PASSIVHAUS – A NEW ZEALAND ADAPTION

An evaluation of New Zealand’s potential to adopt German energy saving standards for residential architecture.

ID: 1216039

ABSTRACT

New Zealand’s reputation as an ecologically advanced nation is brought into question when our architecture is assessed at an international level. The implementation of Green Star New Zealand has brought to public attention the need for environmental principles to become standard practice within the building industry. At present the scheme does not recognise residential buildings, which form one of the largest sectors of energy consumption in New Zealand. The apprehension of society to adopt the principles of energy efficient residential architecture have led experts to suggest that New Zealand is many years behind current practice in Germany, where buildings often generate more energy than they consume. New Zealander’s desire to attain the “Kiwi Quarter Acre Dream’ has been identified as the base of New Zealand’s energy problems, where heating and cooling of single family houses release excessive amounts of CO\textsuperscript{2} into the atmosphere causing its degradation.

New Zealand lacks the distinction between ‘sustainable’ and ‘energy’ architecture that has been identified overseas. There is currently no built example of energy architecture which strictly regulates the Kwh/ (m\textsuperscript{2}a) the building consumes. It is suggested that initiates formed in Germany such as the Passivhaus, which use highly insulated facades to eliminate the need for heating and cooling may have application in New Zealand.

The project aims to identify and compare the Passivhaus and the New Zealand Green Star standards to produce an amended set of principles that will act as a design template. Demonstration and testing of the way energy principles can engage with density and offer alternatives to inner city living will generate an opportunity for public exposure of new ideas towards sustainable intensification and energy efficient architecture. The application of the amended standards, design methods and rating the developed design against selected software will give both architectural and energy efficient results.
ACKNOWLEDGEMENTS

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I would also like to thank all those at the Hochschule Wismar and Unitec New Zealand who enabled the exchange to take place. Your guidance, encouragement and patience made my time in Wismar invaluable. Further thanks must go to the Institut für Gebäude + Energie + Licht-Planung who offered abundant knowledge and assistance throughout the project.
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1.0 INTRODUCTION

New Zealand is regarded by the international community as an environmentally conscious nation. Participation in the Kyoto Agreement, its nuclear free stance and its liberal mindedness, has earned it a reputation as being ‘clean and green’. Travelling abroad as a student I was repeatedly confronted by foreigners’ perspectives of New Zealand as a "paradise" and a "utopia - the dream." In my opinion our status is perceived as a human achievement generated by an ecologically advanced nation.

Energy efficiency is an evolving and significant theme that is rapidly becoming part of public consciousness and political agendas. New Zealand’s campaign to brand itself as ‘100% Pure’ demonstrates the importance of country’s image for economic development. "The 100% Pure New Zealand brand has developed to the point where it has become something that New Zealand can aspire to in its environmental performance." This assertion needs to reflect the state

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of the country’s built environment. Utilising passive thermal design, reducing energy usage and adopting resource efficient, innovative architecture has become a driving market force\(^4\).

Iconic New Zealand architecture such as the kiwi bach, speaks of a self sufficiency and a connection to the natural; attitudes inherent in our culture\(^6\). Advances have been made towards energy efficiency through a number of technical developments that are accredited to the recent implementation of Green Star NZ as an industry standard for architecture\(^7\). However experts such as Professor Robert Vale state that New Zealand is 40 years behind that of Germany and Scandinavia\(^8\). "There's an enormous timidity in the residential sector in New Zealand, when in...Germany they're already commonly building houses that produce more energy than they consume\(^9\)."

A review of the international best practice suggests that initiatives formed in Germany, such as the Passivhaus, may have application in New Zealand. The German “Passivhaus” standard has facilitated 6000 projects in Europe and the development of highly efficient building envelopes. Their efficiency has eliminated the need for space heating and cooling, the main type of energy consumption in German


homes\textsuperscript{11}. A brief investigation suggests that New Zealand has no project of a similar nature\textsuperscript{12}.

1.1 **RESEARCH QUESTION**

How can the principles of energy saving architecture developed in Germany be adapted for use in New Zealand?

1.2 **SCOPE & LIMITATIONS**

I suggest that there is a benefit to developing New Zealand research into German ecological principles and Passivhaus strategies. Professor Vale also proposes that many of the ecological houses we are building (17 of which are promoted as energy efficient structures on the Building and Research New Zealand website) are in fact using more energy than the typical New Zealand house\textsuperscript{13}. The lack of local knowledge and technical expertise implied by this assertion portrays the need for this dilemma to be investigated through the adaptation of Germany’s principles for energy saving architecture in New Zealand.

I propose energy saving architecture such as the Passivhaus as an approach to architecture. Loss of traditional building techniques within the methodologies of the Passivhaus has created an inability to clearly distinguish regional variances in architecture. It has become a building style lacking architectural flair, but highly efficient architecture can also incorporate creativity and style.


It is here that my research and development will focus. For the standard to become a part of our culture and to break down the hesitations present within our society, the application must also respect the local context. A balance needs to be found in the development between the regional conditions and cultural preferences of the users and the merging of the technological norms that such a project requires. This will challenge the standard and encourage experimental designs to emerge that no longer bind energy saving purely to function.

There exists an important division between the definition and concept of environmental architecture in New Zealand and Germany which is important to highlight in this development. In Germany Environmental Architecture is can exist in two forms:

**Nachhaltige Architektur:** Sustainable architecture

**Energie Architektur:** Energy saving architecture

### 1.3 DEFINITION OF TERMS

**Nachhaltige Architektur** works with the principles of renew, reuse, recycle so that the building is ideally made of renewable resources and utilises passive energy processes. The buildings whole lifecycle is assessed:

- "Resource consumption would be minimal
- Materials consumed would be made ENTIRELY of 100% post-consumer recycled materials or from renewable resources (which were harvested without harm to the environment and without depletion of the resource base)

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14 “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”

- Recycling of waste streams would be 100%  
- Energy would be conserved and energy supplies would be ENTIRELY renewable and non-polluting (solar thermal and electric, wind power, biomass, etc.)  

**Energie Architektur** follows the same principles but the focus is predominantly on the conservation of energy. This type of architecture uses a combination of simple and advanced technologies working alongside environmental and contextual conditions in the aim of lessening the use of un-renewable energy by the development. Often this involves active control of building processes (e.g. ventilation) and a greater variety of materials.  

"All possible measures are to be taken to ensure that the building's use of energy is minimal. Cooling, heating and lighting systems are to use methods and products that conserve or eliminate energy use."  

Particular priority is given to the following:  
- Reduce energy needs  
- Efficiently convert energy  
- Integrate renewable energy resources  

Stylistically nachaltige architecture and the use of ‘green’ architecture are being explored internationally to a greater extent than energy architecture, where aesthetics are considered secondary to the building performance. This limitation is governed by the strict energy constraints and the small tolerance these allow for compromise in building form, construction and materials. These constraints often become ‘readable’ within the final building or it becomes autonomic.

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from the surroundings. The notion of technology as cold and intangible restricts energy architecture from gathering public appeal unlike sustainable architecture, which permits greater individual manipulation of the aesthetics.

1.4 THE CENTRAL FOCUS OF THE PROJECT

The concepts form two very different architectural solutions: one with a more global overview of the wider architectural problem, the other with a very specific and refined solution to one aspect of environmental architecture. The benefit of the distinction is the ability to define the conceptual and technical strategies appropriate to the project.

To my knowledge this distinction has not yet occurred in New Zealand and consequently there lies some confusion as to what environmental architecture is. New Zealand’s idea of sustainable development follows that which was outlined by the 1987 World Commission on Environment and Development\(^\text{19}\). In the report ‘Our Common Future’ sustainable development was described as:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations.”\(^\text{20}\)

Therefore we deem a building to be truly ‘sustainable/ environmental’ if it meets New Zealand Green Star standards. This standard will act as the central basis for comparison within this project.


Germany\textsuperscript{21}:
- 356,970 sq km
- 82,369,548 (2008 population estimate)
- 236 persons per square kilometre (2008 estimate)

New Zealand\textsuperscript{22}:
- 270,534 sq kilometres
- 4,154,311 (2008 population estimate)
- 16 persons per square kilometre (2008 estimate)

A greater population density will produce a greater energy demand and less space and natural resources to produce the energy. New Zealand is gifted with an abundance of natural energy resources and space. Energy generation from sustainable methods such as hydro electricity supplies 65\% of the nation’s electricity\textsuperscript{23}. The predominance of Green Star in the commercial and industrial sectors results in the proliferation of ‘nachhaltige’ architecture as there are no energy prescribed benchmarks that are fundamental for certification\textsuperscript{24} (see programme).

Hence the project will focus on energy saving and generating architecture, combining elements of nachhaltige architecture through the comparison with Green Star. Furthermore it will seek to illustrate to the public that collective, energy efficient housing can retain some of the traditional lifestyle qualities through exploration of the aesthetics of energy architecture and its synthesis with New Zealand’s culture and climate.


1.5 PROJECT HYPOTHESIS

Having established the need for research to stem from the German standards which deals with climatic extremes, the standard should be able to be amended for New Zealand’s moderate climate.

It is also my belief that the functional elements of the amended standard can create architecture that is highly efficient, aesthetically appealing and geared to the New Zealand lifestyle and market.

1.6 PROJECT OBJECTIVES

This project will aim to:

- Identify the principles of energy saving architecture primarily through research into Passivhaus design as produced and practiced in Germany.
- Evaluate these principles in the New Zealand context. This evaluation will focus on the similarities and differences between the two societies in terms of their environmental standards.
- Propose that an amended set of principles have application in New Zealand and explain why.
- Produce an architectural design to show how both the important energy saving principles and design can be brought together and derive a preliminary conceptual template which could be used on future projects.
- Evaluate the effectiveness of the use of German energy saving principles within New Zealand residential architecture.
- Propose further research that can be developed from this thesis.
Chapter 2 demonstrates the *methodology* used within the project.

Chapter 3 gives an overview of the *project programme*.

Chapter 4 provides an *urban analysis* of the project’s location.

Chapter 5 provides an outline of the *project development*.

Chapter 6 gives a *critical appraisal* of the finished work.

Chapter 7 gives a final project *conclusion* with reference to future research proposals.

Chapter 8 lists the project’s *bibliography*.
2.0 METHODOLOGY

Initial research was conducted in Germany as part of a university exchange with the Hochschule Wismar. The methods of collection were dictated by the circumstances. The decision to assemble the research in Germany was decided because of the perceived unavailability of technical material and expertise in New Zealand. Development of the design was carried out in New Zealand where qualitative assessment of the design in context could be undertaken.

The sample group selected for comparison of New Zealand and German standards were the Green Star New Zealand regulations and the Passivhaus standard. These were considered representative of each country’s most developed energy regulations. The research followed a descriptive design process where data was sought from literature issued by both institutes and compared on a quantative basis. The evaluation of these standards was used to highlight the similarities and weakness of each and to construct the project’s environmental goals. Additional energy/ environmental building strategies were derived from literature sourced from the Hochschule Wismar library and the internet. Electronic text was selected on its validity as a research paper or endorsement from a credible source. The conclusions of case studies conducted by myself were based on information given on the buildings by the architects and a site visit to gain an impression of the systems and the aesthetic interpretation. Experience on this topic was gained through related courses taken at the Hochschule Wismar on the subject area and work experience I gained while abroad. An element of subjectivity was involved in the assembly of the goals due to the required ‘manipulation’ of existing data to generate a causative variable – in this case Kwh/ (m²a).

The typology of the project was generated from research obtained on energy consumption in New Zealand from Statistics New Zealand and the perceived weakness in the current New Zealand standard. There was also a need to acknowledge a residential project conducted by a team at Auckland University for a prototype New Zealand Passive
House. The brief should demonstrate to the architectural and wider community that the Passivhaus standard does not only conform to singular family homes as the name suggests, but it can also be manipulated to other building typologies.

The ‘environmental goals’ have been used as a rating/design tool to develop the site massing and initial conceptual development as a method to ensure sufficient consideration of the main energy principles in the basis of the design. Contextual and cultural stimuli added weight to design decisions involving logical occupant comfort and perceived expectations. Survey results on inner-city living carried out by the Auckland City Council were influential in establishing the validity of the users’ needs.

Research was also carried out by design. The use of manual sketches and physical modelling of concepts and ongoing development allowed visual and intuitive assessment of each of the design decisions and their relationship to the New Zealand culture/occupant. The use of this subjective tool allowed the design to step away from the tight restrictions placed upon it and investigates alternative methods of promoting public appeal and challenges the role of materials, structure and form so that it acts as environmental and aesthetic elements within the design. Examples of vernacular and international works sourced from books and the internet were used as a primary design tool for inspiration.

Cultural traditions and desires and the translation of these into the building plan, elevations and target atmosphere were used as the main driver in the aesthetics vs. function debate. The priority of function and aesthetics was one that remained unfixed throughout the design. Design decisions were judged and justified individually throughout the development. This was shown to provide the type of integration the project aims to achieve.

The parameters of the design aesthetics were constructed by a correlation study into the history and design styles of the area. A hypothetical overview of the future of the area was formed from predictions associated with the history, current urban trends and an overview of the changes in society and technology that have already occurred. These assertions informed the structural, formal and social nature of the design.

The tools to rate the performance of the design were selected through my ability to learn them within the timeframe and their evaluated efficiency. As an initial comparison tool the official Passivhaus Standard\(^\text{26}\) will be used to determine planning and energy saving strategies. This was chosen because of its ability to be translated clearly into English, and its autonomous nature.

The identified limitations of the Passivhaus Standard are\(^\text{27}\):

- The standard’s predominant focus is on the building’s use and minimising transmission. The standard does not acknowledge the other phases of a building’s lifecycle, and the energy that is needed at each of these stages.
- The standard requires physical tests to be performed on the building after development before certification can be received. Therefore the standard does not act as a planning tool.

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\(^{27}\) “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”
To counteract the limitations of the Passivhaus software, alternative design tools have selected to aid development:

ECOTECT: The simulation programme enables the building to be modelled as an initial concept to aid planning. Therefore sufficient data can be used to assess the buildings performance at an early stage\textsuperscript{28}.

LEGEP: a tool to analyse the integrated lifecycle performance of buildings. This allows all five lifecycles stages of the building to be analysed, from the initial primary energy inputs, Bauphysik (building physics) to the lifecycle, maintenance, refurbishment and demolition costs. The resultant data aims to provide more information than that which would result from use of the Passivhaus software.

These programmes were elected over TRNSFLOW/ TRNSYS software due to their difficulty to be learnt within the time span and the requirements and the level of German translation required.

The major limitation of the project is that the hypothesis is only being tested against a small sample frame i.e. only one energy standard for each nation is used for comparison. This is due to language and time restrictions.

3.0 PROGRAMME

3.1 TENANCY

The proposed tenancy for the design was selected on the basis that their participation in the project would aid acceptance of the scheme within the community. The ability of students/young professionals to embrace alternative living situations will be used as a social marketing strategy implemented to help society and industry consider the standard and the technology was seen as an inductive/logical strategy to employ. Occupation by young professionals and students between the ages of 18 – 30 years allows access and interaction with technologies/strategies that would normally be unobtainable on the conventional student budget. Exploration into the ways younger generations of New Zealanders reside together and the social interactions/necessities of the given group could give way to more progressive residential schemes in Auckland’s city centre.

These students in their professional lives will have to respond to the ever increasing demands of sustainability within society. The project seeks ways via forms of ecological design that enable the occupants to learn how to use the building correctly and understand how it functions. The advantages of an energy efficient building could range from cheaper leases that put a competitive edge on the housing market, to the quality of lifestyle generated for the age group. Funding by the Government for practical research of new technologies is proposed.
3.2 OCCUPANT NEEDS

Create a minimum of 26 rooms within the development which will provide different types of accommodation in the form of:

- Short term rooms (25/35m²)
- Larger flats (90-230m²)
- Studio units (60-110m²)

Evaluated on the basis of Passivhaus 25/35m² per person

Each apartment will include:

- Bedroom
- Bathroom/Lounge/Kitchen (these may be shared in some cases to promote social interaction)
- Outdoor/green space
- Storage space

The layout of these apartments needs to enable flexible reuse as office spaces/retail, etc.

The ground floor will incorporate:

- Retail, cafes
- Reception and mail area
- Waste recycling/waste care
- Technical room
- Bike parking/ scooters
- Second hand store/ workshop
- Gym

The second floor will aim to include:

- Café/library
- Games/computer room
- Communal deck space
- Card access will be the used form of security
3.3 CONCLUSIONS DRAWN FROM THE LITERATURE REVIEW

a) The need to reinvent the Quarter Acre dream:

It is clear that in order for higher densities to be accepted by New Zealanders “a cultural shift of some magnitude, underpinned by the creation of attractive examples, will be needed to turn this option into a more widely accepted one.” It is also clear that the current housing trend can not continue without consequences. Research conducted by the Building Research Association of New Zealand shows that “in 2007 the New Zealand Housing Stock amounted to nearly 1.5 million, of which 80% were stand-alone houses. Nearly a third of these houses’ are colder than the minimum standards outlined by the World Heath Association due to a lack of insulation.” Similar results by Energy Efficiency and Conservation Authority (EECA) New Zealand concluded that 45% of houses suffer from moisture problems. Not only does this affect the health of residents, it also means a greater proportion of nation’s resources are used for heating and cooling, thereby releasing large portions of CO$_2$ (principal contributor to the Green House Effect) into the atmosphere. All of this occurs in spite of New Zealand’s participation in the Kyoto agreement.

