WINDNODE

‘We could heat the entire North-East with wind power’

In the Uckermark region, around 150 kilometres north of Berlin, lies a village which has been heated by wind power since February 2020. What is demonstrated here by this WindNODE project could set the tone for the entire North-East.

ENERTRAG
Eine Energie voraus

On 16th February 2020, the weather conditions were ideal: a steady wind was blowing with speeds of over 8 metres per second from the West across the fields of Uckermark towards Poland. Hundreds of wind turbines were feeding more and more electricity into the 50Hertz transmission grid. However, in the Berlin metropolis, 150 kilometres away, it is the weekend like everywhere else in the country. On Saturdays and Sundays, the electricity demand is usually lower than during the week, and if there is a strong wind front moving across the country, the power supply can exceed the demand in some hours. Apart from this, the large quantities of nuclear and coal-fired power plants, which continue to feed electricity into the grid - regardless of negative electricity prices. As a result, the prices on the electricity exchanges drop below zero (this means that consumers receive money for the electricity they consume).

However, it would not be economically sensible to expand the power grids for such rarely occurring large volumes of electricity. In such circumstances, the system operator signals the wind turbine operators to lower their output. This is also the case in Nechlin: At 6:35 am, the power grid operator sends the following signal to ENERTRAG: Curtail the feed-in from 30 megawatts to zero, then to 9 megawatts as of 7:05 am.

The automatic load control function implements this signal, but in the control room in Dauerthal something is quite different today than usual: the turbines can continue to turn. But the generated electricity is not fed into the transmission grid. This is exactly what Dr. Stefan Käding and his ENERTRAG team had been waiting for.

Wind turbines can keep on turning

Curtailing goes against the grain of any electricity generator. Ultimately, “curtailing” means relinquishing (carbon-) free energy. This energy is needed to obtain our climate protection targets in the heat sector. The problem is that local storage solutions are few and far between. This is exactly why ENERTRAG has worked to keep some turbines turning in the Nechlin wind field this Sunday, despite the large curtailments that would otherwise be necessary.

As part of its WindNODE project, ENERTRAG has laid an 800-metre power cable from the wind field to the village, ending at a green cylinder the size of a house. ‘This is the thermal energy storage,’ ENERTRAG project engineer Stefan Käding explains. A million litres of hot water are stored in this steel container with its thick insulation. Enough to supply the entire town with heat for one to two weeks. The heat accumulator is the new energy source for Nechlin’s local heat network.

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Energy transition in reality thanks to sector coupling

ENERTRAG founder Jörg Müller is a nuclear physicist and power plant engineer. Even 20 years ago, it was already clear to him that the expansion of renewable energy sources would require many energy storage facilities. For this reason, ENERTRAG developed a renewable “combined power plant” in the Uckermark region. Over an area of 40 x 40 km, a power plant grid now connects over 400 wind turbines to a plant for the production of green hydrogen and a battery-based primary controller (22 MW). Especially for the weekly occurring wind peaks, large and readily available storage systems and matching consumers are required ‘on call’. Water heating systems are ideally suited for this purpose.

After all, electricity is “flowing energy” and cannot be stored idly. Even a battery, often mistakenly called an electrical storage unit, does not store electricity, but rather chemically bound energy. Out of all energy storage solutions, thermal energy storage facilities have the advantage that they can absorb extremely large energy volumes and capacities at a very low cost. Wind-based thermal energy storage facilities can, therefore, cost-effectively absorb electricity volumes for which there is no demand at the moment and provide it over the following days and weeks. For the climate, this is a wonderful solution, because this wind power does not use other fuels and as a result, does not emit any harmful CO_2.

And so Müller has been preparing the expansion of heat networks for over ten years. Good ideas often need the right time and place. In the municipality of Nechlin, the idea finally rallied up its much-needed support. Municipal administrator Hartmut Trester convinced all citizens to connect to the planned heat network and the town council supported the implementation.

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‘Combined power plants consisting of many generating and storage units secure our energy supply.’

- Jörg Müller, chairman of the board of directors of ENERTRAG

However, an amendment to the German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) posed unexpected regulatory barriers during the implementation of the wind-powered heating project. In its 2014 version, the EEG considerably limits the possibilities for personal consumption of renewable electricity, making it impossible to economically operate such a heat storage system for wind peaks, even though this is undoubtedly sensible and desirable from a systemic point of view. In addition, the use of the curtailed electricity was prohibited by law. The legal basis to implement the principle of “use instead of shutdown” were no longer given.

