

## A Guide to Electric Vehicles

For commercial fleets, electric and hybrid electric vehicles offer reduced fuel, emission and operating costs. This guide provides a summary for Fleet Owners and Operators which introduces the technology, costs and benefits associated with electric and hybrid electric vehicles.



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## OVERVIEW

For commercial fleets, electric and hybrid electric vehicles offer reduced fuel, emissions and operating costs.

- Batteries fitted in electric vehicles offer Ireland the opportunity to store electricity from our high wind and ocean renewable energy resources, reducing dependence on imported fossil fuels.

This guide provides a summary for Fleet Owners and Operators which introduces the technology, costs and benefits associated with electric and hybrid electric vehicles. A more in-depth analysis of the cost and benefits including a lifecycle calculator and buyer's guide is available from SEAI's website at the following location: [www.seai.ie/transport](http://www.seai.ie/transport)

**This guide aims to give buyers some relevant information to help choose the vehicle that suits you.**

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## ELECTRIC VEHICLES (EV's)

Government policy has set a target for 10% of all vehicles on our roads to be powered by electricity by 2020, this will represent approximately 230,000 vehicles. The plan includes:

- National roll-out of charging infrastructure with:
  - 2,000 domestic charge points
  - 1,500 public access city and town charge points
  - 30 inter urban fast charging points spaced 60km apart
- Government grant of €5,000 for electric vehicles and €2,500 for plug-in hybrid electric vehicles available in 2011 and 2012 from SEAI. Grants will be available via vehicle suppliers for passenger vehicles with M1 classification under the European Whole Vehicle Type Approval Process and an EuroNCAP rating of at least 3. See [www.seai.ie/transport](http://www.seai.ie/transport) for further details.
- VRT exemption for electric cars and a rebate of up to €2,500 for hybrid electric cars until the end of 2012
- SEAI support for research and demonstration projects
- Tax incentives for businesses to purchase electric vehicles

## RANGE

Ireland's average daily round trip commutes of 30km<sup>1</sup> are ideal for electric vehicles operating in urban areas:

- Lithium ion battery equipped vehicles provide ranges of up to 120km on a single overnight charge.
- A network of fast charging points (~20mins per charge) is planned to enable electric vehicles to traverse the relatively short intra urban distances in Ireland. See [www.esb.ie/ecars](http://www.esb.ie/ecars) for further details.

## RUNNING COSTS

EVs offer substantially lower fuel cost and net emissions with lower maintenance costs. As the renewable intensity of Ireland's electricity supply is expected to rise substantially by 2020, the emission benefits for the EVs will improve in step.

## TYPES

Several types of electric vehicles are becoming available in Ireland, broadly they fall into three categories:

- **Battery Electric Vehicles (BEV)** powered only by a plug in charged battery. Electric motors have high torque at a wide range of speeds and therefore do not generally require a gearbox. Electric motors have very high efficiencies ~90+% compared to internal combustion engines at ~30-45%.
- **Hybrid Electric (HEV)** a petrol or diesel engine is used to generate electricity, which then powers the electric drive motor. Surplus electricity is stored in a battery, reducing engine revving and idling losses. Two types of hybrid drive vehicles are available, series and parallel hybrids:
  - A **series hybrid** is an all electric drive-train which decouples the combustion engine (which then exclusively drives the electricity generator) from the drive shaft and allows the elimination of the gearbox.
  - A **parallel hybrid** operates the combustion engine in parallel to the electric motors and uses an automatic gearbox, the vehicle can run on electric, fossil fuel or both in combination.
- **Plug-in Hybrid Electric Vehicle (PHEV)** similar to the hybrid, except it uses a larger battery store to enable a portion of its energy to come directly from the electricity grid, returning to petrol or diesel energy when the battery charge is depleted to a certain level.

All types can have a combined braking and charging system known as – "Regenerative Braking", which improves urban efficiency by recovering the considerable kinetic energy from the car's momentum during braking.

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<sup>1</sup> SEAI Electric Vehicle Buyers Guide

## WHY BUY AN ELECTRIC OR HYBRID VEHICLE?

- EV's are cheaper to operate with low maintenance and up to 70% lower fuel costs<sup>2</sup>.
- EV's are very suitable for stop-start urban driving with good acceleration from rest and lower top speed.
- They are smoother and quieter than conventional vehicles.
- Tail pipe emissions are lower or zero emissions (i.e. for the BEV) making city air cleaner and healthier.
- For BEVs, the overall fuel emissions reductions are 30% compared with diesel assuming the current electricity mix. This figure could rise to a 100% reduction if the electricity was supplied exclusively by renewables (for example in the case of on-site wind generation).

