INFORMATION GUIDE NO. 5

ALTERNATIVE DRIVETRAINS

saving fuel, money and the environment

1 INTRODUCTION

EcoStation is a joint initiative of the Victorian Environment Protection Authority (EPA) and the Victorian Transport Association (VTA) designed to reduce greenhouse emissions and air pollution from the road freight sector.

A key aim of EcoStation is to promote a sharing of information about the practical actions that can be taken by industry stakeholders to improve the fuel efficiency of road freight operation and to reduce the emissions associated with these vehicles.

With this aim in mind, EcoStation is producing information sheets that will provide commercial vehicle operators with guidance on a number of potential improvement actions with a view to encouraging increased adoption of these programs by industry. This information guide discusses the concept of alternative drivetrains.

2 DESCRIPTION

Alternative drivetrains involve a variety of power sources in combination or separate from internal combustion to provide power to a vehicle.

A hybrid drivetrain, as its name suggests, involves the hybridisation of two or more different power sources in the same vehicle. Hybrid drivetrains can use mechanical, electrical or chemical systems to store and deliver energy, with each possessing distinct performance advantages in a particular application.

An electric hybrid is the most commonly used arrangement, and utilises an electric motor coupled with an internal combustion. This is the type of system found in most commercially available hybrid vehicles and many of those currently undergoing development.

A mechanical hybrid drivetrain is analogous to an electric system in that it can recover braking energy but uses a hydraulic motor instead of an electric motor. These systems have been used in waste collection vehicles that already incorporate a hydraulic system.

When coasting or braking, the wheels turn the motor (operating now as a hydrostatic pump) which transfers hydraulic fluid to a high-pressure accumulator. In the accumulator, an inert gas is pressurised by the hydraulic fluid. When acceleration is required, the inert gas pressure is released to drive the hydrostatic motor.

Fully electric drivetrains uses electric motors instead of an internal combustion engine. Generally, the energy for the motor is stored chemically in battery packs (e.g. lithium-ion battery) which are located on board the vehicle. Batteries may be charged from a standard electricity outlet, or in the future may be exchanged at a specialised exchange station.

Limited applications of electric drivetrains exist beyond passenger cars and light trucks.

3 IMPROVEMENT RATIONALE

The primary benefit of both hybrid and fully electric vehicles is the use of the electric motor as a generator to recycle energy of motion by putting it back into the battery when the vehicle slows down, instead of wasting it as heat in the brake linings. This is called regenerative braking.

Additionally, the electric battery can be used as a substitute for engine power and can reduce engine idling by providing an alternative power source for cabin air-conditioning and various other electrical accessories.

For example, in waste collection the main engine can be shut down and the electrical engine can be used to power the hydraulics for compacting and lifting activities.

Finally, the electric motor (or high-pressure accumulator in the context of mechanical hybrids) can also act as a starter motor to provide power on takeoff. Mechanical hybrids often refer to this as 'hydraulic launch assist'.

4 POTENTIAL BENEFITS

The potential benefits of hybrids and fully electric vehicles are highly dependent on the duty cycle of the vehicle.

While electric hybrid technology has provided up to 20% fuel savings in some Australian fleets, the savings are highly variable, being less than 10% in some mixed urban runs.

A mechanical or hydraulic system provides similar regenerative energy benefits but also has lower losses in converting mechanical to electrical energy, allowing recovery of up to 80% of the vehicle's original kinetic energy. For example, Bosch-Rexroth claim that their hydraulic-based system can provide fuel savings of up to 25% in a refuse application, even with an additional weight penalty of around 500 kilograms.

Fully electric drivetrains completely substitute fuel requirements and therefore require cheaper equivalent electricity power to obtain operational savings. A significant benefit in reducing greenhouse gas emissions can also be achieved contingent on sourcing low emissions power supplies and providing an efficient method of recharging the vehicle to decrease transmission losses.

In addition to potential fuel savings and greenhouse benefits, case studies demonstrate that regenerative braking systems extend the life of the braking system by up to 75% and reduce the need for brake system maintenance. In the case of fully electric vehicles, there has also been an observed benefit from the reduction of vehicle noise, especially in urban use.

