Green Light

The Rise of the Energy Efficient Building

Kate Nason

Byera Hadley
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He was dedicated to architectural education, both as a part-time teacher in architectural drawing at the Sydney Technical College, and culminating in his appointment in 1914 as Lecturer-in-Charge at the College's Department of Architecture. Under his guidance, the College became acknowledged as one of the finest schools of architecture in the British Empire.

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Kate Nason was awarded the Byera Hadley Travelling Scholarship in 2018

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New York City

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The Rise of the Energy Efficient Building

Foreword

When undertaking this body of research, the events of the devastating bushfires over the 2019/2020 summer had not yet unfolded. The content of this report addresses the Australian and international context up to October 2019 and has not been edited to reflect the events that took place thereafter. In light of recent events though, this report holds increasing relevance to the architectural community, construction industry and the broader community as it investigates the role the built environment plays in lowering our impact on the environment and creating a more resilient future for generations to come.

Like many, I have family and friends who have been directly affected by the recent fires which swept across the Australian landscape. The impacts will be felt for a lifetime, and many will not recover from what has been experienced this summer. Changing climatic conditions have led to unprecedented drought, extended heat waves and severe storm activity which have in turn intensified bushfire activity to the point where fire fronts have become uncontrollable. With buildings contributing to almost 40% of carbon emissions globally, they present us with a significant opportunity to increase our climate protection efforts. While we must limit their toll on the environment in the long term by significantly reducing their carbon emissions, we also need to respond by increasing the level of protection that they provide to inhabitants. In the Architects Act it states that Architects have a duty of care to protect those that come into contact with the buildings they design. To fulfill this legal obligation, we must increase the resilience of buildings from the outset in a quantifiable way.

The Byera Hadley Travelling Scholarship has allowed me to explore this topic by enabling me to collate insights from internationally recognised leaders in climate protection through the built environment. My research included exploring the perspectives from key policy makers, builders, architects, entrepreneurs, suppliers and educators at the cutting edge of low and zero-emission building design across North America and Europe. I visited Vancouver, New York City and Brussels as these cities have demonstrated true leadership in decarbonising their built environment in measurable ways. My research also took me to key industry events in Heidelberg (Germany) and Wellington (New Zealand) which helped me uncovered a broader perspective on the work being done across Europe and the South Pacific. This has allowed me to explore, contextualise and, ultimately, compare international efforts currently being undertaken to decarbonise the built environment against our own efforts in Australia.

A key finding from my research was that the Passive House (Passivhaus) Standard is becoming the cornerstone to sustainable building policy across each of the cities I visited. Being a fabric first approach to performance and quality control, in both design and construction, it enables a building to maintain a comfortable and healthy indoor environment with minimal energy requirements and without reliance on fossil fuels. This makes achieving zero-emissions buildings viable and allows occupant health and wellbeing to be optimised regardless of fluctuating external conditions. For example, the interviews I conducted in Vancouver revealed that the demand for buildings that achieve the Passive House Standard is rapidly increasing due to changing weather patterns and periods of reduced air quality associated with their wild-fires season. The City of Vancouver revealed that a staggering 20% of all development across the city is now voluntarily targeting the Passive House Standard.

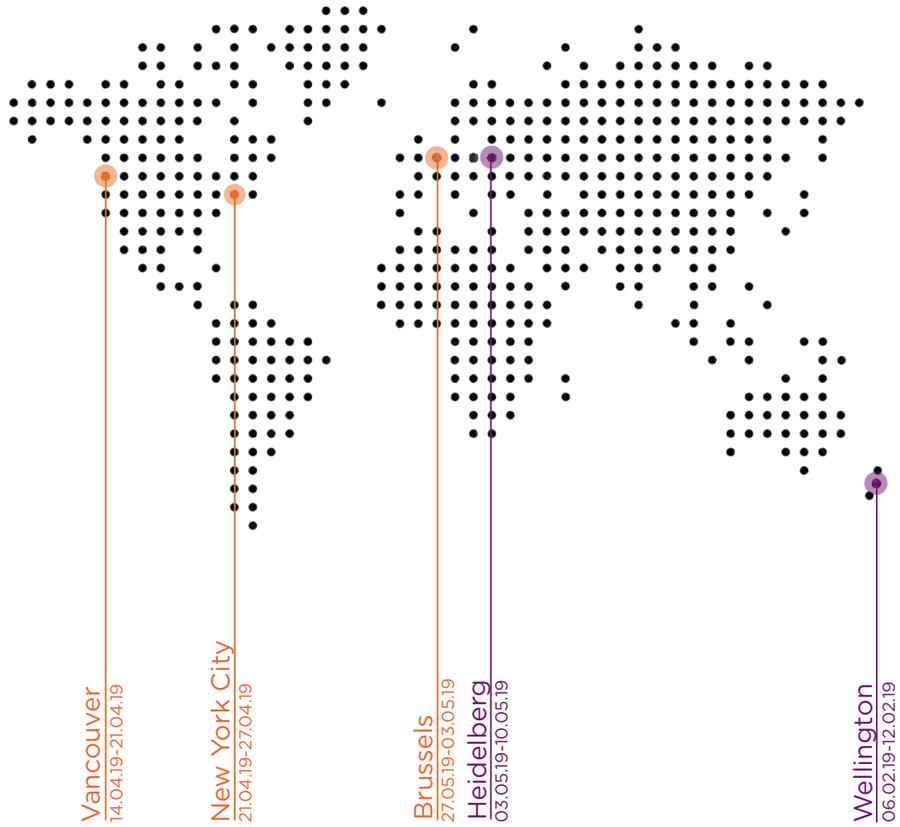
My research also revealed that architects can play a vital role in accelerating the carbon reduction in buildings. The architects whom I met, all reiterated the same point - that by adopting the tools and processes offered by the Passive House Standard, they have been empowered to make a quantifiable and tangible improvement to the buildings they deliver. Most started this as experiment to test the impact on their workflow and creativity, however not one of them has opted to resort back to business-as-usual since delivering a Passive house building. Many architects even extended their work beyond the profession, to successfully shape the overarching regulatory systems and supply chains for buildings in their cities. For example, Sebastian Moreno-Vacce, Director and founder of A2M Architects in Brussels, played a critical role in the process of the formal integration of the Passive House Standard into building code across the region. Another example is Ken Levenson, an architect who left mainstream practice to focus his efforts on upskilling and supporting the construction industry to physically deliver buildings that meet the Passive House Standard across North America.

Across the five cities I visited, I spoke with over 30 individuals who are playing vital roles in accelerating the trajectory to a carbon-neutral future. They have offered personal insight into both the challenges and the opportunity this transition can bring and I have attempted to capture their energy and passion in this report.

I have consolidated and contextualised these insights into a range of recommendations for Australia. Each city visited offers a range of strategies which could be appropriated and implemented in Sydney, as well as other Australian urban centres. These range from skills and tools that can be utilised by architects on a day-to-day basis, right through to city-shaping policy, which would allow us to secure the resiliency of our cities well into the future. These recommendations are intended to generate constructive discussion around the topic of climate mitigation through buildings, and I encourage all readers of this report to actively participate in this discourse.

This report has been a pleasure to author and, behind it, the research and travel was a once in a lifetime opportunity which will enrich my career for years to come. It has acted as a boost of optimism which I hope to pass on to the architectural community and broader industry in times of such uncertainty.

Travel Itinerary



Key
- Conference
- Case Study

European Union Parlaiment (left)
European Union Head Quarters
(right)

Introduction

Challenges :

Climate Protection

The primary goal of this research is to address the challenges and opportunities that Australia faces in order to reach the carbon emission targets set by the Paris Agreement.

It focuses specifically on the building industry and the critical role architects play in lowering the carbon footprint of cities whilst increasing their resilience in the face of climate change.

Climate Protection

Australia is one of 196 countries that have committed to the 2015 Paris Agreement. Therefore, as a nation, we have collectively pledged to cut carbon emissions and keep global temperatures within 2 degrees of those recorded pre the industrial era. All parties to the Paris agreement are required to develop Nationally Determined Contributions (NDC's) which outline specific climate change mitigation targets and action plans. NDC's are to be reported on every 5 years and expected to be updated regularly. [1]

Australian Government committed to reduce emissions by 26 to 28 per cent below 2005 levels by 2030. Progress to date has been promising yet not rigorous enough, with carbon dioxide reductions only having dropped 5% since 2000.[2] To accelerate the reduction in national emissions to meet the 2030 goal, Australia will require radical national action with wide spread collaborative and coordinated effort by all sectors. Australia's emission trends indicate that the 2030 target will be missed by 762 Mega-tonnes of Carbon Dioxide, which is in fact an increase on 2005 levels [3].

The Intercontinental Panel on Climate Change (IPCC) 2018 Special Report states that globally we need to reach and sustain Net Zero emissions to pause anthropogenic global warming on a multi-decadal time scale. This will not stop the impacts of global warming however, so we must also address the resiliency and adaptability of our environment in order to protect our population, ecosystems and biodiversity. [3] Buildings form a vital shelter for people, so should be designed and constructed to withstand changing climatic conditions, whilst also mitigating their impact back on the climate via lowered operational emissions, energy use and embodied carbon.

Climate change poses a direct risk to human health, wellbeing and quality of life. It also places greater strain on the already pressing issues of global inequality, with people in the developing nations being far more vulnerable to the negative impacts of climate change than developed ones. As a country with world-class scientific and academic institutions, a strong commitment to research and development and standing 7th in the world's highest ranking counties for published research and innovation, Australia is in a prime position to become a leader in climate action. [5]

The Role of the Built Environment

The built environment contributes to 39% of global carbon emissions - greater than any other sector alone. Decarbonising the building sector offers an effective way to reduce the impact of climate change. 11% of emissions are attributed to the embodied energy in buildings, and the remaining 28% is attributed to their operational energy requirements. [8]

With climatic conditions becoming more severe, the operational efficiency of buildings needs to be addressed to ensure these figures do not climb. At a minimum, the envelope and systems of our buildings need to offer a more resilient internal environment that supports the health and wellbeing of occupants whilst also protecting them from any negative or extreme external impacts.

Australia is already experiencing unprecedented heatwaves nationally and summer temperatures in major capitals are predicted to reach 50 degrees on a common basis by the turn of the century.[9]

"Adaptation and mitigation are already occurring. Future climate related risks would be reduced by the upscaling and acceleration of far-reaching, multilevel and cross-sectoral climate mitigation and by both incremental and transformational adaptation"

A.3.3- IPCC Special Report: Gobal Warming of 1.5 ºC Summary for

"The global buildings sector is growing at unprecedented rates, and it will continue to do so. Over the next 40 years, the world is expected to build 230 billion square metres in new construction – adding the equivalent of Paris to the planet every single week."

Dr Fatih Birol, Executive Director International Energy Agency

The global building stock will double in area by 2060. This is equal to adding an entire New York City every month for 40 years. [10] It is critical that this new building stock be designed and constructed to meet net- zero carbon standards. An average global improvement of 30% is required in building energy intensity (i.e. energy use per square metre) by 2030 in order to meet ambitions of the Paris Agreement. Addressing the envelope performance of new and existing buildings will play a key role in meeting those 30 by 30 targets. [8]

In Australia's residential sector alone, approximately 500,000 homes will be built between now and the next update to the National Construction Code in 2022. Providing these buildings will have a life cycle between 50-100 years, the impacts of building to higher energy efficiency needs to be urgently addressed to avoid billions of dollars worth of wasted energy costs and to drastically reduce carbon emissions to meet the goals of the Paris Agreement. [11]

This presents Australian cities with an unprecedented challenge, but on the flipside, it also offers unprecedented opportunity to implement a net-zero building strategy.

Individual companies, industry organisations, government agencies and regulatory bodies that are involved in the construction sector need to take equal responsibility in addressing this challenge.

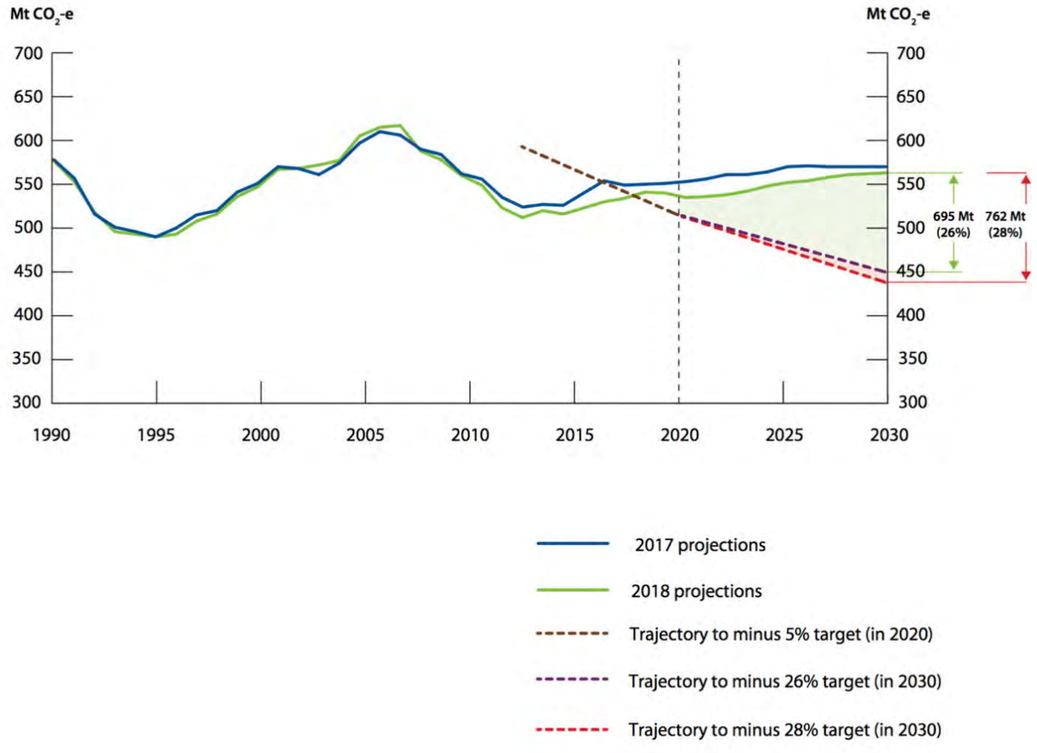
It is also imperative to look to global building standards which can be rolled out to achieve a net-zero emission building stock. Australia needs to follow suit and learn from cities who have done this already. As national standard, we need to have a robust foundation to our building codes with a strong scientific backing and history of successful results in a multitude of applications, typologies and climate types.

The Passive House Standard is a performance based building standard that offers a viable and verifiable way to achieve significant reductions in operational energy consumption of buildings and increase their resiliency in extreme climatic events. In additon to this, the Passive House Standard also ensures a high level of the indoor environmental quality is achieved at all times to support and enhance occupant health and wellbeing.

"The age of abundant cheap energy draws to an end, the consequences of accelerating climatic change and diminishing fossil fuels reserves have promoted a radical re-think about the need for energy efficiency in the built environment. "

Dr. Christina J. Hopfe, Loughbourough University and Dr. Robert S. McLeod, Building Research Establishment (BRE) [7]

FIG 1 Australias Emissions Trends 1990 - 2030[3]



Opportunities
Decarbonising the Built Environment

First regular passive house
Darmstadt-Kranichstein, DE
Completed 1991
Photo: Passive House Institute

Decarbonising Buildings

When seeking to decarbonise buildings, it is important to consider all sources of carbon across their lifespan . The carbon emissions of buildings can be broken down into three main aspects :

1. The operational energy required to keep a building both functional and habitable.

2. The embodied carbon within the material composition of the building.

3. The carbon emissions attributed to the processes in the creation, maintenance and end-of-life of a building.

The focus of this research has been centred around addressing operational energy and ways of achiveing “Net-Zero” Emissions- i.e. buildings that generate 100% of their energy needs on-site from renewable sources. To make this feasible, the energy efficiency of the building must be addressed first. Lowering the overall demand for energy from the outset, is the most appropriate way of reduceing emissions at scale across our cities.

Operational Emissions

With operational energy demands of buildings attributing to 28% of all global carbon emissions, this presents substantial opportunity. With a rapidly changing climate, energy consumption in buildings will be further strained as their systems cope with more common and frequent heat waves for example.

Operational emissions need to be modelled from the beginning of a building’s design process. In the first instance the energy required to maintain a comfortable and healthy interior environment needs to be accurately calculated in order for optimisation to take place. The design of a building directly impacts it’s performance, so the responsibility ultimately falls with the design team.

There are an array of tools that can help calculate operational energy demand, but the challenge is to integrate these with the design process. There is often a misconception that this can be done post-design of a building. This is simply not the case. There needs to be clear benchmarks, guiding principles, a methodology for construction and then a verification process in place to ensure the desired operational energy has indeed been achieved in the as-built product.

