P-ISSN: 2709-6254	Journal of Development and Social Sciences	Jan-March 2025, Vol. 6, No. 1
O-ISSN:2709-6262	https://doi.org/10.47205/jdss.2025(6-I)55	[635-649]

Journal of Development and Social Sciences
www.jdss.org.pk

RESEARCH PAPER

Housing Energy Demand Increase Perspectives of Developing Countries: A Case of Punjab

[1]Usman Awan *, [2]Mutahir Awan and [3]Mamuna Iqbal

1. Assistant Professor, Department of Architecture, University of Engineering and Technology, Lahore, Punjab, Pakistan
2. Director Land & Estate, Punjab Central Business District Development Authority, Lahore Punjab, Pakistan
3. Assistant Professor, Department of Architecture, University of Engineering and Technology, Lahore, Punjab, Pakistan

***Corresponding Author:** usmanawan@uet.edu.pk

ABSTRACT

The research is looking at the demand forecast of energy of the housing sector of Punjab to address the energy shortage crisis arising constantly. The housing sector of developing countries faces an increase in demand for energy consumption. The authorities find it difficult to meet this increasing demand due to a lack of understanding of the factors causing it. The research provided statistical data based on an in-depth literature analysis of key demand perspectives discussed under two different scenarios. The study found huge demand increase factors that are never mitigated to overcome the inherent energy issues. Natural population growth, urbanisation, shift in construction materials, and better lift styles of slums areas, as well as reduced occupancy ratio per household, are increasing energy demand. Based on the actual data and facts, the recommendation is to add substantial energy demand against each perspective and corresponding mitigation measures.

KEYWORDS Housing Sector, Shortage, Demand Perspectives, Inherent Energy, Mitigation

Introduction

Developing countries always face difficulty in meeting energy demands, especially in the domestic sector. Some inherent challenges must be met or considered while developing any mitigation strategies to look for energy supply; otherwise the issue would remain unsolved. In this paper, we will look into these inherent increase factors as well as the enhanced life quality of the residents of these developing countries and will provide insight into the historic demand increase scenarios by understanding the statistical data for the province of Punjab, Pakistan. Sometimes concerned authorities undermine the huge demand, increasing the potential of these factors and resulting in the pit energy crisis. This paper talks about and expands on, considering the established data, providing perspective views to mitigate the overall energy demand factors, rather than just looking at the missing demand. The unmet demand of energy faces energy cuts, especially in the domestic sector, almost all measures are taken to meet this unmet demand which is occurring then. All strategies are to resolve this current issue, however, very little attentions are paid to the exploration and adaptation of an effective approach which would also cater for the demand increase factors highlighted in the current research.

Literature Review

The energy demand forecasting has focussed on systematic reviews and Meta Data analysis of the relevant consumers (Sadaam , Ibu Isha , & Ahmed , 2023), while the time series modelling approach has been found the most effective method of demand estimation incorporating artificial intelligence as well, indicating Weather, GDP and Population as main determinants (Aneeque , Alghassab, & Ullah , 2020). In understanding the forecasting methodologies, the two approaches i.e. econometric and end-use accounting, are found most

relevant, however, rich and poor users and urban and rural divides are issues not addressed in these models (Bhattacharyya & Timilsina, 2010). In a wider research, regression analysis, ARIMA, fuzzy logic, neural networks, along with MARKAL and LEAP, are being used for demand side management of energy mitigations (Suganthi & Sameul, 2012). In an attempt to forecast an increase in the consumption of developing countries considering income, population and price elasticities suggested 5.5% growth per year (Dahl & McDonald, 1998). In a very interesting study, it is said that low-income countries would have great impact on the worlds energy demand in the next 30 years, as the poor population would shift for the very first time in having appliances and vehicles. There would be an increase in the households' ownership of appliances & conditioners (Wolfram, Catherine, & Shelef, 2012). For the long-term forecasting till 2020-2050, energy consumption and socio-economic indicators are utilised by applying artificial neural networks(ANN), through this machine learning process the estimates for developed and developing countries(Iran-130%, Pourtugal 37.4% and USA 58.4%) are made with enhanced model precision (Kiani, Golshaeian, & Hassan, 2024). From the most of the research published between 2005-2015, a neural Network is the dominant model for energy forecasting while computation time being the second most popular (Ghalehkhondabi, Imran, & Ardjmand, 2017). In the context of Pakistan, a LEAP model is presented utilising fossel fules like coal and gas till 2030, considering the capacity factor using MATLAB, and shown very promising results with accurate esimates (Raza, Khatri , & Israr , 2022). Whereas, ARIMA is suggested as the more appropriate model for the demand forecast in Pakistan over LEAP & Holt-Winter Models (Rehman , Cai, & Fasal , 2017). The other research highlighted number of appliances, air conditioners and floor areas as key demand indicators of energy in Punjab (Awan & Knight , 2020). There are many attempt made in literature to understand an forecast the energy demand of developing countries; however in this current research brought forward the un-explored factors never discussed before as a whole.

Material and Methods

The research is framed on two demand increase perspectives, i.e. Inherent growth & Enhanced Life Quality. The housing sector, due to different scenarios, would require additional energy availaibity to minimize energy-cuts Figure 1. and interpreted from the available literature. The research framework looks into two sets of perspectives to decipher the potential of demand increase. In-depth study of statistical data retrieved from published literature enabled us to put these perspectives under one framework for study Figure 1. A detailed understanding of natural population growth, urbanization, shift in the construction material, increased access to energy, and shift from slum to urban areas were the outlocks for increased demand forecasting. The un-met demand as brought forth through deep insight of these factors empowered us to give recommendations for the mitigation measures

