Cladding systems

Cladding is a non-loadbearing skin or layer attached to the outside of a home to shed water and protect the building from the effects of weather. It is a key element in the aesthetic appeal of the home and directly influences both building cost and property value.

Your choice of cladding has a significant effect on the environmental performance of your home.

Initial impacts of cladding, such as embodied energy, resource depletion and recyclability, must be balanced against maintenance and durability appropriate to life span.

The primary roles of cladding are to control the infiltration of weather elements and the egress of water vapour while providing a durable, aesthetically pleasing appearance. Secondary roles can include sound and thermal insulation, fire resistance, and the capacity for cleaning in dusty, polluted or vandal prone environments.

Your choice of cladding should be based on a careful assessment and prioritisation of each of these roles for each orientation of your home. By choosing cladding materials specific to an elevation or exposure, you can often achieve the best in physical performance and aesthetics.


Photo: Suntech Design

West-facing gable walls are clad in durable steel, while the sun-protected north, south and courtyard walls are clad in weatherboard.

For example, in situations where a building's external envelope does not need to be fully 'sealed' (e.g. under deep verandas), highly breathable cladding can be an advantage. In areas or elevations with high exposure to sun, wind or rain, a very different approach is required.

Performance considerations

Cladding is typically made from wood, metal, plastic (vinyl), masonry or an increasing range of composite materials. It can be attached directly to the frame or to an intermediate layer of battens or spacers to prevent condensation and allow water vapour to escape.

Cladding systems include horizontal or vertical boards, sheet materials or smaller overlapping panels such as shingles and tiles. Each system uses different methods to prevent wind and rain entering through the joints, and each system's effectiveness varies depending on wind direction and speed and the degree of exposure to rain.

Most performance characteristics of cladding materials vary substantially and are outlined in the broad, individual materials groupings in 'Cladding options' below.

Appearance

The range of textures, colours, styles and finishes available means that the aesthetic outcome is limited only by the designer's imagination, council regulations or extreme site conditions.

Colour

Apart from aesthetic considerations, the colour of external cladding influences its capacity to absorb or reflect heat. In most climates, it is preferable to use lighter colours or proprietary reflective finishes, especially for roofing. (see *Passive cooling*)

Well designed applications of darker cladding elements can be beneficial in colder climates (*see 'Trombe walls' below*).

Texture or profile

Most cladding materials have a distinctive profile or texture that can create horizontal, vertical or angled patterns and shadow textures. Often a well designed blend of cladding materials can offer both a pleasing appearance and a better matching of materials to specific conditions (e.g. impact zones or areas requiring more frequent wash-down).

Environmental impacts

Cladding selection presents an opportunity to reduce the overall environmental impact of a home by choosing environmentally preferred materials and systems.

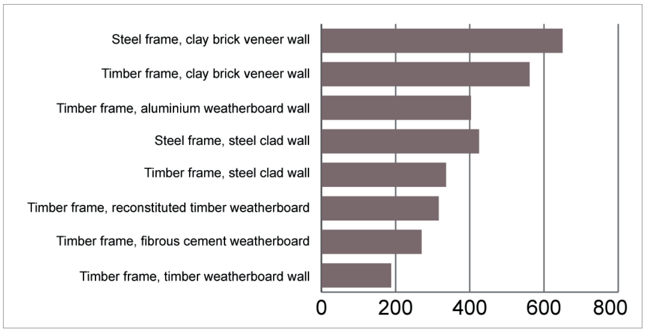
Research indicates that external walling is the most important variable element in residential construction (Treloar and Fay 2000). Research findings vary significantly because standardised methodologies and metrics are yet to be agreed or adopted, but sufficient studies have been conducted to clearly indicate the characteristics of preferred generic materials.

Life cycle assessment (LCA) considers the total environmental impact of a material over its life cycle including environmental emissions and depletions from the materials and the processes used to make it, maintain it, and dispose of or recycle it at the end of its life.

