From AC to DC away with the adapters

The Costa Rican pianist and electrical engineer Laura Ramirez Elizondo thinks our electricity grid needs to be overhauled. She received a two million euro grant to find out how. "I want to give a twist to the future."

Foto: Marcel Krijger

Now they are still indispensable, the large coal and gas power stations in our country, but in twenty years they will hardly play a significant role anymore. Laura Ramirez Elizondo (Faculty of Electrical Engineering, Mathematics and Computer Science) thinks that our electricity supply is going to change enormously.

In the hallway of Ramirez' research department hangs a poster with a cartoon that nicely represents Ramirez' vision of the future. We see industry, a power plant, an urban area, windmills at sea and solar parks. On the plate there are only a few high voltage cables; they connect the wind farms with the mainland and

ensure that the power plant can supply factories with electricity. There are hardly any high-voltage cables in or to the city.

The townspeople are self-sufficient and connected to a direct current (DC) network. All roofs and many walls are covered with solar panels. Here and there a windmill stands on a roof or between the houses.

What does a pianist do in the world of electricity networks?

"I doubted whether I would make a career in music or science. In 2005 I graduated from the Conservatory of San Jose with a specialization in piano. And I also obtained a bachelor's degree in electrical engineering from the University of Costa Rica. I didn't want to have to go on tour all the time. In the end I chose science because I like it so much that I can help to give a twist to the future. I still teach piano. By the way, I am officially allowed to give yoga lessons as well, but I don't have time for that".

What brought you to the Netherlands?

"I came to the TU because of the great emphasis on sustainability issues. In 2007 I obtained my master's degree in electrical power engineering here (cum laude, red). I have always been involved with sustainability. As a child, I was already involved in environmental organizations that collected waste from beaches and educated people in rural communities about sustainability. In addition, my husband is a composer. Like me he wanted to go to Europe. Europe has produced so many great composers. For that reason alone we wanted to come here".

According to you, residential areas are going to generate their own electricity and exchange it with each other via direct current smart grids; intelligent low voltage direct current networks. What role will energy companies play in the future?

"Their role will change enormously. The direct link between energy companies and consumers will be very different. I think that energy companies will mainly work as service providers. They can help regulate the grids and connect households to these grids. You used the word smart grids. That is a vague concept. I prefer to talk about low-voltage DC networks.

According to Ramirez, alternating current also had its best time. The twenty-first century will be the century of direct current. And with it, the wish of Thomas Edison. Edison was at the cradle of the world's first electricity supply. From 1882, he supplied 110 volts direct current to several dozen customers in Manhattan. The problem with direct current was that it was difficult to transport

it over long distances because you could not convert the direct current to high voltages. Now you can do that by means of power electronics. A competition arose between Edison (direct current) and the American businessman George Westinghouse, a fierce advocate of alternating current. This battle would go down in history as the 'War of the currents' and was settled in favor of alternating current. It seems that Edison will get his way posthumously after all, because we are all going to generate our own energy.

Together with colleagues from the electrical sustainable energy department, Ramirez is investigating what needs to be done to make the transition to sustainable low-voltage DC grids possible. They have just received two million euros from the European Union for this.

You envisage a future in which we will get DC power from the wall socket.

"Yes, alternating current is a legacy of the past. Decentralized generation technologies such as solar panels produce direct current, and storage technologies such as batteries and electric cars run on direct current. It's all done at low voltage levels. We can generate and use the electricity on site. If low-voltage grids operate on direct current, we don't need to convert the output of those technologies into alternating current".

Then we no longer need all those adapters.

"That's right. All our devices, from laptops to toasters to TVs, work on DC. Converters now change the AC (Alternating Current) voltage from the power outlet for these

devices into DC voltage. And that while solar panels produce DC voltage. It's actually very inconvenient that we convert electricity from DC, to AC and back to DC again".

This ease of use will not be your only motivation.