The Passive House Standard

The building performance standard known as the Passive House (Passivhaus) standard has been proven to offer viable and verifiable ways to achieve significant reductions in operational energy consumption of buildings, increase the resiliency of buildings in extreme climatic events and also enhance the indoor environmental quality which, in turn, results in improved occupant health and wellbeing

History of the Passive House Standard

The Passive House standard dates back to 1990 with the creation of the first building constructed to the principles - the Kranichstein Passive House in Darmstadt, Germany. This was the product of over a decade of research between the initiators of the standard, Prof.Em. Bo Adamson and Dr Wolfgang Feist. Almost 30 years on, the huge accumulation of data recorded from this single building is still proving the concept a success with energy consumption being well below the benchmarks first set - ie 15kWh/(m^2a).[12]

It is important to note, that this approach to energy conservation in operational building use, was not only being experimented within Germany. There were numerous research projects prior to the establishment of the Passive House Standard such as the Saskatchewan Conservation House in Canada, Conrad Brunner’s low energy building research in Switzerland and the Leger House in Pepperell, Massachusetts.

The science behind these building performance concepts were endorsed by scientists all over the world - it just needed a strategy for implementation. This is where the Passive House Standard provided a clear methodology to follow and a verification process which could be adopted by architects, builders and even people outside the building industry, to achieve energy efficient, healthy buildings. The development of the Passive House Planning Package (PHPP) became the instrumental tool in the standard’s successful implementation around the world.

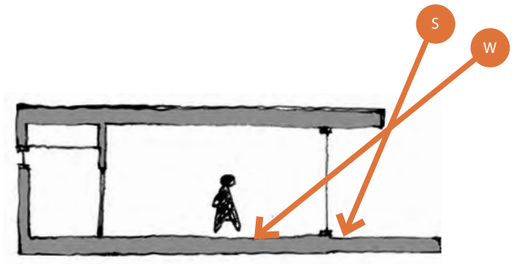
The Passivhaus Institute (PHI) has continued to develop and verify the outcomes of this tool, proving that accurate predictions of energy efficiency and ongoing indoor environmental quality of buildings is attainable. Most notably, it allows an integrated approach to design, enabling variations to be tested throughout the process.

The Passive House Standard has proven highly successful in empowering architects to deliver on promises made to their clients. It has become another “pen at the drawing board”, enabling the deeper understanding of energy flows, and their respective impact on and by the design of a building.

“Passive buildings are not all about technology. Their greatest benefits are not in avoided costs and emissions but in quality of life. “

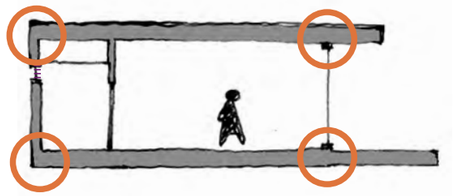
Amrory B.Lovins, Cofounder and Chief Scientist, Rocky Mountain Institute

FIG 2 Passive House Principles



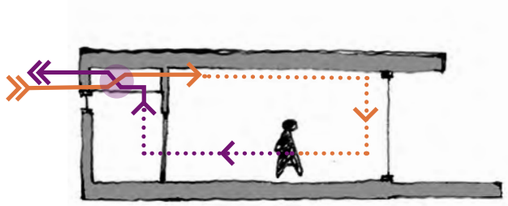
Shading / Orientation

Continuous Insulation



Thermally Broken

High-Perfromance Components



Mechanical Heat-Recovery Ventialtion

Air-tight

Principles and Criteria

The Passive House standard is based on 5 principles which have been derived from scientific laws of building physics and include:

- Continuously insulated envelope
- Thermally broken envelope
- Air-tight envelope
- Mechanical ventilation with heat recovery
- High-perfromance components - windows and doors

The benchmarks of the Passive House standard form the underlying reason for these five simple principles. It would not be possible, for example, to achieve both the operational energy target of 15kWh/(m^2a) as well as maintaining a comfortable year-round temperature and good air quality without integrating all principles in a building.

"A Passive House is far more than the sum of its parts: precise planning is required in order to ensure that the components used work together to achieve the desired result."

Australian Passive House Association (APHA)

The Passive House Planning Package and Certification process provides a robust and transparent integrated design and construction quality assurance framework for the development of comfortable, healthy and efficient buildings. For Monash it has become an invaluable methodology for the design and construction of net zero ready buildings.'

Rob Brimblecombe, Manager, Engineering & Sustainability, Buildings and Property Division, Monash University

Passive House Certification

All though certification is not required for a building to meet the Passive House Standard, it is recommended to certify as it acts as a quality assurance measure, to ensure the building will perfrom as intended. This is in the best interest of all.

Formal Passive House certification involves extensive documentation, evaluation of the project's energy use, and testing of the airtightness and ventilation system. PHI makes it clear that the concept of passive house is not protected, and the process of designing a Passive House certified project is open to any building professional. However, PHI recommends consulting with an experienced or certified designer during the process.

The following is an non-exhaustive list of the benefits of targeting certification:

- Quality assurance 3rd party audit of design and construction
- International recognition of climate resilient, environmentally responsible architectural design.
- International recognition of the highest standard of construction - meeting the airtightness benchmark is a true display of a builder's craftmanship and attention to detail
- Stamp of quality assurance recognised globally.
- Assurance to all stake holders and end users that the building will perform as promised.
- Stakeholder have a guarantee of the building performance, which can help articulate operational expenditure and savings accuratley.

Passive House Vs Passive Solar

There are a lot of misconceptions about the Passive House Standard both in and beyond the building industry. A common one is that Passive House is the same as Passive Solar. Despite some basic similarities, there are some important differences to take into consideration.

The principles of the Passive House Standard build on from some of the well-known principles of "Passive Solar" design, which is founded on orientation for solar control, passive heating and cooling strategies as well as reliance on natural ventilation. Relying on this approach alone will not accommodate "imperfect" conditions however. As our cities densify, control over the orientation of a building is often forfeited due to tighter site constraints, limited direct solar access due to overshadowing of neighbouring buildings and undesirable sources of natural ventilation due to lower air-quality and acoustic conditions of inner city contexts. In addition to this, an envelope which is not air-tight will cause considerable energy loss from the interior space. Cross-ventilation for the purposes of night purging in summer can be utilised in a Passive House building, but should not be relied upon for these reasons.

Other aspects which are not addressed in the Passive Solar approach are the fundamental issues of thermal bridging which bring risk of mould growth, structural damage and energy loss.

FIG 2 Passive House Principles

Passive House Tools and Software

The Passive House Planning Package (PHPP) is the software that was developed as an open-source tool to assist the optimisation of performance, cost efficiency and energy balancing in a building's planning stage. It breaks the building into its individual elements and allows the impact of design changes to be visualised against the likelihood of meeting the benchmarks of the Passive House Standard. Although an Excel based software, the foundations upon which the calculations are based are extremely accurate (down to +/- 0.5 kWh) and derived from 30 years of validated data collected from projects all over the world. This tool has helped close the 'performance gap' which is commonly experienced in built projects which utilised other methods of operational energy calculation.

New plug-in's for PHPP have been developed which allow 3D geometry to be integrated in the workflow, rather than alongside it. DesignPH and BIM2PH are two software plug-ins that have been developed by PHI to visually represent the energy modelling process, however, there are a myriad of independently developed alternatives coming on the market as well, which further validates the relevance of, and demand for, PHPP in the building industry. [12]

Passive House Institute (PHI)

In 1996, Wolfgang founded the Passive House Institute to develop the Passive House concept and act as an administrative hub for the certification process and develop supportive material, education and research to help its uptake in the wider industry. Since then, the standard has been adopted all over the world, in all climatic extremes - from the far north of Canada with sub zero temperatures, to the heat and humidity of Kinshasa in Africa. This has required extensive research and support for these new conditions - PHI leads this research and distributes findings through various channels which the industry can tap into. [12]

In some instances research will be specific to a project type (eg leisure centres and supermarkets) or geographical location. The team is currently undertaking extensive work around hot climates to support the influx of projects in these climate zones (ie Australia and South America) but also to proactively address the climatic shifts occurring due effects of global warming.

Australian Passive House Association (APHA)

The Australian Passive House Association was founded as an affiliate of PHI and acts as a national source of support, advocacy and research for the Australian community. There are over 260 members, ranging from individuals to large corporate firms. The association is governed by a board of 10 directors and is registered as a not-for-profit entity which predominantly relies on voluntary input. [13]

International Passive House Association (IPHA)

The number of international affiliate organisations have increased rapidly in recent years, so the International Passive House Association (IPHA) was founded to act as the international arm of PHI. This organisation's mission is to connect the passive house sector by forging partnerships, sharing expertise and supporting other affiliate passive house organisations around the world. [14]

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Gillies Hall, Monash Unversity
by JCBA
Photo: Peter Clarke

The Fern Appartments
Sydney by Steele Associates
Photo: Steele Associates

Opportunities:

The Role of the Profession

"Architects are being forced to address the role they individually play in helping to mitigate the twin crises of climate breakdown and biodiversity loss at a local level"

Architecture AU, 26 Jul 2019 [1]

Global Community

2019 has made it very clear that the architects in Australia are key players in the global architectural community. This has been exemplified by the recent "Architects Declare" movement that acknowledges the dual climate and biodiversity crisis we face as a civilization, the growing "Friday's for the Future" strikes and increasing intensity of the Extinction Rebellion protests. There has never been more pressure on how the profession should address climate protection, and what actions should be implemented today in order to create meaningful impact tomorrow.

With mounting international pressure, it is evident that each and every person needs to consider their own personal lifestyle impacts on the environment, and how to alter their daily actions and choices to help mitigate negative effects. Architects are not exempt, and have an obligation to bring this same mission to professional practice.

Speaking up publicly about values and aspirations around this topic is one step in the right direction and raising awareness is yet another. It is action we need, however. It is clear that there is the passion and willingness to 'change the world', but how will it actually be done? And who is responsible for carrying it out?

Architects, as individuals, a community and a profession, play a vital role in decarbonising our built environment as they are in the driving seat of its design.

Obligations of the Profession

Architects play a critical role in the formation of projects, helping to formulate and maintain the aspirations of the brief from the initial concept right through to the built product. The close engagement with stakeholders in this process means architects are in a unique position to raise and instigate opportunities that transcend the boundaries of a site, bringing together elements of both art and science, as well as law and commerce. The Australian Institute of Architects (AIA), requires its members to commit to protecting all members of the community via 'the advancement of architecture through involved and innovative practice, with the aim of raising the quality of the environment and, consequently, the quality of life.' [2]

In the AIA Architects Code of Conduct 2006, Standard 1.1 of Principle 1: Obligations to the Public Members states that:

> *"[AIA] Members must respect and help conserve the systems of values and the natural and cultural heritage of the community in which they are creating architecture. They must strive to improve the environment and the quality of life and habitat within it in a sustainable manner, being fully mindful of the effect of their work on the interests of all those who may reasonably be expected to use or enjoy the product of their work."*

In simple terms, architects are expected to both protect and enhance the end users' quality of life within buildings they design, the wider community that come in contact with their work and the surrounding environment which is impacted either directly or indirectly as a consequence.

This is reiterated in statutory law through the NSW Architects Regulation 2017. This regulation also states than an architect must withdraw from the provision of any architectural services if they reasonably believe that it would result in them acting in an 'unethical' manner[3]. This reference to ethics can & should be directly linked to broader issues of climate protection.

With knowledge comes responsibility. If an architect is aware of ways to mitigate any negative impacts associated with emissions attributed to the buildings they design, then it can be said, that they are legally obliged to take the necessary action to rectify it to the best of their ability. There is evidence of effective, innovative ways to address the energy consumption of buildings as explored in this report. It is now a matter of implementing them in Australia in a meaningful way.

There is a rising number of architects in Australia already taking a brave stand on this matter - only accepting to work on projects which resonate with their core values around climate protection. In this regard, the role of the architect needs to expand beyond commission and project based work. The advocacy of these issues to the broader community should also form a core component of an architects role. Increasing the market education will in turn grow the demand for buildings that responsibly address climate protection.

Empowering the Profession

The architectural profession is in an exciting time of change. The challenges faced offer all architects the opportunity to respond and empower ourselves with new perspectives and skills.

Being able to predict the energy consumption of a building over its life time will allow us to integrate energy efficiency measures from the outset, rather than just relying on the additive process that is currently relied on, such as the superficial application of technologies post-design.

An integrated approach to performance will inevitably empower architects to protect more of their design by proving its performative value - whether that be qualitative (indoor environmental quality) or quantitative (operational cost, energy use, lifecycle pay back periods etc). The language of energy needs to be incorporated into the architectural vocabulary at all levels.

The Passive House Standard will allow architects to take control of the performance of their designs, ensuring that the building will operate as promised before it leaves the drawing board. The Passive House Planning Package is a tool which allows multiple variations of design and construction types to be tested for performance and cost optimisation.

Beyond the Profession

Everybody has a role to play in climate protection, not just architects. From the policy makers who dictate the rules that shape our cities, to the trades people who build them and the financial institutions who help fund them. Shifting society's focus from the "Why" to the "How" is more critical than ever if we need to mitigate climate change.

Thefollowing case studies go into detail around three cities which have made significant headway on achieving the climate goals of the Paris Agreement through the decarbonisation of their built environment. Further to these case studies, the conferences in Wellington and Heidelberg provide a snapshot of what actions are being taken in the South Pacific and European regions respectively. This research aims to summarise the successful strategies that have been applied at different scales - from voluntary local government policy to rapid and wide spread changes in regulation. It is interesting to note that the role of the architect in these efforts has been continuously proven to be instrumental.

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A Standard that Empowers the Profession

The following is a non-exhaustive list of the benefits associated with utilising the Passive House Standard in projects:

Practice what we preach

Empowers architects to fulfil their obligation around climate protection and allow us to practice what we preach.

Verification tool

Enables the testing of the as-built-quality though pressure testing for air infiltration (ie the blower door test) to ensure alignement with performance predictions.

Validation process

Increases transparency for client - "they get what they have paid for".

Shared accountability of quality and performance

Emphasizes that quality of design documentation is equally as important as the construction quality. It requires full disclosure of performance data from suppliers as well as professional commissioning for all mechanical services and components.

Quality assurance

The certification process entails 3rd party, independent certifier to audit the documentation, commissioning, test results and construction process.

Design protection

The direct link to performance and design will act as a validation during the value-managment process.

Encourages collaboration

Builder and design teams are encouraged to collaborate earlier in the project which prevents ad-hoc value-management and substitutions to occur further down the track, should the architectural services be novated.

Increase value of services

Architects can utilise the predictive energy assessements provide additional services to their clients, such as indicative financial payback periods and long term cost comparison against buildings constructed to minimum standards.

Increases Resilience

Ensuring that the building will protect its end-users, irrespective of external climatic conditions.

Tools for better design

PHPP is a predictive tool for energy consumption including peak demands and loads for heating and cooling requirements.

Case Studies

Overview

A series of three cities have been selected as case studies to explore ways in which the profession of architecture, policy makers and the broader industry can reach the ultimate goal of decarbonising the built environment.

Vancouver, New York City and Brussels were specifically selected as each of these cities has shown profound leadership and strategies that can be deployed at every level to meet the targets of the Paris Agreement.

Despite their geographic separation, these cities also share some common links. These include:

- They have all identified the Passive House Standard as a viable and scalable way to reduce the impact of buildings on the climate whilst improving the resiliency and quality of buildings to help mitigate negative impacts of climate change on the population.

- They have all set up their own local centres for high performance buildings which are part of the international network established by the United Nations Economic Commission for Europe (UNECE). This is an international community for knowledge sharing, support and research for the construction industry known as the UNECE International Centres of Excellence on High Performance Buildings. [1]

- Prior to the establishment of the Centres of Excellence, each of these cities collaborated at a grass roots level to share experience and knowledge around transitioning to a decarbonised economy.

The construction industry, property market and governmental policy making has undergone extensive change in each of these cities as a result of their collaboration and visionary leadership. Each city has different obstacles and challenges to overcome however, so an adaptive and responsive approach has been required for each city and context. At the heart of this, is the challenge of changing "business-as-usual", in both industry practices and the general ideologies of the population. This process of how 'change' becomes accepted as the 'norm', can be summarised by the Innovation Diffusion Theory.

The Diffusion of Innovation (DOI) Theory is one of the longest standing social science theories. It was developed by W.M Rogers in 1962 as a method of communicating how an new or radical idea or product is accepted and then adopted by the wider population.[2] The process of this 'diffusion' is explained via a simple bell curve graph which illustrates the various stages of adoption over time. The conclusion of Roger's theory states that some people are more apt at adapting to change (or innovation) than others. The behavioural classifications are broken down into five categorie:

1. Innovators
These people are the trailblazers who test and develop new ideas even if the risk is high,

2. Early Adopters
People who enjoy leadership roles and are eager to trial new ideas. They are aware of the need for change and embrace the opportunity to share it. They are less reliant on information to be convinced.

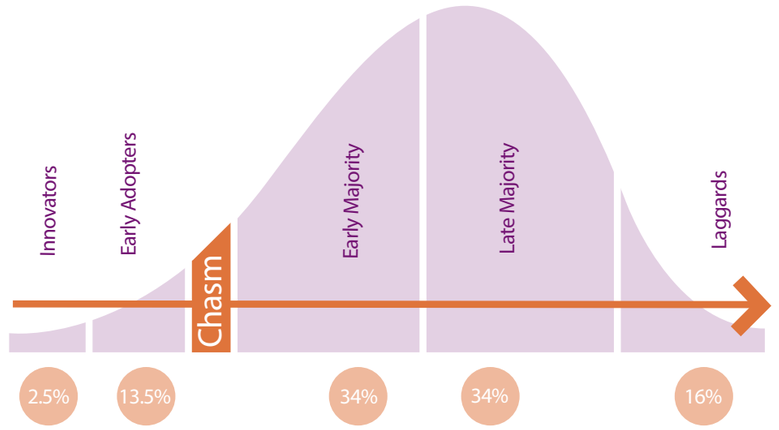

FIG 3 - The Diffusion of Innovation Theory

3. Early Majority
Not leaders, but willing to adopt new ideas if there is substantial evidence of the idea being successfully implemented by others first before trialling it themselves.

