Transcript: Note to Smart Grid: Heal Thyself

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Laurie Howell: Standing at the top of a parking garage on North Carolina State University's campus, electrical engineer Alex Huang points out something so common they're nearly invisible--power lines.

Alex Huang: So, you can see this big transmissions tower. So here, this is basically Progress Energy's power line coming in to the substation. You can think this big cable coming in, you can think this is a legacy system.

Laurie Howell: A legacy system, meaning mostly powered by fossil fuels. Almost 70 percent of U.S. electricity comes from coal, natural gas, and oil. But Huang imagines a future where what's coursing through these lines is renewable, green power. To achieve it, he's not working on wind turbines or solar panels--he's developing the next grid to get renewable energy where it needs to go in the digital age.

Huang is Director of the FREEDM systems center--which stands for Future Renewable Electric Energy Delivery and Management. It's a National Science Foundation Engineering Research Center involving four universities. They're developing the FREEDM system, which is a smart grid, but it's more than that. Mariesa Crow, electrical engineer at Missouri University of Science and Technology, calls it,

Mariesa Crow: … it's kind of like a smart grid on steroids.

Laurie Howell: But what's wrong with our current grid? Well, it's really rigid. Energy flows one direction only, from the power plants to our houses and offices. It's like a plumbing system with no valves. So you can't redirect electricity or control where it goes. The FREEDM vision, on the other hand, is to make energy "digital"--so, as easy to transfer as your digital photos. Thus, what the researchers call the "energy internet."

Mariesa Crow: You plug in your digital camera and suddenly you can share those pictures with anybody in the world.

Laurie Howell: Imagine doing that same thing, only plugging in a wind turbine.

Mariesa Crow: And now, suddenly, I can share that energy with, essentially, anybody in the world.

Laurie Howell: That's the energy internet--a digital grid that's incredibly controllable, participatory, and resilient. For instance, if there was a downed power line, the grid's intelligence could easily cut off power to that line and redirect power to your house from another source—all without sending a technician, and without you even seeing your lights flicker. And, in the "energy internet" age, every one of us could be generating electricity. The most exciting part of which is what would come next.

Alex Huang: By having an energy internet, you're going to unlock the potential for innovation.

Laurie Howell: Like the internet allowed the birth of Google and eBay, the energy internet will hopefully bring about a paradigm shift in renewable energy. To allow that innovation, the researchers are tackling both hardware and software. For hardware, there needs to be a standardized outlet--or, more accurately, inlet--for personal wind turbines and solar panels to plug into the grid. It's a concept like today's USB ports on computers.

Mariesa Crow: It's what we call plug-and-play. We're going to see that same thing. You can buy your own solar panels, your own wind turbine, your own energy storage, you get home, you plug them in, and they will have the intelligence and able to communicate with everything else.

Laurie Howell: And that's the software side of things--the communication. The box you plug into is in communication with the boxes of everyone else in your neighborhood and the central operating system. Each box is like a router, sending energy where it needs to go. That energy will be easier to direct around. But it won't be much greener without one final piece: storage. The grid now has essentially no storage. That means that power plants have to produce energy at the moment it's needed. But renewable sources are intermittent.

Jeff Stein: The wind blows when it does, and the sun is only up when it is.

Laurie Howell: Mechanical engineer Jeff Stein and his colleagues at the University of Michigan in Ann Arbor are studying one of the most promising places to store energy in a future smart grid: in the battery of a plug-in electric vehicle.

Jeff Stein: OK, your neighbor throws their light switch on, the wind is not blowing, so the power company says no problem, I'll take it out of your neighbor's electric battery and give it to the other neighbor and turn on their lights.

Laurie Howell: As the name implies, a plug-in electric car gets its juice from your wall outlet. And to the grid, plug-in vehicles are just big batteries… on wheels. But a longstanding challenge of electric cars has been developing a good battery. So Stein is investigating what causes batteries to lose their storage capacity over time. To study battery lifetime in cars, they're "driving" some batteries in the lab--well, in miniature. A circuit on a tabletop charges and discharges a battery small enough to fit in your hand. But then, the battery has to eventually be tested along with the rest of the car's components. For these experiments, Jeff Stein takes me to a lab testing a full-sized car. A full size car that's mostly invisible.

Jeff Stein: This lab takes an engine which is actually sitting in a room on a stand, and makes it believe that it's sitting in a variety of different vehicles, depending on what kind of vehicle we want to design in the computer.

Laurie Howell: The engineers can then measure fuel efficiency and emissions from the real engine, and test a different kind of vehicle with just a few clicks. The idea is to strike the perfect balance: a car that's great as a vehicle, and also great as an energy storage device on the smart grid. Back on the North Carolina State Centennial campus, just such a grid is under construction. It's the first scaled-up version of the FREEDM grid. Solar panels, wind turbines, and electric vehicles will be networked together,

sharing energy and communicating. This grid will quickly expand, maybe encompassing dozens of surrounding buildings, says director Alex Huang.

Alex Huang: Our plan is to gradually increase the amount of renewable energy so maybe one day we can call the Centennial campus a green campus.

Laurie Howell: Huang leans against the railing overlooking the construction site. You can tell, he envisions green energy as far as the eye can see. And then, much farther.