  

ECOLOGICALLY SUSTAINABLE DEVELOPMENT REPORT

ISSUE

UNIVERSITY OF SYDNEY

CENTRE FOR OBESITY, DIABETES AND CARDIOVASCULAR DISEASE

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ARUP

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TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

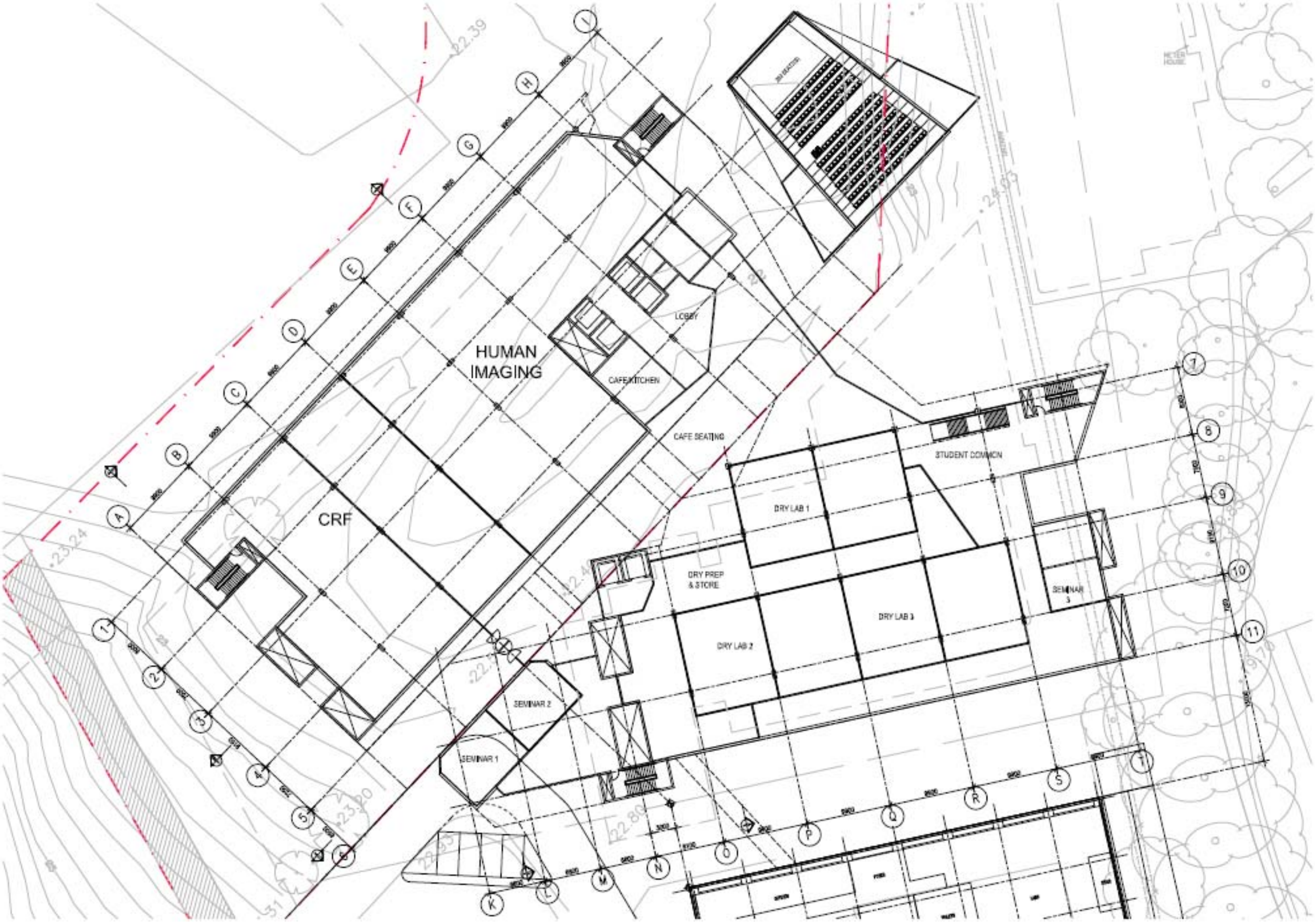


FIGURE 1.1 The ground floor plans of the proposed CODCD (courtesy Hassell).

The University of Sydney's Centre for Obesity, Diabetes and Cardiovascular Disease will be designed as world-class facility that will act as a benchmark for academic research laboratory development in Australia.

INTRODUCTION

This report has been prepared by Arup to provide input for the Development Application submission for the University of Sydney's Centre for Obesity, Diabetes and Cardiovascular Disease (CODCD) on behalf of The University of Sydney for the site located within the Camperdown Campus of the University of Sydney, located at the junction between St John's College, The University, and the Royal Price Alfred Hospital.

The report addresses Ecologically Sustainable Development (ESD), with input on mechanical and electrical building services. The report summarises initiatives under consideration by the design team to reduce environmental impacts caused by the design, construction and operation of the proposed development, aiming at high levels of environmental performance. It also benchmarks the building against international case studies of similar laboratory buildings, resulting in clear and meaningful energy targets the team is committed to achieving.

The design will focus on creating a highly energy efficient precinct that takes maximum advantage of Sydney's climatic conditions for creating efficient, comfortable public spaces and buildings within the site. The development is based on the construction of a new contemporary laboratory facility and associated support facilities, with one level of underground parking. It is propose to include a combination of environmental strategies, including internally daylit atrium spaces, external sun shade and glare control devices, a trigeneration plant to reduce greenhouse gas emissions, a rainwater collection and reuse system, alternative transport amenities and parking, and the creation of significant new public spaces and access points for the University of Sydney and the surrounding precinct.

The design of the CODCD will aim to achieve the following:

►A Green Star Design rating based on a custom laboratory rating tool to be developed with the Green Building Council of Australia; and

►A target 40% reduction in annual energy consumption when compared to the average energy consumption of similar laboratory buildings throughout the world.

The design targets include high levels of indoor environmental quality, environmentally low-impact materials, and efficient water and waste management. These targets are directed at reducing environmental impacts for the whole life cycle of the CODCD. These targets are in part achieved through the incorporation of internal atrium spaces for bringing daylight and social spaces into the core of the building.

The building has been designed to be a landmark in sustainability, achieving high benchmarks for energy efficiency and indoor environmental quality.

2.0 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

REPORT SCOPE

This report is written in response to the Department of Planning Director-General's Requirements for the *Centre for Obesity, Diabetes and Cardiovascular Disease.*

ECOLOGICALLY SUSTAINABLE DEVELOPMENT PRINCIPLES

Ecologically sustainable development aims to sustain and conserve natural resources through *'using, conserving and enhancing the communities' resources so that the ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased'* (Commonwealth Government of Australia, 1990).

The principles of ecologically sustainable development have been an integral consideration throughout the process of developing the proposed campus upgrade and assessing its benefits and impacts. In addition, the preparation and exhibition of the environmental assessment in itself contributes to the consideration of the principles of ecologically sustainable development. It makes detailed information about the proposed upgrade publicly available and assists in the decision on whether the proposed upgrade should proceed.

Definitions of the four principles of ecologically sustainable development quoted below are from the Protection of the Environment Administration Act 1991. The definitions from this act are cross referenced in the Environmental Planning and Assessment Act 1979.

Precautionary principle

If there are 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.

In the application of the precautionary principle, public and private decisions should be guided by:

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and

(ii) an assessment of the risk-weighted consequences of various options.

