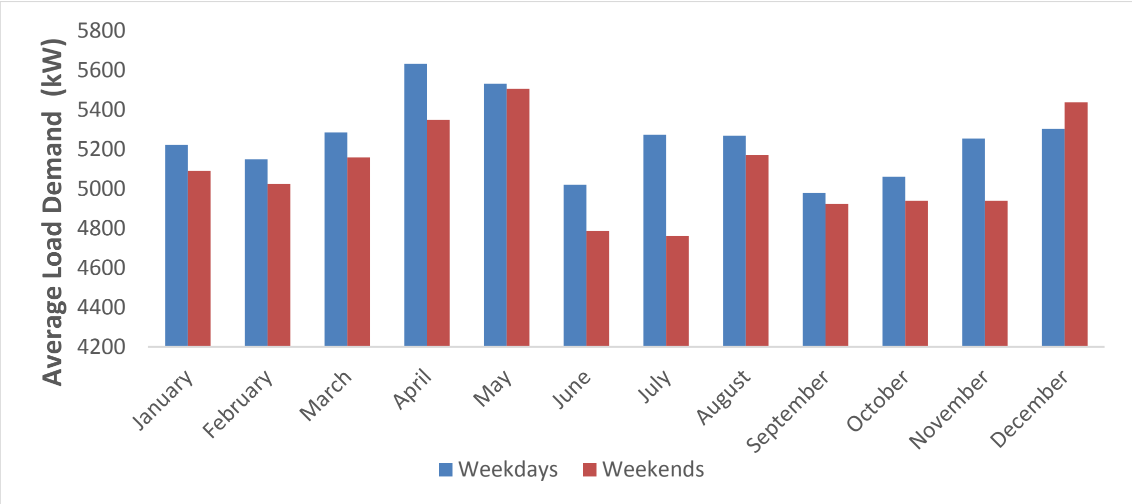
Chapter 2
Forecast of Electricity Demand in Temburong Eco Town

2.1. Actual Electricity Demand Curve in Temburong Area

Actual electricity demand in Temburong area in 2016 is shown in Figure 2.1, Figure 2.2, and Figure 2.3; the data were obtained from the Department of Electrical Services. Electricity demand seemed be highest in April and May and appeared to have dipped in June. The increase in electricity demand could be largely due to the hot period in April and May. The decrease in electricity demand could be due to the Hari Raya Aidil Fitri celebration that fell on 6 July to 8 July 2016. The decrease in electricity demand that occurred in September to November could be due to the rainy season. Figure 2.3 illustrates the typical daily electricity load demand, which seemed to peak in the afternoon and again in the evening.

Figure 2.1. Monthly Average Electricity Load Demand in 2016

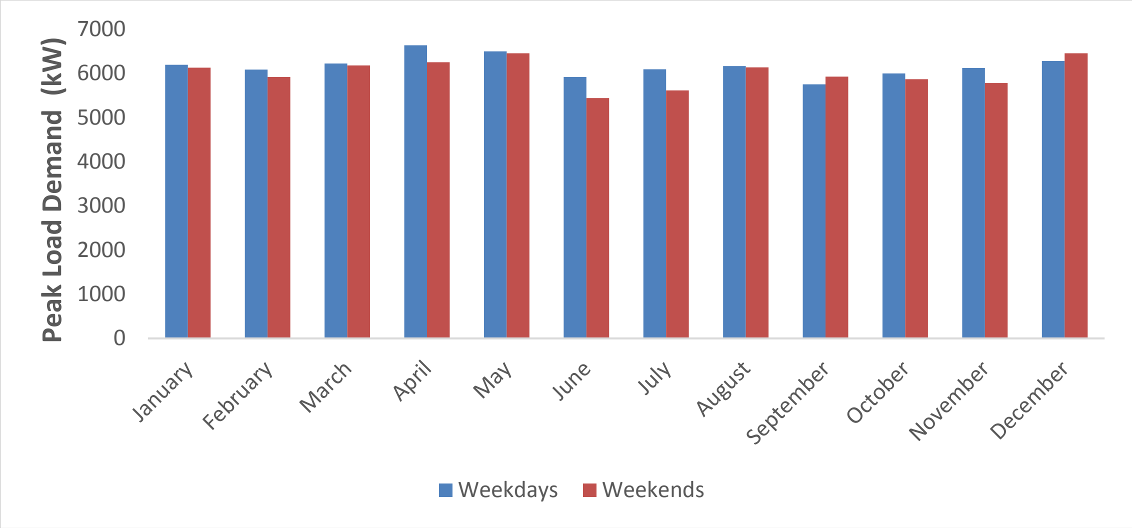


kW = kilowatt.
Source: Department of Electrical Services, Brunei Darussalam (2016).

2.2. Electricity Demand Forecast of Temburong Eco Town in 2025

The electricity demand forecast for Temburong Eco Town in 2025 was based on the information and interpretation of data provided in the Temburong District Plan 2006–2025 published by the Department of Town and Country Planning, Ministry of Development, Brunei Darussalam. The population of Temburong was reported to be 8,900 in 2015. The estimated population based on high growth of 3% is 17,535 by 2025, as set out in the Temburong District Plan. For the purpose of this study, the population was rounded to 20,000. The planning data were developed based on the various developments of anticipated buildings, infrastructures, amenities, and corresponding designated areas, as mentioned in the district plan.

