



2010  
Electric & Hybrid Vehicles  
Complete and Independent  
Buyers Guide



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# 1. INTRODUCTION

## The Purpose of This Guide.

This easy-to-read guide provides the necessary technical details and general guidelines to ensure you understand how to buy a car that can do the job you want it to do. Even people with little technical knowledge should be able to reap the full benefits and value of this book.

World-wide, there is a strong focus on green vehicles and the interest continues to grow as consumers realize the benefits of green cars. The Frankfurt Motor Show 2009 showed a very large number of Electric and Hybrid Vehicles from almost all manufacturers.

Buying a new type of vehicle that you aren't familiar with can be a challenge to any consumer that has little or limited knowledge of the technical details. You don't know what to look for or what test results you should review. Standards for vehicle power consumption are slowly being developed, which makes it even more important to know what to look for. This guide will help you understand what questions to ask and what to take note of when you search for a green vehicle. It will empower you to make the best choice for your specific needs.

## How to Use the Guide

It is important to start with the General Terms in Chapter 3, in order to understand some relevant terms and information you will need as you read through the rest of the guide. The terms aren't difficult to understand. Knowing the terms will also help you confidently converse with car salespersons when you are ready to buy. You will understand what they are talking about when they use these terms to explain the benefits of the car. After the General Terms, the book is divided into three main chapters:

- Electric Vehicles EV
- Hybrid Electric Vehicles HEV
- Plug-in Hybrid Electric PHEV

Each chapter starts with a brief definition and overview. The main section, which is a list of important questions that you can ask before you buy a new car, follows the definition. This will give you the knowledge to compare different cars and enable you to make an informed choice based on your specific needs.

Chapter 10 has a printable list of all the questions from previous sections. You can print the list and take it along as a reminder of all the relevant questions you want to ask when you test drive the cars.

There are links in some sections of the guide that provide an opportunity to get more information by clicking on

the link. Because some of the original links are very long, I have shortened them by using [www.tinyurl.com](http://www.tinyurl.com). For added benefit, I have also added some tips and tricks on how to drive and operate the cars. I wish you all the best and an excellent experience as you prepare for your car-buying excursion!

# 2. MY BACKGROUND

I have worked with Electric Vehicles (EV) for twelve years at the airport in Copenhagen. In doing so, I've acquired extensive knowledge and understanding of Electric Vehicles.

I have been a part of the test team from the beginning and am now project manager for the Electric Vehicle Rampsnake. For more information about Rampsnake, take a look at this YouTube video: <http://www.youtube.com/watch?v=tdAsGtB6Xjk>

During my visit to the Paris Motor Show 2008 and the Detroit Auto Show 2009, it became clear to me how many car manufacturers are "going" electric. In Paris, I tested the Smart EV and the Mitsubishi i-MiEV and realized that the industry has to go that way. The cars are very fun to drive and offer so many environmental advantages. Since then, I have tested many EVs with the Tesla Roadster as the fastest, and the Reva (G-Wiz) as the most-sold EV.

Testing Electric Cars is a lot like testing the electric equipment at the airport. Therefore, I decided to create my website: [www.easycar.com](http://www.easycar.com) to share what I have learned. The purpose of the website is to conduct testing of Electric Vehicles and Hybrid Electric Vehicles. I also have my own video channel on YouTube: <http://www.youtube.com/user/EVtestDK> As I test more vehicles, I will add these to the web site and YouTube.

I have started a group for testing of Electric and Hybrid vehicles on [www.linkedin.com](http://www.linkedin.com). EV/HEV test - electric vehicles and hybrid electric vehicles test. If you join the group you can see the latest discussions: [http://www.linkedin.com/groups?home=&gid=1891673&trk=anet\\_ug\\_hm](http://www.linkedin.com/groups?home=&gid=1891673&trk=anet_ug_hm). Here you can participate by sharing your own experience in testing of Electric and Hybrids or read other people's view on this subject. There are also links to interesting videos and news about testing. Here are some of the subjects:

- Has anyone done any testing with Electric Motor cycles?
- What is the likely minimum requirement for an EV in terms of range/speed?
- Toyota Prius vs. Honda Insight video
- And much more

My LinkedIn profile can be seen on: <http://www.linkedin.com/in/martinmesser>. Feel free to connect with me by indicating that you have read my e-book.

At the EV Li-Ion Battery Forum 2009 in Shanghai I gave a speech about the EV market in Denmark and the ideas on battery swapping for Better Place. [www.ev-li-ion-batteryforum.com](http://www.ev-li-ion-batteryforum.com).

Denmark has the highest amount of power produced from windmills in the world. Therefore we need to have an opportunity to store the power when there is an overproduction. The Danish power company DONG signed an agreement with Better Place to use their cars to store the power when there is an overproduction.

## 3. GENERAL TERMS

### Batteries

There are three main categories of batteries:

1. Lead-acid batteries are the old type of batteries, that are standard in any petrol or diesel vehicle. They are relatively cheap and need to be refilled with water on a regular basis.
2. Nickel-Cadmium (Ni-CD) and Nickel Metal Hydride (NiMH) are sealed batteries that are maintenance-free and can hold more energy.
3. Lithium-ion (Li-Ion) batteries are also maintenance-free. If you compare a lead-acid battery with a Li-Ion battery of the same weight, the Li-Ion can hold six to eight times more power. Li-Ion batteries are still very expensive, but they have just begun to be mass-produced and I expect the price will go down a lot with the mass production.

More information about batteries can be found at: [http://en.wikipedia.org/wiki/lithium-ion\\_battery](http://en.wikipedia.org/wiki/lithium-ion_battery) Here you can read all the technical details and get some information on the chemistry for each battery type.

### Regenerative Braking

Instead of using the mechanical brakes, the electric motor can act as a generator. The resistance in the motor brakes the car when it regenerates energy and the energy will then be stored in the battery, ready to use in the next acceleration.

There are two ways the regenerative braking can be activated:

- In some cars it is activated when the foot is taken off the accelerator.
- In some cars it is activated when the foot is applied to the brake pedal.

In the Mitsubishi i-MiEV you can select two different modes for regenerative braking:

- D: Drive - you have little regenerative braking.
- B: Break - you have a more powerful regenerative braking.

It is very important that the regenerative braking is overruled by the ABS (Anti-lock Braking System). If not, you can easily lose control of the car when the road is wet, snowy or icy. Regenerative braking would be even safer if it could also be integrated in the ESC/ESP (Electronic Stability Control/Program). When the motor is working as a generator, it acts as a brake and in slippery conditions it will block the wheel and you will lose control of the car.

