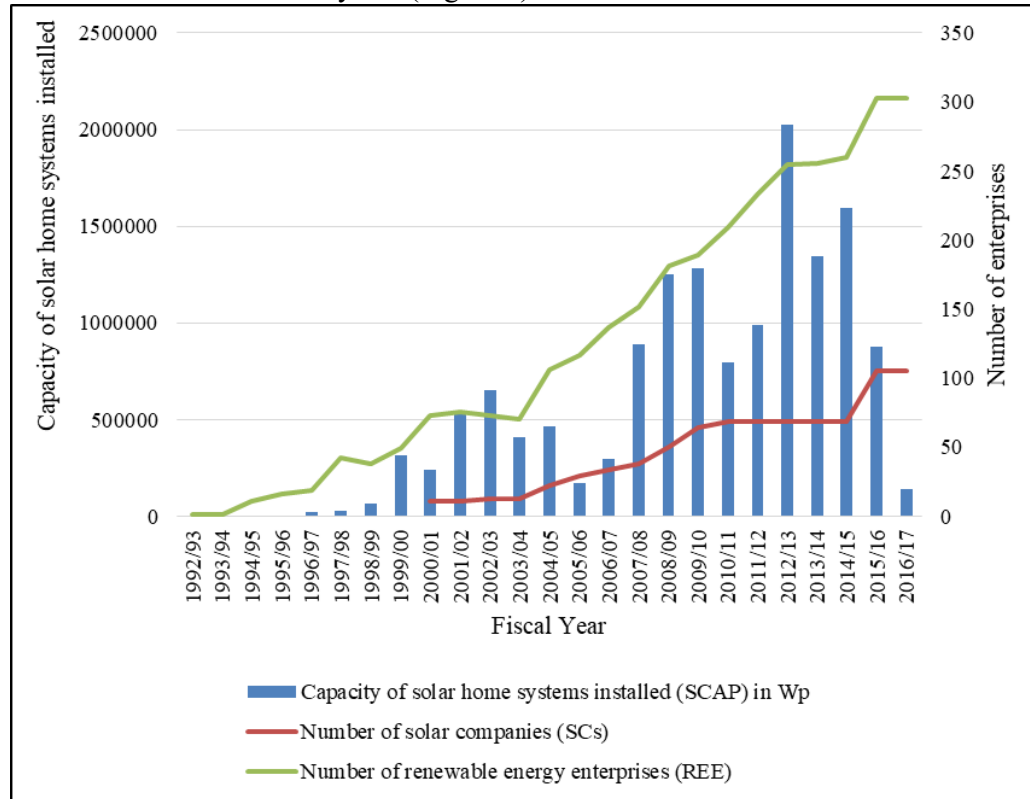


**Figure 2:** Growth in number of solar home systems installed along with number of solar companies and number of REEs in Nepal from 1992/93 to 2016/17

**Source:** Appendix-1.

It indicates the increase in number of solar home systems installed in Nepal till 2014/15 after which it went on declining along with a manifold increase in number of solar companies and number of REEs from 1992/93 to 2016/17 though it has slowed down in recent years.

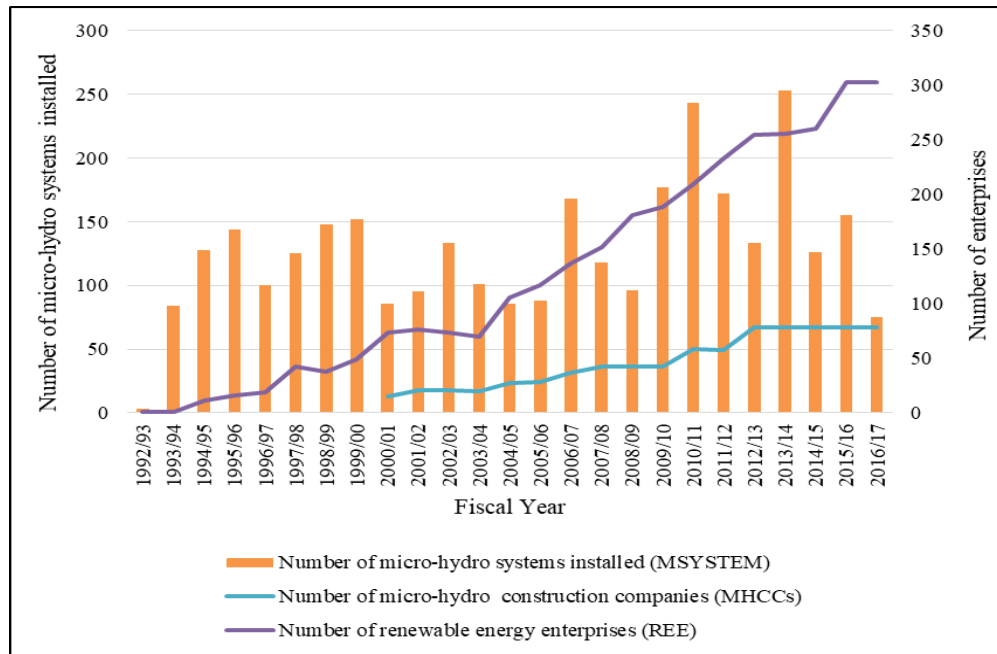
Similarly, the capacity of solar home systems installed went on increasing till 2012/13 after which it started declining accompanied by A manifold increase in number of solar companies and number of REEs from 1992/93 to 2016/17 though it has slowed down in recent years (Figure 3).



