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Review Article

THE ECONOMIC EFFECT OF EXPO 2020 ON THE DEMAND FOR ELECTRICITY IN DUBAI ECONOMICS, ESTIMATION, & FORECAST (2001 – 2022)

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Abstract

The main objective of this study is to analyze the impact of EXPO 2020 0n the demand for electricity in Dubai. This is done by first, constructing and estimating a simple econometric model for electricity using data for the period from 2001 to 2018. The empirical results show that the demand for electricity is price- and income-inelastic, with price and income elasticities of 0.96 and 0.80, respectively. On the other hand, the demand for electricity with respect to the number of users is demand elastic, with elasticity of 1.03. All estimated variables were found statistically significant at the 5% level of significance. The paper concludes that electricity consumption in Dubai grew very rapidly in the past and farther continues growth in the coming years where total electricity demand is projected to increase to 44816 GWh in 2019 and 44696 GWh in 2020, the time of Expo 2020, before it slows down a bit to reach 40606 GWh in 2022. The findings of the research also conclude that the electricity intensity reflects a faster economic growth rate relative to electricity growth rate. These findings imply that important policy implications are required especially when preparing for EXPO 2020, which requires significant investments, in this sector, over the coming years.

keywords: Energy Economics, Econometrics, Estimation & forecast

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INTRODUCTION

Selecting Dubai to host the world expo convention in 2020 event is likely to generate significant economic benefits for Dubai and the UAE as a whole. Approximately 182 countries and companies are expected to participate in the event. The event attracts millions of visitors during its six-month duration, is likely to attract substantial foreign investment into the UAE. Some estimates predict that, by the year 2020, the UAE could attract as much as US$100 billion to US$150 billion in foreign direct investment across a range of industry sectors, including financial services, infrastructure, construction, real estate, hospitality, tourism, and transportation.

By the beginning of the year 2020, Dubai's electricity consumption is expected to increase a 50 percent jump from 2012 levels. In order to cater to around 25 million visitors who are expected at the Expo 2020, Dubai needs to produce more electricity. "This new power generated has to feed the massive developments that are being rolled out to make the city Expo ready. This anticipated consumption levels create a major challenge for Dubai in hosting Expo 2020.

Studies on electricity demand in United Arab Emirates are relatively rare. There is no study that has been conducted to analyze the impact of EXPO on electricity demand in Dubai. Furthermore, little is done on estimating and forecasting the demand for electricity in UAE. This study attempts to fulfill this gap and helps to understand electricity market in Dubai. Specifically, the study aims at empirically estimating electricity demand and forecasting its future trend.

OVERVIEW

Over the past 18 years, Dubai has recorded significant GDP and economic growth, primarily driven by the non-oil sectors. GDP increased from 64289 million UAD in 2001 to 398127 million UAD in 2018 growing at an average rate of 11.3% a year. Dubai Statistics Centre said that the emirate's economy grew 1.94 per cent in 2018 driven by an upswing in trade and infrastructure investments. The GDP is expected to reach Dh410 billion in 2019 following 3 per cent growth and Dh425 billion next year post 3.7 per cent growth. "The growth is underpinned by construction and real estate, business services, hotels and restaurants and transport and logistics sectors," said Khatija Haque, head of Mena Research at Emirates NBD.

In 2018, the dominant sector of Dubai's economy is being wholesale and retail trade and repair services, which in 2018 represented 26.4%, emphasizing Dubai's dominant position as a trade center. Other major drivers of economic growth include transportation and storage 12.3%, financial and insurance activities 10.2%, manufacturing 9.2%, real estate 7.2%, and construction 6.4%.

Because of this high growth, Dubai became one of the largest electricity users in the region. Electricity consumption, which is driven by economic activities and population growth, has increased from 12240 GWh in 2001 to 44570 GWh in 2018 growing at an average rate of 8.4 % a year, figure (1). Electricity production, on the other hand, increased from 12973 GWh in 2001 to 45162 GWh in 2017 growing at an average rate of 8.1% a year.