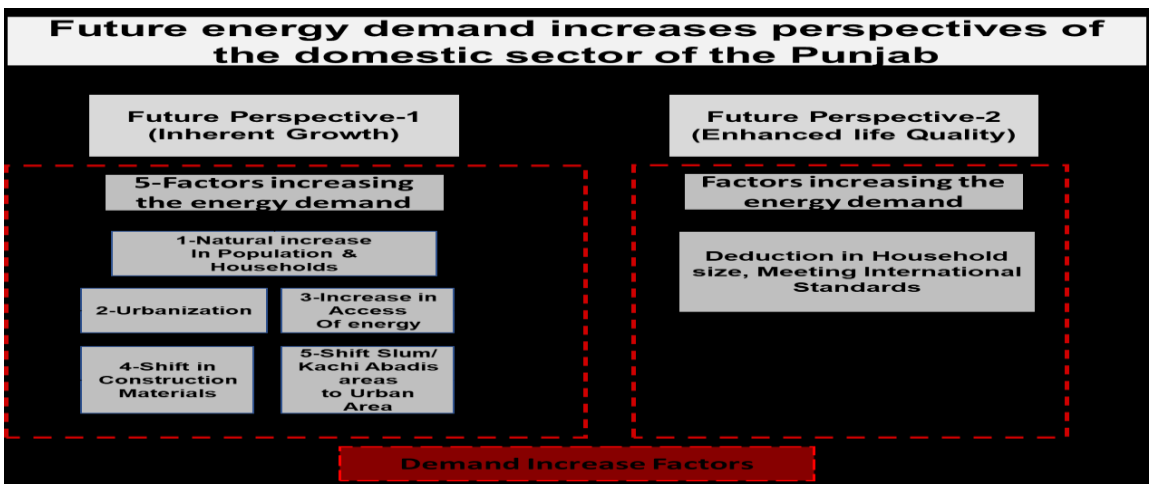

Figure 1 Housing Energy Increase Forecast

Results and Discussion

Perspective-1

Inherent Growth Factors Increasing Domestic Energy Demand

Inherent growth factors are those which are causing an increase in energy demand without coming directly into the account of the authorities but their effect on the energy demand is inevitable. These factors are permanent and play a major role in addressing the issue of energy shortages in developing countries. In this research, we will bring forth the statistical data explaining as they occur in Punjab.

Population and Household Growth

The population of Punjab is increasing at a constant rate of 1.5 AGR(annual growth rate), it was 21.84M in 1951 and has grown to 123.5M in 2025, which shows an increase of 101.7M in 74 years, approximately 1.37M average growth Figure 2. With the current growth rate of 2%(as per the census report 2023), Punjab's population in 2050 will be 177M, which would be 53.5M more inhabitants just in the period of 25 years and these numbers are alarming, and of serious concerns.

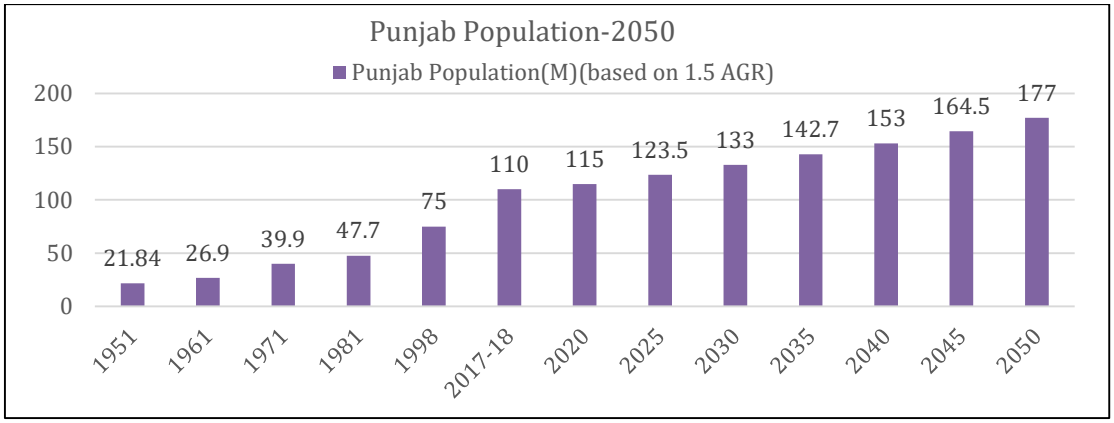

Figure 2 Punjab Population Estimates-2050, source: (Agency, 2022) (Afzal , 2009)

According to the census report 2017, Pakistan has 32.2M households and Punjab 17.1M (53%). As per reports (Feeney & Alam, 2003), there is a 2.13% growth rate of households and in 2030 and 2050 there would be 23.3M and 28.6M in numbers, respectively. It means there would be 6.2M and 11.5M more households in 2030 & 2050 as of the year 2017 with an average occupancy of 6.2 persons per household Figure ***3***.

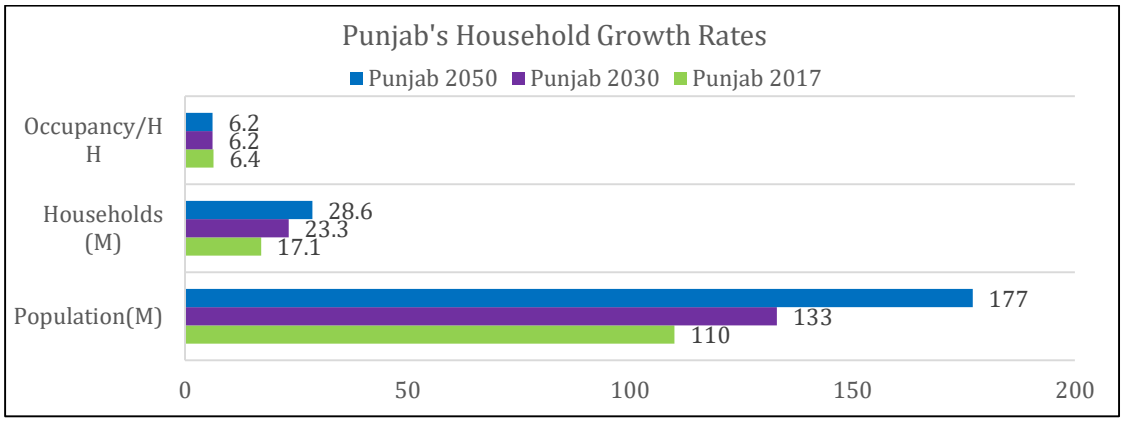

Figure 3 Punjab's Growth Rates of Households, source: (Feeney & Alam, 2003) (Papanek & Naseem , 1996)

We can see a continuous growth in the power consumers of Punjab in the years between 2004 and 2014 **Error! Reference source not found.**. There are approximately 0.5M more consumers per year which are adding energy demand. There were 14.6M consumers in year 2014 and their number increased to 17.1M in 2017, with an average growth of 0.9M annually. This indicates a huge increase per year and higher demands of the Housing Sector of Punjab **Error! Reference source not found.**.

