

## ASSESSING PRIVATE SECTOR CONTRIBUTIONS TO JOB CREATION: IFC OPEN SOURCE STUDY



### THEME: ACCESS TO INFRASTRUCTURE

#### LINKING POWER SUPPLY TO JOBS: ESTIMATING EMPLOYMENT EFFECTS OF POWERLINKS TRANSMISSION LIMITED PROJECT IN INDIA & BHUTAN<sup>1</sup>

*This study estimates the impact on jobs from power transmission lines constructed by Powerlinks Transmission Limited (PTL), a joint venture company supported by IFC, which helped bring power from a Bhutanese hydropower plant to India. The project had a significant development impact in both India and Bhutan. Unlike most studies that focus on jobs created through construction and operations and maintenance (O&M) (Category 1 jobs) of power projects, this study looks at employment effects more comprehensively by including estimates for second-order growth effects (Category 2 jobs) - i.e. those jobs that are created as the increase in power supply brought by PTL helps firms expand output and hence create more jobs. The study uses a mix of methodologies including Input Output models, econometric time series models and step-by-step estimation to determine the different types of employment effects. It finds that indirect and induced jobs created through an investment in power are much larger than the number of direct jobs created. But the most significant employment effect is from second-order growth (category 2 jobs that were created because the increased power supply relieved a key constraint for firms in India.) The project also had a broader poverty-reduction impact because the transmission lines were constructed through some of the poorest states in India. In addition, a large proportion of induced jobs were in the agricultural sector, creating employment and income for the rural low-skilled population.*

#### THE PROJECT

In 2003 IFC committed a loan of US\$75 million to Powerlinks Transmission Limited (PTL), a joint venture between private utility Tata Power Company and state-owned Power Grid Corporation Limited. The project involved building, owning and operating power transmission lines in India that enabled transmission of power from the Tala Hydropower Plant in Bhutan to India's power grid. The Tala project in Bhutan was built and financed by India on an understanding that most of the power generated would be bought by India to meet its needs while also increasing revenue for the Bhutanese government. Construction of the transmission lines started in 2003 and they were operational by 2007.

#### CONCEPTUAL FRAMEWORK

By helping finance the transmission lines from Bhutan to India IFC helped generate two categories of jobs:

- 1. Category 1: Jobs created during construction, operation and maintenance (O&M) of the transmission lines.** These include direct jobs (created by PTL or its contractors), indirect jobs (jobs created in firms supplying material etc to PTL) and induced jobs (jobs created because new direct and indirect jobs create additional demand for household consumption goods etc, which has a spillover effect in the economy).
- 2. Category 2: Second-order growth effects.** These are jobs created because the increased supply and reliability of power helped firms increase output, and hence employment.

#### Note on Methodology

The study uses a mix of methodologies for estimating the job effects.

- 1. Category 1** job effects (which are of three types - direct, indirect and induced jobs) are estimated using an **Input-Output model**.
- 2. Category 2** jobs: second order growth effects of increase in power supply are estimated using a time series **econometric approach** (a Vector Error Correction Model). The job effects due to increased reliability were estimated using a **step-by step estimation model** with World Bank Enterprise Survey data supplemented with data on power outages from primary interviews.

