DEE 3143 BASIC ELECTRICAL MACHINE & POWER SYSTEMS

CHAPTER 4
POWER SYSTEM OVERVIEW

by
Mohd Ikhwan Muhammad Ridzuan, Norainon Mohamed, Mohd Redzuan Ahmad, Ruhaizad Ishak, Norhafidzah Mohd Saad, Amir Izzani Mohamed

Faculty of Electrical and Electronic
correspond author: ikhwanr@ump.edu.my

Load

- Types of load/customer:
  - Residential
  - Commercial
  - Industrial
  - Public Transportation
  - Public Lighting
  - etc.

Residential Load

- Mainly consist of fan, lighting, air condition, television, refrigerator, kitchen appliances, washing machine and etc.
- These load increase during evening to midnight and morning (normal routine of human at home before/after working hours)

Commercial Load

- Consists of fan, lighting, air-condition and small appliances.
- Shops, offices, business premises, schools, universities etc.
- The load is fairly constant from 9am until 9pm (during working hours) with the exception of any mid-day break.

Industrial Load

- Mainly consists of motor load, air conditioner, lighting, welding and furnaces etc.
- It can be divided into small, medium and large category. The nature of industrial load curve will depend on the number of shifts worked in the industry.

Electricity consumers according to sectors

Types of sectors	Quantity	Percent (%)
Domestic	5,627,999	83.4
Commercial	1,045,971	15.5
Industrial	26,993	0.4
Public lighting	47,237	0.7
Mining	6748	0.1
TOTAL	**6,748, 200**	**100%**

kWh consumption according to sectors

Types of sectors	Capacity	Percent (%)
Domestic	14.2×10^9 kWh	18.9
Commercial	22.1×10^9 kWh	29.4
Industrial	38.1×10^9 kWh	50.6
Public lighting	0.75×10^9 kWh	1.0
Mining	0.08×10^9 kWh	0.1
TOTAL	**75.2×10^9 kWh**	**100%**

Load Characteristics

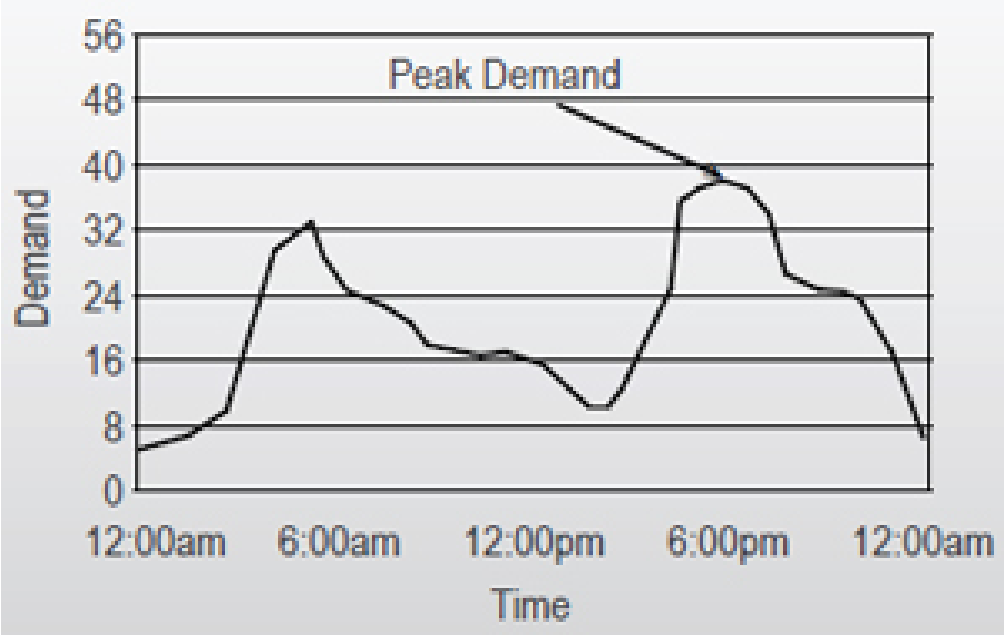
Load Curve

- The load on power system is not constant. It is varies time to time.
- The load curve can be obtained by plotting the load against time.
- Plotted from 24 hours a day – daily load curve.
- If the time considered for one year (8760 hours) – annual load curve.
- Yearly load curve used to determine load factor
- Area under load/curve – energy generated in the period consideration.

