

THE POTENTIAL TO REPLACE AIR CONDITIONING LOAD BY USE OF NIGHT COOLING SYSTEMS.

The IPCC states:



“WE ARE AT WAR”

A world map showing temperature anomalies. The map uses a color scale from blue (cooler) to red (warmer). Significant areas of red and orange are visible over landmasses, particularly in the Northern Hemisphere, indicating warming. The text “WE ARE AT WAR” is overlaid in the center of the map.

“Global CO2 emissions must be cut nearly in half by 2030 to avoid a catastrophic loss of coral reefs and Arctic ice, and intense floods and droughts”

AIR CONDITIONING – THE SINGLE MAIN DRIVER OF POWER CONSUMPTION ACROSS RESIDENTIAL AND COMMERCIAL SECTORS.



- Nearly 50% of electricity consumption in Australia is consumed by residential and commercial sectors.
- On average, close to 20% of electricity consumption by residential and commercial sectors is used for operation of A/C for cooling.
- Consequently 10% of total electricity consumption in Australia is dedicated to power A/C for cooling.
- Globally estimated 1.6 billion A/C units now. Projected 5.6 billion 2050.



THE MORAL DILEMMA.

- We live in a generally warm climate. Human beings operate best at a temperature of about 22-23°C.
- Summer maximum averages for most of NSW, WA, QLD, NT exceed 27C with peaks sometimes at 40°C +.
- Australians will struggle to sleep at temperatures over 24°C.
- The climate is predicted to warm further.
- Much new construction in Sydney, Melbourne and Brisbane is moving away from the coast and therefore facing warmer summers.
- The capital cost of air conditioning systems and standalone units has fallen dramatically in real terms.



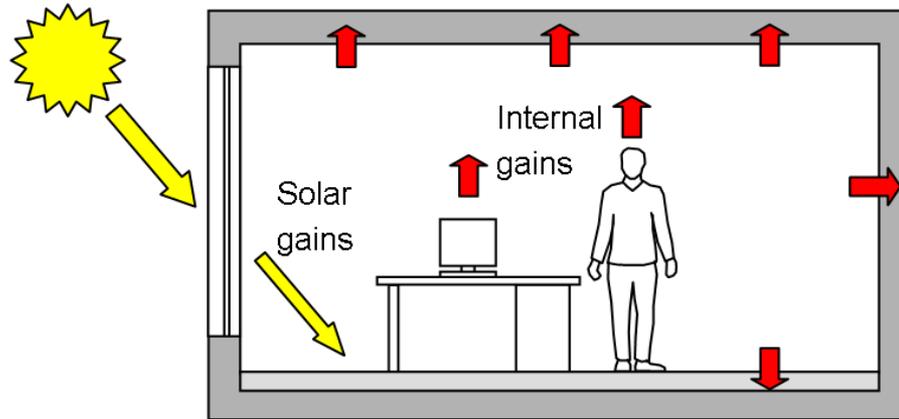
Increased penetration of air conditioning in small commercial, residential and now schools.

OPTIONS FOR REDUCING FOSSIL FUEL USAGE FOR AIR CONDITIONING.

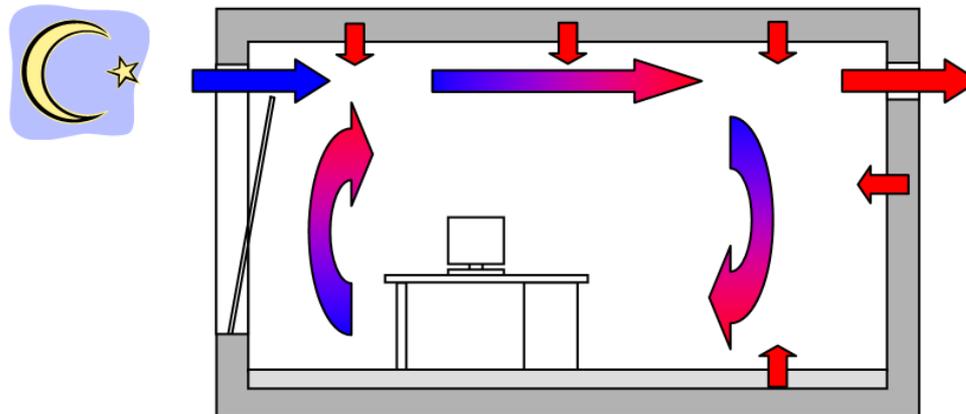
1. Further improvements in air conditioning product energy efficiencies.
2. Improved energy performance of commercial buildings and residential.
3. Supply of much air conditioning load by renewable energy sources, supported by battery storage.
4. Widespread acceptance of the gravity of the climate position with people voluntarily abandoning much air conditioning usage/ reliance or increasing set points.
5. Reduced reliance on air conditioning by adoption of other technologies and practices.
6. Government restrictions on future installs (e.g. New homes, Government schools or even harsher star ratings for homes).
- 6 7. All or a combination of the above.

