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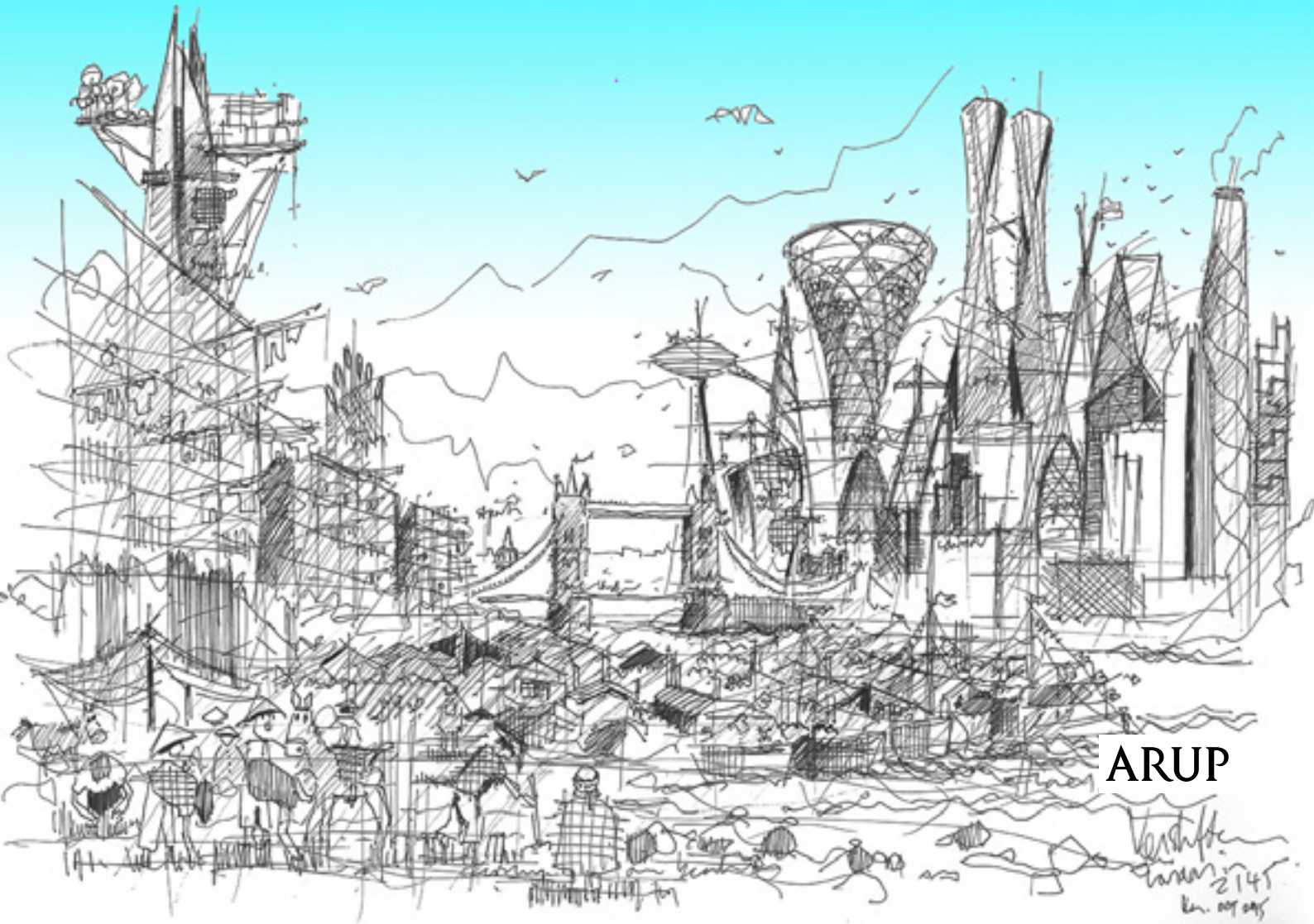
VISIT TOMORROWLAND

BUILDINGS FOR A SUSTAINABLE FUTURE



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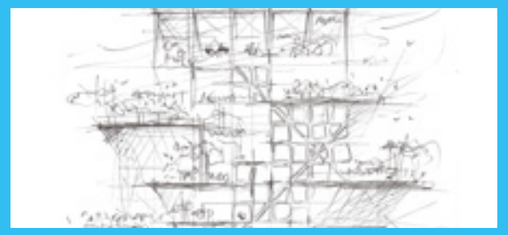

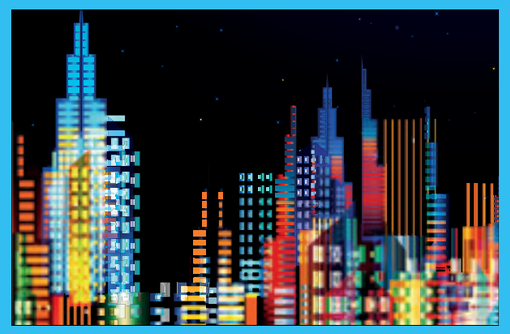

Foreword

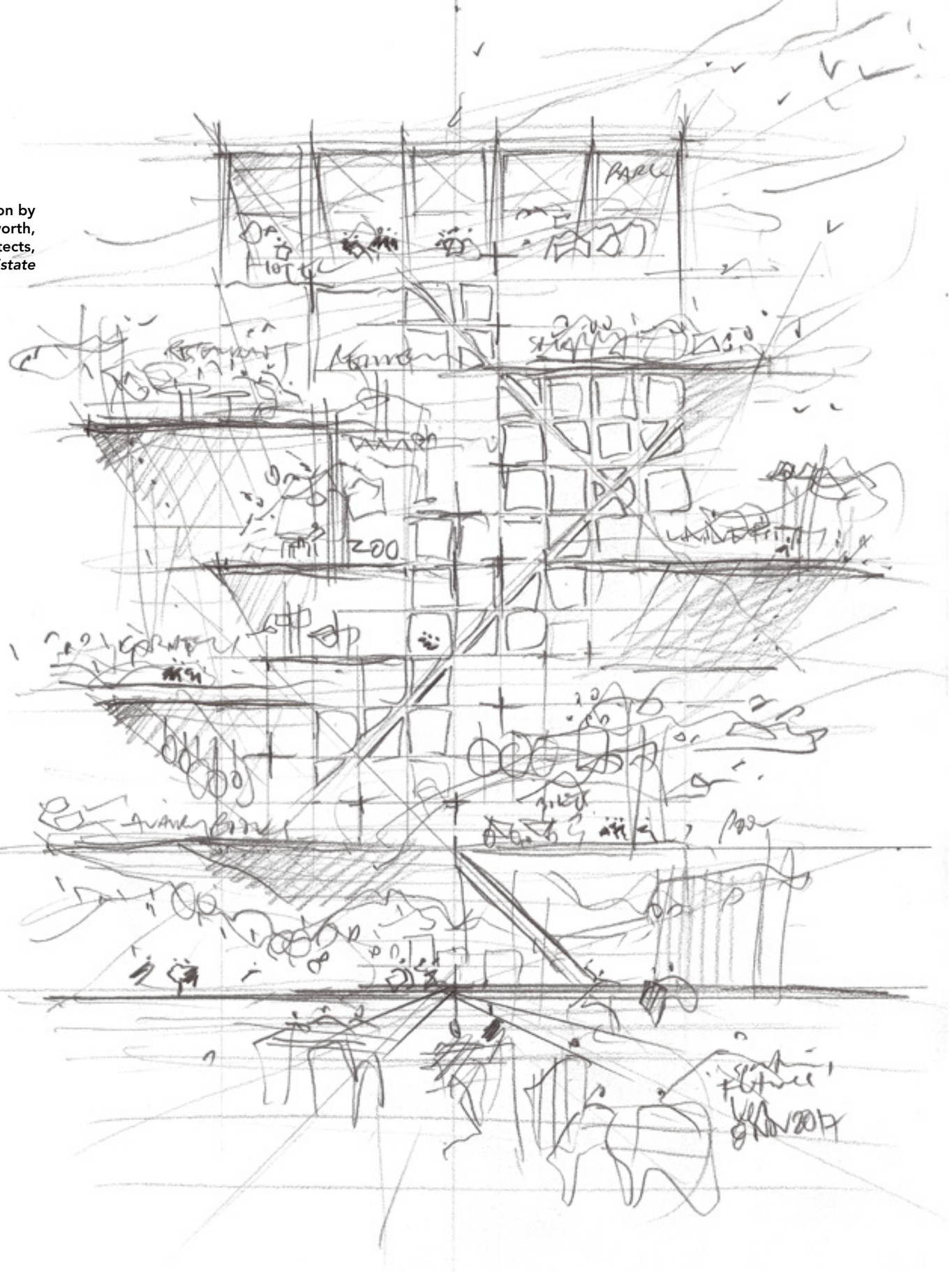

Illustration by Ken Shuttleworth, Make Architects, for *The Fifth Estate*

Our world is speeding up.

We have robotic construction, augmented reality, driverless cars and artificial intelligence. There are new materials invented on an almost daily basis promising better performance and better design outcomes. Old materials are reinvented and repurposed.

Overlaying this is climate change, dealing us the biggest challenge of all. We need resilience and we need net zero carbon buildings. The big question is not if, but how and when?

This is the future and it's snapping at our heels, challenging us to change or be changed.

Flexibility seems to be the safest bet. Finding ways to adapt and change for a future we cannot yet imagine.

For our built environment, that's a tough ask. Our buildings are huge and hopefully there for the long-term given the enormous resources they consume.

And big buildings can take years from the twinkle in the developer's eye to the day the tenants or occupants move cheerily into their new spaces. In the meantime the original concept could well be superseded.

Our Tomorrowland summit, our most ambitious event yet, and this ebook, were designed to give this industry a view, not into the distant future but the probable one around the corner that we need to prepare for now.

We brought together some of the best minds in the country to share their insights.

We started with the architects who envisage the future and cull from its many possibilities the workable options.

We added engineers, academics and scientists who invent the "how" of the future and then we invited the investors and industry – the people who write the contracts, stump up the investments, analyse the end needs of the marketplace and set about picking and choosing from the disparate elements to give shape to our future built environment.

We hope you enjoy this book.

A huge thanks to our lead sponsor **Arup**; to our supporting sponsors Frasers Property Australia, Good Environmental Choice Australia, Low Carbon Living CRC, The Footprint Company and Wood Solutions; event host Dexus and our fantastic MC Howard Parry-Husbands from Pollinate.

We value your support enormously.

Tina Perinotto
Managing Editor
The Fifth Estate

Designing buildings for an unknown future

LYNNE BLUNDELL

There was a time when designing and constructing a new building was reasonably predictable. Architects and engineers knew the parameters, relying on past experience to predict how the inhabitants would use the building and to choose the best materials for the location.

That was then.

Now, a changing climate, rapidly developing technologies and radical changes in workplace use and design have changed all this. The property industry is in a brave new world where what worked in the past will not necessarily work in the future.

So how do we create buildings that will stand the test of time and also meet our changing needs?

It is not an easy task. Buildings of the future will need to be flexible, super smart and to be much more than mere bricks and mortar. Add to that the urgent need to reduce the carbon footprint of buildings, and it is clear that the property sector has a massive challenge ahead of it.

