

## Ecologically Sustainable Development – Glossary of ESD Terms

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### A

**abatement:** reduction/sequestration, generally of greenhouse gases; the amount by which a project reduces or captures greenhouse gases from the atmosphere; also known as the impact of the project or measure. (AGO 2000)

**accessibility:** in buildings and urban forms, refers to the provision of non-discriminatory access to all members of the community including those with a disability to premises or facilities which the public or a section of the public is entitled or allowed to use. (Section 23 Federal Disability Discrimination Act 1992)

**acid rain:** precipitation (in the form of rainwater, snow, fog) containing concentrations of sulphuric (particularly sulphur dioxide) and nitric acids (such as nitrogen oxides), falling to the earth; air pollution from the burning of fossil fuels is the major cause of acid rain; usually forms high in the clouds where sulphur dioxide and nitrogen oxides react with water, oxygen, and oxidant forming a mild solution of sulphuric acid and nitric acid and sunlight increases the rate of most of these reactions; can harm/destroy forests/wildlife, cause corrosion of buildings/cars and affect human health.

**acid sulphate soils:** a mix of low-lying coastal clays and sands containing sulphur-bearing compounds at concentrations above 0.05% in clays and 0.01% in sands. (EPA NSW 2000)

**acidification:** a reduction in pH usually of soils; can occur naturally through processes of weathering and leaching; agricultural activities such as continued removal of alkaline plant material, excessive use of nitrogen fertilisers and nitrogen leaching can accentuate acidification rates; extreme acidification can result in poorly structured soils or hard setting topsoils that don't support enough vegetation to prevent soil erosion; commonly, plant and crop growth are limited because of a reduction in the availability of nutrients (calcium, magnesium, boron) and/or an increase in toxic levels of aluminium, iron or manganese. (Victorian Landcare Guide)

**active systems:** generally refers to mechanical – as opposed to passive – heating, ventilation and air conditioning (HVAC) systems.

**adhesives:** chemicals/substances used in construction capable of holding materials together by surface attachment e.g. epoxy resins, poly vinyl adhesive (PVA) emulsions, cements, mucilages, pastes and glues and may be cold-setting or hot setting; a source of off-gassing in indoor environments where spirit-based adhesives off-gas higher levels of volatile organic compounds (VOC) than water-based ones. (AS/NZS 4491–1997)

**adobe:** roughly moulded and sun-dried blocks, made from puddled earth reinforced with chopped straw or

other fibrous binders, for use in earth-wall construction; a known as mud bricks. *see earth construction, puddled earth*

**aerobic digestion:** decomposition of organic waste using micro-organisms and oxygen in the process. *see composting*

**aeration systems:** systems designed to treat liquid waste by the process of air injection.

**afforestation:** planting of new forests on lands which historically have not contained forests.

**Agenda 21:** the non-binding agreement signed by world nations at the 1992 United Nations Conference on Environment and Development (UNCED); sets out conditions and recommendations for moving towards global sustainability involving various stakeholders from the community, business and government sectors.

**agro-forestry:** a plantation established and managed as part of an agricultural enterprise.

**air quality:** the level of particulates, gases, vapours, pollens and micro-organisms in the air; achieving and maintaining indoor air quality are sustainable design/building management objectives required to mitigate sick building syndrome, enhance amenity and promote work environments. *see off-gassing, volatile organic compounds*

**alliancing:** a long-term commercial partnering agreement enhancing project team innovation and avoiding costs associated with tendering for team formation on every new project; can assist integrated delivery of ESD design and delivery objectives. *see partnering*

**anthropogenic:** man made, usually used in the context of emissions that are produced as the result of human activities.

**aquifer storage and recovery (ASR):** a technique whereby water such as stormwater or even highly treated wastewater can be stored below ground for later extraction and reuse and is particularly useful in urban areas which are underlain with suitable aquifers as the cost of land for above-ground storages that may otherwise be necessary can be extremely high. (Case Study: Cas 25)

**asbestos:** a mineral crystal consisting of thin tough fibres able to withstand high temperatures without change; types include chrysotile (white asbestos), amosite (brown or grey asbestos) and crocidolite (blue asbestos) (Milton 1994); a known carcinogen causing lung diseases of most concern in the building industry are sprayed insulation, acoustic plaster, soundproofing, and insulation fabrics and laminates.

**autonomous (servicing):** a building operating independently of any inputs except those of its immediate environment. (Vale and Vale 2000)

**B**

**bagasse:** the crushed, juiceless remains of processed sugar cane; a by-product that can have further uses such as a feedstock for construction panels or paper making, substituting virgin wood feedstock.

**baseline:** a standard measure or perceived common level of performance at a given point in time, against which design objectives and/or performance targets may be set against to achieve improved design outcomes or performance standards.

**benchmarking:** the process of identifying the best performing product, service, function, process or activity at a given point in time and using its performance as a target, goal or benchmark against which to set or judge performance, e.g. the energy consumption of particular classes of buildings.

**berm:** soil piled against the length of a wall at an angle to reduce the exposure of surface area to external ambient conditions (temperature, humidity and acoustic) in order to assist in maintaining the equilibrium between subterranean ground temperature and a building's thermal mass.

**bio-accumulation:** the process by which chemicals (including some forms of heavy metals and chlorinated pesticides such as DDT) are taken up by organisms from the environment and accumulated in their tissues and subsequent increased concentrations in eco-systems and food chains. see *bio-magnification*

**bio-climatic:** in architecture, responding to climate with minimal reliance on non-renewable energy for achieving comfort.

**biodegradable:** a material capable of being decomposed by bacteria or other living organisms as a result of the action of micro-organisms.

**biodiversity:** the variety of all life forms; the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form; usually considered at three levels i.e. genetic diversity, species diversity and ecosystem diversity.

**biofuel:** a gaseous, liquid, or solid fuel that is rendered from raw biological material (plants, sewage, dry waste, cane sugar or wood pulp) through combustion or fermentation; there are a variety of ways to convert these bulky materials into fuels useful for industry and transport with the majority of biofuels produced biologically, such as biogas, generated by anaerobic digestion (biomethanation) and fuel ethanol generated by a yeast-based fermentation of molasses, sugar cane juice, or hydrolysed seed.

**biological control:** use of organisms (predators, herbivores, parasites, and disease producing organisms) to control pests and weeds.

**biological nutrient:** organic matter as waste able to be reused in natural ecosystems. (McDonough and Baumgart 2002) see *technical nutrient, cradle-to-cradle*

**bio-magnification:** the increasing concentration of a substance as it passes into higher trophic levels of a food web. see *bio-accumulation*

**biomass:** generally to any mass of biological matter; in the framework established by the Australian government to achieve the 2% renewable energy target, biomass that may be included within the measure refers to any recently produced organic matter, matter produced sustainably is considered a renewable energy resource, fossil fuels produced from biomass in the distant past are not; biomass considered as renewable include by-products of agricultural crops (excluding broad-scale land-clearing for agricultural purposes), sustainably managed forests, food processing/production industries and sewage treatment and organic components of mixed municipal wastes. see *abatement, carbon sink, greenhouse debt, sustainable energy, transitional energy, renewable energy*

**biophysical land suitability analysis:** identification of optimal land use, incorporating the consideration of a range of biophysical components to broadly assess the probability of an area to have a comparative advantage from an environmental and productive viewpoint.

**biosolids:** sewerage sludge, solid, semi-solid or slurry material produced by the treatment of urban sewerage; the stabilised organic solids, produced by wastewater treatment processes that in most cases can be beneficially used.

**biotope:** a limited ecological region or area in which the environment is suitable for specific forms of life.

**blackwater:** the waste from toilet systems.

**bottom-up management:** individuals sharing common interests and identity with respect to environmental issues and concerns collectively work towards practises and adopt measures that benefit themselves, their neighbours and their environment. (Diamond 2005)

**brise-soleil:** external sun shading/control device or fixture.

**bromine (Br):** a reactive gaseous element found in some ozone depleting chemicals including halons (fire extinguishing agents) and methyl bromide (a fumigant); a catalyst in destruction of stratospheric ozone.

**brownfield sites:** land in urban areas which has already seen development and is lying vacant; abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination. see *urban form*

**Building Code of Australia (BCA):** the national performance based building code, produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and State and Territory Governments; has the status of building regulations by all Australian States and Territories.

**building envelope:** commonly understood as the skin (external walls, glazing, roofs etc) of a building that enclose interior and/or conditioned spaces and through which thermal energy may be transferred to and from the exterior; critical to achieving sustainable design and operational outcomes, with respect to orientation and shape, thermal efficiency of envelope (including thermal bridging), shading, high performance glazing,

daylighting, natural ventilation, level of exposed internal thermal mass, reflectance of internal surfaces, infiltration, lifts/stairs, and landscaping. see *ecologically sustainable design, energy efficiency, passive design, thermal mass*

**building integrated photovoltaic systems:** photovoltaic systems integrated into the building structure and/or fabric so that they displace other building material requirements, thereby fulfilling a dual role as building material and energy system e.g. active photovoltaic facades. see *photovoltaics*

**building monitoring system (BMS):** computerised monitoring engineering services, security and other building systems for the purposes of recording, reporting and operational control to maximise safety, security, operational performance and for overall cost minimisation and efficiency; increasingly, data linked to management centres in order to compare operational status and response performance of buildings to improve total portfolio performance, maximise occupant productivity, minimise energy use and improve overall efficiency for building owners.

**building orientation:** in relation to on-site placement and concerned with the direction of prevailing winds and position of north-south, east-west exposures that affect heat loss-gain properties of the building. see *building envelope, passive design*

**built environment:** urban systems providing a collection of life support systems for human settlement.

**business as usual (BAU):** a term generally referring to energy practices and consequent greenhouse gas emissions, trends and projections, resulting from everyday business and consumer practices prior to the introduction of greenhouse gas reduction measures; in the Australian context commonly taken to refer to greenhouse emissions and trends evident to/at 1990 representing the baseline from which point the benefits of introduced measures to reduce greenhouse emissions are recorded and attributed as savings within the Commonwealth's initiatives to reduce national greenhouse emissions growth within the period 1990 – 2010. see *climate change, greenhouse gas, greenhouse debt, carbon sink*

## C

**carbon cycle:** the natural processes that govern the exchange of carbon (in the form of carbon dioxide, carbonates and organic compounds) in the atmosphere, ocean and terrestrial systems; includes photosynthesis, respiration and decay between atmospheric and terrestrial systems i.e., thermodynamic invasion and evasion between the ocean and the atmosphere; carbon exchanges from system (or reservoir to reservoir) occur by various chemical, physical, geological, and biological processes. see *carbon dioxide, carbon sink*

**carbon dioxide (CO<sub>2</sub>):** a naturally occurring, colourless gas essential to life, abundant in the atmosphere and essential to natural and industrial processes constituting approximately 0.036 % of the atmosphere; a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes; the principal

greenhouse gas affecting the earth's temperatures and the reference gas against which other greenhouse gases are indexed with a global warming potential (GWP) of 1.0. see *greenhouse gas, global warming potential*

**carbon dioxide equivalent (CO<sub>2</sub> equivalent):** an amount of greenhouse gas expressed as the amount of carbon dioxide that would cause the same amount of global warming; calculated by multiplying the mass of a greenhouse gas by its global warming potential.

**carbon monoxide (CO):** poisonous, colourless gas produced by incomplete combustion of petrol and diesel fuels.

**carbon sink:** a pool or reservoir that absorbs or takes up released carbon from another part of the carbon cycle i.e. if the net exchange between the biosphere and the atmosphere is toward the atmosphere, the biosphere is the source, and the atmosphere is the sink; also, the concept of organic growth (principally trees) functioning as sinks to absorb carbon dioxide from the atmosphere and thus helping to ameliorate the anthropogenically induced greenhouse effect due to the carbon stored in trees (as wood fibre or cellulose) is removed from the cycle for 100 years or more when not allowed to break down or combust. see *greenhouse debt*

**carbon tax:** a tax on emissions resulting from burning fossil fuels due to contributions to the greenhouse effect. (Moore 1997)

**carbon trading:** see *emissions trading*

**carrying capacity:** in terms of the built and urban environment, refers to the upper limits of development beyond which the quality of human life, health, welfare, safety or community character and identity might be unsustainably altered; a measure of the ability of a region to accommodate growth and development within the limits defined by existing infrastructure and natural resource capabilities. (Davidson and Dolnick, 1999)

**catchment area:** the drainage basin of a water body that captures all precipitation that falls on it. see *leachate, porous paving, salinity, total catchment management*.