REPLACING AIR CONDITIONING LOAD BY APPLICATION OF NIGHT PURGE PRINCIPLES.

Incidence of solar load during the day should be limited and residual taken up through exchange with the thermal mass of the building.



At night, an energy efficient means of air exchange with cooler, external air is harnessed to remove radiated heat from the thermal mass and cool internal air to overnight minimum temperature.



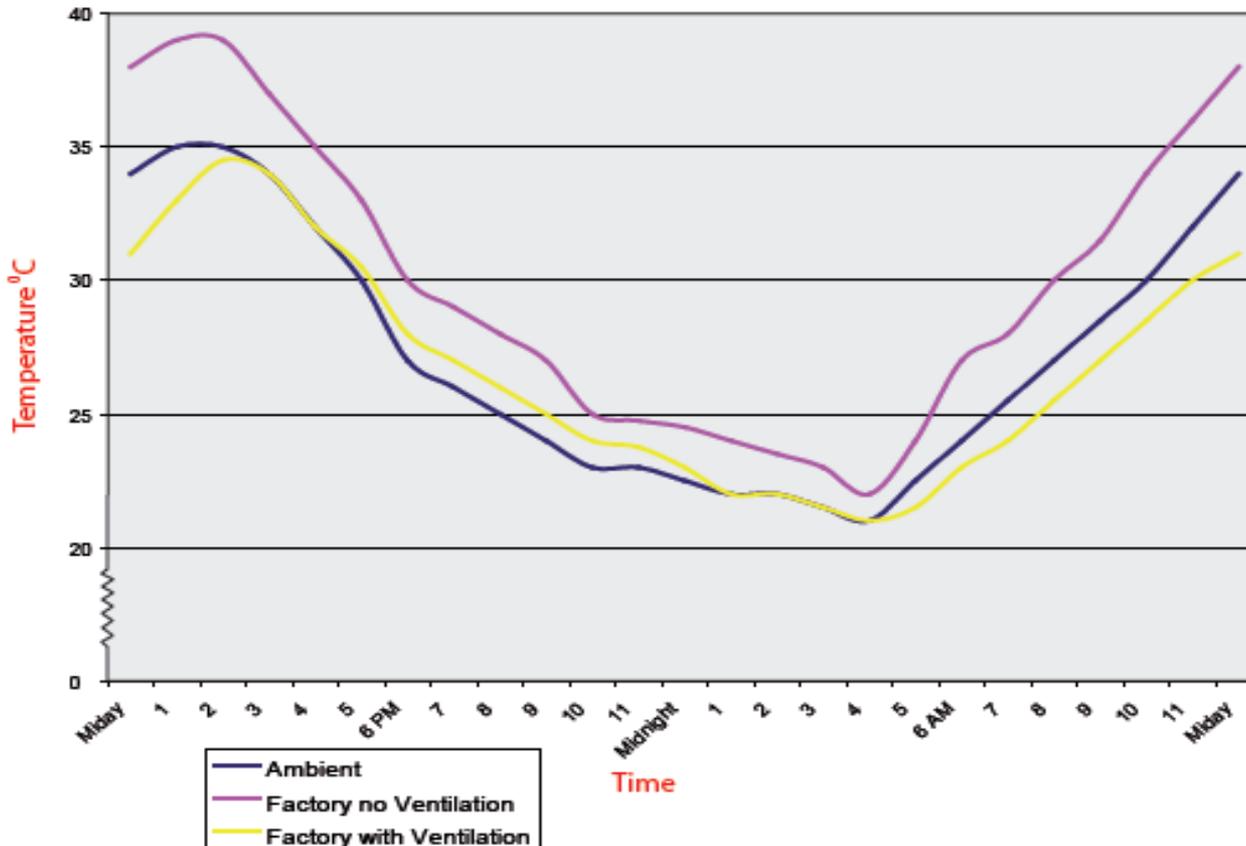
NOT A NEW CONCEPT – BUT SADLY NOT UTILISED ENOUGH.

Old Portuguese forts of 16th century along Omani coast incorporated wind tunnels to exploit night ocean breezes to cool thermal mass.



Use of wind towers to capture and circulate night breezes were common in older Middle Eastern architecture.

RESULT PROFILE OF A SUCCESSFUL NIGHT PURGE SCHEME.



Where a diurnal weather pattern exists and a differential of at least 8°C exists between day max. T and night min. T, a benefit of up to 5°C can be achieved with a well-designed night purge scheme.

WASHINGTON UNIVERSITY – SCHOOL OF BIOMOLECULAR ENGINEERING.