Not that long ago smart buildings focused on heating and cooling systems and solutions that lowered energy use and operating costs. Now advanced sensor technology and new user demands have shifted the focus to the Internet of Things, networked devices and advanced analytics of the building's operation.

Buildings must also cater to the **health and wellness** of occupants and anticipate what their users want in a whole new way, delivering a service far beyond providing a mere space.

This was highlighted by CBRE's **recent research** into what companies expect from a workplace. CBRE surveyed 100 senior decision-makers in large organisations and ASX 200 companies across Australia. What they found was that companies not only expect buildings to be smart, with all the technology that entails, they want them to be flexible and to promote wellness of the inhabitants.

BUILDINGS AS A SERVICE

The next frontier in retaining tenants was to not only meet their needs but also those of their visitors and clients. This concept of "buildings as a service" was behind last year's **acquisition of UK-based user experience designers FreeState** by design firm Hassell.

At the time of the merger, FreeState creative director Adam Scott said the company started with the people in everything it does, imagining their ideal journey as a basis for designing their "ideal future environment".

"What that means is that brands – and places – now live or die by how well they inspire attraction, involvement and a sense of belonging," Scott said.

Corporate Australia has embraced this concept with enthusiasm, with "innovation labs" springing up across the country.

At accounting and advisory firm KPMG's new Innovation Lab at Barangaroo, clients get to brainstorm surrounded by the latest toys and technologies – interactive screens, 3D printers, drones, and virtual and augmented reality sets with some old fashioned whiteboards and play doh thrown into the mix. This is the type of work environment we can expect to see more of in the future.

Engineering firm Arup has been a leader in the innovation lab concept, setting up digital studios in London and Australia to research how people use and interact with technology and how technological developments will change infrastructure needs.

One of the firm's clients, Google, is an early adopter of high-tech construction methods. Google's Silicon Valley headquarters was built using robotic cranes to put large prefabricated sections in place and is a prime example of how buildings can be flexible and adaptable. There is also talk of Google developing kinetic buildings, which can be moved, and which respond and adapt to the environment.

Artist's impression of Circular Quay Tower

The LASIMM project

MULTI-DISCIPLINARY TEAMS

Some of the most exciting work being done globally on new high-tech materials and building production methods involves multi-disciplinary teams involving researchers, architects, builders and manufacturers.

One project – LASIMM (Large Additive Subtractive Integrated Modular Machine) – involving 10 partners, is exploring the potential of metal-based 3D printing to enable fast production of prefabricated building components. The team comprises six companies, including the entire supply chain needed to produce such a machine, two universities and two research institutes.

One partner is architectural firm Foster + Partners, well known for its innovative buildings and recently chosen by Lendlease to design its Sydney headquarters at Circular Quay Tower. A recent project of the firm is the Apple store in Dubai, which features filigreed carbon-fibre shutters that fold around glass walls of the store, shading the interior during the day and opening to views of the city at night.

The LASIMM project is working on developing large-scale and flexible all-in-one hybrid machines that will enable the production of building components directly from CAD models. The machine uses robotic elements and would enable the building industry to move away from standardised components and towards bespoke solutions for every building. The result would be that components could be produced within a reduced timeframe at a fraction of the cost.


Alex Sinickas

RESEARCH IS THE KEY

Alex Sinickas, research leader, Foresight, Research & Innovation with Arup, is conscious of the role engineers play in creating buildings that will last.

"It's our job as engineers to design for the future. We need to be able to design buildings that will withstand a one-in-300 year hurricane even if it happens tomorrow," Sinickas says.

"The real problem is that the next 10 years are not going to look anything like the last 100. Climate change, along with people's expectations of what a building should do, means we are able to rely on history less and less.

"As a society and as an industry we are also too reactive – we react after an event like a flood, or any disaster. The other option is to do research and be prepared."

Sinickas says there are four big trends influencing building design and construction now and into the future. These are:

- Designing for reconstruction and re-use – recycling materials and re-using spaces
- Development of new materials – sustainable and high tech
- The rise of data and machine learning, including artificial intelligence and augmented reality
- Human experience – how people want to use the built environment.

RECYCLING AND RE-USE COMES TO THE FORE

The recycling of both materials and spaces has only just started to have a significant impact on how buildings are made because it now makes economic sense, Sinickas says.

"The circular economy is less about building materials and more about the money behind it. It has become market driven because it makes sense to be less wasteful. If you make it worthwhile for people to care, they will – the industry has to either save money or make money."

NEW MATERIALS: BEAUTY, INNOVATION, SUSTAINABILITY

The development of new materials such as cross laminated timber (CLT), bamboo, green concrete, high-performance glass, graphene and lightweight solar cells that can be applied to just about any surface is being driven by a push to reduce the carbon footprint of buildings, but also by people's desire to have beautiful, innovative buildings.

The integration of nanotechnologies into construction materials will see buildings pushed to a new level in the next decade. Old materials such as timber and concrete are also being re-invented.

BUILDINGS AS ORGANISMS

The use of building data has also reached an exciting era where buildings are almost regarded as organisms. This is also being driven by the ongoing problem that buildings designed to be high tech are too often operated as low tech.

"The difficult thing with all new technology is getting people to trust it."

"We either train people or get the buildings to operate themselves. We are working on a project that involves getting a building to recognise patterns. We have sensors that measure the building environment and generate the analytics on that. That's fine, but as engineers we want to act on that. Do you send the information to a building manager or get the building to do it?"

Now that sensors are light enough and cheap enough to be used in a wide range of situations it is possible for buildings to respond comprehensively to conditions. In a cold climate a building can flush the pipes with warm water to stop them freezing or in a warm climate it can close the blinds to moderate the temperature. A dynamic façade can open and shut in response to the sun with individual tiles

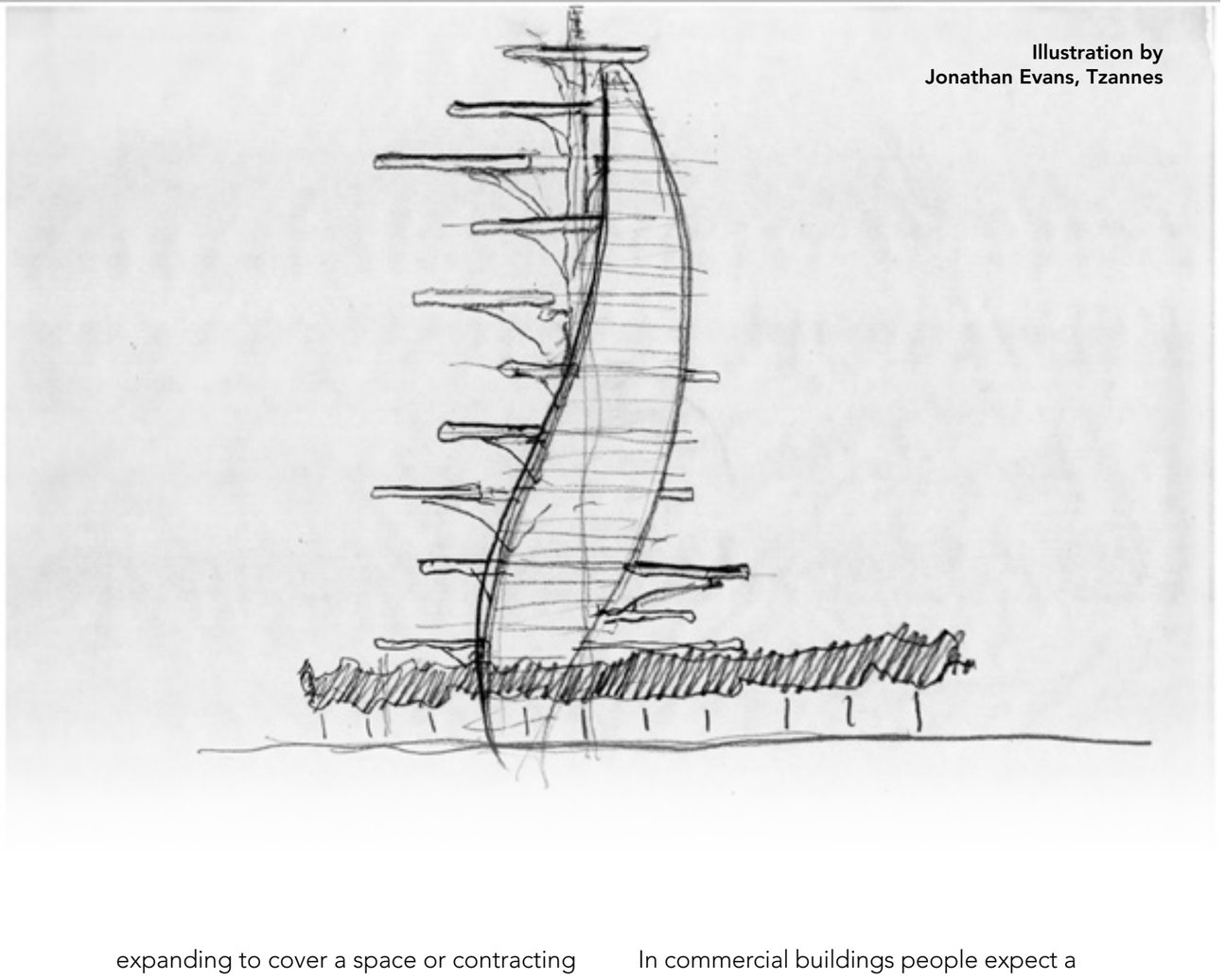

Illustration by
Jonathan Evans, Tzannes

expanding to cover a space or contracting to open it up.

Self-built buildings, where construction is done by robots and drones, are still at experimental stage, Sinickas says.

"The difficult thing with all new technology is getting people to trust it. We have to test for unknown events. So we have to satisfy all the current conditions and future events before people will use new materials."

EXPECTATIONS ARE HIGH

Expectations of buildings are high and this will only increase in the future.

In commercial buildings people expect a seamless high-tech experience with fast internet speeds, comfort and aesthetics. Enlightened employers also want their staff to be well. Arup is working on a project that looks at building acoustics, whether there is an optimum level for humans and how that can be used in design.

In its Sound Lab the firm uses virtual reality to allow clients to experience building design options so they can make better decisions. Augmented reality (think Pokemon Go) is not far away.

"It's not the technology that's important," Sinickas says. "It's the problem you're trying to solve and communicating that to a regular person."

THE FUTURE IS ALREADY HERE

Designing buildings for an unknown future is a concept familiar to **Deo Prasad, CEO of the CRC for Low Carbon for Living**.

Certain aspects of the future, such as climate change and the need for higher density living in cities, are already quite evident and shape the direction of research, Prasad says.

In the workplace, the push for low carbon, low energy buildings is also determining the design and structure of buildings and will continue to do so.

"As we move towards six star buildings there is a strong emphasis on biophilic designs that focus on natural ventilation and light. As soon as you have this hybrid thinking where airconditioning systems are integrated with natural ventilation you have buildings with an atrium in the middle. Most six star buildings have these. That not only deals with environmental performance but also wellbeing and productivity of occupants, which is 80 per cent of the business case for six star buildings now," Prasad says.