Load Characteristics

Load Curve

- ***area under the curve*** divided by the total number of hours gives the average load on the power station.
- The ***peak curve load*** indicated by the load curve represents the ***maximum demand*** on the power station.

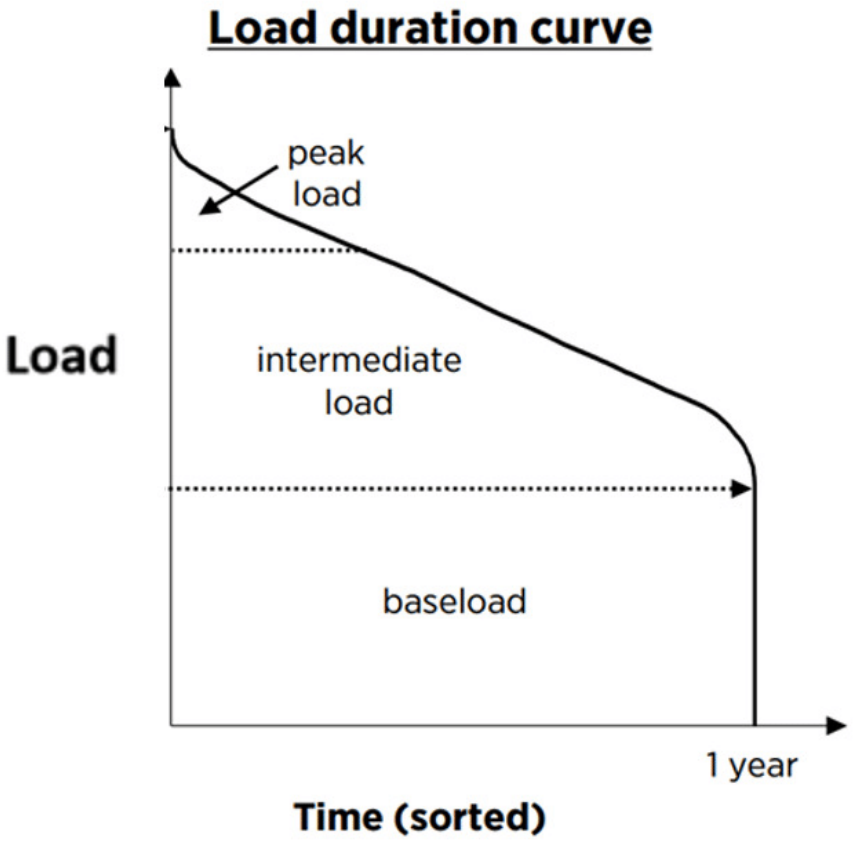


Source: http://energysentry.com/newsletters/high-electric-bills.php

Load Characteristics

Load Curve

- The greatest problem for a power supply company is varying load. The generatior should be matched with the load consistently.
  - The **base load** power is suppli by power plants running continuously.
  - The **Intermediated/Average load** prevails for some part of the day.
  - The **peak load** prevails only a few hours of the day



Source: https://www.researchgate.net/figure/313159889_fig14_Figure-17-Load-duration-curve

Load Characteristics

Terms and Definitions

- Demand
  - Load at specific point/terminal in specific time/duration.

- Demand interval (Δt)
  - The period which the load/demand is averaged.
  - Selected Δt period maybe 15min, 30min, 1 hour, or even longer.

Load Characteristics

Terms and Definitions

- Maximum Demand
  - The highest load during the specified period of time.

