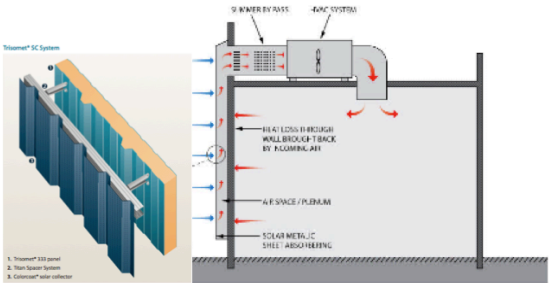


Sustainable Building Envelope Centre, Shotton, N Wales



## **Sustainable Building Envelope Centre, Shotton, N Wales**

Physical output : New building and sustainable retrofit and associated developments in new cladding technologies

a. **Year of output:** 2009-2011

b. **Type of output**

iii. Research Facility

c. **Title of the output:**

Sustainable Building Envelope Centre Shotton, Flintshire

Funders/Clients

TATA Colours and Welsh Government - £2.2m

I. Each of the following is required **where applicable** to the output:

a. **Co-authors:** Thomas. R

b. **Interdisciplinary research**

The panel should note that this is for the architectural and environmental concepts and testing.

A team of consultants were assembled as a fully disciplinary design team – see below.

c. **The research group**

Design Research Unit of the Welsh School of Architecture (DRUw)

TATA Colours/Low Carbon Research Institute

CIRIA

Key specialist contractors

Lesters Cladding and Fabrication Ltd, Buckley, N Wales

Evadex



## Aims and objectives

Based on TATA Steel's ambitions for a new range of products to contribute to what they have headlined 'buildings and power stations' SBEC is one of the first buildings to incorporate transpired solar collectors (TSC) for renewable heat in the UK and is the first building in the UK to use cassette panels for this technology. The cassette panels were developed specifically for the project in response to a need to demonstrate how the technology could be an integral part of the architectural response. The seamless integration into the building provides an exemplar for future designers wishing to incorporate this technology.

A subsidiary aim was to demonstrate best practice in the sustainable retrofit of Industrial Buildings and landscapes.

## Methodology

The research has been conducted through a design process involving integrated collaborative design and prototyping work with the supply chain on the architectural form and environmental performance of new cladding components particularly through passive measures and constructional techniques. This relies predominantly on physical modeling techniques.

## Dissemination

This has taken place in the following ways :-

- through architectural design awards and innovation awards such as RIBA Awards, National Eisteddfod.
- through demonstration - the physical presence of the building as a visitor facility and as a research project
- through publication and exhibition in the form of architectural journals and Best Practice Papers produced by national organisations.

## Authorship

Wayne Forster DRUw (Principal Investigator)  
Rhian Thomas DRUw (Design Research Associate)

In collaboration with the following Design and Construction Team  
TATA Colours, Shotton/LCRI  
Lesters Cladding and Fabrication Ltd, Buckley, N Wales  
Living Solutions, Shotton

## 1.1 Introduction

### 1.1.1 Context

During the past few decades, work at Shotton has specialised in developing high performance pre-finished, coated steel products for the construction industry under the Colorcoat brand name, and Shotton is the European market leader in this area.

Corus is now Europe's second largest steel producer and provides a wide range of products and innovative solutions for industries including the packaging, automotive, construction, energy and rail industries.

In 2007, Corus was acquired by TATA Steel and now forms part of TATA Steel Europe. TATA is now the world's fifth largest steel producer.



The Shotton site in N Wales – a place of steel making for over 100 years

TATA Colors is about to enter the final year of a 3 year £10.5 M programme to develop the world's first continuously manufactured photovoltaic product in steel. The PV Accelerator Facility houses scientists and development personnel from Corus and Australian partner company Dyesol, and the product has been 50% funded by the Welsh Assembly Government.

Additionally, the Low Carbon Research Institute was established to promote the low carbon economy in Wales through research activities in all sectors.

There has been an evolution in building envelope performance requirements, driven by regulatory and client expectations over the last 40 years. The requirements have moved from the building skin as umbrella to basic functional weather tightness achieved through insulated cladding systems, to being part of a fully integrated building envelope. This encompasses aspects of building physics such as insulation, air tightness and solar gains and must also integrate fully with other cladding materials and building components.

The result is a highly energy efficient building envelope which forms the basis of a building with low CO<sub>2</sub> emissions. TATA Colours have worked closely with their supply chain partners to develop and test cladding systems which meet these requirements.

TATA in partnership with the Low Carbon Research Institute have identified that the next 'big thing' in construction is sustainability, and have begun to develop a product range which focuses on the idea of 'building envelope as power station'.

The use of these products to date has tended to be applied in addition to the normal functions of the building envelope and have not been successfully integrated into the overall design of the building envelope.



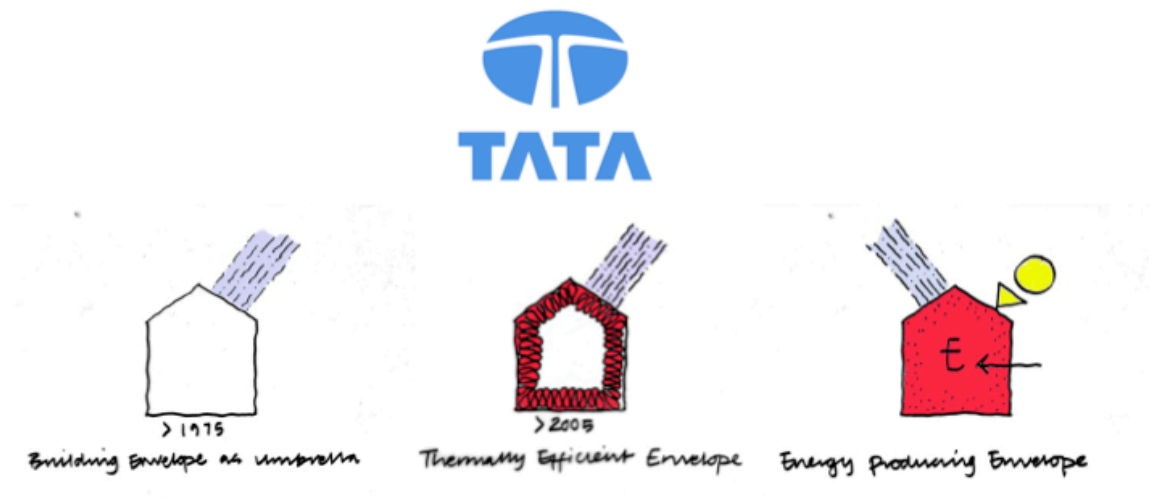
Prior uses of transpired solar wall by TATA were indicative of a Nicorette approach to the wall

