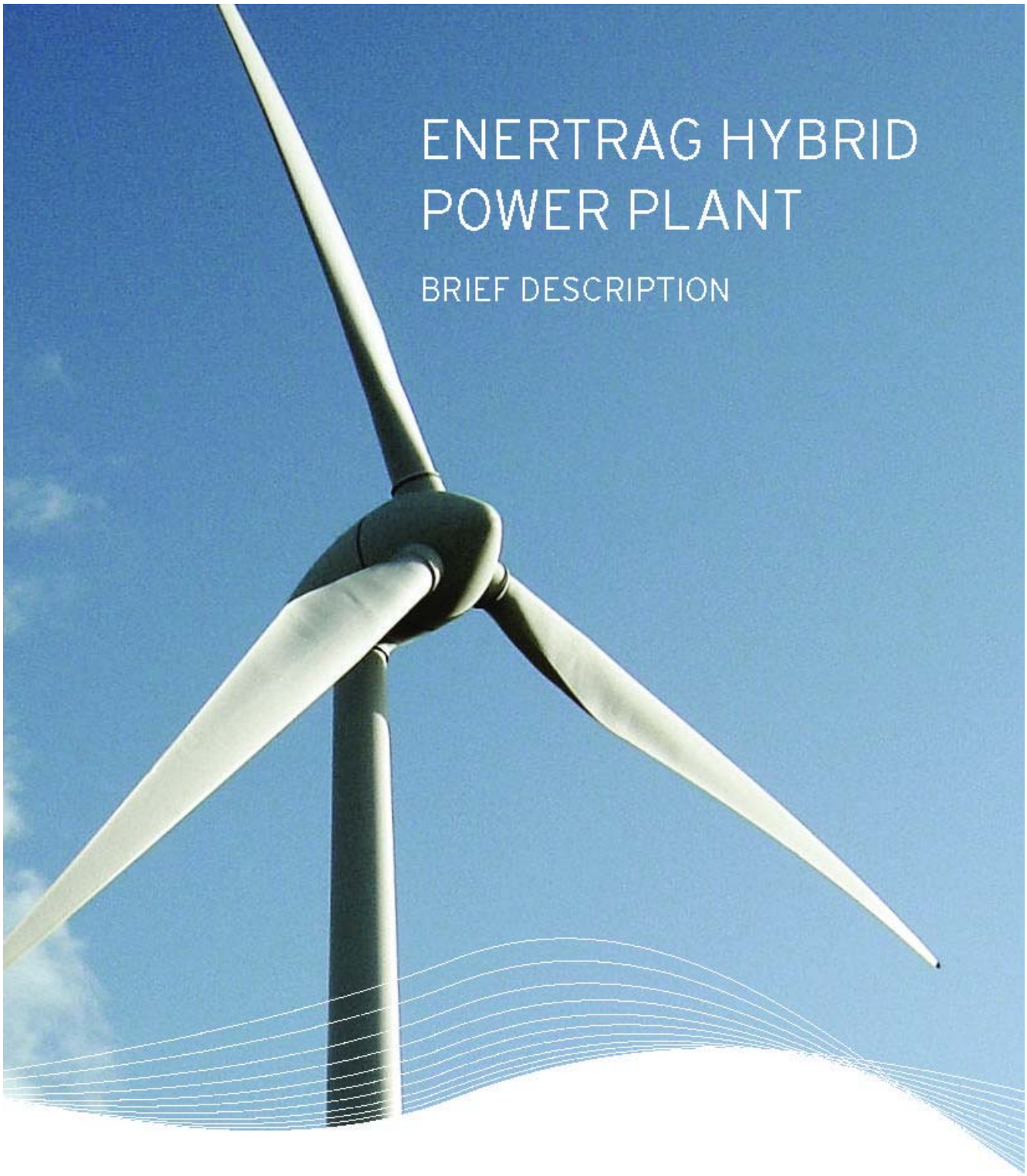

ENERTRAG HYBRID POWER PLANT

BRIEF DESCRIPTION

ENERTRAG

“The lives of our citizens will change a lot in the next few years, as far as we could live in an energetically responsible way, consuming less energy, and, at the same time, preserving the economical basis of the German industrial position.
The energetic mix will also change – with an increase of renewable sources. So we know: with the use of renewable sources, we can not only develop new exportable technologies, but also replace a portion of our own energy supply, here in Germany“