While rigorous LCA of various materials at a generic level is often available, it is seldom so for individual products. When choosing products, apply life cycle thinking (see *Embodied energy*) to address the following considerations:

- appropriateness for intended life span (e.g. some high impact cladding materials have 100 year life spans when the expected life of the building might be only 40 years; a lower impact, less durable product would be preferable)
- durability and appropriateness of fixings, seals and joints: their life span should match that of the cladding material
- quantities of each material used (e.g. some high embodied energy materials such as steel or aluminium have very thin sections, and embodied energy per square metre can be comparable to other materials with thicker sections)
- finishes such as paints and sealants, which can have a greater impact than the product itself and should be given equal consideration
- maintenance requirements over life span, which can equal or exceed the production impact of the cladding material; LCA of the whole wall system is the best approach when available
- emissions, depletions and waste rates during both manufacture and on-site installation, which vary significantly between products; 'cradle to gate' assessments (i.e. from resource extraction to factory gate) provided by manufacturers often examine manufacturing impacts only, whereas 'cradle to grave' LCA examines whole of life emissions and depletions
- designing, choosing and specifying to maximise potential for recycling or reuse (e.g. screw fixing rather than gluing can facilitate easy removal and reuse at end of life providing screw heads are not filled)
- whole system performance (i.e. effectiveness of cladding in protecting other elements from weathering and condensation)
- contribution to thermal performance (e.g. insulation, reflectance, emissivity)
- transport considerations (distance, weight, volume), which can add substantially to embodied energy.

Embodied energy



Note that actual data can vary significantly between studies and products.

Source: Adapted from Lawson 1996

Indicative embodied energy content for some typical cladding systems.

Structural capability

By definition, cladding is generally non-loadbearing (i.e. it doesn't carry roof or floor loads). However, some sheet cladding systems can have a structural bracing role in lightweight framing applications when appropriately fixed to the frame (e.g. structural plywood, reconstituted timber, fibre reinforced cement sheeting). The fixing requirements for bracing cladding can have significant implications for visual appearance, waterproofing, condensation, ventilation and drainage.

Insulation

Cladding systems often contribute little to overall wall insulation values. Specific performance is outlined under 'Cladding options' below.

Several composite cladding products include insulation: those with higher R-values (the measure of a material's resistance to heat flow) can eliminate the need for bulk insulation between the frame members in many climates. With adequately designed and correctly installed vapour cavities, condensation risk can be reduced or eliminated. Note that EPS (expanded polystyrene) is a vapour barrier so it is essential to have drying and drainage cavities for these systems in condensation-prone climates.

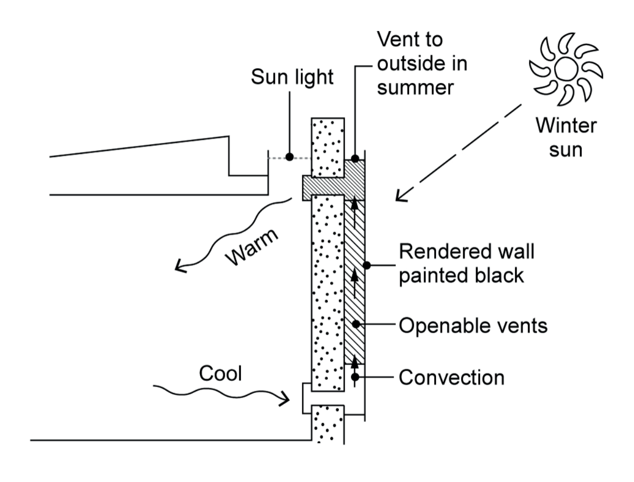
Thermal mass

Regardless of its mass, cladding that is fixed to lightweight insulated frames makes no contribution to thermal performance in terms of thermal mass storage because it is on the outside of the building and uninsulated.

The use of high mass cladding in lightweight framing systems (e.g. brick veneer) can actually decrease thermal performance because thermal lag can maintain higher temperature differentials across insulation layers well beyond normal diurnal cycles (e.g. west-facing brick veneer walls).

Trombe walls

Where the internal loadbearing element is high mass (e.g. reverse brick veneer or water filled containers between frame elements), transparent cladding materials such as glass with high solar heat gain coefficients (SHGC) can contribute to passive solar heating. In these cases, the whole wall must be passively shaded. (see *Passive solar design*; *Glazing*; *Thermal mass*)



Cross-section of a Trombe wall.

In these applications, both the insulation values and transparency of the cladding material are critical considerations, particularly in cooler climates where night-time heat loss can offset daytime heat gain. Trombe walls rely on the combined action of thermal lag of the mass and insulation from the air gap. Unwanted convection is controlled with openable vents at the top and bottom of the wall.

Additional insulation can also be gained in cooler climates through the use of double glazing (higher SHGC, lower R-value) or multi-celled polycarbonate (lower SHGC, higher R-value). In temperate climates, louvred glass allows cooling breezes and night sky radiation to passively cool thermal mass.