**cellulose materials:** vegetable fibres; in building materials can include bamboo, cotton, flax, hemp, straw, thatch and timber and are considered renewable materials.

**charrette:** a design process, usually conducted over a number of days with a facilitator and various briefing materials and resources, enabling multidisciplinary teams, often drawn from many stakeholder groups, to collaboratively address a design project, problem or task to produce one or more optimal design options.

**chemical hazards:** physical (including explosiveness) or toxicological to life.

**corrosively:** toxicological hazards including irritation, allergic responses and carcinogenicity. see also *flammability*

**chilled beams/slabs:** achieved through the circulation of passively cooled water through piping in concrete floor/ceiling slabs or beams. (Case Study: Cas 19)

**chlorine (Cl):** A gaseous element of the halide group (which includes fluorine, bromine, iodine), present in some ozone depleting chemicals such as

chlorofluorocarbon (CFC) refrigerants; a catalyst in the destruction of stratospheric ozone and along with the organochloride family, responsible for a wide range of environmental and human health impacts; forming the main chemical link in the dangerous environmental substances dioxin, DDT, PCB's, CFC's and HFC's. (CSIRO/PACAI, 1996, Gelder, 1997, Greenpeace, 1996)

**chlorofluorocarbon (CFC):** a synthetic compound containing chlorine and fluorine; commonly used in various industrial processes and as refrigerants; prior to 1990, used as a propellant gas for domestic and industrial spray products; powerful greenhouse gases that deplete ozone in the stratosphere. see *hydrofluorocarbons, polyurethane*

**chlorofluorocarbon plastic:** polymers made with monomers composed of chlorine, fluorine and carbon.

**cleaner production:** continuous use and development of maintenance practices, management practices and technologies used in the manufacture of products and provision of services resulting in more efficient use of resources (including energy) and the reduction of waste and risk to the environment. see *eco-efficiency, industrial ecology*

**climate change:** attributed directly or indirectly to human activity, that alters the composition of the global atmosphere and is in addition to natural climate variability over comparable time periods; often used to describe global warming with environmental implications including temperature and sea-level rises, changes in rainfall and extreme weather event intensity and frequency, ground-water and atmospheric and ocean circulation patterns and locations, and displacement of ecosystems and commercial resources.

**climate rejecting:** a design approach that exclusively uses the building envelope and form to reject prevailing climatic elements, providing indoor comfort through mechanical systems and constraining the ability to minimise energy use.

**climate responsive:** a design approach that seeks to achieve year round comfort using exclusively passive means significantly reducing energy consumption. (Design Strategies: Des 2)

**climate zone:** a geographical area which is assumed to have uniform climatic characteristics throughout and adopted by the Building Code of Australia to define climate types in Australia.

**closed-loop recycling:** a recycling system in which a particular mass of material is remanufactured into the same product. see *eco-design, eco-redesign, design-for-disassembly, design-for-life*

**co-generation:** the simultaneous production of two forms of useful power from a single fuel source in a single process. see *sustainable energy, transitional energy*

**comfort:** the optimal degree of psychological and biological stability; in terms of the built environment, relating to the concept of shelter that achieves a safe and healthy environment. (Design Strategies: Des 12)

**commissioning:** generally of plant and equipment; the systematic checking-out and testing of new or refurbished plant and equipment in a building or facility to conform to the performance requirements defined in

the design specifications. see *post-occupancy evaluation*

**compost:** materials resulting from the controlled microbiological transformation of organic materials under aerobic and thermophilic (high temperature) conditions.

**composting:** a waste management option involving the controlled biological decomposition of organic materials into a relatively stable humus-like product that can be handled, stored, and applied to the land without adversely affecting the environment.

**composting toilets** or waterless toilets are not reticulated to sewerage infrastructure but degrade biosolids in-situ.

**compressed-earth blocks:** earth that is mechanically compressed into a block form by hydronic, pneumatic or manual means and often stabilised with cement or bitumen emulsion; generally having a higher compressive strength and better weatherability characteristics than adobe. see *earth construction*

**contaminated land:** artificial addition to the natural chemical levels of a site, usually defined only in terms of additions that are hazardous to human health or the environment; having a low ecological value and hence of low consumer appeal, costly to bring back into use.

**contingent valuation:** a technique for valuing non-market uses of a natural resource.

**cooling load:** the rate at which heat must be removed by cooling equipment to maintain the constant value assumed when calculating heat gain. see *thermal comfort*

**coolth:** coolness; in ESD refers to the ability to store cool temperature (usually in a thermal mass or as air) and redistribute to a internal space as required to passively lower ambient temperatures. (see Case Studies: Cas 19, 34, 36)

**copper chromium arsenic (CCA):** a powerful preservative most commonly used to treat softwoods for external use to provide protection against fungi, termites and wood boring insects; heavy metals (chromium and arsenic) used to produce this compound are what make it both an effective preservative and environmentally problematic; spills can leave short term residues of arsenic and long term residues of chromium in affected soil; arsenic and chromium are a known carcinogens with arsenic causing lung and skin cancers and chromium capable of causing damage to most bodily organs. (Willis and Tonkin 1998) see *bio-accumulation*

**cost-benefit analysis:** a method of evaluating projects or investments by comparing the present value or annual value of expected benefits to costs; the practical embodiment of discounted cash flow analysis; a useful technique for making transparent the benefits of upfront investments in sustainable design features or technologies. see *discounting, life-cost analysis*

**cradle-to-cradle:** design, industrial, management and economic activities which together ensure that materials and products are considered and accounted for throughout their life cycle, such that once their current useful life is complete they are returned to new use lives or functions rather than being relegated to the waste stream (McDonough and Baumgart 2002). see *eco-design/eco-redesign, design-for-life, recycling*

**creosote:** a timber preservative, used on both softwoods and hardwoods, a derivative of tar, not water soluble and is effective against both insect and fungal attack for timbers in ground contact or buried in sea water; toxic and a severe skin irritant and if spilt can migrate through soil indefinitely; recent initiatives have led to the development of a pigment-emulsified creosote (PEC) which is cleaner to handle and entails less hydrocarbon emissions during handling and application; treated wood should not be burnt in open fires, stoves or fireplaces. (Willis and Tonkin 1998)

**critical protection time (CPT):** a key determinant in the conduct of shade audits and subsequent design strategies to minimise exposure to ultra violet radiation (UVR); for a given site is the time of day and year when protection from solar UVR will be most important at that site; determined with site usage patterns as well as levels of UVR.

**cross ventilation:** the use of wind, temperature and pressure differences to ventilate a building naturally usually via windows or vents and orientation. (Edwards, 1996) see *passive design*

## D

**daylight:** a natural source of light which determines the internal Daylight Factor; consists of sunlight and cloud diffused sunlight both reflected by ground and adjoining surfaces. (Edwards, 1996)

**daylight transmittance:** the ratio of the amount of light transmitted through a window system (glass and frame) divided by the amount of light incident on its outside surface.

**daylight design:** the use of controlled natural lighting methods indoors, through skylights, windows and reflected light; diffuse reflection of light from matte coloured surfaces, sky illuminance and the performance of advanced glazing techniques, such as prismatic glazing and light shelves, are incorporated in radiosity based modelling tools and with integrated design approaches can maximise effective utilisation of daylight. see *energy efficiency, passive design*

**deconstruction:** in construction, referring to the disassembly of buildings specifically designed for reducing waste and increased efficiency in the demolition/reuse process.

**defuturing:** activities, processes and products which through the material, social, economic and/or cultural exchange relations which they generate, reduce rather than enhance the possibility of a future which can be sustained. (Fry 1999) see *ecologically sustainable development, sustainability*

**delivered energy services:** see *energy performance contracting*

**demand management:** technological, cultural and economic initiatives which alter practices so that the demand for materially intensive or environmentally deleterious services and products is reduced and the service or access is delivered either more efficiently or in new ways through new products and services.

**design-for-disassembly:** design practices which reflect life cycle considerations and explicitly incorporate

requirements for disassembly and deconstruction to enable the reuse or recycling of components and materials of a product or building at the end of its current use life; utilisation of reversible joining methods (e.g., for timber, steel or concrete and brick elements), and minimisation of complex composite materials which tend to be difficult to recycle. see *design-for-life*

**design-for-environment:** a tool used during product development in which the design of a product, process or facility is optimised, in order to minimise the environmental impacts of that product, and to facilitate recycling and remanufacturing. (Alsop, 2001)

**design-for-life:** a design philosophy and approach which incorporates consideration of the full life cycle of the product, building or material so that its current use life can be maximised and it can be readily returned to further use (via disassembly, recycling, reuse or remanufacture) at the end of its current use or life; not to be confused with design-life which is the intended functional life of a product.

**dieback:** general name for a significant decline in tree health and numbers, especially native trees; caused by a variety of agents, including insect attack, disease, pollution and other human-induced changes in the environment.

**direct gain:** passive radiant energy gain; usually referring to passive solar energy gain, admitted to an internal space as opposed to indirect gain methods (e.g. geo-thermal, thermal mass, Trombe walls, displacement ventilation).

**discounting:** a technique for converting cash-flows that occur over time to equivalent amounts at a common point in time; a decision-aiding technique enabling alternative investments to be evaluated and ranked, the rate of discount used is critical to the evaluation process and the validity of the outcome; can play an important role in design, procurement and construction processes which seek to appropriately incorporate consideration of environmental impacts and alternative design and technology options; energy efficient design and renewable energy plant and equipment are examples of key areas where discounting techniques may support sustainable innovation. see *payback period, whole-of-life costing*

**diurnal:** relating to or occurring in a 24 hour period; daily

**dryland salinity:** accumulation of soil salinity levels high enough to affect plant growth; occurs as a result of natural soil-forming process or in disturbed landscapes through clearing or other activities that interfere with the water and salinity balance to lead to shallow water tables; often associated with the clearing of trees and other vegetation which allows the watertable with soluble salts to rise, killing plants and creating bare erodable areas.

## E

**earth construction:** construction incorporating earth as a building material. see *adobe, compressed earth blocks, pise, rammed earth, stabilised earth*

**eco-design:** design philosophy and methodologies which foreground a material and social ethics of care into the products and processes which are designed, so that full life cycle considerations and social impacts are integrated

into the design problem, task and delivery of the product or process.

**eco-efficiency:** the delivery of competitively priced goods and services while progressively reducing ecological impacts and resource intensity throughout their life cycle; the seven components commonly identified with eco-efficiency are reducing the material intensity of goods and services, reducing the energy intensity of goods and services, reducing toxic dispersion, enhancing material recyclability, maximising sustainable use of renewable resources, extending product durability and increasing the service intensity of goods and services.

**ecolabelling:** environmental assessment of products based on third party certification; also known as Type I or third-party environmentally preferred labelling under the series of ISO 14000 Standards.

**ecological costs:** the direct and indirect costs to ecology by certain actions or procedures. see *natural capital*

**ecological footprint:** a measure of environmental impact defined 'as the area of productive land and water ecosystems required to produce the resources that the population consumes and assimilate the wastes that the population produces, wherever on Earth that land and water may be located'; calculated by totalling the flows of material and energy required to support an economy or subset of an economy which are then converted to standard measures of production required from land and water areas and the total land surface required to support any given activity or product is the footprint (Krockenberger et al, 2000; Hawken et al, 1999); the area of land that is needed to produce the natural resources a population consumes and to assimilate the wastes that it produces.

**ecologically sustainable design:** the use of design principles and strategies which help reduce the ecological impact of buildings e.g. by reducing the consumption of energy and resources, or by minimising disturbances to existing vegetation.