4. Late Majority
Sceptical people who will only adopt a change if it has been trialled successfully by the majority first.

5. Laggards
The extreme sceptics that are the most difficult to persuade. They are guided by tradition and can only be persuaded by statistics, pressure from the majority or fear tactics.

As seen in FIG 3, the DOI Theory states there is a "chasm" between the Early Adopters and Early Majority. Bridging between these two groups is always very challenging. If it is successfully achieved, it essentially means that the 'new idea' or 'change' is on track to being adopted by the late majority.

Introducing ideas around how we can mitigate climate change through the built environment is not immune to this theory. The cities of Vancouver, New York and Brussels have been specifically selected as they offer some interesting insights into how an innovative concept can be introduced and how it can be moved through the various challenging behavioural categories shown in the diffusion curve. The 'change' each of these cities is trying to introduce as the new 'norm' is the integration of Passive House Standard into building regulation. Each city is at a different stage of this journey, which can be mapped across the Diffusion of Innovation Curve.

The following chapter goes into detail of three case study cities which have made significant headway on achieving the climate goals of the Paris Agreement through the decarbonisation of their built environment. It can be said that each city, therefore, has been able to bridge the chasm between the eager early adopters and the particularly hard to persuade group in society referred to as the Laggards.

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Case Study #1 : Vancouver, Canada

Vancouver is located in the Canadian province of British Columbia. It is a particularly interesting city as it has recently introduced some noteworthy city-shaping policy, at both local (municipality) and provincial (state) governemnt level around climate protection with a key focus on the built environment. In less than 10 years the city has transformed it's building sector though various strategic interventions and incentives that are accelerating their emissions reductions. The pace of this change reflects the urgency that the IPCC report advises cities should act, in order to meet global climate protection targets.

Case Study # 1: Vancouver, Canada

Policy Insights

"...The BC Step Code represents a modern, affordable, and technically achievable approach to new construction - and a blue print for other jurisdictions. It will predictably and consistently improve health and comfort, and reduce carbon emissions.."

Jonathan Cote, Judy Brownoff & Karen Tam Wu, 2017[2]

Provincial : British Columbia

British Columbia acknowledges that the built environment contributes more emissions than any other sector alone. The need to address the energy consumption of buildings has therefore become a provincial priority. Along with Alaska, Washington, Oregon & California, the province has committed to "Leading the way to Net Zero buildings" through the formation of the Pacific Coast Collaborative. This collaboration has resulted in the plan for all new buildings to be designed and built to Net-Zero standard by 2032. This is no mean feat but, with the right leadership and support, it is a goal, that is said to be well within reach.

A Net-Zero building consumes so little operational power over the course of the year, that this net total can be off-set with renewable sources of energy[1]. For this to be possible it is critical that the envelope of the building is designed and constructed to be extremely high performing, and accompanied by energy modelling and onsite verification of construction quality.

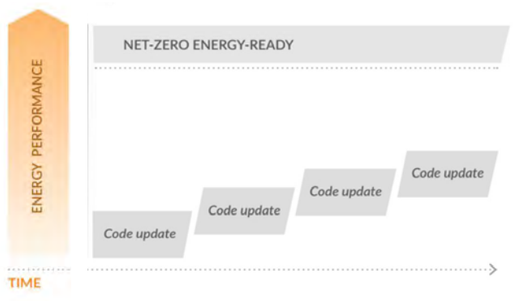
An initiative called the BC Energy Step Code was enacted in 2017 as a result of the convergence of the Pembina Institute, Royal Architectural Institute, Urban Development Institute, Real Estate Foundation and over one hundred architects, developers, government officials, manufacturers and property managers. The goal of this voluntary provincial standard is to support long-term improvements to buildings based on measurable performance requirements around energy-efficiency. The BC Step Code is intended to supplement the current provincial energy-efficiency standards provided by several third parties to the BC Building Code. Industry feedback suggested that the current building code is fragmented and, therefore, challenging to follow. Industry leaders and climate advisors also warned it was lacking the rigour required to meet the targets set out by the Paris Agreement.

Forsuccessful adoption, any incentive like this must respond and fit with the current policy frameworks though. The BC Step Code acknowledges this, and works to build upon, strengthen and fill the gaps of the existing BC Climate Plan through buildings. The BC Step Code Council was formed to provide guidance for governments, industry and stakeholders. It was recognised that this switch to zero emissions could not be done overnight.

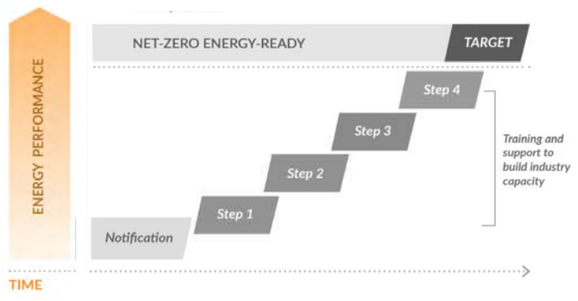
A series of tiers that incrementally increase building performance requirements were established to support a manageable transition - hence the name of the step code. The measurement and verification of design and construction quality is an important aspect if accurately assessing any increase in performance. Specialised software and onsite testing is required, which is where the Passive House Standard has been utilised as a robust method of assessing the performance, not only in terms of energy efficiency, but indoor environmental quality as well.

Although it is currently voluntary, it provides a clear-cut direction for municipalities to set realistic and achievable goals via implementing various levels of the Step Change Code over a time period of their choosing. Adoption by local government serves as an important message. It shows the industry and wider community that it is a dedicated leader in delivering on climate targets, that far out reach those of national requirements, and is committed to improving the quality of building stock in the city for the health and wellbeing of its people. The standard does not specify how a building is designed or constructed, but instead utilises a flexible approach which enables architects and builders to tap into innovative and cost effective solutions to achieve the targets. This way, consumer choice can also be catered for, increasing the adaptability of the buildings to various market demands. The benchmarks of the Passive House Standard were as selected as the top step of the BC Step Code for these reasons.

Typical Building Code (Incremental Approach)[8]



BC Energy Step Code (Back-casting Approach)[8]



"TheZero Emissions Building Plan leverages the Passive House standard and its associated research, tools, training and verification processes to assist industry in successfully transitioning to highly energy efficient building envelope and ventilation system designs."

Vancouver City Council
Zero Emissions Building Plan

Municipal : City of Vancouver

Vision

1. **Become greenest city in the world by 2020**[1]
   The Greenest City Action Plan outlines 10 focus areas with measurable and varifiable targets for building emissions

2. **Vancouver to be entirely powered by renewables by 2050** [2]
   The Renewable City Action Pan provides a 10 year road map consisting of guiding principles, medium to long term targets and specific actions to enable the city to achieve this, as well as reduce its GHG emissions by 80% on 2007 levels. An additional policy has been recently added to cover the embodied carbon in buildings, with a targeted reduction of 40% by 2030.

The City of Vancouver (CoV) has identified that reaching their overarching climate goals is both vital for safeguarding the economy and protecting the quality of life for all. As Chris Higgins, Green Building Planner at the CoV explained in an interview on 16th April 2019, the emphasis is equally weighted on providing quality buildings as well as energy efficient buildings. Aspects that promote health and well-being in occupants, such as good acoustic separation in multi-residential complexes, maintaining high indoor air quality even in the peak of the wild fire season and increasing the affordability of living in Vancouver through reduced power bills, are all taken into consideration. This correlation between quality and performance is why the CoV has sought guidance from the Passive House Standard when developing building policies. The following overview provides highlights to CoV's key transformational policies.

Zero Emissions Building Plan

Adopted in 2016, this forms the cornerstone policy for the built environment for the City of Vancouver, targeting all new buildings to be Net Zero by 2030. It establishes a clear pathway for the industry and seeks to provide leadership from local government to aid the transition to carbon a neutral city.

Key Goals[3]:

- For the end user
  _Improve indoor environmental quality to support health and wellbeing of inhabitants. This includes temperature, air quality and acoustics.
  _Improve energy efficiency, climatic resilience and long-term affordability via reduced operational energy and associated financial strain.

- For the industry
  _Promote a proactive approach to meeting the provincial Energy Step Code.
  _Provide a clear trajectory and timeframe for future updates which will assist the industry to retain economic advantage via the investment in relevant skills, products and services.
  _Create consistency, cohesion and predictability across multiple municipalities

There was a growing evidence base that new buildings, which had abided by the previously used performance standards, were falling short of meeting the energy reduction targets. The LEED Certification[4] had previously been adopted by the City of Vancouver, however being based on energy cost calculation rather than consumption alone, new buildings were favouring cheaper sources of energy, such as gas, rather than renewables.

The City of Vancouver established the need for a new quality assurance process which would enable both the planning and delivery of buildings to meet both the quantitative energy reduction targets without compromising the quality of indoor environmental conditions. It was essential to utilise an evidence based methodology which had a proven track record of providing similar results. There also needed to be clear benchmarking and verification process in place to assess the as-built performance of buildings. For these reasons, the Passive House Standard was adopted as the foundation of this policy. This also tied in with the BC Step Code and would safeguard buildings and property investments against the increasingly stringent future performance standards.

A series of specific by-law policies were introduced to mobilise this plan by removing barriers, introducing incentives and formulating a support structure for wide spread adoption of the Zero Emissions Building (ZEB) Plan.

Specific By-Laws include:

ZEB By-Law 1 : Green Buildings Policy for Rezoning

For rezoning applications, buildings must meet the ZEB standard. Buildings must follow one of 2 pathways:

A. Near Zero Emissions Buildings
- Passive House Certification or Living Futures Institute Zero Energy Standard (Living Building Challenge)
- Energy System Sub-Metering and Reporting
- Low-Emitting Materials

B. Low Emissions Green Buildings.
- LEED Gold - Building Design and Construction
- Performance Limits - increased Thermal Energy Demand Intensity (TEDI) and/or lower Greenhouse Gas Intensity (GGI) levels
- Airtightness Testing
- Enhanced commissioning of energy systems
- Energy System sub-metering & reporting
- Refrigerant Emissions and Embodied Emissions calculation & reporting
- Verification of direct ventilation
- Low Emittance Materials
- Indoor Air Quality Testing
- Integrated Rain water Management & Green Infrastructure
- Resilient Drinking Water Access

"Across the City of Vancouver, the new incentives for complying with the Zero Energy Building Plan have been extremely well recieved. With 20% of all new developments now targeting the Passive House Standard, a major transforamtion to a green economy is taking place ."

Chris Higgins
City of Vancouver

ZEB By-Law 2 : Zero Emissions Building Catalyst Policy

For buildings targeting ZEB standard:
- Density concessions of up to 5% floor area
- Discretionary acceleration of planning approvals for Multi-Residential projects
- Relaxations of some regulations around setbacks, footprint, massing, envelope and façade requirements which would otherwise act as a barrier to the adoption of the ZEB standard.

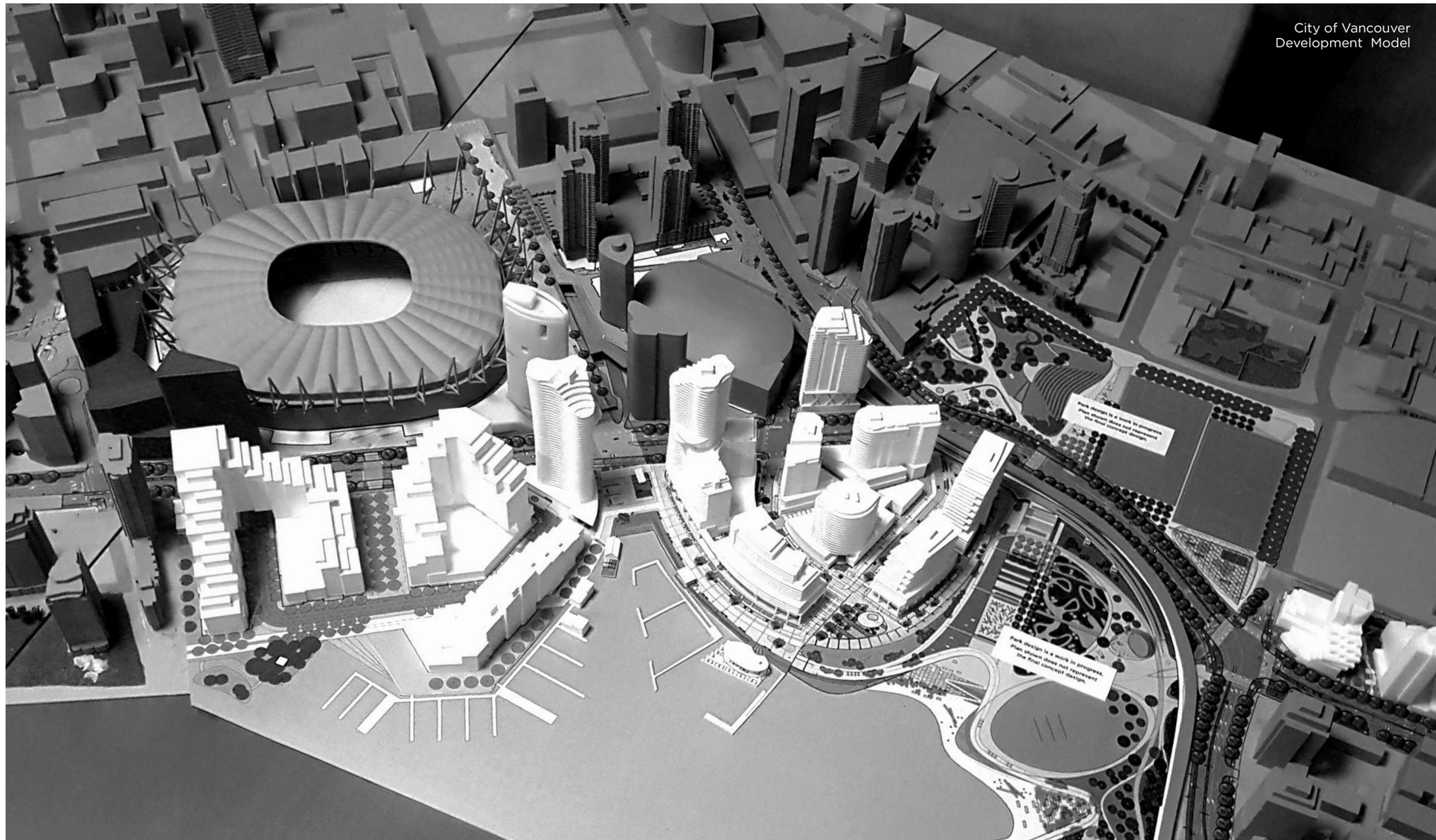
ZEB By-Law 3 : Higher buildings Policy

Aimed to promote the leadership of large scale sustainable development by incentivising ZEB through twopathways:
- Passive House Certification
- Specific energy performance targets based on building type plus the connection to district Low Carbon Energy System (renewable grid)

ZEB By-Law 4 : Supporting Policies for Passive House Buildings

A. Conditional Relaxations and guidelines for Small Scale & residential

B.Conditional relaxations and guidelines for Large Projects
Some of the key details covered by theses by laws assist architects, contractors and developers meet the passive house certification by addressing aspects such as:
- Energy modelling guidelines
- Policies and information specific to Passive House
- Shading devices and yard projections
- Solar hot water and photovoltaic installations
- Roof mounted energy and green roofs
- Floor space exclusion for thermal insulation



City of Vancouver
Development Model

Case Study #1 : Vancouver, Canada

Industry Insights

"British Columbia's leadership in building standards not only improves affordability for homeowners, but offers economic opportunity with better, healthier, and more resilient buildings for everyone. We look forward to working with our industry and government partners to ensure the required skills and technologies are available throughout the province."

Rob Bernhardt
CEO,Passive House Canada [9]

Behind CoV's transformational building policies, is a huge cohort of independent industry organisations that have tirelessly advocated for these changes. The following is an inexhaustive overview of actions and strategies employed in and initiated by various levels of the industry.

Consultation

CoV recognised that this would not be an easy task for the construction industry to suddenly adopt the ZEB standard, so they undertook extensive consultation with the industry in order to pro-actively address any concerns, and seek solutions which would be mutually beneficial. They arrived at a detailed list of relaxations and processes specific to different scale projects that target the ZEB standard, and subsequently Passive House Certification. A formal guideline document was created for both small scale residential and large scale projects. A summary of the Guidelines for Larger Projects [6]

Upskilling

The City of Vancouver (Cov) is acutely aware that change needs to be introduced incrementally and supported from all angles in order for the wider construction industry and property market to adapt.

The CoV emphasise the importance of supporting the front runners in the industry. For this reason, over 100 CoV staff have undertaken formal training through an accredited Passive House education provider. This enables the CoV to assess whether a project is on track to achieve certification or not, and to proactively pick up any discrepancies between planning, design and delivery processes. The type of passive house training is suited to the role of the staff member. For example site inspectors would undertake the trades course.

