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# Living in the Dark in Nepal

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## INTRODUCTION

This paper investigates whether privatization could help control frequent electricity shortages in Nepal. Until 1992, when privatization of the industry began, the country's entire electricity sector—generation, transmission, and distribution—depended solely on the Nepal Electricity Authority (henceforth, NEA), a government-owned and controlled electricity grid.

With hydropower's being the major source of Nepal's energy mix, private sector participation in the electricity sector (henceforth, PSP) refers to hydropower. Although PSP has given rise to varying scales of multiple private hydropower projects, NEA still holds a vertical monopoly[i]; even with multiple electricity generators, NEA continues to be the only supplier. Private sector participants, also known as Independent Hydropower Producers (henceforth, IPPs),[ii] are required to sign Power Purchase Agreements (henceforth, PPAs) with the NEA in order to sell their electricity. According to the International Energy Agency (henceforth, IEA), only 43.6% of the nation's households had electricity access as of 2009.[iii]

NEA's 2009 annual report (henceforth, NEA report) revealed a significant increase in the country's overall energy demand: from 3,490GWh in 2008 to 3,859GWh in 2009. For the latter, 18.9% was declared as load shedding hours. Of the demand met, 88.3% was fulfilled through hydropower: 58.7% from NEA hydro, 29.6% from Nepal's IPPs, 0.3% through NEA's thermal sector, and the remaining 11.4% through imports from India.[iv] Out of Nepal's total hydropower potential of 83,000MW, 43,000MW is technically and economically viable.[v] However, for the first time in a century-long history of electricity demand and supply, the Nepalese government declared a "National Electricity Crisis" during the fiscal year 2008/09.[vi] This paper will consider possible reasons for this crisis and whether a larger degree of PSP might be an efficient solution to it.

## HYDROPOWER AND THE CASE OF PRIVATIZATION

### The Need for Privatization

Results from input-oriented Data Envelopment Analysis (henceforth, DEA)—an efficiency modeling approach that analyzes input-to-output ratios—conducted on fourteen NEA-owned-and-operated hydropower plants from 2001 to 2004 suggest an overall efficiency of only roughly 50%.[vii] This leaves little hope for Nepal's electricity sector since the country heavily depends on NEA. Such input-oriented inefficiency could be improved through more research and development and advanced on-the-job training. These expensive options may not be viable for NEA due to its lack of financial resources;[viii] however, additional investments from PSP could help support such needed improvements.

NEA, due to biased decisions of the country's politicians and top-level government authorities, is one of the most poorly managed and overstaffed electric public utilities in the world.[ix] But this should not be a problem with private firms, as profit-oriented investors try to minimize their production costs, including but not limited to unnecessary labor costs.[x]

The sense of ownership and potential profits persistently motivates private parties to effectively correct any glitches, such as the unsolved electricity pilferage problem that NEA faces at its distribution phase through illegal tapping from its transmission lines. Such theft represented a significant portion of Nepal's total energy loss of about 25% in 2005.[xi] A country facing "national electricity crisis" cannot afford such a loss. Tracking pilferages should not be impossible, but it requires motivation on the management's side along with additional capital to do so. NEA's funding and motivational problems could be moderated by extending PSP's functions to include transmission and distribution. As of 2006, Nepal's power generation sector comprised 21.8% PSP, whereas transmission and distribution consisted of 0% PSP.[xii]

A convincing argument can be made for emphasizing private investments. Even the NEA can opt for financing options from banks, multilateral organizations, and aid from foreign countries. However, one of the main concerns here is to release the already underfunded NEA from any further financial burden. Usually those funds are dollar-denominated, so NEA will have a hard time paying back due to Nepal's weak and unstable currency that lacks bargaining power. PSP, with the help of above mentioned financial assistances, could share NEA's responsibility of supplying electricity in the country. It is a noteworthy fact that although PSP began only in 1992, 29.6% of the NEA's total electricity supply in 2009 was contributed by IPPs. IPPs' relatively quick coverage in the energy market hints that the shift toward PSP is an effective move, and that the scope of this shift should continue to expand.

An important conjecture is that increased PSP will lead to a competitive electricity market. This belief is well supported by the National Water Plan of 2005 (henceforth, NWP), which states that with PSP, Nepal's electricity sector will operate in a truly competitive environment.[xiii] Conventional economic theory suggests that increased competition leads to more efficiency; this will help increase electricity supply. Competition will also help avoid huge price hikes. After all, the ultimate goal of increasing electricity supply is to make it available to people, which includes affordability, especially for a country like Nepal where per capita Gross National Income (henceforth, GNI) is only $440 as of 2009.[xiv] Competition should also be secured by governmental support to help limit IPPs' concentration ratios. As any such limitations may discourage high-scale private investments, their degree should be based upon a careful study of PSP behavior in the hydropower market. Possible discouragements could also be moderated by incentives such as income tax reductions.

## Rural Electrification in Nepal

According to the World Bank (henceforth, WB) data, 82.3% of Nepal's total population resides in rural areas as of 2009.[xv] The IEA's 2008 report reveals electricity access to be at 89.7% for the urban households compared to only 34% for the rural.[xvi] Evidently, Nepal's rural electrification (henceforth, RE) calls for more attention. Tragically making the situation worse, the NEA has given up on RE due to its financial constraints.[xvii] Hence, PSP is a necessity rather than an option for Nepal's remote areas.

