Talking about the Super Grid

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Q.: What inspired you to investigate structures for a cost-optimized future renewable energy supply for Europe?

Dr. Czisch: When I started these studies in 1997, many different technologies had already been developed to make use of renewable energy. But, there was no clear idea of how to combine all these technologies or how to achieve a fully renewable electricity supply. To fill this gap, I wanted to search for a way to have a totally renewable electricity supply for Europe and its neighbors. Simultaneously, I wanted to search for the cheapest solution. My main idea was to find an ecologic method as well as an economic, socially responsible method to get our electricity exclusively from renewable sources. I was quite sure that there were a lot of different possibilities for a renewable supply, among them, some with reasonable costs. And costs are important. In my view, searching for solutions with reasonable costs also means accepting responsibility for social aspects. If we look, for example, at the rich Germany, we will see that about 800,000 to one million households annually are switched off from gas and/or electricity supply, because they can't afford to pay their rising bills. One can easily imagine how much more the cost aspect affects poorer countries, or countries with more unequal income distribution.

Q.: What is your conclusion?

Dr. Czisch: We are faced with the fact that most of the renewable energies have a very unsteady production. Wind energy, for example, fluctuates from short-term, minute or sub-minute fluctuations, up to seasonal fluctuations. My inherent question concerning these fluctuations was how to use these unsteady forms of energy to produce a reliable electricity supply.

There are mainly three approaches to these issues[1]: the use of storage, over-installation, or smoothing the production by geographically spreading the use of the renewable energies or using different renewable sources at the same time. I wanted to find the best of these solutions or the best combination of these solutions.

From studying several data sets[2], I discovered that a larger production area reduces the problem of fluctuation. If you consider, for example, a single windmill, you see

[1] A fourth approach, which was also part of the analysis, was the temporal shift of parts of the consumption.
[2] Mainly from the European Centre for Medium-Range Weather Forecasts (ECMWF), the U.S. National Centers for Environmental Prediction (NCEP), and the U.S. National Center for Atmospheric Research (NCAR)

very strong fluctuations in a very short time. As soon as you have a wind park, the fluctuations smooth each other out in a time scale of, let's say, up to one minute. And if kilometers are separating the windmills, you gain smoothing for several minutes. And if you have dozens of kilometers in between, you get quarters of hours of smoothing. In the end, if you have an area within which you have different climatic zones, you can even handle the seasonal fluctuations.

After I looked for the optimal solution by using a mathematical, and therefore, most objective method, my research shows that large areas that deliver the electricity over thousands of kilometers are the best way to obtain the cheapest renewable electricity supply.

Q.: You and the director of the Office for Sustainability at Southern New Hampshire University, Roy Morrison, are currently developing a proposal for a North American super grid model. What are the main differences between this model and the European model you developed?

Dr. Czisch: First of all, I wouldn't call it a model. It is an optimization. The difference between a model and what I am working on, is that I don't know the outcome before I start. The optimization searches for the cheapest solution and does not care about any subjective preconditioning.

One of the differences between the European and the US-American situation is geography. In the United States, in contrast to Europe, you do not need sea cables, because there are no sea crossings. Instead, you can use overhead lines all the way from the production areas to the consumption centers, which makes things easier and cheaper. In addition, in the U.S. you have a variety of different climatic zones within one single country. This helps to adapt the production to the consumption by choosing the best mix of production sites. In Europe, we have relatively small countries, and within most of these single countries the climate is very homogenous, and therefore, does not offer as broad a variety of different production patterns as the U.S. There are also many different sources of energy within the U.S.: For example, you have great biomass, huge wind, and enormous solar energy potentials. You have hydropower, and if you consider cooperation with Canada, then you have even greater hydropower and biomass resources.

Another difference is the ease of installation. Installation is easier if you are dealing with one country – or two, if you include Canada, whereas I have included 66 countries in my scenarios for Europe.