ZERO CARBON DICTATING MATERIAL SELECTION AND DESIGN

Much of the work at the CRC focuses on achieving zero carbon or carbon positive in buildings. That is what is dictating both

Deo Prasad

"As we move towards six star buildings there is a strong emphasis on biophilic designs that focus on natural ventilation and light."

materials and building design for the future, whether it is passive design or high

tech materials using futuristic production techniques, Prasad says.

"How do we do achieve zero or positive carbon? Materials, product, systems – everything that goes into buildings – needs to have embedded carbon towards low or zero so when the building is built the carbon debt is not that high. You can then look at achieving positive carbon for the building to pay off the debt and over the lifecycle it has a very positive outcome."

The first step in any building, present or future, is good passive design, or passive solar architecture, Prasad says. Then comes materials and systems.

Low embedded carbon materials being researched at CRC include geopolymer cement, which has one-third the embedded carbon of normal concrete. Another area is recycled materials.

"We are looking at recycling glass into new products of the future, not necessarily just to make new glass but for materials such as kitchen benchtops. This is already in pallet production stage.

"We are looking at organic materials – all sorts of timber and organic waste, for example on macadamia farms where they have shells and waste that come out in large quantities. We look at how to produce next generation products from these materials and how to bind them together."

Solar technologies that can be embossed onto surfaces, such as perovskites, will make a huge impact on buildings in the future. Roofs and cladding will be the solar panels of the future and buildings will do the energy collection and generation work. Intelligent buildings will understand how much energy is needed by the occupants and how much they can export.

Generating solar power onsite or buying it offsite from a generator is becoming much more common and will continue to grow in the future as the push for lower carbon escalates.

Another key area is reducing the carbon footprint of production processes. One researcher at CRC is looking at using tyres in the steel manufacturing process rather than coal, as this has much lower carbon. Using renewable power in production processes is another way of reducing the carbon footprint.

ASBEC's Suzanne Toumbourou talks raising standards at Visit Tomorrowland.

(L-R) PrefabAUS's Damien Crough with University of Melbourne's Associate Professor Tuan Ngo and Dr Ali Kashani, working on glass-impregnated concrete.

"One of the biggest failures from a policy point of view in Australia is the lack of certainty for manufacturers."

BUILDING CODE CHANGES KEY

But the real key to pushing Australian buildings and materials into the future, Prasad says, is having a long-term trajectory in the building code, something the CRC is working on with ASBEC.

"One of the biggest failures from a policy point of view in Australia is the lack of certainty for manufacturers. A longer term trajectory improves the stringency of the code to deliver better outcomes from a regulatory point of view but also gives manufacturers certainty so they will invest in new technology and innovation.

"Companies will invest for future rounds of the building code so innovation will happen much faster. It allows them to look into the future."

FASTER SHIFT TO RENEWABLES NEEDED

Haico Schepers, principal, building physics at Arup, agrees that we need a bigger push to innovate, particularly in the area of renewable energy for buildings and preparing for a smart grid.

"These days there is no need to use fossil fuel. Maybe it's not as cost efficient yet but we should be designing out gas and moving towards on-site or off-site renewable energy for buildings.

"The next 20 to 30 years, renewables will be the main source of energy. So why aren't we designing for this future?"

Technologies that reduce water usage are also going to feature heavily in future buildings. Ground source heat pumps and air cooled chillers rather than water-based cooling towers will become the norm. Passive design will also become

> "We should be designing out gas and moving towards onsite or off-site renewable energy for building."

more important and is something where Australian standards are lax, Schepers says.

"There are moves afoot to look at that. Passivhaus in Germany, UK and Europe is a step above anything else. Admittedly theirs is all cold climate design. We have a lot more glazed area in our buildings but there is a lot of potential in passive design technologies, particularly in glazing and automated shading."

Phase change materials will be more frequently applied, with opportunities to use these to offset peak loads in place of other technology such as chilled beams, Schepers. And façade systems will further evolve.

"I think we will see more smart façade systems in future buildings – the nexus between battery technology, PV technology and façade ventilators, together with heat exchange and CO2 sensors. The major changes are around the cost of battery, PV and sensor technologies, which are all coming down.

"Could we wrap these together to provide better facades? With the current price point of facades it doesn't take much more to make them smart. It may not be just around the corner but we will see facades doing more in the future."

AUTONOMOUS VEHICLES WILL RESHAPE CITIES

Beyond buildings we should be thinking about the types of transport we will be using in the future. A lot of work is going into trying to understand the impact of autonomous vehicles and electric vehicles on cities. Our cities will be cleaner and quieter with electric vehicles and we will need less infrastructure and space inside and outside buildings for cars.

"Is there a future where we have congestion charges to drive into a city unless you have an electric car as a way of dealing with pollution and noise pollution? And autonomous vehicles take up less space because they can drive closer together. With these do we end up with an on-demand service so most people don't need to own a car? Half the amount of cars means half the amount of embodied energy to manufacture them. These are all questions we are grappling with," Schepers says.

Already building basements are being designed to accommodate fewer cars and more bikes and electric bikes. The sharing economy with companies like Uber is also making an impact on individual car use.

"One project we're working on, only the CEO is getting a car space. Things will change fast in this area – in 10 years people are unlikely to be buying cars anymore."


Dagmar Reinhardt

THE ROBOTS ARE HERE – FOR US

Dagmar Reinhardt, program director of architecture at the University of Sydney and co-author of *Robotic Fabrication in Architecture, Art and Design*, is adept at looking into the future. She also knows a lot about robots but prefers to talk about people. Robots, drones and 3D printing are all very well, but not if they don't benefit humans, she told The Fifth Estate.

"We need to focus on who is benefiting from 3D printing. I'm not sure we want to take humans off the construction process. I'm more interested in how we can used 3D printing for sophistication of parts such as structural trusses or complex curved features. We can use it to produce modules, joints and moulds for concrete," Reinhardt says.

The other exciting area for 3D printing is the use of sustainable materials and waste products. Clay, paper and plastic waste can all be used for printing.

"We need to focus on who is benefiting from 3D printing. I'm not sure we want to take humans off the construction process."

3D printing combined with robotics can also dramatically reduce manufacturing time by customising production. With teams of architects, engineers and manufacturers working closely together, production of building components can be cut from weeks down to a couple of days. Prefabrication of building structures further reduces construction times.

"Production can be done in a tenth of the time and for a tenth of the cost," Reinhardt says.

"We want to use materials that are long lasting and substantial. Toxic binders are a problem and we haven't solved that yet – we need to work with materials scientists to solve some of these things, going down into the micro scale of materials. That's a fabulous field. I tell my students they are trained as architects but they are going to produce the future materials for architecture."

BRINGING BACK CRAFTS-MANSHIP

Robotics has a significant role to play in producing building components that are both unique and that can be automated, Reinhardt says. There is a chance to reintroduce craftsmanship and variation in craftsmanship. Robots are also particularly useful for tasks that are difficult or unsafe for humans or where they offer greater precision, efficiency and power.

"We can send robots into forests where they can do a data scan of the raw material – the trees – and then harvest them very efficiently. They are also being used in lava fields that are too dangerous for humans. They can cut the lava bricks onsite. This also means we can use local materials rather than ship things. But the humans still do the fine detail."

Creating buildings that withstand changes in the climate and also reduce carbon output means using materials that age well and are resilient. They must be sophisticated from a performance point of view as well.

Computational design and performance modelling is critical to the process, Reinhardt says, and informs all other areas.

"We are still very much engaged in working to the architectural design process but having this possibility of both modelling and then running extensive simulation and analysis of how that building actually performs in terms of technological aspects is the one thing that changes the trade fundamentally."

With computational design it is not the design that is so important, Reinhardt says, but the ability to create different design variations with changing parameter sets.

"The ideal is to achieve a seamless flow between the idea of the building, how that idea is expressed, how the building would perform and how we could bring it to life. In the best case scenario this is not a closed loop but a spiral."

THE ROLE OF ARCHITECTURE IS CHANGING

This process means the role of architects has changed and has moved more into the manufacturing and construction space. Where in the past the architects were divorced from the building site and technical aspects of construction, now they have to understand complex roofing structures, load points, and serialised and advanced manufacturing processes.

"The architect accompanies the whole process with manufacturers and construction companies. We are working in large multi-disciplinary teams where the design data is shared," Reinhardt says.

"It's a hands-on experience, which might seem strange when you're talking about computational design, but it's our big chance."

While reducing the carbon footprint of buildings is a key driver of future building design, climate change is still an unpopular topic.

"Climate change is no longer an unknown. We can predict what's going to happen but as humans we are too good at looking away. Nobody wants to talk about it."

Despite this climate change resilience is already being factored into buildings and infrastructure through consideration of carbon footprint and greening of spaces.

LET'S CO-HABITATE

But one of the most critical areas in the future is providing housing for burgeoning city populations. Reinhardt says the answer lies in thinking differently about the types of buildings we need.

"I like to look at the IKEA catalogue as a social indicator. The 2017 catalogue has a strong theme of young professionals co-habitating. We need to take that phenomenon seriously and develop housing concepts to match it."

This includes relocatable building fabric with internal structures that can be easily modified and moved as the needs of the occupants change. People can buy more space as they can afford it. In Berlin the baugruppen model, where a group of people pool financial resources to build an apartment block, is very popular. Baugruppen considers social inclusion and community, and emphasises shared spaces such as rooftop terraces, function rooms, playrooms and guest rooms.

"We have a great opportunity to do that in Sydney as part of the urban growth plans between Parramatta and the city. If a group is building a place together they can reduce the carbon footprint

Professor Geoffrey London talks to interested community members at a Baugruppen information session in Perth, Western Australia

> "We build into architecture the possibility of being something else if it needs to be."

by choosing sustainable materials, putting in solar cells, opening up green spaces and having green facades or vertical landscapes. By doing this we can increase our urban flora and fauna quite dramatically and reduce our carbon impact," Reinhardt says.

"There is certainly an urgency to this. We could create housing that has a huge cultural impact and addresses the need for flexible, joint spaces … If it can be done in Berlin it can be done here."

FLEXIBILITY

In the end creating buildings that will last into an uncertain future requires a certain mindset, Reinhardt says. She points to Dutch architect Herman Hertzerger, who created the concept of polyvalence – the idea that effective space needs to be flexible, organic and open to interpretation.

"This is how we build for the future. We build into architecture the possibility of being something else if it needs to be. Buildings must have the competence – the technological competence, the design competence and social competence – to provide multiple uses."

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Central Thermal Plant & tri-generation power, Central Park, NSW

Multi-level timber construction, The Green Parkside, VIC

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Materials of the future – they're here

LYNNE BLUNDELL

Technology and human ingenuity have brought us new construction materials that a decade ago seemed inconceivable – well to the average person at least. Researchers and scientists have been aware for decades of the potential for new materials to dramatically improve building performance and reduce greenhouse gas emissions. Just like climate change these materials are not of the future – they are here now. And their development must be accelerated if we want to reach zero carbon or better.