This makes regenerative braking is one of the biggest benefits of an EV!

When you first drive a car with powerful regenerative braking, it can feel strange. It's probably different than what you're used to. Try to brake ten times by only using the regenerative and you will see how easy it is to get used to. Once you get used to it, you will not want to drive without it!

It is said that the dust and particles from mechanical brakes can add up to about one-third of the polluting particles in the air in a city. Regenerative braking reduces the use of mechanical brakes and reduces particles in the city air. This can have a huge impact on environmental air quality.





### Warning:

If you own an EV and use the regenerative brakes a lot, make sure to do some hard braking using your mechanical brakes once a week. If you don't, they may tend to stall and wear out quickly, and use a lot of energy.

## 4. ELECTRIC VEHICLE (EV)

### Definition:

An Electric Vehicle (EV) is a vehicle with an electric engine. The EV has to be charged and the power is stored in the vehicle before it can be driven.

The power used for driving can be stored onboard the EV in different ways:

- In batteries—so far, this is the most common way to store the energy. This is referred to as Battery-Electric Vehicles (BEV). See Chapter 2 for general terms about batteries.
- In super capacitor. (See [http://en.wikipedia.org/wiki/Electric\\_double-layer\\_capacitor](http://en.wikipedia.org/wiki/Electric_double-layer_capacitor) ) This article discusses the technical details of the capacitor and the use of them. In general, a capacitor can store a large amount of energy in a short while and can quickly deliver it back.
- Any combination of batteries and capacitor.

I have not yet seen any cars with a capacitor, so this book will focus on Battery Electric Vehicles (BEV) with battery implicit. Therefore, I just refer to it as an EV.

### Advantages:

- The electric motor makes no or very little noise
- No pollution while driving
- Easy to drive
- Automatic transmission

### Disadvantages:

- Price—some “state of the art” batteries are very expensive. (See chapter about batteries.)
- Range—if you cannot swap batteries, you need to wait to charge the car before you can continue to drive.

### What to Look for Before Buying an EV

#### 1. Range/autonomy—ask to what standard the range is tested.

This is the big issue and still a handicap of the EV. Therefore, some of the manufacturers are not stating the range according to a set standard, but after having measured it at constant speed of e.g. 30 km/h. That produces a number that is far too high and not at all realistic. An EV uses very little power to move the vehicle; therefore, all other power consumers become a big issue and create a big influence on the range. (See question 9 – heating the car.)

My rule of thumb: The distance you drive daily between charging should not exceed 50% of the stated range. Following this general rule of thumb should provide you with a comfortable margin, so you do not run out of power when you need to use a lot of power for a/c, heating, and other power consuming features.

#### 2. Battery—ask what type of batteries the car has.

There are three categories of batteries:

- Lead-acid is the old type of battery. They are relatively cheap and need to be refilled with water on a regular basis.
- Nickel-Cadmium (Ni-CD) and Nickel Metal Hydride (NiMH) are sealed batteries that are maintenance-free and can hold more energy.
- Lithium-ion (Li-Ion) is also maintenance-free. If you compare a lead acid battery with a Li-Ion battery of the same weight, the Li-Ion can hold six to eight times more power. Li-Ion is still very expensive, but they have just begun to be mass-produced, and prices are expected to drop.

#### 3. Battery maintenance—ask if the batteries require maintenance.

If you need to maintain the batteries, keep in mind that it takes time and if you forget to do it right you might have loss of warranty and/or damage the batteries. If the battery is damaged, you will be required to buy a new battery. Only the lead-acid battery should require maintenance,

and if it does, ask how often maintenance is necessary and what to do to correctly maintain the battery.

#### 4. **Battery warranty—ask about the length of the warranty and the exceptions.**

This is one of the key considerations when purchasing a car. Battery prices are high—up to 40% of the price of the car. Therefore, you want to have a long warranty to be relieved of the stress of suddenly having to buy a new battery. I recommend that the minimum acceptable warranty is a five-year warranty. If you have a five-year warranty, I would expect the price of the battery will be a lot lower in five years.

Ask if there are any exceptions to the warranty, such as whether you negate your warranty if you run the battery too far down or do not correctly charge it.

#### 5. **Battery charging possibilities—ask if car can be charged normally, quickly, and/or with battery swap.**

Before you buy any car, it is very important to carefully read the user manual on how to properly charge the battery to maintain a long battery life. Does the battery charging system conflict with your expected schedule and use of the car? For an example, when the REVA with lead-acid batteries needs to balance the cells of the batteries, it has to be on constant charge for 16 hours. Balancing the cells is crucial because all cells must have the same amount of power. Would you be able to allow 16 hours for your car to charge, without needing use of it during the charging time?

#### 6. **Battery use—ask how the battery should be used.**

Some batteries should be run down to a certain level before you can charge it. Some batteries should not be charged just because it is an opportune time for you. Therefore, it is important to know this before you purchase a car.

#### 7. **Battery charging hours—ask how many hours it takes to charge the car.**

You would need to consult with a local electrician about installing a dedicated power outlet for your EV and to

tell you how many Amperes (Amps) you have available at your home.

Charging time for the Mitsubishi i-MiEV:

200Volt 15Amps: 7 hours

100Volt 15Amps: 14 hours

200Volt (Amps is unknown) 3-phase Quick charge: 30 min to 80% charge

It is only possible for a quick charging to charge up to 80%, and charging might not be possible from a normal size household electrical installation.

The Tesla can be quick-charged in 3.5 hours, but you need 70 amps, which is about twice the capacity of a normal household capacity

#### 8. **Leasing the batteries—ask for conditions.**

Leasing is a convenient way to reduce the stress of owning an EV. With leasing, you do not have to worry about when the battery has to be replaced. Check the conditions on the leasing contract and find out if the lease company or your insurance company will cover the battery expenses in case of an accident.

#### 9. **Heating the cabin—ask how it is done.**

Heating the cabin takes a lot of energy compared to driving the car, creating a weakness for an EV. Some of the small cars like the Buddy and the Reva (G-wiz) have solved the problem by installing a cabin heater that runs on petrol. There is a small tank for this heater and the driver needs to refuel the car with petrol specifically for the purpose of heating the cabin. Renault

ZE has created an insulated cabin to lower the amount of energy needed.

