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Entrepreneurial Development in Renewable Energy Sector of Nepal

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Abstract

The paper aims at determining entrepreneurial development in renewable energy sector of Nepal. The study has adopted causal-comparative research design to determine the effect of population, number of households, number of systems installed on entrepreneurship development, i.e., renewable energy enterprises (REEs) in the context of Nepal. The required district level secondary data having 75 observations related to population, number of households, number of renewable energy enterprises, and number of renewable energy systems installed were collected for this study. Furthermore, the formation and analysis of properties of portfolios on population and number of households have been comprised to examine the relationship of district population and district households with various measures related renewable energy sector of Nepal. The analysis of portfolios thus formed is followed by the analysis of estimation of regression equations. The results show that entrepreneurship development, i.e., renewable energy enterprises (REEs) is positively related with market size in terms of populations and district households. This study is useful for renewable energy enterprises (REEs) and development actors to grow their own business and commercialization of the sector. The study can be extended by incorporating other sectors of renewable energy

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such as, biogas, micro-hydro, improved cooking stove, wind technology, and biomass sectors to find out greater insight into the results for the renewable energy sector.

Key words: Entrepreneurial development, biogas companies, solar companies, micro-hydro construction companies, properties of portfolio, renewable energy enterprises

Introduction

Entrepreneurship is a process which involves various activities to be undertaken to start an enterprise (Khanka, 2013). Entrepreneurship deals with opportunities over threats (Krueger *et al.*, 2000). A study by Aribaba*et al.* (2011) found that the participation of the enterprises in technologically innovative entrepreneurial development program is enhanced the firm performance. Wakkee *et al.* (2015) found that growth path used by small and medium enterprises (SMEs) is market penetration through increasing efficiency. The new venture growth depends upon access to resources (Aldrich & Martinez, 2001). The access to resources develops capacity to discover an opportunity (Davidsson & Honig, 2003). In this perspective, the studies showed that the formation of new enterprise is customary when an individual has access to finance (Evans & Jovanovic, 1989; Holtz-Eakin *et al.*, 1994 and Blanchflower *et al.*, 2001). Entrepreneurial development though looks a simple term is highly encompassing.

Population ecology is social context related to the environmental factors that have an influence on survival and success of an enterprise. On the other side, entrepreneurs should have skills in diverse field instead of any one skill indicating that must be jacks-of-all-trades (Lazear, 2005). According to Schoar (2010), individuals are engaged in two types of entrepreneurships: subsistence and transformational. These individuals vary in their economic objectives, skills, and roles they play in the economy. Messersmith and Wales (2011) viewed that entrepreneurial orientation is related to the sales growth. Thus, entrepreneurial development is influenced by market size in terms of population and number of households.

On the goal of universal electrification by 2030, Narula *et al.* (2012) showed that two future demand scenarios with a 'minimum threshold' and a 'higher threshold' of electricity consumption of 65 and 420 kW per household per year in South Asia respectively. Moreover, the public expenses for kerosene can be substantially reduced if all households switch to electricity as their primary source of lighting. In this connection, the Decentralized Distributed

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Generation (DDG) options play an important role by reducing capital investments needed for the technologies to meet the goal of universal electrification by 2030. TERI (2005) showed that the southeast region has common requirements for promoting RETs related to energy security issues and servicing larger rural population. The governments of the respective countries have made commitments towards developing renewable energy sector though their implementations are at various levels of effectiveness.

Market size can be measured in terms of population [(Addario & Vuri, 2010) and (Sato, Tabuchi, & Yamamoto, 2012)]. Market size in terms of population and number of households has been considered as independent variable in this study. Addario and Vuri (2010) found that market size in terms of province population has positive impact on entrepreneurs' net monthly income. Market size in terms of population density is positively related to entrepreneurship (Sato, Tabuchi, & Yamamoto, 2012). Besides, population/energy dependency shows that increase in population leads to increase in energy consumption and increase in energy consumption leads to increase in energy resources which indicates positive relationship between them (Zabel, 2009). Thus, the market size is related to the entrepreneurial success.

Several studies on renewable energy discussed on importance, potentials, and challenges of renewable energy technologies (RETs) in the context of developing countries. Martinot *et al.* (2002) showed that past donor efforts achieved modest results, which leads to a greater market orientation in developing countries. The study further revealed that the markets for rural household lighting with solar home systems, biogas and small hydro power have expanded through rural entrepreneurship, government programs and donor assistance, serving millions of households. Mirza *et al.* (2003) found that increase in the use of solar energy technology leads to decrease in the oil import bills in Pakistan. Yadoo and Cruickshank (2010) revealed that the socially orientated cooperative businesses play a vital role in extending and managing rural electricity services efficiently and effectively in developing countries

In the contxt of Nepal, Pokharel (2006) showed that creation of enterprises on renewable energy technologies is vital for sustainable development in Nepal. However, many electricity schemes in developing countries failed due to lack of entrepreneurship and opportunity forward/backward linkages and the market (Pandey, 2009). Entrepreneurship and small

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business have an important impact on national development for both developed and developing countries (Karki, 2007). Without having conducive business environment nobody would be able to start a business in a specific country successfully (Karki, 2010/11). Furthermore, Moreover, AEPC (2011) and AEPC/ESAP (2010) found that the higher income to electrified households from small business compared to non-electrified households in the context of Nepal. The rural electrification and the installation of solar home system are likely to increase the probability of starting small business.

