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Wireless Electric Vehicle Charging

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Wireless Electric Vehicle Charging

By David Podorson

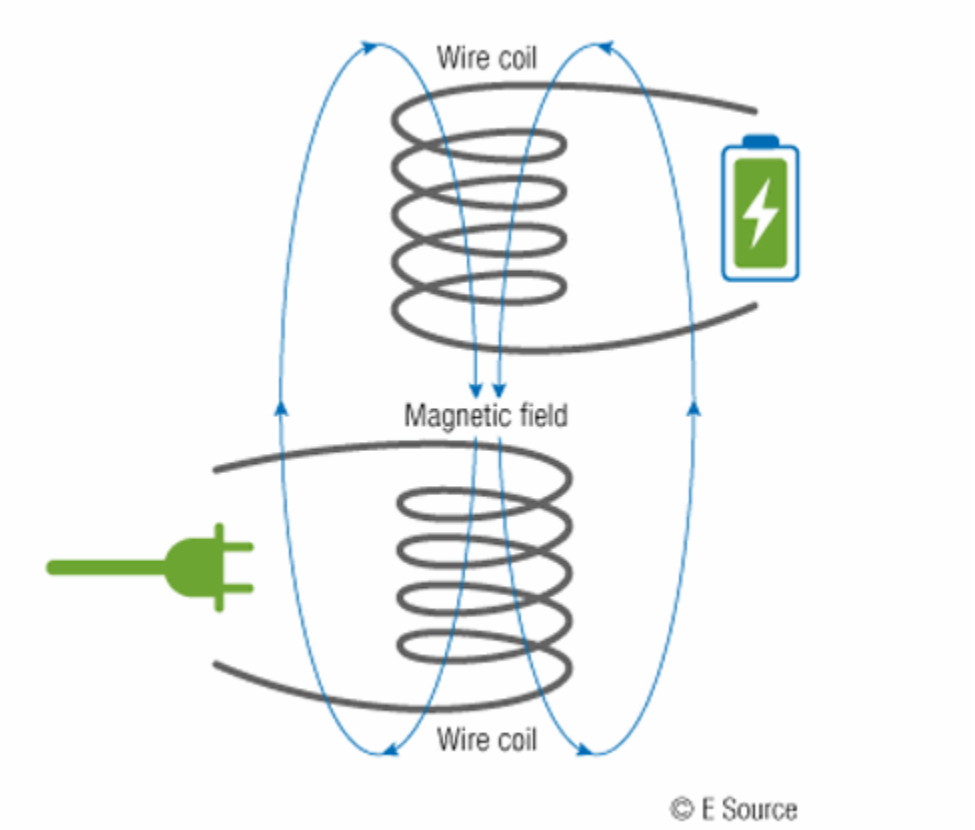
Electric vehicles (EVs) have been gaining in popularity in recent years, and they've moved from expensive niche products to more mainstream commuter models. Examples include the Nissan Leaf, the Chevrolet Volt, and the Ford Focus Electric. The recent advent of wireless charging is adding to the convenience of these vehicles, removing the need to plug in. Customers can simply park their vehicle over the wireless charging pod in their garage and be on their way. However, this convenience comes at a cost. Wireless charging stations are only likely to be about 87 percent efficient according to the Idaho National Laboratory (INL). This means they have the potential to be a large source of energy waste in homes or for commercial vehicle fleets when compared to standard wire-based chargers that have transmission efficiencies close to 100 percent.

How It Works

The laws of physics (specifically, Maxwell's equations) dictate that electricity flowing through a conductor creates a magnetic field and that a conductor placed in the presence of an alternating magnetic field will have current induced through it. That's the concept behind wireless charging: Convert electricity into an alternating magnetic field and, when a capable device is placed in that field, an electric current will be induced that can be used to charge a battery (**Figure 1**).

FIGURE 1: How wireless charging works

Electricity flowing through a wire coil creates an alternating magnetic field. When another wire coil is placed in that magnetic field, a flow of electricity is induced through it, charging the battery.



Wireless EV Charging in the Context of an Average Home

As mentioned above, wireless charging isn't very efficient. For small devices such as toothbrushes and smartphones, it's usually no big deal. But for something as energy-intensive as a car, that inefficiency can translate into a lot of wasted energy. If the energy capacity of a cell phone battery was equivalent to the volume of a basketball, the energy capacity of an EV battery would be roughly comparable to a hot air balloon. To provide an average charge of 6.6 kilowatt-hours (kWh), which is the average electricity consumed per charging event as reported in the INL's EV Project Electric Vehicle Charging Infrastructure Summary Report (PDF), the use of a wireless charger could require a draw of 7.6 kWh—about 15 percent more. Annually, this energy waste would likely amount to about 360 kWh per year and be roughly equivalent to adding an additional compact refrigerator to a home (**Figure 2**).

FIGURE 2: By the numbers—an estimate of the energy wasted from wirelessly charging an electric vehicle

The average residential daily consumption of an electric vehicle is about 6.6 kilowatt-hours (kWh), according to the Idaho National Laboratory, yielding about 360 kWh of wasted energy per year—roughly equivalent to adding an additional compact refrigerator to your home.

6.6	Average daily charge (kWh) of an EV, plugged in
7.6	Average daily charge (kWh) of an EV, wireless
360	Annual wasted energy (kWh) due to wireless charging
341	Annual energy consumption (kWh) of a standard-efficiency compact refrigerator (Energy Star, 2014)
1.1	Wasted energy in compact refrigerator equivalents
0.1128	Average cost ($) per kWh of residential electricity in the US (Energy Star, 2014)
272	Average annual electricity cost ($), plug-in charging
312	Average annual electricity cost ($), wireless charging
40	Average annual cost ($) of wasted electricity due to wireless charging

Notes: EV = electric vehicle; kW = kilowatts; kWh = kilowatt-hours. © E Source

Consumers should also be aware that metal objects located in the vicinity of the electric field may absorb a lot of the delivered energy, creating a potential safety concern and reducing the charging efficiency. This includes items as ubiquitous as coins, soda cans, steel-toed shoes, paper clips, tinfoil, and CDs.

Given the significant energy waste of wireless charging stations, these devices have the potential to counteract some of the benefits of utility energy-efficiency programs and drive residential peak demand higher. With that in mind, it may be a good idea for utilities to make customers aware that—although convenient—these charging stations may offset the good intentions that drove them to buy an EV in the first place, while also increasing their electric bills.