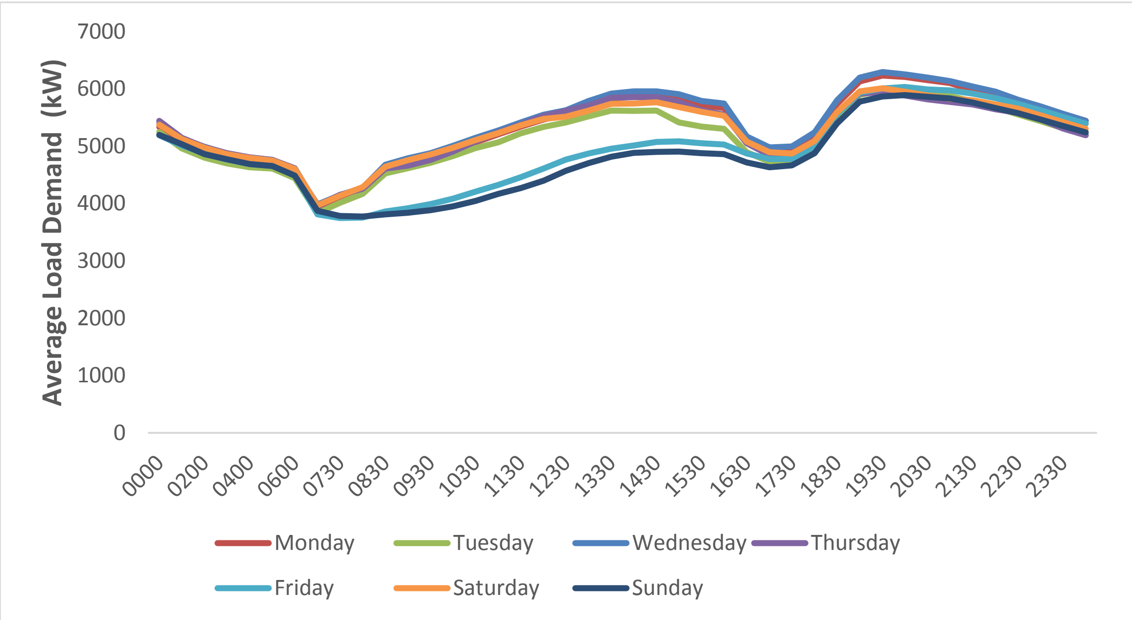
Figure 2.2. Monthly Peak Load Demand in 2016



kW = kilowatt.

Source: Department of Electrical Services, Brunei Darussalam (2016).

Figure 2.3. Typical Daily Load Demand Profile in 2016



kW = kilowatt.

Source: Department of Electrical Services, Brunei Darussalam (2016).

Estimation of building built-up areas was subsequently made based on approximate plot ratio development used in property development practices, with a ratio of approximately 0.6. The planning data are summarised in Table 2.2. However, where land areas are considered to be too large for certain developments, only a portion of the land could be considered for use in this Eco Town development. For other uses such as the building of hotels, the estimation was based on anticipated capacity in terms of the number of hotel rooms.

In Malaysia, the assessment of building energy performance is based on building energy intensity (BEI), which is expressed in kWh per gross floor area (m^2) per year. Similarly, in Singapore BEI is designated as energy use intensity (EUI), which is also expressed in kWh per gross floor area (m^2) per year. Benchmarking values for building energy performance have been established in green building assessment tools for these two countries. For this study, the benchmarking values are based on the Malaysian experience. In addition, Table 2.1 shows the BEI values used in the estimation of electricity consumption for conventional building development, the range of GBI BEI values, and target BEI values for the estimation of electricity demand in Temburong Eco Town development.

Table 2.1. Target Values of Building Energy Intensity (BEI) for Energy-Efficient Buildings

Type of Building	BEI Conventional Building (kWh/m²/year)	GBI BEI Range (kWh/m²/year)	Target BEI Energy-Efficient Building (kWh/m²/year)
Office	250	90–150	120
Hotel	275	≤3-Star: 129–200 4–5 Star: 175–290	233
Hospital	300	• Hospital with limited clinical services: 120–200 • Hospital with major clinical services: 175–290	233
Shopping mall	345	• Average mall: 145–240 • Major mall: 210–350	280

BEI = building energy intensity, GBI = Green Building Index, kWh = kilowatt-hour, m^2 = square metre.
Source: Authors.

2.3. Additional Electricity Demand Based on the Buildings to be Constructed in Temburong Eco Town

It was reported that the existing maximum electricity demand in Temburong was 7.48MW in 2016. This existing maximum demand is added to the forecast of electricity demand to compute the total electricity demand for all of Temburong township, both existing and future, as shown in the last row of Table 2.3. The electricity demand forecast for Temburong was made under two scenarios: (i) conventional building development and (ii) energy-efficient eco town development. Maximum electricity demand in buildings would be estimated for each of the two scenarios. In general, it was assumed that the electricity load demand in energy-efficient buildings is about 20% lower than that in the conventional buildings except where the actual loads are known, e.g. street lighting. The annual electricity consumption was estimated based on the mid-range values of BEI set in the Green Building Index (GBI) assessment tools adopted in Malaysia for buildings that have known BEI targets. For buildings that do not have known BEI targets, maximum electricity demand and appropriate diversity factors used in the general planning of power distribution are adopted as the basis of estimation of electricity consumption.