The city of Vancouver facilitates this training for their staff by partnering with local organisations. Passive House Canada (PHC) is the national accredited training provider for the Certified Passive House Designer/ Consultant courses. In return for subsidised training, the CoV provide access to training spaces in their building. This in turn supports more formal training to be provided to the industry and accelerates the industry upskilling process.

Further to this, the CoV partnered with British Columbia Institute of Technology (BCIT) to provide a 50% subsidy for the Certified Passive House Tradesperson course. This is open to anyone in the building industry and has proven highly successful in growing local supply chains for specialised buildi ng services and components.

Wayne Hand, the Dean of the School of Construction and the Environment, British Columbia Institute of Technology (BCIT) states that BCIT supports the needs of industry in advancing the state of practice in sustainable construction through education and trades training. They work proactively w ith the Province to advance the Clean BC vision of a zero carbon building sector. [9]

BCIT is a publicly funded polytechnic offering technical education and vocational training. The School of Construction and the Environment provides specialised training spaces which facilitate practical learning through demonstration and engagement with high performance building technologies and construction methodologies.

Knowledge Transfer

The Zero Emissions Building Exchange (ZEBx) is an independent organisation which was specifically created to help British Columbia achieve its emissions reduction goals through the built environment. It is formally hosted by the Vancouver Regional Construction Association, with City of Vancouver, Passive House Canada and the Open Green Building Society as key partners. [7]

ZEBx acts as a local Centre for Excellence which was initiated under the United Nations Commission for Europe (UNECE) alongside four other nodes, including the Be-ex in New York (Building Energy Exchange) and the BBRI in Brussels (Belgium Building Research Institute). The primary goal of this network is to disseminate and deploy the Framework Guidelines for Energy Efficiency Standards in Buildings to form scalable and transferable solutions to decarbonising the built environment globally.

ZEBx is focussed on increasing the public, private and civic capacities for zero emission buildings though curated research, training and organised events such as tours of projects under construction. Their work to date assisted with the dissemination of knowledge both locally and internationally and has simultaneously fostered and strengthened a supportive community within the local industry. It provides a platform to support industry leaders and innovators by connecting them to solutions, and supports regulators by collecting industry data to assess impact, identify barriers, and recommend actions for building capacity. [9]

Passive House Canada is the Canadian affiliate of PHI that ties together the local high performance building industry. It is a not for profit organisation that has established itself as the initial port-of-call for people, both in and outside of the building industry, who want to learn about ZEBs (Zero Emission Buildings). They offer a wide range of training suited to all levels of expertise and provide a range of useful resources, such as handbooks, guidelines and an extensive project database. They also organise frequent events, tours and industry gatherings to share knowledge and foster a strong suportive community.

Lateral Support

Pembina Institute acts as an industry resource and policy advisory service at a federal level. As a national organisation of approximately 50 staff spread across Canada, it plays a pivotal role in the country's transition to a carbon neutral economy. This is done by co-creating policy solutions based on external validation from research, analysis and collaboration with industry.

The work Pembina Institute undertook was fundamental in the federal government decision to integrate the BC Energy Step Code with its national Climate Plan, committing to develop a 'net-zero energy ready"'model building code with the goal that provinces and territories adopt it by 2030.

"The Pembina Institute connects the dots between government, the wider industry and the overarching climate objectives at a federal level."

Karen Tam Wu,
Managing Director, Pembina Institute

The Pembina Institute also played a key role in the development of the BC Energy Step Code. This code exceeds both the federal and provincial building codes, aligning instead with the goal of all new buildings achieving a net-zero standard by 2032. This is linked with long term goals of strengthening the local 'green' industry and economy, as well as (and perhaps more importantly) meeting the targets Canada committed to in the Paris Agreement.

Pembina's supporting research covered the identification of ways to overcome market barriers, such as economic viability, social desirability, industry skill and supply chain shortages to enable effective adoption of energy efficiency measures in new buildings. This also extends to research around ways to incentivise and advocate for higher performing buildings though industry education, public awareness and support to empower municipalities to lead by example.

To date, over 50 municipalities have adopted or referenced the BC Step Code in their bylaws and building policies. This has also been largely accelerated by the BC Energy Step Code Handbook for Building Officials. The handbook offers those who do not have a building background an over view of the basics of air-tight construction, energy modelling and metrics that form part of BC Step Code. It also offers guidance on the processes, compliance requirements and the role officials need to play. It was the result of funding and collaboration between a series of independent organisations including Natural Resources Canada, BC Hydro, Building Officials Association BC and ZEBx. [8]

Passive House Canada & ZEBx social event
"Passive House Under Construction"
17th April 2019

Case Study #1 : Vancouver, Canada

Design Insights

“Changes to the national building code that allow for taller wood buildings take effect next year, but we’re not waiting to get started. Our government is ready to work with communities to build safe, secure and green, tall wood buildings that will create jobs, grow B.C.’s value-added sector and realize our low-carbon future.”

John Horgan
Premier of British Columbia

Since the introduction of strategic by-law policies, the uptake of the ZEB standard has been monumental. The number of buildings targeting Passive House Certification as a result has jumped from just one certified project in 2015, to a staggering 2,000 residential units by 2019. This represents 20% of all new development in progress or in the planning process.[5] These statistics are reflective of the industry’s willingness and capability to step up to new ways of working and the associated challenges and risk that change brings.

There have been a number of trail blazers in the construction industry who have shown both foresight and tenacity in trialling and advocating for new ways to design buildings to meet these rigorous targets.

Timber Construction

BritishColumbia has a long standing history of timber trade. Forestry and logging fuelled Vancouver’s economy for most of the 19th Century , leaving a lasting legacy of a well-established timber industry[11]. Combining this with Vancouver’s new building policy around operational and embodied carbon emissions, architects have launched on the new found opportunities within prefabricated timber construction.

In terms of achieving the benchmarks of the Passive House standard, timber offers a huge thermal performance advantage over other forms of construction. It out performs concrete by 10 times and steel by 400 times in terms of insulation properties[13]. This is a big advantage for projects in Vancouver targeting Passive House certification as part of the ZEB standard.

Timber construction also offers a lighter weight construction option, greater seismic durability and biophilic design properties compared to masonry, concrete and steel - another very appealing aspect for architects to adopt timber. With pressure from the construction industry, B.C.’s building code has been amended to enable buildings to reach new heights.

Thishas been the result of proactive advocacy and design proposals from architecture firms such as Lang Wilson Practice in Architecture Culture (LWPAC) and Perkins and Wills, who have big ambitions for timber construction in Vancouver. Many firms are forming collaborative ventures with government agencies, not-for profit societies and grant providers, to provide innovative solutions in the housing sector in particular.

Other firms have adapted their long standing business-as-usual models to incorporate new technologies and performance targets. Perkins and Wills is a global architecture firm, undertaking multiple timber projects across North America. One of the most recent, is Vancouver’s Earth Tower, which consists of a 40 storey tower with mixed use podium and integrated parkland. This is one of many large scale project taking advantage of the ZEB By-laws, which allows additional height, massing relaxations and rezoning opportunities.

Prefabricated Construction

One of the biggest benefits of timber, is its ability to be manufactured offsite for accuracy, quality control and speed of construction. Prefabricated solid panels, lightweight framing and volumetric modular systems open up new design opportunities for architects.

“Styles and trends will come and go, but energy efficiency is here to stay.”

Matheo Durfeld, BC Passive House

BC Passive House was the first company to produce a prefabricated certified passive house construction system. Headed up by Matheo Durfeld, the firm was born after he was commissioned to build the first passive house project in Whistler - the Austria House. This was built for the 2010 winter Olympics Games and was funded by the Austrian Government, Austrian Passive House Group and the Austrian Paralympic committee with the vision of sharing eco-friendly technology with the world. The building was left in situ as a legacy and blueprint for the future.

Thi project marked the beginning of a new era of building for both the Whistler area and Vancouver. The next project Durfeld undertook was the Rainbow Passive House - a duplex which acted as a key marketing tool and display suite for what soon became a steady flow of passive house work. This was Durfeld’s intention from the beginning - to one day only take on work that resonated with the core values upon which the company was based. It was clear from the outset, that a prefabricated approach would enable this quality of building to be realised more effectively than the traditional onsite methodologies used to date.

A purpose factory was a key part in the company’s evolution. Designed by Hemsworth Architecture, the building became the physical manifesto of the company’s values and methodology. A combination of cross laminated timber (CLT) structural panels, glue-laminated timber (GluLam) post and beams and light weight timber walls were used to construct the 1500sqm production floor, office and show room. The office overlooks the production line with the capability of showing visitors without disrupting activity. The workmanship in every element, from structural connections, down to the carefully routed timber ceiling panels for integrated lighting, displays the capability of the BC Passive House.

John Hemsworth, director and founder of Hemsworth Architecture, extrapolated Durfeld’s brief into a beautifully detailed, elegant yet functional piece of architecture. Visiting this building revealed how this collaborative approach between architect, builder and energy perfromance has elevated it from ‘just another factory’ to a precedent of what the future of design and construction could be.

The quality of indoor environment was of upmost importance to Durfeld and Hemsworth. It was equally as important for potential clients to experience the difference of a passive house building compared to a “standard” building, but also for all staff to enjoy the same level of quality as they were supplying. For this reason the showroom and offices were passive house certified and where this was harder to achieve on the factory floor, a hydronic heating system was installed in the ground slab. This heating system is fuelled by offcuts from the fabrication process. Further to this, high level windows allow solar gains and natural light to reduce energy consumption as well.

"Modular, mass timber and Passive House is a perfect fit. The low energy performance standard is inherent in our building systems due to specifically designed construction details for an airtight, well insulated and properly ventilated envelope."

Intelligent City, LWPAC [14]

BC Passive House Plant
by Hemsworth Architecture &
Dürfeld Constructors
Photo by Ema Peter Photography

Since founding BC Passive House, the panelised construction system has been constantly optimised and developed by Durfeld and his team which consists of carpenters, inhouse passive house designers and trades people who undertake the shop drawings and fabrication processes respectively. The work flow has been optimised over the years as well, taking advantage of 3D modelling to coordinate the increasing scale and complexity of projects. With an influx of multi-residential developments, the next phase of the company's evolution will be to expand in workshop floor area, storage areas and Computer Aided Manufacturing equipment to expediate fabrication.

The potential for prefabrication is still evolving. To date there have been huge leaps in the integration of digital design and manufacturing methodologies which are being applied for greater productivity and coordination. Timber is easier to route for service penetrations than steel and concrete for example, and, with the option of undertaking this process offsite, alleviates issues of quality management. Due to the airtightness requirement for passive house certification, this offers a considerable advantage for builders by reducing the risk of unwanted air infiltration often caused by on-site rough-ins by sub-contractors.

Metric Modular is a company that specialises in 'warm-shell' volumetric modular buildings. This entails a building being constructed either as a whole, or as parts which can be fitted together onsite. All cladding, interior fit out and services are prefabricated in an factory for optimum time and resource efficiency. Tom Faliszewski started his career as an architect and now leads the innovation department of the company. His professional career was fuelled by his passion for high performance building outcomes, and making them accessible to the masses. Metric Modular have constructed numerous social housing and First Nation housing projects on limited budgets.

Bella Bella, by Metric Modular, was Canadas first multi-modular certified passive house project. Passive house was a logical choice due to the limited operational budgets - no additional heat would be required once the dwellings were inhabited.

"Previous winter energy bills for the Yale First Nation were in excess of $250 for one month. The energy bill they received after over a month of occupancy was under $20. This on-going savings will make drastic and lasting impact to the economics of this community."

Modular Advantage Magazine, Nov 2018 [18]

Due to the extreme location, building materials were required to be transported via barge, so completing as much offsite as possible was critical in order to meet both time and budget constraints. It was estimated that it would have taken 2 years to build onsite, opposed to 7 months start to finish as a prefabricated system.

Meeting the airtightness was also a deciding factor to use a modular system as quality assurance in a factory environment is far higher than onsite. Having a weather sealed envelope prior to leaving the factory proved to illiminate rework of interiors due to exposure to bad weather during the build process.
The Bella Bella project was completed in 2015 for the Coastal Health Authority and since, the Metric Modular have constructed numerous similar projects across BC to help mitigate the affordable housing crisis. Their preliminary airtightness testing is now no longer required, due to the confidence in their well-rehearsed building processes for modular Passive House projects.

More recent entrepreneurial companies that combine real estate, technology, architecture, construction and software development are popping up across Vancouver to take advantage of these opportunities. For example, LWPAC have established an integrated urban housing company called the Intelligent City which utilised a digitally integrated end-to-end service of design and construction for 4-16 storey mixed use communities. They have also developed a mass timber modular construction system which offers flexibility and adaptability to various building typologies and program requirements - the Platform for Life system.

Construction of a Community

Jennifer Cutbill is an architect at Local Practice & Design, who sees architecture as a way to create positive impact far beyond the boundaries of a specific site.

Jennifer explained that "architects are generalists. We bring new perspectives to problem solving. Architects can think at multiple scale, from the urban context down to the building as a detailed system. The specifics of the individual solutions can be provided by the engineers. We have the opportunity to lead the conversation, pose the right questions and join the right dots."
It is important to share stories from successes and lessons learned both within the architectural profession and beyond it. Disseminating knowledge between disciplines and sectors will strengthen the momentum that the front runners have made to date, and allow them to pave the way for the Late Majority to adopt their new business-as-usual to the Zero Emissions Building strategy.

Jeniffier Cubill shares her knowledge on the subject of regenerative design for example, by teaching at University of British Columbia (UBC), speaking at key industry events and contributing to the American Institute of Architects (AIA) Committee on the Environment (COTE®). This committee is comprised of passionate architects that work to advance, disseminate, and advocate design practices that integrate built and natural systems and enhance both the design quality and environmental performance of the built environment.[10]

Thereis so much opportunity for innovation and leadership in the green building sector. It became clear that the overarching culture in the architectural community in Vancouver is one that lacks competative secrecy. Instead everyone is open to sharing learnings, advice and any innovative solutions they have come across in the process of completing a passive house project.

The unanimous moto for the design community in Vancouver can be put down to the following quote:

> *"We must simply grow the pie so everyone's piece gets bigger."*

Shaun St Amore,
Zero Emissions Buildings Learning Centre and
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Earth Tower
by Perkins + Wills

A proposal combining both Passive House and mass timber constrution to meet the ZEB Plan

Case Study # 2 : New York City, U.S.

“NYC wants to be the front runner, not the runner up, in the race to protect the climate and achieve resiliency of our city.”

Tom Eisele,
NYC Mayors Office of Sustainability

New York City has taken a significant leap in 2019 by introducing a stringent mandatory law on emission reductions in order to meet the goals set out by the overarching One NYC 2050 plan. This plan identifies that there is only a window of 30 years to reverse carbon emissions to pre-industrial levels if we are to avoid catastrophic breakdowns of our climate, ecosystems and, ultimately, civilization as we know it. The next 10 years are identified as critical in making the required headway to meet the required targets in time.

Broadway, NYC
Photo taken 19.04.19

Case Study #2 :
New York City, U.S.

Policy Insights

"Virtually no other standard other than the Passive House Standard delivers low energy buildings that can meet our [80x50] goal"

Tom Eisele , NYC Mayor's Office of Resiliency - Land Use & Buildings

Municipal : City of New York

History

The link between buildings and emissions within policy was made back in 2007, when the Greener, Greater Buildings Plan which was developed as part of the PlaNYC climate action proposal. This was particularly noteworthy as it began the ground work upon which future policy could be based. It required all large buildings to benchmark their energy consumption, run audits and report back to the City of NYC on the buildings' performance. This enabled a huge amount of data to be retrieved on all major buildings across the city.

In 2015 the OneNYC was introduced with an aggressive goal of achieving an 80% emission reduction by 2050 (the '80 x 50 Plan') based on 2005 baseline. Agencies, such as the Building Energy Exchange (BE-ex), were committed by the Mayors Office of Sustainability to research possible pathways to fulfill this goal.

In 2016 the Retrofit Accelerator was established by the Mayor de Blasio. and based on the performance data retrieved. It sought to increase the benchmark of existing buildings being upgraded to meet the energy targets prescribed by the Passive House RetroPHit Strandard (and all new buildings to meet the Passive House Classic Standard (15 kWh per square metre /annum). In addition to the international resources available from the Passiv Haus Institute, the program offered support by assigning a team of local 'energy advisors' to each project.

The Passive House standard is seen as the leading building performance standard by the city as it is based on a scientific approach with a clear methodology verification. Perhaps the biggest draw card of using this rigorous standard, was the quality assurance aspect of the as-built outcome. It supersedes other popular rating systems, such as LEED, as it is not reliant on a 'points based' mechanism of assessment. These new and highly stringent energy targets resulted in the city implementing a Stretch Code, much the same as the one implemented in British Columbia via the BC Energy Step Code.

Vision

Having identified the building sector as contributing up to 70% of all GHG emissions, the city has focussed on reducing the operational energy, not only for new buildings, but also the existing building stock. The goals NYC are targeting are extremely ambitious, but should be viewed as healthy completion in terms of global climate protection. It is important to note that other parts of the state of New York record that buildings are responsible for approximately 40% of all GHG emissions.[1] This demonstrates that densification of the built environment cannot be treated separately from emission mitigation efforts.