**ecologically sustainable development (ESD):** a term which came to prominence in Australia following the World Commission on Environment and Development (*Our Common Future*, 1987) and the Council of Australian Governments (COAG) National Strategy for Ecologically Sustainable Development (NSED 1992); no singular definition is universally agreed, reflecting its overall complexity and the various emphases and interpretations which can be accorded to each of the descriptors within the term; frequently, ESD, sustainability and sustainable development are used interchangeably; the interpretation of the 'ecological' in Australian official definitions of ESD has oriented the term toward bio-physical issues and understandings of the ecological. This approach is progressively being opened up to more 'ecological' understandings of the systems relationships between the social, economic and environmental; that which meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1990); the following principles are said to be able to assist in achieving ESD: (1) the precautionary principle: where threats of

serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. (2) inter-generational equity: the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations. (3) conservation of biological diversity and ecological integrity: the conservation of biological diversity and ecological integrity should be a fundamental consideration. (4) improved valuation, pricing and incentive mechanisms: environmental factors should be included in the valuation of assets and services. see *sustainability*

**ecology:** the interrelationship of living things to one another and their environment and the study of such inter-relationships. (Davidson and Dolnick 1999) see *social ecology*

**economic, effective or useful life:** the timespan within which the building reaches the notional return on investment criteria; Tax Depreciation Rules (Australian Taxation Office 1991) define effective life as 'the estimated life over which an item could be expected to be used for income producing purposes'; common ESD objectives recast the 'end of life' economic thinking in how we value materials, products and components in order to act to ensure that they are restored or redirected to a 'new' use life once their current economic functional use life expires.

**ecosystem:** a level of organisation within the living world that includes both the total array of biological organisms present in a defined area and the chemical-physical factors that influence the plants and animals in it and interdependence is considered integral to ecosystems.

**eco-tourism:** nature based tourism that involves education and interpretation of the natural environment, including cultural components, managed for ecological sustainability.

**electromagnetic field (EMF):** a field with two components, one electrical and one magnetic, arising from the conduction of electricity through a medium of transmission. (Davidson and Dolnick, 1999)

**electromagnetic radiation (EMR):** fields that surround electrical conductors and equipment; generally associated with high voltage or heavy current power cables and with radio frequency transmitters, under increasing scrutiny with regard to a range of electrical devices and associated infrastructure (such as high voltage transmission lines, mobile phones and mobile phone towers); known to cause disturbances to electronic equipment such as hospital monitoring equipment and computers; measurable with specialist instruments, the cumulative health impacts of EMR, high and low frequency, is an emerging area of scientific research and debate; the emission or transfer of energy in the form of electromagnetic waves.

**embodied energy:** the energy required directly and indirectly to produce a product (which may be a physical entity or service); at a specific point in the life cycle of a product/material, accounts for all energy expended in production processes, transportation and maintenance of

that product/material ready for use at that point in time. see *gross energy requirement, process energy requirement*

**emissions:** the act of releasing or discharging air borne pollutants, particles or radiation from any source into the outdoor atmosphere; also the release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time. see *greenhouse gas, global warming potential, radiatively active gases, radiative forcing*

**emissions trading:** a market-based approach to achieving environmental objectives that allows those reducing greenhouse gas emissions below what is required, to use or trade the excess reductions to offset emissions at another source inside/outside the country; generally, trading can occur at the domestic, international and intra-company levels.

**emissivity:** the relative ability of a surface or material to emit radiant energy, compared to a perfect black body at the same temperature and with the same area, expressed as a ratio. (Milton 1994)

**energy (J):** the capacity to perform work (force x distance) which exists in various forms, including but not limited to kinetic, potential, electrical, radiant and can be converted readily from one into another; commonly used in relation to thermodynamic energy matters; SI unit joule (J), which is equal to one Newton metre (Nm) and one watt second (Wsec). (Milton 1994) see *embodied energy, operational energy*.

**energy audit:** an examination and analysis of building elements, environmental support systems (e.g. HVAC, lighting etc), fuel consumption records, operation and use patterns, and sometimes, code compliance; also assist in identifying opportunities for improving energy performance.

**energy efficiency:** in buildings, employing strategies to minimise the use of energy imported from utility companies (gas, electricity) required to maintain occupant comfort and building services that derive power from non-renewable, greenhouse gas producing processes. see *energy performance contracting*

**energy management program:** a program for the monitoring and control of energy use through (1) survey and measurement, (2) reporting, (3) analysis of reported data, (4) selection of a plan of action to reduce energy use, (5) implementation of selected energy management measures, and (6) monitoring of the energy use against the estimated energy budget (AS 2725–1984).

**energy performance contract (EPC):** also known as energy services/savings agreements (ESA) a contract that typically guarantees an energy consumption savings level by the energy service company; two basic types of EPCs are Guaranteed Savings and Shared Savings. (General Issues: Gen 38)

**energy performance contracting (EPC):** a turnkey service for the implementation of energy cost savings measures in buildings where the savings are guaranteed against some measure of performance; these two aspects, turnkey service and guaranteed performance, differentiates performance contracting from other traditional design and construction services. see

*guaranteed performance, energy service companies (ESCOs), shared savings.*

**energy rating tools:** computer aided conversions of calculation and assessment methods that specifically rate the operational energy or greenhouse gas emissions of a building. (Design Strategies: Des 33)

**energy service companies (ESCOs):** firms that offer turnkey performance based services. (General Issues: Gen 38)

**enhanced greenhouse effect:** the expected increase in the earth's temperature resulting from the increase in greenhouse gas concentrations released due to human activity. see *climate change*

**environment:** surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelations; in this context extend from within an organisation to the global system (AS ISO 14050).

**environmental accounting:** involves combining current financial accounting systems with concepts such as material flow and a balanced scorecard i.e. assigning dollar values to all inputs and outputs of the system; financial gains can be recognised from taking the whole-of-life approach and considering natural resources as capital, issues normally viewed as external to the business can be included, to factor in risks associated with potential social and environmental disasters, promoting the economic drive for environmental improvement, highlighting how financial, environmental and social impacts of a company are intrinsically linked. (Alsop, 2001)

**environmental aspect:** an element of an organisations activities, products or services that can interact with the environment. (AS ISO 14050).

**environmental audit:** systematic, documented verification process of objectively obtaining and evaluating audit evidence to determine whether specified environmental activities, events, conditions, management systems, or information about these matters conform with audit criteria, and communicating the results of this process to the client (AS ISO 14050). see *benchmark*

**environmental impact:** any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products, or services (AS ISO 14050).

**environmental impact statement (EIS):** a document, required by legislation, which describes a proposed development or activity, predicts the possible or certain effects of the activity on the environment, and outlines safeguards to mitigate or control environmentally damaging effects.

**environmental impact study:** a multi-disciplinary assessment of existing environmental conditions and the likely effect on a specified environment of the introduction of a proposed development or actions which may change the existing environmental conditions and ecological balance.

**environmental indicator:** a term used to provide information about environmental conditions or performance. (AS/NZS ISO 14031–2000).

**environmental management plan (EMP):** a management and communication process to enable the range of environmental aspects and impacts of a given activity (whether a design process, a project, or consultancy or corporate operation), to be systematically considered, addressed, monitored and reviewed to ensure compliance with regulatory, project and organisational environmental requirements, policies and objectives.

**environmental management system (EMS):** part of the overall management system that includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy (AS ISO 14050).

**environmental performance:** measurable results of the environmental management system, related to an organisation's control of its environmental aspects, based on its environmental policy, objectives and targets (AS ISO 14050).

**environmental policy:** statement by an organisation of its intentions and principles in relation to the overall environmental performance which provides a framework for action and for the setting of its environmental objectives and targets (AS ISO 14050).

**environmental rating system:** design and management systems which provide a framework for identifying, setting and reporting upon environmental design and performance objectives for buildings; provides industry with mechanisms for industry wide improvement and internal benchmarking while also providing a rating system through which to communicate the environmental performance characteristics of buildings to the community.

**environmental traffic capacity:** the limit of the impact of traffic (and, by implication, the amount of traffic, the type and speed of vehicles, and the behaviour of drivers) that is compatible with the types and levels of environmental criteria appropriate for a given type of area. see *carrying capacity, demand management, urban form*

**exotic species:** a species that originates from outside a habitat.

**extended producer responsibility:** a strategy by which producers accept the responsibility for the environmental impacts of products and services beyond the point of sale; focuses on recovering products at their end-of-life (EOL), rather than resorting to pollution abatement measures; potential to unlock and recover valuable resources and information in the product, otherwise destined for the waste stream and methods include product take-back, buy-back, trade in and servicing. see *design-for-life, precautionary principle, recycling, technical nutrient*

**externality cost:** costs and benefits other than those that are normally internalised in a conventional economic analysis.

## F

**factor efficiencies (Factor 4 and Factor 10):** discussed and published in the Carnoules Declaration (Wuppertal

Institute for Climate, Environment and Energy 1994) called for a radical leap in resource productivity and efficiency to reverse growing environmental damage; declaration began with the words 'Within one generation, nations can achieve a ten-fold increase in the efficiency with which they use energy, natural resources and other materials.'; a Factor 10 represents a 90 percent reduction in energy and materials intensity and Factor 4 represents a 75 percent reduction. (Hawken, Lovins and Lovins, 1999)

**facilities audit:** of the physical and functional adequacy of a facility, with particular reference to the building fabric and building services components, to provide an input for life cycle cost analysis, short-term maintenance planning, and long-term planning purposes.

**facilities renewal and replacement program:** a systematic and cost-effective approach to planning and budgeting, which extends the life and retains the useable condition of facilities and systems; may not be covered by the annual operating budget and may include (but not be limited to) the following: deferred maintenance, capital renewal and replacement, facilities remodelling and renovation for functional improvements, retrofitting for energy conservation, health and life safety problems, provisions for accessibility for people with disabilities, compliance with federal, state and local regulatory requirements. see *ecologically sustainable design, design-for-life, obsolescence*

**fly-ash concrete (FAC):** a light-weight concrete produced with pelletised fly-ash as aggregate produced from burning pulverised coal which is separated from flue-gases by electrical or mechanical dust extractors, and used as an admixture to cement.

**fly-wheel:** see thermal fly-wheel

**forest management certification:** involves an independent, third party assessment of field-level forest management practices and/or management systems against performance indicators of specified social, ecological and economic standards; also called forest certification, forest management auditing, or timber certification. (Timbershop) see *timber certification, wood-product certification*

**formaldehydes:** plastics once used for moulding a wide range of products (from ash trays to furniture and bench tops), formaldehyde resins are now more commonly used in buildings as adhesives, surface coatings, foams and in the manufacture of laminates and sandwich panels; can present a health hazard due to the tendency for off-gassing and care is required when working with them; good ventilation can assist in reducing the risks associated with formaldehydes and off-gassing release rates are increased by high humidity, moisture and temperature; release is also greater from cut edges of board and from unpainted surfaces; urea-formaldehyde (now considered potentially carcinogenic) is considered the worst while phenol-formaldehyde is more stable and provided the surface of the panel is well sealed, off-gassing can be minimised. see *off-gassing, indoor air quality, sick building syndrome*

**free running:** without mechanical cooling or heating systems operation; passive operation

**fuel cell:** an electrochemical device, like a battery, that combines hydrogen and oxygen to produce electricity, heat and water; source of hydrogen can be either pure hydrogen or a number of other fuels (such as methanol or other hydrocarbons) which are converted to hydrogen. see *sustainable energy, renewable energy*

**functional life:** the time-span within which building occupants can expect to operate without changes to the building design.

## G

**geo-thermal energy:** also known as ground-source energy, derived from heat stored within the earth's crust, either from hot water or steam that accompanies geothermal activity or by pumping water into geothermal boreholes to be heated to steam and then used to drive turbines and produce electrical power. see *renewable energy, sustainable energy*

**global warming:** the increase in the earth's temperature, in part, due to emissions of greenhouse gases associated with human activities, such as burning fossil fuels, biomass burning, cement manufacture, cow and sheep rearing, deforestation and other land-use changes. see *ground source heat pump systems, enhanced greenhouse effect*

**global warming potential (GWP):** numerical index that allows effects on global warming of various greenhouse gases to be compared, using the 100 year global warming potential (GWP) of carbon dioxide as a reference point where it has a GWP of 1, thus methane =21, and the GWP's of various hydrofluorocarbons range from 140–11,700.