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). In this connection, Nepal has scattered and sparse settlement pattern 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. Thus, the renewable energy sources are most feasible option to fulfil energy need in the country.

Though there are the above-mentioned findings in the context of other countries and Nepal, no such findings using more recent data exist in Nepalese renewable energy sector. This study is the first of its kind as no study has so far been conducted to examine entrepreneurial development in renewable energy sector of Nepal. The study, therefore, deals with the following issues in the context of Nepalese solar sector: Do the districts having larger population and number of households have higher entrepreneurship development? Are there any relationship of population and number of households with number of renewable energy enterprises and number of renewable energy systems installed? Thus, the study dealing with entrepreneurial development in renewable energy sector of Nepal are of greater significance.

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Materials and methods

The study has adopted causal-comparative research design to determine the effect of population, number of households, number of systems installed on entrepreneurship development in renewable energy sector of Nepal.

The required national level and district level secondary data were collected for this study. The district-wise data of 75 districts related to population, number of households, number of renewable energy enterprises, and number of renewable energy systems installed have been collected for this study as given in Appendix-1. Therefore, the study comprised of 75 observations for each of biogas sector, solar sector, and micro-hydro sector for the formation and analysis of properties of portfolios on population and number of households.

Furthermore, the properties of portfolios are studied to examine the relationship of district population and district households with various measures of renewable energy related variables. The study sorts out all the 75 districts into three portfolios based on district population and district households. The smallest, intermediate, and largest districts are contained respectively in portfolios 1, 2, and 3. Splitting districts into more than three portfolios reduces the sample sizes. For each district, the various measures of renewable energy related variables are computed. They are then classified according to the portfolios formed below and average ratios are computed. Analysis of portfolios thus formed is followed by the analysis of estimation of regression equations. The equation to be estimated has therefore been specified as under:

$$V = \beta_0 + \beta_1 NUM + \beta_2 SYS + \beta_3 CON + \varepsilon_{i.} \qquad \ldots (1)$$

The dependent variables, V chosen for the study has been specified as district population or district households of 75 districts while the independent variables are specified as:

NUM = Number of biogas companies (BC) or number of solar companies (SC) or number of micro-hydro construction companies (MHCC) or number of renewable energy enterprises (REE)

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SYS = Ratio of biogas systems installed to number of renewable energy systems installed (BSYSTEM/TSYSTEM) or ratio of solar home systems installed to number of renewable energy systems installed (SSYSTEM/TSYSTEM) or ratio of micro-hydro systems installed to number of renewable energy systems installed (MSYSTEM/TSYSTEM)

CON = Concentration of renewable energy enterprises have been specified as: ratio of biogas companies to number of renewable energy enterprises (BC/REE) or ratio of solar companies to number of renewable energy enterprises (SC/REE) or ratio of micro-hydro construction companies to number of renewable energy enterprises (MHCC/REE)

Results and discussion

An attempt made to analyze entrepreneurial development in renewable energy sector of Nepal. It has been assessed growth and development of entrepreneurship in renewable energy sector in Nepal by district-wise population by forming the properties of portfolios on district population and number of households. This section is based on cross-sectional data analysis of 260 renewable energy enterprises (REEs) with 75 observations (Appendix-1).

Properties of portfolios formed on district population

The properties of portfolios formed on district population and its relationship with various measures of renewable energy related variables are analyzed first. The various measures classified according to the portfolios formed based on population are presented in Table 1 which, among others, reveals the following:

- With the increase in population, the number of renewable energy enterprises also increased. In order words, districts with larger population have higher number of renewable energy enterprises. The average number of biogas companies increased from 0.36 companies for the smallest portfolio to 3.08 companies for the largest. The average number of solar companies increased from zero company for the smallest portfolio to 2.68 companies for the largest. Similarly, the average number of micro-hydro

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construction companies increased from zero company for the smallest portfolio to 2.80 companies for the largest. Moreover, the number of renewable energy enterprises increased from 0.36 enterprises for the smallest portfolio to 8.56 enterprises for the largest. The number of biogas companies, number of solar companies, number of micro-hydro construction companies, and number of renewable energy enterprises under the largest portfolio formed on population are more variable as compared to the smallest.