Ironically, the quarter-acre ‘Kiwi dream’ can be considered to one of the main aspects preventing New Zealand from becoming truly sustainable. David Chote, in a media release from AMP Bank, states

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"despite expectations that the market is going to soften, we’ve continued to see a strong demand for home loans. This reflects our keen desire as Kiwis to chase the house-and-quarter-acre section dream.” What is it that New Zealanders seek from this quarter acre dream that has kept us reaching for the unreachable?

The Ideals of the ‘Quarter Acre Kiwi Dream’:
- The idea of ownership and security: the search for a better life in the city.
- Detachment: the acquisition of one’s own space, privacy and peacefulness for the individual.
- Green space: one’s own outdoor area.
- Smaller nuclear units: households and flats of this type typically accommodate between three - five people and for many this is culturally acceptable.

b) Sustainable Architecture or Energy Architecture?

International sustainable developments are such as Bo01, Västra Hammen, Malmo, Sweden (2001 - )38; Kronsberg, Hannover, Germany (2000)39; Orestad, Copenhagen, Denmark40; Greenwich Millenium Village, London UK41; Viikki, Helsinki, Finland (1999 –


2004)\(^42\) and Quartier Vauban\(^43\) and Reiselfeld in Freiburg, Germany\(^44\) demonstrate that the emphasis on nachaltige architecture no longer lies with the individual buildings but rather with the design of working systems and the integration of long term strategies for the community’s future. The predominant focus of the projects targets the respective areas:

- Transport and Mobility
- Local energy generation via renewable sources
- The use of ecological building materials
- Area Biodiversity
- Social diversity and equity
- Water
- Waste
- Identity
- Mixed use
- Land use
- Economy

A comparative study into the methods endorsed by the World Green Building Council\(^47\) and New Zealand’s Green Star New Zealand building standard\(^48\) have a similar focus. Two crucial gaps have been

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identified by the study in New Zealand’s building industry: the neglect of residential architecture within the standard and secondly misconception that a ‘green building’ is an energy efficient building.

Research into the methods of energy reduction follows several paths. The Beddington Zero Energy Development (BedZED)\textsuperscript{50} is one example of carbon neutrality within a development. This is seen to sit between energy architecture and sustainable architecture due to the use of a percentage rating system. Built experiments of the New Autonomous House by Professors Brenda and Robert Vale requires acute balancing of inputs and outputs similar to that of the Passivhaus, yet is seen as an independent object – a luxury not available in many inner city sites.

The most recognised and rigorous energy/environmental design standard in Europe today is the Passivhaus standard. Architects such as Prehal and Poppe\textsuperscript{51} are producing modern Passivhaus designs using contemporary forms and local materials to distinguish their work. The

\textsuperscript{49} BauNetz, “Plappersnut; Bauphysik-Preis 2005 verliehen,” BauNetz, http://www.baunetz.de/img/416800_1bfe4ae932.jpeg


high-tech, self governing nature of the standard is seen as one of the downsides to adaptation in New Zealand due to the high cost, unavailability and lack of local knowledge.

The transitional architecture of IGEL Architects (Institut für Gebäude + Energie + Licht-Planung) in Wismar, Germany mediates between the exacting energy restrictions of the Passivhaus and the Autonomous House and the ideals of the BedZed development. Exploration by the Institute has recognised the ability of low tech systems to generate the optimal energy requirements outlined by the Passivhaus\textsuperscript{52}. The benefits of this scheme are smaller maintenance costs and a greater flexibility of design provided the basis of the design follows fundamental energy principles analogous to those outlined by the Vale’s Autonomous House. The major difference between the Passivhaus and IGEL technologies lies in the separation of ventilation and water heating in the Passivhaus which creates a need for a greater number of systems to be used to make the transition\textsuperscript{53}. Elimination of this separation by way of an air to water heat pump, a common appliance readily available in New Zealand, implies the possibility of energy architecture being adapted to the New Zealand climate.

\textsuperscript{52} “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”

\textsuperscript{53} “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”
3.4 LIFESPAN

An analysis was carried out to identify the appropriate lifespan for the building. Aspects of the study outlined in Appendix D were:

- What is specified by the New Zealand Building codes and how does this compare to international codes?
- What is the lifespan of the surrounding buildings and what has changed over this period?
- A visual look at Auckland in 30 years – what is predicted to occur?
- What is the buildings function in the urban situation and what could its future use be?
- Advantages and disadvantages of long lifespan, short lifespan and a mixed lifespan for the building elements.

From the study it was determined that a mixed lifespan strategy should be implemented as it allows suitable materials and construction methods to be used where their properties can match the function:

Technical areas: 20 years
Primary structural elements: 70/80 years
Secondary structural elements: 50 years

This result was based on the need for flexibility within the buildings structure. Future use as office, retail or galleries/media were judged possible due to the areas past and current trends, changes in technology and how these elements will imply changes in the buildings occupancy.
3.5 COMPARISON OF PASSIVHAUS & GREEN STAR STANDARDS

Comparison of Passivhaus\textsuperscript{54} and Green Star New Zealand\textsuperscript{55}/ New Zealand building code\textsuperscript{56} highlighted the greatest contrasts between energy benchmarks and individual comfort control.

**Individual comfort control:**
The main difference that occurs between the two standards is the need for individual comfort control. Green Star New Zealand emphasises the need for each individual tenant to be given the opportunity to determine his own thermal comfort.

In contrast the Passivhaus standard specifies a building should be 20 degrees Celsius\textsuperscript{57}, a temperature that research has proven to be sufficiently adequate (the World Health Organisation outlines the minimum temperature a living room should meet is $18^\circ$C\textsuperscript{58}). There is still the opportunity for the user control in the opening and closing of windows, however the standard states:

"The opening of windows for ventilation is deemed unnecessary (though it is not forbidden) in a Passive House due to the highly efficient ventilation system and can lead to higher energy costs due to the extra heat loss it causes. As this behaviour is unknown it is unaccounted for in the calculations. To date statistical information has shown that "only a few individuals tend to use additional window

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ventilation, and even in these cases the Passivhaus principles were shown to work".

“The standard maximum temperature used in PPHP is 25°C...”

Thereby the standard limits user control of ventilated systems so as to control the energy balance of the development. This raises the question of how much control individuals should have over the building – or is it acceptable that buildings in NZ control themselves? Ideally a strategy where occupants can open and close windows/ control shading at whim without severely changing the indoor climate should be found for the development.

**Energy Benchmarks:**
The Passivhaus Standard falls under the Energy Sector of the New Zealand Green Star Standard and it is here that we can compare and contrast the standards the most. Energy is presented by Green Star New Zealand as the following by the following categories.

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## ENERGY

<table>
<thead>
<tr>
<th>Title</th>
<th>Aim of Credit</th>
<th>Credit Criteria Summary</th>
<th>Number of Credits</th>
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<tbody>
<tr>
<td><strong>Energy</strong></td>
<td>To encourage and recognize the reduction of base building operational energy and greenhouse gas emissions.</td>
<td>It is a conditional requirement for obtaining Green Star NZ (office) that: The base building design achieves an energy usage figure of 120 kWh/m²/yr or less.</td>
<td>Conditional Requirement</td>
</tr>
</tbody>
</table>
| **CO₂ emissions**            | To encourage and recognize the reduction of climate change contributors as a result of direct, on-going energy use of the base building over and above Energy (above) | Up to 15 points are awarded where it is estimated that the CO₂ emission figures are significantly lower than a standard building.  
3 points = for predicted CO₂ emissions of ≤ 15kg/m²/yr  
6 points = for predicted CO₂ emissions of ≤ 12.5kg/m²/yr  
9 points = for predicted CO₂ emissions of ≤ 10kg/m²/yr  
12 points = for predicted CO₂ emissions of ≤ 7.5kg/m²/yr  
15 points = for predicted CO₂ emissions of ≤ 5kg/m²/yr | 15                |
| **Electrical Sub-metering**  | To encourage and recognize the provision of energy sub-metering to facilitate energy monitoring of base building services.       | One point is given when sub-metering is provided for substantive energy uses within the building (greater than 100kVa)                                                                                              | 1                 |
| **Tenancy Sub-metering**     | To encourage and recognize the provision of energy sub-metering to facilitate energy monitoring by tenants or end users.        | One point is awarded where it is demonstrated that the sub-metering is provided for each floor and tenancy.                                                                                                        | 1                 |
| **Office Lighting Power Density.** | To encourage and recognize lighting design practices that lessens lighting energy consumption while maintaining appropriate lighting levels. | Up to 4 points can be awarded when lighting power densities for 95% of the NLA meets the following criteria:  
- 1 point = 3 W/m² per 100 Lux | 4                 |
### Office Lighting Zoning

-2 points = 2.5 W/m² per 100 Lux
-3 points = 2 W/m² per 100 Lux
-4 points = 1.5 W/m² per 100 Lux

To encourage and recognize lighting design practices that offer greater flexibility for light switching, making it easier to light only occupied areas.

- All individual spaces must have individual light switches.
- The size of individually switched lighting zones do not exceed 100m².
- Switching is clearly labelled and easily accessible by building occupants.

### Peak Energy Demand Reduction

To encourage and recognize projects that implement systems to reduce peak demand on energy supply infrastructure.

Energy demand reduction systems are installed to reduce peak demand on electricity infrastructure by 25%.

1

NLA: Net lettable area

Green Star ideal is presented as an energy usage figure for the base building design of “120 kWh/m²/yr or less” as an additional measure that can be achieved. However energy figures of the rated buildings have not been documented in the building case studies available to the public from the New Zealand Green Building Council. This target does align the standard with the Passivhaus standard whose maximum Entire Specific Primary Energy Demand is 120 kWh/(m²·a) incl. domestic electricity. This quota must be met to gain qualification as a Passivhaus. The benchmark for ‘Specific Space Heat Demand’ must also be a maximum of 15kWh/(m²·a). To my knowledge this is not part of Green Star regulations.

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Case studies undertaken into the green star rated buildings by the New Zealand Green Building Council show that buildings are often rated on a percentage scheme and the specific target becomes incomprehensible\(^\text{65}\). An example is the Meridian Energy Building, New Zealand’s first building to gain a 5 star rating “uses 60% less energy than comparable buildings\(^\text{66}\).” The term ‘comparable buildings’ does not allow us to achieve an idea of the energy usage of the building, it only allows us to presume that it does not meet the benchmark of 120 kWh/(m\(^2\))a).

However by allowing the scheme to be influenced by the holistic Green Star standard there remains a need for the resulting design to remain sympathetic to the user and the context, thus creating greater flexibility for adaptation of the designs aesthetics and function.

\(^{65}\) “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”

3.6 ENVIRONMENTAL GOALS

The objective of the comparative study was to identify the following project template:

- Mixed Use: the development should be a mixture of residential and retail spaces
- Generate renewable energy onsite
- Reduce the demand for potable water
- Act as a replicable model
- Encourage the use of public and alternative modes of transport
- Provide adequate public and private green space for the occupants
- Incorporate facilities for the separation and recycling of waste
- Lifespan: Primary structure 70/80 years
  - Secondary structure 50 years
  - Technical areas: 20 years
- Provide flexibility for future reuse
- Increase the density of the area
- Respect the surrounding context of the site
- Reduce/eliminate the need for heating and cooling

(A detailed environmental programme formed from the comparison study of the Passivhaus and Green Star New Zealand Standards can be found in Appendix C).
4.0 URBAN ANALYSIS

4.1 SITE SELECTION

Site selection was based on a comparative study of multiple sites, undertaken prior to this proposal, followed by ordinal ranking of the sites’ ability to meet the specified criteria. The hypothetical client is a private developer or investor who is interested in the market benefits associated with the development of ecological architecture and the positive publicity that will stem from the project. The sample group was selected on the basis that it was:

- within range of a university and central business districts
- It is located in an area popular to live in for the age group.
- The site offers opportunities for potential development as a method of future-proofing.

The chosen site was 520-536 Karangahape Road and 2 Gundry Street. It exists as a bare, privately owned carpark of 1360m².

Perceived benefits:
- Close to the major universities in Auckland and the central business district. Therefore it is has the ability to target a large market.
- Surrounded by a range of shops, cafes, restaurants and offices.
- The area where the site is situated acts as a link between Ponsonby Road, Newton and downtown Auckland.
- Close to main public transport and arterial routes.
- The site offers an opportunity to revitalise the area
- The corner site offers good exposure for new architectural ideas
- The site is nearby two inner city parks
- Karangahape Road is an alternative area where experimental architecture and ideas are better accepted.
The site’s location means that it will always have market value and thereby provides a certain amount of future proofing for the development.

The site offers the possibility to demonstrate how the Passivhaus standard can be incorporated into the fabric of the inner city whilst respecting the existing typology of the street.

Perceived problems/restrictions:

- The historical background of the area and surrounding buildings presents restrictions to building height, form and material choice. In order to be sustainable, the design concept must respect this context.
- The noise and pollution generated from traffic on Karangahape Road and the nearby North Western motorway may be a problem for the residences.
- The increase of density can lead to the increase of hard spaces. The design concept must promote the integration of green/soft spaces as a way to combat inundation and increase the quality of life.
- The current site is covered in asphalt. Its use as a car park renders the site polluted and appropriate measures must be taken during removal and disposal.
- The views from the site are ‘not desirable’.
- The slope of the site
- Auckland’s rain/ humidity problems

A view of the corner site along Karangahape Road
4.2 HISTORY

The site sits just outside the Karangahape Road precinct as outlined by the Auckland City Council, in Business Zone 2. This is ideal as although the site is still located on the famous road it enables a more flexible design to be formed that does not need to adhere to the strict regulations that exist in the precinct, without losing the publicity, close location and potential market/resale values that comes with a site on Karangahape Road.

In pre-European times the ridge was used by Maori as a “travel route from the Manukau Heads to the inner isthmus area.” The origin of the name Karangahape is to this day unknown. Different hypotheses have interpreted the meaning to be the “winding ridge or human activity” and “calling on Hape,” an important chief who once lived over the Manukau Harbour.

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69 Karangahape Road Business Association. "Heritage Walk Karangahape Road"
Karangahape Road was Auckland’s busiest shopping street from the 1900’s to the early 1960’s and the origin of any of New Zealand’s main retail chains. The turning point in Karangahape Road’s history was in 1965 with the construction of the inner city motorway system resulting in over 45,000 people having to move out of the surrounding areas. Low rent prices in 1970 introduced the Red Light District in the area and brought with it Karangahape Road’s notorious reputation as an area for prostitution. From 1990 newly constructed apartment blocks have attracted residents back to the area along with the rise in appeal of close-by areas like Ponsonby.

To preserve the area we need to preserve Karangahape Road’s eclectic mix of styles. Photos show that the verandah is an element that was originally built with the buildings, despite the difference in style. This can therefore be considered an element of adaptation for New Zealand. “Their various forms contribute to the character of the streetscape in commercial centres (C15).”


A cross section through Karangahape Road, when contrasted with that of a typical European street, shows the urban space is less enclosed. Karangahape road is a long, two way street whose linear axis encourages movement and hence it is a thoroughfare for many heading from the central city to Ponsonby, Newmarket, Mt Eden and Western Springs. Pedestrian movement throughout the street tends to be direct along one side of the road and dictated by the moderate flow of the four/six lanes of traffic which prevents people from crossing. The barrier of traffic movement inhibits public interaction within the space, promoting “alienation and anonymity” unless there is a deliberate attempt to visit a premises for social or business activities.

The low heights of the buildings, in contrast to the six lanes of traffic result in “space leakage” where the eye can not detect enclosure or an interior space. Instead it tends to form a visually unframed space at high levels. Distinct entrances to the different tenancies on the street maintain connections with the street and echo the traditional complexity of the “many separate buildings” methodology that promotes human interaction. The integration of the different styles


through the observed rules help to generate a “readable story” of clear origins and hence forms an authentic space\textsuperscript{78}.

Parking on the street has both positive and negative aspects. In a city such as Auckland the parking is beneficial for commuters. Furthermore it helps to decrease the speed of the traffic in the street making it more pedestrian friendly.

Cafes such as the Turkish Café along Karangahape Road help to blur the boundaries between public and private sectors by seating people outside. This is positive as it helps promote social interaction on the street.

