The Impact of Rising Electricity Utility Costs Driven by Data Center Load Growth on Low- and Moderate-Income (LMI) Homeowners and Affordable Housing Markets

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Abstract. The high rate of data centers growth caused by cloud computing, artificial intelligence and digital services has caused a significant growth in electricity demand, putting strain on local power grids. The grid improvements and capacity additions needed to support utility companies in their operations are normally paid back by the electricity tariffs that are then transferred to the consumers at the homes. The proposed paper examines the indirect effects of electricity cost increase caused by data centers on Low- and Moderate-Income (LMI) householders and affordable housing. An analytical framework is suggested to have a quantitative measure on data center load growth, model utility cost escalation, measurement of residential tariff pass-through and estimates on household energy burden change. The findings have shown that an increase in electricity costs has a disproportionate impact on LMI households, which makes them vulnerable to high energy costs and financial hardships. Also, the increased electricity rates increase the operating expenses of affordable housing providers, which destabilize the rents and the financial sustainability in the long run. The results underscore the importance of considering energy equity and housing affordability in the process of building the data center, designing the utility rate, and investing in infrastructure.

Keywords: Data centers, electricity load growth, utility cost escalation, energy burden, low- and moderate-income households, affordable housing, electricity tariffs, energy equity.

1. Introduction

Cloud computing, artificial intelligence, and digital services have caused the rapid growth of data centers that have consequently resulted in a steep rise in electricity demand in most areas [1]. Though data centers contribute to the development of the economy and digital infrastructure, their concentrated and energy-intensive activities introduce high pressure on the local power grids [2]. Increased electricity tariffs are a common way of

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recovering the cost of grid upgrades, peak capacity build up and reliability investment by utilities which are ultimately transferred to residential consumers [3].

The Low- and Moderate-Income (LMI) homeowners are equally susceptible to the increasing electricity expenses because the energy bills already occupy a disproportionate portion of the household income [4]. Rising utility costs may further increase energy insecurity, decrease housing affordability, and increase the potential of financial distress [5]. Simultaneously, the cost of affordable housing is becoming increasingly difficult to operate in, with increased electricity rates putting an end to the feasibility of subsidized housing projects in the long term and exerting a price pressure on rents [6].

Although there is a rising concern regarding the energy footprint of the data centers, the current body of research pays much attention to grid reliability, carbon emissions, or data center efficiency [7]. Little consideration has been given to the social and housing affordability consequences of data center driven electricity cost rise [8]. This gap is the subject of this paper that methodically examines the role of data center load increase on the cost of electricity utility and evaluates its downstream effects on LMI homeowners and affordable housing markets.

Key Contributions

- Develops a unified analytical framework linking data center load growth to residential electricity tariffs and housing affordability.
- Quantifies energy burden escalation for Low- and Moderate-Income (LMI) households under multiple data center load-growth scenarios.
- Demonstrates how electricity cost pass-through undermines the financial sustainability of affordable housing operations.
- Provides actionable insights to support energy-equitable data center expansion and utility rate design.

The remainder of this paper is organized as follows. Part II examines the related literature concerning data centres energy demand, electricity cost and energy burden among LMI based households. Section III contains the suggested methodology and workflow analysis. Section IV is a discussion on the findings and how they would impact LMI homeowners and affordable housing markets. Lastly, the paper ends with Section V which will give future research directions.

2. Literature review

Abdi et al. [9] provided Prior research records the fast increase in data center electricity use especially in areas with hyperscale facilities. It has been noted in research that there is greater peak demand, and it is locally grid congested and requires significant upgrades in infrastructure. Nevertheless, all these studies are mainly concerned with technical and environmental consequences as opposed to consumer based impacts. The Eid et al. [10] proposed Electricity pricing literature explains how utilities cover capital and operational expenses using residential tariffs, such as volumetric rates, demand rates, and time-of-use rates. Research indicates that big industrial and commercial demand may end up affecting the cost of residential electricity indirectly, but the presence of data centers is seldom single-handedly determined. The share of household income spent on energy has been commonly referred to as Energy burden proposed by Scheier et al. [11] as a measure of energy equity. The available literature constantly indicates that LMI households experience increased energy burden because of poor housing stock, inaccessibility of energy-efficient technologies, and reduced income. Utility costs have been recognized by affordable housing literature as one of the key elements involved in the operation costs. An increase in the prices of electricity weakens the financial base, limits maintenance costs, and can cause increases in rents or a decrease in the supply of housing. Nevertheless, the direct correlations between the growth of the data centers and low-cost housing pressures have not been sufficiently studied.