- Demand Factor[DF]

$$DF = \frac{\max imum.demand}{total.connected.demand}$$

Load Characteristics

Terms and Definitions

- Diversified Demand/Coincident Demand
  - Composite demand group (residential, commercial, industrial, and miscellaneous), as a whole of somewhat unrelated loads (loss in transmission and distribution) over a specified period of time.

- Utilization Factor[F_u]

$$F_u = \frac{Maximumdemand}{Ratedsystemcapacity}$$

Load Characteristics

Terms and Definitions

- Plant Capacity Factor

$$\text{Plant capacity factor} = \frac{E}{C \times t}$$

Where, E = energy produced (kWh)

C = plant capacity/rating (kW)

t = total number of hours

Load Characteristics

Terms and Definitions

- Plant Use Factor

$$\text{Plant use factor} = \frac{E}{C \times t_1}$$

Where, E = energy produced (kWh)

C = plant capacity/rating (kW)

t_1= total number of hours

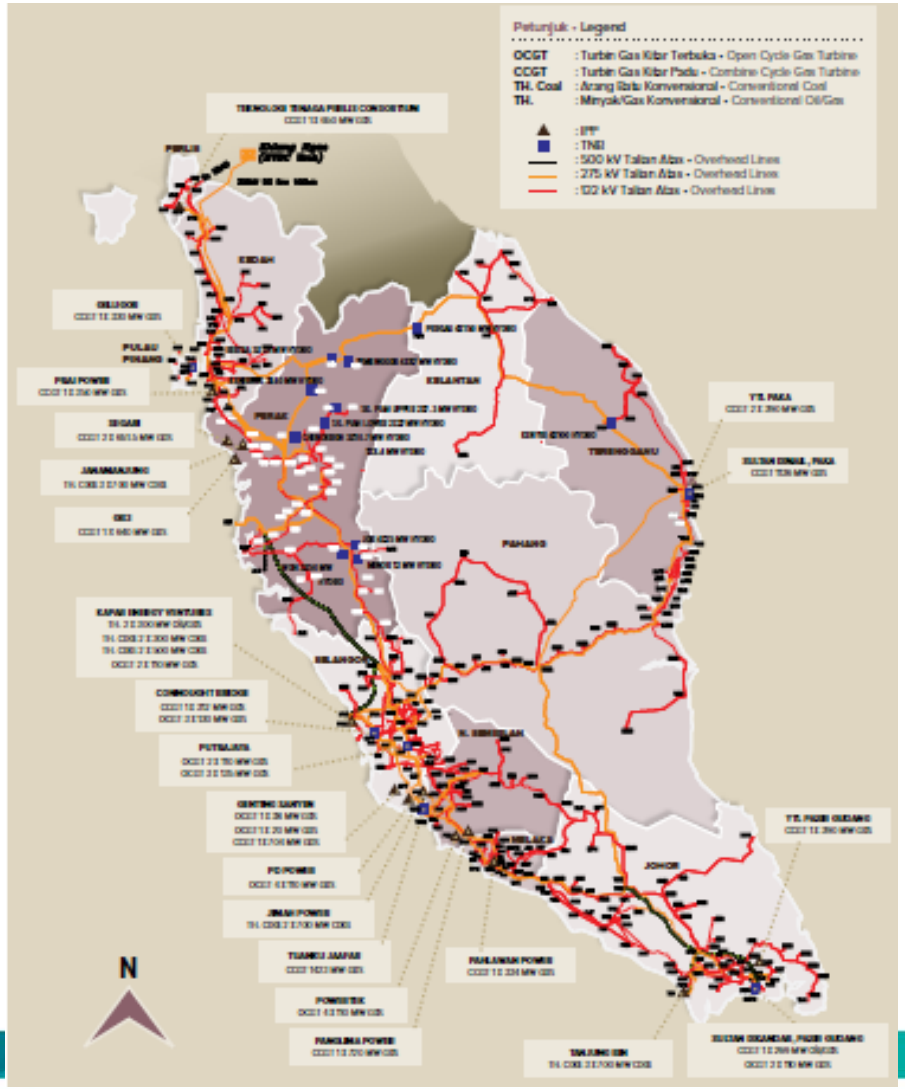
Loads Demand

- The magnitude of load varies throughout the day.
- The highest value of load during 24 hours period is called peak or maximum demand.
- In order to assess the usefulness of the generating plant, the load factor (LF) is defined.
- Daily Load factor and annual load factor is given as,

