

2009 UK Ashden Awards case study

Architype

Finalist's work: Design of buildings to minimise carbon emissions in operation and construction

Organisation: Private company, established 1984, income £2.5m, 34 staff

Location: Hereford and London

Summary

The use of buildings is responsible for a large portion of UK CO₂ emissions, and further emissions are 'embodied' in building materials and the construction process. There are significant opportunities to reduce emissions when new buildings are developed, or old ones refurbished. UK building regulations now specify target CO₂ and energy reductions, but few architects and construction companies go further than these minimum requirements. Current UK policy is to encourage calculated carbon neutrality by offsetting energy consumption with onsite renewables.

Architype is an architectural practice that has always taken a different approach. Its main focus is to design buildings using techniques and materials which simply and significantly reduce energy demand and carbon emissions, and also reduce embodied energy and carbon, by design. Energy used by the building can be provided from low carbon sources. Architype staff also devote significant effort to consulting with their clients during the design process. This provides buildings which clients enjoy using and use correctly, thus achieving the designed energy efficiency.

- Insulation, passive design and natural ventilation are used to reduce energy use.
- Extensive use of timber construction to minimise embodied energy.
- Biomass boilers, solar water heating and solar photovoltaics used for energy supply.
- Architype office in Upper Twyford is built to their exacting standards, with high levels of insulation, natural ventilation, biomass heating, efficient water use, facilities for cyclists and a reed bed to process liquid sewage.
- 29,000 m² of buildings completed in the past five years, saving an estimated 1 GWh/year energy (29%) and 300 tonnes/year CO₂ (36%) compared to 2006 building regulations.
- 34,000 m² of buildings to be completed in next two years, designed for even higher savings of 2.6 GWh/year energy (65%) and over 700 tonnes/year CO₂ (75%).
- Buildings to be completed in next two years will save a one-off amount of 3,500 tonnes CO₂ due to reduced embodied energy compared to traditional construction methods and materials. The use of timber in their construction will lock up a further 3,900 tonnes CO₂, which was absorbed while trees were growing.
- Over 3,000 people are benefitting from Architype's buildings completed in the last five years.
- Occupants have a comfortable environment in which to live or work, low energy costs, and a building tailored to their needs.

Architype

Jonathan Hines

www.architype.co.uk

jonathan.hines@architype.co.uk

01981 542111

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Context

The use of energy in buildings is responsible for around 45% of the UK's CO₂ emissions. Additional energy is used, and CO₂ emitted, during the manufacture of the building materials and their construction on site, and is thus 'embodied' in the building. Every time a new building is built, or an old one refurbished, there is an opportunity to reduce energy demand and CO₂ emissions.

Building regulations in the UK, specify theoretically calculated target reductions in CO₂ and energy consumption. However, there are construction materials and techniques that can reduce a building's energy demand well below these levels, and also reduce embodied energy and CO₂. But many architects and construction companies have been slow to innovate in this area, preferring to use traditional building methods with small adaptations to comply with the minimum requirements of the regulations.

Using the best technology alone is not sufficient to achieve maximum efficiency, because the energy demand of a building also depends on the people that use it. If a building is not well-suited to its occupants, and the controls for heating, cooling and lighting are not easy to use, then the energy performance can in practice fall short of what the architect intended. In the worst case, the occupant may resort to retro-fitting energy-intensive equipment to a supposedly 'efficient' building.

Architype is an architectural practice that aims to design sustainable buildings that really deliver on the promise of reduced CO₂ emissions and environmental impact. This is achieved through designing buildings to require minimal heating, cooling and lighting; using building materials with low embodied energy; supplying energy from renewable sources; and consulting the future occupants extensively to ensure the building will meet their needs.

How the business works

Concern for the environment and for creating sustainable buildings has been the focus of Architype since it was founded in 1984. Although it has since then evolved from a co-operative to a fully commercial business, Architype still retains its original goals and ethos. Within both of its offices the staff work collaboratively, in a flexible team that can draw on the expertise of all staff. To aid this process, Architype uses an internal social networking website which allows staff in the two offices to quickly share information, ask questions, and comment on current projects.

The Architype ethos is apparent in its approach to consultation, which is the process through which the architect and client come to an agreement on the design for a building. Architype puts more time into consultation than many other architecture practices, and makes it an open process, rather than dictating to the client. By giving clients time and opportunity to discuss the options for the building design, Architype tries to ensure that the client will be satisfied with the end result. This also means that the client will use the building in the way it was intended, so delivering the best environmental performance possible. An example of this is in designing schools, when Architype consults not only with the staff but also with the pupils. Hands-on activities like model-making are used to capture information on how the building will be used. Involving clients is also a valuable way of raising awareness of sustainability and energy use, as well as developing the best building for their needs.