#### 10. **Regenerative braking—ask how it is done.**

##### **Warning:**

It is very important that the regenerative braking is overruled by the ABS (Anti-lock Braking System). If it is not you can easily lose control of the car when the road is wet, snowy or icy. It would be even safer if it also could be integrated in the ESC/ESP. See details about regenerative braking in Chapter 3 General Terms.

Test how the regenerative braking is activated:



- On some cars it is activated when you take the foot off of the accelerator
- On some cars it is activated when you apply the foot to the brake pedal.

Warning: If you own an EV and use the regenerative brakes a lot, make sure you do some hard braking about once a week, using your mechanical brakes. If you don't, they will tend to hang and wear out quickly and use a lot of energy.

### 11. Safety—ask to what standards the car is crash tested.

I have not yet seen an EV that has been crash tested to a standard like the Euro NCAP <http://www.euroncap.com> or the U.S. [www.safercar.gov/](http://www.safercar.gov/)

When more EV are available on the market I expect them to be crash tested, so check if the car you want to buy has been crash tested. ESP/ESC is said to be one of the most important safety features. I recommend that you buy a car with ESP/ESC (Electronic stability Control/Program).

### 12. Type of vehicle—ask if it is a Quadcycles, normal vehicle, or other.

There are special rules in some countries of how an EV is approved. You'll want to be sure the car you buy meets approval standards.

In some countries, the Rava (G-wiz) is referred to as a Quadricycle classification L7e or M1 and that means that the car does not have to meet any crash test specification.

In Canada there is a classification called "low speed vehicles." In this class the vehicles are not allowed to travel more than 50 km/h. Some of the vehicles sold in Canada might be capable of traveling more than 50 km/h, but will not be allowed to do so. Ask if there is any local speed limit for the car in your country.

### 13 Incline driving—try to stop while going up a hill.

Some EVs hold the vehicle still if you stop on a hill without you having to touch any pedal.

This prevents the car from rolling backwards when the car starts. This is a nice safety function.

### 14. Ground clearance—check the ground clearance.

Many of the cars have the batteries underneath the car, so the ground clearance might be low.

Drive around in your neighborhood, the shopping mall, and parking garage to see if clearance of speed bumps or other obstacles is a problem. The VW Golf has a ground clearance of 8.9 cm, which is the same as 3.5 inches. The VW Golf is relatively low.

### 15. Drive while the battery is on charge—test to see if it is possible to drive when the car is plugged in.

It sounds like a minor detail, but sooner or later you will forget to unplug, and start driving. Test to see what happens if you try to start driving while the car is on charge. Does a warning light come on? Does the car not drive at all, or will you be able to start driving?

### 16. Service contract—ask if there is a service contract available for the vehicle.

You'll want the service contract to include the battery. If you can get a service contract, the price of it will be a good indication of the price of maintenance to be expected on the vehicle.

### 17. Status of charge—find out if you can see the status of charge (SOC)

When the car is charging it is very convenient if you can see the level of the charge. On some cars you need to unplug it to see the SOC. Can you see it from the outside without having to open the door? Can you see the SOC via SMS or online?

I would prefer if the car could send an SMS when it is fully charged or if the charging is interrupted for some reason. I have not seen any cars that can do it.





### 18. **Vandalism—**is the wire protected/locked so only you can unplug it?

There might be a problem with other people unplugging the car for fun or vandalism. Can the wire be locked both in the car and at the charging point?

### 19. **Pay load—**how much load can the car take?

The batteries are often heavier than the engine they replace, so that gives a lower pay load. Consult with your local dealer as these rules vary from country to country.

### 20. **Pulling load—**how much load are you allowed to pull?

As electric vehicles often are heavier than an ordinary car, this will affect the load they are allowed to pull. Consult with your local dealer as these rules vary from country to country.

### 21. **Insurance—**check the price and conditions. Insurance can vary, depending on the car.

A new product is not always popular with insurance companies, so check price and condition before you buy the car. It would be a shame to buy the new car and realize the insurance for that particular car is extremely high for certain reasons.

If you lease your batteries, find out if the lease company or your insurance company will cover the expense in case of an accident.

### 22. **Towing procedure—**check it before you need it. Don't wait until stranded to realize you don't know how to safely tow the vehicle.

Towing an EV might have to be done in a special way. Check the owner's manual and memorize the towing procedure in case you need it someday.

If you incorrectly tow an EV, you can damage the motor and electronics. These components can be expensive.

## Who Should Buy an EV in 2010?

There are some well proven Quarcycles like the REVA (G-wiz) and the Buddy on the market. If you do not

mind the size and the lack of safety, they can be considered.

The Think from Norway is a real car and they claim it has a crash test approval.

Mitsubishi i-MiEV hits the market in Japan in 2009 and the Tata Indica EV is supposed to go into production in 2009.

A lot of the big car manufacturers are planning to produce EVs that will be available on the market in the next few years.

The EV market is still an immature market, so buying a car now does create some uncertainty. Battery life and the price for a new battery are two things that are very hard to predict. I expect that in 2011 manufacturers will have a larger selection of cars for sale and that the price will be significantly lower.

It is difficult to predict the resell price of used EV. Therefore, I stress that you take this into consideration before buying your first EV. There are well known EV's as Reva, Buddy and Think on the market right now, and by investing in one of these you lower the overall risk, as the technology has been tested over a longer period, making the resell price higher. Buying an EV should not be seen as a future resell opportunity as the technology is constantly changing and being improved.

Tesla Model S is expected to be on the market in 2011



## 5. HYBRID ELECTRIC VEHICLES (HEV)

### Definition:

A hybrid car is a car that has two or more major sources of power to drive the car. Most hybrid cars on the market today have both conventional gasoline and electric motors.

Here are some of the main categories for hybrids:

### Mild Hybrid:

This type of car uses an electric motor to give extra output during the acceleration, and to regenerate power during deceleration. There are also savings through energy recovery through the motor/generator when regenerating.

This electrical energy may be used to drive the a/c, power steering, and other auxiliary electrical systems. Some of the latest on the market are Mercedes Benz S 400 Hybrid and BMW 7-Series.

### Parallel Hybrid:

In a parallel hybrid the electric motor and the internal combustion engine are installed so that they can both individually or simultaneously power the vehicle. Most commonly, the internal combustion engine, the electric motor, and gear box are coupled by automatically controlled clutches. While in combustion mode the engine and motor run at the same speed.