- Districts with larger population also have higher ratio of number of biogas systems installed to renewable energy systems installed, which is consistent with the priori expectation. The average ratio of number of biogas systems installed to renewable energy systems installed increased from 11.67 percent for the smallest portfolio to 63.69 percent for the largest. However, the ratio of number of biogas systems installed to renewable energy systems installed under smallest portfolio is less variable than that of both intermediate and largest portfolio formed on population.

- Districts with larger population have lower ratio of number of solar home systems installed to renewable energy systems installed. The average ratio of number of solar home systems installed to renewable energy systems installed decreased from 83.84 percent for the smallest portfolio to 36.28 percent for the largest.

- Districts with larger population have lower ratio of number of micro-hydro systems installed to renewable energy systems installed. The average ratios of number of micro-hydro systems installed to renewable energy systems installed declined from 0.5 percent for the smallest portfolio to 0.03 percent for the largest. Moreover, the ratios of number of solar home systems installed to renewable energy systems installed are less variable for the smallest portfolio than intermediate and largest portfolio. However, the ratios of number of micro-hydro systems installed to renewable energy systems installed are less variable for the largest portfolio than that of smallest and intermediate portfolio.

Table 1: Properties of portfolios formed on district population

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This table provides properties of portfolios formed on district population with 75 observations. The three portfolios were formed based on district population (DPOP), i.e., up to 196,000 as the smallest portfolio or portfolio 1, population between 196,000 to 260,000 as the intermediate portfolio or portfolio 2, and population 260,000 or more as the largest portfolio or portfolio 3.The various entrepreneurship factors for the purpose are number of biogas companies (BC), number of solar companies (SC), number of micro-hydro construction companies (MHCC), number of renewable energy enterprises (REE), ratio of biogas systems installed to number of renewable energy systems installed (BSYSTEM/TSYSTEM), ratio of solar home systems installed to number of renewable energy systems installed (SYSTEM/TSYSTEM), ratio of micro-hydro systems installed to number of renewable energy systems installed (MYSTEM/TSYSTEM), ratio of number of biogas companies to number of renewable energy enterprises (BC/REE), ratio of solar companies to number of renewable energy enterprises (SC/REE) and ratio of micro-hydro construction companies to number of renewable energy enterprises (MHCC/REE).

Portfolios		1 Smallest	2 Intermediate	3 Largest
Bases of portfolios		≤ 196,000	196,000 to 260,000	≥ 260,000
Number of observations		25	25	25
Panel A: Means				
District population (DPOP)	(thousand)	120.90	265.85	673.02
Biogas companies (BC)	(number)	0.36	1.08	3.08
Solar companies (SC)	(number)	0.00	0.08	2.68
Micro-hydro construction companies (MHCC)	(number)	0.00	0.32	2.80
Renewable energy enterprises (REE)	(number)	0.36	1.48	8.56
BSYSTEM/TSYSTEM	(percent)	11.67	26.50	63.69
SSYSTEM/TSYSTEM	(percent)	83.84	73.15	36.28
MSYSTEM/TSYSTEM	(percent)	0.50	0.35	0.03
BC/REE	(percent)	28.00	51.20	68.36
SC/REE	(percent)	0.00	1.83	8.90
MHCC/REE	(percent)	0.00	10.97	14.74
Panel B: Standard Deviations				
District population (DPOP)	(thousand)	56.59	43.28	269.31
Biogas companies (BC)	(number)	0.70	1.41	2.34
Solar companies (SC)	(number)	0.00	0.28	10.10
Micro-hydro construction companies (MHCC)	(number)	0.00	0.69	7.14
Renewable energy enterprises (REE)	(number)	0.70	1.92	18.07
BSYSTEM/TSYSTEM	(percent)	21.30	31.42	29.41
SSYSTEM/TSYSTEM	(percent)	27.55	31.56	29.41
MSYSTEM/TSYSTEM	(percent)	0.82	1.16	0.11
BC/REE	(percent)	45.83	46.85	35.48
SC/REE	(percent)	0.00	7.02	16.31
MHCC/REE	(percent)	0.00	25.33	23.31

Source: Appendix-1.

- With the increase in population, the penetration of number of renewable energy enterprises also increased. In order words, districts with larger population have higher ratio of number of biogas companies to number of renewable energy enterprises. The average ratio of number of biogas companies to number of renewable energy enterprises increased from 28.00 percent for the smallest portfolio to 68.36 percent for the largest. Districts with larger population have higher ratio of number of solar companies to number of renewable energy enterprises. The average ratio of number of solar companies to total renewable energy enterprises increased from zero percent for the smallest portfolio to 8.9 percent for the

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largest. Likewise, districts with larger population have higher ratio of number of micro-hydro construction companies to number of renewable energy enterprises. The average ratio of number of micro-hydro construction companies to number of renewable energy enterprises increased from zero percent for the smallest portfolio to 14.74 percent for the largest. The ratios of number of biogas companies to number of renewable energy enterprises under largest portfolio are less variable than intermediate and largest portfolios while the ratios of number of solar companies to number of renewable energy enterprises, and the ratios of number of micro-hydro construction companies to number of renewable energy enterprises under largest portfolio are more variable than the smallest.