**Figure 3:** Growth in capacity of solar home systems installed along with number of solar companies and number of REEs in Nepal from 1992/93 to 2016/17

Source: Appendix-1.

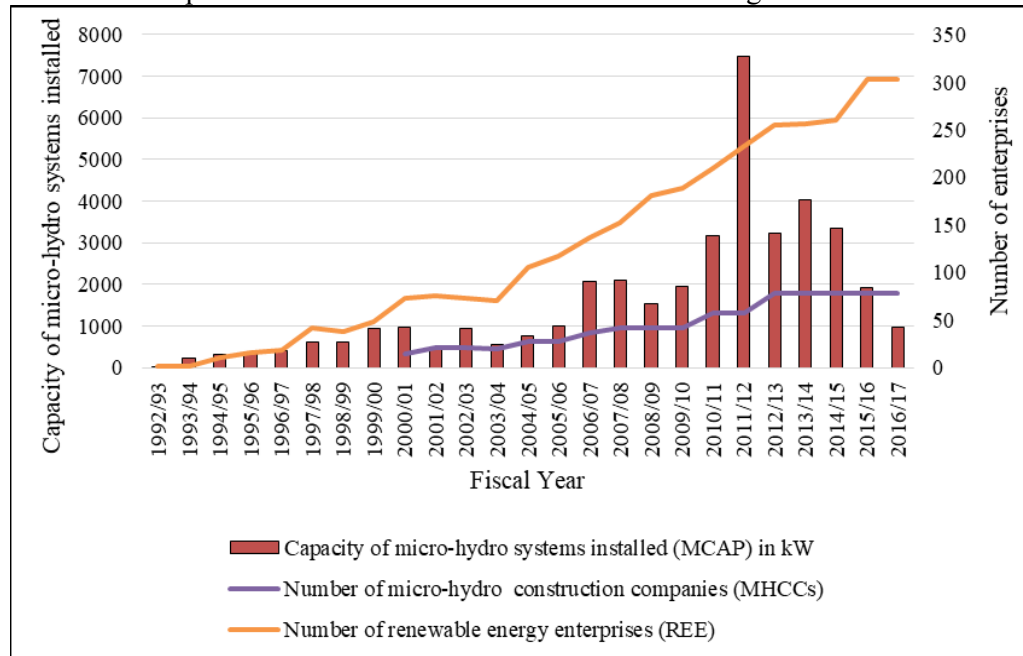
Figure 4 presents the increase in number of micro-hydro systems installed (i.e., hydro power schemes having the capacity up to 10 MW) in Nepal till 2013/14 after which a declining trend has been observed. It is also observed that a manifold increase in number of micro-hydro construction companies and number of REEs from 1992/93 to 2016/17 however the growth has slowed down in recent years.



**Figure 4:** Growth in number of micro-hydro systems installed along with number of micro-hydro construction companies and number of REEs in Nepal from 1992/93 to 2016/17

Source: Appendix-1.

Likewise, Figure 5 shows the increase in capacity of micro-hydro systems installed in Nepal till 2011/12 after which it went on declining.



**Figure 5:** Growth in capacity of micro-hydro systems installed along with number of micro-hydro construction companies and Number of REEs in Nepal from 1992/93 to 2016/17

Source: Appendix-1.

It is also shown that a manifold increase in number of micro-hydro construction companies and number of REEs from 1992/93 to 2016/17 however the growth has slowed down in recent years.

Having analyzed the above, it would be necessary to analyze the growth and development of biogas sector, solar sector, and micro-hydro sector by development regions. Table 3 presents number of biogas systems installed, number and capacity of solar home systems installed, and number and capacity of micro-hydro systems installed by development regions.

The results show that the largest number of biogas systems installed was in western development region (32.10 percent) followed by central development region (29.86 percent), eastern development region (19.04 percent), mid-western development region (9.70 percent), and far-western development region (9.30 percent).

