The House of Representatives
Standing Committee on
Environment and Heritage

Inquiry into Sustainable Cities 2025

Response by CRC for Construction Innovation

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CRC for Construction Innovation

The Cooperative Research Centre for Construction Innovation is a national research, development and implementation centre focused on the needs of the property, design, construction and facility management sectors.

Established in 2001 and headquartered at Queensland University of Technology as an unincorporated joint venture under the Australian Government's Cooperative Research Program, Construction Innovation is developing key technologies, tools and management systems to improve the effectiveness of the construction industry.

Underpinning Construction Innovation is the most significant commitment ever made to construction research in Australia - a seven year $14M Commonwealth grant and $50M in industry, research and other government funding. More that 150 researchers and an impressive alliance of 18 leading partner organisations are involved in and support the activities of Construction Innovation.

CRC Research Program on Sustainable Built Assets

CRC for Construction Innovation has Sustainable Built Assets as one of its three Research Programs (see Figure 1 below).

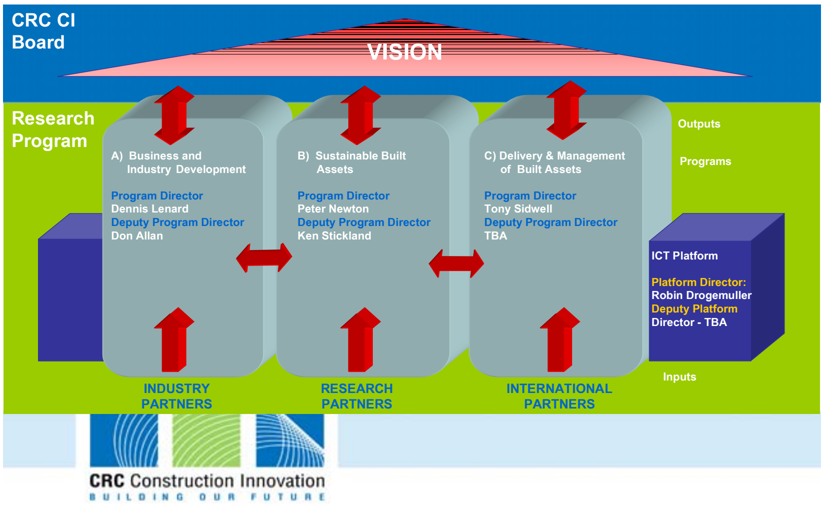


Figure 1: CRC CI Research Program Structure

The objective of the Sustainable Built Assets Program is:

1. to enhance the sustainability of built assets via their eco-efficiency of design and operation through:
    - sound conceptual basis for economic, social and environmental representation and accounting of the built environment
    - virtual building technology capable of examining design performance prior to construction and use, and
2. to increase the human health and productivity benefit via the creation of smart, high quality indoor environments.

CRC CI Response to Inquiry

In CRC CI’s response to the Inquiry, focus will primarily relate to one of the key Inquiry objectives: ***Incorporate Eco-Efficiency Principles into New Buildings and Housing.***

Eco-efficiencies are one of the three critical tradeoffs that need to be made in relation to delivering a more (versus less) sustainable building. This is illustrated in Figure 2 below:

