Effect of Rural Electrification on Growth of Small Enterprises: Nepal Electricity Authority's Distribution Centres (NEA-DCs) vs Community Rural Electrification Entities (CREEs)

Abstract:

This paper reports the findings of a study carried out by Winrock International (supported by the Energy and Economic Growth Applied Research Programme (EEG) managed by Oxford Policy Management and funded by FCDO) that examined the impact of two different systems of electricity distribution on the growth of economic enterprises and local employment generation in rural Nepal. The study has adopted a comparative analysis framework. A total of four geographic areas were selected. In each area two study sites were then identified – one involving a traditional utility-managed distribution system under the auspices of The Nepal Electricity Authority's Distribution and Consumer Services business unit (DCS) and one a community-managed system run as a Community Rural Electrification Entity (CREE). Each pair of sites were selected to be as similar as possible to each other, based on criteria that included: location, number of households, years of system operation, ease of access to market, operational model, access to revolving fund, and whether the system was agency supported.

Using a number of different metrics the results showed that in 3 out of the 4 study sites, the track record for establishing and growing enterprises post-electrification was better in CREE-managed supply areas than in DCS-managed supply areas. A similar trend was found in terms of local employment generation too. When looking at the role electrification may have played in enterprise establishment the study categorized enterprises as having a high, medium or low dependency on electricity and concluded that a greater number of high and medium electricity-dependent enterprises are found in CREE-managed supply areas than in DCS managed supply areas. Finally, the study found that CREEs are more responsive to consumers' needs than the traditional utility model, are quicker to issue new connections, and provide quicker power restoration service when minor faults occur. CREE-managed systems are not entirely independent and still have to rely on the utility for major repairs.

1. Introduction

There are several electricity distribution systems in the world including fully government-owned utilities, private monopolies, and community-based organizations. The distribution of electricity in Nepal is dominated by a quasi-government utility: the Nepal Electricity Authority (NEA). NEA is involved in generation, transmission, and distribution of electricity. The Distribution and Consumer Service (DCS) unit is the business unit within NEA responsible for the distribution of electricity. The DCS is the largest business unit within NEA in terms of number of

employees (67% of the total NEA staff) and in terms of revenue generation. DCS provides services to consumers through its 129 distribution centres spread over the entire country (NEA 2020[1]).

Historically, due to a lack of adequate capital and to losses incurred from rural electrification, the DCS unit was not able to fully meet the growing demand of new consumers for electricity in rural Nepal. As a result people were having to wait for a long time to get an electricity connection. Consequently, electricity consumers began to get together and form community organizations to manage electricity distribution in their area. NEA Electricity By-Law, 2060 (2003) provided a legal basis for these community organizations to distribute electricity. Community organizations formed in line with this legislation are known as Community Rural Electrification Entities (CREEs). More than 300 CREEs have been registered in Nepal so far out of which 285 CREEs are currently operational. The majority of CREEs are registered as non-governmental organizations (145 as NGOs), while 130 are registered as cooperatives, 8 are run by local governments and 2 as private companies. CREEs purchase electricity in bulk from the NEA at a wholesale (reduced) price and sell it to their consumers as per the national NEA tariff. The CREEs have to cover all management, repair, and maintenance costs from the gross income (NEA wholesale price minus retail price) they generate by selling electricity.[2] The operational cost of a CREE is expected to be lower than that of DCS. Each CREE is run by a small number of staff (a manager, line maintenance technicians, meter reader, and accountant) who are often hired from among their consumers with lower salary and benefits than DCS employees, and much lower overhead costs as CREEs do not spend much in purchase and maintenance of vehicles and office buildings. Some CREEs also receive support from development organizations such as ADB and GIZ and from their own umbrella organization, the National Association of Community Electricity Users Nepal (NACEUN), in the form of management and operation training and advice.

The DCS and CREEs have different financial and technical capabilities. In general, the DCS units have a higher technical capability than CREEs as they are staffed with graduate engineers and technical manpower from other units of NEA are available to provide backstopping services, if needed. While CREEs do not have access to graduate engineers, the study found that they have a higher number of semi-skilled technicians per thousand households for servicing their customer base than the DCS units do. The financial capability of DCS units tends to be higher than that of CREEs, as the DCS units have access to vehicles and equipment and receive a regular operational budget from the NEA head office. However, the management and staff of CREEs have more of an incentive to respond to consumer needs than NEA staff as CREE personnel are also local consumers of electricity and so have a greater sense of ownership of the local distribution systems. The requirement by NEA that CREE communities provide a

[1] https://www.nea.org.np/admin/assets/uploads/annual_publications/Annual_report_2020.pdf

[2] The CREE can decide tariffs for its customers but is not allowed to charge higher than the regular NEA consumer tariffs.

'matching fund' deposit before a connection can be made to a transmission line further strengthens the local sense of ownership of CREE-managed distribution systems.[3]

CREEs also differ from DCS units in that CREEs have the potential to benefit from another 'virtuous' incentive – profitability, whereas DCS units do not. CREEs become more profitable as they sell electricity to more electricity-intensive consumers. The NEA tariff, which CREEs are required to stay within, follows an increasing block structure. This means that customers within higher consumption brackets pay a higher rate per kilowatt-hour than those at lower and lifeline brackets. At the same time the wholesale rate at which CREEs purchase electricity from NEA is set at a rate just below the lifeline tariff. This means that while a CREE will just break even if all its customers are within the lifeline tariff, its profit increase if it is able to increase the average kilowatt-hours used per month by residential consumers and / or sell a larger percentage of electricity to higher consuming customers such as enterprises. CREEs are able to utilize any profits they make from selling electricity to benefit their customers and members, whereas DCS units are not designed to operate as an independent profit-making entities. CREEs that are registered as cooperatives will typically share profit as a dividend among members. CREEs which are registered as NGOs can either use any generated surplus for other social activities, or can opt to discount tariffs to their customers.

One of the hypotheses of this study was that the differences in incentives and capabilities outlined above could have differential impacts on the CREE and DCS system performance. An earlier working paper published by this study examined the impacts of DCS and CREE management systems on key performance indicators such as gender and social inclusion, access to reliable electricity, access to an electricity connection, availability of financing, etc. This paper examines impact of DCS versus CREE models of electricity distribution on the growth of economic enterprises and job creation, a key indicator of economic growth. Past studies have shown that electricity use can have a positive impact on key indicators of economic growth such as gross domestic product, enterprise formation, job creation etc. (NRC, 1986; Grimm, Hartwig, and Lay, 2013). The main proposition of this paper is that the institutional arrangements of electricity distribution systems could have different impacts on economic activities among their consumers and consequently, different impacts on economic growth.

The remaining part of this paper is organized as follows: Section 2 presents the study's research questions and hypothesis; Section 3 describes the study methodology; Section 4 discusses the findings of the study; and the final section presents the conclusions of the study.

[3] After the CREE submits an official request for extension of a distribution network for rural electrification, the Community Rural Electrification Department (CRED) under NEA initiates a survey and estimates cost. Then the CREE are required to deposit 10% share of the total costs of constructing the network. This contribution of funds creates a sense of ownership among CREEs members over their networks.

2. Research Questions and Hypothesis

This study aimed to answer the following three questions and associated hypotheses:

- What differences are there, if any, in the number of enterprises enabled to start up by access to electricity between areas electrified by CREEs vs DCS?

- What differences are there, if any, in the types and sizes of enterprises enabled by access to electricity between CREE and DCS supplied areas?

- Which factors might be responsible for any documented differences in either quantity or quality of enterprises enabled by access to electricity through the two modalities?

The study's hypothesis is that easy access to connections and a reliable supply of electricity induces entrepreneurs to start new enterprises, which in turn, creates new jobs. Less bureaucracy, better incentives, and ready access to technical support from CREEs provides a more conducive environment for enterprise creation than DCS management can provide. Therefore, proportionately more enterprises, and in particular more enterprises highly dependent on electricity, will be found in CREE-manages distribution systems than in DCS-managed distribution systems.

3. Study area and methodology

The study has adopted a comparative analysis framework. Section 3.1 describes selection of study areas, section 3.2 the methodology and section 3.3 some of the limitations faced by the study.

3.1 Selection of study areas

A total of five CREEs were initially selected. Given that this study was about the impact of electricity access on the creation and growth of enterprises, one key selection criteria was that each location had to be no more than two hours walking distance from some form of market. The original aim was to sample CREEs from the three main geographical zones of Nepal: the Mountains, the Middle Hills and the southern plains or Terai. However the number of CREEs in mountain locations that fitted the basic selection criteria of being within two hours walking distance of a market was so small (just one fitted this criteria) that a study of that location could not be considered a representative case study of mountain CREEs in general. For that reason the study focused instead on CREEs located in the middle hills and Terai regions only.

Another key criteria for site selection was that, in order to ensure enterprises had a reasonable time to emerge and develop pot-electrification, all CREEs selected had to be in operation for at least 5 years prior to the study.