4.4 CURRENT CULTURE

Today Karangahape Road is known as an alternative street in Auckland and the centre of Auckland’s Bohemian scene\textsuperscript{79}. By day the street features an eclectic selection of cafes, boutique or second hand stores and art galleries alongside the remaining venues catering to the sex trade. On weekends flea markets are present along the Karangahape overbridge. The emerging art scene and the development of contemporary art galleries are transforming the areas reputation into one of creativity and alternative music and fringe arts. By night the street’s restaurants, bars and clubs make it a major part of Auckland's social scene\textsuperscript{80}.


4.5 SUMMARY

The restoration and promotion of the street’s character should be enhanced by the development. An increase in density within the area will help generate visual enclosure and is beneficial by creating a critical mass of people to support shops, public transport and local services.” Furthermore they help to stop the ‘urban crawl’ and help preserve bush and farm land, thereby preserving biodiversity and the qualities that have helped us develop a positive international reputation. Economically this is necessary due to rising land costs and the limited availability of undeveloped sites within the inner city. On a larger scale, a future rise in the density will generate greater profits and a greater sense of community to help the street retain market value. International “studies have shown that vibrant urban areas attract younger, talented workers.”

In mind of this I propose the questions:

- Is it possible that these qualities and ideals can exist at higher densities?
- To what extent can the ‘Quarter Acre Kiwi Dream’ exist in the city as a sustainable form of future housing?
- And how much nature do we need around us?

How to integrate the development into the area?

As each building has been built in the architectural style that was fashionable of its period I suggest that the development do the same as a way to preserve the eclecticism of the area and as an

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architectural timeline for the future. Certain rules/trends can be drawn from an analysis of neighbouring buildings:

- A constant window line for the top and bottom stories of the buildings.
- A central distinction of each of the buildings/sites through mirroring/window placement of differing depths.
- A constant roof line (although there are a variety of parapet styles).
- Central door placement
- A relatively continuous verandah line – however in some areas these step.
5.0 DESIGN PROCESS & OUTCOMES

5.1 CONCEPT

The design concept for a mixed use retail and student accommodation is formed as two building masses connected by a dynamic green atrium space which acts a communal centre of the project. The ETFE covered atrium formed a symbolic expression of the alternative nature of the project. Separating itself from convention through structure, materiality and thermal responses, it is also relying on the conventional buildings to support it as its shelters the occupants, regulates the air temperature and demands public attention through its sculptural form which wraps down and around the corner to emerge onto Karangahape Road as the verandah.

Drawing on the influence of the Passivhaus principles the exterior façade forms a heavy aesthetic that portrays the permanency of the thermal seal together with the strong lines of the historic streetscape. In comparison the interior aesthetic is driven by flexibility and impermanency. The textured facades push and pull to create private green balconies, summer shading and movement that capture the energy and social nature of the students.
The landscape of the atrium floor flows from the corner, moulding to create areas for the occupants to sit, lie or gather together on. The contact with green space is a quality that is often lost within city apartments and yet forms a vital part of our cultural needs.

The green atrium penetrates the corner of the site to announce itself to the public and establishes a new ‘technical green’ aesthetic within the urban context. It challenges the notion of the ‘corner’ on the prominent site through transparent definition of the boundary to promote public interaction and awareness of the project.

i) FORM
The preferred massing options were tested against the environmental goals that had been generated within the project programme (see Appendix E). The use of an interior green courtyard was identified as a strategy that would offer students a communal gathering area and positive psychological and health benefits.

The chosen building form was chosen because of its ability to generate as replicated model for the neighbouring sites or as a further addition/extension of the apartments. This creates an additional ‘green street’ adjacent to Karangahape Road and a dynamic, social environment whilst allowing sustainable intensification of the important urban site.

The concept to increase the density of the site as part of a wider environmental plan for the area will effect the height of the development. The New Zealand Building code requires buildings on this site to be no more than four stories (12.5m) high in order to integrate with existing context. An appropriate design strategy needs to increase the site density without disrespecting the historical nature of the area. This was investigated via section and the advantages and disadvantages of each of the concepts.

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The distance between the two buildings was devised using the height restrictions and New Zealand sun angles to generate the greatest density to sun exposure.

**Advantages of the chosen massing strategy:**

- The development receives direct sunlight to meet Passivhaus demands
- Allows an increase in density
- Lower section to the North allows continuity of the existing street facades/ street scale
- Accentuates desirable views towards the inner city
  Allows different heights and levels to be formed for visual interest

**Disadvantages:**

- Large surface area receiving light may cause overheating in Summer
- The increase in density to the South does not meet council height restrictions
- There may be severe overshadowing of adjacent properties

Figure/ground diagram of the area displaying the proposed future development of the model.
ii) CORNER SOLUTION

The corner is an important urban design feature that will be seen from Ponsonby Road and will act as an element to draw people into the atrium area and promote the use of the atrium, green spaces and the alternative nature of the development. Three predominant corner solutions were investigated:

1. Building up the corner
2. Insertion of a third building with an entry at the corner
3. Opening up the corner

Concept Design:

a) Building up the corner

A library was formed to “wrap” around the corner, adjoining to a café opposite it on the secondary building via a bridge. A staircase on the corner of Gundry Street and Karangahape road was used to create a public entry separate to the atrium entry on Gundry Street to the library, café and individual rooms. It was visualised that this entry would run up a planted green wall that blocked the direct northern light entering the library space and created a focal point on the corner. Natural light was to enter the library using a light well at the back of the planted wall. On the top of the building a bar/games room that connected to a green roof/deck area was formed. This was designed as the social gathering spot for the students, the green roof helping to reduce runoff.

Advantages

- The use of height on the corner can help create definition of the site boundaries.
- A clear entrance can be formed off Karangahape Road separate from the atrium.
- The typology blends with other entries along the street
- Clear identification of the thermal seal along the boundary line
Disadvantages

- The sectional style of the building does not address the street. There is a need to signal the end of the building and acknowledge the street front.
- On the prominent corner the green is not coming out to present itself to the public. Views into the atrium are only visible on Gundry Street. The atrium is therefore not actively promoting itself.
- The corner receives harsh western light that will cause massive overheating at this part of the building leading to larger cooling loads.
- No direct light can enter the atrium floor as it is blocked by the building, creating a permanently dark street which would be unattractive in winter.

DRAFT PLAN of the FIRST FLOOR, JUNE 2009 (NTS):
b) An Additional Building:

A design generated from the need for an entry off Karangahape Road directly into the atrium, and the green atrium emerging from the corner were investigated through the creation of a smaller third building aligning Gundry Street. This building was to act as the universal/public area of the project where the reception, café/bar and library/study rooms would be situated. Entry was suggested via bridges to the other buildings and through the main entry. The generation of the third building created a need for the roof to highlight the corner and unify the different masses. Shelter at an appropriate level was also necessary. The idea of the roof as a funnel to display the water collection and placement of the tank at this point was developed as a concept for the corner. It was thought that by pulling the roof down toward the ground, a feature roof would be created that spoke of the building’s objectives and created an urban sculpture for the prominent corner. A green wall was selected for the western wall of the smaller building to draw the eye from the intersection of Ponsonby Road and allow the green of the interior atrium to seep out/draw people inside.
Advantages

- Created definition along the Gundry street boundary
- Allowed the green atrium to travel off its linear path, acknowledging the atrium’s end and emerging to the public to draw people into the development.
- Generates two different entries into the atrium – one off Gundry and the other off Karangahape Road.
- Aims to publicise the project’s aims, utilising the water tank and green wall to create a sculpted corner.
- Separates the private and public areas of the project
- Promotes internal views into the atrium, away from the busy road.
- More direct light can penetrate through to the atrium floor.

Disadvantages

- The building blocks views into the atrium and the internal streetscape which was considered desirable in the initial concept.
- Critique from an energy point of view was that construction of a separate building was energy intensive and unsustainable.
- An awkward relationship is formed between the roof and the building. The proportions of the roof against the building overpower it and appear visually heavy due to the need to create shelter at a pedestrian level. The small size of the site deems making the buildings larger an unviable option as this would create a dark, cramped interior courtyard and lighting issues.
- Overheating of the western facade may generate larger heating loads.
DRAFT FLOOR PLANS: AUGUST 2009 (NTS)

Ground Floor
First Floor (NTS):
c) Opening Up The Corner
The third building is taken away and the public functions are added to the building mass right of the stairwell on Gundry Street. This reduced the density of the project, however as the development is seen as the first stage of a larger development this does not pose much problem. The height of the building on the boundary is reduced from six storeys to four storeys to respect the height of the surrounding buildings on Gundry Street.

Advantages

- The atrium is opened up towards Karangahape Road to draw people into the building and publicise the green atrium and alternative lifestyle.
- There is a reduction in primary energy and shading which can be controlled by using ETFE on the Western Façade.
- The roof of the corner is developed to create a continuation of the verandah. It uses design strategies employed by the traditional arcade to sympathetically frame the corner.
- The bar is positioned on the corner and opened out onto it to create a vibrant entry with the green wall.
- The ETFE is seen as a separate structure now and it is thought that this should be revealed by it touching the ground and wrapping around the building. The wrapping of the ETFE helps to portray the new material to the public.
- The verandah is blended with the ETFE to form visual continuation of the form and shelter at pedestrian level.
- The water tank takes on multiple uses, creating corner definition and carries the load of the roof.
- Separate entrances are created between Gundry Street and Karangahape Road.
Disadvantages:

- Connecting the canopy to the green wall creates maintenance problems.
- The use of a conventional arcade/ canopy entrance does not project the vibrancy aimed for in the design.
- The lack of corner definition – a feeling that the corner is “forgotten.”
- The suggested outdoor area of the bar does not interact with the atrium and would not generate a comfortable space (undesirable views and busy road)

Conclusion:

The open style of the corner is believed to create the best integration between energy and light principles, project aims and structural integration of the different systems – however the current design needs further resolution to enhance the benefits of the chosen strategy. The decision is based on the potential of the entrance to act as a much longer development.

Development of the open corner strategy:

- The structure was changed to a smaller triangle pattern to allow more flexibility of the structure’s design84. This created an organic flowing form that folded down to the ground creating aesthetic interest, greater elegance of the design and lowered the exposed surface area from that of the original concept design. The organic nature defines the separate structure and generates greater unity in the design.
- The creation of a bank on the corner turns the focus away from the busy road and undesirable view towards the interior and the green wall. The bank generates a place to sit and a defined entry.

- The shelter is brought down onto the large circular water tank that acts as an object that mediates between the small green wall that defines the site boundary and the larger green wall. The bank/landscaping wraps around the water tank to enclose the corner to create two separate entries and provide seating, green space whilst defining the corner and the site boundary.
- The canopy is attached at a point on the green wall to avoid slicing through it and taking the focus off the feature.
- The green wall wraps around onto the Karangahape Road façade to draw people around the corner and create a more elegant relationship between the brick wall and the green wall.
5.2 FINAL DRAWINGS - SEPTEMBER 2009

<table>
<thead>
<tr>
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</thead>
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<td>Elevations</td>
<td>NTS</td>
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<tr>
<td>Section A-A</td>
<td>NTS</td>
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</tbody>
</table>
5.3 FUNCTIONAL ORGANISATION

Green Space/ Atrium
User satisfaction and quality of life with density is sought through the use of public and private green spaces. The lack of personal ownership that comes with the use of the central green atrium led to the formation of individual green balconies for each of the long term apartments. Vertical and horizontal planted space were considered like those used by Knafor Klima architects in their Agrohousing project in China\(^5\). A large green wall wraps around the corner to advertise the developments aims and draw public attention from Ponsonby Road. The internal atrium allows the green courtyard to be used all year round, further aiding the sense of community. Occupants could open and close their windows at will within the atrium space without severely altering the internal temperature, which sits well within the kiwi culture. The green balconies offer space for students to plant vegetables, etc. in pots or sponsored kits if they desire. The benefits of the green space have been shown as lower stress levels, enhanced productivity and improve individual wellbeing\(^6\).


The initial concept involved the compartmentalisation of various private green spaces within the development. These were envisaged as double height spaces to allow trees to be planted. The structure was visualised as light weight boxes that effectively ‘hung’ off large planted walls running on an East/West axis, parallel to the atrium space. Green roofs and large overhangs were utilised as space the tenants could occupy. To achieve privacy the green spaces took on the role of the lounge area and the apartments became multi-storey to accommodate the double height green lounge.

The decision to restructure the long term apartments to open onto the atrium to take advantage of the northern light and views out into the atrium was important for bedroom and living areas. The reduction of stairs within the building has generated apartments spanning only one floor on the east of the southern block for greater user satisfaction. Green areas were reassigned as balconies opening into the atrium off the living room to avoid the functional issues that would result from a green living room and to ensure adequate sunlight is available to enable plant growth.

**Long and short term apartments**

During the development the separate buildings took on different functions. The smaller building on Karangahape Road was deemed the more public and noisier of the two and therefore formed the municipal part of the project. On the first and second floor single rooms were developed, each with a small bathroom (toilet, shower and basin), wardrobe/storage space and adequate room for a double/queen size bed and a study desk/ shelves. Each room has North facing windows or a small balcony onto Karangahape Road allowing views and sunlight into the room. A communal kitchen is situated on each floor with a dining area overlooking the atrium and space for a television/ couches. The choice of accommodation was selected on the basis that as the more universal building of the two, short term lease of six to twelve months would be optimal. These would be aimed at students who planning to study for a short time (i.e. a six month Natcol course
on Symonds Street or first year students). Together there are ten single rooms covering the first and second floor. Third floor consists of a large apartment for six/twelve people.

The larger building at the back of the section was termed as the long-term apartments. Tenancy of three/five years is optimal. The apartments contained a mixture of two, three or five people. The buildings final layout consists of five four/six person apartments, two double height apartments suitable for two/three people and a studio apartment. The larger apartments have an open plan living/dining/kitchen area that opens up onto the green balcony and atrium space. Each bedroom and bathroom receives natural light. Views, light and privacy are controlled by the occupant through moveable louvered screens.

The decision to develop different types of living environments within the project is aimed at exploring the ways New Zealand youth live together and could give indications toward changes that may be necessary in future developments.

**External balcony**
The conflict between the need of “kiwis” to be outside and the enclosure of the atrium was a driver in the creation of external decks. Originally it was intended that a green roof would act as an outdoor space for the occupants. Changes in the roof structure and the increase in density made green roofs an unviable option.

To account for these changes, external public balconies were created on the second and fourth floors to be used for the residences for smoking, etc. The changes in occupant movement created by this design decision caused the stairwell to be moved toward Gundry Street for efficiency. The benefits that resulted from this move were to transfer the residential building mass away from the noisy road and shorten the corridor space. The structure of the stairwell on the north/south axis remained the same as the object created a pleasing asymmetry by breaking up the building mass and allowing light,
ventilation and heating into the back of the building via open balconies to the sides encouraging a comfortable environment.

The need to reduce the building’s height on the Gundry Street property boundary too acknowledge the neighbouring property created space for a large external, communal deck situated on the top of the fourth floor as a place to socialise, have barbeques and grow additional vegetables, etc. This is sheltered from the southern winds by glazing.

**Café/ Study Areas**

Utilisation of the open corner caused a stratification of the southern ‘long term’ block into private residential apartments and a public social area with the Café and study rooms, separated by the stairwell. The café offers space away from the atrium floor for students to meet and pulls the public into the atrium area. The movement of the louvres could be used to demonstrate to the public when the café is open or closed.

The inclusion of study rooms gives students a place to study away from their rooms. It is thought that increases in technology will lead to more internet based courses, distance learning and therefore changes in the way students study/learn. The availability of the two rooms would allow one to be booked for group work, conferences, media presentations etc, leaving the other for individual study. The windows in these rooms are designed to stop the harsh afternoon light entering the room and to filter in the softer southern light suitable for reading. Views into the atrium are controlled by the user through louvered screens. A bar is situated on the corner opening into the atrium and the street corner to generate a vibrant, social space characteristic of the street. The green façade will create a point of difference among its patrons.
Lightwell
Given the predicted increase in the area’s future density and taking into account the New Zealand Building regulations a fire rated shear wall containing no windows had to be established on the boundary\textsuperscript{87}. This created lighting and ventilation problems. Entry to the apartments became restricted to the dark, southern side of the building. A light well was incorporated to solve the problems.

Initial designs used smaller light wells along the wall to draw light into the area. Changes in the apartment layout developed the light well that ran along the wall. However the detachment of the floor from the wall created structural problems. Moving the light well in toward the apartments and creating a bridge element within the light well allows the floors to run to the wall and the shear boundary wall to be used as a rigid structure to support the atrium. It also generates more light in the area and to the back of the apartments. Ventilation of the area is also improved. Moving the corridor space away from the apartments also creates a greater sense of privacy for the occupants.

Retail
Retail on the ground floor forms a link between Karangahape Road and the interior atrium as an extension of the existing retail strip, thus respecting the existing context.

