Advanced Energy

# BALANCING POWER WITH ADDED VALUE

**Power-to-heat technology enables the grid to benefit from temporary excess energy generated from renewable energy methods.** In collaboration with Advanced Energy and Klöpper-Therm, Schwerin, the German municipal utility company, installed three electrically heated boilers, each with a 5 MW output, and used power-to-heat technology to benefit from the secondary balancing power provision.

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In Germany, the share of renewable energies in the electric energy mix has increased rapidly since the beginning of the "Energiewende." Despite efforts to maintain a predictable power supply, such as use of more accurate weather forecasting, the supply input is subject to natural fluctuations (Figure 1).

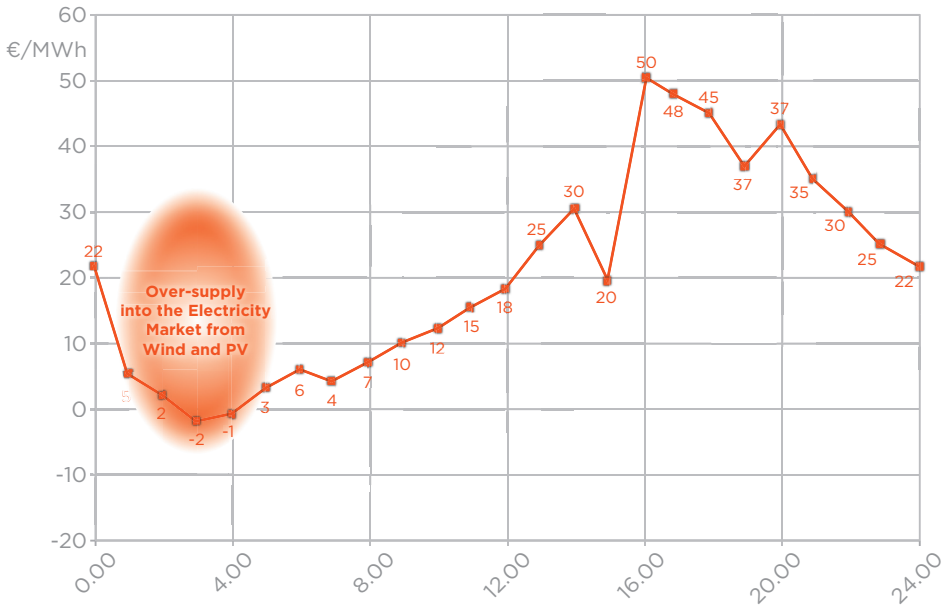


*Figure 1. Electricity price per megawatt-hour on a typical day with occasional over-supply from the influx of renewable energies (Source: Klöpper-Therm)*

The task of transmission system operators (TSOs) is to balance these fluctuations with intelligent systems that react quickly to stabilize and secure the supply of power. A deciding factor for grid stability is frequency; it needs to be kept within a very narrowly defined range. Therefore, there is a need when there is an excess in power to transfer this excess into another form of energy. The use of electrically operated boilers is one method to accomplish this. This method also solves the problem of energy storage because the generated heat can be used in pre-existing district heating grids or sent to separate storage tanks for later use for heating purposes.

## TRANSFORMING EXCESS ELECTRICITY INTO HEAT INSTEAD OF WASTING IT

"Last year, the idea came about, in cooperation with our customers and with Advanced Energy, to link the areas of heat technology and grid stabilization," states Elmar Lohe-Hörder, member of the board of management at Klöpper-Therm GmbH & Co. KG, and responsible for sales. "District heating is being used in numerous fields. Many cities are offering their customers—from industry, the public sector, and private households—this form of energy. In most cases, the municipal utility company is also the local electricity supplier, in part with their own generation plants. It was important to make a connection here. In order to be able to use the occasional excess in electrical energy supply sensibly, we developed a solution that transformed it into heat on a large scale, so we could offer a technical unit for the balancing power market. With an efficiency of nearly 100% for our boilers, there is almost no energy lost."

For grid stabilization, we are not talking about kilowatts, but rather about megawatts. Thus, Klöpper-Therm developed a boiler with an electric output of 5 MW, which is running in nine installations. The primary aim was quick preparation and recirculation of the output in order to satisfy the requirements of a technical unit in the secondary regulation market. At the same time, the balancing concept of the boiler had to be adapted to the operational requirements within the district heating grids. Generally, the grids have a maximum outgoing temperature of 130°C at an operating pressure of approximately 5 to 8 bar. It's critical to design and regulate the boiler in such a way that pockets of steam do not occur in the interior during operation.

