Commentary

The Surge in Riyadh’s Population: Electricity Demand Implications

September 2023

Jeyhun I Mikayilov and Ryan Al Yamani
The city of Riyadh, the capital and most populous city of the Kingdom of Saudi Arabia, is undergoing a makeover to become a global metropolis. Saudi Vision 2030 announced a wide range of projects in the city, placing it on an accelerated sustainable development path toward becoming a world-leading city economy. These projects include King Salman Park, the world’s largest urban park (i.e., seven times the size of London’s Hyde Park); Riyadh Metro, the world’s largest single-phase public transport project; and King Salman International Airport, an aerotropolis and one of the world’s largest airports. Another example is the Green Riyadh Project, which plans to boost the daily amount of recycled water in the city to 1.7 million m$^3$ and use this water to increase the city’s current green coverage per capita by 16-fold by planting 7.5 million trees (Vision 2030, 2016). In addition, the city is strategically located to benefit from forthcoming giga projects by the Saudi Public Investment Fund, including the Qiddiya project, the world’s largest entertainment city; the Derayah project, a world-class destination for culture and heritage; and the Roshn Project, an enormous residential development (Vision 2030, 2016). These substantial investments and associated economic activities have drawn residents from both other parts of the Kingdom and abroad, contributing to the city’s population reaching 7.4 million in 2022. However, the government projects that the city’s population will continue growing to 15-20 million by 2030 (Arabian Business, 2021).

This extensive upgrowth of the city will require close cooperation between government agencies and policymakers to meet the city’s objectives and address any surfacing challenges. One such challenge might be installed capacity planning for the energy required to power the emerging, vibrant city economy. Thus, this analysis focuses on the potential evolution of electricity demand driven by the expected increase in population. In doing so, except population growth, this analysis assumes that all other electricity demand drivers follow the same historical trends.

Background: Riyadh’s Population and Electricity Demand

During the establishment of modern Saudi Arabia in 1932, the population of Riyadh was estimated to be only 27 thousand (Al-Gabbani, 1991), and its economic activity was modest and dependent primarily on agriculture and livestock. Appointed as the Kingdom’s capital, the city has experienced transformational growth in population and economic activity ever since. After the country’s establishment, the population of Riyadh increased fourfold over the following 20 years, estimated to have exceeded 110 thousand residents in 1950, as shown in Figure 1 (World Population Review, 2023). The population data in Figure 1 show that this growth continued in Phase I, supported by King Saud’s decision to relocate existing (at the time) and upcoming government agencies to Riyadh (Al-Hathloul, 2017). During Phase II (1965–1992), population growth continued at a much higher pace, attaining a cumulative annual growth rate (CAGR) of 14.7%. The growth during this period was remarkable and had only a few parallels worldwide (Al-Faleh, 2005; Al-Hathloul, 2017), where the drivers of this significant expansion included the oil boom, high birth rates among nationals and the in-migration of nationals and expats.
In the early 1990s, the population continued to grow but at a relatively moderate rate. Currently, the city is estimated to be the most populous in the country, with an approximate population of 7.4 million, accounting for more than one-fifth of the Kingdom's overall population (World Population Review, 2023).

**Figure 1.** Historical population of Riyadh divided into growth phases.

![Historical population of Riyadh divided into growth phases](image)

Source: World Population Review, 2023

In terms of electricity consumption in the city, the official public data from the Saudi Water and Electricity Regulatory Authority (WERA) divide electricity demand in Saudi Arabia into four regions: central, western, eastern, and southern regions. The central region consists of Riyadh, Qassim, and Hail Provinces, where Riyadh Province accounts for 80% of the population in this region (SAMA, 2023). Within Riyadh Province, the city of Riyadh accounts for 82% of the province's population (SAMA, 2023; World Population Review, 2023). To provide a discussion that aligns with the WERA's regional classification, this analysis is conducted on the central region. In doing so, except for the city of Riyadh, business-as-usual (BAU) population growth (i.e., average historical growth) is assumed in the central region.