Encouraging PSP in rural areas is a challenging task because profit-oriented IPPs are interested in massive returns from large hydropower projects that are less likely to take place in rural areas due to their lack of concrete infrastructure to handle huge hydropower plants. Micro-Hydropower Projects (henceforth, MHP), with a capacity of up to 100KW, and Small-Hydropower Projects (henceforth, SHP), with a capacity of 101KW–1MW, are more suitable for RE. With large hydropower plants, the rural areas' scattered population distribution and lack of connection to the NEA's transmission lines may lead to supply exceeding demand. This would indirectly constrain the plants from reaching their actual potential, as much of the excess electricity produced would have to be wasted. Ultimately, high fixed costs with only limited revenue potential will negatively affect profits. Therefore, most of the IPPs tend to invest in comparatively developed regions.

The need for additional private investment for construction of transmission lines makes RE even less appealing. Therefore, the government needs to create a favorable investment platform in terms of political stability and negotiations with funding parties in order to attract IPPs. In addition to the government's special provisions for MHPs and SHPs, RE could be made more attractive through subsidization of IPPs' investments. Lessons could be learned from

Guatemala, where government allocates a certain portion of its privatization revenue towards subsidies and other facilities to IPPs involved in RE.

## Different Approaches to Electricity Privatization in Nepal

A temporary method of PSP is to lease out NEA's electricity substations to private operators, which might improve management and distribution standards. "Build, Own, Operate, and Transfer" (henceforth, BOOT) is a longer-lasting technique, including PSP in electricity production as well. BOOT requires private businesses to invest in the construction and maintenance of their electricity substations in order to sell this electricity through NEA. The substations are transferred to the NEA after a maximum period of fifty years.[xviii] BOOT, according to the legally bound PPA, requires IPPs to supply a certain pre-fixed amount of energy annually to the NEA.[xix] This secures electricity supply for peak shortages during dry seasons.

Adding to the above efforts, which are already in place, overall permanent private ownership would be more appealing to IPPs, compared to building and temporarily managing substations that eventually will be transferred to the government. To sustain and increase PSP, we need to make sure that those investments seem promising to IPPs. PSP has officially taken place only since 1992, and now there are nineteen private hydropower projects connected to the national grid.[xx] IPPs might find it risky to extrapolate results about their own investments based on such a small number of recently executed examples. IPPs are also likely to steer clear from investing in transmission lines as long as they can benefit from the NEA's lines. Thus, incentives can be provided by supplying research into markets where the private parties might find it profitable to build their own lines; they would then not have to depend on the NEA. On a broader perspective, subsidies, a safer investment environment, license extensions, and if possible,

permanent licenses might help make PSP seem more convincing. These provisions point out the necessity of government support even when stressing private participation.

## Overview of Legal Efforts to Promote Electricity Privatization in Nepal

Legal efforts towards promoting PSP began with the Hydropower Development Policy in 1992, which exempted ten years' income tax for private investors who transmitted electricity to the NEA from their own substations.[xxi] The act also introduced the Hydroelectricity Development Unit under the Ministry of Water Resources (henceforth, MOWR). The unit's responsibilities include promoting PSP in general, approving projects with a capacity of 1,000+KW, and providing any other necessary support to the involved IPPs.[xxii]

The Department of Electricity Development (henceforth, DOED) was established under MOWR in 1993, mainly to issue surveys and generation licenses, to provide concessions and incentives, to facilitate imports of project materials, and to help obtain government land along with permits and approvals. Hydroelectricity projects that have an installed capacity greater than 1,000KW are required to obtain a license to commence and operate. No private hydropower project is allowed to be nationalized as long as their licenses are valid. This is the right that IPPs secure in return for their substantial royalty payments to the government.

Policies are comparatively more favorable towards small-scale PSPs that are suitable for RE. Hydropower projects up to a capacity of 1MW do not require licenses and are exempted from income taxes on their sales revenue.[xxiii] The Hydropower Development Policy of 2001 states that private hydropower projects that are not linked to the NEA's transmission lines are allowed to set their own electricity prices. It also emphasizes MHPs for prioritized loan provisions and any other required assistance.[xxiv]

More policies favorable for RE include allowing the private investors to enjoy monopoly. Licenses are not issued to more than one private party for electricity distribution in the same area as long as the existing private investor is able to satisfy electricity demand for that region.[xxv] Private investors under RE are also exempted from having to pay energy royalties.[xxvi]

## LITERATURE REVIEW

### Measuring Efficiency of Hydropower Plants in Nepal

Jha and Shrestha (2006) [xxvii] provide a general summary of management practices among NEA-owned-and-run hydropower plants, highlighting their weaknesses as the data provided in this study indicate those plants to be highly inefficient. Being an input-oriented DEA, the results focus on input minimization while ignoring output maximization. Results from an output-oriented DEA would have made a better case since the ultimate problem is the lack of output from these hydropower plants. A well-rounded output-oriented DEA would take account of inputs such as planning, plants and operations upgrades, whose better performance would ultimately lead to output maximization. Some of the basic factors needed for such improvement are strong motivation and increased funding, which are more likely to be present in private sectors. This makes PSP seem to be a more reliable solution for Nepal's electricity crisis.

### Private Micro-Hydropower and Associated Investments

Ghale, Shrestha, and deLucia (2000)[xxviii] provide an overview of a basic private MHP in Barpak, a rural village in Nepal. Just as the majority of Nepal's remote areas, Barpak also is deprived of NEA's provision. Electricity was introduced for the first time in the village through Ghale's private MHP initiative in 1991. This reveals that small-scale PSPs were already being practiced prior to the nation-wide PSP declaration in 1992. The article states that the government

started de-licensing all micro-hydropower schemes and related sales in 1984. Further encouragement of PSP for RE by means of micro-hydropower credits and partial subsidies for electrification equipment began in 1985. The government supported such mini-PSP efforts mainly because it had to provide electricity to many rural areas at almost half the average retail tariff.[xxix] It was getting too expensive for the national grid to spend its scarce resources on RE, especially with the urban regions facing heavy load shedding schedules.