Sound insulation

With the exception of brick veneer — which is a high mass, high thickness system — cladding generally provides limited sound insulation. The contribution of denser products and foam insulation backed products is usually indicated as an Rw (weighted sound reduction index) rating or STC (sound transmission class). Individual suppliers factor in these contributions to calculate typical whole-of-wall ratings.

Vermin resistance

Vermin resistance is generally dependent on construction design details rather than cladding properties. Composite cladding systems with EPS foam backing can harbour rats and birds if access for burrowing is not eliminated.

Non-timber systems and most reconstituted timber systems are not subject to termite attack but inadequate detailing can allow termites to access a timber structure undetected. All timber cladding materials are subject to termite attack unless treated.

Regulatory standards

Building Code of Australia Class 1 and 10 Buildings, section 3.5.3, Wall cladding, addresses specific aspects of cladding under Application, Timber weatherboard cladding, Fibre cement planks and weatherboard cladding, Sheet wall cladding, Eaves and soffit linings, and Flashings to wall openings.

Providing cladding meets the minimum standards within each relevant category and meets the appropriate Australian Standards, it is deemed to comply. Innovative cladding systems may require additional testing and certification. This is common with new environmentally preferred systems.

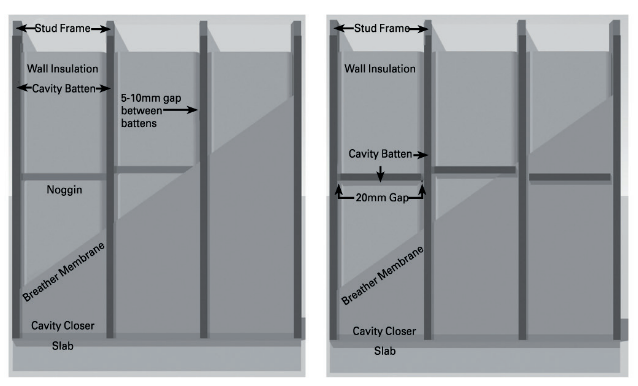
Condensation detailing

Condensation is explained in detail elsewhere (see *Sealing your home*). The following strategies can overcome condensation-related problems related to the fixing of cladding.

Step 1

Fix a vapour permeable membrane to the outside of the frame to allow water vapour to escape. This membrane should have low vapour resistance (less than 0.5MNs/g) and high waterproofness. It should be stretched taut to prevent bulk insulation installed later on the inside of the frame from breaching the condensation cavity.

The current industry practice of lining the frame with reflective foil insulation should be discontinued. These membranes act as vapour barriers (5.0MNs/g and greater) and commonly form the first point at which outgoing water vapour condenses.



Source: Adapted from Weathertex

Cavity systems: weatherboard (L) and sheets and panels (R)

Condensation within the wall structure creates ideal conditions for rot and mould growth, which can lead to substantial structural damage and health issues. Many reflective foil membranes currently marketed as breathable do not achieve sufficient permeability to resolve the problem.

Where reflective layers are required under cladding for fire purposes, they should be placed beneath the cladding on the outside of the vapour cavity as in Step 2 and be additional to the breathable building wrap fixed to the frame.

Step 2

Create a cavity a minimum of 10mm deep between the outside of this membrane and the inward face of the cladding material. This cavity should allow:

- downward migration of the condensation that might form when the cladding reaches dew-point
- in-cavity air movement and ventilation to remove water vapour laden air as it emerges from the membrane.

Cavities should be formed with vertical spacers or battens fixed to studs through the permeable membrane in accordance with AS/NZS 4200.1:1994, Pliable building membranes and underlays. Leave gaps in spacers to allow lateral air movement in case of cavity blocking.

Install a cavity closer at the top and bottom of the cavity (including above openings) that prevents insects and vermin from entering but allows condensate or water (bottom) and vapour (top and bottom) to permeate.

Several proprietary systems are available but you can also use a stainless steel mesh of similar grade and opening size to that used for termite protection.

Step 3

Fix the cladding through the battens with longer fixings that allow adequate penetration into the stud to meet the cladding manufacturer's specifications.

Cladding options

Reconstituted timber products

Many reconstituted timber products are made from forestry waste with minimal energy or chemical input, high manufacturing waste recovery and water recycling. These products are among the most sustainable of all cladding options. Check variations between brands on Ecospecifier. Try to ensure that forestry waste rather than saw log grade timbers are used and that the product contains no old growth forest products.