Intergenerational 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

Conservation of biological diversity

Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Improved valuation, pricing and incentive mechanisms

Environmental factors should be included in the valuation of assets and services, such as:

(i) polluter pays - that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

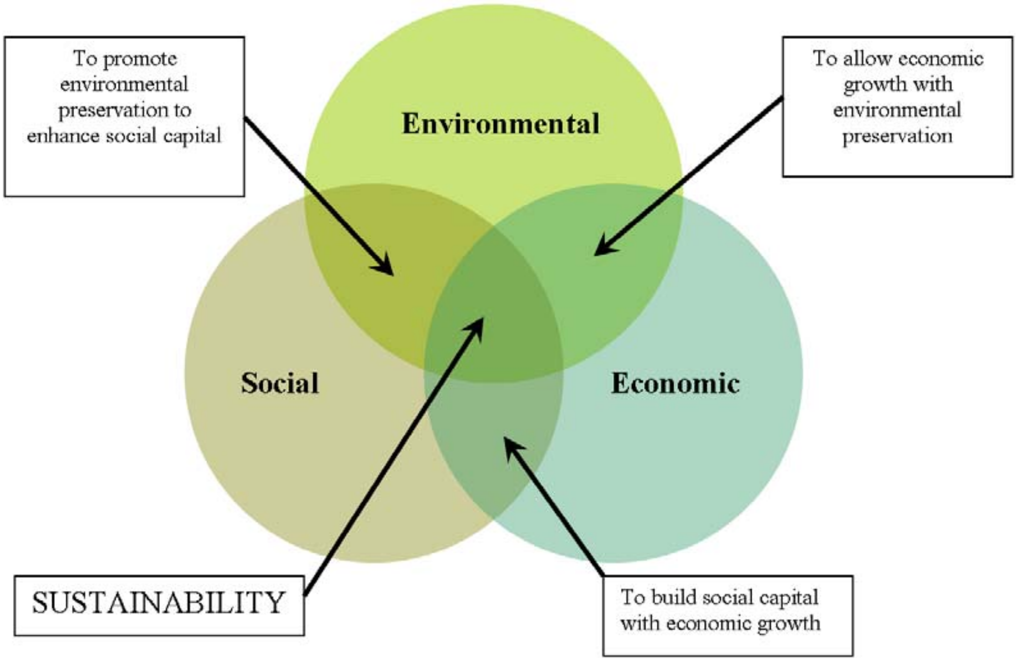


FIGURE 2.1 The fundamental tenets of sustainability include the balanced consideration of environmental, social and economic issues. This approach will underpin the entire design strategy proposed for the CODCD.

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

3.0 THE SUSTAINABLE UNIVERSITY

THE UNIVERSITY OF SYDNEY'S SUSTAINABLE COMMITMENT

The University of Sydney addresses environmental, social and economic sustainability across a broad spectrum of its academic and administrative departments. In the last several years, the University has developed an *Energy Savings Action Plan* to identify energy efficiency projects, a *Water Savings Action Plan* to identify conservation strategies, a *Triple Bottom Line Project* to gauge its carbon footprint and encourage 'international best practice green building and low energy technology,' and a new development framework, *Sustainability Framework—Integrating Sustainability Across Masterplans, Precincts Plans, Buildings and Social Spaces*, to incorporate sustainability into its portfolio of planned expansion and renovation as part of its *Campus 2020 Masterplan*. These initiatives and others form the basis for the University's commitment to reducing its carbon footprint and to demonstrating its environmental leadership among Australian and international peer research universities.

As a research institution, the University of Sydney is committed to developing the CODCD as demonstration of leading-edge sustainable technologies and strategies. This will be pursued as part of the design process through to construction and operation.

BUILDING CODE OF AUSTRALIA—SECTION J

Section J of the BCA outlines basic energy efficiency standards that many buildings in Australia must meet. The CODCD will include a mix of Class 3, Class 8, and Class 9b spaces, all of which would be designed to comply with the requirements of Section J. The CODCD development will not only meet Section J's requirements for energy efficiency but target to exceed these requirements.

GREEN STAR RATINGS

The University of Sydney has made a significant commitment to adopt the Green Star rating system as part of the development of its new buildings on campus. The design of the CODCD is targeted to achieve a formal Green Star rating, either using the existing Green Star Education V1 tool or through the development of a specific and custom laboratory tool for Green Star. The University of Sydney is committed to provide resources for developing a custom laboratory tool as part of this project and in cooperation with the GBCA.

Green Star is a comprehensive rating program developed in a similar vein to programs already in use throughout the world. It is not a standard and is not mandatory, but rather is a voluntary system that can be successfully used to implement green building principles in an effective and measurable way in the development of a new building. Green Star rates buildings across several key environmental criteria and then assigns a star rating, from 4 to 6 Stars. The categories for rating include: Management, Indoor Environmental Quality, Energy, Transport, Water, Materials, Land Use and Ecology, and Emissions.

SUSTAINABLE SYDNEY 2030

As one of the major academic institutions in Sydney, the University has responded to the challenges outlined in the *Sustainable Sydney 2030 City of Sydney Strategic Plan*. This comprehensive plan is driven by increasing concern with global climate change and resource scarcity; the plan outlines the sustainable development of the core of Sydney, which includes the neighbourhoods around the University campus. The SS2030 Plan sets ambitious targets that directly correlate with the goals of the CODCD and will be used to guide the University as it implements development on this new precinct. These targets include a reduction in greenhouse gases, renewable energy generation and use, minimal potable water use, and waste reduction.

CARBON EMISSIONS

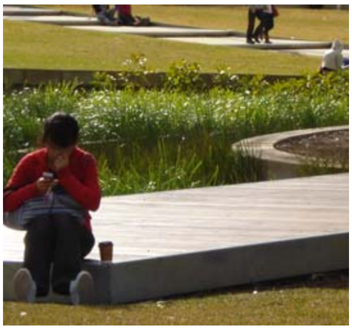
The University of Sydney is committed to reducing its overall carbon emissions footprint, even with the significant expansion presented by the CODCD. Each type of space proposed for the CODCD will have minimum benchmarks for annual operational carbon emissions. The chart below indicates the Green Star Conditional Energy Requirements for Universities as provided with the Green Star Education V1 rating tool. Note that these benchmarks only include energy or base building operation. Energy required for equipment (laboratory, information and communication technology etc.) is excluded.

The design team will gauge carbon emissions to an appropriate benchmark and document how they would reduce emissions. The team will engage the University's *Triple Bottom Line Project* team to identify how carbon emissions reductions will be coordinated for the CODCD project in order to integrate into the University's overall carbon emissions reduction scheme.

Functional Spaces	Max Annual CO2 Emissions [kgCO2-e/m²]
Teaching / classroom spaces	82
Dry Labs/specialty learning spaces and libraries	88
Office/administrative spaces	79
Common spaces	57
Wet labs	Varies on density of fume cupboards
Gymnasiums	143
Car Parks	52

CHART 3.1 Benchmark annual carbon emissions levels for academic spaces as listed in the Green Star Education technical manual. These benchmarks will inform the design of the CODCD's energy strategy, which is detailed in section 6.0.

3.0 THE SUSTAINABLE UNIVERSITY (CON.)



HEALTHY PLANNING

The CODCD provides an opportunity to be a best practice exemplar for improving health outcomes through planning and design. By considering the aims of the research and activities that are to take place within the building, the narrative behind the sustainability strategy is largely driven by the health agenda.

There are clear links between sustainability and health. By virtue of addressing the triple bottom line–social, environmental and economic–healthy and sustainable outcomes can be achieved. The sustainability strategy for the CODCD will seek to ensure that the design supports physical activity and does not contribute to 'urban obesity-promoting environments' both within the site and its precinct by incorporating the design principles espoused by the Department of Health and Ageing's *Healthy Spaces and Places* program and others deemed appropriate.

The sustainability strategy will identify planning and design responses for the CODCD at the precinct level and building level. The design team will consider the curtilage of the building and its precinct. Such approaches may include a wayfinding strategy from public transport nodes to the building which identifies the number of calories that have been burnt by walking from one point to another.

INTELLECTUAL LEADERSHIP AND RESEARCH DEMONSTRATION

The University includes a number of research centres that focus on sustainable design and development, such as the Centre for Integrated Sustainability Analysis; the Faculty of Architecture, Design and Planning; and the Diversity, Ecology and Evolution Research Group. The design and consultant team should consider how the University's academic units and research centres can contribute to the project, as well as how the sustainable design attributes of the project can be effectively communicated to the building's occupants, visitors and the wider community.

COMMUNITY ENGAGEMENT AND BENEFIT

The development of the CODCD will consider stakeholder—both community and occupant—feedback. The CODCD will be a highly visible building with linkages to the Royal Prince Albert Hospital and like the hospital, will consider existing and future community needs in and out of the campus context. The building design will consider how the building operation can be improved and tuned based on occupant feedback. The design and consultant team will also consider how the building's design and performance can be shared with the wider community, either through reporting building performance data or sharing lessons learned with peer laboratories and universities.

The CODCD design, consultant, client and maintenance team will be fully integrated so that all members can participate in the development of the project. The design process will formally recognise this integration and provide mechanisms to ensure it is consistently incorporated. An overall lifecycle cost evaluation will be made at the strategic and system level to gauge feasibility of a design response.

Climate Change

The University recognises that its buildings must be flexible and adaptable so they can respond to changes in the Sydney climate expected in the next 30 to 100 years, based on the design life of the building. The design will address how the building will contribute to Sydney's heat island effect, respond to increased flood risk where appropriate, provide for comfortable pedestrian access to and through the site, and reasonably accommodate occupants in instances where mechanical ventilation systems may fail to deliver comfort conditions. Consideration will be given to microclimate conditions at the ground plane and the effect of the building on surrounding public spaces through the creation of sun and shade spaces, shelter (wind and rain), calm and active spaces, and spaces that avoid wind funnelling and turbulence. The design team will investigate the use of mixed-mode ventilation, allowing for natural ventilation to offices and classrooms, as well as the natural ventilation of the main atrium corridor through the building.