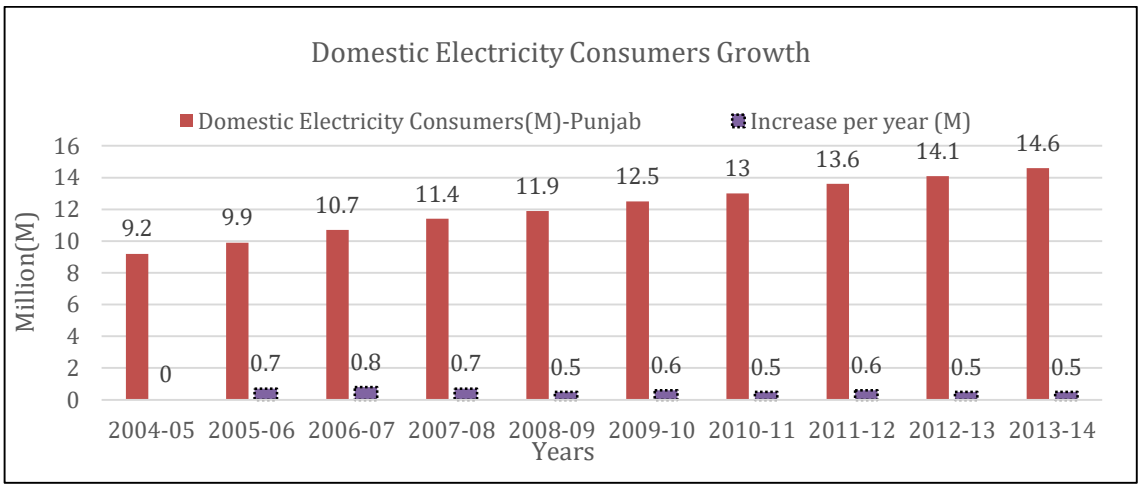

Figure 4 Punjab's Domestic Electricity Consumers Growth Trend (Rana & Bhatti, 2018)

Urbanization

Since the formation of new homelands for the Muslims of the sub-continent in 1947, the urbanisation of Punjab's cities has on inclined. Though it was high in the early years(1951)5.2% with only 17.5% of the population being urbanites **Error! Reference source not found.**. Currently,(2025) still 47.1% of the total Punjab population is living in cities with an annual growth rate of 1.3%. This urbanisation remained always positive since the beginning up-till now, and with the forecasted growth rate of 1.2% the overall 63.2% of the population will be urbanites in the year 2050, this would be almost 112M people Figure 2 & **Error! Reference source not found.**. This huge number of urbanites would demand more energy supply and consumption as urban energy per capita is higher than rural settlements due to different lifestyles. This is inherent energy demand potential which is to be mitigate by the supply companies to overcome the issue of energy crisis, especially supply of power.

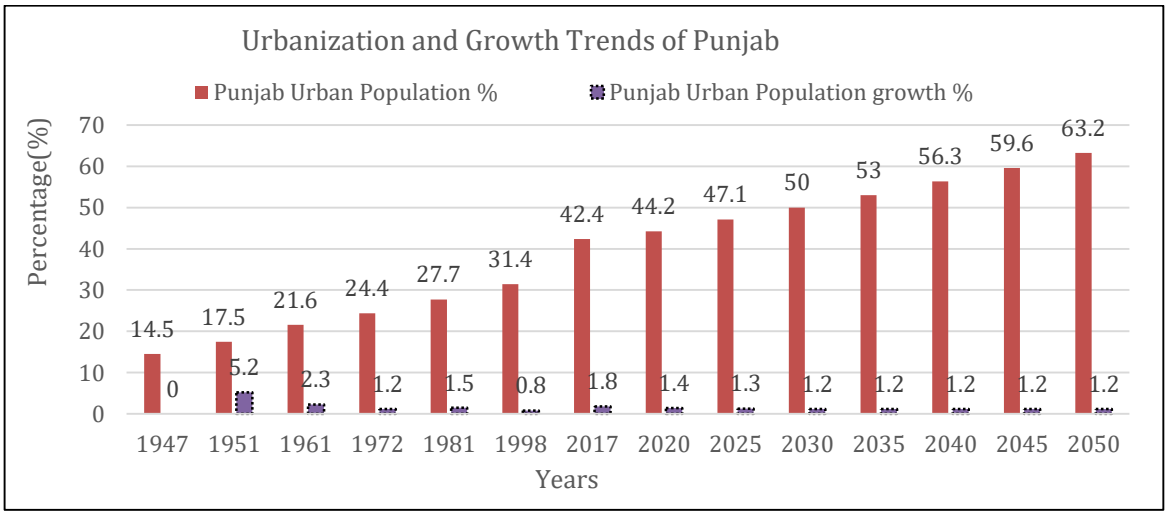

Figure 5 Urbanization and Growth Trends of Punjab, source: (Feeney & Alam, 2003) (Arif, 2016) (Anwar, Nawaz, Parveen, & Nousheen, 2008) (Maria, Iqbal, & Imran , 2006)

Increased Access To Energy

Being a developing country the whole population of Punjab do not have access to energy, in the year 2020 approximately 78% were connected to the energy supplies (Afzal , 2009). Whereas, the advanced world like the USA, UK, UAE etc have 100 population access to the basic need of energy **Error! Reference source not found.**. India and Bangladesh are still struggling to connect their complete population to energy resources. The need would increase if disconnected 22% of householders have access to energy.

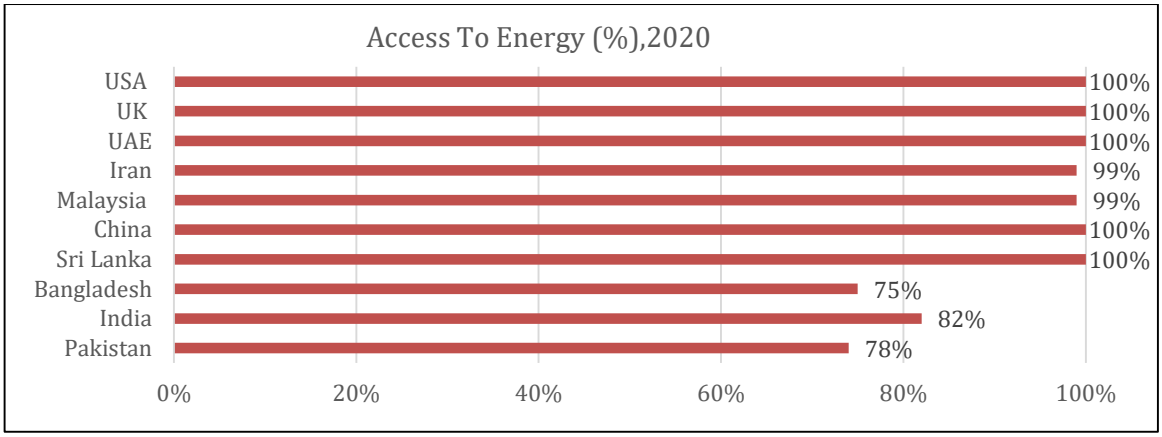

Figure 6 Global Energy Access Differences 2020

The consensus report of 1973 dictates that only 18% of households were connected to the grid, 30% by 1980 (54% urban and 5% rural) (Feeney & Alam, 2003). In the year 2020, 71% had electricity in homes, which means roughly 60M (out of 220M) do not have access to electricity (Papanek & Naseem , 1996) **Error! Reference source not found.**. There are 7.5M households without electricity connections largely in the rural areas(20%) however, approximately 90% of urban and 80% of rural Pakistan are electrified with the main grid (Rana & Bhatti, 2018). Still, there are approximately 20500 whole villages (out of which 621 are in Punjab) of Pakitan required to be connected (Papanek & Naseem , 1996).