Although five CREE locations were originally picked one (Butwal) was dropped after survey work was carried out because, due the size of the population in that location, it was not possible to survey all enterprises. As a result of data being incomplete it was not possible to make meaningful comparisons between the Butwal site and the other four sites surveyed (in all other cases all enterprises in a CREE location were surveyed), and so the Butwal site was dropped, leaving just data from four CREEs to be analysed for this study.

Beyond the three criteria basic CREE selection criteria outlined above (geographic zone maximum distance from market, operational for at least 5 years), CREE sites were selected to offer the opportunity to study the impact of a range of possible variables that it was felt could impact on enterprise creation. These are set out in Table 1.

Table 1: Additional CREE selection criteria

S. No.	CREE selection Criteria	Purpose of selection criteria
1	Number of households	The total number of households in each CREE is used as a proxy for the transformer size serving the communities for its coverage in the area.
2	Operational model (NGO or Cooperatives)	The goal here was to select at least one CREE structured as an NGO and one CREE structured as a cooperative in each of the Hills and Terai region, to ensure a comparison was possible.
3	CREE supported by the developmental agencies for livelihood development	To compare the economic activities between the areas that were supported by developmental agencies with that did not have agency support
4	Access to revolving fund	To compare the economic activities between CREEs that have access to a revolving fund (known to be supported by GiZ for some CREEs) with CREEs that do not have access to the revolving fund (note there is no provision for revolving funds made for DCS communities).

For each of the four CREEs eventually selected using the above criteria, an adjoining DCS area with similar socio-economic status was selected in order to make a comparative study of the impact of different electricity distribution systems (CREE vs DCS) on the growth of economic enterprises. Where more than one NEA-DCS-served community existed in the vicinity of a selected CREE community, the NEA-DCS-served community that was closest to the CREE-served community in terms of size, culture, and economy was selected. Figure 1 shows locations of final selection of study areas in Nepal.

Figure 1: Study locations

Table 2 below lists the locations and key characteristics of the final CREEs and paired DCS locations selected.

Table 2: Selection of CREEs and DCS localities

District	CREE Name	CREE Location	No. of HH	Type	Operation Year	Revolving Fund	Nearest Market	Agency Support	DCS Name	DCS Location
Syangja	Samudayik Gramin Urja/ Biruwa	Biruwa 1,2,3,5,8	1200	Cooperative	2006	Yes	Biruwa market	GIZ/EnDev/ Helvetas	Syangja	Bhirkot 3
Tanahu	Ekikrit	Bhimad 7,9	1200	NGO	2006	Yes	Bhimad market	Hiefer International	Lekhnath	Bhimad 8
Dhading	Amilichhap	Siddhalek 7	600	NGO	2006	No	Highway market	ENERGIA/ HIVOS	Dhading	Siddhalek 7
Parsa	Gadi	Paterwa Sugauli 2	540	NGO	2009	Yes	Rangpur Tadi	Action Aid	Pokhariya	Paterwa sugauli 4

3.2 Study Methodology

A comparative analysis approach was used for the study. The study methodology consisted of a literature review, a structured questionnaire survey (household and enterprise), key informant interviews, focus groups discussions, field observations and consultations with sectoral experts. A review of secondary data and documents helped with the design of the data collection approach and tools.

The enterprise survey was the main source of information on enterprises. The study identified and interviewed all enterprises in the study areas using a structured questionnaire.

Household level information wad collected using a structured questionnaire survey of 770 randomly selected households in the study areas (385 households each in CREE and DCS areas).

Focus group discussions, key informant interviews, and field observations were used to validate data collected through enterprise and household surveys and also to collect additional information. A participatory process was ensured by engaging project beneficiaries, local government authorities, and local partner organizations in the study. Table 3 summarises the data requirements for the study and the collection tools utilized.

Table 3: Data Requirements and collection tools

Parameters	**Indicators**	**Data Collection Tool**
General Information on the area	• Education level of the respondent • Family structure • Occupation • Income level • Ethnicity	Household questionnaire survey
Enterprises	• No of enterprises established (before or after electrification) • Employees (based on gender and ethnicity, before and after electrification) • Ownership of enterprises (disaggregated by gender, ethnicity) • Types of enterprise • Investment Size of enterprise	Enterprise questionnaire survey
Access to Electricity Connection	• Days required for enterprises to get electrical connections from the distribution company (for 1-phase and a 3-phase connection) • Days required for upgrading meters • Connection costs	Household and Enterprise questionnaire survey, Key Informant Interviews (KII) with officials from distribution company
Quality and Reliability of Power Supply	• Voltage issues • Power interruption • Time taken to resolve issues • Regularity of distribution lines maintenance	Household and Enterprise questionnaire survey, Focus Grou0p Discussion (FGD), KII
Management Services	• Paperwork required to get connection • Utility bill payment system • Health and safety awareness • Regular patrolling of distribution lines	Household and Enterprise questionnaire survey, FGD, KII
Promotional Activities by Distribution Company	• Advisory services on legal requirements for registering enterprises • Advisory services for enterprise development and market promotion • Technical advisory services on specifications of electrical machinery and where to source them	Enterprise survey, FGD and KII

	• Financial advisory services on financing for the enterprise • Financial incentives to staffs to promote enterprises and electricity consumption	
Income Generating Activities	• Income generating activities (before and after electrification) • Sales, production, expenses, time (before and after electrification) • Support from CREE/DCs or any other organizations for income generation activities	Household questionnaire survey
Availability of Financing	• Existence of micro finance institutions (MFIs)to provide loans to enterprises • Support from DCs/CREEs to access loans for enterprise development (from MFIs, banks, or savings and credits groups) • Presence of revolving fund	Enterprise survey, FGD, KII
Development Initiatives in Project Areas	• Types of donor-funded programs and focus area of support (access, enterprise, GESI, market linkage, livelihood) • Skill trainings provided by local government	FGD and KII
Information on Market Centres	• Nearby markets (distance, size) • Demand for products from enterprise in the nearby markets	FGD, field observation
Road and Transport Infrastructures	• Proximity to highways • Quality of road • Availability of transport services	FGD, field observation

3.3 Limitations of the study

This study tried to identify and document all enterprises in the study areas based on field observations by study team and information obtained from key informants. In the absence of official records, it was difficult to validate whether all the enterprises in the study areas were covered by the study or not. The onset of COVID-19 pandemic soon after the study started also hindered the free movement of study team and interactions with community. Under this context, it is very likely that the number of enterprises may have been underestimated. In the view of the study team however, only in the case of the Butwal CREE and DCS sites was this under-sampling of enterprises so significant that it made completion of analysis and comparison with other sites meaningless, causing that location to be dropped from the study (see also section 3.1 above).

With the funding available it was not possible to survey sufficient locations to provide a statistically significant sample and a more rigorous statistical treatment of the data. As such this remains a set of observational case studies that suggests potential association between study variables, but does not establish or confirm correlation or causality.

4. Findings and Discussion

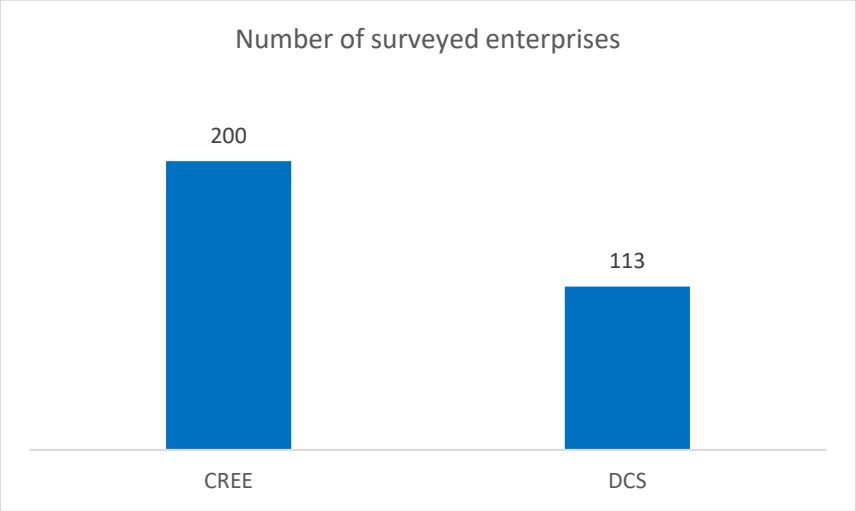
This section presents the findings of the study.It examines the differences in the number, types, and size of enterprises in CREE and DCS areas and also identifies factors that may explain such differences.

4.1 Enterprise Development and Employment Generation

4.1.1 Enterprise Development

Figure 2 shows the total number of enterprises recorded across all CREE and DCS areas surveyed. The number of enterprises in CREE area was 1.76 times more than the number of enterprises in DCs area.