**granulated blast furnace slag (GBFS):** blast furnace slag is a by-product of iron manufacturing, granulated using high pressure water jets dried to produce GBFS which is then ground and used as a supplementary cementitious material (SCM) or cement extender (Cement Industry Federation 1998); by adding SCM's or cement extenders a lower embodied energy cement is produced.

**green power:** electricity generated from clean renewable sources such as the sun, wind, water and organic matter; purchased by energy suppliers on behalf of their customers and independently audited and verified by the National Green Power Accreditation Steering Group.

**green roof:** vegetated roof which has the potential to assist in mitigating poor urban air quality and heat island effects, provide building thermal and acoustic insulation, stormwater retention/evapotranspiration, increased occupant amenity and biodiversity.

**greenfield's site:** a piece of usually semi-rural property that is undeveloped except for agricultural use, especially one considered as a site for expanding urban development.

**greenhouse debt:** a conceptual term pertaining to the amassed greenhouse gas emissions which a product, service or structure may have already have given rise to or caused to be effected through its creation; to be sustainable, a product, service or structure aims to 'payback' the greenhouse emissions for which it is responsible in its creation through the net greenhouse savings which it enables across its life cycle. For example,

photovoltaic cells need to payback the embodied energy of their production; accounting for new forests as carbon sinks needs to incorporate a due balance of the greenhouse emissions created by the processes of land clearing and soil disturbance (and consequent greenhouse emissions) incurred in the establishment of the forests. see *payback period*

**greenhouse effect:** the warming of the planet due to the increase in density of trace greenhouse gases in the atmosphere which have the effect of increasing the absorption of sunlight by preventing the outward radiation of heat from the Earth (see enhanced greenhouse effect); also, the internal warming of a building due to the absorption, usually through glass, of short-wave solar energy which is stored as heat by elements of construction and prevented from being re-emitted as long-wave radiation by the glass (Edwards 1996).

**greenhouse gas:** gases which contribute to the greenhouse effect, frequently referred to as 'carbon dioxide equivalent' since carbon dioxide is the most abundant greenhouse gas (followed by methane); some greenhouse gases occur naturally in the atmosphere, while others result from human activities, naturally occurring greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide (N<sub>2</sub>O), and ozone; certain human activities add to the levels of most of these naturally occurring gases and very powerful greenhouse gases that are not naturally occurring include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF<sub>6</sub>), which are generated in a variety of industrial processes; indirect greenhouse emissions (those which do not have a strong radiative effect themselves but influence the atmospheric concentrations of the above direct greenhouse gases) include carbon monoxide, oxides of nitrogen other than N<sub>2</sub>O and non-methane volatile organic compounds. see *radiatively active gases, radiative forcing*

**greenhouse gas sink:** any process, activity or mechanism which removes a greenhouse gas from the atmosphere. see *carbon sink*

**greenhouse intensity:** known as emissions factor, the time series data about the mass of a greenhouse gas emitted per unit of activity e.g. mass of CO<sub>2</sub> emitted per vehicle kilometres travelled.

**greywater:** a general term for domestic wastewater that has been stored after being used once for non-sewage utilities (such as showers, baths and washing machines), and has not come into contact with sewage or faecal matter. (Design Strategies: Des 13)

**greywater reuse system:** a system where greywater (wastewater but not soil or blackwater), is collected, not treated and reused for acceptable purposes. (AS/NZS 3500.0–1995).

**gross energy requirement (GER):** the measure of all energy inputs which contribute to the embodied energy of a component, material or whole building; includes a range of indirect energy inputs (such as the embodied energy in the manufacture and repair of processing and manufacturing equipment, embodied energy of transport infrastructures utilised in transporting materials) and direct inputs such as energy used in construction on

site; as a measure of embodied energy offers the most comprehensive measure of the comparative embodied energy of materials, components or buildings, however as a preferred measure of embodied energy it raises difficulties – foremostly access to correct, comparable data and Lawson recommends the use of the process energy requirement (PER) as a more readily accessible, firmer basis for comparing the embodied energy performance of materials (Lawson, 1996). see *embodied energy, process energy requirement*

**ground source heat pump systems:** also known as geo-thermal, a passive system that provides heating and cooling using ground water and earth as a medium to reject or absorb heat. (Technology: Tec 6) see *geo-thermal energy*

**guaranteed savings:** a minimum level of savings for the term of the energy performance contract (EPC) that accepts most technical risks for a project and whereby the client accepts the loan repayment obligation if a loan is required for project implementation; a guaranteed savings EPC splits the technical and financial risks between the energy service company (ESCO) and the client. (General Issues: Gen 38)

## H

**habitat:** the physical location or type of environment which sustains an organism or biological population.

**halons:** any of several halocarbons used as fire-extinguishing agents.

**hazardous waste:** component of the waste stream which by its characteristics poses a threat or risk to public health, safety or to the environment. (AS/NZS 3831–1998)

**heat gain:** as applied to heating, ventilation and air conditioning (HVAC) calculations, the amount of heat gained by a space from all sources including people, incoming and reflected radiation, machines, lights etc; represents the amount of heat that must be removed from a space to maintain desired indoor conditions. see *cooling load*

**heat island effect:** see *urban heat island effect*

**heat sink:** an environment or element capable of absorbing heat from another element with which it is in thermal contact (either direct or radiational contact).

**holistic design:** an integrative and comprehensive design approach that considers the interrelatedness of a project's parts, components, systems, and subsystems, in order to optimise energy and environmental performance during the whole-of life of a project.

**hot desking:** the practice of sharing dedicated work spaces between two or more persons, an emerging key area of workplace environment design.

**hybrid system:** a solar heating or cooling system that combines passive and active elements. (Brown 1985)

**hybrid analysis:** an energy analysis method which combines the benefits of process analysis (accuracy for particular processes) with those of input-output analysis (systemic completeness).

**hybrid solar energy system:** incorporates a major passive aspect, where at least one of the significant thermal

energy flows is by natural means and at least one is by forced means. (Stein, 1993)

**hydrofluorocarbons (HFCs):** toxic and flammable transitional replacements for CFCs, they are also greenhouse gases and contribute to ozone depletion; produced by the plastics industry to replace ozone depleting chlorofluorocarbons (CFCs) and considered to have approximately 5% of the ozone depleting potential of CFCs. (Lawson, 1996).

**indicator:** a measurement that reflects the status of some social, economic, or environmental system over time; derived from the Latin verb *indicare*, meaning 'to point out or proclaim'; generally, focuses on a small, manageable, tangible and telling piece of a system to give people a sense of the bigger picture. (Tyler Norris Associates et al, 1997)

**indigenous species:** originally (that is, before European settlement) found naturally in that locality or habitat. (Design Strategies: Des 40)

**indirect gain:** energy gain by non radiative means; usually referring to convective passive energy (e.g. geo-thermal, displacement systems, thermal mass, Trombe walls etc).

**indoor air quality:** the quality of air required within a work environment to minimise harmful effects to human health including the provision of adequate airspace and ventilation, and the limitation of contaminants or harmful substances such as dust, other airborne particles, fumes, mists or vapours, and smoke; generally requirements for workplaces are stipulated in occupational health and safety legislation.

**industrial ecology:** a concept and methodology through which an industrial system or process is understood in relation to its surroundings and other industrial systems, so that ecological connections can be better identified and acted upon to maximise efficiencies and optimise the overall environmental performance of the overall system and life cycle perspectives are adopted and attention paid to material and energy flows within the system e.g. symbiotic siting of complementary industries near one another so that waste from one industry can be used as a material input for another, an example of closed-loop thinking and using waste as a resource on a large scale; draws on the concept of retaining materials in the 'system' as long as possible to minimise raw material consumption, and pollution. (Alsop, 2001) see *cleaner production, precautionary principle*

**inert waste:** material which does not decompose very easily and is virtually insoluble in water.

**input-output analysis:** a method of analysis sometimes used in life cycle analysis where a statistical method is employed, drawing upon data from the Australian Bureau of Statistics showing financial flows (inputs and outputs) between all sectors of the economy and these flows are converted to energy flows used to produce data wherein the upstream energy requirements from all sectors to any one sector are summed; this method, unlike process analysis, is systemically complete however

it is necessarily subject to assumptions and errors. see *embodied energy, process analysis, hybrid analysis, process energy requirement, gross energy requirement*

**insolation:** the total amount of direct, diffuse, and reflected solar radiation incident on a unit horizontal surface at the top of the atmosphere; sometimes referred to as solar irradiance; the latitudinal variation supplies the energy for the general circulation of the atmosphere; dependant on the angle of incidence of the solar beam and on the solar constant and commonly measured in kW per m<sup>2</sup> per day and referred to as peak hours per day.

**insulating glass unit (IGU):** a hermetically sealed, multiple-pane glazing system consisting of two or more glazing layers held and bonded at their perimeter by a spacer bar; thermal heat transference reduced compared with single glass; double-glazed or triple-glazed as opposed to single glazed.

**insulation:** material having a relatively high resistance to heat flow and used primarily to retard the flow of heat and mandatory insulation requirements are now helping to ensure more energy efficient building design and operation.

**integrated design:** a design process which mobilises multidisciplinary design input and cooperation, ideally to maximise and integrate environmental and economic life cycle benefits; a process that delivers value by understanding impacts across a broad range of disciplines during design; can also describe a resulting solution or building/services system, the physical integration of services and building components. see *alliancing, charrette, energy performance contracting, partnering*

**integrated planning:** defined as the process of planning transport, land use and the environment on the basis of common goals, objectives and desired outcomes. (Westerman, 1998)

**intelligent buildings:** building designed with extensive use of sensors, microprocessor controls, and automated systems and able to detect, diagnose, and control the response to varying environmental conditions or operational requirements together with the use of integrated management systems generally results in improved performance and cost savings through conservation of energy and other resources.

**intelligent transport systems:** utilising information and communication technology to improve links between the road, public and private sector vehicles and users, to contribute to traffic management, enhanced access to public transport services, and congestion and demand management strategies.

**interior amenity:** the interior environment based upon spatial quality, extent of natural daylight and indoor air quality. (Edwards, 1996)

**invasive species:** certain plant species which threaten or disrupt natural sites or waterways by their rapid reproduction. (Milton, 1994)

**inverter:** a device which can change direct current to alternating current without utilising moveable parts; a key component required in photovoltaic systems to enable electricity generated by the system to be exported to the grid and to enable alternating current

(AC) electrical devices to be operated using the energy generated on-site.

**ionising radiation:** electromagnetic radiation which is high enough in energy to cause an atom or molecule to gain or lose an electron, creating an ion; occurs above the ultraviolet band of the electromagnetic spectrum (Baggs, 1996).

**irrigation salinity:** caused by poor irrigation practices where more water is applied than can be used by the crop (garden) and by clearing of deep-rooted vegetation such as trees resulting in rising water tables bringing high concentrations of salt within the root zones of plants, killing and stunting vegetation (EPA, NSW, 2000). see *total catchment management*

**ISO 14000:** a series of voluntary international environmental management standards; provides a common framework for the management of environmental issues internationally republished in Australia by Standards Australia as AS/NZS ISO 14000 series. (General Issues: Gen 16)

**ISO14001:** specifies the requirements for an environmental management system (EMS) and an external certification authority can certify compliance.

## K

**kilowatt-hour (kWh):** a measure of electrical energy equivalent to a power consumption of 1,000 watts for one hour; a unit of electricity generally used to describe energy is generated by a photovoltaic system and is equivalent to the amount of energy consumed by a 100 watt light-bulb over 10 hours, where 1 kWh = 3.6MJ.

**kilowatt-hours peak (kWhp):** the maximum amount of power a photovoltaic module can generate under standard test conditions.

**Kyoto Protocol:** an international agreement reached in 1997 in Kyoto, Japan, which extends the commitments of the United Nations Framework Convention on Climate Change (UNFCCC); in particular, it sets targets for future emissions by each developed country over the first commitment period, and foreshadows further action over future commitment periods (2008–2012).

## L

**laminated veneer lumber (LVL):** an assembly of timber veneers laminated with adhesive in which the grain direction of the outer veneers and most of the other veneers, is in the longitudinal direction; generally sourced from plantation resources, the composite gives properties in many instances comparable to common hardwoods that are often not available in larger sizes.