"I think we can make the world a more sustainable place with low-voltage intelligent DC grids. These grids will make the transition to fully sustainable electricity with wind and solar power easier. What's more, we need fewer thick cables and no more large adapters. That saves material. And in places around the world where there is no money to build traditional high-voltage infrastructure - many places in Africa - electricity grids are still within reach thanks to DC.

It will be quite a challenge to switch to DC.

"There are many challenges. Above all, we have to make sure that DC networks are better able to withstand failures such as short circuits. That is one of the topics we will be working on within our European project. We are also working on algorithms to balance supply and demand on DC networks. The electricity production of solar panels and wind turbines varies greatly. You have to deal with that in a convenient way.

Does this new focus on low voltage mean that EWI's high-voltage lab is going to be overhauled?

"We're going to redesign the laboratory in the next few years. Next to the current high voltage equipment there will be solar panels, electric cars and home batteries. For one of our research projects we are imitating a domestic installation in the Netherlands. The goal is to evaluate how effective the home battery is for intelligent energy management".

When can we expect the turnaround?

"I think in about ten years' time we will see the first new construction projects in which entire neighborhoods will be equipped with intelligent DC networks. What helps is that more and more people are driving electrically. Charging electric cars requires a lot of power. At some point, our current electricity grid will no longer be able to cope with all those electric cars. You can create distributed DC networks for that. In Amsterdam, where people drive relatively much electrically, this is already becoming problematic.

I wouldn't be surprised if DC grids were to be installed there especially for electric cars".

Will there also be some kind of demonstration district?

"There will be a demonstration project in the Haarlemmermeer. A number of glasshouse horticulturists will switch to a DC grid. The horticulturists will use a gas turbine to produce their own heat for the greenhouses and generate electricity. Our input in this project is intelligence. We want to set up the turbines in such a way that they produce the right residual heat for the greenhouses and at the same time generate as much electricity as possible. In addition, we need to maintain the stability of the DC grid by means of control algorithms".

So you're not going to equip a residential area with DC networks?

"We are currently applying for a Marie Curie grant from the European Union. If it goes ahead, we will be able to continue working on concepts for intelligent DC networks at the neighbourhood level. We will then look at many more applications, such as ships and airplanes running on direct current. More than thirty research partners from Europe have joined us for this project". <<

CV

photo: Marcel Krijger

Dr. Laura Ramírez Elizondo (1980) is assistant professor bij de onderzoeksgroep DC Systems, Energy Conversion & Storage . In 2003 behaalde ze haar bachelordiploma elektrotechniek en haar bachelordiploma in muziek met een specialisatie in piano aan de universiteit van Costa Rica. In 2007 studeerde ze cum laude af voor haar master electrical power engineering aan de TU Delft. Tot 2011 werkte ze vervolgens als promovenda aan de TU. Nu is Ramírez coördinator van een Europees project dat twee miljoen euro heeft ontvangen om te onderzoeken wat er moet gebeuren om de overstap mogelijk te maken van

hoogspanningsnetten naar laagspanning DC-netten. Dat project heet 'DC SMART: DC Distribution Smart Grids'. DC staat voor Direct Current, de Engelse term voor gelijkspanning. Ze werkt hiervoor onder meer samen met het bedrijf Direct Current, het Fraunhofer-Gesellschaft in Duitsland en het Centre Suisse d'Électronique et Microtechnique.

Dr. Laura Ramírez Elizondo (1980) is assistant professor at the research group DC Systems, Energy Conversion & Storage. In 2003 she obtained her bachelor degree in electrical engineering and her bachelor degree in music with a specialization in piano at the University of Costa Rica. In 2007 she graduated cum laude for her master electrical power engineering at the TU Delft. Until 2011 she then worked as a PhD student at the TU. Now Ramírez is coordinator of a European project that received two million euros to investigate what needs to be done to enable the transition from high-voltage networks to low-voltage DC networks. That project is called 'DC SMART: DC Distribution Smart Grids'. DC stands for Direct Current, the English term for direct current. To this end, she is working with the company Direct Current, the Fraunhofer-Gesellschaft in Germany and the Centre Suisse d'Électronique et Microtechnique.

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