At a national level, 14% of Ireland's electricity comes from renewable energy, this is set to rise to 40% by 2020<sup>3</sup>.

## WHAT ARE THE DISADVANTAGES?

- As the vehicles are produced in low numbers at present, they are generally more expensive to purchase.
- BEVs have ranges of up to 120km for now: For those wishing to drive between urban centres, 30 fast charging points will be available every 60km along major intra urban routes by 2011, vehicles can receive full charge within 20-30mins at these stopping off points.

## CHARGING

- Charging infrastructure is critical to the successful roll-out of electric vehicles in fleets.
- ESB have announced the provision of 1,500 public access charge points by 2011.
- Please consider carefully how and where the vehicle will be charged.
- To re-charge a battery electric (BEV) or plug-in hybrid electric vehicle (PHEV), it must be parked, usually overnight to take advantage of lower cost night rate electricity.
- During day-time operation the driver will have the ability to charge the vehicle at a public charging point in the town, or at a fast charging station when travelling between towns and cities.

The proposed charging options are as follows:

- Fast Charging – 400V with 63amp 3 phase charging station (20-30mins to full charge).
- Domestic Charging – 230V and 16amp single phase power (3-8 hrs).
- On Street or Car Park Charging – 400V with 32amp 3 phase charging point (0.5 to 1.5 hrs).

<sup>2</sup> SEAI Electric Vehicle Buyers Guide

<sup>3</sup> Source: SEAI Renewable Energy in Ireland 2010

## WATCHPOINTS FOR ON-SITE CHARGING

- Is location secure for overnight charging?
- Can cable be run to vehicle without creating a trip hazard?
- Are charging facilities available at all the locations the vehicle may be parked?
- For fast charging a 3-phase electricity supply is needed at the location.
- For longer period charging e.g. 2300-0800 overnight, a single phase supply may suffice.
- If a number of vehicles are planned at one location, discuss the plan with ESB.
- Finally, if your charging location is suitable, could the facility be offered to other electric vehicle users during the vehicles' working day?



Image courtesy of ESB

### Note

The lead-acid battery is slowly being superseded by a Lithium Ion (Li ion) battery. While initially more expensive, Li ion offers greater range and shorter charging time.

These new battery technologies offer four times the storage capacity of traditional lead-acid batteries enabling the use of regular sized vehicles.

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## BUYING A BATTERY ELECTRIC CAR (BEV)

A wide range of BEVs are becoming available from mainstream vehicle manufacturers due to the availability of high performance lithium batteries and the increasing pressure from European regulators to supply the market with more efficient cleaner vehicles.

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### Advantages

- Fuel costs will be up to 70% less than an equivalent conventional fossil fuelled car costs at current energy prices. This is because the electric car needs much fewer units of energy for the same journey and the units of night rate electricity are relatively cheap.
- Maintenance costs are much lower than those of an internal combustion engine vehicle.
- Emissions will be 30 – 40% lower than those from an equivalent petrol or diesel vehicle based on current electricity generation mix. This figure will improve significantly as Ireland increases its supply of electricity from wind and other renewable sources.
- Ideal for stop-start city driving as no energy is used when the vehicle is stationary.
- There is no Vehicle Registration Tax payable on BEV cars until the end of 2012.

### Disadvantages

- Batteries are relatively expensive at present, so the car will be more expensive than a conventional vehicle to buy. Purchase cost will reduce as the worldwide market volume increases.
- Manufacturers are currently offering 3-5 year battery life guarantees for some lithium products.
- Manufacturers are claiming battery lives of 1,000 – 3,000 full charge cycles which would allow a life of between 3 to 8 years assuming that one full cycle charge is needed per day; which is unlikely to be the case for a vehicle used for typical commuting distances.

To address this variance, some vehicle suppliers are proposing to sell the vehicle while separately leasing the battery to the customer. The fuel cost savings would then be used to offset the annual battery leasing costs.