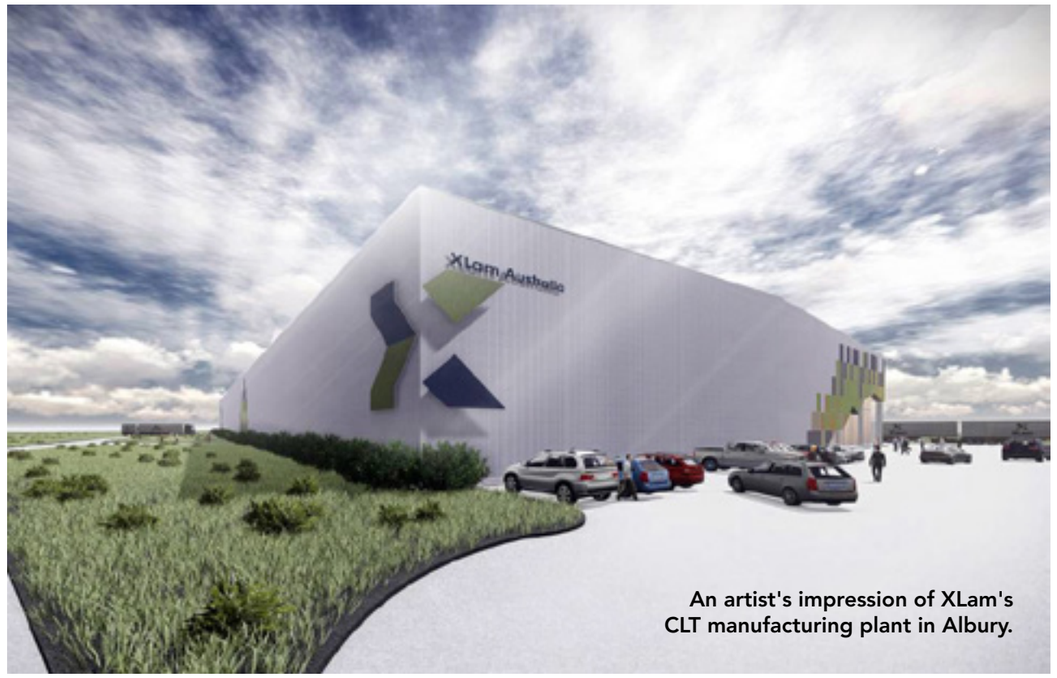
Along with advances in the construction materials we know so well, such as timber, concrete, steel and glass, there are new ones that have the potential to generate power, such as the super thin perovskite solar cells that can be part of the building structure or algae facades that act as biodigesters to generate gas.

Or those that enhance existing materials, such as graphene – 200 times stronger than steel and impermeable – making it a super material for construction and already being used in a wide range of applications from walls to lighting, touch panels, sensors, generators, batteries and solar panels. And geopolymers, new materials for fire- and heat-resistant coatings and adhesives that have wide-ranging uses, including for lower carbon cements.

> "A game changer for timber in Australia is the establishment of a CLT manufacturing plant in Albury by XLam."

TIMBER HAILED AS THE LOW CARBON ANSWER

Probably the biggest push in new materials is coming from the timber industry. Timber is a material loved by builders, engineers, architects and, most importantly, by building occupants. And thanks to new production techniques and engineered products, timber is being hailed as the answer to many of the sustainability issues in construction. It has the ability to store carbon, it can be produced reasonably sustainably, new engineered products are stronger than steel but much lighter, and prefabrication of timber panels can dramatically cut down on construction times. And, because of their high thermal performance, timber buildings also offer social and financial benefits through lower utility bills and greater comfort.



An artist's impression of XLam's CLT manufacturing plant in Albury.

A game changer for timber in Australia is the establishment of a cross laminated timber, or CLT, manufacturing plant in Albury by XLam. The company has been manufacturing CLT in New Zealand for five years and exporting to Australia. The opening of the plant means CLT specifically made for Australia will be available for the first time.

Artist's impression of 5 King Street, Brisbane

Alex Sinickas, head of research & development with Arup, says the new plant will really ramp up the use of timber in Australian buildings. The push for timber, though, is largely as a result of desire for the product from the market.

"People want to work in beautiful buildings and timber is a very attractive material that people enjoy being around," Sinickas says.

Gerard Neylan, lead program development manager of Wood Solutions' mid-rise advisory team, agrees that people love timber buildings. The mid-rise advisory team is Wood Solutions' response to recent changes to the National Construction Code (NCC) that make it easier to use lightweight and massive timber building systems in mid-rise construction.

A pilot advisory program comprising a team of design, engineering, construction and property specialists, it is a free service focused on buildings up to eight storeys. In addition to making the marketplace more aware of changes to the NCC, the project aims to educate industry specialists on what timber products are available.

"We want to give designers and specifiers confidence about how to use new timber products," Neylan says. "Nobody likes to be a pioneer. When the tilt slab came in people said that would never work. The fact is big companies like Lend Lease are pursuing timber and are already using it for multi storey buildings."

Lendlease has been at the forefront of engineered timber buildings in Australia. The six-storey International House at Barangaroo was the first engineered timber office building in Australia and the company's third Australian CLT building, the other two being Forte apartments and the public building Library at The Dock, both in Melbourne.

The company is also building 5 King in Brisbane – the first engineered timber building in Queensland and Australia's tallest so far, at 10 storeys, as well as the Community Hub at Jordan Springs in Western Sydney, NSW's first public CLT building.

Neylan points to the numerous benefits timber offers on building sites – faster and safer construction, a cleaner site with no welding or steel cutting, and less disruption to surrounding buildings and streets. He believes benefits to occupants are even higher.

Michael Lord

"Studies have shown that occupants of timber buildings are calmer, have lower blood pressure and are less prone to absenteeism."

"Studies have shown that occupants of timber buildings are calmer, have lower blood pressure and are less prone to absenteeism. In some schools in the US where timber is used there is even less graffiti."

But what about the sourcing of timber? How can we be sure the growing demand for timber won't mean more clearing of old growth forests and vital habitat for numerous species?

Michael Lord, head of research at Beyond Zero Emissions (BZE), says that's unlikely due to the large quantity of timber that currently goes to landfill and also used for packaging and pallets. Much of this can be re-used in timber production while timber used for pulp could also be redirected to the construction industry.

"We can also grow forests on marginal land that has already been cleared. We've quantified that the area needed [to supply the timber construction industry] is less than that put aside for chickpea farming," Lord says.

LOW CARBON CEMENT AND GEOPOLYMERS

Much work has been done globally to improve the carbon intensity and production methods of concrete. A key area of research is in the production of concrete that does not contain Portland cement, traditionally used in concrete and very carbon intense. BZE recently launched its Rethinking Cement plan, which recommends five strategies for industry to move towards a zero carbon cement industry over the next 10 years.

The BZE report recommends four strategies that can be applied over the next 10 years using already commercialised technologies, such as geopolymer cements, high-blend cements and mineral carbonation, and another strategy that could achieve positive carbon results once the production method has been proven commercially.

Lord says the need to reduce carbon emissions in cement production is urgent as it accounts for eight per cent of global carbon emissions, equal to all the cars on the road.

"Virtually all the cement in the world right now is Portland cement. And 55 per cent of the emissions from the cement industry in Australia come from the carbonisation process used in making Portland cement," Lord says.

"Our first two strategies involve replacing Portland cement, in the first strategy with geopolymer cement. Geopolymer cement is made in a very different way to Portland cement and it doesn't release carbon dioxide. Our second strategy involves mixing Portland cement with other materials such as fly ash and slag rather than clinker to reduce its carbon intensity."

Currently materials added to cement to reduce carbon emissions account for about 20 to 30 per cent of the content. The plan recommends raising the proportion of replacement material to 70 per cent using fly ash, slag, clay and ground limestone to create a "new generation of high-blend cements".

The fourth strategy is to use less cement. By designing structures to use concrete more efficiently, utilising high strength cement, and replacing concrete with timber, BZE says overall cement consumption could be reduced by around 15 per cent in 10 years.

Not enough effort is going into replacing cement at scale, Lord says.

"Structural engineers don't put enough effort into minimising the amount of material. It's easier to standardise things, so they tend to use block shapes. It is often possible to use much less concrete and cement."

BZE would like to see a national policy which puts a price on cement carbon emissions, including imported cement. The plan says a national target by the federal government to reduce carbon intensity of cement, which becomes progressively more stringent, would be a powerful stimulus for change.

The target could be supported by public investment into research and deployment of low-carbon cements, similar to the support for renewable energy provided by the Clean Energy Finance Corporation and the Australian Renewable Energy Agency.

Lord says governments should also introduce new regulations or incentives to encourage the use in cement production of stockpiled fly ash and other waste materials such as waste glass, red mud and bagasse ash.

So far response to the report has been much better than expected.

"The reaction has been really good and the government and private sector are definitely interested in what we are saying," Lord says. "The cement industry has been a little lukewarm but that's not surprising given the amount of investment they have in current technology."

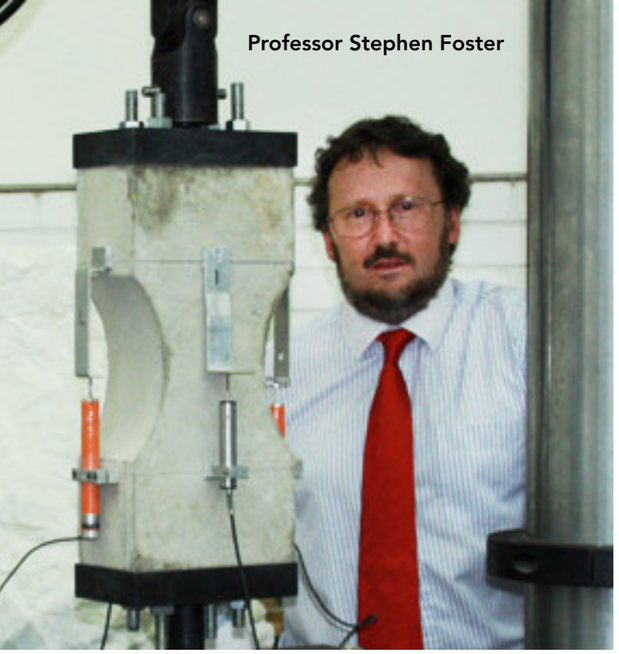
Some in the cement industry are already producing low-carbon concrete.

"It is often possible to use much less concrete and cement."

Professor Stephen Foster, head of school in the School of Civil and Environmental Engineering at University of NSW, has been involved in research on geopolymer concrete for decades, and is working on a project with the CRC for Low Carbon Living. He says the stage of research is now nearing standardisation for geopolymer concrete, which will allow engineers and councils to specify its use with confidence.

"The main issue is durability. We need to know that if we build with the material it is going to be there in 50 years time as normal concrete would be and, if not, what design parameters do we need. Also mechanical issues – if we add steel to it does it perform the same as conventional concrete and if not what is different and how do we quantify that?

"We've got to the stage where we have a handbook that is in drafting stage for designers, engineers and specifiers so they know how to design with the material and specify it."



Professor Stephen Foster

Geopolymer concrete covers a very broad range of materials, Foster says. The major advantage of geopolymer concrete is it has half the carbon emissions of conventional concrete. Globally the use of geopolymer concrete is very small.

"It is very early days for the product. Australia is miles ahead in terms of research."