3. Proposed Method

The suggested approach presents a multi-phase analytical process which will measure the indirect socio-economic effects of the increase in data center electricity demand Fig 1. The model integrates the analysis of the energy system with housing and income data to evaluate the outcomes of cost pass-through and affordability.

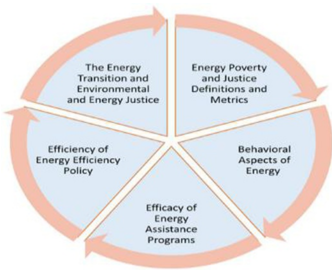

Fig 1: Proposed Method Workflow

3.1. Data Center Load Growth Assessment

The growth of the load in the data centers in the region is measured by estimating the additional demand of electricity due to the new and the expanded capacity of the data centers. The overall data center power consumption at time t is is depicted as Equation (1)

$$L_{DC}(t) = C_{DC}(t) \times U_{DC} \times 8760 \tag{1}$$

where $L_{DC}(t)$denotes the annual electricity demand of data centers (MWh), $C_{DC}(t)$is the installed data center capacity (MW), U_{DC}represents the average utilization factor, and 8760 is the number of hours in a year.

The incremental load added to the power grid due to data center expansion is calculated as Equation (2)

$$\Delta L_{DC} = L_{DC}(t) - L_{DC}(t-1) \tag{2}$$

This incremental load is applied to determine the added strain to the regional power grid and its role in adding to increased utility infrastructure and capacity costs which is then taken into account in residential electricity price modeling.

3.2. Utility Cost Escalation Modeling

The price increase of utility due to load increase due to data centers is estimated through a model calculating the extra grid infrastructure investment, peak capacity and operational cost. The overall utility revenue demand at t is the following Equation (3)

$$R(t) = R_0 + C_{cap}(t) + C_{op}(t) \tag{3}$$

where R_0represents the baseline revenue requirement, $C_{cap}(t)$denotes incremental capital costs for grid upgrades and new capacity, and $C_{op}(t)$accounts for increased operational and maintenance expenses associated with higher electricity demand.

The incremental utility cost attributable to load growth is calculated as Equation (4)

$$\Delta R = R(t) - R(t-1) \tag{4}$$

Peak demand effects are incorporated by linking capacity expansion costs to the increase in system peak load ΔP_{peak}, which directly influences generation and transmission investment needs. The resulting increase in revenue requirements forms the basis for residential tariff adjustments in the subsequent analysis.

3.3. Residential Tariff Pass-Through Analysis

The rise in utility revenue charges along with data center progressions loads are distributed among the residential customers in accordance with prevailing tariff schemes and cost distribution policies. The mean residential tariff of electricity at time t is given as Equation (5).

$$T_{res}(t) = \frac{R_{res}(t)}{E_{res}(t)} \tag{5}$$

where $T_{res}(t)$denotes the average residential electricity price (₹/kWh or $/kWh), $R_{res}(t)$is the portion of total utility revenue requirements allocated to the residential sector, and $E_{res}(t)$represents total residential electricity consumption.

The tariff increase attributable to load growth is calculated as Equation (6).

$$\Delta T_{res} = T_{res}(t) - T_{res}(t-1) \tag{6}$$

The pass-through mechanism captures the relationship between the infrastructure and capacity cost impacts of increasing system demand and residential electricity prices and is the foundation of analysing the household-level cost and affordability of energy in the following steps.

