

THE COST OF UNSERVED ENERGY: EVIDENCE FROM INDUSTRIAL SECTOR OF PAKISTAN

Rehana Siddiqui, Hafiz H. Jalil , Muhammad Nasir, Wasim Shahid Malik and
Mahmood Khalid

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Pakistan Institute of Development Economics (PIDE)
Islamabad

Outline

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- The Cost of Unserved Energy Defined
- The Case of Pakistan
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Energy Situation in Pakistan

- The worst energy crisis of its history since year 2007.
- Initial electricity shortfall but gradually led to deficit in other forms of energy too.
- A load-shedding of on average eight hrs and reaching upto eighteen hours if also include the un-announced load-shedding

Energy Situation in Pakistan contd..

- Slow growth in energy supply
- Lack of proper estimates for demand forecasts
- Water shortages and volatility in fuel prices
- Persistently high transmission and distribution losses (reported 20%+)
- Insufficient focus on development of alternative energy sources and
- Above all the lack of political commitment on the part of government to deal with these issues.
- No coordination between growth and energy policies in Pakistan (Nasir and Rehman; 2011).

Energy Growth Nexus

- Energy-growth causality has been studied extensively in the energy literature.
- In Pakistan generally concluded ; energy shortage has retard growth process in country [see, for instance, Siddiqui (2004); and Aqeel and Butt (2001) among others].
- Industrial sector which is most energy intensive sector is severely affected, subsequently damaging the overall economy.

The Cost of Un-served Energy

- The reduction in output growth due to energy shortfall is also termed as cost of un-served energy.
- That is, had the energy (of any form) been supplied as committed;
 - Output would have been greater
 - Cost in terms of lost output and labor Hour loss, would have been reduced
 - Cost of alternative energy (captive energy creation)
 - Cost to the environment in-terms of pollution created by use of small scale/fossil fuel based generation would have been less.
 - Cost in terms of labor hoarding (due to high cost of employee search and cost of training etc the firms do not fire workers when production stoppages are considered short term)

The Case of Pakistan

- Various studies have tried to quantify the output loss due to power outages for different sectors [see, for instance, Bental and Ravid (1982); Bose *et al* (2005); Wijayatunga and Jayalath (2008) and Kaseke, (2010)]
- In Pakistan, the literature is rare on this issue.
- To our knowledge, only two studies have been published to-date to quantify the production cost, namely, Lahore Chamber of Commerce and Industry (1986) and Pasha *et al.* (1989).
- The objectives of current study are twofold: in addition to quantification of output loss of industrial sector, it also explores the effects of outages on other areas such as labor employment, cost of production and supply orders delays.
- Here a two dimensional analysis for quantification covering for variations in both outage duration and shift hours is done whereas the earlier studies focus on power outages only.

Power Sector

- Development of Alternatives
 - Hydel
 - Thermal-issue of coal fired plants
 - Wind
 - Solar
 - Biofuel
- Impact of Power shortage
 - Cost of Production
 - Impact on economic growth
 - Employment Impact
 - Export Impact
 - Government Revenue
 - Quality of life

Measuring the Cost of Un-served Energy

- This study is an attempt to explore only the cost of unserved energy due to power outages in the country that started in 2007.
- A survey was conducted in the mid 2008 for four major industrial cities of Punjab; Gujrat, Faisalabad, Gujranwala and Salkot.
- Financed by PIDE under the Capacity Building Programme
- It is important to mention here that the focus of this survey was on the inspection of the price setting behaviors of the firms. The energy section in the survey was included to get some baseline view of the issue of energy crises for comprehensive future study.

METHODOLOGICAL ISSUES

- The survey was conducted during the months of May and June in 2008 in four industrial cities of Punjab Province namely Gujrat, Faisalabad, Gujranwala and Salkot.
- Fifty enumerators were hired who were supervised by four field supervisors. Lot of focus was done on the training of enumerators
- Three-step filtration procedure was adopted to obtain the population of firms.
 - All the firms, who got registration with Chamber of Commerce and Industry before 2008, were initially selected.
 - As a first step, the firms who were not operational since the end of 2007 were dropped. This filtration got us what is called ‘initial population’.
 - In the second step, those firms were left out from this ‘initial population’, which were involved merely in trading of goods and not in their production. The firms left after this filtering made our final population.
 - In the last step, in order to avoid overrepresentation of small firms, we ignored the firms with less than 10 employees [following see, for instance, Alvarez and Hernando; 2005, and Martins; 2005]

METHODOLOGICAL ISSUES contd..