Table 2 presents average slopes from cross section linear regressions of population on various measures of renewable energy related variables.

Table 2: Average slopes (t-statistics) from cross section linear regressions of district population on various measures of renewable energy related variables

Portfolios	1 Smallest			2 Intermediate			3 Largest		
Models	1	2	3	1	2	3	1	2	3
BC		24,649 (1.38)		13,213 (1.99)			-8,133 (0.39)		
SC						61,480 (2.12)**		27,869 (5.77)*	
MHCC					1,845 (0.14)				33,281 (5.47)*
REE	21,023 (1.22)		26,881 (1.53)				12,901 (4.78)*		
BSYSTEM/TSYSTEM	1,256 (1.76)			571 (2.19)**					
SSYSTEM/TSYSTEM	1,322 (2.34)**	686 (1.51)	747 (1.67)		-687 (2.43)**		408 (0.27)	222 (0.19)	
MSYSTEM/TSYSTEM			19,049 (1.39)			-1,1,508 (1.20)			-491,883 (1.51)
BC/REE				-275 (1.41)		97 (0.58)			
SC/REE					3,153 (3.06)*			-6,136 (2.12)**	
MHCC/REE						866 (1.95)	-1,093 (0.61)		-3,752 (1.99)
Adj. R^2	0.12	0.04	0.08	0.28	0.44	0.25	0.53	0.63	0.57

Source: Appendix-1.

Notes: (i) Figures in parentheses are t-values.

(ii) The asterisk signs (*) and (**) indicate that the results are significant at 1 percent and 5 percent level of significance respectively.

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Among others, it indicates positive relationship of population with number of biogas companies, number of solar companies, number of micro-hydro construction companies, number of renewable energy enterprises, ratio of number of biogas systems installed to number of renewable energy systems installed, ratio of number of biogas companies to number of renewable energy enterprises, ratio of number of solar companies to number of renewable energy enterprises, and ratio of number of micro-hydro construction companies to number of renewable energy enterprises; and its negative relationship with the ratio of number of solar systems installed to number of renewable energy systems installed, and ratio of number of micro-hydro systems installed to number of renewable energy systems installed.

The overall results suggest that number of biogas companies, number of solar companies, number of micro-hydro construction companies, number of renewable energy enterprises, number of biogas systems installed, number of solar systems installed, and number of micro-hydro systems installed are related to population.

Properties of portfolios formed on district households

The properties of portfolios formed on district households and its relationship with various measures of renewable energy related variables are analyzed in this section. The various measures classified according to the portfolios formed based on district households are presented in Table 3 which, among others, reveals the following:

- Districts with larger number of households have higher number of biogas companies, number of solar companies, number of micro-hydro construction companies and number of renewable energy enterprises. The average number of biogas companies increased from 0.3 companies for the smallest portfolio to 3.1 companies for the largest. The average number of solar companies increased from zero company for the smallest portfolio to 2.7 companies for the largest. Similarly, the average number of micro-hydro construction companies increased from zero company for the smallest portfolio to 2.8 companies for the largest. Moreover, the number of renewable energy enterprises increased from 0.3 enterprises for the smallest portfolio to 8.6 enterprises for the largest portfolio formed on number of households. The number of biogas companies, number of solar companies, number of micro-hydro construction companies and

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number of renewable energy enterprises under the largest portfolio formed on number of households are more variable than that of the smallest portfolio.

Table 3: Properties of portfolios formed on district households

This table reveals the properties of portfolios formed on district households with 75 observations. The three portfolios were formed based on district households (DHH), i.e., up to 42,000 as the smallest portfolio or portfolio 1, number of households between 42,000 to 80,000 as the intermediate portfolio or portfolio 2, and number of households 80,000 or more as largest portfolio or portfolio 3. The various entrepreneurship factors for the purpose are number of biogas companies (BC), number of solar companies (SC), number of micro-hydro construction companies (MHCC), number of renewable energy enterprises (REE), ratio of biogas systems installed to number of renewable energy systems installed (BSYSTEM/TSYSTEM), ratio of solar home systems installed to number of renewable energy systems installed (SYSTEM/TSYSTEM), ratio of micro-hydro systems installed to number of renewable energy systems installed (MYSTEM/TSYSTEM), ratio of number of biogas companies to number of renewable energy enterprises (BC/REE), ratio of solar companies to number of renewable energy enterprises (SC/REE), and ratio of micro-hydro construction companies to number of renewable energy enterprises (MHCC/REE).