Gymnasium
A small student gym was initially placed in the centre of the atrium and bridged from both sides. This was moved to the eastern side of the atrium to open up the atrium space for landscaping and give greater privacy for gym members. The addition of toilets at ground level opposite the gym allows the full space to be available for use.

Utility Areas
A workshop area and laundry are situated within the garage as the utility area for the students. Recycling/ waste facilities are located near the road for easy maintenance. A technical room houses boiler, heat pump and additional water storage facilities.

5.4 ENVIRONMENTAL EFFICIENCY

Atrium
The use of an internal atrium or sunspace between the buildings was selected as a functional and aesthetic strategy to employ within the design. The benefits of the sunspace include:

- Maximising heat gains
- Create good heat distribution
- Provide good storage
- Reduce heat losses

Architecturally the sunspace “adapts to architecture” capable of taking on any expression. An atrium on the site would work effectively as it is within 30° of North. Solar access must be maximised in winter.

Examples of effective use of solar atriums are Robert Vale’s “New Autonomous House”; IGEL architects Plappersnut Kindergarten and

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92 “Notes taken in class ”Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”
Nigel Cook’s ‘wind-rain’ houses in New Zealand. The conceptual basis of Cook’s designs centres around the conflicting relationship between the New Zealand’s culture and climate; “...we want to live like Californians and Australians but we can’t because we don’t have their blue sky climate. What we have is a culture very close to theirs and a warm climate but with lots of wind and rain.”

In these three projects the internal atrium spaces are used as solar thermal collectors, the air inside acting as insulation. In winter the air is heated inside the atrium and used to heat the rest of the building. This could considerably reduce the heating loads of the building, with the temperature to fluctuate between 18-25 degrees all year round. The possible side effects of the atrium could be overheating, noise and a feeling of entrapment. Overheating in the summer could be balanced by transmission losses and natural ventilation of the atrium by forming a stack effect inside space. High volumes permit the warmer air to rise and the cooler air to stay around floor level.” Venting of the air at the top of the atrium creates a convection force sufficient to drive the ventilation of the whole building. Adequate sound proofing via the structure of the building could combat noise issues generated by the atrium. The social nature of students also offers some lee-way in the design. The enclosure of the atrium presents the need to offer some outdoor space for the occupants within the design. The high, transparent roof will reduce the occupants’ awareness of the enclosure.

Green Space
Transpiration by plants helps to cool and stabilise the internal climate physically as well as psychologically by the occupants in summer. In

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winter the use of plants can create a visually warmer and comforting environment⁹⁵.

**Water tank**
Integration of the water tank into the middle of the atrium as a design feature was decided on the basis that it could be shared between the two buildings via a raised floor; and storage inside the thermal seal would decrease temperature fluctuations⁹⁶. The change in the tank’s position, from the centre of the atrium to the corner, have meant that the tank in now ‘outside’ the thermal seal. Although this is not advantageous from an energy point of view, the water tank’s structure is used to hold the weight of the roof and create definition on the corner, thereby reducing the primary energy that would have been required by additional structures to complete these tasks.

**Heating/ Cooling Strategies**

Three strategies were explored as options for the project⁹⁷:

1. **Waste Systems** – systems typical of this title control how the air exits a building/ exhaust air. The benefit of this system is that it utilises the atriums solar storage properties and natural airflows to reduce the need for high tech ventilation units. The main disadvantage of this system concerns the freshness of the air used to heat the rooms. As it is pulled from the atrium space it is not as clean as new air.

2. **Forced Air systems** – systems that control the intake of air entering the building. These systems pull air into the living areas of the development and exhaust it into the atrium, the benefits of which are that the occupants ‘use’ the air within


⁹⁶ “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”

⁹⁷ “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”
their dwellings first. The disadvantage of the system is that it requires cross ventilation of the apartments and atrium which is often not possible in high density sites such as this project. Without efficient cross ventilation high tech mechanical ventilation is necessary.

3. Combined systems – systems that control the intake and exhaust of air from the building. These systems control the internal environment to maintain optimal conditions similar to that within the Passivhaus. However this doubles the technology requirement and maintenance of the building.

**ENERGY CONCEPT**

Comparison of the schemes shows that the waste system is suitable for this project. The social nature of the atrium as a secondary living space for the students blurs the boundaries between the residences and therefore the utilisation of air heated initially in this space is not considered a debilitating issue. The use of the light wells on the southern side as a ventilation spaces will aid natural ventilation and fresh air intake to the residences.

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*Ecotect* model displaying yearly sun path.

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WINTER

- In winter the atrium is sealed to allow it to act as a solar storage space to heat the building, using the air inside as insulation.
- In the bathroom/kitchen of each apartment is a low energy 100W mechanical ventilation unit.
- Air is naturally pulled from the atrium to the bathroom/kitchen – the room which has the most polluted air.
- The air travels up the pipes/chimneys
- The air passes through a heat exchanger at the roof. This takes the warm energy (18°C) to a heat pump which boosts the energy to 3 times the input. This head (54°C) is used to heat the water tank. Auxiliary heating from radiator wall units using low temperature water from the tanks (35°C/45°C) in a closed cycle.
SUMMER:

- The atrium is well ventilated
- Sensored opening of the windows at the top and sides of the atrium and manual opening of the windows within the apartments by the occupants will be used as the main method to reduce internal gains by balancing them with ventilation losses.
- The heat exchanger is turned off in summer
- Shading in the form of louvered screens on the apartments Northern facades opening into the atrium offer privacy and shading of the thermal floor mass.
- Fritted ETFE (ethylene tetra fluro ethylene) was chosen to cover the atrium. This is utilised as a layer stretched between supports and inflated with air to form a foil cushion (refer to Appendix B for a descriptive overview of the material).

In New Zealand ETFE is being used in the Britomart East Project in Auckland, which demonstrates that the material is a viable option and industry accessible.
**WATER CONCEPT:**

Rain water is collected in a main gutter situated at the connection between the atrium roof and the smaller northern building and a gutter running along the Southern block. The main water load is directed to the water tank situated on the corner which acts as a silt filter and then pumped to larger grey water storage tanks in the Southern Block. The tanks have combined volume of 200,000L to allow for Auckland’s 3 month drought period\(^99\). These are built into the foundations, using the earth as insulation to minimize temperature fluctuations. Rain water and grey water from the showers is used for the toilets within the building and for the water efficient irrigation system comprising subsoil drip system/ trickle vents.

The hot water demand of the occupants as given by the Passive House Planning Package 2007 is 25 litres/person/day of 60°C water.\(^{100}\) This amounts to a minimum demand of 1250L per day. Existing city infrastructure will be utilised. A stratified tank will be

\(^99\) “Notes taken in a meeting with Max Hynds, September 2009.”

used to take advantage of the different temperature levels inside the tank that create different energy supplies for the wall heating units and the hot water.

Black and yellow water is taken out via the main sewer system. The site restrictions do not allow for the composting of these elements within the urban framework.

**TESTS CARRIED OUT WITH ECOTECT**

The Ecotect model was created to rate the design decisions that have been made towards energy:

**Testing the use of the atrium: Total Monthly heating and cooling loads**

- No Atrium, single glazing: 35.61 Kwh/m²a
- No Atrium, double glazing: 25.31 Kwh/m²a
- Atrium, single glazing: 18.75 Kwh/m²a

(Corresponding monthly figures and graphs are shown in Appendix F)

Although there is some suspicion surrounding the exact energy figures shown in the graphs, it is clear that the use of the atrium does decrease the heating and cooling loads of the building and that the principle is able to be applied in the New Zealand climate.

The addition of interior shading was tested to portray the shading that would occur from the use of cantilevers/overhangs that are formed through the aesthetics of the interior facade. This was shown to create steadier temperatures in the summer.

Double glazing was shown to be the most effective form, however single glazing could be utilised on the interior of the atrium without large changes. The use of exterior single glazing resulted in high
transmission losses in winter that drastically lowered the temperatures inside\textsuperscript{101}.

Excessive overheating occurred in the fourth floor due to the heat rising and the roof zone\textsuperscript{102}. A study of the optimal shading device for the roof zone by Ecotect showed that the roof overhang was adequate.

Changes were made to the windows adjoining the atrium. The results showed that the reduction in the window height from 2400mm to 1400mm resulted in minimal difference to the temperature in summer but made the apartments cooler in winter, increasing the heating load. It was concluded that the windows were best at the 70/30% ratio as predicted\textsuperscript{103}. The atrium height was increased to 2m above the residence to aid the stack affect and gain greater ventilation. This was shown to have a positive cooling effect within the model.

Questions have arisen regarding the modelling of the atrium zone in the programme. Erratic fluctuations in temperature have led to the implementation of a partition ceiling with a void in it. This decision was based on advice received from a forum on Ecotect and was aimed to mimic the stratification that would occur naturally in the atrium that the programme can not cope with.

Changes to the design prompted by the testing:

The initial problem highlighted by the Ecotect model was overheating of these rooms. Modern box shades are added to generate depth of the façade and necessary shading. The depth of 700mm is taken from the optimal shading for New Zealand.


\textsuperscript{103} “Notes taken in class "Lifetime Building Design" by Prof. Martin Wollensak, September 2008.”
The conventional verandah was changed along Karangahape Road to ETFE to allow more light into the lower storeys in winter and adequate solar protection in summer. The change in the verandah was generated by high heating loads within these spaces. The need for flexibility is demonstrated by the new Ironbank development on Karangahape Road by RTA studio, where the underside of the verandah is cut back from the building to allow light to enter the ground floor.

The garage and workshop areas created a large 7m x 30.80m unheated zone which, it was decided, should be naturally ventilated and external to the thermal seal. The stairwell was incorporated into the seal following Passivhaus recommendations\textsuperscript{104}.

The limited space and the desire to promote public and alternative modes of transport led to the elimination of cars from the garage. It is intended that it would be used to house scooters, bicycles, motorbikes – with the possibility that a small number of compact electrical vehicles could be parked if necessary.

Changes in the roof shape were driven by energy demands. The utilisation of a single plane roof on the southern building decreased the exposed surface area of the building following energy principles\textsuperscript{105}. This reduced the number of thermal bridges and loss of heat via transmission. To the north the roof shape is dictated by the optimal angles for solar panels and water collection\textsuperscript{106}.


\textsuperscript{105} “Notes taken in class "Lifetime Building Design" by Prof. Martin Wollensak, September 2008.”

5.5 STRUCTURE

**CONCEPT:** To allow future flexibility of the building the structure must be designed to allow changes to be easily made over time. Elements of the building that would have a lifespan of 80/100 years were selected to form the structural core of the building, while those with a shorter lifespan were to allow flexibility of space.

Using the building footprint generated by initial concept design and the site dimensions a grid was created for both the buildings. The northern building grid sized 7m x 12m and the southern 6m x 12m. The outside envelope was categorised as a permanent element in the design that is to take on the function of the Passivhaus envelope by functioning as the main thermal seal. The “envelope has to enclose the building without interruption” to make an airtight layer, dividing the interior warm area and the exterior cold area to prevent cold air infiltrating the house; “...only the areas of the thermal envelope are considered. Walls, ceilings etc. in the interior of the building do not
have to be treated in detail. “The grid allowed functional spans to create the basis for design.

The flexibility of levels was developed through volumes. Floors that would support planted areas were chosen as permanent concrete floors due to their structural ability and function as solar heat storage within the cores. These were located on the first, third and fifth floor levels in the larger southern building and the first and third in the Northern building and generated permanent structural cores of 6m x 12m x 9m and 6m x 12m x 6m. Inside these volumes it was envisaged that floors could be added or taken away over time as the tenant and building use changed. Timber floors and staircases with a lifespan of 30/50 years could carry out this function. A permanent steel skeleton frame was thought appropriate for the main structure to allow changes in the walls between the cores.

Integration of the structural concept into the planning and development fuelled the adaptation and development of the apartments on a North/ South axis within the 6x12m grid.

**OUTCOME:** The initial structural concept is not considered a viable option due to the fire and noise problems and the problems with uncertain services requirements. Flexibility is still offered across the floors by the structure.

The move to make the atrium a convex lattice form helps to create a series of compression members to transfer the loads to the two buildings over the large span. The density or triangulation needs to be increased to reduce the size of the structural members from a 200mm diameter steel pipe truss to a 90mm tube. The roof will be dealing with a wind load of approximately 1 – 1.6Kpa. Members need to continue past the roof and be tied down. The added advantage is that

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these members will generate cover to protect from wind driven rain. Beams placed every 6m across the building on the East West axis will provide adequate lateral support. The 2m cantilevering balconies are viable, however a small step down may be required for waterproofing.

The building structure needs to support the load of the atrium. The building is considered too high to use timber for the main structural elements. 200 concrete "Dycore" flooring is optimal. The main shear walls of the apartments will be precast concrete. Load bearing walls will use a steel frame with staggered timber framed infill (260mm). This will still allow flexibility across the zones, whilst taking the loading of the atrium roof. Appropriate wall thickness and insulation for a Passivhaus construction has been adapted from the Passivhaus Bauteilkatalog. A 400mm outer wall acts as the main thermal seal. Non-load bearing walls use conventional timber construction with 120mm stud wall. The external walls within the atrium will be clad with plywood.

Lateral support at the load points on the western wall of the south block will be through thickening of the walls at this point to form columns. Shear walls on the East allow for future development of the building.

The roof will follow Passivhaus construction to avoid thermal bridges; however longrun steel roofing will substitute clay tiles to minimise cost. Box construction of the windows on the exterior thermal seal is shown to further eliminate thermal bridges, as recorded in trials carried out on the 'New Autonomous House' by Brenda and Robert Vale.109


AMENDED STRUCTURAL CONCEPT (NTS):
5.6 AESTHETICS

Exterior Facades
Initial façade designs involved the use of green walls and repetition of the pocketed façade featured in the interior. A decision to reflect the permanency of the exterior wall which acts as the thermal seal generated a more ‘solid’ exterior and a softer interior. The façade developed using the proportions and window line of the neighbouring buildings to respect the historical context. The decision to extrude the windows into a modern box form was driven by the prominence of the of the window frames of the neighbouring buildings. The boxes assist the design aesthetically and environmentally and allow a modern reinterpretation of the Victorian window.

To generate a connection to the interior of the atrium some of the window frames are pulled back into balconies to create more depth and movement. The internal partitions of the boxed windows were changed into a moveable shading device to provide further solar protection. The third storey of the Karangahape Road block was pulled back from the boundary by a deck to create a visible change in the aesthetics from that below. The intentional change aims to decrease
the visible height difference between the neighbouring two storey buildings from pedestrian level thereby generating density without compromising the streetscape.

Reclaimed bricks were chosen to be used on the façade for historical reference. The lifespan of the bricks will be around 80 years – suitable for the exterior thermal seal. Recycled bricks reduce the primary energy of the building as no new materials were used to create them. The change of the verandah to ETFE signals the change in building style and draws people along Karangahape Road into the atrium. Additional UV protection for store front displays would be through a canvas cover drawn out and attached to the verandah structure under the ETFE.

Similar material and proportions were chosen for the Gundry Street façade where the café and study rooms are situated, to unify the buildings so they read as one development. The need to reduce the height of the western façade to acknowledge the height of the neighbouring property was done by stopping the brick wall at the third floor, where a parapet forms the edge of the external balcony. Similar shading devices are used on the upper study rooms to protect from the harsh Western light and filter in southern light, whist portraying a change in function. The use of louvered screens also directs the eye away from the changes in height between northern ‘short term’ building and the southern ‘long term’ building.
Interior façades

Initial concept design was drawn from the idea of the compartmentalised green spaces. This evoked a pocketed visual image similar to that of the Copenhagen Student Hall of residence by Danish architects Lundgaard & Tranberg\textsuperscript{110}.

Development of this idea was initially created through sketches of the Western elevation on Gundry Street where the internal street could be viewed. The design suggested by the rough elevation was tested in model form. This model was formed intuitively, with aesthetics as the predominant focus. The asymmetrical nature of the design and the textured interior create vibrancy within the model that I had aimed to achieve within this project.

The incorporation of the structural concept led to an interior layout formed on a 3m framework. The decision to reflect this in the aesthetic generated a 3m x 3m grid pattern. The aesthetics move away from asymmetry helped to tie the external and internal facades together. Double height balconies used to link the remaining split level apartments. Additional double height protrusions have been used to allow the layout of the single span apartments to follow a similar layout without generating static repetition of the green spaces. The facetted facades act as a form of shading for the rooms in addition to the moveable louvered screens – selected for shading and privacy. The green balconies are highlighted in plan and elevation as the larger protrusions and help to create a sense of green surroundings that utilize the ideals of the Kiwi Quarter Acre Dream.

