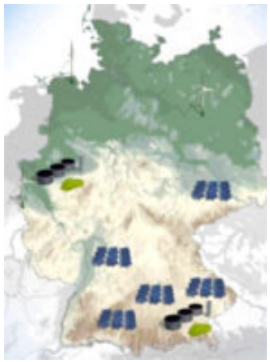
Solar Energy System of the Month:

- The Combined Power Plant: first stage in providing 100 % power from renewable energy
- PV-TEC – Research factory for solar cells
- Solar power system offers protection against blackouts
- Power for Africa: solar hybrid systems for rural electrification
- Economic feasibility of PV systems in Germany: more than just a little sunshine
- The world's largest photovoltaic solar power plant is in Pocking

The Combined Power Plant: the first stage in providing 100 % power from renewable energy

Renewable energy is already contributing over 14 percent to the electricity supply in Germany. That wind energy, photovoltaic and bioenergy plants can replace electricity from nuclear and coal plants is no longer disputed. To what extent this is possible, remains to be proven. The next consistent step is thus to prove that it is possible to provide the full electricity supply from renewable sources. The symposium "On our way to full supply from renewable energy sources" showed the way ahead. It outlined the current state of development, explained the medium-term plans for 100 percent electricity from renewable energy and provided an outlook for 100 percent renewable energy for electricity and heat supply as well as for mobility. Existing reference projects such as the "Regenerative Combined Power Plant" formed the point of departure for this event. The Solarserver is presenting the pioneering project, carried out by the companies Enercon GmbH, SolarWorld AG and Schmack Biogas AG together with the Institute for Solar Energy Supply Technology of the University of Kassel, as "Solar System of the Month" in January 2008.

Solar Energy System of the Month as PDF-Document



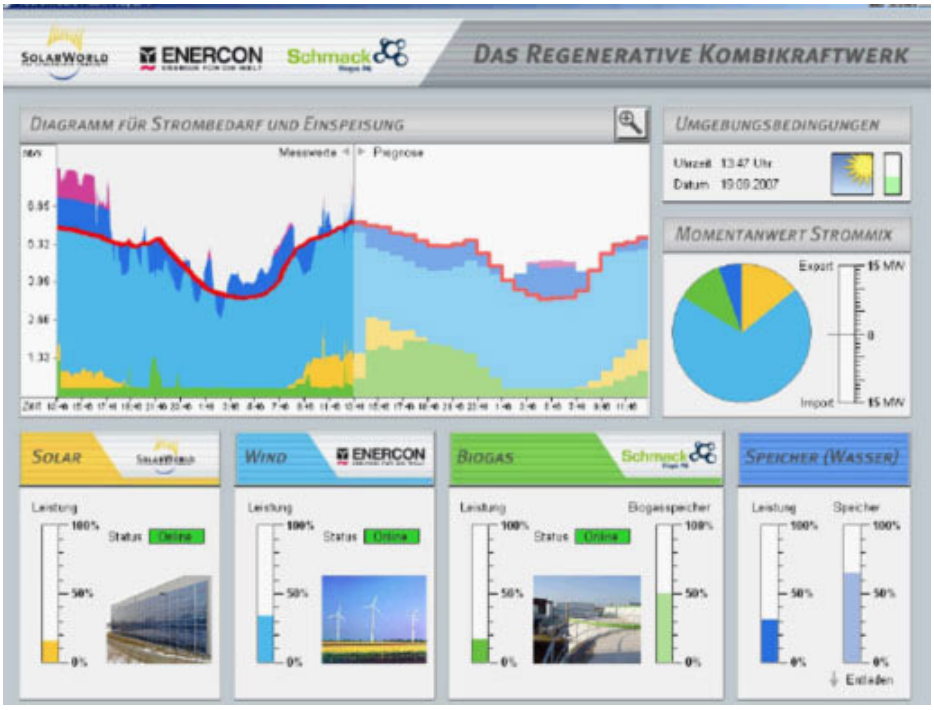
The Combined Power Plant consists of three wind parks (12,6 MW), 20 solar power plants (5,5 MW), 4 biogas systems (4,0 MW) and the pump storage Goldisthal (Output: 1.060 MW; Storage: 80 hours, i.e. 8480 MWh). Photos: www.kombikraftwerk.de

