ERNEUERBARE ENERGIEN

Background Paper: The Combined Power Plant

The secure and constant provision of power anywhere and at anytime by renewable energies is now made possible thanks to the Combined Power Plant. The Combined Power Plant links and controls 36 wind, solar, biomass and hydropower installations spread throughout Germany. It is just as reliable and powerful as a conventional large-scale power station. The Combined Renewable Energy Power Plant shows how, through joint control of small and decentralised plants, it is possible to provide reliable electricity in accordance with needs.

The Combined Power Plant optimally combines the advantages of various renewable energy sources. Wind turbines and solar modules help generate electricity in accordance with how much wind and sun is available. Biogas and hydropower are used to make up the difference: they are converted into electricity as needed in order to balance out short-term fluctuations, or are temporarily stored. Technically, there is nothing preventing us from 100 per cent provision with renewables.

The Combined Power Plant is an initiative of the companies Enercon GmbH, Schmack Biogas AG and SolarWorld AG, and is supported by many partners from the renewable energy sector.

Why a Combined Power Plant?

Germany's energy policies are facing major challenges, the use of renewables is helping to meet.

- **Security of supply**: renewable energy sources prevent dependence on oil and natural gas, which to some extent come from politically and economically unstable regions. They offer an alternative to increasingly expensive oil and gas imports.
- **Climate Change**: renewables do not emit greenhouse gases, which are primarily responsible for climate change. This prevents severe damage to the economy and the environment.

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- **Nuclear phase-out**: renewables can in combination with energy efficiency replace the amount of electricity that is currently produced by nuclear power stations.

Renewables are already making a considerable contribution to sustainable and environmentally friendly energy generation. More than 14 per cent of Germany's electricity consumption stems from renewable energy sources. The Combined Renewable Energy Power Plant shows that renewables can assure 100% of electricity needs. The Combined Renewable Energy Power Plant dispels arguments that the availability of electricity from renewable energy sources is too dependent on meteorological influences. Cutting edge technology is already able to forecast energy yields reliably. The Combined Renewable Energy Power Plant makes use of this technology and regulates electricity needs just as securely as conventional, large-scale power stations. The Combined Power Plant guarantees reliable electricity generation at any time using renewable energy sources only.

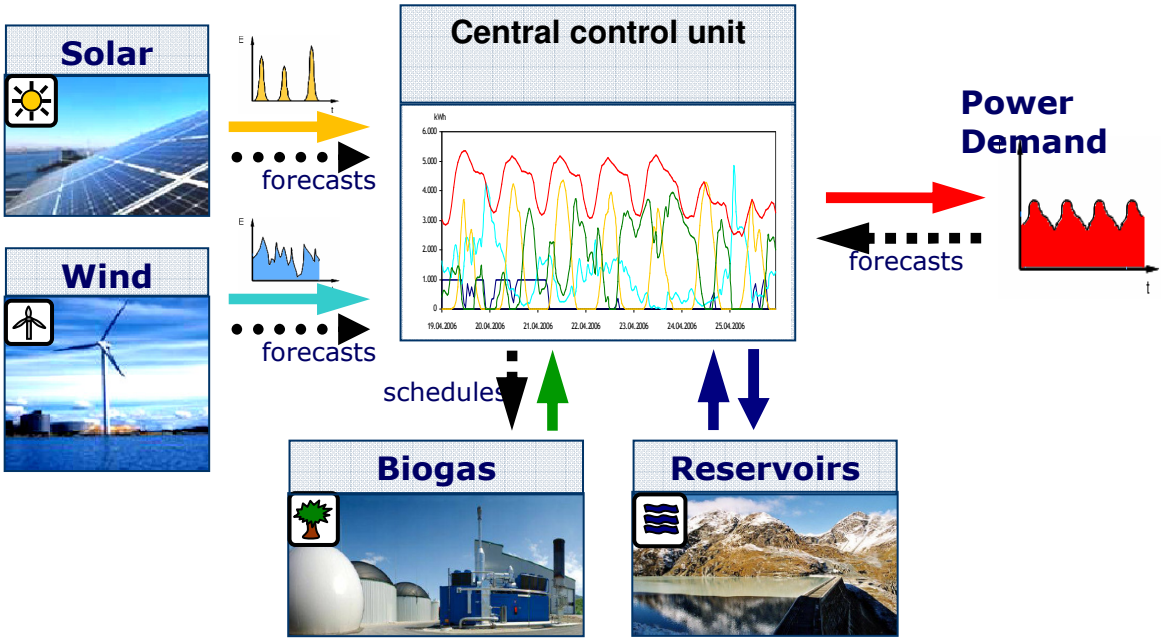
The Pilot Project

The companies Schmack Biogas AG, SolarWorld AG and Enercon GmbH have been quick to realise that reliable power supplies can only be provided by combining different renewable energy sources. The combination of wind and solar energy, as well as bioenergy and hydropower, balances out fluctuations and enables continual power generation.