The café and study rooms follow a similar pattern but are set apart by the use of a longer 6m x 3m grid to show a change in function and detachment from the residential area of the building. Similarly the Northern ‘short term’ building follows a similar pattern but the

\textsuperscript{110} Detail, ”Student Hall of Residence in Copenhagen” in Konzept: Gemeinsam wohnen, (48, Serie 2008, no 9) 953 -967.
inclusion of the walkways and a 3.5m x 3m grid gives a change in the appearance from that of the southern ‘long term’ apartments.

**Lightwell/ stairs**
The glazed stairwells act as objects that separate the public and private sectors of the buildings. Their placement creates a pleasing asymmetry of the interior facades. Likewise the lightwell in the southern block allows the bridge to become a formal structure within it that is disconnected from the apartments. Light and shadows filter down through the floors promoting to create movement and occupant interaction.

**Landscaping of the Atrium**
The landscape of the interior atrium is derived from the wider city context. Green spaces within the city are compartmentalised in the form of parks. The static nature of these green spaces and the fluid nature of the streets was the generator for the landscaping concept. The idea that the landscape inside the atrium could take on the form of the street with the buildings acting as the restricting footprints, would allow the continued development of the green atrium along the neighbouring sites.

The use of green strips, moulded to meet the required function of the space when placed on the site resulted in a lively, animated enclosure and allowed functions to double to reduce costs and create overall unity of the atrium. Where seating is needed the forms create varied heights to mimic the requirements of a chair. Drainage is the result of strips creating a concave form at ground level whiles others are planted or moulded to create a structural platform for decks. This results in the creation of both public and private spaces. At the corner a bank is used to define the boundary of the site and create a relaxing space for the students where they look towards the planted green wall instead of the busy road and undesirable views of the petrol station.
Atrium Roof
Initially the form of the atrium roof was a single pitch with trusses running on a North to South axis. This form was utilised as it would give greatest exposure to Northern light as demanded by the Passivhaus.

As the roof structures of the northern and southern buildings were simplified to reduce the exposed surface area, there was a need for the atrium to become a feature of the project. The use of ETFE as a new material that takes on a very different aesthetic to the conventional building structure that support it also demanded this change. Aesthetically the notion of the roof as fluid and graceful form was sought through the use of butterfly trusses. Examples of Glen Murcutt’s work (such as the Magney House, 1975, Bingie Point, Australia) were used as inspiration.

At the corner it was necessary that the height of the atrium was brought down to a pedestrian level with the use of the ‘open corner’ strategy. The use of the trusses created a static aesthetic that failed to portray the vibrancy of the project or create a sculptural statement because of the need for set connection points between the buildings. The need for greater structural flexibility coupled with a system that could span the 18m gap produced an organic lattice form, using triangulated steel pipes to act as trusses. Aesthetically the organic form visually highlights the differences in the atrium structure and function. It allows the atrium to wrap fluidly around the smaller building and down onto the water tank which helps transfer the load of the roof to the ground. By converging at this point it allows the water tank to take on a sculptural quality, directing the eye to the connection where water is captured. The atrium then pushes out to the corner boundary to expose the nature of the internal atmosphere and movement, curving around to protect the occupants from the road. This generates a blurred exterior/interior space for the bar patrons where interaction with the road and the atrium is possible.
6.0 CRITICAL APPRAISAL

The purpose of this project was to investigate the ways German energy saving principles can be adapted for use in New Zealand. The research stemmed from the dilemma New Zealand faces between its international reputation as an environmentally advanced nation and its architecture being described by "appalled" international experts as "scarily cold." It is said that New Zealand lies 40 years behind Germany and Scandinavia, where architecture in some cases now generates more energy than it consumes (and this in a vastly cooler climate).

The Passivhaus standard was selected as a form of energy architecture which, if adapted in NZ, could generate a significant reduction in the energy used to heat and cool households - New Zealand’s largest energy drain and main barrier to sustainability.

The main obstacle to adoption of the PH standard appears to be with the cultural acceptance of the scheme. Not only does it require highly advanced technology and experience that is not readily available within New Zealand, but an additional problem is the rigidness of the Passivhaus aesthetic and thermal seal. In a culture such as New Zealand’s, where a building’s design needs to blend environment and life rather than create a distinct seal between ‘outside’ and ‘inside’, many of the traditional Passivhaus applications would fail.

Comparison with the Green Star New Zealand standard, New Zealand’s principal sustainability guideline, revealed that the two schemes could only be judged on their energy objectives. There was a clear definition in their aims to the point where they formed two separate types of architecture. This separation exists in Europe, where a building can be described as ‘sustainable’ or ‘energy’ architecture, as two very different solutions to the environmental architecture debate. This distinction is not present in New Zealand and I suggest it is an area of refinement that could be researched within our
legislation and energy standards. Furthermore it implies that there is no ‘energy’ architecture at present constructed within New Zealand.

In order to construct a design able to eliminate the need for heating and cooling (a task that requires strict energy monitoring) and making energy efficient architecture publicly appealing, the broader social aims of Green Star were used in combination with the Passivhaus targets pertaining to the purely environmental goals.

In an attempt to resolve the aesthetics vs. function debate, the design was derived from two concepts fused together: the desire of New Zealanders to attain the “Kiwi Quarter Acre dream” despite increasing density, and the regulation of the design to meet the energy targets. Throughout the design the rally between design and energy created challenges that bore no obvious answer. The methodology of the project was to leave the priority of either of these elements open.

Nevertheless, the energy targets played a large part in the early stages of my design, in the building form and the overall energy strategy. They dictated to some extent the macro-elements that make up the design (such as the atrium). The decision to use the atrium strategy was based on its ability to bring together the community and incorporate green space, deemed as essential for the New Zealand lifestyle, but also doubling as solar heat space.

The other big objective of the project had been to provide an example of the way density and a quality lifestyle can co-exist. This has lead to experimenting with social living situations and alternative/ stimulating urban housing types for students and young professionals. The atrium provides a key space to meet these aims. The atrium allowed flexibility within the interior space – the central requirements being ventilation and shading. The need for private ownership of a green space directed the incorporation of planted green balconies that opened into the atrium of the living spaces. The final result entices movement, allows different levels of social interaction and caters to various types of living situations, including long and short term leases and a variety of communal and private facilities.
The atrium’s structure has also formed the main aesthetic element of the scheme. The use of materials and structure was seen as a way to make a statement – specifically that Passivhaus targets can be met by vibrant, creative architecture. However, the greatest difficulty in using this strategy was the way this element reveals itself to the public on the corner. The site is a prominent urban corner and is likely to generate a large amount of publicity for the scheme. The argument concerning the triple goal of corners definition, its simultaneous transparency and the solution’s environmental implications, was one such example of where the design challenged Auckland’s urban fabric and traditional design conventions. Definition by building mass is dominant in this area of Auckland. However the need to display the green interior of the atrium to the public and the transparent nature of the atrium clashed with this urban design principle.

The relationship of the atrium to the relatively conventional structures either side of it also raised challenges. The different aesthetic of the materials and the structure required the atrium to be a separate element from the buildings. However, this creates additional structure and therefore higher primary energy. Eventually, the argument centred on the details of the connection: how do you portray the difference in systems whilst providing structural unity?

The design meets main principles of the Passivhaus, identified as:

- Compact form and good insulation
- Southern (in New Zealand this would be northern) orientation
- Energy efficient window glazing and frames
- Building envelope air tightness
- Passive pre-heating of fresh air
- Highly efficient heat recovery from exhaust air using air to air heat exchanger
- Hot water supply using regenerative energy sources
The final analysis of the design on Ecotect revealed the following:

MONTHLY HEATING/COOLING LOADS

All Visible Thermal Zones
Comfort: Zonal Bands

Max Heating: 23880 W at 07:00 on 16th June
Max Cooling: 37338 W at 12:00 on 16th January

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PER M²

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Floor Area: 2832.8 m²

This amounts to a Total Energy Load of 14.6Kwh/(m²a) and a monthly heating load of 9.14Kwh/m²a. Comparing these results with the energy benchmarks outlined by the Passivhaus (a maximum space heat demand of 15kwh/(m²a)) it can be concluded that the project does have the potential to meet this aspect of the standard.

The fluctuation of temperatures were minimal, however the high cooling loads shown by the data lead me to believe that over heating within the atrium will inevitably be the greatest problem that will result from its use in the New Zealand climate. However, I also
believe this can be mitigated in reality, and in doing so, this may lower the cooling loads to ensure the standard is met.

There is suspicion surrounding the results due to problems with Ecotect that I have encountered throughout the project. Correct modelling of the ventilation within the atrium is very difficult to achieve, as it must be linked with a developed operation timetable. The model I have created uses the mixed mode tool which assumes that when internal temperatures increase past the outlined limits (in this project 18°C - 25°C) and the external temperature is within these limits, occupants will open the windows to allow natural ventilation or use a heating system. Failure of Ecotect to recognise thermal stratification within the atrium and therefore the proposed stack effect that would form has led to extreme temperatures being portrayed within the atrium which affected the heating and cooling loads of the building. Refinement of the model has been aided by online forums to overcome this problem. The UV value of building elements were changed to be closer to those outlined in the Passivhaus Building Catalogue, yet the modelling of the airtight construction of the outer thermal seal, and the manipulation of the atriums shading by the ETFE, were not easily realised.

Although this and other strategies helped to overcome the identified problems with the thermal modelling programme (with the aim of generating a more realistic result), I do believe a more in-depth thermal analysis of the building needs to be carried out. This is to see if the use of the atrium in the New Zealand climate will passively create constant temperatures like that of the Passivhaus and reduce/eliminate the heating and cooling required within the building.
7.0 CONCLUSION

Overall, this project has achieved the objectives originally set out. Nevertheless, the nature of architectural design is such that improvements are always possible. In that sense further refinement of this project would include an in depth study of the Primary Energy Requirement of the building components and whether a more efficient system is possible through the manipulation of the building’s structure, aesthetics or form. The effect of the interior landscaping on the humidity levels within the building would also need further investigation.

Future research concerning this type of urban housing project specifically has been identified as:

i) If the atrium is seen as a useful strategy in New Zealand conditions, what is its optimal size and volume?

ii) How can this strategy be used for other residential and building typologies in New Zealand without advanced technology?

iii) How should we define Sustainable Architecture in New Zealand? Should the definition change to align with international definitions? Should there be guidelines produced to help identify which type of architecture should be used within a given context?

iv) Are the New Zealand Green Star rating system and the building legislation having an impact on the industry? Are there other ways the situation may be improved?

v) What insulation levels are optimal for New Zealand? Should there be changes to current structural solutions?

vi) What technologies and skills are available within New Zealand to allow Energy Architecture to become part of our building practice? Is there a need for the government to aid training within the industry/ Universities?
Areas identified from the literature review and the design process of this project as having the potential to develop into informative future research projects between industries are:

i) How can a high quality of lifestyle coexist with density? What are the parameters that determine this and is this possible in every development? To what extent is the Kiwi Quarter Acre dream really possible within the city?

ii) How can architecture allow greater flexibility for change? Can a building predict and adapt to its future? Can a building ‘learn’ and ‘evolve’?

iii) Living patterns within New Zealand: what are the advantages and disadvantages of current trends and what alternatives may be developed from these?
8.0 BIBLIOGRAPHY:


Auckland City Council, “Karangahape Road Street Upgrade,” Auckland City Council, 2009,  


Austrian Federal Ministry of Transport, Innovation and Technology,  
"Austrian Program on Technologies for Sustainable Development", Vienna, Austrian Federal Ministry of Transport; Division of Energy and Environmental Technologies, 2008,  
www.nachhaltigwirtschaften.at/pdf/program_e.pdf


”Email “Re: Contactform” received from K. Rosemeier, 17 August 2008”.


Headlines, “Green Lease – A load of ‘green wash’ or the way forward?” August 2008.


Janson, U, “Passive Houses in Sweden; Experiences from design and construction phase”, Department of Architecture and Built Environment Lund University; Faculty of Engineering LTH, 2008, www.ebd.lth.se/fileadmin/energi_byggnadsdesign/images/Publikation er/Lic_avhandling_UJ_web.pdf


New Zealand Union of Students’ Associations, “The $10 Billion Debt Millstone,” New Zealand union of students’ associations,  

http://www.un-documents.net/ocf-02.htm

Nigel Cook Architects, “A New Zealand House,” Nigel Cook Architects, 2008,  

NIWA "National Climate Data Base,” NIWA, 2009,  
http://cliflo.niwa.co.nz/

“Notes taken in a meeting with Max Hynds, September 2009”
“Notes taken in meeting with Victor Lam at Babbage Consultants Ltd, September, 2009.”

“Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”


APPENDIX A: LOG BOOK

GERMANY: HOCHSCHULE WISMAR

24.02.09 8.00am
Meeting with Professor Wollensak to establish the project structure.

5.03.09 8.00am
Meeting with Professor Wollensak regarding the initial research process and an overview of research I have already undertaken. It is established that a comparison of the schemes is needed to identify the main differences and focus. Three weeks have been designated for focused research into the schemes and a comparison to be made.

5.03.09 - 30.03.09
COMPARATIVE STUDY

30.03.09 – 7.03.09
FORMULATION OF THE ENVIRONMENTAL GOALS

30.03.09 2.00pm
Meeting with Professor Wollensak
Having gained an in-depth understanding of the differences in the standards I am to compile an environmental programme that takes its strengths from both standards. A discussion of the difference between Nachhaltige and Energie architecture is held to help me understand the translation.

7.04.09 – 20.04.09
FORMULATION OF THE PROJECT PROGRAMME

7.04.09 11am
Meeting with Professor Wollensak regarding my progress on the project. It becomes clear that I need to undertake a series of analyses including:
Urban, Traffic, Climatic, History and the current culture of Karangahape Road in order to generate arguments for the decisions I will have to make regarding building aesthetic and structure. This is to be done in greater depth than necessary for a separate paper that I am working on for the Hochschule Wismar. Professor Wollensak also directs me to look at the information that I find and form a visual picture of what the street will be like in 30 years to establish the building lifespan and function. The conclusions of these analysis will be brought together to create a building programme.

5.04.09 10.30pm
A meeting with Dushko Bogunovich via Skype allows me to view the first project critiques held in New Zealand so that I can view my progress in terms of the New Zealand time schedule.

7.04.09 10pm
Meeting with Dushko Bogunovich via Skype to introduce the project and discussing its progress. The result is that I am to put together three to four visual examples of the type of spaces I aim to create and undertake an in-depth site analysis/ initial concepts that tell of the traffic, geometry, views, access and microclimate. I am encouraged to develop many alternative concepts.

20.04.05 2.00pm
Meeting with Professor Wollensak to present a PowerPoint presentation on the urban analysis and the conclusions I have formed from it in regards to development. A written overview of the project programme is also presented. How the conclusions may direct the design development is discussed and I am to continue with the site analysis, using the programme created to justify conceptual development.
CONCEPT DESIGN

4.05.09 9.00am
I have produced a summary of the perceived problems/restrictions and benefits of the site and strategies I intend to use to solve some of these problems. Different massing strategies are presented and their pros/cons are discussed with Professor Wollensak. I need to decide my argument on what approach I want to take and investigate heights/densities in regards to the New Zealand Building code. I am advised to simplify the concepts as much as possible. The steps need to reflect scientific methodology.

20.04.09 – 4.05.09
SITE ANALYSIS

04.05.09 – 20.05.09
CONCEPT DESIGN

11.05.09 2.00pm
Meeting with Professor Wollensak to discuss the results of the massing strategies and initial conceptual design ideas with examples I have sourced. I am encouraged to develop an initial design and plans, making sure I continue to use the outlined problems and the programme as a generator for a design.

20.05.09 9.00am
Presentation of sketches and the design model gains a positive response from Professor Wollensak as a good starting point for the design and a clear visual statement of the design moves I have made. Development of plans needs to continue. Professor Wollensak suggests that I develop a structural concept concerning the use of zoning and the placement of heated zones, along with the main fixed points of the design.
The mass walls used as part of the design created lighting issues due to the east/west orientation blocking Northern light entering the apartments and the permanency of the wall. Attempts to find a mixture of private green space and density that channelled the ideas of the Hanging Garden of Babylon, 8th Century BC. This was considered unviable after exploration via section, plan and mass models.

**20.05.09 – 8.06.09**

**DEVELOPMENT OF THE STRUCTURAL CONCEPT**

**27.05.09 3.00pm**
Confusion over the structural concept has meant that I have started to explore alternative ideas over the buildings form and conceptual ideas. In a bid to gain greater clarification about the formation of a structural concept and zoning Professor Wollensak talks me through how I may go about setting up a structural grid within my design. I am to develop the plans using the idea of the structural grid.

