Pitfalls of oil-based expansion of electricity generation in a developing context

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Abstract

In the context of growing demand and the need to rapidly increase access to convenient forms of energy, developing countries face many challenges for the development and upgrading of national energy infrastructures. Constraints on primary fuel sources, lack of capital and socio-political dynamics often result in the adoption of sub-optimal strategies for the expansion and upgrading of the existing infrastructure. Bangladesh is one such example that recently initiated a 10-year expansion program in 2010 to treble its generation capacity to 20 GW by 2021. The majority of about 3 GW capacity increase in the last two years has been based on imported oil such as heavy fuel oil (HFO) and high speed diesel (HSD). Despite having surplus generation capacity in 2011–12, the country continues to experience blackouts almost on a daily basis. By analysing the profiles of electricity demand, generation and shortage, as well as fuel imports, this study on Bangladesh demonstrates that increasing oil-based generation capacity does not always result in a proportionate increase in net electricity production. Moreover, increased dependence on volatile international energy markets for sourcing of fuel results in greater macroeconomic risks. Such macro-scale stress in a developing economy can be counter productive for social and economic development, as it takes resources away from other important sectors. Outcomes of this study can be useful for other developing countries that are undertaking energy sector reforms.

Keywords: Electricity generation strategy, Fossil fuel, Energy security, Developing countries, Bangladesh

1. Introduction

Developing countries face many challenges for the development of national energy infrastructures, in the context of growing demand and the need to rapidly increase access to convenient forms of energy at an affordable price [1]. Some of the challenges relate to the lack of capital for upgrade and/or new installations and others relate to the constraints on primary fuel sources. Most developing countries, in particular the ones with large populations are also heavily dependent on traditional hydrocarbon sources for energy, which are often imported.

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Increasing dependence on imported oil and petroleum products in a rising and volatile international energy market results in greater energy insecurity and additional risks to the economy. Energy security (or the lack of) is, therefore, increasingly being recognized as the new frontier of strategic discourse [2], regionally and internationally.

Bangladesh serves as an ideal candidate for studying energy infrastructure development challenges faced by the developing economies with relatively higher rates of economic growth and lower rates of access to electricity. The country has been experiencing a steady growth rate of around 6% in gross domestic product (GDP) since 2004 [3], against an electrification coverage of 50% and one of the lowest per capita electricity use of 252 kWh[1] [4, 5]. The average rate of annual growth in demand for electricity was 7.16% for the period 2001–2011. For most part of the country's 40 years history, demand outstripped supply [4]. The situation exacerbated in the last decade, resulting in rolling blackouts throughout the year, albeit with varying intensities due to the variations in seasonal demand. Power outage has been reported to impact negatively on the overall economy, with substantial individual and national losses [6].

The primary fuel for generating electricity has been natural gas, the share of which used to be around 80% of total generation, less than a year ago – at the end of the financial year 2010-11 [7]. Recent oil-based expansion of the generation capacity has reduced the share of natural gas to 67.98%[2]. The remaining capacity comes from coal (2.85%), furnace oil (3.15%), heavy fuel oil (17.28%), high speed diesel (6.12%) and hydro (2.62%). Most of this additional generation capacity came from the private sector, which was given fiscal and structural incentives for speedy implementation of projects – from fast-tracked approval to tax-break. Lack of public funding for large-scale projects was cited as the reason for allowing the recent expansion of the private energy sector [8]. Although the initial policy aim was to increase net electricity generation, in reality, the potential of the increased capacity was rarely used to the full. Typical daily net energy generation still hovers around 100 GWh.

This study aims to investigate the recent expansion in the electricity sector in Bangladesh – to shed light on whether the capacity increase based on imported oil was a sustainable strategy to meet even the short term growth in demand and discuss the impact on energy security and

[1] As of June 2011

[2] Calculated using generation data on 15 May 2012, obtained from the Bangladesh Power Development Board (BPDB). http://www.bpdb.gov.bd/

the national balance of payments.