- Next, we classified firms into ten different industrial categories on the basis of their manufacturing activities. This way, a total of 10 strata were obtained.
- Using random sampling within strata and after controlling for no response problem, a sample of 339 firms was selected which constitutes almost 8 percent of total population.
- Year 2007 is considered as reference year in the survey.
- In case the owner was not available, the manager of respective firm was interviewed to collect data.

Survey Results

Cost of energy shortages

- Effect on Employment
- Cost of Production
- Delay in Supply Orders
- Quantification of Output Loss

Distribution of Firms by Products and by Cities

Industry Groups	Faisalabad (%)	Gujranwala (%)	Gujrat (%)	Sialkot (%)	Total (N)
Food & Beverages	32	42	18	8	50
Textiles	68	13	8	11	85
Leather & Products	-	4	13	19	23
Wood & Furniture	5	26	68	-	19
Paper & Products	-	100	-	-	2
Industrial Products	55	36	-	9	11
Rubber and Plastic	5	59	23	14	22
Potter and Ceramic	6	63	31	-	32
Iron and Metal	14	64	11	11	28
Machinery (E & NE)	16	51	33	-	67
Total % (N)	29 (99)	38 (129)	21 (72)	12 (39)	100 (339)

Labor Hour Loss per Day by Industry

Industry Groups	No Loss	Less than 1 Hour	Between 1 to 3 Hours	Between 3 to 5 Hours	Between 5 to 8 Hours	Above 8 Hours	Total (N)
Food & Beverages	34	2	8	20	28	8	50
Textiles	31.8	4.7	10.6	16.5	31.8	4.7	85
Leather & Products	17.4	21.7	21.7	34.8	-	4.3	23
Wood & Furniture	10.5	-	26.3	36.8	21.1	5.3	19
Paper & Products	50	50	-	-	-	-	2
Chemical Products	27.3	18.2	18.2	9.1	27.3	-	11
Rubber and Plastic	18.2	4.5	18.2	40.9	13.6	4.5	22
Pottery and Ceramic	9.4	6.3	21.9	37.5	12.5	12.5	32
Iron and Metal	17.9	17.9	21.4	32.1	10.7	-	28
Machinery (E & NE)	20.9	4.5	23.9	31.3	16.4	3	67
Average % (Total N)	23.6(80)	7.1(24)	17.1(58)	26.8(91)	20.4(69)	5.0(17)	100(339)

Labour Demand Reduction by Industry

Industry Group	No Change	Less than 5 Percent	Between 5 to 10 Percent	Between 10 to 20 Percent	Above 20 Percent	Total (N)
Food & Beverages	83.7	8.2	-	2	6.1	49
Textiles	79.8	-	2.4	1.2	16.7	84
Leather & Products	90.5	-	9.5	-	-	21
Wood & Furniture	52.9	-	5.9	-	41.2	17
Paper & Products	100	-	-	-	-	2
Chemical Products	90.9	-	-	-	9.1	11
Rubber and Plastic	100	-	-	-	-	21
Pottery and Ceramic	73.3	-	6.7	3.3	16.7	30
Iron and Metal	96.3	-	-	-	3.7	27
Machinery (E & NE)	77.8	3.2	6.3	3.2	9.5	63
Average % (Total N)	81.8(266)	1.8(6)	3.4(11)	1.5(5)	11.4(37)	100(325)