The first mass production parallel hybrid is the Honda Insight.

### Serial Hybrid:

A series hybrid uses an electric motor(s), which is powered by a single-speed internal combustion engine. While operating at its most efficient single speed, the combustion engine drives an electric generator instead of directly driving the wheels. This engine can charge the battery and/or directly power the electric motor. When large amounts of power and torque are required, the electric motor can draw electricity from a battery and the generator.

The first mass production parallel hybrid is the BYD F3DM. It is also possible to plug it in to charge the batteries, please see Chapter 6 about PHEV.

### Serial-parallel Hybrid:

In a serial-parallel hybrid electric drive train (components from motor to wheels) there are always two electric motors and one internal combustion engine. This is a typical passenger car platform, such as those from Toyota and Lexus. One motor mostly acts as a generator while the other one is used as a motor or generator. The two motors are connected through a planetary gear set ([http://en.wikipedia.org/wiki/Epicyclic\\_gearing](http://en.wikipedia.org/wiki/Epicyclic_gearing))

On the open road, the primary power source is the internal combustion engine (partly to maximize the life of the batteries), but when maximum power is required, for example to overtake, the electric motors are used to maximize the available power for a short time, giving the effect of having a larger engine than the one actually installed. The Toyota Prius, the Ford Escape, and the Lexus Gs450

and LS600 are serial-parallel hybrids.

The [hybridcenter.org](http://hybridcenter.org) has wonderful graphics to show the different types of hybrids and how they work at different stages:

<http://tinyurl.com/n8hjrjv>

### Ford Fusion Hybrid

What You Should Look for Before Buying an HEV

#### 1. Fuel economy

Some of the hybrids, such as the Toyota Prius II, have a low fuel consumption compared to the standard, but some tests show that real life driving provides a lot lower value. In cold weather the effect is even stronger, because the battery is not as efficient in cold temperatures.

#### 2. Battery—ask what type of batteries the car has.

There are three categories:

- Lead-acid is the old type of batteries. They are relatively cheap and need to be refilled with water on a regular basis. I have not seen a Hybrid with these
- Nickel-Cadmium (Ni-CD) and Nickel Metal Hydride (NiMH) are sealed batteries that are maintenance-free and can hold more energy. So far, these are the type of batteries used in Hybrids.
- Lithium-ion (Li-Ion) batteries are also maintenance-free. If you compare a lead-acid battery with a Li-Ion battery of the same weight, the Li-Ion can hold six to eight times more power! Li-Ion is still very expensive, but they have just begun to be mass-produced; therefore I expect the price will go down a lot. So far, Li-Ion batteries in Hybrids are only in Mercedes S 400 Hybrid, but BMW and other manufacturers are creating prototypes with Li-Ion batteries.

#### 3. Battery maintenance—ask if the batteries require maintenance.

It should only be the lead-acid batteries that require maintenance, and if it does ask how often it is necessary and what to do to correctly maintain the battery.



#### 4. **Battery warranty—ask about the length of the warranty.**

The battery for a hybrid is not yet very big, so the cost of replacing the battery is not expected to be high, which is nice to know.

#### 5. **Regenerative braking—ask how it is done.**

It is very important that the regenerative braking is controlled by the ESC/ESP (Electronic stability Control/Program). If not, you can easily lose control of the car when the road is wet, snowy or icy.

Regenerative braking is a great benefit of the HEV!

The electric motor can act as a generator, so instead of using the mechanical brakes, the resistance in the motor brakes the car when it regenerates energy. The energy will be stored in the battery and be ready to use in the next acceleration.

There are two ways the regenerative braking can be activated:

- On some cars it is activated when you take the foot off the accelerator.
- On some cars it is activated when you apply the foot to the brake pedal.

On the Honda Insight and Toyota Prius, you can select two different modes for regenerative braking:

With the Insight, it regenerates on a low level as a standard and higher when you press the “Eco” button.

With the Prius you select D for driving that gives low regenerative braking, and you can select B for higher. The more power you regenerate the lower fuel consumption. I always prefers to have as high regenerative breaking as possible to save fuel and wear on breaks.

#### 6. **Safety—ask to what standards the car is tested.**

There are two major test websites: Europe [www.euroncap.com](http://www.euroncap.com) or US [www.safercar.gov/](http://www.safercar.gov/)

Check the rating of the car you want to buy, so you can ensure you are buying a relatively safe car.

ESP/ESC is said to be one of the most important safety features. I recommend that you buy a car with ESP/ESC!

Warning: It is very important that the regenerative braking is overruled by the ABS (Anti-lock Breaking System).

If not, you can easily lose control of the car when the road is wet, snowy or icy. It would be even safer if it also could be integrated in the ESC/ESP (Electronic stability Control/Program).

#### 7. **Electric Vehicle mode—ask if it can drive as an electric vehicle (EV).**

The Prius has an EV mode, but it can only run at a max speed of 45 km/hours at a range of up to 1.5 km. This is not impressive and has a limited use in real life. The one I tried could only run less than 0.5 km.

The Honda Insight cannot run in EV mode.

#### 8. **Hill braking—try to stop the car while going up a hill.**

Some HEVs securely hold the vehicle if you stop on a hill, without you having to touch any pedal. This is a convenient safety function. Toyota Prius has it and they call it uphill assistance control.

#### 9. **Constant speed—try to test whether it is easy to drive at a constant speed.**

The Honda Insight is quite difficult to hold at a constant speed in the city. This is because it is very quiet and you cannot hear the engine. It would be nice with a cruise control.

#### 10. **Towing procedure—check it before you need it.**

Towing a HEV must be done in a special way because of the special motor/gear combination. Check the owner's manual and make sure you understand the towing procedures before you find yourself in the circumstances of needing to tow.

#### 11. **Pulling load—find out how much load are you allowed to pull.**

The Honda Insight and the Toyota Prius are not designed to pull a load. Check whether the HEV can pull a load before you buy it.

#### 12. **Insurance—make sure to check the price and conditions.**

HEVs have been on the market for some years, so it should not be a problem to get an insurance policy, but you should always check price and conditions before you buy the car.

## Who Should Buy an HEV in 2010?

The Japanese have been leaders in this field for a decade, but the German and U.S. automakers are catching up.

Toyota, Honda, and Lexus all have well proven models and have easily been compared to the conventional car. A large number of new Hybrid models will hit the market in 2010 and 2011.

The hybrid is technically more complex, so expect higher maintenance costs as the car ages.

