Economic Cost of “Power Outages”

By

Dr. Aisha Ghaus-Pasha

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ECONOMIC COST OF POWER SHORTAGES IN THE INDUSTRIAL SECTOR OF PAKISTAN

The year 2008 witnessed a major increase in the frequency and intensity of power loadshedding or outages generally in Pakistan and in particular in the industrial sector. A manifestation of this problem can be seen in the large number of reports in the popular press of high incidence of outages and protests, by not only the domestic and commercial, but also industrial consumers. We have also seen, during the course of the year, complaints by the various chambers of commerce and industry and other industrial associations in the country that the level of production in a number of industries has been reduced due to the persistence of outages which apparently have fundamentally disturbed the normal rhythm of the production cycle in a large number of industrial units, especially in electricity-intensive sectors like textiles, non-metallic mineral products, basic metals, leather products, rubber and plastic products, paper and paper products, etc.

Casual empiricism supports their claim. At the macro level, the industrial sector of Pakistan has shown a decline of about 6 percent during the first seven months of 2008-09. Further, at the micro level, there is some evidence of shortages in various manufactured goods as indicated by a big double digit increase in prices over the course of the year. Clearly, there is need to undertake research to quantify, in more precise terms, the impact of outages on the national economy. This exercise was last done in 1989, when the problem of power loadshedding was also significant. Following an appreciation of the gravity of the power outage problem, the government promoted the establishment of Independent Power Plants (IPPs) later in the mid-90s.

In this paper we estimate the economic costs of power outages in the industrial sector, which accounts for about 28 percent of total power consumption. The magnitude of the cost is a basic indicator of the benefits that could be realized from investment and improved management of the power sector.

1. Causes of Power Outages

One major long-term factor which has contributed to increased power shortages in Pakistan was the growth in demand for electricity during the last decade of over 7 percent per annum. In particular, there was a high growth in domestic demand for electricity, averaging about 10 percent per year. Growth in energy demand increased more rapidly in the current decade after some moderation in the decade of the 1990s (4 percent per annum) following the spurt in the

1980s (11 percent per annum). This growth in energy demand was fuelled by subsidized tariff rates and the phenomenal increase in the use of electrical appliances like air conditioners, refrigerators, televisions, etc. As a result, the share of domestic consumers in total power consumption has increased from 23 percent in 1980-81 to 46 percent in 2007-08. The growth in demand in the current decade was clearly not fully anticipated and adequate provisions, therefore, were not made to cater for this increased demand. This is reflected in the lack of expansion and up gradation of power plants (which could have been accomplished at one-thirds of the cost of expansion). The share of public sector expenditure on the power sector, which averaged at about 28 percent since the 1980s, fell to less than 3 percent in the current decade.

Furthermore, the IPPs also did not invest in improvement/up gradation partly because of the uncertainty caused by the adhocism in the government's privatization policy earlier. On top of this, appropriate tariff reforms, which may have suppressed somewhat the growth of domestic demand, were not made in a timely fashion. It, therefore, appears that public policy neglect and public mismanagement over the years have contributed to the power sector shortages. An example of the overall mismanagement of the power sector is the accumulation of over Rs.370 billion of circular debt. The inability of federal and provincial government agencies and semi-autonomous corporations to timely pay their dues to power generating entities has in turn weakened their ability to pay for their inputs, in particular fuel, resulting in reduced power supply by IPPs. Heavy line losses, large scale theft are other examples of the overall mismanagement of the sector.

Factors which explain short-term supply-demand imbalances are, on the supply side, power system generation capacity is lower at particular times of the year, particularly in late December and January, when hydel generation capacity is at a seasonal trough because of water reserves/flows. The thermal capability also fluctuates somewhat due to seasonal changes in ambient temperature, fuel supply (calorific value and availability) and maintenance requirements.

2. Quantifying Outage Costs

Costs of outages consist of direct costs which primarily comprise the spoilage cost and net value of lost production, also referred to as 'idle factor cost'. Costs of loadshedding also consist of adjustment costs. Firms frequently make adjustments in their operations to recover at least some of the output lost during and immediately after outages. These are referred to as indirect costs of outages. The particular mechanisms chosen for recovering output lost, will, of course,

be based on cost minimization considerations. Accordingly, firms would opt for a particular strategy up to the point where it is cheaper than the other options. It is possible, therefore, for a firm to make multiple types of adjustments in response to outages. Typically, types of adjustments madeby a firm include: acquiring self-generation capacity; more intensive utilization of capacity; working overtime; working additional shifts and; changing shift timings. The costs associated with these adjustments are briefly discussed below.