## QUICK, RELIABLE POWER REGULATION IS KEY

Use of Advanced Energy® Thyro-P® power controllers made it possible to achieve flexible operating and regulation performance (Figures 2 and 3). Up to 300 resistance heating devices are included in the boilers. These heating elements can be operated on a maximum supply voltage of 690 V, so correspondingly high currents must be controlled. To achieve this, the heating elements are initially configured into smaller groups that can be switched on or off individually. To give customers the option of switching to any desired power value, a higher-level exact power regulation system with thyristor power controllers was built for the switched heating groups. For each system, two thyristor power controllers from the Thyro-P series are built in. They provide different types of regulation and are connected with the process control technology via integrated communications interfaces. At the same time, the power controllers have very high efficiency, which, even in partial load operation, exceeds 99%. When implemented, the thyristor power controllers guarantee continuous operation, free from wear, as they have no mechanical switching elements. Status notifications are transmitted via the built-in display as well as LEDs on the device. In parallel, relevant data and signals are sent to the central control technology via Profibus protocol.


*Figure 2. A 5 MW boiler power-to-heat system at the municipal utility of Schwerin with 250 heating elements that are subdivided into 14 heating groups (Source: Klöpper-Therm)*


*Figure 3. Power supply for power-to-heat at the municipal utility of Schwerin for a 5 MW boiler with two Thyro-P 2P690-500HF power controllers and a Thyro-Step Controller for 2x7 heating circuits (Source: Klöpper-Therm)*

Using the two Thyro-P thyristor power controllers to power up the individual heating element groups gradually and then transferring them to Thyro-Step Controller resulted in a favorable switching system construction and retention of maximum regulation flexibility. If a group has reached its maximum power, then a corresponding contactor switches it through without further regulation. If not all heating elements are needed, the Thyro-Step Controller alternates the switched groups in rotation to achieve a consistent operating duration. The Thyro-Step Controller combines multiple load control with data capture and monitoring. In addition, it serves as an input/output device and offers a wider range of applications (Figures 4 and 5).

## A SYSTEM THAT PAYS FOR ITSELF

The aim of the municipal utility company in Schwerin is to provide the responsible TSO a service in terms of secondary balancing power provision with its power-to-heat plant. The TSOs—with an increasing share of renewable energies in the grid—rely on this service to meet their obligations concerning grid stability.

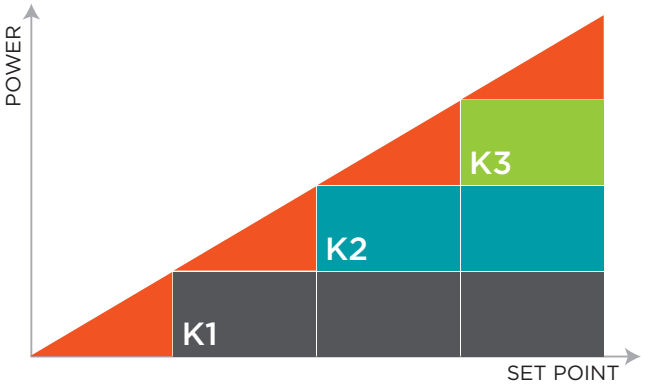


*Figure 4. Multiple load control, e.g. 3 + 1 channel (Source: Advanced Energy)*

This is why the plant in Schwerin was, from the start, linked in from a technical regulatory perspective into the overriding control, so that its supervision can be rented weekly to the TSO.

"Invoicing with the TSO is based on power and operating prices," explains Gerd Burmeister, department head at the municipal utility company in Schwerin. "As a supplier of this type of power provision, we offer our services at a market price, and our bid will be accepted if the price is right. For the agreed timeframe, we then get a guaranteed amount and according to the operating price offered, partly a payment for the volume of purchased electricity."