There is a wide range of applications with geopolymer concrete. Whether it is made with predominantly fly ash or with a mixture of fly ash and slag or, less common in Australia at present, with metakaolin, it performs differently, particularly with durability but also with shrinkage and creep.

One of the biggest potential uses for geopolymer concretes is in pavements, which accounts for 70 per cent of all concrete. These could be any pavements from buildings to airports and carparks.

The issue of creep – or flow – while a problem if it is too high in concrete used in building features such as structural beams – is not such an issue in pavements. In geopolymer concrete creep can be higher, the amount dependent on the mix used in the product and whether it is heat treated or not. These issues are currently being tested and quantified.

"Creep can be a good thing. From a structural aspect it can relieve areas of high stress and in pavements what happens with conventional concrete is you get shrinkage and that causes tension and cracking. If you have more creep it reduces that tension and potentially the amount of cracking. That can be a positive," Foster says.

The world's largest geopolymer concrete project to date is at Brisbane West Wellcamp Airport, Australia's first privately funded public airport. Located at Toowoomba, the airport was built by the Wagner Group for farmers to take their produce to international markets. All the taxi-ways at the airport are made from geopolymer concrete. Wagner Group used its own Earth Friendly Concrete (EFC) to build the airport in order to dramatically shrink its carbon footprint.

When the airport opened in 2014 Wagner Group's John Wagner said Wellcamp would be "the greenest airport in the world."

"One tonne of regular cement produces one tonne of CO2 – we reduce that by 90 per cent just by using the EFC concrete for all the pavements, the terminal and the car park. There will be no normal concrete used in this project," Wagner said.

"What we have discovered through our R&D process is EFC has far superior flexural strength, which is very important in airport pavement, and low shrinkage… We've got a product which is not only the same price [as regular cement], it has a very low carbon footprint."

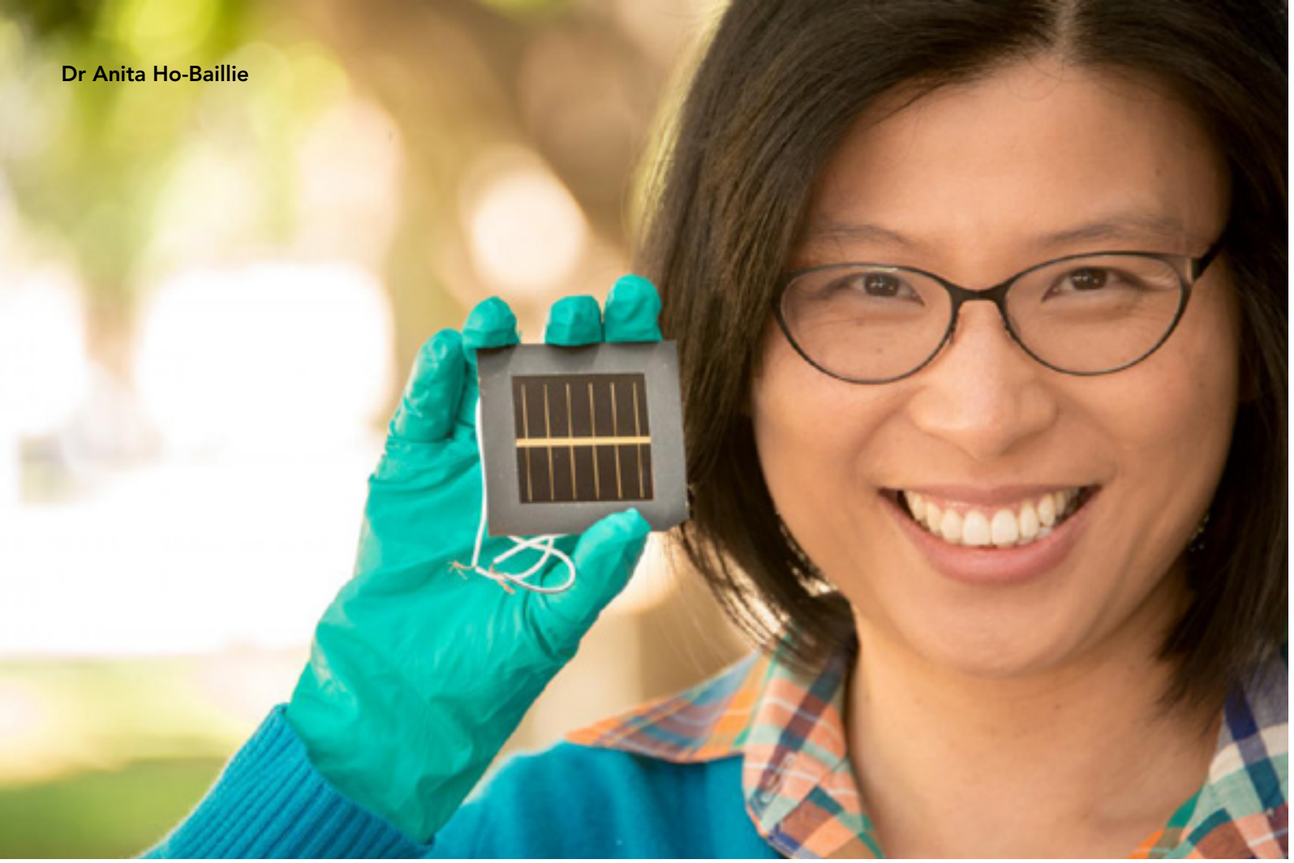
Brisbane West Wellcamp Airport

Using recycled glass in concrete is another idea being investigated by a research team at the University of Melbourne. As reported recently by *The Fifth Estate*, the team is working on a solution for making strong, lightweight and cheap concrete panels using waste glass instead of sand, which is a dwindling resource.

Project manager for the project, Associate Professor Tuan Ngo, said that as the world **ran out of sand**, waste glass was an obvious choice to target for replacement. He believes the new product has great commercial potential.

"Our work has shown it has excellent sound, thermal insulation and fire-resistant characteristics," he said. "We are looking forward to working with the cement and concrete industries and building standard regulators to prove the viability of using these products in traditional concrete structures."

"The major advantage of geopolymer concrete is it has half the carbon emissions of conventional concrete."



Dr Anita Ho-Baillie

GLASS, PEROVSKITES AND SMART WINDOWS

Glass is the wonder material that we take for granted – in construction it has so many advantages that the disadvantages are often overlooked. But as climate change effects escalate, keeping the heat out of buildings is becoming more urgent. Finding ways of doing this while also harnessing the benefits of glass is the holy grail.

A joint research project involving two universities and a glass manufacturer is on this path. **Dr Anita Ho-Baillie, associate professor in the Faculty of Engineering at UNSW**, is partnering with University of Sydney's **Professor David McKenzie and Viridian Glass** on the project, which involves integrating semi-transparent perovskite solar cells into a double-glazed vacuum-insulated window unit.

As previously reported, the project has received $365,000 in funding from the Australian Research Council Linkage Grant program, with the goal to create a high-performance glazing system that can mitigate heat gain in summer and heat loss in winter, while also controlling the entry of light and generating electrical energy in order to create, according to the research statement, "the ultimate energy solution for future cities".

Ho-Baillie has a reputation for her work on perovskites, the latest super material in the solar industry. Last year she broke the record for perovskites, with a 12.1 per cent efficiency rating for a 16cm perovskite solar cell, up from 3.8 per cent in 2009.

Perovskites can be sprayed, printed or painted on almost any surface.

Transparent, lightweight, flexible and highly efficient, these tiny solar cells can be applied to windows, cladding or cement, effectively turning buildings into energy generators.

A key advantage is they can operate in lower light conditions than current solar technologies and don't have to face the sun.

With low production costs, commercial versions of perovskites are expected by 2018. Payback periods for installation is expected to be months rather than years, which has enormous implications for a shift to renewable energy generation.

At Griffith University another glass project is on track to develop a low-cost, low-energy smart window. **Professor Huijun Zhao, director of Griffith's Centre for Clean Environment and Energy**, has been awarded $513,210 through the Australian Research Council's Linkage Projects scheme to develop a window that can change its colour and the amount of light or heat it transmits.

With additional support from partner organisation **Confirmation Australia Pty Ltd**, Professor Zhao and his team will develop low-cost and scalable synthesis of functional nanomaterials that make smart windows work.

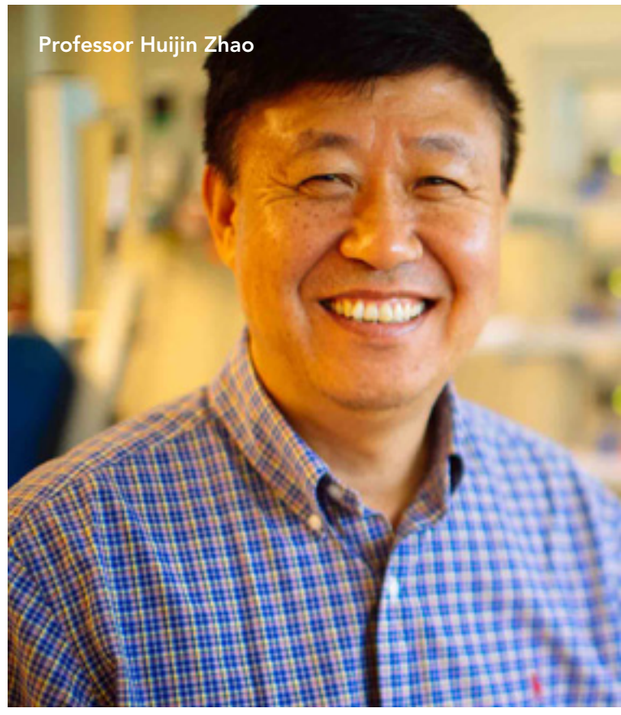
Zhao says the windows promise a significant energy savings by reducing reliance on air conditioning, heating and artificial lighting.

"The ease of energy exchange through conventional windows can be almost

"Perovskites can be sprayed, printed or painted on almost any surface."

10 times that of insulated walls and this energy wastage can account for more than 50 per cent of the energy consumed for HVAC, especially during the summer and winter," Zhao says.

The research project will also facilitate the commercialisation of the new windows by investigating how the new materials can be integrated into the glass manufacturing process to assist Australia's manufacturing industry and environmental sustainability.



Professor Huijin Zhao

ALGAE – IS IT A POTENTIAL NEW ENERGY GENERATOR?

According to **Haico Schepers, building physicist and head of Arup's Buildings team in Sydney**, new materials and technologies may seem like the next big thing but they must have multiple benefits for them to become mainstream.

"There has to be a value proposition."

Algae, for example, is being explored for its potential to generate energy on the facades of buildings and is the focus of a trans-disciplinary research project at **University of Technolgy, Sydney.** UTS researchers and industry partners including **Arup, Lendlease and Steensen Varming** have designed and fabricated prototype algae panels on campus at UTS to monitor performance as well as to demonstrate the technology and transfer knowledge to UTS students, practitioners and the public.

The technology has been used elsewhere. In Hamburg BIQ House, a cubic five-storey apartment block claims to be the first algae powered building in the world. The sides of the building that face the sun have a second outer shell set into the façade and microalgae are produced in this shell to supply energy to the building.