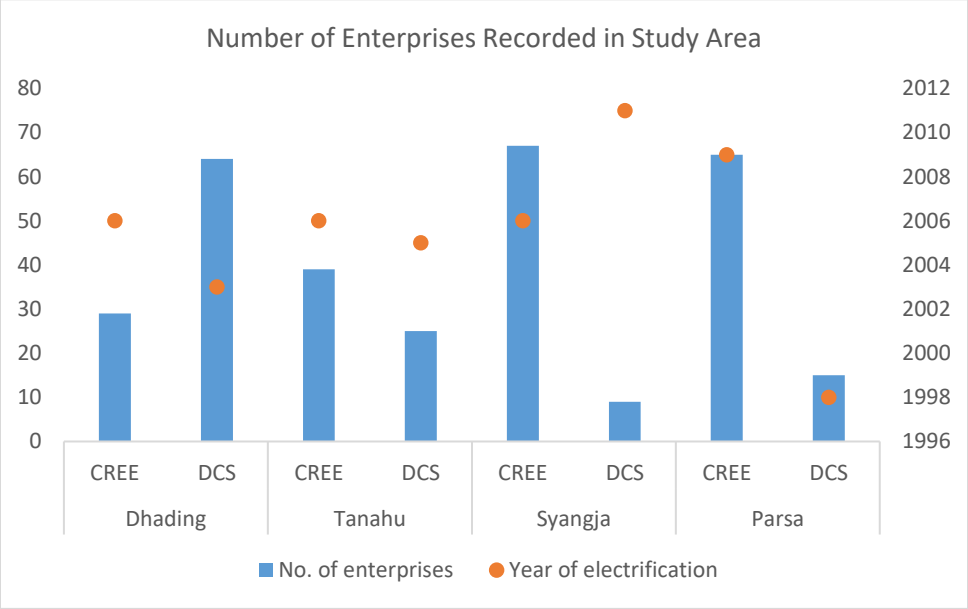
Figure 2: Total Number of Enterprises Recorded in Study Area



Source: Enterprise Survey.

Figure 3 below shows the number of enterprises recorded and interviewed in each of the four study sites, as well as the year of electrification of each site. The research team was able to survey vast majority, if not all, of the enterprises in the studied CREEs and DCs communities at all sites. As the figure shows, there were more enterprises in CREE areas than in corresponding DCS areas in Tanahu, Syangja, and Parsa districts. The situation in Dhading was reverse as there were more enterprises in the DCS area than in the CREE area.

Figure 3: *Number of enterprises recorded in CREE and DCS study areas and year of electrification*



Source: Enterprise Survey.

Table 4 presents number of households per enterprise in study area. The size of the local community is likely to have some bearing on establishment of enterprises as it is an indicator of the potential size of the local market for products or services. The absolute numbers of enterprises at different locations could therefore could be influenced by local population size, making direct comparison between locations less meaningful. To take account of this, the number of enterprises recorded in each location is divided into the local population figure[4] to give a 'number of households per enterprise' figure also in table 4. Locations with lower figures for number of households per enterprise would suggest a higher density of business (and thus relatively more success enterprise creation) than locations with higher numbers of households per enterprise. On this basis CREE locations have been more successful at creating enterprises than DCS locations in Parsa, Syangja, and Tanahu districts, whereas the reverse was found to be true in Dhading district.

[4] The number of households in each survey area for Dhading, Tanahu, Syangja and Parsa was taken from the respective ward office.

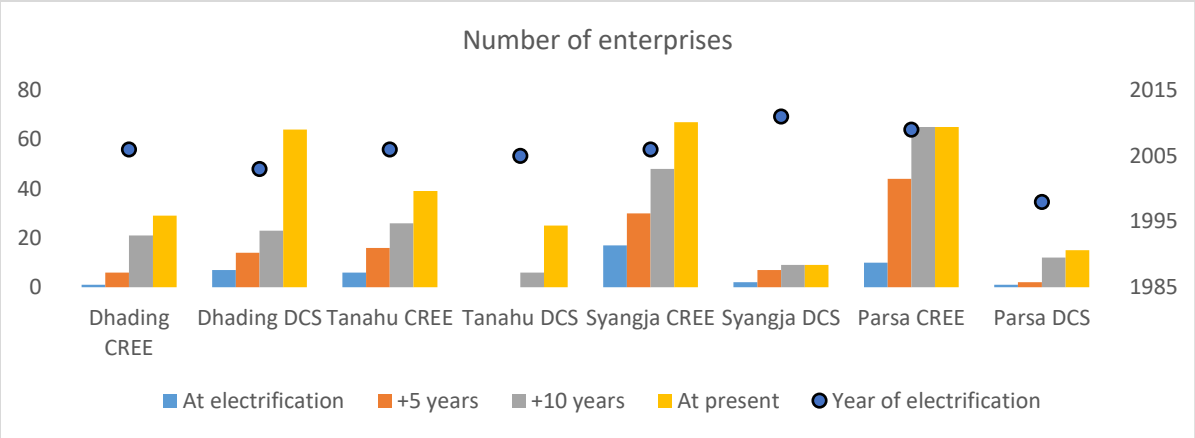
Table 4: Number of households per enterprise in each study area

Districts	**Survey area** (Village and ward number in brackets)	**Number of Households**	**Total Number of Enterprises**	**Number of HHs per Enterprise**
Dhading	CREE (Siddhalek 7)	650	29	22.4
	DCS (Siddhalek 7)	600	64	9.3
Tanahu	CREE (Bhinad 9)	628	38	16.5
	DCS (Bhimad 8)	667	25	26.7
Syangja	CREE (Biruwa 1)	386	67	5.7
	DCS (Bhirkot 3)	300	9	33.3
Parsa	CREE (Paterwa Sugauli-2)	540	62	8.7
	DCS (Paterwa Sugauli-4)	1261	15	84.1

Source: Field survey, 2020; Official records of Ward office.

Figure 4 presents data on the growth of enterprises in study areas. It shows the number of enterprises at each location at the point of electrification and then at five and ten years after electrification as well as at the time of the current survey. The number of enterprises in both the CREEs and DCS communities have risen significantly after the electrification. There were some enterprises that were not dependent on electricity running in the study areas (such as grocery stores, tea shops, restaurants etc.) before electrification. Households in Biruwa market (Syangja CREE) already had access to electricity from locally run Micro Hydro Power Plant (for lighting) before the CREE was established. Therefore, we can see that there were relatively more enterprises prior to grid electrification at that location than at others. However, these enterprises were mostly grocery shops, tea shops and clothing stores.

Figure 4: Growth of enterprises in study area



In most of the CREE and DCS locations, a lag of few years has been observed between year of electrification and the establishment of enterprises. Anecdotal evidence from surevys suggests that it typically takes 2-3 years after the establishment of a CREE for such changes to occur. The reasons for the lag could be because the CREEs were initially established with only a local vision of provision of lighting services, with local people not having much knowledge of the potential for using electricity to develop or expand income generation activities. Another reason for slow initial take up of electricity for enterprise activity may be that, in any CREE location, not all areas were electrified at once, with it taking a couple of years typically to electrify the whole of each present-day CREE area. During this period it is likely that, gradually, people realized the prospects for the productive use of electricity and started establishing businesses. A time lag between electrification and enterprise creation taking off is also seen in DCS areas. Another way of looking at this data is to consider the rate of creation of new enterprises (in terms of new businesses created per year) between the date of electrification and the present day. Table 5 demonstrates that, by this measure **CREE locations have achieved greater rates of creation of new business per year than DCS locations in all instances except Dhading**, Where the reverse is true.

Table 5: Growth of enterprise in different study areas

	Dhading CREE	Dhading DCS	Tanahu CREE	Tanahu DCS	Syangja CREE	Syangja DCS	Parsa CREE	Parsa DCS
Year of electrification	2006	2003	2006	2005	2006	2011	2009	1998
At electrification	1	7	6	0	17	2	10	1
At present	29	64	39	25	67	9	65	15
Average number of new enterprises per year since electrification	1.86	3.16	2.2	1.56	3.33	0.7	4.5	0.60

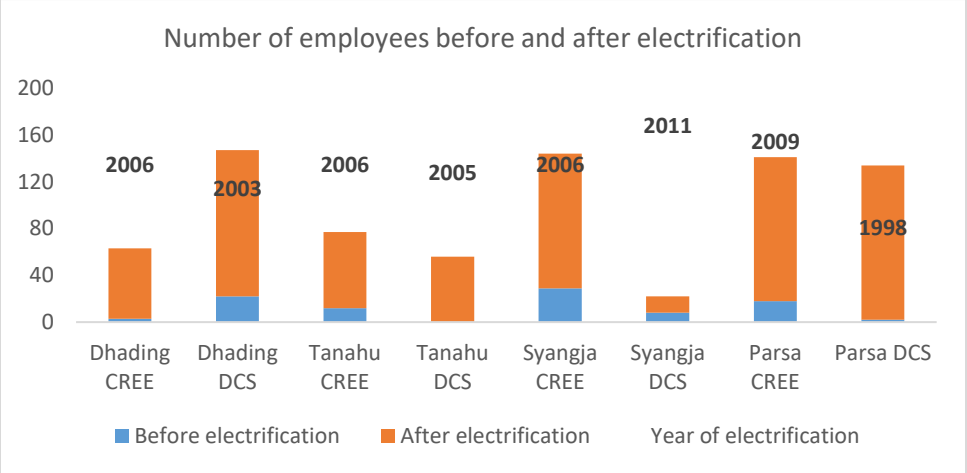
Source: Field survey, 2020.