5 ASSESSING FLEET SUITABILITY

Hybrid drivetrains are most effective for commercial vehicles operating in urbanised cities with stop-start conditions. Regional linehaul vehicles that spend extended periods at open throttle may not realise sufficient benefits to support the adoption of hybrid electric vehicles as the electric component would be underutilised at the expense of additional fuel consumption to transport the weight of the hybrid engine components.

The ability to use fully electric vehicles can be constrained by limited range and horsepower requirements. Current experience suggests that the technology is most appropriate for light commercial vehicles in an urban application, although in some instances electric freight vehicles up to 10 tonnes have been successful.

Overall, alternative drivetrains are considered most effective for vehicle operation that is characterised by:

- low average speeds
- high stopping frequency rates (i.e. stops per hour)
- limited vehicle range (if fully electric).

6 IMPLEMENTATION CONSIDERATIONS

The higher capital cost of alternative drivetrain technologies means that an acceptable payback period needs to be achieved by ensuring benefits can be realised. Payback will be contingent on the duty cycle, operational life and mileage.

One complication of hybrids having the flexibility of two power sources is the subsequent need to incorporate two energy storage systems. This includes the petrol tank for the conventional combustion engine and a battery pack for the electrical drive. This can have negative implications for vehicle mass and space utilisation. As a consequence there is a small possibility that fuel consumption could actually increase if hybrids are heavier than conventional vehicles and if the electric component is not sufficiently utilised.

With respect to fully electric or plug-in hybrids (yet to penetrate the vehicle market), the potential for escalating electricity costs (in excess of the expected rise in conventional fuel costs) should also be taken into consideration.

Feedback from a small number of companies already using hybrids in Australia suggest that benefits are achievable; however, the scope of potential fuel savings in other countries may not always be transferable to Australian driving conditions.

Fully electric vans and light trucks have undergone a series of successful commercial trials with a number of companies in both North America and Europe. Some operators are now expanding electric vehicle use across their urban delivery and courier fleets.

7 RESOURCE INFORMATION

Additional information on alternative drivetrains can be obtained from the following sources.

7.1 HINO HYBRID

Several fleet operators have used Hino hybrids for urban delivery, including TNT. Experience has shown that fuel savings of 20–30% are achievable. Further information can be found at:

http://hino.pressroom.com.au/press_kit_detail.asp?clientID=31&navSectionID=6&categoryID=1000&kitID=224

7.2 US POSTAL SERVICE (USPS)

USPS has trialled 2-tonne hybrid electric postal vans since 2004 and has recently purchased another vehicle.

www.azuredynamics.com/corporate/investor-relations/documents/PR_Aug26_2009.pdf

7.3 DENVER REFUSE COLLECTION

A mechanical hybrid Peterbilt Model 320 refuse collection truck equipped with a hydraulic launch assist system has achieved a 25% reduction in fuel consumption. Further information can be found at:

www.hydraulicspneumatics.com/200/Issue/Article/False/84207/Issue

7.4 TNT (UK)

TNT began running a fully electric 7.5-tonne truck in 2006. Following its success, 50 more trucks were ordered in 2007 and a further 50 in 2008. Fuel costs have reduced by almost 80% when considering the cost of electricity versus that of diesel. Further information can be found at:

www.smithelectricvehicles.com/casestudies_tnt.asp

7.5 TK MAXX (UK)

TK Maxx has added a 10-tonne fully electric Smith Newton vehicle (largest carrying capacity of any electric truck) to its distribution fleet. It has a body length of 7.5 metres and a cargo payload over 4000 kilograms.

The vehicle has a top speed of 50 miles per hour, and after it has been fully charged over a 6–8 hour period, it has a range of up to 200 kilometres (per charge). Further information can be found at:

www.smithelectricv3ehicles.com/casestudies_tkmaxx.asp

8 FURTHER INFORMATION

Further information about EcoStation, including program participation, can be obtained by contacting the EcoStation Project Manager on:

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