I can recommend the HEV to anyone who can afford the higher maintenance costs. You will also save money on the fuel to offset some of the maintenance costs.

I did test the Honda insight in the city and it performed a remarkable 25 km/l = 4l/100 km = 58 MPG in average fuel consumption which is far better the standard if I drive fuel efficient. When I did the same round acceleration fast and break relatively hard I did 16.9 km/l = 6.1l/100 km = 40 MPG which is not much better than a normal car. So you get a lot of benefit out of your hybrid if you do not accelerate and break to hard.

A large number of new Hybrid models will hit the market in 2010 and 2011.

## 6. PLUG-IN HYBRID VEHICLE (PHEV)

The plug-in hybrid vehicle is the most advanced car of the cars discussed in this guide. You will be able connect it to the power outlets and charge the battery from the mains. When you drive and the battery runs out of power, a petrol/diesel engine kick in and charges the battery. This type of car serves all needs. You can run it as an EV for a fair distance and you do not have a range problem because the petrol/diesel engine helps when you are out of the range of the EV.

The PHEV sounds ideal—like it solves all the challenges of green cars and is perfect for everyone. Then why aren't there any of these cars for sale yet?

The big problem is that it is basically two cars in one, so they are VERY expensive to produce. They need large battery, a charger, and a relatively large electric motor. In addition to that, they have a petrol/diesel engine.

The most talked about car is the GM Volt, which is expected to go into production in November 2010. BYD F3DM is for sale in China.

## What to Look for Before Buying an PHEV

### 1. Range/autonomy—ask to what standard the range is tested.

Range is a big issue and still a handicap to the EV and the PHEV. Therefore, some of the manufactures are not stating the range according to a set standard, but after having measured it at the constant speed of, say, 30 km/h. This method produces a number that is far too high and is not at all realistic. A PHEV uses very little power to move the vehicle. Therefore, all other power consumers become a big issue and have a big influence on the range. (See question 9 – heating the car).

There are a number of standards that calculate the full consumption in a combination of driving the car in EV mode and on petrol. Obviously, if your daily commute is about the same as the range in your EV mode you would seldom have to run on the petrol engine. Therefore, you would get an impressive standard such as GM's announcement that the Volt can do 230 miles/gallon = 1 l/100 km = 100 km/l.

### 2. Battery—ask what type of batteries the car has.

There are three categories of batteries:

- Lead-acid is the old type of batteries. They are relatively cheap and need to be refilled with water on a regular basis.
- Nickel-Cadmium (Ni-CD) and Nickel Metal Hydride (NiMH) are sealed batteries that are maintenance-free and can hold more energy.
- Lithium-ion (Li-Ion) is also maintenance-free. If you compare a lead-acid battery with a Li-Ion battery of the same weight, the Li-Ion can hold six to eight times more power! Li-Ion is still very expensive, but they have just begun to be mass-produced. Therefore, I expect the price will go down a lot.

### 3. Battery maintenance—ask if the batteries require maintenance.

Only the lead-acid should require maintenance, and if it does, ask how often it is necessary and what to do to correctly maintain the battery.

#### 4. **Battery warranty—ask about the length of the warranty and the exceptions.**

This is one of the key issues when purchasing a car! Battery prices are high. Therefore, you want to acquire a long-lasting warranty to eliminate the stress of suddenly needing to buy a new battery. I would say that a five-year warranty is the minimum warranty you should get. If you have a five-year warranty, I would expect the price of the battery to significantly go down before the warranty expires.

Ask if there are any exceptions to the warranty—such as if you run the battery too far down.

#### 5. **Battery charging possibilities—ask if the car can be charged normally, quickly and/or with battery swap.**

Before you buy the car, it is very important to carefully read the user manual on how to properly charge the battery to maintain a long battery life. Determine whether the length of the charging time conflicts with your expected use of the car.

#### 6. **Battery use—ask how the battery should be used.**

Some batteries should be run down to a certain level before you can charge it. Some batteries should not be charged at your convenience, but at specified levels. Therefore, it is important to know what you can expect and whether the charging method works with your schedule for the car usage.

#### 7. **Battery charging hours—ask how many hours it takes to charge the car.**

You would need to consult a local electrician to install a power outlet for your PHEV and to tell you how many Amperes (Amps) you have available at home.

Quick charging only charges up to 80% and might not be possible from a normal size household installation.

#### 8. **Leasing the batteries—ask for conditions.**

Leasing batteries is a convenient and affordable way to own your EV, without the stress and cost of new battery replacement.

Check the conditions on the leasing contract and also find out if the lease company or your insurance company

will cover the expenses in case of an accident.

#### 9. **Heating the cabin—ask how it is done.**

Heating the cabin takes a lot of energy compared to driving the car, this is a weakness for a PHEV when running in EV mode.

Renault ZE has created an insulated cabin to lower the amount of energy needed for heating the cabin.

#### 10. **Regenerative braking—ask how it is done.**

Warning:

It is very important that the regenerative braking is overruled by the ABS (Anti-lock Breaking System). If not, you can easily lose control of the car when the road is wet, snowy or icy. It would be even safer if it also could be integrated in the ESC/ESP (Electronic stability Control/Program).

See details about regenerative braking in Chapter 3 General terms.

Find out how the regenerative braking is activated:

- On some cars it is activated when you take the foot off of the gas pedal.
- On some cars it is activated when you apply the foot to the brake pedal.

Warning: If you use a PHEV and use the regenerative brakes a lot, make sure to do some hard braking about once a week, using your mechanical brakes. If you don't, they will tend to hang and wear out quickly and use a lot of energy.

#### 11. **Safety—ask to what standards the car is crash tested. I have not yet seen a PHEV that has been crash tested to a standard like the Euro NCAP <http://www.euroncap.com> or the U.S. <http://www.safercar.gov/>**

Check the rating of the car you want to buy, so you can make sure to buy a relatively safe car.

ESP/ESC is said to be one of the most important safety features. I recommend that you buy a car with ESP/ESC!

**12. Type of vehicle—ask if it is a Quaternary, normal vehicle or other.**

There are special rules in some countries of how an EV is approved.

In some countries, the Rava (G-wiz) is referred to as an L7e Quadricycle classification and that means that the car does not have to meet any crash test specification.

In Canada there is a classification called “low speed vehicles.” In this class, the vehicles are not allowed to travel more than 50 km/h. Some of the vehicles sold in Canada might be able to travel more than 50 km/h, but will not be allowed to do so. Ask the authorities in your country if there is any local speed limit.