4.1.2 Employment Generation

Local employment has also grown after electrification and, as would be expected, the trend is similar to the increase in number of enterprises. In most cases, the enterprises are family-owned businesses and run by one or two members of the family, mainly owner and the spouse. In some enterprises, such as carpentry shops and metal grill works, people from outside the family are also employed. The employees in these cases are mostly locals, however sometimes people from other places are also brought in when there is lack of manpower with the required skills.

Figure 5 shows the number of employees before and after electrification. Again, as was the case with the number of enterprises, Figure 5 shows that the number of employees has increased greatly after electrification in both DCS and CREE electrified areas.

Figure 5: Number of employees before and after electrification



Source: Field survey, 2020.

Again, as was the case with new enterprise creation, **the rate of increase in job per annum is higher at CREE locations than at DCS locations, with the exception of Dhading** (see table 6).

Table 6: Number of employees before and after electrification

	Dhading CREE	Dhading DCS	Tanahu CREE	Tanahu DCS	Syangja CREE	Syangja DCS	Parsa CREE	Parsa DCS
Year of electrification	2006	2003	2006	2005	2006	2011	2009	1998
At electrification	2	22	11	0	31	3	18	2
At present	60	125	65	56	119	14	123	35
Average number of new employees per year since electrification	3.86	5.72	3.60	3.50	5.86	1.1	8.75	1.43

Source: Field survey, 2020.

4.2 Types and Sizes of Enterprises in CREEs and DCSs Locations

4.2.1 Types of Enterprises

Enterprises can be categorised in terms of their level of dependence on access to electricity. This study established three levels of dependence (high, medium and low) for the purpose of

analysis. Table 7 shows the different types of enterprises found in the study areas, grouped by level of electricity dependence. The survey results show that grocery stores (a low electricity dependent type of enterprise) are the most common type of business established across the study areas, accounting for 30% of businesses in CREE locations and over 50% of businesses in DCS locations. This is followed by restaurants and hotels (classified as having medium levels of dependency on electricity). Poultry farming, carpentry workshops and and rice mills were the most common high electricity dependent enterprises found across the study areas.

Table 7 illustrates that the proportion of enterprises with a high dependency on electricity is far greater across all CREE locations than across all DCS locations (30% of CREE enterprises vs just 18% of DCS enterprises), indicating that **entrepreneurs in CREE served areas are somehow better able to convert access to electricity into new forms of enterprise than those located in DCS areas.**

Table 7: Types of enterprises in CREE and DCS area

Types of Enterprises	**Dhading**		**Tanahu**		**Syangja**		**Parsa**		Average proportion of enterprises in each category	
	CREE	DCS	CREE	DCS	CREE	DCS	CREE	DCS	CREE	DCS
High electricity dependent										
Mobile repairing center	0	0	0	1	4	0	6	1	5%	2%
Rice mills/ oil mills/Spice grinding mills	4	2	2	0	1	3	3	3	5%	7%
Carpentry shop	1	3	6	2	3	0	0	0	5%	4%
Metal shop	0	0	0	0	2	0	0	1	1%	1%
Garment	0	0	0	0	0	0	0	0	0%	0%
Poultry	13	1	0	1	5	0	2	1	10%	3%
Cyber café, photo copy, printing	0	0	0	0	6	1	0	0	3%	1%
Milk chilling	0	0	0	0	0	0	1	0	1%	0%
Sub Total	**18**	**6**	**8**	**4**	**21**	**4**	**12**	**6**	**30%**	**18%**
Medium electricity dependent										
Tailoring	0	5	1	0	3	0	13	3	9%	7%
Beauty Parlor/Salon	0	2	1	1	2	0	2	0	3%	3%
Hotel/restaurant	0	4	9	4	5	0	7	2	11%	9%
Meat shop	0	1	0	0	4	0	0	0	2%	1%
Medical shop	0	1	0	0	2	0	4	0	3%	1%
Vehicle workshop	0	0	0	0	1	0	4	2	3%	2%
Sub Total	**0**	**13**	**11**	**5**	**17**	**0**	**30**	**7**	**29%**	**22%**
Low electricity dependent										
Livestock farming	0	0	0	0	1	0	0	0	1%	0%
Vegetable farming	0	0	0	0	0	0	1	0	1%	0%
Grocery shop	11	38	20	16	10	5	18	1	30%	53%
Fish farming	0	0	0	0	0	0	0	1	0%	1%
Metal smith	0	0	0	0	0	0	1	0	1%	0%
Jewellery shop	0	0	0	0	3	0	0	0	2%	0%
Other shops	0	7	0	0	15	0	3	0	9%	6%
Sub Total	**11**	**45**	**20**	**16**	**29**	**5**	**23**	**2**	**42%**	**60%**
Total	**29**	**64**	**39**	**25**	**67**	**9**	**65**	**15**		

Source: Field survey, 2020.

Table 8 brings together information from tables 5 and 7 to examine the rate of growth of enterprises with different levels of electricity dependency since electrification. It assumes that all 44 enterprises

listed in Table 5 as pre-existing at the point of electrification must, by definition, be low electricity dependent[5].

Table 8: Growth of enterprises with different levels of electricity dependency since electrification

Level of electricity dependence	Number of enterprises at CREE locations			Number of enterprises at DCS locations		
	At electrification	Now	Growth	At electrification	Now	Growth
High	0	59	+59	0	20	+20
Medium	0	58	+58	0	25	+25
Low	34	83	+49	10	68	+58
Total	34	200	+166	10	113	+103

What is clear from Table 8 is that **there has been significant growth in enterprises that have a low dependency on electricity since electrification, alongside the growth in enterprises that have a medium or high dependency on electricity**. There could be at least three explanations for this. The growth in enterprises with a low dependency on electricity could be:

1. simply a reflection of national economic growth across Nepal over the period of years being viewed – i.e. growth in enterprise that would have happened even if electricity had not arrived in those locations.
2. a spill over effect from the growth of enterprises with medium and high levels of dependency on electricity – i.e. electricity dependent enterprises generate revenue which circulates back into the local economy and stimulates a rise in demand also for goods and services from enterprises with low electricity dependency.
3. A combination of (1) and (2) above.

Without a control group (of communities that have received no electricity) to compare to, it is not possible to provide further insight on which of these explanations is more likely.

4.2.2 Size of Enterprises

Table 9 presents investment level and the number of enterprises in DCS and CREE areas formed after electrification. As the table shows, majority of the enterprises have been established with an investment of less than Rs 500,000 (USD 4,220). These are mostly the smaller grocery stores and tea shops/restaurants. **The table does not suggest any strong patterns for differences in levels of investment following electrification between DCS and CREE locations.** In Dhading and Tanahun the split between businesses investing less than or more than Rs500,000 is not hugely different between DCS and CREE sites, whereas in Syangja and Parsa the difference is more marked. Viewed across all four sites the differences between CREE and DCS sites largely disappears. This is somewhat counter intuitive given the differences found between DCS and CREE sites for higher vs lower electricity dependent businesses being established, as one would

[5] This is likely to not be strictly correct as some of the 31 enterprises in the Syangja CREE may have been utilising electricity from a micro hydro project for lighting prior to the arrival of the CREE managed grid connection.

expect higher electricity dependent businesses to involve additional investment costs in electrical appliances.

Table 9: Number of new enterprises established after electrification and size of investment

Districts/ Investment	Dhading		Tanahun		Syangja		Parsa		Average proportion of enterprise in each category	
	DCS	CREE	DCS	CREE	DCS	CREE	DCS	CREE	DCS	CREE
Less than or equal NPR 500K (<=USD 4220)	52 *91%*	25 *89%*	23 *92%*	30 *91%*	7 *100%*	44 *88%*	9 *64%*	45 *82%*	91 *88%*	144 *87%*
NPR 500K to 1 Crore (USD 4221 to 85K)	2 *4%*	2 *7%*	1 *4%*	2 *6%*	0 *0%*	4 *8%*	4 *29%*	7 *13%*	7 *7%*	15 *9%*
More than NPR 1 Crore (>USD 85K)	3 *5%*	1 *4%*	1 *4%*	1 *3%*	0 *0%*	2 *4%*	1 *7%*	3 *5%*	5 *5%*	7 *4%*
Total	57	28	25	33	7	50	14	55	103	166

Source: Field survey, 2020.

Relatively few enterprises that were established before electrification reported to have expanded their investment after electrification (Table 9). Out of the 44 enterprises established before electrification, only 9 (20%) expanded their operation after electrification. The number of enterprises that expanded their operation was higher in CREE area (five) than in DCS area (four), but given the small overall number involved this difference cannot be considered significant.