The results reveal that the largest number of solar home systems installed was in mid-western development region (38.55 percent) followed by eastern development region (15.80 percent), western development region (15.78 percent), far-western development region (15.74 percent), central development region (15.13 percent), and far-western development region (14.74 percent). Similarly, the largest capacity of solar home systems installed was in mid-western development region (32.62 percent) followed by western development region (19.24 percent), eastern development region (18.51 percent), central development region (15.80 percent), and far-western development region (13.38 percent).

**Table 3:** Number of biogas systems installed, number and capacity of solar home systems installed, number and capacity of micro-hydro systems installed by development regions as of 2016/17

Development region	No. of biogas systems installed	No. of solar home systems installed	Capacity of solar systems installed in Wp	No. micro-hydro systems installed	Capacity micro-hydro systems installed in kW
Far Western Development Region	36,618 (9.30)	99,934 (14.74)	1,928,859 (13.38)	233 (6.70)	6,957 (12.11)
Mid-Western Development Region	38,181 (9.70)	261,413 (38.55)	4,703,097 (32.62)	291 (8.37)	7,247 (12.61)
Western Development Region	126,368 (32.10)	107,022 (15.78)	2,817,185 (19.24)	912 (26.24)	17,955 (31.25)
Central Development Region	117,580 (29.86)	102,611 (15.13)	2,299,017 (15.80)	686 (19.74)	10,070 (17.53)
Eastern Development Region	74,965 (19.04)	107,118 (15.80)	2,668,914 (18.51)	1,354 (38.95)	15,220 (26.49)
Total	393,712 (100.00)	678,098 (100.00)	14,417,072 (100.00)	3,476 (100.00)	57,449 (100.00)

**Source:** NRREP Baseline Part B: Baseline of Renewable Energy Technology Installations in Nepal, and Annual Report of AEPC, various issues.

**Note:** Figures in parentheses are percentage over total.

Moreover, the largest number of micro-hydro systems installed was in eastern development region (38.95 percent) followed by western development region (26.24 percent), central development region (19.74 percent), mid-western development region (8.37 percent) and far-western development region (6.70 percent). The largest capacity of micro-hydro systems installed was in western development region (31.25





percent) followed by eastern development region (26.49 percent), central development region (17.53 percent), mid-western development region (12.61 percent) and far-western development region (12.11 percent).

It is also necessary to assess the growth of renewable energy sector by periodic development plans from fiscal year 1992/93 to 2016/17. Table 4 presents the number of installments of bio-gas system, solar home systems and micro-hydro systems in Nepal by periodic development plans.

The results show that the largest number of biogas systems installed was during the Tenth Plan (20.1 percent) followed by Thirteenth Plan (20.0 percent), Ninth Plan (17.2 percent), Twelfth Plan (15.4 percent), Eleventh Plan (14.1 percent), Eighth Plan (7.0 percent), Fourteenth Plan (4.0 percent), Seventh Plan (1.8 percent), Sixth Plan (0.3 percent) and so on.

The results indicate that the largest number of solar home systems installed was during Thirteenth Plan (36.4 percent) followed by Twelfth Plan (25.3 percent), Eleventh Plan (22.0 percent), Tenth Plan (10.2 percent), Ninth Plan (4.6 percent), Fourteenth Plan (1.4 percent) and Eighth Plan (0.1 percent). The results show that the largest capacity of solar home systems was installed during Twelfth Plan (26.5 percent) followed by Thirteenth Plan (26.4 percent), Eleventh Plan (23.8 percent), Tenth Plan (13.8 percent), Ninth Plan (8.3 percent), Fourteenth Plan (1.0 percent) and Eight Plan (0.2 percent).

The results show that the largest number of micro-hydro systems installed was during Ninth Plan (17.4 percent) followed by Tenth Plan (16.6 percent), Twelfth Plan (15.8 percent), Thirteenth Plan (15.4 percent), Eighth Plan (13.2 percent), Eleventh Plan (11.2 percent), Seventh Plan (4.3 percent), Sixth Plan (4 percent) and Fourteenth Plan (2.2 percent). Furthermore, the results show that the largest capacity of micro-hydro systems was installed during Sixth Plan (28.5 percent) followed by Twelfth Plan (24.2 percent), Thirteenth Plan (16.2 percent), Eleventh Plan (9.7 percent), Tenth Plan (9.3 percent), Ninth Plan (6.3 percent), Eighth Plan (2.4 percent) and Fourteenth Plan (1.7 percent).