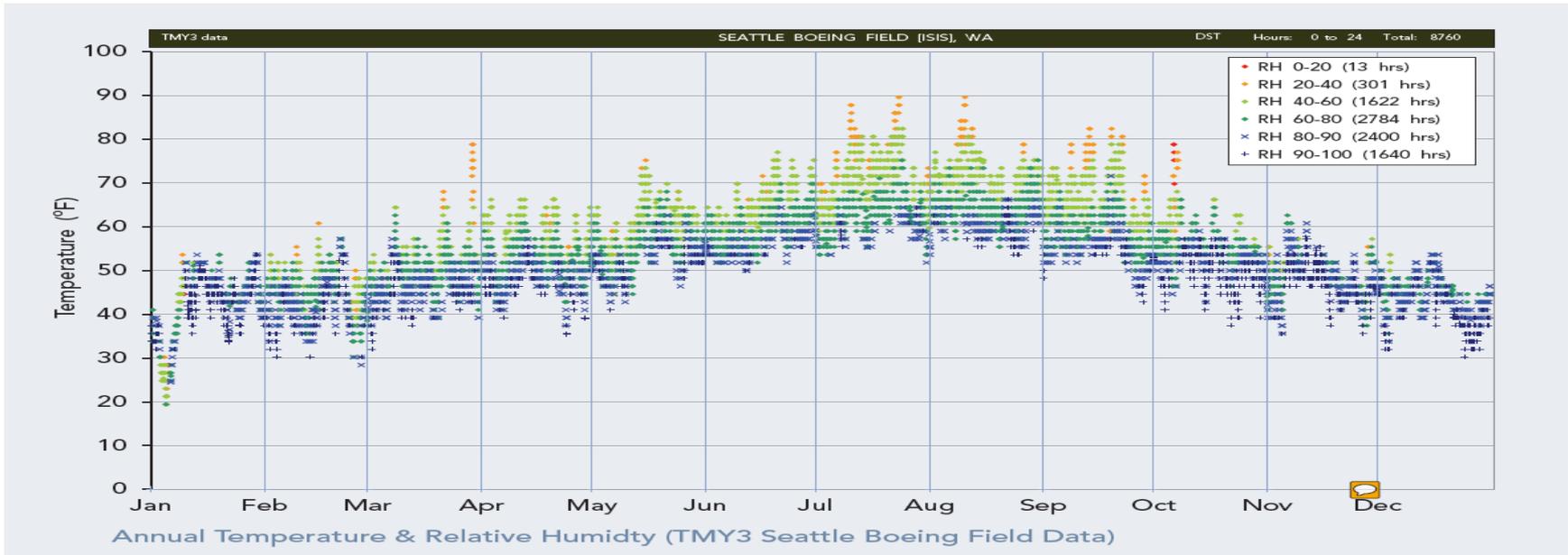
- **Project commenced in 2009 and was completed in 2012.**
- **Brief was to achieve LEED GOLD.**
- **Strategy to achieve brief was to replace large slabs of air conditioning load with low energy ventilation, design suitable façade incorporating phase change material, provide suitable thermal mass, and design suitable daylighting.**

SUSTAINABILITY OBJECTIVES



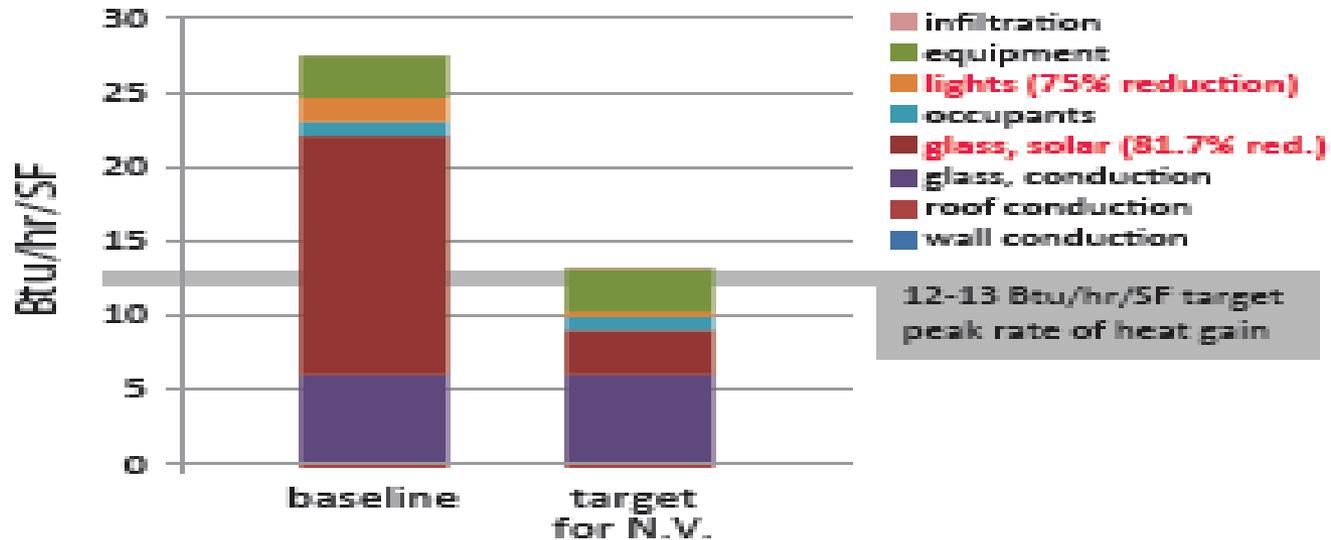
- **Capability to provide an acceptable working environment, a night purge based ventilation process, for all offices, meeting rooms and common walkways.**
- **Use water capture and filtration to provide much of water needs.**
- **ACHIEVE LEED GOLD**

