

**HW#11 Internal Combustion Engines**

1) A “bi-fuel” motorcycle can be operated on either LPG or gasoline. In LPG mode it gets 40km/l in normal usage, in gasoline mode it gets 45km/l. The “bi-fuel” conversion kit costs 450RM. Assuming the vehicle is driven 10,000km annually. In gasoline mode it only burns gasoline. In LPG mode it uses LPG 80% of the time and gasoline 20% of the time (when the LPG tank is out and needs to be refilled). Use the following data in your calculations:

Fuel	LPG (basically butane)	Gasoline
Cost	25RM/15kg	1.95RM/liter
Density	590g/liter	720g/liter
Composition	C <sub>4</sub> H <sub>10</sub>	C <sub>8</sub> H <sub>18</sub>

Calculate the annual cost for each mode.

Calculate the CO<sub>2</sub> emissions per year in each mode [kg/year].

Assuming it is run on LPG 80% of the time and gasoline 20% of the time, what is the ROI time (ie. how long will the operator have to use the vehicle to recuperate the money spent on the conversion) [years]?

2) A “plug in” hybrid electric delivery vehicle drives 50km/day with an average power demand of 25kW, and an average speed of 45km/hour 5 days per week. The vehicle’s 50Ah, 240V battery pack is recharged every evening. The vehicle is designed for a peak power of 35kW and an average power output 20kW. Assume the charge-discharge efficiency of the batteries is 80%, and that electricity costs 0.30 RM/kWh and gasoline costs 2RM/liter. Take the ICE’s efficiency to be 30%.

What are the capacities of the motor and gasoline engine for a Series and Parallel hybrid configuration vehicles? [kW]

Assume that the power output is constant, and that the control system relies on electrical power as much as possible given the intended drive cycle (ie. batteries are discharged by end of drive). For each vehicle configuration, what will the annual cost of operation of the vehicle be?