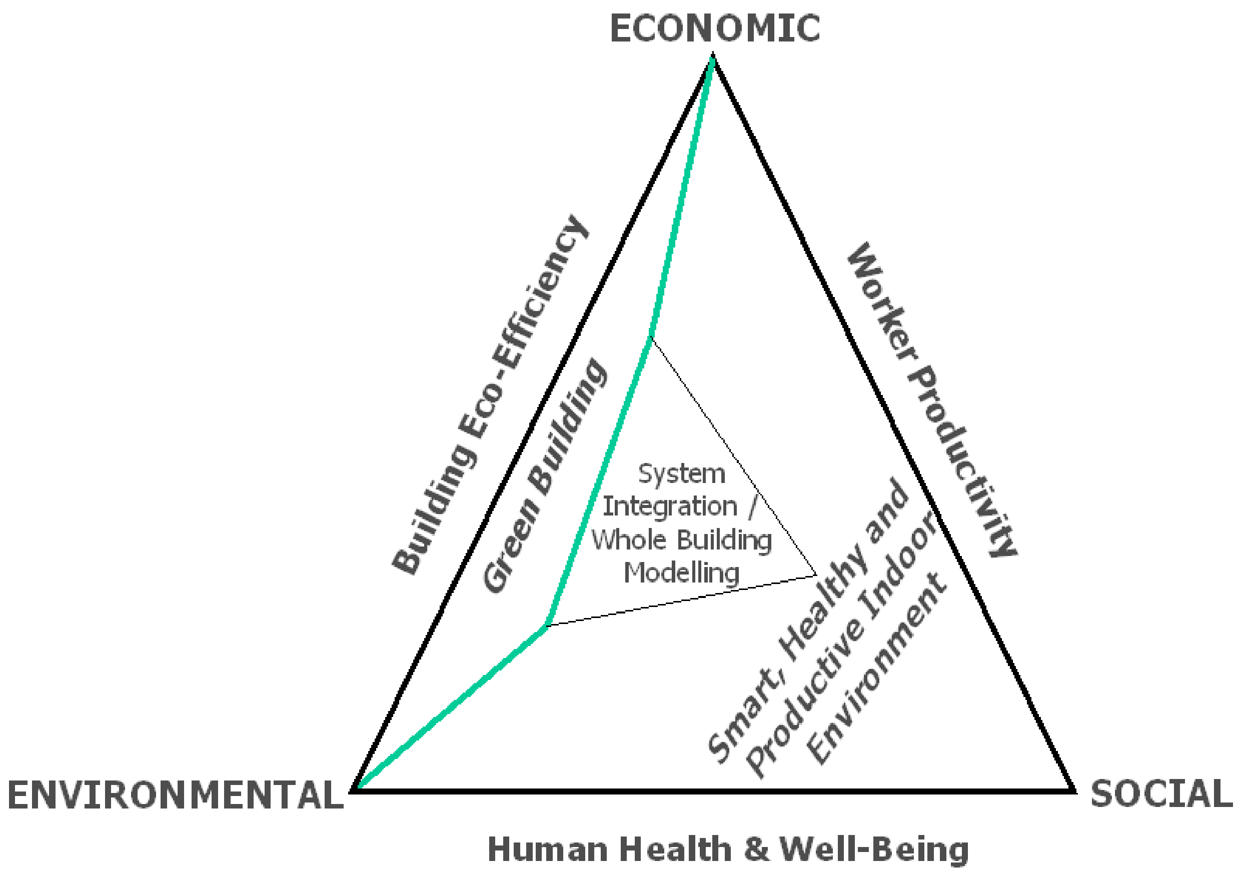


Figure 2: Sustainability Triangle for Commercial Buildings.

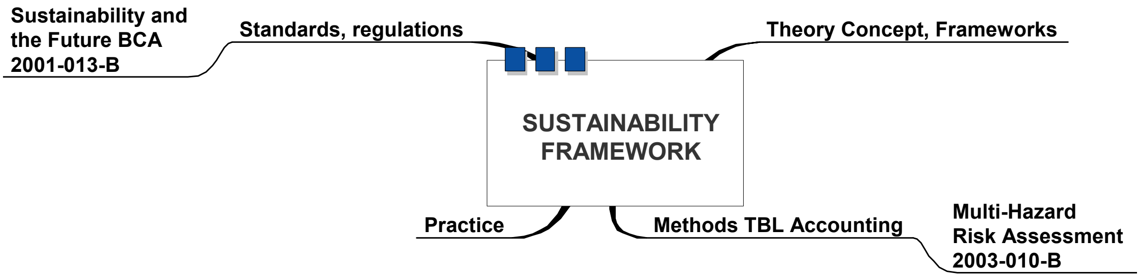
Source: P. W. Newton "Green Building Innovation", Keynote Address to Institute for International Research's Green Building Conference, Sydney, 23 June 2003.

Building eco-efficiency represents the delivery of joint benefits to environment and economy through a specific built asset such as commercial building; *worker productivity* in the building context is the joint outcome of an optimal mix of economic and social (organisational) factors; while *human health and well being* as mediated through buildings – where Australian's spend over 90% of their time – requires delivery of high quality physical and social environments.

