Thesis Brief

An Alternative to Pakistan's Electricity Demand Forecasting Model

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Key Massages

- The IGCEP electricity demand forecast model is overfitted due to aggregated data (annually) and inappropriate electricity demand drivers, resulting in an anomalous electricity demand projection.
- The IGCEP assumes that electricity sales are equivalent to electricity demand. However, this study established that energy generation capacity planning based on electricity demand and electricity sales are significantly different phenomena.
- To develop the electricity demand forecasting model for Pakistan, metrological variables are more appropriate than economic variables.
- Power sector inefficiencies are a bigger issue than its electricity generation capacity. Without improving DISCO's efficiency, installing more energy generation capacity leads to accumulating capacity charges without utility.
- Implementing IGCEP's proposed electricity generation capacity planning could result in an additional capacity of 16000 to 21000 MW by 2031.

Electricity demand forecasting is a critical aspect of power generation capacity planning, serving as the foundation for generation, transmission, and distribution plans. It plays a crucial role in investment planning for the power sector and associated industries such as manufacturing, fuel, and resource exploration [1]. Accurate energy demand forecasts can significantly impact power generation costs, optimal resource allocation, and the overall sustainability of the power system. For instance, policymakers can use energy demand forecasts to make informed decisions regarding investment in infrastructure and energy security measures. By understanding future energy demand, policymakers can better allocate resources and plan for a more sustainable energy future [2].

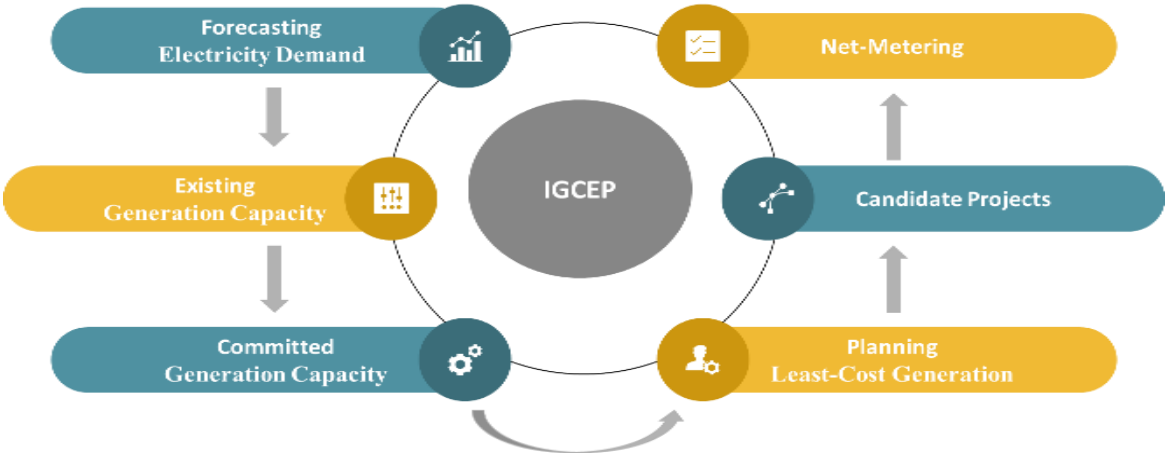
Pakistan's Energy Generation Capacity Planning

The power sector in Pakistan faces numerous challenges, especially in electricity generation capacity planning, which are exacerbated by the country's contrasted seasonal patterns, such as increasing demand during summer and a decrease in winter. Pursuing summer demand for planning power generation capacity leads to capacity payment without utility during the winter. In this scenario, the planning of power generation capacity becomes a challenging task. All

[1] This document is extracted from the M.Phil. thesis entitled **"An Alternative to Pakistan's Electricity Demand Forecasting Model"**. For detailed thesis, see PIDE website: https://pide.org.pk/thesis/.