Since the Barpak grid is not connected to the NEA's transmission lines, Ghale gets the privilege to decide on the electricity tariffs. Ghale, Shrestha, and deLucia state that the project has been profitable to the private investor, but further analysis is needed since the authors have not mentioned some revenues and costs calculations. During the initial year of operation, the plant capacity exceeded domestic demand by a huge margin. Such capacity underutilization should be considered an increase in fixed costs, which has not been mentioned. Some of the other overlooked costs include expenses for construction materials and equipment along with their transportation, extra labor, and construction of concrete poles. On the revenue side, the total electricity revenue received from wealthy households in the village, who use extra amounts of electricity and in return pay per unit (KWh) consumption instead of a flat rate as paid by the rest of the villagers, has not been included in the calculation. These higher-level tariffs should have enhanced total revenue. Such negligence does not allow for an accurate picture of profitability.

The number of households that now have electricity because of Barpak electrification is also not mentioned, but this information would have been helpful to assess how effective MHPs are. Since the Barpak electrification, five new MHPs have been delivered in the region with five more in the process of being established. These developments hint that the Barpak project indeed was profitable to its investor. Such profitability should be highlighted to IPPs to create a larger

base for RE. The project's success is also due to financial and technical assistances from multilateral organizations and the Nepalese government. Private investors, who can easily afford capital for small-scale RE, often try to fetch larger projects with higher profit margins. Small-scale private investors interested in RE usually are the ones who need financial aid. So, support from those institutions is essential for PSP in rural areas, including but not limited to information dissemination, market assessment and development in addition to the above mentioned assistances.

**Does Infrastructure Reform Work for the Poor? A Case Study from Guatemala**

Foster and Araujo (2004)[xxx] have presented a case study of electricity privatization in Guatemala. The options tried in Guatemala might be expected to be suitable for Nepal as well, based on the two countries' closely comparable political and economic features as of 2009, including income and external debt as a percentage of GNI as depicted by World Development Indicators (henceforth, WDI). Guatemala implemented its electricity reform to address a mismatched structure of increasing electricity demand with stagnant supply caused by inefficient operations and limited funding for new investments, as is the case in Nepal.[xxxi] A common solution, which is PSP, applied for these common problems will help confirm the effectiveness of PSP.

Before Guatemala's energy sector reform in 1996, electricity used to be provided by two state-owned companies: Empresa Eléctrica de Guatemala (henceforth, EEGSA) and Instituto Nacional de Electrificación (henceforth, INDE). The country's Electricity Law of 1996 opened up PSP opportunities—generation was equally divided between INDE and private investors, leaving transmission still operated by INDE alone, and distribution now completely handled by three private firms. This high concentration ratio of IPPs suggests that increasing PSP may not guarantee market competition. Additionally, the Guatemalan government allowed them to set

their own electricity prices in an effort to make PSP attractive and sustainable. Due to these monopoly practices, electricity tariffs soared between 60% and 80% from 1998 to 2004, requiring the government to introduce social tariff to keep the prices at pre-reform levels.

As a result of electricity privatization, Guatemalan households experienced a rise in electricity coverage from 53% in 1996 to 70% in 1999. Between pre- and post-privatization eras, 1993-1996 and 1997-2000 respectively, the number of new electricity connections rose by 58%, 13%, and 94% at the national, urban, and rural level, respectively, increasing the probability of electricity access by 89%, 84%, and 123% for the so far neglected households at the national, urban, and rural level, respectively. Between 1996 and 2004, financial resources including privatization revenue channeled towards RE has nearly tripled. All these positive outcomes support the need to encourage more PSP.

From Graph A in the appendix, we can see that Guatemala has achieved much better results than Nepal even though Guatemala privatized its electricity sector four years after Nepal did in 1992, and the gap in power consumption between the two countries is expanding widely with Guatemala's rising rapidly. Such differences could be due to their different privatization structure: Guatemala has privatized both electricity generation and distribution; however, in Nepal, the NEA still is the sole distributor. The above analysis suggests the need to expand PSP's role in electricity distribution in Nepal, as well.

**Privatization and Liberalization of the Electric Power Industry in Developing Countries**

Bacon and Besant-Jones (2001)[xxxii] present a larger group of economies that have undergone electricity privatization. Reasons for privatization in these countries include poor performance of state-owned electricity sectors in terms of high costs, lack of power supply in some areas and unreliable supply in areas that have electricity access, and their national grids'

inability to invest in advanced technologies that would help improve efficiency and increase electricity supply.

Prior to privatization, most of those nations' public grids did not have any incentive to make profits due to lack of competition, and therefore had excessive costs, as in the NEA's overstaffing case. The deteriorating service quality with no motivation to reduce power shortages reflects NEA's performance and situation.

