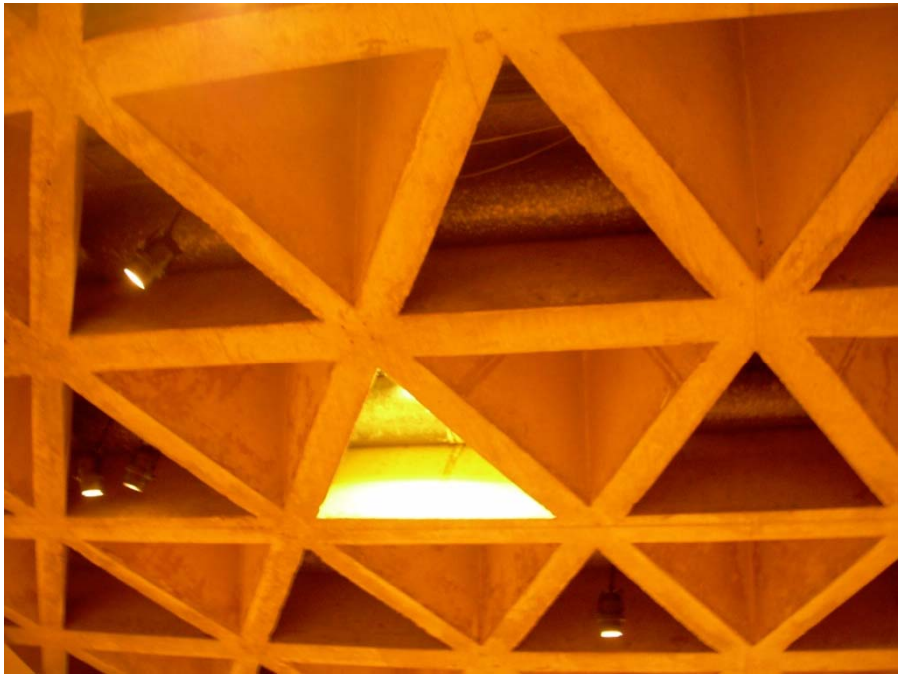
Thoughts on Services Engineering Strategies for a Low Carbon Future

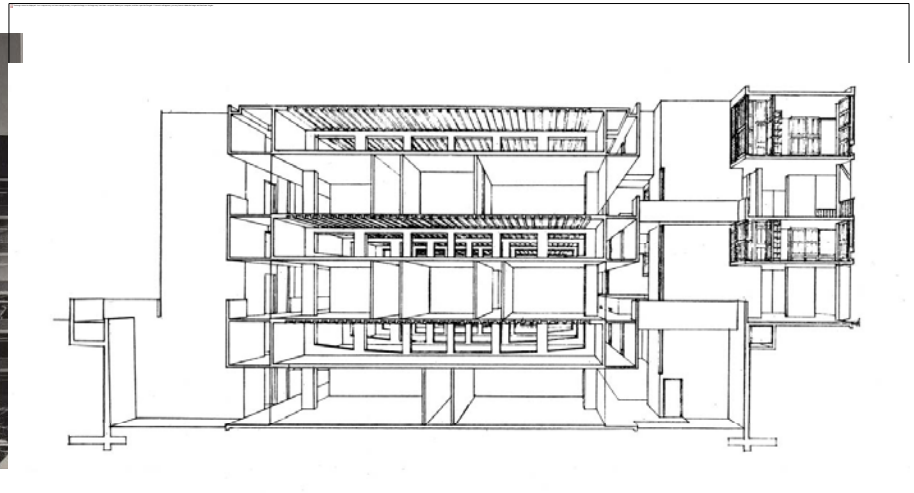
David Fullbrook

eCubed

‘Pasting over the construction by light and acoustic material and the burying of tortured and unwanted ducts, conduits and pipelines is intolerable’

Louis Kahn





‘How will your building perform if it has to run on half as much energy as you expect it to need’

Fred S Dubin

‘Something should be said and done about such architecture as this, or there will be no future for architecture.’

Dr Edith Farnsworth

It’s not just about the way a building looks its also about how it performs

We need to move to a four fold improvement in the performance of our buildings in the next 10-15 years

The use of emerging services technologies from the 50s onwards assisted the era of the possible.

Can the avoidance of or development of traditional services technologies recreate a new era of the possible in a low carbon future?

Impacts of HVAC systems

- It can make an otherwise uninhabitable architectural design habitable.
- It has a major influence on its occupants (and clients) satisfaction with a building
- It accounts for roughly 7-8% of energy use in New Zealand
- It can occupy 5-6% of the gross floor area
- It can occupy 300mm to 700mm in section at each floor level
- It can account for 10 -15% of the initial construction budget.
- It consumes 30-40% of a buildings energy use
- It needs to be replaced every 25-30 years and is the largest whole of life cost
- As such HVAC is one of the largest determinants of unsustainable building design

Its easy to go wrong at an early stage.

When the first 1% of projects up-front costs are spent up to 70%, of its life cycle costs may already be committed.

So what are the underlying needs for a HVAC system?

Underlying needs for HVAC

Heating 65- 75%

- Residential
- Schools
- Community Facilities
- Sports Facilities
- Smaller offices
- Apartments
- Smaller Hotels

Regulate

Push back by design

Comfort heating , cooling and ventilation 25-35%

- Larger offices
- Shopping Centres
- Large Hotels
- Performance Spaces
- Assembly Spaces
- Hospitals
- Laboratories

Minimise and Mitigate

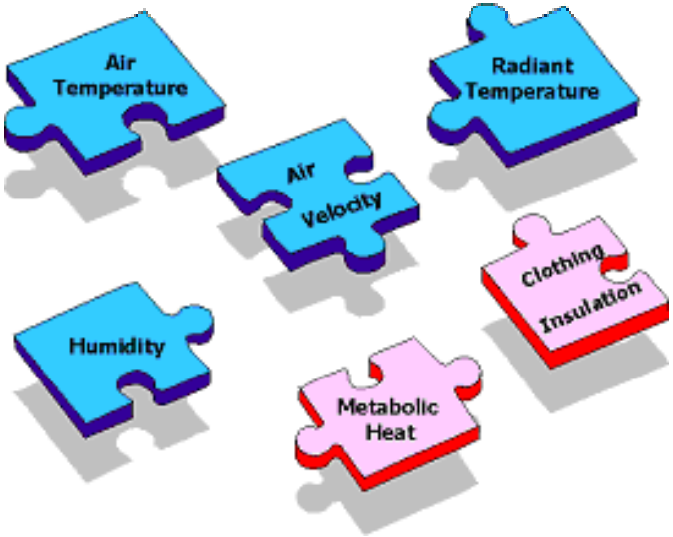
Air – Conditioning <5%

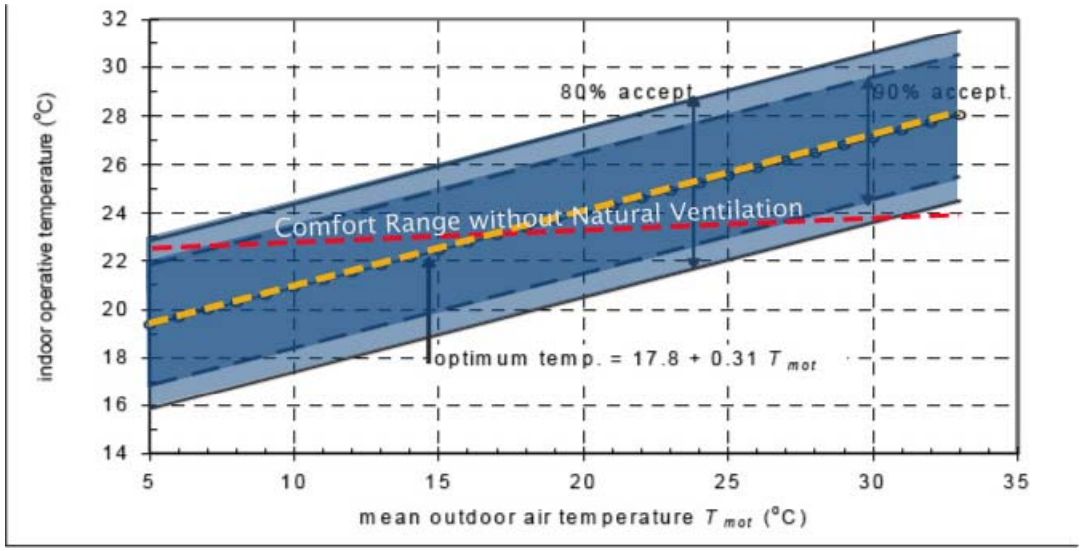
- Art Galleries, Museums and Archives
- Clean Rooms and Production Facilities
- Data Centres
- Operating Theatres
- High Performance Laboratories

Mitigate by green technologies

Increasing Control and Energy Use

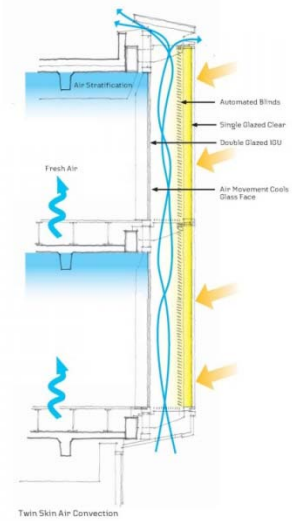
Perceptions of Comfort are being extended