Table 2.2. Identification of Anticipated Buildings to be Constructed

Building Type	Land Area (hectare)	Built-up Area (m^2)	Capacity	Remarks
Hotel	N/A	10,000	200 hotel rooms	Assumed about double the existing capacity would be required
Shopping mall	3.2	6,000		Assumed 1/3 land area would be used for the development
Shop lots	1.0	6,000	16 units	Assumption
Hospitals	6.0	3,600	100 beds	Assumed 1/10 land area would be used for the development
Government office	1.5	4,000	200 staff	Assumed about half the land would be used for the development
Industrial park	2	12,000		Based on land area of 2 hectares
University campus	10	10,000	800 students	Assumed 1/4 land area would be used and a plot ratio of 0.4 for the campus development
Primary school	4	N/A	800 students	Assumed 25 students per class
Secondary school	8	N/A	1,200 students	Assumed 25 students per class
Students' apartment for university	N/A	N/A	200 students	Assumption
University staff apartment	N/A	N/A	80 staff	Assumption
Hospital staff apartment	N/A	N/A	90 staff	Assumption
Bus terminal building	N/A	1,000	N/A	Assumption
Park & amenities	N/A	N/A	N/A	To provide electricity for park facilities such as water, fountains, and landscape lighting
Port facilities for goods & services including port authority offices & warehouses	6	36,000	100	Based on land area of 6 hectares
Petrol kiosks	N/A	N/A	2 petrol kiosks	Assumed 16 hours daily operation

Building Type	Land Area (hectare)	Built-up Area (m^2)	Capacity	Remarks
Utilities: Wastewater treatment plant	N/A	N/A	7,000 PE	Extracted from Temburong district plan Bangar: 4,000 PE Kg. Rataie: 3,000 PE
Residential houses	253	N/A	1,515 houses	1,715 houses were planned in the Temburong district plan, but it is assumed that 200 houses would be converted to 200 apartment units
Residential apartment	N/A	N/A	200 apartment units	Assumption
Road infrastructure: Street lighting	N/A	N/A	~ 200 km new roads	Estimated road length and street lights to be 30 metres apart

km = kilometre, m^2 = metre, N/A = not applicable, PE = Population Equivalent.

Source: Authors.

Table 2.3. Estimation of Electricity Demand in Normal Township Development and Eco Township Development

Building Type	Maximum Demand Normal Township (kW)	Maximum Demand Eco Town (kW)	Estimated Electricity Consumption Normal Township (kWh/year)	Estimated Electricity Consumption Eco Township (kWh/year)
Hotel	10,000x0.15x0.9 = 1,350	10,000x0.125x0.9 = 1,125	10,000x275 = 2,750,000	10,000x233 = 2,330,000
Shopping mall	6,000x0.11x0.9 = 594	6,000x0.09x0.9 = 486	6,000x345 =2,070,000	6,000x280 = 1,680,000
Shop lots	16x18x0.85 = 245	16x14x0.85 = 190	245x365x0.55x16 = 786,940	190.4x365x0.55x16 = 611,565
Hospital	2,400x0.09x0.9 = 194	2,400x0.07x0.9 = 151	2,400x300 = 720,000	2,400x233 = 559,200
Government office	4,000x0.09x0.7 = 252	4,000x0.07x0.7 = 196	4,000x250 = 1,000,000	4,000x120 = 480,000
Industrial park	12,000x0.08x0.6 = 576	12,000x0.06x0.6 =432	576x365x0.5x16 = 1,681,920	432x365x0.5x16 = 1,261,440
University campus	10,000x0.090x0.7 = 630	10,000x0.07x0.7 = 490	10,000x250 =2,500,000	10,000x120 = 1,200,000
Primary school	800/25x5x0.75	800/25x4x0.75	120x365x8x0.55	96x365x8x0.55

Building Type	Maximum Demand Normal Township (kW)	Maximum Demand Eco Town (kW)	Estimated Electricity Consumption Normal Township (kWh/year)	Estimated Electricity Consumption Eco Township (kWh/year)
	= 120	= 96	= 192,720	= 154,176
Secondary school	1,200/25x7x0.75 = 252	1,200/25x6x0.75 = 216	252x365x8x0.45 = 331,128	216x365x8x0.45 = 283,824
Students' apartment for university	200x5x0.7 =700	200x3.75x0.7 = 525	700x365x0.4x24 = 2,452,800	525x365x0.4x24 = 1,839,600
University staff apartment	80x5x0.7 = 280	80x3.75x0.7 = 210	280x365x0.5x24 = 1,226,400	210x365x0.5x24 = 919,800
Hospital staff apartment	90x5x0.7 = 315	90x4x0.7 = 252	315x365x0.5x24 = 1,379,700	252x365x0.5x24 =1,103,760
Bus terminal building	1000x0.1x0.75 = 75	1000x0.07x0.75 = 53	75x365x0.6x16 = 262,800	52.5x365x0.6x16 = 183,960
Park & amenities	80	60	80x365x0.4x4 = 46,720	60x365x0.4x4 = 35,040
Port facilities for goods & services including port authority offices & warehouses	36,000x0.065x0.7 = 1,638	36,000x0.045x0.7 = 1,134	1,638x365x0.55x12 = 3,945,942	1,134x365x0.55x12 = 2,731,806
Petrol kiosks	2x100x0.7 = 140	2x80x0.7 = 112	140x365x0.55x16 = 449,680	112x365x0.55x16 = 359,744
Utilities: Wastewater treatment plant	40x7000/12/(24x12) = 81	81.02x0.9 = 73	81.02x365x0.8x24 = 567,788	72.92x365x0.8x24 = 511,023
Residential houses	1,515x5x0.7 = 5,303	1,515x3.75x0.7 = 3,977	5,302x365x0.5x24 = 23,222,760	3977x365x0.5x24 = 17,419,260
Residential apartment	200x5x0.7 = 700	200x3.75x0.7 = 525	700x365x0.5x24 = 3,066,000	525x365x0.5x24 = 2,299,500
Road infrastructure: Street lighting	200,000x0.25/30 = 1,667	200,000x0.07/30 = 467	1,667x365x8 = 4,867,640	467x365x8 = 1,363,640
Estimated Total Electricity Demand/ Consumption:	15,193	10,770	53,527,486	37,327,338
Estimated Total Electricity Demand	12,914	9,155	N/A	N/A

Building Type	Maximum Demand Normal Township (kW)	Maximum Demand Eco Town (kW)	Estimated Electricity Consumption Normal Township (kWh/year)	Estimated Electricity Consumption Eco Township (kWh/year)
(after diversity factor of 0.85):				
Estimated Total Electricity Demand (after diversity factor & adding existing load):	20,394	16,635	N/A	N/A

kW = kilowatt, kWh = kilowatt-hour, N/A = not applicable.
Source: Authors.