Architype also likes to involve the building construction company at an early stage, so that any specialist technologies and construction techniques can be discussed and potential problems avoided. Its ideal is a partnership between client, architect and constructor, rather than a hierarchy.

Technology and use

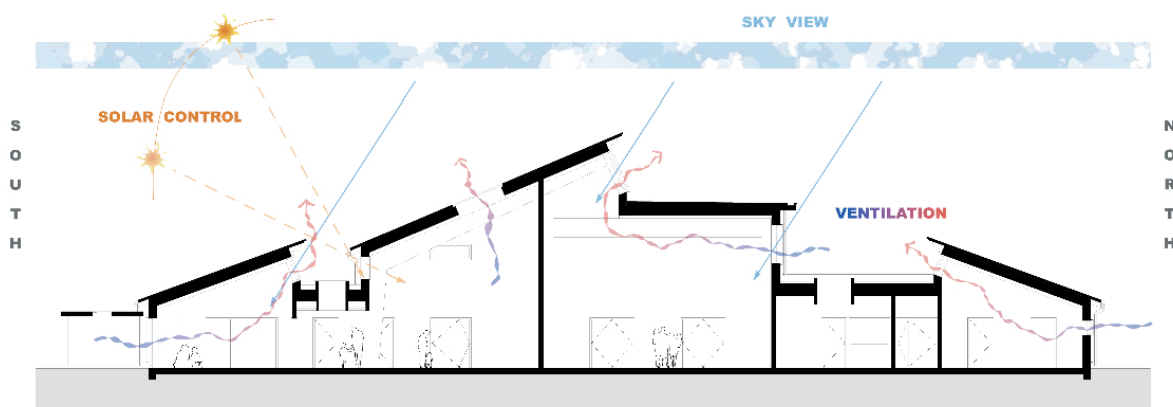
The technologies and techniques used by Architype can be separated into several areas:

Design for passive regulation

The most significant use of energy in buildings is for heating, but cooling using air-conditioning is becoming increasingly common. Demand for both heating and cooling can be minimised by careful design of a building, as can the need for artificial lighting. The demand for heat is minimised primarily through increased insulation. Architype typically uses 300 mm recycled newspaper insulation in the walls and 400 mm in the roof to give performance in excess of that required by current building regulations, which require around 120 mm in walls and 200 mm in the roof, and uses high-performance glazing for the windows. It is also possible to increase the heating from the sun, known as passive solar gain. This is achieved by orienting the building such that some large windows face south, allowing the winter sunlight to penetrate the building and heat it. Finally, the building fabric is designed to reduce thermal bridging and is air-tight to eliminate draughts, with controlled ventilation available through specially designed vents.

As well as being warm in the winter, a building needs to be cool in the summer, preferably without the use of air conditioning. The first step is to control solar gain – while this is desirable in the winter, it must not be excessive in the summer. Control is achieved by using horizontal sun-shields above south-facing windows, so that as the sun rises in the sky the direct sunlight penetrates a shorter distance in to the building, and does not enter at all during the hottest part of the day in the summer. The second step is to arrange the ventilation of the building to keep it cool through passive means. This is achieved by designing the structure of the building to allow warm air to rise out of high windows or vents in the roof, while cool air is drawn in near ground level, especially from shaded areas. Automatically controlled vents enable colder night time air to passively cool the building fabric, to create comfortable daytime temperatures without the need for artificial cooling and fans.

The measures taken to increase solar gain in the winter also maximise the amount of daylight entering the building. Strategically placed north-facing windows can admit additional daylight without causing excess solar gain in summer. In some of Architype's buildings these windows are placed high up, so they can also function as the vents for hot air to exit the building. Factors specific to the particular use of the building are also taken into account; for example, in classrooms it is possible to design the daylighting so that there is a darker area where a projector screen or interactive whiteboard will be placed. This is the kind of detail that is often identified during the in-depth consultation process that Architype uses. The diagram below illustrates the operation of passive regulation.



Design to minimise embodied energy

The embodied energy in a building is the energy used to produce the construction materials, transport them to the site and assemble them. Historically the energy embodied in a building has been around 20% of its lifetime energy use, so it is understandable that the operational energy use of buildings has been the primary focus of efforts to reduce energy consumption. However, as operational energy use falls due to improvements in efficiency, the embodied energy in a building represents a greater proportion of its lifetime energy use, and must also be reduced in order to cut CO₂ emissions further. This is energy saved at the time of building, rather than in the future.