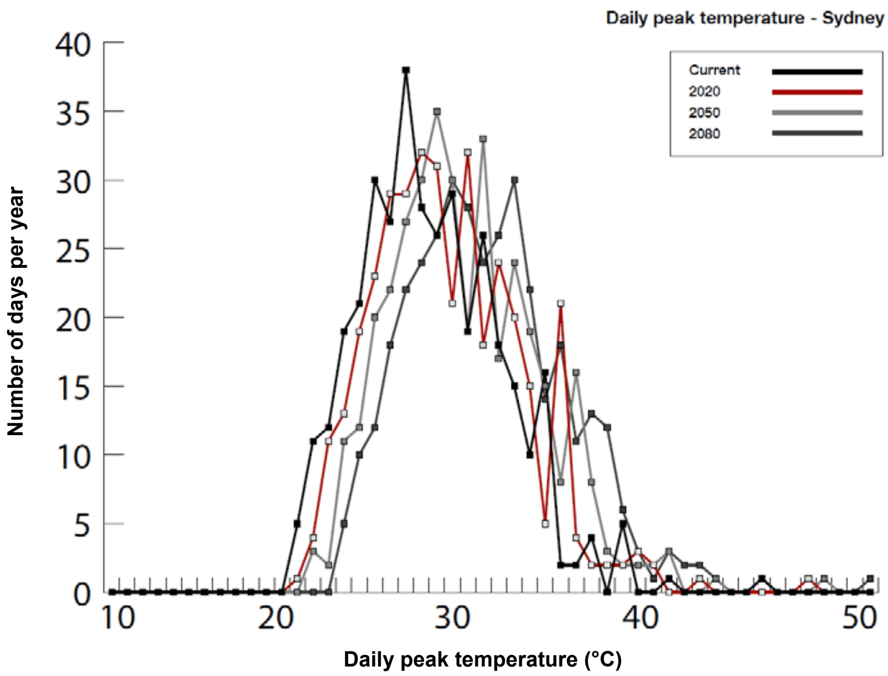


FIGURE 3.1 Arup has morphed existing climate data for Sydney to gauge potential temperatures in the future based on climate change models recognised by the Intergovernmental Panel on Climate Change. The graph above indicates that Sydney will experience a significant increase in the number of hot days each year. By 2080, for example, there would be expected to be twice as many days where the temperatures reach above 40°C than occurs in 2050.

4.0 BENCHMARKING

The University of Sydney is committed to delivering a facility that achieves a reduced environmental impact and a high level of occupant satisfaction when viewed in the context of similar laboratory buildings both in Australia and internationally. The University will target a formal green building certification through the Green Building Council of Australia, but also recognises the need to address global best practice performance benchmarks for buildings of the same typology. As a result, a review of all available tools and case studies was undertaken to aid in defining baseline performance benchmarks the design team will seek to achieve for the CODCD.

REVIEW OF INTERNATIONAL CASE STUDIES

In the absence of a specific laboratory tool for environmentally rating buildings in Australia, a review of international case studies and rating tools has been undertaken in order to aid in the establishment of benchmarks for the CODCD. This review included the USA-based Laboratories for the 21st Century program (Labs21), developed by the U.S. Department of Energy and the U.S. Environmental Protection Agency, to specifically benchmark and improve the energy and environmental performance of laboratory buildings. Labs21 is an internationally recognised program that provides designers with benchmarking data for annual energy consumption in the context of laboratory type, climate and ratios of lab to office space. Arup has based its benchmarking exercise on this data and combined it with other data compiled independently through experience and in publicly available media.

The Labs21 program also includes design strategies and targets based on the U.S. Green Building Council's LEED rating tool. Many of these same strategies—such as recycled content in materials, reduction in potable water use—have already been adopted into the proposed design of the CODCD.

The following sections outline the benchmarks established in the areas of energy, water, materials, waste, transport, and indoor environmental quality that the design team will seek to achieve for the CODCD. In some instances, the design team would expect to exceed the performance requirements of these benchmarks, while the University also recognises that some benchmarks may not be met due to unforeseen issues that can only be addressed during the detailed design phase.

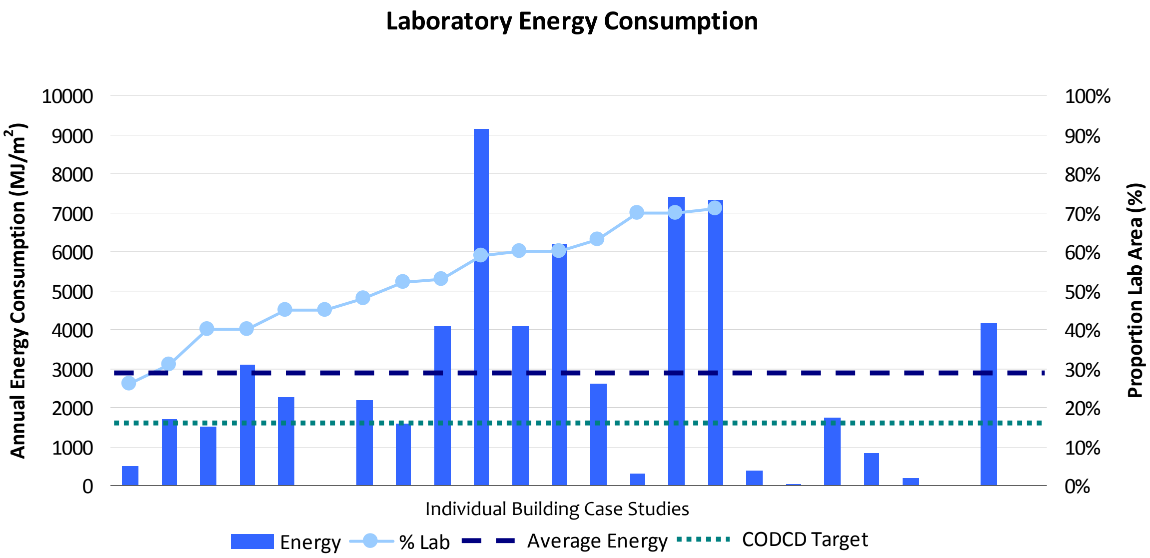


FIGURE 4.1 Annual energy consumption for 23 laboratory buildings with comparable conditions to the CODCD, using published energy data provided by the building owners.

Energy and Greenhouse Gas Emissions

Benchmarks:

- *Maximum Annual Energy Use (design): 1650MJ/m²*

Data was gathered on the energy consumption of several laboratory buildings and educational buildings containing laboratory facilities. The graph on the opposite page shows the total annual energy consumption of each building (MJ/m^2) in relation to the proportion of laboratory space in the building. The two horizontal lines show the CODCD annual benchmark as an approximate 40% reduction in comparison to the average annual energy consumption of the data collected.

The design of the CODCD will target this 40% reduction through a combination of passive design strategies like building shading, as well as through the installation of efficient equipment and systems. This will significantly decrease the CODCD's greenhouse gas emissions.

Water

Benchmarks:

- *Maximum Annual Water Use (design): 65L/m²*

For regional context, Green Star Education v1 was used to provide an design potable water consumption benchmark. Following this, a review of water consumption data for other buildings of similar typology was undertaken to confirm that this benchmark is an improvement on international best practice. Further to this, benchmarks have been established for the specific technologies that will be implemented to reduce potable water consumption as follows:

- *Target Rainwater Collection: 90%*
- *RO Water Plant Waste Water Reuse: 100%*

These recycled water benchmarks will be needed to achieve the overall water use benchmark. Based on a comparison to the NABERS Water rating program for office buildings, if the CODCD achieves its water use benchmark, it would approximately equate to a 5 Star rating in operation. This would be a significant achievement for a laboratory building.

Materials

Benchmarks:

- *PVC Reduction: 60% by cost*
- *Mercury: No mercury or low-mercury lamps specified*
- *Copper: No copper solders for stormwater systems*
- *Cement Replacement Target: 60% for in situ, 40% for precast, and 30% for stressed concrete*
- *Recycled Concrete Aggregate: 20%*
- *Recycled Steel: 90% of all steel to contain at least 50% recycled content*
- *Certified Timber (by cost, based on all timber on project): 95%*
- *Low TVOC content: 95% of all paints, carpets, sealants, and adhesives*
- *Composite timber products: To be E0 or contain no formaldehyde*

Benchmarks for materials to be used in the construction of the CODCD have been guided by the Green Star Education v1 tool. A review of international case studies revealed that these benchmarks align with international best practice design for educational and laboratory facilities. The benchmarks stipulated for materials address issues of recycled content of materials, recyclability of materials, embodied energy, and toxicity of materials both in production and application.