$$\text{Daily LF} = \frac{\text{average load}}{\text{peak load}}$$

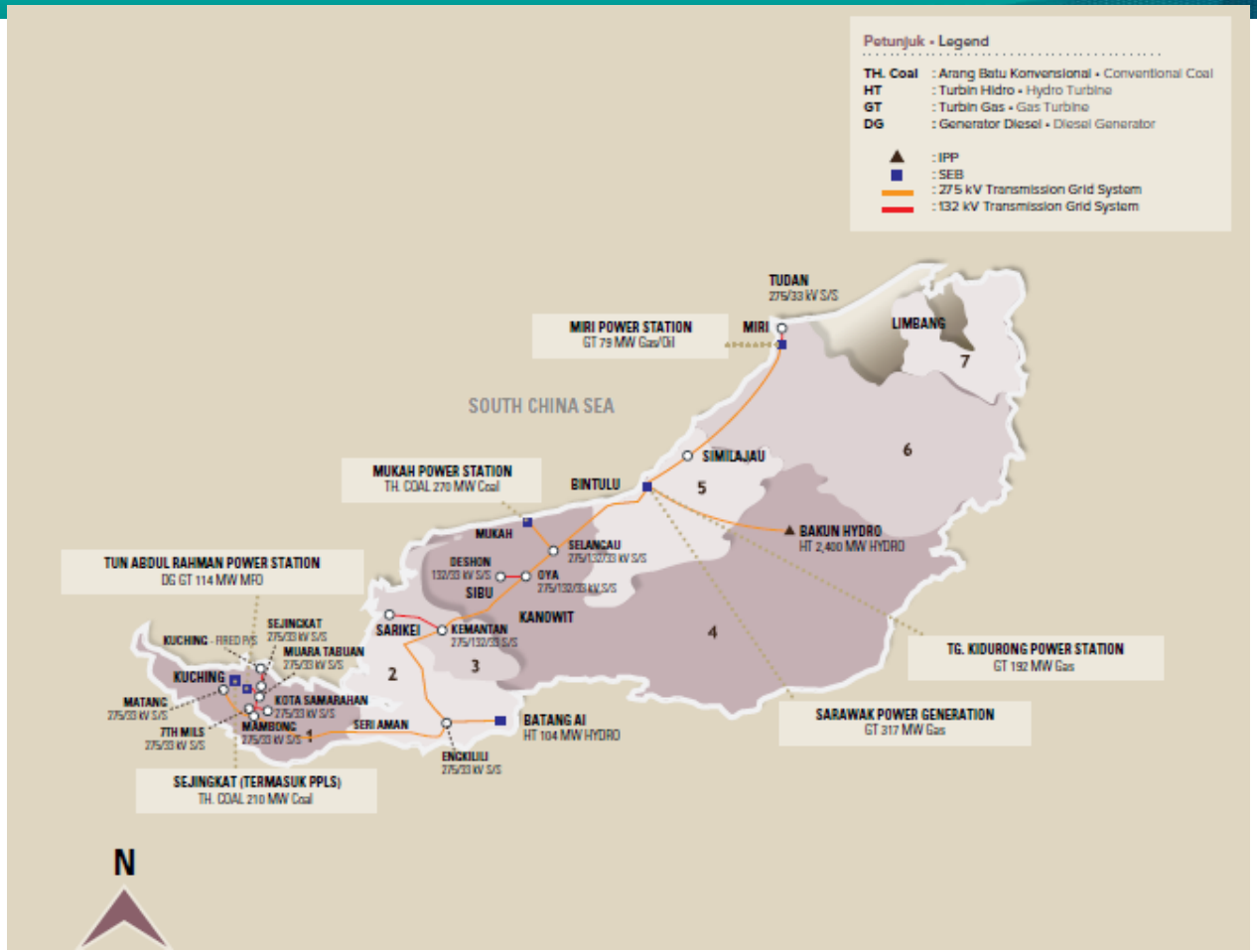
$$\text{Annual LF} = \frac{\text{total annual energy}}{\text{peak load x 8760 hr}}$$

