

SPATIO-TEMPORAL VARIATIONS IN ELECTRICITY DEMAND AND SUPPLY IN LAHORE CITY

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ABSTRACT

The present study is an empirical investigation of prevailing energy crisis and power shortages in the country. Lahore city district was taken as the study area and spatial variations regarding electricity demand, supply and load shedding were examined on annual basis as well as administrative town wise. Data sources were mainly secondary that were gathered from Power distribution company (PDC) and Lahore Electric Supply Company (LESCO). Temporal changes were analyzed during year 2004 to year 2012. The collected data was further arranged and tabulated through MS Excel 2010 and the results were also displayed through thematic mapping that were prepared by Map Viewer 7.0. The present research suggests that the responsible factors of severe electricity shortages not only prevailing in the study area but also nationwide should be figured out through future researches.

KEYWORDS: Electricity demand, Electricity supply, Load shedding, Lahore, Map Viewer 7.0

INTRODUCTION

Uninterrupted and continuous energy supply is a key to the economic growth and development that further leads the country towards success and prosperity (Sanghvi, 1991, Schramm, 1993, Qudratullah & Davidsen, 2001, and Jamil, 2013). Unfortunately, like many other developing countries Pakistan is facing many challenges e.g. enormous population size, one of the highest population growth rates, unplanned rural to urban migration, raising unemployment, poor law and order situation and the most severe one being-Energy Crisis particularly Electricity shortages. The daily outage of electricity has crossed 18 hours per day in most parts of the country, with a worsen condition in rural areas where some times it crosses 22 hours (Jamil 2013). Even the large metropolitans remain deprived of the electricity for longer durations and the situation is becoming chronic with every passing day. Lahore- the provincial capital and the second largest urban plus trade center of the country with an estimated population size of 9.2 million (CDGL, 2012) is going through same problem and bears the burden of electric load shedding ranging between 8 to 12 hours a days and sometimes reaches to 16 hours in hot weather. The pattern of load shedding greatly varies within the city from posh areas to low income residences and vice versa. The power supply is not being provided in the city as per demand or population size etc. Keeping in view the severity of the issue, the present research intends to find out the spatio- temporal variations found in the demand and supply of electricity in Lahore in previous years and administrative town wise as well. Study area

The administrative boundaries of Lahore city district were selected as the study area in the present research (Figure 1). The city is situated in the north eastern part of the country and lies between 31°-15' and 31°43' north latitudes and 74°-39' east longitudes. It is bounded by Sheikhpura district on north and west separating the two districts by

Ravi River, on the east by India and on the south by Kasur district. It covers a total land area of 1772 sq.km. and is considered the most urbanized district of Pakistan (DCR, 2000).