Table 9: Number of enterprises established before electrification and size of investment pre and post electrification to expand

Districts/Investment		**Investment made before electrification**			**Number of enterprises expanded after electrification**	**Investment made for Expansion after electrification**		
		Less than or equal NPR 500K (<=USD 4220)	**NPR 500K to 1 Crore (USD 4221 to 85K)**	**More than NPR 1 Crore (>USD 85K)**		**Less than or equal NPR 500K (<=USD 4220)**	**NPR 500K to 1 Crore (USD 4221 to 85K)**	**More than NPR 1 Crore (>USD 85K)**
Dhading	DCS	7			1	1		
	CREE	1			0			
Tanahun	DCS	0			0			
	CREE	6			2	1	1	
Parsa	DCS	1			1		1	
	CREE	6	4		0			
Syangja	DCS	2			2	2		
	CREE	14	1	2	3	1	2	

Source: Field survey, 2020.

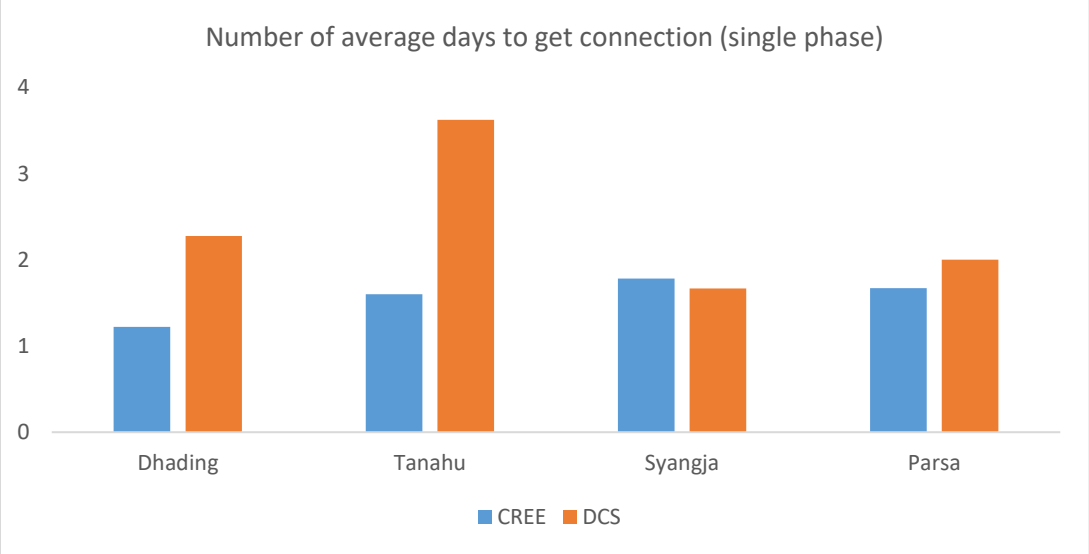
The above data suggests that **electrification has tended to lead more to investment in new enterprises as opposed to expansion of existing ones**.

4.3 Factors Responsible for Differences in the Number and Types of Enterprises in CREEs vs DCSs Area

4.3.1 Ease of Access

Access to reliable electricity in CREE and DCS was studied in terms of access to electricity connection and quality and reliability of power supply. From the questionnaire survey, the average number of days taken to get electricity connection for single phase meter was found to be slightly lower in four out of five CREEs compared to corresponding DCs (Figure 6).

Figure 6: *Days taken for electricity connection in CREE and DCS areas (Source: Field survey, 2020)*



One striking difference between obtaining an electricity connection at a CRE location as opposed to a DCS location is the amount of paperwork required. DCS offices normally require citizenship papers, landholding certificates, construction approval, a ward recommendation and photo during application, whereas CREEs only require citizenship papers, photo and recommendation from Tole Development Committee or load centre committee as proof of address. These committees are locally formed committee with residents of the area and getting their recommendation is easy since it does not involve any bureaucratic procedure. Given it doesn't require a landholding certificate, the CREE connection process also covers people living in informal settlements. While the Electricity Distribution By-law 2012 has made a provision

that allows people without landholding certificates in DCS areas to get an electricity connection, the process in that case is more complicated and will need more paperwork than an equivalent person in a CREE area (namely an additional recommendation from the respective local government and proof of construction approval).

Apart from requiring fewer documents, CREE staff also provide better support to their customers for both the new connection and for MCB upgrading, including help with filling out forms without any extra charge. DCS officials do let their customers know about the types of document they need to submit, but do not provide this sort of application support.

Variations in connection costs were found between and within CREEs and DCs. The connection charge that has to be paid to the distribution entity typically includes the cost of an application fee, the electricity meter and a service charge. Some CREEs also take membership fee. Other costs such as those for cables, connectors, miniature circuit breakers (MCB) and poles (when the household is far from an existing pole) are borne separately by consumers. Table 10 shows the one-off costs required to be paid to the distribution entity to get a new single-phase connection.

Table 10: One-off costs (in NPR) to be paid to CREE and DCS for new single-phase connection

Districts	CREE/DCS	Application fee	Membership fee	Electricity meter	Service Charge	Total
Dhading	CREE	0	0	2,000	500	2,500
	DCS	100	0	1,954	500	2,554
Tanahu	CREE	0	5,000	2,000	0	7,000
	DCS	100	0	1,954	500	2,554
Syangja	CREE	0	7,500	2,800	0	10,300
	DCS	100	0	1,954	500	2,554
Parsa	CREE	0	0	3,600	200	3,800
	DCS	100	0	1,954	500	2,554

Except for Dhading, the cost for new single-phase connection was found to be higher in CREEs. The cost for new connection was higher in Syangja and Tanahu CREEs mainly due to the membership fee, whereas it was higher in the Parsa CREE because they charge NPR 1,000 as a security deposit for the electricity meter. The membership fee was taken in CREE areas as NEA requires CREEs to contribute 10% of the capital cost of the distribution system to NEA as joint funding during the CREEs establishment. No equivalent deposit is from communities prior to

supply of electricity from DCS. The membership fee is still being taken by 2 out of 4 CREEs for new customers. Dhading and Parsa CREEs no longer charge membership fee to new customers however. The Syangja CREE, which is operated as a cooperative, has provided shares to their members against their membership fee.

All the CREEs purchase electricity meters from DCS and charge the same price for electricity meters to their members. Consumers have to buy MCBs and cables themselves in both the DCS and CREE areas. The Syangja CREE also add transportation cost to the price of electricity meter charged to consumers.

Different service charges (essentially a one-off connection fee) were found to be charged to consumers by different CREEs, whereas DCS charge the same service charge to all consumers, as per their policy. The Syangja CREE and Tanahu CREE do not take service charges separately as it is effectively included in their membership fee.

Electricity poles are very expensive compared to other items and if any consumers, whether in a DCS or CREE location has to buy electricity poles on their own, their connection cost will be very high.

CREEs are allowed to determine their own tariff rates to charge their customers, but it must not exceed the tariff set by NEA. The CREEs studied akk charged the same tariff rate as that prescribed by NEA.

With the exception of Dhading, enterprises in CREE locations pay an additional premium that is between 50% and 300% of the equivalent DCS cost to be connected to an electricity supply. Given that, amongst the study sites CREE locations seem to have fostered faster rates of growth of enterprises than the DCS ones, this higher charge does not seem to have deterred enterprise investment however.

4.3.2 Reliability of Electricity Supply

One of the reasons enterprises may be willing to pay the higher costs of connection in CREE areas may relate to the comparative reliability of supply in those areas, something that is explored further in this section.

Although there is no formal load shedding[6] throughout Nepal, frequent power interruptions and voltage issues were reported during household and enterprise survey in both the CREE and

[6] Load shedding occurs when demand exceeds supply, and some consumers have to be cut off temporarily to balance supply. Formal load shedding is when hours of supply are according to a published timetable about who will be shut off when.

DCS areas (Figure 7 and Figure 8). Figure 7 shows that the voltage problem is very high in Tanahu, both in CREE and DCS locations. Voltage drops were mainly due to longer transmission lines (common in all study sites) and due to higher loading in areas like Biruwa market (Syangja CREE). In two of the locations studied reported power interruptions were marginally worse for DCS and CREE locations, but in the other two locations the reverse was true. Figure 8 shows that the number of reported weekly power interruptions were slightly higher in all the DCS areas compared to corresponding CREEs. Power interruptions were reported to be higher during storms, heavy rains and lightning.

What is important to note here is that at least some of the problems of voltage drops and blackouts may not be something that the local distribution entity (either CREE or DCS) has much control over, as they can be affected by the state and capacity of the transmission network.

