CIMclad

Computer-Integrated Manufacture of Cladding Systems

Potential for process improvement

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1.0 Introduction

1.1 Background

“Cladding” is the generic term for the external envelope or skin of a building which is non-load bearing. It is intended primarily to keep out the weather and provide the building’s aesthetic appearance and impact. There are different types of cladding, each suitable for one or more building application as described in Section 2.0. Overall, the different cladding types can be broadly classified by the number of layers that form the vertical wall envelope of the building. Thus cladding can be a single or multi-layered cladding. Because of the diverse nature of cladding types and systems, the initial focus of this study is on rainscreen cladding – a form of multi-layered cladding, which will serve as a pilot for the wider cladding sector. Essentially, rainscreen cladding consists of a backing wall, a cavity, and an outer skin. The outer skin acts as the main shield against the rain but has unsealed joints that may allow rain to enter the cavity. The backing wall is the air and vapour barrier.

1.2 Aim

The CIMclad project is investigating the feasibility of improving the efficiency and competitiveness of the cladding sector through the development of a standardisation framework for computer-integrated design and manufacture of cladding systems.

The specific objectives of the overall project are:

To establish the potential for process improvements through the standardisation of procedures and more effective use of information technologies, leading towards computer-integrated design and manufacture of cladding systems.

To consolidate and state more formally a set of standard performance specifications for layered cladding walls.

To develop a product model to support the major aspects within the specification, design, manufacture and construction of layered cladding walls.

To implement and test these concepts via fast-track implementations and industrial deployment of standard object oriented CAD technology, configured to support the product model and incorporate proprietary knowledge from the industrial collaborators.

To propose a road map for the cladding sector as a whole to realise computer-integrated design and manufacturing, this in the context of wider developments within the construction sector.

This first CIMclad report focuses on item (i), the potential for process improvement through standardisation. A complementary second report, ‘Information and Communication Technology (ICT) Usage: Current and Future’ focuses on the ICT aspects and establishes the boundaries for subsequent development work on the rainscreen product model.

1.3 Approach

Relevant information relating to rainscreen cladding, its supply chain and business processes were obtained from visits to twelve companies involved in the rainscreen supply chain, in particular those engaged in the front end activities – project designers/specifiers and those involved in back end activities – rainscreen cladding contractors which include system fabricators and installers. Particular attention was given to establishing the current industry practice, identifying the bottlenecks, and assessing the potential for improvement in the business efficiency through standardisation of procedures and components. Where necessary, the views of the research team are clearly distinguished in the text from those expressed by members of the industry. General cladding related information has been obtained largely by reviewing the Centre for Window and Cladding Technology (CWCT) publications and other literature on cladding.
Appendices 1 and 2 show a list of individuals interviewed and a summary of key company related-information respectively.

1.4 Structure
Section 2 presents an overview of the different types of cladding systems used for building envelopes including multi-layered cladding.

Section 3 focuses on rainscreen cladding, its historical development, key features and types. It also defines rainscreen cladding in the context of this work and reviews its use as a cladding system.

Section 4 describes the different building procurement methods in relation to the cladding supply chain and presents a generalised view of the functions and the relationships within the rainscreen supply chain. It also describes the key business processes involved in the procurement of rainscreen cladding highlighting who is involved. Company and project related case studies are presented and the future trends of the cladding industry in general and issues likely to have an impact on the rainscreen supply chain business processes discussed.

Section 5 assesses the potential for process improvements through standardisation. It also evaluates the benefits of computer-integrated manufacture of rainscreen cladding. Section 6 presents the main conclusions.

A glossary of key terms used in this report is shown in Appendix 3.

1.5 Main findings
In relation to the potential for process improvements through the standardisation of procedures and components, the key findings are as follows:

- the efficiency of the current business practice would be greatly improved through standardisation of the concept-detailed design interface by using a robust product model that links the rainscreen system to the requirements of the building envelope. This also sets the scene for computer-integrated manufacture of cladding systems; and

- the standardisation of components would drive cost down and benefit end-users by becoming a commodity item. However, this has the effect of suppressing product development and encouraging the cladding sector of the UK construction industry to become more reliant on innovative imports. Rather than standardising components, a greater efficiency would be achieved by optimising materials usage and co-ordination of components particularly for a large building layout.

The rainscreen supply chain spans the construction and manufacturing industries and comprises a number of principal parties namely: project designer/specifier, system designer/supplier, system fabricator, system installer and materials supplier. The supply chain is largely reliant on rainscreen system products supplied by the system companies.

Rainscreen cladding currently accounts for less 10% of the cladding output. There is a steady growth in the use of rainscreen cladding owing to a variety of reasons. This is partly explained by its lower cost and lesser sophistication when compared with curtain walling, and the extensive choice of materials for rainscreen panels.

Rainscreen components are produced to fit the area of the building envelope as dictated by the concept design. Hence the number of different components involved determines the number of suppliers to cladding contractors.
2.0 Cladding

2.1 Introduction

This section reviews the different types of cladding systems used for building envelopes and briefly describes in a general context multi-layered cladding which includes rainscreen cladding. The primary function of the cladding of a building is to protect the internal environment and occupants from the weather, particularly from rain. Technical Note 15 [CWCT 2000] summarises the different approaches to fulfilling this function as:

- use of porous cladding materials such as brickwork of sufficient thickness and reasonable permeability to obviate the penetration of water into the structure. The porous nature of the materials permits drying out of moisture at low relative humidity. New construction usually introduces a cavity behind the wall to provide an additional barrier to the passage of water;
- use of impermeable cladding materials and the joints between the cladding units are completely sealed to prevent the ingress of water; and
- use of rainscreen panels to shield the wall from direct rain. The joints between the panels may allow some water to penetrate but an air gap and airtight backing wall behind the panels combine to limit this penetration.

2.2 Cladding Systems

2.2.1 Types

There are a number of cladding types currently used in buildings, Technical Note 15 [CWCT 2000] grouped them according to the type of construction as follows:

- Profiled metal systems (Formed metal systems)
- Small and large cladding panels
- Fully supported metal sheeting
- Curtain walling
- Masonry, and
- Others

It was noted that some of the categories are clearly defined but others cover a range of options and some variations could be considered to fall in more than one category. There may be other variants that use new or traditional materials in a novel way. The distinction between curtain walling and some other cladding types is particularly vague.

The different types of cladding are summarised in Table 2.1 according to the following:

- building application;
- material type;
- form of construction; and
- support type.

The different cladding types suit different types of building and budgets, thus their application varies with the type of building. The form of construction could be either a single or multi-layer construction. For a single layer construction, a single wall is the primary weather barrier of the building and forms the full thickness of the vertical envelope. However for multi-layered construction, two or more layers are used to ensure the weather tightness of the building. The support for the cladding varies with the cladding type, some are self supported but anchored to the structural building frame to transfer wind loading, while others are supported on a grid framework or horizontal rails spanning the structural framing.
Table 2.1 Summary of the different cladding types.

<table>
<thead>
<tr>
<th>Cladding type</th>
<th>Building application</th>
<th>Material</th>
<th>Form of construction</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Single layer (Single skin or double skin with insulation)</td>
<td>Multi layer (Outer skin, cavity, insulation, backing wall)</td>
</tr>
<tr>
<td>Formed metal systems</td>
<td>Industrial, agricultural, commercial and office building</td>
<td>Aluminium and galvanised steel</td>
<td>x</td>
<td>Sheeting rails spanning between structural framing or inner tray liner</td>
</tr>
<tr>
<td>Small cladding panels</td>
<td>Commercial buildings and over-cladding of existing buildings</td>
<td>Fibre reinforced cement and gypsum, resin laminate glass, reinforced polyester, aluminium and steel sheets, stone and terracotta tiles</td>
<td>x</td>
<td>Backing wall or secondary framing member</td>
</tr>
<tr>
<td>Large cladding panels</td>
<td>Small to high rise residential, commercial and office buildings</td>
<td>Precast concrete and composite metal panels</td>
<td>x</td>
<td>Spans between main structural frame</td>
</tr>
<tr>
<td>Fully supported metal sheeting</td>
<td>Prestige buildings</td>
<td>Copper and lead</td>
<td>x</td>
<td>Supported on plywood boards</td>
</tr>
<tr>
<td>Curtain walling</td>
<td>Medium to high rise residential, commercial and office buildings</td>
<td>Metal and glass framing, precast concrete, insulated infill units of different materials and facing – glass, metal, stone</td>
<td>x</td>
<td>Self-supporting but anchored to the building frame</td>
</tr>
<tr>
<td>Masonry</td>
<td>Low to medium rise, and industrial buildings</td>
<td>Clay and calcium silicate and concrete bricks; concrete and stone blocks</td>
<td>x</td>
<td>Self-supporting, outer layer tied to the inner layer and structural framing</td>
</tr>
</tbody>
</table>

**Formed metal sheeting systems**

Formed metal sheeting systems are a relatively cheap form of cladding. The width of profiled sheets varies between 600 and 1000 mm, with a length of at least 2 m. Most of the systems are profiled with the depth of the corrugations ranging from 7 mm to 120 mm, and the wavelength/pitch from 30 to 350 mm. The spacing of fixings depends upon the wind load and flexibility of the sheet (e.g. depth of profile) and pitch (of roof cladding), but fixings are typically made every 250-300 mm along the spacers. Formed metal sheeting may be used in one of the following ways:

- as a single un-insulated skin supported on cladding rails spanning between the main structural columns;
- as two skins of metal sheeting separated by a spacer bar and with insulation in the resulting cavity;
- use of liner trays which span between columns providing both the internal lining and support for the outer sheets. The liner trays can also be filled with insulation; and
- as composite panels formed from two metal skins separated by a layer of rigid insulation, bonded with adhesive or extruded between the skins. The panels are supported on sheeting rails.
Small cladding panels

Small cladding panels are too small to span between the main structural framing members, hence are either supported by a backing wall or secondary framing members. Where the backing wall is designed to transfer wind loading to the structural framing, the panels may be fixed to timber battens or metal rails supported by the backing wall. Insulation may be incorporated in the wall, generally in the cavity between the cladding panel and supporting wall. They vary widely in size and materials used and the joints between the panels may be sealed or open joints.

A range of materials or combination of materials may be used for small cladding panels:

- cellulose and glass fibres reinforced cement sheets with thickness between 5 and 10 mm and in sizes up to 1220 mm x 3050 mm. A wide range of finishes is available including untreated, various types of paint and resin bonded aggregate. Sheets are normally supplied to site ready cut to size and with predrilled fixing holes. Similar panels are fibre reinforced calcium silicate, resin laminate and glass fibre reinforced polyester;
- aluminium and steel sheets may be given increased stiffness by folding the edges or adding stiffeners either within or at the back of the panel;
- thin composite metal panels may be formed from two layers of aluminium separated by a layer of polyethylene giving an overall panel thickness of 3 to 8 mm. The composite action of the layers gives a stronger panel than the aluminium alone. Panels can be used as flat sheets but can be bent to form curved panels or folded to form sharp corners if the inner layer of aluminium is first cut along the line of the fold;
- thick composite panels may be formed from aluminium or steel strip separated by a core of insulation. These panels differ from those produced from profiled metal in that they are manufactured as rectangular panels and may have flat faces. The edges of the panels may incorporate grooves to facilitate fixings, which can then be hidden by gaskets; and
- cut stone, between 6 mm and 40 mm in thickness, such as granites, marbles, hard limestones, slates, quartzites, limestones and sandstones are increasingly used as non-load bearing cladding and they offer a range of colours and surface textures with good durability.

Large panel cladding

Large panel cladding has sufficient stiffness to span between discrete fixing points on the main building frame, often as storey height panels, and may be manufactured from reinforced concrete or as pre-assembled curtain wall. Concrete panels/units can be produced with a variety of smooth and coarse finishes or faced with factory-set natural stone, clay brick or tiling systems. They can also be made from carefully selected materials to give the appearance of stone. Some composite metal panel systems may be used to span horizontally between columns and fall into the group. Panel-to-panel joints are either weather sealed or left open (but baffled to prevent direct water ingress).

Fully supported metal sheeting

Fully supported metal sheeting such as copper and lead may be used for cladding but are expensive and hence only used to a limited extent where required for appearance on prestige buildings. Due to its weight and low stiffness lead must be fully supported, usually by plywood boards. Due to its cost, copper is used in thin sheets that also need continuous support.

Curtain walling

Curtain walling is a form of vertical building enclosure which supports no load other than its own weight and that of ancillary components and the environmental forces which act upon it. Stick curtain walling is very common and versatile and can be used for anything from ‘glass towers’ tens of storeys high to single storey shop fronts. Unitised or panellised curtain walling systems are generally adopted where the additional expense of factory assembly is compensated by faster installation. They are only economic where a large number of similar units or panels is required. The highest-cost bespoke curtain walling systems will generally only be used on prestige buildings, large or small. Although the term is often restricted to metal framed curtain walls, the above definition embraces many different construction methods and materials including non-load bearing precast concrete.

