

Energy Use Intensity of Substations Under UAE Climate Conditions

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Abstract: Electricity consumption is increasing daily due to population growth, industrial development, and a greater reliance on technology. This has led to a rise in the average amount of electricity consumed per person (per capita electricity consumption). As a result, several global initiatives have been established to reduce power consumption and decrease GHG emissions. In this research, the adopted power consumption metric is energy use intensity (EUI), which is used to assess building energy efficiency. The intensity of energy consumption will vary based on the building type and occupation. Different building properties will result in different EUI values. For instance, hospitals will have a higher EUI than schools due to the continuous occupation of hospitals 24/7. A lower EUI indicates better energy performance, but context matters based on building type and purpose. This study analysed 170 substation buildings with low annual occupancy, where the HVAC system operates continuously to maintain equipment temperature and humidity. Various initiatives aimed at reducing power consumption and EUI in many substations.

Keywords: Energy Use Intensity (EUI), DEWA, energy management, power consumption

1. Introduction

The Statista report in Figure 1 ^[1] shows that Dubai's electricity consumption rose from 33,145 to 56,516 gigawatt hours in the last decade, leading to an expanded electricity grid. DEWA built numerous 132/11 kV substations to meet the rising

demand. Over 10 years, the number of substations significantly increased. The Transmission Power (TP) substation target will be set based on the existing average EUI of substation buildings. Substations require 24/7 climate control, unlike conventional buildings, making their EUI critical for operational cost and sustainability.

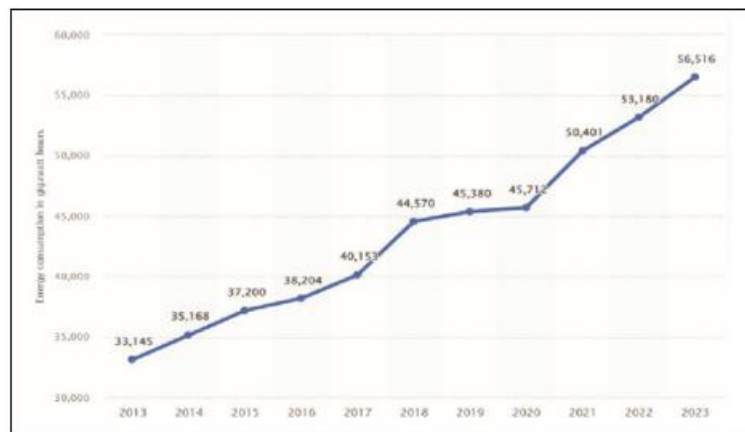


Figure 1: Consumption of electricity in Dubai from 2013 to 2023, in gigawatt hours

DEWA's Transmission Power has installed smart meters to monitor substation power consumption, specifically for auxiliary systems such as HVAC, lighting, fire protection and cranes. A study was conducted to set a benchmark for power consumption in current and future substations using the EUI metric to establish performance benchmarks. Based on the EUI results, an energy audit was performed, and an energy management strategy was implemented. The study established clear EUI targets for existing and future TP substations.

2. Literature Survey

Improving energy efficiency is a necessity nowadays due to the increase in demand for electricity. Energy Use Intensity (EUI) is the best indication to evaluate energy performance, which is basically calculated by dividing the total energy consumed by a specific building by its floor area. Optimising HVAC systems, integrating energy sources and upgrading lightning were the focus in previous studies to reduce EUI. Limited research was done on substations that require continuous energy usage due to systems such as HVAC.

3. Problem Definition

The growing electricity demand has led DEWA to commission a big number of substations in a short period of time. These substations have HVAC systems that work 24/7 at a certain temperature to ensure that the equipment in the substation is working in optimal condition. Identifying strategies to reduce power consumption in Transmission Power substations without affecting efficiency is the goal of this study.

4. Methodology

The study adopted quantitative methodology to determine and compare the yearly power consumption and gross area of each substation building. The EUI for each substation was then be calculated. Substations with high power consumption were visited, and tailored strategies were implemented to reduce their energy use.

Energy usage was measured at the building site, reflecting heat and electricity consumption recorded by smart meters. This provided insights into the energy consumption patterns of individual buildings. Customised practices enhanced the EUI of substations with above-average individual EUIs.

The strategy for reducing EUI varied depending on the specific substation building requirements. In the below mentioned points, the initiatives taken to reduce EUI are discussed. There are some common best practices to follow:

- Conducting an energy efficiency audit to identify opportunities for improvement and prioritising projects based on cost and energy savings' potential
- Replacing fluorescent lighting systems with more efficient LED lights
- Improving HVAC system performance through regular maintenance, upgrades and decreasing the fresh air opening from 10% to 5%
- Improving HVAC system performance by reconducting the air balancing for substation rooms x Rectifying the continued working of compressors due to malfunctioning return sensors x Closing openings and rectifying broken doors and windows to avoid the escape of cold air x Implementing renewable energy systems like solar panels to offset energy use for HVAC systems x Educating occupants on how to save energy and encouraging participation by switching off lights before exiting substations.

5. Results & Discussion

The analysis covers 170 DEWA-operated substations. In the below table shows the reduction in EUI and power consumption between 2022 and 2023.

Table 1: Results of Power Consumption Between 2022 and 2023

Criteria	Value
Reduction in EUI	1.04%
Reduction in power consumption	1.12%

The results show a significant reduction in both EUI and power consumption that reflects the importance of energy management strategies implemented at the substations.

6. Conclusion

In conclusion, through concerted efforts, we successfully reduced power consumption by 1.12% between 2022 and 2023. The efforts also led us to achieve a 1.038% EUI reduction between 2022 and 2023. This reduction reflects Transmission Power's commitment to energy efficiency and environmental sustainability and sets a positive precedent for future initiatives aimed at further decreasing power consumption.

References

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