Federal Chancellor, Dr. Angela Merkel

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Contents

1. Goal of the project

The ENERTRAG Hybrid Power Plant will prove in practice, that the attainment of a safe and sustainable energy supply based on renewable sources – specially on wind energy – is really possible. This power plant produces environmentally-neutral hydrogen from wind energy, and reconverts it, on demand, into electricity again. So, it will become possible to supply the grid with renewable sources in tune with the demand. The wind forecast – an important factor for the management of an electric grid – will be, by the use of this hybrid power plant, so much assisted, that the difference between the expected electricity production and the real one will be reduced to an absolute minimum.

The power plant shows how different energy devices based on renewable sources, for which a demand forecast, as well as an online control system already exists, can be integrated by the use of hydrogen. This technology opens the way to the long-term commercialization of renewable energy in a demand-oriented way, as well as to its use as regulating energy. This regulating energy will always be necessary for equalizing the oscillations of the grid derived from the time-differences between offer and demand. Also, another economically and technologically highly interesting market segment, as it is the direct supply of high volumes of hydrogen to the industry and to the transport market, can also be reached.

The hydrogen, as a CO_2-free fuel, can be applied at the transport sector. In the frame of a conception developed by the German Federal Ministry for Environment (BMU) and the German Federal Ministry for Transport and Urban Development (BMVBS); from years 2009 / 2010, several mass-produced hydrogen-fuelled products will have to enter the commercial market, in order to substantially increase the demand of hydrogen as fuel. In accordance to that program, ENERTRAG has already established a cooperation contract with TOTAL Deutschland GmbH for studying the potential and production costs of the hydrogen generation based on wind energy.

2. Production and reutilization of the hydrogen

The core of this first hybrid power plant will be a 500 kW electrolyzer, able to produce hydrogen and oxygen by electrolysis, out of wind energy.

The hybrid power plant will be integrated in ENERTRAG's own power grid. So, during the periods when the grid cannot accept all the available wind power, the non-dispatchable surplus will be used for producing hydrogen, in order to reduce the electricity offer, bringing it near to the demanded values.

On the opposite, during periods of high electricity demand, the hydrogen will be mixed with biogas, and used to fuel two 350 kW high-efficiency combined-heat-and-power (CHP) units; in which it will be converted again into electricity in a CO_2-neutral way, for supplying the grid. Simultaneously, the CHP units will also produce heat for heat supply out of that hydrogen-biogas mixture.

To optimize the control system of the plant when working under different operative strategies, ENERTRAG AG has developed an innovative software which continuously analyses the behavior of the whole system by observing its most relevant parameters. Both the available wind power (based on local wind measurements) as well as a standard curve for the turbines installed at the wind park will be calculated on a hourly basis.

3. Electrolysis background

For the last few decades, the electrolysis, as the supporting technology for the production of hydrogen from renewable sources, has been more and more in the focus of a sustainable and foreign-supply-independent energy system.

The most critical advantage of the water electrolysis is derived from the possibility of directly connecting it to renewable electricity sources (wind turbines, PV modules, hydropower stations), and also the alternative of using it as an adjustable power consumer, for smoothing the naturally-oscillating energy supply coming from the primary sources (grid integration). Electrolysers have the capacity of instantaneously matching a variable power supply, and cannot only be used to produce hydrogen, but also to regulate the electric grid.

4. Design and function of the hybrid power plant

The configuration of the whole system (hybrid power plant) ensures the following functions:

- Hydrogen generation by means of electrolysis.
- Electricity and thermal energy production.
- Stabilized power supply to the electricity grid.
- Enhancement of the forecast certainty for the energy supply to the electricity grid.