One NYC 2050 Plan

1. Transition to 100% renewable energy by 2050
2. 80% reduction in emissions by 2050
(Targets based on 2005 emission levels commonly referred to as the 80x50 target)

The Climate Mobilization Act

'On April 18, the New York City Council passed the Climate Mobilization Act (CMA), an ambitious legislative package aligned with the City's 1.5°C Climate Action Plan. This plan represents New York City's commitment to the carbon drawdown targets set out in the Paris Agreement, pledging the city to carbon neutrality by 2050.' [2]

Christian Bergland
Building Energy Exchange NYC

As stated by the Mark Chambers, Director at NYC Office of Sustainability, there are no exemptions from this bill - everyone has a role to play in decarbonising the building sector. He also points out that this bill will save lives - by increasing the resiliency of buildings to protect occupants from severing climatic conditions. It is anticipated that by 2030, this bill alone will avoid 30 to 50 annual deaths and up to 150 hospitalizations each year.[3]

In addition to protecting health and wellbeing, this bill also seeks to protect the economy of NYC. Based on current trends, it is anticipated that 26,700 jobs will be created by 2030. In reality the green economy is likely to grow at a much faster rate due to the trajectory laid out by this Act. [4]

"This bill looks at carbon as the new currency"

Mark Chambers,
Director NYC Office of Sustainability

There are 4 key components of the Climate Mobilization Act that impact buildings:

1. Local Law 92 & 94
Green roof and Solar PV

This law applies to all new buildings and expansion (or extensive structural work) requiring all available roof space to be utilised for green roofing and/or solar PV cells. The primary aim of this law is to reduce the urban heat island effect. There are several exemptions and incentive programs being developed to help overcome challenges of the implementation of this law.

2. Local Law 95, 2019
Building energy efficiency grading

As an amendment to Local Law 33, 2018, all buildings over 25,000 sqf will be required to publicly display their energy efficiency rating. Effective as of October 2020, this will help to create awareness and transparency around energy efficiency and encourage building owners to comply with Local Law 97. It is also a method of recognising proactive front runners.

3. Local Law 96, 2019
Financing programs and supporting legal mechanisms for sustainable energy loans

An imminent challenge around implementing this suite of laws, will be the financial implications on building owners. A private loan program is being set up to allow landlords to carry out building upgrades sooner.

"Reducing harmful emissions from buildings is critically important to our carbon neutral future and a vital part of New York's aggressive strategy to curb the impacts of climate change and stimulate green economic development,"

Governor Cuomo, NYC [6]

4. Local Law 97, 2019

Commitment to reducing GHG emissions to specified levels

This law builds on from the Environmental Protection Agency's benchmarking and reporting platform "Portfolio Manager" which has required large scale buildings in NYC to report on their consumption of oil, district steam, utility gas and electricity. This has been running for the last 10 years under Local Law 87 and has enabled the city to gather extensive data on individual buildings. These records will form the basis for setting tailored future emissions reduction targets, taking into consideration a building's energy history, use and occupancy. Building owners are already familiar with this reporting process, so the transition is anticipated to be more seamless than introducing a new methodology. Accredited professionals will need to oversee the reporting, however. This is to ensure accuracy and transparency is maintained.

These 4 Laws will see the requirement for deep retrofitting of existing buildings. To ensure that affordability of housing is not compromised from these measures, there is an 'Alternative Compliance' pathway which multi-residential buildings with at least one 'fixed rental unit', can utilise. This taps into the pre-existing Retro-commissioning program which sets out clear aspects of a building that will need to be upgraded, replaced or repaired in order to increase the energy efficiency of the building as a whole.

The city has created an Office of Building Energy & Emissions Performance to oversee, administer and enforce Local Law 97, 2019. They will form an Advisory Board of 16 members which will be tasked with consulting the industry and understanding specific barriers and challenges that specific buildings may face (eg unique typologies or mixes of use). This advisory board will then provide recommendations to the Minister of Buildings and NYC Mayors office of Sustainability & Resiliency on ways to measure, report and support building owners meet their emissions reduction targets. As part of Local Law 97, there will also a study conducted into a Carbon Trading Scheme for buildings.

Building Excellence Competition

To accelerate the industry adoption of the specific laws within the Climate Mobilisation Act the city has announced an $18 million investment in a building Excellence Competition. This mimics the highly successful strategies that Brussels deployed, with the bold aim to not only promote energy efficiency in buildings, but also to promote high calibre design and architectural merit. The scheme will both financially assist project teams as well as act as a local and international recognition platform for the winners - ie the 'early adopters'. The competition is now up to its second round, with the first round awarding 53 buildings the prestigious prize.

With funds provided of up to $1 Million USD per project, applicants has to demonstrate that the proposal meets the following criteria:

- Achieves low carbon performance
- Equiped for broad adoption
- Provides superior financial benefit for owners
- Provides a healthy and safe living environment for occupants.
- Agree to provide comprehensive in design, construction and cost, enabling the number of low-to-zero-carbon buildings to increase across the state of New York.

This competition was a public private venture between Governor Andrew M. Cuomo and New York State Energy Research and Development Authority (NYSERDA). It is governed by an Advisory Council comprising of a diverse array of industry representatives from the design, property and sustainability sectors with partners including American Institute of Architects New York State, ASHRAE and The Real Estate Board of New York.

The winners of the first round are currently on display at the Building Energy Exchange, in the City of New York Council buildings.

"The Buildings of Excellence competition is a dramatic commitment to stimulate leading examples of very low carbon buildings. BE-Ex is excited to support this program by showcasing these inspiring high performance projects in an exhibit at our NYC centre of excellence and delivering educational programs based on their innovative solutions, providing every building decision-maker the confidence and know-how to act and help put New York State on a pathway toward carbon neutrality."

Richard Yancey, FAIA, Executive Director, Building Energy Exchange

BE-ex
Exhibition, training & demonstration space
NYC

Case Study #2 : New York City, U.S.

Industry Insights

BE-ex
Exhibition, training & demonstration space
NYC

As was witnessed in Vancouver, the industry was the driving force behind the recent laws around climate protection in the built environment. There were several key players driving this - from local and international organisations to passionate individuals who tirelessly advocated for higher building standards across the state of New York.

Fostering International Networks

The Building Energy Exchange (BE-ex) has played a fundamental role in tying NYC to the international community of high performance buildings. It was formed under the United Nations Commission for Europe alongside four other nodes, including the ZEBx in Vanouver (Zero Energy Building Exchange) and the BBRI in Brussels (Belgium Building Research Institute).

The vision of these centres is to disseminate and deploy the Framework Guidelines for Energy Efficiency Standards in Buildings around the world. In other words, they are local nodes in an international network, trying to understand how a low energy building standard, such as Passive House, might be applied across the entire building sector as a scalable, transferrable solution to decarbonising cities.

Richard Yancey, Executive Director at BE-Ex, led a delegation of industry leaders and government representatives on a tour of Brussels in 2015 to learn from their journey to date in decarbonising their built environment. The result of this trip was a concise and water-proof list of recommendations to NYC policy makers outlining the challenges, opportunities and strategies around incorporating the Passive House Standard into building regulation.

BE-ex published the report called “Passive NYC - A snapshot of low energy building opportunities, barriers, & resources” which became the first of many publications to follow. There is now a huge data base on the BE-ex website which offers the construction industry and government support equally. Hosting regular events is also another highly successful strategy to disseminate knowledge to those leading the charge in low-energy buildings. The recent series has focussed on the Climate Mobilisation Act and its implications on building design, delivery and management.

Tom Eisele, New York City Mayors Office of Sustainability, stated that the whole industry needs to be targeted if NYC is to reach its goals and become a world leader in climate action. The City of New York support the BE-ex through the provision of a physical space for events, training, demonstrations and exhibitions, which demonstrates thier undivided support for the industry. This space has become the focal and meeting point for the industry leaders and early adopters to undertake training and upskilling.

Accelerating Uptake

New York Passive House (NYPH) and the North American Passive House Network (NAPHN) also works with BE-ex to deliver training, organise industry events, coordinate research and initiate wide reaching advocacy initiatives. Upskilling and educating the industry has formed a major focus for the City of New York.

Founded in 2010, the New York Passive House (NYPH) was initiated by a group of like-minded professionals who saw the need for energy efficieny. It began as an un-official meet-up and has since developed into a strong non-profit with members from diverse professional backgrounds.

> *“Throughpublic outreach, education, and advocacy, the team at NYPH works to promote the Passive House standard for a healthy, comfortable and energy-efficient built environment.”*
>
> *New York Passive House (NYPH)*

NAPHN operates in a a similar manner, but was set up to help support the affiliates across North America, providing cohesive and consistent support, advice and advocacy. Collating and distributing resources between affiliates has bridged barriers in knowldge sharing and collaboration. Events are regularly held to further assist this important netowrk of affiliates form stronger and more impactful partnerships.

> *“The Building Energy Exchange (BE-Ex) is a centre of excellence dedicated to reducing the effects of climate change by improving the built environment. BE-Ex accelerates the transition to healthy, comfortable, and energy efficient buildings by serving as a resource and trusted expert to the building industry.”*
>
> *Building Energy Exchange (BE-ex) NYC*

Public Demonstration

In addition to industry upskilling, there has also been a focus on educating the market and general public on the importance of more stringent building standards. Ice Box Challenge was first initiated in Belgium as a public demonstration of how a ‘code compliant’ building compares to one built to the Passive House Standards. This entailed the construction of two small envelopes built to each standard to be exhibited in a highly activated public space. Each box held a mass of ice weighing between 650Kgs and 1 Tonne. The event would take place for one whole month, revealing the amount of ice left inside at the end of this period. Public engagement was encouraged through guessing competitions, real time data display, live demonstrations and education sessions throughout the event. It was supported by the Brussels-Capital Region, Brussels Invest & Export (hub. brussels), A2M Architects and the Passive Platforme Maison Passive (PMP).

The origin of the event can be traced back to Brussels. After the success of the event there, it moved to Vancouver where the City of Vancouver hosted the demonstration with the support from Passive House Canada, ZEBx, British Columbia Institute of Technology and 475 High Performance Building Supplies.

The City of Vancouver then donated the Ice Box to NYC in 2018. The NYC event was supported by the Brussels-Capital Region and Brussels Invest & Export / HubBrussels, Building Energy Exchange, NYC Mayor’s Office of Sustainability, NYC Department of Transportation, Garment District Alliance, A2M Architects, New York Passive House, North American Passive House Network, 475 Building Performance Supply, Steven Winter Associates, SYNLawn, and Ice Box donation from the City of Vancouver.

In 2019, the Ice Box Challenge reached Australian shores with the event taking place in the peak of summer in Melbourne as part of the Sustainable Living Festival . Hosted by the Australian Passive House Association, the results were extremely revealing. In the NCC compliant box, the 750kgs of ice had completely melted 3 days before the end of the event whilst 143kgs of ice still remained in the PH compliant envelope by the end of 12 days. This demonstrated to ther public how effective the Passive House standard is in hot climates.

In the New York Ice Box Chellenge, the results revealed the following:

- The Passive House box is, ice melted to 58%
- The Standard Building Code box, ice melted to just 7% [13]

This is a true testament to the perfromance difference between code compliant buildings and the dramatic increase in comfort, resilience and energy efficieny that can be provided by integrateing the Passive House principles into buildings, regardless of their geographic location.

The Ice Box Challenge NYC
Photo by Alexandre Ayer Photography

The Ice Box Challenge NYC
Photo by Alexandre Ayer Photography

Public demonstration project showcasing the difference in perfromance between the building code and the passive hosue standard.

Case Study #2 : New York City, U.S.

Design Insights

It is important to note that change is not always influenced by large or prominent organisations alone. There are thousands of humble individuals across the world who make small, yet important, advocacy moves to help initiate higher climate protection efforts. In New York City, there are several noteworthy architects, who have shown true, unwavering leadership in this space. They have stood their ground firmly over the years despite dismissal from the market, government (federal) and even peers in the industry who didn't believe it would be possible to transform the majority of NYC's building stock to be efficient, resilient and healthy.

Supporting Innovation

For over 10 years, Ken Levenson had been an architect in NYC. Although his work was largely focussed around sustainability, it wasn't until stumbling across the Passive House standard in 2010 that he truly connected the dots between performance and design. At the time, the passive house standard was only just beginning to gain traction in the U.S. and this is when Ken saw the hurdle to wider uptake - the supply chain. Identifying the urgent need to support other architects and builders realise energy efficient buildings, he founded a company which would streamline the sourcing of specialised products and support the industry with the appropriate technical information. Through initiating this company, 475 High Performance Building Supplies, Ken has been instrumental in making Passive House buildings achievable right across North America.

Ken is also a board member of NYPH and a founding member of NAPHN. Ken is more than an architect with a vision for changing the building industry for the better, he is a passionate entrepreneur with a long term strategy to tackle climate change head on through the built environment.

Ken urges the industry to not fear change or competition. Expanding our networks, gathering like-minded allies and working with government are all key in creating meaning full impact.

Implementing Innovation

Deborah Moelis, senior associate at Handel Architects NYC, and was the lead Architect on, what was at the time, the tallest Passive House building in the world. The House at Cornell Tech is situated on Roosevelt Island in New York City. It has not only become a significant landmark on the NYC skyline, but also signified a major milestone for New York's green building sector. Deborah explained that the combination of a visionary client, open minded developer and highly skilled consultant and construction team created the perfect conditions to push the boundaries of what the future of sky scrapers could be.

To design and construct this ground- breaking building, the architectural team researched and oversaw the implementation of a host of new products, procedures and innovative details. Sketches showing overlapping vapor barriers, tape methods, continuity of insulation, and thermal separation of metals became the new normal for the construction site. Keeping the project on time and on budget required a major coordination effort on the architect's part — communicating Passive House needs and technologies among agencies, contractors, 19 separate consultants, and 3 client bodies.[9]

Beingthe first building of this scale to aspire to the Passive House standard, it made sense to keep the construction as conventional as possible to mitigate cost premiums. This meant a cast in-situ concrete structure, however to mitigate risk around meeting the air-tightness requirement of 0.6ACH@50Pa, a prefabricated façade system was adopted to ensure all window and cladding elements were sealed in a secure, quality monitored environment offsite. Prefabrication of the façade also lent itself to a faster onsite construction time which resulted in greater cost-effectiveness.

Since opening its doors to students in 2017, The House at Cornell Tech has not only saved 882 tonnes of CO_2 per year[10], but has become an inspirational beacon for local and international architects, builders, other educational institutions, and municipalities. The innovation distilled in this project has been an important catalyst for wide spread change in the industry and has opened up minds to the viability of incorporating Passive House in 'business-as-usual' regardless of this scale and typology of building.

After successfully completing the project, the Handel architectural team became adamant that the Passive House methodology should be the default route taken for all buildings that are owner-operated, with savings in ongoing energy bills easily offsetting any upfront increase in construction costs. Innovation and change can often trigger an increased construction cost due to percieved risk however, as the Passive House Standard becomes more common place, the cost will come down through a flattening of the learning curve and maturation of supply chains.

Distributing Innovation

Both Ken Levenson and Deborah Moelis have become acclaimed international keynote speakers, aiming to share the lessons learned, the challenges and the successes encountered throughout the design and construction of their passive house projects. Deborah explained in an interview that Handel Architects are dedicated to changing the way buildings are built - from optimising the indoor environmental quality for healthier occupants, to ensuring a higher quality constructed outcome for durability, to mitigating the impact our building have on the environment by lowering their operational energy consumption. She has become a passionate advocate for the Passive House methodology as it allows her team to achieve their goals of quality and performance in a verifiable way, yet still with the freedom to innovate throughout the design process. Using PHPP as a tool to test and run iterations in order to optimise performance and design outcomes has been a game changer for her firm. [11]

> *"Embrace disruption. Innovation means change, and change brings opportunity."*
>
> *Ken Levenson, Founder & Director at 475 High Performance Building Supplies NAPHN and PHNY*

Baxt Ingui architects have also made their mark in the NYC high performance building scene. With the retrofitting of the existing building stock being a primary focus in NYC, the team embarked on some of the first Brown Stone passive house retrofits in the area. Seeking a greater outlet to share some of their learning on these projects, and to exchange knowledge and news beyond their immediate architectural circles, they set up 'The Passive House Accelerator' . This is a not-for profit platform that provides another layer of connection between members of the international Passive House community.

From these findings, it can be concluded that archictects will continue to play a leading role in driving New York's transition to carbon neutral built environment, and ultimately, lowering the carbon footprint of their entire city.

> *"The Passive House Community is creative, driven, and Collaborative. Passive House Accelerator has been created to make it easier for others to learn about Passive House, to support the community by allowing them to share ideas and solutions, to continue and expand on the incredible conversations and sessions at conferences, and to allow those who are succeeding in creating beautiful projects and/ or solutions to share their knowledge."*
>
> *Passive House Accelerator* [12]

Importance of Retrofitting

Retrofitting the existing building stock holds arguably, the greatest potential for positive impact when it comes to reducing the CO_2 emissions of our cities. Approximately 66% of all building area that exists today will still be in use in 2050. With renovations only contributing to 0.5-1% of all building stock annually[14], we are putting the current efforts of meeting the targets set by the Paris Agreement at serious risk if we are to only address the efficiency of new buildings.