Adaptive comfort model

Facades are getting more efficient



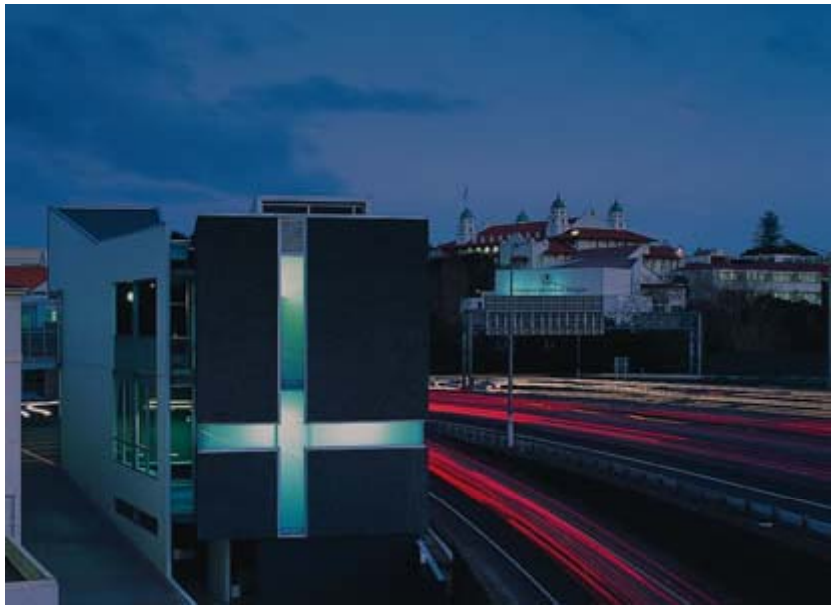
Flexibility

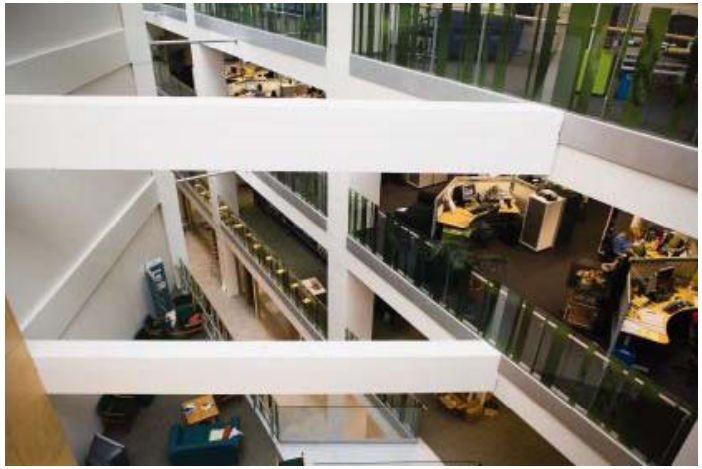
Buildings have generally becoming hallower and more environmentally responsive

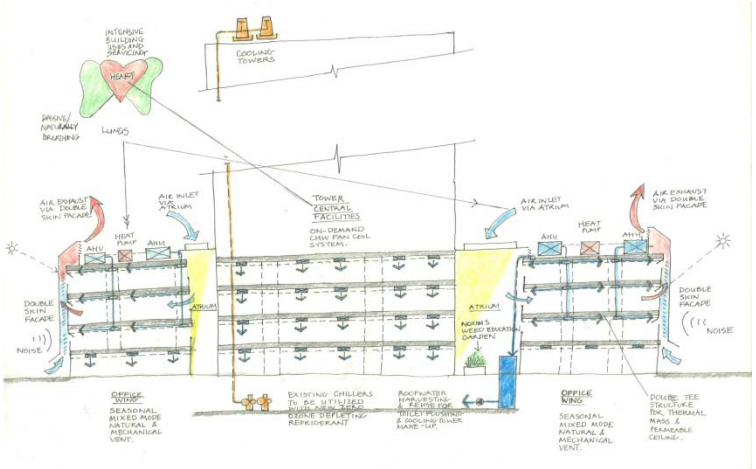
Internal Loads are reducing

Era	Lighting	Small Power	Total
70's	20	5	25
80's & 90's	20	25	45
2000+	<10	<15	<25

Building Location can be overcome





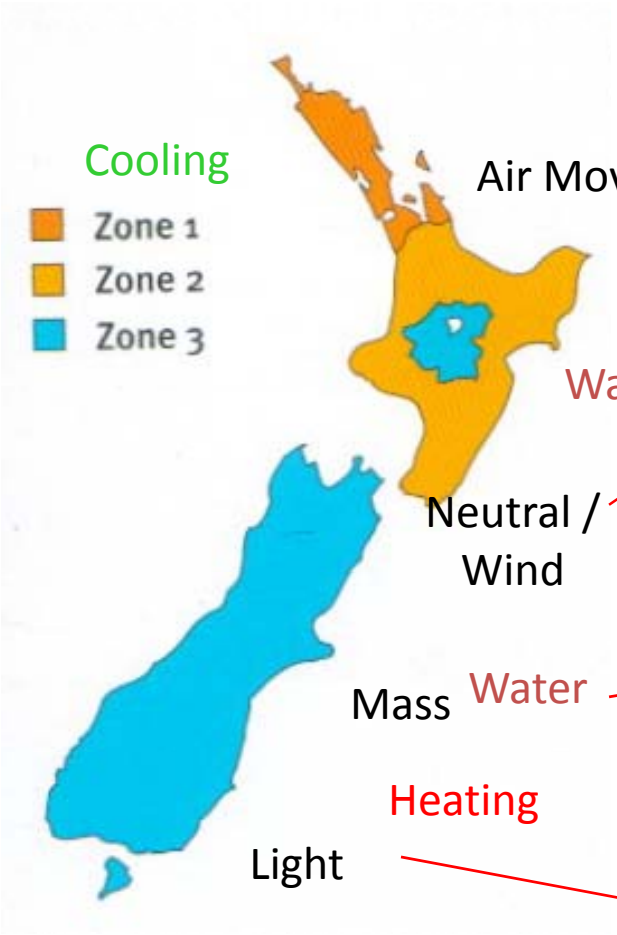


Perceptions of building quality are changing

Property Council New Zealand

NZGBC NEW ZEALAND GREEN BUILDING COUNCIL

Our temperate climate is ideal



Air Movement

Water

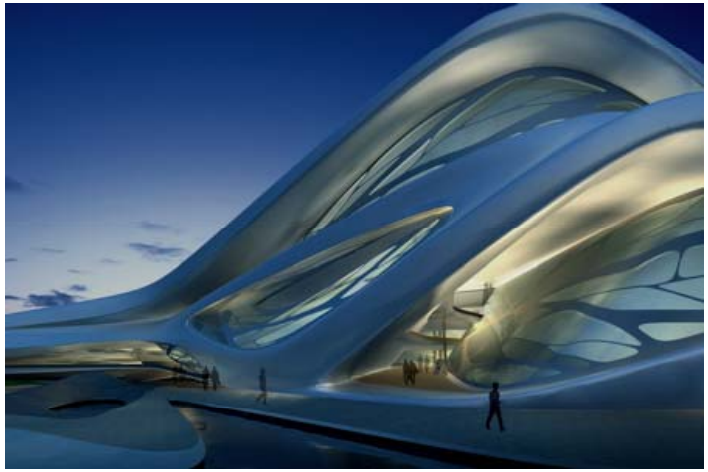
Neutral / Wind

Mass Water

Heating

Light

What does this mean for buildings in a low carbon future?