Concerning our studies for the U.S., we also want to have a broader focus, which goes further beyond electricity than my studies for Europe, with a stronger emphasis on the other sectors of energy consumption and on efficiency measures. This also means that we are interested in finding additional partners and appropriate funding for our ambitious interdisciplinary research project.

Q.: What areas in the U.S. would benefit most from such a super grid concept – and why?

Dr. Czisch: Based on the results of my research for a European renewable electricity supply, I am expecting a super grid solution will also be the best way to provide everybody in North America with cheap renewable electricity. The research will investigate the optimal redesign of the U.S. energy supplies. It will show what the

energy supply structures should look like and their impact on different areas. I expect market changes and regionally-specific shifts in employment. Areas with better renewable potentials might attract more investment, while areas, for example, that are today dependent on coal production might switch to wind energy production, if they have good potentials with appropriate temporal production patterns. It is also possible to include some political restrictions in the studies, like having a minimum domestic production share in each of the federal states. This would help to understand the influence of political decisions on the possible outcome for the future electricity supply, structures, and resulting costs.

Q.: You and Morrison also drafted a "Declaration of Support for an Efficient Renewable Energy Future," which was signed by eight other international energy experts. The declaration presents renewable energy and energy efficiency as clear choices that can lead to long-term prosperity and sustainability. What are the key steps for such a shift?

Dr. Czisch: This declaration wants to take renewable energies more seriously than they had been taken before the BP oil spill. We want to make clear that we want to move away from all fossil fuels, be it oil, gas, or coal.

I am very sure that we have all the technologies available, to provide the energy needs of the U.S. I liked Al Gore's statement that he wants to have a totally renewable energy supply for the U.S. within 10 years. He mentioned that anything that takes longer than 10 years, doesn't lead politicians to act.

I think that a faster track is the much cheaper, climate-friendlier, and more ecological solution than a track, which, for example, takes as long as four decades. If we opt for a slow change, we will be faced with the fact that our older fossil plants are running out, before we have installed the renewable alternative. No matter what the details of these scenarios for the U.S. will be, the fast track will be the solution that avoids more climate problems and investments in the installation of intermediate systems causing extra costs.

It is important to go for a stepwise construction of the new system. That means, we have to find pieces to add together to the whole system. For example, in order to transport huge amounts of wind energy from the Midwest to the consumption area in the Eastern United States, it would be necessary to build high-capacity lines[3], which will be combined into a US-American super grid at a later time. This process needs some coordination.

It is also important to consider technical and cost development of the different renewable technologies. This should be done in a kind of online optimization, which should be elaborated during the whole process of installing the new energy system, and should be used as a kind of feedback, in order to adapt the system during the course of its installation.

We must also find and evaluate financing mechanisms, such as feed-in tariffs or ask for the most appropriate adaption of power tax credits, and search for possible barriers and incentive tools in order to explore good pathways for a fast development of the investment into the new renewable energy supply.

[3] Most likely new HVDC (High Voltage Direct Current) systems

Q.: Can you estimate how long a shift from traditional energy sources to renewable energies will take?

Dr. Czisch: First of all, this is a question of will. But I am convinced that this – at least for electricity, by far the most climate-unfriendly part of the energy supply worldwide - can be achieved within 20 years. If we look at the different renewable energy markets, we see extremely high growth rates. In the case of wind energy - which is the biggest new renewable energy technology - installations grew in average by roughly 28% annually in the last 15 years – and, the growth rates in last years were even better. If you extrapolate with this figure and calculate how much electricity could be produced from wind energy with the installed wind energy converters at an average load of 28% of the installed wind power, you find that by 2024, wind energy alone could provide for all of today's electricity needs worldwide. The challenge is to maintain the high growth rates of wind energy and the other renewable technologies. Then, it is possible to arrive at a totally renewable electricity supply within less than two decades, and significantly shift the other sectors of energy consumption to renewable sources within the same time.