CRC CI aims to deliver on its two principal objectives via a program of research involving its industry, government and research partners (refer www.construction-innovation.info for more details on CRC) which focuses on 5 strategic areas:

1. Sustainability Frameworks: Advancing

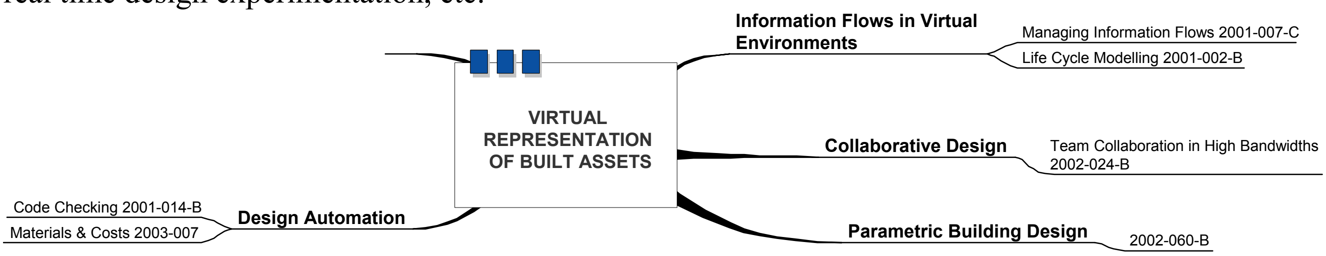
Projects in this cluster are those which advance our understanding of sustainability in the context of built environments from theoretical and applied perspectives.



A major report has been produced on *Sustainability and the Future Building Code of Australia*, the contents of which will be examined by the Australian Building Codes Board (November 2003) in deliberating on the extension of BCA to include a Sustainability Theme.

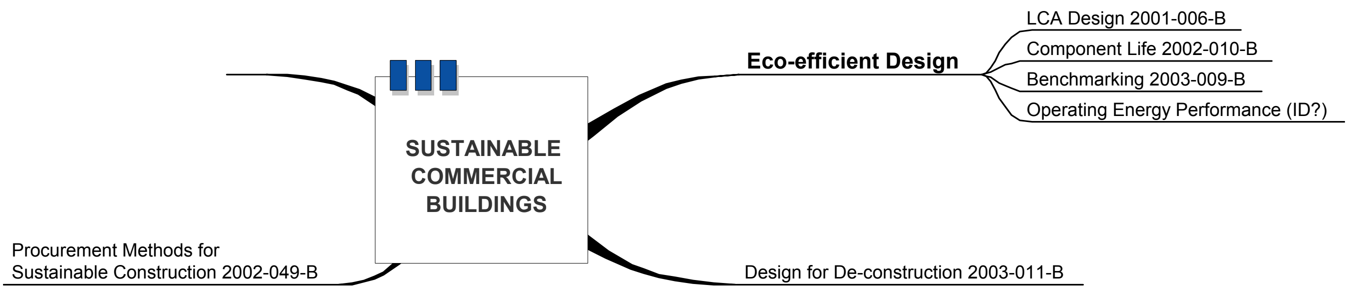
2. Virtual Representation of Built Assets

Projects in this cluster are those which enable a virtual representation of whole buildings or parts of structures *prior* to their construction, including an ability to facilitate assessments of their Triple Bottom Line performance against established benchmarks. The ICT toolkit for AEC applications include: inter-operability, visualisation, automation, collaboration and integration, real time design experimentation, etc.



3. Sustainable Commercial Buildings

Projects in this cluster will deliver next generation methods and tools for sustainable design, monitoring and management of commercial buildings. Focus will be on whole-of-life eco-efficiency assessment, enabling a significant contribution to: reducing resource use (especially water and non-renewable energy), minimising damaging environmental emissions (GHG, air pollution, liquid and solid waste flows, noise) and improving indoor air quality.



One of the key projects in this cluster involves development of *LCADesign*, an eco-efficiency assessment tool for commercial buildings capable of providing an automated cost and environmental assessment of a building direct from a 3D CAD model. For the designer, this will be equivalent to the use of Spell Checker in MS Word by the writer.

Details on the functionality of *LCADesign* are outlined in Appendix I.

LCADesign also has the capacity for extension as an eco-efficiency assessment tool for housing and urban infrastructure (e.g. road, rail, water, energy, etc). It will have the capacity to perform the role of an assessment tool against future environmental sustainability performance measures that may appear in a future Building Codes of Australia or State Government building performance guidelines or industry guidelines (see Figure 3 below).