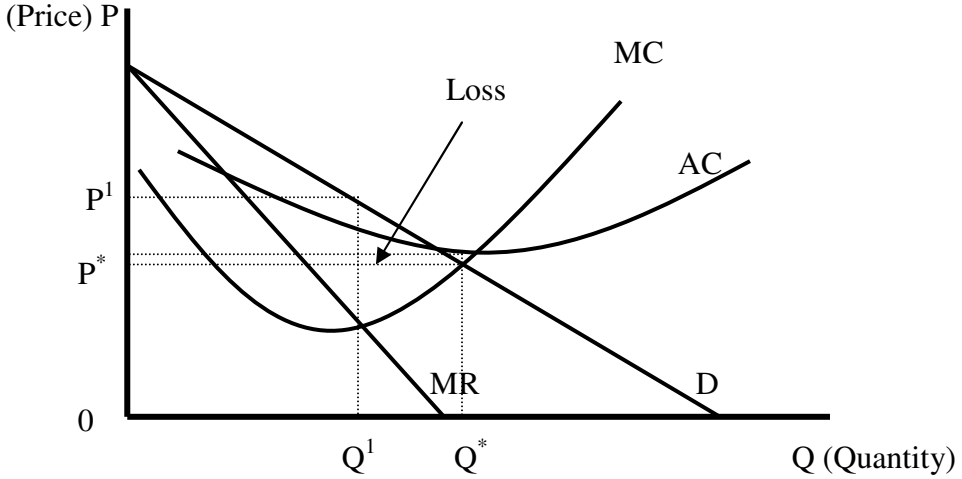
Table A in the appendix shows the benefits of electricity privatization on the distribution side in four South American countries. The data include results from different years of privatization until 1998, highlighting significant rise in energy sales, and reduction in energy losses as well as number of employees. This, in addition to Guatemala's case, creates a more concrete argument for the need to extend PSP towards distribution in Nepal.

## Synthesis

The authors of all four articles agree that publicly owned and controlled electricity sectors tend to limit the supply due to management inefficiencies and limited financial sources. They also show a rise in electricity supply after privatization, pointing towards the need of PSP expansion in Nepal. Price hikes may result as seen in Guatemala's case due to a high concentration ratio of private investors. As mentioned previously, legal restrictions, in addition to NWP's declaration, should help control such hikes. If needed, government provisions of social tariffs, as practiced by Guatemala, and subsidies to the customers would help moderate possible price rise. Such provisions could be supported through tax revenues and substantial royalties paid by IPPs involved in larger projects.

Hydropower plants in rural areas are most likely natural monopolies; they have decreasing average cost (AC) over the relevant market range (see the graph below). An

unregulated natural monopoly wants to maximize profits and produce at $Q^1$ where marginal revenue (MR) = marginal cost (MC), charging the high price $P^1$. But the socially optimal production level is at Q* where P* = MC, which generally requires two-tariff pricing, that is, marginal cost pricing combined with an access fee to ensure a socially optimal amount at a reasonable price. Since marginal cost pricing would produce a loss here, the access fee helps to cover the loss that will occur from charging a price less than average cost.




There are some limitations with the analyses offered in the aforementioned studies. For example, the study by Jha and Shrestha is biased towards electricity privatization as it shows the NEA's inefficiency but does not mention how it compares to the efficiency of the involved private companies. Yet, overall, evidence seems to support the research hypothesis, suggesting increased PSP as a solution to Nepal's energy crisis based on the Barpak example along with the study by Foster and Araujo as well as that of Bacon and Besant-Jones, which address both the benefits and costs of privatization in countries that have undergone electricity privatization.

## EMPIRICAL ANALYSIS

### Private Micro-Hydropower Project in Barpak Village: A Case Study

The following self-conducted cost-benefit analysis (henceforth, CBA) on Barpak electrification provides further evidence of PSP as a solution. In light of the NRs. 0.5 million grant from Nepal's electrification subsidy program, a set of figures and assumptions in relation to direct costs and benefits has been extracted from Ghale, Shrestha, and deLucia (2000) for closer examination.[xxxiii]

As we can see from the detailed calculation under exhibit B in the appendix, the calculated discounted or present value, (henceforth PV) of total costs is "NRs. 2,442,515.9" and PV of total benefits is "NRs. 2,315,436.2". Although these figures suggest the project's discounted net direct benefits to be "-(NRs. 127,079.7)", suggesting a loss rather than a profit, we need to consider that the article does not give a complete picture of costs and benefits. The region's new PSP initiatives mentioned earlier would not have taken place had the Barpak project not been rewarding enough to its investor. Thus, there must have been factors enhancing profit beyond those considered in the above calculation.

### A Case Study on Khimti Hydropower Project

Khimti Hydropower Project (henceforth, KHP) is Nepal's first private BOOT-based hydropower project, delivered in July 2000. Its installed capacity of 60MW is supported by the Khimti river.[xxxiv] Nepal's Himal Power Limited was established to build, own, and operate this project, but Norway's Statkraft developed its financial package. Out of its total capital cost of US $140M (million), major equity worth $25.1M was contributed by Statkraft, and a major loan worth $92.6M was granted by multilateral agencies: Asian Development Bank (henceforth, ADB), Norwegian Agency for Development Co-operation, International Finance Corporation

(henceforth, IFC), and Eksportfinans.[xxxv] Along with the Nepalese government's contribution of a 22-km access road to the rural area,[xxxvi] $20M was funded by Finland in order to construct the 100 km Khimti-Kathmandu transmission line.[xxxvii] As can be noticed here, multilateral along with domestic and foreign government assistances are essential for PSP since domestic IPPs alone cannot afford huge hydropower projects like Khimti.

KHP is an example of RE on a larger scale that annually adds 350GWh of electricity supply to the national grid.[xxxviii] The project's PPA with NEA is valid for 20 years, whereas its BOOT license has been granted for 50 years. After the PPA period ends, NEA gets 50% ownership over the project, and once the BOOT license expires, the entire project will be transferred to the Nepalese government.[xxxix] This might be an obstacle in attracting PSP as the profit-oriented IPPs invest only when they find projects to be beneficial to them. They might not want to see their investment of time, money, and effort eventually become a public property. Although 50 years is a long duration, the incentive to efficiently run the plant may slow down as the time of partial and full transfers approaches. This might lead to a slowdown of electricity supply once again. Permanent private ownership could avoid this scenario.

There was no electricity or nearby grid in the project area when its construction required power supply.[xl] This need led to the construction of a 500KW SHP, which in its first three years fulfilled lighting needs of 300 households and helped establish seven small-scale electricity-based enterprises.[xli] This shows that any level of PSP is a valuable addition to Nepal's electricity-deprived population.