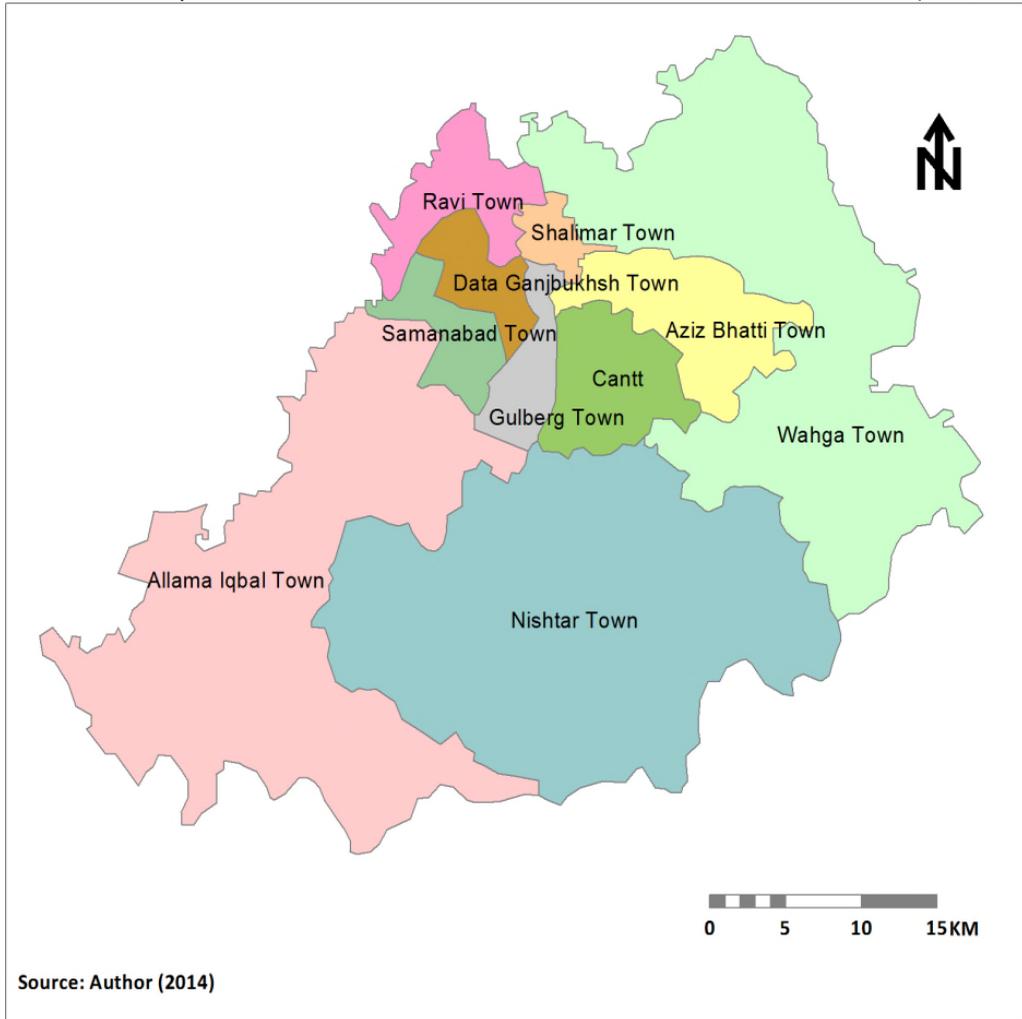


Figure 1. Lahore – The study area

Administratively, Lahore is divided into following 09 administrative towns and 01 Cantonment

- Allama Iqbal Town
- Wahga Town
- Shalimar Town
- Aziz Bhatti Town
- Ravi Town
- Data Ganj Bukhsh Town
- Gulberg Town

- Samanabad Town
- Nisthar Town
- Cantonment

DATA SOURCES AND METHODOLOGY

Secondary data sources were utilized in present research and following organizations were contacted in this regard:

- Power Distribution Company (PDC), Lahore Regional Office
- Lahore Electric Supply Company (LESCO) Head quarter and grid stations

The data acquired from PDC and LESCO was based on:

- annual electricity demand and supply in Lahore since year 2004 to 2012
- annual electricity demand and supply by administrative towns since year 2004 to 2012

Moreover, some information was also gathered from following sources:

- District Census report , Lahore (2000)
- Daily Newspapers
- Online and published reports and research articles

The collected statistics were arranged and further tabulated with the help of MS Excel 2010. The data was organized firstly on annual basis (Table 1) that represented the annual electricity demand, supply and result load shedding in the study area from year 2004 to 2012. Secondly, the collected statistics were further arranged administrative town wise for same time period and same parameters i.e. electricity demand, supply (Table 2 and Table 3). Thirdly, the load shedding was calculated on interval basis of five years so to analyze the variations and changes occurred in the pattern of electricity outage in different towns of the study area (table 4). Load shedding was calculated through following formula:

- Electricity demand – Electricity supply = Load shedding

The town wise variations found in the amount of electricity demand, supply and load shedding were also displayed through thematic bar chart maps. The maps were prepared by mapping software Map Viewer version 7.0.

Result and Discussions

As discussed earlier, the country is passing through one of its worst energy crisis in the form of electricity outages due to increased demand and reduced supply of electricity. This issue was started in year 2006 and became severe and intense with passage of time. Similar situation was faced by Lahore in previous years (see Table 1).