2. Electricity demand, generation and shortage

Table 1 shows yearly installed and derated generation capacities and demand, as well as annual percentage changes for the period 2001–12. The data are aligned with financial years that run from July to June. During the first half of the period, annual increases were in single figures. Significant additions were made in 2009, 2011 and 2012, with capacity increases of 25.08, 25.95 and 22.74%, respectively. In 2007, there was a net decrease in capacity. Despite consistent growths in demand for electricity in the last decade, the increase in generation was always less than what was required, except in 2012 when capacity was greater than demand for the first time. In theory, the country should now be able to meet most, if not all of the demand as there is a surplus derated capacity of 978 MW. In reality, there was a severe power shortage throughout 2011 and the trend is set to continue for 2012.

Seasonal trend in demand for electricity in Bangladesh is shown in Figure 1, using monthly peak and minimum generation and peak demand from January 2011 to March 2012. Three predominant seasons are present: hot summer from mid-March to mid-June; hot and humid monsoon from mid-June to mid-October; and cooler and drier winter season from mid-October to mid-March [10]. Peak occurs during monsoon months, primarily due to high moisture content in the air, with relatively humidity above 90% for most of the time, requiring cooling and hence electricity. Hot summer months also require cooling because of higher ambient temperatures. The need for agricultural irrigation during dry winter months also increases demand for electricity [11]. Upward trends in demand growth result in a somewhat flatter curve for peak generation, which struggled to keep up with peak demand during most, if not all, months.

2.1. Ownership and fuel mix

Before the recent expansion, most of the electricity used to be generated by public-sector power plants using natural gas. Public sector generation is operated through Bangladesh Power Development Board (BPDB), a government organisation. The deregulation of the power sector was initiated in 1994, when Rural Power Company Limited (RPCL), a publicly owned company, began its journey as the first independent power producer (IPP) in the country. IPPs, wholly owned by the private sector, started in 1997, under build-own-operate (BOO) model of public

Table 1: Installed capacity and demand for electricity between 2001 and 2012.

Year	Capacity			Demand	
	Installed MW	Derated MW	Change %	Forecast MW	Change %
2001	4005	3033	–	3394	–
2002	4230	3218	6.10	3659	7.81
2003	4680	3428	6.53	3947	7.87
2004	4680	3592	4.78	4259	7.90
2005	4995	3721	3.59	4597	7.94
2006	5245	3782	1.64	4693	2.09
2007	5202	3718	-1.69	5112	8.93
2008	5201	4130	11.08	5569	8.94
2009	5719	5166	25.08	6066	8.92
2010	5823	5271	2.03	6454	6.40
2011	7264	6639	25.95	6765	4.82
2012	8769	8149	22.74	7171	6.00

Data sources:

2001–2011: Bangladesh Power Development Board [4].

2012: Power Grid Company of Bangladesh [9].