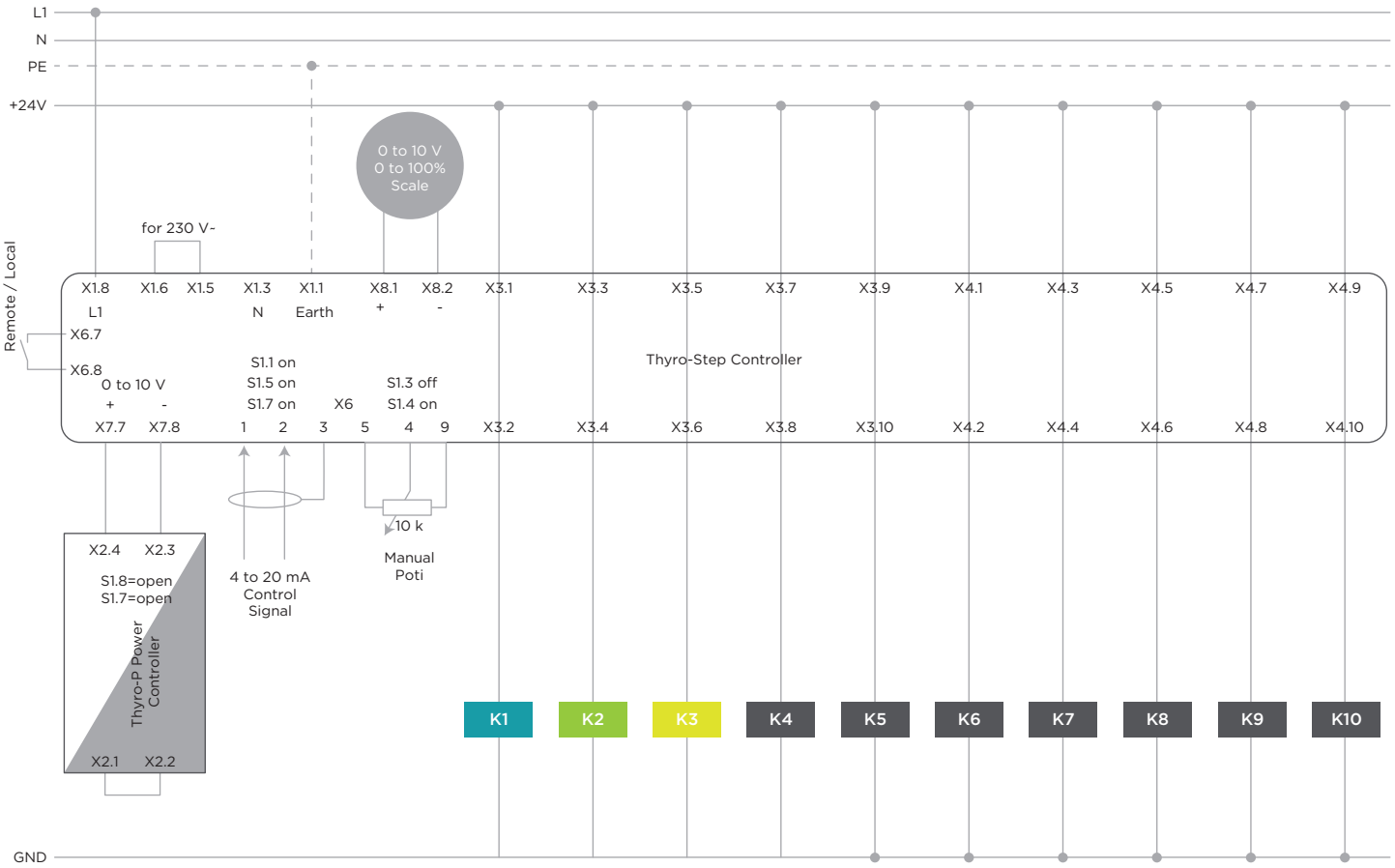


*Figure 5. Power controller with Thyro-Step Controller for four heating circuits (Source: Advanced Energy)*

## CONCLUSION

Klöpper-Therm has already installed 45 MW of balancing power provision at district heating network operators. Advantages of the plants include their compact construction, easy operating mode, and short payback period. "Together with Advanced Energy, we have found a solution that makes a contribution to maintaining the supply quality at a high level. This is possible because, using the power controllers and the control system, we are able to make balancing power provision available in a short timeframe so that we can use excess energy peaks appropriately," says E. Lohe-Hörder.

## BALANCING POWER

Based on the valid rules of ENTSO-E, the German TSOs procure the following types of control reserve:

Primary balancing power:

- Provided according to the solidarity principle by all TSOs connected within the ENTSO-E area
- Automatic and complete activation of primary control reserve within 30 sec
- Period per incident to be covered: 0 < t < 15 min

Secondary balancing power:

- Energy balance of the control area and frequency control
- Immediate automatic activation by the concerned TSO
- Complete activation within 5 min (at the most)

Minute reserve (tertiary balancing power):

- The activation is (currently still) based on a timetable and requested by telephone by the TSO
- Complete activation within 15 min of the telephone call
- Period per incident to be covered t > 15 min to four quarter hours or up to several hours in case of several incidents


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