Figure 7: : household and enterprises reporting voltage issues

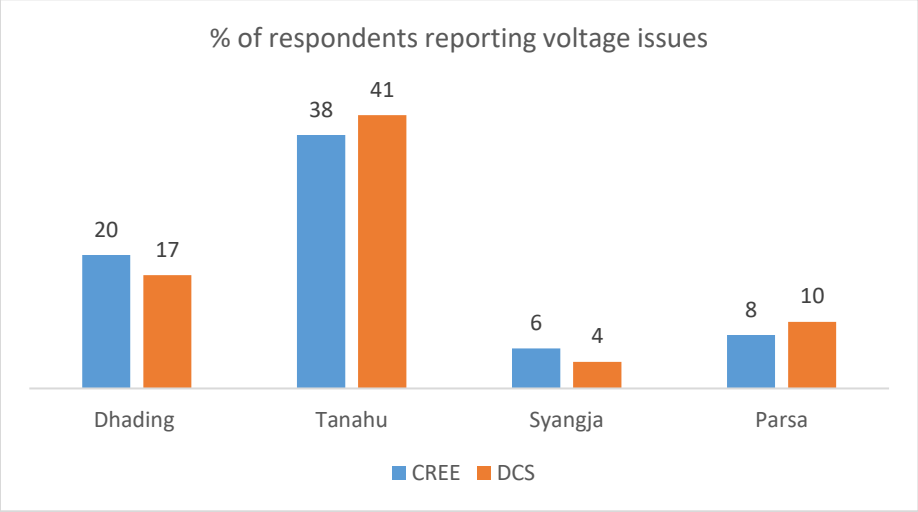
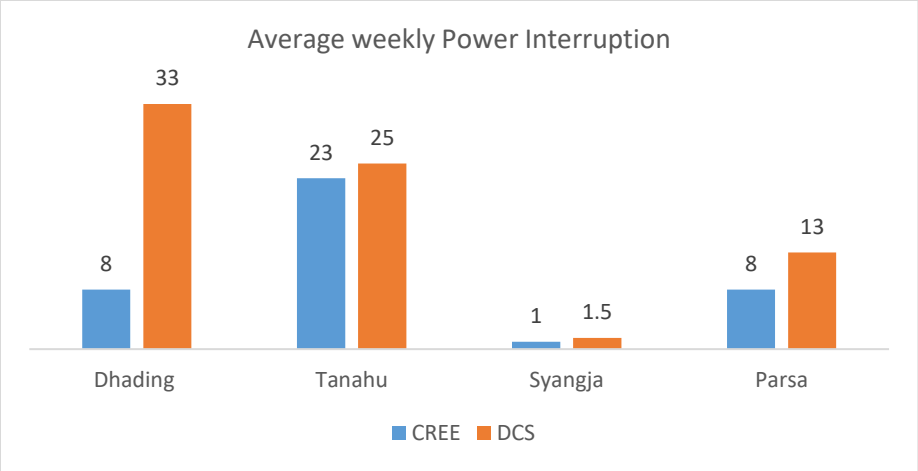


Figure 8: *Average number of weekly power interruptions*

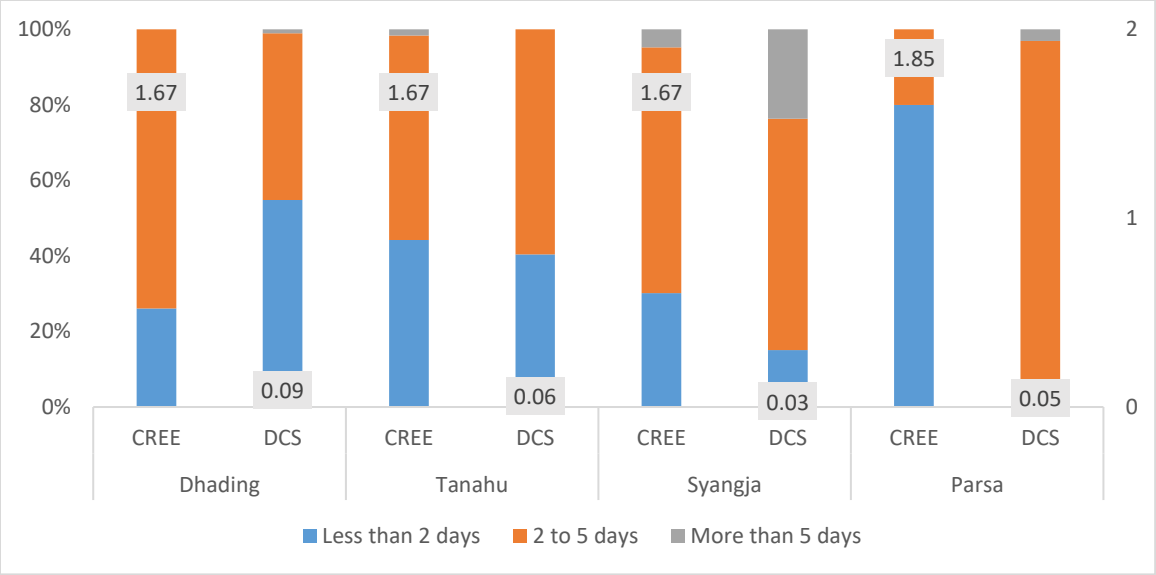


Neither CREEs or DCS offices t have provision for scheduled distribution lines maintenance and the work is, instead, carried out when and where needed. However, during focus group discussions, CREEs were reported to have conducted regular patrolling of distribution lines and to have carried out preventive maintenance like bush-cutting twice a year. Smaller geographic coverage, a more detailed knowledge of the operational area and the community ownership structure has allowed CREEs to carry out maintenance activities on a more regular basis. In contrast, DCS offices have to cover larger areas and are usually situated far from rural localities and so only carry out maintenance activities when an issue arises.

The study found that, with the exception of Dhading, CREEs generally take less time to address minor faults because their technicians are based locally (see figure 9 which shows the number of semi-skilled technicians in each CREE and DCS and average time taken by CREE and DCS to resolve issues). DCS on the other hand have fewer technicians compared to their larger coverage area and are not always able to provide swift service in rural areas. As Figure 9shows. . essentially DCS technicians for the study areas are each serving between 18 and 55 times the population that a CREE technician has to cover, which would explain the quicker response times by the latter on minor repairs.

DCS however have higher skilled technicians (including engineers) whereas CREEs employ local people with limited training. Because of lack of sufficient skill, it sometimes takes multiple days to restore major faults in CREEs as they require support from DCS engineers. The longer time taken to resolve issues in Dhading shown in figure 9 was reportedly mainly due to problem in transformers which CREE technicians could not resolve.

Figure 9: *Days taken to resolve power issues and number of technicians per thousand households (Source: Field survey, 2020).*



4.3.3 Management Service

Provision of adequate management services facilitate the growth of economic enterprises. This study hypothesized that CREEs provide better management services than DCS. The management services examined in this study include the utility bill payment system; health and safety awareness; paperwork support; and control of electricity theft.

Electricity bill payment was found to be easier in CREE locations because their consumers do not have to travel far from their home as CREE offices are located within their locality. Additionally CREEs also offer the facility of collecting tariff from consumers at home during the time of meter reading. For DCS customers, offices are located in towns or cities, usually a few hours away from their home, requiring time consuming travel. Table 11 shows the average distance consumers have to travel to pay their electricity bill.

Table 11: Average distance to travel to pay electricity bill

Districts	**Dhading**		**Tanahu**		**Syangja**		**Parsa**	
	CREE	DCS	CREE	DCS	CREE	DCS	CREE	DCS
Average distance in KM	0.5	4	0.5	17	1	14	0.5	17

Although DCS has introduced an online payment system, most of the rural customers interviewed were found to be unfamiliar with the process.

CREE and DCS offices provide electrical health and safety trainings to their staffs. NEA celebrates 'Electrical Safety Day' annually and DCS offices across the country organize awareness rallies (or other programs) on or around that day. However, these programs are

organized in the towns and cities and rural customers do not generally benefit from these activities. On a national level, NEA does provide safety information through audio-visual and print media which benefits both the CREE and DCS customers. Syangja CREE reported sensitizing its customers using technicians during the time of electricity connection and also during regular meter reading. The percentage of enterprise owners reporting their awareness on electric hazard was as follows: Dhading DCS-75%, Dhading CREE-93%, Tanahu DCS-96%, Tanahu CREE-56%, Parsa DCS-67%, Parsa CREE-88%, Syangja DCS-89%, Syangja CREE-58%.

Stealing electricity (hooking) by attaching wires to the distribution lines and bypassing the household meter has been a reported problem in rural DCS areas and was observed during this research in one of the study areas (Parsa DCS) during field visits (Figure 10). Regular patrolling and a sense of community ownership may have eliminated this problem in CREEs, whereas a longer and more bureaucratic procedure for getting a connection, the absence of local monitoring and the absence of a sense of community ownership has made it difficult to avoid cable hooking in rural DCS areas

Figure 10: Electrical hooking at Paterwa Sugauli-4 of Parsa DCS (observed during field visit)

In summary, addition to providing an easier (albeit more expensive) connection, CREEs were found to provide an easier bill payment service, better application support service, and more regular monitoring of distribution lines (and thus quicker turn around times on minor repairs). A greater sense of community ownership in CREEs seems to have eliminated power theft through 'hooking' and thus contributed to better tariff collection in rural areas.

CREEs are not entirely independent however and their ability to provide a good service to consumers can be constrained by DCS or NEA capacity. For example, CREEs still have to rely on

DCS to resolve issues arising at high tension lines or at substations. Similarly, if transformers in CREE locations need to be repaired, that is a job for NEA, which usually takes a longer time. CREEs ability to provide 3 phase meters to all customers who demand them is also constrained since they must get them from the NEA which is generally itself short of these meters.