Joining up the dots

Global Consensus

Climate change agreements

Kyoto

Environmental movement

National Government

Energy security of supply

Climate Change commitments and policies

Regulation

Taxation mechanisms

Regional Government

Environment

Infrastructure

Land use /planning

Sustainability Frameworks

Rates

Local Government

Infrastructure

Land use /planning

Sustainability Frameworks

Buildings

Rates

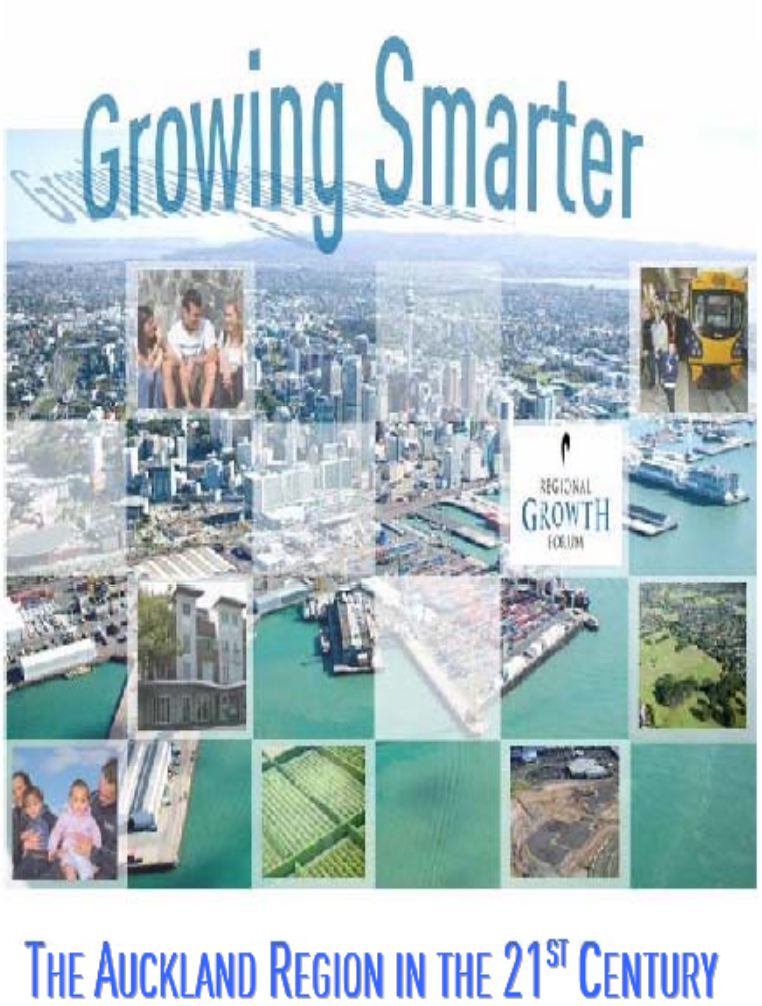
Individual

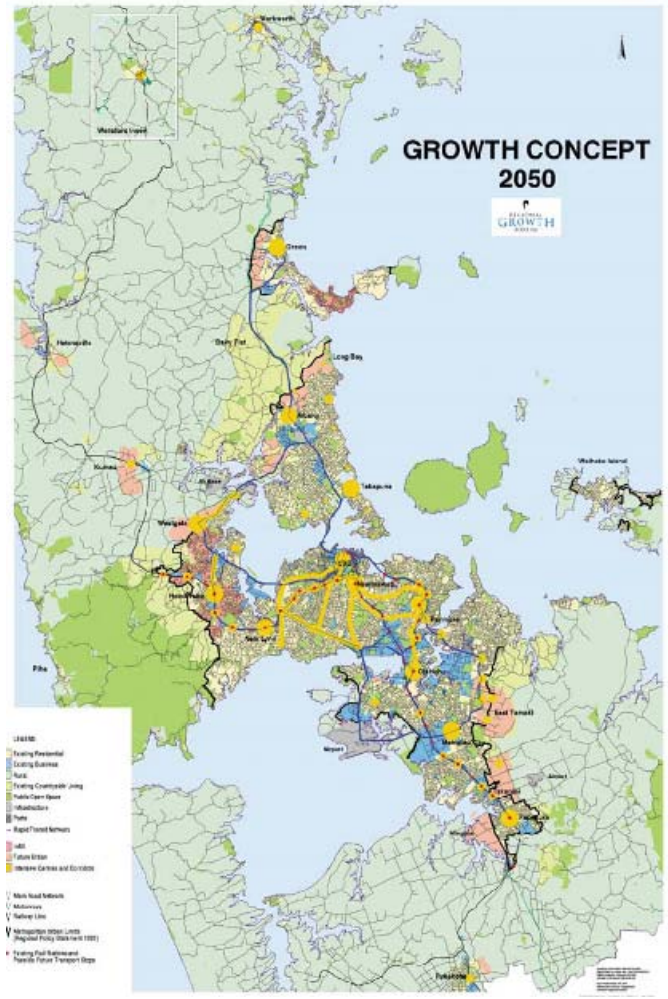
Personal choice

Personal actions

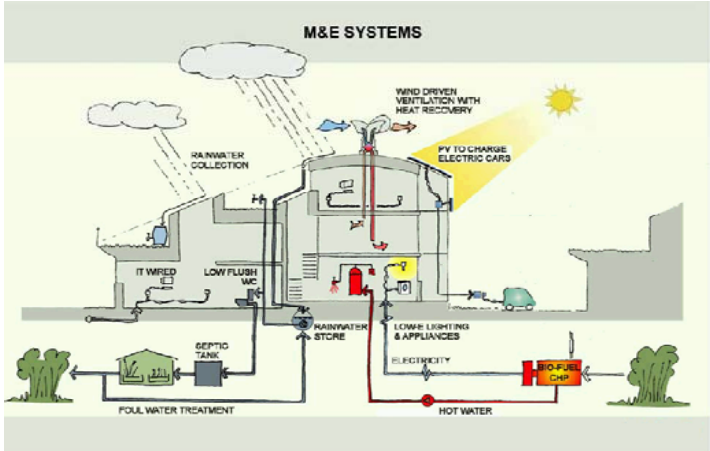
Community commitment

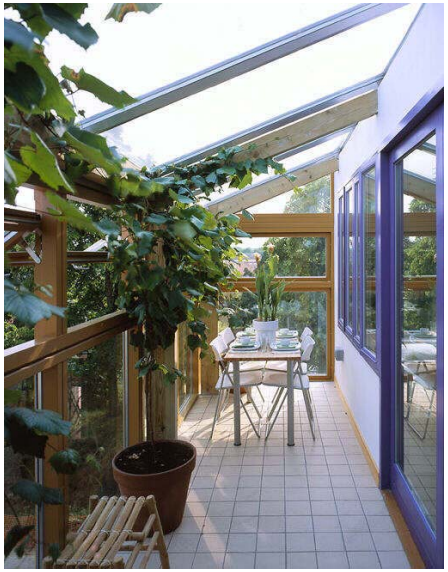
Growing Smarter – Our biggest challenge?



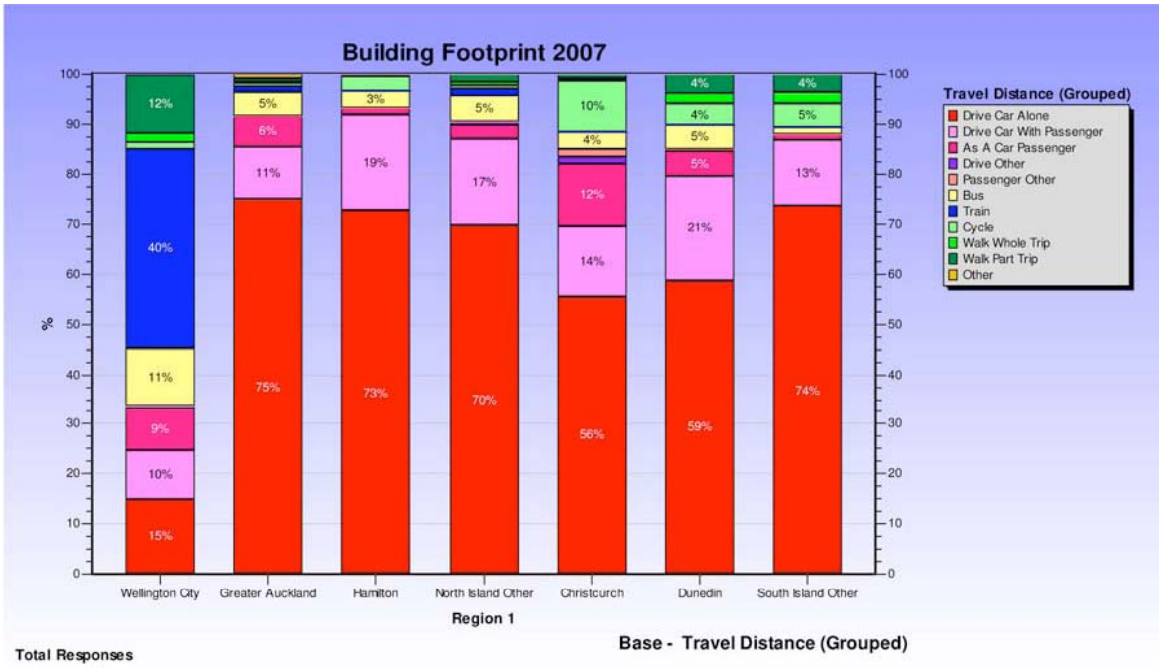


New Intensification – Equity, Community energy/carbon, food, multi - mode transport options and environment/design quality