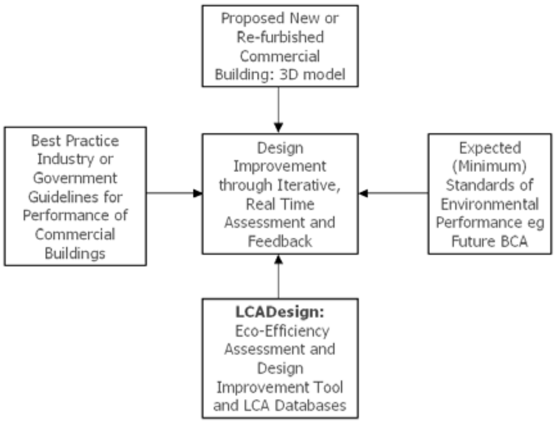


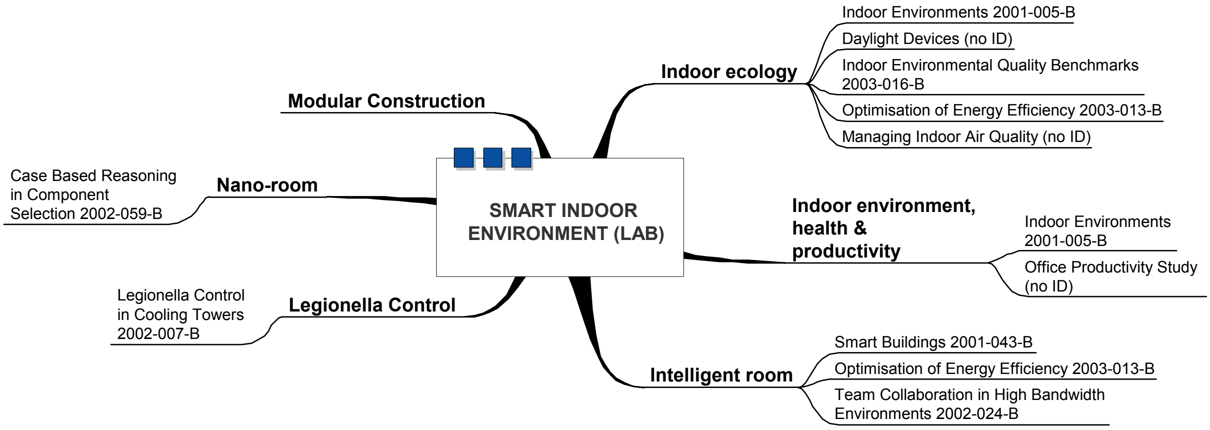
Figure 3: Green Space Future

LCADesign also has an extensive LCA database of building materials that could support a future eco-labelling product scheme.

4. Indoor Environments: Design, Health and Productivity.

Projects in this cluster will deliver new knowledge in relation to:

- Indoor ecology and design of high performing physical indoor environments: understanding and modelling the complex inter-relationships of facades, lighting, thermal performance, acoustics, ventilation and air quality.
- Indoor environments, epidemiology and productivity: quantifying the linkages between indoor environment, health and productivity.
- Intelligent rooms: smart spaces that incorporate sensor technologies for a wide spectrum of operations, ranging from management of indoor environment to human-computer interfacing and distributed collaborative working.
- Nano-rooms: that incorporate new, high performing surfaces and material components.
- Modular construction: as a basis for delivering new building services as well as new building products.



The rationale for such a facility relates to:

- the service and information sectors in advanced economies such as Australia now account for over 50% of GDP – generated predominantly in indoor, office environments.
- the Australian population spends over 90% of its time in indoor environments – environments deemed "unsatisfactory" by 25% of the population, based on recent surveys (Sustainable Buildings 2002 Conference, Oslo)
- business enterprises (public and private) over their life time will have total outgoings in the following ratio: 1:5:200 for capital cost, operating cost and cost of employees salaries.

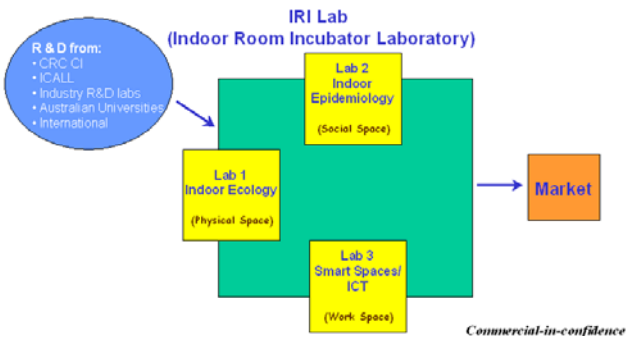
Building research clearly must focus more on what delivers improved health and productivity to the *workforce*.