By nature, KHP depends on river flows, so its annual electricity supply is divided into 104GWh during dry periods (November to April), and 246GWh during the remaining wet seasons. Any excess supply is charged at 8.5 cents and 4.2 cents per KWh during dry and wet

seasons respectively, compared to its normal tariff of 5.9 cents.[xlii] With KHP's operation, excess power supply is at least an option to help reduce NEA's shortage. KHP's annual supply accounted for a little over 11% of the NEA's 2009 total supply. Considering Nepal's peak power shortage during dry seasons, PSP should be encouraged more towards projects that are able to store water and use it to produce energy whenever needed, rather than limiting options to river flows.

### Comparison of Private vs. Community-Owned and Controlled MHPs

More than just increasing Nepal's PSP base, the goal should be to make it a sustainable and thus a reliable option. Comparison of private and communal investments from this article shows that privately-owned and controlled MHPs turn out to be more beneficial to the investors than the community-owned and controlled ones. Unlike in community-based MHPs, private investors are entitled to both profits and losses, and therefore are more careful in handling their projects. Although all three projects discussed are desirable for more electricity supply, only Angakhola MHP - a PSP is financially viable with a net present value of +$703, whereas despite grants and more subsidies, community-owned-and-run MHPs - Daunekhola and Tikhedhunga occurred losses of $20,884 and $60,706, respectively.[xliii] This smaller-scale PSP result also shows that private investments tend to be more profitable compared to publicly owned, further supporting the idea of PSP.

## CONCLUSION

In 2009, 95.5% of Nepal's total electricity demand came from its domestic sector,[xliv] but only 42.5% of the total electricity sales satisfied those needs, whereas 37.4% of the sales went towards industrial sector that made up only 1.7% of the total demand.[xlv] These figures suggest

that Nepal's electricity distribution is concentrated in urban areas. This can also be noticed from exhibit A in the appendix, where the biggest red mark in the centre is Nepal's capital city - Kathmandu. Even as of February 2012, Kathmandu experienced a daily load shedding of fourteen hours. If this is the condition of the capital city, then we can expect a much worse scenario in the rural Nepal. Considering that 82.3% of Nepal's total population resides in rural areas, with only 34% of them with electricity access compared to 89.7% electrification among urban households, the need for RE is alarming. Especially since the NEA has given up on RE, PSP is no longer an option but a necessity. As of 2008, a total of 2,496 micro-hydro systems had been installed in 40 districts, generating a total of approximately 17MW.[xlvi] This figure is negligible compared to Nepal's total hydropower capacity. Hence, favorable policies towards PSP in rural areas should be implemented along with drawing IPPs' attention towards profitable REs such as Barpak electrification in order to attract further private investments.

There are some hindrances in the effort to increase PSP. As with KHP's case, settlements for projects financed by foreign assistances are typically agreed in USD. This creates higher liabilities for the investors; Nepalese currency (NPR.) devaluated against the USD from NPR 20 = USD1 to NPR 75 = USD1[xlvii] over just 10 years until 2001. NPR's falling trend has continued: on December 16, 2011, the NPR reached 86.1 per USD.[xlviii] Such expensive payment standards might deter private investors.

PSP has slowed down compared to the initial years of privatization;[xlix] however, the reasons for this trend are not clear. The WB and IFC have highlighted political instability as one of the biggest constraints to private business investment in Nepal.[1] Therefore, if we are to secure PSP, although difficult and time-consuming, the government should try to create an investment-friendly platform through political and economic stability. More policies supporting PSP in both

rural and urban areas should also be established in addition to the ones already in place. For example, it could reduce royalty amounts charged on larger hydropower projects until Nepal's energy sector develops a strong and long-term base. If not, then a portion of such royalties could be allocated towards RE as in Guatemala's case. A bolder step to attract more PSP would be to provide permanent licenses. Private investors might not be very keen on investments that need to be transferred to the government at the end of their license period. Instead of receiving compensation for the transfer, they have to buy back the plants they established if they would like to continue with the same project.[li] This definitely is a huge disincentive for IPPs.

Besides the slowing down of PSP, there are other reasons for Nepal's "national electricity crisis" declared in 2009. Because of Nepal's hilly terrain and abundance of southwards flowing rivers, run-of-the-river projects highly dominate Nepal's hydropower industry. Thus, as the rivers slow down during dry seasons, so does Nepal's power supply. Out of the country's total installed capacity of 568.7MW, only 16.2% is contributed by storage-type hydropower plants; the rest is covered by run-of-the-river schemes.[lii] In order to reduce seasonal electricity shortages, PSP needs to be geared towards pumped storage types of hydropower systems, where water is stored and converted into energy during peak shortages. This requires construction of huge dams in order to hold water. However, dam construction may not be a good idea in most of the rural areas, not only because of its high capital costs, but also because their weak infrastructure may be prone to floods and landslides during the construction phase. Thus, MHPs and SHPs still remain better options for extremely rural areas, whereas pumped storage projects are suitable to fulfill urban electricity demands.

As mentioned previously, PSP's considerable coverage in hydropower generation itself defines its outstanding performance. This suggests PSP to be an effective move, and therefore

this model should continue to grow not only in the generation sector but also towards distribution. Nepal should learn from its own experimentation of increasing electricity supply through PSP. Furthermore, lessons should be taken from Guatemala and the South American electricity companies discussed earlier; they managed to substantially increase electricity supply through privatization of their electricity distribution sectors. Necessary governmental support may be required to control possible price escalations that could result from market reforms.