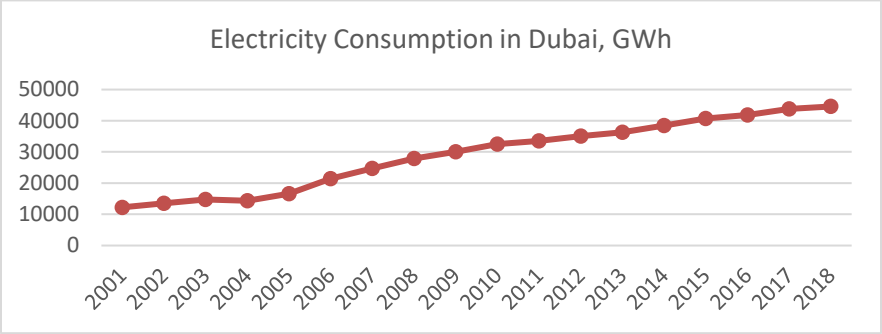

Fig. 1. Total Electricity Consumption in Dubai, GWh

Electricity intensity, which measure the electricity required to generate a unit of output, decreased from 0.19 in 2001 to 0.11 in 2018 decreasing at an average rate of (-3.15%) a year. This ratio showed a moderate decrease in the examined period reflecting faster economic growth rates relative to electricity growth rates, figure (2).

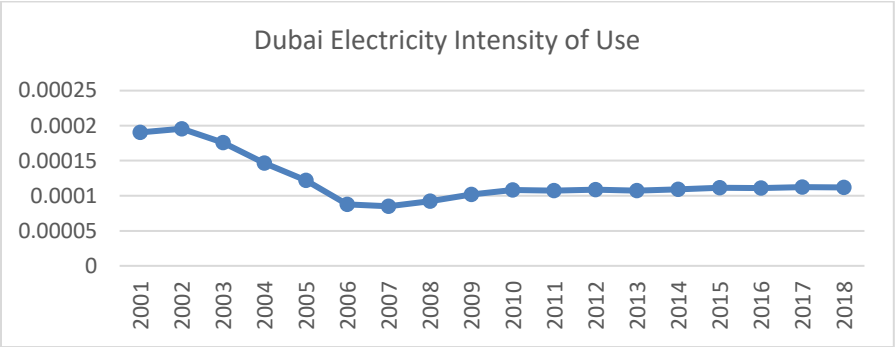

Fig. 2. Electricity Intensity of Use

PREVIOUS STUDIES

Previous studies on modeling the demand for electricity are discussed in this section. Variables affecting the demand for electricity may vary from one region to another. A model developed for one region may not be appropriate for another region.

Ferguson et al. (2000) found that for developed countries, there is a strong correlation between increases in wealth over time and increases in energy consumption. Moreover, there is a stronger correlation between electricity use and wealth creation than there is between total energy use and wealth. Further, increasing electricity use has been identified as an important source of productivity improvement in developed countries and it is the sector that is currently fueling the "new digital economy", Rosenberg (1998). Harris JL, and Lon-Mu L. (1993), studied the dynamic relationships between electricity consumption and several potentially relevant variables, such as weather, price, and income. They used a 30 years data series from southeast USA and they found that high seasonality exist on electricity demand. Yu Hsing (1994) estimated residential demand for electricity for five Southern states during 1981–1990 with the cross-sectional correlated and time-wise autoregressive model (CSCTWA) that simultaneously takes into consideration heteroscedasticity, autocorrelation, and spatial correlation that are likely to be detected when a pooled sample is used. He concluded that, the model yields more efficient estimates when compared with the ordinary least square (OLS) model. Rajan M, and Jain VK. (1999), analyzed the consumption pattern of electricity in Delhi for the period 1984–1993 as a function of population and weather sensitive parameters. They developed multiple linear regression models of energy consumption for different seasons. Egelioglu F, Mohamad A, Guven B. (2001), studied the influence of economic variables on the annual electricity consumption in Northern Cyprus and they concluded that a model using the electricity prices, the number of tourists and the number of customers has a strong predictive ability in estimating the demand for electricity. Abdul Razak F. Al-Faris (2002), used cointegration techniques to study the effects of economic variables on electricity demand in the GCC countries. A dynamic model is estimated using aggregate data for the six states for the period 1970–97. Statistical investigations confirm the existence of unit root, which called for the use of cointegration and error-correction methodologies. Massimo F., Shonali P. (2004), studied the demand for electricity in India using monthly data for the winter, monsoon and summer season. Three electricity demand functions have been econometrically estimated in order to understand the extent to which factors like income, prices, household size and other household specific characteristics, influence variations observed in individual households' electricity demand. The results showed that electricity demand is income and price inelastic in all three seasons, and that household, demographic and geographical variables are significant in determining electricity demand. Mohamed Z, Bodger P. (2005), studied a model for electricity forecasting in New Zealand. He concluded that a model based on the multiple linear regression analysis, with economic and demographic variables, would fit best for that purpose. A.Azadeh, M.Saberi, S.F.Ghaderi, A.Gitiforouza, & V.Ebrahimipour, 2008, have investigated the demand for electricity on seasonal bases along with changes in consumption of electricity for countries like IRAN and China. MAPE of genetic algorithm along with artificial network shows the suitability of given algorithm. (Adom, 2011), has tested the causality and Toda test to find a relationship between consumption of electricity and economic growth. He concluded that there is long run relationship between electricity consumption and real per capita GDP.