The hybrid power plant is based on the following main components:

1. Grid connected wind turbines from ENERTRAG AG (able to be regulated, up to a power of 500 kW, by the electrolyzer and other ancillary components). Three wind turbines, with a unitary nominal power of 2 MW are directly connected to the electrolyzer by means of a medium voltage link. This medium voltage connection is also bound to the medium voltage grid that supplies energy directly to the 220 kV high voltage grid from Vattenfall Europe Transmission GmbH through the transformer station Bertikow.

2. Electrolyser

- Gas production: 120 Nm^3 / h of hydrogen, 60 Nm^3 / h of oxygen.
- Hydrogen purity: 99,997 %
- Operation pressure: atmospheric (ca. 15 – 20 mbar).

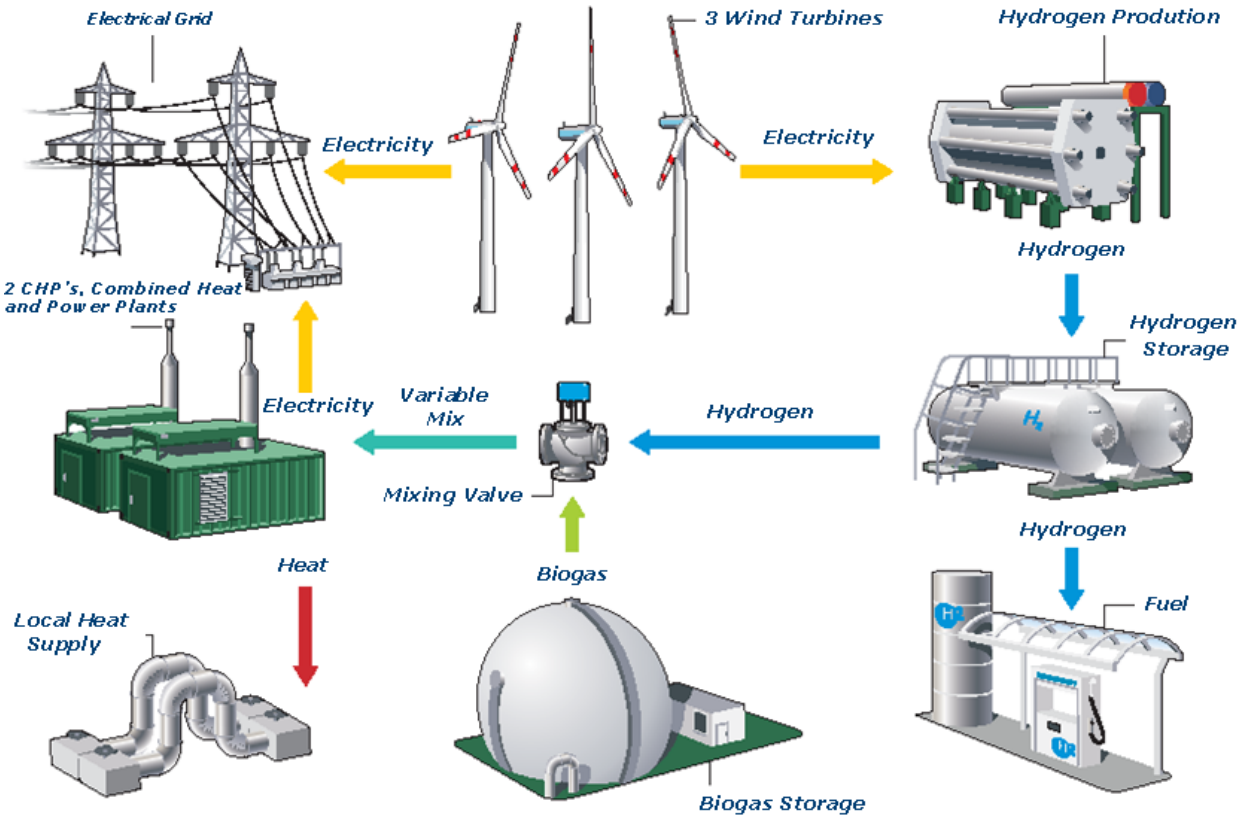
3. Compressor

- Gas: Hydrogen
- Nominal flow: 2 x 60 Nm^3 / h of hydrogen
- Output pressure: 31 bar (abs.)
- Stationary gas storage, composed by 5 pressure vessels with a total storage capacity of 1.350 kg of hydrogen at a pressure of 31 bar (abs.)