Electricity privatization, along with benefits, may come with some costs. However, it would be nearly impossible to find any developmental strategy without some defect. This study has a few limitations in itself. No DEA on Nepal's private hydropower projects could be found, so we could not compare performances of government versus privately-owned and operated hydropower plants. Had we seen positive results from DEA on private plants, the case "for" more PSP would have been even stronger. NEA's DEA-resulted overall efficiency could not be compared with that of other countries' power utilities because of lack of common denominators with the information available. This comparison would have been helpful to assess where NEA's overall efficiency stands in general.

The case study on Barpak electrification does not portray all the costs and benefits, which restricts its CBA from giving a true picture of its profitability. CBA for KHP could not be calculated due to lack of data availability; if profitable, KHP could have been set as an example to encourage more PSP in larger hydropower projects.

This study also lacks information on Nepal's national budget allocation for its energy sector. Had we known this missing piece of information, the extent of the energy sector failure would be clearer. This would also show the national budget's opportunity cost of investing in the

energy sector. If this failure, and thus the opportunity cost, is severe, then the argument for more PSP, including its extension towards distribution, would be more persuasive.

It was difficult to choose the most reliable source for facts and figures. In any case of confusion, information published by the Nepali authorities and journal articles has been chosen over the ones provided by multilateral organizations and other online websites.

## REFERENCES


[i] (2004). *Technical Assistance to the Kingdom of Nepal for Restructuring of Nepal Electricity Authority*. Asian Development Bank, 2004. Page 3. Print.

[ii] Assuming the NEA 2008/2009 annual report referred to Independent Power Producers (IPP) as mentioned by Independent Power Producers' Association, Nepal (IPPAN).

[iii] "Table 3: Electricity access in 2009 - Developing Asia." *IEA, World Energy Outlook 2010, The Electricity Access Database*. n.d. Web. 2 Dec. 2010. <www.iea.org/weo/database_electricity10/electricity_database_web_2010.htm>.

[iv] *Nepal Electricity Authority, A Year in Review, Fiscal Year 2008/09*. Kathmandu: Nepal Electricity Authority, 2009. Page 9. Print.

[v] "1.0 General ." *Working Paper for Nepal Development Forum 2004 On Water Resources Development Sector (Hydropower)*. Kathmandu: His Majesty's Government of Nepal, Ministry of Water Resources, 2004. Page 2. Print.

[vi] Nepal Electricity Authority (2009). Page 8.

[vii] Jha, Deependra K. , and Rabin Shrestha. "Measuring Efficiency of Hydropower Plants in Nepal Using Data Envelopment Analysis ." *IEE Transactions on Power Systems* 21.4 (2006): Page 1502. Print.

[viii] Nepal Electricity Authority (2009). Page 10.

[ix] Pokharel, Shaligram . "Hydropower for Energy in Nepal ." *Mountain Research and Development* 21.1 (2001): Page 6. Print.

[x] Pokharel, Shaligram . (2001). Page 6. Print.

[xi] (2008). *Potential and Prospects for Regional Energy Trade in the South Asia Region*. Washington, DC: The World Bank Group. Page 17. Print.

[xii] The World Bank Group (2008). Page 26.

[xiii] "Action Programmes". *National Water Plan - Nepal*. n.d. Web. 20 Nov. 2010. Page 62. <www.moen.gov.np/pdf_files/national_water_plan.pdf>.

[xiv] The World Bank.( n.d.) *Data by Country*. Web.11 Nov 2010 <http://data.worldbank.org/country/nepal>

[xv] The World Bank. ( n.d.). *World Development Indicators.* Web.26 Nov. 2010. <http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2>.

[xvi] "Table 3: Electricity access in 2008 - Developing Asia." *The Electricity Access Database*. n.d. Web. 20 Nov. 2010. <www.iea.org/weo/database_electricity/electricity_access_database.htm>.

[xvii] Nepal Electricity Authority (2009). Page 12.

[xviii] Honningsvag, B, G. H. Midttomme, K. Repp, K. Vaskinn, and T. Westeren. *Hydropower in the new millenium: proceedings of the 4th International Conference on Hydropower Development, Hydropower '01, Bergen, Norway, 20-22 June 2001*. Lisse, Netherlands: A.A. Balkema, 2001. Page 7. Print.

[xix] Honningsvag, Midttomme, Repp, Vaskinn and Westeren (2001). Page 5.

[xx] Nepal Electricity Authority (2009). Page 13.

[xxi] "Hydropower Development Policy, 1992."*Nepal Electricity Authority*. n.d. Web. 14 Nov.2010. Page 3. <http://www.nea.org.np/images/supportive_docs/4561Hydropower%20Development%20Policy.pdf>.

[xxii] Hydropower Development Policy, 1992. Page 5.

[xxiii] National Water Plan – Nepal. n.d. Web. 20 Nov. 2010. Page 5.

[xxiv] "The Hydropower Development Policy, 2001." *Ministry of Water Resources*. Web. 28 Oct. 2010. Page 12. <http://www.doed.gov.np/policy/hydropower_development_policy_2001.pdf>.

[xxv] "Electricity Act, 1992." *Nepal Electricity Authority*. n.d. Web. 14 Nov. 2010. Page 2. <http://www.nea.org.np/acts-regulations.html>.

[xxvi] The Hydropower Development Policy, 2001. Page 11.

[xxvii] Jha, Deependra K. , and Rabin Shrestha. (2006): Pages 1502-1511. Print.

[xxviii] Ghale, Bir Bahadur, Ganesh Ram Shrestha, and Russell J. deLucia. "Private micro-hydro power and associated investments in Nepal: the Barpak village case and broader issues." *Natural Resources Forum* 24 (2000): Pages 273-284. Print.

[xxix] Nepal Electricity Authority (2009). Page 12.