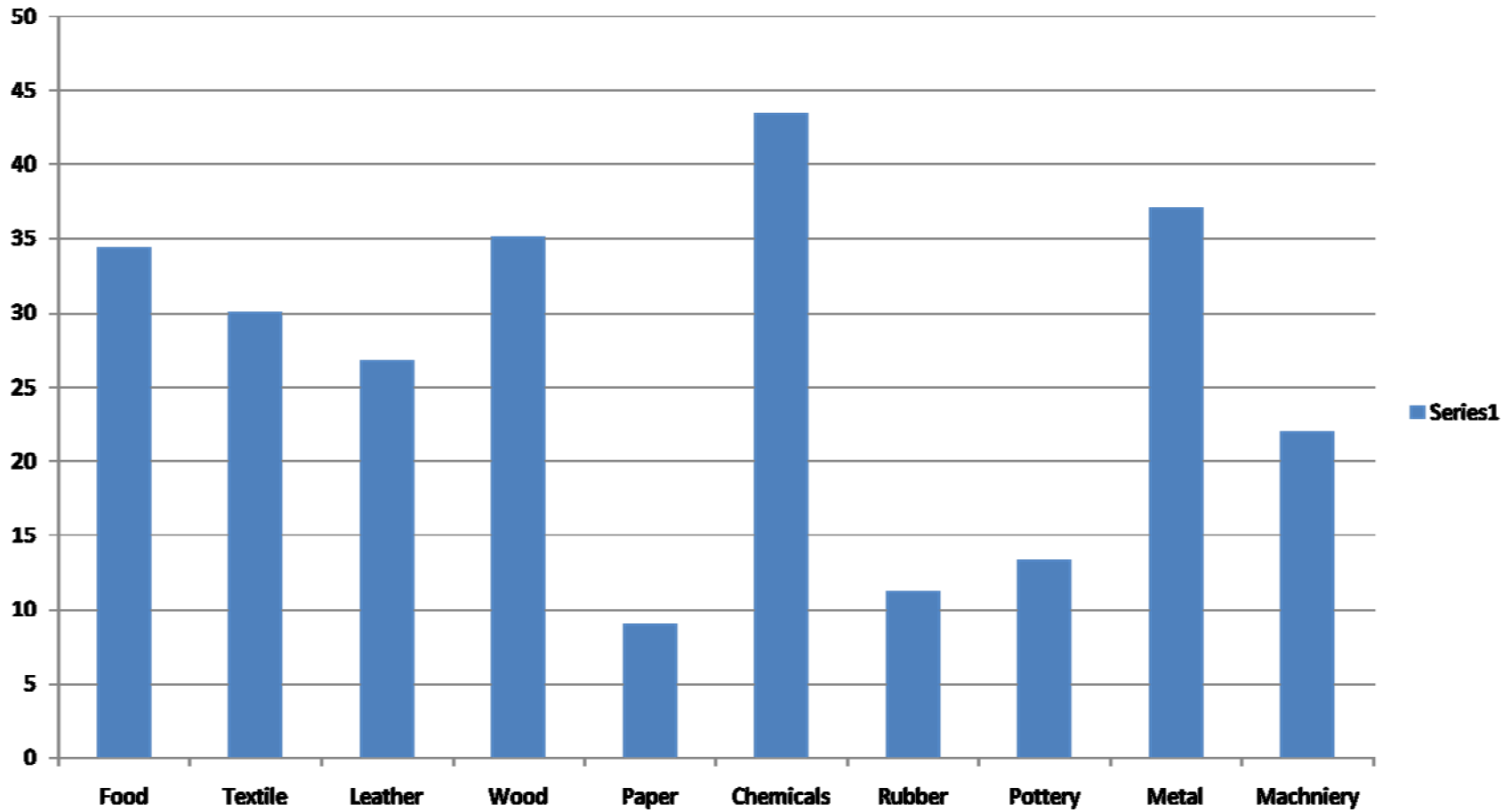
Alternative Energy Arrangements by Source and by Industry

