The Algae House – a building that generates energy from living algae on its façade

Rockwell Automation remote control technology connects building technology with innovative bioreactors

Background
The world’s first building with a bioreactor façade was unveiled in 2013 by Internationale Bauausstellung (IBA) in Hamburg, Germany. Micro-algae breeds within the building’s shell, using photosynthesis and solar energy to produce biomass and heat. One of the biggest challenges in this project was to link the technology needed to cultivate micro-algae with modern building technology. Rockwell Automation provided the control elements, which integrate all the disparate technologies into one system while enabling automatic operation throughout the year.

IBA in Hamburg set itself a goal: to shape the future of cities in the 21st century. As a part of this ambition, it developed several projects that provided innovative and sustainable responses to today’s questions about urban development. It presented the BIQ – IBA’s name for its house self-sufficient in energy – in the Wilhelmsburg area of Hamburg in 2013. The building featured the world’s first bioreactor façade, in which micro-algae are cultivated in plate glass tanks and produce biomass and heat from solar energy and photosynthesis. This warmth is then fed into heat exchangers and made available to the building for heating. The algae are harvested regularly and used as raw material for the creation of biogas. The green façade elements give the building an original look, along with its nickname of The Algae House.

Solutions
A Rockwell Automation and Endress+Hauser solution was installed, which included:
- Allen-Bradley CompactLogix PAC
- Remote I/O
- FactoryTalk View visualisation software
- EtherNet/IP
- Measurement and process technology from Endress+Hauser

Results
- CompactLogix controller provide seamless integration between the programming software, controllers and I/O modules
- Acceleration of initial development time and reduction of commissioning and operation costs
- Simplified programming process with control system’s tag-based architecture
- Realistic view of all processes thanks to the easy-to-use graphical functions of FactoryTalk View, easy to monitor the system and analyse processes
- The software also enables the user to react rapidly to error alerts and alarms.
- If necessary, the user can also intervene in processes directly via the visualisation software

Alliance Partner
Endress + Hauser

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Allen-Bradley · Rockwell Software

Rockwell Automation
The Algae House is a cube-shaped, five-storey passive building comprised of fifteen apartments. It was designed by the architectural practice Splitterwerk from Graz in Austria, whose concept won an architecture competition run by IBA. The façade system was developed jointly by SSC Strategic Science Consult GmbH, Arup Deutschland GmbH and Colt International GmbH. They used automation products and solutions from Rockwell Automation, which integrated seamlessly with the measurement and process technology from Strategic Alliance partner Endress+Hauser.

**Challenge**

The bioreactor façade covers a 200m² area and forms the heart of the energy system. It is made up of glass tanks that measure 2.6m high by 70cm wide and about 2cm deep with a capacity of about 24 litres. The tanks are filled with a culture solution enriched with nutrient salts, giving the micro-algae optimal conditions for growth. Compressed air ensures that the algae are always moving and CO₂ is continually fed into the reactor to boost their growth further. The CO₂ is provided by a gas boiler. The sunlight not used by the algae also warms the reactor liquid. As with a solar energy system, this warmth is separated off into an energy unit and used to heat the building.

Dr. Martin Kerner, Managing Director of SSC Strategic Science Consult GmbH, comments: “The biggest challenge in this pioneering project was to combine the innovative technology used for growing algae with modern building technologies. That was the only way to underpin the various functions of the micro-algae façade – such as heating and biomass production – while ensuring soundproofing and light protection for the building too. We managed to achieve this with the Algae House – it’s the first of its kind in the world.”

**Solution**

The automation technology is an important part of the whole system and allows it to be run automatically throughout the year. A CompactLogix™ controller from Rockwell Automation forms the core of the automation system by providing seamless integration between the programming software, controllers and I/O modules, helping to accelerate initial development time and reduce commissioning and operation costs.

Other devices connected to the CompactLogix controller include building technology systems, such as heat exchangers, as well as algae cutters and the conversion units that turn biomass into biogas. The PLC also controls all the pumps used to guide the reactor modules towards the sun. The remote I/Os are connected to the controller via EtherNet/IP, providing decentralised control across all floors of the building. It provides robust, real-time networking and high-speed discrete control. Unlike other networks that continuously alter their network design to meet the demands of industrial applications, EtherNet/IP helps ensure high stability and consistency of the entire system for increased real-time capabilities.
The entire system is operated by a specialist at SSC Strategic Science Consult GmbH, using Rockwell Automation FactoryTalk® View visualisation software. The easy-to-use graphical functions give the user a realistic view of all processes, making it easy to monitor the system and analyse processes. The software also enables the user to react rapidly to error alerts and alarms. If necessary, the user can also intervene in processes directly by modifying predefined control parameters via the visualisation software. As a result, FactoryTalk View is an essential element contributing to the error-free operation of the bioreactors.

Several measurement devices from Endress+Hauser – such as flow meters and analysis instruments – are connected to the Rockwell Automation controller. They check the fill levels in the reactor modules as well as the pH, oxygen and nitrate levels in the growing medium. A process photometer is used to define when the algae should be harvested, so that the removal of the biomass can also be controlled automatically.

The system was initially designed as a prototype, but Rockwell Automation is preparing it for worldwide implementation with the addition of four programming languages. Depending on the background of the local technicians, the system can be programmed using ladder logic, structured text, a function plan or a sequential function chart. In addition, the control system’s tag-based architecture simplifies the programming process.

For the first time, the Algae House has made it possible to test a decentralised system that supplies a building with heat and power while producing high-quality biomass energy. It also reduces the greenhouse gas CO₂. The company SCC GmbH is compiling production and performance data in the context of a two-year monitoring project, while HafenCity University in Hamburg is collecting information for this project concerning the acceptance of the new technology.

“The goal of this accurate data analysis and evaluation is to enable us to implement this technology in the future in larger systems and enable more energy-efficient and ecological construction methods,” says Dr. Kerner from SSC Strategic Science Consult GmbH.

Additional Information

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The results mentioned above are specific to this application’s use of Rockwell Automation products and services in conjunction with other products. Specific results may vary for other customers.
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Rockwell Automation and Endress+Hauser are able to provide a wide range of pre-tested, standards-based measurement, automation and information solutions to help you reduce integration costs, improve operational and maintenance efficiency and optimise plant assets.