The central region consumes approximately 30% of the electricity in the entire Kingdom. Based on the data for the last three years, the main contributor to this electricity demand is the residential sector (52%), followed by the commercial (19%) and government (15%) sectors. The data for the last decade show a 3% average annual growth in electricity consumed in the region. Since 1990, the region has experienced continuous growth in electricity demand, except during two periods: the second waves of energy price reforms in 2018 (-6%) and 2019 (-1.6%) (SAMA, 2023).
Assessment Approach

Consequently, this study utilizes Mikayilov and Darandary’s (2023) regional electricity demand model for Saudi Arabia. This model uses a partial equilibrium framework, expressing electricity demand as a function of income, population, and region-specific weighted electricity price. In this analysis, the model is simulated under three scenarios to evaluate the impact of incremental electricity demand due to Riyadh’s population increase. The first scenario represents electricity demand with BAU population growth, while the other two scenarios use backcasting from the 2030 population expectations of 15 and 20 million, respectively. In all scenarios, the populations of all other parts of the central region are assumed to have followed the same historical average growth rate for the last 10 years. The abovementioned three scenarios are described below.

- In the **BAU scenario**, population growth is assumed to follow that of the World Population Review (2023), attaining a 1.6% population increase in the city of Riyadh for the 2023–2030 period. In the context of the central region, this increase will lead to an annual population growth of 1.7%.

- In the **15-million scenario**, starting in 2023, the city of Riyadh’s annual population growth rate is assumed to be 9.0%, reaching 15 million in 2030. Consequently, this rate corresponds to an annual population growth of 7.8% in the central region.

- In the **20-million scenario**, to reach 20 million in 2030, the city of Riyadh’s annual population growth rate is assumed to be 13.0% starting in 2023, which translates to an annual population growth of 11.3% in the central region.

The population projections for Riyadh in Figure 2 are attained by utilizing the growth rates for the three described scenarios.

Given the current population of Riyadh, the announced 2030 population growth expectations (15–20 million) indicate that the city would have to at least double its population in the upcoming decade. However, as shown in Figure 1, the level of population growth needed for Riyadh to reach 15–20 million by 2030 far exceeds its historical growth levels. While similar growth rates were attained in fast-growing cities worldwide between 2000 and 2020, they are much smaller in size and thus indicate smaller increments of new residents annually. In the 15-million scenario, however, Riyadh would welcome (by birth or migration) an average of approximately 900 thousand new residents each year over the coming decade. While this situation would be unparalleled even in light of the fastest-growing cities in the world, the magnitude and speed of Riyadh’s transformation are nothing short of exceptional. Thus, we focus here on analyzing the electricity demand implications in a case where the remarkable evolution of this city leads to the projected population.
Simulation Results and Discussion

Utilizing Mikayilov and Darandary's (2023) model and decomposition analysis (see Ang (2005, 2015), among others), the marginal contribution of each additional person to electricity consumption is calculated across years. It is found that based on historical data for the last ten years, as shown in Figure 3, one additional person in the central region’s population leads, on average, to a marginal increase of 3.8 MWh in the amount of regional electricity consumption. As indicated in Figure 3, decomposition analyses conclude that the marginal contribution of each person has gradually declined after the first wave of energy price reforms in 2016. This decline might be the result of the reforms targeting energy efficiency improvements as well as the saturation of consumption behavior.

As discussed earlier, Mikayilov and Darandary (2023) express electricity demand as a function of income and electricity prices in addition to the population. To have a greater understanding of the potential increase in electricity demand, for all scenarios, changes in these factors are considered. In doing so, the central region’s GDP (i.e., as a proxy for income) is assumed to have a constant 3% annual growth rate.

Figure 2. Scenarios of Riyadh’s population, in million persons.

Source: Authors’ calculations based on announced targets

It is found that based on historical data for the last ten years, as shown in Figure 3, one additional person in the central region’s population leads, on average, to a marginal increase of 3.8 MWh in the amount of regional electricity consumption.
The Surge in Riyadh's Population: Electricity Demand Implications

The sector-specific electricity prices are held constant at 2022 prices. The inflation impact is also considered, having an average annual 2% CPI inflation over the forecast period. Importantly, one would expect the GDP growth levels in the 15- and 20-million scenarios to be higher than that in the BAU scenario; however, the former is kept the same as the latter in this analysis to understand the impact of population growth on the isolation of other factors. The consequent demand levels for the three scenarios are presented in Figure 4.