Masonry

Masonry is a labour intensive cladding material largely used for low rise housing (where it is usually load-bearing) although on large structures it is often used for small areas with less labour intensive cladding materials being used for large areas of façade. It is suitable for both low-cost industrial buildings and
prestige structures owing to the wide range of materials available. Cavity wall construction is commonly used for external walls because it provides an increased degree of thermal insulation and protection against water penetration compared with a solid wall of the same overall thickness. In modern construction the external leaf is normally a non-load bearing cladding 100 mm thick and the units are chosen primarily for their appearance, durability and cost. The load bearing structure may use a steel, concrete or timber frame or an inner leaf of load bearing masonry. The inner leaf of a cavity wall may consist of concrete blocks, concrete or an insulated panel typically consisting of a timber frame with plywood or plasterboard sheathing. Where masonry is used for the inner leaf the requirements for the unit are normally low density (for insulation), adequate strength and low cost. An inner leaf is typically 100mm thick but this may be increased to improve insulation or strength. Thermal insulation (typically mineral fibre quilt) is often required within the cavity.

Others
Other types of cladding are weatherboarding and tile hanging which are traditional forms of cladding generally confined to housing. PVC and fibre cement panels are now available as alternatives to timber for weatherboarding. Tile hanging may use traditional clay or concrete tiles, or slates of natural stone or fibre cement.

2.2.2 Multi-layered cladding
The weather tightness of the building relies on a single or multi-layered envelope acting as a barrier to environmental elements in order to provide the required performance. The classification for the different cladding types in terms of single or multi-layered cladding is highlighted in Table 2.1.

A multi-layer building envelope typically consists of the following:

- an outer skin;
- a cavity; and
- a backing wall.

There are a number of different ways of controlling or preventing the ingress of water in multi-layered envelopes. A multi-layer building envelope with drainage provisions between the walls would permit the ingress of water through the outer skin into the cavity between the walls. The water is drained back to the outer face of the outer skin and drainage holes (co-ordinated with the internal drainage paths) are provided to allow water to drain from the cavity. In addition to the drainage provisions, other air vents or holes may be provided specifically to improve air circulation, thus facilitating the drying of any residual moisture in the cavity and removing water vapour. Compartmentalization of the cavity also controls the ingress of water through the outer skin by maintaining almost equal atmospheric pressure inside the cavity and outside of the outer skin. The outer skin may be designed as a completely sealed system thus obviating the provision of drainage holes, air vents or compartments.

The backing wall usually acts as the air barrier. For a blockwork wall with an inner plastered surface the plaster layer provides the air barrier. With some forms of construction the air barrier is the internal plaster or dry-lining system. The air barrier has to be continuous with all components such as windows and doors which must be sealed onto it.

The type of joint in both the outer skin and backing wall are critical to the performance of multi-layered envelope and determines whether the system is drained, drained and back ventilated, pressure equalised or sealed. Only in face-sealed systems are sealed joints applied in the outer face of the outer skin to preclude the penetration of water. Joints in the inner face of the backing wall and the inner most joints of a dual sealed system are required to provide an air seal.
3.0 Rainscreen cladding

3.1 Historical development

Anderson and Gill [1988] reported that the development of the concept of rainscreen cladding for weatherproofing buildings dates back to the 1950s and 1960s in North America and Scandinavia respectively. They also presented in a chronological order the development of the rainscreen approach. Traditional forms of rainscreen wall are tiles or slates hung on a wall, timber shingles and lap boarding. Modern rainscreens generally comprise panels larger than traditional tiles. They may be up to a storey in height but are typically of dimension 600 mm to 1200 mm on any side.

The market for rainscreen cladding in the UK started about 15 years ago with the over-cladding of post-war residential high-rise tower blocks that were showing signs of severe degradation, both externally and internally, due to dampness and condensation [CGL Cometec 2000]. The local authority owners had the options of demolition/rebuild or repair, and the choice of the over-clad option allowed the properties to be aesthetically improved whilst upgrading their thermal performance and shielding the existing external façades from continued failure. Examples of over-cladding of existing buildings using light steel have been reported [Lawson et al. 1998].

More recently, the rainscreen concept has been adopted by designers for new build and is being increasingly utilised on commercial and utility buildings such as hospitals, theatres, and schools and prestigious city centre developments [CGL Cometec 2000].

3.2 Features

Rainscreen cladding is a multi-layer form of wall construction as described in Section 2.2.2. In a rainscreen there are two layers of wall. An outer skin (rainscreen) that minimises or prevents water entering the wall and a backing wall (incorporates air and vapour barriers) that prevents excess air leakage. The joints in the rainscreen may allow driven rain to enter the cavity. It is common for rainscreen cladding to incorporate sealed and open joints (sealed vertical and open horizontal). The seals in the air barrier then provide an air seal to control air penetration.

The typical features of rainscreen cladding are:

- an outer skin – rainscreen panels;
- an air gap;
- an insulation layer; and
- a backing wall.

Figure 2.1 shows the key feature of a rainscreen cladding and they are briefly described as follows.

Outer skin

The primary function of the rainscreen panels is to shield the majority of the wall from direct rain. However, depending upon the nature of the joints between the panels some water penetration may occur, and the air gap and airtight backing wall combine to limit this penetration. The performance of rainscreen systems thus depends upon the particular way in which joints, air gap and backing wall are constructed.

Some materials used as rainscreen panels include:

- Aluminium panels
- Thin natural stone
- Terracotta units
- GRP panels
- GRC panels
- High pressure laminates, and
- Composite panels.
Air gap
The air gap is a key feature of a rainscreen system and is designed to minimise the likelihood of water reaching the insulation or backing wall. There are two possible configurations of the air gap:

- continuous air gap, perhaps running up through several storeys, and across several panel widths, although artificial cavity barriers may be introduced and the air gap is often limited by firestops or closers around penetrations. With this approach water penetration is allowed to drain downwards and outwards, and air movement is encouraged to dry out any water which enters the air gap. To enable this ventilation the rainscreen layer may have all joints left unsealed or open, or may only have unsealed joints at the top and bottom of the air gap.

- compartmentalised air gap - the air gap is compartmented into cavities which may be no more than one panel width and height in extent, or which may encompass several panels. At least one joint at the perimeter of the panel is left unsealed or open, to enable pressurisation of the air gap, which then limits water penetration by virtue of the reduced pressure difference across the panel.

Cavity
The space between the backing wall (air barrier) and the inner face of the outer skin (rainscreen panels) is called the cavity. Insulation normally fills part of the cavity and thus the cavity width is not the same as the air gap.

Backing wall
The backing wall is critical to the performance of rainscreen systems. If air movement through the backing wall is too great then the risk of water penetration past the rainscreen is increased; air leakage through the backing wall also represents an energy loss, and so must be limited for this reason. The backing wall should therefore be reasonably airtight. There are four main forms that the backing wall can take:
• a masonry or blockwork or concrete support wall. This type of wall may be an existing wall, or may be new build;
• a dry lining system;
• a prefabricated support wall; and
• a stick system backing wall. In this type of wall, the insulation is in the form of prefabricated panels held in a stick system curtain walling frame, with the rainscreen panel fixed to the outside of the stick system.

It is not necessary for the backing wall itself to be airtight - there may be a layer (air barrier) associated with the backing wall which presents the most resistance to air flow. It may be provided by a layer of plaster or render on the inner face of a blockwork wall, a continuous sheet affixed to the outer face of a plasterboard dry lining, or the insulation trays in an integral wall construction. The air barrier needs to be continuous, although it need not lie in a single plane.

3.3 Types
Multi-layered wall with rainscreen cladding can be distinguished by how they keep water out from the building into:

• drained and ventilated; and
• pressure equalised.

Drained and ventilated
In this arrangement, joint configuration and wall design are such that water will penetrate the outer skin and drainage routes are provided to ensure that all water passing the rainscreen flows back through the rainscreen (to the outer face). Ventilation is also provided so that all cavities may dry by residual water evaporating and the resulting water vapour being removed by ventilation. The openings in a drained and ventilated rainscreen are governed only by the need to drain water and provide a circulation of air for ventilation.

The Standard for Walls with Ventilated Rainscreens [CWCT 1998] specifies a ventilation path comprising an air gap of 25 mm minimum dimension immediately behind the rainscreen, particularly for systems incorporating breather membranes. This increases up to 50 mm depending on the joint type. The path may be reduced in cross section by fire barriers or support rails, however not by more than 50% localised reduction, to ensure that no blocking or bridging of the cavity occurs. The minimum acceptable air gap is designed to allow any water passing the rainscreen to flow down the back face of the rainscreen without wetting the insulation or backing wall. This is particularly important for open jointed rainscreens where the volume of water within the cavity can be larger than that for a baffled system. However a large air gap leads to a large cavity volume and affects the cavity wind pressures. Air gaps must be kept small to optimise the effects of any pressure moderation and there is an optimum width for the air gap in any rainscreen wall.

Many systems incorporate open joints at intervals up a facade to achieve good ventilation. Ventilation is promoted by differential pressures resulting from wind loading on the wall, also by the thermal stack effect of air in the cavity being warmed from the building and solar warming of the rainscreen panels.

Interfaces and discontinuities arising from openings (such as window and door openings) through a drained and ventilated rainscreen are flashed to ensure that the drainage ventilation is not impaired. Window and door openings are normally formed using window or door pods; pre-formed metal assemblies that incorporate all necessary flashings and closures to maintain:

• continuity of the water barrier;
• drainage of the cavity;
• ventilation of the cavity;
• drainage of any window frame; and
• continuity of the air barrier.
For example, a window provides the opportunity to ventilate the rainscreen cavity through an opening beneath the window sill and drainage and ventilation at the head of window.

**Pressure equalisation**

The rainscreen cladding is designed to prevent the ingress of water into the air gap based on the pressure equalisation principle. This involves reducing the pressure difference across the rainscreen by balancing the pressure on the outer and inner face of the rainscreen by compartmentalisation (or opening) on the rear of the joint. Thus, the cavity pressure is as nearly equal to the external pressure as possible at any time. In practice there is a degree of pressure moderation where the pressures are sufficiently close, however for the purpose of design, regarded as pressure-equalisation.

This approach brings about weather tightness by elimination or minimisation of the most significant leakage mechanism – pressure induced flow, and also reduces the effective wind design pressure on the outer skin.

### 3.4 Working definition

There are different perceptions of rainscreen cladding, ranging from rainscreen panels or ad-hoc supporting frame for panels to integral systems with backing walls. In practice, some include the backing wall as part of the rainscreen cladding while others do not. For the purposes of the current phase of the CIMclad project, Rainscreen Cladding is defined as a layered cladding system comprising of:

- A visible outer skin that also forms the primary rain barrier. This layer sheds the majority of water down its surfaces, but does not prevent the passage of air into the air gap.

- An air gap that prevents water ingress into the building. This provides ventilation and, depending on the design and dimensions of the rainscreen and air gap, may be intended to provide pressure equalisation across the outer skin.

- A backing wall that forms an effective air barrier. This typically also provides support to the outer skin, and frequently includes an insulating layer.

This definition is consistent with the CWCT document on Standard for Walls with Ventilated Rainscreens [CWCT 1998], and effectively it includes the backing wall within the scope of “Rainscreen Cladding”.

### 3.5 Rainscreen cladding in practice

Rainscreen cladding is a fast growing area for cladding application, both in new-build and refurbishment projects. As highlighted in Section 3.1, on refurbishment projects, they are often used as over-cladding to improve the thermal performance of a building and enable the existing cladding to be retained; these make the approach attractive for sustainable construction.

The installation rate for rainscreen cladding, depending on the details of the systems (for example whether the backing wall is included or not), is slower than traditional cavity walls or metal composite/insulated panelling, however, the whole-life costs show rainscreen cladding to be cost-effective, mainly due to low maintenance requirements [CGL Cometec 2000]. In addition to a low maintenance requirement, the maintenance cost is also low. This is attributed to the relative ease of removing individual panels for replacement or inspection, the self-cleaning characteristic of open/baffle-jointed panels (compared with sealed panels) and the option of complete replacement of the façade without disruption to the internal processes of the building.

Rainscreen cladding offers an extensive choice of façade materials. This has been possible due to the development of sophisticated support systems which attach the panels to the backing wall or span between structural members. Metal baffled-joint panels are produced in aluminium, zinc, stainless steel and copper in a wide range of sizes and finishes. Flat, open-jointed panels present other options in thin, strengthened stone, ceramics and glass.
There is a wide range of construction possibilities with rainscreen cladding. At one end of the spectrum a cladding contractor could purchase timber battens, insulation and boards and erect a rainscreen cladding. At the other end there is bespoke stone or metal panels on a prestige building. The range can include:

- board/panels on battens;
- board/panels on proprietary carrier/support frame;
- a total proprietary panel design and carrier/support system;
- bespoke panels on a proprietary/standard support system; and
- complete bespoke rainscreen cladding.