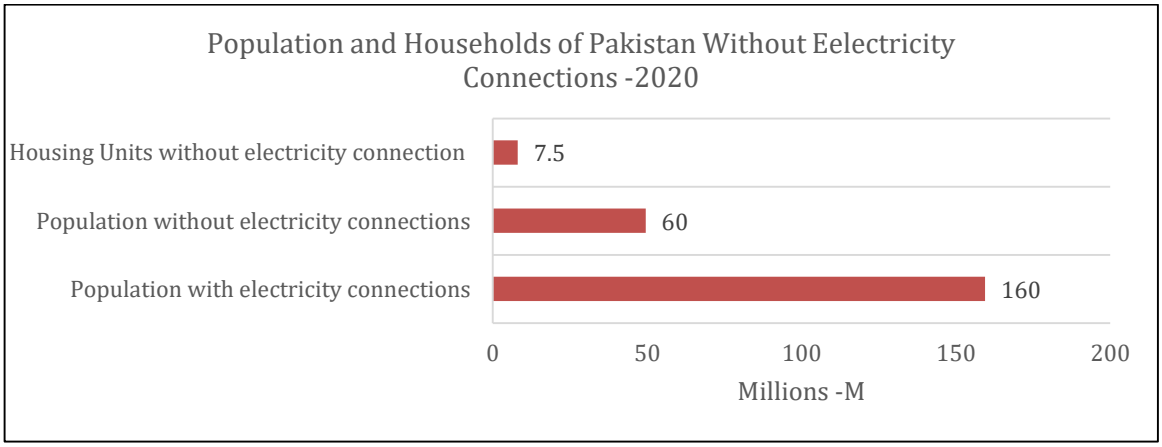

Figure 7 Pakistan's Population and Households Lacking Electricity Connections-2020, source: (Papanek & Naseem , 1996)

Shift in the Construction Materials

Previously, housing construction was made with varied materials in Pakistan. As per Pakistan social and living standards measurements(PSLM 2005), urban houses use brick walls which is a huge shift from the vernacular mud house constructions. Traditional mud houses are known as KACHI ABADIS **Error! Reference source not found.** (Kaccha) are now using brick materials(Pacca) (Arif, 2016) **Error! Reference source not found.**. The Mud is used for the walls of Kaccha houses, and bamboo along with rice thatch for roofs. Whereas in semi-kaccha houses the burnt bricks walls while roofs are of bamboo and rice thatch. In the Pacca house construction, all walls are made of burnt bricks with mortar and concrete roofs steel bars **Error! Reference source not found.** & **Error! Reference source not found.**.
We can see that the thermal resistance of Kaccha houses was more than that of Pacca houses, as a result it requires more cooling in modern Pacca houses hence larger electricity consumption. This change in the construction materials and their thermal properties enforced more power requirements by the housing sector of Pakistan.

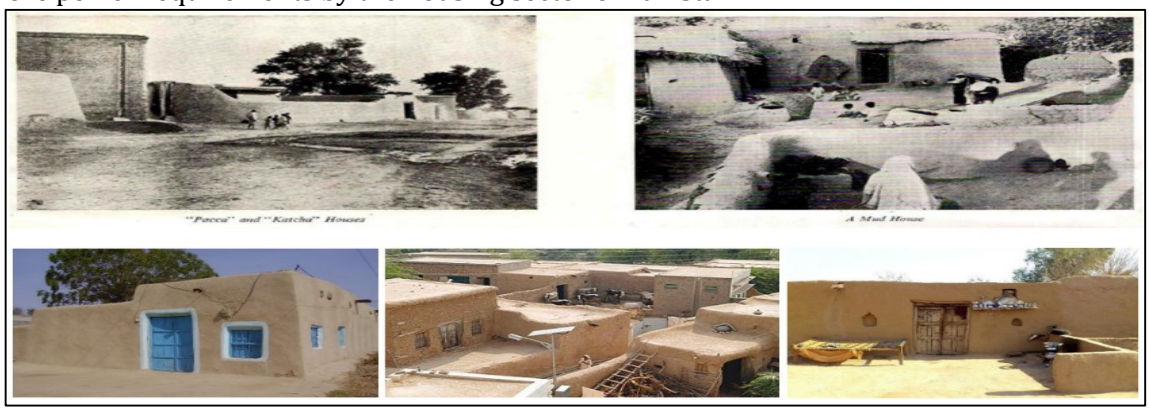

Figure 8 Mud Construction (Kaccha) of Punjab

Figure 9 Brick-Concrete Construction of Punjab

The latest census report of 2023 shows that there are 81% Pacca, 12% semi-Pacca and 7% Kaccha houses in Punjab. In the whole county, there are 67% Pacca houses, 13% Semi-Pacca and 20% Kaccha houses. These kaccha houses when shifted to Pacca houses, due to modernisation and changes in life-styles, would consume a larger amount of energy to maintain a habitable environment inside.

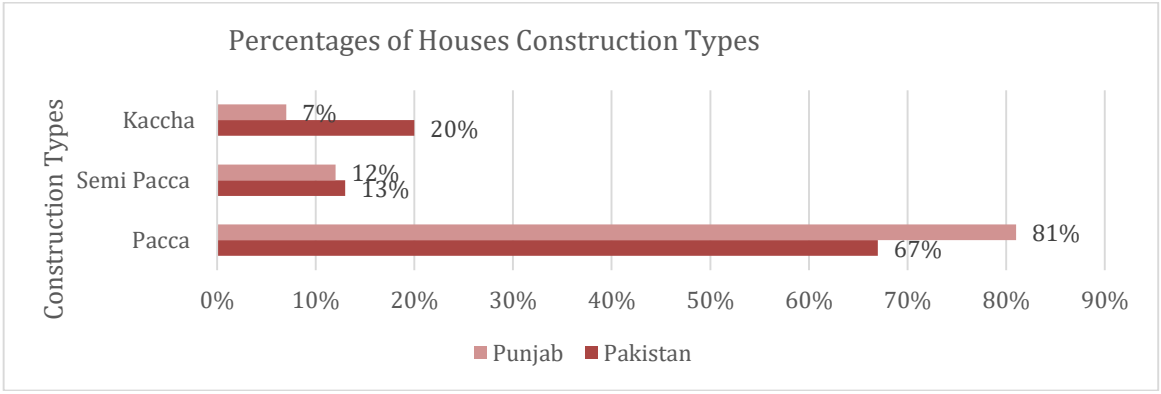

Figure 10 Percentages of Construction House Types in Punjab source: Census report of 2023