We also run the risk of the ageing building stock becoming burdens and ‘stranded assets’ i.e. buildings which are unfit for purpose in a changing climate and un-lettable, unsellable and, ultimately un-occupiable.

Baxt Ingui Architects, are one of many architecture firms tackling this challenge of ‘deep-retrofits’ in NYC. They have plunged into the deep end of restoring heritage listed residences, proving that the needs of the future can be met without compromising the history of the city

Images on this page shows one of the firm’s restored brownstone building that was the first Passive House certified home in Manhatten, marking the beginning of a revolution in deep retrofits across the New York City. It demonstrates how the existing building stock can be approached to unlock huge potential in energy savings, health and historical preservation.

IMAGES
Manhattan’s First Passive House, 2016
Manhatten, NYC
Architect: Baxt Ingui Architects
Passive House Consultant : Sam McAfee
Photo : Peter Peirce, Inc.

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Case Study #3 : Brussels, Belgium

Brussels has become a true source of inspiration for many cities around the world who wish to make dramatic and effective changes to their building policy in order to reduce their carbon footprint.

The city elevated the status of its building standard from one of the poorest in Europe, to an international precedent of best practice in less than a decade. It is recorded that in 2001 there was 250megajoules of energy lost per metre squared of building envelope, which was more than double that of other countries throughout Europe. The directive on energy efficiency that came into effect to mitigate climate change, was the initial spark which ignited a regional uplift in building performance and the associated overhaul of the entire construction industry to meet it. [1]

It is important to note that a group of government delegates and industry leaders from both Vancouver and New York, chose to visit Brussels while formulating their own strategic building policies around climate protection. These included the founding members of the Building Energy Exchange, ZEBx and local policy makers.

Cultural Centre & Brussels Environment by Architectenbureau Cepezed
Photo taken 30.04.19

Cultural Centre & Brussels Environment by Architectenbureau Cepezed
Photo : Leon van Woerkom

Case Study #3 : Brussels, Belgium

Policy Insights

“The passive house concept was an existing high performance standard, with a developed calculation method, so it seemed a logical choice... No other high energy performance standard came into our mind.”

Joke Docx
director for energy,
Brussels Environment

Being a heavily populated, land locked region, Brussels had little choice than to explore the energy efficiency of buildings. It could not rely on methods of offsetting their current inefficiency with large scale renewables such as hydro or wind generated power. The appointment of Evelyne Huytebroeck as Minister of Environment and Energy in 2004 , saw the beginning of building policy reform towards carbon neutrality.

Targeting the built environment to reduce state-wide emissions was both a logical and strategic move by the government. With mounting pressure from leading organisations cross the construction industry, such as the A2M architects and the local industry associations, a new policy instrument was launched to kick start the transition to a zero emission built-environment.

Exemplary Building Programme

The Brussels Exemplary Building Competition, commonly known as Batex, was launched in 2007 across the Brussels-Capital region to promote the design and construction of buildings to meet a series of strict environmental criteria. This took the form of a financially subsidised competition, with winning buildings being awarded EUR 100 per square metre of built area that met the Passive House Standard. Incorporating the benchmarks, principles and quality assurance methodology of the Passive House standard into the criteria for the Batex programme was a strategic decision by the government. [2]

Passive House was known as a pre-established, tested and proven methodology of reaching strict energy efficiency demands, and with the in-built auditing by the Passivhaus Institute in Germany, it alleviated pressure off the Brussles government to develop their own assessment tools. The Passive House Planning package (PHPP) was an accessible tool that both design teams and the government could use and interrogate easily. In addition to using this tool to predict the performance, all Batex buildings were required to regularly report to the Brussels Environment Administration on energy consumption. [5]

The Batex Programme ran until 2013, with 6 calls for entries totalling 243 buildings across Brussels Capital. By the time the final projects reached completion in 2015, there was 620,000 sqm of built area that met the rigorous Passive House Standard[6]. This was a true testament to how the industry could adapt in a short period of time, sending a clear message to the next cycle of political leadership that this could indeed become the base line standard for all building.

With €45million dedicated to the Batex Programme, by 2012 it had already generated €319million in turnover and created over 1200 jobs[7]. Not only did it boost economic growth, the programme also initiate the revitalisation of some of the most economically disadvantaged areas. Municipalities of areas such as Gare de Bruxelles-Nord, benefitted by the ability to increase the quality of social housing stock and community child care facilities with projects such as the mixed use development known as Linné-Plantes, designed by A2M Architects. This was just one of many developments that helped inject optimism in downtrodden areas.

The Brussels ‘Passive Standard’

The Batax program was not only a way to spur on the front runners of the building industry, it also encouraged others to take the leap too, moving swiftly across the chasm between the innovators to the vast majority. The support grew for the vision of a PEB Passive 2015 Standard (colloquially referred to as the ‘Passive Standard” which was a modified version of PHI’s Passive House standard. Although containing some minor differences, it abided by the same net heating and cooling requirements, primary energy consumption, ventilation, and airtightness benchmarks as the ‘Classic Passive House Standard’.

With mounting pressure placed on policy makers, the bold move was made to write it into the law, taking effect in 2015 and appli ed to all new housing, offices and schools, and heavily renovated projects across the region.

A growing portfolio of building performance data and financial evidence showed that that this would be a decision which would revolutionise the city into becoming a global leader in environmental protection and prosperity in terms of quality of life and economic growth. It was hard to argue against regulating it.

Regional Commitment and Support

The commitment and backing by the regional government was instrumental. A series of financial subsidies that had evolved since 2004, were significantly increased to incentivise various sectors according to both their programmatic needs and changed performance requirements. For example the subsidies for insulation, energy efficient heat pumps and solar hot water systems were doubled, while the double glazing subsidy was tripled.

Other financial support mechanisms included a frame work of green social loans with zero interest. These were targeted at lower income families, upgrade works to existing buildings where upfront investment can at as a barrier. Loans between €500 to €20,000 helped overcome the long pay-back periods of some of the construction works but also enabled owners to benefit from the lower living costs due to reduced energy consumption.

Larger scale education, commercial and community buildings were also targeted through energy subsidies, which accelerated the uptake across all sectors of the built environment and diversified the innovation in construction methodologies, supply chains and green technology. [3]

An important factor in making this standard of building financially viable lies with those involved in the design and delivery of these projects. With the Passive House approach, the cost of achieving the desired performance of both energy efficiency and optimal indoor environment, cannot be controlled by an ‘adding-on’ mechanical systems. The performance is heavily controlled by the wholistic design, with particular attention needing to be paid to the external envelope.[3]

Case Study #3 : Brussels, Belgium

Industry Insights

Brussels, as a region, has been extremely proactive in fostering strong industry support networks both within the construction sector and surrounding it. The government has played a major role at facilitating this from the top down, but equally, non-governmental and private organisations have made a significant impact from the bottom up as well. Some of the key strategies implemented are as follows:

Strengthening Network Nodes

A network is only as strong as the sum of its individual parts. The strengthening of each node of this network, whether it be a privately operated institution, government run organisation or not-for-profit entity, has been vital for Brussels in its transition to a 'greener' construction industry.

Sustainable Building Facilitator Network (SNFN)

The Brussels Government collated a network of highly experienced specialists to assist individuals and organisations embarking on projects aspiring to the Passive House Standard[1].This network was established in 2008 to meet the demand for tailored, independent consultancy and guidance for all project stages. This was the "phone a friend" service which helped project teams work through issues on a case-by-case basis. This was particularly useful for the first passive projects undertaken, becoming less necessary as experience was gained over time and with each subsequent passive house project.

The Employment Environment Alliance (AEE)

The brussels Government recognised the need to both stimulate and laterally support the market for more environmentally responsible buildings. The Employment Environment Alliance (Alliance Emploi-Environnement or AEE) was set up to act in this capacity. Instead of defining priorities and imposing respective solutions from the top, the government calls on key stakeholders to propose solutions.[8]

The AEE brought together public, private and non-government organisations industry bodies involved with environmental protection to collaborate on strategies for the construction sector to grow employment and support organisations meet sustainability goals in order to remain competitive.

A couple of examples of the work that the AEE has undertaken are the establishment of an online "one-stop" resource for information on eco-building and a series of training programs specifically designed for upskilling job seekers.[3]

Brussels Enterprise Agency (BEA)

Created in 2003, this was yet another highly successful initiative of the Brussels government which provided unbiased consultancy for start-ups in the construction industry. This was a free service, however was offered on a selective basis to businesses that showed particular promise in the areas of innovation in the green building sector.

BEA formed the "Eco Cluster" which acted as an umbrella incubator for over 50 organisations including architects, engineers, eco-product suppliers, property developers, renewable energy companies and education institutions. The BEA offered members of the cluster networking opportunities, educational seminars, a platform for knowledge sharing and ultimately, an active and supportive community united by the same goal - to decarbonise buildings.

Belgian Building Research Institute (BBRI)

This independent research institution was founded in 1960 by the National Federation of Belgian Building Contractors. It has over 200 staff who provide supportive scientific and technical research, assistance and advice to members. [9]

"Since the beginning of our policy in 2006, we have seen the emergence of more architects and contractors with experience in passive house and the availability of more [passive] products."

Joke Docx
director for energy
Brussels Environment

Connect, Collate & Communicate

Platforme Maison Passive (PMP) and Pixii (previously known as the Passive House Platform, or PHP) are two sister not-for-profit organisations leading efforts around the advocacy of energy efficient construction. Pixxi serves the Flemmish part of Belgium and is known as the "knowledge platform for energy neutral building". PMP serves the francophone portion of Belgium.

Their activities are mirrored, including consultation with the industry and government bodies and the provision and development of resources, events and professional development courses to their membership base. They both work collaboratively with SNFN, BEA, AEE, BBRI and the regional government department, Brussels Environment.

Tailored Education

The need for training and upskilling grew in parallel with the increasing uptake of the passive house standard. Both pre and post integration with the Brussels-Capital Regional building code, a broad spectrum of training initiatives unfolded. These have been provided in unison by industry organisations, regional government and educational institutions. PMP, PHP, BBRI and Brussels Environment were just some of the key providers of various education programs. It was identified that the formation of strong partnerships with all stakeholders was fundamental to transitioning business as usual to the passive standard. This led to training becoming more targeted at a specific audiences involved with the construction industry - from builders, architects and developers to federations, tertiary education institutes and vocational trades schools. Further to this, Brussels Environment have also set up programs to integrate educational round sustainable development in both secondary and primary curriculums.

Tailoring the Passive House training to the needs of each stakeholder forms a large part of the strategy to upskill the industry. For example, PMP have developed a focussed series of training modules which rotate in a continuous cycle throughout the year. This allow architects, developers, building managers, end users to enter training at a level suitable to their pre-existing knowledge and fit the training in with their respective schedules. This format was developed in lieu of the standard two week intensive and fulltime course which many international affiliate organisations still offer. Adapting the course to reflect the immediate needs of the industry was a priority for PMP.

Training programs are not just structured to deliver knowledge in a single direction though- they have been carefully sculpted to facilitate the lateral sharing of information between attendees too. Creating a dialogue and community within each target group has proven highly successful in delivering a peer support network where an architect can call on another fellow architect for advice or guidance.

Another fundamental strategy of any training provided both in Brussels or internationally, is to address the global vision first, and the building second. Linking the role that the built environment plays in the overarching world-wide goals around climate protection helps to contextualise any new approaches, that are being suggested, such as the Passive House standard.

"...after two or three years everybody was fulfilling passive house. It was really the market that went to passive house."

Sebastian Moreno-Vacca
Director, A2M Architects

Case Study #3 : Brussels, Belgium

Design Insights

Architects have played an instrumental role in increasing the building standards across Brussels and have demonstrated the importance of architectural thinking in guiding this process. Sebastian Moreno-Vacca is the founder and one of three directors of A2M Architects. The firm started as a humble practice in 2000 and has since expanded from Brussels to include satellite offices and projects in North America, Africa and Europe. This expansion has taken place due to their extensive experience in delivering buildings that meet the passive house standard and successfully integrating new disciplines and workflows in their design process as a result.

The Fourth Dimension of Design

Julie Wilhem, Co-director at A2M, explained that there is a fourth dimension to architecture which is shaping the way the practice approaches design. This dimension is energy. Understanding how building performs over the course of a day, a season or year is highly impacted by the energy flows within and through the building fabric. The dynamic nature of energy will impact the experience of a space - whether that be temperature, light, moisture, materials or occupants themselves. The tools to dynamically model, predict, analyse and optimise the interior atmosphere of buildings can be seen as a "pen" for architects - enabling a new type of drawing to unfold.

Software programs such as Vlux (day lighting), Grasshopper (parametric design), WUFI (Hygrothermal analysis) and Ladybug (environmental simulation) in combination with the PHPP (Passive House Planning Package) allows for a highly informative design process for high performance buildings. The team at A2M is interdisciplinary with both architects and engineers operating under the same roof. Energy flows in buildings are not linear, and so, the design process and inhouse workflows need to reflect this. All design staff are trained to calculate energy demands, and likewise, all thermal engineers are integrated in the design process.

A2M recently published "Permacity" - an urban concept inspired by permaculture and the circular flow of energy in the lifecycle of buildings. It calls for buildings to be designed around the principles of optimal energy performance and long term resilience. The passive house standard ensures the most effective low tech approach, and is no longer a question, but a necessary condition of the architectural design.[10]

Architects as Ambassadors

With pressure to address climate change continuing to increase, the importance of sharing knowledge and inspiration between cities and nations around solutions and effective strategies has become more and more critical. A2M recognised the need for advocacy at an international level around the key role the architectural profession plays in climate protection.

A2M Architects, have become an ambassador for high performance, resilient and future proof buildings. The directors, Sebastian Moreno-Vacca, Julie Wilhem Andaline Branders have delivered numerous key note speeches at major architecture events around the world, sharing their insights with how 'Brussels went Passive'. They have stressed the need for the profession as a whole to embrace the responsibility of building performance, by pushing beyond aesthetics to incorporate the language of energy in the design process too. They have also emphasised the importance of addressing energy as a fundamental design parameter, and its integral role in the future of the profession in a rapidly changing world.

One particular type of training they developed was a hands-on workshop which demonstrated how some of the most historically influential, modernist architectural masterpieces could be redesigned to meet the Passive House Standard. This included dissecting the notoriously sleek details of the Farnsworth House by Mies Van Der Rohe, reconstructing them to be thermally broken, insulated and airtight while still maintaining their design intent. He created a series of interactive tasks that utilised physical props, such as coloured string to represent the various building membranes. Despite being a fairly simple and non-technical approach, it has proved highly successful in communicating the core principles of the passive house standard and how they can be used to empower architects. This 'simple and fun' approach also helped dissipate any preconceptions about the complexities of building physics. This workshop was first given to the New York Chapter of the American Institute of Architects in 2016, and has been re-created at a number of international events since.

Sebastian urges all architects to expand their horizons - to work beyond the bounds of their job description and to blur the boundaries between disciplines to push the boundaries of what can be achieved. There is no need to reinvent the wheel - the technology, skills and knowledge to decarbonise our buildings already exists. He is a firm beliver that, as architects, we just need to tap into these resources, connect the right dots, and guide the desired outcome. Essentially he urges architects to take responsibility for the impact buildings have on both people and the planet.

> *"Designing without the awareness of architecture's inherent capacity to provide comfort and delight passively is like trying to draw or build whilst being blindfolded....*
>
> *The language of energy needs to be integrated in the vocabulary of architecture"*
>
> *Sebastian Moreno-Vacca & Julie Willem*
> *Directors, A2M Architects*

Acknowledge & Inspire

be.Passiv Magazine is a quartelly magazine publication (that has since become digital), initiated by both the PMP, Pixii and A2M architects. This glossy, coffee table magazine was distributed to each and every architect in the Brussels region, showcasing the most growndbreaking architecture and innovation in the space of sustainable, low energy building. All buildings published were constructed to the passive house standard, helping to show how this standard is not restrictive, but instead helps drive innovation through intergated design principles.

'be.passive' is also intended for the public authorities, engineers, manufacturers suppliers, builders and any actors in the real estate sector.

Increasing Transparency

A2M believes transparency is key to wide spread success of the "passive building". One of the most regular and persistent questions A2M is asked by other architects and stakeholders, is around the "cost". This is a topic which is traditionally not openly disclosed. In addition to covering the topic of cost in workshops and presentations, the firm has published numerous articles that offer detailed case studies on recent projects and useful advisory notes.

Some of the key design aspects related to the passive house standard that impact cost are:

- Compactness of built form - The ratio of floor space to external envelope has significant cost implications. Geometric thermal bridges (corners) may need to be balanced out by increasing the thermal resistance of other parts of the envelope for example.
- Proper use of analysis tools - Use of PHPP to assess performance against cost to arrive at the most feasible solution in both the short term (capital expenditure) and long term (operational expenditure & pay back periods based on energy consumption).
- Retrofit Vs new-builds will usually require customised approaches to existing conditions such as wall build-ups and structure where as new buildings can utilise pre-designed, standardised a construction approaches.[10]

Belle-Vue Brewery & Apartments
A2M Architects
Photo : Georges De Kinder

Belle-Vue, Hotel
A2M Architects
Photo taken 30.04.19

Some of A2M's most note-worthy projects that demonstrate cost-effective outcomes include:

The Belle-Veu Brewery
Brussels

This adaptive re-use project transformed a disused, dilapidated brewery into a 150 room hostel and adjoining 14 unit apartment block. Designed to the Passive House Standard it was completed in 2015 as one of the final Batex scheme buildings.