## The site and brief

### 1.1.2 Client Brief

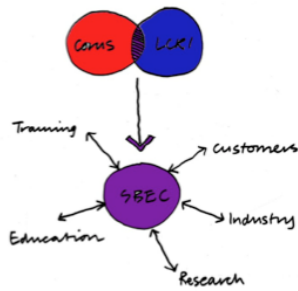
The vision for SBEC was defined by the client group as follows:

1. SBEC will be an outstanding project which will become a focus of global aspirations for research and development into sustainable building technologies. The facility will be a base for applied research in the development of the sustainable building envelope, and whilst this will focus on TATA products, there will be collaboration with other materials manufacturers and supply chain specialists. The centre will provide facilities for research teams to prototype and test.



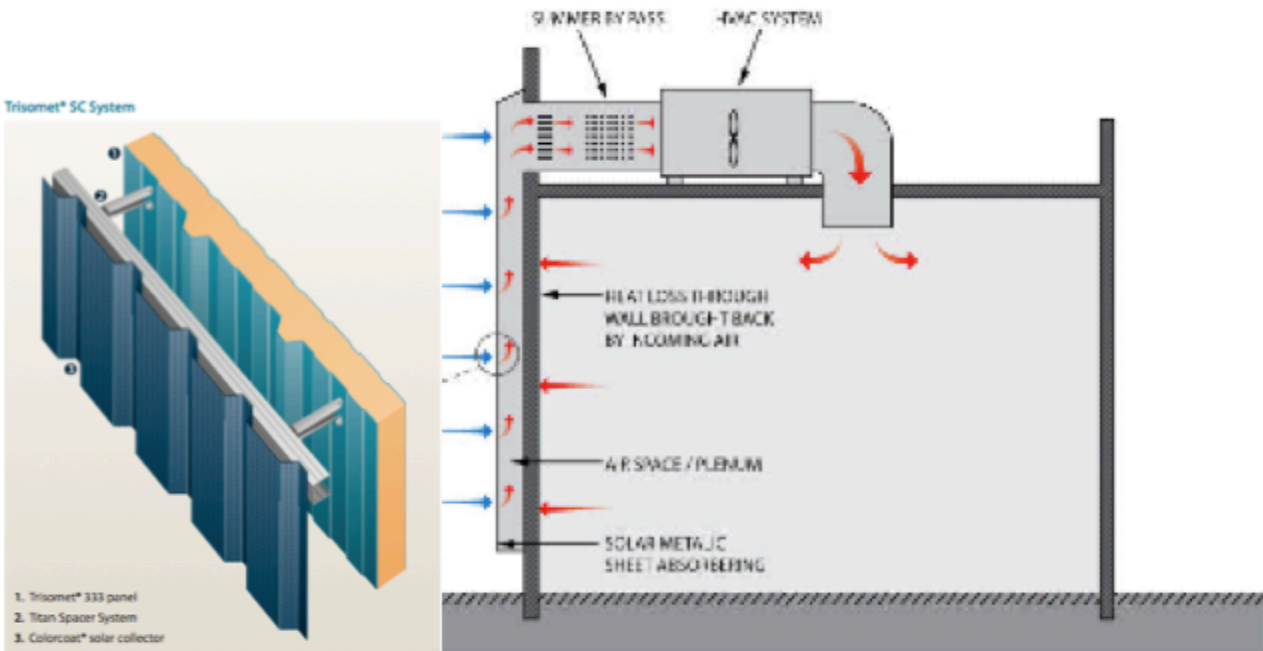
Initial sketches made to define the evolution of the building envelope

2. A home for the SBEC team which is more than just a workspace within the site but also a building that exemplifies the strong ethos of the partnership. It should also be a place where TATA and LCRI employees feel comfortable visiting and taking clients for informal meetings or education seminars, or just to socialise.
2. SBEC will welcome and attract world-class research and key customers and visitors; not only those attending training or education workshops in the main spaces, but as an exciting place to visit. The building must be a showcase for sustainable building envelope products, and in this way, engage and inspire. This will require a subtle balance of formality and informality and have a sense of openness and welcome and should encourage life and activity in the public spaces. At times, it is envisaged the facility may be used as a major receiving venue for an exhibition or unveiling of a product, though this is not seen as a primary function of the building.



Schematic of the functional brief for the building

4. SBEC will provide an integrated approach to design with sustainable technologies and the areas of daylighting, heating, cooling, ventilation and microgeneration of power using renewable technologies. SBEC will develop new solutions but also work closely with all construction activities on the site and make maximum use of the proximity to and synergy with these activities.



The principles of the transpired solar wall

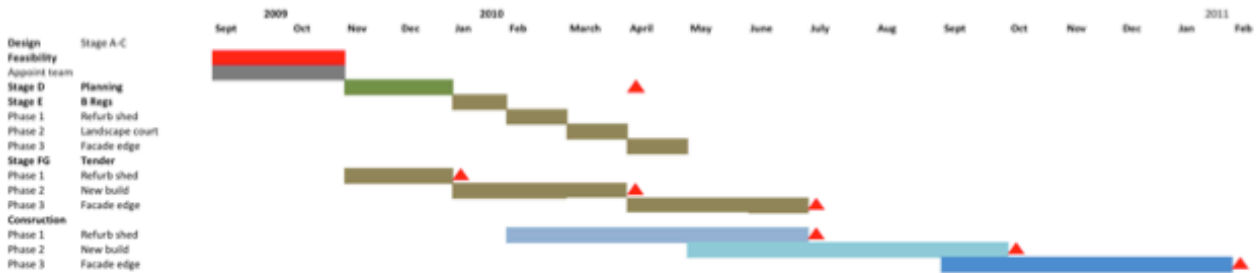
5. SBEC will be designed and constructed in a way that it embodies the above aims and objectives, and embrace the cultural heritage and ecology of the site.