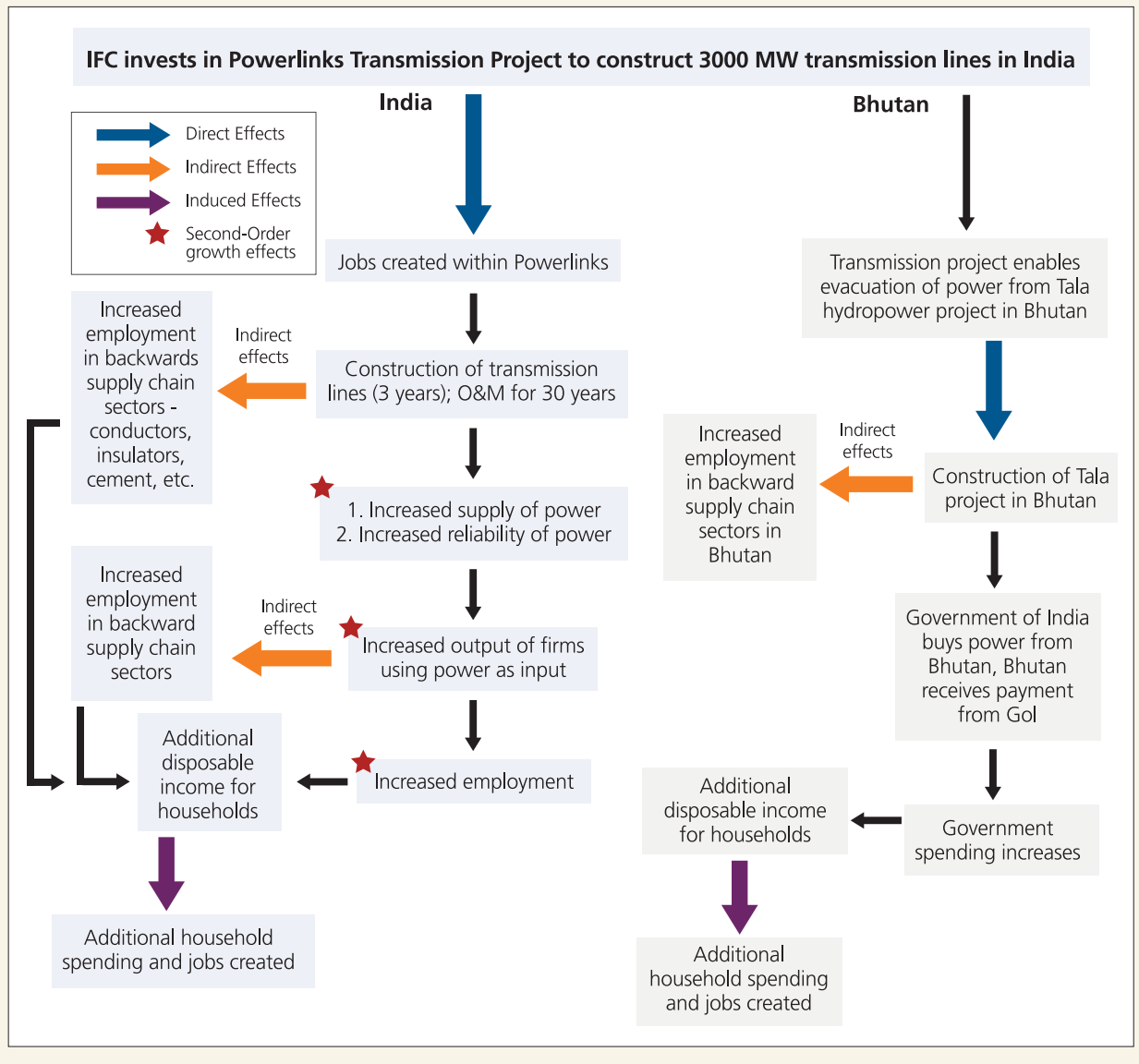
#### KEY FINDINGS

##### **Finding 1: Indirect and induced job effects are much larger than direct jobs created**

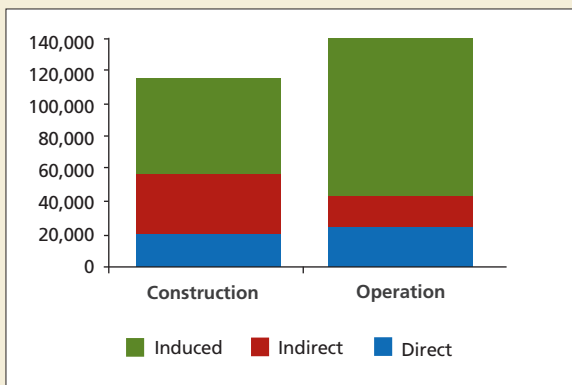
Category 1 jobs are created first during construction and later during O&M of the transmission lines. Using a 2006 Input-Output model for India we estimated that the construction and O&M of the power lines would create a total 243,000 person-years employment over the 25 years of the life of the project<sup>2</sup>. The number of indirect and induced jobs created is much larger than the direct jobs created by PTL, demonstrating that the project has large economy-wide spillover effects. In fact, induced jobs are the largest contributor to category 1 employment at 144,000 person-



**Figure 1: Chain of employment effects of the Powerlinks Transmission Project**



**Figure 2: Total employment effects of PTL (Person years)**



years. Interestingly, sectors like agriculture and forestry that initially appear to have no direct relationship to power transmission in fact were the most strongly affected be-

cause the new income generated was spent largely on food and that in turn created more jobs in the labor-intensive agricultural sector.