DEVELOPMENT OF INTEGRATED DESIGN STRATEGIES – CLIMATE CONSIDERATIONS.



- 97% of all operating hours would be within the so-called adaptive comfort range.
- Peak temperatures occur in late afternoon in July and August.
- Clear seasonal wind pattern with strong directionality when temperatures exceeded 24°C (75°F).

LOAD REDUCTION TASK

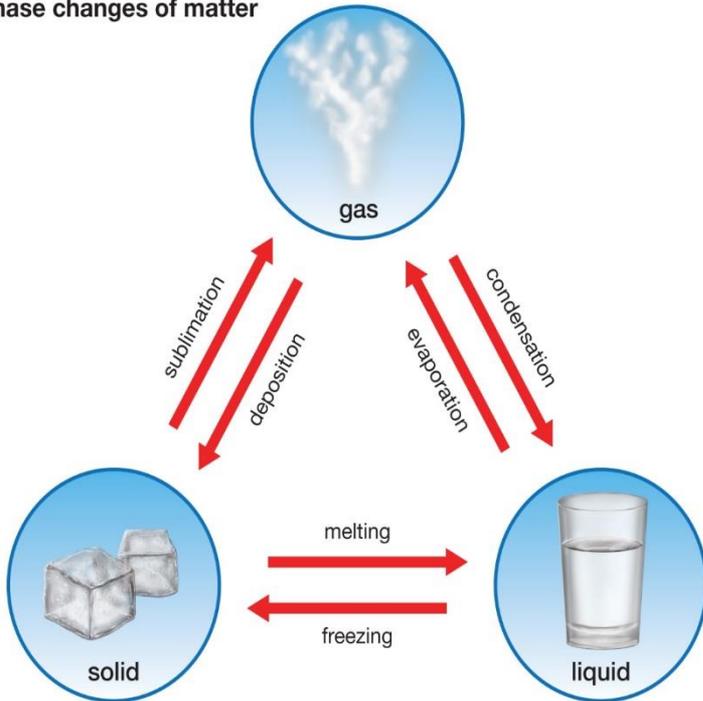


Peak load condition: July 10, a.m.

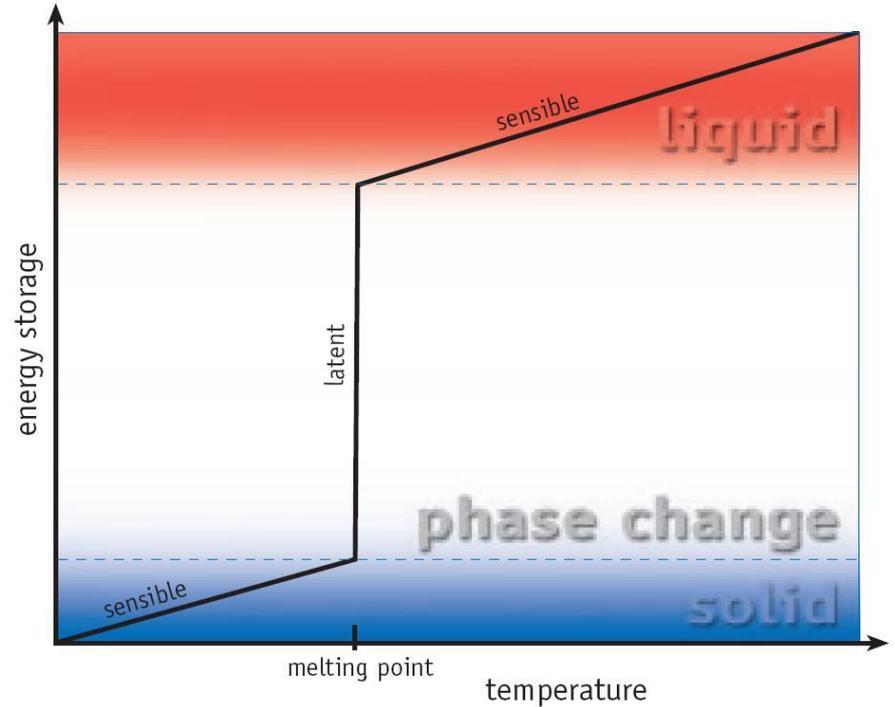
- Initial energy model constructed in eQuest
- For natural ventilation to work in this temperate climate target is less than 39W/m²²
- Model revealed peak load in office of 85W/m²