[xxx] Foster, Vivien, and Maria Caridad Araujo. *Does infrastructure reform work for the poor? A Case Study from Guatemala*. N/A: World Bank Research Working Paper 3185, 2004. Pages 3, 6-7, 10-11, 19, 21, 29-34, 49, 51. Print.

[xxxi] "Supply of Electricity - 3.38." *Guatemala Investment Climate Assessment*. Washington: The World Bank, 2008. Page 52. Print. <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2009/02/25/000334955_20090225071728/Rendered/PDF/471930ESW0v10G10Box338854B01PUBLIC1.pdf>

[xxxii] Bacon, R. W. , and J. Besant Jones. "Global Electric Power Reform, Privatization and Liberalization of the Electric Power Industry in Developing Countries." *Annual Reviews Energy & the Environment* 26 (2001): Pages 331-359. Print.

[xxxiii] Ghale, Bir Bahadur, Ganesh Ram Shrestha, and Russell J. deLucia. (2000): Pages 273-284.

[xxxiv] "Description." *Nepal: Building Water Infrastructure As Part of Khimti I Hydropower Project (KHP-I), Case # 191*. n.d. Web. 28 Nov. 2010. Page 1.< http://www.gwptoolbox.org/images/stories/cases/en/cs%20191%20nepal.pdf >.

[xxxv] Honningsvag, Midttomme, Repp, Vaskinn and Westeren (2001). Page 5.

[xxxvi] Honningsvag, Midttomme, Repp, Vaskinn and Westeren (2001). Page 4.

[xxxvii] Sharma, Sudhindra, Juhani Koponen, Annette Skovsted Hansen, and Tatsuro Fujikura. *Partnership in Action, Nordic and Japanese Aid in Nepal* . Stockholm: Paper from The European Institute of Japanese Studies, Stockholm School of Economics, Stockholm , 2005. Page 25. Print.

[xxxviii] Honningsvag, Midttomme, Repp, Vaskinn and Westeren (2001). Page 181.

[xxxix] Honningsvag, Midttomme, Repp, Vaskinn and Westeren (2001). Page 6.

[xl] *Nepal: Building Water Infrastructure As Part of Khimti I Hydropower Project (KHP-I), Case # 191.* Page 2.

[xli] *Nepal: Building Water Infrastructure As Part of Khimti I Hydropower Project (KHP-I), Case # 191.* Page 8.

[xlii] Honningsvag, Midttomme, Repp, Vaskinn and Westeren (2001). Page 5.

[xliii] Dhungel, Prateek. "Financial Analysis." *Financial and Economic Analysis of MicroHydro Power in Nepal* . N/A: Master of Science Paper from The University of Minnesota, 2009. Pages 16. Print.

[xliv] Nepal Electricity Authority (2009). Page 77.

[xlv] Nepal Electricity Authority (2009). Page 9.

[xlvi] Dhungel (2009). "History and Present Situation." Page 8.

[xlvii] Honningsvag, Midttomme, Repp, Vaskinn and Westeren (2001). Page 8.

[xlviii] "Data and Statistics." International Monetary Fund. Web. 24 Jan. 2012. <http://www.imf.org/external/np/fin/ert/GUI/Pages/Report.aspx?CU='NPR'&EX=REP&P=DateRange&Fr=634267584000000000&To=634629600000000000&CF=Compressed&CUF=Period&DS=Descending&DT=Blank>.

[xlix] Nepal Electricity Authority (2009). 'Message from the Chairman'.

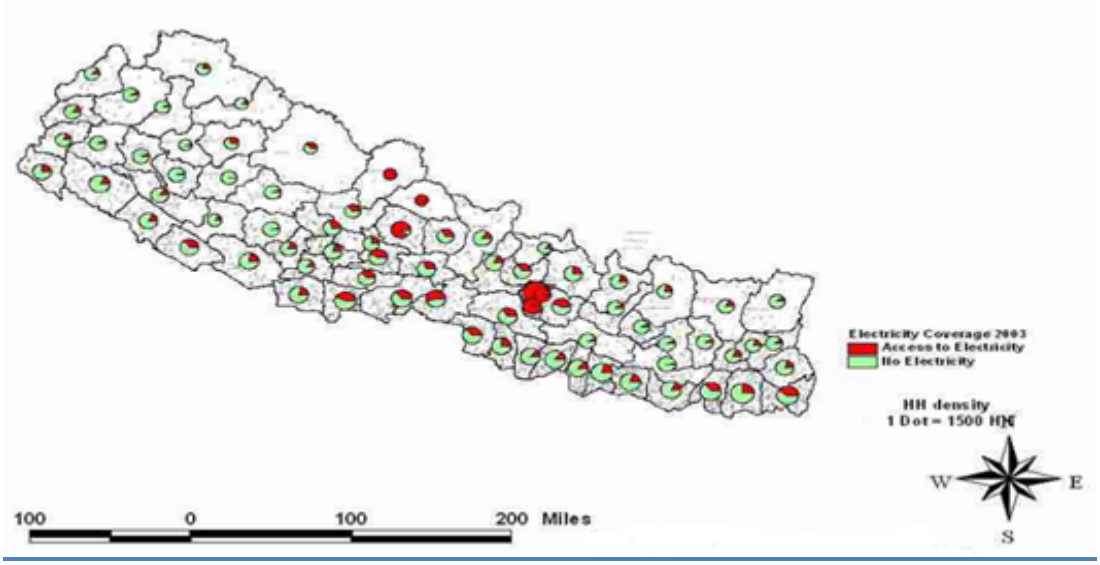
[l] "Business Environment Snapshot for Nepal". *The World Bank & International Finance Corporation.* n.d. Web. 18 March. 2012. Page 3. <http://rru.worldbank.org/BESnapshots/Nepal/default.aspx>.