With this pilot project the participating parties impressively showed that renewable energy can cover 100 % of electricity demand. "The Combined Power Plant shows that renewable energy sources can supply sufficient electricity, can be controlled at any time, function in combination and can be balanced out across the grid", says Ulrich Schmack, Board Spokesman of Schmack Biogas AG. The joint project of Schmack Biogas, SolarWorld and Enercon links and controls 36 decentralised wind, hydropower, solar power and biogas installations so that they can cover the electricity demand in any weather conditions by tapping into the unequally

distributed energy potential across Germany.

Regenerative full supply on a scale of 1:10.000

The Combined Power Plant is scaled to meet 1/10 00th of the electricity demand in Germany using renewable energy. This scale corresponds to the annual electricity requirements of a small town with around 12 000 households, such as Stade. The Combined Power Plant therefore shows in miniature what is also possible on a large scale: 100 percent electricity provision using renewable energy sources," emphasises Frank H. Asbeck, CEO of SolarWorld AG.



Intelligent controlling and accurate weather forecasts allow regenerative power supply around the clock. Photo: www.kombikraftwerk.de. [Wording of images: The regenerative Combined Power Plant; Diagram of electricity demand and feed-in; Measured values; Forecasts; Environmental conditions; Time, Date; Current electricity mixing ratio; Solar, Output; Wind, Output; Biogas, Output, Biogas storage; Reservoir (water), Output, Storage]

Safe supply from renewable energy, all the time and everywhere

The power plant that is definitely not only a "virtual concept" links and controls 36 wind, solar, biomass and hydropower plants that are distributed throughout Germany. It has proven to be just as reliable and powerful as a conventional large-scale power plant, since it optimally combines the advantages of the different renewable energy sources. Wind turbines and solar modules, depending on availability of wind and sunshine, make their contribution to the generation of electricity. Biogas and hydraulic power are used to make up the difference and 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 percent provision with renewables.

Pilot project on the complete energy turn-around

Schmack Biogas, Solarworld and Enercon realised at an early stage that reliable electricity supply can only be provided when the different renewable energy sources are combined. The concept of the Combined Power Plant is based on establishing a network between different renewable energy power plants that allows balancing out. In research the "virtual power plant" is already a well-known concept. The Combined Power Plant, however, is more than a mere simulation – it permits an active control of renewable energy power plants in real-time operation. Variations in the various underlying conditions, such as electricity demand 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 they ensure sufficient electricity supply to cover the demand. The function of the regenerative Combined Power Plant can be divided into two stages: anticipatory control and fine-tuning.

Wind energy and biogas plants generate three quarters of the electricity output of the Combined Power Plant, photovoltaic systems provide the rest. Photos: Enercon; Schmack Biogas AG

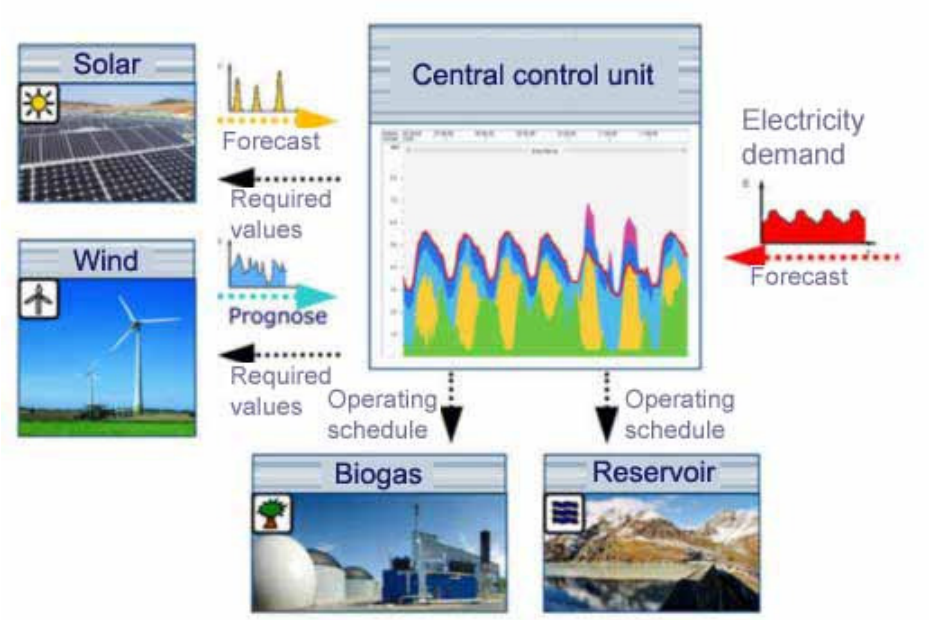
This is how the Combined Power Plant works