Cradle to cradle regeneration



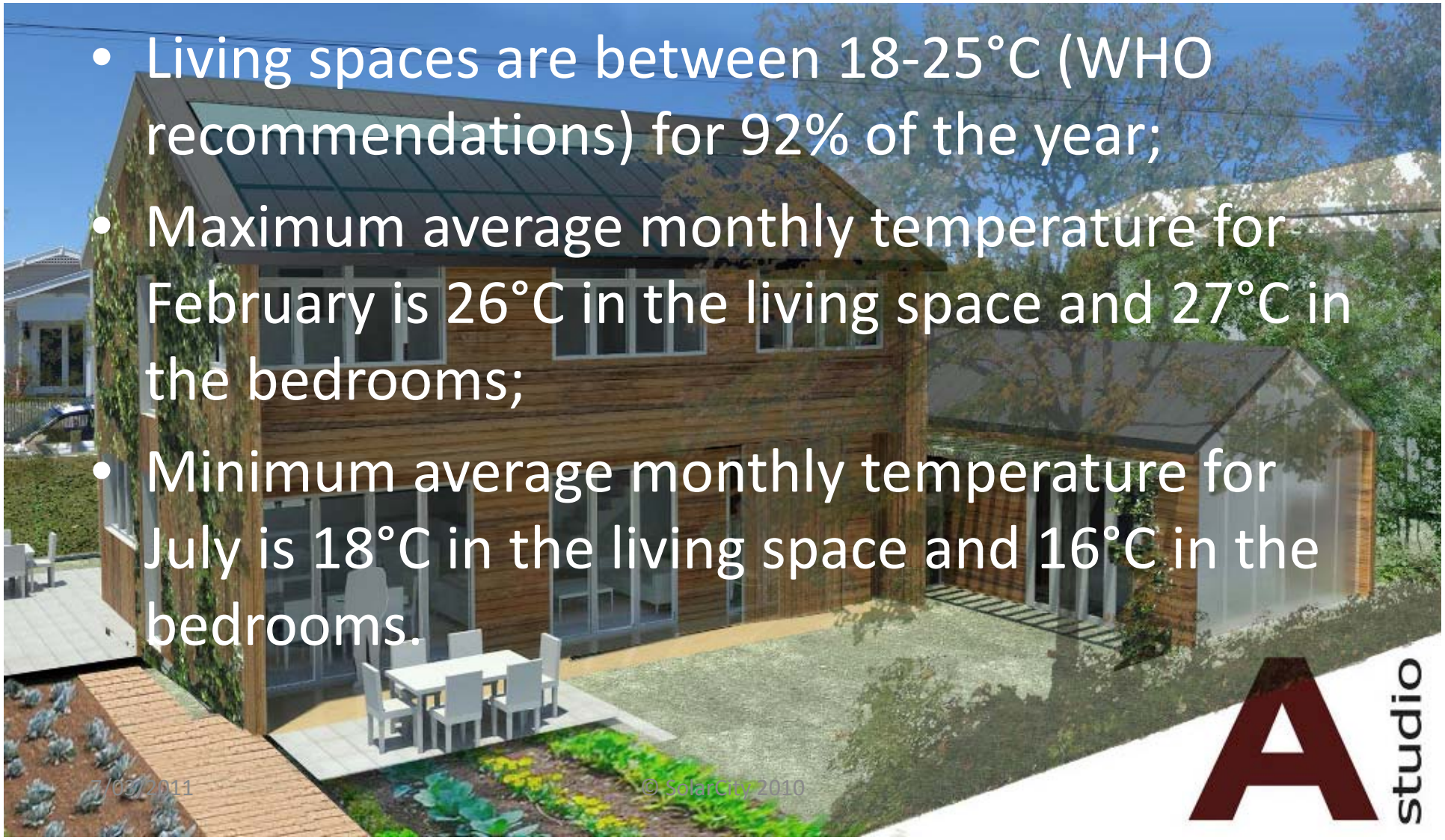
Actively Discouraging Cars

Residential

Target Carbon neutrality or Carbon Positive

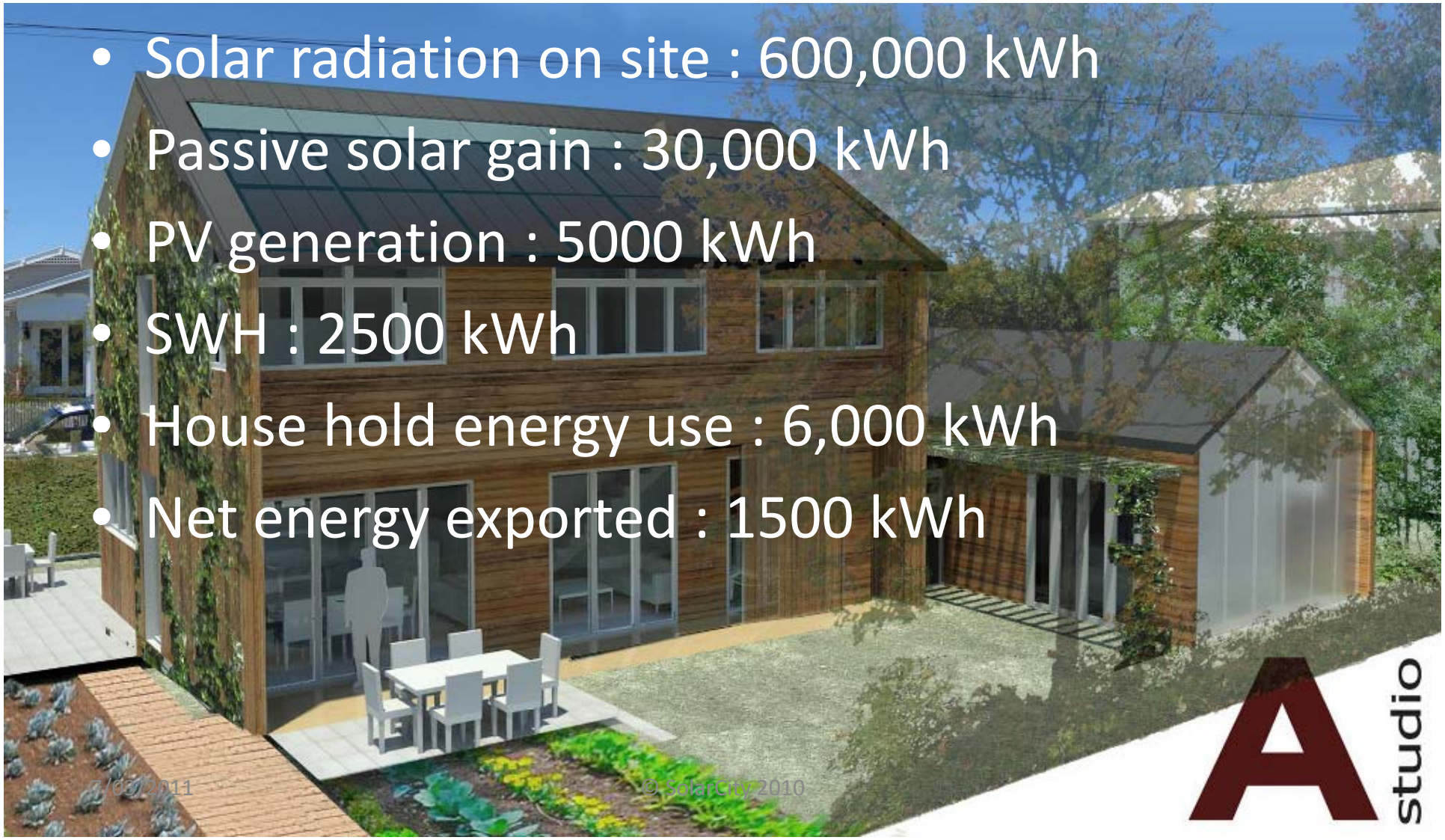
Smaller but smarter

Passive temperature control



- Living spaces are between 18-25°C (WHO recommendations) for 92% of the year;
- Maximum average monthly temperature for February is 26°C in the living space and 27°C in the bedrooms;
- Minimum average monthly temperature for July is 18°C in the living space and 16°C in the bedrooms.

Energy Exporting

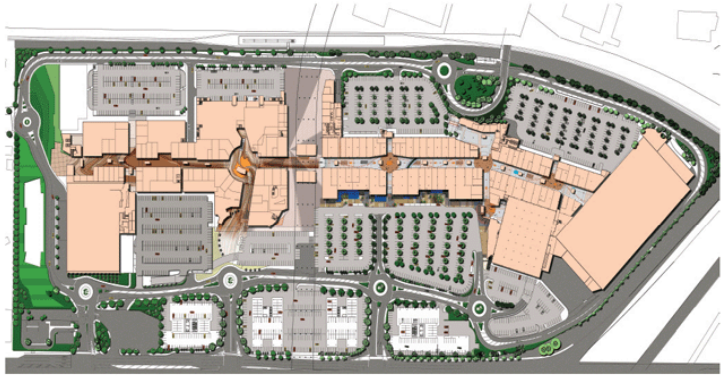


- Solar radiation on site : 600,000 kWh
- Passive solar gain : 30,000 kWh
- PV generation : 5000 kWh
- SWH : 2500 kWh
- House hold energy use : 6,000 kWh
- Net energy exported : 1500 kWh

Commercial

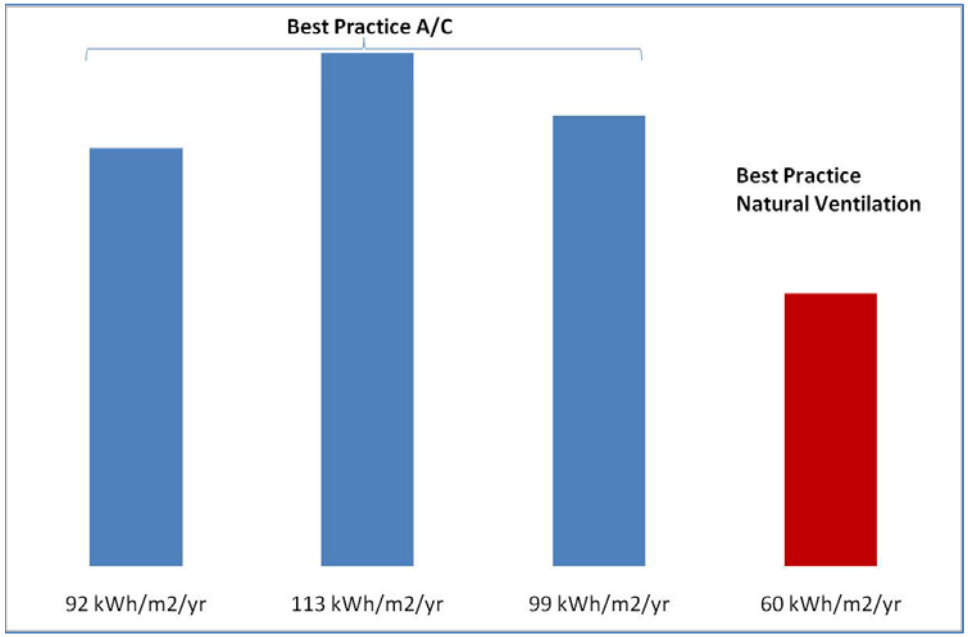
Target
50kWh /m2
average

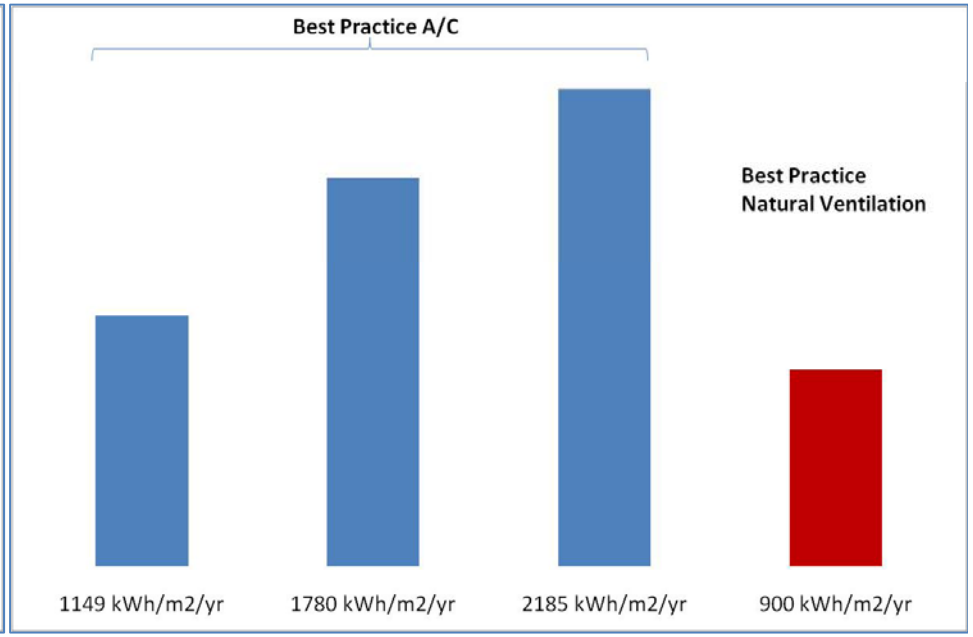
Reconsider our city demographic and real estate solutions