Waste

Benchmarks:

- *90% diversion of construction and demolition waste from landfill.*

The benchmark for waste diversion from landfill includes both demolition and construction waste. The Green Star tools award 80% waste diversion as best practice. After a global review, it was found that the average waste diversion rate for similar buildings was slightly above 80%. The benchmark was therefore reviewed and set at 90% for the CODCD.

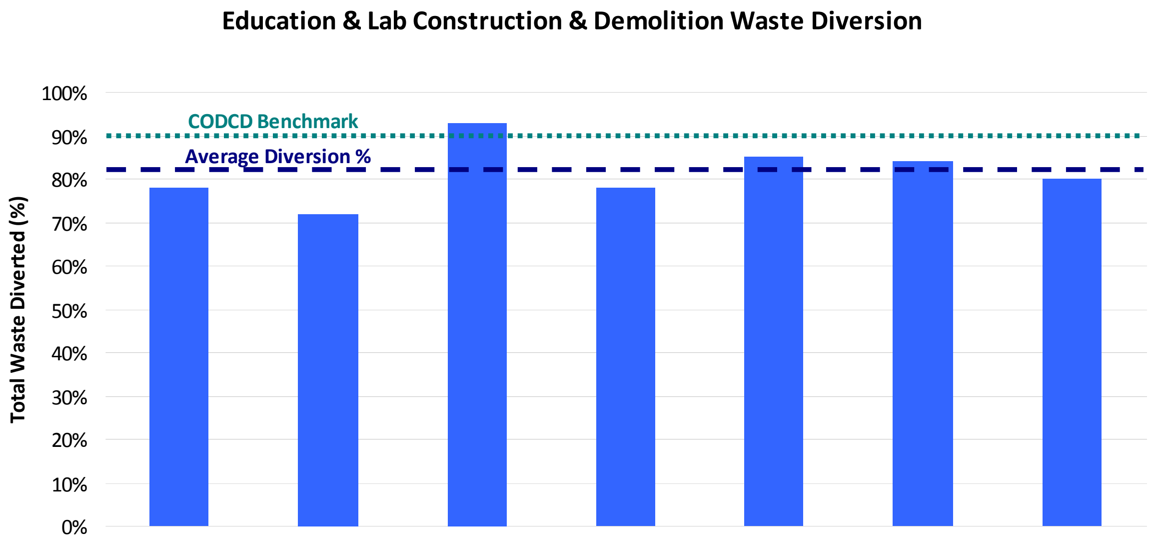


FIGURE 4.2 Based on similar laboratory buildings researched in the benchmarking process, the average waste-to-landfill diversion rate is slightly more than 80%. The CODCD will target a rate of 90% to exceed best practice.

Indoor Environmental Quality (IEQ)

Benchmarks:

- *Temperature Band (offices, classrooms, circulation): ASHRAE 55 or better*
- *Target Daylight Factor (non-laboratory spaces): 5% to 10%*
- *Target Floor Plate Area with External Views (non-lab spaces): 90%*
- *Lighting Levels (laboratories): 400Lux*
- *Lighting Colour Rendition (laboratories): >85CRI*
- *Lighting Levels (offices): 320Lux*

Benchmarks for aspects of the indoor environment in the non-laboratory areas have been guided by the standards set in Green Star Office Design v3. Data from buildings of similar typology from across the globe has been gathered in order to set benchmarks for the laboratory spaces. This data was assessed in the context of building envelope, climate, site location, and site orientation and transformed into regionally contextual benchmarks for the CODCD.

5.0 WATER-SENSITIVE URBAN DESIGN MEASURES

FIGURES 5.1, 5.2 AND 5.3 The WSUD measures proposed for the CODCD include the use of bio-swales within the site to slow stormwater and treat it prior to releasing it into stormwater systems, as well as the use of low-flow, WELs-rated tapware and ultra-low-flow urinals.

BENCHMARKS

The design team has proposed to achieve the following water-sensitive urban design benchmarks:

► Maximum Annual Water Use (design): 65L/m²

► Target Rainwater Collection (based on roof area): 90%

► Irrigation: No potable water use

► RO Water Plant Waste Water Reuse: 100%

ASSESSMENT

Water benchmarks and targets will be assessed by using the practices required by the Green Building Council of Australia's Green Star rating system and the NABERS Water program.

INITIATIVES

Stormwater

Bio-retention pits and treatment systems will be investigated for adjacent green spaces, particularly within the practice ovals; these could detain and treat storm water to ensure that peak storm water flows are not increased for 1-in 2-year storms. For 1-in-20-year storm events, the design team will seek to ensure that all stormwater leaving the site has been treated in accordance with the *Urban Stormwater Best Practice Environmental Management Guidelines* (CSIRO 1999) and *Australian Runoff Quality, A Guide to Water Sensitive Urban Design* (Engineers Australia, 2006). The design team will also consider installing a subterranean collection tank for detaining stormwater for reuse in the building's cooling towers where feasible prior to releasing it into the city stormwater system.

Site Irrigation

Where feasible, the new development will use vegetation with minimal or no irrigation requirements for campus landscape areas. The design team will investigate systems with the goal of using no potable water for irrigation purposes.

Rainwater Capture

The design team proposes the use of rain water for toilet flushing, cooling tower make-up, and irrigation purposes. Where appropriate, the development will incorporate dual-reticulation of hydraulics services to enable the use of non-potable sources in the building.

Water Efficiency

The CODCD will use water-efficient tapware based on the Water Services Association of Australia's National Water Conservation Rating and Labelling Scheme as follows: 5 Star taps, 4 Star water closets, and 5 Star urinals. The potable water use for irrigation and recy-

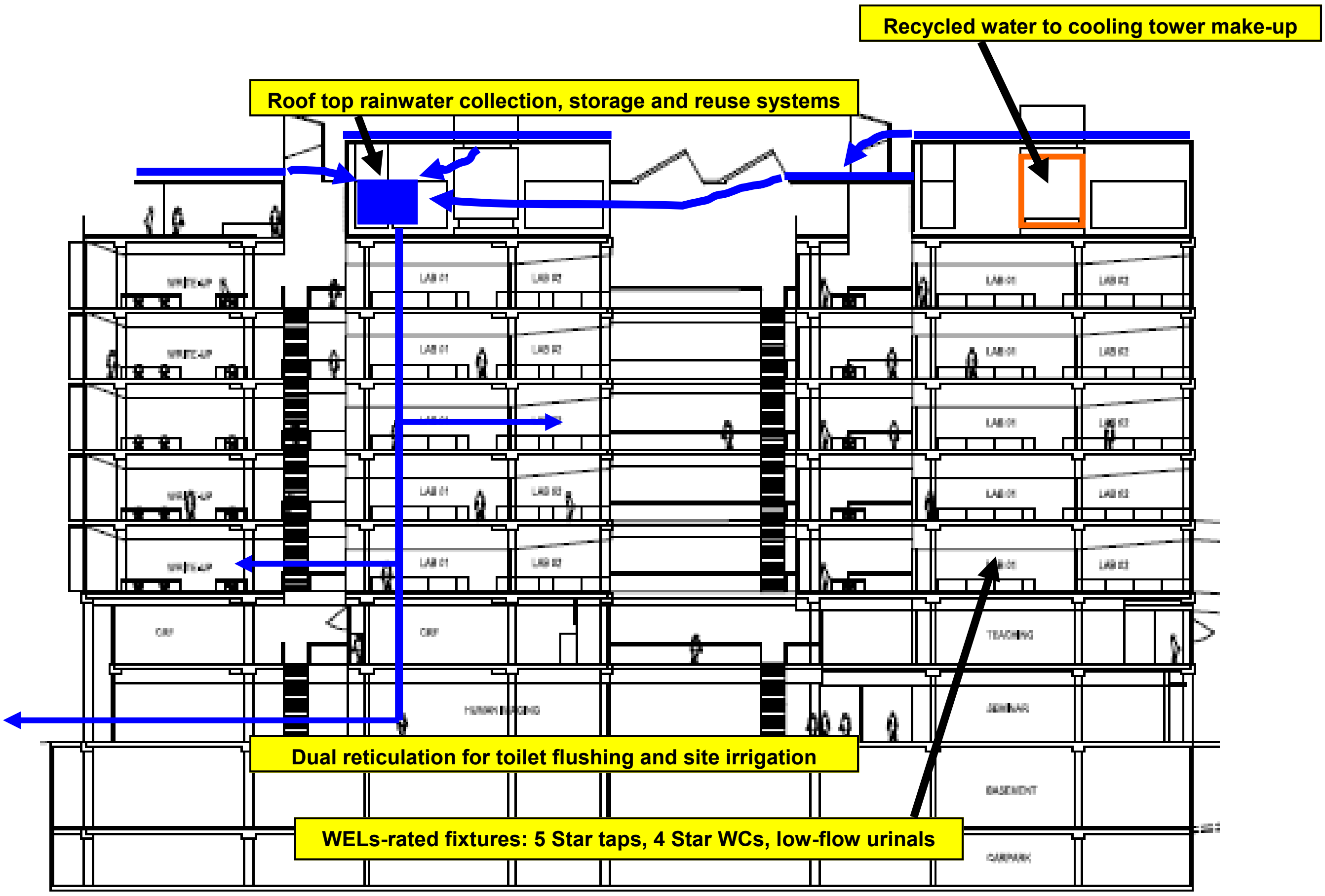


FIGURE 5.4 **This diagram indicates proposed water conservation and reuse strategies for the CODCD. These strategies are currently under investigation by the design team.**