In studying the electricity demand in Ontario province of Canada, GholamrezaZahedi, Saeed Azizi, Alireza Bahadori, and Sharifah R.Wan Alwi (2013) used a model called an adaptive neuro fuzzy inference system. Inputs for the model include number of employment, gross domestic product, population, dwelling count and two meteorological parameters related to annual weather temperature. The data were collected and screened using statistical methods. Then, based on the data, a neuro-fuzzy model for the electricity demand is built. It was found that electricity demand is most sensitive to employment. Salahuddin, Alam, Ozturk, & Sohag, 2018, have analyzed the nexus between electricity consumption, economic growth and FDI based on the results the authors concluded that with growing energy demand its very essential for Kuwait to have a policy of conserving the energy. As the generation of energy is mostly depended on fossil fuels, which is at higher risk of generating CO2 its essential for the country to search for renewable sources of energy producing. Lin & Ouyang, 2014, also forecasted the demand for energy in china. With fast and enormous growth its essential for China that the price do not hike which will ultimately lead to reduction in carbon. Hamedmoghadam, Joorabloo, & Jalili, 2018, have studied the monthly demand of electricity in Australia with tool of artificial neural network. They found that neural network is effective in predicting the electricity demand.

HYPOTHESIS & RESEARCH METHODOLOGY

To test the hypothesis that EXPO 2020 will have a significant effect on the demand for electricity in Dubai, an econometric model will be developed to estimate and forecast the total demand for electricity in Dubai for the period 2001 - 2023. The model is built according to the stock adjustment theory of demand, which allows for distinguishing short and long run effects of changes in income, price, and other explanatory variables on the demand for electricity. The stock of adjustment theory assumes that at price P_t and income Y_t the consumer has a desired level of consumption Q^*_t , but the actual change in consumption $Q_t - Q_{t-1}$ is proportional to the difference between the desired consumption Q^*_t and Q_{t-1}:

$$Q^*_t = B_0 + B_1 Y_t + B_2 P_t + U_t \quad (1)$$
$$Q_t - Q_{t-1} = s\,(Q^*_t - Q_{t-1}) \quad (2)$$

Where: $0 < s < 1$ the speed of adjustment

By substituting (1) in (2), we have:

$$Q_t - Q_{t-1} = s\,(B_0 + B_1 Y_t + B_2 P_t + U_t - Q_{t-1}) \quad (3)$$

By arranging equation (3), we get:

$$Q_t = s\,B_0 + s\,B_1 Y_t + s\,B_2 P_t + (1\text{-}s)\,Q_{t-1} + s\,U_t \quad (4)$$

$$Q_t = a_0 + a_1 Y_t + a_2 P_t + a_3 Q_{t-1} + e_t \quad (5)$$

Where:

$$a_0 = sB_0 \quad (6)$$
$$a_1 = s\,B_1 \quad (7)$$
$$a_2 = sB_2 \quad (8)$$
$$a_3 = (1\text{-}s) \quad (9)$$
$$e_t = sU_t \quad (10)$$

The model also can be formulated in logarithms as:

$$ln\,Q_t = a_0 + a_1 ln\,Y_t + a_2\,ln\,P_t + a_3\,ln\,Q_{t-1} + e_t \quad (11)$$

Where a_1 and a_2 denote elasticities in the short run.
When this model is not appropriate or is statistically insignificant, the following regression model will be used instead:

$$Q_t = a_0 + a_1 Y_t + a_2 P_t + a_3 U_t + e_t \quad (12)$$

Where:-

a_1, a_2 and a_3 are; income, price, and users parameters, respectivelly

Q_t = Annual Electricity Consumption,
Y_t = Annual Income (GDP)
P_t = Price of Electricity
U_t = Number of Electricity Users
e_t = Error Term.