Architype uses a range of building materials that minimise embodied energy while also delivering the required low operational energy use. Timber is often used for the structural frame, walls and roof of a building, and for external cladding, and is sourced as locally as possible. Not only does timber have low embodied energy compared to concrete and steel, but using it in a building 'locks up' the carbon absorbed by the tree while it was growing. Timber is a reliable construction material, and gives buildings a natural appearance. Although people raise concern about the risk of fire in timber-framed buildings, they can actually perform better than steel in case of fire, as timber burns at a predictable rate and can be sized to retain its structural integrity, while steel needs protection to avoid it softening and buckling, once a certain temperature is reached. Rammed earth is used to construct walls in some buildings, to avoid the need for bricks and mortar, both of which require significant energy to manufacture. Precisely machined clay blocks with air gaps for insulation are also employed to minimise the use of mortar in some cases. Straw bales are another option, popular for buildings with an environmental focus, providing insulation and structural strength in a single material. They are usually covered with a lime plaster for weatherproofing.

Using low-carbon energy sources

The first priority of Architype is to reduce energy demand through good design and materials. However, even the most efficient buildings need energy to run them, and Architype looks to low-carbon energy sources to deliver this. Biomass boilers are the most common heating option due to their cost-effectiveness, and are often used with underfloor heating to increase the efficiency. Other technologies used include solar water heaters to provide hot water, and solar photovoltaics to generate electricity. Because Architype buildings have been designed for efficiency, the renewable energy systems can provide a greater percentage of the energy demand.

Case study: the Hereford office

In 2006, Architype had the opportunity to design its own office at Upper Twyford near Hereford, starting from derelict farm buildings. It took this as an opportunity to develop its approach and gain more insight into the process by monitoring the performance of the building after completion. The features used in the building include:

- External appearance of the building designed to fit in with the surroundings.
- Highly insulated building fabric.
- Passive cooling by opening vents during the night.
- Strategically placed windows to give good daylighting while avoiding glare on computer monitors.
- Low embodied energy materials such as recycled newspaper insulation, recycled flooring and locally-sourced timber.
- 15 kW biomass boiler, burning locally-sourced woodchip.
- Water-saving taps, and liquid sewage processed by a reed bed.
- Shower room and clothes drying room for staff that cycle to work.

How the work is financed

Most of Architype's contracts are won through competitive tender, with the client making a selection according to a range of criteria including cost. Architype competes commercially with more traditional architects.

Buildings designed by Architype include schools, colleges, offices, community buildings, visitor centres, housing projects and student accommodation. Much of this work is currently in the public sector and community. In developer housing and commercial projects sustainability has generally not been such a strong theme. However this may change as building regulations become more stringent, and companies like Architype demonstrate that sustainability does not need to be prohibitively expensive.

Training, support and quality control

Support for the occupants of a building actually begins before construction is started, at the consultation stage, when Architype makes every effort to understand the needs of the client and ensure that the building design meets those needs. Quality control is an integral part of Architype's work, and an architect will regularly be on site to inspect construction as it progresses. Once the building is complete, all of its systems are commissioned, checking for correct operation. After commissioning, the building is handed over to the client. Architype will always provide a detailed user manual for the building manager. There is also on-site training for the building manager, and this is sometimes recorded to make an instructional video for future reference. Buildings have a warranty that covers any defects arising in the first year.

Architype recognises that a building manual and well-trained manager are not necessarily enough to ensure that all the systems in the building are used in the most efficient manner, so other approaches are used as well. For example, at a school which is currently (2009) under construction, Architype is planning to put a cartoon-style poster in every classroom, explaining in simple terms what to do if the room is too hot, too cold or too dark.

Another training aspect in Architype's work arises from partnerships with construction companies. By working on Architype projects, the staff of these companies are exposed to new building materials and techniques. Architype has often arranged specialist training for builders to ensure they are able to complete work to a high standard.

Architype also takes students on work experience, with typically six students working with the practice at any time.

Benefits

In the past five years almost 29,000 m² of buildings designed by Architype have been completed. These directly benefit over 3,000 regular building users, and several thousand more people pass through visitor centres each year. In addition, a further 34,000 m² of Architype-designed buildings are currently in progress and due to be completed within two years – these will benefit a similar number of people in addition.

Environmental benefits

Like most architects, Architype does not usually have control over buildings after they are completed, which makes it difficult to monitor energy performance. However, monitoring equipment was incorporated in the Upper Twyford office as part of the refurbishment. The table below shows the energy use, compared to the values the Carbon Trust predicts for a typical naturally ventilated office of 300 m²:

Energy	Architype office	Carbon Trust benchmark
Heating	23.4 MWh (woodchip)	45.3 MWh (gas or heating oil)
Electricity	12.9 MWh	25.5 MWh
Total	36.3 MWh	70.8 MWh

Over the past year, the 300 m² building has used just 121 kWh/m² per year. This is an impressive 49% less than the Carbon Trust benchmark (236 kWh/m² per year) and 56% less than the benchmark for an air-conditioned building. For space and water heating, the building saves about 11.4 tonnes/year CO₂, or about 95% of the benchmark for a naturally ventilated building. About half of this saving comes from the building design, and half from the use of biomass heating.