Power generation station (Peninsular Malaysia)



Source: Performance And Statistical Information On Electricity Supply Industry In Malaysia, Energy Commission Malaysia, 2014

Power generation station: Sarawak



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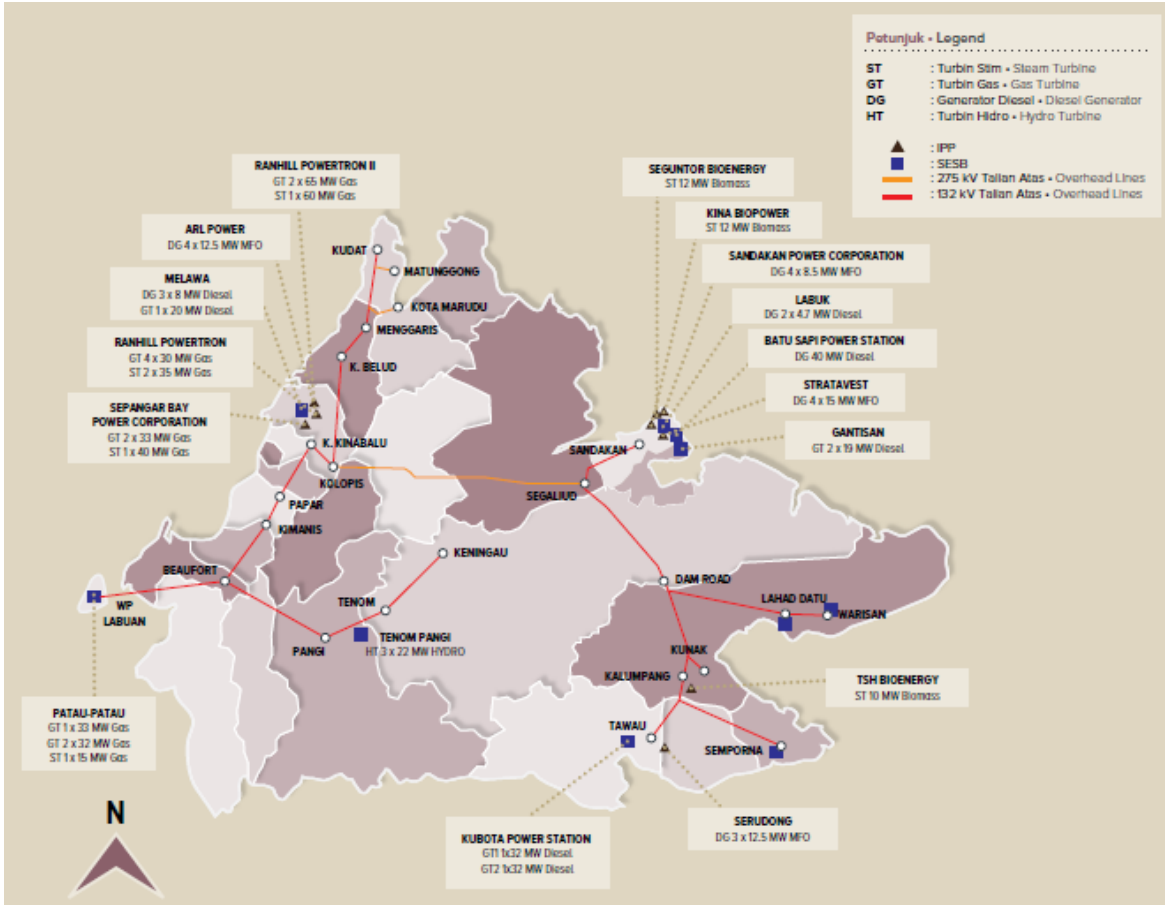
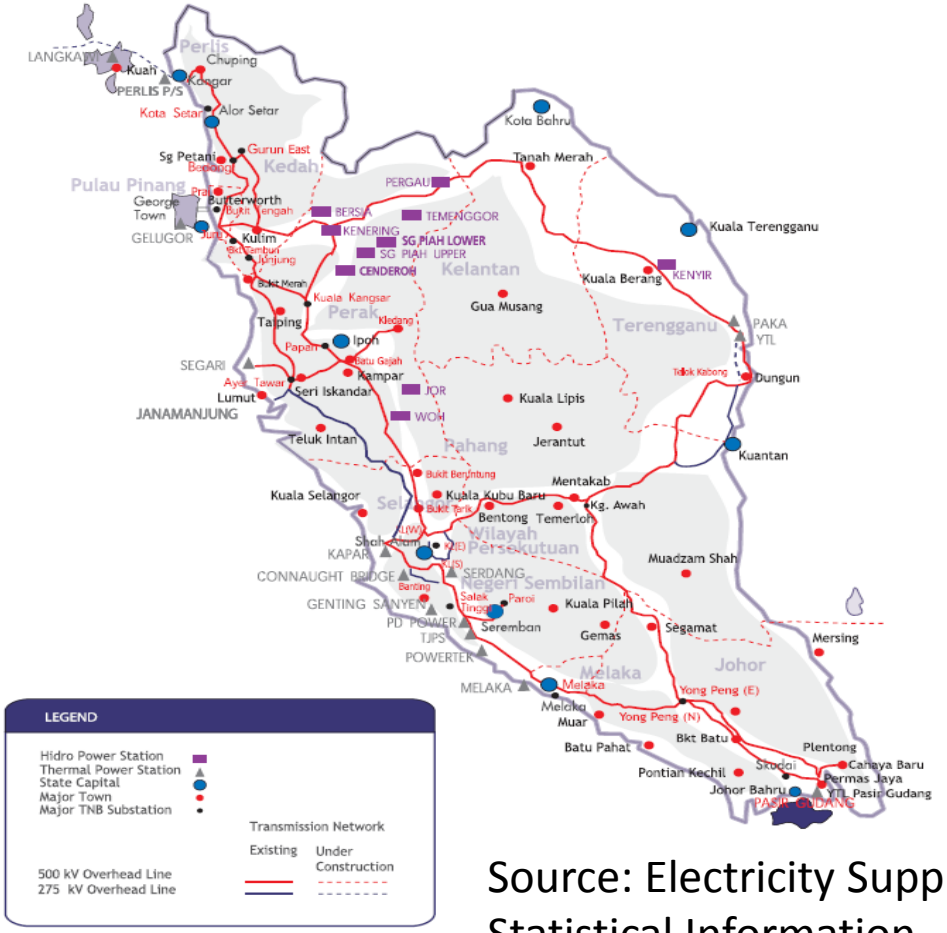
On Electricity Supply Industry In Malaysia, Energy Commission Malaysia, 2014

