

Carbon Neutral Offices - DRAFT

> The Pixel Building Case Study

SNAPSHOT

Organisation

Grocon Pty Ltd

Building type

Commercial Offices

Project name

Pixel

Project objective

To design and construct the world's first carbon neutral and water balanced office building with regard to both operational and embodied carbon emissions.

Results

Modelled

Perfect 105 point Green Star score (Australian GBC)

105 out of 110 point LEED score (USGBC), ten points more than the previous best rated building.

Operational

Pending full occupancy.

Status

Completed July 2010, currently partially occupied.



“ There are over 44,000 buildings in 120 countries around the world that have used the LEED rating system ... Pixel has now surpassed all of them ”

Daniel Grollo
Grocon CEO

sustainability.vic.gov.au

SV Program Context

Sustainability Victoria (SV) works with research and businesses to develop and drive resource efficiency in the property sector.

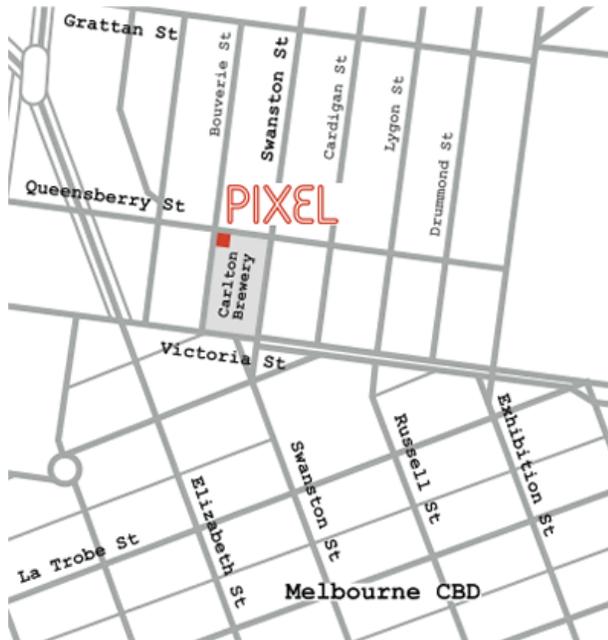
Office buildings account for approximately 25% of commercial sector energy consumption indicating a significant opportunity for sustainability improvement and investment.

In its Commercial Buildings Program, SV partnered with Grocon to publicise the sustainable achievements of the project. SV facilitated a link between Grocon and the International Energy Agency through the Energy Conservation in Buildings and Community Systems program which has generated much international interest in the Pixel building.

About the Carlton Brewery site

The 1.6ha former Carlton Brewery site on Swanston Street, just to the north of the CBD, is a key urban development site in Melbourne.

The first building on the site is Pixel.



Objective

The brief for Pixel was to provide an innovative world leading carbon neutral and water balanced office building for Grocon's development and sales team overseeing the adjoining 1.6ha development site. It was to include a display suite area and a green rooftop viewing area.

Following completion of the adjoining development the project may be strata titled, or be held in one title as commercial offices.

Project targets included:

- zero emissions
- water balanced
- Highest Green Star Office Design rating
- Highest LEED rating
- Highest BREEAM rating

Project

A team comprising Grocon (developer, builder, tenant and owner), studio505 architects, and sustainability consultants Umow Lai was put together to deliver Pixel. The aim was to design an example of the "office of the future", a future in which there is a constraint on carbon emissions. Pixel incorporates many new and emerging green technologies with the aim of testing them for larger commercial developments.

The focus for the Pixel project has been carbon balance rather than energy. As a consequence Pixel is energy positive but carbon neutral.

Results snapshot

Grocon's Pixel building is the first carbon neutral¹ office building of its type in Australia. To be more precise, when "netted" on an annual basis, Pixel does not produce any carbon emissions due to its operational energy use. In addition, over its 50 year life cycle, the building recoups all of the embodied carbon emissions generated during its construction

¹ At conception, no carbon neutral labels were available for the building. The definitions used were derived from those current in the United Kingdom in the mid-2000's. Building carbon neutrality was established by "netting" the carbon use and energy exported to the grid on an annual basis. During the course of developing the project, however, the Australian Government developed a more onerous local definition of carbon neutrality for products and services that does not acknowledge a net arrangement.