Portfolios		**1 Smallest**	**2 Intermediate**	**3 Largest**
Bases of portfolios		≤ 42,000	42,000 to 80,000	≥ 80,000
Number of observations		25	25	25
Panel A: Means				
District households (DHH)	(thousand)	25.2	57.2	134.7
Biogas companies (BC)	(number)	0.3	1.1	3.1
Solar companies (SC)	(number)	0.0	0.1	2.7
Micro-hydro construction companies (MHCC)	(number)	0.0	0.3	2.8
Renewable energy enterprises (REE)	(number)	0.3	1.5	8.6
BSYSTEM/TSYSTEM	(percent)	6.7	31.5	63.7
SSYSTEM/TSYSTEM	(percent)	88.8	68.1	36.3
MSYSTEM/TESYSTEM	(percent)	0.5	0.4	0.1
BC/REE	(percent)	32.0	47.2	68.4
SC/REE	(percent)	0.0	1.8	8.9
MHCC/REE	(percent)	0.0	11.0	14.7
Panel B: Standard Deviations				
District households (DHH)	(thousand)	12.3	11.5	70.9
Biogas companies (BC)	(number)	0.5	1.5	2.3
Solar companies (SC)	(number)	0.0	0.3	10.1
Micro-hydro construction companies (MHCC)	(number)	0.0	0.7	7.1
Renewable energy enterprises (REE)	(number)	0.5	2.0	18.1
BSYSTEM/RESYSTEM	(percent)	14.2	32.2	29.4
SSYSTEM/RESYSTEM	(percent)	23.4	32.3	29.4
MSYSTEM/RESYSTEM	(percent)	0.8	1.2	0.1
BC/REE	(percent)	47.6	46.8	35.5
SC/REE	(percent)	0.0	7.0	16.3
MHCC/REE	(percent)	0.0	25.3	23.3

Source: Appendix-1.

- With the increase in district households, the ratio of number of biogas systems installed to number of renewable energy systems installed also increased. In order words, districts with

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larger number of households have higher ratio of number of biogas systems installed to number of renewable energy systems installed. The average ratio of number of biogas systems installed to number of renewable energy systems installed increased from 6.7 percent for the smallest portfolio to 63.7 percent for the largest. Moreover, the ratio of number of biogas systems installed to number of renewable energy systems installed under the smallest portfolio is less variable than that of the intermediate and largest portfolio.

- Districts with larger number of households have lower ratio of number of solar home systems installed to number of renewable energy systems installed. The average ratio of number of solar home systems installed to number of renewable energy systems installed decreased from 88.8 percent for the smallest portfolio to 36.3 percent for the largest. Moreover, the ratios of number of solar home systems installed to number of renewable energy systems installed under the smallest portfolio are less variable as compared to intermediate and largest portfolio.

- Districts with larger number of households have lower ratio of number of micro-hydro systems installed to number of number renewable energy systems installed. The ratio of number of micro-hydro systems installed to number of number renewable energy systems installed declined from 0.5 percent for the smallest portfolio to 0.1 percent for the largest. Moreover, the ratios of number of micro-hydro systems installed to number of number renewable energy systems installed for the largest portfolio are less variable as compared to the smallest and intermediate portfolio.

- Districts with larger number of households have higher penetration of number of renewable energy enterprises. The ratios of biogas companies to renewable energy enterprises increased from 32.0 percent for the smallest portfolio to 68.4 percent for the largest. The ratios of solar companies to renewable energy enterprises also increased from zero percent for the smallest portfolio to 8.9 percent of the largest. Similarly, the ratios of micro-hydro construction companies to renewable energy enterprises increased from zero percent for the smallest portfolio to 14.7 percent for the largest. The ratios of biogas companies to renewable energy enterprises under largest portfolio formed on district households are less variable as compared to the smallest. However, the ratios of number of solar companies to

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renewable energy enterprises and the ratios of number of micro-hydro construction companies to renewable energy enterprises under largest portfolio are more variable as compared to districts having lower number of households.

Table 4 presents average slopes from cross section linear regressions of district households on various measures of renewable energy related variables. Among others, it shows that district households are positively related to number of biogas companies, number of solar companies, number of micro-hydro construction companies, number of renewable energy enterprises, and number of biogas systems installed, while negatively related to number of solar home systems installed and number of micro-hydro systems installed.