Power generation station: Sabah



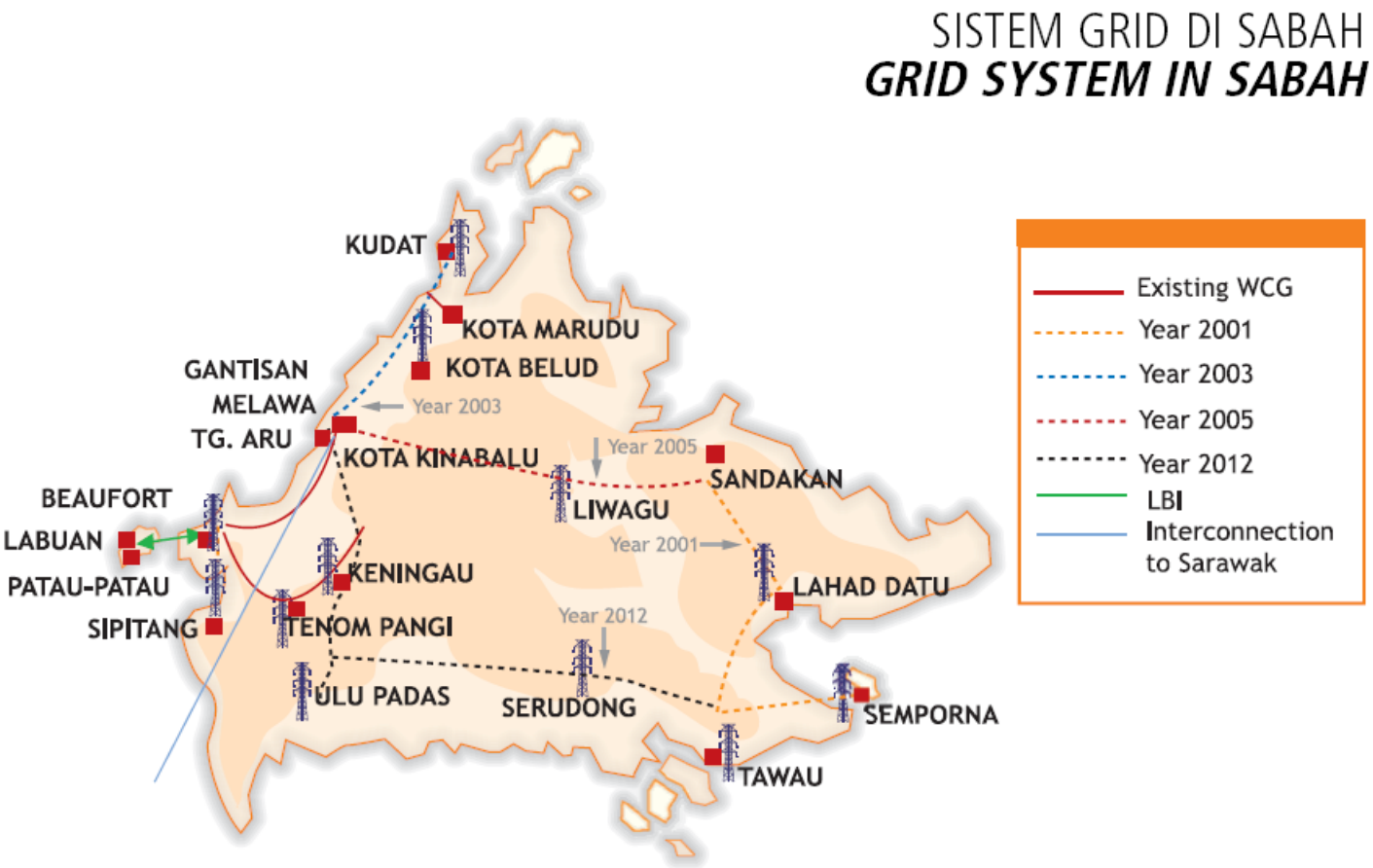
Source: Performance And Statistical Information
On Electricity Supply Industry In Malaysia, Energy Commission Malaysia, 2014

Grid system: Peninsular Malaysia



Source: Electricity Supply Industry in Malaysia Performance and Statistical Information,
Energy Commission Malaysia, 2006