5.0 WATER-SENSITIVE URBAN DESIGN MEASURES

cled water will be metered for the building, in addition to water for all site wash down and irrigation demand. The design team will also investigate metering water use for each of the laboratory spaces, since research shows this is an effective way of reducing potable water use.

A condensate reuse system that collects condensation from the building's air-handling units will be targeted by the design team as a way to reduce potable water consumption.

Fire System Water Consumption Minimisation and Capture

A bypass valve and a storage tank, sized to house the total quantity of water expelled during a single test, will be included in the design of the fire water system such that testing any water used for testing will be able to be salvaged and reused on site.

Water Monitoring

Water meters will be installed, in line with standard Green Star requirements for all large-scale water uses including cooling towers, hot water services, and kitchen facilities. These meters will be linked back to the BMS. In addition to metering large scale water use, each individual laboratory will be monitored as well.

Process Water Metering

Meters will be provided at each laboratory to gauge water use and identify those labs that are using excessive amounts of water. These metered approaches have been shown to help a building's maintenance staff identify wastage and improve overall water conservation.

MANAGEMENT

These water initiatives will be managed as part of the services provision for the CODCD and documented against benchmark requirements in Green Star and NABERS Water.

FIGURE 6.5 The University of Sydney has developed Water-Sensitive Urban Design strategies as part of recent campus renovation projects, including an underground stormwater collection and retention system along a new pedestrian corridor in its Camperdown campus. Similar systems will be investigated for the CODCD.

FIGURE 6.6 Other campus WSUD measures have included sensitive landscaping and raised walkways that allow for the natural flow of water underneath. The University's experiences and success with such strategies will directly influence the design of the CODCD.

6.0 ENERGY EFFICIENCY

Energy efficiency is a key component of the sustainability strategy for the CODCD, especially since laboratory buildings are among the most energy intensive building types. The proposed systems for the CODCD include efficient mechanical plant, trigeneration, comprehensive controls, and the potential for renewable energy generation.

BENCHMARKS

The design team has proposed to achieve the following energy and environmental quality design benchmarks:

Energy Benchmarks

► Targeted Maximum Annual Energy Use for the Overall Building (design): 1650MJ/m²

► Targeted Maximum Annual Gas Use for Heating and Hot Water for the Overall Building (design): 65MJ/m²

► Lighting Allowance for Primary, Secondary and Tertiary Laboratory Spaces (design): 14W/m²

► Lighting Allowance for Support, Education and Circulation Spaces (design): 8.6W/m²

► Lamp and Ballast Efficacy for Primary, Secondary and Tertiary Laboratory Spaces: 90Lumens/Watt

► Target On-site Renewable Energy or Low-Carbon Generation Capacity: 5% (based on expected, non-peak overall building energy demand)

► Peak Energy Demand Reduction Target: 30%

► Refrigerants: Zero Ozone Depleting Potential (R11 and R12 cannot be used)

Indoor Environmental Quality Benchmarks

► Temperature Band (Support areas, Education areas, Circulation): ASHRAE 55 or better

► Target Daylight Factor (Support areas, Education areas, Circulation, Write-up research areas): 5% to 10%

► Target Floor Plate Area with External Views or Views to a Day-lit Atrium (Support areas, Education areas, Circulation, Write-up research areas): 90%

► Lighting Levels (Primary, Secondary, Tertiary laboratory spaces): 400Lux

► Lighting Color Rendition (Primary, Secondary, Tertiary laboratory spaces): >85CRI

► Lighting Levels (Support areas, Education areas, Write-up research areas): 320Lux

► Acoustics Design for Building Service Noise: Comply with Table 1 of AS/NZS2107:2000

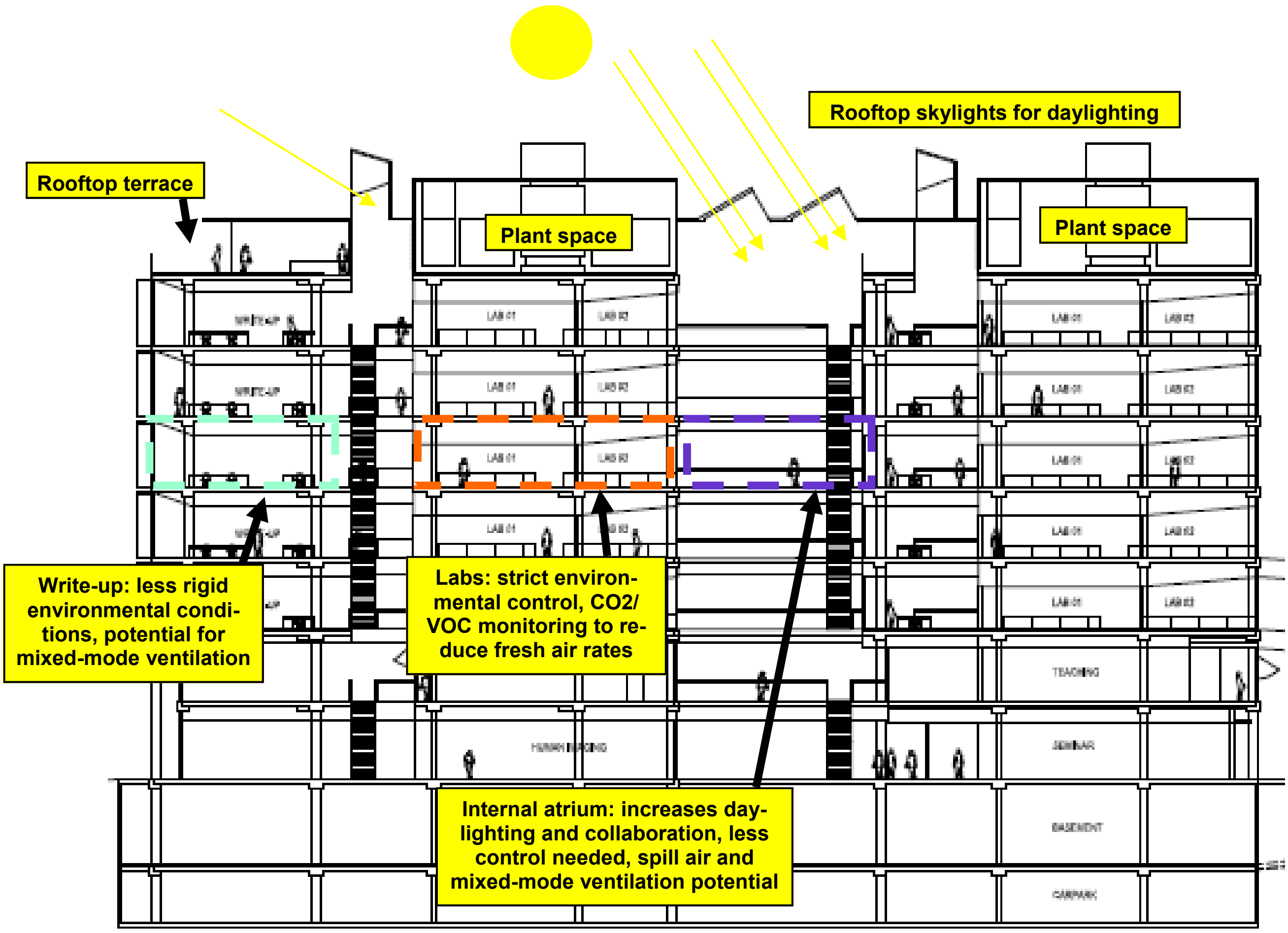


FIGURE 6.1 **A section through the CODCD indicates three major space types: write-up/offices, laboratories and the atrium, each with their own energy efficient environmental control strategy (courtesy Hassell).**

ASSESSMENT

Energy benchmarks and allowances will be assessed based on the energy model developed for the CODCD based on the Green Star energy calculation methodology. This model will also be assessed against the Laboratories for the 21st Century benchmarking program and the case study information outlined in the Benchmarking section to ensure international best practice.