Industry Group	Gas	Petroleum	None	No of Firms
Food & Beverages	10	54	36	50
Textiles	34.12	36.47	29.41	85
Leather & Products	8.7	73.91	17.39	23
Wood & Furniture	5.26	68.42	26.32	19
Paper & Products	0	100	0	2
Chemical Products	9.09	81.82	9.09	11
Rubber and Plastic	40.91	59.09	0	22
Pottery and Ceramic	15.63	46.88	37.5	32
Iron and Metal	21.43	50	28.57	28
Machinery (E & NE)	22.39	62.69	14.93	67
Average % (Total N)	21.83(74)	53.98(183)	24.19(82)	100(339)

Percentage Increase in Cost of Production by Industry

Industry Group	No Change	Less than 10 Percent	Between 10 to 20 Percent	Between 20 to 30	Between 30 to 50 Percent	Above 50 percent	Total (N)
Food & Beverages	12	56	8	-	8	16	25
Textiles	20.5	22.7	22.7	15.9	-	18.2	44
Leather & Products	41.2	17.6	5.9	11.8	5.9	17.6	17
Wood & Furniture	-	58.3	8.3	-	-	33.3	12
Paper & Products	-	50	50	-	-	-	2
Chemical Products	-	57.1	-	-	14.3	28.6	7
Rubber and Plastic	26.7	40	13.3	20	-	-	15
Pottery and Ceramic	22.2	38.9	22.2	-	16.7	-	18
Iron and Metal	5.9	35.3	11.8	23.5	5.9	17.6	17
Machinery (E & NE)	6.3	45.8	20.8	2.1	14.6	10.4	48
Total % (N)	15.1(31)	39.0(80)	16.1(33)	8.3(17)	7.3(15)	14.1(29)	100(205)

Increase in Cost of Production Due to Use of Alternative Source of Electricity (%)



Supply Order's Delay

Industry Groups	No	Yes	Total
Food & Beverages	42.2	57.8	100 (45)
Textiles	32.5	67.5	100 (83)
Leather & Products	38.1	61.9	100 (21)
Wood & Furniture	27.8	72.2	100 (18)
Paper & Products	100	-	100 (2)
Industrial Products	36.4	63.6	100 (11)
Rubber and Plastic	31.8	68.2	100 (22)
Potter and Ceramic	29	71	100 (31)
Iron and Metal	28.6	71.4	100 (28)
Machinery (E & NE)	18.5	81.5	100 (65)
Total % (N)	31 (101)	69 (225)	100 (326)