Table 4: Average slopes (t-statistics) from cross section linear regressions of district households on various measures of renewable energy related variables

Portfolios	**1 Smallest**			**2 Intermediate**			**3 Largest**		
Models	1	2	3	1	2	3	1	2	3
BC							16,368 (2.83)*		
SC				15,578 (0.954)				7,022 (6.50)*	
MHCC					4,168 (1.08)				
REE	7,177 (1.33)	4,656 (0.93)			2,301 (1.71)	2,471 (2.04)**			3,492 (7.82)*
BSYSTEM/TSYSTEM	254 (1.19)		249 (2.06)**				23 (0.05)		
SSYSTEM/TSYSTEM	295 (2.38)**	210 (2.06)**	143 (0.72)	-165 (2.73)**				-139 (0.52)	
MSYSTEM/TSYSTEM					146 (0.08)	-1,746 (0.65)			-83,155 (1.23)
BC/REE							-658 (1.94)		
SC/REE				188 (0.29)				-986 (1.52)	
MHCC/REE						153 (1.19)			-282 (0.80)
Adj. R^2	0.12	0.11	0.09	0.36	0.24	0.25	0.32	0.73	0.73

Source: Appendix-1.

Notes: (1) Figures in parentheses are t-values.

(2) The asterisk signs (*) and (**) indicate that the results are significant at 1 percent and 5 percent level of significance respectively.

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The overall results suggest that number of biogas companies, number of solar companies, number of micro-hydro construction companies, number of renewable energy enterprises, number of biogas systems installed, number of solar home systems installed, and number of micro-hydro systems installed do have some relation with district households.

Furthermore, the study concludes that there is positive relationship of market size in terms of populations and households with renewable energy enterprises (REEs) in terms of biogas companies, solar companies, and micro-hydro construction companies. This finding is consistent with the findings of Sato, Tabuchi, & Yamamoto (2012) and Zabel (2009).

Conclusions, implications, and recommendations

The analysis of the properties of portfolios led to the important conclusions. The results from the properties of portfolios formed on population and number of households show that districts with the larger population and number of households have larger number of biogas companies, number of solar companies, number of micro-hydro construction companies, number of renewable energy enterprises and number of biogas systems installed while smaller number of solar systems installed, and number of micro-hydro systems installed in Nepal. It means that entrepreneurship development, i.e., renewable energy enterprises (REEs) is positively related with populations and district households.

This study is useful for renewable energy enterprises (REEs) and development actors in the sector. The study is valuable particularly for REEs to grow their own business. The development actors can utilize the findings of this study for more commercialization of the sector. Furthermore, the extension of this study can be extended by incorporating other sectors of renewable energy such as, improved cooking stove, biogas, micro-hydro, wind technology, and biomass sectors to get greater insight into the results.

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Appendix-1: Population, number of households, number of renewable energy enterprises and number of renewable energy systems installed in Nepal by districts

District	District population	District households	No. of biogas companies	No. of solar companies	No. of micro-hydro construction companies	Total No. of renewable energy enterprises	No. of biogas systems installed	No. of solar home systems installed	No. of micro-hydro systems installed	Total No. of renewable energy systems installed	Biogas systems/total renewable energy systems installed	Solar home systems/total renewable energy systems installed	Micro-hydro systems/total renewable energy systems installed	Biogas companies/ total REEs	Solar companies/ total REEs	Micro-hydro construction companies/ total REEs
Achham	257,477	48,351	-	-	-	-	-	3,617	4	3,621	0.0%	99.9%	0.1%	0.0%	0.0%	0.0%
Arghakhanchi	197,632	46,835	-	-	-	-	15	830	-	845	1.8%	98.2%	0.0%	0.0%	0.0%	0.0%
Baglung	268,613	61,522	-	-	1	1	59	70	8	137	43.1%	51.1%	5.8%	0.0%	0.0%	100.0%
Baitadi	250,898	45,191	-	-	-	-	-	2,875	2	2,877	0.0%	99.9%	0.1%	0.0%	0.0%	0.0%
Bajhang	195,159	33,786	-	-	-	-	95	2,665	10	2,770	3.4%	96.2%	0.4%	0.0%	0.0%	0.0%
Bajura	134,912	24,908	1	-	-	1	-	790	5	795	0.0%	99.4%	0.6%	100.0%	0.0%	0.0%
Banke	491,313	94,773	4	2	-	6	562	2,244	-	2,806	20.0%	80.0%	0.0%	66.7%	33.3%	0.0%
Bara	687,708	108,635	1	-	-	1	436	446	-	882	49.4%	50.6%	0.0%	100.0%	0.0%	0.0%
Bardiya	426,576	83,176	2	-	-	2	1,300	113	-	1,413	92.0%	8.0%	0.0%	100.0%	0.0%	0.0%
Bhaktapur	304,651	68,636	1	-	3	4	6	-	-	6	100.0%	0.0%	0.0%	25.0%	0.0%	75.0%
Bhojpur	182,459	39,419	-	-	-	-	16	1,299	7	1,322	1.2%	98.3%	0.5%	0.0%	0.0%	0.0%
Chitawan	579,984	132,462	7	1	1	9	1,309	1,147	-	2,456	53.3%	46.7%	0.0%	77.8%	11.1%	11.1%
Dadeldhura	142,094	27,045	1	-	-	1	2	621	2	625	0.3%	99.4%	0.3%	100.0%	0.0%	0.0%
Dailekh	261,770	48,919	2	-	-	2	-	7,899	2	7,901	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%
Dang	552,583	116,415	2	1	-	3	1,223	2,005	-	3,228	37.9%	62.1%	0.0%	66.7%	33.3%	0.0%
Darchula	133,274	24,618	-	-	-	-	13	1,592	-	1,605	0.8%	99.2%	0.0%	0.0%	0.0%	0.0%
Dhading	336,067	73,851	4	-	1	5	946	1,239	3	2,188	43.2%	56.6%	0.1%	80.0%	0.0%	20.0%
Dhankuta	163,412	37,637	-	-	-	-	6	18	1	25	24.0%	72.0%	4.0%	0.0%	0.0%	0.0%
Dhanusa	754,777	138,249	1	-	-	1	55	9	-	64	85.9%	14.1%	0.0%	100.0%	0.0%	0.0%
Dolakha	186,557	45,688	-	-	-	-	122	134	1	257	47.5%	52.1%	0.4%	0.0%	0.0%	0.0%
Dolpa	36,700	7,488	-	-	-	-	-	384	1	385	0.0%	99.7%	0.3%	0.0%	0.0%	0.0%
Doti	211,746	41,440	1	-	-	1	20	2,055	1	2,076	1.0%	99.0%	0.0%	100.0%	0.0%	0.0%

