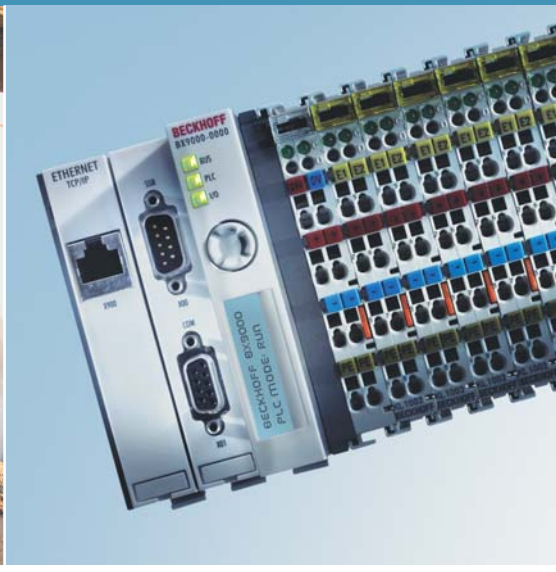
PC-based automation technology controls biogas plant

Farm waste recycled into biogas

Feeding screws convey the biomass into the fermenters.

BSAutomatisierung GmbH from Rosenfeld, Germany, provides complete automation solutions for manufacturing and assembly plants for machine construction and for plants in the regenerative energy industry. In Geislingen, Germany, they installed and programmed a biogas plant for the operating company, Bio-Energie Heuberg GmbH & Co. KG, with automation technology from Beckhoff. The main areas of use for Beckhoff automation technology are high-tech applications in machine and plant construction. However, Beckhoff technology is so universal in use that simpler tasks, such as the control of a biogas plant can also be achieved without problem.



The biogas plant has an output of 500 kW. It is fueled with biomass such as corn silage or liquid manure.

The plant has an output of 500 kW and was put into operation in summer 2006. It is powered with biomass such as corn silage or liquid manure. The biomass ferments at a temperature of 38.5 °C (101.3 °F) in two fermenters. This produces the flammable gas methane, plus auxiliary products such as carbon dioxide, water and trace gases, e.g. hydrogen sulfide. The gas is purified and converted into electricity in a combined heat and power plant.

Four farms are connected to the operating company. The biogas plant is distributed locally over the farms. The fermenters and the gas purifier are located on one farm, while gas storage as well as a combined heat and power plant are on the other. The four operators feed the generated electricity into the grid. The heat generated by the conversion into electricity is used to heat houses and stables and for drying wood. In this way, an overall efficiency of 80 % is achieved. "One of the challenges lies in the coupling of all of the parts of the plant and the users over distances of up to 500 meters," explains Thomas Maier, Software Development and Construction Manager at BSAutomatisierung. "The operators wanted a PC-based controller with a connection to the house network, so that the plant can be monitored and its efficiency evaluated from there. A further challenge was to integrate the existing prototype plant. The PC-based controller from Beckhoff allows the integration of existing bus systems in the new plant. In addition, databases can be tied in very simply as a basis for evaluations."

High-tech connection to farms

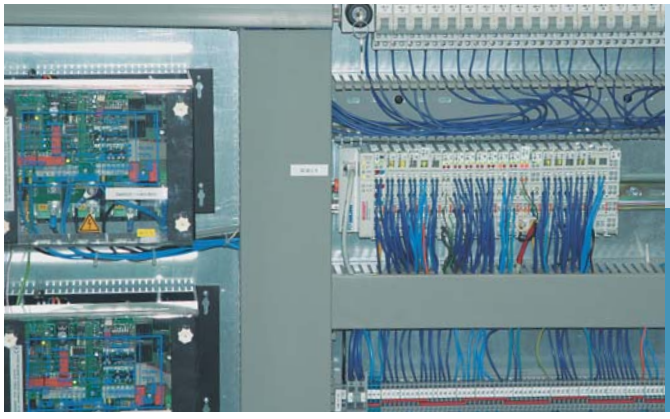
The core of the controller is a commercially-available PC with the Windows XP operating system and the TwinCAT control platform. It controls and monitors all parts of the plant in which Beckhoff Bus Terminals are used. The controller from the old plant was replaced by a BX9000 Ethernet Bus Terminal Controller. Existing cables continue to be used on the framework of CANopen and are connected to the SSB interface of the BX9000. SSB is a CANopen-based sub-bus system for connecting peripheral devices. The new parts of the plant were connected via fiber-optic cables using Ethernet TCP/IP and real-time Ethernet. "This way, we achieve fast, secure data transmission – even over large distances. The different Bus Couplers integrate the various bus systems easily in the overall system of the biogas plant and in the operators' network," explains Thomas Maier, and he continues: "The terminals used from the Bus Terminal system connect all sensors and actuators locally. Thanks to the modular I/O structure, we can assemble the Bus Terminal systems simply and easily in accordance with our exact requirements."

Combining distributed process parameters

The biomass is fed to the fermenters in portions of approx. 350 kg (approx. 772 lbs). The operator specifies the daily quantity of biomass to be fermented via the PC. On the basis of this and the predefined portion size, the program calculates the required number of filling processes per day and both initiates and monitors them. Scales weigh the portions and feeding screws convey the biomass into the fermenters, where agitators provide for thorough mixing. Analog Bus Terminals acquire the data from the scales. The KL3403 three-phase power measurement terminals monitor the power consumption of the motors for the feeding screws and the agitators. "High power consumption on the part of the screw feeder points to a blockage. The power consumption of the agitators gives an indication of the viscosity of the biomass. If this is too thick or too thin, liquid or solid biomass must be added. In addition, maintenance of the operating temperature is important for an optimum fermentation process. To this end, PT100 sensors monitor the operating temperature in the fermenters. The sensors are connected directly to the bus system via the KL3202 2-channel input terminals," explains Thomas Maier, adding: "Using the comprehensive range of Beckhoff Bus Terminals, we can optimally connect all data points. Even the measurement data from the calorimeter in the combined heat and power plant, which is based on the M-bus protocol, can be connected conveniently via a serial interface without using additional hardware."

Controller increases plant efficiency

Beckhoff TwinCAT PLC automation software monitors and controls all processes in the biogas plant. Thomas Maier explains: "The system communicates with the AWITE gas analyzer via the TwinCAT ADS interface. The visualization is tied in via TwinCAT OPC. In addition, TwinCAT supports the output of process data in the form of CSV files and accommodates the use of the data in Excel and Access for further processing and archiving. Based on the stored data, the operator can track the consumption of biomass and the amount of electricity generated, derive the efficiency and intervene via the controls if necessary."



Albert Eberhart, one of the operators of the biogas plant, makes clear: "Plant downtime must be avoided at all costs. Following a downtime event, the entire plant must be restarted via an elaborate process. This unnecessarily wastes resources and reduces the quality of the fermentation process. For these reasons, a secure error messaging system is indispensable." If the system detects an error, the controller reports the error directly to the operator's mobile phone by SMS and to the PC via e-mail. Thomas Maier is satisfied with the control solution for the biogas plant and looks toward the future potential: "On account of our positive experience, we will continue to equip plants in the regenerative energy sector and in machine and plant construction with Beckhoff Automation technology in the future."

→ BSAutomatisierung GmbH, Germany, **www.bsautomatisierung.de**