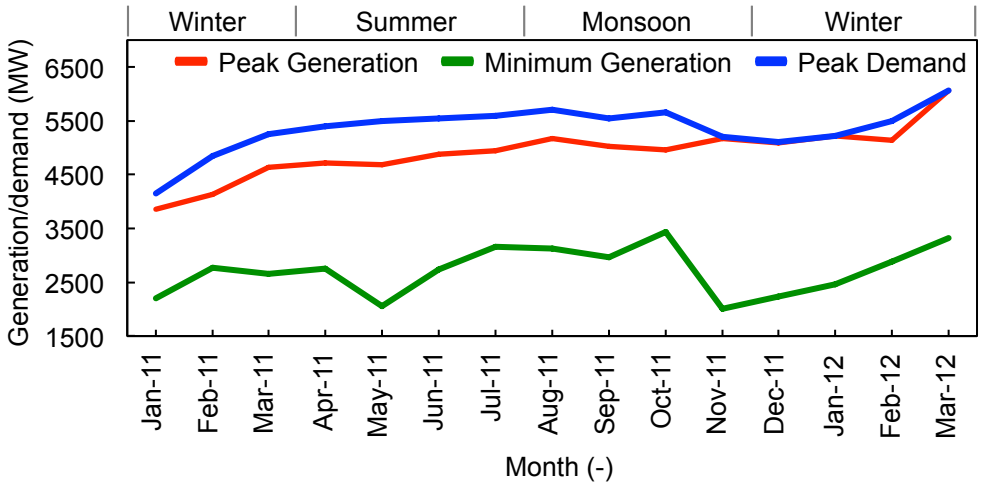
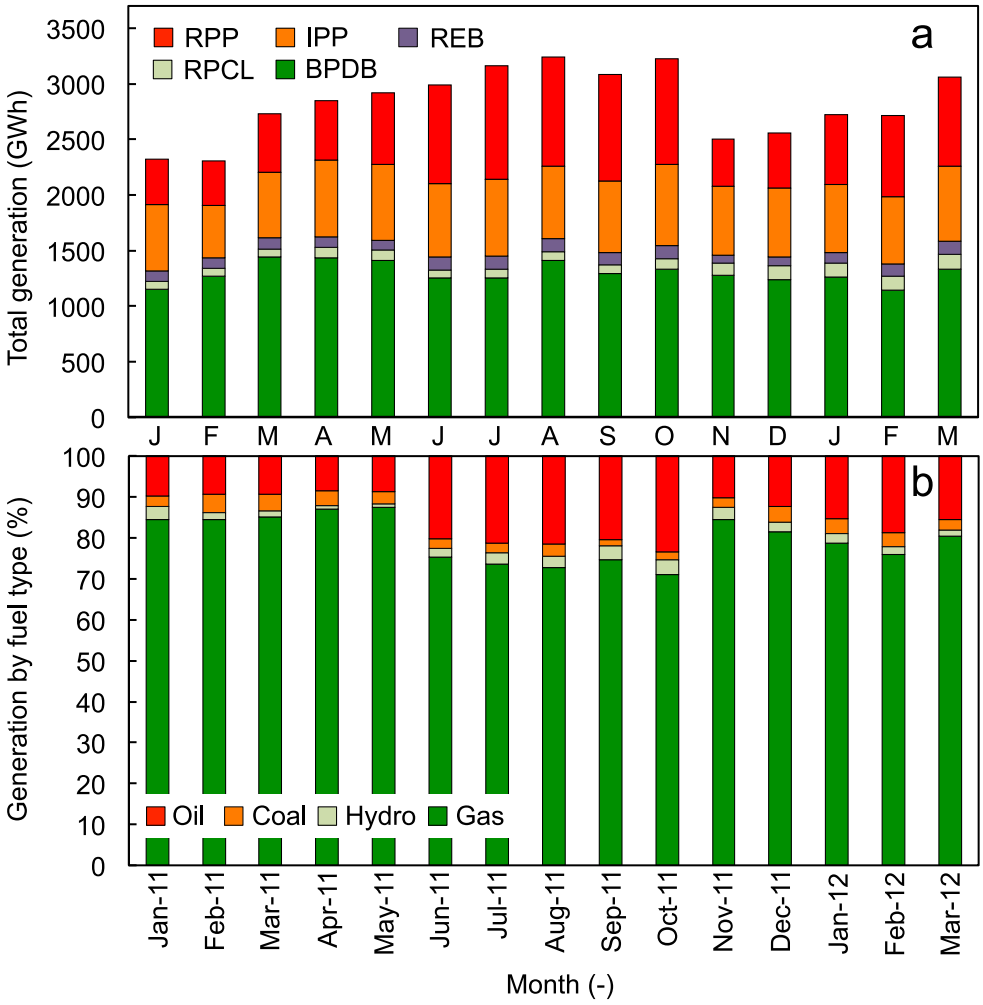


Figure 1: Peak demand, and minimum and peak generation in a month; between January 2011 and March 2012. Data source: [9].

private partnership (PPP) [12]. Further deregulation allowed private sector power generation companies to operate under rental agreements lasting between 3 and 15 years. First rental power plant (RPP) started its operation in 2008. A host of new RPPs began operation in the last three years and now accounts for the majority of the private sector electricity generation.

Figure 2 shows total monthly electricity generation between January 2011 and March 2012 by producer (Figure 2a) and fuel type (Figure 2b). Maximum total monthly generation, 3244 GWh, was in August 2011, closely followed by a generation of 3227 GWh in October 2011. Minimum total monthly generation of 2308 GWh was recorded in February 2011, closely followed by the generation of 2320 GWh in the preceding month. Of note are the shares of public and private sector generation. Private sector independent producers (i.e., IPP, orange bar in Figure 2a) on average generated 636 GWh with a standard deviation (SD) of 59 GWh, whereas private rental sector (i.e., RPP, red bar in Figure 2a) generated 693 GWh [SD: 219 GWh]. In contrast, public sector power plants generated 1301 GWh [SD: 89 GWh]. Seasonal demand fluctuations appear to be met by increasing the share of rental plants, most of which are based on imported and state-subsidized oil. Generation by fuel type is illustrated in Figure 2b, which illustrates month by month variations in the fuel mix. Increased demand for imported oil during high-demand months (i.e., June – October) may adversely affect other uses of oil and petroleum products

and put the overall national balance of payments at risk.