The eleven wind energy plants, four combined heat and power (CHP) units based on biogas, twenty photovoltaic plants as well as a pumped storage power plant are linked to one another through a central control unit. 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 requiremenst, 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. In the central control unit this data is then evaluated. 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.

Additional solar power plants guarantee highest outputs. Photo: SolarWorld AG

Adjusting to the actual electricity demand

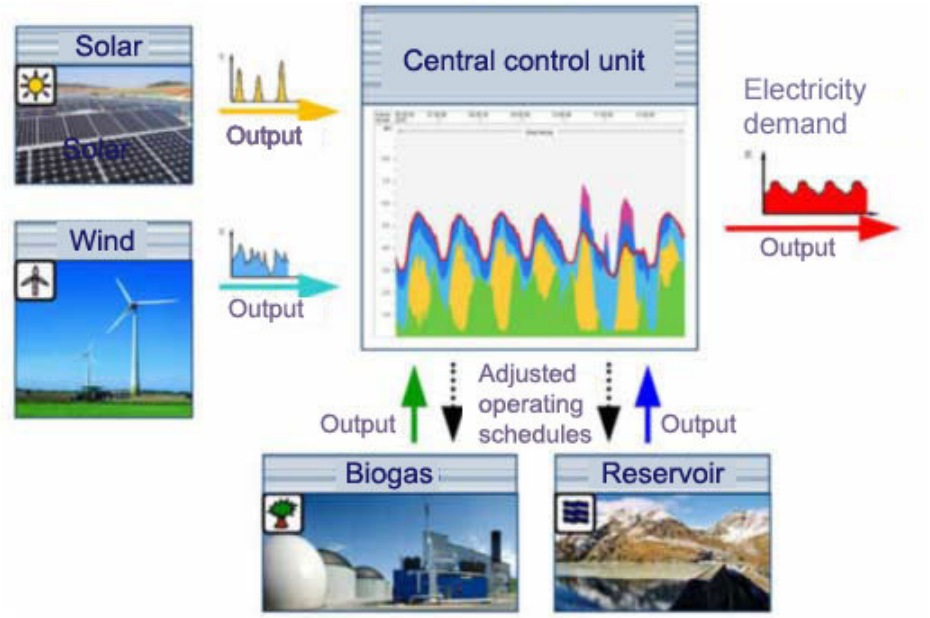
The central control unit controls the installations included in the Combined Power Plant in order to produce electricity in accordance with demand. If wind and solar power installations do not produce enough electricity, additional plant power is required, which comes from two sources: firstly, combined heat and power (CHP) plants are used to produce electricity and heat from biogas. 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 requirement 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 plants can be throttled back, but this would mean that existing potential energy is not utilised.



Principle of how the regenerative Combined Power Plant functions, 1. stage: anticipatory control. Photo: www.kombikraftwerk.de. [Wording of image: Forecast, Required values; Central control unit; Operating schedule; Biogas; Reservoir; Electricity demand, Forecast]

Fine-tuning on the basis of accurate measuring values

The accurate 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 and in the electricity demand. This requires fine-tuning of the central control unit. It adjusts the original schedule to the actually measured values.



