

# Renewable Energy for Everyone, Everywhere

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If somebody said what's the one most significant invention in the modern world, it's electricity. Everything else is derivative. I see myself as someone who's putting the ideas of science to work to solve societal problems. I mean that's what engineering should be. The engineer is the steward of the earth's resources, so let's figure out how to make the best use of these resources, and start looking at the tough problems that are much longer range.

So the biggest problem, as I see it, in the world of energy is electricity sustainability. I mean electricity is a modernity. Without electricity you don't have the modern world. All the stuff that we have today, the wireless world, internet, communications, all of it's predicated on electricity. So we really need to figure out how to bring electricity to everybody. Unfortunately, a lot of the electricity that we generate today we do so by burning carbon. We have sustainable waste to make electricity, wind, solar, but they're intermittent. What happens after dark, when the sun doesn't shine? What happens when the wind doesn't blow? If I told you I'd give you electricity 12 hours a day for free, but I won't tell you which 12 hours, what are you going to do with that? That's useless. So how are we going to be able to harness wind and solar, and do so in a way that's reliable? It's with a battery, and that's why I've been working on that. I want to give us the ability to draw electricity from the sun even when the sun doesn't



shine, and that's a powerful idea.

So how do you deal with the intermittency and do it at a cost point that's acceptable? Just be smart and invent to the price point, and make it come in because it's cleaner, it's cheaper, and it's better. So the only way I know to make it dirt cheap is to start with dirt. Go in the back yard, take a shovel of dirt, bring that into the lab, and tell the people invent a solution based on what's in this pile of dirt. That's the approach that I took to invent this battery. It's called the liquid metal battery.

We've got data now from these batteries, and the fade rate is so low if we cycled them once a day for 10 years we'd retain over 99.4 percent of the initial capacity. Or if you want to wait until they're down to 80 percent, that would be 305 years. That ought to take care of pretty much everybody who's listening to this. Earth-abundant elements and a simple design that's easy to build, that means you can put it all over the world. Batteries in the United States will be built by Americans in the United States. Batteries for Africa will be built by Africans in Africa, from African resources, and then they become authors of their own futures, because now they've built the devices that are keeping them electrified. You don't build a giant next-generation grid. You break the grid up so that every user can be a generator, so I generate my electricity on my roof, and I store it in my basement.

The other area is metal production. What's the number one source of carbon dioxide? Steel production. Steel production. So how are you going to produce steel without greenhouse gases? I know. The electron. We use the electron as the reducing agent, and the electron has no emissions. It only comes in one purity, 100 percent pure, and if we have carbon-free electricity, and then we take dirt and convert it to metal, so we make iron at the one electrode and oxygen at the other electrode, and so now we have the ability to build modern society.

People live by the Golden Rule. You know, I'm going to treat you as well as I hope you'll treat me. I enunciate the Platinum Rule. The Platinum Rule is I treat you better than I expect to be treated. Now I put that into my research. Imagine a process that makes metal in such a way that the air is cleaner in the vicinity of the smelter, that the water is purer downstream from the Smelter. The residents fight to have the factory sited in their neighborhood, because their neighborhoods are cleaner than the rest. Why aren't we thinking about big ideas instead of little ideas?

So world of energy 2064, we will generate electricity without burning carbon. That will give us sustainability. Once these things become competitive, then they're going to blow the doors off of the other stuff, and then you'll see it go. Imagine that you electrify parts of the world that at the moment don't have access to electricity. What does that bring? The first thing that comes to mind is water purification, and that means sanitation, which then means health, which then means the opportunity for a lifetime of other than survival, and then with the knowledge that comes streaming through the wires comes education, and then you've got it. You've got healthy people that can feed themselves and put themselves to work. I mean it's so enabling. It's the missing piece.

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