4. Two Combined Heat and Power Units (CHPs)

- Gas mixture with a minimum of 30 % biogas + a maximum of 70 % hydrogen / the mixture proportions are modified on demand – an increase of the biogas fraction up to 100 % is possible.
- Generation mode: Able to run under a full isolated-grid mode.
- Nominal electrical power: 350 kW each (in accordance to the mixture proportions).
- Nominal thermal power: 340 kW each.
- Output parameters: 230 V / 400 V, 50 Hz.

Each CHP unit is able to produce ca. 2.776 MWh of electricity and ca. 2.250 MWh of thermal power yearly. The supply of that heat to the heating grid of the City of Prenzlau is planned. This thermal output is enough to heat 80 single-family houses.



5. Power potential and regulation capabilities of the hybrid power plant

For the hybrid power plant to be able to adapt its working regime to the power requirements and for effectively being able of supporting the grid; two different aspects are decisive:

1. How the hybrid power plant can compensate the calm periods, for instance, those periods with low or no wind, when there is a strong power demand at the same time.

2. How the hybrid power plant can cope with the power excesses, that is, those periods during which the wind turbines attain high output values, when there is a low power demand at the same time.

The hybrid power plant was conceived in such a way that each of its components can play different roles, depending on the power requirements. For this purpose, all of them are controlled and monitored by the software on a real-time basis.

Through the two CHP units, with 350 kW each, a negative power control effect is exerted (compensation of low wind power production periods), even when the electrolyzer allows a positive power control effect up to 500 kW (limiting effect during high wind periods)

6. Description of the operation modes

The hybrid power plant can be run, in accordance to the needs, under four different operation modes:

- Hydrogen production mode
- Base load mode
- Wind forecast mode
- Generation against peak demand

6.1 Hydrogen production mode

When running under this mode, the hybrid power plant operates as a real hydrogen factory. The goal is, in this case, generating as much hydrogen as possible (given the existing components and the available energy potential (wind profile)), or, at least, attaining some previously-defined hydrogen volume.

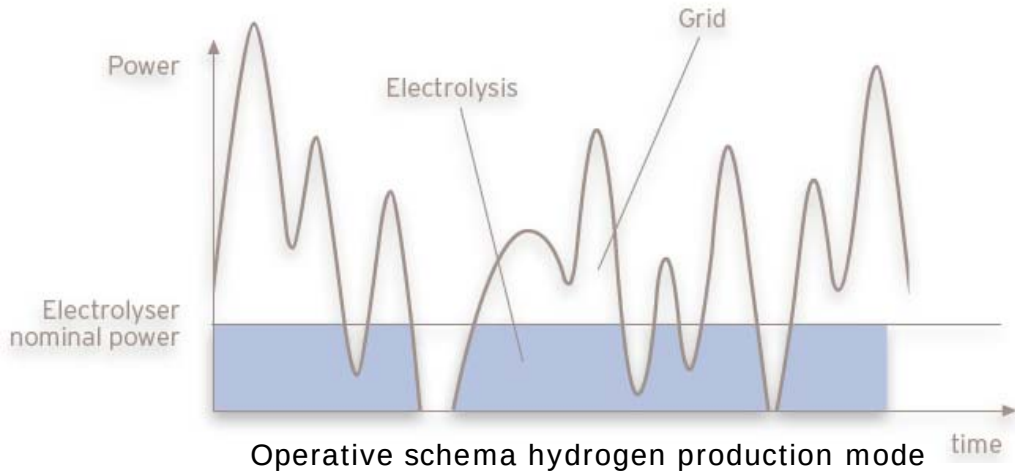
Use cases for this mode:

- CO_2-neutral production of hydrogen.

- Decentralized supply of hydrogen, with all its linked advantages, as the reduction of the expensive costs of fuel transportation by ship, rails or road.