**13. Hill—try to stop while driving up the hill.**

Some EVs stop and hold the vehicle while going up the hill, without you having to touch any pedal. This is a convenient function. Find out if this feature applies to a PHEV in both modes?

**14. Ground clearance—check the ground clearance**

Many of the cars have the batteries underneath the car, so the ground clearance might be low. Drive around in your neighborhood, the shopping mall and parking garage to see if speed bumps or other obstacles are a problem.

**15. Drive when it is on charge—test to see if it's possible to drive when the car is plugged in.**

It sounds like a minor detail, but sooner or later you may forget to unplug it and start driving. Test to see what happens if you try to start driving while the car is on charge. Does a warning light come on? Will it just not drive? Can you start to drive?

**16. Service contract—ask if one is available.**

Ask if it is possible to get a service contract for the vehicle, including the battery. If you can get one, the price of the contract is a very good indication of the maintenance costs of the vehicle.

**17. State of charge—can you see the state of charge (SOC)?**

When the car is charging, it is very convenient if you can see the level. On some cars you need to unplug it to see

the SOC. Can you see it from the outside without having to open the door? Can you get the SOC via SMS or online?

I would prefer if the car could send an SMS when it is fully charged and if the charging is interrupted for some reason.

**18. Vandalism—is the wire protected/locked so only you can unplug it?**

There might be a problem with other people unplugging the car for fun or vandalism. Can the wire be locked both in the car and at the charging point?

**19. Pay load—how much load can the car take?**

The batteries are often heavier than the engine they replace so that gives a lower pay load. Consult your local dealer as pay load rules vary from country to country.

**20. Pulling load—how much load are you allowed to pull?**

Plug-in electric vehicles might be heavier than an ordinary car. This will affect the load they are allowed to pull. Consult your local dealer as these rules vary from country to country.

**21. Insurance—make sure to check the price and conditions.**

A new product is not always very popular with insurance companies, so check insurance prices and conditions before you buy the car.

If you lease your batteries, find out if the lease company or your insurance company will cover the expenses in case of an accident.

**22. Constant speed—try to test to find out if it is easy to drive the car at a constant speed.**

A PHEV might be quite difficult to hold at a constant speed in the city. This is because it might be so quiet that you cannot hear the engine. It would be nice with a cruise control.

**23. Towing procedure—check it before you need it.**

Towing a PHEV must be done in a special way. Check the owner's manual and make sure you understand how to correctly tow the vehicle in case you ever need to do so.

## Who Should Buy a PHEV in 2010?

The EV market is still very new, so buying a car now does create some uncertainty. Battery life and the price for a new battery are very difficult to predict. The resell price for a used EV is also very hard to predict. Therefore, I do not recommend that anyone buys an EV at this stage if buying the car would create stress in your personal finances.

If you can afford to do so without stress, go ahead and buy one as soon as you find one that suits your needs.

## 7. CONVERTING A CAR

My experience in working with some of the conversion projects in Denmark has given me a unique insight to the challenges in this field.

One of my major concerns is safety.

1. Electric and battery safety. As many of the conversions are done by buying components from different suppliers, it can be difficult to judge whether there are any safety issues. If a conversion kit is bought, make sure to follow the instructions for correct installation. Still, a conversion kit is no guarantee that it is safe. All these safety matters can be very difficult to prove when viewing the car.

2. Passenger safety in case of an accident. All newer cars have been constructed to perform well in a crash test, and even a small change to the design can have a big effect in case of a crash.

The front and the rear of a car is the deformation zone in case of a crash and the cabin is supposed to stay intact. You can see crash tests and read much more about this on [www.euroncap.com](http://www.euroncap.com) or at the U.S. site at [www.safercar.gov/](http://www.safercar.gov/).

If you remove the engine and replace it with an electric motor and fill the front with batteries, you change the car's behavior in case of a crash and can put the drivers' and passengers' lives in danger!

In Europe, you can get a converted car approved if you sell in small numbers (less than 1000 a year), and then you do not need to perform a crash test. So buying a car from a company that converts cars does not necessarily mean that it is safe in case of a crash.

Therefore, I cannot recommend buying a converted car if you are concerned about safety.

## 8. MAJOR PLAYERS

### Better Place

Better Place (BP) is founded by Shai Agassi and the overall idea is:

“To ensure that we can confidently drive an EV anytime, anywhere, Better Place is developing and deploying EV driver services, systems and infrastructure. Subscribers and guests will have access to a network of charge spots, switch stations and systems which optimize the driving experience and minimize environmental impact and cost.” This is taken from [www.betterplace.com/solution](http://www.betterplace.com/solution) where you can read more about the solution.

Better Place has a strong focus on one of the biggest problems with EVs: The short range you can drive before you need to charge for many hours.

BP says that this is a limiting factor for major sales of EVs. Therefore, they work to develop the battery switch station. A prototype unit has been displayed in Japan in May 2009. You can read about that here: <http://tinyurl.com/lxaww4>

BP has signed contracts to start operations in Israel, Denmark, Australia, USA, Canada, and Japan. Tests should be done until 2011 and then it will be in full operation.

### Build Your Dream (BYD)

BYD is a Chinese battery manufacturer that has started to produce cars. They are moving ahead with an amazing speed.

They are first in the market with a Plug-in Hybrid Electric Vehicle (PHEV) model called F3DM for Dual Mode: <http://www.byd.com/showroom.php?car=f3dm>. This car is for sale in China in 2009 and is expected to hit the market in Europe and USA in 2010/2011.

They have built a very exciting model called e6: [www.byd.com/showroom.php?car=e6](http://www.byd.com/showroom.php?car=e6). I saw it at the Detroit Motor Show in 2009, and it is a large Electric Vehicle with some remarkable specifications:

Range: 400 km (249 miles)

Top speed: 160 km/h (100 miles/h)

0 – 100 km/h (60 miles/h): in less than 8 s.

Quick charge: 50% in 10 min

It is for sale in 2009 in China and I really look forward to testing it!

## 9. CARS TESTED by [easyecar.com](http://www.easyecar.com)

I have tested most of the EVs and HEVs on the market. For more details, please see [www.easyecar.com](http://www.easyecar.com)

### Small cars:

#### Reva i (G-Wiz):

The car is very small. There is room for two adults in the front and two small children in the rear, but then the car is fully loaded with no room for luggage. Having said that, the car is easy to handle and an overall positive driving experience.