Forecasts of electricity maximum demand and electricity consumption for Temburong in 2025 are given in Table 2.3, which shows the estimates under two scenarios, i.e. normal and eco town developments. It is recognised that the estimates made in this study could only provide an order of magnitude in electricity demand and consumption, as well as trending forecast analyses and comparison of normal and eco township developments. More accurate maximum demand and electricity consumption will need to be recalculated once the Temburong Eco Town planning details are finalised.

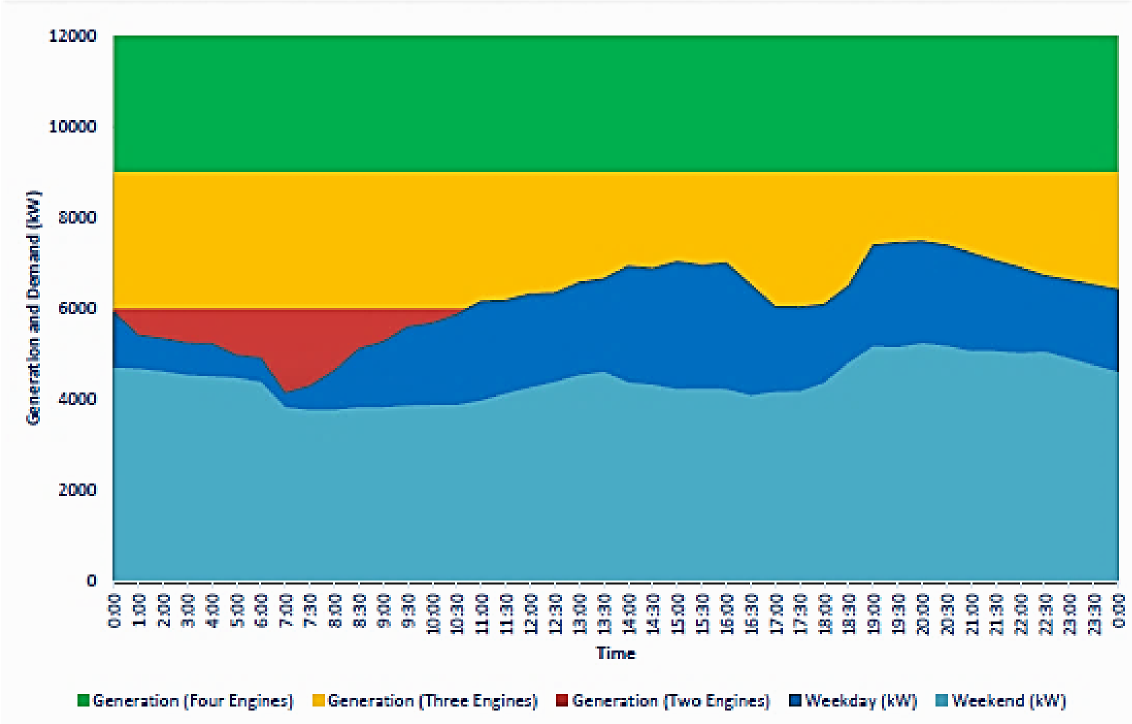
Table 2.3 shows that the additional maximum electricity demand for normal township developments, excluding existing loads, is 12.914MW, and that for eco township developments, excluding existing loads, is 9.155MW. The additional electricity consumption for the conventional and eco town developments is 53,527MWh and 37,327MWh, respectively.

2.4. Existing Electricity Demand

The electricity supply for the existing Temburong township is provided by the Belingus Power Station, which has been operating since 1985. The station has four sets of MAN Mirrlees Blackstone K6 Major Mk3 diesel engine generators with a combined generating capacity of 12MW. The upgrading of local control panels for all diesel engine generators incorporating auto start–stop sequence, remote control, detailed alarm reporting, etc. was completed in 2013. The typical load demand in 2016 is shown in Figure 2.4.

Figure 2.4 shows that three-diesel-engine generators catered mostly for the daytime and night-time loads, and two-diesel-engine generators catered for the overnight load. The daytime load would start to increase from about 7:00 a.m., and peak load seemed to occur at about 4:00 p.m. The load demand would dip after 4:00 p.m. and would peak again to more than 7MW at about 7:00 p.m. Electricity demand would dip thereafter to below 6MW overnight. According to the Department of Electrical Services, Brunei Darussalam, the maximum peak demand recorded in 2016 was 7.48MW. This peak demand value is used in the estimation of total electricity demand for the forecast of electricity demand in Temburong Eco Town.

Figure 2.4. Belingus Power Station Typical Load Demand in 2016



kW = kilowatt.

Source: Department of Electrical Services, Brunei Darussalam (2016).