Availability: Available in most locations. Transport considerations should address the high mass, low volume of these products when transported long distances (e.g. composite loads with low mass, high volume materials).

Embodied energy: Among the lowest embodied energy cladding materials currently available in Australia. Also sequesters carbon.

Maintenance: Moderate. Requires painting. Surface and dimensional stability reduce frequency of maintenance. Usually pre-primed.

Durability: Highly durable. Suitable for sites subject to seismic or geotechnical movement.

Breathability: Good (depending on finish) with low condensation risk. Can encourage mould growth (by providing nutrients) if exposed to regular condensation. Breathable sarking with a condensation cavity is strongly recommended in condensation prone climates.

Waterproofness: High.

Insulation: Negligible.

Fire resistance: Good.

Toxicity: Non-toxic. Natural timber resins are used to bond particles under high temperature and pressure. Paints and sealants can have toxicity issues.

Finishes: Must be painted. Available in a diverse range of patterns, shapes and finishes.

Resource depletion: Virtually nil when product is made from forest waste.

Recycling/reuse: Generally not recycled due to finishes. Limited reuse is possible but often not implemented due to low cost of new materials.

Fibre cement

Manufactured in a strict factory controlled environment, most fibre cement products have high sustainability credentials. However, considerable variations can occur between brands and manufacturing plants depending on waste recovery rates, water sourcing and recycling, and energy efficiency (particularly the recovery of autoclave energy). These can be checked on Ecospecifier.

Typically produced as planks, weatherboards or sheets. Sheet products are generally thinner and therefore less material intensive but often have higher site waste rates — particularly on complex designs and shapes.

Availability: Commonly available due to high level transportability.

Embodied energy: Generally low. Varies with volume, cement content and manufacturing efficiency.

Maintenance: Low maintenance due to stability but requires painting to maintain waterproofness. Some applications in sheltered locations require one-off staining. Stamped or sawn patterns applied during manufacture can add aesthetic variation.

Durability: Highly durable and dimensionally stable. Suitable for sites subject to seismic or geotechnical movement.


Photo: Quentin Chester

Fibre cement cladding.

Breathability: Good (depending on finish) with very low condensation risk. Can be subject to surface mould growth if exposed to regular condensation. Breathable sarking with a condensation cavity is strongly recommended in high risk climates.

Waterproofness: High. Varies according to thickness and finish.

Insulation: Poor insulator.

Fire resistance: High.

Toxicity: Non-toxic. Paints and sealants can have toxicity issues.

Finishes: Available in a diverse range of patterns, shapes and finishes.

Resource depletion: Plantation-grown cellulose reinforcing fibre is renewable. Cement is non-renewable, and a finite resource with high embodied energy. Sand and fines are abundant but non-renewable.

Recycling/reuse: Generally not recycled due to finishes. Limited reuse is possible but often not implemented due to low cost of new materials and deconstruction damage.

Brick

Availability: Most common cladding system.

Embodied energy: Very high in quantities used.

Maintenance: Lowest maintenance if unpainted and not rendered; otherwise high.

Durability: Highly durable on well designed footings. Less suited to seismic loads and reactive soils.

Breathability: High with very low condensation risk when breathable sarking is used, due to well ventilated, wide cavity.

Waterproofness: Low. Requires wide cavity and specially designed ties, flashings and cavity drainage. Cavity ties and weep holes must be cleared of mortar droppings on completion.

Insulation: Poor insulator.

Fire resistance: Excellent but structural capacity during fires is under-utilised in non-loadbearing cladding applications (e.g. brick veneer).

Finishes: Diverse range of (unpainted) colours and finishes.

Toxicity: Non-toxic. Paints and sealants can have toxicity issues.

Resource depletion: Abundant but finite resource.

Recycling/reuse: Increasingly recycled into new bricks (cradle to cradle) or crushed for fill. Use of high strength mortars prevents reuse but bricks laid with low strength mortar are often cleaned and reused.

Timber weatherboards: vertical and horizontal

Availability: Various products and profiles widely available.

Embodied energy: Among the lowest of all cladding materials. Embodied energy ranges from low to very low depending on manufacturing process, preservatives and termite treatment. Provides carbon sequestration.

Maintenance: High. Timber is subject to shrinkage, swelling, cracking and rot unless well sealed. Ongoing movement requires regular retreatment.