3.4. LMI Household Energy Burden Estimation

The Low- and Moderate-Income (LMI) households are estimated on the energy burden by computing the ratio of household income used on electricity. It is a measure of the affordability implication of increasing electricity charges on households at risk and is very common in energy equity research. Energy burden Equation (7).

$$\text{Energy Burden} = \frac{C_{elec}}{I_{hh}} \tag{7}$$

where C_{elec}represents the annual household electricity expenditure and I_{hh}denotes the annual household income.

Residential electricity tariffs are multiplied with the levels of household consumption to get annual electricity expenditure. When energy burden values are high, this implies a higher level of financial strain especially to LMI households who have low ability to absorb any increases in utility costs. This is then measured to determine the risks of affordability and make comparisons between the effects on different income groups.

3.5. Affordable Housing Market Impact Analysis

The effect of increasing electricity prices on affordable housing is analysed by including the increased utility bills in the housing operating budgets. Total operating cost per annum on a low cost housing unit is Equation (8).

$$C_{op} = C_{base} + C_{elec} \tag{8}$$

where C_{op}denotes total operating cost, C_{base}represents non-energy operating expenses (maintenance, management, taxes), and $C_{elec}$is the annual electricity cost.

The change in operating cost due to electricity price increases is calculated as Equation (9).

$$\Delta C_{op} = C_{elec}(t) - C_{elec}(t-1) \tag{9}$$

The higher operating expenses lower financial margins of affordable housing providers which may cause rent pressures, deferred maintenance or become more subsidy-dependent. This discussion points out that the increase in the cost of electricity has the indirect impact on the affordability of housing and long-term financial sustainability.

3.6 Case Study and Scenario-Based Analysis

Hypothetical Regional Case Description

To demonstrate the applicability of the proposed framework, a hypothetical metropolitan region with significant data center presence is considered. The region currently hosts 500 MW of installed data center capacity, reflecting conditions typical of major urban technology hubs. Driven by continued expansion in cloud computing and artificial intelligence services, a 20% growth in data center capacity is projected over the planning horizon.

The regional electricity system serves a mixed load profile comprising residential, commercial, industrial, and data center consumers. Residential customers, including LMI households, are assumed to be subject to uniform tariff adjustments based on utility cost recovery mechanisms.

Comparative Data Center Load Growth Scenarios

Three load growth scenarios are analyzed to assess the sensitivity of electricity tariffs and affordability outcomes:

- Low Growth Scenario: +10% data center load increase
- Medium Growth Scenario: +25% data center load increase
- High Growth Scenario: +40% data center load increase

These scenarios represent conservative, moderate, and aggressive data center expansion pathways observed in emerging digital infrastructure regions.

Scenario-Based Impact Assessment

Under each scenario, incremental electricity demand is estimated and incorporated into the utility cost escalation and residential tariff pass-through models. The resulting tariff increases are then used to calculate changes in energy burden for LMI households and operating cost impacts for affordable housing providers.

The analysis indicates that even under the low-growth scenario, residential electricity tariffs increase measurably, while medium and high-growth scenarios lead to non-linear escalation in energy burden for LMI households. Affordable housing operating costs rise correspondingly, increasing financial stress and reducing long-term sustainability. Table 1 is the Impact of Data Center Load Growth on LMI Households.

Table 1: Impact of Data Center Load Growth on LMI Households

Scenario	Avg Tariff Increase (%)	LMI Energy Burden (%)
Low DC Growth	3.2	6.1
Medium DC Growth	6.8	8.4
High DC Growth	11.5	11.9

4. Result and discussion

This part contains the results of the suggested analytical framework and discusses the impact of the growth of electricity costs in this direction caused by data centers on LMI households and affordable housing markets. The findings indicate disparities in the energy burden among the income groups and measure the financial pressure to the affordable housing operations. Expansive consequences of energy equity and housing affordability are also addressed. All results presented in this section are based on scenario-based modeling using the hypothetical regional case described in Section 3.6.