2.5. Total Electricity Demand

The total electricity demand is based on the maximum peak demand recorded in 2016 at 7.48MW, which is added to the projected total demand (after applying a diversity factor of 0.85) for the new developments in Temburong. Applying a diversity factor is an industry practice since it is anticipated that not all maximum electricity demands would peak at the same time. The total electricity demand estimated for normal township development is 20.394MW and that for eco township development is 16.635MW, as tabulated in Table 2.3 and illustrated in Figure 2.5. This represents a reduction in electricity demand of 18.4% when total electricity demands are compared under the two scenarios, i.e. normal township development and eco township development. Such reduction in electricity demand for eco town is made possible through planning and adoption of passive design measures such as building orientation, building configuration (geometry and layout), building facade, roof design, choice of building materials and colour, insulation, fenestration, and lush landscaping for improved microclimates.

However, it should be pointed out that in a real-case situation, the saving in electricity demand could be increased. The reason is that in deriving an electricity demand reduction of 18.4%, the existing electricity demand is assumed to remain constant. However, through promotion and greater public awareness of eco town benefits or through legislative requirements, the existing load demand would have been reduced by 2025. Such development will result in further reduction in total electricity demand in the Temburong area when full-scale eco township is comprehensively developed. Therefore, it may be possible to see a saving of at least 25% in total electricity demand for a complete eco township development. Table 2.3 shows that reduction in yearly electricity consumption that can be achieved from eco township development is 16,200MWh, which is about 30% saving in yearly electricity consumption.

Reduction in total electricity demand can be translated into the following savings:

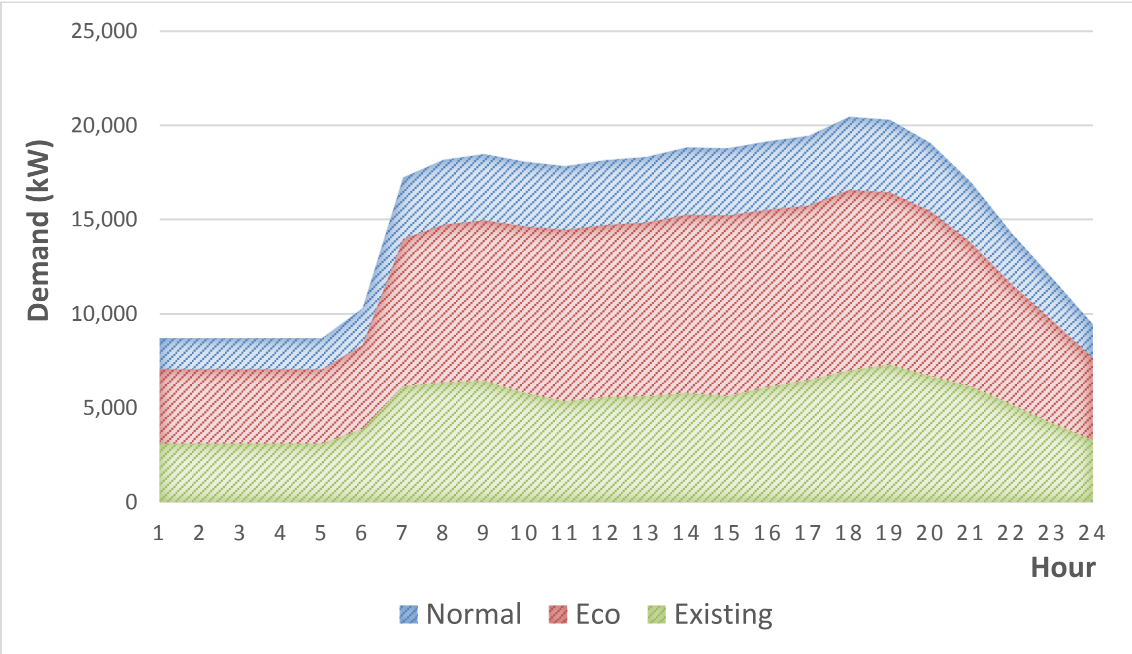
(1) Savings in constructing a power plant with smaller capacity;

(2) Savings in capital purchase of smaller capacity air-conditioning equipment;

(3) Savings in electricity consumption with the operation of more energy-efficient equipment and appliances; and

(4) Savings due to reduced use of air-conditioning equipment resulting from eco township design dwellings and commercial buildings.

Figure 2.5. Daily Electricity Demand Comparison of Eco Township Development vs Normal Township Development