**Table 4:** Number of biogas systems, number and capacity of solar home systems, number and capacity of micro-hydro systems installed in Nepal by periodic development plans with percentage over the last plan as of 2016/17

Periodic development plan	Number of biogas systems installed	% change over the last plan	Number of solar home systems installed	% change over the last plan	Capacity of solar home systems installed in Wp ('000)	% change over the last plan	Number of micro-hydro systems installed	% change over the last plan	Capacity micro-hydro systems installed in kW	% change over the last plan
Till fifth Plan (1975-1980)	799 (0.2)	-	-	-	-	-	-	-	-	-
Sixth Plan (1980-1985)	1,090 (0.3)	36	-	-	-	-	139 (4.0)	-	16,347 (28.5)	-
Seventh Plan (1985-1990)	6,939 (1.8)	537	-	-	-	-	148 (4.3)	6.5	1,072 (1.9)	-93
Eight Plan (1992-1997)	27,485 (7.0)	296	844 (0.1)	-	30 (0.2)	-	459 (13.2)	210.1	1,353 (2.4)	26
Ninth Plan (1997- 2002)	67,570 (17.2)	146	30,870 (4.6)	3558	1,198 (8.3)	3,882	606 (17.4)	32.0	3,639 (6.3)	169
Tenth Plan (2002-2007)	79,183 (20.1)	17	69,069 (10.2)	124	1,996 (13.8)	67	576 (16.6)	-5.0	5,333 (9.3)	47
Eleventh Plan (2007/08-2009/10)	55,521 (14.1)	-30	149,095 (22.0)	116	3,425 (23.8)	72	391 (11.2)	-32.1	5,554 (9.7)	4
Twelfth Plan (2010/11-2012/13)	60,751 (15.4)	9	171,850 (25.3)	15	3,813 (26.5)	11	548 (15.8)	40.2	13,892 (24.2)	150
Thirteenth Plan (2013/14-2015/16)	78,667 (20.0)	30	247,079 (36.4)	44	3,812 (26.4)	-0.03	534 (15.4)	-2.6	9,302 (16.2)	-33
Fourteenth Plan (2016/17-2018/19)*	15,707 (4.0)	-80	9,291 (1.4)	-96	143 (1.0)	-96	75 (2.2)	-86.0	957 (1.7)	-90
Total	393,712 (100.0)		678,098 (100.0)		14,417 (100.0)		3,476 (100.0)		57,449 (100.0)	

**Source:** NRREP Baseline Part B: Baseline of Renewable Energy Technology Installations in Nepal 2013, Alternative Energy Promotion Centre (AEPC), Ministry of Science, Technology and Environment, Government of Nepal, and Annual Report of AEPC, various issues.

**Note:** (1) Figures in parentheses are percentage over total.  
 (2)\*Fourteenth plan includes only data for fiscal year 2016/17.

In this connection, it is also necessary to analyze the growth and development of renewable energy sector. Table 5 presents structure and pattern of growth in the number of renewable energy enterprises, number of renewable energy systems installed, GDP, population, and number of households in Nepal from 1992/93 to 2016/17 along with GDP per capita, GDP per household, population per REE and household per REE.