- Range is currently limited to between 60 and 120 km on a single charge, however, public access charging points including fast charging points are planned to be widely available by 2011.
- Charging time from zero is ca. 3 to 8 hours (230v single phase), depending on vehicle's charge state, reducing to 20mins when using 3 phase fast charging units with the appropriate battery technology.
- Top speed is generally 65 -100kph.

### Conclusion

Battery Electric Vehicles are in a state of rapid development which will offer competitive purchase costs and better range.

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*Image courtesy of Nissan*



*Image courtesy of Mitsubishi Motors Ireland*

## BUYING A HYBRID (HEV) OR PLUG-IN HYBRID ELECTRIC CAR (PHEV)

Hybrid cars on the market today are fuel efficient fossil (petrol or diesel) fuelled cars which use a battery to increase efficiency, by enabling the vehicle to move and operate without fossil fuel while in traffic, and by recovering the considerable kinetic energy from the car's momentum during braking.

Plug-in hybrid cars available from 2011 onwards use a bigger battery to extend range on all-electric drive. This battery can be charged by storing surplus wind and ocean energy for transport applications.

### Advantages

- Hybrids offer fuel cost and emissions savings by reducing the energy wasted during engine idling in traffic and recovering kinetic energy from the vehicle during braking (regenerative braking).
- With a series hybrid, the internal combustion engine can operate at its optimum energy efficiency at all times regardless of the vehicle or wheel speed.
- Plug-in hybrids offer improved fuel and emission savings over the hybrid vehicles available today.
- Plug-in hybrids offer some of the advantages of the BEVs at a lower cost with less reliance on public charging infrastructure due to extended range using fossil fuels.
- Plug-in hybrids are likely to have sufficient range for most commuting drivers in Ireland to operate primarily on grid supplied electricity from overnight charging during the week.

- For longer range journeys, the vehicle will operate as a hybrid vehicle relying on the fossil fuel supply, giving range and driving speed comparable to a conventional car.

### Disadvantages

- Maintenance costs may be higher which would be associated with the use of two power systems (engine plus electric motors) which in turn may be offset by less engine and brake wear (due to optimum engine speeds and regenerative braking) coupled with the elimination of the gearbox as in the case of the series hybrid car.

### Conclusion

Users with high urban mileage and longer term ownership will see the greatest fuel cost savings.



Image courtesy of Universal Honda Ireland Limited



Image courtesy of Toyota Ireland Limited

Compare to petrol / diesel cars	HEV	PHEV	BEV
<b>Fuel cost savings</b>	17%	40%	70%
<b>CO<sub>2</sub> Emission Reductions (current average mix electricity)</b>	19%	30%	30-40%
<b>CO<sub>2</sub> Emissions Reductions (100% wind generated electricity e.g. on-site wind generation)</b>	19%	60%	100%
<b>Range</b>	Comparable to diesel vehicle		60-120Km
<b>Overall running costs</b>	Lower	Lower	Lower
<b>Noise</b>	Quieter	Quieter	Silent
<b>Motor tax</b>	A	A	€ 80 <1500kg
<b>Battery life</b>	Guarantees of 3-5 years may be available from some manufacturers		
<b>Vehicle Grant – 2011 to 2012</b>	n/a	€ 2,500	€ 5,000
<b>VRT rebate – To 2012 only</b>	n/a	€ 2,500	Exempt

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## BUYING A BATTERY ELECTRIC VAN (BEV)

Early electric vans used lead-acid batteries and were favoured for early morning and night time deliveries in residential areas due to their quietness. More powerful modern batteries have enabled the conversion of regular sized commercial vehicles.

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### Advantages

- Ideal for multi-drop, stop start deliveries.
- On-site wind or other renewable electricity generators may be used to supply electricity for transport to own vehicles or potentially for visiting vehicles.
- Battery warranties of 3-5 years with number of full charging cycles of 1,000 to 3,000 are currently available from manufacturers.
- Commercial vehicles operating on regular or fixed routes each day provide the opportunity to match BEVs with required ranges and possible access to distributed depots for intermediate charging or fast charging of vehicles as required.

### Disadvantages

- While the lithium batteries are the most expensive single component of the vehicle, their cost can be expected to reduce quickly as the numbers on the road increase and manufacturing processes become more automated.
- The van must be able to park for sufficient time to charge it for a full day's work.
- Lack of market experience amongst fleet operators and leasing agents for these types of vehicles

### Conclusion

Highly competitive for smaller areas with stop/start operations.

