

# Mitsubishi Outlander - Plug in Hybrid Electric Vehicle Performance Review



By Bob Gell – GELCOservices

Hybrid Electric vehicles are now becoming a sort after option to pure fossil fuel powered internal combustion engines. Globally there is a plethora of new models of passenger cars, SUV's and 4WD available from most vehicle manufacturers, as the car makers now focus on lowering vehicle emissions, gaining in ICE fuel consumption economies and much improved electric with traditional drive line designs and configurations.

The recent release of Plug in Hybrid Electric Vehicles – PHEV – is an example of the current technologies being applied to motor vehicle manufacture.

The plug in to the mains option is seen by the motorist as a very suitable and economic option, particularly as the plug in feature offers the choice of a regular Hybrid drive system, with on-board charging and the ability to utilise the vehicle as an Electric vehicle (EV) and thus gain full economies of energy options.

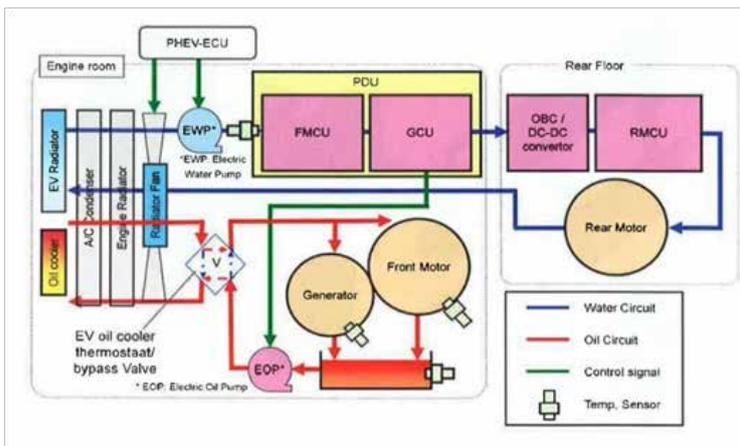
The Mitsubishi Outlander PHEV is one such excellent example of combining regular ICE and electric drive with a respectable total EV&ICE driving range, very suitable for the mix of urban transit and country touring. Combined fuel systems on the Outlander can deliver up to 726 kilometres of travel! (source – GELCO services test data)

GELCO services has recently acquired an Outlander PHEV and we have been able to capture operating data of the vehicle. By using strict operational records and access to the PHEV on-board data capture we have been able to extract and analyse a number of operational aspects of the PHEV in “real time” types of use.

- Cooling coefficients of generator and front drive motor
- Regeneration use data
- Air-conditioning use data
- Recharge data
- Overall fuel consumptions

## Cooling Coefficients:

The on-board energy generator is cooled via an oil cooler pump and heat exchanger. The front drive motor utilises the same



cooling circuit. At outside ambient of 25°C it was noted the highest recorded heat exchanger temperature was 44°C.

The differential in temperatures gives the generator and front electric drive motor a sufficient variance to ensure cooling via radiation at vehicle rest, and enhanced cooling when ram air is passed through the front mounted heat exchanger.

## Regeneration use data:

The Outlander PHEV has a very advanced regeneration design, which can be controlled in “braking” force by the driver, via two paddles beneath the steering wheel. The maximum energy regeneration is controlled by the paddle being placed in #5 setting. Driver education in regard to the principle of energy regeneration from the AC Synchronous motors will then allow maximum recharge of the high voltage pack, and potentially longer drive distances when in EV mode. Typical driver use of regen paddles shows highs around 0.3kWh generated.



## Air-conditioning use data:

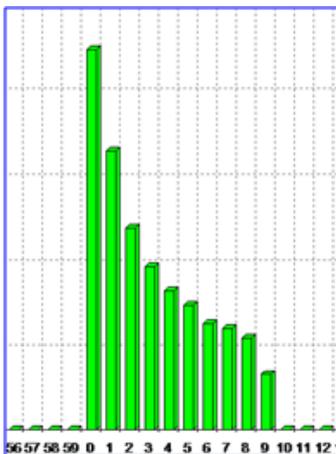
Air conditioning use for this driver is minimal – has a positive effect on energy consumption. (see top of 1st column on next page)