PHASE CHANGE

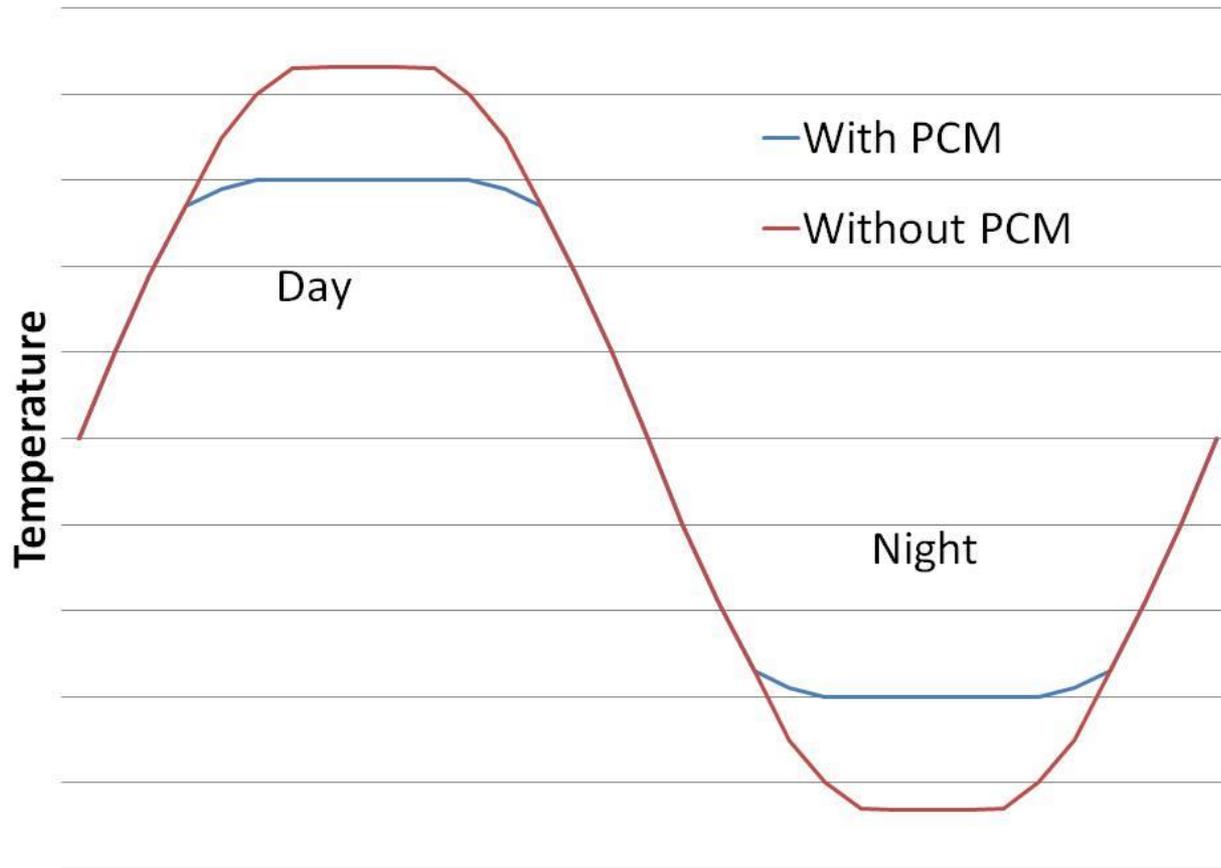
Phase changes of matter



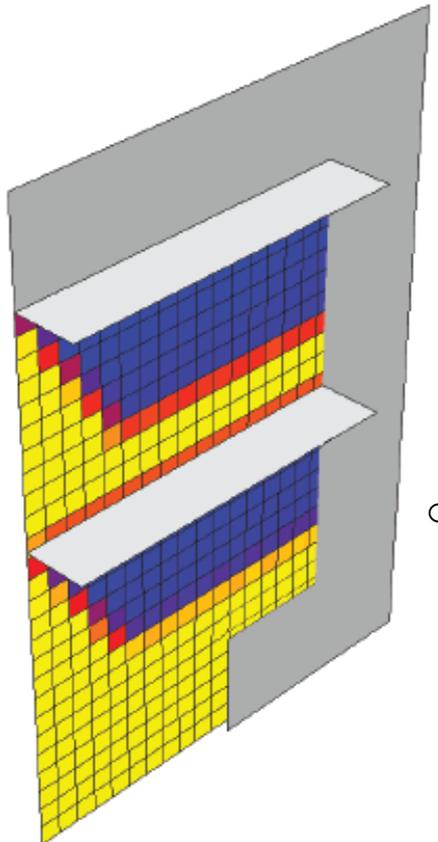
© 2012 Encyclopædia Britannica, Inc.



