# Booklet 3: Vehicle Design Guide

(Read before starting Part 3. **Do not** mail this back.)

# **Vehicle Buyers' Guide** An introduction to vehicle technologies

Thank you in advance for completing Part 2 of the survey. This booklet serves as an **introduction to some of the technologies** that we will ask you about in Part 3. Please review this document *before* you **complete Part 3** of the survey. You may refer back to it as you complete Part 3 online.



#### This booklet is divided into the following sections:

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## INTRODUCTION

This guide will introduce you to the technology and terminology used in Part 3 of the survey. We will discuss vehicles that can be powered by gasoline only, electricity only, or both. We will also discuss how the vehicles that are powered by electricity can be recharged.

In Part 3 you will have the opportunity to complete **design games** where you tell us about a vehicle that would be **ideal for you**. In addition to this, we will be asking you tell us how you may like to **use and charge** the future vehicle technologies that you will see here.

After reading this guide, we hope that you will understand **how these vehicles differ** and **how they can be charged or refueled.** We will be asking you **how you feel about these different technologies** throughout Part 3 of the survey. If there are any aspects of this information that you do not understand, please do not worry. Further explanation will be available during the survey.

## VEHICLES - VEHICLE TYPES

This section discusses the different *types* of vehicles that you will encounter in Part 3. The main focus here is how the different vehicle types are fueled. Whilst reading about these vehicles, please consider which of these different *types* you may prefer.

- A regular gasoline vehicle uses only gasoline.
- A **hybrid** uses a small battery to reduce fuel use but cannot be plugged in to recharge.
- A **plug-in hybrid** can be plugged in to recharge its battery and can also use gasoline like a hybrid.
- An electric vehicle must be plugged in to recharge its battery it never uses gasoline.

The table below demonstrates the differences between these vehicles.

Vehicle Type		Refuel or Recharge?		Mada of Operation	
		Gasoline	Electricity	mode of Operation	
Regular gasoline	-0-	Ø		<ul> <li>Gasoline only:</li> <li>This vehicle uses fuel like a <i>typical</i> gasoline vehicle.</li> </ul>	
Hybrid		V		<ul> <li>Gasoline only:</li> <li>A small battery and electric motor assist the engine to give help the hybrid use <i>less</i> fuel per 100km than a regular gasoline vehicle.</li> </ul>	
Plug-in Hybrid		V		<ul> <li>Battery &amp; Gasoline:</li> <li>With a fully charged battery, the vehicle is powered by <i>electricity</i> for the first 16 to 64 kilometres. The vehicle then <i>automatically switches</i> to gasoline. Like a hybrid, when using gasoline, it uses <i>less</i> fuel per 100km than a typical gasoline vehicle.</li> <li>The vehicle must be periodically <i>plugged into</i> a normal outlet or recharge station to be powered by the battery.</li> </ul>	
Electric	-0-		Ŋ	<ul> <li>Battery only:</li> <li>The vehicle is powered by <i>electricity</i> for 80 to 240 kilometers. The battery recharges by <i>plugging</i> it <i>into</i> an electrical outlet or recharge station. This vehicle cannot use gasoline.</li> </ul>	

## VEHICLES - REFUELING & RECHARGING

This section discusses how you may refuel or recharge different vehicles and addresses common questions that you may have about this.

## Refueling With Gasoline

**Gasoline**, **hybrid** and **plug-in hybrid** vehicles can operate using gasoline. These vehicles can be refueled at any gasoline station.

## **Recharging With Electricity**

**Plug-in hybrid** and **electric vehicles** can operate using electricity from the battery. These vehicles must be recharged using an electrical outlet or a recharge station:

• Normal outlet:

Normal electricity outlets are the **same type** you use for recharging your cell phone or laptop computer. You might find a suitable outlet in your home garage, on the side of your house, or at a parking lot.

• Recharge station:

This station is designed specifically for recharging **plug-in hybrid** and **electric vehicles**. It can recharge your vehicle up to **6 times faster** than a normal outlet. You might install a recharge station at your home or find an existing recharge station in a parking lot at your workplace or elsewhere.

## Commonly Asked Questions

## 1. How long does it take to recharge?

Recharging time depends on the size of your vehicle, the size of its battery and the power output of the charger. Larger vehicles and vehicles with a higher electric range need **larger batteries** and therefore, take **longer** to recharge. Outlets with a higher voltage **reduce** charging time.

## 2. Can I partially charge the battery?

Yes. For example, imagine that your battery is empty and requires 4 hours to fully recharge. If you plug it in for only 1 hour, it will be 25% recharged. This is similar to refueling your gas tank—you can fill it all the way or just or fill it part way.