Power cable for the wind turbine to the thermal energy storage facility

Instead of being able to use the energy from the wind turbines at peak times, more and more wind power has been curtailed in Germany since 2015. Subsequently, almost 5.4 billion kilowatt-hours of electricity go unused each year. This is enough to supply a million people with heat. (Source: Federal Network Agency (2018): quarterly report on grid and system security measures for the entire year and fourth quarter of 2018)

This means that at first, the energy for the heat supply in Nechlin could not be made available as planned due to legal and economic reasons. Instead, a wood burning system using wood chips from the forestry industry had to be installed. Jörg Müller said: ‘Wood is a valuable and very scarce raw material and should only be used for heating as an emergency measure. Wind power, on the other hand, is widely available. You just need to use it.’

In 2019, the share of renewable energy in Germany’s electricity generation already exceeded the 40 percent mark. In the WindNODE region, it was even higher: around 60 percent. A few years ago, when the percentage of renewables was still at a low, wind and solar power were hardly perceptible in the large power grid. As a result of the desired expansion, there are more and more hours each year during which there is a build-up of unused, but readily available electricity that needs to be stored, either in electrical or simply in functional storage systems.

‘What used to be coal stocks, now have to be heat and gas storage systems,’ the ENERTRAG founder claims. That is why the power cable runs from the wind farm to the thermal energy storage facility.

Several curtailments per month

In Nechlin, it now happens several times a month that the power grid operator orders curtailment - down to a complete stop in wind power production. Even in winter, where heat is profoundly needed, we can expect the same.

Technically speaking, the conversion of wind power into heat is not complex. Stefan Käding points to a three-metre-long cylinder with roughly the same diameter as a medicine ball. ‘Around a hundred metal bars are installed inside this electric heating element. When electricity flows through them, they get hot and heat the water.

The same principle is used in bathroom boilers. This one is just a bit larger:

instead of 10 kilowatts, the electric boiler for Nechlin’s heat supply is designed for 2,000 kilowatts. What’s more, the water tank does not just contain a few, but a staggering one million litres of water. ‘The largest technical challenge here at the edge of Nechlin was our aspiration to build a thermal energy storage facility with a limited height for visual reasons,’ Käding explains.

A boiler with special geometry

With a height of only five metres, the storage unit is only a quarter of the height of the trees here at the edge of the town. To compensate, it has an unusually large diameter of eighteen metres. Conventional boilers have a geometry where the height is several times the radius. The reason for this is that heat storage units work at maximum efficiency if they are able to build a clear layering of the heat. This is what allows one to take hot water from the top of the tank for heating, while the water that has cooled down flows back to the bottom of the tank.

To prevent the inflowing and outflowing water from mixing in the reservoir like in a whirlpool, the water must be evenly distributed with an even and steady flow. 'These structural details were calculated specifically for our thermal energy storage in the scope of a thesis,' Käding explains, adding: 'We have a few hours each time to heat the water, up to 95 degrees depending on the duration of the curtailment. The large water volume then ensures that the average heat output of 200 kW is available for a week, until the thermal energy storage has cooled down to 60 degrees. Normally, the next curtailment is ordered by then.' This way, the wind field is able to successfully meet the town's entire heat demand.

New opportunities

For Jörg Müller, Nechlin is a model for the entire North-East of Germany. Most medium-sized cities in Brandenburg, like Prenzlau or Pasewalk, have large heat networks, he explains. But even in the smaller towns, such grids can be installed with ease and at low cost. Not to forget: 'Up to 5 percent of the wind power that would otherwise go unused is available for the cheap heating of hundreds of thousands of homes.'

In Germany's eastern states, there is a window of new opportunities: not only has the installation of new oil heaters been prohibited from 2026 for the entire country.

Furthermore, most of the existing oil heaters were installed in the 1990s and are now between 20 and 30 years old. 'New investments are imminent. We have to use this opportunity to convince more municipalities of favourable and climate-friendly wind-powered heating, before new CO_2-spewing gas heaters are installed,' Müller insists. 'In the communities and cities of North-East Germany, one can use wind power to offer local heating solutions, which can be quickly implemented. Co-financing with the aid of financial participation models like a "wind heat bonus" is imaginable.' Nechlin shows that it is easily done.

WindNODE only makes the project possible

Where do we stand in respect to the legal barriers? For Nechlin, as for all WindNODE and SINTEG projects, there is a so-called regulatory experimentation clause issued by the Federal Ministry for Economic Affairs and Energy. The SINTEG regulation, which is based on § 119 of the German Energy Industry Act (Energiewirtschaftsgesetz, EnWG), creates specific freedoms that would otherwise not exist under the applicable legislation and payment of the EEG surcharge. As a result, the electricity can be consumed locally by installations like the one in Nechlin, in order to gather experience using the technology and to try out new rules of play within the energy market. This method is known as "regulatory learning" and is an innovative approach in advancing the energy transition, also reflected in the federal government's regulatory sandbox strategy.

'The EEG surcharge on renewable electricity alone is much higher than the cost of natural gas, even if the cost of wind power is lower,' says Jörg Müller, adding: 'From a climate policy perspective, it is counter-productive to impose high government charges on carbon-free electricity, while sources of CO_2 like natural gas are free of such charges. It should be the other way around! We need clear legal framework conditions so that projects like Nechlin remain possible, even after the experimentation clause expires at the end of 2020.'