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Gorkha	271,061	66,506	1	-	-	1	508	325	5	838	60.6%	38.8%	0.6%	100.0%	0.0%	0.0%
Gulmi	280,160	64,921	-	-	-	-	31	912	-	943	3.3%	96.7%	0.0%	0.0%	0.0%	0.0%
Humla	50,858	9,479	-	-	-	-	-	237	1	238	0.0%	99.6%	0.4%	0.0%	0.0%	0.0%
Ilam	290,254	64,502	1	-	-	1	289	190	-	479	60.3%	39.7%	0.0%	100.0%	0.0%	0.0%
Jajarkot	171,304	30,472	1	-	-	1	1	4,450	2	4,453	0.0%	99.9%	0.0%	100.0%	0.0%	0.0%
Jhapa	812,650	184,552	9	-	-	9	970	2	-	972	99.8%	0.2%	0.0%	100.0%	0.0%	0.0%
Jumla	108,921	19,303	-	-	-	-	-	1,412	4	1,416	0.0%	99.7%	0.3%	0.0%	0.0%	0.0%
Kailali	775,709	142,480	1	-	1	2	2,156	4,115	-	6,271	34.4%	65.6%	0.0%	50.0%	0.0%	50.0%
Kalikot	136,948	23,013	1	-	-	1	17	2,813	3	2,833	0.6%	99.3%	0.1%	100.0%	0.0%	0.0%
Kanchanpur	451,248	82,152	2	1	-	3	1,094	161	1	1,256	87.1%	12.8%	0.1%	66.7%	33.3%	0.0%
Kapilbastu	571,936	91,321	2	-	-	2	355	11	-	366	97.0%	3.0%	0.0%	100.0%	0.0%	0.0%
Kaski	492,098	125,673	4	-	4	8	589	32	-	621	94.8%	5.2%	0.0%	50.0%	0.0%	50.0%
Kathmandu	1,744,240	436,344	8	50	32	90	14	-	-	14	100.0%	0.0%	0.0%	8.9%	55.6%	35.6%
Kavrepalanchok	381,937	80,720	5	-	-	5	655	261	5	921	71.1%	28.3%	0.5%	100.0%	0.0%	0.0%
Khotang	206,312	42,664	-	-	-	-	11	765	6	782	1.4%	97.8%	0.8%	0.0%	0.0%	0.0%
Lalitpur	468,132	109,797	4	11	13	28	104	18	-	122	85.2%	14.8%	0.0%	14.3%	39.3%	46.4%
Lamjung	167,724	42,079	3	-	-	3	717	196	6	919	78.0%	21.3%	0.7%	100.0%	0.0%	0.0%
Mahottari	627,580	111,316	4	-	-	4	205	31	-	236	86.9%	13.1%	0.0%	100.0%	0.0%	0.0%
MakWanpur	420,477	86,127	2	-	3	5	1,945	1,439	-	3,384	57.5%	42.5%	0.0%	40.0%	0.0%	60.0%
Manang	6,538	1,480	1	-	-	1	-	-	-	-	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Morang	965,370	213,997	4	1	1	6	500	147	-	647	77.3%	22.7%	0.0%	66.7%	16.7%	16.7%
Mugu	55,286	9,619	-	-	-	-	-	640	-	640	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Mustang	13,452	3,354	-	-	-	-	-	16	-	16	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Myagdi	113,641	27,762	-	-	-	-	46	479	1	526	8.7%	91.1%	0.2%	0.0%	0.0%	0.0%
Nawalparasi	643,508	128,793	2	-	-	2	507	1,123	3	1,633	31.0%	68.8%	0.2%	100.0%	0.0%	0.0%
Nuwakot	277,471	59,215	2	-	1	3	463	87	-	550	84.2%	15.8%	0.0%	66.7%	0.0%	33.3%