Characteristics of this operation mode:

- Constant daily hydrogen production.
- The main control parameter is the level of the hydrogen tank
- Maximal use of the electrolyzer
- During low wind periods, the CHP units can supply the electrolyzer in a partial mode.
- If the tank is near to full condition, the electrolyzer operates under a partial power mode.
- When the tank is full, the electrolyzer remains in stand-by.
- CHP units will not run on mixed fuel in this operation mode
- The wind power not used by the electrolyzer will go directly to the grid.



Operative schema hydrogen production mode

6.2 Base load mode

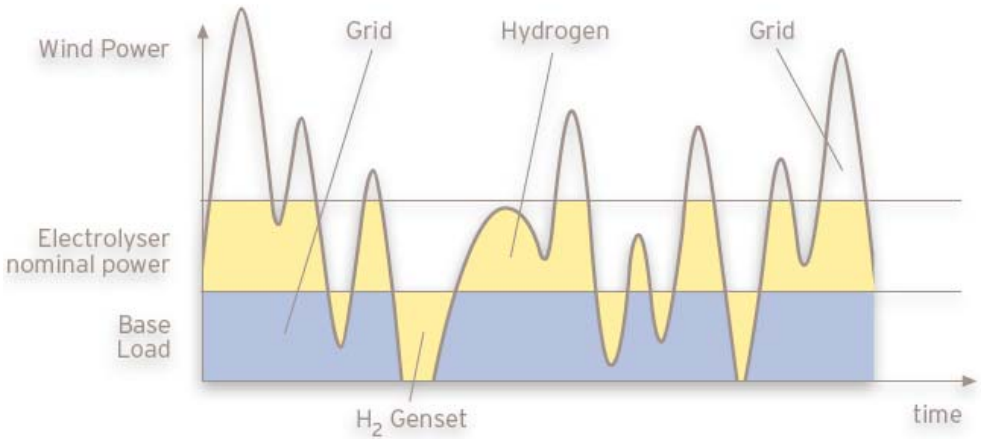
The operative mode base load pursues the goal of supplying a constant, ensured electrical power, independently of the wind conditions. The oscillations coming out from the wind will be balanced by the hybrid power plant. The excesses of wind energy will not be sent to the grid, but converted into hydrogen and stored. During low wind periods, the stored hydrogen, mixed with biogas, will be used to fuel the CHP units, for additional electricity production. From the point of view of the grid operator, the hybrid power plant will be operating as a base load power station.

Use cases for this mode:

- Decoupling of the main grid from the power oscillations coming from the wind turbines.
- Pre-planned power supply pattern.
- Effective use of the electrical power supply capacity.
- Inclusion of the advantages of the decentralized hydrogen production.

Characteristics of this operation mode:

- A constant power value will be supplied to the grid during a certain period.
- The main control parameter is the ensured power supply value.
- If the wind power output was momentarily larger than the ensured output supply, the excesses will be conducted to the electrolyzer.
- Any wind power excess beyond the nominal power of the electrolyzer will be limited by pitching (repositioning of the rotor blades in order to modify the gain of wind power).
- If the available wind power output was lower than the ensured output supply, hydrogen will be used to fuel the CHP units, thus compensating the output power deficit.



Operative schema base load mode

6.3 Wind forecast mode

When running under this mode, an improved tracking of the forecasted wind power production is intended. That means, for the main grid operator, that the forecasted output of the wind turbines could be dispatched as-it-is.