The Nechlin project demonstrates that wind power peaks for which grid expansion would not be efficient, can be used to provide a renewable heat supply to communities and cities. The possibility of supplying cheaper heating using wind power from the edge of town will also, in turn, create more acceptance around the use of wind turbines.

'Our approach was to involve the local population from the start.'

- Simon Müller, head of energy systems at ENERTRAG

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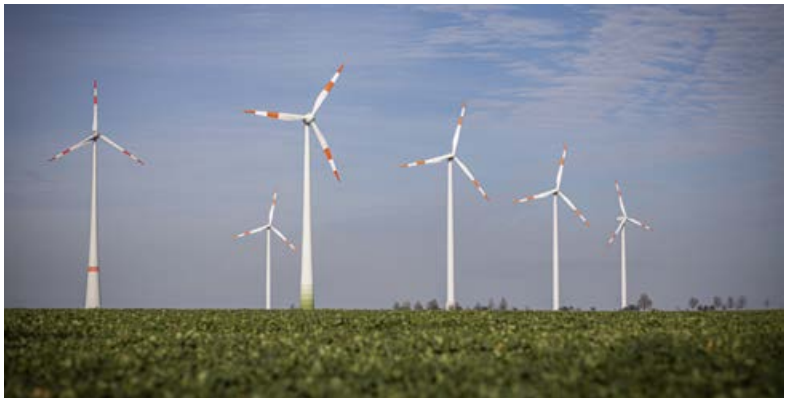

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What does WindNODE have to offer?
WindNODE and the SINTEG regulation have created the legal foundations to make "use instead of shutdown" even possible at all, and to test it in the regulatory sandbox. The four-year funding was largely spent on IT applications. Together with other WindNODE partners, such as grid operator 50Hertz and the flexibility platform, we were able to play out different scenarios and study the interaction for the use of renewables for grid, system and energy transition purposes.

We now need a further-reaching regulation, so that the project can continue to operate beyond November 2020.

Where can you see the project in action?
The project is located in Nechlin. There is a visitor centre around the wind-powered heat accumulator that is also easily reached via the local train station.

What can be done in terms of regulations to make more wind-powered heat accumulators possible?
Strictly speaking, one should actually return to the legal provisions of the EEG before the 2014 amendment. At the time, the amendment in a sense threw out the baby with the bathwater with regard to sector coupling projects: a limitation of 10 kilowatts was imposed on the private use of green electricity. It was stipulated that each electricity generator is only eligible to consume the same percentage of his electricity every quarter of an hour and is obliged to feed the remaining electricity into the public grids. The result is that the use of wind peaks for heating purposes became impossible, as this would involve the use of thousands of kilowatts. It goes without saying that the water is only heated if feed-in into the grid is not possible, and it will not always consume 5 percent of the generated output. Since 2014, an EEG surcharge is also a requirement on self-generated electricity, but this surcharge is higher than the actual value of heat energy.

'Our storage systems balance the fluctuations in generation and ensure a constant flow of electricity.'

- Jörg Müller, chairman of the board of directors of ENERTRAG

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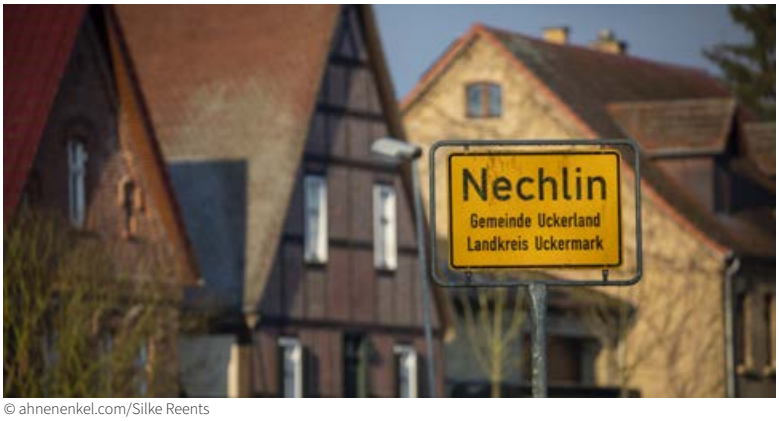
- ENERTRAG.ORG - WIND-POWERED HEAT
- ENERTRAG.ORG - FRAMEWORK FOR PTG
- VIDEO: ASEW-WINDNODE: ENERTRAG, ENERGY TRANSITION THROUGH SECTOR COUPLING
- ZDF-ZOOM „DAS ENDE DER ENERGIEWENDE" ("THE END OF THE ENERGY TRANSITION", AVAILABLE AS OF JULY 2021)



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