As we understand that the Kaccha houses consume lesser amount of energy for their cooling needs than Pacca houses, there is a huge increase not only in the number of Pacca houses but also in the overall percentage of the Punjab housing sector **Error! Reference source not found.**. We see that the house units till 1998 were 10.92M in roughly 50 years since independence, while in 2023 their number approximately doubled in 25 years i.e. 19.83M **Error! Reference source not found.**. We found a major shift in the construction materials of almost all districts of Punjab, the residents prefer to build Pacca houses **Error! Reference source not found.**. This huge increase in the overall number and shift in the construction material from Kaccha to Pacca houses would require a lot of energy to meet their demands, hence pressure on the national grid.

Table 1

Comparison Of Types of Construction Materials of Houses of 36 Districts of Punjab Between Censuses of 1998 & 2023

Sr. No.	District	HOUSES (1998)	HOUSES (2023)	PACCA HOUSES (1998)	PACCA HOUSES (2023)	SEMI-PACCA HOUSES (1998)	SEMI-PACCA HOUSES (2023)	KACCHA HOUSES (1998)	KACCHA HOUSES (2023)
		(M)	(M)	(M)	(M)	(M)	(M)	(M)	(M)
1	Attock	**0.21**	**0.35**	**0.16**	**0.30**	**0.01**	**0.04**	**0.04**	**0.02**
2	Bahawalnagar	0.31	0.56	0.12	0.38	0.03	0.1	0.16	0.076
3	Bahawalpur	**0.36**	**0.67**	**0.17**	**0.50**	**0.04**	**0.13**	**0.16**	**0.04**
4	Bhakkar	0.16	0.31	0.05	0.23	0.01	0.048	0.09	0.039
5	Chakwal	**0.19**	**0.29**	**0.06**	**0.26**	**0.02**	**0.03**	**0.04**	**0.01**
6	Chiniot	0.12	0.26	0.05	0.2	0.01	0.034	0.06	0.023
7	D G Khan	**0.21**	**0.45**	**0.06**	**0.24**	**0.01**	**0.07**	**0.14**	**0.14**
8	Faisalabad	0.75	1.38	0.51	1.24	0.11	0.11	0.12	0.035
9	Gujranwala	**0.45**	**0.85**	**0.41**	**0.74**	**0.02**	**0.09**	**0.02**	**0.02**
10	Gujrat	0.31	0.49	0.28	0.43	0.01	0.05	0.02	0.01
11	Hafizabad	**0.12**	**0.2**	**0.08**	**0.15**	**0.00**	**0.04**	**0.04**	**0.08**
12	Jhang	0.43	0.49	0.16	0.4	0.05	0.054	0.22	0.04
13	Jhelum	**0.19**	**0.23**	**0.16**	**0.18**	**0.02**	**0.03**	**0.01**	**0.07**
14	Kasur	0.34	0.65	0.23	0.54	0.02	0.08	0.1	0.025
15	Khanewal	**0.29**	**0.53**	**0.10**	**0.42**	**0.04**	**0.06**	**0.15**	**0.05**
16	Khushab	0.15	0.25	0.1	0.18	0.01	0.055	0.04	0.016
17	Lahore	**0.89**	**2.01**	**0.82**	**1.94**	**0.03**	**0.04**	**0.04**	**0.04**
18	Layyah	0.15	0.34	0.04	0.267	0.01	0.04	0.1	0.034
19	Lodhran	**0.16**	**0.32**	**0.05**	**0.25**	**0.02**	**0.05**	**0.09**	**0.03**
20	Mandi Bahauddin	0.17	0.285	0.16	0.225	0.001	0.05	0.01	0.01
21	Mianwali	**0.15**	**0.29**	**0.10**	**0.21**	**0.01**	**0.01**	**0.04**	**0.03**
22	Multan	0.43	0.89	0.21	0.69	0.03	0.12	0.19	0.082
23	Muzaffargarh	**0.36**	**0.8**	**0.10**	**0.49**	**0.03**	**0.16**	**0.23**	**0.16**
24	Narowal	0.17	0.28	0.13	0.23	0.01	0.038	0.03	0.01
25	Nankana Sahib	**0.16**	**0.25**	**0.06**	**0.19**	**0.02**	**0.05**	**0.08**	**0.02**
26	Okara	0.37	0.55	0.16	0.45	0.04	0.06	0.17	0.036
27	Pakpattan	**0.2**	**0.344**	**0.07**	**0.27**	**0.02**	**0.04**	**0.11**	**0.03**
28	Rahim Yar Khan	0.42	0.826	0.19	0.56	0.06	0.173	0.17	0.095
29	Rajanpur	**0.15**	**0.354**	**0.03**	**0.14**	**0.02**	**0.06**	**0.11**	**0.15**
30	Rawalpindi	0.52	0.998	0.46	0.954	0.03	0.028	0.03	0.015
31	Sahiwal	**0.27**	**0.446**	**0.09**	**0.39**	**0.03**	**0.03**	**0.09**	**0.02**
32	Sargodha	0.41	0.684	0.32	0.466	0.01	0.168	0.08	0.049
33	Sheikhupura	**0.45**	**0.593**	**0.33**	**0.51**	**0.02**	**0.07**	**0.11**	**0.02**
34	Sialkot	0.37	0.671	0.32	0.6	0.02	0.051	0.03	0.015

35	Toba Tek Singh	**0.23**	**0.393**	**0.10**	**0.34**	**0.05**	**0.04**	**0.08**	**0.02**
36	Vehari	0.3	0.543	0.13	0.46	0.03	0.054	0.14	0.029
	Total	**10.92**	**19.83**	**6.57**	**16.04**	**0.90**	**2.32**	**3.34**	**1.57**

Kachi Abadis & Slums converted to urban Modals

Kachi Abadis are illegal and unplanned Squatter occurrences meaning temporary settlements (Arif, 2016), they are domestic without any infrastructure and access to utilities (Anwar, Nawaz, Parveen, & Nousheen, 2008) (Maria, Iqbal, & Imran , 2006) **Error! Reference source not found.**.

