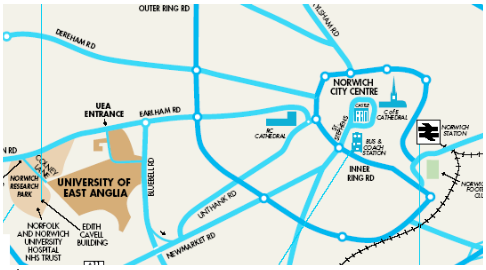
ZICER building



site map

location: University of East Anglia, Norwich

dates: 2003

type: New construction

use: The Zuckerman Institute for Connective Environmental Research (ZICER) is a University building on campus- Educational facility

size: 2,860m2 divided across 5 floors

people:

actors: Whitbybird - responsible for the structural engineering of the building as well as the PV outline design and integration into the naturally ventilated top floor space using CFD modelling;
RMJM – architect; Northcroft - the quantity surveyor; and Willmott Dixon - the contractor

goals:
- Implement technical means of low-energy building design, installing renewable energy sources, good energy management and raise awareness
- Test 'termodeck' construction principle
- Demonstrate potential of PVs: both on vertical and gently sloped roof surfaces
- Lower the Co2 emissions (CO2 emissions are designed to be 70% lower than mid-1990s best-practice buildings, with carbon index is in excess of 10.0)

energy use	KWh/m^2
heating&electricity, goal	<100
heating&electricity,achieved	
heating&electricity,best	

construction
- 'Termodeck' construction principle (concrete slabs for heating and cooling)
- blockwork walls
- Construction materials included recycled aggregates and timber from managed sources
- Triple-glazed timber windows with lowemissivity coatings and louvres

amenities

systems	
district heating	
combined heat & power	x
solar panels	
solar cells	x
biomass and refuse	
wind power	
natural ventilation	x
forced vent.w/heat recovery	
non-renewable energy	
individual metering	

special projects
- Combined heat and power plant
- Electricity produced is used locally
- Atrium for demonstrating the potential of PVs
- Independent heating and lighting control systems

site ecology

Façade, photo: whitbybird

process and history
The University of East Anglia (UEA) was established in 1963 on a campus approximately 4 km west of the city of Norwich. It currently has over 13 000 students and over 2200 employees, of whom 465 are academic staff. The initial phase of campus development centred around buildings constructed in the mid to late 1960s, many of which represent the energy-wasteful approaches to building design that were prevalent at the time.

Left and below: The ZICER building emphasised low energy consumption from the start.

Photos: Cambridge Architectural Research

process and history, continued

Many of these are now Grade II listed buildings and the scope for significant improvements in their thermal performance is thus limited.

Since 1990, university policy for most new buildings has been for construction to standards well in excess of the then and likely future building standards. The buildings fall into two broad types: low-energy highly efficient student residences dating from the early 1990s and four (shortly to be five) education/office buildings employing the 'Termodeck' method of construction.

The ZICER building is a new research venture designed to address the environmental challenges facing us through much closer and more effective connections with business, policy makers and wider society. The Institute is also the first physical symbol of recognition commemorating Lord Zuckerman, the Government's first Chief Scientific Adviser and one of the founding fathers of the School of Environmental Sciences.

description of special project features

The lower four floors (including the basement) were Termodeck construction (an exhibition area on the top floor, designed to demonstrate the use of PV cells, is outside the Termodeck envelope).

The UEA was a pioneer in the UK in constructing educational/office buildings to the 'Termodeck' principle. The construction uses lightweight hollow-core ceiling slabs through which both incoming and exhaust air can circulate. The system provides high insulation standards, good air tightness and a highly efficient heat recovery system. There is provision for individuals to open windows, although this facility is seldom used. Nevertheless, it is important that such provision is available as user acceptability of working environments is important.

In winter heat gains from occupants and office equipment are absorbed by the exposed concrete during the day and reradiated at night. In summer the absorbed heat is rejected outside the building by running the fans at night, so enabling the concrete to give the impression of radiating cooling energy the next day. There are extremely high levels of insulation and airtightness. The blockwork walls have 190mm of expanded polystyrene insulation. Triple-glazed timber windows with lowemissivity coatings and louvres between the panes give excellent thermal performance. These windows open, to give occupants a degree of control over their environment.