Managed under the Meininger Hotel group, the first year of operation demonstrated energy savings ten times lower than other hotels of similar size and occupancy. This equates to an annual energy saving of 109,674 Euros.[11]

Anvers-Simons,
Brussels

Winner of the Batex scheme in 2012, this government owned mixed-use project incorporates a primary school, a kindergarten and 21 units of affordable housing. A2M's proposal was one of 4 entries that incorporated the Passive House Standard and therefore qualified under the funding scheme. It came as a surprise that the estimated construction cost was less than other entries that only aspired to 'low energy'. Proof was certainly "in the pudding", with final build costs coming in at 90% of the planned budget of the winning tender. Furthermore, the development achieves an energy saving of 19,026 Euros per year compared to other projects of a similar program and scale. [11]

Embassy of Belgium and the Netherlands.
Kinshasa, Africa

Completed in 2017, this 5,769sqm Passive House Certified building broke all preconceptions of the applicability of the standard in a hot and humid climate. The building demonstrates a performance uplift of 70% (ie uses 70% less energy to cool and dehumidify) compared to other local newly constructed projects of a similar scale. A2M won the design and construct bid as it also came in at the lowest delivery cost saving an estimated 7.4 Million Euros. In addition to this, energy savings over the projects life time are anticipated to be 43,000 euros per year.

The key to the success of this building was the rigorous and iterative design process for the façade to optimise cost efficiency, performance and aesthetic outcome . The rhythm, inclination and perforation of the shading system was exposed to this objective analysis, forming a framework for the subjective design process. [11]

A2M Architects represent just one of the many practices across Brussels that have had a significant impact on raising the quality of buildings on a city wide scale from the bottom up. Combining this passion and determination with top-down leadership from the Government and the support of the broader construction industry, the city of Brussels has become an international role model for climate protection through the built environment.

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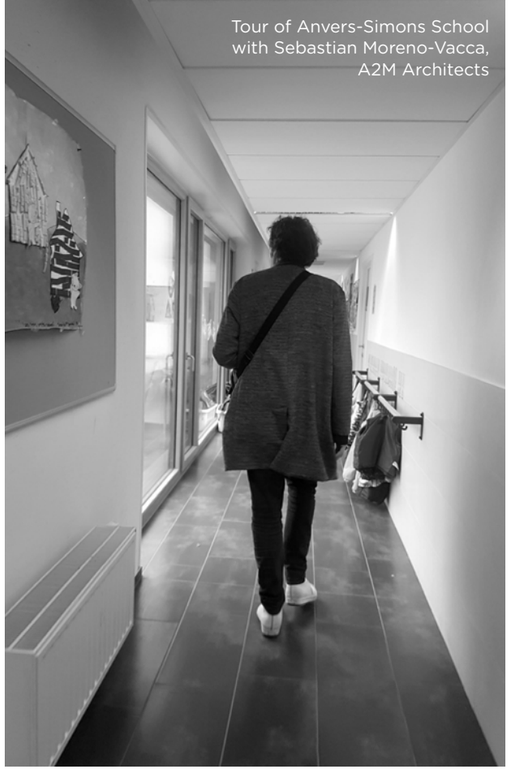
Anvers-Simons
by A2M Architects
Photo : A2M

Anvers-Simons
by A2M Architects
Photo : A2M



Tour of Anvers-Simons School
with Sebastian Moreno-Vacca,
A2M Architects

WorkshopbySebastianMoreno-Vacca
A2M Architects
“Redesigning the master’s details”

BE-Passive Magazine

Conferences

South Pacific Passive House Conference 2019

Date
8 -10th February, 2019

Location
Wellington, New Zealand

Host
Passive House Institute New Zealand (PHINZ) & Australian Passive House Association (APHA)

The South Pacific Passive House Conference was held in Wellington this year, hosted by the Passive House Institute of New Zealand (PHINZ) . Every year this event alternates between Australia and NZ with the purpose of generating a stronger network and knowledge transfer between members of the local passive house community and wider industry.

The NZ Housing minister, Phil Twyford, gave the opening address setting the tone for the rest of the conference acknowledging the important link between the quality of housing and public health, pressures on the welfare system and issues of affordability. He clearly communicated the urgency to address energy efficiency of housing in parallel with efforts to improve indoor environmental quality. He stated that 600 premature deaths per year are attributed to the incapacity of housing to retain a stable temperature and control interior moisture levels. With the "Leaky Building" epidemic, the construction standards have been under scrutiny for several years - this is no new topic, but requires more rigorous intervention than has been witnessed so far.

Elrond Burrell, director VIA Architecture and Chair of PHINZ, kicked off the proceedings with some words of wisdom. Havin spent 10 years in the UK leading some of the most noteworthy large scale Passive House projects with the architecture firm, Architype, he has become an acclaimed international key note speaker, and a key driver of the passive house movement in the south pacific region. He urged Australia and New Zealand to the consider "quality" as well as "quantity" when dealing with our respective housing crisis'. With an overpowering emphasis currently on quantity, we are locking in substandard performance and long term negative outcomes.

> *"Inhabitants will be condemned to the impact of our decisions"*
>
> *Elrond Burrell, Director VIA Architecture*

Despite acknowledging that there is still a long journey ahead to reach a building standard that supports the health of both people and the planet in equal measure, the rest of the conference presented some remarkable steps that are being taken in the right direction.

Emma Osmundsen presented the work she has been undertaking with Exeter City Council in the UK. Similar to the City of Heidelberg, they decided to set up a development company in order to deliver the type of buildings they wanted. Through this strategic venture, they committed to only delivering projects that met the Passive House standard in order to meet the council's triple bottom line targets - optimising benefits for people, the environment and financial return so the council can sustainably continue to deliver projects of this calibre and upscale their efforts.

Through various pilot projects in the social housings sector since 2010, they have recorded improvements to occupant health (both physical and psychological) and cost parity against buildings constructed to the national standard. One occupant reported not needing to turn central heating on at all during winter and their respiratory health issues had all but disappeared since living in first generation of Passive House projects completed at Silverberry Close. The council has now completed four generations of Passive House projects, with the next development anticipated to push new boundaries. The community leisure centre is targeted for completion in 2020 and will be the world's first passive house certified building of its kind.

More inspirational government leadership was presented by Chris Higgins from the City of Vancouver. The Zero Emissions Building Plan has revolutionised their trajectory towards a 40% reduction in embodied carbon and an 80% reduction in operational emissions for all new buildings by 2050. They are also aiming 100% of energy to be supplied though renewable sources in that time frame too. The city has strategically weaved the Passive House Standard into their building by-law policies to help incentivise a more rapid transition to the energy efficient resilient buildings they require in order to full fil their climate goals. (See case study #1 for full details).

In the local context, Rochelle Ade, PhD Candidate at Auckland University, presented the actual and perceived cost uplifts of applying the passive house standard to social housing projects in NZ. With the perceived cost being 8% higher than the estimated 10% actual uplift (should it be applied today) highlighted the power of psychological influence when dealing with any sort of change. This topic was explored further by Jess Berentson-Shaw, Co-Director at The Workshop which is an organisation specialising in research and training around communication techniques and strategies for effective impact. She calls herself an "evidence agitator", combining facts and behavioural science to remove barriers in communication chains and generate support for new ideas.

This is particularly important when advocating for any sort of shift in attitude or to counter balance existing preconceptions that are subconsciously embedded . For example, the common statement of "that sounds complicated, therefore it must be expensive" is simply a preconception which may or may not be based on real evidence.

Andy Marlow, Director of Envirotecture and oard member at APHA, also presented a case study on the cost of passive house buildings. He presented a cost comparison for a residence in Sydney that was originally designed to the Passive Solar principles, but was upgraded to the Passive House standard mid documentation. By using the PHPP tool to test the feasibility and performance of different construction systems, the final contract price of the passive house version turned out to be much lower than the original passive solar option. This exemplified that the Passive House Standard can be achieved at a competitive price, with the caveat that all parties (client, builder and architect) remain committed throughout the process

Several other case studies were also presented from around the South Pacific region, including Australia's recently completed Gillies Hall for Monash University's Peninsula Campus. This 150 bed student residence was constructed from a mass timber in a tight timeframe of just 11 months. This is currently the largest Passive House building in the region and proves that this rigorous standard can be achieved at scale.

Like Australia, New Zealand also suffers from lack of political action in the improvement of building standards. It is clearly the industry that is leading the way to a more resilient, sustainable and healthy future.

Conferences

Heidelberg Passive House Conference 2019

Date
3rd- 5th May 2019

Location
Heidelberg, Germany

Host
Passive House Institute (PHI) & International Passive House Association (IPHA)

With the 2019 International Passive House conference being held in China later in the year, the Heidelberg conference became predominantly geared towards the European region. Unlike the international event, this conference was far smaller and more intimate, with 350 delegates in attendance and including key note addresses by Dr Wolfgang Feist (founder of the Passive House Standard) and numerous local government representatives from across Germany. The conference ran in four parallel sessions with presentations of key case studies and research from around Europe and the UK, panel discussions, technical and policy workshops as well as an extensive trade exhibition of innovative building products and technologies from around the world.

Perhaps the strongest message that could be taken from the conference was the importance of leadership by government at a local level. The Lord Mayor of Heidelberg, Prof. Dr. Eckart Wurzner, opened the conference with a poignant message - that local government has both the capability and responsibility to show true leadership in climate action. Having a background in environmental science, he is deeply committed to making Heidelberg a pioneer for best practice in climate protection. With the new suburb of Heidelberg-Bahnstadt becoming the largest zero-emissions precinct in the world, the bar has been set high already.

The city took the reins by purchasing 116 hectares of disused land adjacent to the main train station. It then formed its own private development company to deliver a whole new township which was to provide 6000 new dwellings as well as community amenities such as schools, day care centres, parkland, retail, entertainment and even a new fire station. As the land owner, the city was able to dictate the development policies - the passive house standard formed the operational performance criteria for all buildings and it was mandated that 100% of its power would need to be supplied by renewable energy. To do this, a micro-grid with a biofeul district heating system was constructed.

Other aspects of sustainability were also addressed, including rain water management via green roofs which reduced the excess water ingress to nearby ecosystems by up to 70%. These also acted as additional thermal insultation to assist with the energy efficient of the buildings.

Emissions from the construction process have also been concidered - with all cut and fill soil restricted to stay within the site boundary. This alleviated a considerable about of transportation energy and disruption to nearby neighbourhoods. A network of ponds also assist to retain excess rainwater, and add to the biophilic beauty of green space that weaves through the development.

Emission free transport is also encouraged via provision of extensive cycle connections and an electric tram. Personal car use is accommodated but disincentivised through subterranean access and an urban planning strategy heavily prioritising pedestrians. Car and e-bike charging stations are supplied in all underground carparks.

The city went one step further, though, and commissioned a large scale heat storage system, commonly known as the "Energy Park". The winning competition entry for the Stadtwerke Heidelberg Energie Park + Storage Building was won by LAVA in collaboration with A24, White Void, Priedemann and Transsolar. The proposal incorporates a dynamic, sculptured facade, and also houses a knowledge hub on sustainable energy. It is intended to be fully accessible to the public and will become an iconic landmark on the city skyline - a visual representation of the Heidleberg's innovation and leadership in sustainability.

The Bahnstadt precinct saw the creation of over 6000 new jobs in the green economy, either directly in the construction sector or the research and development of supporting industries such as electric mechanics and renewable energy technologies.

> *"If you don't invest in zero emissions you are throwing away your investment"*
>
> *Prof. Dr. Eckart Wurzner,*
> *Lord Mayor of Heidelberg, Germany*

With a heavy emphasis on the importance of knowledge dissemination, the City of Heidelberg has committed to sharing its experience and lessons learned from Bahnstadt to help initiate and facilitate global progress in decarbonizing the built environment.

Heidelberg was not the only city showing inspirational leadership though. Christiane Staab, Lord Mayor of the City of Waldorf, gave an emotional speech about the need to think globally but act locally. For this reason, her municipality has mandated that all buildings on city owned land are to meet the Passive House standard as a minimum. Financial incentives are also offered to encourage the front runners in return for energy monitoring data.

> *"Climate protection and fire protection need to be considered equally in building design - fire is a perceived risk but may not ever be experienced. The impacts of climate change are a guaranteed risk however. We need to take a leaf from Greta Thornburg's book and act as if our house is on fire. "*
>
> *Christiane Staab, Lord Mayor*
> *City of Waldorf, Germany.*

Professor Michael Braum, Managing Director of the International Building Exhibition Heidelberg (IBA), urged the audience to consider the impacts of lifestyle - efficiency is important on one hand, but sufficiency also needs to be factored into the equation. By considering what is truly sufficient to survive and to consciously reduce our overall consumption day-to-day should not be underestimated. Perhaps the phrase "waste not, want not" would be the English translation of this moto.

Despite Germany being at the heart of the European Union's Nearly Zero Energy Building (NZEB) regulations, they, like many other nations, are still not on track to fulfil this obligation by 31st December 2020. This became apparent in some of the plenary discussions around the current emission reduction trajectory and the role of the built environment in achieving the overarching goals of the Paris Agreement. Franz Unterstellar, Minister for Environment and Energy of the State of Baden Wurttemberg, stated that being a role model requires going beyond what is required by law.

Prof. Wolfgang Fiest, founder of the Passive House Institute, gave a key note speech on the challenges that are afoot, including the uncomfortable acknowledgement that the coexistence of civilisation as we know it will no longer be viable if urgent action is not taken today.

> *"A gradual transition to a sustainable economy can work: presuming, however, that we start now at the latest. This means no new fossil fuel power plants...., no new vehicle lines with internal combustion engines, and in the long run no more fossil fuelled heating systems in our buildings."*
>
> *Prof. Wolfgang Fiest, Founder*
> *Passive House Institute*

The topic of "how" we will achieve this was then covered in more depth in some of the presentation streams. The widespread uptake for any sort of change is directly linked with accessibility and affordability. The Affordable Zero Energy Buildings project (AZEB) presented some of the work they have been undertaking in this space to identify the challenges around delivering Passive House buildings on mass. One of the key drivers for savings identified, was the need for stronger lines of communication between design and construction teams from the outset of a project. Early Contractor Engagement contracts were found to help optimise performance whilst driving both build and consultancy cost down. Getting all stakeholders to commit to the value proposition from the beginning and to include performance guarantees in agreements will also assist establish the responsibilities of each party, keeping costs in check.

AZEB have developed a series of useful tools, training modules and resources for the industry, including a 27 step methodology to help guide projects towards Net Zero Emission goals. This resource is free and applicable to any project irrespective of location.

Marcus Lembach provided an architectural perspective, stating that we need to step away from the 'extravagant-for-the-sake-of-extravagant' and provide more humble, honest designs, where form has function and function provides added value to the end user, stakeholder and planet in equal measures. SØren Dietz, partner at Bjerg Arkitekten, reinforced this message by emphasising the role of the architect in driving projects to a Net Zero Energy status. Architects are employed to manage the vision of a project and it therefore our responsibility to communicate the end goal effectively to all parties, ensuring it is fulfilled.

Chris Herring, Director of Green Building Store and Chair of International Passive House Association gave an insightful presentation at the Affiliate workshop which took place after the main conference. Chris presented a summary of how complex systems do not change in linear ways, emphasising the need to be ready for the societal tipping points where things change rapidly and unexpectedly. Establishing the right industry and governmental support systems will be of increasing importance as we bridge the 'chasm' from ealy adopters to vast majority. How will our respective cities deliver passive house at the scale seen in Heidelberg Bahnstadt?

At the end of the conference, the main message for architects could be summarised as follows:

Climate protection is the responsibility of each and every one of us. As professionals involved in the creation of buildings, architects are in the hot-seat to make a meaningful contribution. We have an opportunity which others in our society are not privy to - to shape the world around us. So let's not waste any opportunity that we are presented with. After all, the technologies and tools are already in front of us.

Heidelberg Bahnstadt

Stadtwerke Heidelberg
Energie Park & Storage Building
Image by LAVA

B3 community center & School
Gadamerplatz, Bahnstadt
Photo : buck

Bahnstadt community
Photo: Latz + Partner

Bahnstadt walking tour
PHI + Affiliates

Neuefeuerwache (Firestation)
Bahnstadt
Photo: Latz + Partner

Conclusion

City of Sydney
Photo: ARUP

In conclusion, the findings from this reseach offer valuable insights into how Australia could increase its efforts around climate protection through the built environment on home soil. The following is a summary of recommendations which could be utilised to propel Australia's trajectory in carbon emission reductions and also overcome the hurdles in making Net Zero Emissions buildings the norm, not the exception on home soil.