A pattern of response by industrial units, which is being increasingly observed in Pakistan, is that of development of own sources of energy supply through investment in generators. The case for such investment becomes greater the larger the time losses due to outages and the stronger the expectation that relatively high levels of power interruptions will persist in the long run. In practice, however, the extent of substitution of the conventional power source will depend upon the energy-intensity of operations, the extent of access to and cost of capital, on the possibility of making other cheaper adjustments and the ability of the firm to transfer the higher costs in the form of higher prices. Therefore, both partial and complete substitution of the standard power source by generators could be observed during periods of outages. The cost of

Box 1
SAMPLE DISTRIBUTION BY INDUSTRY GROUP, PROCESS AND LOCATION

	% of Sample
Industry Group	
Textile	27
Chemicals and Products	17
Engineering	28
Paper and Board	5
Cement	9
Food and Consumer Care	5
Miscellaneous	9
Process	
Continuous	36
Batch-Making	64
Location	
Karachi	39
Lahore	31
Faisalabad	20
Sialkot	10
Total Sample (number)	65
Source: IPP Survey	

operating generators also crucially depends on the type of fuel used (diesel or gas).

Firms generally report higher repair and maintenance costs due to more intensive utilization of machinery when there is no power outage. This represents the adjustment cost of moving to a higher rate of capacity utilization during the period not affected by outages. As far as overtime costs are concerned, if the firm does not operate a 24 hour production schedule daily, then there exists some opportunity for overtime. Whether or not overtime is actually resorted to will depend upon the magnitude of overtime differential, the importance of labour costs in total costs of production and the extent to which the firm has the market power to transfer the higher costs on to consumers. Likewise, if a firm operates one or two shifts only, adequate slack time may be available to alter the shift timings in order to avoid or work around periods of maximum outages during a particular day. However, given the fixity of contractual arrangements with labour any major changes in shift timings are likely to result in additional labour costs for payment of shift differentials. Costs associated with changing work days are, more or less, similar in character.

3. Incidence of Outages

As shown in Table 3.1, the average annual hours of outages per unit in the sample was 1379 in 2008. The average duration per day was 4 hour and 36 minutes. The duration of loadshedding varied widely, from a low of no loadshedding, in priority industries (like cement), to a maximum of over thirteen hours a day. The highest incidence of outages in 2008 was between the months of December and January and in June.

TABLE 3.1
INCIDENCE OF LOADSHEDDING, 2008

	Average Hours per Month
January	166.5
February	167.1
March	116.6
April	85.3
May	88.8
June	89.2
July	97.7
August	96.4
September	89.2
October	97.7
November	96.4
December	151.1
Annual in 2008	1379
Average per day	4.6

Source: IPP Survey

Industries which have been affected more by outages are textiles, machinery and equipment, food, glass and allied products. Also, continuous-process industries appear to have been less exposed to outages than batch-making industries. This could be attributed at least partially to efforts by WAPDA to protect the former.

4. Pattern of Direct Costs

Effective time losses, corresponding to time losses during the outage plus restart time, were over 20 per cent. That is, 20 per cent of the time firms could have been in production, but was lost due to loadshedding.

5. Types of Adjustments to Outages

As shown in Table 5.1, about 84 percent of the sample units have responded to outages by making some changes in their operations. The highest proportion, 75 percent, of the sample units, have gone in for self-generation during outages by investment in stand-by generating capacity. Industries with a relatively high proportion of firms with generators are chemicals and petrochemicals and machinery and equipment. It is also of interest to note that wherever generators have been installed, the extent of substitution has been high, at 85 percent of the normal power consumption. Further, another 17 percent of the sample firms had plans to invest in generators. Therefore, industrial units in Pakistan probably feel that loadshedding is a phenomenon that will persist for several coming years. The potential demand for generators continues to rise, with the import bill of generators rising to about $ one billion in the first eight months of 2008-09.

TABLE 5.1
TYPES OF ADJUSTMENTS TO LOADSHEDDING

	% of Sample	Extent of Recovery (%)
Self-Generation of Electricity	75	85
Working Overtime	18	30
Working Additional Shifts	15	33
More Intensive Utilization of Machinery	10	28
Changing Shift Timings	6	30
Changing Working Days	5	6
Firms making some adjustment to Loadshedding	84	60
Source: IPP Survey		

Of the sample firms surveyed 65 per cent have diesel generators, 22 per cent have gas generators and about 12 per cent have multiple fuel i.e. both diesel and gas generators. It appears that such firms prefer self-generation using gas, presumably because of lower

operating costs, but because of unreliability of gas supply (Pakistan experiences gas loadshedding also), sole reliance on gas generators is not a preferred option for them.