The car has two modes for forward driving. The normal mode (F) gives a smooth steady acceleration and max speed at about 50 km/h (31 miles/h). The boost mode (B) provides faster acceleration and max speed at around 70km/h (43 miles/h).

Regenerative breaking is applied when you press the break pedal.

The Reva is very popular in London and I can see why. It is comfortable to drive and easy to get to know.

Buddy:

It fits two adults, one small child in the middle and have additional luggage space. "Buddy" is not a stable drive when going at higher speed.

Regenerative breaking is applied when you press the break pedal.

#### Smart:

Driving this car is easy. With that said, the accelerator must be pressed quite hard before it starts driving and breaking could be more smooth.

It accelerates fast and is almost noiseless.

Regenerative breaking was low, which is positive.

I find that the Smart is a great option city car suited for two people.

#### Thinkcity:

Driving this car is extremely easy.

It has a very nice sound, sounding a bit like a compressor or turbo, and accelerates fast.

Regenerative breaking was at a fair level.

It is a quite small car, but perfect for 2 people, and I had the feeling that it was made of quality materials.

Think has come very far in a short time. It has limited potential do to the small size, but it is very suitable as an additional family car.

### Family cars:

#### Peugeot Tepee Expert:

Peugeot Tepee Expert Conversion by Allied ZEV

It is very easy to handle, all though it does not accelerate as fast as some of the smaller EV's I have tried.

Additional information about the company can be found at [www.zevelectric.com](http://www.zevelectric.com).

#### Tata Indica:

I had the opportunity to drive the Tata Indica at EVS24 in Norway.

I drove a prototype and the interior of the car was not up to modern standard. At the exhibition there was a production model that looked a lot nicer on the inside, with a quality close to European cars.

On the outside the Tata Indica is very nicely design.

At the back there is a not a lot of room.

The car was easy to drive and fits 4 adults.

The car will be produced in India are then shipped to Norway where the EV components are fitted.

The car will go production in 2009

There is no indication of the price yet, but keep an eye out for his car, as it might give the EVs a break through!

#### I-MiEV:

Driving this car is extremely easy, and it has fast acceleration and is almost noiseless.

Regenerative breaking was to low, which I find positive.

The motor is at the back, therefore the trunk has a limited amount of volume.

This is the type of car I have been looking for and it is the first EV I have tested that feels like a real car. Mitsubishi is in my view far ahead of all other competitors In this space.

#### Citroen Saxo:

Driving this car is extremely easy, it is almost silent and the acceleration is decent.

Regenerative breaking was at a fair level.

It is a normal size Saxo so it fits 4 people.

Taking into consideration that it is a relatively old car, it is comfortable and easy to drive. It must have been the price that stopped it from becoming a success.

### Hybrid cars:

#### Honda Insight:

The fuel economy is much better than the standards and



it is very silent.

The Honda Insight has ECO assistance that helps you drive fuel efficient.

It creates an unpleasant sound when you are accelerating fast. It has plenty of room at the back seat but limited cargo volume.

It was a surprise, that the more I drove it, the better I liked it. The Honda Insight does not have cruise control. You need this, as the Honda Insight is very silent, which makes it difficult to keep a constant speed.

Driving the Honda Insight is easy and pleasant if you do not try to push it to the limits. If you accelerate to maximum speed, the car gives an annoying sound and steering becomes inaccurate as I expected from a Honda. When you do not drive the Insight at maximum speed the car is very silent and easy to handle.

The Insight is equipped with an "ECO" button. When you press it the car regenerates more power when braking and use more power from the e-motor when accelerating. The backlight color on the dashboard is green when you accelerate and break economically. It takes a while to get acquainted with the eco drive system, but then it is a big help in saving fuel. Unfortunately the Insight has some limitations. I find the space in the back limited to two adults and one child. The booth space is also limited to 15.9 cu ft. or 408 liter.

I tested the Honda Insight on a cold day in Copenhagen and here are my results:

1. "ECO" mode. I did try to keep the backlight in the display at a green color trying to save a much fuel as possible. That means accelerating slowly and breaking slowly allowing for maximum regenerative breaking. The average fuel consumption was:  $25 \text{ km/l} = 4\text{l}/100 \text{ km} = 58 \text{ MPG}$  which is fare better the standard. Before driving into the inner-city the average fuel consumption was as high as:  $29 \text{ km/l} = 3.4\text{l}/100 \text{ km} = 68 \text{ MPG}$ .

2. Driving with the "ECO" button OFF. I accelerated fast, pressing the accelerator half way down and made hard stops. This will not allow the car to assist with the e-motor. The average fuel consumption was:  $16.9 \text{ km/l} = 6.1\text{l}/100 \text{ km} = 40 \text{ MPG}$ , which is right on the American standard and lower that the European.

This city test shows that a Hybrid is very depended on

the assisting e-motor and regenerative breaking if you want it to perform better than a normal petrol car. I also did a 120 km drive at the country side with varied speed limits between 110 and 60 km/h. The average fuel consumption was:  $23.3 \text{ km/l} = 4.3 \text{ l}/100 \text{ km} = 55 \text{ MPG}$ . That is fare better than I had expected.

I would definitive recommend Honda Insight if you can accept the limited space in the back and if you do not have an aggressive driving style. Then the car is very nice to drive and operate. Having the option to perform more than 50 MPG without difficulty is very nice

Here are some videos from my tests:

<http://www.youtube.com/evtestdk>

## Public transportation:

See <http://www.easycar.com/category/public-transportation/>

## 10. CHECK LISTS

On the following pages I have formatted all of the questions into a single form, so you can print it out and take it along when you go to test cars.

This makes it easy to remember all the details while looking at cars, and when you get home you can compare your answers to the questions and make the right decision regarding the car you will purchase.