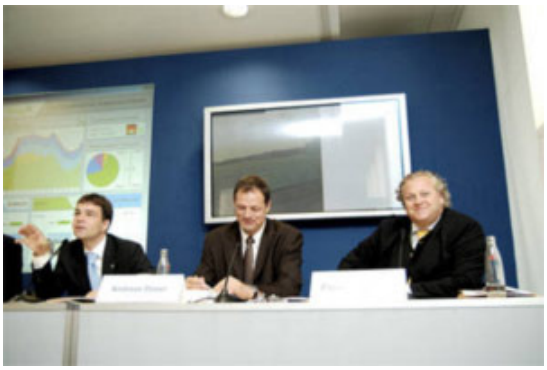
Principle of how the regenerative Combined Power Plant functions, 2. stage: fine-tuning. Photo: www.kombikraftwerk.de. [Wording of image: Output; Central control unit; Adjusted operating schedules; Biogas; Reservoir; Electricity demand, Output.

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 peak load and balances out the natural fluctuations in wind and solar energy.

German Minister of Economic Affairs Michael Glos: Innovative solutions such as the Combined Power Plant are to be taken into consideration in the renewable energy law

The wind and the sun cannot be influenced, which places particular importance on linking wind, solar and biogas plants. “The decentralised network enables wind, solar and biogas installations to be controlled like a conventional large-scale power station and thus meet Germany’s fluctuating energy requirements,” says Kurt Rohrig from ISET, explaining the Combined Power Plant’s central control unit.

Words of praise for the Combined Power Plant were also expressed by the German Minister of Economic Affairs Michael Glos, "This demonstration project shows that a virtual Combined Power Plant provides the possibility to make available electricity in the same way as a conventional large-scale power plant by jointly controlling smaller, dencentralised energy plants.” The use of intelligent controlling and regulatory technology allows the combination of decentralised wind and solar systems with biogas and hydraulic power plants so that fluctuations in the feed-in of wind electricity can be compensated. Glos was in favour of further developing such solutions in order to ensure the required grid stability, even if an increasing amount of electricity is fed in from wind and solar plants. "Particularly with regard to the coming amendment of the German law on renewable energy, we must provide adequate incentives so that such solutions will not remain mere demonstration projects but can be realised in future because they present the most economically feasible utilisation of renewable energy,” the Minister said. Thus far the law on renewable energy does not make provision of load-specific compensation. A bonus for “continuous electricity” could provide an incentive for the realisation of further Combined Power Plants and could boost the decentralised production of electricity from renewable energy sources. This is precisely the point where politics will come into play.



Ulrich Schmack, Andreas Düser and Frank H. Asbek presented the Combined Power Plant to the public on 9 October 2007. The Business Institute Solar Strategy (BISS), Sunbeam GmbH, the German Weather Service (DWD), SMA Technologie AG, Stadtwerke Schwäbisch Hall GmbH and Tauber Solar support this project. Photo: "deutschland hat unendlich viel energie"

Further information on 100 % renewable energy:

- 100 Prozent erneuerbare Energien: Solar-Konferenz diskutiert Projekte und Perspektiven.
- Contributions to the symposium "On our way to full supply from renewable energy sources" can be downloaded from the following website: www.unendlich-viel-energie.de

Video clip: "The Combined Power Plant" (7:20 minutes; MPEG) can be downloaded from the following website www.unendlich-viel-energie.de	Animation on the Combined Power Plant (2:40 minutes; MPEG) on the Net under www.unendlich-viel-energie.de
	

Further Solar Energy Systems of the Month:

- Electricity and heat from the sun and salad oil
- Sun, Light and Heat: Light Control and Optimizing EnergyBuildings
- Solar Thermal Combination Systems: An Asset for Every New Building
- Fraunhofer Institute for Solar Energy Systems (ISE) in New Quarters
- Building with the Sun: Solar Facades Insulate with Sunlight
- Power Generation with Perspective: Transparent POWER-Cells for Solar Architecture
- Local Solar Heating Systems for the Eco-City
- Solar Boats Turn into Tourist Attractions
- CIS-Solar Cells From the Assembly Line
- Follow the Sun: tracking solar power arrays can increase energy yield by up to 30%
- Summer Sun all Winter: Seasonal Heat reservoir covers heating needs up to 100%