**land capability:** land evaluation for broadly specified land uses (e.g., urban development, conservation, agriculture, forestry) and is a term commonly used in Land Resource Assessment (General Issues: Gen 37).

**land suitability:** the evaluation of the immediate potential of the land for a specific purpose in a precise biophysical, socio-economic and technological setting; commonly used in Land Resource Assessment (General Issues: Gen 37).

**landfill:** waste disposal site used for the controlled deposit of solid waste onto or into land (AS/NZS 3831–1998). *see methane power generation*

**landfill gases:** gases produced as the result of anaerobic decomposition of putrescible material – principally methane 60% and carbon dioxide 40% (EPA NSW and NSW TAFE, 1997) whereby their negative impacts can be reduced by capture and reuse, either directly and/or to generate electricity.

**leachate:** the liquid that passes through a landfill and by doing so, picks up contaminants from the deposited waste.

**Legionnaires Disease:** a respiratory disease caused by legionella bacteria found in some water cooled air conditioning systems whereby water stored in stagnant conditions between 30–40°C is contaminated by organic sources that can lead to the growth of legionella bacteria.

**life-cost planning and analysis:** describes total cost approaches encompassing a range of common terminologies including life cycle cost, recurrent cost, cost-in-use, operational cost and ultimate cost; incorporates economic costs, but does not include environmental externalities or costs for material end of life rehabilitation, reuse or recycling; should be understood as life cycle cost; currently generally defined as the economic assessment of competing design alternatives, considering all significant costs of ownership over the economic life of each alternative, expressed in equivalent dollars and the technique takes account of both initial design and acquisition costs and subsequent running costs and is measured over the assets 'effective life', generally considered as the economic or operating life; often aggregate costs under capital and operating expenses; more useful categories for consideration include capital, operating, and finance costs; increasingly recognised as essential for effective investment decision-making and for the integration of sustainable design and sustainable energy considerations into design and capital expenditure programs (Langston, 1997). *see life cycle cost analysis, whole-of-life costing, discounting, cost benefit analysis*

**life cycle:** consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal (AS/NZS 3831–1998); sustainable design objectives maximise the 'use' life of a material or product and ensure further 'use' lives for the material or product via reuse, refurbishment, re-manufacturing or recycling. *see ecodesign, ecodesign, design-for-life*

**life cycle assessment (LCA):** a technique for assessing the environmental aspects and potential impacts associated with a product or process, by compiling an inventory of relevant inputs and outputs; evaluating the potential environmental impacts associated with those inputs and outputs; and interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives (scope, boundaries and levels of detail) of the study (AS/NZS ISO 14040:1998).

**life cycle cost:** the sum of acquisition cost and ownership cost of a product over its life cycle (acquisition cost: the initial cost to gain possession of the completed

product and includes any research, development, testing and evaluation costs, as well as the investment and installation cost; ownership cost: summation of all operating expenses, maintenance, support and disposal costs borne by the owner or user of a complete product during its life cycle) AS/NZS 4536–1999.

**life cycle cost analysis:** a technique which enables a comparative cost assessment to be made for various investment alternatives, over a specified period of time, taking into account all relevant factors, both in terms of initial capital costs and future (estimated) costs with the objective being to identify the most economic overall choice and initial costs include all investment costs directly related to the project, such as the costs of planning, design, construction and installation, fees and changes, and financing costs, and future costs and future costs mainly comprise operating, maintenance, rehabilitation, demolition or removal costs, and property and capital gains taxes (Milton, 1994).

**life cycle energy:** the energy attributable, in the case of a building, to the energy used in operation over its lifetime, together with the embodied energy and the added embodied energy as the building is maintained and refurbished or altered, over its lifetime.

**life cycle inventory analysis:** phase of life cycle assessment involving the compilation and quantification of inputs and outputs, for a given product throughout its life cycle (AS/NZS ISO 14040:1998).

**light shelves:** a means of deflecting incoming daylight deeper into an internal space; generally horizontal projections with reflective surfaces placed either outside, half outside/half inside or fully inside a window, providing indirect light deep into an interior space, while reducing solar gain and glare; effectiveness depends upon window height, room height and depth, and the dimensions, surface finish and positioning of the light shelf.

**light organic solvent preservative (LOSP):** a timber preservative suitable for external, above ground use; comprises of solutions of organic fungicides and insecticides, often containing water repelling agents; not as toxic as CCA however still contains synthetic pyrethroid insecticides and organic fungicides (such as tributyltin compounds).

**lighting level:** the level of illumination inside a facility usually measured in light (1 lux = 1 lumen per square metre) which can be determined with the help of specialist equipment; Australian Standards have documented prescribed lighting levels for the different types of activities/spaces in a building. (FMA, SA, 1997)

**liveability:** emerging term becoming enshrined in planning discourse, means developing urban forms, which provide security, identity, historical continuity, cultural significance and healthy living.

**load:** the demand for energy required at any moment to compensate for the difference between existing outdoor conditions and desired indoor conditions (Brown, 1985).

**load collector ratio (LCR):** the ratio of the building load coefficient to the collection area. LCR is an expression of the relationship between energy conservation and solar

gain and can be used to compare buildings within the same locality (Brown, 1985).

**low-emittance (low-e) coating:** a thin (<100nm thick) metal oxide or multi-layer coating deposited on a glazing surface to reduce its thermal infrared emittance and thereby reduce radiative heat transfer; near-infrared transmittance may also be reduced depending on whether solar heat is to be rejected or admitted behave as heat mirrors; increases a window's ability to insulate (lower U-value) and also includes spectrally selective coatings which are low-e coatings, on one or more surfaces of a glazing, whose optical properties vary with wavelength, so as to transmit visible radiation more than near-infrared and long-wave radiation (AWC, 2000).

## M

**maintenance:** all actions necessary to retaining an item or asset in, or restoring it to, its pre-existing condition; the Facilities Management Association defines a number of forms which reflect different life cycle management strategies including condition, corrective, deferred, operational, periodic, planned, preventive, programmed, routine, routine corrective, running, shutdown and statutory maintenance approaches (FMA, SA, 1997).

**maintainability:** the ability of a product, under stated conditions of use, to be retained in, or restored to, a state in which it can perform its required functions, when maintenance is performed under stated conditions and using prescribed procedures and resources (AS/NZS 4536–1999).

**materials recovery facility (MRF):** plant and equipment for sorting and pre-processing materials from the waste stream for resource recovery (AS/NZS 3831–1998).

**medium density fibreboard (MDF):** a reconstituted wood product frequently used for detail joinery, mouldings, skirtings, architraves and cornices and for stair construction; generally comprised of softwood fibres and formaldehyde resin adhesives which can present a potential health hazard to workers during construction or occupants subject to off-gassing from them; urea-formaldehyde is considered the worst offender while phenol-formaldehyde is more stable and provided the surface of the panel is well sealed, off-gassing can be minimised. *see volatile organic compounds (VOCs), formaldehyde, sick building syndrome*

**methane (CH<sub>4</sub>):** colourless, odourless, inflammable gas released from decaying organic material; a powerful greenhouse gas with a global warming potential (GWP) of 21. *see global warming potential, landfill gases*

**methane power-generation:** trapping methane gas emissions from putrescible (decomposing) landfill (also called methane recovery) and using the gas as a power source (General Issues: Gen 21).

**micro-climate:** the climatic environment in a very small or confined local area with a climatic region which may be modified by the creation of artificial lakes or planting of trees; usually differs with altitude and varies from regional averages in humidity, temperature, rain shadows, wind patterns, cloud cover etc (Milton, 1994).

**mixed-mode ventilation:** natural ventilation involving operable windows combined with mechanical air change

usually with an emphasis upon local control of the environment (Edwards, 1996). *see passive design*

## N

**national estate:** places, being components of the natural environment of Australia, or the cultural environment of Australia, that have aesthetic, historic, scientific or social significance or other special value for future generations as well as for the present community (Commonwealth of Australia, 1975).

**native forest:** a forest or woodland in which the tree species are predominantly native to the locality in which the forest occurs and where natural regenerative processes operate either fully or in part for the recovery of canopy structure following natural or artificial disturbance (Clarke, 1995).

**natural capital:** can be viewed as the sum total of the ecological systems that support life, different from human-made capital in that it cannot be produced by human activity.

**natural cooling:** the use of ground cooling, night time radiation loss and purging, cross ventilation and evaporative cooling to reduce internal temperatures or improve thermal comfort i.e. cross ventilation doesn't necessarily reduce internal temperatures, but has a cooling effect on bodies thus improving thermal comfort.

**natural turpentine:** a solvent obtained by distilling the oleoresin of pine trees and used as a solvent and thinner for paint; also known as 'vegetable turpentine' and 'wood turpentine' (Milton, 1994).

**natural ventilation:** ventilation by natural (non-mechanical) air flow through fixed ventilators, doors or open-able windows and louvres due to differences in thermal and/or pressure gradients and relying on natural convection.

**naturalised:** a non-indigenous species which self-propagates after being introduced to an area (Design Strategies: Des 40).

**net energy analysis:** a method of evaluating the life cycle performance of energy efficiency features and devices, comparing the 'energy pay back period' and the 'energy return on investment'.

**net present value (NPV):** is the sum of the discounted present values of net benefits over the life of a project (asset or piece of equipment); commonly considered one of the most useful methods employed for determining project/investment/capital equipment selections and useful for making transparent the benefits of investment in ESD features which may entail comparatively greater upfront investments, the financial benefits of which are returned over the life of the asset in operation when compared to more conventional technologies or features. *see life cycle cost analysis*

**night purging:** generally refers to the flushing out of an internal space, particularly with a high thermal mass component, with lower night temperature and humidity levels, capitalising on diurnal temperature swings to naturally cool down built up heat from daily gains, thus charging the thermal mass with coolth for the following day. (Case Studies: Cas 19, 34, 36)

**no regrets:** with respect to climate change, actions which result in greenhouse gas limitations and abatement, but which do not require additional economic costs in the short to medium term.

**noise rating:** a single rating of noise in a given acoustic environment intended to rank its undesirability for human activities; it is derived by a special procedure (AS 1469), using numerical or graphical means, from a frequency analysis of the sound pressure in the environment (Milton, 1994).

**non-renewable resources:** a natural resource considered finite in supply because of its scarcity, rapid depletion or extreme length of time to reproduce (AS 1886 Supp1–1994).

## O

**obsolescence:** buildings and other physical assets held on a long term basis that have limited useful or economic lives i.e. their service potential declines over time to a point where, for all practical purposes, it is used up or lost (Australian Accounting Standard: AAS 4 1993); can be measured in terms of the decrease in a building's value, i.e., depreciation, which is a measure of the wearing out or reduction in the economic life of a fixed asset whether arising from use, passage of time or through technological or market changes; often a result of cultural change rather than of physical deterioration or failure and is thus something that is amenable to cultural change strategies to forestall its onset. (Design Strategies: Des 31) see *sustainability*

**off-gassing (outgassing):** the emissions from a process, equipment, material or product occurring under 'normal' conditions within an indoor environment as it cures or ages (American Institute of Architects, 1996); common emission sources are paints, adhesives, synthetic floor coverings and laminates and some can have irritating, toxic or carcinogenic effects on human health, particularly volatile organic compounds (VOCs) and formaldehydes (Willis and Mellick, 1999). see *volatile organic compounds, formaldehydes*

**open-loop recycling:** a system in which a product from one type of material is recycled into a different type of product.

**operational energy:** the energy used in the day to day operation of a building including energy used for space conditioning (heating and cooling), cooking, refrigeration, lighting and appliances and other equipment.

**operations and maintenance manuals:** manuals provided by the services engineering contractors after setting up a new installation of electrical/mechanical/hydraulic/fire protection services for a facility (FMA, SA, 1997) that can play a key role in the life cycle management of energy and environmental performance of buildings. see *energy rating tools, environmental ratings systems, total building commissioning services*

**organic solvents:** includes in many building products such as paints, adhesives and some laminates which are a health and environmental hazard in application, use and disposal as opposed to water-based, solvent-free materials and cleaning agents (Edwards, 1996).