Firms which do not have self generation capacity, either because it is not economically feasible or affordable, have tried to recover some of the lost output with 18 percent working overtime, and10 percent achieving more intensive operation of machinery. 15 percent have worked additional shifts while 6 percent have changed shift timing. About 5 percent have changed working days. These figures are surprisingly low. The principal reason for a lack of response in terms of a change in timings is that power distribution companies have been unable to announce well in advance scheduled timings for outages and to adhere to these schedules over time. The resulting uncertainty has prevented firms from changing shift timings or working days.

6. Extent of Recovery of Output

Adjustments made by firms in response to outages have meant that a significant proportion of output lost during the outage and the subsequent restart time has eventually been recovered. For the sample as a whole, the extent of recovery of output is approximately 60 percent. Highest recovery rates have been observed in industries which have acquired self-generation capabilities, at 85 percent. Units which are unable to acquire generators lose about 73 percent of the output.

7. Total Outage Costs to the Industrial Sector

One of the key objectives of the research is to estimate the overall magnitude of economic costs of outages in the industrial sector at the national level. Given that average industrial value added per Kwh of electricity supplied during the last year is Rs 81.25 and time lost due to load shedding, as revealed by the sample firms, was 20 percent, about Rs. 350 billion of value added would have been lost. However, our estimates shows that about 84 percent of the firms made an effort

BOX 2
TOTAL COSTS OF LOADSHEDDING TO THE INDUSTRIAL SECTOR

For Firms with Self-Generation	
Additional Cost of Power Self-Generation	Rs 32 Billion
Value Added Loss	Rs 42 Billion
Total Costs	**Rs 74 Billion**
For Firms Without Self-Generation	
Additional Costs of Adjustments	Rs 6 Billion
Value Added Loss	Rs 77 Billion
Total Costs	**83 Billion**
Overall Costs to the Industrial Sector	Rs 157 Billion
Cost as % of Industrial Value Added	9
% Loss of Production	7
Loss of Industrial Employment	300,000 workers

Source: IPP estimates

to recover part of this lost output through various adjustments. The highest proportion was recovered through self-generation. The recovery was, however, at a higher cost. The average DISCO tariff was Rs 7.94 per Kwh. According to Sheikh (2008) the average cost of self-generation is almost two and a half times more than this, i.e. Rs. 19.85 per Kwh, implying that self generation costs an extra Rs. 11.91 per Kwh. Therefore the extra cost to the industrial sector due to self-generation of electricity is about Rs. 32 billion (See Box 2). This is also the extent to which profitability of firms is lower because of load shedding. Also, since such firms recovered about 84% of the output, the cost of output permanently lost is estimated at Rs 42 billion. Therefore for firms which acquired self-generation capabilities, the cost of loadshedding is estimated to be Rs 74 billion.

Firms also recover output lost through other mechanisms, as indicated earlier. The extent of recovery is, however, limited to only 29 per cent. Also this recovery is made at additional costs which include overtime/ shift/changing working days premia to labour, additional wear and tear of machinery and spoilage of raw material/inputs in process. These costs aggregated to Rs. 6 billion at the national level. For such firms the cost of value added lost is Rs. 77 billion. The aggregate cost to firms which have not been able to self- generate power is, therefore, Rs. 83 billion. The costs of firms which have not been able to supplement their energy need through generators is higher than those which have done so. Overall, the cost to the industrial sector of loadshedding is estimated at Rs 157 billion. This is equivalent to 9 percent of the industrial value added. The loss of industrial output is estimated at 7 percent. Further, lower industrial activity leads to a contraction in industrial employment, particularly in the case of daily wage and part-time workers. Given the employment elasticity of industrial production of about 0.65, the reduction in industrial value added has led to a likely loss of industrial employment of about 300,000 workers. This magnitude of retrenchment can have significant consequences on the level of poverty in the country, where already poverty is on the rise due to escalating prices and lower growth.