4.3.3 Complementary Inputs

The availability of complementary inputs such as access to finance, revolving funds and development agency initiatives, as well as activities carried out by the CREE and DCS offices to promote productive use of electricity can all play a part in stimulating enterprise development. The availability of road networks and transportation facilities is also a critical factor in access markets. These factors are examined in more detail in this section.

Access to finance: The study areas were found to have different financial institutions such as commercial banks, savings and credit cooperatives and micro finance institutions that provide loans to their customers for different purposes such as agriculture, education, enterprise development, and hire purchase of goods. The rates of interest were found to differ across sectors by purpose of loan and type of financial institution. Micro finance institutions generally charge higher interest rates, followed by cooperatives and banks. Banks however require lots of paperwork and take longer time to process loans compared to cooperatives and microfinance institutions. Similarly, interest rates are generally lower for the agriculture sector and higher for purchasing consumer goods such as vehicles. Interest rates on loans for enterprise development are generally a little higher than those for agricultural purposes. During the study people were also found taking personal loans from other individuals at a very high interest rate at certain locations . Table 12 shows the percentage of enterprise owners in the study areas that have received credit from a local financial institution or, in the case of Parsa, from individual lender. The proportion of enterprises takings loans was more in CREE area than in DCS area in Dhading district, almost equal in Tanahu and Syangja districts, and less in Parsa district.

Table 12: Enterprises taking credits from financial institutions (Source: Field Survey, 2020)

Districts	CREE/DCS	% Taking credit	Tenure	Interest rate (%)
Dhading	CREE	59	1 to 5 years	14 to 18
	DCS	38	1 to 5 years	13.5 to 20
Tanahu	CREE	15	1 to 5 years	16 to 20
	DCS	16	1 to 2 years	10 to 12

Syangja	CREE	43	1 to 5 years	12 to 20
	DCS	44	1 to 5 years	12 to 20
Parsa	CREE	3	1 year	36
	DCS	7	1 year	36

Enterprises in both CREE and DCS areas thus seem to have roughly equal access to financial institutions. However, CREEs operating using a cooperative model of association have an additional source of finance from their cooperative, which is not accessible to enterprises in adjoining DCS area. For example, Syangja CREE is organized as a cooperative with all of its consumers as members. Members of Syangja CREE can get loans from their savings and credit cooperatives against collateral, or they can also get collateral-free loan of up to NPR 80,000 per household against 4 share certificates that each member household has received from the CREE. Four enterprises reported of taking the collateral-free loan from the electricity cooperative. About 46 percent of the total number of CREEs in the country are based on cooperative model.

Revolving Fund: Tanahu, Syangja and Parsa CREEs had all received a revolving fund (a loan provided to CREEs which has to be repaid) from the GIZ EnDev programme. The fund was however only utilized to contribute the CREE's share of 20% of the initial network investment cost (which was later reduced to 10%) that has to be paid up-front to DCS before electrification work can start. The revolving loans funds were not used at any CREE location for any enterprise development programme[7]. The GIZ EnDev programme has now handed the Revolving Fund to NACEUN (the national body representing CREEs) and from this year all CREEs are eligible to apply for the funds from NACEUN at 3% interest rate. The expectation is that, in addition to contributing to the initial p-front cost of construction, CREE's will use at least 20% of the revolving fund they access to promote productive use of electricity and 10% to promote electric cooking. There was no such compulsion earlier. This new programme is in the process of implementation. It is unlikely that the Revolving Fund has made direct impact on the number of enterprises as of yet.

Development initiatives by development agencies: Evidence from this study indicates that there are comparatively more externally funded development initiatives in CREE areas than in DCS areas. Development projects may work directly to promote productive use of electricity that may encourage people to start electricity-based enterprises or generate new ideas in the

[7] Communities at DCS locations have not been provided with similar revolving loan funds as they do not need to finance any up-front contribution to overall construction costs before the community is connected to the grid.

community that inspire enterprise development. Organizations like GIZ EnDev, ENERGIA, Helvetas, CRT-N, Heifer International and Action Aid have all worked in the study areas.

GIZ EnDev and Helvetas, in association with NACEUN, have provided enterprise development trainings to CREE staff in Syangja. The CREE staff of Syangja subsequently supported 10 poultry and 3 tailoring enterprises to develop their business plans. No development organizations were reported of working in the adjoining Syangja DCS. Similarly, HIVOS/ENERGIA in association with CRT-N and NACEUN has provided training for Women Entrepreneurship in Dhading CREE. The trainings included commercial agriculture, sewing and tailoring, poultry and making incense sticks.

In Tanahu, Heifer International has provided training on goat rearing at Tanahu CREE whereas agricultural training was only provided by an organization in the DCS area almost 3 decades ago. Action Aid in collaboration with local NGO- Dibya Youth Club has provided vegetable farming training in both the CREE and DCS areas of Parsa. Action Aid is also promoting sanitation and hygiene in both the areas.

The evidence collected suggest that comparatively more externally supported development initiatives have happened in Syangja and Dhading CREEs compared to the respective DCS areas at these locations. That said, similar initiatives have been conducted in both the CREE and DCS areas of Parsa and Tanahu.

Availability of road and transport facility: Better roads and transport facilities promote enterprise development by providing access to markets.

In Dhading the road and transport facilities were found to be similar in both the CREE and DCS areas - an earthen road with no regular public transportation facility. The DCS area however is closer to highway and only a walking bridge away from a market located on the highway, which may partly explain why there are more enterprises in the Dhading DCS area than in CREE area.

In Tanahu, the CREE area can be reached via a partly blacktopped and partly gravelled road, with the facility of regular public transportation. Although, closer to the highway, the DCS area is accessed mostly by earthen road and does not have the facility of regular public transportation. The better road condition and transportation facility in the CREE area also coincides with a higher number of enterprises.

Both the CREE and DCS areas of Parsa can be reached via mostly concrete/blacktopped and gravelled roads, with the CREE area having a comparatively better road and public transport facility.

In Syangja, the CREE area has a better road (blacktopped and gravelled) and transport facility (more regular) compared to the DCS area, which has earthen road and less frequent public

transport facilities. Better road and transport facilities in CREE areas may partly explain the higher number of enterprises in CREE areas than in the adjoining DCS areas in both Syangja and Parsa districts.

Incentives for CREE or DCS to promote electricity consumption: DCS is mainly focused on electrifying their areas and are not mandated to promote productive use of electricity. Until now, DCS staffs do not get any incentives for increasing electricity consumption in their service area. CREEs organised as cooperatives, on the other hand, are potentially incentivised to increase electricity consumption in their systems. CREEs run in cooperative model provide share dividends to their members and bonuses to their staffs as a percentage of their profit. This if a CRE co-operative can make a profit from electricity sales there is an incentive to promote productive use as a means of raising electricity sales. In the four CREE sites studied one was operating under the cooperative model (Biruwa CREE at Syangja). It has provided dividends of NPR 2000 to its initial members and has been providing a bonus equal to one month of salary to staff. The CREE is financially strong and has also built its own office building. As only one of the study CREE's was operating in this manner however it was not really possible to draw any conclusion as to whether the profit incentive was a 'common factor' associated with better enterprise creation performance.

5. Conclusion

This study examined the effects of two main modalities of rural electrification in Nepal on enterprise growth: utility-managed DCS systems and community-managed CREE systems. This study also explored factors responsible for differences in enterprise growth enabled by access to electricity through the two modalities. The following section sets out our conclusions from the study, arranged against the research questions outlined in section 2 above.

Research Question 1: What differences are there, if any, in the number of enterprises enabled to start up by access to electricity between areas electrified by CREEs vs DCS?

A direct comparison between DCS and CREE sites of numbers of enterprises does not make sense as, even between the pairs in the same district there are differences between locations such as population size, and notably the date of electrification. In this report two alternative metrics are used to make this judgement: households per enterprises (which gives a sense of the relative density of enterprises but potentially leaves locations that received electricity later at a disadvantage) and number of enterprises created per year since electrification (which gives a sense of rates of change but which is likely to leave smaller communities with fewer potential customers for new enterprises at a disadvantage). It is hoped that the use of both of these

metrics together will take advantage of their strengths and compensate for their individual weaknesses.

Table 13: Relative performance in terms of enterprise creation across different study locations

Districts	**Survey area**	**Number of HHs per Enterprise** *(smaller figure is better)*	**Average number of new enterprises per year since electrification** *(bigger number is better)*
Dhading	CREE (Siddhalek 7)	22.4	1.86
	DCS (Siddhalek 7)	9.3	3.16
Tanahu	CREE (Bhinad 9)	16.5	2.2
	DCS (Bhimad 8)	26.7	1.56
Syangja	CREE (Biruwa 1)	5.7	3.33
	DCS (Bhirkot 3)	33.3	0.7
Parsa	CREE (Paterwa Sugauli-2)	8.7	4.5
	DCS (Paterwa Sugauli-4)	84.1	0.6

From the table 13 above it can be seen that at three out of the four study sites **the CREE-managed distribution systems demonstrated higher levels of enterprise development than the DCS managed systems, by a clear margin, using both metrics.**

<u>Research Question 2:</u> What differences are there, if any, in the types and sizes of enterprises enabled by access to electricity between CREE and DCS supplied area?