The Indoor Environmental Quality benchmarks will also be assessed using the Green Star methodologies with the exception of the following:

- ► Temperature Band (offices, classrooms, circulation): ASHRAE 55 Adaptive Comfort or better (refer to the Adaptive Comfort section below)

6.0 ENERGY EFFICIENCY (CON.)

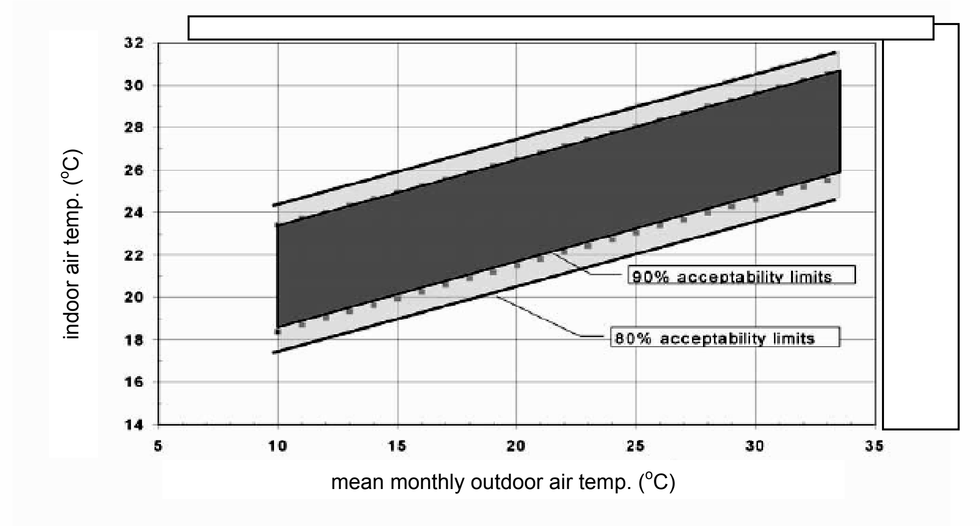


FIGURE 6.2 The ASHRAE 55-2004 chart for adaptive comfort indicates the conditions at which occupants will feel comfortable given outdoor air temperatures.

INITIATIVES

Energy-efficient Equipment

The design team will specify and select all new equipment so that it meets current best practice for energy efficiency. For appliances, products supplied with the Energy Star or TESAW labels will be used. These should be within 1 Star of the best available appliance on the market based on Australian Government standards.

Adaptive Comfort Conditions

Designing for adaptive comfort is one of the key design strategies for non-laboratory space within the CODCD, since this allows the mechanical system to provide for a wider temperature band in occupied spaces (as opposed to keeping the entire building cooled to 22.5°C). By using established standards, such as the ASHRAE 55-2004 standard as shown in Figure 6.2, the designers can relax the temperatures and reduce the requirement for mechanical cooling (i.e. reduce energy use) in spaces that are not continuously occupied and in open and individual offices. The design team will pursue this strategy in areas like write-up, the atrium spaces, circulation spaces, classrooms, and back of house support areas that could effectively be provided with mixed-mode ventilation or a relaxed temperature set point band for the air-conditioning system.

Trigeneration

The design team will undertake a feasibility study for implementing a trigeneration plant into the CODCD This plant would reduce greenhouse gas emissions associated with grid electricity supplies and to also reduce the peak energy demand consumption. It is proposed that the trigeneration plant would operate parallel to the utility power source using natural gas-fired generators to produce electricity, with the waste heat from the units used to provide heating hot water and steam to power an absorption chiller for additional “free”

FIGURE 6.3 A trigeneration plant as installed in a central plant.

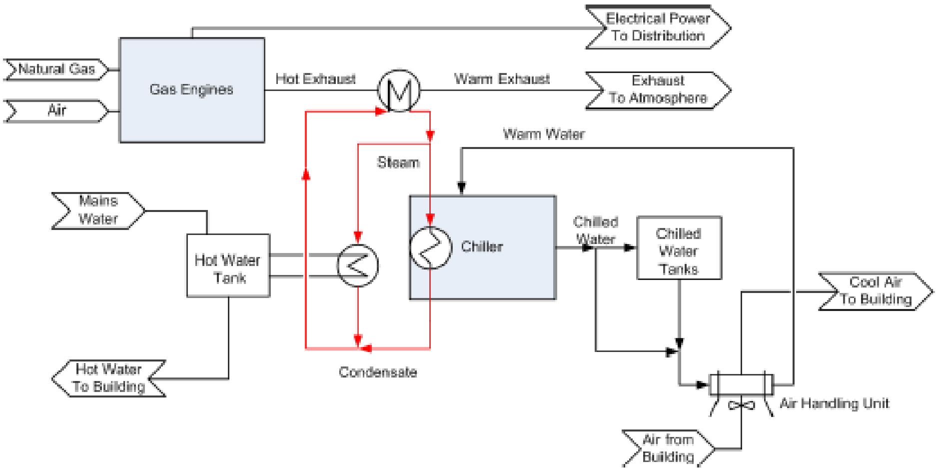


FIGURE 6.4 The trigeneration schematic proposed in the CODCD by the University of Sydney Faculty of Engineering research project.

cooling to the CODCD. A preliminary trigeneration plant analysis undertaken by the University as part of a research project in the Faculty of Engineering indicated an optimum size for the plan of (2) 770kW gas generators to provide 374kW of cooling from the absorption chillers. These sizes will be further studied during the detailed design phase. The plant will target a Nitrogen Oxide (NOx) emissions limit of 300mg/ m^3, which is in line with international NOx emission standards. This preliminary study, as well as analysis provided by consultants Steensen Varming, demonstrated that the trigeneration plant could help in reducing the building's greenhouse gas emissions by more than 16 percent when compared to conventional systems.

Geothermal Heat Exchanger

The design team will investigate the potential for a geothermal heat exchanger to provide a renewable means of offsetting heating and cooling loads for the CODCD throughout the year. Such a system works when ground temperatures remain stable. Preliminary analysis indicates an exchanger with a capacity of 3MW could be feasible. This would translate into carbon emissions reductions equivalent to removing 500 cars off of the road per year.

Energy Modelling

A full energy model is being developed that will give the project a realistic baseline for energy performance of all proposed systems in the CODCD. The energy model will be used to test alternative design strategies that could lead to further energy improvement. This model will also allow the CODCD to be compared to other laboratory project energy benchmarks to guide the project in its sustainability approach.

Metering and Commissioning

The design team will investigate the installation of real-time, digital electricity usage meters for the CODCD, including the metering of major electrical loads, as well as metering of water and electricity use in individual labs in order to encourage conservation and efficiency.

6.0 ENERGY EFFICIENCY (CON.)

The design team will incorporate a comprehensive commissioning and building tuning plan into the design, construction, and operation of the project. This will be a core component of the integrated design process and following through into building operation. Commissioning will occur for all major systems, such as mechanical, hydraulics, and controls. An independent commissioning agent will be employed to overview the design process and well as post occupancy building tuning which will occur over a minimum of a heating and a cooling period.

Renewable Energy

It is proposed that, where appropriate, the design team will undertake a feasibility study for incorporating building-integrated photovoltaics or other renewable energy sources into the project. Criteria to be gauged will include payback, carbon emissions reduction, energy efficiency, and demonstration potential.

Energy-efficient Lighting Strategies

It is proposed that the CODCD will use occupancy sensors and high-efficiency lighting in buildings. The design team will avoid using incandescent or halogen lamps and instead design with T5 fluorescent fixtures in classrooms and offices. The design team will use LED light fixtures where possible to extend lamp life and reduce re-lamping costs and waste. For corridors, the design team will use high-efficiency fixtures with maximum on-centre spacing to reduce energy use and will avoid using purely decorative luminaires or light sources with poor efficacy. High-frequency ballasts (at least 32,000 Hertz) for fluorescent light fixtures will be specified.

Buildings will be designed to take advantage of maximum daylight, while avoiding glare and thermal comfort issues. Daylight guidelines of at least 250 Lux in at least 90 percent of the NLA, where feasible and appropriate, or with a Daylight Factor of at least 2 percent at 760mm above finished floor level will be used to reduce the need for electric lighting.