Quantification of Output Loss

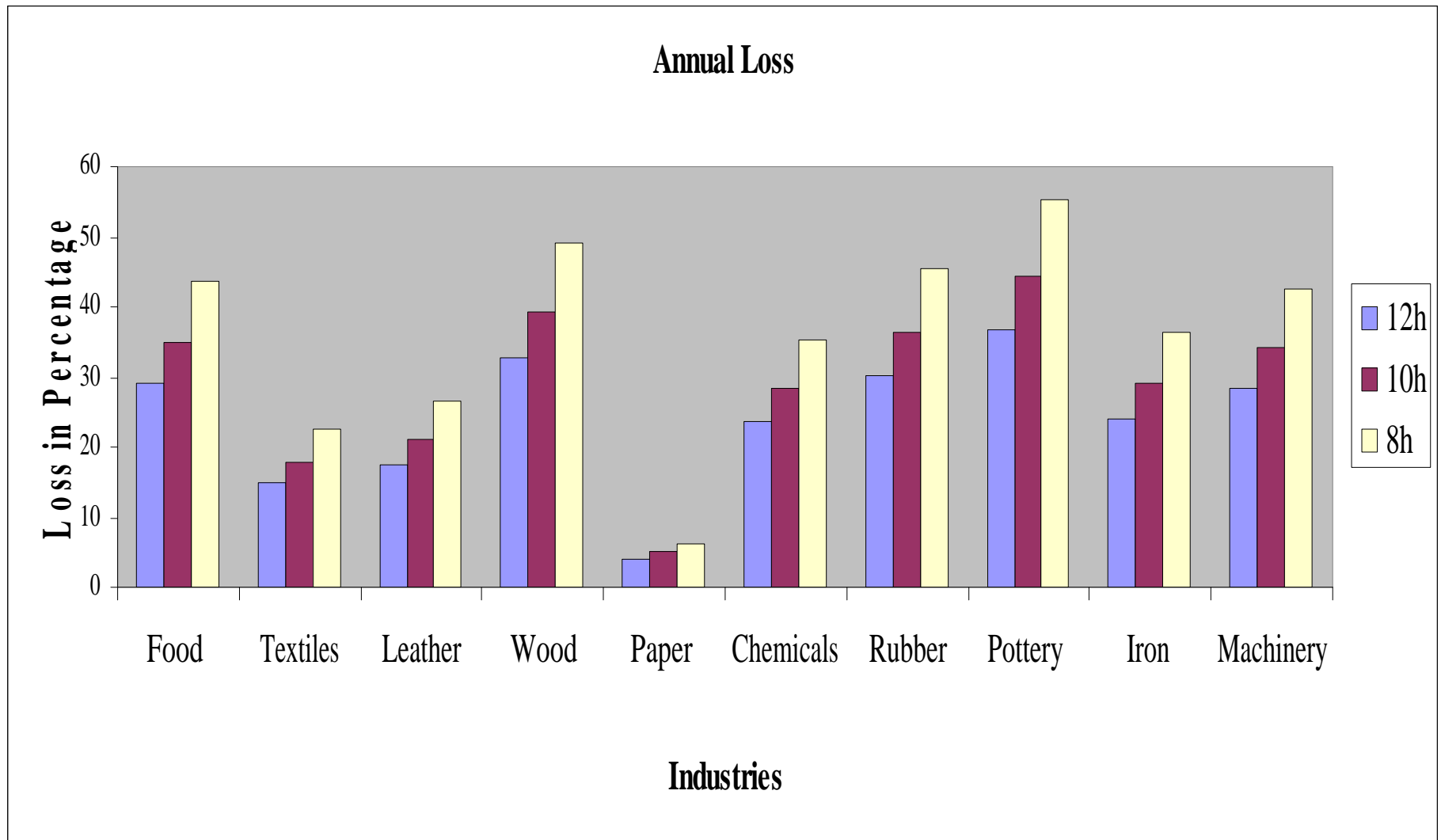
Methodology

$$O_{ij}^z = \left[Y_z / (L_z \times SH_i \times AWD_z) \right] \times L_z \times ALH_z \times AWD_j$$