The companies therefore developed the Combined Power Plant. Its design is based on the idea of linking and balancing out various renewable energy power plants. The "virtual power plant" is a concept well known in research. It means that individual, decentralised power plants are linked to one another via a central control unit using information technology. The Combined Power Plant applies this principle by using renewable energy sources only. The Combined Power Plant is more than a simulation. It permits an active control of renewable energy power plants in real-time operation. Variations in the various underlying conditions, such as electricity needs or the wind availability, immediately change the interaction between

the networked plants. The project thus demonstrates powerfulness and ease of control of renewable energy. Together, these two factors ensure needs-oriented electricity generation. The increased development of renewable energy sources is *the* key to a secure and environmentally friendly energy supply.

How does the Combined Power Plant work?



(Figure: Central control unit of the Combined Power Plant)

The operation principle of the Combined Renewable Energy Power Plant is divided into two steps: anticipatory control and fine tuning.

Anticipatory Control

The Combined Power Plant links 36 renewable energy power plants that are distributed across Germany. Eleven wind turbines, four combined heat and power (CHP) units based on biogas, twenty solar power systems and a pumped storage power plant are linked to one another via a central control

unit. These power plants are intended to meet one ten-thousandth of Germany's electricity needs – roughly equal to the electricity requirements of a town with 12,000 households (such as Schwäbisch Hall in Germany). The Combined Power Plant therefore shows in miniature what is also possible on a large scale: 100 per cent provision with renewable energy sources at all times. The Combined Renewable Energy Power Plant adjusts itself to the nearest minute to meet daily needs. It covers peak loads, such as at midday, and stores electricity that is not needed during quiet periods.

The actual course of the electricity demand is the central starting point for all power plant functions. The forecast of the electricity requirements, the "load profile", is communicated to the central control unit.

This is also where the forecasts for the wind and solar power installations arrive. The German Weather Service (DWD) provides the forecasts for wind strength and hours of sun. The various data are then compared with one another in the central control unit. Wind and solar energy cannot precisely meet the electricity demand since the amount of wind and solar radiation fluctuates. This creates oversupplies and shortages, which have to be balanced out in order to ensure security of supply and grid stability.

How is this adjusted to meet the actual electricity demand?

The central control unit controls the installations included in the Combined Power Plant in order to produce electricity in accordance with demand. If wind and solar power installations do not themselves produce enough electricity, additional plant power is required, which comes from two sources: firstly, combined heat and power (CHP) plants are used to produce electricity and heat from biogas. Since biogas can be stored, this source of electricity is always available as needed. Secondly, energy can be stored temporarily in a pumped storage power plant and can be quickly made available again. If electricity is needed, water flows downwards from high-level reservoirs and drives a generator. If there are electricity surpluses, water is pumped through pipes back into the reservoirs. Forecasting of the output requirements makes it possible to draw up schedules in sufficient time for

controlling the combined heat and power plants and the storage systems. If the amount of electricity produced by wind and solar power installations exceeds demand, the surplus of energy is used for filling up the pumped storage reservoirs. The electricity can also be exported or used for driving electrical cars. In exceptional cases, the wind and solar power installations can be throttled back, but this would mean that existing potential energy is not utilized.

Fine Tuning

The precise forecast of the output of all involved power plants enables the Combined Power Plant to specify anticipatory control models. However, there is still a need for balancing out in terms of the actual electricity fed into the grid. Despite precise weather forecasts, there is generally a slight deviation in the actual electricity production in and the electricity demand. This requires fine tuning of the central control unit. It adjusts the original schedule to the actually measured values.

If there is insufficient electricity available, the biogas/CHP plants and the reservoirs release their available capacities. The central control unit receives continuous data on the current output of all power plants involved and, if necessary, requests additional power. Thus, the Combined Renewable Energy Power Plant is able to immediately meet electricity demand entirely from renewable energy sources. The use of biogas, in particular, plays a central role in controlling the Combined Power Plant. Biogas covers the peak load and balances out the natural fluctuations in wind and solar energy.

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