**8.06.07 4.00pm**

**APPROPRIATE TOOL SELECTION**
Meeting with Professor Wollensak regarding the planning. I present plans drawn up on CAD as part of the development of the design into more detail. The issue of the design of the corner and the front façade are brought up but out of respect for time and expected learning outcomes it is deliberately left as a design aim for New Zealand. I am introduced to the type of thermal modelling tools available and there is a discussion over suitability for the project. I have decided to learn ECOTECT due to the availability in English and will attempt to learn it by modelling this initial design. Research into the systems concept must be undertaken simultaneously.
10.06.09 -
LEARNING ECOTECT

10.06.09 8.30am
Meeting with Professor Wollensak to discuss simplification of the design into zones. It is clear that I must develop another view of the project in order to simplify the plans into a form that can be understood by ECOTECT.

10.00am
Meeting with Christin from IGEL architects to install ECOTECT and gain an initial overview of the project. Examples of IGEL architects work were shown as part of the overview.

Ecotect was learnt via the Internet from tutorials found on the Ecotect website and forums\(^\text{111}\). Initial modelling trials of the conceptual design found that further simplification of the thermal model/zones was necessary. Windows were incorporated on a 70/30 ratio thought to be the most effective for solar designs\(^\text{112}\). Initial problems that were highlighted from these trials showed overheating of the Northern short term rooms and rooftop zones. Retail zones on Karangahape Road suffered from under heating in the winter, needing high heating loads. Problems with the atrium modelling due to the inability of the programme to model the thermal stratification that would occur within the space were found.

18.06.09 – 24.06.09
DEVELOPMENT OF A SYSTEMS CONCEPT

18.06.09 9.00am
Meeting with Professor Wollenak to discuss the projects systems concept and the options available given my planning.


\(^{112}\) “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”
2.30pm
A further meeting with Christine from IGEL architects to install LEGEP and get an overview and basic translations of the programme.

23.06.03 1.00pm
Meeting with Professor Wollensak and Professor Römhild to discuss the problems I have come up against whilst using ECOTECT. It appears that the modelling is producing unviable results. I am advised to simplify the model further and check to see if the problem stems from the Auckland NIWA climate data I have downloaded into the programme\textsuperscript{113}.

24.06.09 8.30am
Review of system schematics that I have developed and a discussion concerning the main differences between Passivhaus systems and the system proposed for the project. Identification of the results I aim to achieve and how I am going to go about calculating these.

3.07.09 9.00am
Final meeting with Professor Wollensak at the Hochschule Wismar. The meeting establishes an overview of the process I have taken and that which I wish to follow when I return to New Zealand. The areas highlighted as being in need of further development are the design aesthetics – in particular the approach to the corner design, the functionality of the floor plans, ECOTECT modelling and calculations in regard to:

- water concepts
- heating and cooling loads
- solar/photovoltaic sizing and integration into the design
- LEGEP

\textsuperscript{113} NIWA “National Climate Data Base,” NIWA, http://cliflo.niwa.co.nz/ (accessed June 9, 2009)
PROJECT OVERVIEW: TRANSITION FROM STUDY IN GERMANY TO NEW ZEALAND
During this time a presentation was developed with PowerPoint to show the project’s progress at a student critique scheduled for the 21.07.09

DESIGN DEVELOPMENT

NEW ZEALAND: UNITEC, AUCKLAND

21.07.09 11am
First meeting with Dushko Bogunovich in New Zealand. The meeting is used as an opportunity to reorient him with the project’s progress using the presentation prepared for the critique. The need to address the corner of the site and the importance of the corner in the urban design and how to integrate the old with new green architecture concerning the Karangahape Road façade. Questions were also raised over the need to incorporate fresh air by way of external decks in the larger tenant block. Necessary changes highlighted:

- On the prominent corner the green is not coming out to present itself to the public. Suggestions that this should be done by channelling historical arcade corner entry using a dramatic turning of the planted atrium from its lineal path.
- Building resolved predominantly in section – needs a more holistic approach
- The use of green areas as lounge is not viable – functional issues
- Need to reduce the number of stairs within the design – create apartments that span only one floor for user satisfaction.
2.00pm CRITIQUE

Key issues raised by the students following the design were:

- Is the gap between the buildings large enough to get adequate light in winter?
- Lighting in the apartments to the south – conviction of the light well.
- Questions rose about dragging the building around the corner for use as a statement. There is a need for the building to link the two street facades. Consensus show an entry into the atrium from Karangahape Road is necessary.
- The sectional style of the building does not address the street – need to signal the end of the building or acknowledge the street front.

23.07.09 2.00pm
Meeting with Christoph Schnoor regarding the development of the programme. Acknowledgement that I have reached a point where there is a distinction between energy and aesthetic requirements and compromises will need to be made and justified as development continues. There is a suggestion made that continuity between both buildings is needed for the development to read as a whole.

28.07.09 11am
Meeting with Dushko Bogunovich results in a critique of the changes I have made to the form of the roof. There is a need for the main roof to become more elegant and flowing. It is argued that the structural concept is not a viable option.

6.08.09 9am
Meeting with Dushko Bogunovich and the presentation of a new corner design using sketches and a simple conceptual model. Movement of the library/café/reception into a third building aligned with Gundry Street is tested in order to open up the corner whilst defining the boundary. Further development of the corner is needed – issues regarding shelter and flexibility are raised.
13.08.09 9am
Meeting with Dushko Bogunovich to discuss the development of a working model I have constructed. Changes to the floor plans and larger tenant block are deemed appropriate. The inclusion of outdoor decks on the second and fourth floor goes some way to provide occupants with outdoor space. The corner channels the design I had presented last week, yet when put into practice does not yield satisfactory results. The third building feels squashed under the large roof and the verandah feels disconnected.

14.08.09 10am
Meeting with David Turner regarding the overall project and the approach to the western façade. There is a need to provide shading from the afternoon light, perhaps by way of a large overhang or pushing the building back from the boundary line. The western façade needs to form architectural continuity by way of materiality, yet its design is driven by another set of rules. Need to determine my sensitivity to the neighbouring two storey building.

19.08.09
An email from Christoph Schnoor regarding the latest design further highlights the awkwardness in the relationship between the third building and the roof “new building seems to struggle a bit with the load of the heavy roof - proportions are a bit out of scale there”. It also blocks views into the main courtyard, which were an important part of the initial concept design. Attention is also drawn to the rupture created by the abrupt stop of the Karangahape Road verandah and the inability of the small building to cope with the void. More conviction is needed if the feature roof is to be pursued. Suggested examples to look at were the extension to the Foreign Office in Berlin by Müller/Reimann, and the Landgericht (Regional Court) in Frankfurt/Oder.
20.08.09 9.00am
Meeting with Dushko Bogunovich results in a conclusion that the smaller building needs to be eliminated from the design. The library/study rooms and café are to take over the flats closest to the Gundry Street entrance forming a separate public building. Need to determine how the roof will graduate and provide shelter at the pedestrian level.

27.08.09 9am
Meeting with Dushko Bogunovich continues development of the roof and the corner. The ETFE now wraps around the corner and the design with small manipulations is considered sufficient by Dushko. Preparation for critique to be carried out.

1.09.09 2.00pm
Final interim critique is conducted by Mike Austin, Jeanette Budgett and Richard Archbold. The suggestions are that the corner needs a little more designing, perhaps a more flowing feature? The layout and lighting within the larger tenant block needs further development and a landscape plan should be constructed to show the potential of the atrium. Structural details may need to be developed further.

3.09.09
An email from Christoph Schnoor advises that the corner looks somewhat forgotten and needs greater definition. The suggestions are that I place a larger building parallel to Gundry Street, or add a circular tower structure/ another building that wraps around or balances the other buildings. The example given to look at is Jena University.

9.09.09 2.30pm
Meeting with Richard Naish regarding the overall design. A positive response is gained with a suggestion that the connection of the canopy to the green wall may need refining and that a stronger
conceptual basis may form if the ETFE is wrapped over the external deck.

REFINING THE CORNER DESIGN

11.08.09 11.30am
Meeting with John Hewitt to try and establish a strategy for the problematic corner. The issues that arise are:

- The connection of the canopy to the green wall
- The use of a conventional arcade/canopy entrance does not project the vibrancy I aimed for in the design.
- The lack of corner definition – a feeling that the corner is “forgotten”
- The suggested outdoor area of the bar does not interact with the atrium and would not generate a comfortable space (undesirable views and busy road)

Experimentation using the model suggests that the use of landscaping, walls and water tanks should be used as tools to develop the corner.

DEVELOPING THE ATRIUM STRUCTURE

14.09.09 11am
Brief meeting with John Hewitt over new design advocates that the development has improved the corner. There are still issues regarding the verandah relationship to the canopy.

2.00pm
Meeting with Graeme McConchie regarding the latest design highlights the structural issues that may arise from the more organic nature of the atrium. Details of structure need to be developed to define the structure’s relationship to the buildings.
15.09.09
An email from Regan Potangaroa regarding the structure advises that architecturally the relationship between the ETFE and the remaining structure looks confused. The relationship needs explaining and/or balancing.

17.09.09 10am
Meeting with Max Hynds on the building services and the effects that the atriums design may now have on the ventilation. Advice on the required volume suggests a need for foundation tanks and that the atrium should be raised up by 2m at its highest point to aid ventilation. The structural details should be formed from looking at examples of international works using ETFE. The structural approach I have taken to the atrium is thought of as the correct way given the future development of the building.

12pm
Meeting with Victor Lam of Babbage Consultants Ltd resulted in the atrium taking on a more convex form, creating a series of compression members to transfer the loads to the two buildings over the large span. Joints specified can be a tube joint, ball joint or a compression ring. The final structure is formed from this meeting.

DEVELOPMENT OF THE LANDSCAPING CONCEPT

18.09.09 10am
Meeting with Pete Griffith
The landscape of the interior atrium was discussed and its role in the wider site context.

114 “Notes taken in meeting with Victor Lam at Babbage Consultants Ltd, September, 2009.”
APPENDIX B: LITERATURE REVIEW

Modern day theories for achieving overall sustainability look towards a development’s size and its scale of impact\(^\text{115}\). Current trends indicate there is growing support for the utopian dream of the ‘sustainable city’\(^\text{116}\). Research into the optimal size and generation of the model city has followed several avenues. The exploration of overall sustainability by ARUP through the Dongtan project in China\(^\text{117}\) is the first interpretation of a modern day ‘eco-city’. Developed as an entirely new city, the project does not deal with the restrictions and problems that come with the existence of traditional city infrastructure and therefore must be addressed as an isolated case and an external design reference for the renewal of current cities.

Various examples of urban renewal and urban neighbourhood extensions within Europe have addressed the issues of sustainable integration and reuse. These are developments supported by European governments following the trend towards new sustainable communities within large cities. The communities are a mixture of existing and new infrastructure and are utilised as a way of revitalising areas to aid economic development\(^\text{118}\).

Smaller block refurbishment and urban infill schemes such as Hedebygade Block, Vesterbro, Copenhagen, Denmark\(^\text{119}\); Leidsche

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\(^{115}\) “Notes taken in class "Lifetime Building Design" by Prof. Martin Wollensak, September 2008.”

\(^{116}\) Energie-Cites.eu “Sustainable Neighbourhoods,” European Commission, http://www.energie-cites.eu/-Sustainable-Communities-


Rijn, Utrecht, Amsterdam, Netherlands (1997 – 2015)\textsuperscript{120}; the Prototype Design Eco-block China sustainable Neighbourhood project\textsuperscript{121} and Earthsong Eco- neighbourhood Ranui, Waitakere City, Auckland, New Zealand\textsuperscript{122} are smaller developments, with a focus on the reduction of the community’s ecological footprint. They aim to portray to society that a modern lifestyle is still upheld within a sustainable development. In the United Kingdom a movement to use only local materials is underway in an attempt to generate a truly sustainable future for both the environment and economy in the form of Transition Towns\textsuperscript{123}

It appears that when confronting sustainability on a large scale, the emphasis no longer sits with the individual buildings but rather with the design of working systems and the integration of long term strategies for the community’s future. The predominant focus of the projects targets the respective areas:

- Transport and Mobility
- Local energy generation via renewable sources
- The use of ecological building materials
- Area Biodiversity
- Water
- Waste
- Social diversity and equity


A comparative study into the methods endorsed by the World Green Building Council\textsuperscript{124} in the international green movement found that there is an underlying similarity in the focus on overall system sustainability rather than regulation by means of specific targets/figures to that used in these European developments\textsuperscript{125}. The building standards set up by each of the seven participating countries provides an outline of the different areas a non-residential development must contribute to or respect to achieve certification as a ‘green building.’ New Zealand’s participation in the schemes has resulted in the formation of the Green Star New Zealand building standard\textsuperscript{126}. The programme’s strengths lie in its ability to achieve a wide analysis of a project’s impact on the environment and surrounding area\textsuperscript{127}. Two crucial gaps appear in New Zealand’s building industry based upon the utilisation of this building rating scheme. Firstly, is the neglect of residential architecture within the standard and secondly the common misconception that a ‘green building’ is an energy efficient building.

Research conducted by Energy Efficiency and Conservation Authority (EECA) New Zealand concluded that 45% of houses suffer from moisture problems\textsuperscript{128}. Ironically, the quarter-acre ‘Kiwi dream’ can be considered to be one of the main aspects preventing New Zealand


\textsuperscript{125} “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”


\textsuperscript{127} “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”

\textsuperscript{128} Bernhardt, J. \textit{A Deeper Shade of Green} (Auckland: Balasoglou Books, 2008) 34.
from becoming truly sustainable. The predominance of the single family house throughout New Zealand is one of the aspects luring foreigners to the so called ‘dreamland’ and the acquisition of the Kiwi quarter acre dream appears to have always been present. British colonists came in search of it in the 1800’s, military were given land this size during the wars, and the New Zealand government enforced this lifestyle in the twentieth century with the development of the state house. Whether it is a student flat or a family home, the dream of owning your own quarter acre plot of land in the suburbs has had a role in building our nation and has become an iconic cultural mindset passed down through generations – it is part of what it means to be a New Zealander.

Market research undertaken by EECA showed that 60% of those surveyed considered their house to be energy efficient despite the fact that a quarter of our homes remain un-insulated and double-glazed windows are rare. This "shows how low expectations of energy efficiency are in this country." While the Green Star standard does go some way into creating buildings that utilise sustainable energy, the lack of definition surrounding energy efficient architecture in New Zealand creates a false impression of its real output. Within the Green Star Structure the Energy Category recognises:

- Energy benchmarks (conditional requirement)
- CO2 emissions
- Electrical Sub-metering
- Tenancy Sub-metering

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130 Mitchell, A. The Half Gallon Quarter Acre Pavlova Paradise (Christchurch: Whitcombe and Tombs, 1972)


• Office Lighting Zoning
• Peak Energy Demand Reduction

MERIDIAN ENERGY BUILDING:

<table>
<thead>
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<th>Points Gained</th>
<th>Total Possible</th>
<th>Percentage</th>
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<tr>
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</tr>
<tr>
<td>Emissions</td>
<td>6</td>
<td>14</td>
<td>43</td>
</tr>
</tbody>
</table>

An example is the Meridian Energy Building, New Zealand’s first building to gain a 5 star rating “uses 60% less energy than comparable buildings.” It can be seen that energy, one of the heavily rated categories, was one of the least successful in terms of awarded points. Energy is instead described as:

• Efficient Solar Shading and active facades to reduce cooling and heating needs
• Exposed structure at perimeter to absorb heat
• Integrated with lighting control system
• Energy Monitoring

Hence it can be concluded that these focused energy regulations should be a part of the environmental goals/ adapted standard. As the sole focus of the Passivhaus is energy, sustainability on a larger holistic scale will be formed from a combination of Green Star and

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published energy principles. This may imply changes in the structural envelope of the building and the base ventilation rates.

It should be concluded then that when defining the building scheme under the German definitions of Architecture, the Green Star Building standard comes under Nachhaltige/ sustainable architecture rather than energy architecture.