- Create a sustainable flagship facility that celebrates synergy between heritage, built and natural environments.
- Create a stimulating fusion of education entertainment and awareness.
- Create a high quality educational, cultural and leisure facility that is vibrant and attractive.
- To promote sustainable building and demonstrate renewable energy use heat, power and water management in this market sector to as wide an audience as possible.

## 1.2 Research aims and objectives

The primary research issues in the scheme include:

1. How to integrate transpired solar collectors in 'mainstream' cladding elements rather than appear as applique.  
This includes the development of two wall types – sinusoidal and flat rainscreen plus associated technologies for the capture and distribution of energy.
2. How to employ strategies for sustainable design – particularly the integration of passive and active design for retrofit of an industrial heritage building – and to test through modeling and proto-typing on site at 1:1..
3. How to use off-site production technologies to meet the extremely tight budget and construction schedule - in this case through integrated working with the supply chain.



The innovative aspects of the scheme resulted in the development of a 'cycle' of design – specify – prototype – build for each separate element of the envelope. This was conducted through close working on and off site with the supply chain.

### 1.2.2 Research methods

The initial concepts and aspects of passive design were based on graphical macro and micro climatic studies and physical and computer modeling conducted in the school's environmental laboratory.

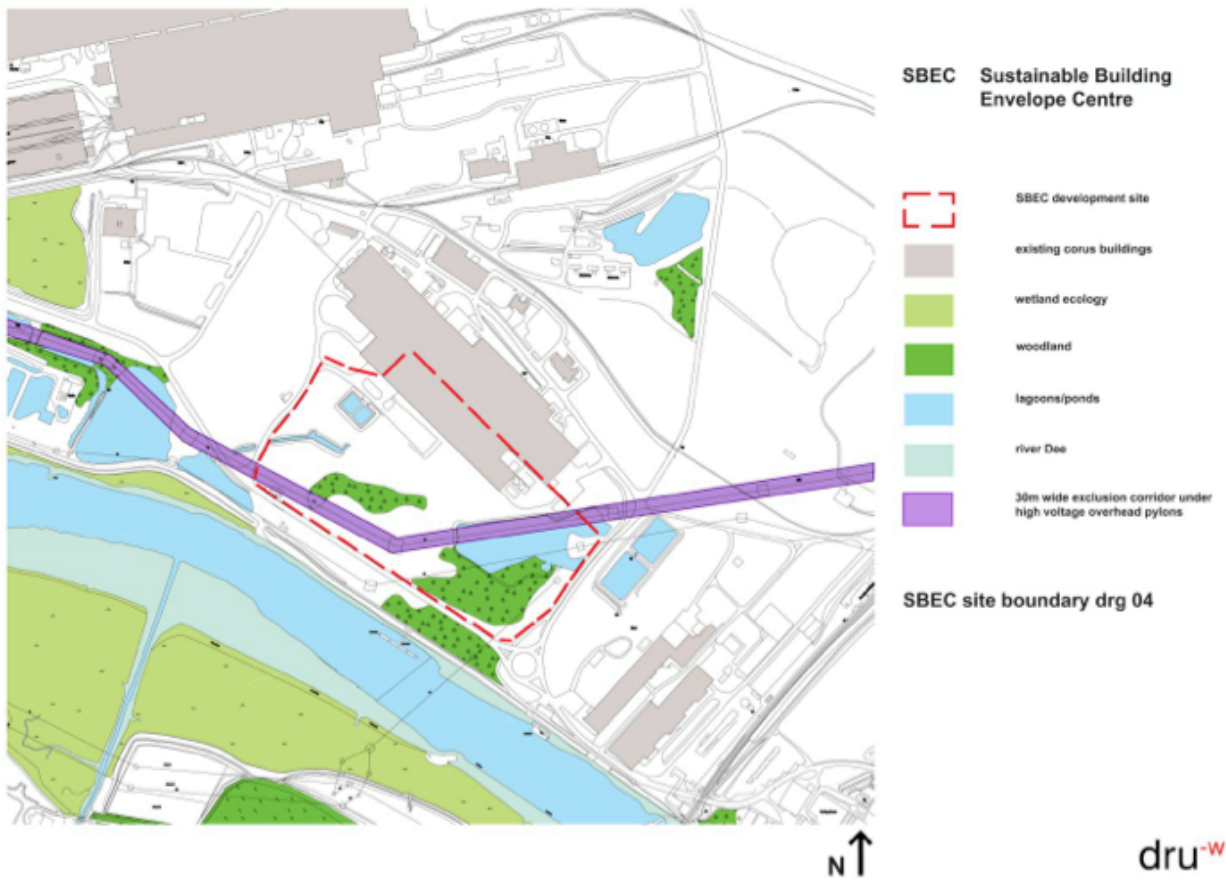
Following concept design, research methods were developed to ensure that the new and innovative technologies were designed and then specified and tested for each element of the scheme. This entailed the presence of the job architect on site at Shotton through the process.

### 1.3 Inception and Feasibility

DRUW were appointed initially by Welsh Government in Sept 2009 to undertake inception and viability studies. These were conducted primarily through a series of workshops held in Shotton with the client group and Welsh Government and a full brief and budget emerged from this process in late 2009.

This included site analysis and selection, establishment of a functional brief for the organisation, technical brief for the building envelope and associated environmental developments and experiments and detailed budget. We were then appointed to take the scheme forward.