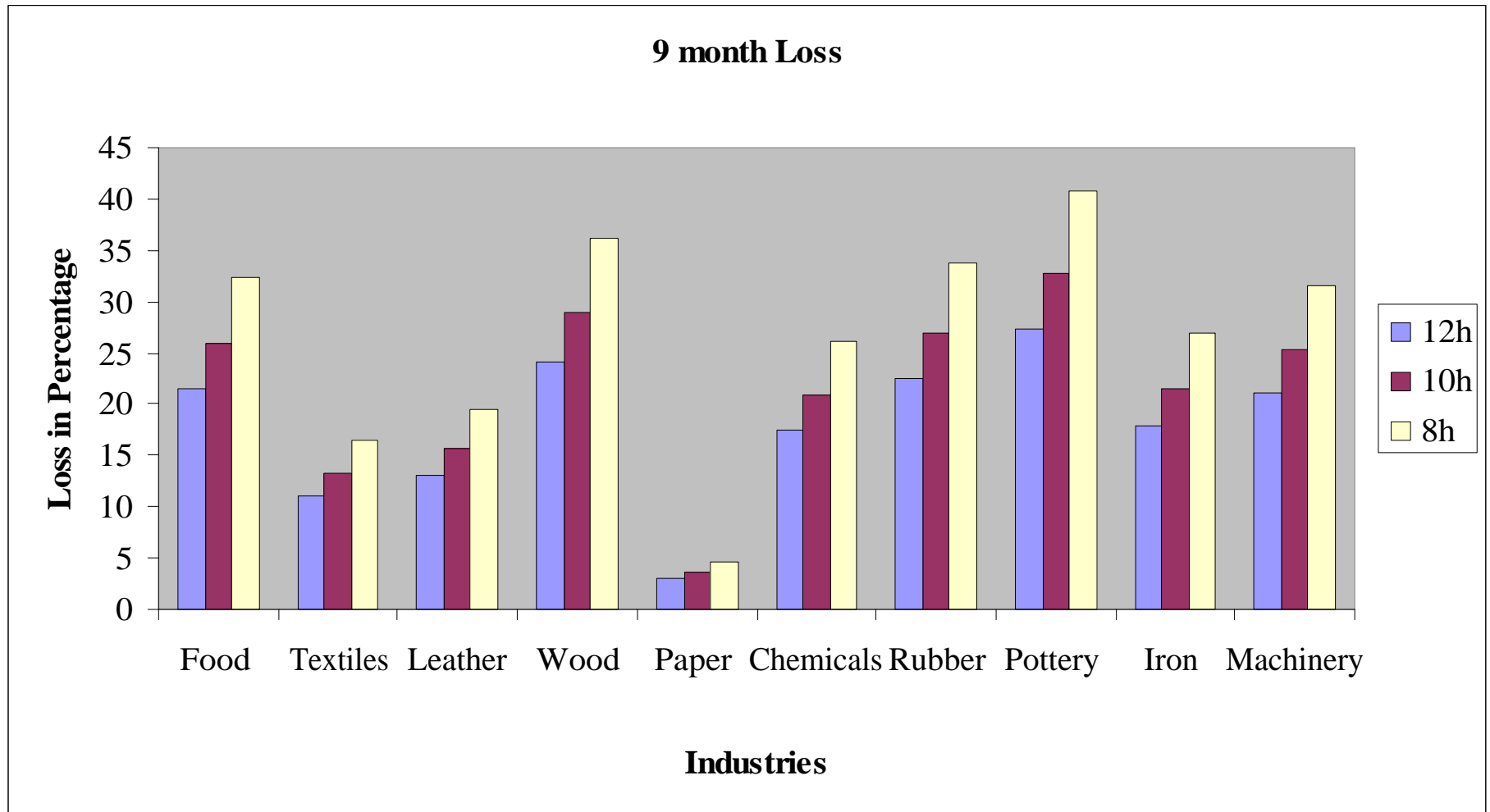
Where

- O_{ij}^z = Output loss due to unserved energy
- Y = Total annual output of industry
- L = Number of workers in industry
- SH = Shift Hours
- AWD = Annual Work Days
- ALH = Average Labor Hours loss per day
- The subscripts i and j in the equation denote the length of shifts (in hours) and duration of outages (in months) and take the values 12; 10; 8, and 12; 9; 6 respectively