For further information

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(materials and activities) through the surplus on-site renewable energy it generates and feeds back into the electricity grid.

Building Description

Pixel is a four level structure using reinforced concrete floor slabs, lift core and easterly shared wall. Double glazed low-e external envelope is used for the north, west and south facades. The building also has a green roof.

Significant design effort was invested to ensure that a large proportion of the building envelope is able to be removed and re-used in order to reduce the future footprint of the building when it is demolished.

The concrete used at pixel is a new design that has been developed and patent-protected by Grocon. The concrete is called "Pixelcrete" and under third party independent review undertaken by RMIT University's Centre for Design, the design was shown to almost halve the embodied carbon of the mix when compared with traditional 40MPa concrete mix designs. This product has now been made available to the construction industry in Australia via an industry partner.

100% fresh air (ie no re-circulation) is circulated throughout the building via the floor spaces and is controlled via floor vents at each workstation. This facilitates passive night cooling of structural exposed floor slabs. A heat exchanger captures energy from the exhaust air to pre-heat or pre-cool the incoming fresh air. The thermally active floor slabs directly condition the office spaces through radiant cooling, and indirectly condition the spaces by pre-conditioning the incoming fresh air.

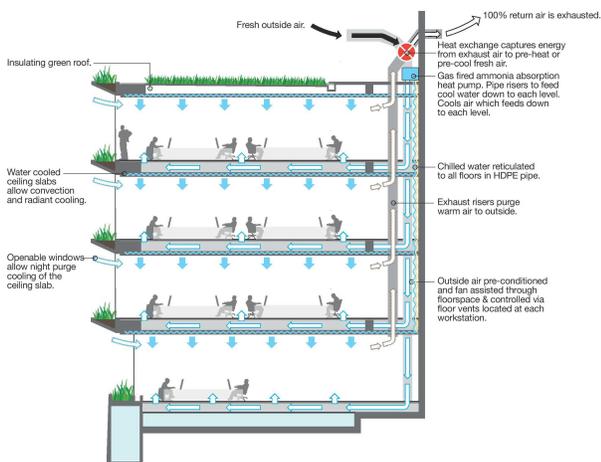


Figure 1 Cooling strategy

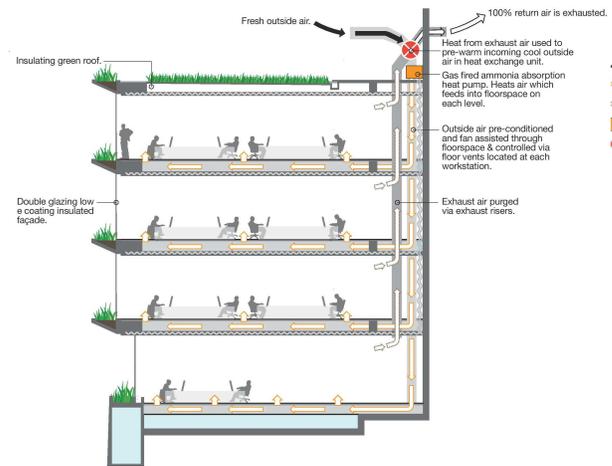


Figure 2 Heating strategy

Energy/Carbon Emissions

A strategy of energy demand reduction, low carbon intensity fuel sourcing, and on-site renewable energy generation was followed in order to reduce carbon emissions.

Firstly, the building was designed in order to reduce energy demand. This focussed on energy efficiency in the facade and services to minimise the energy required for lighting, heating, cooling and ventilation. As an example of this thinking, the whole building uses only two fans, one for supply air and the other for exhaust. Other measures include external shading system to minimise solar thermal loads, individual addressable dimming on the office lighting, and LED lighting to all non-office areas of the building.



Figure 3 External shading minimizes solar thermal gain (photo: Shane Esmore, Umow Lai)

A reliable fuel source was required for the building's greatest energy demand, heating and cooling. Gas, with a carbon intensity of 0.21 kgCO₂e/kWh, was selected over the traditional Victorian brown coal powered grid electricity, which has a carbon intensity over six times greater (1.34 kgCO₂e/kWh). A gas fired

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absorption chiller using ammonia refrigerant was used. In addition to dramatically reduced carbon emissions, the refrigerant has no ozone depleting potential, nor is there any possibility of legionella. The natural gas supply also acts as a back-up for the anaerobic digester.