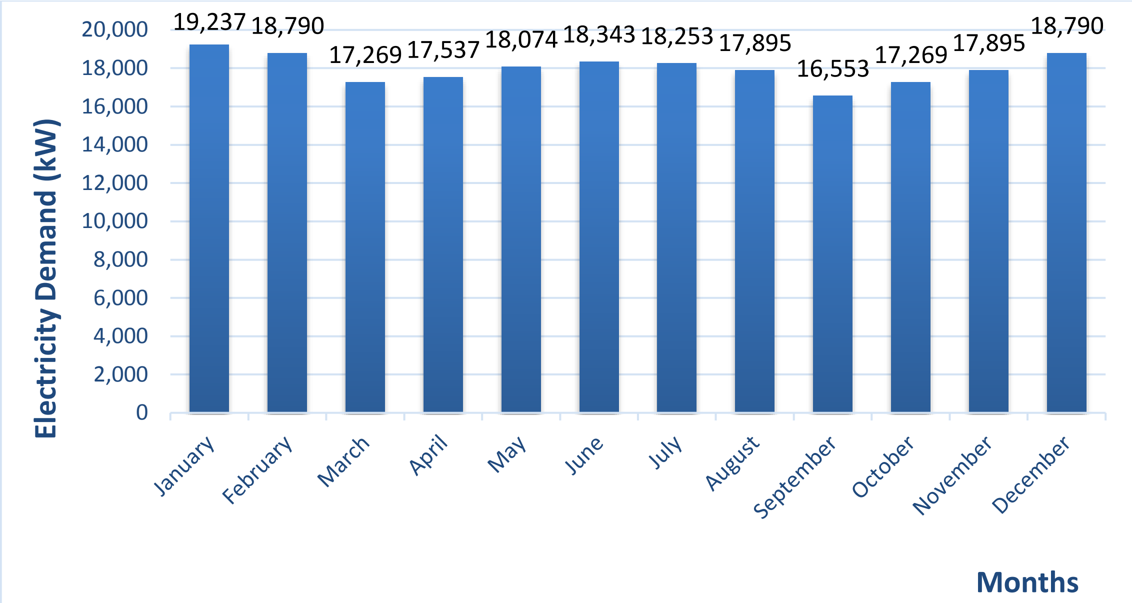


kW = kilowatt.

Source: Authors.

Figure 2.5 compares the electricity demand of normal township development and that of eco township development. If the existing township will also adopt the eco township energy-efficient measures, the difference in electricity demand between these two types of development will be bigger. In other words, the combined reduction in electricity demand for both the existing township and new eco township developments will be greater.

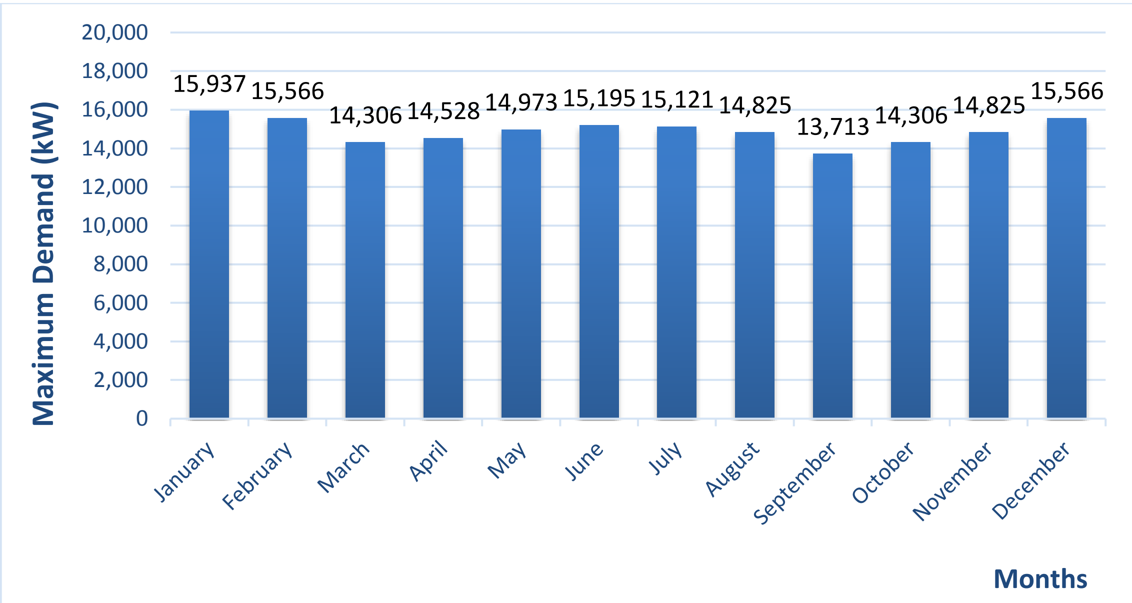
Figure 2.6. Monthly Electricity Demand for Normal Township Development (Forecast for January–December 2025)



kW = kilowatt.

Source: Authors.

Figure 2.7. Monthly Electricity Demand for Eco Township Development (Forecast for January–December 2025)



kW = kilowatt.

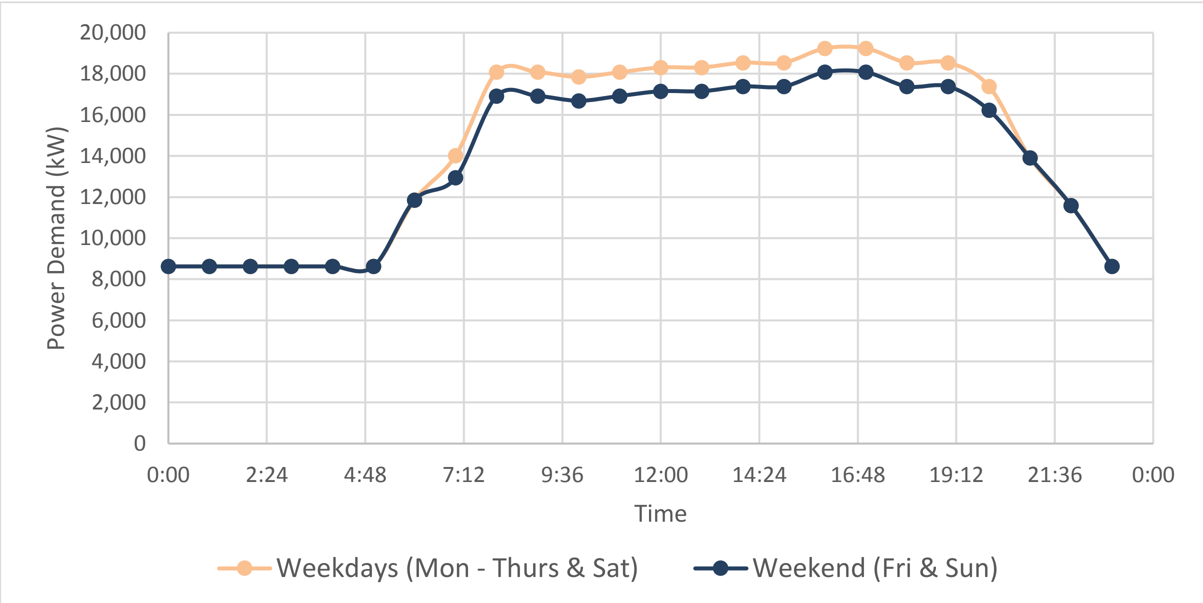
Source: Authors.