PHASE CHANGE



FACADE



- Sun shading

- Phase change install.
- Solar gains required to be reduced by 80% through façade.
- Reduce glazed area.
- Use high performance thermal glazing.
- Quality insulation

DAYLIGHT



Detailed daylight studies undertaken using both physical and digital models.



Automatic blinds to redirect direct sunlight to the ceiling.

AIRFLOW

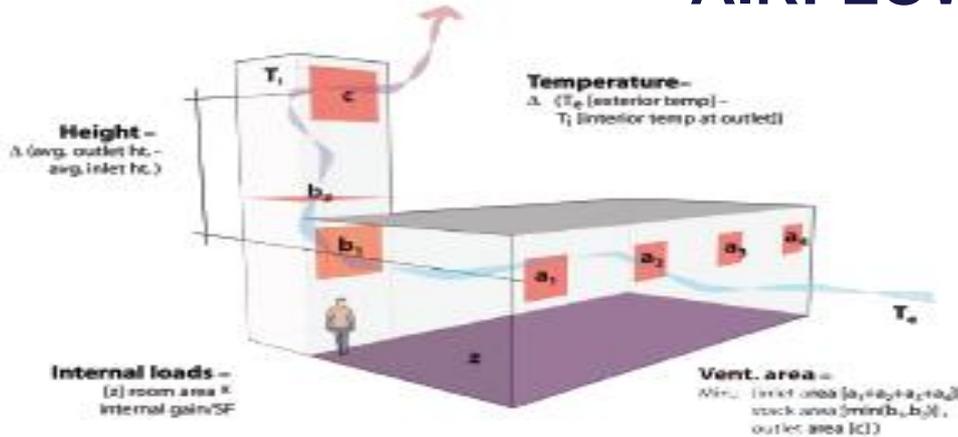
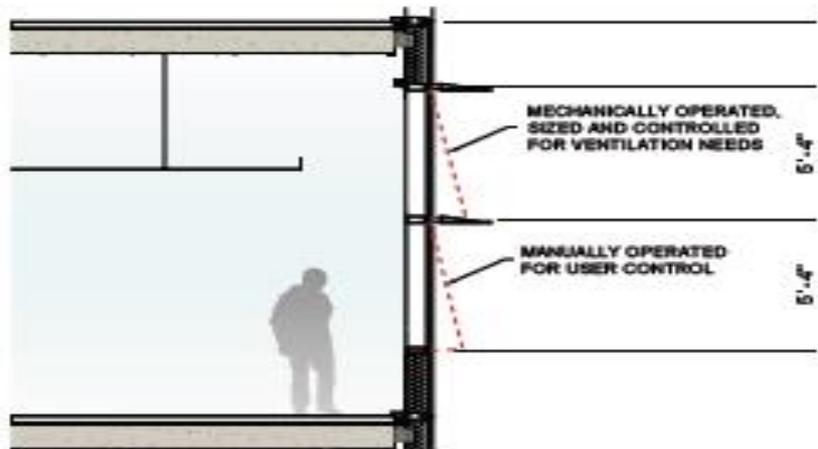