Grid system: Sabah



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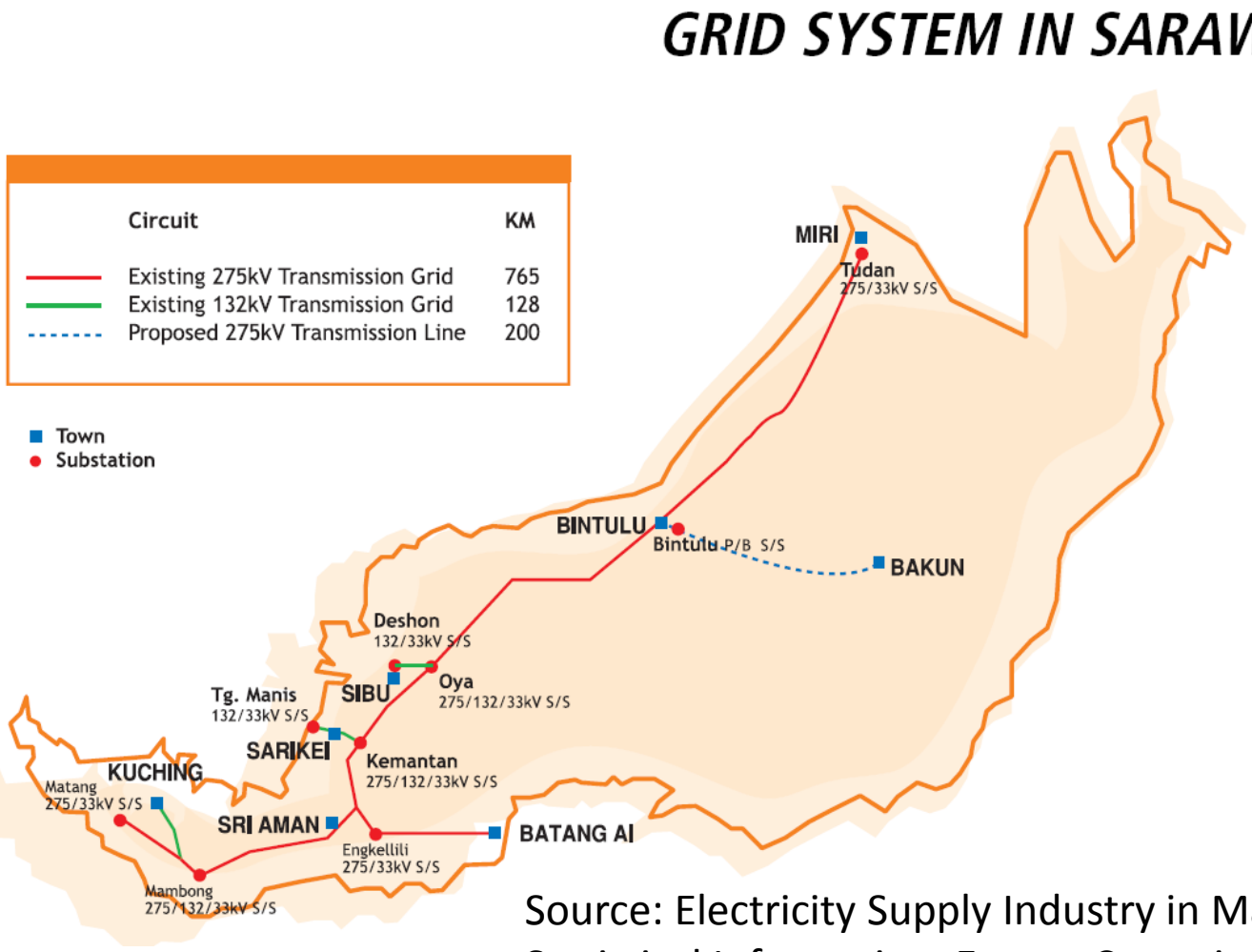
Grid system: Sarawak



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Mohd Ikhwan Muhammad Ridzuan, PhD
Faculty of Electrical and Engineering
Universiti Malaysia Pahang
ikhwanr@ump.edu.my

Research interest: Reliability, Distribution network, smart grid, risk asessment