Energy Policy 75 (2014) 179–188

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

# The transaction costs driving captive power generation: Evidence from India

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## HIGHLIGHTS

- We analyze why some firms opt for captive power generation while others do not.
- We examine the role of transaction costs in this decision making using probit model.
- Unique data from a primary survey of manufacturing firms in Andhra Pradesh, India.
- Transaction-specificity significantly determines who installs captive power plant (CPP).
- Firm-level characteristics crucial in policies incentivizing captive generation.

## ARTICLE INFO

*Article history:*
Received 18 May 2014
Received in revised form
2 October 2014
Accepted 7 October 2014
Available online 30 October 2014

*Keywords:*
Captive power generation
Transaction-specificity
India

## ABSTRACT

The 2003 Indian Electricity Act incentivizes captive power production through open access in an attempt to harness all sources of generation. Yet, we observe that only some firms self-generate while others do not. In this paper we give a transaction cost explanation for such divergent behavior. Using a primary survey of 107 firms from India, we construct a distinct variable to measure the transaction-specificity of electricity use. The ‘make or buy’ decision is then econometrically tested using probit model. Results are highly responsive to transaction-specificity and the likelihood of captive power generation is positively related to it. At the industrial level, this explains why food and chemical firms are more likely to make their own electricity. Since the burden of poor grid supply is highest on smaller sized and high transaction-specific firms, the grid access policies need to account for firm-level characteristics if government wants to incentivize captive power generation.



## 1. Introduction

Recent institutional changes in India, notably The Electricity Act 2003, encourage private production of electricity by industrial users unlike other developing countries like China[2]. Such a policy is necessitated out of the dire shortage of generation capacity in the country. Therefore, the aim of the government is to harness all sources of generation especially from the private investors (Joseph, 2010). This stems from the fundamental problem that state-owned utilities are financially insolvent and operate at losses. This makes costly infrastructural improvements unviable and limits the role of the state in reducing the electricity demand-supply gap. The experience with grid based large scale independent power producers (IPPs) did not prove to be highly successful either in the early years of reform (Bhattacharyya, 2007). At the same time economic liberalization post 1991 led to an era of manufacturing growth where electricity demand outpaced supply (*ibid.*) and severely strained the grid causing outages and poor quality supply. A combination of these factors resulted in proliferation of industrial self-generation of electricity, through the setting up of backyard units known as captive power plants (CPPs)[3]. Between 1995 and 2004, the total CPP generation capacity in India increased by

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[2] China, owing to pollution reduction standards and problems posed by low-efficiency, has a policy of discouraging small coal-fired power plants including those for industrial self-use (http://www.iea.org/publications/insights/Insight_PolicyOptions_LowCarbon_China.pdf) accessed in July 2014).

[3] By definition in India, captive power plants (CPPs) are power plants of capacity 1 mega-watt (MW) and above, commissioned by the industries for their self-consumption (Ramesh et al., 1990; Shukla et al., 2004).

http://dx.doi.org/10.1016/j.enpol.2014.10.003
0301-4215/

68 per cent[4]. In the last decade the installed capacity of CPP has more than doubled. In 2001, the capacity was 16,157 MW whereas by the end of 2011, it became 32,900 MW[5]. Correspondingly, the share of CPP capacity to total installed capacity increased from 13.7% in 2001 to 15.9% in 2011.

The policy to encourage captive production gives the sense of a dual track economy (Joseph, 2010). This means that, post the partial reform[6] of allowing 'open access'(as per the Electricity Act, 2003), there is the possibility that industries, facing high priced cross-subsidizing power and shortages, can exit the grid and set up their own CPPs[7] and eventually feed the power back to the grid. It also gives politicians the option where they can continue to cross-subsidize the key political constituencies (like agriculture and household) without depressing the growth of private power (*ibid.*). This dual track policy, based on the assumption that firms facing shortages will always opt out of the grid, builds on a sub-assumption that this is an efficient bypass (Faulhaber, 1975; Mitchell and Vogelsang, 1991) which means that the incremental cost of self-supply of electricity by firms is lower than the incremental cost of grid supply. However, this is hardly true (as will be explained in greater detail in Section 2.2). Moreover, despite similarities in their size, marginal cost structure, product profile or location, only some firms have CPP while others do not. When we compare (in Table A1, Appendix A) firms sampled in an industrial survey conducted by the authors for one particular location in the state of Andhra Pradesh in India, we find that for firms in a similar range of size (or cost structure) and factor demand (CMD), 43% opted for captive power generation whereas 57% did not.