8. National Costs of Load Shedding

Over and above the direct costs to the industrial sector, a change in the value added in the industrial sector has secondary or multiplier effects on the rest of the economy. Therefore, outages in the industrial sector by reducing the value added in that sector cause a decline in the level of economic activity in other sectors of the national economy like wholesale and retail trade, transport and communications, banking and insurance, etc. Pasha et.al. (1989) derived the short-run magnitude of the multiplier at 34 percent. Allowing for the multiplier effects, the

overall costs of industrial loadshedding to the rest of the country is estimated to be Rs 53 billion (See Box 3). Therefore, the total cost to the economy of power loadshedding in the industrial sector is estimated to be Rs. 210 billion. This is equivalent to two percent of the Gross Domestic Product (GDP). In turn, exports have also been affected. The loss of exports is estimated at Rs. 75 billion, equivalent to about US $ 1.2 billion in 2008.

BOX 3
NATIONAL COSTS OF LOADSHEDDING

Cost to the Industrial Sector	Rs 157 Billion
Cost to the Other Sectors of Industrial Loss of Value Added	Rs 53 Billion
Total Cost of Industrial Load Shedding to the Economy	Rs 210 Billion
Cost As % of GDP	2
Loss of Employment in the Economy	400,000
Loss of Exports	Rs 75 Billion equivalent to over $ 1 billion

Source: IPP Estimates

In summary, power loadshedding in the industrial sector has cost the country Rs 210 billion or over two percent of the GDP, over US$ 1 billion of export earnings and potential displacement of 400,000 workers. Costs could be even higher if impacts on other sectors like agriculture and services are allowed for which account for almost the same share in power consumption as industry.

Comparison with Earlier Estimates of Outage Costs. The other national study in Pakistan on outage costs was conducted in 1984-85, a year of high power shortages. The study, [Pasha et. al (1989)] was based on a larger sample of 843 units. A comparison of results indicates the gravity of the power shortage the country currently faces.

BOX 4
COMPARISON OF ESTIMATES WITH THE EARLIER RESULTS (1984-85 STUDY)

	1984-85	2008
Average Hours of Loadshedding (Annual)	175	1379
% of Sample Making Adjustment through Self Generation	12	75
Extent of recovery of Output (%)	44	60
Impact on Value Added (%)	8	9
Impact on Production	2.6	7.0

Source: IPP estimates, Pasha (1989)

Box 4 compares the key results. Clearly loadshedding is a graver problem now then it was in the mid-80s. Also, firms now have developed expectations of power shortages and have adjusted to minimize losses. This is revealed both by the percentage of firms acquiring self-

generation capabilities and the extent of recovery of output. However, the cost of power outages is significantly higher to the economy as is indicated by the percentage of loss of value added and production. Clearly, the country has not faced a power crisis of the magnitude it currently does. Also, the urgency to address the problem has never been historically higher.

9. Policy Implications

Policy recommendations identified by the industrial units surveyed are presented in Box 5, ranked by frequency. A number of public policy initiatives can be taken regarding the development of the power sector, regulation and pricing of electricity and its management. Some of these are identified below:

BOX 5
POLICY RECOMMENDATIONS BY SAMPLE UNITS

- Build more dams
- Reduce industrial tariffs
- Reduce gas tariffs
- Priority to Industry at times of peak
- Change outage times to night
- Conserve electricity
- Reduce theft
- Develop other sources of energy
- Uniform tariff
- Improve load management
- Reduce diesel prices
- Improve management of power transmission and distribution

Source: IPP Survey

9.1 Investment in Power Sector:

As mentioned earlier, the economic cost of unsupplied electricity is one of the key indicators of returns to expansion in the generation capacity and enhancement of the reliability of a power system. The results indicate that the cost of outages is relatively high in comparison to current tariff levels for power supply to the industrial sector. There is thus a strong case for expanding power generation capacity in the country. Given the high outage costs, our analysis shows that any investment in the sector will pay-off in a short span of time. In fact, there is a stronger case for upgrading existing power generation facilities, which can be accomplished at almost one-third the cost of new plants. This will require development and quick implementation of an accelerated generation investment programme both in thermal power plants, which will provide firm generation capability throughout the year, and in smaller hydel plants. Gas based and inefficient WAPDA plants should be replaced by new more efficient combined cycle plants. The hydel projects in the pipeline, like Neelum-Jhelum (969 MW), Tarbela 4th Extension (960 MW), SukiKinari (840 MW), Munda Dam (700 MW), Khan Dubar (130 MW), Allai (126 MW), and Jinnah Hydro (96 MW), should be executed on fast track. Also, the project to import 1000 MW electricity from Iran should be followed up.