Durability: Low to moderate depending on species and maintenance. Graded in durability classes ranging from 1 (best) to 4 (unsuitable for external use). Variations are common within these gradings due to sapwood (prone to rot) and heartwood (more durable) content and exposure during milling.

Breathability: High but can be decreased with paints and finishes. Joint detailing generally allows enough breathing to prevent condensation. Breathable sarking is essential and vapour cavities are important in climates with high condensation risk.

Waterproofness: Generally good but dependent on profile and stability (shrinkage, cupping, splitting, warping). Vertical tongue and groove or lapped systems are more common sources of leaks because joints can open or 'pop'. Horizontal weatherboard systems are generally more waterproof in rain exposed locations. Natural timber defects (e.g. knots) can also compromise waterproofness.

Insulation: Varies with thickness, sealing and density.

Fire resistance: Poor with the exception of a few hardwood species.

Toxicity: Non-toxic if untreated. Some treatments (e.g. copper chrome arsenate, or CCA) have known toxicity issues. Paints and sealants can have toxicity issues.

Finishes: Generally painted, oiled or stained. Requires regular retreatment due to natural movement and deterioration. High durability timbers (Class 1) can be left to weather naturally; however, this is not advisable in locations highly exposed to the weather or to low sun angles (particularly west), as repeated cycles of drying and wetting break down even the most durable of species.

Resource depletion: Renewable when plantation grown but when sourced from old growth forests contributes to high value biodiversity loss and the depletion of non-renewable resources. Plantation forests with their mono-species plantings often fail to establish an ecological balance and exhibit limited biodiversity.

Recycling/reuse: Typically difficult to reuse due to the fixings and the additional joins required as lengths decrease with each use. Recycling options are generally limited to chipping for mulch although this is not possible for painted and treated products.

Plywood sheeting

Availability: Available throughout Australia.

Embodied energy: Low to moderate. Manufacturing process and glues make embodied energy higher than natural timber.

Maintenance: Moderate to low depending on grade.

Durability: Moderate to very high depending on grade, species, glues and maintenance. Low grade ply requires similar protection to timber. While expensive, marine grade ply is among the most durable finishes available for corrosive environments (e.g. waterfront) but can contain toxic glues and preservatives.

Breathability: Generally low but variable with thickness and grade. Breathable sarking is essential and vapour cavities are strongly recommended in high condensation risk climates.

Waterproofness: High depending on finish and joint detailing.

Insulation: Limited.

Fire resistance: Poor to average.

Finishes: Generally painted, oiled or stained.

Resource depletion: Renewable when plantation grown.

Recycling/reuse: Plywood cladding is highly reusable but unable to be recycled. It should be screwed, not glued.

Steel

Steel cladding comes in a wide variety of cold formed profiles with varying base metal gauge and structural capacity. New steel finishes are being trialled which rely on weathering to produce a thick rust coating that protects the steel from further corrosion and allows it to become more corrosion resistant over time.

Availability: Available in all regions of Australia.

Embodied energy: High.

Maintenance: Very low. Steel finishes are very durable and, while coloured finishes often fade, they rarely require repainting for maintenance. Because steel expands, adequate tolerances must be left at joins and junctions.

Durability: Durability is very high: galvanised corrugated steel can last more than 100 years on a building and is a material highly sought after for decorative reuse. However, it must be installed carefully, with fixings and flashings that are compatible for corrosion and life span. Scratches, lead pencil marks and swarf from cutting can lead to early corrosion.

Breathability: Steel cladding is a vapour barrier and its excellent conductivity makes it highly susceptible to dew-point formation and water vapour condensation. It should always be fixed via a breathable cavity (often provided by the profile).

Waterproofness: Among the most waterproof of cladding materials.

Insulation: Zero insulation.

Fire resistance: High in both roofing and walling applications.

Toxicity: Non-toxic.

Finishes: A range of standard colours and finishes including galvanised and zinc/aluminium corrosion treatments. A range of standard baked enamel pre-finish colours is available.

Resource depletion: Steel is a non-renewable resource.

Recycling/reuse: Steel sheeting is highly reusable and 100% recyclable. Current products include up to 40% recycled content.

Aluminium

Aluminium cladding has a similar range of profiles to steel but also includes a folded weatherboard product. It is more corrosion resistant than steel. Aluminium cladding comes in a wide variety of cold formed profiles with varying base metal gauge and structural capacity.

Availability: Available in all regions of Australia.