The support frame for boards is completely different to that for metal panels, and different to that for stone. Different support systems exist in the market produced for the different types of rainscreen panels, as indicated above, some rainscreen panels use dedicated support systems while others are ad hoc. It is noted that timber rainscreen systems are becoming more widely specified by architects due to ecological concerns.
4.0 Current industry practice

4.1 Introduction

This section of the report is largely based on the information and documents collected from the industrial visits. Section 4.2 describes the different building procurement methods in relation to the cladding supply chain. Section 4.3 presents a generalised view of the functions and the relationships within the rainscreen supply chain. Section 4.4 describes the key business processes / activities involved in the procurement of rainscreen cladding and also highlighting who is involved. Section 4.5 presents company and project related case studies while Section 4.6 discusses the future trends of the cladding industry in general and issues likely to have a significant impact on the rainscreen supply chain’s business processes.

The design, fabrication and installation of cladding involve a supply chain comprising of a number of participants having formal or informal relationships. For a given building project, the key activities are:

i. Project commission
ii. Project design and specification
iii. Project contract
iv. Cladding system design
v. Cladding materials supply
vi. Cladding fabrication and pre-assembly, and
vii. Cladding installation

The relationships between the different parties involved in items (i) to (iii) vary with the procurement method and have an influence on the cladding supply chain as discussed in Section 4.2. Items (iv) to (vii) indicate the functions involved in the cladding supply chain, a sub set of the building supply chain. The functions are briefly described for the rainscreen cladding supply chain in Section 4.3 but in greater detail in Section 4.4.

The cladding supply chain spans two industries with two different cultures, manufacturing and construction. The project designer, specifier and installer predominantly function within the construction sector while the cladding system designer, manufacturer and materials supplier largely function within the manufacturing sector. The effect of this interface on the business process is highlighted in Section 4.4.

4.2 Building procurement methods

4.2.1 Project commission, design and specification

This section describes a high level summary of a project relationship and covers the following:

- project commission;
- project design and specification; and
- project contract.

Project commission

For the purposes of this study, the client is considered to be the organisation or individual that is commissioning and paying for the building being constructed or refurbished, of which an aspect of the work involves rainscreen cladding. In what is commonly referred to as the traditional method of procurement, the client appoints the design team, (hereafter referred to as the designer/specifier) and advisors, and then chooses a project contractor either by selective or competitive tender. The project contractor in turn selects a cladding contractor via the same route although the cladding contractor may have been involved with the main contractor as part of the main contract negotiations.

A dramatic departure from this method is in a partnering arrangement where the client chooses all the project team including the cladding contractor and they enter into a shared risk/shared benefit relationship, either for a specific project (often known as 'alliancing'), or for a longer period of time (often known as 'strategic partnering'). These variations are explained further in section 4.2.2.
In all cases, the client’s project brief instructs the designer/specifier, the project contractor, or the project team on the needs and budget of the client. For a one–off client, the project designer/specifier, project contractor or manager of construction provides an interpretation of the brief. The brief is general in nature mostly relating to the functional requirements of the building and would not include any information on the cladding type. However, repeat clients like BAA or commercial developers are experienced at commissioning design and producing a design brief describing their needs in terms of space, performance and appearance. They are typically more specific on the appearance of the building and often make the final decision on the cladding type.

Project design and specification
The designer/specifier of a cladding is usually an architect, who for some projects, may employ a façade consultant to act as its technical arm. However, there are instances where a façade consultant works directly for the client.

The scheme design produces general arrangement drawings of the building showing the elevation and section details of the building envelope. The external appearance of the building envelope gives an indication of the type of cladding required. A performance or prescriptive specification is developed simultaneously for the project using NBS, CWCT, or similar standards.

The designer/specifier would not always develop a project specification as many repeat clients have their own specifications that have been developed over a series of contracts.

Project contract
The project contractor works directly for the client and undertakes to deliver to the client the whole building to the client’s specification. Depending on the procurement method, the project contractor may undertake to manage the construction of the building, or to construct the building or some part of, employing sub-contractors to deliver other parts of the building. For example, a sub-contractor or specialist contractor may be responsible for one aspect of a contract such as the building envelope or cladding work package.

4.2.2 Procurement methods
The cladding supply chain of which rainscreen cladding is a part could be regarded as a subset of a building project supply chain. However, the cladding supply chain relationship with other parties in a building supply chain varies with method of building procurement. Figures 4.1 to 4.4 summarise the cladding supply link with other parties in the building supply chain. Much has been written about the pros and cons of each approach and such a debate is outside the scope of this project. The comments made in this section are intended to highlight the main differences in order to better understand the implications for the cladding process. General project management texts such as Masterman [1992] should be sought for a fuller examination of procurement methods. For the purposes of this report, four main procurement approaches are considered, although the researchers acknowledge that, in practice, there are many variants of these approaches.

The four approaches are:

- traditional lump sum - fixed price;
- design and build;
- management; and
- partnering.

Traditional lump sum / fixed price contract
In this approach, a client appoints a design team and various advisors. A concept design is developed up to a level where specifications, drawings and a bill of quantities can be prepared. These are then used as the basis for a fixed price/lump sum tender by a main contractor in conjunction with sub-contractors and suppliers for the various building elements. Once the contract has been awarded the contractor and the supply chain proceed to deliver the project. In the simplest form of the approach, the contractor carries the full risk, which is typically passed on ‘back-to-back’ to the supply chain. The design team (usually the architect for building projects) typically control the payments to the contractor and any client variations in the design are dealt with as additions to the contract. There are many variants to this approach, where...
varying levels of design are completed prior to tendering and various levels of risk are shared between the parties. In particular, work packages such as cladding involve a certain amount of specialist contractor design development and this must be handled within the overall contract conditions. In many cases a two-stage tender approach is adopted for the cladding package (See section 4.4.2)

Currently, more than half of the UK’s building construction projects still use this approach, despite its poor image amongst many leading organisations. It generally suits straightforward projects where the overall project time is not critical. It is often criticised as epitomising an outdated adversarial approach with the final cost sometimes considerably in excess of the initial price.

**Design and Build**

In the design and build (D&B) approach, the client appoints advisors to help prepare a design brief. The client then employs a D&B team, often lead by a construction company, to deliver the building in its entirety. There are many variants to this approach including turn-key, design and manage and options including project finance and operation such as PFI (Private Finance Initiative), DBFO (Design-Build-Finance-Operate) or BOT (Build-Operate-Transfer). The client may retain advisors with a continued involvement with design development. The D&B team typically guarantee a maximum price. The cladding supply chain works along with the D&B contractor to develop the design brief, typically under the guidance of the D&B architect.

This approach has rapidly increased in popularity over the last decade of the 20th century, now accounting for around 20-30% of all building projects. The approach suits relatively straightforward projects, where the client wants cost certainty and is prepared to take a hands-off approach to managing the project. It has been criticised for producing utilitarian, cost driven buildings although some high-profile teams are challenging this assumption.
Management (Construction management & Management contracting)

With the management approach, a construction organisation is employed on a fee basis to manage the project. A project design team and other advisors are also appointed on a similar basis. The specialist contractors and suppliers forming the supply chain are either employed by the construction organisation (Management Contracting) or directly by the client (Construction Management), although in normal circumstances the Construction Manager would still control the payments to the supply chain. The design team produces a concept design and then completes the detailed design in work packages to suit the construction programme. Each of these packages is let by competitive tender as soon as the information is available. The cladding supply chain would again work up the design produced by the design team into a workable solution for the project.

This approach suits complex projects where a short overall project period is desired and it currently accounts for between 5 and 10% of building projects, many of them in city centres. It has been criticised for wasted expense in construction and a lack of cost certainty. Traditionally the construction organisation takes no risk other than negligence although hybrids where the risk is shared with the client are becoming more common.
Partnering
Partnering has received a lot of press coverage in the last decades of the 20th century, especially with high-profile, repeat-order clients such as BAA. The principals are risk and benefit sharing and open-book accounting. There are two main approaches:

Strategic partnering Where teams work together for a number of years
Project alliancing Where teams work together for one major project

The cladding supply chain should form a major partner in the team and have a relationship directly with all the members of the project team, not just the main construction organisation.

Its supporter’s claim it is the best way to innovate, reduce costs and increase quality as it capitalises on a team approach and removes the need for tendering for individual projects (for strategic partnering). However, despite its press coverage, partnering only accounts for between 5 and 10% of building projects in the UK, mainly for the larger client bodies. Many smaller clients do not see partnering as a viable option.

Figure 4.4 Simplified partnering supply chain relationship

4.3 Rainscreen cladding supply chain

4.3.1 Functions
Irrespective of the procurement route, the delivery of rainscreen cladding involves a number of organisations, forming the cladding supply chain and playing one or more roles. The key functions involved are:

- system design;
- project specific rainscreen cladding design;
- components and materials supply;
- system fabrication; and
- system installation.
The different configurations of the above functions within the rainscreen cladding supply chain are shown in Figures 4.5 to 4.7. The representations have been adapted from work by Ledbetter [1997]. Fully or partially enclosed activity boxes indicate the extent of the function carried out within a cladding company.

Figure 4.5 shows an arrangement where the rainscreen cladding design and fabrication are undertaken within one company. The company is a dealer for a system design company. The installation may be undertaken by the company or sublet to an installation only company. Nevertheless the rainscreen cladding designer/fabricator – the contract holder, retains the contractual responsibility for warranties, including installation. The installation company will have a separate contract with the contract holder and will guarantee the installed work.

Figure 4.6 illustrates an arrangement where an installation company is the cladding contract holder and collaborates with a fabricator, a dealer for a system design company, to realise the detailed design of the rainscreen cladding. The fabricator fabricates the components and supplies them to the installation company.

Figure 4.7 shows where a company acts as the managing cladding contractor. Under this arrangement, the company arranges for the detailed design, fabrication and installation to be undertaken by separate parties and plays mainly a co-ordination role. The company may get involved in the detailed design of the rainscreen cladding.

It should be noted that the materials required for the manufacture of the system profiles and fabrication of the rainscreen system are bought in, thus introducing a second level supply chain within the rainscreen supply chain.

System design
The design of a typical rainscreen cladding system largely involves the design of components that make up the system, connections between the different standard system components, and rainscreen panel joints and interfaces with other elements of the building envelope such as window pods. The standard system components are extruded profiles or formed sections that form the skeletal support structure of the system, and associated gaskets and brackets. Typically the system designer holds the patent for a particular rainscreen system design and provides technical information in the form of design guidance, latest design software, test reports, installation instructions and warranty to support and cover the use of the system. A system design company manufactures and supplies the system profiles such as extruded aluminium profiles. Another manufacturer usually produces the other components such as gaskets and brackets on behalf of the system company. The manufactured components of the system are used to fabricate a rainscreen cladding system to suit a specific project design.

Rainscreen cladding design
For a new build, rainscreen cladding may be specified as a part of or the whole of the building envelope. The latter is common in buildings requiring over-cladding. The scheme drawings show an outline of the elevations and sections of the building envelope. The general arrangement drawings and specification of the building envelope produced by the project design team form the basis for the design of the rainscreen cladding. The design produces a detailed layout of the rainscreen cladding including component length and sizes, spacing of secondary frame members, fixings and connections, and interfaces with other elements of the building. The design is aimed at satisfying the requirements of the project specifications but within the limits of the rainscreen system used. Thus project-specific rainscreen cladding design is undertaken against a performance specification and back-to-back warranties provided by the designer and the system company respectively.

A rainscreen cladding may also be designed from scratch using non-system components. Rainscreen cladding design is further discussed in Section 4.4.3.
Figure 4.5 Integrated design and fabrication

Figure 4.6 Partially integrated design and installation.

Figure 4.7 Separate design, fabrication and installation
Materials and components supply
A number of materials and components are supplied for the fabrication of the rainscreen system. They include:

- extruded aluminium profiles and channel sections that form the skeletal support frame structure of the system;
- rainscreen panels (which may comprise various materials);
- brackets and gaskets; and
- accessories like fixing screws and anchors.

Sealants are supplied prior to installation. Different suppliers are involved in the delivery of the components and materials.

Fabrication of rainscreen system
Rainscreen cladding involves a number of components. The design produces a schedule of components required based on the general arrangement drawings for the cladding. This includes detail of their location on the building envelope, dimensions, shape, number, and cutting list. Using the materials bought in from the various suppliers, fabrication essentially involves cutting, drilling and punching the system or non-system components to the required sizes and shapes, and packaging in readiness for site delivery.

Installation of rainscreen system
Installation is a site-based activity of which involves the erection of the rainscreen components to form a wall cladding. Installation of the outer skin is often undertaken towards the end of the construction programme although the backing wall such as blockwork and windows may be completed earlier to obtain building watertightness for the following trades. Rainscreen may also be incorporated into unitised or panellised curtain wall construction.

4.3.2 Relationships
As discussed in Section 4.2, the functional and contractual relationships between the various parties involved in the building supply chain are linked to the method of procurement. Rainscreen cladding supply chain could be regarded as an integral part of, but a subset of the building supply chain as shown in the relationship diagrams, Figures 4.8 to 4.10.