## Recharge data:

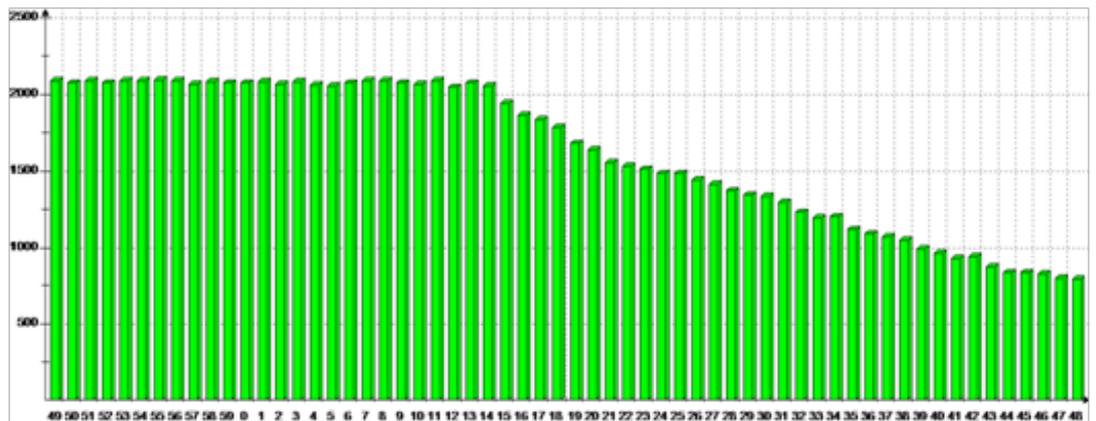
As the Outlander PHEV is designed to be totally flexible with charging the high voltage battery pack from either the regeneration, on-board generator (ICE driven) or plugged into a wall socket at home or workplace as well as the plug in from an Electric Vehicle Charge Station, we ran typical re-charge tests from various state of charge percentages, when coupled to an EV Charge Station.

The relatively short recharge times captured when using the EV Charge Station were exceptional, and clearly demonstrate the technology available from a high quality EV Charge Station, that can communicate with the PHEV and regulate / modulate the amount of charge current delivered to the PHEV.

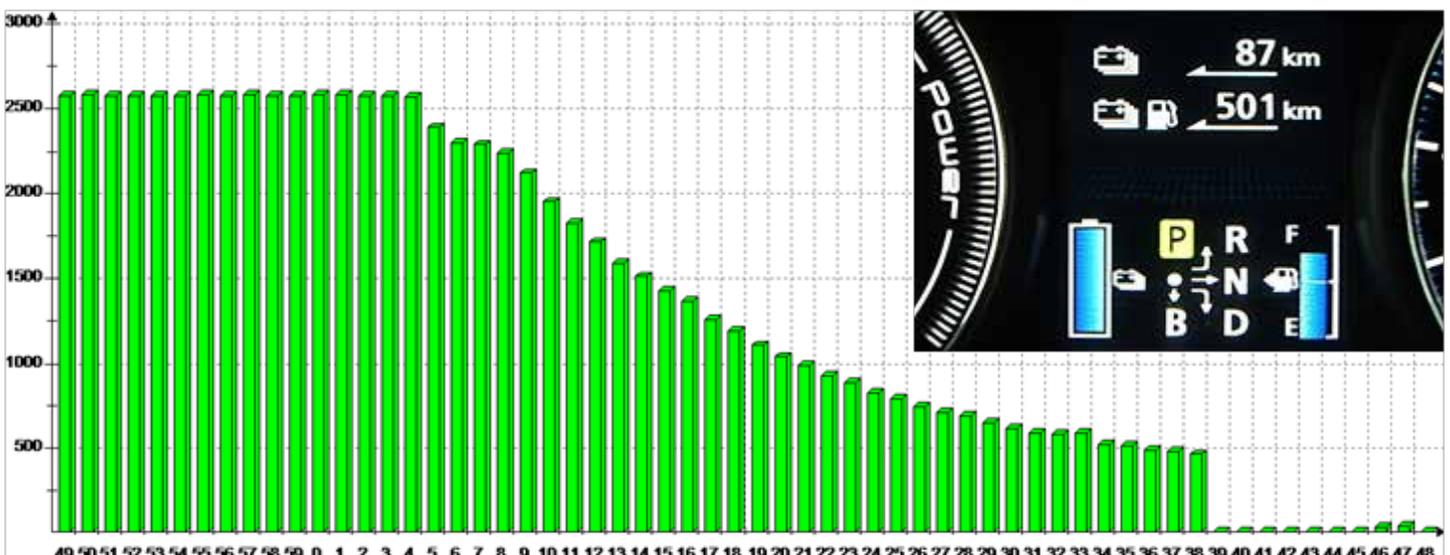
The charts show the charge profile of an AeroVironment Level 2 EVSE with modulated charge controls. (source – GELCO services test data)



**Short duration EVSE charge**  
– 9,579Watts – 0.95kWh in just  
9.0mins



**Medium duration EVSE charge – from 40%SOC – to 90% in just 47.0mins**



The chart above and the image from the Outlander instrument panel clearly shows that the Charge Station in just 149 minutes has delivered sufficient charge to enable the SUV-PHEV to be driver for 87 kilometers in electric mode. The official Mitsubishi EV mode travel distance fully charged is stated at 50-52 kilometers, so the use of the modulated and controlled charge from the external AeroVironment EV charge Station demonstrates the full capability of the Outlander PHEV.

As the motorist demand builds for the options for alternate fuel sources, there will be many more offerings from companies like Mitsubishi in the near future.

Bob Gell and his business GELCOservices operates a Technical Laboratory service and Consultancy based in Adelaide which focusses on battery testing and validation to manufacturer's specifications and relevant Standards. More info go to [www.gelcoservices.com.au](http://www.gelcoservices.com.au)