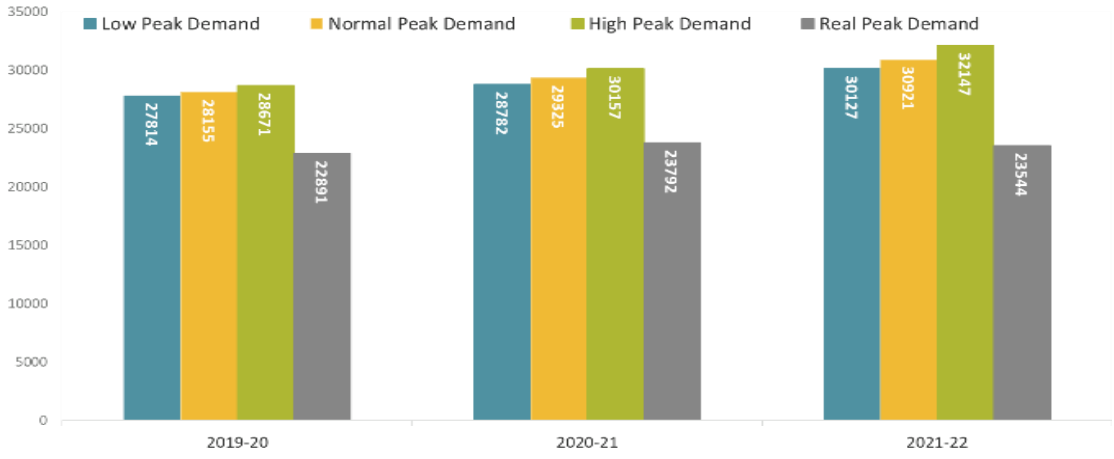
planning foundations build on electricity demand forecasts and demand overestimation, resulting in capacity charges without utility. This study provides a detailed examination of the Indicative Generation Capacity Expansion Plan (IGCEP) demand forecast model. The IGCEP is a pivotal snapshot of power planning meticulously developed by the National Transmission & Dispatch Company (NTDC) and approved by the National Electric Power Regulatory Authority (NEPRA). Figure 1 represents the IGCEP framework which shows all IGCEP targets built on electricity demand forecasts.

Figure 1: Indicative Generation Capacity Expansion Plan



The IGCEP, integral to future electricity generation planning, relies on electricity demand projections. However, since 2018, the IGCEP forecasting model has exhibited overfitting issues, employing an annual data approach that overlooks seasonal variations. Figure 2 shows the three projected peak demand scenarios of different IGCEPs with actual peak demand. For the IGCEP demands forecast model, data is aggregated from hourly electricity sales on an annual basis. This study examines the data aggregation and inappropriate demand drivers that lead to an overfitting forecasting model.

Figure 2: IGCEP Projected Peak Demand & Actual (MW)



Unveiling the Disparity: Electricity Sales vs. Actual Demand

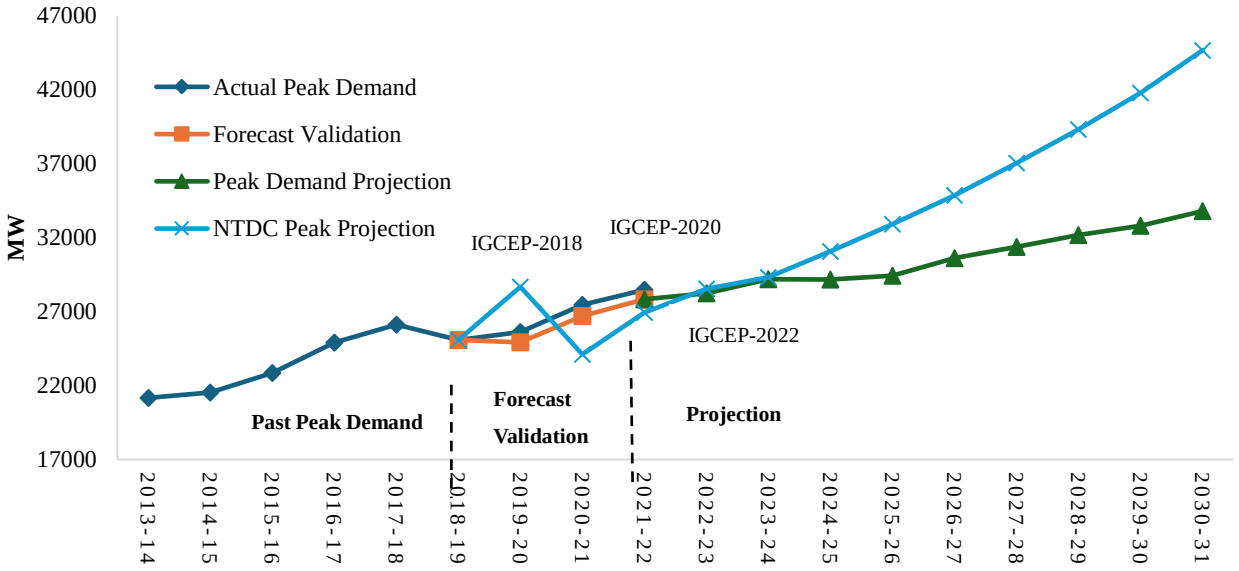
The NTDC and other stakeholders in the Ministry of Energy assume that electricity sales are equivalent to demand. Our study establishes that energy generation capacity planning based on demand and sales are significantly different phenomena. Electricity demand encompasses the sum of total electricity generation along with demand management strategies such as load shedding and other related factors, while electricity sale is determined as the difference between total generation and total losses.