Abbreviations:
RPP: Rental Power Plant
IPP: Independent Power Producer
REB: Rural Electrification Board
RPCL: Rural Power Company Limited
BPDB: Bangladesh Power Development Board

Figure 2: Total monthly electricity generation between January 2011 and March 2012. (a) By producer, and (b) By fuel type. Data source: [9].

2.2. Shortage and blackouts

Having surplus generation capacity, in particular in 2012, did not eliminate the problems of rolling blackout. Number of black-out days and minimum and maximum shortage during blackout days for January 2011 – March 2012 are shown in Figure 3a and 3b respectively. Blackouts occurred almost every day between January and October 2011. Situation improved in November but quickly turned worse in the subsequent months and everyday occurrences of blackouts were back on course by March 2012.

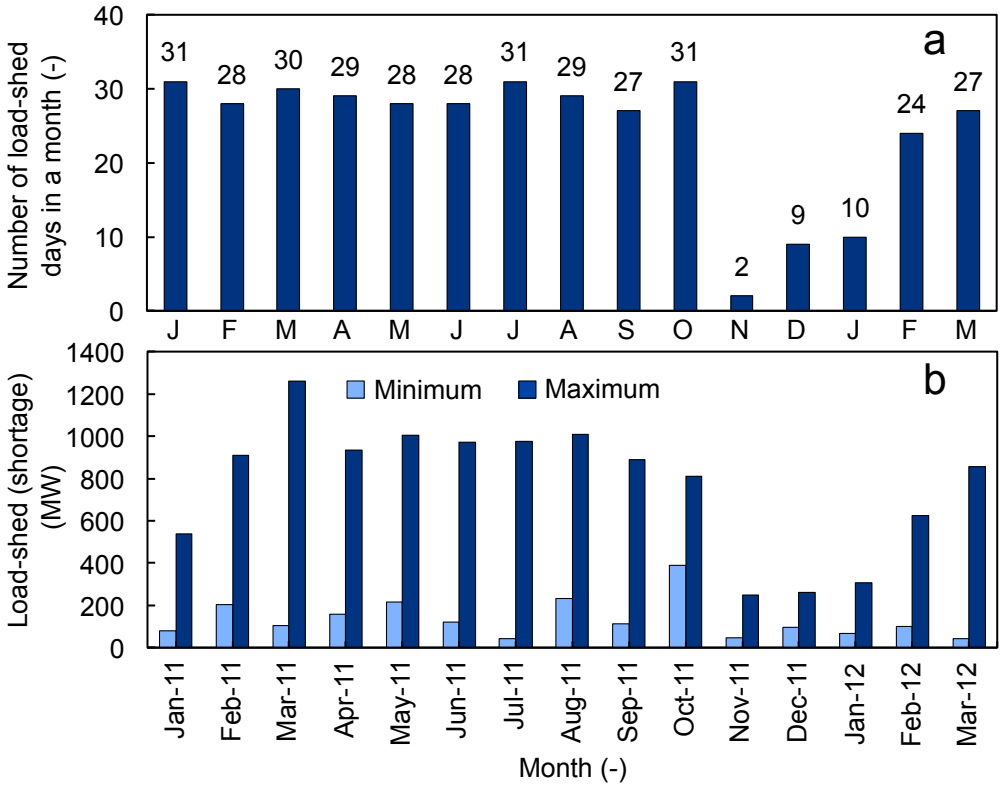


Figure 3: Monthly blackout (load-shed) statistics between January 2011 and March 2012. (a) Number of blackout days in a month, and (b) Maximum and minimum power shortage. Data source: [9].