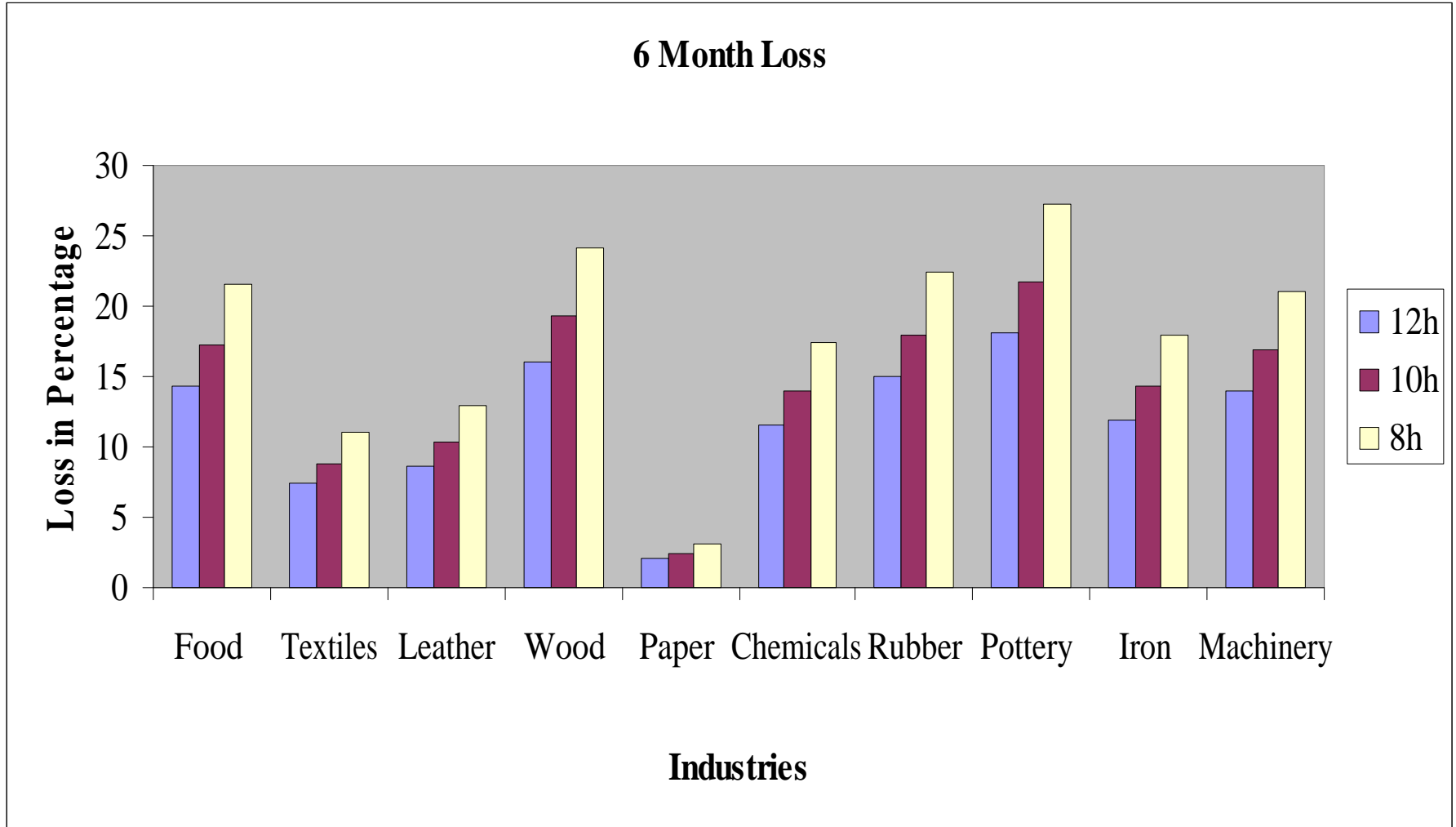
Annual Output Loss by Industry and by Shift Hours