Research into the methods of energy reduction follows several paths. The Beddington Zero Energy Development (BEDZED)\(^{136}\), Sutton, UK, 2002 by Bill Dunster Architects in partnership with ARUP and BioRegional Development Group is one example of carbon neutrality within a development. The focus to create a “net zero fossil energy development”\(^{137}\) sits between that of energy architecture and sustainable architecture due to the use of a percentage rating system and an overview of all areas, similar to that of Green Star. Only energy from renewable sources is used to meet the energy needs of the development and therefore the result is that there is no net addition of carbon dioxide into the atmosphere. The development utilises photovoltaic/ solar panels and a combined heat & power plant fuelled by woodchips and waste timber\(^{138}\). Knafo Klimar Architects Agro-housing\(^{139}\) scheme seeks to meet this goal through the use of high-rise apartment complex with a vertical greenhouses to counteract the impact new urban megalopolises have on the environment and society’s traditions. Whilst relevant in New Zealand,


the systems approach is suited for dry climates with large temperature fluctuations between the seasons.\textsuperscript{140}

The most recognised and rigorous energy/environmental design standard in Europe today is known as the Passivhaus standard.\textsuperscript{141} The concept originated in 1988 by Professors Bo Adamson of Lund University, Sweden, and Wolfgang Feist, followed by the development of project housing at the University of Darmstadt in 1990\textsuperscript{142}. These examples certified that the techniques and concepts developed, reduced the energy consumed for space heating to 90% less than comparable houses at the time when using traditional building methods was standard practice. The Passivhaus buildings are defined in the central European climate as having “negligible heating requirements and therefore no need for active heating.”\textsuperscript{143} The buildings are kept warm ‘passively’ using only the “existing internal heat sources, solar energy admitted by the windows and by heating the fresh air supply.”\textsuperscript{144} The underling methodology of the Passivhaus is to eliminate the need for conventional heating systems by using extremely efficient building envelopes to significantly decrease energy consumption to a maximum of 120 KW/m2 per year. The development of highly efficient building envelopes reduces thermal bridges and creates a thermal seal, forming a separate interior climate

\textsuperscript{140} Knafo Klimar Architects, “Agro-Housing, Wuhan, China,” Knafo Klimar Architects, 2007, \url{http://www.knafoklimor.co.il/living-steel/03.html} (accessed November 28, 2008)

\textsuperscript{141} Feist, Dr. W. “Informationen zum Passivhaus,” Passivhaus Institute, \url{http://www.Passivhaustagung.de/Passive_House_E/Examples_passive_houses.html} (accessed August 19, 2008)


from the exterior\textsuperscript{145}. Certification as a Passivhaus requires the building to meet a strict set of measures, much higher than standard international building codes encourage, by employing essentially passive strategies:\textsuperscript{146}

- Max. 10 W/m² constant heating-load
- Max. 15 kWh/(m²a) annual space-heat requirement
- Max. 42 kWh/(m²a) annual total amount of active energy input.
- Max. 120 kWh/(m²a) total energy requirement for space-heating, domestic hot water and household appliances.

\begin{tabular}{|l|l|}
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compact form and good insulation: & All components of the exterior shell of the house are insulated to achieve a U-factor that does not exceed 0.15 W/(m²K) (0.026 Btu/h/ft²/°F). \\
\hline
Southern orientation and shade considerations: & Passive use of solar energy is a significant factor in passive house design. \\
\hline
Energy-efficient window glazing and frames: & Windows (glazing and frames, combined) should have U-factors not exceeding 0.80 W/(m²K) (0.14 Btu/h/ft²/°F), with solar heat-gain coefficients around 50%. \\
\hline
Building envelope air-tightness: & Air leakage through unsealed joints must be less than 0.6 times the house volume per hour. \\
\hline
Passive preheating of fresh air: & Fresh air may be brought into the house through underground ducts that exchange heat with the soil. This preheats fresh air to a temperature above 5°C (41°F), even on cold winter days. \\
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\end{tabular}


\textsuperscript{146}Passivhaus Institut and Dr. W. Feist. Passive House Planning Package 2007 (Darmstadt, Passivhaus Institut, 2007).

\textsuperscript{147}Passivhaus Institute, "What is a Passivhaus?" Passive House Institute, http://www.passiv.de/English/PassiveH.HTM (accessed August 15, 2008)
Highly efficient heat recovery from exhaust air using an air-to-air heat exchanger: Most of the perceptible heat in the exhaust air is transferred to the incoming fresh air (heat recovery rate over 80%).

Hot water supply using regenerative energy sources: Solar collectors or heat pumps provide energy for hot water.

Energy-saving household appliances: Low energy refrigerators, stoves, freezers, lamps, washers, dryers, etc. are indispensable in a passive house.

Kerstin Rosemeier, building physicist, planner and the director of NZ Passive House Homepages is a professional working within New Zealand who has expertise in this field. She is part of a team at Auckland University who are currently designing the prototype for the first certified Passive House in New Zealand. This corresponding research targets the problem that I have established above and the parallel investigation will be used to source further issues and possible solutions. For instance, Rosemeier has personally recognised that there is a lack of knowledge in New Zealand about the ways to achieve effective air tightness and avoid thermal bridges.

The implication of architectural experimentation on the fundamentals of the Passivhaus is an area that continues to develop. In Austria particularly, architects such as Prehal and Poppe are producing modern Passivhaus designs using contemporary forms and local materials to distinguish their work. The high-tech, self governing nature of the standard is seen as one of the downsides to adaptation in New Zealand due to the high cost, unavailability and lack of local knowledge. The strength of using a standard such as this for adaptation in New Zealand is the credibility of the outcome due to the

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149 Email “Re: Contactform” received from K. Rosemeier, 17 August 2008”.

specified targets and the availability of an English translation through the Passive House Planning Package\textsuperscript{151}, to offer an overall understanding of the issues and solutions.

Built experiments of the New Autonomous House by Professors Brenda and Robert Vale show the possibilities of a “house operating independently of any inputs except those of its immediate environment. The house is not linked to the mains services of gas, water, electricity or drainage, but instead uses the income-energy sources of sun, wind and rain to service itself and process its own wastes.\textsuperscript{152}” The development requires acute balancing of inputs and outputs similar to that of the Passivhaus, yet is seen as an independent object – a luxury not available in many inner city sites. Given that any reliance on the city’s existing infrastructure contradicts the underlying initiative of the scheme, the scheme’s flexibility is minimal. The relativity of the Vale’s research to New Zealand is none the less important as it articulates the principles of development critical for energy efficiency.

The transitional architecture of IGEL Architects (Institut of Gebaude, Energie und Licht Plannung) in Wismar, Germany mediates between the exacting energy restrictions of the Passivhaus and the Autonomous House and the ideals of the BedZed development. Exploration by the Institute has recognised the ability of low tech systems to generate the optimal energy requirements outlined by the Passivhaus\textsuperscript{153}. The benefits of this scheme are smaller maintenance costs and a greater flexibility of design provided the basis of the design follows fundamental energy principles analogous to those outlined by the Vale’s Autonomous House. Projects by the practice act as a testing ground for new technologies and energy strategies, The


\textsuperscript{153} “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”
Rostock Energie Schule, commissioned by the German government combines the underlying motives of energy reduction with public promotion of alternative technologies to help make such schemes common place. The major difference between the Passivhaus and IGEL technologies, as outlined in the Plappersnut Kindergarten scheme, lies in the separation of ventilation and water heating in the Passivhaus which creates a need for a greater number of systems to be used to make the transition\textsuperscript{154}. Elimination of this separation by way of an air to water heat pump, a common appliance readily available in New Zealand, implies the possibility of energy architecture being adapted to the New Zealand climate.

ETFE (ethylene tetra fluoro ethylene) has been identified as a material that will aid the application of energy architecture in New Zealand. Advantages:

According to L. Robinson in *Structural Opportunities of ETFE*:\textsuperscript{155}

- 95% transmission of all light frequencies which allows plants to grow successfully in an atrium environment. 6mm single glazing transmits 89% of light waves.
- Utilised as a layer stretched between supports and inflated with air to form a foil cushion. Air is used to prestress the cushions and carry the applied loads.
- The pillow weighs less than 2% of the equivalent glass cladding. The structure is 10% to 50% the weight of that needed to support a glass enclosure.
- The cushions can be produced in any size and shape respecting snow and wind loading capacities. Triangular pillows can take advantage of two way loading and therefore offer larger spans than rectangular pillows.

\textsuperscript{154} “Notes taken in class "Lifetime Building Design" by Prof. Martin Wollensak, September 2008.”

Pressure is maintained within the cushions by an air inflation unit. Air dryers are used within the pillows to decrease the humidity and avoid condensation.

ETFE has thermal properties equivalent to triple glazing.

Flexible structure that can support high short term loading. It is a ductile material that shows large deformations before failure. Elongations of 200/300% are possible before breakage occurs. Movement can be tolerated (earthquakes).

Self cleaning to minimise maintenance costs.

Chemically inert to acid and alkaline solutions (pollution). Does not degrade under UV light.

100% recyclable

Estimated life expectancy 50/100 years (possibly up to 200 years)

ETFE cushions are easily replaced.

ETFE is acoustically transparent and therefore the foil acts as an acoustic absorber for room acoustics. External noise reduction is thought to be less than that of conventional glazing.

According to C. Strongman\textsuperscript{156}:

- Inflation of the pillows can alter the thermal and shading properties of the pillows to control the buildings temperature or lighting. It can be changed to allow from 95% to 10% of light to enter.

According to S. Tanno\textsuperscript{157}:

- Performance from -200°C to 165°C. In the event of a fire the material has a low flammability and is self extinguishing. The material will shrink back from the heat source allowing smoke and heat ventilation thereby eliminating the need for smoke extraction.


Disadvantages according to L. Robinson\textsuperscript{158}:

- The pillows can be punctured with sharp objects.

ETFE has been shown to work successfully on high profile projects such as:

- Eden Project by Nicholas Grimshaw & Partners, Cornwall, UK\textsuperscript{160}
- Watercube, Herzog & de Meuron, Beijing, China
- Vista Alegre Arena, Schlaich Berghmann & Partners, Madrid, Spain\textsuperscript{161}
- Allainz Area, Herzog & de Meuron, Munich, Germany\textsuperscript{162}
- Information Centre in Kochel Am See, Hauschild & Boesel, Bavaria, Germany\textsuperscript{163}
- Khan Shatyry Entertainment Centre, Foster & Partners, Astana, Kazakhstan\textsuperscript{165}


• Media-Tec Building, Enric Ruiz Geli, Barcelona, Spain\textsuperscript{166}
• Cloud 9, Enric Ruiz Geli, Barcelona, Spain\textsuperscript{167}
• Southern Cross Railway Station, Nicholas Grimshaw and Partners, Melbourne, Australia\textsuperscript{168}.

In New Zealand ETFE is being used in the Britomart East Project in Auckland, which demonstrates that the material is a viable option and industry accessible.


APPENDIX C: PROGRAMME

Programme for Passivhaus – A New Zealand adaption

1. Passivhaus regulations will take precedence over the New Zealand Building code and Green Star regulations.

- Occupancy of 35m² per person
- Specific Heat Demand 15kWh/(m²a)
- Entire Specific Primary Energy Demand 120kWh/(m²a)
- Air Change Rate : 20 – 30m³/h per person at 0.3/h (treated floor area x 2.5 room height)
- Hot water demand: 25L/person/day of 60°C hot water (cold water at 10°C)
- Constant temperature of 20°C (max. 25°C not to be exceeded more then 10% of the year). No individual control necessary.
- Glazing U-values less than 0.8W/(m²a)
- Exterior Building elements U-value less than 0.15W/(m²a)
- Thermal Bridge Free Construction
- Humidity: max. 12g per kg of dry air
- Solar system: 1m² per person
- Solar thermal storage tank sizing: 0.5m²/50L per person.
- Development uses triple pane, low emissivity glazing with high quality window frames.
- Development should show:
  Specific Annual Heat Demand
  Primary Energy Demand
  Space Heating Load
  Frequency of summer overheating
  Useful Cooling Demand
  Cooling Load

2. Sustainable aspects of the design outside Energy Consumption will be drawn from the New Zealand Green Star Code
MANAGEMENT:
Waste Management: Provision to reduce the amount of construction waste going to landfills.
Environmental Management: adoption of formal environmental management system.

INDOOR ENVIRONMENT QUALITY:
Daylight: the provision of good levels of daylight for building users (1 point = 90% of the NLA has a Daylight Factor not less than 2.5% as measured at the floor level under a uniform design sky)

Daylight Glare Control: reduce the discomfort of glare from natural light for building occupants (typical glazing façade, fixed shading devices shade the working plane 1.5m in from the centre of the glazing from 80% of the sun OR
Where occupant controlled automated blinds/screens with a visual light transmittance of more than 10%) are used.

External Views: reduced eyestrain for building occupants by allowing long distance views and the provision of visual connection to the outdoors (90% of the NLA has a direct line of sight through vision glazing. The distance to the nearest glazing is to be no more than 8 metres).

Volatile Organic Compounds: reduce the detrimental impact on occupant health from finishes emitting internal air pollutants (all painted surfaces, carpets and sealants are low VOC).

Formaldehyde Minimisation: reduce the use of formaldehyde composite wood products in order to promote a healthy indoor environment (all composite wood products are low-emission formaldehyde OR No composite wood product is used).

Tenant Exhaust Riser: present if necessary in areas where there are fumes.
INNOVATION:
Innovative strategies and technologies used within the development to improve the developments environmental impact.

To recognise initiatives which demonstrate additional environmental benefit by exceeding the current benchmarks in Green Star NZ.

EMISSIONS:
Watercourse Pollution: reduce the potential of pollution in water running off from buildings and hard surfaces to natural watercourses.

Reduced Flow to Sewer: reduce water flows to the municipal sewage systems for treatment.

Cooling Tower: No cooling tower services the building.

Insulant ODP: Specification of thermal insulation has to avoid the use of ozone depleting substances in both manufacture and composition.

LAND USE & ECOLOGY
Ecological Site Value: development on land that already has a limited ecological value.

Reuse of land: reuse of land that has previously been developed (75% of the site has been previously built on).

Contaminated Land: positive actions to use contaminated land that otherwise would not have been developed.

Change in Ecological Value: minimization of ecological impact from development and to maximise the ecological enhancement of a site for both new and existing buildings.

Topsoil & Fill: reduce the amount of topsoil and fill removed from development sites (Cut and fill requirements are balanced on site and where there is no exportation of fill or topsoil from the site).
MATERIALS:
Recyclables Storage: separate storage area is provided for separation and collection of recyclables.
Integrated Fit out: some of the refurbishment is either ‘shell or core’ (i.e. no ceiling, floor finishes or partitions are installed).

Recycled Content of Concrete: concrete to be used in the building construction or refurbishment has a significant recycled content.
1 point = 20% of insitu or 10% precast is replaced with inert filler and/or industrial waste.
1 point= 10% of all aggregate is recycled
2 points= 20% of all aggregate is recycled.

Recycled Content of Steel: percentage of all steel in the design has a post-consumer recycled content greater than x% as follows:
1 point = 60% by mass
2 points = 60% by mass.

PVC Minimisation: Total PVC content cost for major services elements (pipes, conduits and cables) is reduced by replacing alternative materials:
1 point = 30% reduction by cost
2 points = 60% reduction by cost

Sustainable Timber: all timber and composite timber products used in the building and construction works are required to be sources from:
-Post-consumer reused timber
-Forest Stewardship Council Certified Timber.
Locally sourced timber should be used.
WATER:
Occupant Amenity Potable Water Efficiency: reduce the potable water consumption of building occupants.

Water Meters: the design of systems that monitor and manage water consumption.

Landscape Irrigation Water Efficiency: 90% of the water requirement for landscape irrigation is sourced from on-site rainwater or recycled water OR a water efficient irrigation system comprising subsoil drip systems and automatic timers with rainwater to soil moisture sensor is installed OR where plants chosen are all drought-tolerant.

TRANSPORT:
Provision of Car Parking: promote the utilization of alternative modes of transport by limiting available car parking spaces - 50% less than the maximum local planning allowances.

Small Parking Spaces: 25% of the total parking spaces are designed for smaller cars. A minimum of 10% of the total parking spaces provided must be for smaller cars.

Cyclists and Foot Commuter Facilities: promote occupant and visitor cycling and foot commuting by ensuring adequate facilities are provided.

Commuting Public Transport: developments should be within close proximity and have good access to public transport networks with frequent services.

ENERGY:
CO² emissions: 15 points = for predicted CO² emissions of ≤ 5kg/m²/yr.

Peak Energy Demand Reduction: implement systems to reduce peak demand on energy supply infrastructure.
3. The project will adhere, where possible, to the New Zealand Building Code to demonstrate its capability as a replicable model:
- Maximum height: 12.5m
- Maximum floor area: 4884m² (including landscaped area)
- Retail and commercial premises must front the street
- Visual privacy offered for all tenants
- All residents should have a private outdoor space adjoining habitable room space.
  - Ground Floor – 25m²
  - Balcony – 8m² with min. width 1.6m²
  - Rooftop space – 10m² with min. width 2m
- Development should be visually compatible with the surrounding neighbourhood (history) in scale and continuity.
- Protection from Noise and Odours

4. INDEPENDENT AIMS:
- MIXED USE: the development should offer a mixture of housing types and retail/entertainment sectors.
- LIFESPAN:
  - Primary Structure: 70 years.
  - Secondary Structure: 50 years (set by council regulations however the building must make provisions for element deconstruction and recycling for changes in tenancies)
  - Technical Areas: 20 years.
- Develop a sense of Community within the building
- Acknowledge/ provide flexibility for future changes in use and function and new developments in learning.
- Proposal of schemes to help bring financial comfort to NZ students.
The occupants’ needs were drawn from the results of the Inner City Living Survey: Re-urbanisation of Inner City Auckland survey\textsuperscript{169}, conducted due to the rapid increase in population within the inner city of Auckland. Of the 185 people surveyed, 67% were students.