Diagram of ventilation inlets and outlets

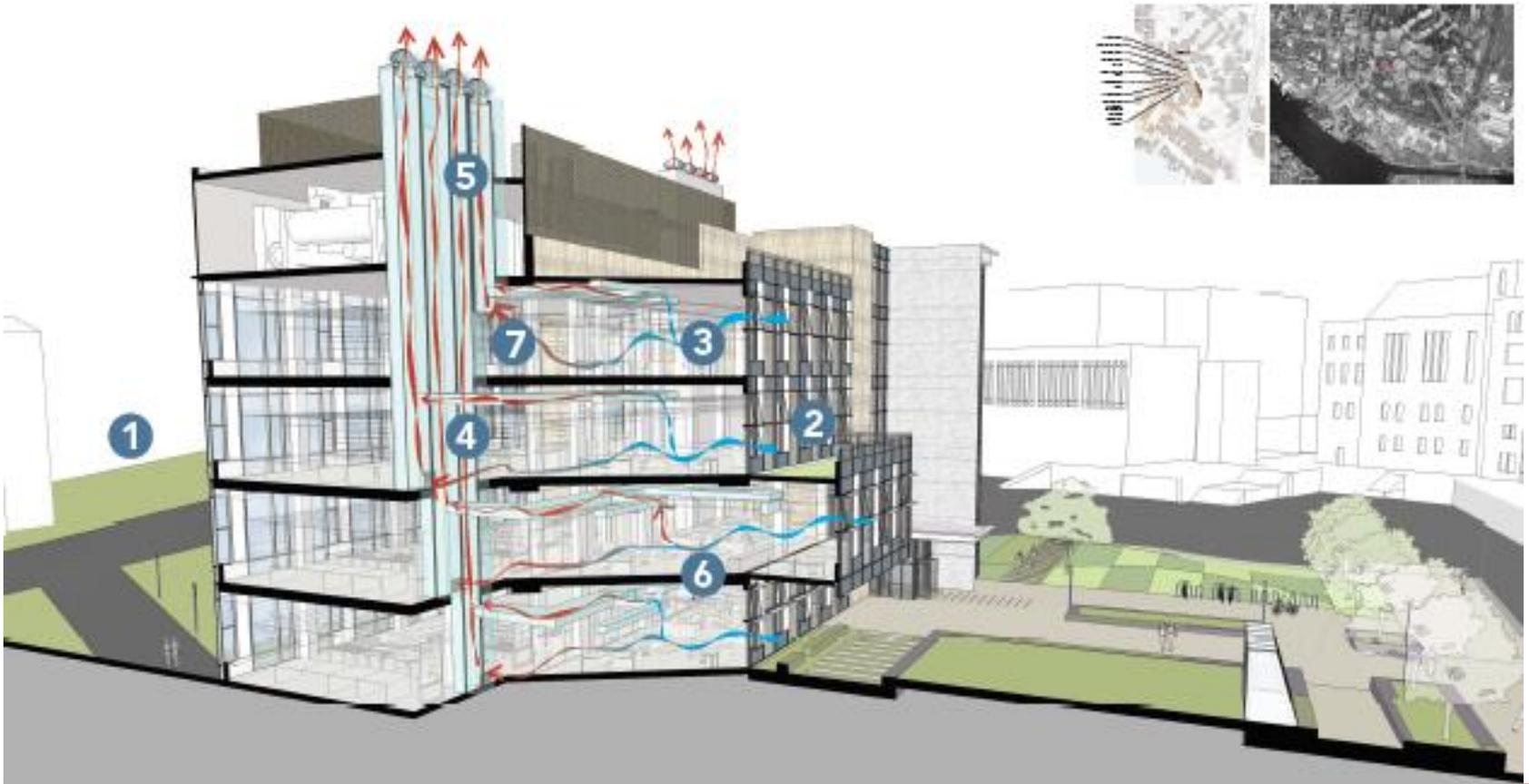


Typical office window wall section

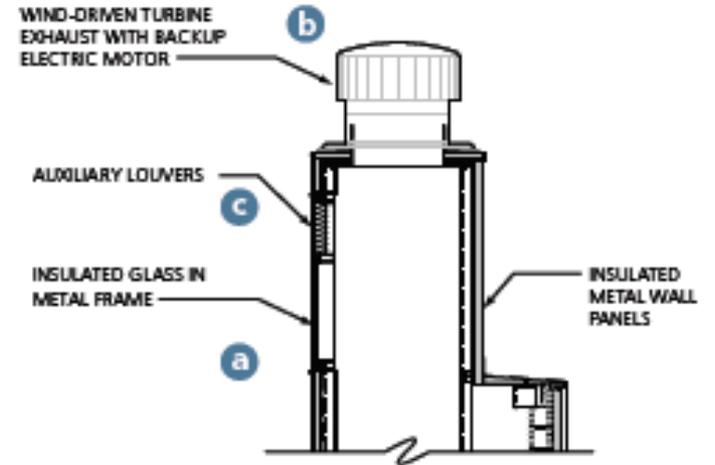
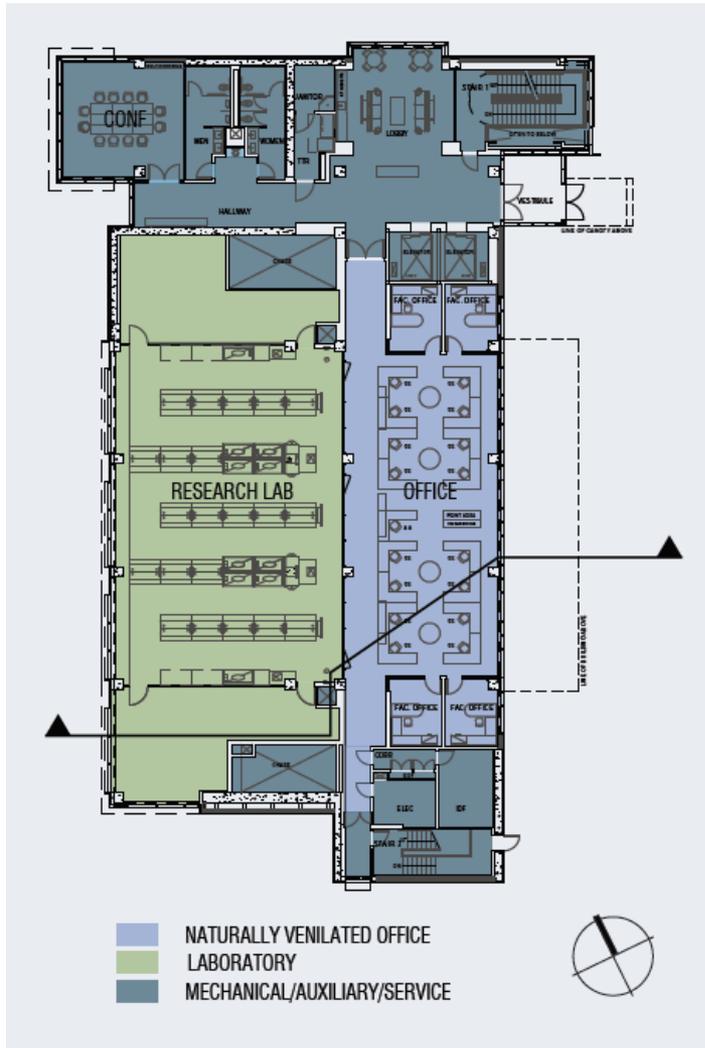
- Single zone airflow model used to determine airflow pathway to ensure enough cross sectional area for passive draw.