Figure 2.6 and Figure 2.7 show the forecast for monthly electricity demand in 2025, which is essentially modelled on 2016 electricity demand. In 2025, the Eid al- Fitr celebration will begin in the evening of 30 March and will end in the evening of 1 April. Electricity demand is expected to dip a little in the month preceding the festive celebration. The demand trend shows that it will gradually increase after the Hari Raya celebration and will peak around the middle of the year. Electricity demand is expected to be lower during the rainy period, which is usually from September to January. The increase in demand in December may be due to year-end school holidays. Based on the higher electricity demand forecast for January 2025, Figure 2.8 and Figure 2.9 show the projected load profiles for normal township and eco township developments.

2.6. Breakdowns of Total Electricity Demand

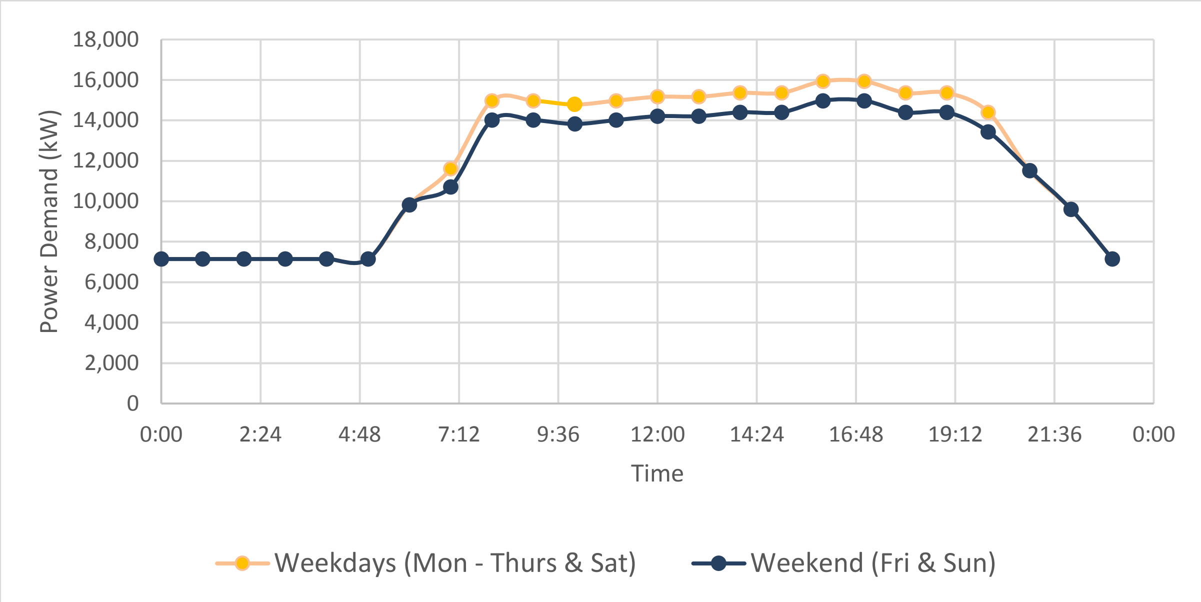
Table 2.3 tabulates the estimates of breakdowns of electricity demand for normal and eco township developments. Figure 2.10 and Figure 2.11 illustrate the projected daily load profile of each of the various sectors such as residential, commercial, industrial, institutional buildings, and infrastructure, as well as the total electricity demand trending for normal and eco township developments based on the assumptions and estimates made in this study. The residential sector has the highest proportion of electricity demand, taking up about 40% of the total electricity demand under both scenarios. It may be anticipated that the commercial sector will take up a more substantial proportion. However, due to lack of information on detailed township planning for this study, electricity demand for the commercial sector is not significant since conservative estimates were made on the premise that there was no extensive commercial development. If there were plans to have more and larger hotels and resorts, larger shopping malls, theme parks, etc., electricity demand for the commercial sector would take up a larger proportion.

Figure 2.8. Projected Daily Load Profile in January 2025 for Normal Township Development



kW = kilowatt.
Source: Authors.