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Okhaldhunga	147,984	32,502	1	-	-	1	43	1,077	8	1,128	3.8%	95.5%	0.7%	100.0%	0.0%	0.0%
Palpa	261,180	59,291	-	-	-	-	378	1,117	2	1,497	25.3%	74.6%	0.1%	0.0%	0.0%	0.0%
Panchthar	191,817	41,196	-	-	-	-	40	1,323	5	1,368	2.9%	96.7%	0.4%	0.0%	0.0%	0.0%
Parbat	146,590	35,719	-	-	-	-	7	30	-	37	18.9%	81.1%	0.0%	0.0%	0.0%	0.0%
Parsa	601,017	95,536	-	-	-	-	99	82	-	181	54.7%	45.3%	0.0%	0.0%	0.0%	0.0%
Pyuthan	228,102	47,730	1	-	-	1	146	1,242	-	1,388	10.5%	89.5%	0.0%	100.0%	0.0%	0.0%
Ramechhap	202,646	43,910	2	-	-	2	185	1,285	2	1,472	12.6%	87.3%	0.1%	100.0%	0.0%	0.0%
Rasuwa	43,300	9,778	-	-	-	-	105	69	-	174	60.3%	39.7%	0.0%	0.0%	0.0%	0.0%
Rautahat	686,722	106,668	2	-	-	2	179	800	-	979	18.3%	81.7%	0.0%	100.0%	0.0%	0.0%
Rolpa	224,506	43,757	-	-	-	-	-	6,138	5	6,143	0.0%	99.9%	0.1%	0.0%	0.0%	0.0%
Rukum	208,567	41,856	1	-	-	1	-	5,901	3	5,904	0.0%	99.9%	0.1%	100.0%	0.0%	0.0%
Rupandehi	880,196	163,916	5	-	14	19	303	-	-	303	100.0%	0.0%	0.0%	26.3%	0.0%	73.7%
Salyan	242,444	46,556	-	-	-	-	-	5,892	-	5,892	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Sankhuwasabha	158,742	34,624	-	-	-	-	11	832	1	844	1.3%	98.6%	0.1%	0.0%	0.0%	0.0%
Saptari	639,284	121,098	2	-	-	2	19	136	-	155	12.3%	87.7%	0.0%	100.0%	0.0%	0.0%
Sarlahi	769,729	132,844	-	-	-	-	493	828	-	1,321	37.3%	62.7%	0.0%	0.0%	0.0%	0.0%
Sindhuli	296,192	57,581	2	-	-	2	708	3,320	10	4,038	17.5%	82.2%	0.2%	100.0%	0.0%	0.0%
Sindhupalchok	287,798	66,688	1	-	-	1	137	165	1	303	45.2%	54.5%	0.3%	100.0%	0.0%	0.0%
Siraha	637,328	117,962	1	-	-	1	61	139	-	200	30.5%	69.5%	0.0%	100.0%	0.0%	0.0%
Solukhumbu	105,886	23,785	-	-	-	-	5	255	4	264	1.9%	96.6%	1.5%	0.0%	0.0%	0.0%
Sunsari	763,487	162,407	3	-	1	4	124	34	-	158	78.5%	21.5%	0.0%	75.0%	0.0%	25.0%
Surkhet	350,804	72,863	1	1	1	3	211	5,365	-	5,576	3.8%	96.2%	0.0%	33.3%	33.3%	33.3%
Syangja	289,148	68,881	1	-	-	1	433	123	-	556	77.9%	22.1%	0.0%	100.0%	0.0%	0.0%
Tanahu	323,288	78,309	6	1	1	8	716	466	-	1,182	60.6%	39.4%	0.0%	75.0%	12.5%	12.5%
Taplejung	127,461	26,509	-	-	-	-	19	721	4	744	2.6%	96.9%	0.5%	0.0%	0.0%	0.0%
Terhathum	101,577	22,094	-	-	-	-	33	59	1	93	35.5%	63.4%	1.1%	0.0%	0.0%	0.0%
Udayapur	317,532	66,557	-	-	-	-	295	2,566	3	2,864	10.3%	89.6%	0.1%	0.0%	0.0%	0.0%

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