Such expansion in capacity will need to be supported by the implementation of a comprehensive programme to reduce technical losses and improve the reliability of the distribution system. WAPDA and its thermal arm, need to be given autonomy to prepare, market and construct new projects, as happened in the 1960s and 1970s. Simultaneously, the enabling environment has to be improved so that IPPs investment plans can be encouraged. The distribution companies should also be provided adequate resources to modernize the overloaded transmission and distribution systems. The required investment can be recovered in less than three years through savings in transmission and distribution losses. The problem of circular debt has to be resolved on a priority basis. The payment should also be linked to higher capacity utilization to ensure that thermal stations will increase their generation to at least 75 percent of their capacity.

9.2 Load Management Strategy: There appears to be a major variation among different types of industries in the outage costs. Our survey was limited and therefore we were constrained to draw conclusions on the magnitude of variation by type and size of industry. Earlier study on outages clearly brings out the differences and our survey also points it out. This indicates that there is scope for pursuing a loss-minimizing strategy rather than following a policy of equal curtailment. In particular, it has been highlighted that losses are high in continuous-process industries and more generally in those units which are especially vulnerable to spoilages. Also, they are high in export-oriented industries like textiles and leather. To the extent that power feeders can be distinguished by type of consumers an order of priority may be evolved regarding the extent of their curtailment during periods of energy shortages. The loadshedding schedule should reflect clear and transparent priorities, in consultation with all stakeholders and be predictable. Sectors that deserve priority should include, in particular, export industries.

9.3 Information Flows and Customer Education: Responses to the survey questionnaire indicated that the distribution companies, do not announce loadshedding schedules well in advance which constrains a firm's ability to adjust to loadshedding. Also, there is a strong case to develop and implement customer outreach programmes to encourage energy conservation measures, steps to improve the power factor, and methods of limiting peak demand. It is also important that alternative sources of energy, in particular solar and wind energy, be explored, as recommended by our survey respondents. Internationally, new and renewable sources of energy such as wind power and solar energy, are a focus of research and development. Pakistan should enhance its capacity to follow these developments and promote greater use of renewable energy for light, heating, agriculture and small-scale enterprise.

9.4 Pricing Policy: The scope for variation in tariffs intertemporally needs to be examined in line with the level of demand and the associated marginal costs of providing service. Given the seasonal character of incidence of outages in Pakistan with the highest frequency of occurrence during the winter and early summer months there is a strong case for a corresponding seasonal variation in the level of tariffs generally. On top of this, the difference between daily peak and off-peak tariffs may also be enhanced with the help of appropriate metering systems.

BOX 6
SHORT-TERM POLICY RECOMMENDATIONS

- Up-gradation of Existing Power Plants
- Resolution of Circular Debt
- Reduction in transmission and distribution system's losses
- Import of Electricity from Iran
- Development / Implementation of Load Management Strategy
- Development/Implementation of Energy Conservation Strategy
- Consumer Education

Source: IPP Survey

Some of the policy recommendations enunciated above can be implemented immediately while others have a medium term perspective, given the gestation period required for completion/execution of investments. The recommendations which can potentially be implemented in the short run are identified in Box 6.

Annex 1

Methodology

Purposive sampling will be used to carry out the survey of 115 industrial units in four cities namely Lahore, Faisalabad, Sialkot and Karachi. Proposed sample size and its distribution by type of industry and location is given in Table 1.

6 enumerators for cities in Punjab and 4 enumerators for Karachi will be recruited. They will collect and enter data on a pre-coded questionnaire. The potential enumerators should have some background in accounting, finance and technical work. The enumerators will be trained by IPP staff. The questionnaire will be pre-tested in Lahore before carrying out the actual survey. The proposed survey alongwith data entry, which will be carried out simultaneously will be completed in two weeks. At the same time, the IPP team will prepare a tabulation plan for data analysis. The expected time frame for collection, processing and analysis of data is 4 weeks.

The tentative budget for proposed survey is Rs. 2,21,000. The detailed breakup is presented in Table 2.

Location

Karachi
Lahore
Faisalabad

Process

Continuous
Batch Process

Industries

Textile Spinning
Textile Weaning
Textile Composite
Synthetic & Rayon
Fertilizer
Pharmaceutical
Chemicals
Engineering
Automobile Assembler
Cable and Electric Goods
Sugar and Allied Industries
Paper and Board
Cement
Power Generation and Distribution
Leather and Tanneries
Food and Personal Care Products
Glass and Ceramics
Vanaspati and Allied Industries

Total	85
Continuous Process	52
Batch Making	30
Categories with Process Undefined	3