Table 1: Electricity demand, supply and load shedding in different years, Lahore

Year	Demand (MW)	Supply (MW)	Load Shedding (MW)
2004	1331.4	1331.4	0
2005	1433.19	1397.7	35.49
2006	1603.09	1511	92.09
2007	1729.23	1538.9	190.33
2008	1859.01	1178.6	680.41
2009	1996.9	1529.5	467.4
2010	2141.72	1640.15	501.57
2011	2278	1711.3	566.7
2012	2445.09	1637.5	807.59

Source: PDC, LESCO, Lahore (2014)

As the Table 1 shows many changes have occurred in almost last 10 years in the study area. The electricity demand has increased greatly rather almost doubled from 1331.4 MW in year 2004 to 2445.09 MW in year 2012. This is mainly due to increased domestic and commercial demands of electricity in last few years. Somehow the electricity supply has not shown much improvement in the study area and there is an increase of only 306.1 MW of electricity in the reference period i.e. from year 2004 to 2012. The electricity supply has just gone up from 1331.4 MW in year 2004 to 1637.5 MW only. Likewise, load shedding was totally absent before year 2005 and started with a shortage of 35.09 MW only but gradually increased and reached up to 807.59 MW in year 2012. The situation can be further analyzed from Figure 2. As the Figure shows the demand for electricity has progressively increased in last years in the study years, while fluctuations can be seen in the supply of electricity particularly in year 2008 when the supply was suddenly fell to 1178.6 MW only. The same fluctuation can be observed in the amount of load shedding which was slowly increasing since year 2005 but abruptly was risen up in year 2008 due to sudden short fall of electricity and then again started rising up and so on.

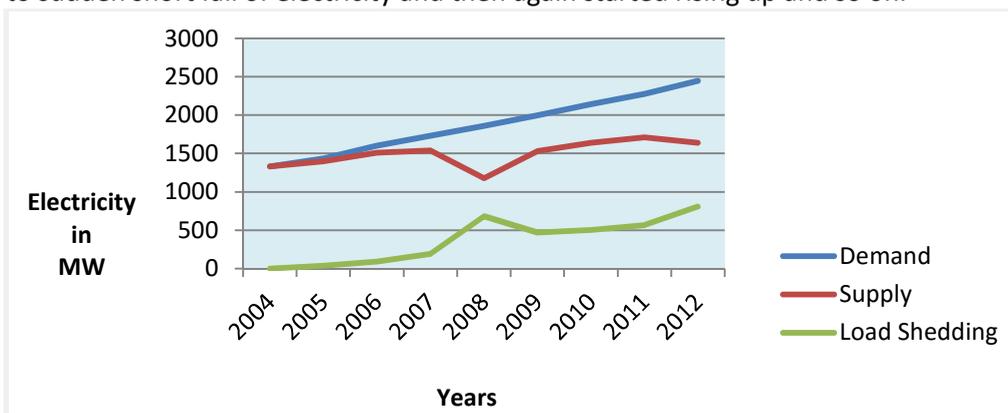


Figure 2. Electricity demand, supply and load shedding in Lahore

So far the demand for electricity though increased but has not been the same in the study area by administrative towns (Table 2).

Table 2: Electricity demand by Administrative towns in Lahore in different years (in MW)

Administrative Town	2004	2005	2006	2007	2008	2009	2010	2011	2012
Cantonment	33	40.3	44.7	50	59	65	73	78.4	84
Wahga	105	113.49	122.5	132.6	144	155	170.5	184	198.7
Aziz Bhatti	71.2	73	75.33	77.5	80	84	92.6	97	102
Nishtar	88	93.33	99	109	115.25	126	137	146	163.2
Allama Iqbal	284.65	293	339.4	361	390.8	421.8	452	481.4	518
Samanabad	37	39.83	40	43	47	50	53.3	55	57
DattaGunjbukhsh	122	135	149.4	160.1	172.66	185.7	198.99	211.5	227.7
Gulberg	294	319.64	343	365.03	386	410.9	432	454.7	476.4
Shalimar	172.3	193.15	221	237	254	267	284	300	314.76
Ravi	115.9	140.8	168.76	194	210.3	231.5	248.33	270	303.33

Source: PDC, LESCO, Lahore (2014)