In spite of the policy of encouragement why do we observe that only some firms self-generate while others do not? In other words, what is the key factor determining the decision to install a CPP? This paper is an attempt in understanding this relatively unexplored aspect of CPPs without which it will be difficult to discern whether policies driving CPP growth can be effective or not[8]. Since the decision to install a CPP is of a 'make or buy' nature, which the previous literature with emphasis on factor demand, marginal costs and scale economies does not adequately explain, we find in transaction cost economics (TCE) (Williamson, 1979; Masten, 1984; Nooteboom, 1993) a useful framework to test the relevant hypotheses leading to vertical integration of electricity production. A distinct variable is created to measure the transaction specificity of electricity use for a firm. Contextual factors like firm size, land asset, power shortages, industrial category and operating environment are used as controls in a binary choice probit specification. The data comes from a primary survey of 107 firms (of which nearly 40% have gone for vertical integration). The survey was conducted in the Southern Indian state of Andhra Pradesh over a period of eight months in the year 2012–2013. This state is a leader in power sector deregulation and an industrial state of prominence with one of the fastest growing captive power sectors. It has the highest share of captive generation and consumption in Southern India and fifth highest in all-India (CEA, 2010–2011).

The rest of the paper is structured as follows: In Section 2, the literature on the investment decision to install CPPs, the relations between power shortages and self-generation are reviewed. This section also highlights the gaps in this literature and argues that TCE provides a better framework to understand this decision. Section 3 describes the hypothesis, data and variables. Section 4 gives the results and validates the theoretical claims laid down in earlier sections. Section 5 presents a discussion of how transaction specificity explains the decision for CPP installation based on the results of the preceding analysis. Section 6 concludes with some policy concerns and agenda for future research.

## 2. The 'make or buy' dilemma

### 2.1. Power shortages and firm response

What are the economic costs of power shortages and how do firms respond to it? Wijayatunga and Jayalath (2004) estimated the impact of power outages on the GDP of Sri Lanka. This was done by calculating the cost of un-served power to industrial consumers. They found that not all industries were impacted alike. For example, the planned loss to the industries in Food and Beverages category was as high as 153 US$/hour (US$/h) whereas that of the Tea industry was only 22 US$/h. Similarly the unplanned losses for Food and Beverages industry were 363 US$/h whereas for Tea industry it was only 22 US$/h. In aggregate terms, the costs of outages for industries in Sri Lanka came out to be 0.9 % of the GDP. Pasha et al. (1989) estimated the economic cost of power outage for Pakistan and found that the average cost of planned outages was Rs. 6.67/kW h[9]. The highest burden was on machinery equipment industries with an average cost of Rs. 25.71/kW h. For some other industries like textiles and non-metallic manufacturing, the average cost was as low as Rs. 4.24/kW h. Overall power outages reduced the national GDP by 1.8%. Majority of firms (72% of the sample) responded to outages by adjusting their operations. Twenty seven per cent firms tried to make up for losses by increasing intensity of machine use, 26% stretched working hours and 8% increased the number of shifts. Only 12% of the sampled firms went for the option of self-generation where the proportion of chemical and machinery equipment industries were the highest. Bose et al. (2006) calculated the economic impacts of power outages on industries in the southern Indian state of Karnataka. They found that economic losses due to power outages ranged from 0.09% to 0.17% of the total State Domestic Product (SDP) for High Tension (HT) industries. For the Low Tension (LT) industries it ranged from 0.04% to 0.05% of the SDP. They also found out that LT industrial consumers had a higher willingness to pay for improved power supply as compared to the HT consumers indicating that the burden of power outages was higher for them and that HT consumers had an option to self-generate.

[4] *Source*: All India Electricity Statistics (General Review), 2005 report by the Central Electricity Authority (CEA) of India.

[5] *Source*: Energy Statistics, 2012 report by Central Statistics Office, Government, of India, p. 15.

[6] Partial reform is when the electricity sector in somewhere between being regulated and completely deregulated. In India, the generation segment has some private participation but the distribution sector is still mostly state dominated. The Electricity Act, 2003 envisaged a transition towards a market based electricity sector where multiple (state or privately owned) generators and distributors would operate to provide electricity at marginal prices. Any player could set up a generation or distribution utility without seeking state licenses and subject only to regulatory approval and oversight of electricity regulators. Captive power production was also made license free and provided open access to the transmission grid. For details about the reform process refer to the Electricity Act 2003 (http://aptel.gov.in/pdf/The%20Electricity%20Act_2003.pdf). However, not all of the features of this Act have materialized, leaving the sector in a state of partial reforms.

[7] In certain specific contexts, self-supply could arise because of other reasons like meeting air pollution targets through cleaner or renewable resources as in China.

[8] As Joseph (2010) points out, the Electricity Act, 2003 'encourages further power production from these captive plants through its open access clause' and hopes that this policy will be effective in more CPP investment. Joseph argues that this policy is necessitated out of the dire shortage of generation capacity in the country and the aim of the government is to harness all sources of generation especially from private investors.

[9] 1 US $=(Pakistani) Rs. 17.50 in 1989.