What Australia currently lacks is a national research facility capable of supporting research and technology development in areas related to:

- design of high quality indoor environments (where the complex interactions of lighting, ventilation, thermal, acoustic, indoor air quality etc) need to be better understood and managed
- understanding the extent to which higher quality indoor environments deliver health and productivity benefits (refer 1:5:200 above)
- designing smart, adaptive and highly sensed ICT environments to support information-intensive work
- stimulation of modular construction of indoor environments as a new service industry.

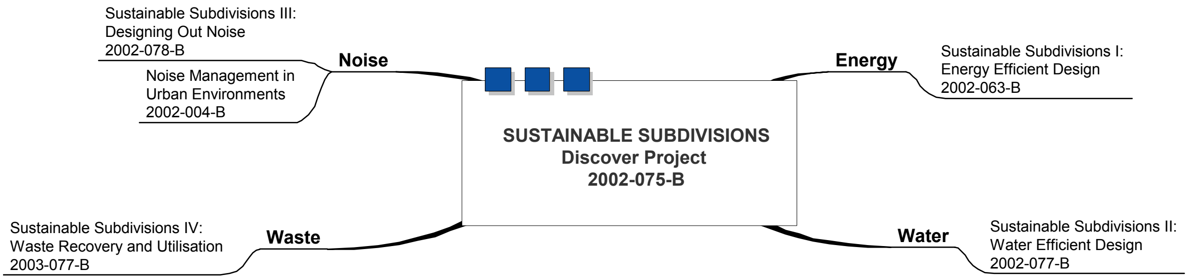
In Australia there has been a dearth of investment in laboratories and R & D incubators capable of supporting basic and applied research on indoor environments. Commonwealth assistance is sought for the development of such a facility in Australia, along the lines suggested below:

Proposed National Centre for Smart Indoor Environments



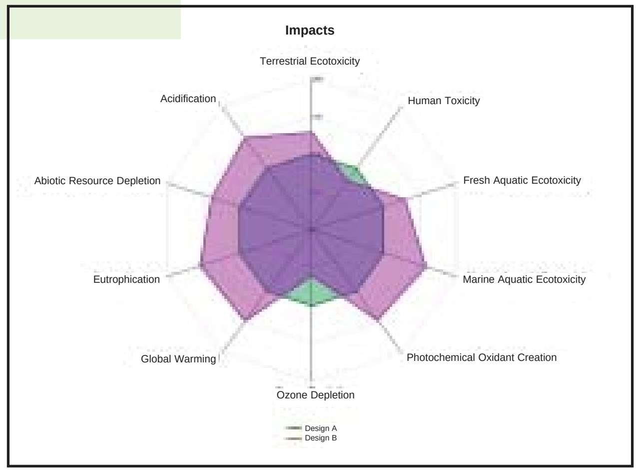
5. Sustainable Subdivisions

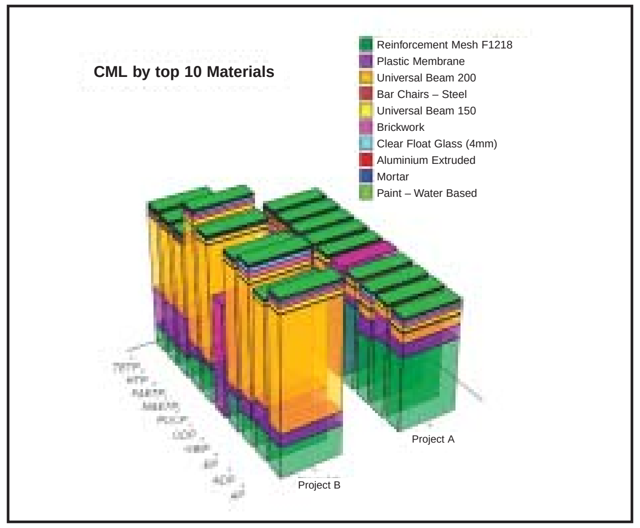
Projects in this cluster will deliver a step change in sustainable performance of subdivisions via parallel and interfaced innovation at both the dwelling scale and the neighbourhood infrastructure scale



The first project underway in this cluster – *Sustainable Subdivisions 1: Energy Efficient Design* is applying CSIRO's AccuRATE (NATHERS 2003 version) towards establishing new design principles for medium density and high rise housing – an area where there is a dearth of guidelines and best practice case studies.

Appendix I





Cooperative Research Centre for Construction Innovation

The Australian Cooperative Research Centre for **Construction Innovation** is a national collaboration involving 19 industry, government and research partners and has been made possible through a $14 Million federal government grant to the Cooperative Research Centre program. **Construction Innovation** is developing LCADesign to facilitate a paradigm shift to eco-efficient design, construction and management within the architecture, engineering and construction (AEC) sector, both in Australia and internationally.