**organochlorines:** widely used generally stable chlorine based products resistant to natural breakdown processes and are accumulated in food chains (CSIRO/PACAI, 1996, Gelder, 1997, Greenpeace, 1996).

**overall insulation level:** the total resistance of a building element, taking into account resistances of construction materials, internal air spaces, insulation, and air films adjacent to solid materials.

**ozone (O<sub>3</sub>):** triatomic form of oxygen formed naturally in the stratosphere by a photochemical reaction with solar ultraviolet radiation providing a protective layer shielding the Earth from ultraviolet radiation; a greenhouse gas, it is usually formed from anthropogenic emissions and is a major component of photochemical smog in the troposphere. (Stein, 1993).

**ozone depletion:** the reduction in the concentration of stratospheric ozone as a consequence of chemical reactions caused by chlorofluorocarbons (CFCs) and other halons; reduced stratospheric ozone concentrations have resulted in increased levels of ultraviolet radiation reaching the earth's surface. see *chlorofluorocarbons*

**ozone layer:** a layer in the stratosphere containing a high concentration of ozone that absorbs most of the sun's ultraviolet radiation (Moore, 1997).

## P

**participatory design:** a design process in which all stakeholders of the project are included and outcomes include a physical design and an increased participant awareness of the implications of a building's production, future use, and eventual alteration, reuse or disposal (General Issues: Gen 2). see *charrette*

**particleboard:** a reconstituted wood product generally manufactured from softwood (although hardwood may be used) and formaldehyde resin adhesives which can present a potential working and/or indoor health hazard. see *formaldehydes, sick building syndrome*

**Passive design/passive solar design:** an integrated building design approach in which thermal energy is collected and stored by natural means exploits a building's orientation, layout and form and the choice of building materials in relation to solar radiation to modify the indoor climate and thermal comfort and reduce building energy requirements; focuses on the admission of desirable radiation, the prevention of heat losses, and the storage of excess energy for subsequent use. (Milton 1994, Baggs, 1996)

**passive solar gain:** direct admittance of winter solar heat to a building via equator-facing windows, to reduce or eliminate bought heating energy. (AWC, 2000)

**passive system:** a system of heating and/or cooling for buildings by natural energy sources without any electrical or mechanical assistance (Milton, 1994).

**payback period:** a popular non-discounting project selection technique used when organisations require the capital investment of a project to be recovered within a specified period; the period it takes for the stream of net cash flows to equal the initial investment; a term is gaining increasing use in the evaluation of sustainable and renewable energy options, wherein greenhouse

or greenhouse intensive energy savings which the technology may enable over its useful life, are assessed in relation to the embodied energy required for its manufacture; for renewable energy systems, it can also be used to refer to the period of time over which energy cost savings derived from accessing renewable energy offsets the up-front capital costs of the system. *see life cycle cost*

**peak cooling load:** the delivered cooling capacity (in kW) required to cool a space down to the thermostat setting in one hour on the hottest day in the climate data file.

**peak heating load:** the delivered heating capacity (in kW) required to heat a space up to the thermostat setting in one hour on the coldest day in the climate data file.

**perfluorocarbons (PFCs):** a by-product of aluminium smelting and uranium enrichment and a powerful greenhouse gas (IPIECA, 2000).

**performance based selection:** selection of consultants or service providers against specified performance targets (such as energy efficient design and operation or other environmental performance criteria), the achievement or exceeding of which are reflected in incentive based remuneration structures. *see qualification based selection*

**performance based contracting:** a technique that mainly utilised in the energy industry with the potential for being applied to many parts of business activity where a third party contractor takes responsibility for the management of a specific part of the business, adopting the risk for managing that part of the business and receiving financial rewards for making increased efficiency that are shared between the contractor and the business owner. (Environment Australia) *see energy performance contracting*

**performance indicator:** a quantitative or qualitative measure of the quality of service, efficiency, productivity or cost-effectiveness of an agency, program, or activity which enables a comparison to be made of performance against a standard or defined target or norm.

**permaculture:** primarily about establishing the conditions that enable people to be more self reliant; the conscious design of agriculturally productive ecosystems which have the diversity, stability and resilience of natural ecosystems; the harmonious integration of landscape and people providing the food, energy and shelter and other material and non material needs in a sustainable way. (Mollison, 1988)

**piase:** prepared earth or clay, sometimes mixed with straw or gravel, rammed between formwork, to provide monolithic walling. *see earth construction.*

**phase change materials (PCMs):** environmentally benign salts or organic compounds with variable environmental credentials, which store and release latent heat by changing chemical bonds through a phase transformation, unlike conventional heat storage materials such as water or masonry, which change structure mechanically. (Centre for Sustainable Engineering, UK, 2005)

**photovoltaics:** devices which capture photons of light from solar insolation (light) and convert it into electrical energy stored as direct current (DC); typically solid

state devices, often made from silicon and expanding to include technologies based upon a range of thin film and other material technologies.

**physical or technical life:** the timespan within which a building meets the technical performance criteria in a given maintenance strategy.

**plenum:** a condition, space, or enclosure in which air or other gas is at a pressure greater than that of the outside atmosphere.

**plywood:** an assembled, composite timber product, comprised of layers of softwood and/or hardwood (often rainforest) veneers, bound through heat pressing and the use of formaldehyde resin adhesives, with the direction of the grain in alternate plies usually at right angles; four bond grades are given by the Standards Association of Australia for a range of structural and architectural applications including concrete formwork and the formaldehyde content raises indoor air quality issues. (AS/NZS 4491–1997) *see formaldehyde, sick building syndrome*

**pollution control:** activities designed to control contamination of the environment (Milton, 1994).

**pollution-intensive industries (PII)**

**polychlorinated biphenyls (PCBs):** a group of synthetic chlorinated organic compounds, toxic to humans and identified as a carcinogenic substance, that were used mainly in older type electrical capacitors (ballasts) for fluorescent luminaries or in transformers (Milton, 1994).

**polyurethane (PUR):** a common plastic polymer used in the building industry, until recently produced via a foaming process using the blowing agent CFC-11 and water; currently being phased out in accordance with the Montreal Protocol agreement due to its toxicity and global warming potential (GWP). (Institution of Engineers, 1997). *see chlorofluorocarbons, hydrofluorocarbons*

**polyvinyl chloride (PVC):** used to make a wide variety of building products, the main application being in pipes and associated fittings and associated with a number of adverse environmental impacts including disposal methods (in Australian building sites most is in landfill); environmental concerns include the addition of stabilisers of heavy metals, such as lead and cadmium, for some applications and the emission of volatile organic compounds (VOCs) during production and/or from incineration; high density polyethylene (HDPE) and fired clay are considered as preferable alternatives to PVC piping, in terms of performance and environmental impact advantages. (Products and Materials: Pro 14, UNESCO, 1995)

**porous paving:** any paving system designed to reduce runoff and facilitate groundwater recharge; different proprietary products are available for pedestrian and trafficable areas and where used in landscaping applications can reduce or eliminate the need for irrigation. *see catchment, native vegetation, salinity*

**post-occupancy evaluation (POE):** a systematic way of comparing actual building performance with stated performance criteria usually undertaken by organisational or facility managers; usually undertaken

after the building has been occupied for at least one year and seeks to measure and evaluate user satisfaction, fitness for purpose (based on client requirements), technical performance and value for money; developed in the 1960s, still a young field that requires further research and development and comprehensive application to integrated ESD and energy efficient design initiatives which may need to be explained and promoted to building managers and occupants. *see extended producer responsibility, total building commissioning services*

**potable water:** water that is satisfactory for drinking, culinary and domestic purposes and meets the requirements of the health authority having jurisdiction; free from impurities that could cause disease or harmful physiological effects and whereby bacteriological and chemical quality must conform to the regulations of applicable codes (Stein, 1993).

**precast:** concrete building elements (structural and non-structural walls, floors/ceilings, structural beams and columns and the like) prefabricated off-site as opposed to cast in-situ (on site) and can include pre-tensioned and post-tensioned members. (NPCAA, 2003)

**precautionary principle:** when-in-doubt-don't; moves the onus of proof from the recipient of the effect to the manufacturer, specifier or agent of the effect; forms part of the Intergovernmental Agreement on the Environment (agreement among the States, Commonwealth and Local Government) and enshrined in many international treaties (Principle 15 of Rio Declaration, 1992); states that where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation (IGAE, 1992).

**prefabrication:** fabricated or manufactured prior to delivery and on-site assembly or placement.

**primary energy:** the energy of a fuel source that has not undergone any processing to alter its nature and convert it into useful energy, such as crude oil or natural gas at the wellhead, or coal at the pit (Milton, 1994). *see secondary energy*

**process analysis:** a method for determining the energy requirements of a particular process and a limited number of upstream processes. (Design Strategies: Des 35) *see process energy requirement*

**process energy:** energy input required for a unit process to operate the process or equipment within the process excluding energy inputs for production and delivery of this energy (AS/NZS ISO 14041–1999).

**process energy requirement (PER):** is that component of the Gross Energy Requirement (GER) of a material or component which directly relates to the manufacture of the material or component; in the absence of comprehensive, comparable and publicly available full life cycle analyses of the embodied energy of building materials and components, generally more readily accessible and considered a useful basis for comparing building materials and components in terms of their embodied energy; generally thought to be within the vicinity of 50–80% of the GER. (Lawson, 1996) *see embodied energy*

**product stewardship:** managing the life-cycle of a product or service from 'cradle' to 'grave', to systematically limit its direct and indirect impacts on the environment at all stages of that 'life'; involves taking an holistic approach, and is often underpinned by the related concepts such as extended producer responsibility, shared producer responsibility and environmental stewardship (Alsop, 2001). *see design-for-life, extended producer responsibility, life cycle*

**puddled earth:** clay-rich soil prepared by mixing with water and tempering for the production of adobe blocks. *see adobe*

## Q

**qualification based selection (QBS):** consultant selection based on the qualification and capacity of that consultant to meet the specific objectives in a project and fees are negotiated once the preferred consultant is chosen and where if, after negotiation, the preferred consultants fee for the project is beyond the client's budget the second ranked consultant is asked to detail the project and negotiate a fee; Australian Auditor General and the Australian Competition and Consumer Commission agree that QBS provides required probity and meets competition guidelines. *see performance based selection*

**quality audit:** a systematic and independent examination to determine whether quality objectives, management activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives (AS 3911.1–1992/NZS 10011.1–1992/ISO 10011.1–1990).

## R

**R-value:** a measure of the thermal resistance of a building element or material; the reciprocal of the U-value; thermal resistance of a window, wall or other building element where units are measured in m<sup>2</sup>.K/W (SI units) or ft<sup>2</sup>.hr.<sup>o</sup>F/Btu (US units). (AWC, 2000) *see U-value*

**radiatively active gases:** gases that absorb incoming solar radiation or outgoing infrared radiation, thus affecting the vertical temperature profile of the atmosphere; most commonly are water vapour, CO<sub>2</sub>, methane, nitrous oxide, chlorofluorocarbons, and ozone. *see greenhouse gas*

**radiative forcing:** a change in the balance between incoming solar radiation and outgoing infrared radiation in the absence of which solar radiation coming to the Earth would continue to be approximately equal to the infrared radiation emitted from the Earth; increased ongoing additions of greenhouse gases trap an increased fraction of the infrared radiation, radiating it back toward the surface and creating a warming influence i.e. due to incoming solar radiation exceeding outgoing infrared radiation. (US EPA website)

**rammed earth (pise-terre):** prepared earth rammed between formwork, similar to that used for poured (in-situ) concrete walls, to provide monolithic walling; generally requiring less processing of raw materials and embodied energy than fired building materials. *see earth construction*

**rangeland:** the internationally recognised term for land where livestock are grazed extensively on native vegetation, and where the rainfall is too low or erratic for agricultural cropping or for consistent pasture improvement.

**recharge area:** an area where water is absorbed in intake beds to be added to the groundwater body into the rock layer.

**recoverable resources:** materials which retain useful properties that can be reclaimed following the production or consumption process (AS 1886 Supp1–1994).