In this model, the variables that could affect electricity consumption, as discussed by many researchers, are own price, a measure of economic activity, and the number of electricity users will be used. Due to data limitation, time series data for the years 2001 to 2018 were utilized. Gross National Product data were obtained from the Center for National Statistic, and Dubai Statistics Center. Data for electricity production, consumption, number of users, and the consumer price index (CPI) were obtained from the Authority for Electricity and Water in Dubai.

MODEL ESTIMATION & FINDINGS

Ordinary Least Square equation was used to estimate the total demand for electricity in Dubai. All coefficients are well determined at the 5% level of significance with signs expected by economic theory. R^2 was found quite high (0.87) which made me to look for the existence of multicollinearity, equation (13).

Electricity Consumption in Dubai

$$\mathbf{Q_t = -\,160.51 + 10.69\,\mathit{log}\,GDP_t - 9.13\,\mathit{log}\,P_t + 4.01\,\mathit{log}\,U_t + 13.76\,\mathit{log}\,Q_{t-1}} \quad (13)$$

(-3.8) (4.2) (-3.1) (2.3) (6.2)

Adj. R^2 = 0.87, D.W = 1.5, Years = 2001 - 2018

After re-estimating the model and correcting for multicollinearity, one of the independent variables, the number of electricity users, was omitted from the equation, which resulted in a lower R^2 and made the model look more acceptable than before. Although, the D.W. statistic is within the range of acceptance, close from two, but this value indicates that a problem still exist due to either lack of existing data or an indication of autocorrelation, equation (14).

Electricity Consumption in Dubai

$$\mathbf{Q_t = -\,67.837 + 5.23\,\mathit{log}\,GDP_t - 2.61\,\mathit{log}\,P_t + 12.12\,\mathit{log}\,Q_{t-1}} \quad (14)$$

(-5.1) (4.5) (-2.9) (5.1)

Adj. R^2 = 0.83, D.W = 1.8, Years = 2001 - 2018

This result suggests that, beside gross domestic product and price, there are some other factors that might affect the demand for electricity in Dubai. The preferred solution to this problem is first, to increase the number of data periods and second, to include the missing variables in the model by introducing auxillry variables.

ELECTRICITY PROJECTION & METHODOLOGY

To forecast the electricity consumption in the coming years, it is necessary to have future values of our predictors' variables in the estimated equations, income, price, and the number of electricity users. Consequently, electricity consumption will be estimated for a possible scenario for these variables.

The projection methodology adopted is very simple in that, projections are basically driven by scenarios for income growth rate, price growth rate, and the number of user's growth rate.

Given scenarios for those variables, the future demand for electricity will be forecasted using the previously estimated equation.

The first scenario examined in this study assumes that income, price, and the number of electricity users will continue to grow to the year 2022 at 2013-2018 average annual growth rates. This growth rate was selected to represent the average growth in the last five years since the Bureau International des Expositions (BIE) general assembly in Paris awarded Dubai as the host of Expo 2020 on November 27, 2013, table (1).

Table (1) Projection of the Independent Variables Based on 2013 – 2018 Average Growth Rate(2019 – 2022)

Year	Dubai GDP Million AED 2.53%	Price Index 0.02%	Total Electricity Users in Dubai 4.5%	GDP For Dubai Million UAE Dirham High Growth Rate, 3% & 3.7%*	Population 7.57%
2019	408200	108.64	882941	410000	3433930
2020	418527	108.66	922673	425000	3693878
2021	429116	108.68	964193	440725	3973505
2022	439973	108.70	1007582	457032	4274299

*The same growth rate (3.7%) for the year 2020 also used for the years, 2021 and 2022.

