

ELON MUSK'S GRAND PLAN TO POWER THE WORLD WITH BATTERIES

NATHANIEL WOOD FOR WIRED

Elon Musk wants to sell you a battery. And he doesn't care whether you drive an electric car.

Musk, ever the showman, unveiled his grand "Tesla Energy" scheme to electrify the world on Thursday night, and it actually makes a lot of sense. Tesla, which is in the middle of building a vast "Gigafactory" battery production plant in the Nevada desert, plans to offer new versions of the batteries it puts in its Model S car to residential, commercial, and utility customers.

The "Powerwall Home Battery" offers either 7- or 10-kWh of storage, and will allow consumers to store energy they produce with a solar array—even go off the grid if they want. It's available for small businesses as well, while bigger operations will want the Powerpack, a 100kWh refrigerator-esque unit, to use more renewable energy, avoid peak demand charges, and keep things running in the event of a power outage. These larger batteries are being produced for utilities as well, and can help the energy providers improve demand response and increase their use of renewables.

"Our goal here is to fundamentally change the way the world uses energy," Musk says. "At the extreme scale."



The "Just in Time Market"

Just as he's done with the auto industry, Musk is hoping to shake up the energy business. Today, the generation of electricity is inextricably linked to its consumption. Utilities don't store what they produce, they deliver it immediately, and so they produce exactly as much as is needed at any given moment. This is what Matt Roberts, executive director of the Energy Storage Association, calls the "just in time market." When you flip on a light switch, a power plant ramps up to generate that tiny extra bit of electricity.



THE POWERWALL BATTERY IS MADE FOR HOME INSTALLATION. NATHANIEL WOOD/WIRED

One problem with this model is the system must be capable of catering to maximum demand, delivering all the energy required during that hellish week in August when everyone's running their A/C. That means the system is designed and maintained to generate far more capacity than typically needed. Roberts estimates the American system is overbuilt by 30 to 40 percent.

That's why utilities often bill large customers based partly on their peak energy usage: The spikes in consumption may come rarely, but the provider has to be ready for them at all times, an expensive proposition.

Another problem with the "just in time" model is that it doesn't jibe with the increasing demand, from consumers and regulators alike, for renewable energy. Utilities can burn coal or natural gas, or spin up a hydroelectric turbine as needed. But

they can't turn on the sun or create wind to meet demand. To make renewables truly effective, they need a way to store that power when it's generated so it can be delivered when it's needed.

Batteries can do exactly that, which is why, Roberts says, everyone wants them. "It would change the way we all do business."

The Energy Storage Opportunity

The idea of energy storage has been around since the 1970s, says Ravi Manghani, a senior energy storage analyst at GTM Research, but didn't advance much until the early 2000s. In the past decade, an increased appetite for renewable energy and advances in solar panels and lithium ion batteries have attracted dozens of players to the idea of letting consumers and utilities put their power in reserve.



FOR BIGGER APPLICATIONS, TESLA OFFERS THE REFRIGERATOR-ESQUE POWERPACK. NATHANIEL WOOD/WIRED

Battery efficiency is growing about 8 percent annually, according to Manghani. Prices are expected to drop 50 percent in the next two to three years, says Sam Wilkinson,

research manager for solar and energy storage at IHS Technology. That's due in part to Tesla, and while there's still room for improvement, it's a great start.

The market for energy storage is split into three segments, Wilkinson says: Utilities, commercial, and residential.

At the utility scale, huge batteries could be built into the grid to balance energy demand and supply, making the entire system more resilient and efficient. Electricity generation could move from a relatively small number of big plants to what Roberts calls "virtual power plants"—small solar, wind and other installations around the country—because they'd be able to store what's generated in batteries connected to the grid.

Commercial customers could maintain a bank of batteries to reduce what they draw from the grid, particularly at peak times, when power costs more. You "can make very very significant savings on your electricity bill," Wilkinson says. Consumers, too, could benefit. Tens of thousands of American homeowners have solar panels on their roofs, many of them SolarCity customers. They use solar power as it's being generated, cutting down utility bills. Come nightfall, or a stormy day, they're pulling from the grid like the rest of us. A battery would let them store excess generation.

But these customers don't necessarily want the ability to store energy they don't consume in the moment. That's because many of them now get paid by their utility for surplus energy they feed into the grid. Rates vary, but in most cases, there's not much difference between how much they get paid, and how much they pay later (like at night) to get energy from the grid. So there's no economic benefit to installing a big battery over status quo: selling that extra electricity, then buying more later when you need it.

Utilities in more than 20 states are working on alternate rate structures to change this, says Manghani, but as it stands, there's little incentive to hold onto what you can get paid to sell.



THE POWERPACK IS "INFINITELY SCALEABLE," MUSK SAYS. NATHANIEL WOOD/WIRED

At the residential scale for solar, "there's no real business case for storing electricity from an economic point of view," Wilkinson says. "It's more to do with backup and energy security, or some sort of emotional idea that people would like to become more self-sufficient and generate their own electricity, and store and use it."

And while some people may want that backup or self-sufficiency, the battery is too expensive to make it practical. But, Wilkinson says, if the upfront cost drops low enough, or if the customer can subsidize it by selling services to the grid, that could make it a good deal.

Tesla's Plan

The 220-pound Powerwall will, as its name suggests, be mounted on a wall, and is made for home use. It's just six inches deep, comes in different colors, has a 10-year

warranty, and is available in two versions: a 10-kWh setup for \$3,500, and a 7-kWh unit for \$3,000. It's Internet-connected and has an integrated DC inverter. It's available for order now and will be installed by distributors. Tesla expects deliveries to start late this summer.

There are plenty of advantages for consumers, Musk says. If the grid goes down, you can still have power. You can fill up the battery at night, when rates are lower. The typical household uses somewhere around 30kWh a day, says Stu Lipoff, an electronics industries consultant and IEEE fellow. So the Powerwall wouldn't really be enough to keep your home going off-grid for long (depending on how much solar energy you're putting in), but it's a lot better than nothing.

In the US, Musk says, customers often have to sell energy back at wholesale prices, then pay for more at retail cost, so "it actually makes huge economic sense." It should be even better overseas, where sell back prices are well below how much energy costs. "It's gonna be huge in Germany."

For bigger applications, there's the "Powerpack," which is about the size and shape of a refrigerator. Businesses not satisfied with the size of the Powerwall can use them to avoid those peak rates and keep everything running if a storm takes down the power lines. Target's on board to test it out at some stores, so is Jackson Family Wines.

Utilities need way, way more power. That's why Tesla is making the Powerpack "infinitely scaleable," Musk says: You can pile together as many as you want. Several partners have signed up, including Southern California Edison. And you need just 2 billion of these things to switch the entire world over to renewable power stored in batteries. That's how many cars and trucks are on the planet's roads, Musk says.

If Tesla's right, consumers and businesses will be able to save money by holding onto electricity they produce, thanks to a not-so-big white (or black, or blue, or red) box stuck onto their garage wall. The rest of us will benefit too, from a world in which the aging electric grid is less strained, and in which we power our cars not by burning fuel, but by taking advantage of the sun.