The project designer/specifier working for the client or the project contractor communicate and discuss, either directly or via the project contractor, technical issues with the rainscreen cladding contractor after the contract is let. Although a functional relationship exists between the cladding contractor and the designer/specifier, no contractual relationship exists. The predominant function of the latter is to review the detailed design and working drawings produced by the cladding contractor and make comments or issue instructions when necessary but does not approve drawings. The project contractor or the client employs the rainscreen cladding contractor.

Figures 4.8 to 4.10 show the different rainscreen supply chain relationship varying with the type of company holding the contract. The type of company is largely determined by its primary business activity. The three possible scenarios:

- a fabricator as cladding contract holder;
- an installer as cladding contract holder; and
- a managing cladding contractor as contract holder.

The key features of each scenario are summarised below.

Fabricator as cladding contract holder (Figure 4.8)
- Contractually responsible for the design, layout and detail of the rainscreen cladding including design co-ordination and special co-ordination with the designer of the supporting structure (typically the backing wall)
- Procures the rainscreen system profiles, components and accessories from system and material suppliers. The suppliers also provide product information data.
- Fabricates the rainscreen’s system components.
• Employs system installers supervised by in-house personnel.
• Delivers the rainscreen’s system components to site for installation.

**Installer as cladding contract holder (Figure 4.9)**
- Contractually responsible for the design, layout and detail of the rainscreen cladding including design co-ordination and special co-ordination with the designer of the supporting structure (typically the backing wall).
- The installer commissions a fabricator to produce the rainscreen system in accordance with the detailed design.
- The fabricator procures the rainscreen system profiles, components and accessories from system and material suppliers. The suppliers also provide product data.
- The fabricator delivers the rainscreen’s system components to site.
- The installer procures installation accessories and installs rainscreen’s system components on-site.

**Managing cladding contractor as contract holder (Figure 4.10)**
- Contractually responsible for the design, layout and detail of the rainscreen cladding including design co-ordination and special co-ordination with the designer of the supporting structure (typically the backing wall).
- Commissions a fabricator to produce the rainscreen system components in accordance with the detailed design and deliver to site.
- Employs system installers to install the rainscreen system’s components on-site.
- Although managing cladding contractors arrange for the different work packages to be undertaken by separate parties and play mainly a co-ordination role, there are instances where they hold the contract for one of a series of packages and acts as lead contractor for the whole work package.

Although shown as separate parties, it should be noted that the cladding contractor and inner wall constructor could be one company. For this scenario, the cladding contractor assumes the responsibility for the vapour and fire barriers, insulation, and breather membrane.
Figure 4.8 Supply chain relationship showing a fabricator as rainscreen cladding contract holder.
Figure 4.9 Supply chain relationship showing an installer as rainscreen cladding contract holder.
Figure 4.10 Supply chain relationship showing a managing cladding contractor as the rainscreen cladding contract holder.
In summary, cladding contractors make a large design input to the building envelope work package. The role undertaken by cladding contractor depends on the company’s primary business activity. Some may limit their role to only the detailed design and installation while others would undertake detailed design, fabrication and installation. Installer only companies buy in the services of a fabricator. Even companies that fabricate and install usually require an external labour supply for installation. Cladding contractors are often dealers for the system designers and manufacturers. With increasing design responsibility being devolved down the supply chain, the cladding contractors together with the rainscreen system companies are required to supply against a performance specification and provide back-to-back warranties.

The limited survey undertaken in this study so far did not reveal situations in the UK where rainscreen cladding contractors manufacture system components in-house.

### 4.4 Business processes

The current business processes relating to the procurement and installation of rainscreen cladding are shown below in Figure 4.11

![Diagram of business processes](image)

**Figure 4.11 Current business processes**

#### 4.4.1 Concept design and specification

For all the procurement routes except partnering, the project designer/specifier acting on the client’s brief, particularly within the boundaries of cost and performance, produces scheme drawings showing the external appearance of the building envelope. This process takes due consideration of the function of the envelope and visual effects through the selection of appropriate materials and performance specification. The architect undertakes the concept design prior to planning approval, and it is essentially an iterative process involving the designer sketching elevation and section details of the building envelope, showing amongst others, the rainscreen cladding element. Together with the project’s quantity surveyor, the cost
implications of the alternative design solutions are continuously assessed and revised to suit budget constraints. The process is similar for partnering projects except that it is more likely that the cladding company would be involved from a very early stage.

Rainscreen cladding is generally cheaper than curtain walling. The cost of rainscreen cladding is not only related to the technical performance required but also the materials used to create the desired visual effect. Hitherto there is no generally accepted standard specification for rainscreen cladding. Most designers/specifiers have developed their own in-house specification in a generic format but tailored to meet the requirements of a specific rainscreen cladding project. Thus the specification for rainscreen cladding may differ from contract to contract depending on the materials used.

There are two common approaches to specifying rainscreen cladding:

- prescriptive specification; and
- performance specification.

The former is where the specifier has full understanding and working experience of the performance of a particular rainscreen system and specifies the system. However with increasing variety of materials being used in the rainscreen cladding such as aluminium, terracotta, granite, and zinc for rainscreen panels, the specifier often requires assistance from materials specialists or product manufacturers. This is partly because the specifier does not fully understand the all the implications of selecting a particular product or material.

Performance based specification for rainscreen cladding is becoming more popular. This allows the specifier to stipulate the as-built performance of the cladding system. It is then the responsibility of the cladding contractors to meet the specified requirement with whatever cladding system that they deem fit. Also a specification could be part performance and part prescriptive where the specifier knows the material required and performance.

Two documents have recently been published and are widely used as guidance documents for writing performance specification for rainscreen cladding. The documents are the Standard for Walls with Ventilated Rainscreens (CWCT 1998) published by the Centre for Windows and Cladding Technology (CWCT) and Section H92 on Rainscreen Cladding (NBS 2000) published by National Building Specification (NBS).

The Standard for Walls with Ventilated Rainscreens, published in July 1998, sets out performance criteria for rainscreen cladding as a wall unit including all materials and components, sub-assemblies and all junctions between it and interfacing building elements under the following main headings:

- Fixings
- Fasteners
- Wind loads
- Wind resistance – serviceability
- Wind resistance – safety
- Wind resistance – cyclic loading
- Dead and live loads
- Accommodation of movement generally
- Accommodation of thermal movement
- Accommodation of thermal movement
- Air permeability
- Cavity ventilation
- Water penetration resistance
- Thermal performance
- Condensation
- Noise
- Acoustic properties
- Fire performance
- Electrical continuity and earth bonding
- Corrosion
Sections of relevant Building Regulations, British Standards, and other guidance documents are referenced in the document.

NBS Standard H92 on Rainscreen Cladding, published in March 2000, gives specification clauses for rainscreen cladding under the following main headings.

- Types of rainscreen cladding
- General requirements / preparatory work
- Design / performance requirements
- Testing
- Products
- Finishes
- Fabrication and installation

References are made to relevant British, German and European standards, CWCT and BRE publications, and other documents published by UK and international research institutes and organisations.

Rainscreen cladding specification is dealt with in greater detail in CIMclad’s Work Package 2 report on performance specification.

It was noted that typically the development of a rainscreen concept design and specification, prior to planning approval, does not have the input of the rainscreen cladding contractor. This procedure has been partly responsible for major revisions to the concept design during the detailed design stage, and often has serious cost implications. The argument put forward by the designer/specifier in favour of the current procedure is that supplier input at the concept design stage would limit competition and could be interpreted as favouring a cladding contractor prior to the tender stage or confining themselves to the expertise of one cladding contractor.

In summary, the key outputs of this business process with respect to rainscreen cladding are:

- the scheme wall drawing showing elevation and section of rainscreen cladding; and
- rainscreen cladding specification.

### 4.4.2 Procurement

For the sake of simplicity, the process description given in this section mostly relates to a building procured under the traditional method. The contrasts between the different methods of building procurement are highlighted in Section 4.2.

Upon completion of the concept design and specification for the rainscreen cladding and other aspects of the building envelope, the project designerspecifier takes that scheme through the planning stage and then adds sufficient design detail to enable the building envelope work package which includes rainscreen cladding element go out to tender. Depending on the complexity of the building envelope in terms of the number of different elements involved, a one stage or two stage tender design is adopted.

During the tender period, the cladding contractor estimates the cost of procurement and installation of rainscreen cladding based on the concept design and specification. Where the bidder is a system fabricator, the system designer’s estimating software is used to estimate the quantities for rainscreen components. However where the bidder is an installer, installer’s system fabricator usually performs the estimation of quantities. In a two-stage tender, the second stage allows the selected cladding contractors to further develop the concept design with a view to reducing cost but not at the expense of performance or quality, and ensuring that nothing is missed out. If there is no design cost reimbursement incentive, cladding contractors are not keen in participating in the second stage of the tender unless that the contract is somewhat assured. Buildings with only rainscreen cladding would normally be let through a one stage tender since the complexity of the wall is greatly reduced. Following on from the tender stage, the successful cladding contractor is commissioned by the project contractor to undertake the detailed design, procurement and installation of the rainscreen on site. Maintenance is not usually included in the contract.
The cladding contractor holds the contract for the procurement and installation of the rainscreen cladding. As earlier highlighted in Section 4.3.2, the cladding contractor may be a system fabricator, with or without installation facility, management cladding contractor, or a cladding installer. System fabricators are reliant on the system designer/supplier and materials supplier to supply system components and accessories respectively. A managing cladding contractor employs fabricators and installers, co-ordinates the various activities and often undertakes the detailed design with assistance from the system designers. A cladding installer relies on suppliers, fabricators and materials suppliers to deliver system components and accessories to site for installation.

The procurement of the building envelope which includes rainscreen cladding is often left towards the end of the construction programme, and some of the cladding contractors and façade consultants visited felt that the process is not currently given the attention it deserves when compared to other aspects of the building works such as structures, M&E, and fit out.

4.4.3 Detailed design

The cladding contractor is responsible for the detailed design of the rainscreen cladding in terms of layout, function and appearance. This is partly achieved by using the design software provided by the system designer/supplier. Where an installer holds the cladding contract, the system fabricator performs a part of the design. The software also checks that the design is within the performance limits of the rainscreen system. Performance cannot be guaranteed by the system designer/suppliers if the design is outside the rainscreen system’s limits, for example if the maximum permissible spacing of the supporting vertical frame members is exceeded, thus advice is sought from system designers in such circumstances. Occasionally, a façade consultant may carry out the full detailed design of the rainscreen cladding, generating production drawings for the fabricator. During the whole design process, the concept designer/specifier is involved in checking and reviewing details of the design and any proposed changes.

The detailed design phase considers the overall performance of the building envelope of which rainscreen cladding is a part.

The detailed design of rainscreen cladding involves the following activities:

- design of rainscreen cladding layout/configuration, materials optimisation, and co-ordination with other elements of the building envelope;
- structural and serviceability calculations and checks;
- detailing of rainscreen panels, supporting frame systems, window pods and all flashings;
- design of fixings and connections to the structural frame; and
- production of working / shop drawings.

Other design considerations include:

- Handling and transportation;
- Ease of installation;
- Tolerances and fit; and
- CDM regulations

The layout design involves the arrangement of the rainscreen panels and supporting systems to form cladding to the required layout and dimensions shown in the architectural design. This also requires co-ordination of all rainscreen cladding members, one with another and with the structural frame, and interfaces with other elements such as windows, doors, metal louvres, glazing or other cladding types. A great emphasis is placed on the optimisation of the dimensions of the rainscreen system components and materials in order to minimise wastage during fabrication.

4.4.4 Fabrication

The fabrication of a rainscreen cladding system essentially involves the following activities:
• drilling and cutting of extruded aluminium or steel profiles that form the skeletal support structure of the system to required lengths as shown on the production drawings;
• cutting or cutting and forming the rainscreen panels to required shapes as shown on the production drawings. Some rainscreen like terracotta tiles come in standard dimensions and do not require any cutting, and
• assembling of system components and accessories, and packaging.

Based on a number of visits to fabrication companies reported in Section 4.5, the drilling and cutting activities are generally computer-controlled operations but the whole process starting with extraction of component dimensions from the production drawings to component fabrication is not a fully computer-integrated process.

The rainscreen system designers are the principal suppliers of profiles to the fabricators. In addition to supplying profiles in bar lengths to fabricators, system suppliers may also buy in and supply to their fabricators gaskets, fixings, and brackets that are integral parts of the system. Their warranties to the fabricators are dependent on the use of the correct components recommended by the system company. However, fabricators may outsource the system accessories from the suppliers to the system companies in order to reduce cost or buy from other suppliers provided that they meet the minimum standards set by the system companies. The system suppliers test components in advance as part of the overall rainscreen system. A substitution of inferior components by the fabricator may well lessen the performance of the finished rainscreen cladding. Some companies supply only the support framework for the rainscreen panels.