**Finding 2: Significant impact of the project on poverty**

There were two main channels through which poverty was reduced. First, jobs created during construction added Rs 47,000 lakh (US\$ 94 million) to household income, which was particularly significant since the transmission lines were constructed through some of the poorest states in India. The project used local labor so the construction activity added to household incomes of unskilled and skilled workers who were employed. Secondly, a large proportion of induced jobs were created in the agricultural sector where poverty is widespread. Since the agricultural sector has the highest employment-to-output ratio and one quarter of total household expenditure goes to buy primary food the total number of induced jobs created is highest in agriculture and thus the poverty-reduction impact for rural areas is significant.



**Finding 3: Largest job effects come from second-order growth effects (Category 2) i.e. jobs created due to increased power supply, which confirms other studies that show that power is a major binding constraint for output, growth and employment in India.**

Unlike most studies that only estimate jobs created through construction and O&M, this study also estimated how increased power supply helps firms expand output and hence create more jobs. We used an econometric time series model - Vector Error Correction Model (VECM), to establish the relationship between electricity consumption and employment. VECM is a dynamic time series model that allows a dynamic interrelationship between variables. This time series model allows us to measure the long-term relationship between the endogenous variables (electricity consumption, employment and real GDP) and also to estimate the short-term dynamics of the adjustment to the long-term equilibrium relationship.

The analysis found a causal relationship between electricity consumption and employment for India, and also for West Bengal and Bihar, the two states that received a majority share of the power transmitted through PTL lines. The model gives us a long-term equilibrium relationship between electricity consumption and employment and establishes that the elasticity of employment with respect to electricity consumption is 0.53 for India and 0.24 for West Bengal. In other words, a one percent growth in electricity consumption in India will result in 0.53% growth in employment for India because additional power consumption will increase output and result in employment growth. Discounting the power generated at Tala by the amount of power internally consumed in Bhutan, and further discounting for internal transmission and distribution losses in India, we convert this additional power supply brought to India from Tala into an amount actually available for consumption in India. Then, this can be used in the long-run equilibrium elasticity established by the model to arrive at the final figure for second-order employment effects.

An increase in power supply from Bhutan's Tala hydropower plant transmitted through PTL's transmission lines created about 75,000 new formal jobs in India over the period 2006-2012, including about 4,600 new formal jobs in West Bengal. The impact on informal job creation would be larger than on formal jobs but our analysis focused only on jobs in the formal sector due to data limitations.

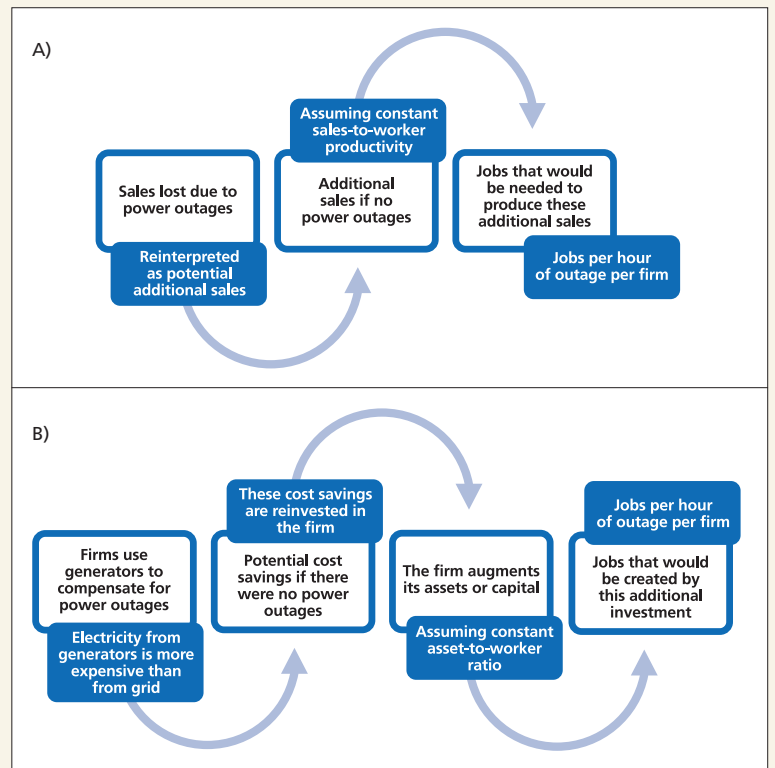
**Finding 4: Reliability of power supply is a key constraint for firms. An improvement in power reliability (reduction of power outages) helps firms reduce production losses, save the cost of running generators, and increase their output, hence create more jobs.**