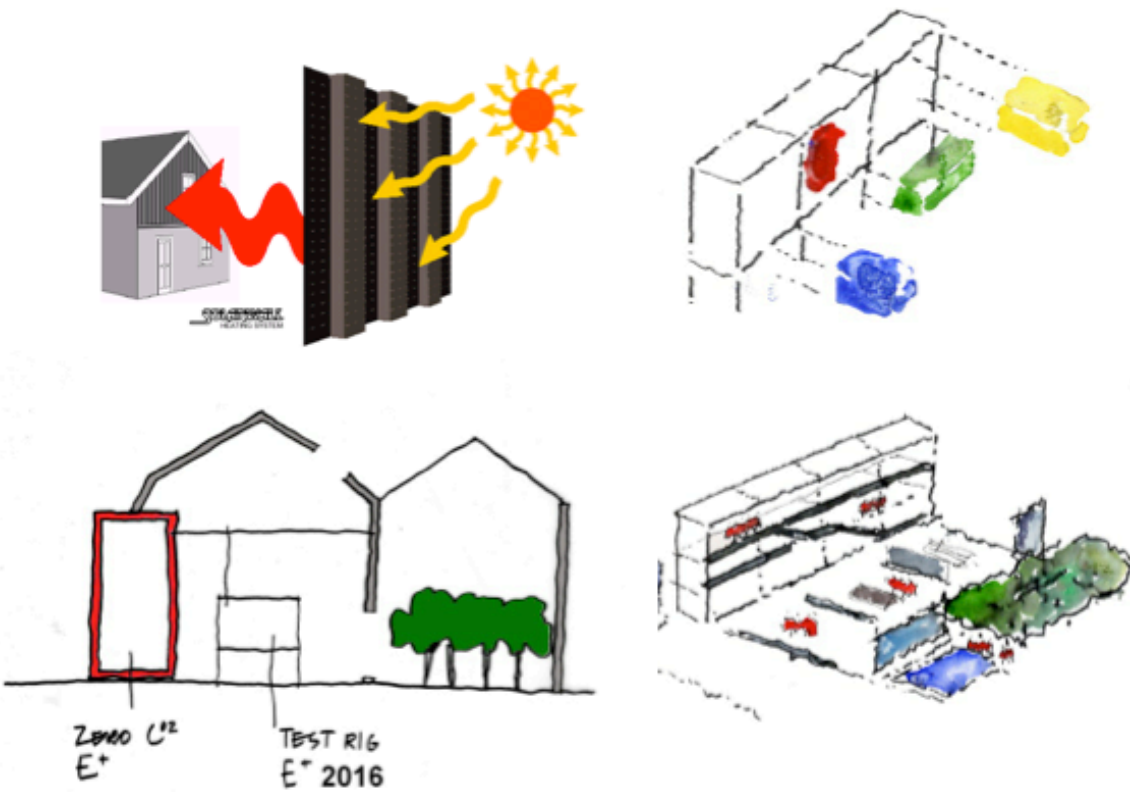
The Shotton site was studied (mapped) at a number of levels to identify a location for the new facility which would enable the demonstration of sustainable building envelope technologies. This would also involve integration into the retrofit of one of the existing vacant buildings.







The chosen site was to be a 50m long section of a 1920s former rolling mill with a south facing façade. The existing building fabric was in a particularly poor condition.



Part of SBEC's role is to act as a test rig and proving ground for the technologies being explored.

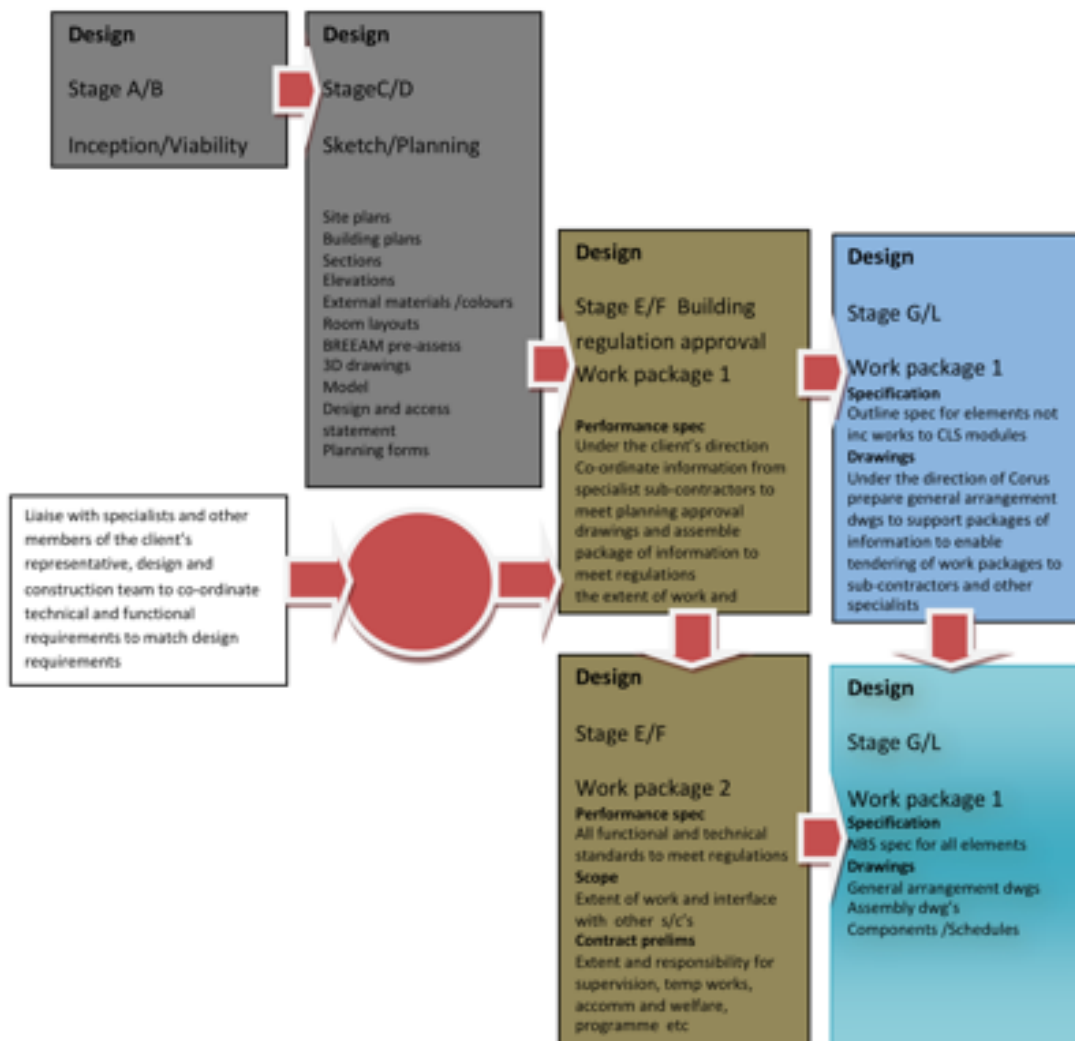
## 1.4 Detailed design

One of the consequences of the feasibility was the adoption of the brief as set out and also that £500k of Welsh Government grant had to be spent by the end of April 2010 and that the building was to be substantially complete by the end of 2010.