Non-system components such as rainscreen panels, insulation and interface materials are usually sourced elsewhere. If a cladding contractor is responsible for the overall performance of the rainscreen cladding, for example fire and thermal performance, materials for non-systems components are carefully selected to meet the specified performance requirements. This is onerous for cladding contractors who only supply and install the rainscreen panels onto a backing wall constructed by others.

### 4.4.5 Installation

Installation of the rainscreen system to form cladding on a building is currently a labour intensive, site-based activity undertaken either by the fabricator’s installers, the labour gang of the installation company holding the contract or by sub-contract to labour only installers. The labour intensity decreases as the size of the rainscreen panels increases.

This process largely entails:

• setting out the system lines with respect to a reference point on the building;
• fixing the supporting frame of the rainscreen panels onto the structural frame or backing wall;
• fixing of insulation, waterproofing membranes, flashings etc at interfaces with adjoining elements; and
• hanging or fixing the panels off the supporting frame including flashings, fire barriers, etc.

Installation-only cladding contractors are supplied with fabricated rainscreen system components by a fabricator, however, they are still left to source the supply of fixings and other hardware.

### 4.4.6 Summary

In general, the different parties involved in the rainscreen cladding supply chain play different roles. The project designer/specifier, primarily involved in front end activities, develops the concept design and specification for the rainscreen cladding. The cladding contractor, often with the assistance of the system designer’s design software, produces a detailed design of the rainscreen solution including interfaces with other parts of the building envelope and structural elements. The system designer and material supplier supply the rainscreen system profiles, and rainscreen panels and accessories respectively to the system fabricator. One or more companies may undertake the fabrication of rainscreen components and installation depending on the type of company holding the contract.
4.5 Rainscreen cladding case studies

4.5.1 Introduction

A number of companies involved in the rainscreen cladding supply chain were visited to ascertain the following:

i. their role in the rainscreen cladding supply chain;
ii. relationship with other parties / companies in the supply chain;
iii. key business processes;
iv. IT support tools currently used;
v. future trends and issues likely to have significant impact on the cladding industry and, in particular, the rainscreen cladding, and
vi. potential for improvement through standardisation of procedures and components.

This section provides a summary of the visits for items (i) to (iii) shown above. Item (iv) is covered in Report 2 on ICT Usage: Current and Future, while items (v) and (vi) are dealt with in Sections 4.6 and 5.0 respectively.

Table 4.1 shows a classification of the twelve companies visited in terms of type and their role in the rainscreen supply chain. Of these, five could be regarded as cladding companies but three are able to lead a cladding contract. The remaining seven serve as technical advisors of various types.

A majority of the activities involved in the design, fabrication and installation of rainscreen cladding are undertaken by the cladding companies – either by a system fabricator, an installer or managing cladding contractor. The size of the rainscreen cladding element of the contract undertaken by the companies visited varies between £50,000 and £250,000 and the number of permanent employees varies between 50 and 80. Thus they could be regarded as medium-sized companies. The size of the contract undertaken is often limited by cash flow and capacity rather than skills shortage. They purchase system components and accessories and pay staff, all in advance of the payment by the project contractor who is expected to pay within 30 days of delivery and installation. The time lag between the payment for the purchase of system components and materials and client payment was deemed to be very critical.

It should also be noted that for the cladding companies visited, only in one instance did rainscreen cladding business stream represent a significant proportion of the company operations. The statistics for the different companies are shown in the Appendix 2.

Companies that own or supply rainscreen systems market their products directly to the designers/specifiers in the hope that the specification of their product would bring new business. Promotional materials include technical literature on products including model specification information and accreditation by appropriate bodies. The model specification provides an interpretation of specification clauses in relation to their products. They offer free advice to designers/specifiers outside the scope of their core product range, for...
example rainscreen suppliers could advise on the design, specification and choice of backing wall, insulant, membrane, wall fixing and interfaces with other envelope elements. The costs of these activities are built into the system companies’ overhead. They also work closely with companies bidding for cladding contracts.

4.5.2 Company case studies
Section 4.4 described the business processes, apart from the concept design and specification process, other downstream processes usually involve more than one company as shown in Figures 4.8 to 4.10. The absence of a fully integrated company offering a complete package from detailed design to installation could be partly explained by the limited market for rainscreen cladding of which is currently less than 10% of the total UK cladding market. Thus the current workload for rainscreen cladding probably does not justify the existence of such companies. The system fabricators visited do not own their systems, instead, they hold the dealership of one or more system suppliers.

The companies shown in Table 4.1 could further be grouped with respect to the industry in which they function and culture, however, in relation to the rainscreen supply chain, the companies are classified with respect to their function as follows:

- designer/specifier;
- project contractor;
- system fabricator;
- system fabricator and installer;
- system components supplier; and
- installer

It should be noted that the above classification is solely based on the companies visited and does not represent the full range of companies involved in the rainscreen supply chain. For example, companies engaged in the design and manufacture of the systems and profiles are not represented.

The activities of EPL, a roofing and specialist cladding contractor, are described in the project case study.

**Designer/Specifier**

**Companies:** Amec, Buro Happold, BDP, Geoffrey Reid Associates, Ove Arup, Whitby Bird

Rainscreen cladding generally represents less than 25% of their cladding workload and varies between them.

Amec, BDP, and Geoffrey Reid Associates are predominantly involved in developing the scheme drawings for the building envelope involving one or more cladding types of which rainscreen cladding may be a part. The drawing shows elevations and sections of the building envelope. The companies either undertake the development of project specifications or use those supplied by the client. These practices tend to have in-house generic specifications with extensive reference to building regulations, codes, CWCT and NBS standards on cladding, and British Standards but configured to suit specific projects. Specifications found to be satisfactory on a previous project are usually repeated on a future projects. Some of them would specify a particular cladding system based on their experience of the system while others would specify performance requirements and then select a system at the tender stage that meets the specifications and offers other advantages such as cost-savings.

They issue general arrangement drawings to the cladding contractor who is expected to produce a detailed layout design of the rainscreen cladding showing elevation and section details for comments. They usually make comments but do not actually approve the detailed drawings. The professional liability may differ from contract to contract, however, in most situations, this falls on the cladding contractor except where a façade consultant undertakes the detailed design of the system.

Buro Happold, Ove Arup and Whitby Bird work as façade consultants, either serving as the technical arm of the architect or working directly for the client. They may undertake all or some aspects of the cladding design, starting from concept design and specification to the detailed design and production of shop
drawings, particularly for bespoke cladding systems. They are often commissioned by the cladding contractors to undertake structural calculations and serviceability checks.

Where the companies are appointed on a design basis only, contractual links would be between them and their client, and not with any cladding contractor. Amec would have contractual links to the cladding contractor if they also acted as the construction managers.

**Project contractor**  
Company: Taylor Woodrow

Taylor Woodrow acts as a project contractor undertaking project management and supply chain management, and, through its consultancy arm Taywood Engineering, a range of design and cladding testing services. The company has set up a database of preferred suppliers for cladding and other building elements. This will result in closer working relationships and a move away from traditional competitive tendering.

**System fabricator**  
Company: CGL Cometec

CGL Cometec is the only UK dealer for Cometec, a German system design company. By contract, only CGL Cometec is allowed to use Cometec’s trademark in the UK. CGL Cometec specialise in rainscreen systems of which account for about 50% of its cladding workload. They buy system drawings with specifications from Cometec, although based on the German standards, have been related to appropriate British and European standards. CGL Cometec promotes rainscreen systems amongst designers and specifiers on the back of the technical support and back-to-back warranty provided by Cometec. They consult Cometec when a requirement outside the system specification is desired which would require the modification of the existing standard systems.

Currently they have a number of rainscreen structural systems with varying types of rainscreen panels. The system does not include windows or doors but could be interfaced with them and other elements of the envelope elements. The systems are drained and back-ventilated rainscreen, but the system arrangement of panels with baffle joints and cavity between the backing wall and the outer skin could result in equalisation of pressures externally and inside the cavity, thus inhibiting the drive of airborne moisture across the cavity and protecting the structure. Occasionally they produce other items outside the range of their core products such as metal louvres to go with the rainscreen, to satisfy the designer. NBS (Section H92) and CWCT’s Standard on Walls with Ventilated Rainscreens are used as guides in writing the system specifications. Product specifications are produced to the NBS format.

CGL Cometec outsource the extrusion of system profiles to a local UK manufacturer, the dies are based on Cometec’s design and specification. The manufacturer mass produces the profiles and supplies them to CGL Cometec for stock in bulk. Any major modification to the profiles or additional profiles requires the approval of Cometec. Rainscreen panels like aluminium and zinc sheets are bought in for fabrication, granite slabs are supplied pre-cut. Other accessories like bolts, screws, gaskets are bought in from various suppliers.

CGL Cometec specialises in the fabrication of rainscreen systems to comply with the specification for the building envelope but within the performance limits of Cometec’s rainscreen system. This includes layout and wind load design, the wind loading determines the spacing of the vertical rails and brackets.

They receive purchase orders from contract holding cladding installation companies like Grainger – a roofing and cladding contractor. Although CGL Cometec undertake part of the detailed design and fabrication of the system components, the cladding contractor is responsible for meeting the whole aesthetic and performance requirements of the building envelope of which may include doors, windows, and glazing and other cladding types. The cladding contractor supplies the design data, bay dimensions and panel sizes to CGL Cometec.

The fabrication process is semi-automated. The schedule of sections and quantities, generated by their in-house drafting and detailing software, is electronically transmitted to the computer-controlled punching machine and serve as instructions for cutting and punching the sheets and profiles. The sheets are manually transferred by trolley to another machine that turns the sheets into shapes. Bending data is manually fed into the machine’s controller.
Rainscreen systems are fabricated and supplied to cladding installers on ex-factory sales agreements. The fabrication process is co-ordinated with installation programmes to avoid the storage of finished goods by applying just-in-time fabrication and supply approach. CGL Cometec have little presence on site. Installers’ operatives are required to receive training on the system’s installation.

System fabricator and installer
Company: Glamalco

Glamalco holds a dealership for Kawneer (a subsidiary of parent company Cowa) and offers several different cladding types. Kawneer, a system designer/manufacturer, supplies Glamalco with technical data and literature of their systems including specifications and drawings, and computer software for layout design. Glamalco specialises in the design and fabrication of system frames for curtain walls and rainscreens to suit the required layouts.

Rainscreen cladding accounts for less than 10% of their cladding workload while curtain wall is greater than 55%. Glamalco is a cladding contract holding company, either as a lead contractor or sub contractor to an installation company (cladding and roofing specialist contractor) and undertakes the detailed design, fabrication and installation. In addition to the cladding element, they could be responsible windows and doors work packages of which they usually outsource to other manufacturers. However, being in control of the work packages helps in the design co-ordination and minimises lack of fit at the interfaces.

They design the rainscreen cladding to comply with the specification for the building envelope but within the performance limits of Kawneer’s rainscreen system. Where the requirement is outside this limit, modification could be made but only with the approval of Kawneer. The number of referenced national and international standards and documents in a contract specification may range between 30 and 40. This usually includes CWCT and NBS standards.

Upon completion of the detailed design, shop drawings, schedule of parts and quantities for the rainscreen system, all the materials required are procured at once and stocked in-house. Glamalco obtain metal sheets used for rainscreen panels from EuroClad. The level of automation in the fabrication process is very limited. The current operation in the factory involves the use of manually set-up semi-automated drilling and cutting machines.

The size of the installation gang ranges from 4 to 6 people depending on the project. It was noted that installation companies are not highly organised and are not affiliated to any professional body. Glamalco normally employs them under their supervision and covered by their professional indemnity. A supervisor would look after one or more sites. Block and brick walls and curtain wall are common backing walls on which to erect rainscreen cladding.

System component supplier
Company: EuroClad

EuroClad operates as a fabricator/supplier of formed metal sheets to workshop drawings produced by others. Presently, about 10% of their market is in the UK and they have about 5 other major competitors excluding many one-man companies set up with rolling machines and cutters. The company is a flat steel sheets dealer for Corus Group who supplies 90% of their PVC-embossed galvanised steel roll coils, and procures aluminium sheets and polystyrene from Hoogovens and Vencil respectively. They supply Glamalco with flat metal sheets used for rainscreen panels.

The materials are bought in bulk for stock. The sheets are machine cut in plan to the required section dimensions and panels produced by cold forming in a press into the required shapes to comply with the customer’s order. The core product range is interior and exterior building envelope sheeting (trapezoidal rolled formed panels and curved sheeting profiles), fully sealed composite cladding, and rainscreen panels and carriers. For rainscreen panels and carriers, they can supply them ex factory or install on site depending on the purchase order. Previously, most of their products were mainly used for industrial applications but because of the higher fire, thermal and UV rating of the materials currently used, they are now being used in commercial buildings.
Installer
Company: Grainger

Grainger, a roofing and cladding specialist company, is a cladding contract holding company and takes full contractual responsibility for installation of cladding in accordance with design drawings supplied. They are also responsible for the co-ordination of the rainscreen cladding with other elements of the building envelope. Rainscreen cladding currently accounts for up to 50% of their cladding workload and they buy rainscreen assemblies from CGL Cometec. About 60% of the price of a rainscreen contract goes towards purchasing the rainscreen components while the remainder is for installation and purchase of other accessories like gaskets, sealants etc.