# Questions To Ask Before Buying an EV:

Car manufacturer: \_\_\_\_\_

Model: \_\_\_\_\_

Dealer's name: \_\_\_\_\_

1. Range/autonomy: \_\_\_\_\_
2. km or miles. Standard: \_\_\_\_\_
3. Battery type: \_\_\_\_\_
4. Do the batteries require maintenance? Yes: \_\_\_\_\_ No: \_\_\_\_\_  
If yes describe details: \_\_\_\_\_
5. Battery warranty. Years: \_\_\_\_\_ Distance : \_\_\_\_\_ km or miles
6. Battery charging possibilities: Normal: \_\_\_\_\_ Quick: \_\_\_\_\_ Battery swap: \_\_\_\_\_
7. Battery use: are there any special ways to use the battery? Yes: \_\_\_\_\_ No: \_\_\_\_\_  
If yes, how: \_\_\_\_\_
8. Battery charging hours: Normal: \_\_\_\_\_ Quick: \_\_\_\_\_ Battery swap: \_\_\_\_\_
9. Leasing the battery, is it possible?: Yes: \_\_\_\_\_ No: \_\_\_\_\_
10. How is cabin heated: Fossil fuel: \_\_\_\_\_ Electric: \_\_\_\_\_
11. Regenerative braking, how is it done: Foot off the gas: \_\_\_\_\_ Brake pedal: \_\_\_\_\_
12. Crash test ratings: Euroncap: \_\_\_\_\_ Safecar: \_\_\_\_\_ Other: \_\_\_\_\_
13. Type of vehicles: Quartocycles: \_\_\_\_\_ Normal: \_\_\_\_\_ Other: \_\_\_\_\_
14. Hill assistant: Yes: \_\_\_\_\_ No: \_\_\_\_\_
15. Ground clearance: How much: \_\_\_\_\_ sufficient: \_\_\_\_\_
16. Drive when on charge possible: Yes: \_\_\_\_\_ No: \_\_\_\_\_
17. Service contract: price: \_\_\_\_\_
18. State of charge: Seen from the outside? Yes \_\_\_\_\_ No: \_\_\_\_\_
19. Vandalism: Cable protected? Yes: \_\_\_\_\_ No: \_\_\_\_\_
20. Pay load: How much: \_\_\_\_\_
21. Pulling load: How much: \_\_\_\_\_
22. Insurance: Price: \_\_\_\_\_ own risk: \_\_\_\_\_
23. Towing procedure: \_\_\_\_\_

## Questions To Ask Before Buying an HEV:

Car manufacturer: \_\_\_\_\_

Model: \_\_\_\_\_

Dealer's name: \_\_\_\_\_

1. Fuel economy: \_\_\_\_\_ km/l or miles/gallon. Standard: \_\_\_\_\_
2. Battery type: \_\_\_\_\_
3. Do the batteries require maintenance? Yes: \_\_\_\_\_ No: \_\_\_\_\_  
If yes describe details: \_\_\_\_\_
4. Battery warranty. Years: \_\_\_\_\_ – Distance : \_\_\_\_\_ km or miles
5. Regenerative braking, how is it done: Foot off the gas: \_\_\_\_\_ Brake pedal: \_\_\_\_\_
6. Crash test ratings: Euroncap: \_\_\_\_\_ Safecar: \_\_\_\_\_ Other: \_\_\_\_\_
7. EV mode: Yes: \_\_\_\_\_ No: \_\_\_\_\_ How long: \_\_\_\_\_ km or miles
8. Hill assistant: Yes: \_\_\_\_\_ No: \_\_\_\_\_
9. Constant speed, is it easy: Yes: \_\_\_\_\_ No: \_\_\_\_\_ Cruise Control: Yes: \_\_\_\_\_ No: \_\_\_\_\_
10. Towing procedure: \_\_\_\_\_
11. Pulling load, Possible: Yes: \_\_\_\_\_ No: \_\_\_\_\_ How much: \_\_\_\_\_
12. Insurance: Price: \_\_\_\_\_ own risk: \_\_\_\_\_

# Questions To Ask Before Buying a PHEV:

Car manufacturer: \_\_\_\_\_

Model: \_\_\_\_\_

Dealer's name: \_\_\_\_\_

1. Range/autonomy: Power \_\_\_\_\_ km or miles. Fuel/diesel: \_\_\_\_\_ km or miles Standard: \_\_\_\_\_
2. Battery type: \_\_\_\_\_
3. Do the batteries require maintenance? Yes: \_\_\_\_\_ No: \_\_\_\_\_  
If yes describe details: \_\_\_\_\_
4. Battery warranty. Years: \_\_\_\_\_ – Distance : \_\_\_\_\_ km or miles
5. Battery charging possibilities: Normal: \_\_\_\_\_ Quick: \_\_\_\_\_ Battery swap: \_\_\_\_\_
6. Battery use, are there any special ways to use the battery? Yes: \_\_\_\_\_ No: \_\_\_\_\_  
If yes, how: \_\_\_\_\_
7. Battery charging hours: Normal: \_\_\_\_\_ Quick: \_\_\_\_\_ Battery swap: \_\_\_\_\_
8. Leasing the battery, is it possible: Yes: \_\_\_\_\_ No: \_\_\_\_\_
9. How is cabin heated: Fossil fuel: \_\_\_\_\_ Electric: \_\_\_\_\_
10. Regenerative braking, how is it done: Foot of the gas: \_\_\_\_\_ Brake pedal: \_\_\_\_\_
11. Crash test ratings: Euroncap: \_\_\_\_\_ Safecar: \_\_\_\_\_ Other: \_\_\_\_\_
12. Type of vehicles: Quartocycles: \_\_\_\_\_ Normal: \_\_\_\_\_ Other: \_\_\_\_\_
13. Hill assistant: Yes: \_\_\_\_\_ No: \_\_\_\_\_
14. Ground clearance: How much: \_\_\_\_\_ sufficient: \_\_\_\_\_
15. Drive when on charge, possible: Yes: \_\_\_\_\_ No: \_\_\_\_\_
16. Service contract: price: \_\_\_\_\_
17. State of charge: Seen from the outside? Yes \_\_\_\_\_ No: \_\_\_\_\_
18. Vandalism: Cable protected? Yes: \_\_\_\_\_ No: \_\_\_\_\_
19. Pay load: How much: \_\_\_\_\_
20. Pulling load: How much: \_\_\_\_\_
21. Insurance: Price: \_\_\_\_\_ own risk: \_\_\_\_\_
22. Constant speed, is it easy: Yes: \_\_\_\_\_ No: \_\_\_\_\_ Cruise Control: Yes: \_\_\_\_\_ No: \_\_\_\_\_
23. Towing procedure: \_\_\_\_\_

## 11. DISCLAIMER

All attempts have been made to verify the accuracy and current status of the information provided in this publication. Neither the author nor the publisher assumes any responsibilities for errors, omissions, or contradictory information contained in this book. The purchaser of this book assumes all responsibility for the use of material and information provided.

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