**recycling:** a cyclic process of respecting the ecological integrity of all products, materials and structures (natural or anthropogenic) by extending and/or adapting their form and or use so that their useful material cycle is not terminated via relegation to landfill or incineration; set of processes (including biological) for converting recovered materials that would otherwise be disposed of as wastes, into useful materials and or products; closed loop recycling – process in which the reclaimed output is used as an input to the same product system; open loop recycling – process in which the reclaimed output is used as an input to another product system. (AS/NZS 3831–1998)

**recyclable:** having the potential to be collected, processed and reused as a raw material for the manufacture of a useful new product through an existing commercial process. (AS 4082–1992)

**recycled timber:** wood products from post-consumer sources; processed timber or wood products which remain unused for a period of ten years or more. (Timbershop)

**reflective glass:** glass with a metallic coating to reduce solar heat gain. (AWC, 2000)

**refurbishment:** the remodelling, refashioning and general renovation of a building, site, product or social and community infrastructure.

**rehabilitation:** action to restore, regenerate, renovate and/or improve a building, site or catchment; usually involves action to improve past adverse environmental and/or social impacts.

**re-manufacturing:** industrial system and process whereby products and/or materials are refurbished for the same or a different use and the design for which ensures the inclusion of features which enable products to be refurbished, upgraded or manufactured for other use.

**remediation:** the action or measures taken/to be taken, to lessen, clean-up, remove or mitigate the existence of hazardous materials existing on a property to such standards, specifications or requirements as may be established or required by federal, state or local statutes, rules or regulations. (Davidson and Dolnick, 1999)

**remnant vegetation:** any patch of native vegetation around which most or all of the native vegetation has been removed and may include corridors or islands of vegetation located on land with a variety of tenure. (NCC website)

**renewable energy:** any source of energy that can be used without depleting natural reserves; for the purposes of the Australian 2% renewable energy target, includes solar, wind, ocean/wave/tidal, hydro-, geothermal, biofuels (landfill gas, biogas, biomass), specified wastes (biomass by-products of agricultural crops but excluding broad-scale land-clearing for agricultural purposes, biomass by-products of sustainably managed forestry operations, biomass by-products of food processing and production industries, sewage treatment, biomass component of mixed municipal wastes, other biomass wastes (as approved by regulators), solar water heating, hydro- pump storage, Renewable Stand Alone Power Systems or Remote Area Power Systems (RAPS), co-firing renewables with fossil fuels and fuel cells using a renewable fuel. (AGO, 2000)

**renewable materials:** organic materials (that by definition contain carbon) used as carbon sinks and are degradable. (Products and Materials: Pro 10)

**renewable resource:** natural source of material that is capable of regeneration. (AS/NZS 3831–1998)

**renovation:** renewing the building fabric and installations to their former condition (Design Strategies: Des 38).

**resource depletion:** the systematic reduction of finite resources from useful life, by complete consumption or by degrading them (via use or transformation to forms from which they cannot be usefully extracted or remodelled for reuse) or by relegating them to the waste stream.

**resource recovery:** processes that extract material or energy from the waste stream. (AS/NZS 3831–1998) see *ecodesign/coredesign, design-for-disassembly, industrial ecology*

**retro-fitting:** improving the building fabric and installations for higher performance and new uses. (Design Strategies: Des 38)

**reuse:** using a product again for the same or different purpose without further manufacture. (AS 4082–1992)

**revegetation:** reinstating, regenerating or replanting indigenous or naturally occurring site specific (with respect to soils, topography and climate) vegetation (flora) to preserve biodiversity in terms of flora and fauna.

**reverse brick veneer construction:** refers to a method of construction that exposes the thermal mass (generally masonry or concrete panels) to the internal space thus capitalising the heat storage potential to assist in passive thermal.

**reverse disassembly:** reverse manufacturing, in which the removal of screws, clips, and other fasteners permits refurbishment and reuse of some or all of the components and modules of a product.

**riparian land:** land with frontage along a river, watercourse or other body of water.

**rural salvage:** the practice of removing material for timber or wood product use, including but not limited to mining, forestry, agriculture and clearing outside metropolitan boundaries. (Timbershop)

**S**

**salinity:** the presence of salts in soil, which results in progressive infertility of land. (Moore, 1997) see *dryland salinity, irrigation salinity*

**salinity of water:** the concentration of chemical salts dissolved in the water usually expressed in milligrams per litre (mg/L) or parts per million (ppm). (Milton, 1994)

**sandwich panels:** lightweight (metal clad) or high mass building elements; concrete sandwich panels refer to two layers of precast or cast in-situ concrete layers with a interlayer of insulating material.

**secondary energy:** the energy contained in a fuel source at its point of use after processing and distribution; whereas primary sources, such as coal, is used to generate electricity as the secondary source of energy; secondary energy consumption (e.g., kilowatt hours) at the point of use fails to account for the energy lost in the primary energy conversion and energy lost in transmission and distribution.

**secondary resources:** materials or objects recovered from the waste stream which can be used to provide energy and materials for reuse and recycling (AS/NZS 3831–1998).

**septic tank:** a watertight covered single or multiple chamber tank designed to receive sewage or sullage, or both, from a building that is isolated from or cannot be connected to a sewerage systems and allowed to flow slowly to separate solids from liquids by settlement where organic matter is decomposed (digested) by anaerobic bacterial action, and the clarified liquid effluent either discharged to absorption trenches or pumped (collected) and transported away (Milton, 1994).

**septic system:** a sewage disposal system which relies on bacterial action to break down the sewage, usually comprising a holding tank, a liquefying tank, and an effluent disposal line or trench. (Milton, 1994)

**shared savings:** where in a energy performance contract (EPC) the energy service company (ESCO) is the borrower and has an independent agreement with its lender for project funding; where the ESCO maintains the loan repayment obligations, not the client and the contract provides for an agreed sharing of the resulting savings from the project, not a minimum guarantee; the amount and percentage of share which the ESCO receives is calculated on the basis of the ESCO meeting their monthly repayment obligation and accepts the technical and financial risks. (General Issues: Gen 38).

**shower tower:** passive cooling tower where air and water gently fall to provide cool water for reticulation and cool air supply to condition internal space. (Case Study: Cas 36) see *spray mist cooling*

**sequestration:** the removal of greenhouse gases from the atmosphere by photosynthesis or technological measures through storage in a sink; may involve containing the gas physically without changing its chemical form, or more commonly fixing the gas within a different material through a chemical or biophysical process. (AGO, 2000) see *abatement, carbon sink, emissions trading*

**shading coefficient (SC):** the ratio of the solar heat gain coefficient (SHGC) of a glazing system, for a particular

angle of incidence, to that of reference with a clear single 3mm glass pane under the same conditions where the latter has a SHGC of 0.87, and thus the relationship between SC and SHGC for it is:  $SC = SHGC/0.87$  (AWC, 2000)

**sick building syndrome (SBS):** as it relates to people, a term coined over the past 10-15 years to describe conditions of illness or discomfort experienced by occupants in certain office buildings; symptoms can include headache, nausea, stress, ear, nose and throat irritations, coughs, mental fatigue and general lethargy; associated with a combination of factors including poor thermal, visual and aural comfort conditions and indoor air quality issues such as the presence of volatile organic compounds (e.g., formaldehyde and xylene, off-gassed from materials), other gaseous pollutants, microbiological contamination, dust and fibres and tobacco smoke; exacerbated when building occupants lack the ability to perceive natural conditions (daylight) and are unable to control their own internal environment conditions; design to minimise or mitigate requires a thorough appreciation of the toxicology of all materials and finishes, occupant interaction with external and internal environments and enhanced natural ventilation and lighting. (Edwards, 1996) see *formaldehydes, medium density fibreboard, passive design, post-occupancy evaluation, ventilation*

**social ecology:** the social relations of individuals and human organisations, within the social environment, and in inter-action with other environments (bio-physical, made, economic, political, information, symbolic etc). see *Ecologically Sustainable Development, sustainability*

**slag concrete:** a concrete in which blast furnace slag is used as aggregate; relatively light in weight and with good fire-resisting and thermal insulating properties.

**smart glazing/windows:** where thermal, solar and light transmitting characteristics can be varied dynamically in response to the application of an electrical signal. (AWC, 2000)

**solar collector:** components used in buildings to enable the capture of solar thermal energy for direct heat transfer, e.g. solar collectors for solar hot water systems or a feature window or space specifically designed to capture solar thermal gain.

**solar control glass:** tinted and/or coated glass that reduces the amount of solar heat gain transmitted into the building (AWC, 2000).

**solar energy:** the energy of the sun, which reaches the surface of the earth in the form of visible light, shortwave radiation, and near ultra-violet light.

**solar energy reflectance:** in the solar spectrum, the percentage or fraction of solar energy that is reflected from the glass surface. (AWC, 2000)

**solar energy transmittance:** percentage or fraction of ultraviolet, visible and near infrared energy within the solar spectrum (300 to 2500 nanometres) that is transmitted through the glass. (AWC, 2000)

**solar heat gain:** the heat gained due to direct and diffuse radiant energy from the sun, entering a building or falling on a surface and being conducted or radiated to

the interior.

**solar heat gain coefficient (SHGC):** the total solar heat gain divided by exterior solar irradiance; consists of the solar direct transmittance plus the inward-flowing fraction of absorbed solar energy that is re-radiated, conducted, or connected into the space; also known as total solar energy transmittance (TSET). (AWC, 2000)

**solar heat gain factor (SHGF):** hourly-averaged solar heat gain in  $W/m^2$  through a single 3mm clear glass based on average cloudless day and ground reflectance of 0.20 (US and Australian usage). (AWC, 2000)

**solar heating:** the use of heat from the sun to heat buildings, through direct solar transfer to a space or via another conduit (e.g. thermal mass such as stone, concrete, water or masonry) which stores and releases heat into spaces over time.

**solar hot water systems:** hot water systems in which the primary source of heating is provided by solar collectors which convert solar thermal energy to heat the water or other heat transfer fluids.

**solar panels:** panels which provide a platform for the interconnection of solar cells. *see photovoltaics*

**solar power:** energy obtained by converting solar energy to other useful forms; common forms include photovoltaics which convert light energy to electricity, and solar thermal systems, which directly transfer thermal energy to other applications, such as domestic solar hot water systems.

**solar shading:** the protection of a building from sunlight radiation by external (and sometimes internal) means of shading. Since the sun moves both seasonally and during the day, such shading is often adjustable (Edwards, 1996).

**solar thermal:** energy produced by using the sun's rays to heat a gas or liquid that then performs useful work, such as powering an electrical generator.

**solar transmittance:** fraction of direct-beam solar radiation energy transmitted by a glazing system but not including the inward-flowing fraction of the absorbed solar irradiance. (AWC, 2000)

**spill light (stray light):** light emitted by a lighting installation which falls outside the boundaries of the property on which the installation is sited. (AS 4282–1997)

**stabilised earth:** prepared earth for use in rammed, in-situ, adobe block construction or compressed earth to which a stabilising agent such as portland cement or a bituminous emulsion has been added to improve its weather resistance. *see earth construction*

**stack effect ventilation:** the draught that is created by warm buoyant air as it rises in a tall confined space such as a chimney, stairwell, atrium or lift shaft; a means of naturally ventilating and cooling a building e.g. the use of a building element, such as a stairwell or shaft, with a top vent used to extract hot air out and induct cool fresh air at a lower (usually) ground level.

**stand alone power systems:** sometimes referred to as remote area power supply (RAPS) systems; not connected to the power distribution systems of an

electric supply authority but supplied with power from one or more of a number of sources, including but not limited to photovoltaic arrays, wind turbine generator, micro-hydro generator or engine generator set. (AS 4509.1–1999)

**stormwater:** also known as rain water, the runoff due to rainfall from roofed areas (roof water), paved and unpaved areas (surface water) and from water bearing ground (subsoil water). (AS/NZS 3500.0–1995)

**straw-bale construction:** a method using baled straw (stalks of crops such as wheat, rice, oats or barley) and include structural options of construction (load bearing) where the bales are stacked as bricks and support roof loads, or as infill independent of a structural system; characteristic of high insulative properties and generally are a waste product from farms therefore considered a renewable material. (Gray and Hall, 2000)

**super-windows:** highly insulating usually employing three or more glazing layers, low-emittance coatings and inert gas fill instead of air or may be an evacuated window; U-value is below  $1 W/m^2.K$  and visible transmittance and SHGC usually in the range 0.4–0.7 (AWC, 2000).