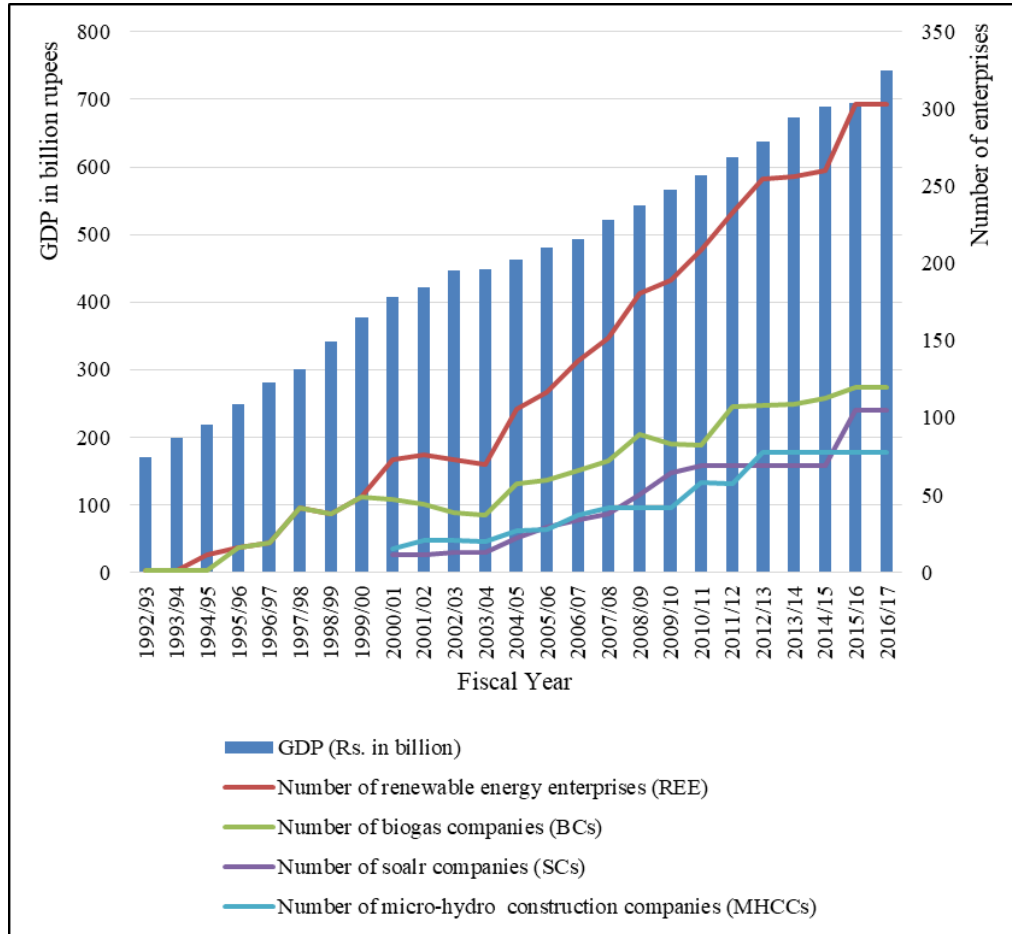
**Table 5:** Number of REEs, number of renewable energy systems installed, GDP, population, and number of households from 1992/93 to 2016/17 along with GDP per capita, GDP per household, population per REE and household per REE

Fiscal Year	Number of renewable energy enterprises (REE)	Number of renewable energy systems installed (TSYSTEM)	GDP (RS. in billion)	Population in million (POP)	Number of Households in '000 (HH)	GDP/POP in '000	GDP/HH in '000	POP/REE in '000	HH/REE in '000
1992/93	1	3,329	171	20	3,548	9	48	19,770	3,548
1993/94	1	3,679	199	20	3,595	10	55	20,032	3,595
1994/95	11	5,281	219	20	3,599	11	61	1,823	327
1995/96	16	7,450	249	21	3,685	12	68	1,283	230
1996/97	19	9,049	281	21	3,773	13	74	1,106	199
1997/98	42	10,730	301	22	3,863	14	78	513	92
1998/99	38	13,099	342	22	3,956	16	86	580	104
1999/00	49	21,696	378	23	4,050	17	93	461	83
2000/01	73	24,154	408	23	4,155	18	98	317	57
2001/02	76	29,367	421	24	4,346	18	97	311	57
2002/03	73	34,955	446	24	4,441	18	100	331	61
2003/04	70	26,466	449	24	4,443	19	101	346	63
2004/05	106	35,776	463	25	4,498	19	103	231	42
2005/06	117	22,994	480	25	4,553	19	106	212	39
2006/07	137	28,637	494	25	4,627	20	107	184	34
2007/08	152	53,377	522	26	4,682	20	112	168	31
2008/09	181	73,237	543	26	4,755	21	114	143	26
2009/10	189	78,393	566	26	4,829	22	117	139	26
2010/11	209	54,517	588	26	5,423	22	108	127	26
2011/12	233	64,508	615	27	5,506	23	112	115	24
2012/13	255	114,124	638	27	5,568	23	115	107	22
2013/14	256	119,056	674	28	5,650	24	119	108	22
2014/15	260	133,593	690	28	5,731	25	120	108	22
2015/16	303	73,631	694	28	5,793	25	120	93	19
2016/17	303	25,073	743	29	5,875	26	126	95	19

**Source:** Appendix-1.

The result shows an increase in the number of renewable energy enterprises from one in 1992/93 to 73 in 2000/01 and to 303 in 2016/17, the increase being 4.2 times over 2000/01. The number of renewable energy systems installed increased from 3,329 in 1992/93 to 133,593 in 2014/15 which declined to 25,073 in 2016/17. Likewise, it shows that an increase in GDP from Rs. 171 billion in 1992/93 to Rs. 743 billion in 2016/17, the increase being 4.3 times. The population increased from 20 million in 1992/93 to 29 million in 2016/17, the increase being about 1.5 times. Moreover, the number of households increased from 3.548 million in 1992/93 to 5.875 million in 2016/17, the increase being 1.7 times. The population per REE decreased from 19.77 million in 1992/93 to 0.095 million in 2016/17 while the household per REE decreased from 3.548 million in 1992/93 to 0.019 million in 2016/17.