The ZICER building also uses high quality ductwork and variable-speed fans. It has independent heating controls for each floor, some automatic lighting controls, and efficient 'T5' lighting. An air pressure test achieved an impressive 2.8 air changes/hour @50 Pa. This significantly undercuts the airtightness of the Elizabeth Fry building. Like that building, ZICER has a very efficient heat recovery system – reckoned to recover most of the energy from air leaving the building. However, due to the large amount of glazing, the top floor of the building uses almost the same amount of energy as the other four floors. Since commissioning, the heating strategies have been modified, which approximately halved the heating load. The changes included re-circulating air on the top floor, maintaining the floor at 15oC unless it is occupied, and installing sensors to bring the temperature up to 20oC when it is being used. The heating energy requirements are now slightly higher than the Elizabeth Fry building, but electricity use is lower.

It is one of the most energy-efficient buildings in Europe, incorporating high thermal-mass Termodeck concrete slabs for heating and cooling in the majority of the building, with triple-glazed windows and insulation rates far in excess of current UK standards.

UEA also has a combined heat and power plant, which uses the waste heat produced from electricity generation to heat buildings. UEA estimates that this saves about 8,600 tonnes of CO_2 per year, or more than 30% of the University's CO_2 emissions

A 34 kW PV array on the facade of the top floor and the roof of the building.

Electricity generated by this building is used in the ZICER Institute, or exported to other buildings on the UEA campus.

It is better to use as much of the electricity locally like this in order to reduce transmission losses through cables.

The glass/glass PV is fitted to the 'atrium' like arrangement on the top floor, which was designed to maximise the potential for demonstrating PV: both on vertical and gently sloped roof surfaces. Glass/glass laminates were selected to give semi transparent glazing that also included PV. This area is naturally ventilated, with air entering at low level, passing over the PV panels to remove heat, and leaving again through louvres at high level. The roof shape was designed to draw warm air up over the PV panels in the roof, and away from the occupied area.
Detailed life-cycle cost and impact analysis for the construction, fittings and furniture was undertaken.

funding

The building integrated PV cells part of the project was supported by the funding from DTI Major PV Demonstration Programme and the EU Framework 5
Total value of the project was 5 million pounds

results

Adverse effects of global warming and climate change is a critical issue. For the past 15 years the University of East Anglia has been addressing these concerns through a multi-pronged approach using technical means of low-energy building design, installing renewable energy sources, good energy management and raising awareness. Through good energy management, the university has been able to reduce the energy consumption of already low-energy buildings by as much as 50%. A large-scale building-integrated photovoltaic (PV) array has been installed along with on-site generation of heating, cooling and electricity via a 3MWcombined heat and power (CHP) plant and, recently, an adsorption chiller.

The PV system has been providing monitoring data since January 2005. During the first year of generation a total of 22,650 kWh was provided to the building, slightly below the predicted output of 28,400 kWh. As expected, the roof-mounted array performed better than the vertical façade, generating 730 kWh/kWp. Generated output from the façade was only 415 kWh/kWp.

CO2 emissions are 70% lower than mid-1990s best-practice buildings, and the carbon index is in excess of 10.0.

The ZICER Building has an effective energy management policy. Heating consumption was reduced by a further 57% by careful record keeping, management techniques and adaptive approach to building control.

Leasons learnt:

Installing the glass/glass laminates was problematic as the contractor, Wilmot Dixon, found it difficult to find a glazing/façade company to take on the work. Potential contractors saw the PV installation as different and complicated.

No special or bespoke components were required to integrate the PV laminates. Standard Schuco curtain walling was adapted to accommodate the PV cabling. The PV array influenced the design of the building's atrium. A passive ventilation strategy makes use of the heat building up behind the PV array to drive a "stack effect", with warm, stale air ejected at high level through opening louvers. However, the ventilation louvers increased the noise and dust entering the atrium. The lamination on 11 of the roof-mounted modules was peeling away due to a manufacturing problem. This has now been rectified and BP Solar is replacing all the roof modules with Romag glass-glass laminates.

The University encountered a number of problems with the PV monitoring system, including incorrect wiring and calibration of some of the sensors. Nevertheless, since the problems were rectified the PV system has been providing reliable performance data.

The PV contractor was not involved right at the end of the project when the building was handed over to UEA. If UEA's Estates staff had been present when the PV work was completed there may have been fewer problems later.

Energy summary results:
Total PV system output 22,650 kWh/year
Power used in building 249,760 kWh/year
Power imported into building 227,500 kWh/year
Power exported to grid 390 kWh/year

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sources: www.dti.gov.uk/energy/renewables