Embodied energy: Highest of any cladding. Most appropriate in highly corrosive environments where products with lower embodied energy have a reduced life span.

Maintenance: Low. Powdercoated finishes generally have a life expectancy of 15 years and, although fading is common, they rarely require repainting for protection.

Durability: Durability is very high due to corrosion resistance of the material itself (rather than protective coatings). Life span and corrosion compatibility of fixings and flashings is essential. Careful installation is required.

Breathability: Aluminium is a vapour barrier and its excellent conductivity makes it highly prone to dew-point formation and water vapour condensation. It should always be fixed via a breathable cavity (sometimes provided by the profile).

Waterproofness: Among the most waterproof of cladding materials.

Insulation: Zero insulation.

Fire resistance: Good.

Toxicity: Non-toxic.

Finishes: Generally powdercoated in standard colours but for special orders any colour can be supplied.

Resource depletion: Aluminium is an abundant but non-renewable resource.

Recycling/reuse: Aluminium cladding is highly reusable (if screw fixed) and 100% recyclable.

Composite materials

A broad range of composite cladding systems is available. The most common form is closed cell or EPS foam-backed composites. These are often bonded to the generic products listed above and have similar performance characteristics but offer added insulation.

Some systems fix the EPS directly to the frame and finish with a variety of rendered or site applied finishes that can include high embodied energy polymers. These finishes often have multiple layers that can extend construction times and have varying LCA implications which should be verified before selection.

Because buildings react to wind or soil movement and cladding materials expand and contract with changing temperature or humidity, systems that include rendered finishes or rigid joins between elements can develop cracks. While cracking in these systems is generally accommodated through control joints, it can have an impact on both aesthetics and weatherproofness.

EPS usually contains high impact greenhouse gases, which can increase its embodied energy relative to other insulation materials. A small percentage of imported foams also include ozone depleting substances that are banned in Australia.

Innovative eco-preferred cladding products

Innovative products using environmentally preferred materials such as agricultural waste (straw) or post-consumer waste (paper) are constantly emerging. These employ a range of methods to ensure waterproofness and durability, and typically have a lower environmental impact including embodied energy. See Ecospecifier for reviews and listings of new products.

One such product is an extremely tough, lightweight material for corrugated roofing and wall cladding, manufactured from recycled wastepaper and saturated with bitumen under intense pressure and heat. It is flexible and easy to handle, comes with a 15 year warranty, and is available in four colours.

This product acts as a reflective thermal and acoustic insulator. Being partially manufactured from recycled wastepaper, it has a lower embodied energy than other cladding materials and helps to reduce the amount of waste going to landfill. See Ecospecifier for product details and sources of supply.

Panels made from wheat and/or rice straw fibres are also now available. The manufacturing process combines extreme heat and compression in a dry extrusion process to form the solid panel core. A natural polymer in the straw fibre is released during the procedure, and a water based PVA (polyvinyl acetate) glue is used to encapsulate the finished core with a high strength recycled Kraft paper liner. The result produces zero toxic waste and no water or gas is used during the manufacturing process.

Another product uses a blend of cement and recycled polystyrene. While the cement content raises embodied energy levels, added insulation and recycled content can offset this to some extent. This product can deliver 90 minute fire ratings.

Vinyl

Vinyl cladding (predominantly polyvinyl chloride, or PVC) is available in a range of profiles, colours, textures and low or no maintenance finishes.

While PVC resin production is a regulated process in Australia and emissions from the process are low by world standards, the production of vinyl or PVC for cladding relies on international supply chains and includes hazardous and toxic materials. It is generally not considered to be an environmentally preferred application.

It has high embodied energy and emits toxins during manufacture and life cycle use, including end of life disposal. Advances are being made with PVC recycling but current recycling rates remain low due to cost and complexity.

Fire risk is also an issue. While fire retardant additives reduce the flammability of PVC, it releases toxins (including acidic hydrogen chloride gas) if burnt. Some types also release dioxins although this is decreasing in Australian made products.

A new certification system for PVC products that comply with best environmental practice (for PVC only) has been developed to certify products for credits available in GreenStar ratings. These credits currently apply only to flooring, cable, pipe and conduit where alternative materials have similar environmental costs. At the time of writing, no PVC cladding products had been approved — see www.vinyl.org.au/FindPVCProducts for up-to-date ratings.

Contemporary cladding options can be both ecologically responsible and aesthetically pleasing.

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