Important conclusions drawn from the survey:
- Noise, odours and a lack of outdoor space were the main problems identified.
- 60% stated that the provision of outdoor space was important to them.
- Only 30% knew their neighbours
- 55% stated that the inner city had a poor sense of community
- However 41% stated that living in an area where there is a strong community is very important to them.

APPENDIX D: LIFESPAN ANALYSES

How long should the building be built to last for?
The New Zealand Building Code regards 50 years as the minimum time a building should stand\textsuperscript{170}, yet the ‘Leaky Building Syndrome’ of high density dwelling developments of the late 1990’s has highlighted the pitfalls in Government legislation, industry knowledge and poor design of buildings unsuitable for New Zealand climate. At least 15,000 homes were affected by this episode, many of which resulted in lifespan of only 10 years\textsuperscript{171}. In Europe buildings must be built to last 80/100 years\textsuperscript{172}, which presets the society with a richer history of structures, architectural typologies and urban spaces.

Surrounding Buildings:
Neighboring sites such as the Brick House have been standing since 1884, with major renovations completed in the 1960’s. Similarly the Hereford Street Shops, M.J Bennett Ltd and Garrets Buildings were all constructed between 1886 and 1900 with major upgrades between 1960-1980. The majority of these buildings are formed of brick and hence more durable than the wooden Church of the Epiphany & the Star Hotel which stood on the site from 1886 until 1960\textsuperscript{173}. Today the neighbouring buildings on the site are 40 year old masonry buildings.


\textsuperscript{172} “Notes taken in class “Lifetime Building Design” by Prof. Martin Wollensak, September 2008.”

\textsuperscript{173} Karangahape Road Business Association, “History: Karangahape Road,” Karangahape Road Business Association, \newline http://www.kroad.co.nz/kroad/history/default.asp (accessed March 25, 2009)
Taking these statistics we can determine three concepts for the development:

Long life of the whole building (100 years):
Short Lifespan of the whole building (30/50 years)
Mixed Lifespan of different components

What has changed?
During the lifespan of these buildings it can be seen that constant renovations have continually modernised the buildings to meet the tenants’ needs and expectations. Even in the past thirty years the precinct’s reputation and the character of the people using the streets has changed. Other changes have included the development of the internet and the resulting changes in the technology now demanded by tenants. Tenant changes and the changes in the building use have led to interior renovations of the buildings which differ from that originally intended. Situations such as these are typically hard to predict when designing a building yet must be, to some extent, considered in order to present a sustainable design solution.

A visual situation for Auckland in the next 30 years
Taking what would be considered to be the shortest lifespan a building should stand for, thirty/fifty years, could assumptions be made towards the types of situations the building may have to endure:

- Continued changes in levels of technology expected within society and the building industry. The repercussions of this will mean constant upgrades in the buildings technical systems.
- A change in the areas character/reputation. The increase and popularity of Karangahape Road as an area for the development of fringe and mainstream arts. Modern mediums such as digital art will increase in dominance as long as there is not another economic downturn. The presence of the Universities within the area could be considered a future proofing as a constant student community within the area will keep the area as a popular within Auckland’s design community. The present District Council Regulations seek to
preserve the area’s architecture; however it will gradually change with the periodic movement of architectural styles.

- The establishment of Green Star New Zealand and the increase of energy and water bills will see a move to upgrade and refurbish many of the existing commercial properties around Auckland.

- A change in climatic conditions. If the continued trend towards skyscrapers continues, Auckland’s wind patterns will change and there will be an increase in temperature at ground level.

- Changes in tenant and building use. International companies will continue to have a greater presence in Auckland. The skyscrapers that are present in Auckland may become abandoned as they get older because of the high costs of refurbishment needed and their present unsustainable nature.

- Many of the apartments built between 1970 and 2005 will be demolished, resulting in a need for housing.

- Suburbs such as Grey Lynn will gain popularity.

- Unless major changes to the existing transport system are made and the public’s psychology changes, Auckland will continue to form as many American cities have with increasing isolation of the individual and dependence on the automobile.

- If there is an economic downturn then Karangahape Road’s previous reputation as the Red Light District will return or continue to develop in the area. Provisions should be made for this.

- An increase in retail in many of the surrounding suburbs and developments such as Botany Downs and Sylvia Park may limit retail opportunities to account only for tourists in the area.

- More efficient and easier access to international travel may generate an increase in tourists within the central city.
The building's function/ use in urban situation and its potential for future urban development:

Students/Tenancy periods: Due to the younger ages of the tenants it can be presumed that the average tenancy will be for 3-5 years. This will mean that there is a high turnover rate of occupants within the apartments which may place a higher demand on the infrastructure/waste requirements with the moving processes, creating unstable living patterns. The aim of the apartments would be to provide a modern home and not a dormitory in order to promote longer tenancies. The close proximity to the universities and their long history on the sites mean that there will be a constant presence of students in the area. In order to maintain appeal the building must offer the benefits of sustainable practice (no heating bills, cheaper rents, green space) that the present day university housing can not provide due to its age and cheap construction. It can be presumed that lease terms for retail tenants will run the longest. Any office spaces will have a lease terms average five to ten years.”

Future possible uses: The development should be flexible to be able to accommodate other uses/ functions during its lifespan to be truly sustainable. It can be presumed that future possible uses may include the use as an office block, retail possibilities: the green mall, accommodation for older families in the area and the use as a gallery space/ art network that may come about with the continual increase in the art society’s presence in Karangahape Road and the alternative nature of the building.

Comparison of the 3 solutions toward lifespan:
Long lifespan for the whole building: The benefits of the whole building having a long lifespan can be seen in Europe where the streetscape and urban structures act as a readable history that is often lacking in New Zealand due to the predominant use of timber in construction. Long lifespan inherently means the use of massive materials such as brick or concrete which have a much higher embodied energy than that of timber. However, the economic and environmental costs of using the material are decreased with the
consideration of the lifecycle analysis. The use of massive materials that require little or no maintenance are needed for the building to meet its functional aims over the time span, often saving energy and CO$_2$ as a long term benefit. The negative aspects that result with the lifespan of all the elements in the building is that there is no flexibility or adaptability offered by the building needed to meet the ever-changing demands and developments of society, technology, function and use. This can result in the building needing heavy renovation to adapt to change, or the early demolition of the building as a more economic way of meeting the new needs of the occupant: an unsustainable building practice in terms of energy and the environment.

**Short Lifespan for the whole building:** A short sustainable lifespan of the building is typically hard to achieve. A short lifespan implies that the materials and construction of the building is only durable for ten-thirty years or that all the building elements can be individually taken apart at the end of the buildings lifetime and reused. This is one goal of modular constructions. The results of this not occurring is that many materials with high embodied energy or toxic components are destroyed or dumped in landfills resulting in environmental degradation and high energy losses. Short lifespan and modular construction, if implemented correctly, are useful in areas where constant upgrades and changes need to be made as it allows for flexibility and change over short periods of time.

**Mixed Lifespan:** Designed lifespan of building components is the most sustainable method of building. It allows suitable materials and construction methods to be used where their properties can match the function. This is particularly important in today’s ever-changing society where the typical lease period is ten years, implying that there may be changes every ten years to the building’s use and function. Technology is one area where constant upgrades will be needed. However, primary structural elements and facades may remain for a longer period of time to enable a sense of history to be maintained and as an economically sustainable choice.
Life spans considered suitable for the development:

Technical areas: 20 years
Primary structural elements: 70 years
Secondary structural elements: 50 years

Ideally these elements are of modular construction and can be reused easily or separated into the separate components. A design for 50 years is needed to meet New Zealand building code standard. However, it is assumed that these elements may only be used for 30 years (two-three retail tenancies).
APPENDIX E: MASSING EXPLORATIONS

CONCEPT 1:

Function:
The concept allows for a mixed use development with retail fronting both streets.
Future flexibility of use is minimal.
Form does not target younger occupants, is more suitable for families/older communities.

Concept:
Interior courtyards provide a private space for residents with an emphasis on a sense of community.
Traditional design does not emphasis an alternative way to live in the city. The courtyard space is not dynamic. There are many existing examples in Europe of this type of massing where it can be seen that the large massing of the communal space results in a lack of ownership which discourages occupation, rendering the space useless.

Green Space:
The traditional internal communal green space is provided with balconies as the means of private green space. The provision of an archetypal green space does not encourage greater densities of a higher quality of inner city life; nor does it represent the addition of the ideals of the New Zealand dream.

Urban Design:
Problems arise when the concept is applied to neighbouring sites. Occupation on all sides of the courtyard prevents replication as a future proposal for the area of expansion of the apartments as this will result in some apartments with undesirable lighting conditions. A solution would need to result in additional courtyards being formed on the boundaries which reduce the square metres of available apartment space.

Solar Radiation:
The form generates dark, low light spaces in the corners of the courtyard – reference Berliner Corner. The small courtyard space may result in constant shadow.

Energy:
Compact exterior form is suitable for the development of the Passivhaus standard.
Simple construction makes it economically sustainable.
The largest building mass is orientated East/West. To meet Passivhaus standard it is ideal that the largest mass is orientated north to maximise solar gains.

Views:
The courtyard provides internal views where the external views may not be desirable.
Privacy may become an issue.
CONCEPT 2

Function:
The inclusion of a variation of different levels of private and communal space generates further complexity and vibrancy to target younger tenants and improve the flexibility of the development. It also helps to secure economic stability for the developer.

Concept:
The break away from the traditional rectilinear courtyard begins to generate subsidiary spaces that offer more quality to the individual. This allows for a better sense of ownership and more active occupation of spaces. This alternative is more in line with the ideals of the New Zealand lifestyle.

Green Space:
Varying levels of private and public space are created with the alternating heights, dimensions and levels of green space. The concept steps away from the more traditional apartment block and offers a fresh example for higher density developments and the quality of life in the city.

Urban Design:
Similar problems occur with the replication of the concept as a model for future development of the area.

Solar Radiation:
The addition of spaces and varying facade depths offers ways to open up the courtyard and let more light in. This is especially helpful in terms of letting more light enter the corner apartments, although this will still be an issue.

Energy:
The massing of the development is not optimum for Passivhaus orientation and maximising solar gains. The additional internal complexity makes construction methods more complex/expensive. The compact outer façade works with the Passivhaus standard.

Views:
The addition of spaces and varying depths helps generate a variety of internal views and visual interest and allows for greater tenant privacy.
CONCEPT 3

Function:
The concept allows for a mixed use development with retail fronting both streets and within the different courtyards. The ability for interconnecting courtyards to be given individual atmospheres (Hackescher Markt, Berlin) could be used to attract both young and old. It also allows for future flexibility of use and has commercial appeal.

Concept:
The courtyards lack individual ownership which is important to New Zealanders. The focus would tend to be directed more towards the retail sector then the quality of life in the apartments. This goes against the main aims of the development.

Green space:
Green space is once again limited to the internal courtyards and half private/communal space. There is limited private, personal green space available for the tenants.

Urban Design:
Similar problems arise with the replication of the model as a future proposal due to occupation on all sides of the site. Additional courtyards on the site boundaries would need to be formed for light and ventilation, resulting in the loss of useable apartment space (m²).

Solar radiation:
The small size of the courtyards means that no direct sunlight will enter, and hence the apartments will have unsustainable low natural light levels all year round.

Energy:
The compact form is favourable for the Passivhaus standard. Construction methods are relatively simple and hence economic. The majority of the building mass is orientated east/west and therefore can not maximise solar energy gains.

Views:
Multiple courtyards create a variety of different spaces and enhance the visual interest of the spaces. Internal views can be targeted when external views are not desirable. The small size of the courtyards leads to invasion of privacy among tenants.
CONCEPT 4: Chosen Concept

Function:
The concept encourages a mixed use development that could accommodate future changes in use. The alternative space is suited for younger tenants.
The western façade fronting Gundry Street may need more enclosure to frame the site and the intersection but presents an opportunity to generate access predominantly off Gundry Street, energising the immediate area and creating a safer environment. The form supports the continuity of retail along Karangahape Road.
The concept may generate less square metres of apartment space because of the east/west orientation of the site.

Concept:
The concept offers the possibility for the outlined ideals of the Kiwi dream to be met. The atypical massing and complexity of the interior space presents an unconventional method of development for the street in line with the aim of the project.

Green space:
The concept generates altering levels of private and half private space that allow individual ownership and occupation and the possibility of a dynamic environment that encourages a higher quality of life.

Urban design:
It could be proposed that the concept be used as a replicated model on the neighbouring sites or as a further addition/extension of the apartments. The concept allows the connection to be made without the problems that arise with the other concepts with lighting and views. It creates a dynamic space that could support many future uses.

Solar radiation:
The concept insures that the majority of the apartments are orientated north so as to receive maximum solar gain. This is optimal in winter but could lead to overheating in summer.
The long narrow site could mean that the courtyard is small which causes overshadowing of the interior space. Varying façade depths offer a way to open up the courtyard and create shallower apartment depths to let more light in where necessary.

Energy:
Principal massing is orientated in the north/south direction which is advantageous for the implementation of the Passivhaus standard as it ensures maximum solar gains.
The additional internal complexity makes construction methods more complex/expensive.
The compact outer façade works with the Passivhaus standard.

Views:
The concept accentuates the most desirable views on the site towards the inner city and Ponsonby area.
Where views are not desirable, a lively and interesting thoroughfare/internal courtyard provide visual interest.
Tenant privacy may be an issue that needs to be regarded.
DENSITY & FORM INVESTIGATIONS:

CONCEPT 1:

Advantages:

- The development receives direct sunlight to meet Passivhaus demands
- Allows an increase in density
- Lower section to the North allows continuity of the existing street facades/ street scale
- Accentuates desirable views towards the inner city
- Allows different heights and levels to be formed for visual interest

Disadvantages:

- Large surface area receiving light may cause overheating in Summer
- The increase in density to the South does not meet council height restrictions
- There may be severe overshadowing of adjacent properties

CONCEPT 2

Advantages:

- Greater shadow stops overheating in the summer
- Increase in density

Disadvantages:

- Prevents direct sunlight from entering the interior space
  - Less visual interest created by the form
- Fewer desirable views available for tenants
- Less privacy permitted
- Overshadowing of the neighbouring buildings on Gundry Street.
- Does not meet council height restrictions
- Does not fit the existing street scale
CONCEPT 3:

Advantages:

- The loss of direct solar gains decreases the chance of summer overheating
- Increase Density within the area.
- Does not overshadow neighbouring buildings on the back sections of Gundry Street.

Disadvantages:

- Minimal sunlight enters the interior space in winter
- Building opens up to the noise and pollution of the motorway
- Accentuates undesirable views
- Does not meet the council height restriction of 12.5m
- Does not fit the existing scale of Karangahape Road
- Does not allow the building to receive maximum solar gains to aid in Passivhaus design.

CONCEPT 4:

Advantages:

- The development receives direct sunlight to aid Passivhaus design
- Lower section to the North adheres to the existing scale of the street.
- Accentuates desirable views towards the inner city
- Allows different heights and levels to be formed for visual interest
- Creates definition of the corner
- Increase in the areas density
- Creates a landmark near the connection to Ponsonby
Disadvantages:

- The large solar gain may cause overheating of the building in summer.
- The increase in density to the South does not meet council height restrictions or the scale of Gundry Street.
- There may be severe overshadowing of adjacent properties.
- The tower may block sunlight entering some tenant’s flats and create undesirable dark corners.
**APPENDIX F: ECOTECT TEST RESULTS**

1. **CONVENTIONAL CONSTRUCTION: NO ATRIUM, SINGLE GLAZING:**

   **MONTHLY HEATING/COOLING LOADS**

   All Visible Thermal Zones  
   Comfort: Zonal Bands  

   Max Heating: 63525 W at 05:00 on 31st August  
   Max Cooling: 116138 W at 13:00 on 25th February

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   **TOTAL**  
   57848212  
   35226592  
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   **PER M²**  
   22134  
   13479  
   35613

   **Floor Area:**  
   2613.534 m²
2. DOUBLE GLAZING, NO ATRIUM:

MONTHLY HEATING/COOLING LOADS

All Visible Thermal Zones
Comfort: Zonal Bands

Max Heating: 48230 W at 07:00 on 18th June
Max Cooling: 118212 W at 13:00 on 25th February

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<tr>
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<td>11430</td>
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Floor Area: 2613.534 m²
3. USE OF THE ATRIUM WITH SINGLE GLAZING:

MONTHLY HEATING/COOLING LOADS

All Visible Thermal Zones

Comfort: Zonal Bands

Max Heating: 33339 W at 05:00 on 31st August
Max Cooling: 28733 W at 12:00 on 16th January

<table>
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<th>MONTH</th>
<th>HEATING (Wh)</th>
<th>COOLING (Wh)</th>
<th>TOTAL (Wh)</th>
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PER M²

Floor Area: 2832.8 m²