Dark Sky Lighting Requirements

The design team will attend to diurnal patterns and biodiversity by minimising dark sky issues by installing low cut-off luminaires that direct light on surfaces and not toward the sky. The team will also design site lighting in accordance with Australian Standard 4282-1997 (*Control of Obtrusive Effects of Outdoor Lighting*) and ensure that at least 95 percent of outdoor spaces do not exceed the minimum requirements of AS1158 for illuminance levels.

Systems Descriptions

The project will target specifying and selecting all new equipment so that it meets current best practice for energy efficiency. For appliances, products supplied with the Energy Star or TESAW labels will be used, where possible and appropriate. These should mostly be within 1 Star of the best available appliance on the market based on Australian Government standards.

The design team is investigating the use of night purge systems for office and write-up areas. Such systems automatically open windows during cool evening hours, allowing ther-

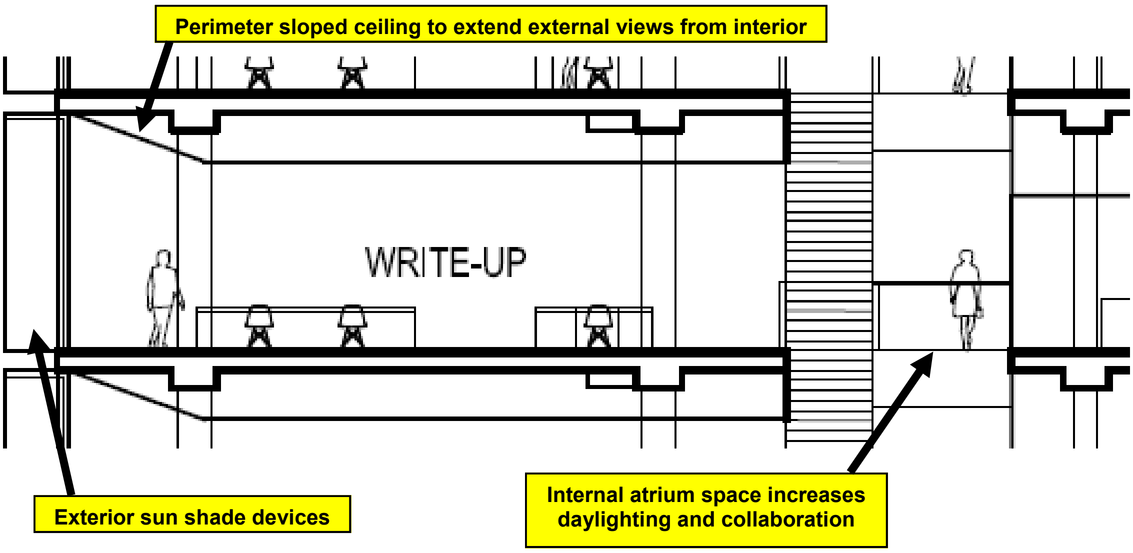


FIGURE 6.5 A section through a typical write-up space proposed for the CODCD (courtesy Hassell).

mal mass in the building to cool. This stored coolth is then released during the warmer daytime hours.

Car park ventilation energy consumption will be reduced through the use of variable speed drives (VSD) and carbon monoxide sensors. The use of occupancy sensors to reduce lighting and fan use will also be investigated during detailed design to further reduce energy use. Systems containing refrigerants will be housed in a moderately air-tight containers and the design team will investigate the use of a refrigerant leak detection system at all critical points. In such a system, upon alarm, factory-installed standard refrigerant recovery systems will ensure no leakage occurs.

In order to reduce energy loads, the design will implement the following initiatives:

►**General:**

- An integrated building management system for systems controls.

- Occupancy sensors for lighting throughout the building

- High-performance façade materials with external shading devices to reduce solar cooling demand by 40% at peak condition and even greater at non peak times.

- Good insulation that exceeds Section J requirements

►**Central atrium:**

- Tempered spill air from adjacent spaces.

- Tempered control of atrium conditions, focussing on passive measures where feasible.

- Maximise daylighting to reduce electrical lighting energy consumption

- Exterior sun shading to reduce solar gain and daylight glare

- Potential for mixed-mode or tempered supply air

6.0 ENERGY EFFICIENCY (CON.)



FIGURES 6.7 and 6.8 (left and middle) Low-flow fume hoods with automatic sash closers and a system of VOC and CO2 monitors can save a significant amount of fan energy in laboratories. FIGURE 6.9 Office and laboratory general lighting will be low-mercury, energy efficient T5 fluorescent lamps.

►Office areas:

- The design team is investigating the use of a hybrid displacement ventilation system with in-floor fan coil units to reduce supply air temperatures, which translates to energy savings due to reduced chiller use.

- Minimal and high-efficiency lighting, coupled with task lighting

- Exposed structure to reduce material use and activate thermal mass to reduce mechanical cooling requirements.

►Laboratory spaces:

- Maximise daylighting within the performance constraints of the laboratory's environmental tolerance

- Efficient ventilation systems and control

- Proposed automatic sash closers on fume hoods to save energy through reducing conditioned air lost to the fume cupboard ventilation system when sashes are left raised.

- Innovative air quality monitoring systems to manage supply air and conserve energy via reducing air change rates when air quality and temperature is maintained. This initiative is expected to provide significant energy savings.

- Right-sizing of laboratory electrical loads. The project team are undertaking actual monitoring of the existing facility to ensure electrical capacities and cooling capacities are not oversized for the application.

Solar Thermal Systems

The design will provide a solar thermal hot water system on the roof of the CODCD to reduce energy demand by using the sun's energy to pre-heat water for use in the building. A standard solar thermal module system will be selected with full back up hot water provision from a gas system.

MANAGEMENT

Energy initiatives will be managed with energy model analysis and design specifications as part of the services provision for the CODCD.

7.0 MATERIALS AND WASTE DISPOSAL

BENCHMARKS

Recycling and Reuse

- ► Construction and Demolition Waste Diversion from Landfill: 90%

Materials Benchmarking

- ► PVC Reduction (by cost): 60%
- ► Mercury: No mercury or low-mercury lamps specified
- ► Copper: No copper solders for stormwater systems
- ► Cement Replacement Target (based on flyash or equivalent): 60% for in situ, 40% for precast, and 30% for stressed concrete
- ► Recycled Concrete Aggregate: 20%
- ► Recycled Steel: 90% of all steel to contain at least 50% recycled content
- ► Certified Wood (by cost, based on all wood on project): 95%

ASSESSMENT

Assessment will be based on the implementation of a waste management plan for the CODCD and in line with the methodologies outlined in the Green Star rating tool. The building will also be designed to ensure a NABERS Waste rating could be achieved in operation.

INITIATIVES

Materials

The design team will seek to ensure that a minimum of 2 percent of all material, based on the project's contract value, represents reused products or materials that are not steel, concrete or timber. Where applicable, the design team will investigate materials with a life-cycle approach that considers embodied energy to maximise the environmental benefits of the development.

No CFC or HCFC will be used in refrigerant systems, nor CFC/HCFC and Halons used in fire suppression devices. No asbestos is to be used in the project.

Materials with ozone-depleting substances in their manufacture will not be used. For paints, VOC limits shall be in accordance with the Good Environmental Choice Australia (GECA) standard GECA-23-2005. For adhesives and sealants, VOC limits shall be in accordance with the limits adopted by the South Coast Air Quality Management District (California, USA) Rule 1168. Carpet VOC levels shall meet or exceed those of the Carpet and Rug Institute's Green Label Plus (USA). All timber is to be from FSC-certified, recycled or plantation or re-growth forests which are sustainably managed. Wood products may not contain formaldehyde.

7.0 MATERIALS AND WASTE DISPOSAL

Construction Waste Management

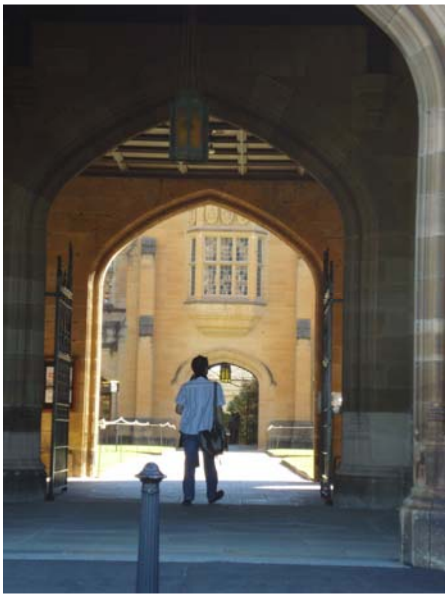
A construction waste management plan will be incorporated into the CODCD in order to ensure that more than 90% of the waste from building construction, demolition and tenancy demolition associated with the existing buildings on the site is diverted from landfill.