Back-casting

Back casting has proved to be highly effective at reaching any type of goal in shorter periods of time. Time is something which is not a luxury in the current trajectory of emissions reductions. According to the 2018 report issued by Climate Works Australia, the property sector is only tracking towards an 11% reduction in emissions, opposed to a possible 69% reduction base on 2005 levels. [1]

Despite this the Australian Government Department of Environment and Energy state that they are committed to taking strong domestic and international action on climate change. They also state that the Government is implementing national policies to reduce emissions and adapt to the impacts of climate change in the context of coordinated global action. In line with its commitment to the Paris Agreement, the Australian Government aims to reduce emissions by 26 to 28 per cent below 2005 levels by 2030.[2]

A key focus of the Commonwealth Government's Energy White Paper 2015 and innovation agenda, is improving energy productivity to enable a reduction of carbon emissions through increased energy efficiency measures and associated market reforms. [3]

Australia's 2030 Emissions Reduction Target are supported by 3 key national policies :

1. Emissions Reduction Fund & associated Safeguard Mechanism
Supporting Australian businesses, communities and landholders to undertake activities which reduce GHG emissions

2. Renewable Energy Target
Accelerating the transition to clear energy sources by supporting uptake of renewable energy technologies by residential and commercial sector and boosting the growth of the green economy.

3. National Energy Productivity Plan 2015-2030 (NEPP)
Increasing energy productivity by 40% by 2030 (compared to 2015) via increasing efficiencies in residential, commercial and industrial energy use. The Council of Australian Governments' (COAG) Energy Council was formed to guide this process.

The NEPP specifies particular provisions for the residential and commercial building sectors. Some key ambitions are for building energy efficiency rating disclosure, improvement to compliance regulation and support for best practice[4]. Measure 31 of the NEPP specifically addresses the construction industry with the formation of the Trajectory for Low Energy Homes and potential energy efficiency changes for 2022 National Construction Code updates[5]. The timeline associated with this trajectory states that "Zero Energy Ready Buildings" should be targeted post 2028, however no specific plan has been provided.

Whilst there has clearly been some traction in reducing emissions, there is still an overwhelming opportunity to accelerate efforts.

> "51% of Australia's buildings in 2050 will be built after 2019"
>
> Australian Sustainable Built Environment Council (ASBEC)

A clear roadmap which will guide the property sector to successfully reach the overarching emission reduction goals is not only imperative but also urgent. The Provincial Energy Step Code in British Columbia offers a clear pathway and a tool by which building operators and stakeholders alike can plan for and safeguard their investments as the building code becomes incrementally more stringent over a projected period. This voluntary policy instrument could be combined with the New York City's mandate approach, with step changes being written into the National Construction Code to meet the emission reduction tradjectory.

Considering that buildings accounting for around 20 per cent of Australia's energy usage and two thirds of the buildings standing in 2050 having been built post 2019, there should be a heightened urgency to address the building sector as part of our national climate protection strategy.

As suggested in ASBEC's Built to Perform report, the government should kick start this by committing to a rigorous step change for energy efficiency in buildings, similar to British Columbia's provincial Energy Step Code [10]. This should form part of the 2022 NCC update and be accompanied by a clear implementation path for commercial and residential buildings to safeguard it's success. It should use the methodology of back casting from a specific goal, rather than incremental change which offers little assurance of reaching any formal goals that have been set.

With the scale of growth predicted for the building sector in the coming years, the window to have meaningful, long-lasting and positive impact on the national emission reduction targets has never been more pressing.

"Our education has a key role to play in addressing the ongoing ecological crisis. Our generation will encounter unprecedented social, political and ecological challenges, and we all need to respond with the urgency these circumstances demand. Architecture is an important factor in this - partly because of how it uses resources and shapes environments, but also because of the political and social systems it enables. Just as ecological breakdown is connected to many aspects of society, so too is architecture. Practitioners now and in the future must be equipped with a nuanced understanding of these connections."

Architecture Education Declares, 2019

Green Funds & Financial Support

There is currently a misconception that incorporating more rigorous performance measures in buildings will only result in increased financial burden. The Housing Industry Association has conducted research around the economic opportunities related to growing the sustainable housing market though, reporting that every $1 million of construction output creates nine construction jobs, seven additional jobs in the supply chain, and $2.9 million in economic value across the economy.[12]

By growing supply chains in the "green building sector" Australia will increase choice for consumers and drive down costs. Increasing choice still needs to be supported by increased consumer demand though. This market demand is reliant on both consumer awareness and education, as well as incentives and support from the government and financial sector.

As per ASBEC's Sustainable Homes Transition Roadmap, the development of suitable and accessible financial support is imperative to achieve wide spread change in the construction sector. The report outlines some key actions to boost the uptake of more sustainability measures in buildings. This includes training the whole property industry, implementing sustainability marketing tools and providing incentives through the finance sector such as access to green bonds.[12]

In New Zealand, ANZ has created a Healthy Homes loan package which provides a 1% saving in standard loan rates for houses that meet a the NZ 6 Homestar rating by the NZ Green Building Council.[14]

This not only drastically improves the quality of life of residents, but also provides them with resilience to adverse climatic events, lower their living costs and reduces risk of defaulting on their loan due to energy price fluctuation or poor health. ANZ have jumped on these mutual benefits not only for new homes, but also for upgrading the existing housing stock by pledged NZ$100 million for interest free-loans for improve insulation levels.[15]

Building Excellence Program

There is a huge opportunity to replicate the successful strategies of the Batex Program witnessed in Brussels. Formulating a design excellence competition with clear guide lines would be an effective way to encourage architects to step out of their comfort zone and take on new rewarding challenges.

The Passive House Standard is a robust mechanism to achieve carbon neutral buildings, so using this as this as the basis for the building performance would be a wise choice. It would elevate Australia's efforts to the world stage, alongside with New York, Vanvcouver and Brussels.

Multi-level Education

There is an urgent need to incorporate more specific training on how to achieve carbon neutral buildings at all levels. Specific tertiary and vocational courses relating to the built environment need to include more focussed education on the role of building physics, systems and technologies that will prepare the next generation of industry professionals to take more impactful action.

The integration of the built environment in early learning, primary and secondary school syllabuses is another fundamental requirement, with school buildings themselves needing to become exemplary "learning laboratories". The Anvers-Simons School in Brussels is an excellent example of how the building has become an education tool and an example of best practice to inspire the next generation of leaders.

At a tertiary level, the architecture courses in universities should have specific core subjects that ensure all students have a basic understanding of the fundamental importance of integrated design, with supporting electives to allow students to choose which aspect of sustainable design they would like to pursue. This could be high performance indoor environments, resilient building envelopes, or design for climate protection. This should all be integrated into the design studios, where innovative and creative approaches can be explored while addressing these fundamental criteria. Recently, "Architecture Education Declares" announced an open letter to the architectural community, calling for Curriculum Change to more adequately address this topic.

Education of the market and real estate sector is equally as important. More value needs to be placed on the quality of the building envelope, rather than the superficial finishes such as marble benchtops. Insulation, airtightness and correct ventilation are currently not on the "shopping list" of the average home buyer as these are not as visually apparent. Being able to communicate how a building will improve the inhabitant's quality of life, exponentially save them money and also protect them from more severe climatic shifts in the long term, should all become part of the dialogue in the property sector.

Events such as the Ice Box Challenge create the opportunity for the public and broader industry to witness how the current building standards perform in comparison to the Passive House Standard. This is not only useful to promote more stringent building regulations, but most importantly demonstrates the inadequacy of our current buildings to cope with "normal" climatic conditions let alone extreme scenarios as a result of climate change.

Supporting the Early Adopters

There is a significant opportunity to tap into the growing body of industry leaders who have already shown leadership through the adoption of voluntary performance standards and who continuously strive to exceed minimum regulated standards.

There are many widely used building energy assessment tools and rating systems that already exist at a national level in Australia, such as National Australian Built Environment Rating System (NABERS) 5 and National Housing Energy Rating Scheme (NatHERS)[7]. These have been complimented by an array of voluntary programs such as Green Star and WELL Rating. This shows that the construction industry can adjust to increasing stringency and complexity of building sustainability requirements.

The mandatory disclosure under the Commercial Building Disclosure Program has also seen an increased motivation from owners to improve the energy efficiency of large scale commercial buildings. This program requires buildings over 1000 square metres to obtain a Building Energy Efficiency Certificate (BEEC) in order to sell or lease out commercial spaces. [8] With the announcement of the Net Zero Carbon Buildings Commitment by the World Green Building Council, organisations all around the word are pledging their commitment to take urgent action and ensure their portfolios operate at net zero carbon by 2030. Along with the City of Heidelberg, the City of Melbourne, Monash University and the Commonwealth Bank of Australia have signed this pledge with more following suit each day.

Other local municipalities and private stakeholders across Australia have also shown leadership by initiating projects targeting the Passive House Standard and even the Living Building Challenge. The Wheatsheaf Community Hub for Moreland City Council and the recently completed War Museum for Bendigo City Council are just two of many large scale public buildings that aim to promote more resilient public amenity as a result higher performance standards.

The architects, consultants and construction firms involved in the delivery of Passive House buildings, currently have few local precedents to fall back on, especially those catering for complex programmatic requirements or unique climatic conditions such as bushfire zones. These early adopters will require specialist and tailored support. Government funded, industry networks and advisory services will be of increasing importance in the process of decarbonising Australia's built environment. Looking to the strategies that Vancouver and Brussels deployed would be of great benefit in making this shift both smoother and quicker.

Supporting these market leaders, who have voluntarily adopted more stringent performance benchmarks, would be an ideal target for any support or new incentive schemes.

Policy Incentives

On the 11th April 2019, the City of Sydney announced that climate change is the city's top priority and subsequently joined 34 other local councils in declaring a Climate Emergency. There has never been more pressure to follow through with impactful action.

The existing reward and incentive schemes for Design Excellence would be an ideal vehicle for an additional tier of excellence that addresses climate change. Using the criteria of the Passive House Standard would offer a viable comparison and benchmarking system by which to assess applicants. Furthermore, the resources available to assist this process are well established and transferrable as exemplified in Brussels, Vancouver and NYC. Incentivising leading architecture firms to meet a performance standard which has both a local and international reputation, would give Sydney a comparative edge in the global efforts to address climate change with more urgency.

The City of Sydney, along with other municipalities, could integrate incentives similar to those seen in the Zero Emission Building Plan at the City of Vancouver in their own Development Control Plans for example. This would not only show council leadership in climate protection, but also leadership in ensuring that resilient buildings are being provided to help improve the overall quality of life of the people living, learning and/ or working in their jurisdiction.

At a State and Federal level, there could be specific focus on sectors of rapid growth, such as owner operated buildings in education, single & multi-residential housing. The affordable housing crisis and severe shortage of schools that Australia faces nationally, should make this a logical consideration for increase federal funding. Improving the quality of the building stock available whilst lowering their operational energy requirements would not only save the government millions in running and maintenance costs, but would also alleviate pressures on the healthcare system.

Ensuring people's health is supported in the buildings where they spend most time is the first and most vital step in preventing both acute and chronic illnesses, such as asthma, pneumonia, heatstroke, insomnia and allergies which are often caused or aggregated by poor indoor environmental quality.

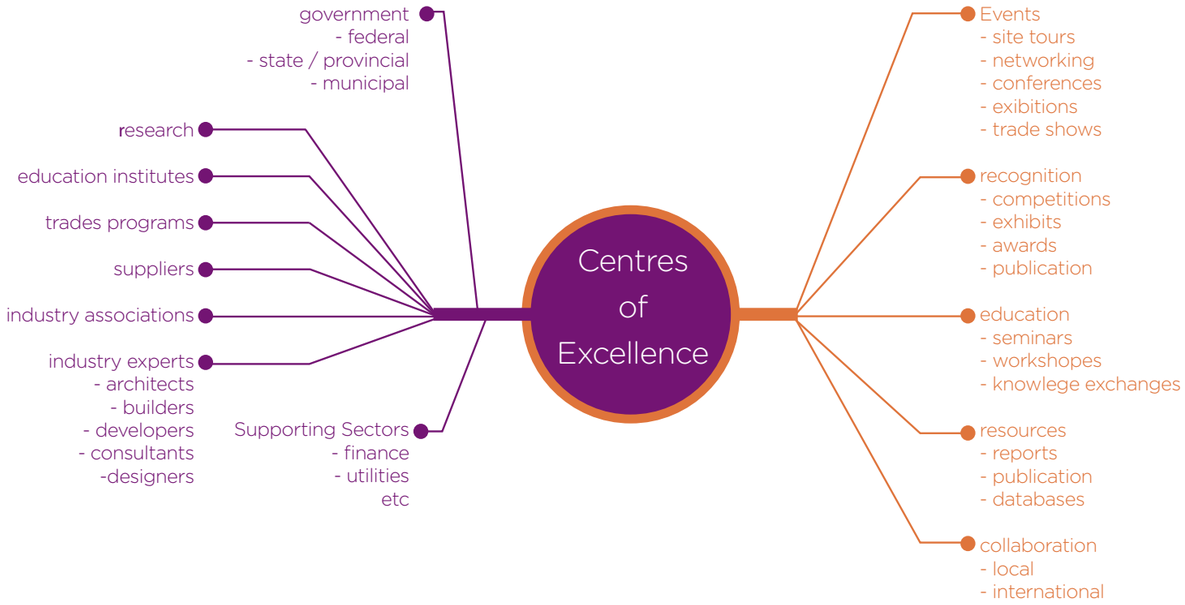


Diagram
Inputs + Outputs of a successful Centre of Excellence

Centre of Excellence

There is an urgent need for a Centre of Excellence for the wider building industry nationally. Creating an Australian branch of Vancouver's ZEBx , New York's Beex and Brussels' BBRI would be a significant step in the right direction, helping to accelerate emission reductions right across the built environment.

This would need to take the form of both a physical space as well as an online platform for centralised, unbiased support, resources and connectivity to industry networks. It should hold industry events for training, policy updates that impact the industry & exhibitions. Currently there is a fragmentation of institution research "hubs" which need to be brought together in a more unified way in order to disseminate knowledge and resources, which in turn would benefit from a broader dialogue with industry practices.

ARC programs that are federally funded could benefit directly from a platform through which to share findings, for example. It would increase exposure of findings to networks which in turn may lead to external investor interest in their innovative developments.

Whether there has been an announcement of a climate emergency or not, the impacts of climate change need to be considered and addressed proactively. The importance of improving the resilience of buildings during power outages, heat waves, severe storms or even prolonged periods of poor air quality from extensive bushfires, are becoming increasingly apparent.

With buildings standing for multiple generations, there is a severe urgency to act proactively and ensure that the buildings constructed today, will withstand the unprecedented changes that are afoot tomorrow.

Every individual, both in the construction industry and outside it, needs to feel empowered to protect both people and the plant. The architectural profession has an obligation to act on this - it is a legal duty of care.

This report aims to instill optimism by collating international insights which show that the transition to a carbon neutral economy, zero emissions built environment and healthy, resilient future, is in fact, well within reach.

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About the Author Kate Nason

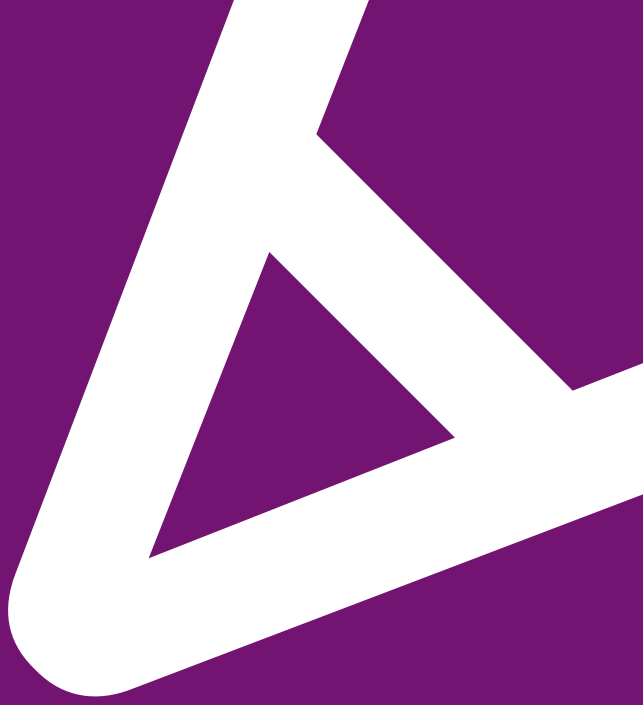
Kate Nason graduated from the University of Technology, Sydney with a Masters of Architecture, and has since become a registered Architect (ARBV) and Certified Passive House Designer (PHI).

During her studies, she always had a keen interest in the impact buildings have on both people and the planet. During her studies, her work was the recipient of both the Jack Greenland Energy Efficiency Prize and Research Scholarship between 2013 and 2014.

Having worked at several locally and internationally acclaimed architectural practices, her passion for sustainable, resilient architectural design has truly continued to shape her career. She is currently an architect in Melbourne, working in the space of environmental design, and high performance architecture which seeks to minimise the impact buildings have on the environment, increase their resiliency and optimise the quality of life for those who use them. This has also involved exploring various delivery strategies, including the role that prefabrication and modern methods of construction play in enabling Passive House buildings to be cost effective and accessible to all.

Her passion in this field has led her to become a Board Director at the Australian Passive House Association, speaker at industry events and sessional lecturer at several universities across the state. Through these activities, she contributes to the wider profession via the advocacy of integrated design strategies that will reduce the carbon footprint of cities and help us to meet our obligations under the Paris Agreement.

She seeks to continue to connect the dots between government agencies, education institutes, industry organisations and the wider community through her work as an active advocate for the important role each individual can play in protecting our planet.



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