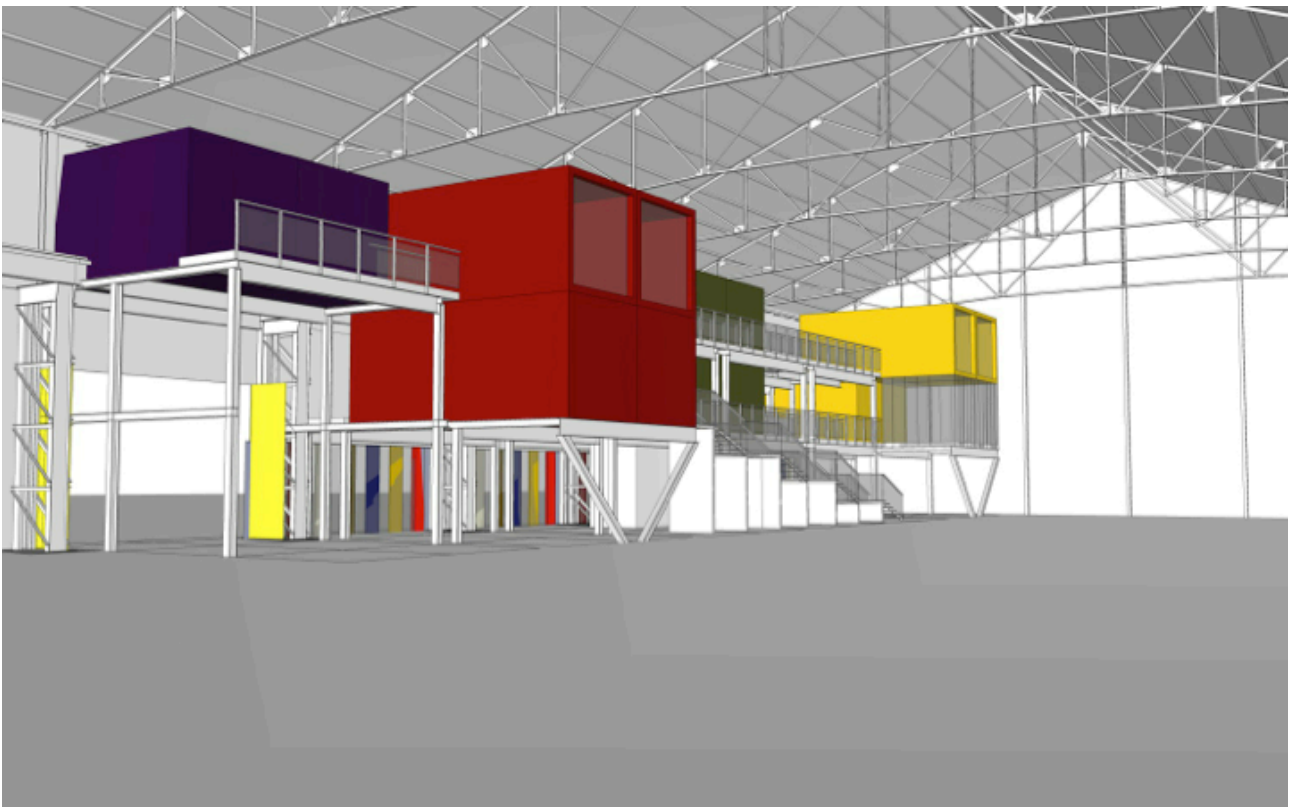
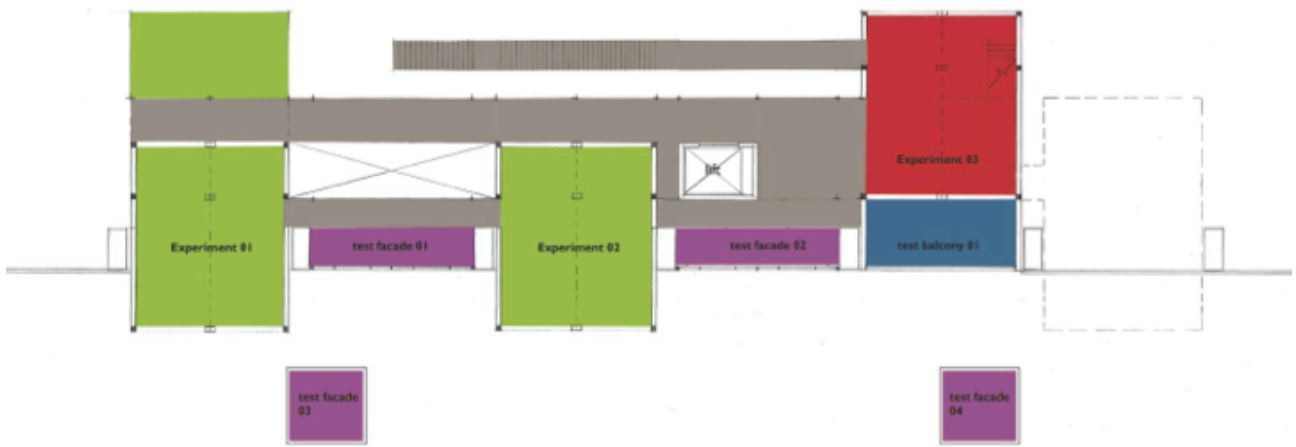
A series of work packages were programmed to enable this and which involved design, prototyping and construction often overlapping. (See below)