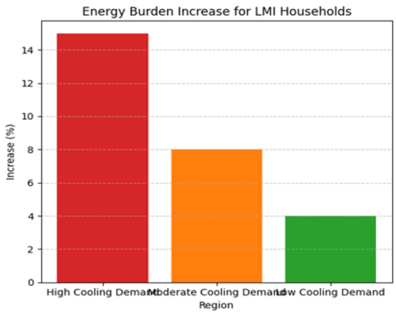

Fig 2: simulated impact of electricity tariff increases on LMI household energy burden under data center load growth scenarios

The Fig 2 shows that when electricity prices are increased by data center load growth, the burden of energy increase on LMI households is also increased at a disproportionate rate. Any increase in tariffs will cause a huge burden of affordability especially in the high cooling demand areas. LMI house owners have limited ability to counter the increase in costs because of limited access to energy efficiency improvement or distributed renewable energy production.

A sensitivity analysis was conducted by varying residential electricity tariff increases between 2% and 12% across the defined data center growth scenarios. The results indicate a non-linear escalation in energy burden for LMI households, with the burden exceeding the commonly cited 6% affordability threshold under medium and high data center growth conditions. This finding highlights the heightened vulnerability of LMI households to relatively small increases in electricity prices.

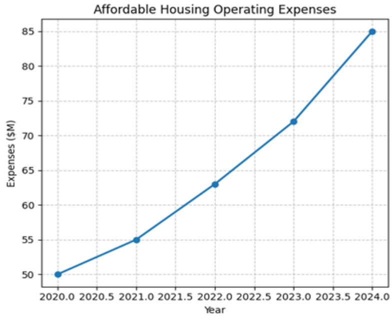

Fig 3: Modeled operating cost escalation in affordable housing under rising electricity prices

As revealed in Fig 3, an increase in the price of electricity would greatly impact on the operating costs of affordable housing providers. This decreases financial margins, heightens the dependence on subsidies, and can also result in postponed maintenance or rent hikes. In the long run, the increasing cost of utility is a latent affordability constraint, which jeopardises housing sustainability.

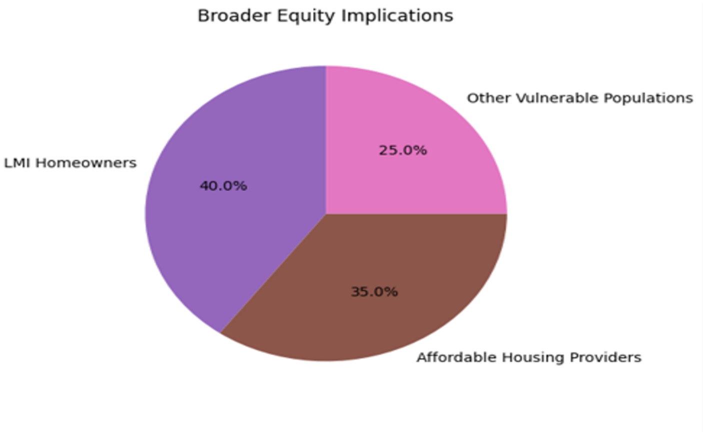

Fig 4: Scenario-based distributional impacts of data center–driven electricity cost escalation on vulnerable populations

Fig 4 also draw attention to a major equity challenge: infrastructure expenses related to the expansion of data centers are indirectly imposed on the vulnerable populations who benefit little directly on the infrastructure Table 2. Unless the problem of increasing electricity costs is addressed through specific policy intervention, housing insecurity and energy poverty can be exacerbated.

Table 2: Scenario-Based Impact of Data Center Load Growth on LMI Households

Data Center Growth Scenario	DC Load Increase (%)	Residential Tariff Increase (%)	Average LMI Energy Burden (%)
Low Growth	+10	3.2	6.1
Medium Growth	+25	6.8	8.4
High Growth	+40	11.5	11.9

5. Conclusion

The paper also provides an analytical framework to assess the effects of electricity utility costs increase due to data center on LMI homeowners and affordable housing markets. The findings indicate that the increasing load in data centers is one of the factors in residential electricity price increases, which more likely pile up more energy costs among LMI households and weaken the viability of the affordable housing standards. According to the study, there is a need to consider the concept of energy justice and housing affordability in the process of planning data centers, utility rates, and infrastructure investments. In the future, the framework will be expanded to region-specific case studies and dynamic pricing models along with policy evaluation scenarios with a view of protecting vulnerable populations and facilitating the expansion of digital infrastructure.

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