Operational Waste

The CODCD will be designed with dedicated recycled waste storage facilities to ensure that waste can be sorted and processed to target achieving a NABERS Waste rating. The NABERS Waste program provides an operational protocol for measuring waste generation, reduction and recycling and is geared toward office buildings. However, it is the only formal program available to building maintenance staff to institute a comprehensive waste management program once the building has been occupied and will be further investigated during detailed design.

MANAGEMENT

Management will be based on the provision of the waste management plan as a contractual obligation of the contractor for each building project.



FIGURES 7.1, 7.2, 7.3 AND 7.4 (CLOCKWISE FROM TOP LEFT) The University of Sydney has many landmark buildings constructed of sandstone, a locally sourced material with an extensive lifespan. The intention of the CODCD design is to target using low-impact materials, including FSC certified timber, recycled steel, and recycled aggregate in certain types of concrete.

8.0 TRANSPORT & SOCIAL SUSTAINABILITY

The design team seeks the opportunity to create education and environmental awareness by providing information that contributes to a more sustainable way of living. This includes initiatives to stimulate the use of public mass transport, monitor and communicate environmental results, and provide a space for creativity, diversity and innovation. The following strategies proposed are key to this strategy and will be investigated.

Education and Environmental Awareness

Media screens: to display real-time transport information (to stimulate and facilitate the use of public transport), weather, travel, events and community information as well as data on water and energy consumption and generation.

Resources monitoring: BMS information made available to tenants and the broader University community. This helps on promoting public awareness, leading to longer term behavioural change, and contributes to the achievement of performance targets.

PV powered lamp posts: Public lighting to be emissions-free and have a visible reference to sustainability.

Sustainable Transport

Electric car charging stations: for 5% of the car parking associated with the CODCD, to stimulate the procurement and use of low emissions vehicles.

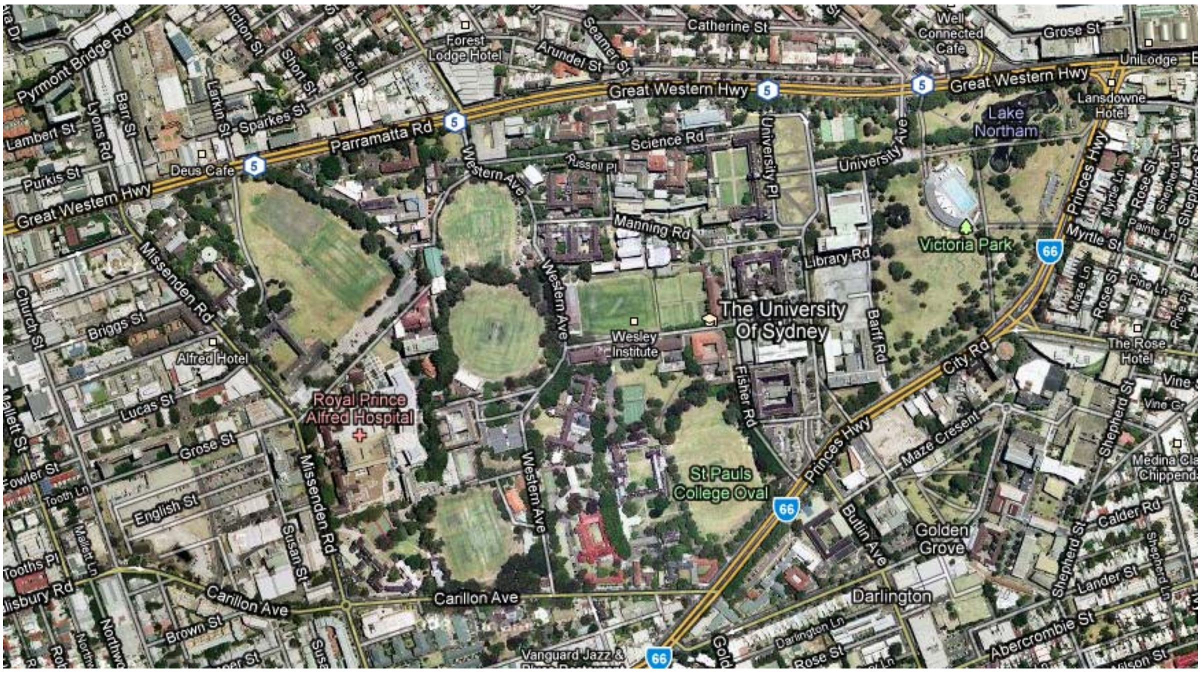


FIGURE 8.1 A map of the Camperdown campus, indicating the major transportation networks within the CODCD vicinity. The transportation plan for the project will address the location, seeking to enhance connections to the larger community.

FIGURES 8.2 AND 8.3 The University recognises that the CODCD will be near the proposed new Metro rail station along Parramatta Road. The design team will investigate ways to forge an accessible and open connection to this new piece of civic infrastructure. One way to do that—and to reinforce the health mission of the CODCD—is to develop a so-called "green links" program, as has been done in Bondi Junction, that informs pedestrians of the calories they burn by walking along certain distances between buildings and transportation nodes. The design team will investigate this further with the University during detailed design.

Car share: The University will investigate local car share companies to provide 2-3 car share locations for the parking associated with the CODCD.

Small car parks: in accordance with the requirements of Green Star to encourage the use of fuel efficient vehicles.

Cyclist facilities: The CODCD will incorporate significant expansions of the existing University and Royal Prince Albert Hospital bicycle storage facilities, while also providing more changing facilities for faculty and staff who bike to work.

Community and Occupant Engagement

The development of the CODCD will consider stakeholder—both community and occupant—feedback. The CODCD will be a highly visible building with linkages to the Royal Prince Alfred Hospital and like the hospital, will consider existing and future community needs in and out of the campus context. The building design will consider how the building

8.0 TRANSPORT & SOCIAL SUSTAINABILITY

operation can be improved and tuned based on occupant feedback. The design and consultant team will also consider how the building's design and performance can be shared with the wider community, either through reporting building performance data or sharing lessons learned with peer laboratories and universities.

Building Occupant Satisfaction

In addition to As-Built (Green Star) and Energy in operation certification (NABERS Energy, potentially extended to NABERS for Water and Waste), the project will investigate the potential for green leasing and post-occupancy certification from the standardised PROBE/ BUS Dataset method (Post Occupancy Review of Buildings and their Engineering – Building Use Studies Ltd Method) to gauge occupant satisfaction with the building and its internal conditions. The method would evaluate, as a minimum, occupant satisfaction with:

►Overall building design;

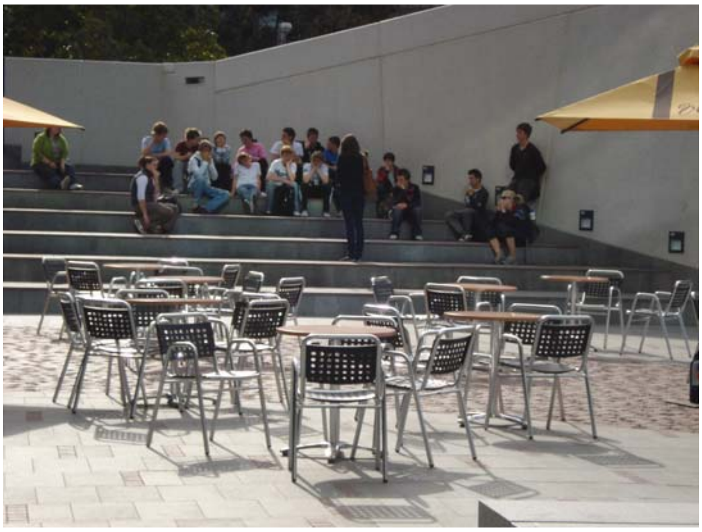
►Personal control (lighting, cooling, heating, etc);

►Speed and effectiveness of management response after complaints have been made;

►Temperature, air movement, air quality, lighting and noise;

►Overall comfort, health and productivity.

FIGURE 8.4 The design of the CODCD has been carefully sited to avoid impacting the adjacent practice ovals that are a hallmark of the University of Sydney and an important component of the social sustainability of the campus.



FIGURES 8.5, 8.6 AND 8.7 (CLOCKWISE FROM TOP LEFT) The University of Sydney and the design team will seek to incorporate other aspects of social sustainability into the project, including provisions for child care, indoor and outdoor restaurant and dining facilities, and public space where the CODCD's research units can provide outreach to the campus and surrounding communities.