In an **article** written for *The Fifth Estate*, UTS Associate Professor Sara Wilkinson, who is involved in the UTS algae project, describes how BIQ works:

"The biomass and heat are transported to an energy management centre, where the biomass is harvested and heat is recovered by a heat exchanger. Excess heat from the PBRs pre-heats domestic hot water, warms the building interiors, or is stored under the building. Algae biomass is converted to biogas and powers a small-scale combined heat and power micro-turbine, generating electricity and heat; providing around a third of the total heat for 15 apartments. More sunlight makes the algae grow more rapidly which could make it more productive in sunny Australia."

The algaes used in Germany are unlikely to cope with Australian temperatures so it is important to research different types.

Wilkinson points to 19 reasons why algae might in time be the next sustainable building technology. Among these are that algae sequesters carbon dioxide, it has the potential to produce sustainable by products, it lowers greenhouse gas emissions, and mass adoption could lower the urban heat island effect.

Schepers says that while work is experimental at present, if algae proves to have multiple uses the technology just might stack up.

"It has to compete with PVs for cost effectiveness. It would struggle to do this right now. But the UTS project is looking at different algaes to find ones that have the right properties so it stacks up financially. We have to find the sweet spot."

The beauty of algae is its multiple purposes – it can generate oils, generate energy and clean waste water and polluted air. Potentially it could be used to line roadways and clean up cities.

Ultimately, Schepers says, we are searching for materials solutions to address multiple issues – energy consumption, climate change, resource constraint and a need for better quality of life in cities.

"All these ideas and technologies must have multiple benefits. Climate change is a major issue we have to address and you can see how difficult it is by how intractable [the problem] is at the moment. Progress is reasonably slow. Achieving zero carbon is not simple but we have to just keep up with the work, pushing at different parts. That forms a background to a lot that we do.

"The UTS project is looking at different algaes to find ones that have the right properties so it stacks up financially. We have to find the sweet spot."

"But the other major driver is resource constraint – a massive issue for the planet, along with access to clean water and energy. In the area of buildings and cities quality of life is a major driver. Cities are where most of us live now and the greening of cities is something we must address for each other as a community."

BIQ House, Hamburg

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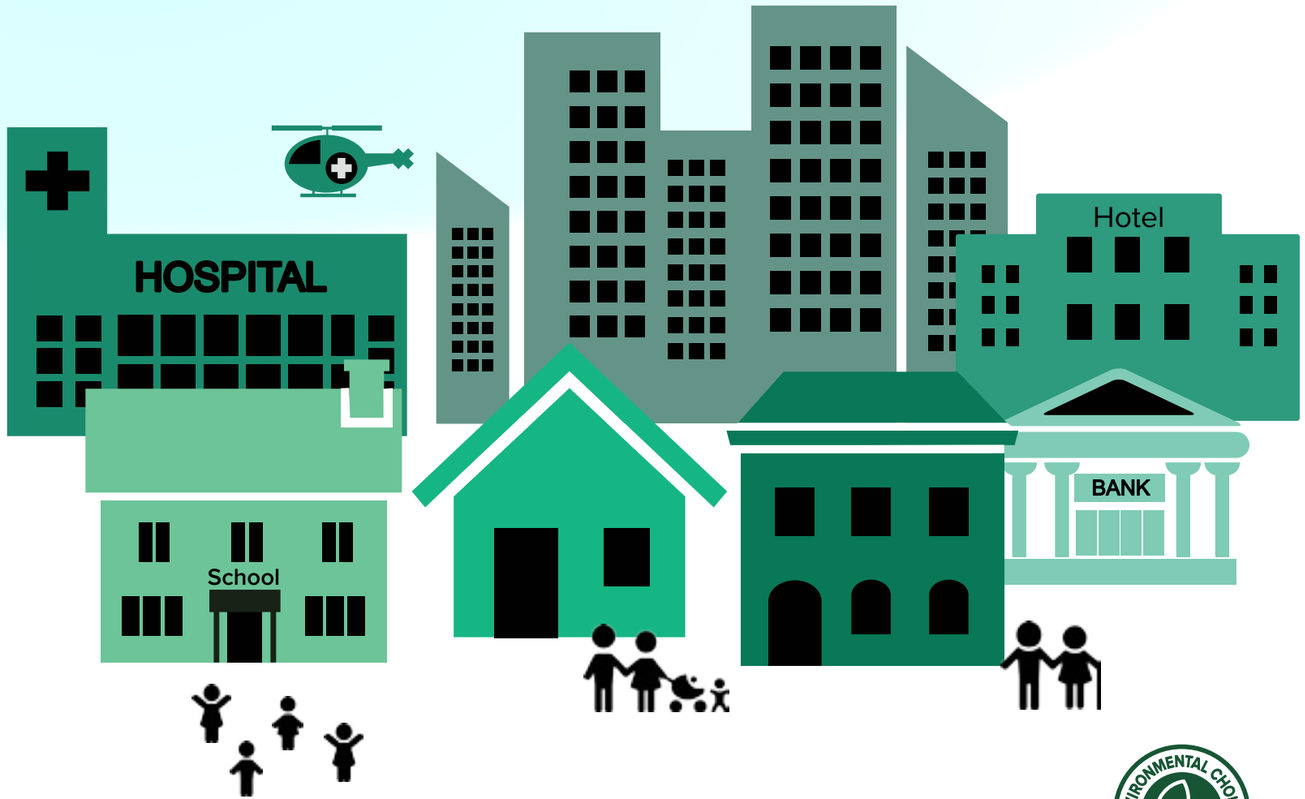

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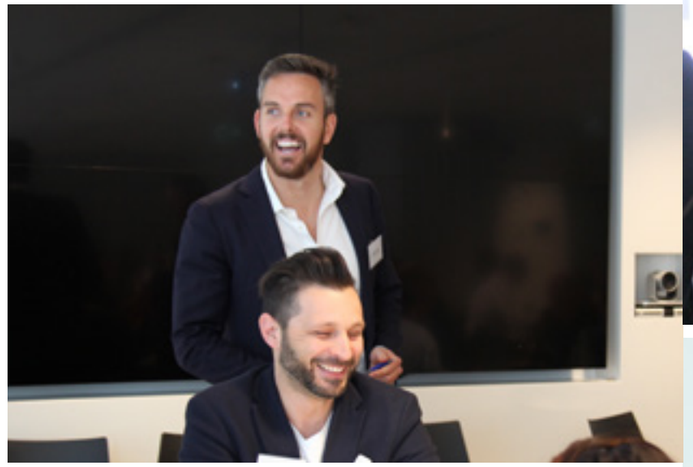
Visit Tomorrowland

an ideas fest on technology and materials



LYNNE BLUNDELL

The Fifth Estate's recent industry gathering, **Visit Tomorrowland**, was a hotbed of ideas – an ideas fest. There was a buzz in the air and a palpable sense of optimism – perhaps in contrast to the Australian political and economic landscape.

So why the buzz? The participants were excited about what future buildings could look like – not necessarily by throwing away the past, but not getting stuck there either. New ideas, new technology, innovation, low carbon and clean. And most of all people-based.

Session 1:
Sci-fi Has Arrived

Robots rule. Or do they?

PLAY VIDEO OF
THE PRESENTATION

First up was the dynamic **Dagmar Reinhardt**, program director of architecture at the University of Sydney, who delved into the world of robots. For many people robots are the baddies that are going to take all our jobs away from us. Not true, Reinhardt said. They are here to help make the world better for humans. And in the construction industry they are already adding enormous value.

The co-author of *Robotic Fabrication in Architecture, Art and Design*, Reinhardt painted a picture of a brave new world where robots are used to improve the world for humans rather than take it over.

In the construction industry they are already partners to humans, executing tasks that enable buildings to be more beautiful, stronger and better for human habitation.

Robots have the capacity to take ideas from designers and architects through to advanced manufacturing and robotic fabrication, all in one seamless line. They enable cheap ways of building complicated components – trusses and modules that can be connected to create "geometries that would not have been possible 10 years ago", Reinhardt said.

To create better buildings for us to work and live in robots are being used to create vast numbers of different shapes and patterns that impact on the acoustics of a space. Based on "nature, biology and mathematics", these shapes can be constructed from new materials or from one of the oldest construction materials – clay.

Robotics offers major advantages at the design and fabrication stage of these shapes, with the ability, Reinhardt said, to "create a thousand drawings based on the same DNA code" and to carve the final panels at high speed and precision.

"We can build a very different sustainable future by looking at acoustics for wellbeing."

Ask the right questions and solutions will follow

PLAY VIDEO

"Everything that is inconvenient now will be automated and removed."

Alex Sinickas

Alex Sinickas, research leader, Foresight, Research & Innovation with Arup, pondered over sci-fi concepts from the past to assess whether in fact the future had arrived. Some past imaginings of the future like the "homer" tracking device in the 1964 James Bond *Goldfinger* movie have become reality for all of us in our mobile phones, she told the audience. Cryogenics from the 1973 Woody Allen movie *Sleeper*, not so much. And the world of eugenics imagined in the 1997 movie *Gattaca* – pretty much possible today. So what?

"This is how people in the past imagined the future and some got it right and some got it wrong. The question for me is how do we prepare ourselves for the future so we don't build things that are obsolete like the car phone or the mini disc or even worse change things that are already really good."

One way is to encourage a culture of questioning. At Arup, Sinickas said, if a client asks for a bridge to be built they will be asked why they want the bridge in the first place.

The foresight and research teams work together from different angles – foresight comes up with the future questions and research finds solutions to those questions, collaborating with external partners. While they may focus on the built environment, the boundaries with other sectors are increasingly blurred.

Sinickas points to five key areas that drive both the questions and the solutions for the world of the future: social, technological, environmental, economic, and political.

Her philosophy on the future:

"Everything that is inconvenient now will be automated and removed."

"People worry about the future and worry about their jobs but I don't think they should. Instead of worrying about the technology I think we should let our experts do that."

What the design and construction industry should focus on is three things:

- What problems were you solving at the start of your career?
- How has that evolved into the problems you're solving now?
- How will they evolve into the problems you'll be solving in 10 years?

"My contention is that if we get that problem definition right the technology and science will catch up and solve the issues."

Blending past and future with adaptable re-use

Creating buildings that are adaptable and that allow people to interact is the key to making buildings of the future, according to **Ian Lomas**, partner, Make Architects.

"Cities are for people to connect and be together. They still want to do that despite technology that is trying to keep us apart," Lomas said in his presentation.

"There is an obsession with the future solving everything but we can keep our heritage and look back to get some of the answers. It can be part of the answer for tomorrow."

Buildings can be re-purposed or even used for multiple purposes. For example, an old industrial warehouse can be re-used as an art gallery, apartments or offices. This is not about looking to technology for the answers but rather tuning into universal ideas about space and light.

Lomas pointed to influential English architect Cedric Price whose philosophy was to create spaces where people's needs and desires are met.

This was exemplified in the Centraal Beheer Offices in Apeldoorn, the Netherlands, built in the 1950s but just as viable today.

Built to a human scale and designed so there are spaces for all types of people – sociable and unsociable – the building allows for both individuality and social interaction.

It accentuates natural light and ventilation and is still being used in the exactly the same way today.