This study aims to analyze electricity demand drivers in Pakistan and propose a more accurate forecasting model by focusing on meteorological variables. Because meteorological conditions play a crucial role in influencing electricity consumption [3]. Our study scrutinized electricity demand drivers in the context of Pakistan, challenging the conventional variables used by IGCEP for energy demand forecast models. This study emphasizes the superiority of meteorological variables over economic factors for constructing an accurate electricity demand forecasting model for Pakistan.

Evaluating IGCEP's Peak Demand Projections

Figure 5 demonstrates that the IGCEP peak demand projections, which are based on the highest sales, exceed the actual peak demand. Which highlighted the inappropriate methodology adopted by NTDC. The peak demand projection significantly varies from one IGCEP to another, with a bust after the first boom indicating the next version projection of the IGCEP.

Figure 3: Peak Demand Projections



Let's imagine NTDC projected actual peak demand (sale + demand management) data with the same methodology. By how much would those projections overestimate the actual peak demand? In the forecast validation section of Figure 3, there is also projected peak demand followed by metrological factors that resemble actual peak demand patterns.

Unveiling the Pitfalls of Demand Overestimations in IGCEP-22

IGCEP-22 may have overestimated the peak demand for electricity, which could lead to an excessive installation of energy generation capacity. This excess capacity could lead to capacity payments despite not using the generation capacity. Our study found that implementing IGCEP's proposed generation capacity planning could result in an additional capacity of 16000 to 21000 MW by 2031. The study warns against increasing the electricity generation capacity because the efficient utilization of proposed net-metering projects (480 MW for every year) of IGCEP-22 will be sufficient to cover future energy demand and the share of retired projects, which will be retired by 2031.

IGCEP's approach focuses on planning power generation capacity based on peak demand rather than addressing the winter-summer energy demand gap. In 2022, the peak demand days reached around 30,000 MW, but our calculations indicated that just 29 days of peak demand exceeded 26,000 MW. Additionally, during these 29 days, the demand exceeded this threshold (26000 MW) by an average of 9 hours per day. Enhancing generation capacity for 261 hours and rest-of-year bear capacity payments is not a policy-oriented approach because it may not address the fundamental structural issues causing peak demand.

This study suggested that adjusting the price mechanism to make domestic consumers prefer electricity to gas during the winter will significantly decrease the electricity demand gap between the winter and summer seasons. During the summer, the domestic sector commonly uses home appliances that run on electricity, while in the winter, gas-related home appliances are used because gas is a cheaper energy source in Pakistan compared to electricity. Therefore, adjusting the price mechanism to favor electricity consumption during winter is crucial for narrowing the electricity demand gap between the winter and summer seasons.

The Way Forward

- NTDC should use the suggested methodology, which incorporates meteorological factors and actual demand data, for greater precision in forecasts, the proposed methodology applies at the DISCO level instead of applying it to the entire NTDC system.

- Before installing additional power generation capacity, it is imperative to prioritize significant reforms aimed at improving the performance of DISCOs. The inefficiencies within DISCOs currently pose a major obstacle to meeting the actual electricity demand.

- To efficiently utilize net-metering resources, this approach is sufficient to meet the increasing share of electricity demand in the future and retire energy projects by 2030-31.

- To establish more balanced energy consumption patterns, it is essential to transition from a uniform tariff system to a variable pricing mechanism.

- The pricing mechanism for electricity and gas should be adjusted in this way during the winter, as domestic consumers tend to prefer electricity over gas. Therefore, aligning the pricing in a way that favors electricity during the winter season can help stimulate electricity demand during this period. This adjustment not only supports a more efficient energy consumption pattern but will also contribute to a more resilient and responsive energy infrastructure.

Reference:

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