2.3. Daily energy profiles

A closer look at the daily demand vs. generation; i.e., energy curves, highlights the impact of the current oil-based expansion strategy on actual generation and unmet demand. Two daily

energy curves, one for an atypical day in March and another for a typical monsoon day in July, are given in Figure 4. The atypical day (Figure 4a), 22 March 2012, is chosen because it represents the maximum grid electricity generation in the country's history[3]. The additional demand between 14:00 and 23:00 hrs was due to the Asia Cup cricket final match between Bangladesh and Pakistan, which started at 14:00 hrs local time[4]. The peak demand of 6065.5 MW occurred at 19:30 hrs in the evening and represents the increased demand for space cooling and lighting, as well as for watching the game on television. On the other hand, the typical daily energy curve, shown in Figure 4b has distinct day and evening demand peaks of 4633 MW at 10:00 hrs and 5274 MW at 19:30 hrs respectively.

Contrary to conventional wisdom of using oil-based generation to meet only the peak demand, in both the above cases private-sector oil-based generation made significant contributions in meeting the base demand throughout the day. Of particular interest is the amount of total generation on both days – 110.10 GWh and 106.80 GWh on 22 March 2012 and 19 July 2011 respectively, which are not too dissimilar. Generation was staggered on the match day (22 March) towards the evening peak to have a blackout-free game experience for the consumers, at the cost of blackouts during the remaining periods of the day. Maximum generation of 6065.5 MW on 22 March serves as an example that the country has the capacity to generate enough electricity to meet the peak demand but does not do so on a regular basis. The reason for under generation lies in the current share (26.55%) of oil in the fuel-mix. Cost per unit (kWh) of electricity is more than five times for furnace oil and more than seven times for diesel than gas-based generation, at 2011 pricing structure that includes fuel subsidies [13]. Keeping oil-based power plants offline, therefore, serves to reduce the overall cost of electricity and hence government subsidies, which may be the reason for limiting generation.

3. Economic impact of oil-based generation

Increasing the share of oil-based generation adversely impacts on small economies that rely on imported petroleum, oil and lubricants (POL) to meet the national demand. Annual quantity of POL imports and its annual change in Bangladesh between financial years 2003-04 and 2010-11 is given in Figure 5. Bangladesh imported 3.3–3.8 million tonnes of oil products per

[3] As of 15 May 2012.

[4] International Cricket Council: Asia Cup 2012 fixtures. http://icc-cricket.yahoo.net/