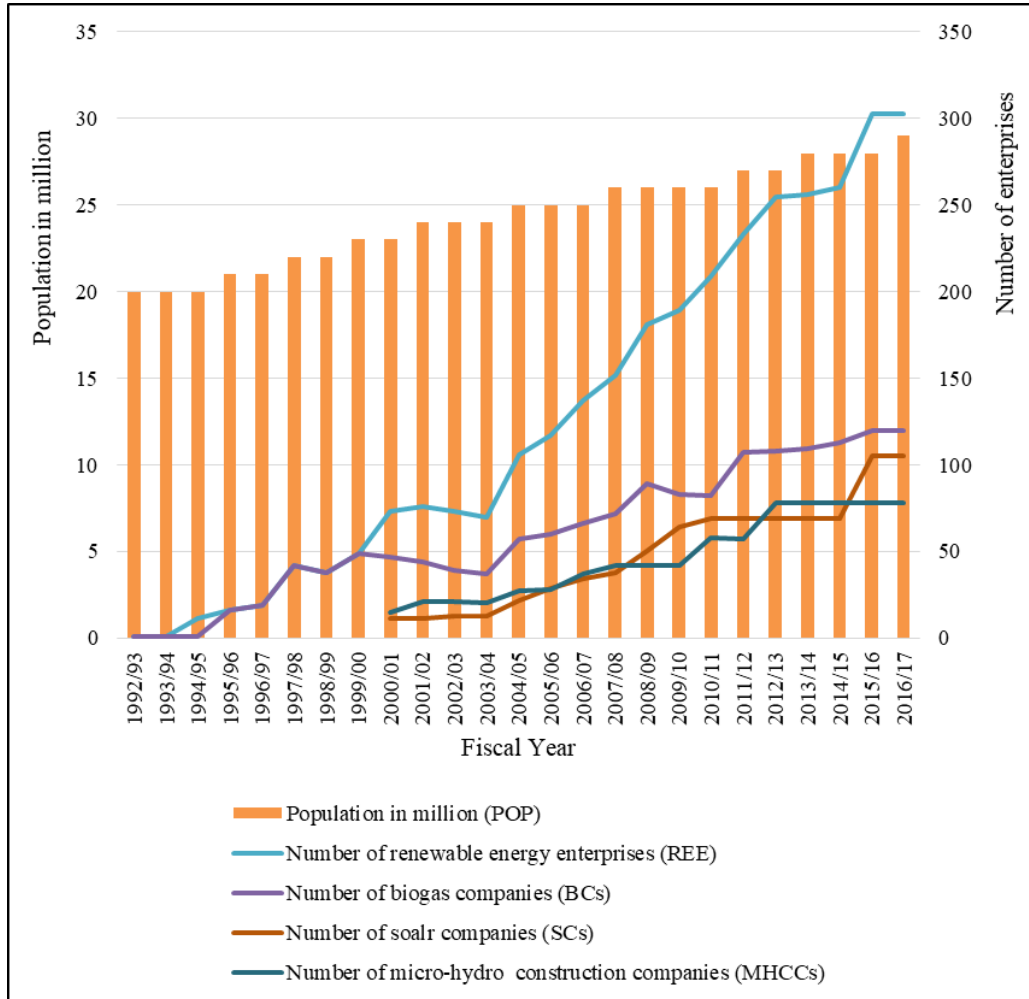
Moreover, Figure 6 shows an increase in number of renewable energy enterprises, number of biogas companies, number of solar companies and number of micro-hydro companies along with an increase in GDP from fiscal year 1992/93 to 2016/17.



**Figure 6:** Growth in GDP along with number of REEs, number of biogas companies, number of solar companies and number of micro-hydro construction companies in Nepal from 1992/93 to 2016/17