"This is a more appealing view of the future," Lomas said. "I love the way it is built around scale and repetition. While it is very mechanical architecture when looked at on plan and very economical, it has a soul. It is robust and will be here in another 100 or 200 years time.

"This is what Tomorrowland should be. Yes, we do want technology, but we don't necessarily want technology to solve all our problems."

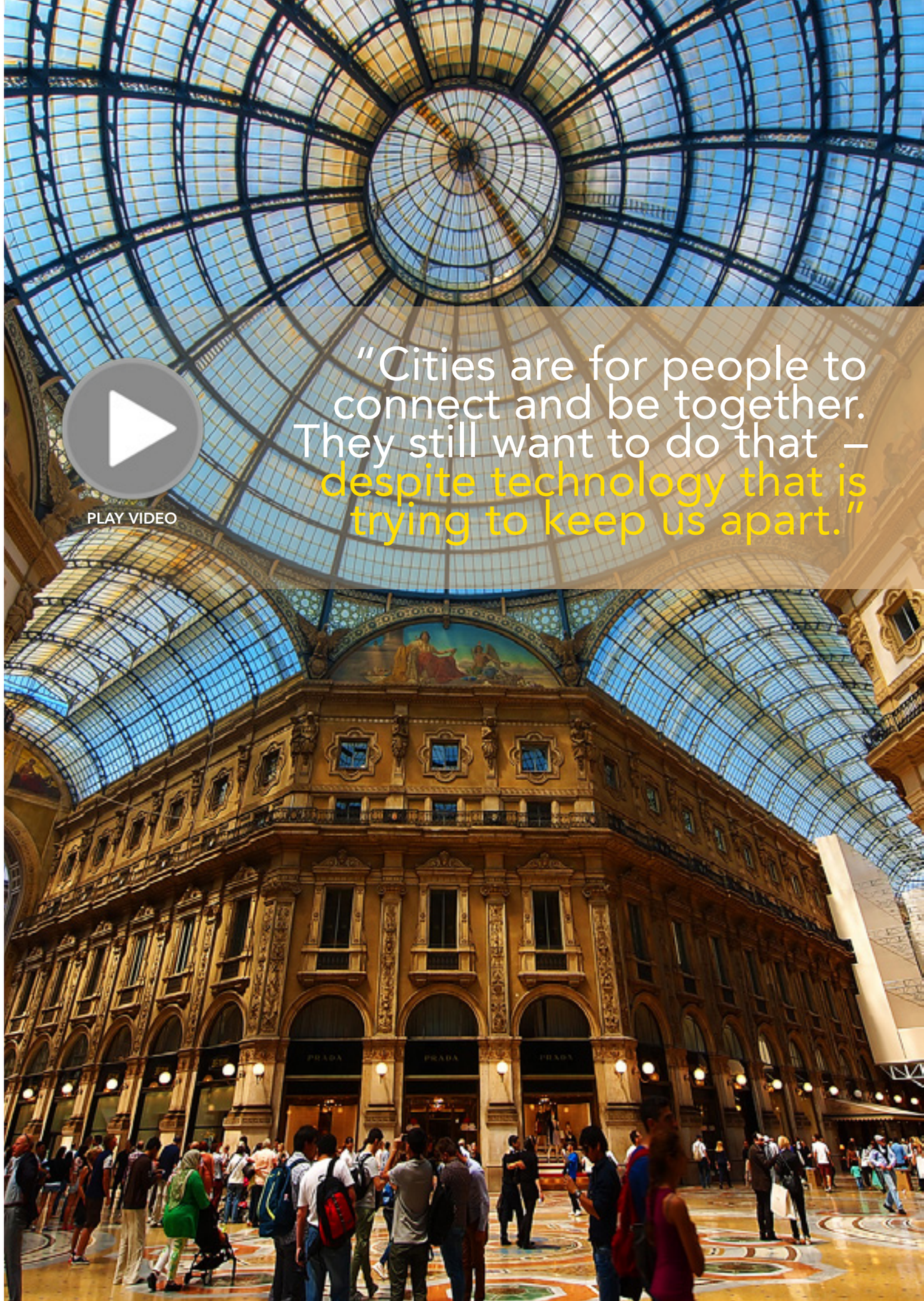


Image courtesy of Arup

The future is electric, PV electric

PLAY VIDEO

"That stampede you can hear is people rushing to get PVs on the roof."

Alistair Sproul, associate professor, School of Photovoltaic and Renewable Energy Engineering at UNSW and CRC for Low Carbon Living program leader, was unequivocal about the future – it's electric.

"That stampede you can hear is people rushing to get PVs on the roof. Solar on the roof is cost effective now," Sproul said.

Sproul admitted he smiled every time he heard energy prices went up, as it was another nail in the fossil fuel coffin. In contrast there was a rapid decrease in the price of renewables, which he said will change things very fast with just about every flat roof covered by PVs in the near future.

"Five years ago I thought, 'Why are we going down this route [of PVs]?' But not now – not with the price of gas; not with the price of electricity."

As for resurrecting old coal-fired power stations, they are all held together with old welding and need to be regularly repaired.

"It's just too expensive."

The figures really say it all. High efficiency HVAC systems powered by photovoltaics can now heat a Sydney home around 10 times cheaper than with gas, at 2 cents a kilowatt hour, compared to 18 cents a kWh for gas.

"We really need to stop burning things. Electricity [powered by PVs] is so much smarter and it's here and it's now."

Making buildings more efficient was key, Sproul said, because poorly designed buildings that let in the summer heat were the reason energy prices were so high – that inefficiency was driving network size.

"If you ignore efficiency because you think it's going to be irrelevant when we use green energy you will be paying with the poles and wires. We spent $50 billion on poles and wires in recent years for the few days of the year when it goes above 35 degrees in our capital cities."

Simple things can drive efficiency. Bigger duct work on air conditioning, for example, is a big saver, with a 20 per cent increase in diameter saving 60 per cent in energy use of fans and pumps.

"Please, please, give those mechanical engineers a bit more space for bigger duct work," Sproul said. Think of Paris' Pompidou Centre for a good example.

And if you were thinking pumps and fans don't make much difference to energy use – well, you'd be wrong. They account for 50 per cent of energy used in buildings, largely because they are pushing against friction of air and water.

The responders

Questions came thick and fast for the high tech sci-fi presenters. Here are some of them and edited versions of the answers.

Paul Wall, head of group sustainability and energy, Dexus, and chair of the Better Buildings Partnership: What is it that people care about in a building when they come to the office and sit down for their day's work?

Ian Lomas: If people feel that those who designed and built the building cared about it they feel valued and enjoy being in it. Also natural ventilation and light makes a huge difference to people wanting to be there.

Alistair Sproul: There is a challenge with daylight. LEDs are coming to the point [where] they've got greater luminous efficiency now. I'm not suggesting we should build concrete bunkers. Have windows definitely, but I think Australians do daylight quite badly – whole walls of glass – and we end up with over-heated buildings or sometimes freezing cold buildings. If we can't get it right I'm just going to put LEDs in and solar panels.


Pall Wall, Dexus

Dagmar Reinhardt: I do not think technology is the answer – it's not even the problem. I think we need to start with humans … In housing, for example, in Australia it's completely idiotic that we have all these single houses in residential projects … People who are first home buyers can't even get a house. I'd like to suggest a couple of things. Firstly, how can we invest together, like the Baugruppen model in Germany, where you can get together with friends and build an apartment block. The second one is please plan for multi-generations – accommodating different life cycles. And the third is different workspaces. Nobody wants to sit at a table all day – people want to work at a table, then go to the cafeteria and then sit on a sofa and hook up with someone and discuss a problem. They truly will not be staying in a cubicle. So if those aren't concepts that are going

> "I do not think technology is the answer – it's not even the problem."
> – Dagmar Reinhardt

“Don’t underestimate the people in the building and the desire they have to see a change in the way [buildings] are designed and operated.”
– Alex Sinickas

to drive new spaces we’re not going to develop the answers.

Alex Sinickas: There are two things I’ve noticed in recent years. Firstly, what people want may be changing a bit. If you look at WeWork, the fastest growing real estate company in the world, more people are working from home and they have different expectations [of their workspace]. Maybe it’s a generational thing. Secondly, people are smart – if they know their building is naturally ventilated they’re happy to deal with slightly higher temperatures inside. Don’t underestimate the people in the building and the desire they have to see a change in the way they’re designed and operated.

Simon Carter, director, Morphosis: How long until we see 3D printed buildings in Australia?

Dagmar Reinhardt: Why would we want 3D printed buildings? … It’s a great technology but it’s relative to the machine you’re operating … It could be interesting if we were repurposing materials that would otherwise go into waste but we have to have new materials strategies. We need to look at what we are printing with … the structure, where we are printing, materials characteristics … Let’s look at some of the larger challenges we do have rather than just having a competitive feast of the technology.

Ann Austin, national sustainability manager, building, Lendlease: Alistair, you talked a lot about PV panels. Can you tell us about other PV technologies, such as on glass or in tiles. Is that fanciful nonsense or is it real?

Alistair Sproul: When I started in photovoltaics in the 1980s it was going to be about crystalline silicon. Other materials have come since but still it’s about crystalline silicon. The industry has grown 10,000 times since I’ve been involved. Any other material will have to grow 10,000 times to catch crystalline silicon. I think the challenge for any new material is to get integrated with what’s


Paul Edwards, Mirvac

happening now. Rooftop solar is five per cent of Australian power – it's taken us 30 years to get to that.

Paul Edwards, general manager workplace experiences, office and industrial, Mirvac: Two questions – one, what are the experiences of the future we should be targeting or looking for? Two, what language will you be using in relation to your work, given that language has always been a problem when it comes to sustainability. Our research shows people are interested in innovation and saving money but not in saving the environment.

Ian Lomas: People want to interact no matter what the activity is. They want connections. In our office where we have a lot of millennials they say they are also feeling disconnected and quite lonely and crave connection as well.

Alex Sinickas: I was going to say pretty much exactly that but more eloquently [laughter from the audience]. We did a survey about the five things that matter most in life and values like love and happiness far outweighed consumerism.

Dagmar Reinhardt: People crave community and the second driver is people want to be creative. This is where I see the robots come in – they are design tools. We can print 3D houses but we can go beyond 3D printing towards advanced manufacturing that allows us to make communities and work cells that will enable us to be creative. Language is about what these buildings are supposed to do. So resilience is about being able to operate under different circumstances and these may change rapidly or slowly … we want to produce buildings that are not about the lowest common denominator but are high quality, are tactile with beautiful materials and have typologies that can be adjusted – like Herman Hertzberger's concept of polyvalence, which basically means you have a way to respond to different conditions.

Alistair Sproul: One of my favourite cities is Freiburg [Germany] … it's a human-scaled city. Germans have great rules – once you build a city to a certain size, that's it. The city doesn't get any bigger. So all the green space stays on the edge of the city. Nothing's allowed to be bigger than the cathedral so all the buildings are low rise. Buildings are efficient with solar panels on the roof, good public transport, cycles, gardens, kids everywhere kicking balls on the street. Or I could go to Beijing with all its high rise but lots of big parks.

"People want to interact no matter what the activity is. They want connections."
– Ian Lomas

Session 2:
The Materials Inquisition

The new age of timber

Big visions of the future made way for the world of science and new construction materials in the second session of Visit Tomorrowland.