## 3. Why use electricity instead of gasoline?

This depends on your priorities and interests. Electricity is generally **cheaper** than gasoline, but it is difficult to say how much cheaper. Gasoline prices change often, while your electricity price may differ by how much you use, by season, and by time of day. In most regions today, driving with *only* electricity would cost 50-70% less per kilometre than driving with *only* gasoline. This saving is like reducing your gas cost from \$1.30 per litre to between \$0.39 and \$0.65 per litre. Also, driving with electricity usually causes **less air pollution and greenhouse gas emissions** than driving with gasoline—even counting emissions from electric power plants. The size of these reductions depends







on which generators are used to produce your electricity. For example coal-generated electricity produces more air pollution and greenhouse gas emissions than wind-generated electricity.

#### 4. Why leave a vehicle plugged in if it is fully charged?

If you are willing to allow it, your electric utility may want to delay the charging of your vehicle by a few hours until later in the evening **or** take electricity from a battery onboard your vehicle. They may do this to **help manage your local power supply**, or to **help increase the amount of renewable energy in your regional power supply**. In return for letting them take this electricity from the battery, your monthly electricity bill may be reduced.

## **VEHICLES - VEHICLE FEATURES**

As we mentioned, in the survey we will be asking you to design your ideal vehicle. When doing this, there will be features that you will be able to personalize.

This section introduces three key features in the operation of some of the vehicles that we have discussed: battery range, home recharge times and gasoline fuel use. We want to know which ones are important to you. Please see below for an explanation of how these features differ by vehicle type.

#### 1. Battery Range

For **plug-in hybrid** and **electric vehicles**, the *base* battery range is the distance in kilometres that the vehicle can travel on a fully charged battery. In some cases people often upgrade to a larger battery to increase the battery range of the vehicle. Examples of these options are as follows:



## 2. Home Recharge Time

For **plug-in hybrid** and **electric vehicles**, your base home recharge time will depend on the results of your *Recharge Questionnaire* that you filled out earlier. As an example, imagine that your plug-in hybrid vehicle requires 6 hours to fully recharge using a normal outlet.

You might be provided with the following options:



**Note:** The actual recharge time also depends on the size of the battery. A larger battery would take longer to recharge. The times above have been given as an example.

## 3. Gasoline Fuel Use

**Gasoline**, **hybrid**, and **plug-in hybrid vehicles** can be refueled and powered by gasoline. Compared to a regular gasoline vehicle, a hybrid or plug-in hybrid vehicle reduces gasoline fuel use by **at least** 33 %.

For example, if a gasoline vehicle uses **10 L/100km** (litres per 100km), the hybrid or plug-in hybrid version will use around **6.7 L/100km**. In short, to travel 100km, the hybrid or plug in hybrid versions of a vehicle will use 3.3 litres of fuel less than the gasoline vehicle. As a result, **fuel use is reduced** and can **cost less**.

## 4. Vehicle Summary

The table on the next page summarizes all of the vehicle types and vehicle features that we have just discussed. The numbers in this table are compared to a typical sedan vehicle that achieves a fuel economy of 10 L/100km. This table may serve as a useful reference when completing Part 3.

To help you think about these vehicles, we would like to introduce you to **Tim**. After reading the information in the vehicle section of this guide, Tim has some opinions. Tim was originally considering buying a gasoline Honda Civic as his next car. Now that he has been introduced to hybrid, plug-in hybrid and electric vehicles, he thinks that they might be better than a gasoline vehicle.





	Regular Gasoline Vehicle				
Operation Fuel Economy <del>Electric Distance</del> <del>Charge Time</del>	Base Case Example <ul> <li>Gasoline Only</li> <li>10 L per 100km</li> </ul> <li>- <ul> <li>-</li> </ul></li>	Alternate Upgrades • - • - • - • -			
	Hybrid Vehicle				
Operation Fuel Economy <del>Electric Distance</del> <del>Charge Time</del>	Base Case Example <ul> <li>Gasoline Only</li> <li>6.7 L per 100km</li> <li>-</li> <li>-</li> </ul>	Alternate Upgrades • - • - • - • -			
	Plug-In Hybrid Ver	nicle			
Operation Fuel Economy Electric Distance Charge Time	<ul> <li>Base Case Example</li> <li>Gasoline AND Electricity</li> <li>6.7 L per 100km</li> <li>16 km</li> <li>3 Hours (Normal Outlet)</li> </ul>	Alternate Upgrades • - • - • 32 or 64 km • Minimum 0.5 Hours (Home Recharge Station)			
	Electric Vehicle				
Operation <del>Fuel Economy</del> Electric Distance Charge Time	<ul> <li>Base Case Example</li> <li>Electricity Only</li> <li>-</li> <li>80 km</li> <li>23 Hours (Normal Outlet)</li> </ul>	Alternate Upgrades • - • - • 120, 160, 200 or 240 km • Minimum 4 Hours (Home Recharge Station)			

After looking at the summary, Tim likes the idea of the gasoline savings that he can make with the hybrid and plug-in hybrid vehicles. Tim works less than 32 km away from his home and likes to take road trips on the weekend. Although he does not know if he can charge at work, he likes the idea that he could get to work using just electricity from charging at home overnight.