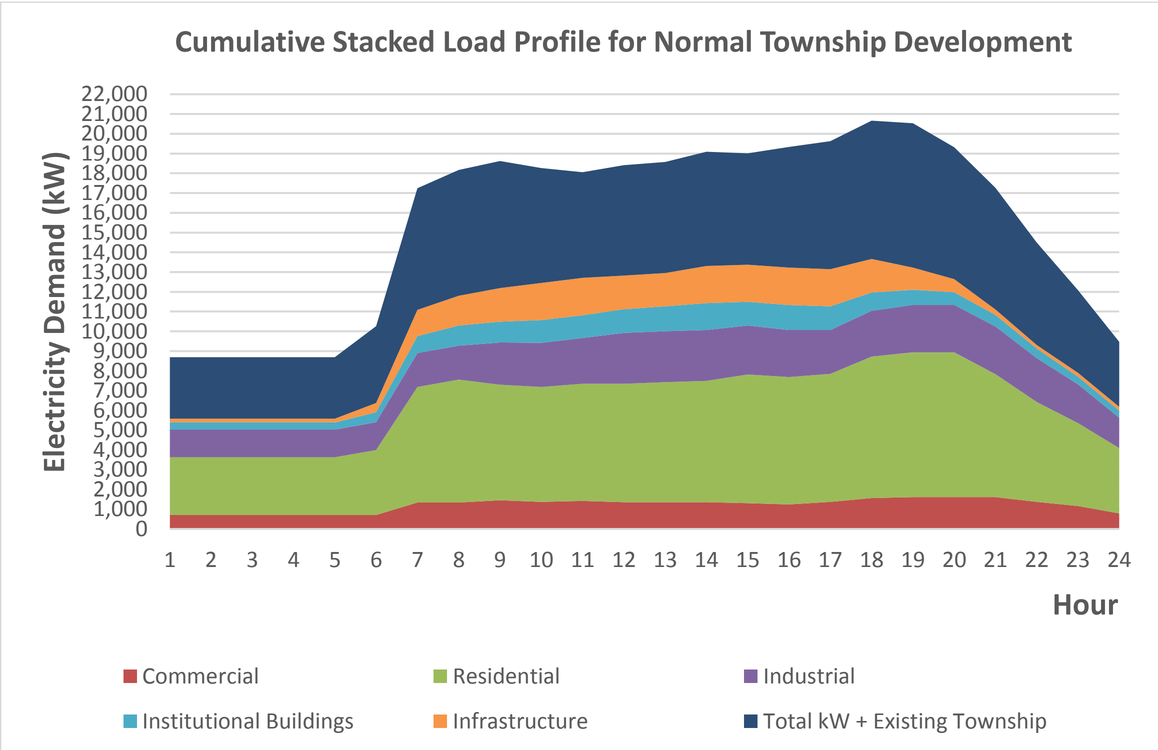
Figure 2.9. Projected Daily Load Profile in January 2025 for Eco Township Development



kW = kilowatt.

Source: Authors.

Figure 2.10. Daily Electricity Load Demand Profile Showing Breakdowns and Total Demand for Normal Township Development

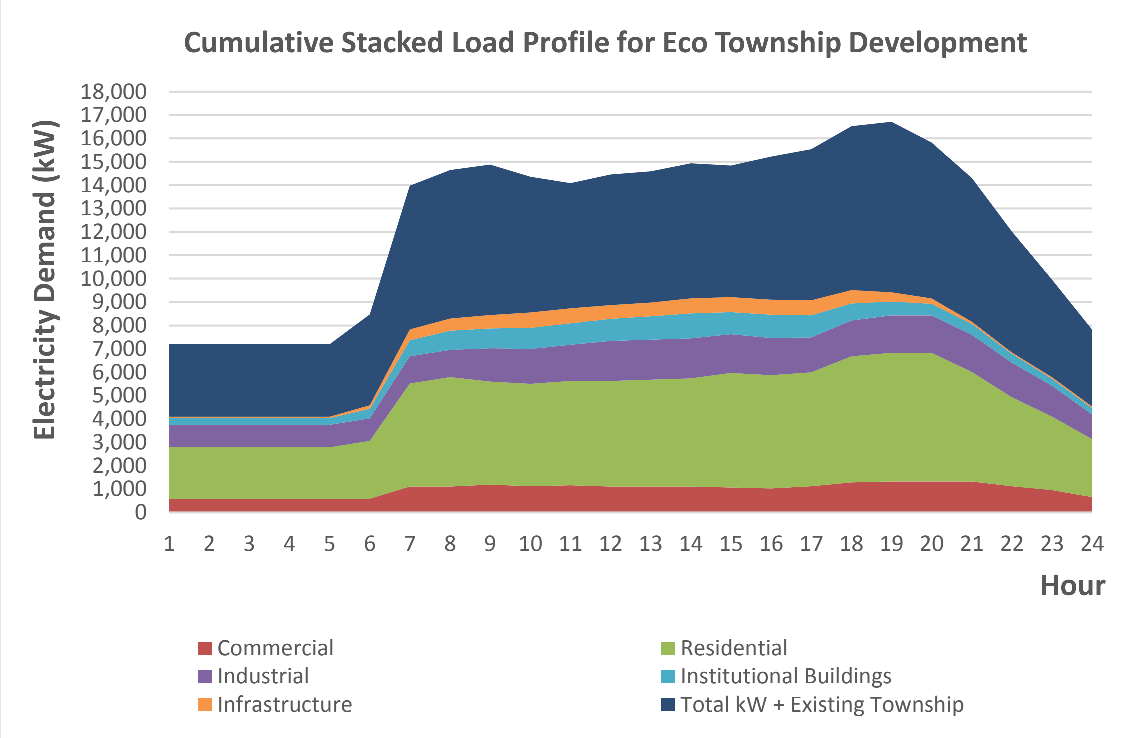


kW = kilowatt.

Source: Authors.

Figure 2.10 and Figure 2.11 show similar trends in the daily electricity demand for normal and eco township developments. The difference is mainly in the values of electricity demand. The graphs for eco township development show reduced electricity demand. The residential sector is the largest electricity consumer. However, if larger and greater numbers of commercial developments are planned for the Temburong township, electricity demand from the commercial sector will increase substantially.

Figure 2.11: Daily Electricity Load Demand Profile Showing Breakdowns and Total Demand for Eco Township Development



kW = kilowatt.

Source: Authors.