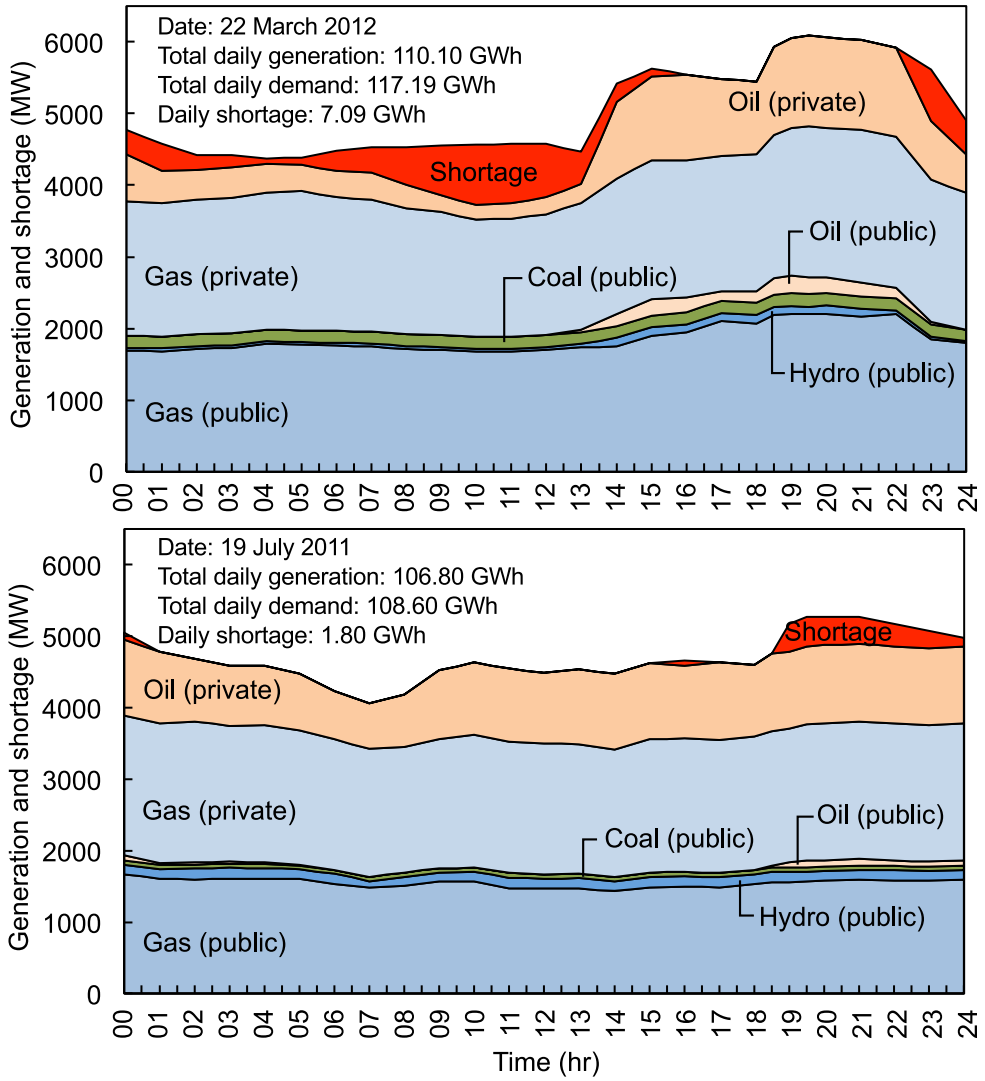


Figure 4: Daily energy curves on a 30 minutes timestep. Red areas show periods of blackout. (a) Atypical day with the historical maximum generation. (b) A typical monsoon day in July. Data source: [9].

annum from 2003-04 to 2009-10. The quantity of import decreased in some years and can be attributed to: (a) the rise in oil prices in the international market (e.g., 2008), and (b) the rapid conversion of petrol and diesel based light transport vehicles to run on compressed natural gas (CNG) [14], thereby reducing the dependence on oil. Despite this decreasing trend of the use of oil in the transport sector, import increased, year on year since 2008-09. The increase in 2010-

11 was significant – an increase of 29.8% on the previous year. Such increase in import is set to continue in the current financial year because of the increased use of oil in power generation [15].

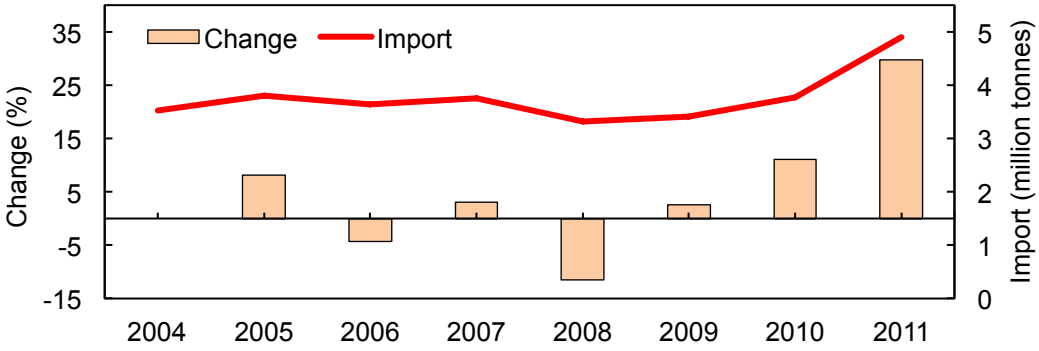


Figure 5: Annual quantity of import of petroleum, oil and lubricants in Bangladesh between financial years 2003-04 and 2010-11. Data source: [16].

Actual cost of import increased almost every year due to the rise in oil prices in the international market. Fuel-weighted average price paid by Bangladesh for its import between 2003-04 and 2010-11 is given in green in Figure 6. The total uncorrected cost of import in US$ is also given in Figure 6, which shows an increasing trend. Import cost nearly doubled in two years, between 2009-10 and 2011-12, from just under 2 billion US$ to almost 3.7 billion US$ up to April in 2012, with two months remaining in the financial year [15].