Table 14 below shows that **the proportion of enterprises in high and medium electricity dependent industries was higher in CREE managed system than in DCS managed system** which is consistent with the hypothesis of this study.

Table 14: Relative performance in stimulating enterprises that use electricity

Level of dependence of enterprises on electricity	Proportion of enterprises in each dependency category across all sites	
	CREE Managed systems	DCS Managed Systems
High electricity dependence	30%	18%
Medium electricity dependence	29%	22%
Low electricity dependence	41%	60%

This study also found that the number of **enterprises with higher level of investment was more in CREE areas than in DCS areas.**

<u>Research Question 3:</u> Which factors might be responsible for any documented differences in either quantity or quality of enterprises enabled by access to electricity through the two modalities?

The key factors that may inhibit or support enterprise development at the study sites have been discussed in the text above. The following four tables summarize the detailed information collected around the presence or absence of those factors at each site, separately for DCS and CREE managed systems. They also highlight whether the DCS or CREE site at each location was the most 'successful' at enterprise creation, based on the enterprise creation metrics outlined above.

Table 15: Factors inhibiting and promoting enterprise in Paterwa Sugali, Parsa

	Factor inhibiting enterprise	Factors supporting enterprise	Enterprise metrics
Ward 4 (DCS)	• More paperwork needed to get electricity connection (need citizenship, landholding certificate, construction approval, ward recommendation and photo) • Population largely Tharu ethnic group, traditionally favours agriculture rather than business. • Consumers unaware of possibility of 15A upgrade connections for business • 3 Financial Institutions in ward 4, reported to be reluctant to lend because of previous poor credit records in ward • Local DCS has to cover larger population (6000 hh) • On an average 13 power interruptions per week • 10% reported voltage issues • More electricity theft than Ward 2	• Access to highway (similar to ward 2) • ActionAid skills training • Local Government skills training since 2016 • Dibya Youth Club has provided vegetable farming training • Electrified 4 years earlier than Ward 2 (2009) • Financial institutions present in the area to provide credit	0.66 enterprises per year since electrification 84.1 households per enterprise WORST PERFORMANCE FOR ENTERPRISE CREATION IN PARSA
Ward 2 (CREE)	• Electrified 4 years later than ward 4 (2009) • On an average 8 power interruptions per week • 8% reported voltage issues	• Less paperwork needed to get electricity connection (need citizenship and photo) • Access to highway (similar to ward 4) • ActionAid skills training • Local Government skills training since 2016 • Dibya Youth Club has provided vegetable farming training • Mixed population more open to participating in business • Easy to get electricity connection (just need citizenship paper and letter from ward office) • Parsa CREE provides additional energy meter for those who apply for irrigation meter. However, they charge the same tariff as of household meter. • 15A connections available to businesses	4.5 enterprises per year since electrification 8.7 households per enterprise BEST PERFORMANCE FOR ENTERPRISE CREATION IN PARSA

		• CREE has to cover relatively small number of consumers (540 households) • CREE partnership with NIC Asia Bank for provision of credit to consumers	

Table 16: Factors inhibiting and promoting enterprise in Biruwa and Bhirot, Syangja

	Factor inhibiting enterprise	Factors supporting enterprise	Enterprises
Bhirkot Ward 3 (DCS)	• More paperwork needed to get electricity connection (need citizenship, landholding certificate, construction approval, ward recommendation and photo) • Electrified 5 years later in 2011 • Poorer road (mud / gravel) than Biruwa • On an average 2 power interruptions per week • 4% reported voltage issues • Agriculture focused trainings	• Local Government's skill training since 2016 • Financial institutions present in the area to provide credit	0.7 enterprises per year since electrification 33.3 households per enterprise WORST PERFORMANCE FOR ENTERPRISE CREATION IN SYANGJA
Biruwa Ward 1 Market (CREE)	• Higher connection cost as membership fee of NPR 5000 is to be paid • On an average 1 power interruption per week • 6% reported voltage issues	• Less paperwork needed to get electricity connection (need citizenship and photo). • Connected to motorable road with frequent public transportation • Financial institutions present in the area to provide credit and promote credit facility to enterprises for expanding their business • Electrified in five years earlier in 2006 • Established market even before electrification • Better road (gravel / concrete) than Bhirkot • Share dividends are provided to members upon profit • The CREE staffs of Biruwa supported around 10 poultry and 3 tailoring enterprises in developing their business plan • Local Government's skill training since 2016 • Central location from all other wards	3.33 enterprises per year since electrification 5.7 households per enterprise BEST PERFORMANCE FOR ENTERPRISE CREATION IN SYANGJA

Table 17: Factors inhibiting and promoting enterprise in Siddhalek, Dhading

	Factor inhibiting enterprise	Factors supporting enterprise	Enterprises
Ward 7 (DCS)	• More paperwork needed to get electricity connection (need citizenship, landholding certificate, construction approval, ward recommendation and photo) • Seasonal & difficult mud road for vehicles	• Closer to footbridge to highway • Electrified 3 years earlier than CREE area • Local Government's skill training since 2016 • CRT-N has provided poultry training	3.16 enterprises per year since electrification

	• connection to main highway only via footbridge • on an average 33 power interruptions per week • 17% reported voltage issues • Agriculture focused trainings	• Financial institutions present in the area to provide credit	9.3 households per enterprise BEST PERFORMANCE FOR ENTERPRISE CREATION IN DHADING
Ward 7 (CREE)	• Seasonal & difficult mud road for vehicles • Electrified 3 years later than DCS area • On an average 8 power interruptions per week • 20% reported voltage issues • More distant from footbridge to highway • Agriculture focused trainings	• Less paperwork needed to get electricity connection (need citizenship and photo). • HIVOS/ENERGIA in association with CRT-N and NACEUN has provided training for Women Entrepreneurship • Local Government's skill training since 2016 • Financial institutions present in the area to provide credit	1.86 enterprises per year since electrification 22.4 households per enterprise WORST PERFORMANCE FOR ENTERPRISE CREATION IN DHADING

Table 18: Factors inhibiting and promoting enterprise in Bhimad Tanahu

	Factor inhibiting enterprise	Factors supporting enterprise	Enterprises
Ward 8 (DCS)	• More paperwork needed to get electricity connection (need citizenship, landholding certificate, construction approval, ward recommendation and photo) • Long distribution line causes power drops • On an average 23 power interruptions per week • 41% reported voltage issues • Agriculture focused trainings	• Connected to motorable gravel road • Agriculture training was provided some 30 years ago • Local Government's skill training since 2016 • Financial institutions present in the area to provide credit	1.56 enterprises per year since electrification 26.7 households per enterprise WORST PERFORMANCE FOR ENTERPRISE CREATION IN TANAHU
Ward 9 (CREE)	• Long distribution line causes power drops • On an average 25 power interruptions per week • 38% reported voltage issues • Agriculture focused trainings	• Less paperwork needed to get electricity connection (need citizenship and photo). • Connected to motorable gravel road comparatively better in comparison to Bhimad 8 • Heifer International has provided training on goat rearing • Local Government's skill training since 2016 • Financial institutions present in the area to provide credit	2.2 enterprises per year since electrification 16.5 households per enterprise BEST PERFORMANCE FOR ENTERPRISE CREATION IN TANAHU

Based on the data in the four tables above table 19 below summarizes the comparative advantages of the most successful system (CREE or DCS managed) at each of the four study locations, to provide an analysis of the factors that seem to most commonly be associated with a high performing site, in terms of enterprise creation.

Table 19: Summary analysis of most common comparative advantages of most 'successful sites'

Study Sites	For each pair of CREE and DCS sites, what were the comparative advantages of the site with the highest number of enterprises created per year since electrification (i.e., the 'most successful' site)?												Who managed the 'most successful' site?	
	Better road connection	More agency initiatives	Better financial access	More enterprise oriented ethnic group	Fewer power interruptions per week	Fewer voltage issues	Higher number of technicians per household	Fewer days required to resolve minor issues	Less paperwork required to establish a connection	Lower distance to travel to pay electricity bill	Electrified earlier	Easy power upgradation to 15A connections	CREE managed	DCS managed
Parsa				X	X	X	X	X	X	X		X	X	
Syangja	X	X	X		X		X	X	X	X	X	X	X	
Dhading	X					X		X			X			X
Tanahu	X				X	X	X	X	X	X		X	X	

The comparative advantages most commonly associated with the 'best' sites in terms of enterprise connection (those factors with at least three 'Xs' against them in Table 19), were found to be: better road access, fewer power interruptions per week, fewer voltage issues, higher numbers of technicians per thousand households, fewer days to resolve minor issues, lower distance to travel to pay bills and easier ability to upgrade power connection to 15 Amps.

In three out of four cases studied the CREE-managed site was found to have a comparative advantage overall on these factors and was associated with a higher effectiveness in enterprise creation.

These finding suggest that more attention should be paid to the CREE model of distribution system management as a means of providing higher quality and more sustainable access to grid electricity for rural communities.

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