In 2022, electricity demand in the central region was 99 TWh (SAMA, 2023). According to Figure 4, demand at a level double that of current demand would occur over the coming decade if Riyadh reaches even its 15-million population projection. Moreover, the results from Figure 4 show that for the 20-million scenario case, demand in 2030 almost triples the current consumption level. Undoubtedly, such a substantial population increase means additional electricity demand, which consequently raises the question of generation/supply capacity. This question is of great importance, especially for the central region, as at its current consumption levels, it has to rely on transmission interconnection with other regions in the Kingdom. Additionally, in light of the Kingdom’s announced

---

**Figure 3. Marginal electricity demand, in MWh, for an additional person in the central region’s population**

<table>
<thead>
<tr>
<th>Year</th>
<th>Marginal Demand (MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>3.5</td>
</tr>
<tr>
<td>2011</td>
<td>3.5</td>
</tr>
<tr>
<td>2023</td>
<td>3.6</td>
</tr>
<tr>
<td>2013</td>
<td>3.7</td>
</tr>
<tr>
<td>2014</td>
<td>3.8</td>
</tr>
<tr>
<td>2015</td>
<td>4.1</td>
</tr>
<tr>
<td>2016</td>
<td>4.2</td>
</tr>
<tr>
<td>2017</td>
<td>4.1</td>
</tr>
<tr>
<td>2018</td>
<td>3.9</td>
</tr>
<tr>
<td>2019</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations based on Mikayilov and Darandary’s (2023) model
The Surge in Riyadh's Population: Electricity Demand Implications

environmental target, special consideration of the expected growth in the central region's electricity demand could support the success of ongoing efforts to replace liquid fuels with renewables and natural gas in the energy generation mix.

The assessment of generation potential can be elaborated considering the demand projections in this study and other ongoing reforms to replace liquid fuels with renewables and natural gas in the energy mix for power generation. In addition, as decomposition analyses show, the contribution of each driver to demand might change over time as a result of policies focused on efficiency improvements, social awareness of the consequences of excessive consumption, and environmental concerns.

Figure 4. Simulation results for the central region

Source: Authors’ calculations, based on simulations
Trying to disentangle only the impact of population from 2023 to 2030, the projection results conclude that the 15-million plan would double the current electricity consumption level in the city.

Conclusions

Using a partial equilibrium framework, this study estimates the electricity demand projections brought about by the strategy through which Riyadh’s population will reach 15 and/or 20 million in 2030. It is essential to note that this approach neglects the potential growth of Riyadh’s population due to migration within the central region. Trying to disentangle only the impact of population from 2023 to 2030, the projection results conclude that the 15-million plan would double the current electricity consumption level in the city. Moreover, it is also concluded that the demand for electricity in the 20-million population target case needs to be tripled. Numerically, compared to the case where the current policies remain as they are and 2030 demand is 130 TWh, demand values reach 207 TWh and 267 TWh in the 15-and 20-million population cases, respectively. Taking into account this substantial increase in electricity demand, the power supply potential of Riyadh could be reassessed by considering other fuel replacement and environmental targets.

Moreover, we discover that based on historical information for the last decade, one additional person in the central region’s population leads, on average, to a marginal increase of 3.8 MWh in the level of regional electricity consumption. Furthermore, it is also found that the contribution of one additional person to electricity consumption demonstrates gradually declining behavior after 2016. This decline seems to be the result of the ongoing energy price reforms targeting efficiency improvements and reduction in the amount of unnecessary energy used. The findings of the study could be utilized for demand and supply-side policy planning purposes.
References


About KAPSARC

KAPSARC is an advisory think tank within global energy economics and sustainability providing advisory services to entities and authorities in the Saudi energy sector to advance Saudi Arabia’s energy sector and inform global policies through evidence-based advice and applied research.

Legal Notice

© Copyright 2023 King Abdullah Petroleum Studies and Research Center (“KAPSARC”). This Document (and any information, data or materials contained therein) (the “Document”) shall not be used without the proper attribution to KAPSARC. The Document shall not be reproduced, in whole or in part, without the written permission of KAPSARC. KAPSARC makes no warranty, representation or undertaking whether expressed or implied, nor does it assume any legal liability, whether direct or indirect, or responsibility for the accuracy, completeness, or usefulness of any information that is contained in the Document. Nothing in the Document constitutes or shall be implied to constitute advice, recommendation or option. The views and opinions expressed in this publication are those of the authors and do not necessarily reflect the official views or position of KAPSARC.