**Source:** Appendix-1.

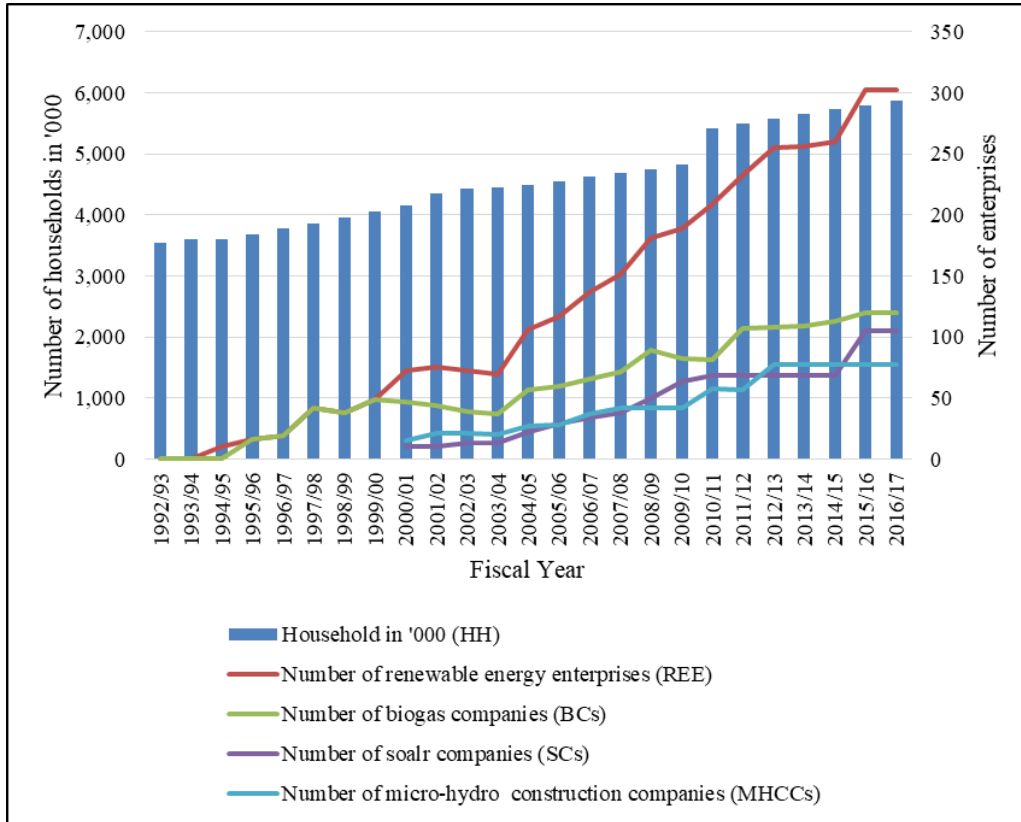
Likewise, an increase in REEs, biogas companies, solar companies and micro-hydro construction companies along with an increase in population is also observed when studied from fiscal year 1992/93 to 2016/17 (Figure 7).



**Figure 7:** Growth in population along with number of REEs, number of biogas companies, number of solar companies and number of micro-hydro construction companies in Nepal from 1992/93 to 2016/17

**Source:** Appendix-1.

Moreover, Figure 8 presents an increase in number of REEs, number of biogas companies, number of solar companies and number of micro-hydro construction companies along with an increase in number of households over a period from 1992/93 to 2016/17.



**Figure 8:** Growth in number of households along with number of REEs, number of biogas companies, number of solar companies and number of micro-hydro construction companies in Nepal from 1992/93 to 2016/17

**Source:** Appendix-1.

The overall result indicates that with the increase in GDP, population and number of households, there is an increase in the REEs, biogas companies, solar companies and micro-hydro construction companies from 1992/93 to 2016/17. In addition, the results on number and capacity of renewable energy systems installed by development regions and by periodic development plans show that the growth and development of renewable energy sector is encouraging throughout the country and over the period. This is consistent with the findings of Pokharel (2006), AEPC (2011), and AEPC/ESAP (2010).

**4. Conclusions, implications, and future avenues**

The results of the empirical analysis led to the important conclusions. The results show that manifold increase in biogas companies, solar companies and micro-hydro construction companies from 1992/93 to 2016/17 though the growth has slowed down in recent years. The results reveal the increase in number of biogas systems installed in Nepal till 2013/14 after which it all went on declining. The results also show the increase in number of solar home systems installed till 2014/15 after which it went on declining while the capacity of solar home systems installed went on increasing till 2012/13 after which it started declining. Likewise, the results indicate an increase in the number of micro-hydro systems installed till 2013/14 after which a declining trend has been observed while the increase in capacity of micro-hydro systems installed till 2011/12 after which it went on declining. Moreover, the results indicate that with the increase in GDP, population and number of households leading to increase in the number of REEs, number of biogas companies, number of solar companies and number of micro-hydro construction companies from 1992/93 to 2016/17. In addition, the results on number and capacity of renewable

energy systems installed by development regions and by periodic development plans show that the growth and development of renewable energy sector is encouraging throughout the country and over the period.

This study is useful for renewable energy enterprises (REEs), development actors in the sector, academia, and policy makers. It is valuable particularly for biogas companies, solar companies, and micro-hydro construction companies to grow their own business. It is also useful for the development actors of renewable energy sector for more commercialization of the sector. It is useful for academia by generating at least some new knowledge in the literature of entrepreneurship and provides avenues for future research. Finally, it is also useful for policy makers as reference materials to formulate entrepreneur-friendly policies to facilitate the existing and potential REEs.