As the Table 2 shows, the demand for electricity has not been same in all of the administrative towns of Lahore in last years. Moreover, great variations can also be seen in the increased demand for electricity with highest in Allama Iqbal town rising from 284.65 MW in year 2004 to 518 MW in year 2012 which is nearly doubled since 2004. On the other hand, Samanabad town has registered an increase of merely 20 MW from year 2004 with a demand of 37 MW only to 57 MW in year 2012. Moreover, if compared individually, then only cantonment has registered more than 100 percent increase in electricity demand that rose from 33 MW in year 2004 to 84 MW in 2012. The other towns which have shown noticeable increase in the demand of electricity include Gulberg, Ravi, Nishtar towns and to some extent in Wahga and Data Ganjbukhsh towns as well. This might be to aerial expansion of the city and greater shift of activities especially residential to these areas in last few years. The situation can also be analyzed through Figure 3.

Spatio-Temporal variations in electricity demand and supply in Lahore city

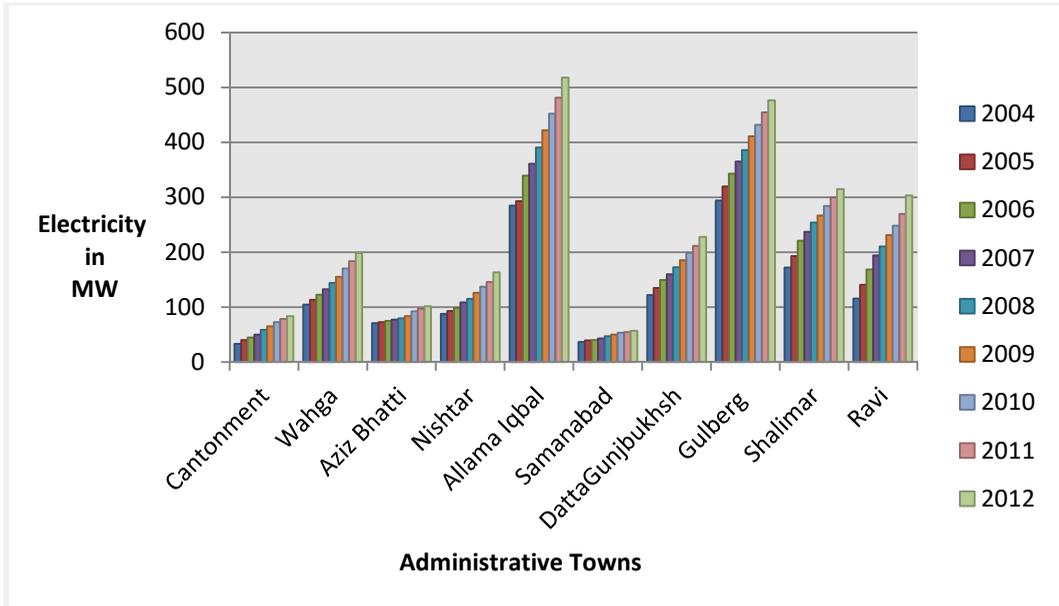


Figure 3. Electricity demand by administrative towns of Lahore

Although the demand for electricity has greatly increased in all of the administrative towns of the study area but unfortunately the supply of electricity has not been sufficient in last years (Table 3).

Table 3: Electricity Supply by Administrative towns in Lahore in different years (in MW)

Administrative Town	2004	2005	2006	2007	2008	2009	2010	2011	2012
Cantonment	33	34.6	37.4	38.1	29.2	37.9	40.6	42.3	40.4
Wahga	105	110.2	119.1	121.3	93	120.6	129.35	135	129.2
Aziz Bhatti	71.2	74.8	81	82.5	63.2	82.1	88.1	91.9	87.9
Nishtar	88	92.4	99.9	101.7	77.9	101.1	108.4	113.1	108.2
Allama Iqbal	284.65	307.6	332.5	338.6	259.3	336.5	360.9	376.6	360.4
Samanabad	37	39	42.2	42.9	32.8	42.5	45.5	47.5	45.4
DattaGunjbukhsh	122	128.1	138.5	141.1	108.1	140.3	150.4	156.9	150.2
Gulberg	294	308.6	333.6	339.8	260.2	337.7	362.2	377.9	361.6
Shalimar	172.3	180.8	195.4	199.1	152.5	197.9	221.2	221.4	211.9
Ravi	115.9	121.6	131.4	133.8	102.4	132.9	142.5	148.7	142.3