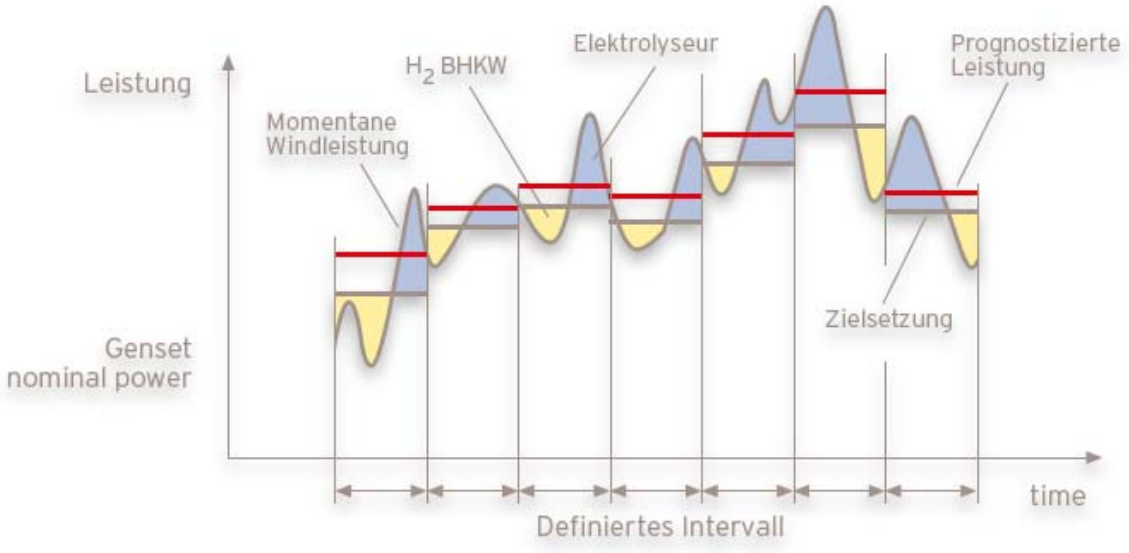
Based on the forecasted wind power values, and always taking into account the maximal regulation capacity of the hybrid power plant, an hourly-based production program for the hybrid plant will be emitted, with an advancement of eight hours. Later, at any moment, the power production of the plant will be in accordance to the previous program. This operation mode is similar to the base load mode, provided that the load value varies on a hourly basis.

Use cases for this mode:

- Almost 100 % assurance of the previously defined power supply values.
- Pre-planned grid-connected operation chart.
- Inclusion of the advantages of base load model, and of those of supply of pure hydrogen.

Characteristics of this operation mode:

- The previously-stated power production levels will be held throughout the corresponding periods.
- The main control parameter is the forecasted wind power supply.
- An hourly-based production program for the plant is emitted eight hours in advance.
- The production program for the hybrid plant considers the internal losses of the plant, as well as the hydrogen storage tank level.



Operative schema wind forecast mode

6.4 Generation against peak demand or best tariffs

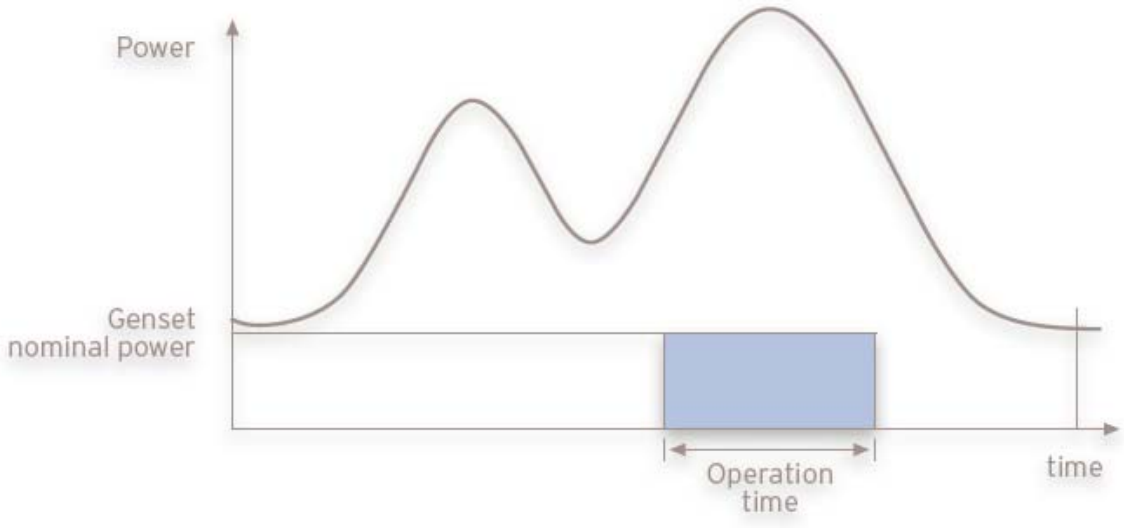
This operative mode is focused to a definition of the production pattern in accordance to the achievable reimbursement values (for example, that of the EEX – European Energy Exchange). The hybrid plant enters into production only when a certain minimum tariff level is attained. The rest of the time, the wind energy is used to produce hydrogen, or is directly sent to the grid.