The study can be extended by incorporating other sectors of renewable energy such as, improved cooking stove, wind technology, and biomass sectors to get greater insight into the results. The extension of this study can be made through conducting a detail analysis of sector-wise comparison of renewable energy enterprises to find out widespread results for the sector and their actors. It would be more worthwhile of incorporating the opinions and views of respondents from customers, regulating authorities and development actors in this sector in future studies.

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Appendix-1

Basic data related to renewable energy sector of Nepal

Fiscal Year	No. of biogas systems installed (BSYST EM)	No. of Solar home systems installed (SSYST EM)	Capacity of solar home systems installed in Wp (SCAP)	No. of micro-hydro systems installed (MSYST EM)	Capacity of micro-hydro systems installed in KW (MCAP)	Total No. of renewable energy systems installed (TSYST EM)	No. of biogas companies (BC)	No. of solar companies (SC)	No. of micro-hydro construction companies (MHCC)	Total No. of renewable energy enterprises (REE)	GDP (RS. in billion)	Population in million (POP)	No. of Households in '000 (HH)
Pre 1992/93	8,828	-	-	287	17,419	9,115	-	-	-	-	-	-	-
1992/93	3,318	8	272	3	27	3,329	1	-	-	-	171	20	3,548
1993/94	3,506	89	3,276	84	226	3,679	1	-	-	-	199	20	3,595
1994/95	5,117	36	1,247	128	316	5,281	11	-	-	-	219	20	3,599
1995/96	7,157	149	4,898	144	378	7,450	16	-	-	-	249	21	3,685
1996/97	8,387	562	20,398	100	406	9,049	19	-	-	-	281	21	3,773
1997/98	9,869	736	27,612	125	616	10,730	42	-	-	-	301	22	3,863
1998/99	11,052	1,899	68,410	148	613	13,099	38	-	-	-	342	22	3,956
1999/00	13,265	8,279	316,540	152	933	21,696	49	-	-	-	378	23	4,050
2000/01	17,857	6,211	242,064	86	972	24,154	47	11	15	73	408	23	4,155
2001/02	15,527	13,745	543,486	95	505	29,367	44	11	21	76	421	24	4,346
2002/03	16,340	18,482	650,669	133	934	34,955	39	13	21	73	446	24	4,441
2003/04	11,259	15,106	411,095	101	562	26,466	37	13	20	70	449	24	4,443
2004/05	17,803	17,887	462,679	86	762	35,776	57	22	27	106	463	25	4,498
2005/06	16,118	6,788	175,052	88	994	22,994	60	29	28	117	480	25	4,553
2006/07	17,663	10,806	296,393	168	2,081	28,637	66	34	37	137	494	25	4,627
2007/08	14,884	38,375	888,334	118	2,091	53,377	72	38	42	152	522	26	4,682
2008/09	19,479	53,662	1,250,799	96	1,525	73,237	89	50	42	181	543	26	4,755
2009/10	21,158	57,058	1,285,476	177	1,938	78,393	83	64	42	189	566	26	4,829
2010/11	20,055	34,219	796,606	243	3,161	54,517	82	69	58	209	588	26	5,423
2011/12	18,584	45,752	990,494	172	7,492	64,508	107	69	57	233	615	27	5,506
2012/13	22,112	91,879	2,026,000	133	3,239	114,124	108	69	78	255	638	27	5,568
2013/14	31,765	87,038	1,342,836	253	4,046	119,056	109	69	78	255	674	28	5,650
2014/15	30,196	103,271	1,593,281	126	3,346	133,593	113	69	78	260	690	28	5,731
2015/16	16,706	56,770	875,855	155	1,910	73,631	120	105	78	303	694	28	5,793
2016/17	15,707	9,291	143,300	75	957	25,073	120	105	78	303	743	29	5,875

**Source:** Statistical Year Book, Central Bureau of Statistics, Government of Nepal, various issues; Economic survey of Nepal, Ministry of Finance, Government of Nepal, various issues; Annual report of AEPC, various issues; annual report of BSP-Nepal, various issues; annual report of SEMAN, various issues; annual report of NMHDA, various issues, A year in review (July 2012 to July 2013), Making renewable energy mainstream supply to rural areas of Nepal, Alternative Energy Promotion Centre (AEPC), Ministry of Science, Technology and Environment, Government of Nepal; and NRREP Baseline Part B: Baseline of Renewable Energy Technology Installations in Nepal 2013, Alternative Energy Promotion Centre (AEPC), Ministry of Science, Technology and Environment, Government of Nepal.