**supplementary cementitious materials (SCM):** by-products of heavy industry and most commonly granulated blast furnace slag, GBFS, (produced from a by-product of iron manufacturing) and fly-ash (produced in coal powered power generation plants), (Cement Industry Federation 1998); used as a cement extender resulting in a lower embodied energy cement.

**supply chain management (SCM):** improving the processes and relationships that exist to support the provision of goods and services along a supply chain (i.e. a group of organisations that contribute to the provision of a final product or service); environmental gains include greater efficiency in distribution, better environmental management practices and identification of market opportunities for environmentally preferable goods. (Environment Australia, 1999)

**sustainability:** an emerging and expanding field of thought, practice, judgement and advocacy involving many stake-holders, interests and points of view; included in a range of definitions are a desired state, a wide ranging web of aptitudes, skills and abilities, an ethical and pragmatic imperative, the sum of the many actions and decisions which are effected daily in everyday life, politics and commercial practice to better sustain wellbeing; unlike ecologically sustainable development (ESD), it is not described in legislation, however in broad terms it shares and is the means by which many of the principles, concepts and objectives of ESD being put into practice; a complex and contested term, may be best defined as the ability of society and individuals to sustain the systems (natural, made, social, knowledge, symbolic, economic etc) of life on which society and individuals depend to sustain themselves and the ability to effect change and innovation to generate more sustainable inter-relationships between the systems of life, so that change in one part of the system enhances rather than depletes the ability of that which is essential in other systems to sustainably adapt and support life

and its diversity and involves the ability to envisage, consider and evaluate the inter-relationships, impacts and consequences between various systems or ecologies over time, across different sites and types of impact, prior to determining and then taking action in incremental and/or transformatory ways through avenues and means available to you. see *defuturing, ecologically sustainable development, ecologically sustainable design, social ecology*

**sustainable energy:** generally understood to refer to renewable energy and energy efficiency initiatives (management approaches, efficient technologies and demand side management initiatives); also considered to include transitional fuels, such as natural gas, which in the range of applications to which it can be applied, is generally substantially less greenhouse intensive than other fossil fuels.

## T

**technical nutrient:** synthetic materials able to be broken down and circulated infinitely in industrial cycles and recycled into the same or other products. (McDonough and Baumgart, 2002) see *biological nutrient, cradle-to-cradle*

**temperature gradient effect:** the exploitation of different temperatures of air (and hence density and pressure) to create currents, thereby ventilating a building, usually by natural means. (Edwards, 1996) see *stack effect ventilation*

**thermal comfort:** a variable level of perceived comfort based upon a combination of metabolism, clothing, skin temperature, room temperature and relative humidity. (Edwards, 1996)

**thermal mass:** the availability of a material to act as a storage medium for heat; measured as a function of a material's specific heat and its density; materials suitable for thermal mass are heavy (or dense) materials with the ability to store large amounts of heat energy (Des 4) and in construction terms refers, but is not limited, to concrete, masonry, earth construction or water walls or brick floors, brick, mud brick, rammed earth and water walls (General Issue: Gen 12).

**thermal flywheel effect:** the process whereby a thermal mass absorbs abundant energy and releases it when required to passively temper or moderate indoor temperature and humidity.

**timber certification:** the process of accreditation of wood products to a designated standard or process; may be divided into two distinct components including certification of the forest or plantation management practices, and certification of the wood product; developed internationally through the 1990's and currently a number of certification schemes are advocated by competing interests including, but are not limited to Pan European Certification, ISO 14001, Sustainable Forestry Initiative and Forest Stewardship Certification. (Timbershop, Willis and Tonkin, 1998) see *forest management certification, wood-product certification*

**top-down management:** where a large society with centralised political organisation and structure pursue

environmental and other policies affecting the whole state or country with the view that government leaders can have an overview of the state or country beyond the capacity of most citizens. (Diamond, 2005)

**total building commissioning services:** a new type of commercial service now offered in the United States which is designed to encourage and enable compliance with initial design intent for the delivery of energy, ESD and performance objectives across different stages of the procurement and process. (Malin, 2000)

**total catchment management:** the coordinated and sustainable use and management of land, water, vegetation and other natural resources on a catchment basis to balance resource use and conservation. (EPA NSW, 2000)

**toxic:** poisonous or injurious to life (animals, humans or plants) through contact or through systemic chains of effect in ecosystems.

**toxic waste:** waste materials that contain toxins or poisonous substances, and which require special precautions for handling and removal. (Milton, 1994)

**traffic calming:** the process of developing and implementing an acceptable relationship between traffic and the local environment, and setting priorities for different road and street users (Westerman, 1998); the introduction of physical measures such as speed humps, to reduce speeds of vehicles in favour of pedestrian safety. see *travel demand management, social ecology, urban form*

**transitional energy sources:** energy sources which can assist in the transition to a less carbon and greenhouse intensive future including natural gas for vehicles and electricity generation and fuel cells using non-renewable fuels. see *renewable energy, sustainable energy*

**transmissivity:** a standard measure of the ability of a material to transmit sound or radiation from one side of a material to the other.

**travel demand management:** initiatives to influence the level and/or mode of travel demand of a society, economy, region or locality; intelligent transport systems, urban and infrastructure design, information, integrated ticketing, pricing and other economic and financial incentives and disincentives are all influential strategies to produce more socially and environmentally sustainable travel behaviours. see *intelligent transport systems*

**triple bottom line reporting:** involves reporting on economic, environmental and social performance.

## U

**U-value:** coefficient of heat transfer; the rate of heat flow through a window or other building element, driven by a temperature difference across the element; measured as heat flow per unit area, per degree of temperature difference; also called the thermal transmittance or overall heat transfer coefficient. (AWC, 2000)

**ultraviolet radiation (UVR):** electromagnetic radiation from the sun, with wavelengths shorter than visible light; i.e., below 380 nanometres (AWC, 2000); that portion of the electromagnetic spectrum with a wavelength

shorter than those of visible light but longer than those of x-rays and mostly is normally absorbed by the stratospheric ozone layer; harmful to living matter when it reaches the Earth's surface and exposure to high levels can cause skin cancer, cataracts, suppression of the immune system in animals, and leaf damage and reduced yields in some plant crops.

**urban form:** encompasses the pattern and density of land use and the nature of transportation within cities and towns. (General Issues: Gen 33)

**urban heat island effect:** a dome of elevated temperatures over an urban area caused by the heat absorbed by structures and pavements due to waste heat from energy-using processes in a city. (General Issues: Gen 11)

**urban microclimate:** the local climate in a town, usually modified by the configuration of streets and buildings and the presence of planting. (Edwards, 1996)

**urban salvage:** the practice of removing from a site within metropolitan boundaries material for timber or wood products use (Timbershop website).

## V

**variable-air-volume (VAV):** air delivery systems using variable volume terminal units which regulate the quantity of air supplied to the occupied space according to the temperature within the space. If more cooling is required, more cold air is introduced into the space. In the best implementation of these systems, the central air handling unit fan speed is controlled to maintain a constant duct pressure. An interlock is arranged between the supply and extract fans; common in larger office buildings. (AGO, 2006)

**vapour barriers:** also moisture barrier; non-breathable, impervious to water vapour movement.

**ventilation:** intentional air flow through a building.

**visual comfort:** the perception of vision based upon relative brightness, clarity and even colour spread; generally, glare free conditions and artificial lighting colours close to natural lighting are preferred options. (Edwards, 1996)

**volatile organic compounds (VOCs):** chemicals that contain carbon molecules and are volatile enough to evaporate from material surfaces into indoor air at normal ambient indoor temperatures (off-gassing); can be natural or synthetic with examples from building materials including solvents, paints, stains, adhesives, carpeting, particle-board and other petroleum based products; can be off-gasses from a variety of interior sources including partitions, floor adhesives and coverings, curtains, upholstery, and newly painted surfaces; contain chemicals such as benzene or formaldehyde which can be toxic or carcinogenic to human health; also contribute to smog formation in the atmosphere. (Willis, A and Mellick, A, 1999, American Institute of Architects, 1996). see *sick building syndrome*

## W

**waste:** both an under-utilisation and misuse of resources associated with wasted energy, health and pollution costs (Gen 21); materials and energy which have no further use and are released to the environment as a means of disposal. (AS/NZS 3831–1998) see *extended producer responsibility, life cycle, obsolescence*

**waste avoidance:** preventing the generation of waste using practices such as resource conservation and source control. (AS/NZS 3831–1998)

**waste management:** strategies which will reduce the likelihood of on-site waste being produced, and that deal with waste when it is produced (Tec 1); addresses the entire process from production to final disposal. (AS/NZS 3831–1998)

**wastewater:** the spent used water of a community or industry which contains dissolved and suspended matter. (AS/NZS 3500.0–1995).

**whole-of-life cost:** the integration of life cost planning and analysis and life cycle assessment and analysis in project planning, feasibility assessment, design and management decisions, so that all due economic and environmental costs and considerations are integrated into decision-making processes and delivery and operational practices.

**window labelling:** concept and implementation of standards and ratings for energy performance, weather-tightness, structural, acoustic and safety issues for window products (AWC, 2000).

**windpower:** non-continuous renewable form of energy.

**wood-product certification:** the second step in the timber certification process involving an independent, third party chain-of-custody inspection to trace wood harvested in certified forests through all stages of transport, processing and marketing to the finished product; products that can be traced from a certified forest to the point of sale are awarded a green label/eco-label/ certificate to verify that they are made from timber produced according to a particular set of good forest management standards; this process may also be called forest product labelling. (Timbershop) see *forest management certification, timber certification*

## X, Y

**xeriscaping:** landscape design using natural and drought tolerant species of plants and appropriate/efficient water management design. (American Institute of Architects, 1996)

## Z

**zone control:** in buildings, the control of conditions such as temperature, humidity, or air flow within a portion or zone of an air conditioned building by means of manual or automatic control devices that are applicable only to that zone.

## Acronyms

ABCB	Australian Building Codes Board
ABGR	Australian Building Greenhouse Rating
ACA	Association of Consulting Architects Australia
ACF	Australian Conservation Foundation
ABCB	Australian Building Codes Board
ABSA	Australian Building Sustainability Assessors
ACEA	Association of Consulting Engineers Australia
ACIF	Australian Construction Industry Forum
AEPKA	Australasian Energy Performance Contracting Association
AGDF	Australian Green Development Forum
AGO	Australian Greenhouse Office
AHC	Australian Heritage Commission
AILA	Australian Institute of Landscape Architects
AIRAH	Australian Institute of Refrigeration Air-conditioning and Heating
AIQS	Australian Institute of Quantity Surveyors
ANZSES	Australian and New Zealand Solar Energy Society
APCC	Australian Procurement and Construction Council
ASA	Australasian (Iron and Steel) Slag Association
ASBEC	Australian Sustainable Built Environment Council
ASHRAE	American Society of Heating, Refrigeration and Air-conditioning Engineers
BCA	Building Code of Australia
BDA	Building Designers Association
BDP	Australian Council of Building Design Professions
BDP <i>EDG</i>	Building Design Professions <i>Environment Design Guide</i>
BRE	Building Research Establishment (UK)
BREEAM	British Research Establishment Environmental Assessment Method
COAG	Council of Australian Governments
CRC-CI	Co-operative Research Centre for Construction Innovation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEH	Department of the Environment and Heritage
EA	the Institution of Engineers Australia trading as Engineers Australia
FSC	Forest Stewardship Council
GBC	Green Buildings Council
HIA	Housing Industry Association of Australia
IPCC	Intergovernmental Panel on Climate Change
LEED	Leadership in Energy and Environmental

Design, a voluntary US based Green Building Rating System®

MBA	Master Builders Association
NGGI	National Greenhouse Gas Inventory
OECD	Organisation for Economic Co-ordination and Development
PCA	Property Council of Australia
PIA	Planning Institute of Australia
PLEA	Passive and Low Energy Architecture Association
RAIA	Royal Australian Institute of Architects
SA	Standards Australia
UNFCCC	United Nations Framework Convention on Climate Change
UNCED	United Nations Conference on Environment and Development

## Biography

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