

A COMPREHENSIVE APPROACH FOR DESIGNING A SUSTAINABLE ENERGY MANAGEMENT SYSTEM

R. JEYA BALAN^{1,2}, M. BAJURI^{1,2} and M.A.SHAFIE^{1,2}
1 Facilities Management Department, IJN, Malaysia
2 Institut Jantung Negara (IJN), Malaysia

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INTRODUCTION

As the premier government link organization in providing integrated cardiovascular and thoracic care, Institut Jantung Negara (IJN) also known as National Heart Institute of Malaysia is committed to a comprehensive green initiative to reduce CO2 emissions, with the primary goal of becoming a Green Healthcare facility (Frumkin et al., 2007).

AIM

To complement the national aspiration to reduce 40% CO2 emission by 2030 (Malaysia International Trade Investment, 2018).

The primary objective of IJN’s energy management program is to achieve 10% energy saving by 2025 compared to the baseline year of 2018.

METHOD

To determine actual energy performance, IJN uses **TWO** methods specified by the International Performance Measurement and Verification Protocol (IPMVP) to measure overall energy performance.

- **Option B** : Calculation of the static factor measurement and verification for the entire facility, and
- **Option C** : Regression analysis was used to assess the impact of various clinical and environmental variables on energy consumption.

RESULTS

Savings calculation using static factor analysis (OPTION B).

The trend for energy saving performance has been increasing since 2018.

- The highest percentage of energy savings attained was 15.92% in March 2021. As the Covid-19 pandemic ended by late 2021 and situations were back to normal by 2022, the percentage of savings dropped.
- The savings achieved by end of 2023 was 11.81%.
- Over the same period since January 2019, the static factor also increased, rising from 67,908 kWh to 137,144.67 kWh.

Savings calculation using regression analysis (OPTION C).

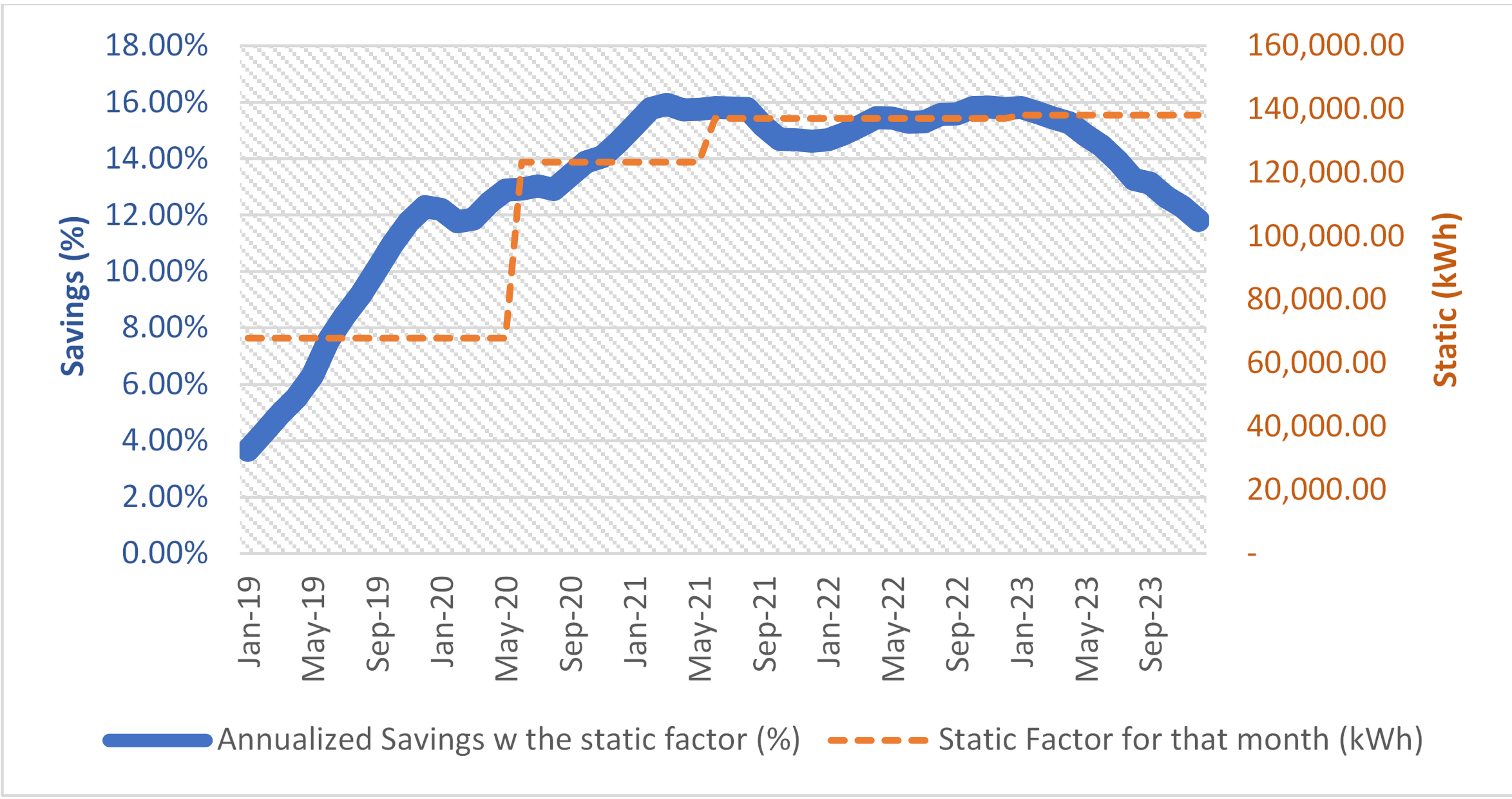
According to the regression output report,

- the R2 is 0.789, which exceeds the IPMVP requirement of 0.75.
- The report also stated that the ANOVA for significance F is 0.241, which is less than 0.5 and considered significant.
- The report then indicates that the P-values for each of the coefficients are all less than 0.5, indicating that the variables are likewise significant in the study. As a result, the regression-generated coefficient formula is as follows :

$$Y = 377.87X1 + 55.83X2 - 3466.40X3 - 517.88X4 + 135.59X5 - 13586.21X6 + 1372.40X7 + 1801616.98$$

- The modified baseline is then determined by applying the regression method to the data for the year 2022. The final energy savings achieved for 2022 was 16.79%.

Trend: Annualize savings(%) and static factor (kWh)



Exogenous Variables	
X1	Inpatient
X2	Outpatient
X3	Operating Theatre
X4	Catheterization Lab
X5	NCL
X6	Bed Occupancy Rate
X7	Cooling Degree Days

CONCLUSIONS

As of December 2023 (Baseline 2018),

- **Energy Consumption Saving**
Annualized savings = **5.68%**
Cumulative Savings = 1.27 MWh
CO2 Emissions reductions = 743 tCO2e
Total replanting of trees = 8,177 mature trees
- **Energy Saving Through Option B**
Annualized Savings = **11.81%**
- **Energy Saving Through Option C**
Annualized Savings = **16.79%**

ACKNOWLEDGEMENT

The energy management system has the full support of the company's top management and all employees to be a sustainable culture in daily operations.

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CONTACT INFORMATION

RAJANEN JEYA BALAN
Email : Rajanen@ijn.com.my
Institut Jantung Negara,Malaysia