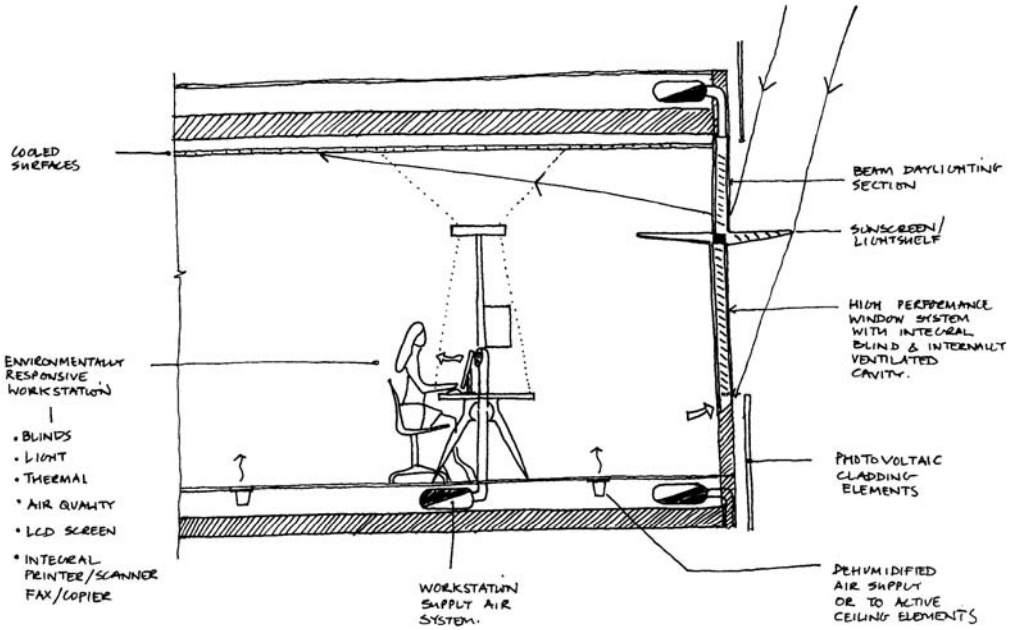
97.2% (463,278) of enterprises in New Zealand employ 19 or fewer people.

Deliver Space and Energy Efficient Real Estate Solutions



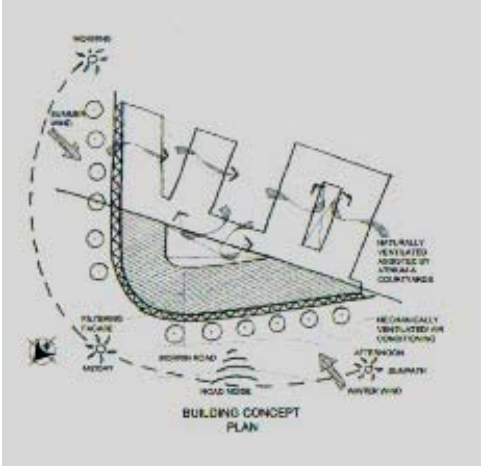


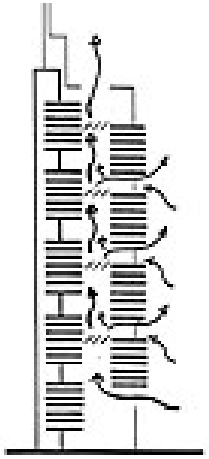
From macro to micro



Task conditioning.
We only occupy 20% of a buildings volume yet we condition 80% of it.