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Light commercial vehicle – image courtesy of ESB



Image courtesy of Galway City Council



Image courtesy of Avia Truck



Medium truck – image courtesy of Celtic Linen

*“We were determined from the introduction of our electric truck that it would work as hard as any vehicle in the fleet, to date we have made no exceptions for it. The running cost savings so far are very attractive, charging is easy. Drivers love it and something we didn't expect is the positive feedback from some of our early morning hotel customers who are delighted with how quiet it is. Re-charge anxiety only lasted for a few days, now drivers accept that its merely a smaller tank”.*

**Hugo Malone, Commercial Manager, Celtic Group**

## BUYING A HYBRID (HEV) OR PLUG-IN HYBRID ELECTRIC VAN (PHEV)

Hybrid electric vans or trucks offer similar advantages to those described previously for the hybrid car. For vehicles operating on longer range tasks with fewer urban routes or heavier duty cycles than those offered by the BEV, a hybrid electric vehicle may be an alternative choice. As the power density (and hence range) of the lithium batteries improve, more of these vehicles can then avail of the fuel cost and emission savings offered by plug-in charging.

### Advantages

- Range will be considerably further than an equivalent battery electric van.
- Battery life is often guaranteed by manufacturers for 8 years or van lifetime.
- Top speeds are comparable to conventional fossil fuelled vans.

### Conclusion

Suitable for normal van use, but a higher utilisation e.g. double shifts, or a higher mileage may be needed to generate the fuel cost savings required for the additional capital investment.

### Disadvantages

- Maintenance costs may be higher, with 2 power sources – electric and petrol or diesel - offset by lower brake replacement due to regenerative braking and having no clutch.
- Whilst hybrid vans do not need charging points, plug-in hybrid vans do, as above you must be able to park, cable and charge the van for sufficient time to do its next day's work.

Compared to diesel vans	HEV	PHEV	BEV
Fuel cost savings	17%	24%	70%
CO <sub>2</sub> Emission Reductions (current average mix electricity)	23%	27%	30-40%
CO <sub>2</sub> Emissions Reductions (100% wind generated electricity e.g. on-site wind generation)	23%	40%	100%
Range	Comparable to diesel vehicle		120km
Overall running costs	Lower	Lower	Lower
Noise	Quieter	Quieter	Silent



Image courtesy of ESB

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## BUYING A BATTERY ELECTRIC BUS (BEV)

Battery electric buses offer enhanced fuel cost and emission savings. As with BEVs, range and duration of daily duty cycle will need consideration at the planning stage. If the vehicle is incapable of storing sufficient energy over the night time period, then the operator must ensure that sufficient access is available during the day from depots or public charge points to provide the range necessary within the charging time available. It is likely that shuttle bus scale operations may see the first application of BEVs in Ireland.

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### Advantages

- They are very suitable for short range multiple pickup/set down and intermittent use (e.g. operation during peak hours only).
- Emissions are less than 25% of diesel buses.
- Operational costs should be considerably lower due to lack of mechanical complexity.
- Electric buses can significantly reduce noise pollution in urban routes.

### Conclusion

Highly competitive for smaller areas with stop/start operations.

### Disadvantages

- Smaller (7.5m) buses are up to twice the price and 10m versions are 50% more than equivalent diesel buses.
- Range will be reduced due to weight and is unlikely to be more than 120km.
- Application may be limited to 10-15 tonne electric vehicles in the near to medium term.
- Recharging is generally expected to be performed over night, however if day time charging is required, charging may take a long time unless 3 phase fast charging is available.



Image courtesy of Wright Bus



Image courtesy of Wright Bus



## BUYING A HYBRID (HEV) OR PLUG-IN ELECTRIC BUS (PHEV)

Hybrid scale buses and trucks are still in the development/proving phase. As with the smaller hybrid vehicles, hybrid buses offer some of the advantages of the all electric vehicles without the range and infrastructural issues. As the energy density of the battery technology improves, plug-in versions (new and retrofit) of these buses should become available thereby benefitting from low cost electricity with associated emission reductions.

### Advantages

- Fuel costs will be up to 30% lower than a conventional bus.
- CO<sub>2</sub> and particulate emissions will be up to 30% lower than a conventional bus.
- Options for silent mode operation in specified urban areas during pre-defined hours of operation.
- Speed and available power is similar to a conventional bus.
- Daily travel range and passenger carrying capacity equivalent to a conventional commuter bus.