The reliability of power supply (using power outages as a proxy for measuring reliability), and not just quantity of power supply, is a key constraint for firms. Using data from the 2005 World Bank Enterprise Surveys in India we constructed a step-by-step estimation model to establish an approximate relationship between employment and power outages.<sup>3</sup>

Power outages impose two costs on firms that, if avoided, can be reinvested in productive activities that increase output and employment. We estimate two main types of costs: a) value of production loss, and b) the additional cost of using generators.

- a. Value of production loss.** This is the amount of output that firms lose due to lost production time, time needed to reset machines, and losses and damages due to interruption of production processes. The Enterprise Surveys ask firms to estimate these losses, which we apply in our model as potential additional sales that would occur if there were no power outages. Assuming constant sales-to-worker productivity, it can be estimated how many workers would be needed to produce these additional sales.

**Steps in the estimation model**





**b. Cost of using generators.** Firms try to minimize production losses due to power outages by investing in backup generators. However, running generators imposes an additional cost on firms because using generators is more expensive than using power from the grid. This additional cost of running generators, as opposed to using power from grid, could be saved and reinvested by firms more productively if there were no power outages. Such additional investment would create additional jobs if we assume a constant capital or asset-to-worker ratio. We use the additional *incremental* cost of using power from a generator as compared to power from the grid, and ignore the capital cost of installing power generators as sunk cost.

By combining the impact on jobs from both a) and b), the study estimates the number of jobs created by improving the reliability of power. Primary data collected from the government in West Bengal and corroborated by the private sector shows the number of hours of outages per year decreased from 440 hours to 180 hours from 2005 to 2010. Combining this information with the estimated jobs per hour of outage ratio from the estimation model outlined above, the study finds that a total of 10,636 jobs were created in West Bengal by this reduction in power outages. Of that total, about 1,600 jobs can be attributed to power brought by PTL from Tala. For Bihar, information collected in the region indicated that there had not been a significant improvement in reliability.<sup>4</sup>

**Finding 5: By enabling the evacuation of power from Tala, the PTL project helped bring in significant revenue for the Bhutanese government, contributing almost 9% to its GDP, and enabling it to spend more on education and health.**

The PTL transmission lines help evacuate power from Bhutan's Tala hydropower plant to India. The Tala plant was built with funding from the Indian government on the understanding that power from it would largely be exported to India. This project has a significant development impact in Bhutan contributing almost 9% to Bhutan's GDP. The

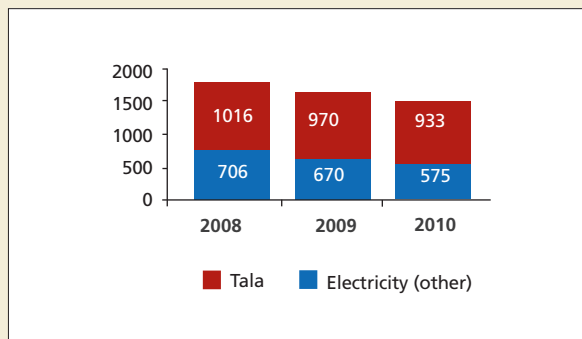
increase in government revenues further enables the Bhutanese government to spend more on social sectors like health and education, thus improving quality of life and employment prospects for the people of Bhutan.

Using a simple National Accounting model we find that as a result of Tala's contribution to GDP over the period 2007- 2010, on average, each year 973 students are enrolled and 1,215 patient days are supported. That represents more than half of total beneficiaries that the electricity sector reaches as a whole. For example in 2010, 933 students were reached by the government with the increased revenue from Tala as compared to 575 students that were reached as a result of increased revenue from the rest of the power sector. In fact, the total number of students and patients reached more than doubles with the contribution of Tala (figures 3 and 4). Improved educational access increases employment opportunities and income levels. Similarly, healthy people are expected to get and keep jobs more than unhealthy ones. Therefore, Tala hydroelectric power plant not only contributes to Bhutan's GDP and growth, but also supports employment indirectly by making it possible for the government to spend more on providing crucial health and education services.