Use cases for this mode:

- Integration of renewable sources into the market.
- Adjustment of the generation to the power requirements of the grid.
- Active grid support.

Characteristics of this operation mode:

- A forecasted constant power value can be held constant throughout a previously defined period.
- The main control parameter is the electricity market evolution.
- The daily production program for the plant is emitted twenty-four hours in advance.



Operative schema generation against peak demand or best tariffs mode

7. Investments and workplaces

The total investments for all the equipment involved in the project exceed the amount of 21 million Euros. The pilot project was sponsored by the Federal State of Brandenburg in the frame of the Joint Task East (Gemeinschaftsaufgabe Ost) and in accordance to the 7th program for R&D. ENERTRAG also performed more than 2 million Euros investments on its own account for research and development activities around the hybrid plant.

In connection with the development, the construction and the further operation of the hybrid power plant, ten previously-existing qualified working positions were retained by ENERTRAG and six new working places were developed.

8. Other involved companies

TOTAL Deutschland GmbH is a worldwide active petroleum corporate group, who is since a long time involved with the use of renewable energy sources. The suitability of the hydrogen as an energy carrier for its practical use in the transportation market will be thoroughly studied, in a close cooperation with BMW.

ELT GmbH was founded in year 1995 by two of the most relevant electrolyzer specialists. Since that moment, ELT was able to get the outstanding experience and the highly qualified personnel from the BAMAG and Lurgi companies. Its engineering staff possesses more than thirty years of experience in water electrolysis projects all around the world, comprising different fields as basic design, start up processes as well as service and maintenance of the electrolysis units.

The Brandenburg Technical University of Cottbus (BTU Cottbus) is conceived as a research-intensive university, strongly oriented to the effective implementation of technological projects. It acts as a driving force for the economical development within the Federal State of Brandenburg. A high-excellence learning and research offer, within the profile of a technical university, assures the subsequent transference of the research results and innovations into the local economy.

The University of Applied Sciences of Stralsund is extensively dedicated to research activities, specially in the field of the practical application of technological developments. Its main focus relays on the practical cooperation between researchers at one side, and enterprises and companies at the other. The results of the research activities flow directly to the teaching process, assuring its permanent actualization.

The NOW GmbH – the German National Hydrogen and Fuel cells Technology Organization - was commissioned by the Federal Government to coordinate and implement the “National Innovation Program for Hydrogen and Fuel Cells Technology”. NOW also evaluates different demonstration projects and select some of them to be financially sponsored.

9. Building plan

The approval for building the ENERTRAG hybrid power plant will be obtained by several different application procedures.

1. Wind turbines: An application was submitted in accordance to the BImSchG: (Bundes-Immissionsschutzgesetz - federal emissions control act). Approval is expected for April 2009.

2. Biogas plant and CHP units: Another application was also submitted in accordance to the BImSchG. Approval is available since January 2009.
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3. Electrolysis module: An application was submitted in accordance to the BauGB und BBgBO: (respectively. Baugesetzbuch – German Building Code, and Brandenburgische Bauordnung – Building Normative of the Federal State of Brandenburg). Approval is expected for the summer of 2009.

4. Gas and electric lines: Public participation procedures, with special permissions from the local nature conservation authorities and from the local water management authorities, as well as the compliances of affected persons are considered as a matter of public interest. Permissions are currently being held.

The building process of the first components started at April 21st, 2009. The finishing of the building phase of the whole project is expected for the beginning of year 2010. Around the middle of 2010 should the initial operation as well as the adjustment phase be completed.

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