Energy saving and emission reduction 35 kWh

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The electrical tariffs for commercial buildings in the selected countries were sourced from Department of Electrical Services, Brunei Darussalam (%20Elektrik.aspx, accessed on June 13, 2022), Tenaga Nasional Berhad, Malaysia (https://, accessed on June 13, 2022), Energy Market Authority of Singapore (https://, accessed on June 13, 2022) and Thailand Board of Investment (https://, accessed on June 13, 2022). The averaged electrical tariffs for commercial buildings in the respective countries were used to estimate the electricity costs of lighting, which are B$0.10/kWh for Brunei Darussalam, RM0.23/kWh (~ B$0.07/kWh) for Malaysia, S$0.26/kWh (~ B$0.26/kWh) for Singapore and Baht 3.32/kWh (~ B$0.13/kWh) for Thailand.

The energy consumption, CO2 emissions and electricity costs of lighting for each building type in the selected countries were calculated using the following equations:

where (H) is the building operating hours for the corresponding year (h), (N) is the number of lamps, (P) is the power rating of lamp (kW) (fluorescent lamp: 0.036 kW; incandescent lamp: 0.017 kW; LED T8 tube: 0.008 kW and LED bulb: 0.004 kW), subscript (i) represents the types of lamps (fluorescent lamp, incandescent lamp, LED T8 tube or LED bulb) and (A) is the floor area of the building (m2) (~ 1642 m2).

The collected energy and lighting data for commercial buildings (such as hospital, hotel, library, mosque, office, retail and university) in Brunei Darussalam, Malaysia, Singapore and Thailand were used to calculate the BEI and percentage of energy consumption of lighting for each building type in the respective countries. Results showed that commercial buildings from these Southeast Asia countries have BEI ranging from 54.09 kWh/m2/year to 556 kWh/m2/year with a mean value of 281.85 kWh/m2/year (Table 1). The box plot in Fig. 1a shows that retail building consumes the most energy (mean = 427.60 kWh/m2/year) among the assessed buildings, indicating high energy-consuming activities (such as lighting, heating, cooling, ventilation and electrical appliances) in the building.

Box plots of (a) building energy intensity (BEI), (b) energy consumption, (c) CO2 emissions and (d) electricity cost of lighting for different types of commercial buildings in Southeast Asia.

Correlation plots between building energy intensity (BEI) and (a) energy consumption, (b) CO2 emissions and (c) electricity costs for lighting by linear regression model for commercial buildings in Southeast Asia with 95% confidence interval.

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Scatter plots of calculated and estimated (a) energy consumption, (b) CO2 emissions and (c) electricity costs for lighting by linear regression model for commercial buildings in Southeast Asia with 95% confidence interval (represented by the green lines).

Decarbonisation pathway for lighting by linear regression model for commercial buildings in Southeast Asia with 95% confidence interval.

Life cycle assessment (LCA) could also be used to assess the potential environmental impacts of lighting systems (using metrics such as the global warming potential or the CO2 emissions), its materials and energy resources over its whole life cycle. Normally, the LCA study includes environmental information such as CO2 emissions, acidification, eutrophication, energy, waste, water and recycled content26. Although LCA methodology gives comprehensive information, it is more complex and difficult to compare between different studies on lighting systems (due to limitations in methodology and data availability, leading to different assumptions being made27) than the approach presented in this work.

Projection of electrical costs of lighting for (a) different types of commercial buildings in Southeast Asia with a 5% increase in annual electricity price and (b) commercial buildings in the same region with 5%, 10% and 15% increase in annual electricity price.

(a) Estimated energy consumption, (b) decarbonisation pathway and (c) projected electricity costs (with a 5% increase in annual electricity price) of different lighting systems for a library building in Brunei Darussalam in comparison to commercial buildings in Southeast Asia.