Source: PDC, LESCO, Lahore (2014)

It can be fully analyzed from Table 3 that electricity supply has slightly increased in every town of the study area since year 2004. It can also be noticed that this increase in supply varies from town to town and ranges between from 7 MW to 75 MW of electricity. Maximum increase in electricity supply is observed in Allama Iqbal town from 284.65 MW

in year 2004 to 360.4MW in 2012 thereby an increase of almost 75 MW. On the other hand, the minimum increase in electricity supply is shown by Cantonment from 33 MW in year 2004 to 40.4 MW meaning that an increase of hardly 7.4 MW in Almost last 10 years (Figure 4). Moreover, it is clearly noticeable that the supply for electricity is not according to the required demand of administrative towns (Table 2).

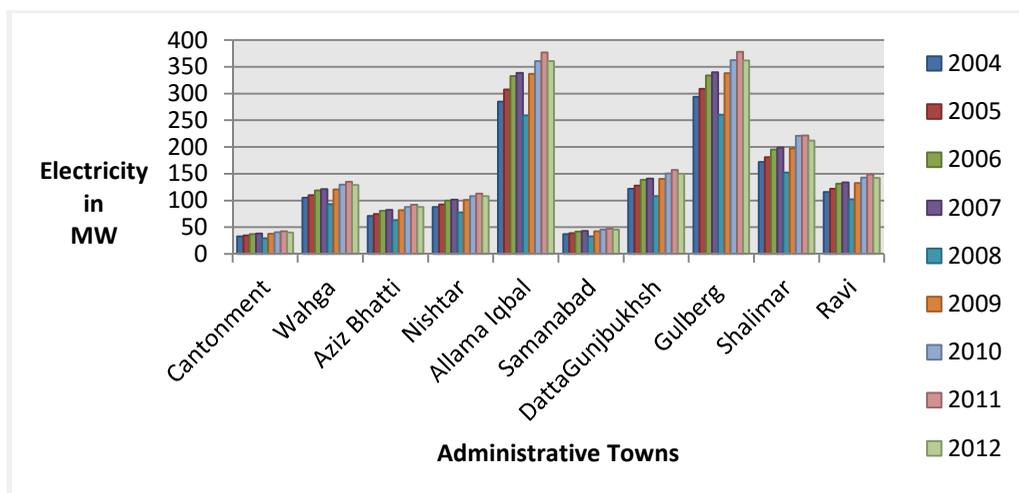


Figure 4. Electricity Supply by administrative towns of Lahore

As discussed earlier, the load shedding for the administrative towns was calculated on interval basis of 5 years namely for year 2004, 2008 and 2012. The details can be seen in Table 4.

Table 4: Town wise Electricity demand, Supply and Load Shedding in different years, Lahore (in MW)

Administrative Town	2004			2008			2012		
	Demand	Supply	Load shedding	Demand	Supply	Load shedding	Demand	Supply	Load shedding
Cantonment	33	33	0	59	29.2	29.8	84	40.4	43.6
Wahga	105	105	0	144	93	51	198.7	129.2	69.5
Aziz Bhatti	71.2	71.2	0	80	63.2	16.8	102	87.9	14.1
Nishtar	88	88	0	115.25	77.9	37.35	163.2	108.2	55
Allama Iqbal	284.65	284.65	0	390.8	259.3	131.5	518	360.4	157.6
Samanabad	37	37	0	47	32.8	14.2	57	45.4	11.6
DataGunjbukhsh	122	122	0	172.66	108.1	64.56	227.7	150.2	77.5
Gulberg	294	294	0	386	260.2	125.8	476.4	361.6	114.8
Shalimar	172.3	172.3	0	254	152.5	101.5	314.76	211.9	102.86
Ravi	115.9	115.9	0	210.3	102.4	107.9	303.33	142.3	161.03