Open Building Forms

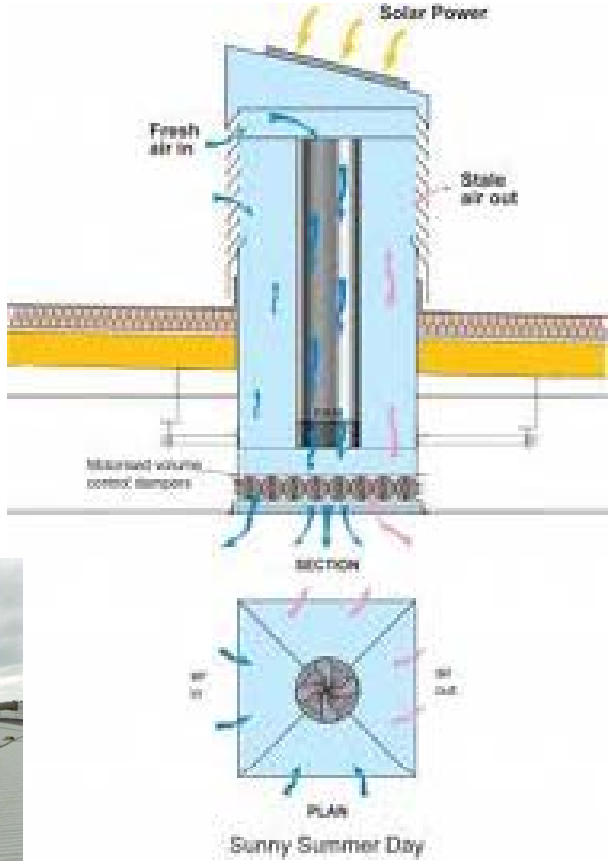




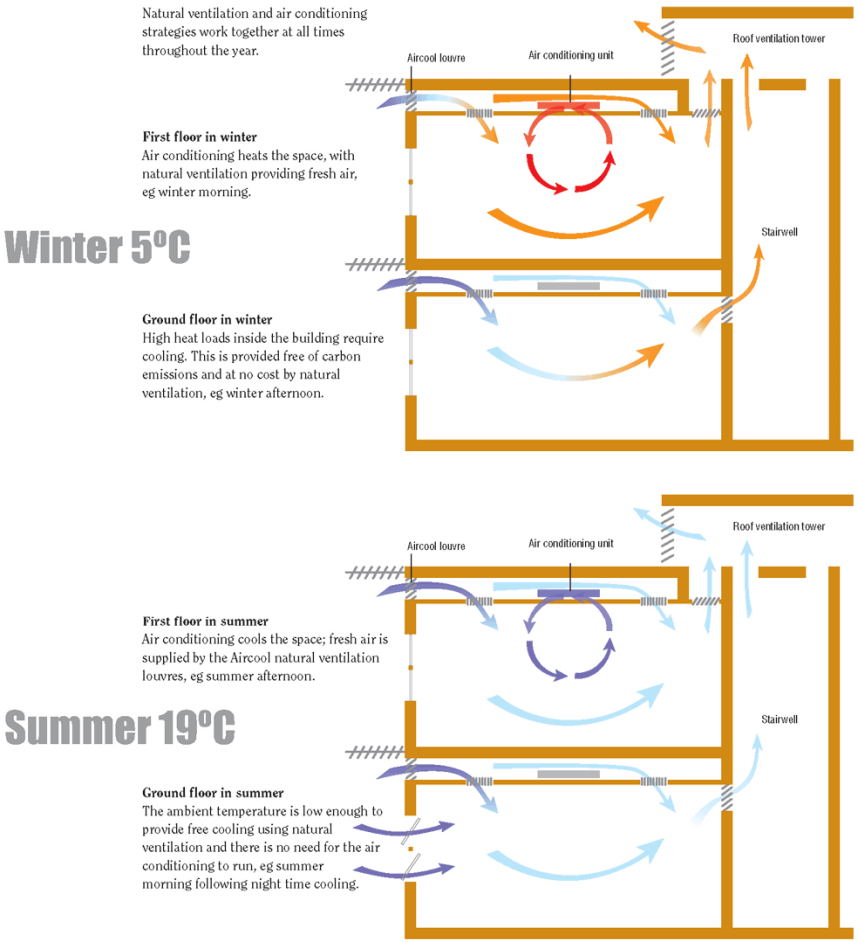
Advanced natural ventilation solutions

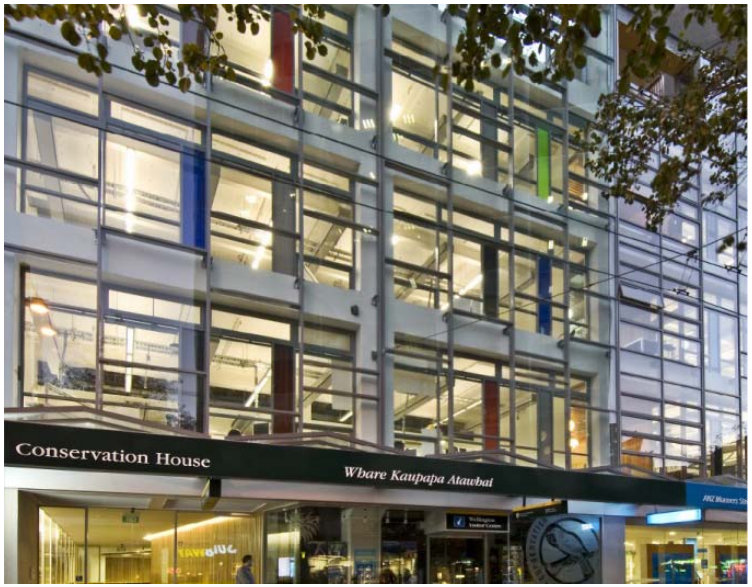
Ormiston Senior College

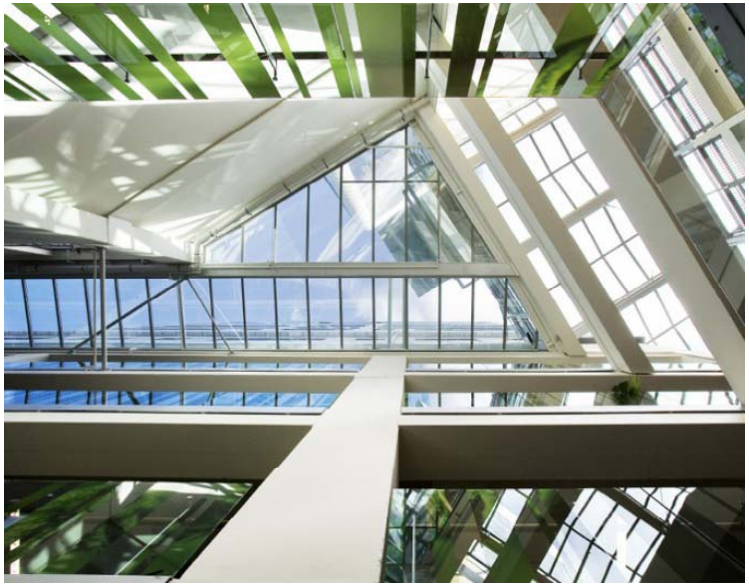
Monodraught Wind Catchers with Solar Boost



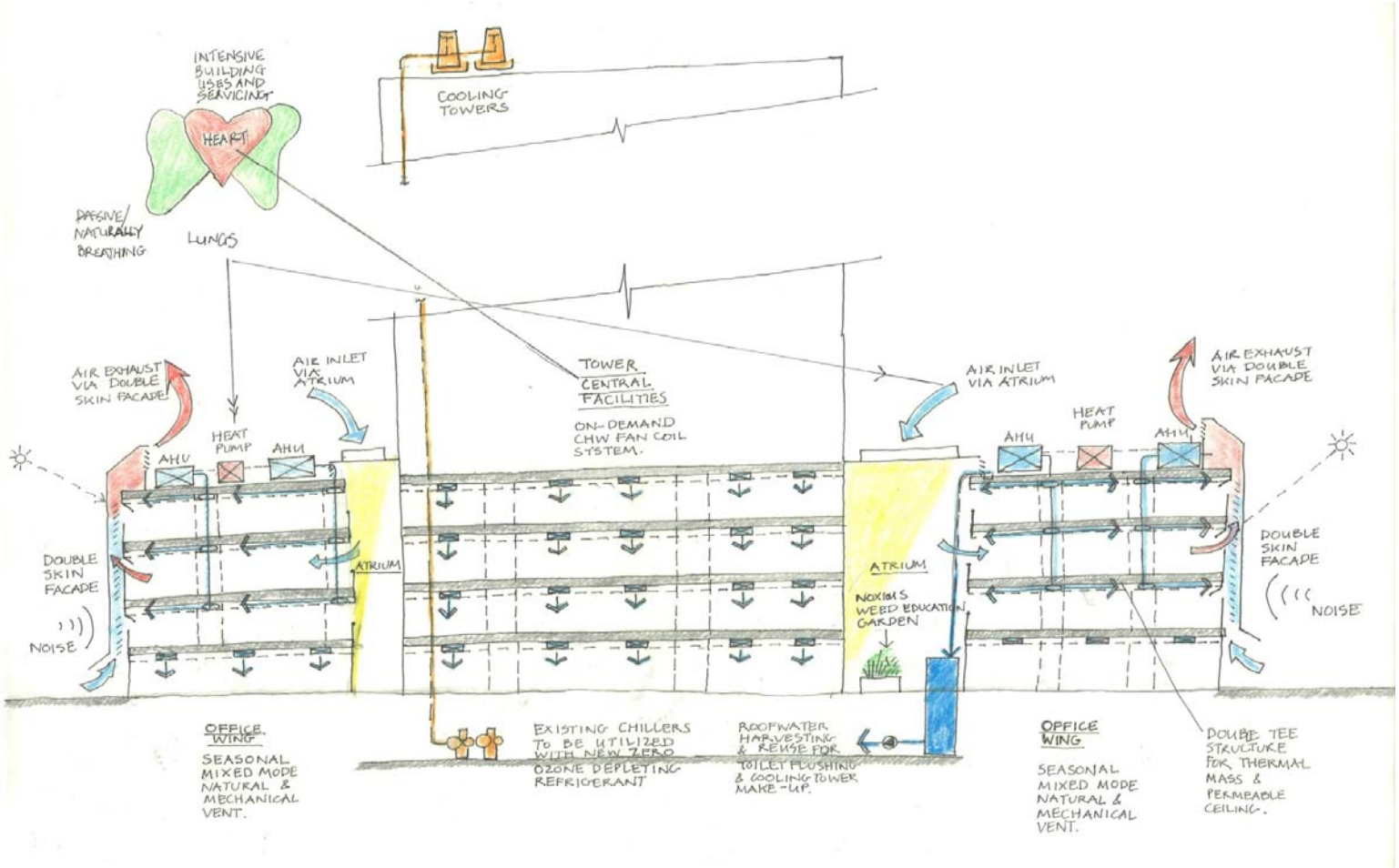
Mixed Mode strategies for larger buildings



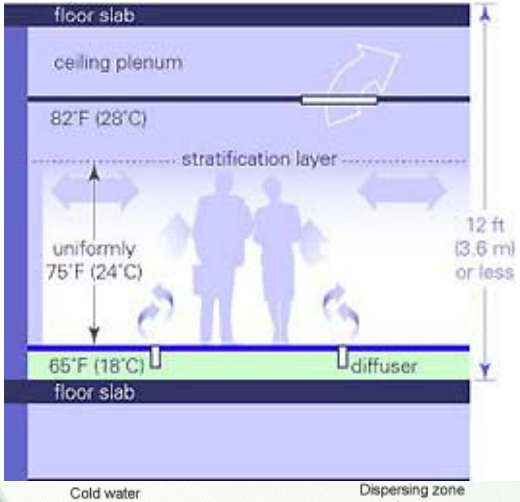


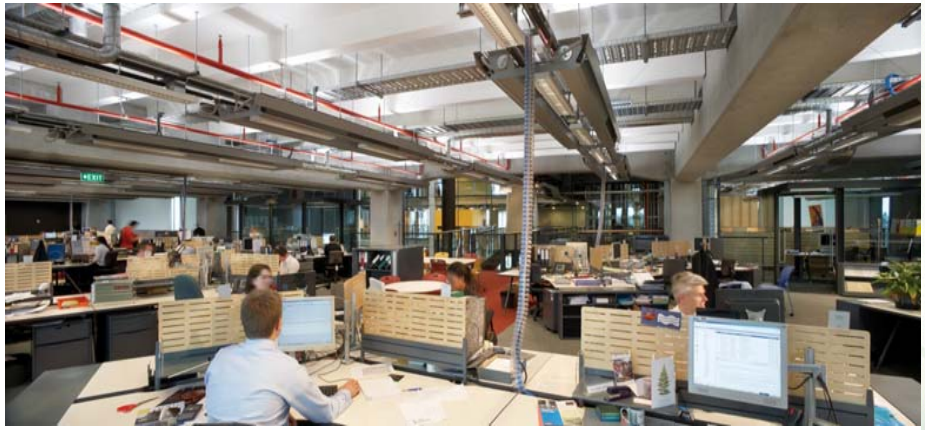


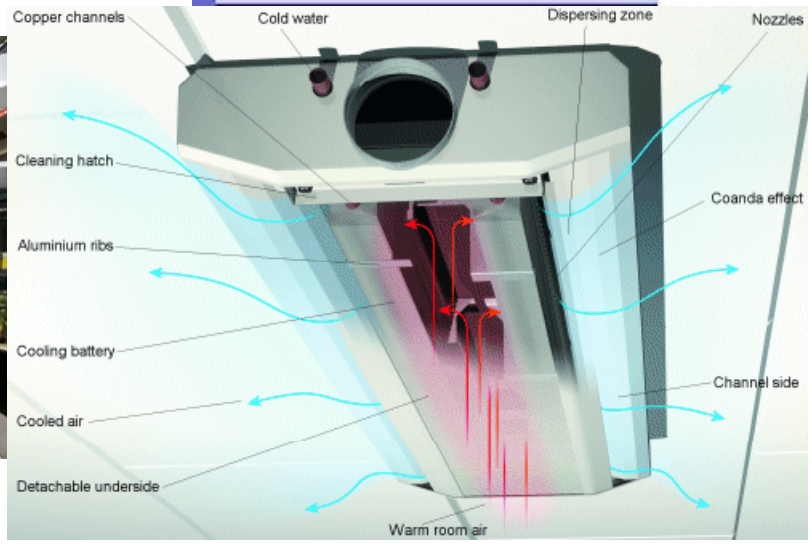
Mixed Mode strategies for larger buildings
Conservation House - Wellington



