

## Introduction – V2G-101

Before we begin reading to learn everything available today on the topic of vehicle-to-grid (V2G) technology, let's fast-forward to the year 2020 and predict how the future could potentially look if all the necessary pieces to the V2G puzzle have fallen in place. In optometrist lingo, 20-20 is perfect vision. The year 2020 will also be a time for 'perfect vision': clear skies to see the distance, clean air to breathe, clean water.

This cleaner environment is largely a result of the transportation evolution from petroleum-powered cars, trucks and buses to electric-powered propulsion.

In 2020, all-electric-powered cars are plugged in overnight or whenever they are idle. Corner gas stations are largely a thing of the past. On interstate highways, travelers can 'refuel' with a five-to-ten minute quick battery recharge, with the 'fill up' price based on the time of day the recharge is purchased. Morning and evening electric is more economical than mid-day, and the overnight rate is the lowest.

There is no longer a limited driving range associated with electric-powered vehicles since quick recharging is available at many convenient locations. Drivers can take the family on a gasoline-free vacation drive on Interstate I-95 from Maine to Florida or across the country as easily as they can commute from home to work.

Car manufacturers in 2020 offer dozens of models in their all-electric vehicle line, in much the same way they did over 10 years ago when they offered as many models of the non-plug-in hybrid cars. But those old non-plug hybrids were self contained, operating fully on gas power and averaging between 20 and 45 miles per gallon. In 2020, the owner takes advantage of lower cost and efficient electric power, and the electric cars cause no pollution as when the gas was burned in the engine-powered cars. They also can store power in the car for income generation or for use as emergency power to the home or business during an outage.

The 2020 electric vehicles are clean and efficient. The electricity used to charge the battery pack is generated at power plants with a mixture of domestically produced fuels, each controlled for minimal environmental impact. By 2020, a majority of states have met or exceeded their Renewable Energy Portfolio Standard (RPS) goals, with many achieving above 20% of their power produced by wind, solar, wave power or other renewable sources. The electricity generated by utilities to power the electric cars results in a minimum of 3 times less pollution (from well to wheel) than their gas-powered predecessors. Many home owners voluntarily generate a portion of their power needs with a photovoltaic solar array on the rooftop or with a small windmill in the yard. When that power is transferred to the electric car's battery pack, the car drives using 100% clean power; free of any greenhouse gas pollution.

With an equivalent of about 135 miles per gallon, the 2020 car owners enjoy a cost per mile that is about one-sixth that of a gas-powered car with comparable performance and accommodation, which a decade ago burned gasoline costing over \$4.00 per gallon.

The new car is no longer considered a liability, with a sizable equity reduction when it is driven from the auto dealer's lot. The cars now pay the owners with the fuel efficiency savings already mentioned, coupled with lower maintenance needs (no oil changes,

tune-ups, exhaust system or transmission repairs, etc.), AND the car generates income for the owner by enrollment in Vehicle-to-Grid (V2G) services with an aggregator.

The all-electric car of 2020 makes use of its large battery pack in other ways to add efficiency and convenience to the home of the future. By reacting to price signals communicated via smart metering at the home, the car can recharge overnight at the lowest possible rates and then, when the car is home and power prices are high, feed power to the house to reduce the electric bill. In the event of a power outage, the car's battery pack powers the **home!**

Even recreational events look different in the year 2020. The kids' soccer, baseball, football or other outdoor sporting events are no longer cut short by sunset. The parents park a dozen electric cars around the playing field, and light up the night with inexpensive floodlights powered by the **cars.**

Imagine electric-powered school buses. No smelly diesel exhaust and noisy engines propelling the buses through the neighborhood in the mornings and afternoons, just a quiet, clean electric-powered bus. During the 20 to 22 hours per day that the buses sit idle, and 24 hours a day on weekends and during the summer, the school buses produce a revenue stream for the local school district by providing V2G services. School buildings that become shelters during weather emergencies that interrupt power to a large community now have back-up power. The buses' batteries power the school for days until the power is restored!

Tow trucks and emergency repair vehicles are much less needed in the future since the all-electric vehicles have so few parts that can break down. (There is only one moving part in the electric motor, compared to hundreds of moving parts in a gas-powered engine.) On the rare occasion when the driver of an electric car, for whatever reason, overestimates the driving range, ignores the gauge and then the warning buzzer, and runs out of power on the side of the road, any other electric car driver can come to the rescue. By connecting the cars together using the standard power cord, the car with excess power can transfer part of its reserve to the stranded car in a matter of minutes so the stranded operator can drive to a nearby recharge station.

The cars of the future sound too good to be true, right?

Not at all! Prototype cars with vehicle-to-grid technology, quick recharge, high efficiency and low operation & maintenance costs are already on the road today in small quantities. How we get from today to the future is described in the following chapters of V2G - 101. The list below outlines priorities in groups that, achieved on a large scale, will propel us toward our 'clear vision' 2020 target. To assemble a puzzle, one begins the project by sorting the corner and edge pieces. In this text, the top priorities, the corners and edge pieces, are covered first to get started. Then, the next priorities, like the center pieces of the puzzle, can be assembled, finding their way into place until the puzzle is complete and beautiful. Each piece, whether it is a center, edge, or an important corner, all contribute to the end product. Without any one piece, the picture is not complete.

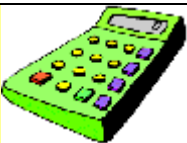
**Top Priorities (the puzzle corners and edge pieces) include:**

- Clean Transportation (reducing greenhouse gases from cars)
- Vehicle Options – New (Current and Future Electric Cars)

- The Pre-owned Car; Electric Conversion Options with V2G
- EV Batteries
- Safe Operation (equal or better than today's cars)
- The Economic Value of Vehicle-to-Grid ('Show me the money!')
- Access to an Aggregator and Grid Connections

**Next Priorities (the center sections) include:**

- Electric Car Maintenance; Cost of Operation
- Promoting V2G Cars
- Government Interaction and Incentives
- More About the eBox and the Next Generation of V2G Vehicles
- International and Island Country Potential for V2G
- Off-Shore Wind Generation to Power Our Cars

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| <p>Introducing the <b>Calculation Box</b> (with chapter references and Roman numerals): Throughout this text, you will find shaded boxes like this that take you step by step through the various calculations being discussed. The advanced reader can skim over the contents; those meeting the topic and calculations for the first time can follow the details to fully understand the concept and how the result is determined. Examples are included to reinforce the concepts, when appropriate. Note – Throughout this text, the symbol “ * ” is used in formulas to indicate multiplication.</p> |  |
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Another resource you will find within this text are tables titled **Good News Article (with chapter and letter references)**. These will provide pertinent information related to the topics being covered. The articles may be full length or abridged, and within the article, you will often find a link for more information. When photographs or sketches are available, they are also included.

**A Reader Questioned (with a reference number)...**  
 This last reference box was added in response to various inquiries by my Editors or other contributing readers, related to topics I comment on from personal experience or to provide more credibility to my discussions and proposals. These additions were good questions that enhanced the project by their inclusion.

We will review the above priorities and more, as we assemble the puzzle pieces contained in the three units of this text. Let the fun and learning begin!