Source: PDC, LESCO, Lahore (2014)

As the Table 4 shows, the pattern of electricity outage varies in all towns of the study area. It is quite visible that the phenomenon of load shedding was totally absent in year 2004, when the electricity supply was sufficient to fulfill the demand in all towns (Figure 5). However with the rise of energy crisis in the country the administrative towns of study area were also greatly affected and though the demand for electricity had increased in all of the towns in year 2008 the supply decreased in all towns even less than year 2004 (figure 6). This resulted in power shortages and in all of the towns ranging between a shortage of 16.8 MW in Aziz Bhatti town to 131.5 MW in Allama Iqbal Town in the same year.

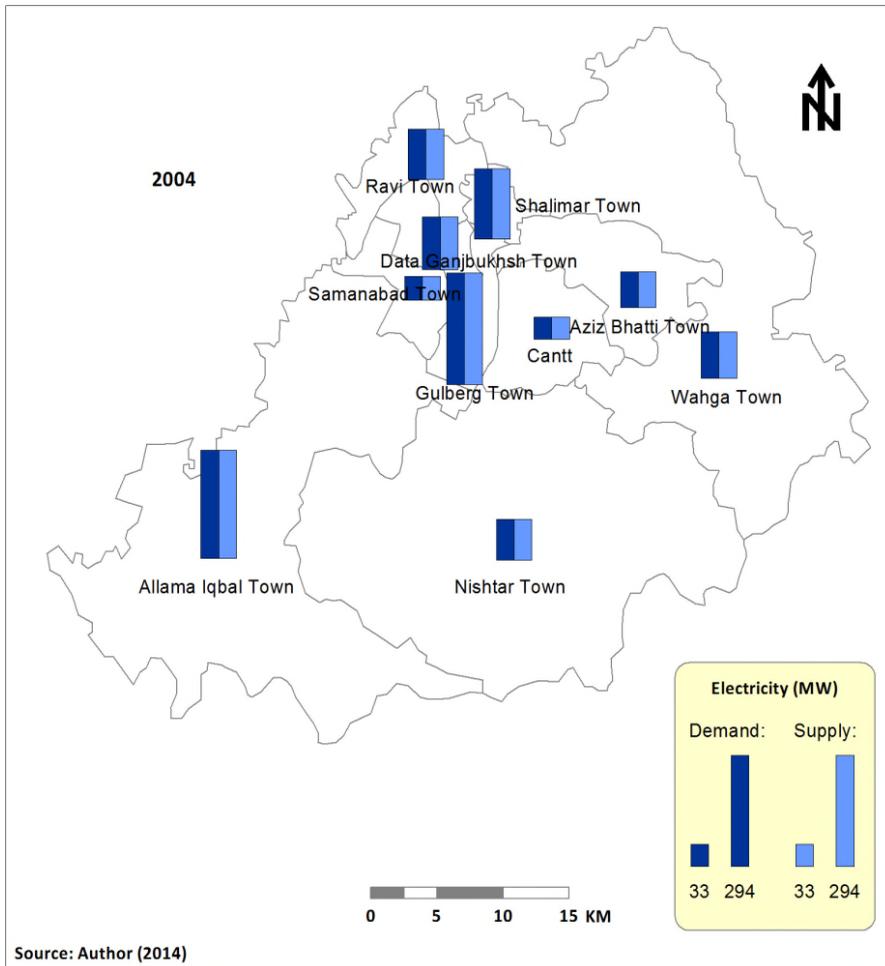