More efficient air conditioning technologies

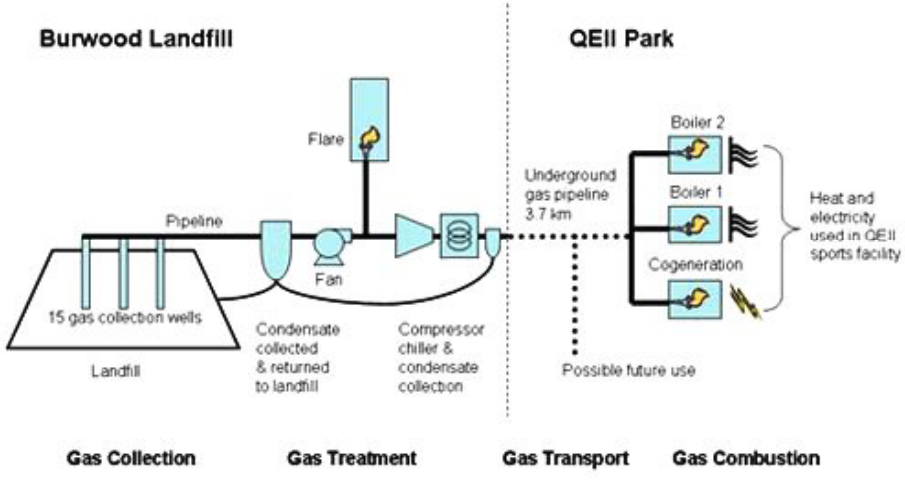






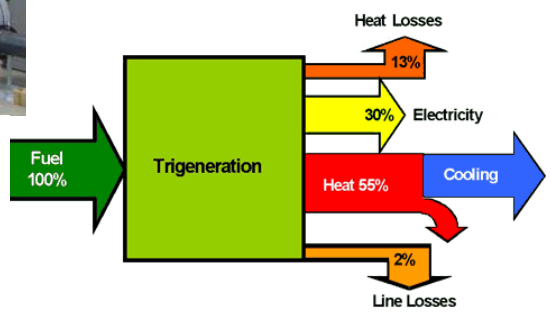
What systems have the best value?

System	Ranking (initial Capital Cost)	Ranking (25yr Whole of life Cost)
Low flow VAV	4	2
Chw Fan Coil with elec reheat	1	7
Chw Fan Coil with warm water reheat+HP	3	6
VRF/VRV	2	5
Active Chilled Beam	5	3
Passive Chilled Beam/Displacement ventilation and perimeter heating	7	4
Underfloor	6	1



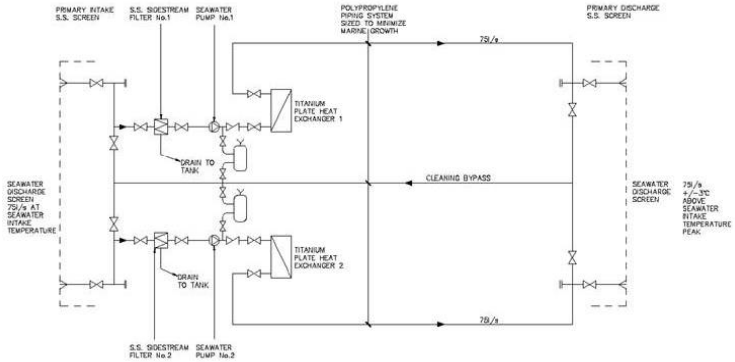
Integrated energy and low carbon solutions

Christchurch Civic Building
Carbon Neutral Landfill Gas
Heating, Cooling and
Electricity Tri - Generation

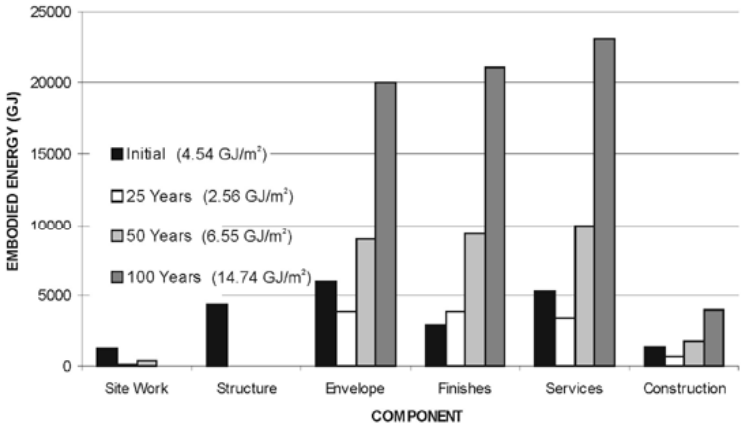


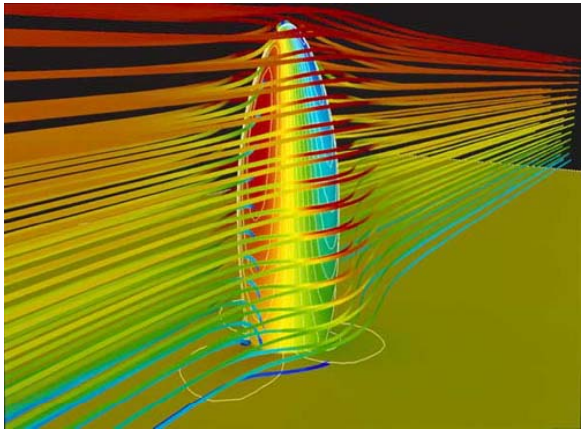
Using ambient energy sources

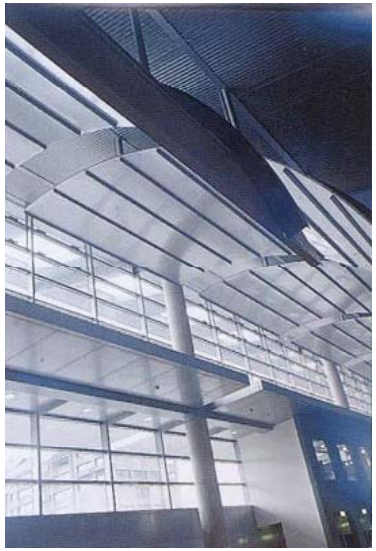
Viaduct Events Centre Seawater Heating and Cooling System



Embodying Technology





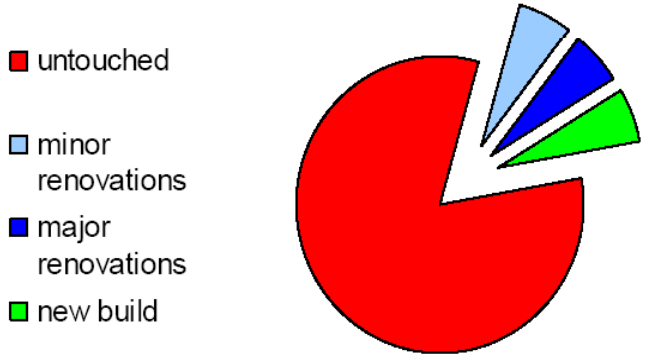


Taking the F out of refrigerants

In our rush to make refrigerants zero ozone depleting we have ended up with some dogs which are inefficient and have significant global warming potential. There are natural alternatives but they have downsides in turns of cost, toxicity and flammability

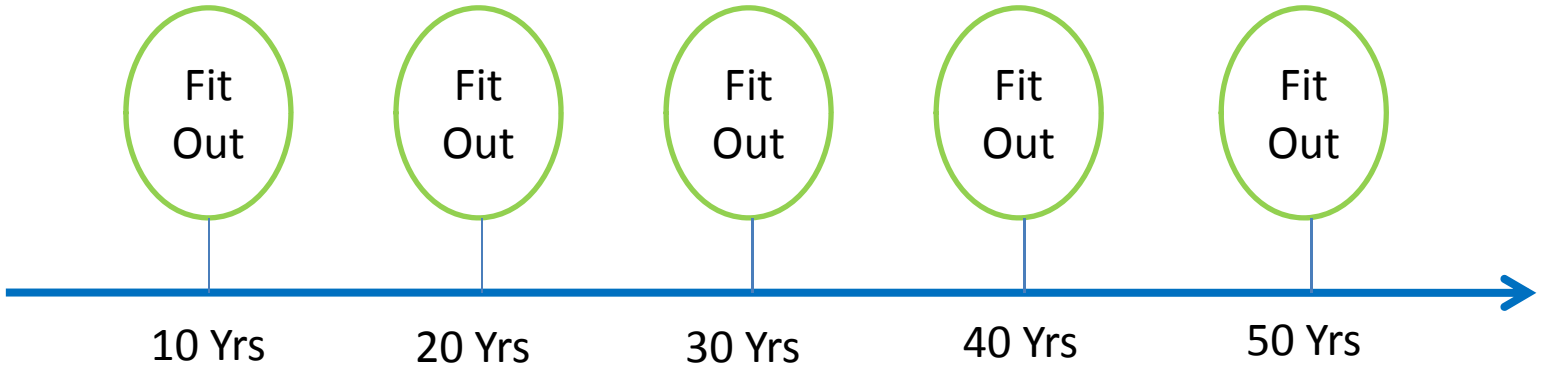
We need to improve the performance of our existing buildings,
We cant rely on new buildings

Making a life cycle difference to existing buildings



Services Upgrade

Building Upgrade



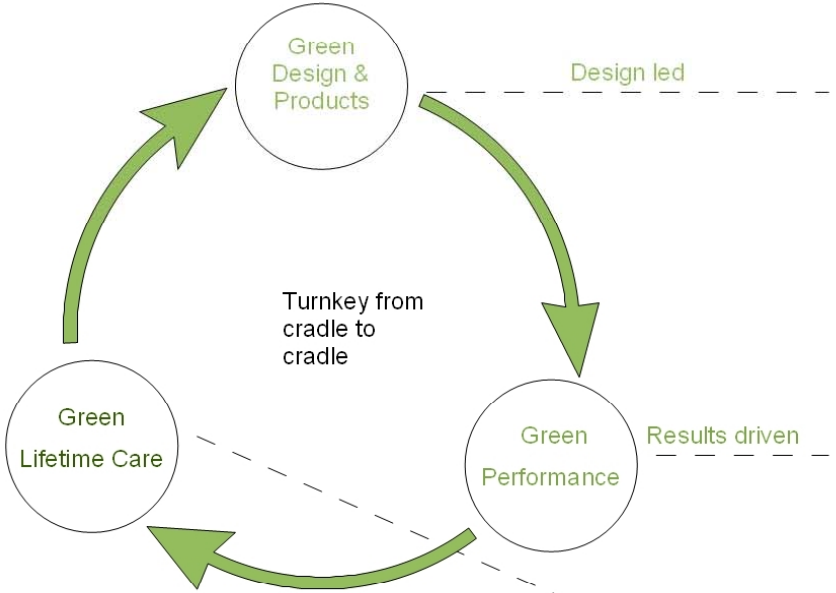
Timeline

Reconsidering how we consult

eCubed

True Green - Our promise, the real thing!