The second scenario, on the other hand, is of a higher growth rate of income because of hosting Expo 2020.
Dubai Statistics Centre (DSC) had said that the emirate's economy grew 1.94 per cent in 2018 to Dh398.13 billion, driven by an upswing in trade and infrastructure investments. The GDP is expected to reach Dh410 billion in 2019 following 3 per cent growth and Dh425 billion next year post 3.7 per cent growth. The growth is underpinned by construction and real estate, business services, hotels and restaurants and transport and logistics sectors," said Khatija Haque, head of Mena Research at Emirates NBD. Given scenarios for those variables, the projected demands for electricity are shown in table (2).

Table (2) Projected Electricity Demand for Dubai (GWh) (2019 – 2022)

Year	Total Electricity Demand Using Equation (14) Using the 2013 – 2018 Average Growth Rate	Total Electricity Demand Using Equation (14) Using the High Growth Rate 3 % & 3.7 %
2019	44641	44816
2020	44327	44696
2021	42549	43709
2022	39067	40606

FINDINGS LIMITATION & CONCLUSION

Before discussing estimates, it is important to note that, the price that has been used so far in estimating the demands for electricity is the consumer price index for electricity and fuels.

Ordinary Least Square equation was used to estimate the total demand for electricity in Dubai using the two previous equations. All coefficients are well determined at the 5% level of significance with signs expected by economic theory. R^2 was reasonably good (0.87) in the first estimated equation, but the value of the D.W. statistics is low (1.5) which made me to look for the existence of multicollinearity. After re-estimating the model and correcting for multicollinearity, one of the independent variables, the number of electricity users, was omitted from the equation, which resulted in a lower R^2 (0.83) but improvement in the D. W. statistics (1.8) and made the model look more acceptable than before. Although the value of D. W. statistics is close to two, but it still indicates the existence of autocorrelation. The preferred solution to this problem is first, to increase the number of data periods and second, to include the missing variables in the model by introducing auxillry variables.

Demand elasticities for electricity with respect to income and price are demand inelastic with elasticities of (0.80), (- 0.96) respectively. Whereas, the elasticity for electricity with respect to the number of electricity users is demand elastic with elasticity of (1.03). Those elasticities were evaluated at the means of income, price, and number of users. Actual and fitted values are shown in figure (3).

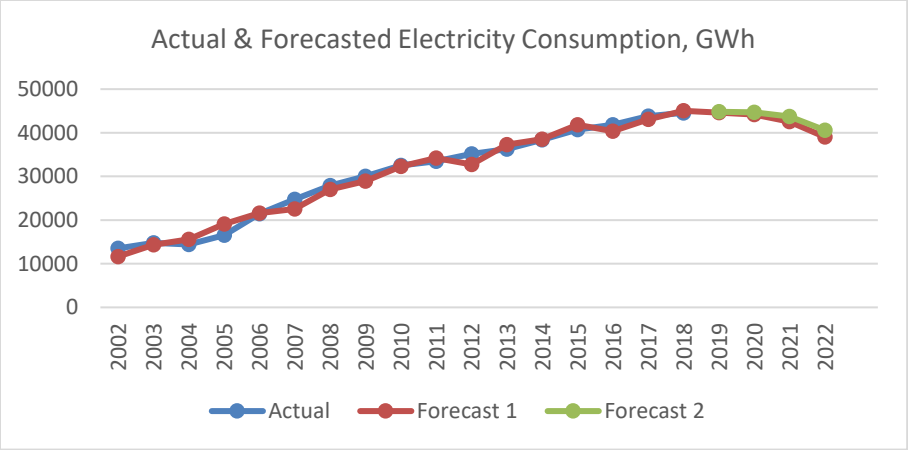

Fig. 3. Actual & Forecasted Electricity Consumption in Dubai (GWh)

The study concludes that, demand for electricity in Dubai will continue to grow in the coming years, which requires significant investments by the government to secure demand in the sector. This is in line with the electricity intensity, which decreased over the study period, indicating a faster economic growth rate relative to demand growth rate, which is consistent with the goals of economic growth and sustainability of development in the future. The total electricity demand is projected to increase during our projected periods. The total demand will increase to 44816 GWh in 2019 and to 44696 GWh in 2020, the time of EXPO 2020, before it slows down a bit to reach 43709 GWh in 2021 and 40606 GWh in 2022 respectively.

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