Figure 5: Town-wise electricity Demand, Supply and load shedding in year 2004

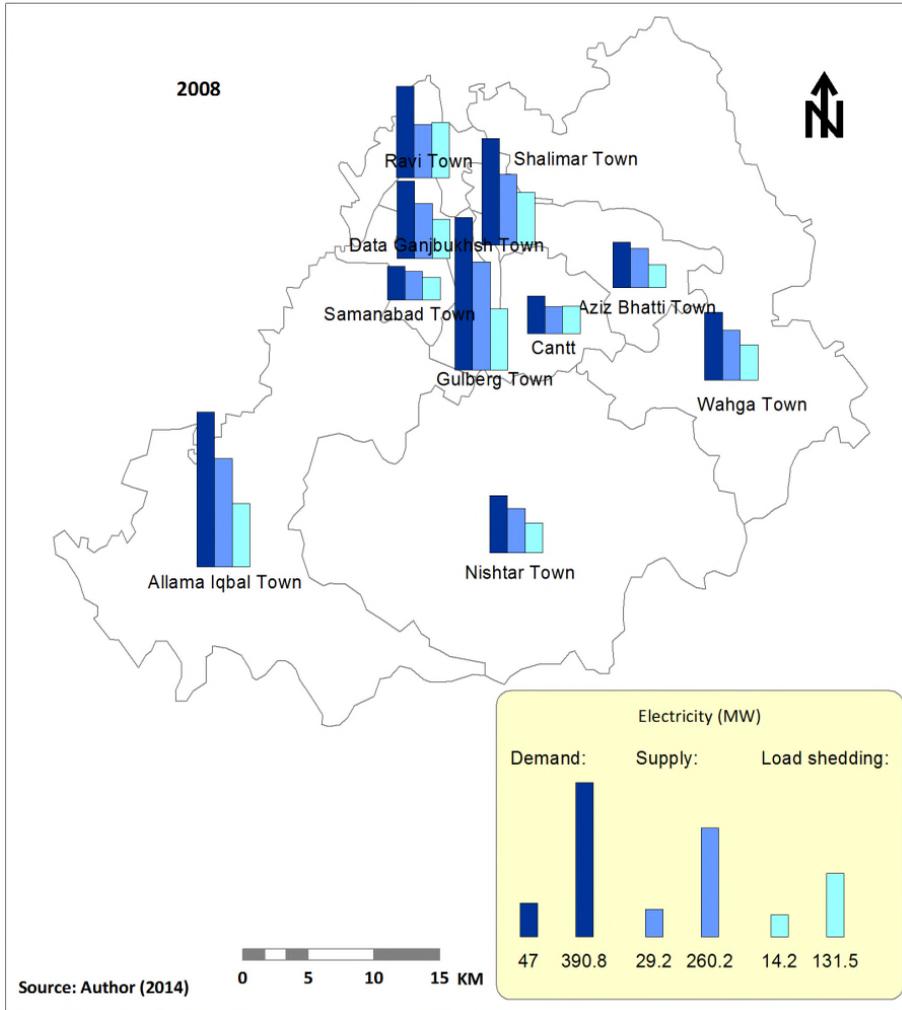


Figure 6: Town-wise electricity Demand, Supply and load shedding in year 2008

Besides, it is also quite obvious from the illustrated table that the pattern of load shedding was not similar in all of the administrative towns as some areas were bearing an increased burden of load shedding than the rest ones such as Ravi town and Cantonment. However, the other towns were bearing comparatively less electricity outages keeping in view their respective pattern of demand and supply such as Aziz Bhatti and Nishtar towns. The situation was rather intensified in year 2012 with an increased demand in electricity in all of the towns especially Allama Iqbal and Gulberg towns (Table 4 and Figure 7).