### SBEC

#### Design Process

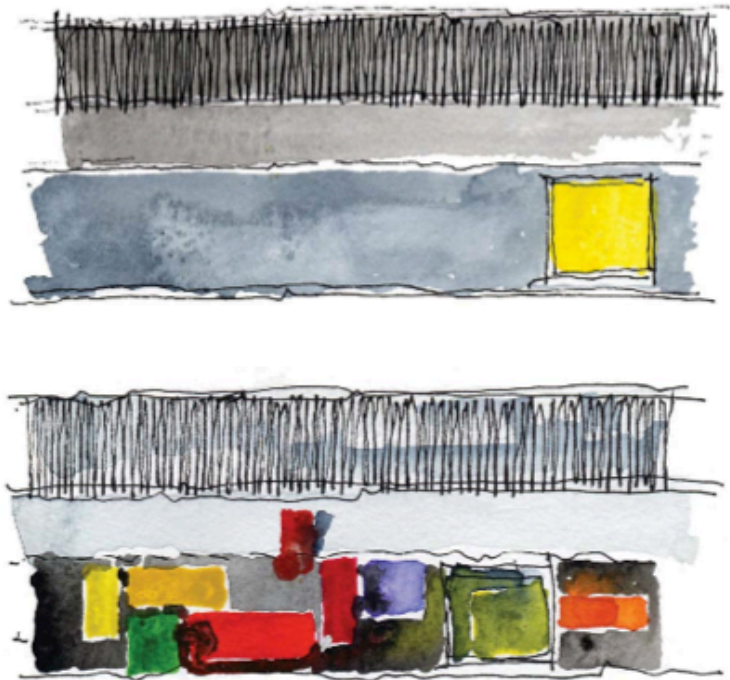


The building was organized spatially so that structural bays corresponded with functional use and a particular performance characteristic of the building envelope. Each of these modular bays was then designed to benefit from the pre-fabrication facilities on-site of Corus Living Solutions, who specialized in volumetric steel construction.



Drawings showing spatial organisation to correspond with functional use in the research facility. Each Zone has a different means of storing, converting and distributing heat or cooling.





Colour would be used both aesthetically as seen in this early sketch referencing a Paul Klee painting , and as means to test the relative thermal performance characteristics of TATA's colour range





Whilst this work was proceeding parallel studies relating to daylight using physical models were conducted to establish new daylight interiors throughout and the existing shed was stripped and made ready for a new roof and internal walls.

A planning application was made to Flintshire County Council in Feb 2010 with the intention of commencing works to the south façade and research offices in April.

#### Construction

Transpired solar collectors are installed as an additional micro perforated pre-finished steel skin onto an existing (or new) structurally sound wall (metal and non metal), creating a cavity between the wall and the metal skin.

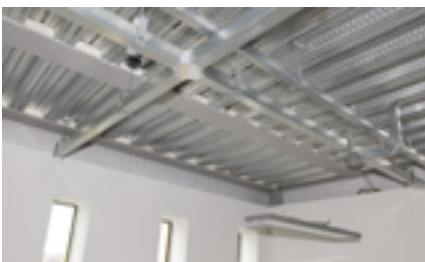
The building was split into number of separate zones that can be independently controlled and monitored using a building management system (BMS).



construction

Using a myriad of sensors and control systems embedded within the building, the BMS collects, analyses and responds to incoming data and allows for the optimisation of the building's performance. It also acts as a central hub for data collection to feed into optimising the building technologies being tested and help identify areas for enhancement.

The main technologies that were incorporated into the design were as follows:-



#### Phase change material (PCM)

In this application, the phase change material consists of micro-encapsulated paraffin wax that melts at 23°C and acts as an addition to the thermal mass of the building. SBEC is testing the application of phase change material (PCM) as an addition to the thermal mass of the building. The micro-encapsulated paraffin wax melts at 24°C and is incorporated into the composite floor slab. When the building is overheating, this melts and absorbs the excess heat by changing from solid to liquid. This heat is released when the temperature drops below the specified level and the liquid becomes solid again. This can be used in floors, walls or ceilings to capture, store or buffer thermal energy and enable a constant room temperature to be maintained. The PCM at the SBEC is above the ground floor meeting room and is a ComFlor 60 Active floor deck by Tata Steel. This takes the form of BASF's Micronal PCM within a concrete mixture above the steel deck.





#### **Thermo active floor**

A radiant floordeck reduces the need to heat water to high temperatures by utilising the floor area as the radiator. Instead of the usual 70°C water temperature needed for conventional radiator systems, the floor deck is hydronically fed with supply temperatures of 30 to 35°C, thereby operating at the most efficient phase of heat pumps. The room is heated evenly from floor level. Pipes embedded in the concrete/ steel floor deck enable the slab to be chilled by circulating cold water, absorbing thermal gains during the day and storing the captured heat so that it can be released at night.



#### **Retrofit under floor heating system**

This system works by using a lightweight floor system with overlaid pipes running through insulation to provide heating or cooling. This is a retrofit overlay system.