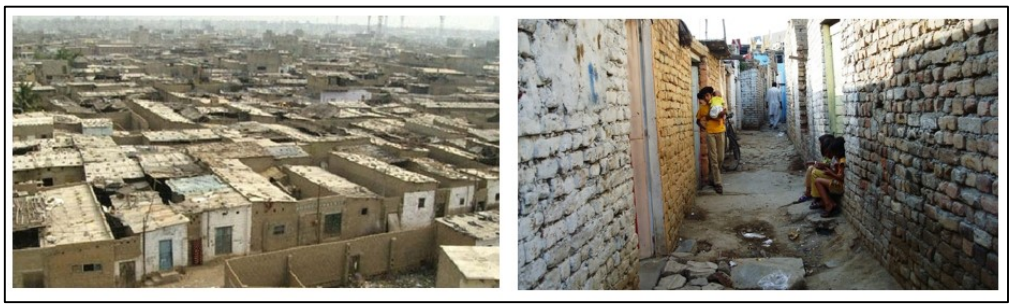

Figure 11 Glimpse of Kachi Abadis of Pakistan

Kachi Abadis are considered a natural solution to the shortage of houses in Pakistan. In the eighties near Islamabad 13K and 2004 50K habitants were living in Kachi Abadis (Maria, Iqbal, & Imran , 2006) (Rabbani & Merchant, 1999). It was found that there are 3K such Abadis with over 7M residents in Pakistan, and as of 2009 it was about 9.5M (Hassan, Arif , & Mohib , 2003). The occupancy of these settlements is sometimes 10-15 persons per two rooms.

In Karachi only in 2000, there were 0.7M such houses with over 5M inhabitants (Jabeen, Ume-Farwa, & Jadoon , 2017). The report of 2001 says that 6-8M more houses are required (Pakistan Housing Agency). In another report of 2011 (Arfanuzzaman & Dahiya, 2019), roughly 74% resides in Urban Slums with 36.5M (Unicef, 2016), inhabitants and as per UN-HABITAT, their number is around 30M (Siddique, Haroon, & Zahidi , 2009).

To deal with the housing issues a new concept of Khuda-Ke-Basti was introduced wherein the land was given on easy instalments and houses were built gradually as per the availability of funds (Tariq & Fariha , 2012).

The PHATA(Punjab Housing and Town Planning) department estimated 3K house requirements in different cities, because of expensive land, the Kachi Abadis started to emerge within cities (Pokhariyal & Ganesh , 2005). Punjab has a directorate general of Kachi Abadis and urban improvement, and in different cities under local development authorities, there are separate wings dedicated to deal with Kachi Abadis, and for governing Laws there is Punjab Kachi Abadis Act of 1992 in place.

SLUMS, are living areas with no access to basic utilities and infrastrucrures **Error! Reference source not found.**. Their residents are impoverished and are destined to live in these shabby lands, with no legal rights (UN-HABITAT) (Maria, Iqbal, & Imran , 2006). The rough estimates tell that 23-32M inhabitants are living in such slums of Pakistan (Hussain , Anwar, Ahmed, & Hussain , 2022).

The world bank report of 2014 **Error! Reference source not found.** claims 32.3M slum dwellers with no clean drinking water, sufficient food supply, sanitary and

infrastructures. When these huge number of residents of Kachi Abadis and Slums have access to basic needs(energy supply) in these houses the demand for energy would be manifold which requires timely mitigation.

Figure 12 Slum Regions of Pakistan

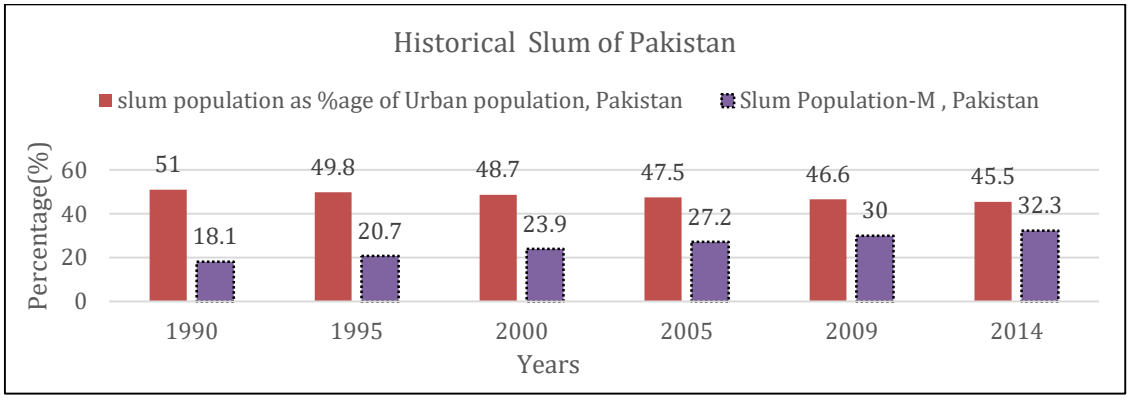

Figure 13 Historic Growth of the Slum of Pakistan, source: (Rashid, Jawaria, & Hussain) (Bill & Draft , 2011) (Delina & Laurence, 2011) (Farooq, Hassan , & Khan , 2020)

Perspective-2

Enhanced Life Quality

Scarcity of households and drop in occupancy ratios per household

There was a shortage of housing units in Pakistan in 2000 4M & year 2004 6M were recorded (Aziz, Ahmed, & Mayo, 2015), the missing units demand was taken up by Kachi Abadis(25%), densification of houses(15%) and through sub-division of land to accommodate more houses(60%) (Gattoo, Hussain , & Akhtar, 2015). According to the Central Bank Statistics of 2010, Pakistan is lacking 8.8M houses, and it needs 0.7M per year, but it could only be built 0.3M yearly (Pokhariyal & Ganesh , 2005). Resultantly, 24% of the citizens are living below the poverty line (Jabeen , Nasira , & Ume-Farwa , Urbanization in Pakistan: a governance perspective., 2017) (Pokhariyal & Ganesh , 2005).

The upper class($250K-above) consists of 12% of the inhabitants and owns 56% of houses, the middle income(($3K-250K) 20% population hold 43% and lower income group ($0.8K-$3K), 68% of population own only 1% of overall housing units of Pakistan, which is very alarming situation (Zaidi , 2014) (Rasch & Rebecca, 2017), whereas, Punjab's have 46% of middle-income group (Ahmed & Ayaz, 2015).

The PSLM 2005 indicates that the One-room units declined from 38.1% to 24.2% while Two-rooms increased from 55% to 68.7% as of 1998 (Jabeen , Azra, Sheng, & Aamir, 2015).