- Mechanical louvres coordinated with air supply need through BMS.
- Manually operated lower louvres under occupant control.

AIRFLOW DESIGN



AIR QUALITY & AIR COMFORT



**Edmonds
EcoPower 900**



ECOPOWER HYBRID VENTILATOR – 900MM



- **Patented Australian technology.**
- **Operated by wind/stack alone or mechanical/wind/stack together.**
- **Controlled through BAS with flow rate measure through thermal dispersion sensors.**

Solar Chimneys

RESULTS.



PRE-VEGETATED MATT SYSTEM



NATURAL LIGHT & CONTROLLABLE WINDOWS



CONFERENCE ROOM WITH TOP WINDOWS CONTROLLABLE



LAB SPACE

THE ELEMENTS FOR PROJECT SUCCESS.

- **BUILDING ORIENTATION**
- **THERMAL MASS**
- **EXCELLENT LEVELS OF INSULATION**
- **SUITABLE CLIMATIC CONDITIONS – DIURNAL**
- **SHADING WHERE APPROPRIATE**
- **CONTROLLED ENERGY EFFICIENT VENTILATION SYSTEM**
- **AIR SUPPLY SYSTEM CO-ORDINATED WITH VENTILATION**
- **CONSIDERATION OF USE OF PHASE CHANGE MATERIALS**

COMPARISON WITH DEFICIENT NIGHT SCHEMES.



So called 'Red Centre', UNSW

- Thermal Mass ●
- Shading ●
- Energy Efficient, Effective Ventilation ●
- Controllable air inlets ●
- Insulation ●

SUCCESS IN A TESTING ENVIRONMENT.

Kuenhe & Nagel new warehouse, Dubai.
Operating on night purge scheme when building is shut at night. BMS controlled operation driven by internal and external thermostats and exploiting variable speed ventilation capability. During day operates ventilators on natural mode only.



18 x EcoPower 900



Blowers with pre-filters for injection of night air.

THE EXPERTS HAVE THEIR SAY

“In the small hours of the morning (at night) on a summer day in Brisbane, the internal temperature of the houses is well above the outside temperature. This is one example that would suggest that people are not taking advantage of the opportunity for passive cooling through ventilation. Ventilation is a particularly important concept that can be used to encourage occupants to save energy and achieve comfort.” (Ambrose, James, Law, Osman, & White, - CSIRO 2013)

Griffith University 2yr study on unoccupied office buildings – Dr. H. Skates.

Study established that energy savings on cooling could be as much as 40% by using effective night purge ventilation in conjunction with quality ventilation.

“The main issue is you really need to be ventilating at night and get cool air through the building”.

SMART PURGE VENTILATION

Performance to-date has established that for night purge systems to be successfully the main ingredient is the need for 'smart' purge ventilation. It must operate at the right time, at the right rate and not conflict with air con systems.

Technologies exist but some are 'smarter' than others.



Odyssey



Wholehouse fan

EcoPower



BMS