Using design calculations, it is estimated that all Architype-designed buildings from the past five years are saving about 1 GWh/year of energy compared to 2006 building regulations (the most recent in force). This is a significant 29% saving. In terms of greenhouse gas emissions, the buildings are saving about 300 tonnes/year CO₂, or 36% of emissions. The percentage savings are higher for CO₂ than for energy, due to the use of biomass and other renewable energy sources.

Architype aims to go even further, and buildings due for completion in the next two years will save an estimated 2.6 GWh/year or 65% of energy use, compared to 2006 regulations. This is over 700 tonnes/year CO₂, or 75% of emissions. In addition to these annual savings are the savings in embodied energy and carbon. For buildings due for completion in the next two years, these amount to about 3,500 tonnes CO₂, largely from the use of wood as a construction material instead of concrete. This does not take account of the carbon locked up in the structure of the wood, which the trees will have acquired by absorbing approximately another 3,900 tonnes of CO₂.

Recycled and natural materials are used where ever possible throughout Architype's buildings, reducing pollution due to the production of the materials they may have replaced. For instance, where timber has replaced metal and concrete, it has also avoided the environmental impact of mining.

Using water efficiently is another area in which Architype pays careful attention in the design of its buildings. Its calculations show that on most sites reducing water consumption by careful design of systems and specification of fittings is more energy- and water-efficient than collecting and recycling rainwater. On many sites, to avoid contributing to flooding, rainwater is directed through a Sustainable Urban Drainage System (SUDS) that temporarily stores any sudden rainfall underground, releasing it slowly over a period of time.

Social benefits

The obvious benefits to building occupants are that their building should be well-suited to their needs, well-lit by daylight, at a comfortable temperature all year round and properly ventilated. This is particularly important for schools and offices, where a pleasant, comfortable environment can help people concentrate and be more productive.

Economic and employment benefits

The buildings that Architype designs are competitive on cost grounds with more traditional types of building. However, reduced energy demands make them much cheaper to run. On a wider scale, the work of Architype promotes the use of sustainable construction materials and techniques, so supporting the creation of jobs in industries that will be crucial for achieving national targets for reductions in CO₂ emissions over the next fifty years. The Architype office at Upper Twyford receives many visitors who are interested in sustainable construction.

Potential for growth and replication

General interest in sustainable architecture has been increasing in recent years, as people become aware of the changes that are needed to avoid significant climate change and improve energy security. Architype itself has seen its profile rise steadily since it was founded, and Jonathan Hines is well known as a public speaker on sustainable architecture at both specialist and mainstream events attended by other architects and also developers. As the pressure grows to reduce energy use and CO₂ emissions, Architype's message and public advocacy for sustainable architecture is ever more important. Architype has always pushed the boundaries of energy efficiency and is now advocating the adoption of German 'passivhaus' standards to drive down energy consumption by 80 to 90% compared to current UK regulations.

Through 2009 and 2010 there is expected to be a significant increase in UK government spending on building programmes, especially for schools. This is one of Architype's most successful areas, so presents a range of opportunities. Where appropriate Architype will partner with other architects or construction companies to take on large projects, and through this promote a low-energy design approach to more traditional businesses.

Management, finance and partnerships

Architype was established by Bob Hayes and John Broome in 1984, and initially functioned as a co-operative. Over time the company grew and the structure changed, and it is now a private company with Bob Hayes and Jonathan Hines as directors, and a staff of 34.

The company was originally based solely in London, but in 1995 set up an office near Hereford, and in 2006 completed the renovation of two disused farm buildings there, to provide an energy-efficient building to work in. Projects are distributed between the two offices according to their geographical location in order to minimise the time and energy used in travel to visit construction sites.

Architype is entirely funded by its income, with no external investment, and keeps a tight control over its financial affairs, with the result that it has almost no bad debtors. Monthly payments and billing are preferred, to smooth out cash-flow while waiting for payments to come in.

Architype works with a range of construction companies on projects, and is also a member of the Royal Institute of British Architects (RIBA), the Association of Environmentally conscious Building (AECB) and the Timber Research and Development Association.

Architype

Jonathan Hines

Upper Twyford

Hereford

HR2 8AG

www.architype.co.uk

jonathan.hines@architype.co.uk

01981 542111

This report is based on information provided to the Ashden Awards judges by Architype, and findings from a visit by members of the judging team to see its offices in Upper Twyford and London, and buildings it has designed.

Dr Mike Pepler, Technical Manager, Ashden Awards

www.ashdenawards.org

Dr Anne Wheldon, Technical Director, Ashden Awards
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