#### **Photovoltaics**

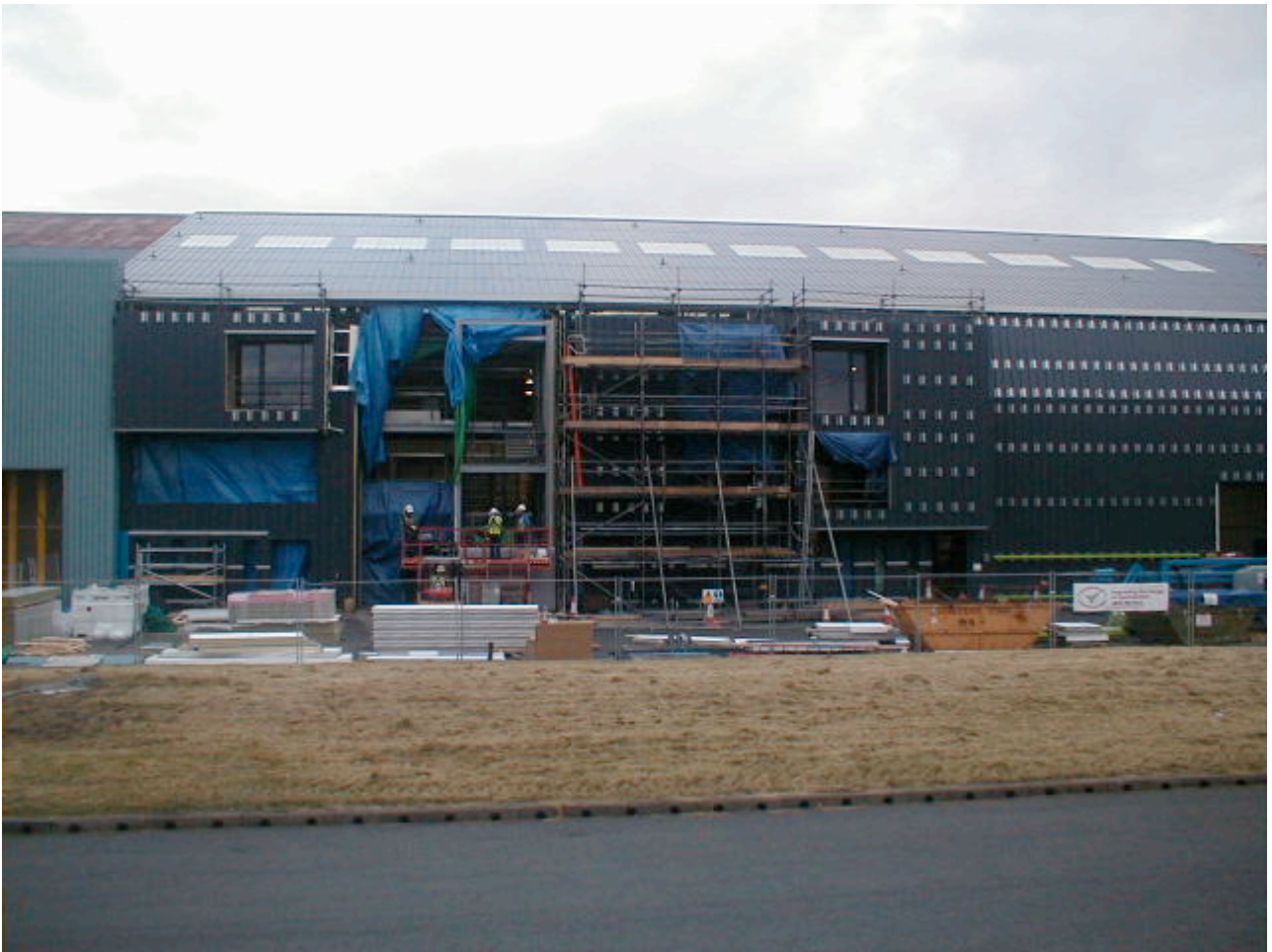
Photo Voltaic panels generate electrical power by converting solar radiation into electricity using semiconductors that exhibit the photovoltaic effect. The Sustainable Building Envelope Centre is trialling a frameless lightweight PV system on both its own roof and that of the newly refurbished Deeside Leisure Centre. The panels have a weight of less than 10kg/m<sup>2</sup> and use 3.2mm transparent toughened safety glass. This uses 42 high-performance Solon Solbond crystalline PV panels covering an area of 84m<sup>2</sup>.

### **Sustainable retrofit of Industrial Heritage Buildings**

SBEC serves as an example of a low carbon solution for the creative re-use and retrofit of steel intensive industrial buildings. The scheme achieves BREEAM Excellent without factoring in the energy gains from the transpired solar wall. The application of the new building envelope has been achieved by applying it to the existing steel structure enabling the original interior volume to be preserved. At SBEC trapezoidal and flat sheet profiles were employed but there is no reason why a traditional sinusoidal form could not work effectively.



Existing composite columns and steelwork was preserved and used to carry the new energy producing envelope





## I.9 Record of artifact



South Elevation



Entrance and south façade





Interior showing galleried offices overlooking the proto-typing area





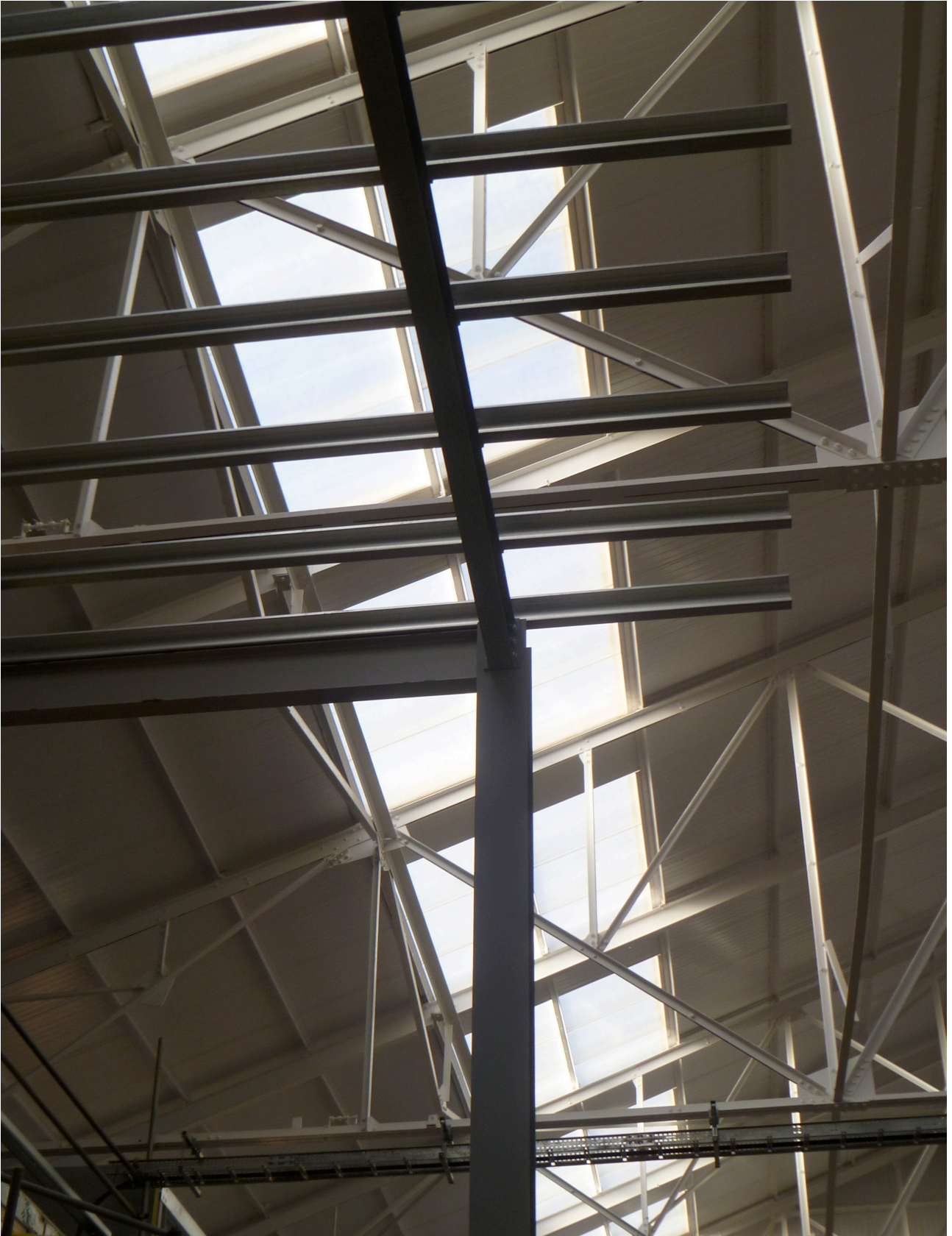
Interior – Daylighting from prototyping hall also supplements the research offices