Rising cost of fuel resulted in the increase of wholesale price of electricity. Bangladesh Energy Regulatory Commission (BERC), the independent body to oversee the energy sector, has recently published a report on the public hearing on 19 March 2012, in which the decision to increase electricity tariff for all consumer groups was taken. The increasing cost of oil[5] was stated as the sole reason for an increase of 0.41 Tk (1 US$ = 81.76 Tk, Bangladeshi Taka) per kWh generation of electricity to 5.7 Tk from 5.29 Tk, since November 2011 [17]. In the end, taxpayers bear the cost of short-sighted policies. The average price of electricity in Bangladesh is set to increase further, as more and more oil-based power plants come online, with additional burdens on an already-stressed economy.

[5]Oil and petroleum products are imported by the Bangladesh Petroleum Corporation (BPC), which then sells at a subsidized price to power producers and other endusers.

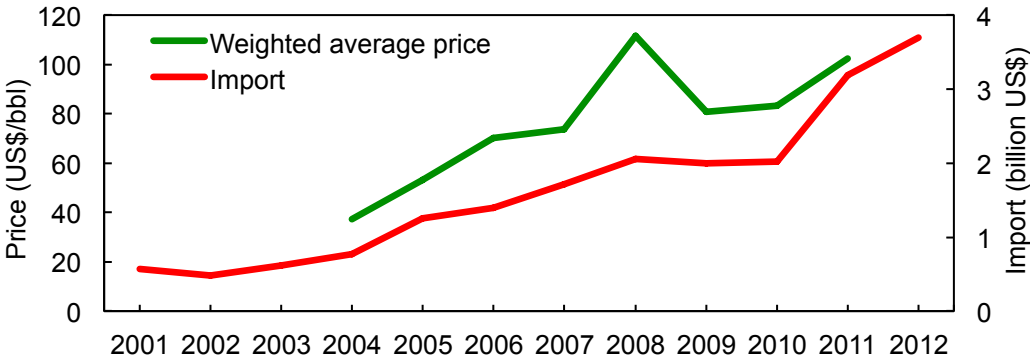


Figure 6: Annual import of petroleum, oil and lubricants, and weighted average price paid for import between financial years 2000-01 and 2010-11. Note, the data for 2011-12 is up to April 2012. Data source: weighted average price [16], quantity of import in US$ [15].

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This study shed light on the impact of 'ad-hoc' and 'short-sighted' energy strategies in a developing context. It did not explore the process(es) by which the investigated strategies were developed and whether the strategic decisions were based on robust analyses of the sector and its dynamics. The author was unable to find noteworthy evidence of wider stakeholder engagement for these strategies in published literature and local media outlets. In contrast, evidence of discontent with the current policies, in particular the 'increased dependence on imported oil' has been found [18]. However, the development and implementation of sub-optimal energy strategies may as well be due to a lack of in-country skills and framework for strategic assessment and decision-making in public and private sectors, as well as in the civil society. The lack of skills may also be linked with limited investments in training, research and development, the importance of which in the energy sector and sustainable development has been emphasized in past research [19, 20]. Future research can look into these process aspects of policy development.

4. Conclusion

Developing countries are faced with a multitude of challenges for the development of their energy infrastructures. They need to improve access to reliable and affordable sources of energy, while adopting a low-carbon pathway for development with limited resources. The situ-

ation is particularly challenging for the least-developed countries that rely on imported oil and petroleum products to meet national demand. Increasing socio-political pressures and resource constraints often lead to the adoption of unsustainable oil-based generation, which has been the case in Bangladesh.

This paper investigated the recent expansion of oil based generation in Bangladesh for meeting the burgeoning growth in demand for the short term. Analyses of demand and generation profiles, and the impact on oil import and economy demonstrated that despite having surplus generation capacity from the oil-based expansion, Bangladesh struggled to meet demand, even during off-peak winter season. This is primarily due to the increasing cost of oil imports, both due to increased requirements and international market price. Rolling blackouts and shortages of electricity are likely to have adverse impacts on economy and development, evidence of which is found in the increased enduser tariffs, which will probably be increased further to ease pressure on the balance of payments.

Taxpayers, as the key funder of all government activities, ultimately bear the cost of short-sighted policies. Robust analyses and stakeholder buy-in is, therefore, essential for energy sector development, which did not appear to be a feature in this investigated case. Care should be taken in adopting such policies that may impact on economy and energy security in countries in similar circumstances to Bangladesh.

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