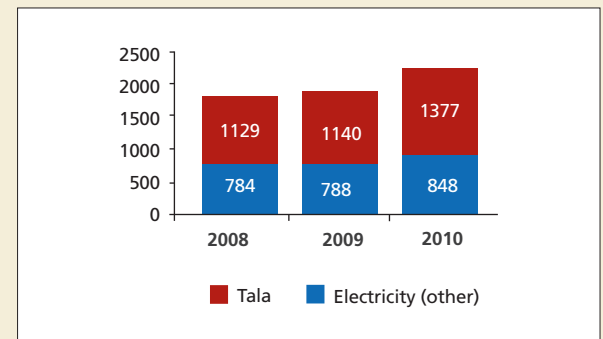
## Conclusion

This study shows the significant impact of an increase in power supply on jobs in an economy where power supply is a key constraint for firms. Improved power supply can play a significant role by helping developing countries increase their output and create jobs. While assessing the employment effects of power projects, it is very important for policy makers to focus more on the second-order growth effects (category 2 jobs) that are created as a result of increased power supply that enables increased output and hence jobs, rather than focusing on short term direct jobs that are created through construction or even through O&M of the project. The significant impact of investment in the power sector on jobs, through second order growth effects, can be transformational for an economy.

**Figure 3: Number of students enrolled**



**Figure 4: Number of patient-days**



Source: Bhutan National Account Statistics (2010) & Bhutan Statistical Yearbook 2011



TYPES OF JOB EFFECTS			METHODOLOGY USED
<b>Category 1 jobs (created during construction and O&amp;M)</b>			
1	Direct	44,000 person years	Input-Output model
2	Indirect	55,000 person years	
3	Induced	144,000 person years	
	Total	243,000 person years (about 9,700 jobs over 25 years)	
<b>Category 2 jobs (created as an increase in power supply relieves a constraint for firms)</b>			
1	Impact of power supply	75,000 jobs in 6 years	Econometric time series (VECM model)
2	Impact of reliability of power supply (subset of 1)	1,600 jobs in 6 years in West Bengal	Step-by-step estimation model using Enterprise Surveys and primary data from interviews.

## Endnotes

- <sup>1</sup> This study was led by Namita Datta (CDI) with a team consisting of Govinda Timilsina (DECRG), Mahima Khanna (CSA) and Ferran Casadevall Massuet (CDI), under the overall guidance of Roland Michelitsch, (Manager, CDI). This case study is part of a broader study on 'Private sector contributions to Job Creation' led by CDI, IFC, which is aligned with World Development Report 2013 on Jobs. More information can be found at [www.ifc.org/jobcreation](http://www.ifc.org/jobcreation). Acknowledgements: The study benefitted from insightful comments, suggestions and support from Clive Armstrong (CNGSF), Tom Davenport, (CSA), Shalabh Tandon (CSA), Soumya Banerjee (CSA), Priyanka Sood (CSA), Fan Zhang (ECSSD), Robert Bacon, Ulrich Bartsch (PREM), Luis Andres (SASSD), Alexis Diamond (CDI), Gabriela Armenta (CDI), Anqing Shi (CDI) and Om Bhandari (CSA). A more detailed version of this study can be found at [www.ifc.org/jobcreation](http://www.ifc.org/jobcreation).
- <sup>2</sup> While Input–Output models have been used in a large number of studies that estimate employment effects of infrastructure projects, the models are built on a number of assumptions. For example, the model assumes a constant production function, which excludes the possibility of efficiency and productivity improvements or other dynamic effects. Given that a new power transmission line might increase productivity, the job estimates provided by the input-output model will be conservative.
- <sup>3</sup> This step by step model is only meant to provide an approximate estimation of the magnitude of the importance of reliability of power - highlighted in various studies, in Enterprise Surveys, and also in our primary interviews as a very important issue for firms in India. The model involves a number of assumptions at various steps. In the absence of a more recent Enterprise Survey data set, we used the power –employment relationship in India in 2005 to give us an estimate.
- <sup>4</sup> These results are conservative estimates as it only considers the effects on formal employment. In 2004-05 the informal sector employment was six times that of the formal sector in India. The informal sector would also have benefitted from the improved power supply. Power theft for example, would have led to more production in the informal sector, even though it is a drain on the revenues of the power utility or the government.



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