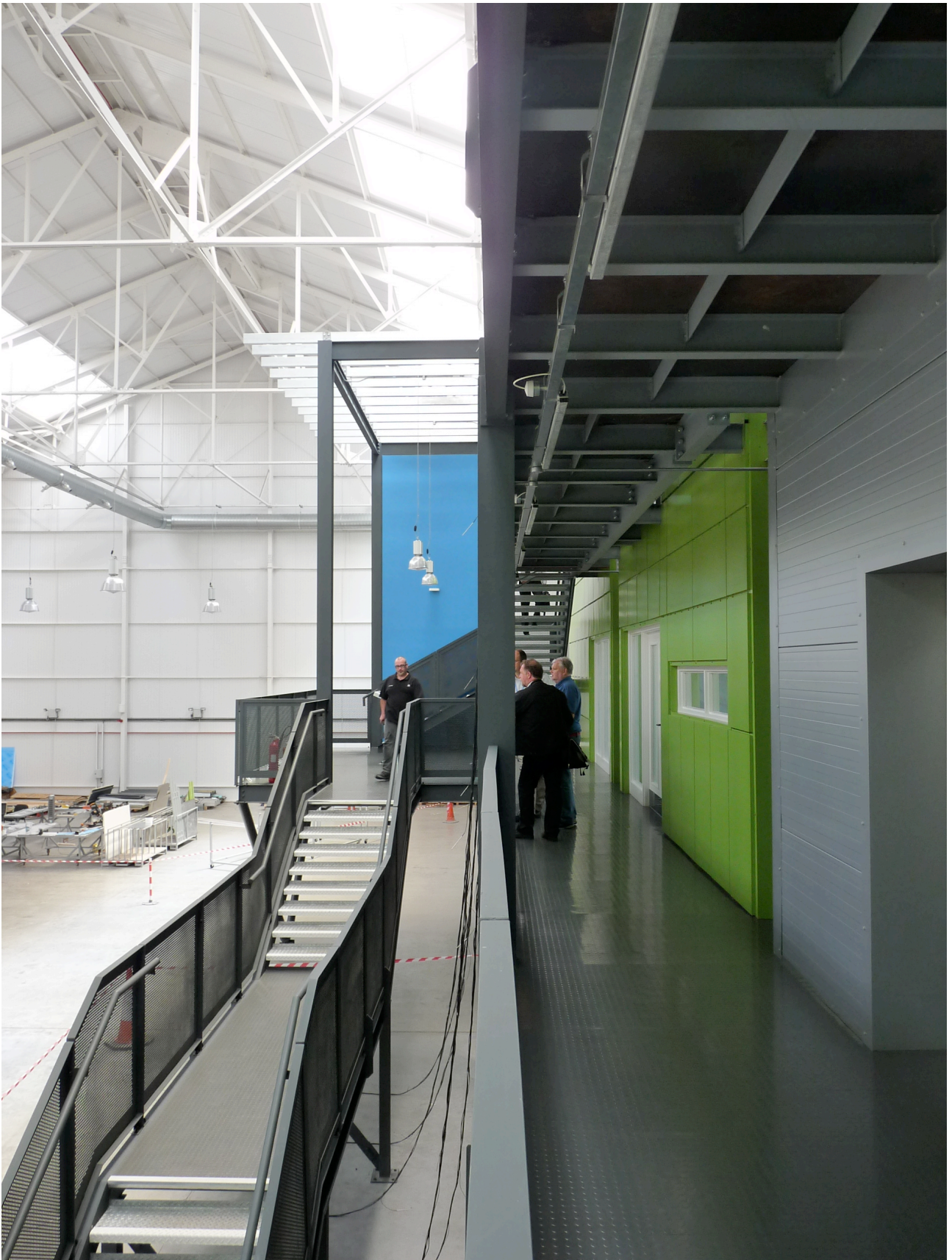
Interior – Note heating duct with delivery nozzles in roof space from transpired solar wall





Interior – New insulated roof covering to existing structure and daylighting as original design





Interior – entrance stair and gallery overlooking prototyping hall





Meeting rooms are stacked above the education room





Interior –gallery access to meeting rooms







Welfare facilities are installed in steel 'coils'.

## **I.10 Significant Appendices**

BD Online

February 2012

SBEC sustainability centre finds ways to push the envelope

Pamela Buxton pps 7