Figure 4 Roof top wind turbines and tracking PVs

Both the reduction in demand and carbon intensity allowed for relatively small renewable energy sources to be installed onsite to achieve a net balance of carbon emissions. Renewable energy systems were designed into the building and consist of fixed and tracking photovoltaics and wind turbines on the roof, in addition to a small amount of biogas produced from an anaerobic digester connected to the vacuum toilet black water system.

The wind turbines and photovoltaics are grid connected and use the grid as a 'bank' where excess renewable energy is exported. The nature and time of energy generation was also considered. Peak loads in Australia are related to cooling energy demand with the biggest need occurring during summer mid-days. The use of site based wind and solar power generation matches well with this system need and creates a direct relationship between peak power generation and peak grid load.

Water and waste

The water strategy calls for a reduction in demand, together with reuse, in order to achieve water neutrality.

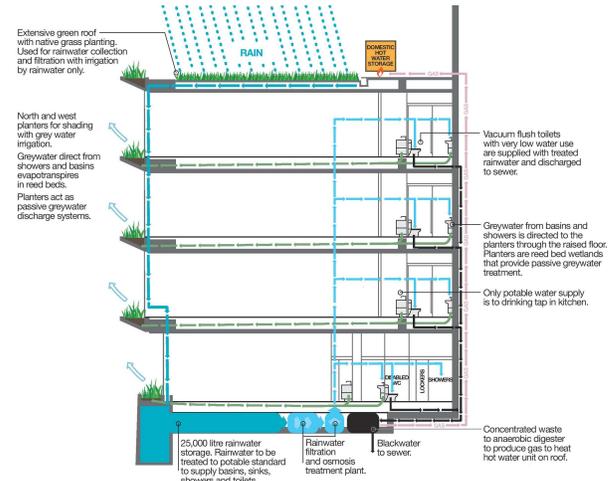


Figure 5 Water cycle

Demand reduction is achieved through a number of measures including the use of vacuum toilets designed to reduce water consumption to an absolute minimum.

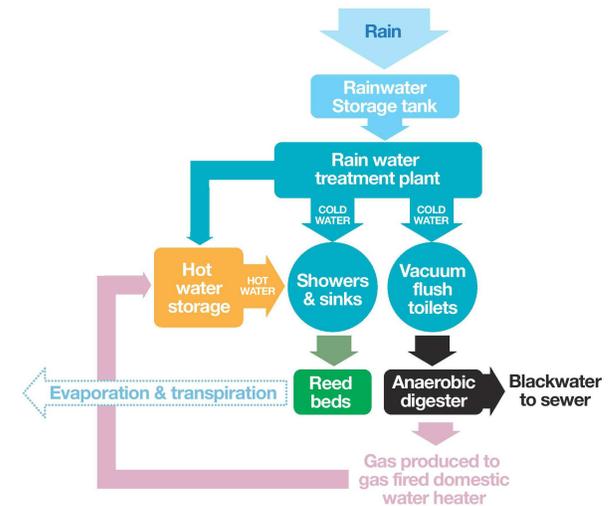


Figure 6 Water reuse and waste treatment

Reuse is achieved on a number of levels. Water falling on the Pixel building as rainwater is collected after it has been used to irrigate the native Victorian grassland species re-introduced in the roof garden. The rainwater is stored in tanks before being treated by reverse osmosis to potable water standard. This treated water is distributed to all fixtures and fittings within the building and the resulting grey waste water is then filtered and directed to the living edge reed beds where it is used to irrigate the reeds and plants.

This process means that there is no grey water waste leaving the Pixel site except for the wettest month of the year in Melbourne, dramatically reducing the waste flow to sewer.



Figure 7 Edge reed beds receive grey water from showers and sinks

The anaerobic digester on the ground level holds all of the black waste from toilets and kitchen facilities. The methane is extracted and used as the energy source for the hot water heaters on the roof. These in turn provide the hot water to the showers that subsequently produce the grey water that irrigates the reed beds. The black waste is then sent to the sewer in a liquefied form and with reduced methane levels.

