Introducing micro-markets for electricity in India: Improving reliability as well as sustainablity

Pradyumna C. Bhagwat, Delft University of Technology, +31 152 783 963, p.c.bhagwat@tudelft.nl
Laurens J. de Vries, Delft University of Technology, +31 152 781 137, l.j.devries@tudelft.nl

Overview

India is one of the fast growing economies in the world with an ever-rising growth in demand for electricity from both the industrial as well as residential sector. The per capita power consumption in India has grown from 16.3 KWh per capita in 1947 to 1010 KWh per capita in 2015 (CEA India, 2015). However, in most regions, the private and government investment in generation capacity has not been able to keep up with the demand growth. This can be observed from an expected peak load deficit of 2.1% - 2.6% in fiscal year 2015-16.

Furthermore, as demonstrated by the power outage in 2012, that left roughly 300 million people without electricity, the electrical infrastructure in India is unreliable. These issues have led to debilitating load shedding across the country, especially in the rural areas. These outages negatively affect industrial and agricultural productivity and also the comfort of common citizens. Due to this, many consumers resort to installation of back up capacity. This back up capacity mainly consists of diesel generators. According to Central Electricity Regulatory Commission (CERC), it is estimated that the total decentralized diesel generator based installed capacity in India is in the range of 90 GW as of 2014 (CERC India, 2015). A comparison of the cost of electricity from such diesel generators in the range of 15 - 17 ₹/KWh to a retail price (industrial consumers) estimated between to be between 7 – 9 ₹/KWh, indicates a substantially high willingness to pay for electricity. CERC estimates a Value of lost load (VOLL) of between 34 ₹/KWh to 112 ₹/KWh for India.

In this study, we propose a micro market for electricity that operates during hours supply when supply is insufficient (load shedding hours). The distributed back-up capacity is integrated into the system for supply and further combined with capacity subscriptions on the consumer end in order to improve adequacy.

Methods

Initially, a literature review of the indian electricity sector is conducted to find the required data and also to understand the dynamics of the Indian electricity sector. Based on this research, we have proposed a framework for micro-market for electricity during planned loadshedding hours. To understand the impact of this system on distributed generation, we analyze the business case for investing in two generation technologies namely, diesel generation and rooftop solar generation, based on their revenues from the the micro-market. We use payback period and return on equity as indicators for quantifying the results.

Results

These results indicate that the micro-market is able to provide incentive for investment in distributed generation even as a stand-alone mechanism. There could be a valid business case for investing in these technologies exclusively for operating on the micro-market. The results also indicate a higher incentive for diesel generation as compared to solar-rooftop. However, note that most distributed generation systems are implemented to provide off-grid power to the owners of the equipment during hours of shortage. Thus, the income from selling the power during idle hours is additional revenue. Moreover, the results are sensitive to the market clearing prices. Lower prices in the micro-market may make it less attractive for diesel generator.

However, various technological and policy barriers to implementation of a system exist and need to be addressed.

Conclusions

In this research we propose a micro-market for providing electricity during load shedding. Micro-markets would make investments in diesel and solar energy based distributed generation attractive, even if these distributed generation systems depend exclusively on these micro-market for revenues. For both distributed generation systems analyzed in this research, in many of the scenarios, the return on equity is higher than the risk free rate of return even at a market clearing price significantly lower than the estimated value of lost load. Considering the conservative

market clearing prices and VOLL values from literature, a higher willingness to pay on the consumer side could be expected, which would make the micro-market more attractive for generators.
We can also conclude that consumers would strongly benefit from the avoidance of outages. A policy instrument such as the micro-markets for electricity can lead to improvement in electricity adequacy for industrial as well as residential sectors. It could lead to an improvement in the overall of productivity in industries that depend on electricity and would thus reflect positively on the macro-economic indicators of the country, especially if this system is implemented in multiple regions.

The system presented here is easy to replicate across the entire country and could evolve into a more integrated system in the future. Furthermore such a system could be implemented in many other developing nations.

References

CEA India, 2015. Growth of Electricity Sector in India from 1947-2015. New Delhi.

CERC India, 2015. Minutes of the 19th meeting of the central advisory committee (CAC) of CERC. New Delhi.