The occupancy per house has seemed to be 6.5 persons and in some extreme cases it is 14 people/unit (Rashid, Jawaria, & Hussain). The UN standards suggest occupancy of 1.5-2 persons per room while it is 3 in Pakistan (Bill & Draft , 2011) (Delina & Laurence, 2011).

As per the latest census reports of 2023, Pakistan's population is 241.5M with 38.2M households, the occupancy per housing unit comes out to be 6.3 which is higher than the world's bank recommended rate of 6 per household. If the above standards of 6 persons per household are followed Pakistan lacks 2.1M houses (it requires 40.3M).

There are 27.5% of housing units in Punjab have only one room and 37.8% with 2-rooms, which shows a high occupancy rate per room **Error! Reference source not found.** So, the number of rooms per household needs to be increased OR new houses need to be built. These stats are very concerning and eye-opening when international standards are to be met. This implies that there is a huge demand for housing units, which would require a large amount of energy to meet.

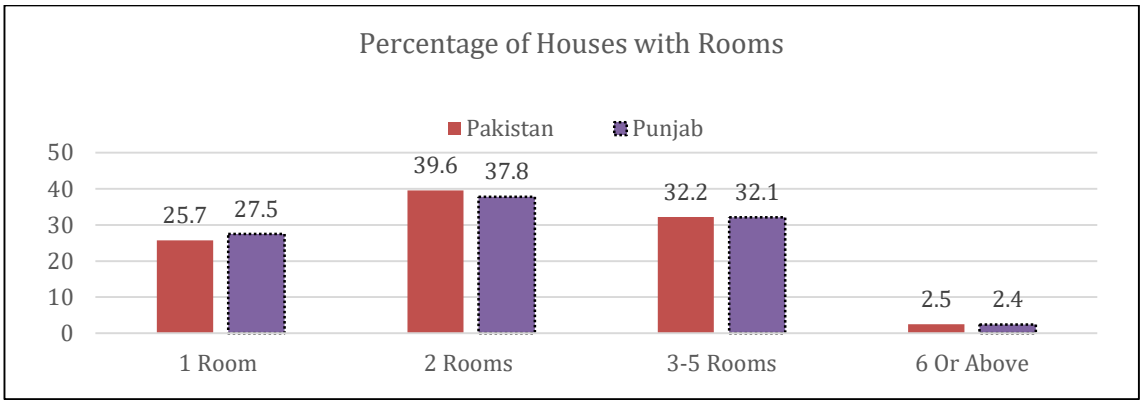

Figure 14 Percentages of Housing Units as per Number of Rooms (Delina & Laurence, 2011)

Discussion

In this unique research, we have tried to bring forth the domestic sector energy demand increase parameters which are generally ignored while authorities of developing countries mitigate the energy shortage issues. The different perspectives of hidden demand potentials are discussed, mainly focussed on the province of Punjab, Pakistan. Punjab's population has never been on the decline in growth rate, the natural increase in population would add energy demand as the increase in the number of users. There would be more requirements of households demanding new energy connections, especially those who can afford them, others would be forced to live in low-quality living conditions. The increase in the 11.5M more people in 2050 in Punjab's population would require a much larger energy demand (Figure 2 & Figure 3).

The increased urbanization trend shows that there will be 16.1M more urbanites in Punjab by 2050 **Error! Reference source not found.**. This change in lifestyle would require more energy as they would be using more electronics and modern tools, comforter living patterns, and modern fuels for cooking and heating the spaces than of bio-fuels being used in rural areas of Punjab.

As we saw in 0, at present, Pakistan is not completely linked to the energy grids. when 62.5M people (26% of 241M) & 10.1M households get access to national energy resources, the colossal energy demand would occur **Error! Reference source not found.**. In the current situation where the country is facing a severe energy supply crisis when 3/4th of the population is connected, the remaining connected people would intensify the critical situation if mitigation strategies are not well in place.

We have further identified that the construction material of houses was mixed, not all Pacca (modern) houses were built with cement, sand and bricks. This trend has changed as seen in the current census report **Error! Reference source not found.**, now people prefer to make these Pacca houses which consume more energy to make them comfortable and inhabitable in the form of increased timings of fan usage or even air-conditioning, as compared to Mud houses(Kaccha).

Approximately, 35.5M people are living in the sub-standard settlements (kachi-abadis & Slums) with limited or no access to energy/electricity supply in them. They mostly use fossil fuel, cow dunk cakes wood straws etc as the source of cooking energy. Though some of them have limited access to electricity illegally taking connections from their urban neighbourhoods. When their inhabitants are connected legally to the grid it would increase huge energy demand (0).

An interesting fact brought forward in this research is the shortage of housing units & occupancy ratio of households in Punjab and Pakistan. It is much higher(6.2/hh) as compared to international standards of 2-4/hh. The severe shortage of houses is very concerning and can't be ignored. They are houses whose occupancy is as high as 14 people per room.

The overall scenarios discussed in this research are relatable to other developing countries in the world especially in South Asia having similar circumstances.

Conclusions

Developing countries often deal with very difficult energy crises mainly because the estimation of energy demands is inaccurate. As a result, the mitigation strategies followed are insufficient. In this current research, we have provided deep insight into some key perspectives which have a direct impact on the housing energy demand. A thorough literature and statistical data-based reality check analysis is provided highlighting the severity of the matter. The six different perspectives discussed are not only affecting the demand increase, there are other which may cause an increase in demand. The research is explained by focusing on the case of Punjab in particular, but the findings can be implemented in similar neighbourhoods and other struggling countries.

Recommendations

Based on the analysis of information gathered and data collected, we would recommend the following inputs for the proper evaluation of the energy requirement of the housing to actualise the scenarios on the ground;

- Considering the average growth rate of 2%, the current per capita increase of energy supply should be added in the main grid. For the year 2023, with 241M population 4.81M new per capita capacity needs to be enhanced yearly.
- Based on the estimated urbanization trend of a 1.2% yearly increase, the increased demand of 25% more energy per person (shifting from a rural to an urban lifestyle) should be adjusted.

- Currently, 22% of the population is not connected, estimated 2-3% more people are connected to the main grid per annum; these new users should be added to overall demand calculations.
- Roughly 0.4M new Pacca houses are made overall, as Pacca houses consume more energy for their different needs nearly 10-15% additional energy demand should be considered per Pacca Household.
- The residents shifting from Kachi-Abadis & Slums to better life quality and living standards every year, approximately 1-2% of these inhabitants would have increased demand per year.
- The demand for 0.3M houses annually should be automatically added to the overall energy demand.
- As the GDP is growing every year, the living standard of residents is improving so the higher occupancy of 6.3 per household would reduced to 4-5 persons. A forecasted, atleast 5 occupancy ratio should be put in calculations after every five years plan. This would mean that the household would increase in number so the mitigation measures be placed.

