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The BIQ House, Hamburg, Germany

Living architecture

The BIQ HOUSE - first building in the world with bio-reactive microalgae facades

Arup's BIQ house is the first building with Bio-Intelligent Quotient (BIQ) situated in Hamburg, Germany. It is the prototype building that combines design, smart technologies and modern building materials. The construction of the BIQ House cost approximately 5 million Euros. This five storey passive house has two types of facades. The sides of the building which are exposed to the sun are built with the shell consisting of Microalgae what enables the building to supply its own energy. Microalgae are the source of the renewable energy and generate electricity and heat. Moreover, Microalgae biomass collects energy by absorbing the light and generating heat in a similar way to the solar thermal unit. Such heat can be used for central heating or can be kept in the special heat exchangers. Also, the façade has the function of insulating the building from sound, heat, and cold, and provides shade in bright sunlight.

The BIQ house is a solid cubic built of stonework and concrete. The building consists of 15 apartments, and some of them can be switched to a neutral zone. Interior design is very straightforward and modern; the living space has underfloor heating. The facade is built with the conception in mind that light can be converted to heat like in solar thermal design. It also can be converted to biomass. Microalgae-like vegetables use sunlight for the photosynthetic process and this is linked to the process, of conversion of CO2 to organic matter. This fact leads to a new opportunity of reducing CO2 emissions through building façades. The combination of different energy sources which work together makes the BIQ house a sustainable building. In one building the combination of solar energy, geothermal energy, a condensing boiler, district heating and biomass production is used to enhance the building performance.

The Energy cycle with renewable systems is based on the principal point of all processes- the algae reactor modules. Bioreactor facade due to sunlight and a constant turbulence produces heat and biomass. It achieves significant CO2 reduction per year in comparison to other technologies. Algae Biomass collect the biomass which is transformed into biogas in the outdoor plant. The associated heat production is transferred back into the system via the heat exchanger and stored in the geothermal boreholes. Biogas is also converted into methane. A heat pump is used in the pumping back the heat into the system. A gas burner is used to cover the supply of hot water at 70 C or heating in the energy network. A central building management system (BMS) called Rockwell SPS manages all the processes necessary to operate the bioreactor façade and to fully integrate it with the energy management system of the building. This includes the control of the algae cell density and the temperature in the culture medium. "Wilhelmsburg Central Integrated Energy Network" is the name of the local network which provides/receives heat to/from this building. Initially, the original plan envisaged the use of photovoltaics on the extensively greened roof surface. But this was not implemented. Therefore, until the installation of PV system, all electricity required is provided from the grid. The heat demand of the building is already relatively low since the "BIQ" runs in accordance with the Passive House standard. Much of the heat is therefore needed on a seasonal basis for hot water.

The LIAR project - smart digestive bricks

Newcastle University has launched a new project which focuses on the development of the living architecture (LIAR). It aims to transform building facades into biological computers made of digestive bricks that can create useful products from waste. Clever brick will be able to collect resources from sunlight, wastewater and air. Walls built of digestive bricks will work as bioreactors and can be easily incorporated into buildings. At the heart of the new blocks is a microbial fuel cell filled with programmable synthetic microorganisms. Robotically activated each chamber will contain microorganisms chosen to clean water, reclaim phosphate, generate electricity and create new detergents. The living cells will be able to sense and react to their surroundings through a series of digitally coordinated mechanisms.

Rachel Armstrong, Professor of Experimental Architecture at Newcastle University, explains: "The best way to describe what we're trying to create is a 'biomechanical cow's stomach. It contains different chambers, each processing organic waste for a different, but overall has related purpose – like a digestive system for your home or your office."

The LIAR project is incredibly exciting – it brings together living architecture, computing and engineering to find a new way to tackle global issues, like sustainability" Professor Rachel Armstrong, Newcastle University

The project now underway will see the development of blocks through which waste water can permeate allowing microbial fuel cells to go to work. It is anticipated that the first prototype will be exhibited later this year. The researchers also aim to find ways to reclaim phosphate – a mineral which is becoming increasingly scarce – and create new detergents using the blocks. Professor Armstrong explains: "While this project deals with very small amounts of the substance, the insights we will be able to gather into how communities may collectively harvest reusable substances from their wastewater could potentially create an economy through re-distributing resources through councils, or other interested parties such as washing machine manufacturers."

The LIAR project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 686585.