Tim does not like the idea of an electric vehicle because he is not sure if he will be able to take his weekend trips. As a result, at this point he is keen to learn more about the plug-in hybrid vehicle. To find out more about how he may be able to charge a plug-in hybrid Tim is going to read more below.

## CHARGING

In the survey we will also ask you about how you may want to use or charge your future vehicle. As part of this, you will be able to personalize different vehicle use and charging features. This section will introduce you to some of the features that you may find important when charging a plug-in hybrid or electric vehicle. We address green electricity, green electricity sources, morning electric range and your monthly electricity bill. We want to know which of these features are important to you.

## 1. Percentage Of Green Electricity

Green electricity is electricity that has come **from renewable energy** sources that have a **low negative environmental impact** relative to large-scale hydropower and fossil fuels. It comes from energy sources that are **renewed naturally** and as a result are not running out.



## 2. Green Electricity Source

Sources of **green electricity** include wind, small hydro (typically run-of-the-river), tidal, solar, geothermal and biomass-fuelled power sources. Green electricity sources typically have **little or no greenhouse gas emissions** from their fuel source. They often have **little or no air pollutants**, which may be toxic or cause poor air quality (e.g. smog) and negative health impacts. Although some sources of green electricity are not always available (e.g. solar power cannot be harnessed at night), they can be stored and used when needed. These sources are explained below:

- Wind: As the wind blows, it spins large turbines. The spinning movement is turned into electricity by a generator.
- **Small Hydro:** Small sections of rivers are diverted through pipes. In the pipes, water turns a generator to produce electricity. The diverted water is then fed back into the river. When we refer to this we **do NOT** include large-scale dams.
- **Solar:** Solar panels absorb the sun's energy. This energy is converted in the solar panels to create electricity.
- **Renewable Mix:** It is common that green electricity supplies incorporate a mix of different renewable sources. In this case, the mix would be decided by your electricity provider (electric utility) and depends on where you live. You may prefer this if you do not have a particular preference for your source of renewable energy.

#### 3. Guaranteed Minimum Charge

The guaranteed minimum charge is the **minimum** level of charge that your battery would have after a

I he guaranteed minimum charge is the **minimum** level of charge that your battery would have after a night of being plugged-in. For example, if your Guaranteed Minimum Charge is 50%, then your battery would be **at least** half full in the morning. There is a chance that the level of charge could be higher than this.

If you are willing to allow it, your electric utility may want to delay the charging of your vehicle by a few hours until later in the evening. It is also possible that your electric utility may want to take electricity from a battery in your vehicle when it is plugged-in. They may take this electricity to **help manage your local power supply** or to **help increase the use of renewable energy in your region**. If you allow this, there is a chance that your battery may not be fully charged in the morning. In return for letting the utility take this electricity from the battery, your monthly electricity bill could be reduced. This will depend on the size of the battery and it's level of charge.

For example, Tim has a plug-in hybrid electric vehicle with an electric range of 32 km. Tim can save \$10 per month on his electricity bill if he agrees to have a battery that is only half charged with a range of 16 km in the morning. If he does not want this, he can still choose to have a fully charged range of 32 km in

Option	Guaranteed Minimum Charge	Monthly Electricity Bill
1	32 km (100% charged)	\$40 / Month
2	16 km (At least 50% charged)	\$30 / Month

**Tim's Options** 

the morning **but** his monthly electricity bill will not be reduced.

## 4. Monthly Electricity Bill

This is simply your monthly household electricity bill. This **includes** approximate electricity consumption by the plug-in hybrid or electric vehicle that you may have and your current household spending on electricity. **Before** purchasing a plug-in hybrid vehicle, Tim's monthly electricity bill is \$30 per month. Charging a plug-in hybrid vehicle to drive to work each day, will cost Tim an additional \$10 per month. As a result, his electricity bill will be \$40 per month. Since Tim wants a **full charge** of 32 km in the morning, his electricity bill would not be reduced by his electric utility. This same situation is also discussed in the previous section "3. Morning Electric Range".

# WHEN PART 3 ARRIVES...

If you do not understand any of the information outlined in this guide, please do not worry. This information will be re-iterated in Part 3 of the survey. Please keep this document in hand for your reference when completing Part 3. We will also give you an opportunity to download a copy of this document (PDF) during the survey.

In Part 3, we will refer to the features and technologies discussed in this guide. We will ask you to make a series of choices and complete vehicle designs based on your personal preferences and lifestyle. These exercises will help us to develop an understanding of what type of vehicle you may choose to purchase in the future, and how you may refuel this vehicle.

# Thank you very much for reading. We look forward to your responses in Part 3!