They guarantee the system’s performance based on the warranty and Agrèment certificate provided by the system fabricator – CGL Cometec. The rainscreen cladding is designed to transmit wind loads based the British Standard.

Current general practice does not permit Grainger or similar contract holding contractors to get involved at the concept design stage. Quite often they bid for the whole building envelope to minimise problems of programme co-ordination, construction tolerances and lack of fit which are prevalent when more than one contractor is involved in the package on site, each responsible for a different work package such as roof, windows or doors.

Using the outline design of the building envelope as a guide, they undertake a layout design of the rainscreen cladding. The layout design highlights the panel grids, joints and other architectural requirements. Method statements, layout and detail drawings are submitted to the designer for comments, Grainger assume full responsibility for the performance of the rainscreen cladding.

The fabricated components are supplied when required for erection (just-in-time delivery method). This requires them to advise the system fabricator of the project’s installation programme. The installers are a mixture of permanent and self employed, about 80% to 20% in proportion and an average of 6 installers per site.
Summary of company activities
Table 4.2 shows a breakdown of company activities.

Table 4.2 Summary of company activities

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<tr>
<th>Processes</th>
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<th>Buro</th>
<th>Haddad</th>
<th>BDP</th>
<th>Geoffrey Reid</th>
<th>Ove Arup</th>
<th>Whitby &amp; Bird</th>
<th>Taylor Woodrow</th>
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4.5.3 Project case study

New Engineering Complex
Manufacturing and Mechanical Engineering (MME) Building
Loughborough University

The organizational structure for the MME Building is shown below in Figure 4.12.

The vertical building envelope comprises of curtain walling, rainscreen cladding and windows.

Pre-Planning stage
Computer integrated dynamic modelling of some areas of the building was undertaken by Amec to inform on the performance requirements. This was partly based on the anticipated ultraviolet loading on the building. Those areas, for example the main entrance stair, were perceived as likely problem areas. The U-value for the glazing was specified using this approach.
Amec produced general arrangement drawings showing elevations and sections of the building envelope including weather lines, structural framing, and generic performance specification based on the NBS standard. Also included are 1:5 details of 90% of junctions to indicate proposed weathering and required aesthetics. The drawings were conveyed to DLE to produce a bill of quantities. This was an iterative process constrained by budget. For a typical floor-to-floor level, rainscreen section of the envelope consists of the following:

- zinc in-fill panel;
- window;
- terracotta; and
- metal louver.

Generic specifications were provided for these elements including details of the manufacturers or equally approved manufacturers.

The emphasis at this stage was to create the right visual effects and develop a specification that would ensure that the performance requirements in terms of weather tightness and energy efficiency are met. The specification was developed using the NBS standard of which also covered materials and structural performance.

**Choice of cladding material**

Terracotta tiles occupy a greater proportion of the rainscreen wall area. There is an increasing resistance to the use of brick as a cladding material because of its weight. Aesthetically, terracotta tiles are alternative to bricks, and were chosen because it fitted the type of building – manufacturing building and also for durability reasons. Red bank tiles were originally specified, however clay look-alike (clay and cement mixture) tiles were used although more expensive. The unit price was reduced because Buchtal were trying to buy into the British market.

The rainscreen wall consists of the following layers:

- outer skin (terracotta tiles, zinc panels, metal lourves);
- cavity;
- supporting brackets of the outer skin;
- breather membrane
- backing wall – EPsteel frame (insulation sandwiched between boards); and
- vapour barrier.

**Cladding contract procurement**

The procurement of the cladding contract was originally intended to be a two stage tender. However, DLE changed the tender conditions to be a single stage tender, as a consequence, only two tenders (Exterior Profiles Limited and Allscot) were returned. This was after Amec had interviewed a number of prospective bidders and informed them of the intended two stage tender process. EPL and Allscot agreed to put in a contractor’s proposal (and be paid for it) which would develop to a complete bid. This period was effectively the second stage.

- Pre-Qualification or 1st Stage
  In the pre-qualification stage, the building envelope was tendered as two separate work packages – curtain walling, rainscreen, and windows as one package and roof as the other. Judgement at this stage was based on past experience and design capability of the bidders.

- 2nd Stage
  The second stage was a 5-week period of which the pre-selected bidder (Exterior Profiles Limited) used to develop further the concept design, particularly interfaces between the different elements of the building envelope and propose any modification to the concept design. The contractor’s proposal also outlines the building envelope works programme in relation to the overall project programme, and priced items. This stage was felt was necessary because, in addition to getting a fixed price, it was expected that by applying the expertise of the specialist cladding contractors to the design would lead to a more weather tight structure and cost savings.
EPL managed to integrate the various work packages to present a single bid. This required the input of the various suppliers highlighted Figure 4.12.

**Contractual arrangement**

The MME building was procured under a management contract. The whole of the building envelope work package was sub-contracted by the management contractor Tilbury Douglas Construction (TDC) to Exterior Profiles Limited (EPL), a domestic contractor under the amended form of JCT 80. Under the Contractor Design Portion Contract (Domestic to TDC), EPL was a domestic sub-contractor contracted under the amended form of JCT 80. By using the CDPC EPL have no contractual link with the University, the design responsibility is taken by TDC. However, TDC as part of their domestic sub-contract condition got EPL to sign a direct design warranty with the University. Hence, if TDC went into liquidation the University would have some come back. By being classed as domestic sub-contractor, the Nominated Subcontract Conditions (NSC) is not used which was the primary reason for using a CDPC. If EPL cause a delay, TDC are not at risk of a claim from the University.

In relation to the building envelope:

- Amec was contractually responsible to the client to provide general arrangement drawings including elevation and sections, and specification which forms the client requirements. Amec had no contractual relationship with EPL, but commented, answered, queries, advised or clarified technical issues when requested by EPL using TDC headed paper;
- TDC was responsible for the procurement, and installation of the building envelope. This package was sub-contracted to EPL who undertook the detailed design and involved a number of suppliers as shown in Figure 4.12. TDC was responsible for managing the people/meeting between EPL and Amec, whilst Amec and EPL were involved in technical aspects of the building envelop with TDC as an observer.

EPL agreed a pre-order programme with TDC detailing timescales for detailed design, procurement of materials and installation. A bulk order was placed with the different suppliers once the contract was let.

**Detailed design**

EPL’s office at Tamworth produced the detailed design drawings of the various elements and components of the building envelope. The scope and programme of work was covered in EPL’s proposal at the tender stage. The building envelope was split into different work packages with divisions either based on specific areas of the building envelope or cladding type. Each work package constitutes a phase of work, from detailed design to installation and its delivery programme is linked to the pre-order agreement with TDC. Some work packages ran concurrently.

For each phase of design completed, the drawings were passed to Amec for comment. The drawing status is classified into three categories:

- A - proceed;
- B – proceed but subject to minor comments; and
- C - rejected.

Drawings with A and B status are issued for the production of a Pass List Schedule while C is re-issued to Amec. It should be noted that status A and B means that Amec is satisfied with the details in terms of aesthetics but meeting the specified performance requirements rests with EPL.

A Pass List Schedule is generated for each component or item in each drawing using generic CAD software. The schedule is issued to the Purchase Department via the QA Department.

Owing to the phased approach adopted, design information required for a particular work package were only requested at the time of design. The time taken to process and feedback the required information often delayed the design process. EPL did not have a sequencing programme dictating well in advance when and what design information would be required. Insufficient time to develop the full design was partly blamed for this situation and further reinforces the argument that cladding design should be a front-end activity.
Fabrication and Installation
The Pass List Schedules for the various components are forwarded to the various suppliers to prepare the production drawings using their systems and fabricate. Kawneer, a system supplier, own a workshop and undertake fabrication for a number of companies including EPL. The delivery schedule for fabricated components ties in with the start of the work package. However because of space availability on-site or to avoid late delivery or where some of the components require preparatory work, some materials were delivered about 2 weeks in advance.

EPL has trained cladders and curtain wallers within its work force and supplements its installers with labour only installers. The terracotta tiles were found to be very laborious to install, and in some instances, rows of tiles had to be removed and re-installed owing to incorrect gap between the last tile and the one before.

Role of the cladding contractor
The role of EPL in the cladding supply chain could be regarded as a mixture of cladding managing contractor and an installer. EPL has the sole responsibility for all aspects of the MME building envelope. They undertook the detailed design of the whole building envelope and arranged with separate parties to fabricate and deliver the different components based on their design. In-house installers supplemented by labour-only subcontractors undertook the installation.

4.6 Future trends and potential
As highlighted previously, there is a limited market for rainscreen cladding usually accounting for less than 10% of the cladding output. There are about 10 suppliers of rainscreen cladding in UK with a range of products. This section discusses the future trends and issues likely to have an impact on the cladding industry in general and in particular rainscreen cladding.

A number of major changes relating to design, specification, procurement, and supply chain relationships were identified to have taken place over the last few years, and are expected to continue into the near future. They include:

- increasing design responsibility;
- the use of façade consultants;
- gradual increase in the participation of cladding contractors at the concept design stage;
- the development of rainscreen specification;
- steady growth in the use of rainscreen cladding;
- more use of nominated suppliers; and
- closer working relationship between the different cladding companies.

In recent years, there has been a significant increase in design input that is expected from the cladding contractors. They are expected to use their expertise to rationalise the concept design and usually produce cost savings. In the present practice, cladding contractors are not usually involved in the concept design stage. They claim that the earlier they can be involved in the process, the better the result could be. However, this can lead to problems in the client expecting lower fees from the leading consultant, splitting of design responsibilities, and having to bring sub-contractors on board (with fee implications) prior to competitive tendering taking place.

Another emerging trend is the use of façade consultants. They are either employed by the client or the architect to offer independent advice on cladding systems and write open (performance) specifications, or in some situations have full design responsibility, from concept to detailed design and production of shop drawings. Such consultants are common in Germany but there are few in the UK. This trend was partly explained by the increasing technical sophistication of the cladding systems in the market.

Hitherto, cost overruns experienced in some commercial building projects are often attributed to the cladding element. In a majority of the cases, this has been partly attributed to the time spent reworking that aspect of the project. Early involvement of the cladding contractor at the design stage was felt would limit potential clashes in future and minimise cost. This is the current practice in Germany, where design involves the whole design team. This problem, however, is largely solved where a partnering arrangement
CIMclad: Potential for process improvement

exists. Some repeat building clients like BAA procure their buildings involving a 5-year rolling partnering arrangement.

Involvement of the cladding contractor at the concept design and specification stage or first stage of the tender process is gradually gaining popularity. However, the resentment has always been that the cladding contractor will end up specifying or designing a system that ensures that it is at least within the contractor’s capability. Also, a cladding system is not expected to drive the building envelope of a project. Performance and aesthetic effects were felt to be primary considerations, then the cladding system to fit or meet the requirements.

The Standard on Walls with Ventilated Rainscreen [CWCT 1998] and more recently Section H92 on Rainscreen Cladding [NBS 2000] are believed to have greatly enhanced the understanding of rainscreen cladding and its design principles. Specification clauses for rainscreen are likely to be drawn from these documents. It was however noted that the standards are only guidance documents and not expected to replace the designer’s working experience of the systems. Of the two common types of rainscreen cladding, ventilated and drained, and pressure equalised systems, the former is more common. Only Schuco was identified as solely a designer of pressure equalised systems. The prototype testing of new or unusual systems and interfaces has also facilitated the understanding of their performance.

Relative to other cladding types, the key considerations for specifying or selecting rainscreen cladding have been cost and appearance. The use of rainscreen cladding is on a steady increase and expected to increase further in the future primarily for the following reasons:

- it is reasonably cheap, the cost lies between formed metal sheets and curtain wall;
- it is lightweight and durable with a low maintenance requirement;
- extensive choice of materials for rainscreen panels and coatings that fulfill varying aesthetic and performance requirements. Panels are suitable for incorporating PV cells;
- joints facilitate accommodation of movement;
- increasing efficiency of the fabrication process through automation;
- it is fairly easy to install although laborious and the build rate is slower when compared to other cladding types. This could be improved by the use of larger panel sizes and pre-assembly; and
- the principle of operation has become fairly well understood.

Another important feature of the multi-layer wall construction such as rainscreen cladding is the ability to take the outer skin – rainscreen panels and supporting structure, out of the critical path in the project programme. As the building will be wind and weather tight after the backing wall is erected, the outer skin element can be erected close to the programme conclusion and this also helps to protect the front from all interfacing trades.

Repeat building clients have a huge influence on the selection of the cladding. They build regularly and are well informed about their needs. It is expected that in future the repeat big building clients like BAA would help drive the market for rainscreen if it is regularly specified by them.