[li] Electricity Act, 1992. Page 3.

[lii] "Hydropower in Nepal." *IPPAN.* n.d. 24 March.2012.<http://www.ippan.org.np/HPinNepal.html>.

## APPENDIX

### Exhibit A – Map of Nepal




Dhungel (2009). "History and Present Situation." Page 39.

### Exhibit B – Cost Benefit Calculation

Present Values (PV)/ Discounted Values of direct costs:

PV of the loan obtained from Asian Development Bank, Nepal (henceforth, ADBN):

Loan = NRs. 1.2 million; duration = 7 years; interest rate = 17%; monthly loan installments = NRs. 18,000 (given) → yearly loan payments = NRs. 216,000. Since the interest rate has already been incorporated in the annual payments, we consider the discount rate (henceforth 'i') to be the investor's opportunity cost of borrowing from ADBN instead of other banks. Other banks' lending interest rate in 1990, according to the WDI, was 14.42%. Since the investor makes the same payment over the 7 years, it is an annuity. Therefore,

PV of loan = payment * PV of annuity of $1 factor = 216,000 * [1-1/(1+r)^n]/r

= 216,000 * [1-1/(1+0.1442)^7]/0.1442 = "-NRs. 914,508.2"

PV of the land sold: "-NRs. 840,000". Since this cost took place at the time of construction, it is not a future cash outflow. Therefore, we do not need to discount the value.

PV of plant repair cost (incurred once): The plant was damaged by lightning and had to be fixed at a cost of NRs. 400,000. The article does not mention when this occurred and only mentions that the plant started operating in 1991 and was repaired by 1994. Therefore, time period to consider = 3 years (1994 minus 1991); the "i" is the deposit interest rate because the investor could have earned an interest of 11.92% in case he did not have to spend on the repair. Hence,

PV of the repair cost = 400,000/(1+0.1192)^3 = "-NRs. 285,323.1"

PV of the operating labor cost: Since the article does not mention for how long the investor pays the same salary to the employees managing the plant, we consider the time period to be infinity with the same salary. Deposit interest rate of 11.92% is the "i" for the same reason as above. So,

PV of operating labor cost = 48,000/0.1192 = "-NRs. 402,684.6"

PV of total direct costs = NRs. -(914,508.2 + 840,000 + 285,323.1 + 402,684.6)

= "-NRs. 2,442,515.9"

<u>Present Values of direct benefits:</u>

PV of the operating benefit from the electricity sales revenue: Since the article does not mention for how long the same revenue will flow in, the time period is considered as infinity and the revenue as constant every year. To be consistent with the PV calculations above, the "i" is again the deposit interest rate. Therefore, the PV of the operating benefit = 276,000/0.1192

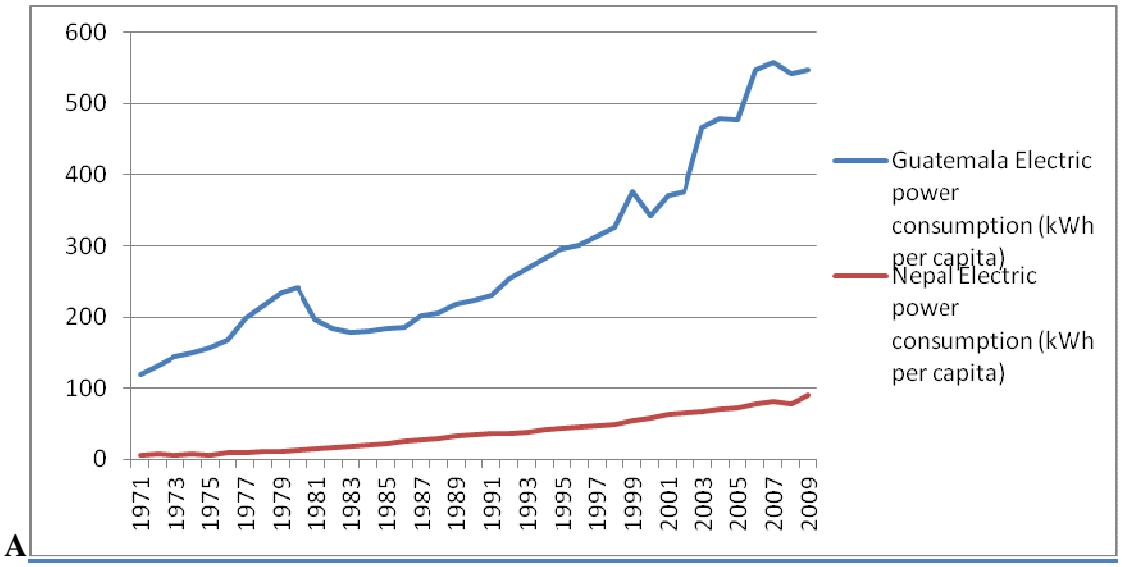
= NRs. 2,315,436.2.

PV of total direct benefits = NRs. 2,315,436.2

Therefore, Discounted Net Direct Benefits = total PV of direct benefits – total PV of direct costs

= NRs. (2,315,436.2 – 2,442,515.9) = - NRs. 127,079.7.

**Graph A**




**A**

Self-created graph using data from World Development Indicators.

< http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2>.

**Table A**

| Determinant | Peru (b) | Argentina (c) | Argentina Edenor | Chile Chilectra |
|---|---|---|---|---|
| Year privatized | 1994 | 1992 | 1992 | 1987 |
| Energy sales (GWh/year) | +19% | +79% | +82% | +26% |
| Energy losses (%) | -50% | -68% | -63% | -70% |
| No. of employees | -43% | -60% | -63% | -9% |

Bacon and Jones (2001). Page 17.