Not greenwash or ticking boxes but proven lifetime environmental performance – from cradle to cradle

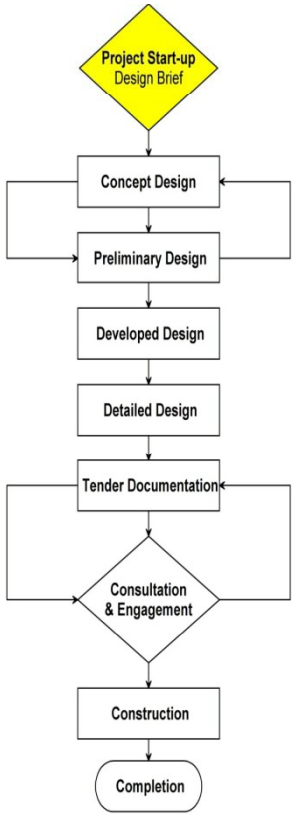


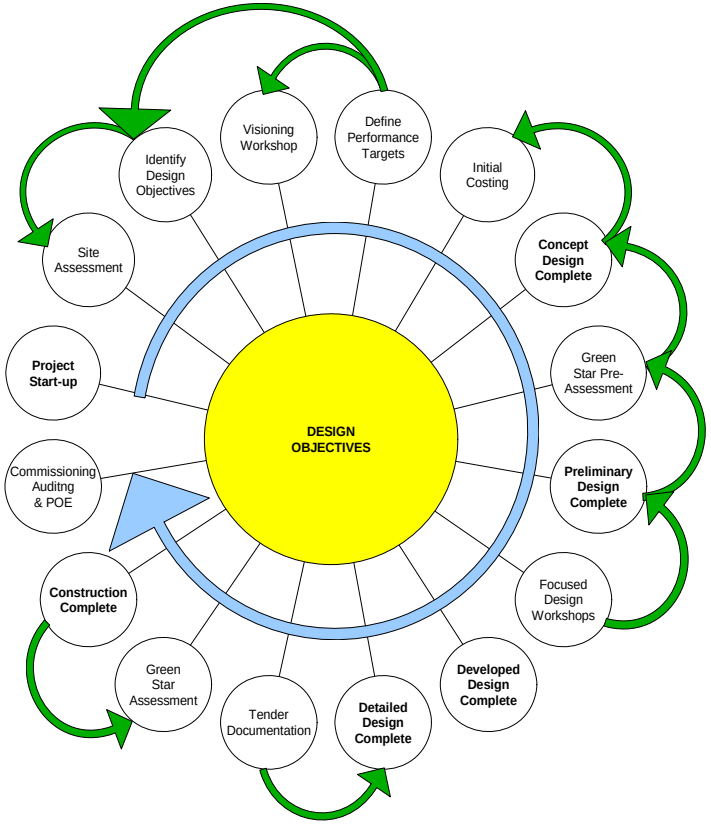
Green Design & Products
- Sustainability frameworks + Master plans
- Renewable energy supply – wind, solar, biomass
- Integrated whole building design
- Green building services design
- Green materials and product selection
- Building Information Modelling (BIM)
- Research, development and incremental innovation

Green Performance
- Complete building modelling and prototyping
- Environmental rating assessment/accreditation
- Environmental / waste management plans/auditing
- Independent commissioning
- Building tuning
- Energy, water and waste auditing
- Post occupancy / productivity evaluation
- Value cases, cost benefit analysis, life cycle analysis

Green Lifetime Care
- Performance contracting
- Continuous commissioning
- Building check-ups + auditing
- Portfolio benchmarking and asset planning
- Carbon footprinting / ETS performance

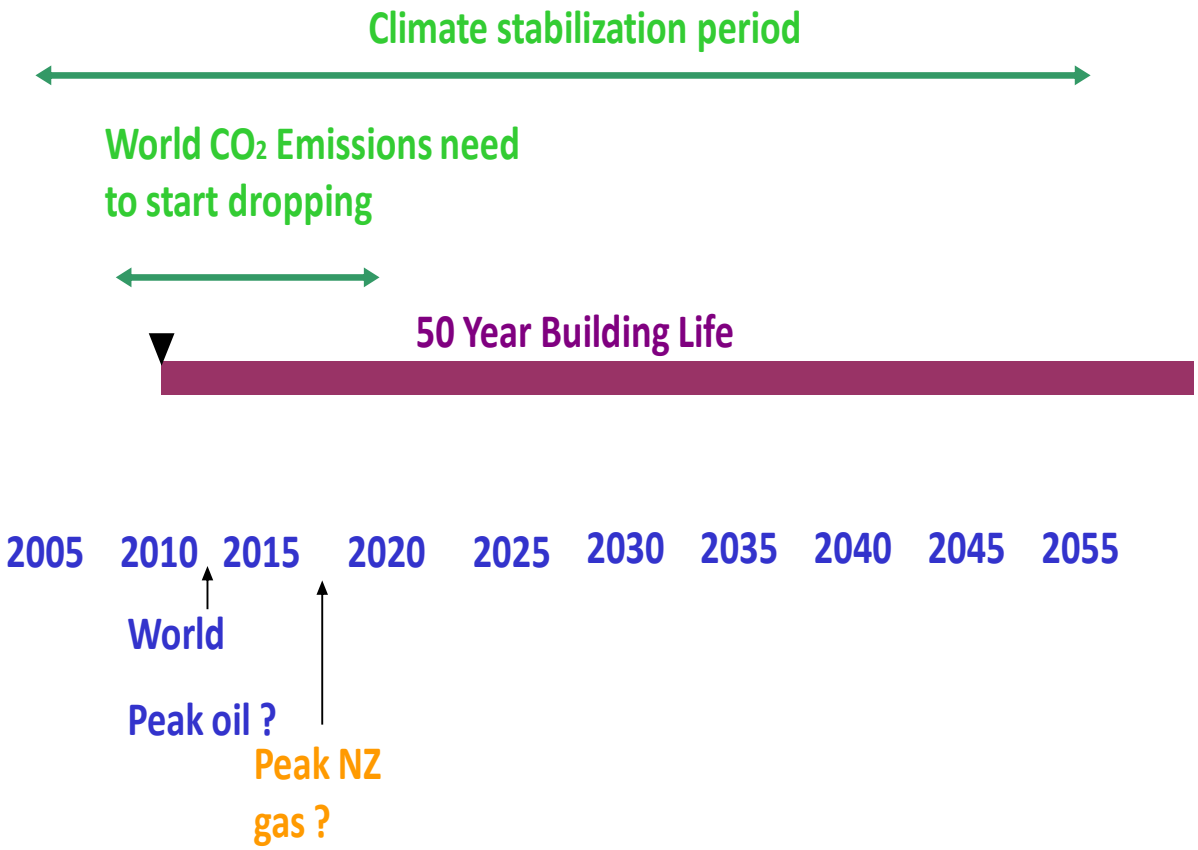
Reconsidering how we design



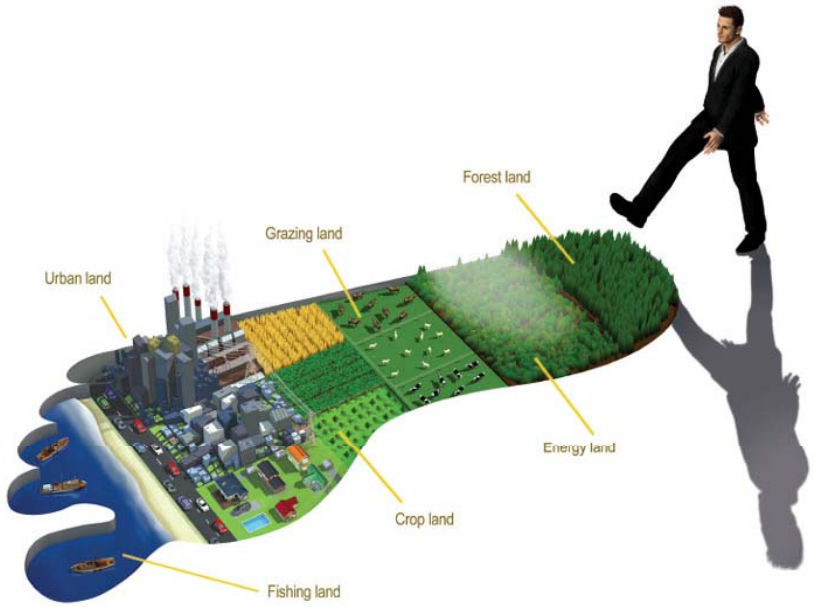


From linear programming to integrated whole building design

What were you doing 10 years ago?



Managing expectations and obligations



Taking personal responsibility

- Home energy 200
- Private transport 157
- Public transport 5
- Waste 0.5
- Food 1000
- Total 1362
- Per Person 340
- **Approx 4 tonnes pa**

- Home energy 30
- Private transport 41
- Public transport 0
- Waste 0
- Food 200
- Total 271
- Per person 136
- **Approx 1.6 tonnes pa**

Design is not making beauty,
beauty emerges from selection,
affinities, integration, love.”

Louis Kahn