Nine Months Output Loss by Industry and by Shift Hours



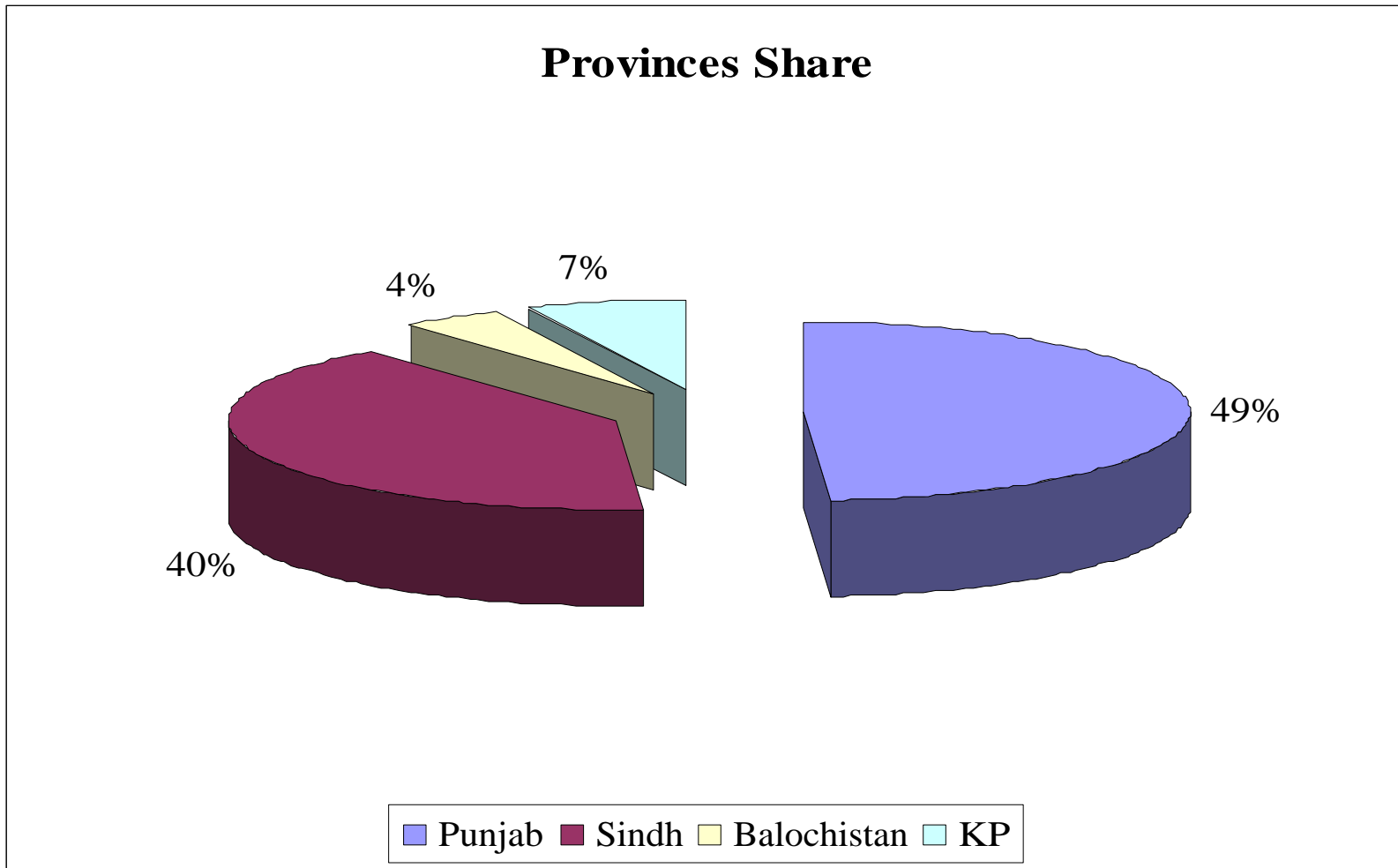
Six Months Output Loss by Industry and by Shift Hours



Province Wise and Overall Output Losses

Province/Country	Shift Hours	AL	9 ML	6 ML	Percentage
Punjab	12	266.971	197.484	131.656	
	10	320.363	236.981	157.988	49%
	8	400.454	296.227	197.484	
Sindh	12	220.556	163.15	108.768	
	10	264.668	195.781	130.521	40%
	8	330.833	244.725	163.15	
Khyber Pakhtunkhwa	12	36.135	26.729	17.821	
	10	43.361	32.077	21.385	7%
	8	54.201	40.094	26.729	
Baluchistan	12	22.477	16.626	11.083	
	10	26.972	19.951	13.3	4%
	8	33.713	24.939	16.626	
Pakistan	12	546.139	403.989	269.328	
	10	655.364	484.79	323.194	100%
	8	819.201	605.985	403.989	

Provincial Shares in Output Loss



Concluding Remarks

- Cost of unserved energy in form of electricity shortfall to the industrial sector of Pakistan
- Employment has not been reduced significantly due to alternative energy arrangements
- Increase in cost of production
- Delay in orders
- Output loss varies from 12 to 37 percent with in Punjab
- Loss of 22.36 percent of value added due to unserved energy
- Future Research
 - spoilage cost, overtime cost, and adjustment cost
 - Sustainability of alternative energy arrangements in the long-term
 - Effect on investment
 - impact of unserved energy on household
 - Burden of loss
 - Cost of Planned and Unplanned power outages

Policy Implications

- Policy makers in power sector can find the rate of return on other possible sources of energy i.e. Solar energy, Bio fuels etc in terms of the shadow prices (cost of unserved energy).
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