### Disadvantages

- On average these buses cost around 50 – 60% more to procure than a conventional diesel bus.
- Maintenance costs can be higher, with 2 power sources – electric and petrol or diesel - offset by the elimination of a gearbox, reduced brake wear associated with the use of regenerative braking.
- Limited experience and awareness of these vehicles in the sector at present.

### Conclusion

The higher purchase cost must be offset by fuel, emission and operating cost savings to ensure competitiveness with diesel models.

Compared to diesel buses	HEV	PHEV	BEV
<b>Fuel cost savings</b>	25%	33%	75%
<b>Range</b>	Comparable to diesel vehicle		120km
<b>CO<sub>2</sub> Emission Reduction (current average mix electricity)</b>	25%	36%	40%
<b>CO<sub>2</sub> Emission Reductions (100% wind generated electricity e.g. on-site wind generation)</b>	25%	43%	100%



Image courtesy of Dublin Bus

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## COMMERCIAL CHECKLIST

Consider the following points when choosing battery, hybrid, or plug-in hybrid electric vehicles:

<b>Payload</b>	<input type="checkbox"/> Can vehicle carry the weight you need? <input type="checkbox"/> Can vehicle carry sufficient volume?
<b>Passengers</b>	<input type="checkbox"/> How many seated / standing?
<b>Range</b>	<input type="checkbox"/> What range do you require, does this change daily, monthly, yearly?
<b>Charging locations</b>	<input type="checkbox"/> Can vehicle be parked, where it can be charged ready for next journey? <input type="checkbox"/> Can the cable be safely deployed to vehicle for long periods?
<b>Re charge time</b>	<input type="checkbox"/> Is vehicle free to be charged overnight?
<b>Duty cycle &amp; Route Planning</b>	<input type="checkbox"/> How many stops, distances between stops, how much braking / stop-start? <input type="checkbox"/> Are there productivity gains / losses from revised vehicle configuration?
<b>Noise</b>	<input type="checkbox"/> For night-time or early morning deliveries, does silent operation allow more cost effective and environmentally friendly operation?
<b>Lifetime</b>	<input type="checkbox"/> Can the vehicle be used for 10 or more years, extending its useful life and return on investment?

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## VEHICLE SUPPLIERS

Vehicles for commercial use must be roadworthy, the standard for roadworthiness of new vehicles is Type Approval, new vehicle purchases should comply with EU Type Approval Rules. The NSAI are the authority in Ireland who approve vehicles for sale or registration on the Irish car market. There are 3 routes to approval:

- Individual Vehicle Approval (IVA)
- National Small Series Type Approval (NSSTA) and
- EU Whole Vehicle Type Approval (EC-WVTA)

Information on all three are available from the NSAI website:

[www.nsa.ie/Our-Services/Certification/Transport-Certification/Motor-Vehicle-Approval-Schemes.aspx](http://www.nsa.ie/Our-Services/Certification/Transport-Certification/Motor-Vehicle-Approval-Schemes.aspx)

See also ESB eCars list of suppliers:

[www.esb.ie/main/sustainability/ESB-ecars-manufacturers.jsp](http://www.esb.ie/main/sustainability/ESB-ecars-manufacturers.jsp)

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## ACCELERATED CAPITAL ALLOWANCES (ACA) TAX INCENTIVE

SEAI operates the ACA scheme which allows the full value of the Corporation Tax relief on capital assets to be claimed in year 1 rather than over the standard 8 year depreciation period. This incentive is only available for specific technologies which include electric vehicles and their associated charging equipment. More details on the ACA and its associated products are available from [www.seai.ie/aca](http://www.seai.ie/aca)

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## ELECTRIC VEHICLE GRANTS

Grants of up to € 5,000 will be available for BEVs and grants of up to € 2,500 will also be available for Plug-in HEVs. The support will be available from 2011 to 2012 and the grants will apply to passenger vehicles classified as M1 under the European Whole Vehicle Type Approval. SEAI will produce a list of registered products and dealers. Grants will be applied for online via the vehicle dealership.

**Note:** Both the ACA and EV grant can be proportionally claimed for the same vehicle.

For more information refer to SEAI's other Transport Energy Guides, visit [www.seai.ie/transport](http://www.seai.ie/transport)

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