Spatio-Temporal variations in electricity demand and supply in Lahore city

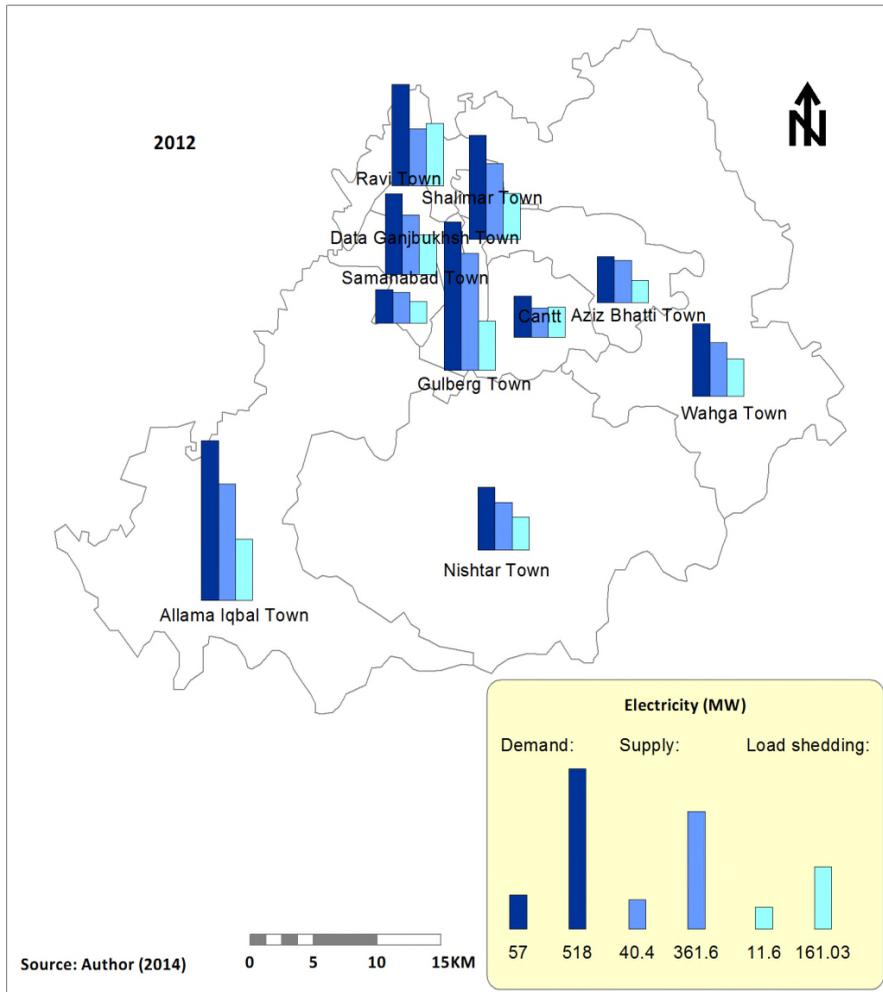


Figure 7: Town-wise electricity Demand, Supply and load shedding in year 2012

It is quite observable from Table 4 and Figure 7 that the electricity supply was also improved in all towns and increased as compared with year 2008, but still insufficient to fulfill the widening gap between electricity demand and supply in the study area. This time the amount of load shedding was found to be greater than the total supply of electricity in some towns e.g. Ravi Town and Cantonment. More interestingly, the electricity outages were observed to be decreased in few towns if compared with year 2008. Gulberg, Aziz Bhatti and Samanabad towns had observed decrease in load shedding as compared with year 2008 while all other towns observed increase in load shedding as compared with year 2008.

CONCLUSIONS

Keeping in view the discussion carried out in the previous section, following conclusions are carried out:

- The demand for electricity increased rapidly and progressively i.e. 1113.69 MW during year 2004 to 2012 with approximately an increase of almost 45% in the study area
- The supply for electricity increased slightly and observed quite fluctuations especially in year 2008 and registered an overall increase of just 306.1 MW during the reference period
- The problem of power shortage and electricity outages started after year 2004 in Lahore and gradually increased with time and reached from 35.49 MW to 807.59 MW in just 8 years i.e. from year 2005 to 2010
- Great variations were observed in electricity demand by administrative towns of Lahore as highest demands were observed by Allama Iqbal and Gulberg towns throughout the reference period
- Variations and differences were also observed in the pattern of electricity supply in administrative towns as the supply was not found to be similarly distributed in all towns as per their share of demand
- The pattern of Load shedding was also found to be varying from town to town as on individual basis Ravi town and cantonment were bearing more electricity outages and load shedding than other towns
- Load shedding was found to be decreased in few towns in terms of balance between demand and supply e.g. Gulberg Aziz Bhatti and Samanabad towns had observed decrease in load shedding as compared with year 2008 while all other towns observed increase in load shedding as compared with year 2008.

Finally it is concluded that the electricity shortage is increasing day by day in Lahore and the pattern of demand and distribution of electricity is not equal by administrative towns and some areas are suffering more from the issue of electricity outages than others. The study further suggests to find out and analyze the responsible factors behind increased electricity shortages and so so.

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