Project contractors are increasingly moving away from competitive tendering to using selective suppliers that they have enjoyed good working relationships in the past. The likely long-term implication of this on the procurement of rainscreen and other cladding types is the overhaul or transformation of the cladding procurement process. The authors’ view is that cladding contractors may align or become an integral part of the project contractor’s team.

The understanding between the different cladding contractors is felt to be improving. In some instances, they have a partnering arrangement amongst themselves, particularly where the different elements of the building envelope are involved in the work package and usually for projects with a value higher than £500,000.
5.0 Process improvement

5.1 Introduction

This section of the report examines the business processes and assesses the potential for improvement through standardisation of procedures and components. The approach adopted for procedure standardisation, discussed in Section 5.2.1, was to identify the bottlenecks within the current business processes and then to explore the application of value engineering and concurrent engineering. In the context of this work the two principles are defined as follows:

- value engineering - rationalising procedures by eliminating non-value adding activities; and
- concurrent engineering - streamlining activities and processes to reduce lead times.

Organisation and business units that would be affected by the proposed standardisation are also identified.

The rainscreen system is a component-based assembly. Different suppliers supply the different system components and accessories, the system core components differ from one system to another. Section 5.2.2 examines the pros and cons of system component standardisation in relation to business process improvement.

Section 5.3 examines the technical benefits of computer-integrated manufacture of rainscreen cladding. The second report on ICT Usage: Current and Future, identifies enabling technologies and how it could be achieved, and presents as-is process model.

5.2 Potential for process improvement

5.2.1 Standardisation of procedures

The industrial visits were partly aimed at ascertaining the following information from the companies involved in the rainscreen supply chain:

- the extent of variation in procedures from contract to contract;
- the scope for standardisation of some or all procedures across the supply chain; and
- the limitations / hindrances to standardisation.

At each point of the business flow, the opportunities and benefits of procedural standardisation were assessed. It was widely accepted that functional and contractual procedures differ from contract to contract, and are largely related to the procurement route. These procedures are normally defined in the contract or project manual. Traditional, design and build and construction management were identified as the most common procurement routes. In addition to the procedures outlined in the project manual, the companies have their own in-house procedures that satisfy QA requirements. The fabrication and installation companies operate just-in-time supply/delivery methods. The differences in company procedures become more distinct when viewed with respect to the industry they operate.

Mixed views were expressed on the scope and benefit of procedure standardisation. Some of the companies visited felt that the procedures are fairly standardized, thus the scope is limited. However, the general view was that any standardisation would be beneficial and would possibly reduce lead times. One issue that came out strongly from those involved in the detailed design was the need to standardise or formalise the interface between concept design and detailed design. It was felt that the current practice does not give adequate attention to the cladding package prior to letting the contract, thus the package is often not properly integrated into the whole building project. This is further illustrated by the usual composition of the client’s design team - architect, structural engineer, building services engineer and other consultants working for the client. Cladding consultants or contractors are not usually included in the client’s design team to design or advise on the construction and performance of the building envelope. An exception to this practice would be on a complex and customized cladding contract or in a partnering arrangement where the cladding contractor will be appointed early in the procurement process to make an input to the work of the design team during or immediately after the concept stage of design.
The implication and argument against the involvement of a cladding contractor at an early stage of the process were highlighted in Section 4.6. For a less complex cladding system like rainscreen, a compromise approach would be to standardise this interface using a robust product model that sets the requirements for a seamless integration of the outline and detailed design.

Standardisation of the concept - detailed design interface using a product model that links the rainscreen system to the requirements of the building envelope is expected to improve the current business process because it should:

• reduce the current design loop or changes in the detailed design associated with missing or insufficient information in the concept design and/or specification;
• provide better optimisation of materials and waste reduction through the use of envelope grids matching standard sheet sizes;
• provide better integration of the rainscreen cladding with other parts of the building;
• improve information, data and work flow between the parties involved;
• improve understanding between the various parties involved
• facilitate computer integration of downstream activities such as fabrication; and
• possibly lead to a cost reduction.

The whole rainscreen supply chain, but in particular, the designerspecifier and the cladding contractor - two key players in the rainscreen supply chain, would benefit from the standardisation. However, it is not expected that this standardisation would have a significant impact on the present company structures and business flow.

5.2.2 Standardisation of components

Since the rainscreen system is a component-based assembly, the site visits also sought to establish whether the efficiency of the current business process could be improved by the use of standard components. Thus the scope for components or sub assemblies standardisation vis-a-vis business benefits was investigated.

Hitherto, system supply companies design and produce profiles that are used to fabricate the rainscreen system. The systems and their profiles are designed and manufactured independently by system companies, thus profiles vary from one company to another. System designers/manufacturers produce a range of rainscreen systems, the major variant in each system being the material and finish used for the rainscreen panels. Generally the panels are the more variable part of the rainscreen system. The dimension and shape of the rainscreen panels are to a large extent determined by the architectural requirements, that is, geometry and area of the building envelope where they will be fitted, but within the safe design limits of the system. However, the main system components such as extruded system profiles and brackets are fairly standardised for each rainscreen system. The scope for component standardisation across the whole of the cladding industry appears to be limited only to the system profiles and brackets since the size and geometry of rainscreen panels are to a large extent controlled by the performance and aesthetic requirements, and geometry of the building envelope.

The individuals met during the industrial visits had diverse views regarding the potential benefit of component standardisation. Some felt that the standardisation of the key components across the whole of industry would enhance just-in-time supply/delivery of rainscreen cladding because components can be bought off-the-shelf and fabricated into the required assembly, thus opening the market to more fabricators and reducing the supply chain. Others argued that this approach would be restrictive and leads to less choice, and the potential benefit of standardisation of system components needs to be viewed with caution. While standardisation in the UK timber window industry may have driven down costs (becoming a commodity item), this had the effect of suppressing product development with the longer-term effect being that the UK industry has been badly affected by innovative imports. Although standardisation of components would drive cost down and benefit end-users, the components would have less features and become less profitable to manufacturers. Rather than standardising components, optimising the materials for a large building layout (the system layout) and the co-ordination of the various components would improve the overall efficiency of the whole process.
Some fundamental issues that the rainscreen cladding industry would need to address in relation to component standardisation are:

- criteria for the rationalisation of the existing system profiles;
- standardisation of design and specification guidance;
- who provides in-service performance warranty for the system; and.
- re-organisation issues in system companies.

It could be argued that as more demand is made on the performance of cladding systems, this model may not be sustainable because the system fabricators may not have the skills and resources to invest and develop new systems. It is expected that the system designers will still drive the market and provide the necessary warranties against the required performance.

5.3 Computer integrated manufacture

This section of the report introduces the potential benefits of computer-integrated manufacture of cladding while Report 2 on ICT Usage addresses how it could be achieved.

In relation to cladding manufacture, computer integrated manufacture is described as a process where the outline design of the rainscreen generated by a computer software is electronically transmitted to the system fabricator who completes the detailed design and the automated fabrication of the rainscreen components are digitally controlled without the need for paper copies of the drawings.

Currently, such a fully computer-integrated process does not exist in the cladding industry. Even where a fabrication machine has a software interfacing capability this is not often exploited. This practice has been attributed to negligible time saving when compared with manually set up machines. However, for projects involving a vast number of components, there are potential benefits, particularly, reduction in the overall process times.

Computer integration of the processes involved in the procurement of rainscreen cladding or the integration of the different computer software systems used at the various stages of the process would greatly improve information flow. This is key to improving the efficiency of the current fabrication process. The integration of all stages of the specification-design-manufacture-installation cycle have direct potential in reducing overall process times. Furthermore, improved information flows provide increased flexibility for modifications to aspects such as specification or design requirements.

Process integration would also facilitate the pre-assembly of large sized panels, thus improving the build rate for rainscreen cladding.
6.0 Conclusions

This report has reviewed the different types of cladding systems used for the building envelope focusing on multi-layered cladding – rainscreen cladding, and assessed its future potential as a cladding system and issues likely to have an impact on the rainscreen supply chain. It described the different building procurement methods in relation to the cladding supply chain including a generalised view of the functions and relationships within the rainscreen supply chain. The key business processes involved in the procurement and installation of rainscreen cladding are described and the potential for process improvements through standardisation of procedures and components assessed. The benefits of computer-integrated manufacture of rainscreen cladding are also evaluated.

The following conclusions are drawn from this study.

The rainscreen supply chain spans the construction and manufacturing industries and comprises a number of principal parties namely: project designer/specifier, system designer/supplier, system fabricator, system installer and materials supplier. The supply chain is largely reliant on rainscreen system products supplied by the system companies.

Rainscreen cladding currently accounts for less 10% of the cladding output. There is a steady growth in the use of rainscreen cladding owing to a variety of reasons. This is partly explained by its lower cost and lesser sophistication when compared with curtain walling, and the extensive choice of materials for rainscreen panels.

There is potential for process improvement through standardisation of the concept- detailed design interface by using a robust product model that links the rainscreen cladding to the requirements of the building envelope. This also sets the scene for a computer-integrated manufacture of cladding system.

There is scope for standardisation of key system components such as the profiles and brackets. The standardisation of components would drive cost down and benefit end-users by becoming a commodity item. However, this has the effect of suppressing product development and encouraging the cladding sector of the UK construction industry to become more reliant on innovative imports. Rather than standardising components, a greater efficiency would be achieved by optimising materials usage and co-ordination of components particularly for a large building layout.

Rainscreen components are produced to fit the area of the building envelope as dictated by the concept design. Hence the number of different components involved determines the number of suppliers to cladding contractors.

This study has shown that there is scope for improving the current business process by standardising concept-detailed design interface using a robust product model that links the rainscreen cladding to the requirements of the building envelope. Consequently, consolidation of the existing performance specifications for rainscreen cladding, and the development of a rainscreen cladding product model will be addressed in work packages 2 and 3 respectively.
References


Ledbetter S (1997) Mapping and quantifying the curtain wall industry. CWCT Bath


## Appendices

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix 1</td>
<td>List of individuals interviewed</td>
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<td>Appendix 2</td>
<td>Company related information</td>
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<tr>
<td>Appendix 3</td>
<td>Glossary</td>
</tr>
</tbody>
</table>
Appendix 1 List of individuals interviewed

Include a list of all persons interviewed including affiliations / companies in tabular format

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>David Downing</td>
<td>Amec</td>
</tr>
<tr>
<td>Iain McNab</td>
<td>BDP</td>
</tr>
<tr>
<td>Dale Sinclair*</td>
<td>BDP</td>
</tr>
<tr>
<td>Stephen Tanno</td>
<td>Buro Happold</td>
</tr>
<tr>
<td>Brian William</td>
<td>CGL Cometec Ltd</td>
</tr>
<tr>
<td>Matt Sutters</td>
<td>CGL Cometec Ltd</td>
</tr>
<tr>
<td>Steve Phillips</td>
<td>EuroClad</td>
</tr>
<tr>
<td>Dominic Collins</td>
<td>Exterior Profiles Ltd</td>
</tr>
<tr>
<td>Paul Warner</td>
<td>Geoffrey Reid Associates</td>
</tr>
<tr>
<td>Duncan Clendenan</td>
<td>Geoffrey Reid Associates</td>
</tr>
<tr>
<td>Peter Jones</td>
<td>Glamalco Ltd</td>
</tr>
<tr>
<td>Alan Quartly</td>
<td>Glamalco Ltd</td>
</tr>
<tr>
<td>Alex Owens</td>
<td>Grainger Building Services Ltd</td>
</tr>
<tr>
<td>John Hughes</td>
<td>Grainger Building Services Ltd</td>
</tr>
<tr>
<td>Peter Hartigan</td>
<td>Ove Arup</td>
</tr>
<tr>
<td>Ray Elliott</td>
<td>Taylor Woodrow</td>
</tr>
<tr>
<td>Russell Fry</td>
<td>Taylor Woodrow</td>
</tr>
<tr>
<td>Richard McWilliams</td>
<td>Whitby Bird</td>
</tr>
<tr>
<td>Will Stevens</td>
<td>Whitby Bird</td>
</tr>
</tbody>
</table>

* Only provided company related information shown in Appendix 2, was not interviewed.
Appendix 2  Company related information

Name of company:  Amec, Stratford-upon-Avon

1  Type of company
Architects and Engineers

2  Approximate cladding workload distribution (%)  
Rainscreen  (15)  Curtain wall  (30)  Precast concrete  (20)  Formed metal sheets/panels  (25)  Others (10)

3  Significant factors controlling cladding system used
Cost followed by appearance

4  Company’s involvement in the procurement and installation of rainscreen cladding
Specification, and Installation when acting as the Managing Contractor

5  Key considerations in the procurement of rainscreen cladding, ranked in order of importance* (1-high to 5-low)  
Performance  (3)  Appearance  (1)  Cost  (2)  Materials  (5)  Quality  (4)
*Note that the above ranking does not suggest that any of the considerations has a low rating. Quality is linked with performance.