References

Afzal , M. (2009). Population growth and economic development in Pakistan. *The Open Demography Journal, 2*(1), 1-7.

Agency, I. E. (2022, September 5). Retrieved from www.iea.org.: https://www.iea.org/

Ahmed , & Ayaz. (2015). *Housing demand in urban areas of Pakistan.* Islamabad: Department Of Economics Pakistan Institute Of Development Economics, Islamabad, Pakistan Research Repository.

Aneeque , M., Alghassab, M., & Ullah , K. (2020). A review of electricity demand forecasting in low and middle income countries: The demand determinants and horizons. *Sustainability*, 5931.

Anwar, Nawaz, H., Parveen, S., & Nousheen, F. (2008). Physical impact assessment of Katchi Abadi improvement programme in Punjab-Pakistan. *Pak. J. Life Soc. Sci,, 6*(2), 108-111.

Arfanuzzaman, M., & Dahiya, B. (2019). Sustainable urbanization in Southeast Asia and beyond: Challenges of population growth, land use change, and environmental health. *Growth and Change, 50*(2), 725-744.

Arif, M. (2016). How Planning Creates the Unplannable: The Case of the Katchi Abadis (Impermanent Settlements) of Lahore. *yorkspace.library.yorku.ca*.

Awan, U., & Knight , I. (2020). Domestic sector energy demand and prediction models for Punjab Pakistan. *Journal of Building Engineering*.

Aziz, Ahmed, & Mayo, S. (2015). Urbanization and its impacts on founded areas of big cities in Pakistan: Case studies of" Ichra" and" Sanda" areas in Lahore. *University of Engineering and Technology Taxila. Technical Journal, 20*(1).

Bhattacharyya, S., & Timilsina, G. (2010). Modelling energy demand of developing countries: Are the specific features adequately captured? *Energy policy*, 1979-1990.

Bill, & Draft . (2011). Ministry of Economic Development. *Bill Financial Market Conduct*.

Dahl, & McDonald, L. (1998). Forecasting energy demand in the developing world. *Energy Sources*, 875-889.

Delina , & Laurence. (2011). Clean energy financing at Asian development bank. *Energy for Sustainable Development, 15*(2), 195-199.

Farooq, Hassan , & Khan , M. (2020). The 21st Century World Order And Pakistan. *Journal of Contemporary Studies, 9*(11), 19-41.

Feeney, G., & Alam, I. (2003). New estimates and projections of population growth in Pakistan. *Population and development review, 29*(3), 483-492.

Gattoo, Hussain , M., & Akhtar, J. (2015). The Development of India's Financial Inclusion Agenda—Some Lessons for Pakistan. *The Pakistan Development Review*, 569-583.

Ghalehkhondabi, Imran, & Ardjmand, E. (2017). An overview of energy demand forecasting methods published in 2005–2015. *Energy Systems*, 411-447.

Hassan, Arif , & Mohib , M. (2003). *Karachi Pakistan.* Karachi: Urban Slum report Karachi.

Hussain , Anwar, Ahmed, A., & Hussain , W. (2022). Increasing housing demand in Pakistan. In Accessible housing for south Asia: needs, implementation and impacts. *Cham: Springer International Publishing*, 103-125.

Jabeen , Azra, Sheng, H., & Aamir, M. (2015). Housing crises in Pakistan: Review of population growth and deficiencies in housing laws and policies. *International Journal of Sciences: Basic and Applied Research, 24*(3), 323-347.

Jabeen , Nasira , & Ume-Farwa . (2017). Urbanization in Pakistan: a governance perspective. *Journal of the Research Society of Pakistan, 54*(1), 127-136.

Jabeen, N., Ume-Farwa, & Jadoon , M. (2017). Urbanization in Pakistan: a governance perspective. *Journal of the Research Society of Pakistan, 54*(1), 127-136.

Kiani, H., Golshaeian, S., & Hassan, M. (2024). Comparison of Long-term Energy Demand Forecasting in Developing and Developed Countries Using Machine Learning-based Algorithms. *2024 9th International Conference on Technology and Energy Management*.

Maria, Iqbal, S., & Imran , M. (2006). Planning of Islamabad and Rawalpindi: What went wrong. *In Proceedings of the 42nd ISoCaRP Congress, Istanbul, Turkey*, 14-18.

Papanek, G., & Naseem , M. (1996). Pakistan's Development and Asian Experience. *The Pakistan Development Review, 35*(4), 343-382.

Pokhariyal, & Ganesh . (2005). Models for understanding social problems in slums. *International Journal on World Peace*, 59-75.

Rabbani, F., & Merchant, A. (1999). Economic development and health status among the poor in squatter settlements of Karachi. *Journal of the Pakistan Medical Association, 45*(5).

Rana, I., & Bhatti, S. (2018). Lahore, Pakistan–Urbanization challenges and opportunities. *Cities, 72*, 345-355.

Rasch, & Rebecca. (2017). Measuring the middle class in middle-income countries. *In Forum for Social Economics, 46*(4), 321-336.

Rashid, Jawaria, & Hussain , I. (n.d.). Insight of the Quality of Housing of Pakistani Households: Using New Methodology and the Countrywide Unit Record Data. *Insight, 13*, 121-133.

Raza, M., Khatri , K., & Israr , A. (2022). Energy demand and production forecasting in Pakistan. *Energy Strategy Reviews*.

Rehman , A., Cai, Y., & Fasal , R. (2017). An integrated modeling approach for forecasting long-term energy demand in Pakistan. *Energies*.

Sadaam , A., Ibu Isha , M., & Ahmed , S. (2023). Energy demand forecasting and optimizing electric systems for developing countries. *IEEE Access*, 39751-39775.

Siddique, Haroon, M., & Zahidi , S. (2009). Community Oriented Low-Income Housing-'Khuda-Ki-Basti', Kala Shah Kaku, Lahore–A Step Forward. *Greater mekong subregion academic and research network, 117*.

Suganthi, & Sameul, A. (2012). Energy models for demand forecasting—A review. *Renewable and sustainable energy reviews*, 1223-1240.

Tariq, & Fariha . (2012). The potential of microfinanced housing after Pakistan disasters. *International Journal of Safety and Security Engineering, 2*(3), 265-279.

Unicef. (2016). *Strategy for water, sanitation and hygiene 2016-2030.*

Wolfram, Catherine, & Shelef, O. (2012). How will energy demand develop in the developing world? *Journal of Economic Perspectives*, 119-138.

Zaidi , S.-h. (2014). *Low Income Housing in a Rapidly Urbanizing Pakistan.* Islamabad.