Building ratings

The building has achieved the highest score in two major green building rating schemes to date. A perfect 105 point score was achieved under the Australian Green Building Council's Green Star rating system. That system provides for a maximum of 5 points available for innovation yet the Pixel project documented and claimed 38 innovation points knowing that of those only 5 could be awarded.

In addition, the building was assessed by the US Green Building Council's LEED scheme and scored 105 points out of a possible 110, 10 points more than the previous best rated building. The US LEED rating

system has been used on more than 44,000 buildings in 120 countries around the world.

The building is also being assessed using the UK BREEAM scheme and is targeting achievement of the highest score yet achieved using this tool.

Simulation tools

Modelling of Pixel's energy performance was primarily conducted using the building energy simulation tool Indoor Climate and Energy (ICE). Additional software tools were used to calculate photovoltaic and wind renewable energy production, daylight levels (Radiance and Ecotect), and embodied carbon.

Lessons learned

A number of lessons were learned from the project experience.

The inverter systems proved to be the most problematic to solve. Whilst the vertical axis turbines have spun regularly, the interface to the electrical grid has regularly defaulted to the "off" position, causing energy generated to be wasted. A direct link from the inverters to the alarm on the building automation system was implemented so that turbine outages could be quickly identified and the energy re-connected to the grid.

The original installation of the bio-gas systems used a stainless steel vessel for the sludge with copper piping for the gas transmission to the roof level. The copper pipe was subsequently plastic-sleeved to enable use with methane.

The specified light fittings were upgraded by the supplier during the project to include an uplight function which should provide a more even spread of light in the office space. That uplighting affected the lighting sensors on the DALI lighting control system and sent the wrong message to the software in the building. The light fittings were subsequently adjusted.

Vacuum toilets are relatively new to the Australian market and the contract cleaning community has had limited experience in cleaning and maintaining them. Early problems had to be overcome when cleaning materials were drawn into the systems damaging the vacuum pump.

Finally, the tracking photovoltaic panels have a control system that monitors their illumination and adjusts their direction to maximize light levels. It was found that the system was adjusting the panels at night to face the strong lighting from the nearby city of Melbourne, wasting energy in the process. Time clocks were added to the system to limit the panel movement to daylight hours.

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Project information

General	
Owner/developer /builder	Grocon Pty Ltd
Architects	studio505
ESD and Building Services	Umow Lai
Structural	VDM Pty Ltd
Cost	Slattery Australia
Landscape	studio505 and University of Melbourne
Carbon Analysis of Pixelcrete	RMIT Centre for Design
Grey Water and Embodied Carbon Analysis	CSIRO
Location	205 Queensberry Street, Carlton, Victoria, Australia
Status	Completed July 2010
Duration	29 months conception to completion
Project cost	AUD \$6m (excluding site cost)
Gross Floor Area	1136.4 m ²
Net Floor Area	837.4 m ²

Energy Indices	Modeled	Full Operation
Space Heating Demand	4.7 kWh/m ² .a	pending occupancy
Water Heating	1.2 kWh/m ² .a	pend. occ.

Site Energy Consumption for Heat (incl. DHW)	5.9 kWh/m ² .a	pend. occ.
Final Energy Cooling	42 kWh/m ² .a	pend. occ.
Electricity Demand	22 kWh/m ² .a	pend. occ.
Total Primary Energy Demand	123 kWh/m ² .a	pend. occ.
Total Primary Energy Generation	84 kWh/m ² .a	pend. occ.

Solar & Wind	
Annual global radiation at site	1600 kWh/m ² .a
Area of PV	38.4m ²
Installed PV cap.	6.3kW _p
Installed Wind cap.	5kW _{el}

Building Fabric	U-value	R-value
External Walls	0.55 W/m ² K	1.82 m ² K/W
Windows (incl. frames)	1.80 W/m ² K	0.55 m ² K/W
Roof	0.31 W/m ² K	3.23 m ² K/W
Ground Floor Slab	0.13 W/m ² K	7.69 m ² K/W
Mean Building Envelope	1.06 W/m ² K	0.94 m ² K/W

Links

Sustainability Victoria

Grocon (Pixel Website)

IEA Energy Conservation in Buildings and Community Systems Project

ASBEC Defining Zero Emission Buildings Report

www.sustainability.vic.gov.au

www.pixelbuilding.com.au

www.ecbcs.org

www.asbec.asn.au/node/393

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