6  Information on a rainscreen cladding project involving your company  
Year  Project description  Approx. project value (£ m)  Approx. Cladding value (£m)
1999/2000  New Engineering Complex  Loughborough University  10.5 (prime cost)  2.2 (including roof)

7  Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used  
Type (VD, PE, H)  Outer skin  Backing wall  
PE  Zinc and Terracotta panels  Sandwiched EPsteel frame
Name of company: BDP, Glasgow

1 Type of company
   Architects

2 Approximate cladding workload distribution (%)
   - Rainscreen (<25)
   - Curtain wall (>50)
   - Precast concrete (<25)
   - Formed metal sheets/panels (<25)
   - Others (<25)

3 Significant factors controlling cladding system used
   Design and cost

4 Company’s involvement in the procurement and installation of rainscreen cladding
   Specification

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance
   (1-high to 5-low)
   - Performance (3)
   - Appearance (2)
   - Cost (4)
   - Materials (1)
   - Quality (5)

6 Information on a rainscreen cladding project involving your company
   Year | Project description | Approx. project value (£ m) | Approx. Cladding value (£ m)
   1997 | Braehead Shopping Centre | 200 | 8

7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used
   - Type (VD, PE, H)
   - Outer skin
   - Backing wall
   - PE
   - 3 mm anodised aluminium sheet
   - Galvanised steel sheet
1 Name of company: Buro Happold, London

2 Approximate cladding workload distribution (%)

<table>
<thead>
<tr>
<th>Cladding Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainscreen</td>
<td>(&lt;25)</td>
</tr>
<tr>
<td>Curtain wall</td>
<td>(&gt;50)</td>
</tr>
<tr>
<td>Precast concrete</td>
<td>(&lt;25)</td>
</tr>
<tr>
<td>Formed metal sheets/panels</td>
<td>(&lt;25)</td>
</tr>
<tr>
<td>Others</td>
<td>()</td>
</tr>
</tbody>
</table>

3 Significant factors controlling cladding system used

- Aesthetics and cost

4 Company’s involvement in the procurement and installation of rainscreen cladding

- Specification and advisory service

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance (1-high to 5-low)

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Rank</th>
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<td>Performance</td>
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<td>Appearance</td>
<td>2</td>
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<tr>
<td>Cost</td>
<td>2</td>
</tr>
<tr>
<td>Materials</td>
<td>3</td>
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<tr>
<td>Quality</td>
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6 Information on a rainscreen cladding project involving your company

<table>
<thead>
<tr>
<th>Year</th>
<th>Project description</th>
<th>Approx. project value (£m)</th>
<th>Approx. Cladding value (£m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Millennium Point, Digbeth, Birmingham</td>
<td>100</td>
<td>4.5</td>
</tr>
</tbody>
</table>

7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used

- Type: VD
- Outer skin: PE
- Backing wall: H
Name of company: CGL Cometec Ltd, East Kilbride

1 Type of company
System fabricator

2 Approximate cladding workload distribution (%)

<table>
<thead>
<tr>
<th>Cladding Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainscreen</td>
<td>50</td>
</tr>
<tr>
<td>Curtain wall</td>
<td>0</td>
</tr>
<tr>
<td>Precast concrete</td>
<td>0</td>
</tr>
<tr>
<td>Formed metal sheets/panels</td>
<td>15</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
</tr>
</tbody>
</table>

3 Significant factors controlling cladding system used
Architectural specification, cost, and planning restriction

4 Company’s involvement in the procurement and installation of rainscreen cladding
System design, manufacture and assembly, component supply, advisory service, and supply chain management

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance (1-high to 5-low)

<table>
<thead>
<tr>
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<th>Rank</th>
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<tbody>
<tr>
<td>Performance</td>
<td>5</td>
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<td>Appearance</td>
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<tr>
<td>Cost</td>
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<td>Materials</td>
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<td>Quality</td>
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6 Information on a rainscreen cladding project involving your company

<table>
<thead>
<tr>
<th>Year</th>
<th>Project description</th>
<th>Approx. project value (£ m)</th>
<th>Approx. Cladding value (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>Wellcome Wing, Science Museum, London</td>
<td>10</td>
<td>400,000</td>
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7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used

<table>
<thead>
<tr>
<th>Type (VD, PE, H)</th>
<th>Outer skin</th>
<th>Backing wall</th>
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</thead>
<tbody>
<tr>
<td>VD</td>
<td>PVDF painted aluminium system</td>
<td>Block</td>
</tr>
</tbody>
</table>
1 Type of company
Architects, Research & Development

2 Approximate cladding workload distribution (%)
   - Rainscreen: (<25)
   - Curtain wall: (>50)
   - Precast concrete: (<25)
   - Formed metal sheets/panels: (>50)
   - Others: (Masonry >50)

3 Significant factors controlling cladding system used
   Cost and appearance

4 Company’s involvement in the procurement and installation of rainscreen cladding
   Specification, system design and supply chain management

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance
   (1-high to 5-low)
   - Performance: (1)
   - Appearance: (2)
   - Cost: (2)
   - Materials: (5)
   - Quality: (1-2)

6 Information on a rainscreen cladding project involving your company
   Year    Project description              Approx. project value (£ m) Approx. Cladding value
   1999/99 Cargo Handling Buildings, BAA, London            5 -7                      15-20%

7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used
   - Type (VD, PE, H)
   - Outer skin
   - Backing wall
Name of company: Glamalco Ltd, Cardiff

1 Type of company
System fabricator and installer

2 Approximate cladding workload distribution (%)

<table>
<thead>
<tr>
<th>Cladding Type</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>Rainscreen</td>
<td>(&lt;25)</td>
</tr>
<tr>
<td>Curtain wall</td>
<td>(&gt;55)</td>
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<tr>
<td>Precast concrete</td>
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<tr>
<td>Formed metal sheets/panels</td>
<td>(&lt;25)</td>
</tr>
<tr>
<td>Others</td>
<td>()</td>
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</table>

3 Significant factors controlling cladding system used
Kawneer specification, architects requirements, structural spans

4 Company’s involvement in the procurement and installation of rainscreen cladding
Manufacture and assembly, installation, advisory service, supply chain management

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance (1-high to 5-low)

<table>
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<tr>
<th>Consideration</th>
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<td>Appearance</td>
<td>(3)</td>
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<tr>
<td>Cost</td>
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<td>Materials</td>
<td>(5)</td>
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<td>Quality</td>
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6 Information on a rainscreen cladding project involving your company

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Description</th>
<th>Approx. Project Value (£)</th>
<th>Approx. Cladding Value (£)</th>
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<tbody>
<tr>
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7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used

<table>
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<th>Type (VD, PE, H)</th>
<th>Outer skin</th>
<th>Backing wall</th>
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<tbody>
<tr>
<td>VD</td>
<td>Metal panels</td>
<td>Part blockwork / Part curtain wall</td>
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</table>
Name of company: Grainger Building Services Ltd, Strathclyde

1 Type of company
Installer

2 Approximate cladding workload distribution (%)

<table>
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<tr>
<th>Cladding Type</th>
<th>Distribution (%)</th>
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<tbody>
<tr>
<td>Rainscreen</td>
<td>(50-75)</td>
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<tr>
<td>Curtain wall</td>
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<td>Precast concrete</td>
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<td>Formed metal sheets/panels</td>
<td>(&lt;25)</td>
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<tr>
<td>Others</td>
<td>(&lt;25)</td>
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3 Significant factors controlling cladding system used
Cost

4 Company’s involvement in the procurement and installation of rainscreen cladding
Installation

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance (1-high to 5-low)

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Rank</th>
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<tbody>
<tr>
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<td>Materials</td>
<td>3</td>
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<td>Quality</td>
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6 Information on a rainscreen cladding project involving your company

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<th>Approx. project value (£ m)</th>
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<td>Glasgow</td>
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7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used

<table>
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<th>Type (VD, PE, H)</th>
<th>Outer skin</th>
<th>Backing wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD</td>
<td>Aluminium panels</td>
<td>Plaster boards</td>
</tr>
</tbody>
</table>
Name of company: Ove Arup

1 Type of company
   Engineers

2 Approximate cladding workload distribution (%)
   | Rainscreen | Curtain wall | Precast concrete | Formed metal sheets/panels | Others |

3 Significant factors controlling cladding system used
   Appearance, cost and performance required

4 Company’s involvement in the procurement and installation of rainscreen cladding
   Specification, system design and advisory service

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance
   (1-high to 5-low)
   | Performance | Appearance | Cost | Materials | Quality |
   | (3)         | (1)        | (3)  | (1)       | (5)     |

6 Information on a rainscreen cladding project involving your company
   | Year | Project description | Approx. project value (£ m) | Approx. Cladding value (£ m) |
   | Yet to be built | Irish Times | 60-70 | 4 |

7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used
   | Type (VD, PE, H) | Outer skin | Backing wall |
   | H               | Aluminium panels | Plasterboard |
Name of company: Taylor Woodrow, Southall

1 Type of company
Main contractor, test house, cladding consultant

2 Approximate cladding workload distribution (%)

<table>
<thead>
<tr>
<th>Rainscreen</th>
<th>Curtain wall</th>
<th>Precast concrete</th>
<th>Formed metal sheets/panels</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&lt;25)</td>
<td>(&gt;50)</td>
<td>(&lt;25)</td>
<td>(&lt;25)</td>
<td>()</td>
</tr>
</tbody>
</table>

3 Significant factors controlling cladding system used
Primarily the performance requirement of the architect’s specification

4 Company’s involvement in the procurement and installation of rainscreen cladding
Specification, advisory service, installation and supply chain management

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance (1-high to 5-low)

<table>
<thead>
<tr>
<th>Performance</th>
<th>Appearance</th>
<th>Cost</th>
<th>Materials</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(4)</td>
<td>(5)</td>
<td>(3)</td>
<td>(2)</td>
</tr>
</tbody>
</table>

6 Information on a rainscreen cladding project involving your company

<table>
<thead>
<tr>
<th>Year</th>
<th>Project description</th>
<th>Approx. project value (£ m)</th>
<th>Approx. Cladding value (£ m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Millennium Plaza</td>
<td>8</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Cardiff</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used

<table>
<thead>
<tr>
<th>Type (VD, PE, H)</th>
<th>Outer skin</th>
<th>Backing wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD</td>
<td>Profile metal cladding (Aluminium)</td>
<td>Insulated panels</td>
</tr>
</tbody>
</table>
Name of company: Whitby Bird & Partners, London

1 Type of company
Engineers, Façade Engineer

2 Approximate cladding workload distribution (%)

<table>
<thead>
<tr>
<th>Cladding Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainscreen</td>
<td>10</td>
</tr>
<tr>
<td>Curtain wall</td>
<td>20</td>
</tr>
<tr>
<td>Precast concrete</td>
<td>20</td>
</tr>
<tr>
<td>Formed metal sheets/panels</td>
<td>10</td>
</tr>
<tr>
<td>Others</td>
<td>40</td>
</tr>
</tbody>
</table>

3 Significant factors controlling cladding system used
Architect

4 Company’s involvement in the procurement and installation of rainscreen cladding
Specification and advisory service

5 Key considerations in the procurement of rainscreen cladding, ranked in order of importance (1-high to 5-low)

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>2</td>
</tr>
<tr>
<td>Appearance</td>
<td>3</td>
</tr>
<tr>
<td>Cost</td>
<td>5</td>
</tr>
<tr>
<td>Materials</td>
<td>4</td>
</tr>
<tr>
<td>Quality</td>
<td>1</td>
</tr>
</tbody>
</table>

6 Information on a rainscreen cladding project involving your company

<table>
<thead>
<tr>
<th>Year</th>
<th>Project description</th>
<th>Approx. project value (£ m)</th>
<th>Approx. Cladding value (£ m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Lakeshore Stone rainscreen (part)</td>
<td>48</td>
<td>0.2</td>
</tr>
</tbody>
</table>

7 Type of rainscreen cladding (ventilated & drained (VD), pressure equalised (PE) or hybrid (H) systems) and combination of front and backing wall materials used

<table>
<thead>
<tr>
<th>Type (VD, PE, H)</th>
<th>Outer skin</th>
<th>Backing wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD</td>
<td>Stone</td>
<td>Precast concrete</td>
</tr>
</tbody>
</table>
Appendix 3  Glossary

Keys terms used in this report in relation to rainscreen cladding are explained as follows:

**Non-standard system components**
Non-system components such as rainscreen panels, sealants, insulation, vapour barrier, breather membrane, gaskets and brackets are common to a number of rainscreen cladding.

**Rainscreen**
Panels or tiles that make up the outer skin of a rainscreen cladding.

**Rainscreen cladding**
This comprises of the outer skin and its supporting framework, air gap, insulation and a backing wall.

**Rainscreen system**
This refers to rainscreen and its supporting framework. A system comprises of standard and non-standard components.

**Standard system components**
An assembly of components forming a system and its patent is held by the system designer. Standard components are extruded profiles and folded metal rails that form the support framework of the system, and associated gaskets and brackets.

**Support framework**
The framing system which supports the rainscreen, which may comprise simple timber battens or complex extruded or folded metal rails.