International Alliance for Interoperability

IFCs have been developed by the International Alliance for Interoperability (IAI), a non-profit, global alliance of the building, construction and software industries with over 650 member organisations in 20 countries. Interoperability enables participants to share common project information across disciplines and technical applications. www.iai-international.org

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Qld Dept of Main Roads Qld Dept of Public Works Qld Dept of State Development Qld University of Technology Rider Hunt
RMIT University Springfield Land Corporation University of Newcastle University of Sydney University of Western Sydney Woods Bagot

LCADesign™

Automated Eco-efficiency Assessment of Commercial Buildings

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Use of LCADesign (Life Cycle Analysis of Design) will enable building design professionals to make informed decisions on the environmental impact of commercial buildings by providing detailed environmental and cost measures for different materials, products and designs, automatically from their 3D CAD drawings. It will meet a growing need from designers and regulators for real-time appraisal of design performance of built assets against an emerging set of sustainability criteria.

Benefits of LCADesign Include:

- Automated environmental assessment direct from 3D CAD drawings
- Choice of environmental impact and performance measures
- Detailed design evaluation
- Comparative ratings of environmental impacts of alternatives at all levels of design analysis
- Comprehensive graphical and tabular outputs

LCADesign has been specifically designed to:

- Drive innovative and eco-efficient building design through an automated environmental impact assessment design tool for building design professionals
- Audit and assess current and future building codes and standards
- Harmonise with simpler checklist and other environmental rating tools
- Provide a method for environmentally conscious design which aligns with the International Standards Organisation framework for assessment of building environmental performance

Environmental Profiles

Buildings consume significant amounts of resources including water and energy, and contribute to pollution of our air, water and soil, but remain an essential part of the world we live in. The ability to readily assess their impact and to design alternatives to reduce that impact is the core purpose of LCADesign. Assesment measures include a range of environmental impacts as defined through international standards, covering such topics as:

- Resource depletion
- Air pollution
- Water pollution
- Solid waste
- Economics
- Human impact

Life Cycle Assessment

Life Cycle Assessment (LCA) is a technique for assessing environmental aspects and potential impacts associated with a product by:

- Compiling an inventory of relevant inputs and outputs of a product system
- Evaluating potential environmental impacts of those inputs and outputs
- Interpreting the results of the inventory and impact assessment in relation to the objectives of the study (ISO 14043 – 2000)

For buildings, the inventory includes resource acquisition, transport, manufacture, construction, maintenance, final demolition, removal processes and recyclability of building products.

Environmental Assessment

LCADesign is fully automated from the completion of the 3D CAD drawing of a building to viewing of calculated environmental impacts resulting from building construction. The automated take-off provides quantities of all building components made of products such as concrete, steel and timber. This construction information is combined with the life cycle inventory to estimate key internationally recognised environmental indicators.

Advances in LCADesign

The LCADesign concept is a significant advancement on current tools in that the LCADesign approach:

- Obtains building data direct from CAD
- Is objective rather than subjective assessment
- Includes economic and environmental impacts
- Provides a variety of performance measures
- Can compare full life cycle performance of components
- Provides repeatable evidence based environmental reports
- Makes weighting of environmental impacts transparent to the user
- Evaluates impacts at a detailed product specific level
- Quantitatively computes absolute values rather than relative values
- Is aimed at compliance for standards, codes and performance based tests
- Calculates totals from building components not just the whole building
- Assesses a building using comprehensive databases of environmental impact of building components and materials
- Is applicable to evaluation at both sketch design and detailed design stages
- Facilitates assessment of tradeoffs

3D CAD and IFC Technology

Modern 3D, object-oriented CAD files contain a wealth of building information. LCADesign accesses this detail through utilising Industry Foundation Classes (IFCs) - the new international standard file format for defining architectural and constructional CAD graphic data as 3D real-world objects - allowing interrogation of intelligent objects by construction professionals.

Life Cycle Inventory Database

The life cycle inventory database includes details of resource consumption and environmental emissions generated during the manufacture of building materials, including embodied pollution and water as well as energy.

The individual environmental indicators are nested under three major categories of impact: resource depletion, degradation of the physical environment, and harm to human population. LCADesign has the capability to drill down into the source of environmental impacts by material category, individual material, building assembly or component.