Jonathan Evans, director of Tzannes Associates and **Caroline Noller** from The Footprint Company, set the scene for what we should expect from future materials.

ENGINEERED TIMBER

Tzannes is the architectural firm responsible for designing International House, Lendlease's new engineered timber office building at Barangaroo.

Clearly, Jonathan Evans is a big fan of timber and was enthusiastic about what he described as "the new age of timber".

First he visited the past, looking at timber buildings through the ages.

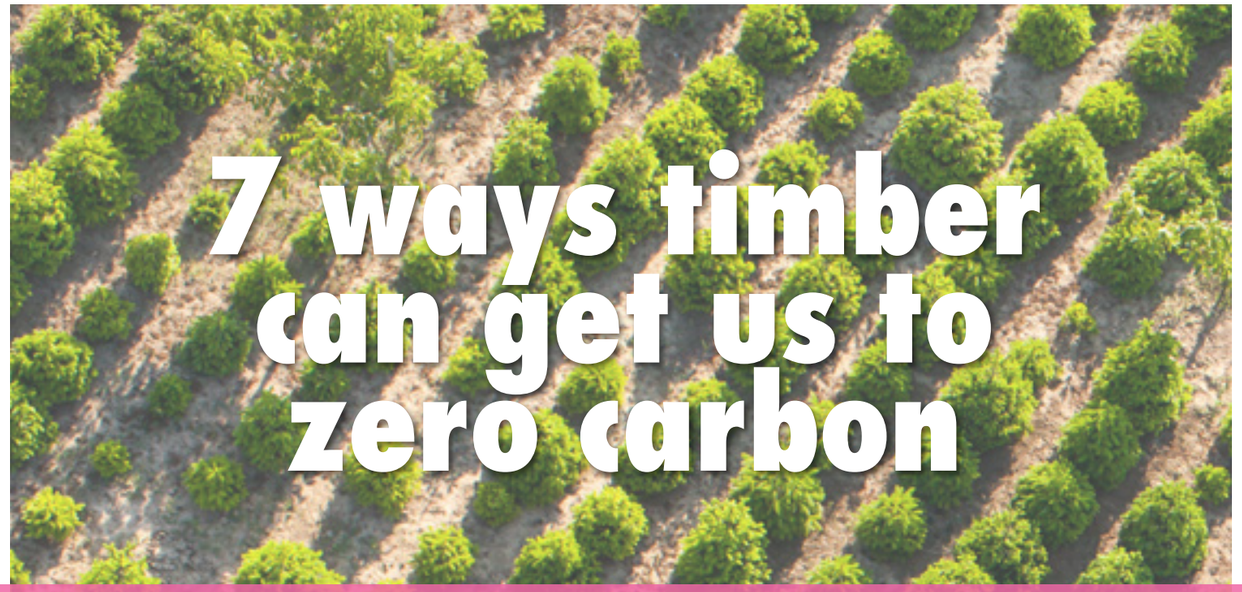
Timber, Evans said, has been used as a building material for centuries because of its abundance as a local resource, its rate of growth, the fact it can sustain and grow itself and its impressive strength to weight ratio.

Its benefits are many – you need simple tools to harvest and prepare it for use, it is durable and can be reclaimed for future use and it stores carbon.

"Concrete and steel have been the materials of recent years and they both contribute significantly to global warming. It's not a good model for the future," Evans said.

At International House everything above ground is made from engineered timber. What would have been 5000 tonnes of concrete and steel is now 1500 tonnes of timber.

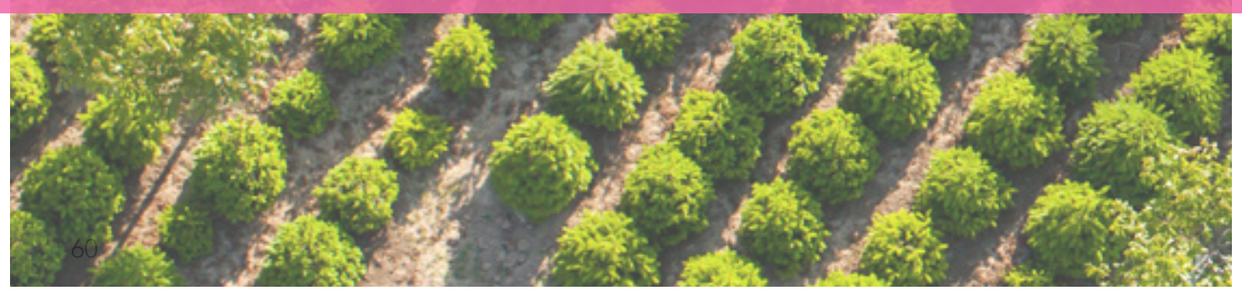
> "Concrete and steel … both contribute significantly to global warming. It's not a good model for the future."
>
> – Jonathan Evans



7 ways timber can get us to zero carbon

Jonathan Evans proposed seven ways timber can help cities reach zero carbon:

1. It is the greatest natural renewable resource, predicated on it being grown in well-managed protected forests. As such it will increase in value, attract investment and can be easily recycled.
2. Timber absorbs carbon and stores it. If we increase forests by 20 per cent it will help with carbon deficit elsewhere.
3. Direct supply line provides efficiency and certainty. Architectural drawings can go straight to the timber mill and timber is cut precisely to the designs. This combines with digital modelling and prefabricated building components for efficiency and carbon emissions reduction.
4. Prefabrication of timber means rapid assembly taking months off construction programs. Disassembly is also fast and accommodates re-use of components.
5. Timber has inherent fire protection, charring on the outside and preserving the inner core. This works the same in buildings.
6. Timber is lighter than concrete and steel, weighing 70 per cent less.
7. Beauty and biophilia – people love being near timber and it enhances wellbeing of people in buildings.



Jonathan Evans

Lifecycle assessment – a powerful tool for change

"We need another 100 Shanghais in the next 20 years."

The Footprint Company's **Caroline Noller** spoke passionately about the power of lifecycle assessment.

"It is a very powerful interrupter if used to its maximum extent. It's not always used to its maximum extent. Lifecycle assessment give us the quantification framework to prove which materials make a difference.

"Materials are an enormous part of the [carbon] story," Noller said.

But there has been a lack of access to information on materials.

The physical fabric of buildings can be the pathway to reducing carbon emissions. The embodied carbon footprint of buildings can be reduced 30 to 40 per cent at no extra cost by using the right materials, Noller said.

She put forward some numbers:

1 billion – the number of extra people coming to cities over the next 20 years

135 square metres – the amount of space each person needs in buildings

244 tonnes – the amount of embodied carbon in that 135 square metres

25 gigatonnes – the amount of embodied carbon in total as a result

"We need another 100 Shanghais in the next 20 years," Noller said. "If we are going to meet the Paris agreement we need to halve the carbon emissions for every square metre in new buildings."

Lifecycle assessment is like a budget for a building. In the same way people do tradeoffs with a financial budget to meet their targets, we can do tradeoffs with carbon.

There are four main pathways to achieve this, Noller said:

1. **Adaptive recycle.** We need to reuse buildings rather than design them to last only 30 years. The structure of a building accounts for 20 to 25 per cent of its carbon footprint so if it's designed to be adaptable or reused you pocket that amount of carbon footprint.
2. **Different assembly methods** also influence carbon content of the building structure. This needs to be factored in.
3. **Recycled content.** Using recycled materials is a crucial plank in the progress of embodied carbon reduction but labelling needs to be clear.
4. **Low carbon supply chain.** We need to understand where materials are coming from and the manufacturing method to ensure lower embodied carbon content.


Caroline Noller

The Materials Inquisition

The Materials Inquisition (taking its name from *that* inquisition but a touch friendlier) took a panel of experts and flipped around standard procedure so instead of being asked questions, they became the interrogators. The idea was to call "material witnesses" to take the stand and submit to cross examination on their material of choice and see how it stood up on a range of criteria such as sustainability, commercial viability and supply chain issues.

The expert panel of Inquisitors included (L-R):

Kate Harris, CEO, GECA

Jonas Bengtsson, CEO, Edge Environment

Robin Mellon, CEO, Sustainability Supply Chain School

Dr Caroline Noller, CEO, The Footprint Company

Professor Veena Sahajwalla, Director, the Centre for Sustainable Materials Research and Technology, UNSW

Perovskite solar cells

Anita Ho-Baillie

Dr Anita Wing Yi Ho-Baillie, associate professor at the School of Photovoltaic and Renewable Energy Engineering UNSW, put forward the case for perovskites.

Made from a material that is 500 times thinner than silicon, is a good optical absorber and can be integrated on any surface, perovskites are seen by many as the future of solar power generation in the fabric of buildings.

Ho-Baillie is working on a project with USYD's Professor David McKenzie and Viridian Glass to integrate semi-transparent perovskite solar cells into a double-glazed vacuum-insulated window unit.

The perovskite "adds function to the glass, so thermally insulated glass also becomes energy generating," Ho-Baillie said.

The main issue with lifecycle assessment on the integrated product is the cost of the glass.

"We found there is a direct correlation between the environmental impact and the cost so if that cost can be brought down it is likely the environmental cost is also lower.

"Perovskite adds function to glass, so thermally insulated glass can also becomes energy generating."

KEY QUESTIONS

What is the recyclability, particularly brominate compounds?

Ho-Baillie agreed more work needs to be done in this area, particularly in respect to the bromine compounds.

What is the demand compared to solar PV?

Ho-Baillie: Perovskites are competing with silicon so researchers are adding in functions to make them competitive.

They have different properties so is a bit like comparing apples to oranges.

What about durability?

Ho-Baillie: Researchers are working with manufacturers, including glass manufacturers, to make perovskites last longer.

VERDICT: HEAVEN. JUDGES AWARDED 3 HEAVENS, 1 PURGATORY AND 1 HELL.

Glass


Jesse Clarke

Jesse Clarke, building scientist, CSR Building Products put forward the case for glass. Glass is an essential building material and glass technologies in Australia need to catch up with some of the advances overseas such as triple and quadruple glazing to add more value to glass, Clarke said.

High spec, high end glazing technologies can improve the performance of glass dramatically. For every extra layer of glazing you can add one square metre of value for every metre of glass, Clarke said. Improving the solar heat gain of glass reduces energy use of buildings.

Lifecycle footprint can be reduced through using more recycled materials in glass manufacturing – currently about 30 per cent, but it needs to go higher.

KEY QUESTIONS

What are the recycling limits?

Clarke: There is a limit to the amount of recycled content that can be included because the process isn't there yet to extract the impurities from the recycled materials. How do you convince users to invest more upfront to reduce operating costs of buildings? It's about capital expenditure versus operational expenditure.

We have technologies now that can offset the need for shading on windows. We could put a thin perforated metal screen on the window instead of shades. This reduces the lifetime maintenance cost of shading materials will be unnecessary because with new glass you won't need them. Inevitably there will also be a reduction in the glass area and it will be better glass.

Is there a zero carbon roadmap?

Clarke: The market will demand it so ultimately we will get there.

VERDICT: PURGATORY. JUDGES AWARDED 3 PURGATORIES AND 2 HEAVENS.

Timber

Andrew Dunn, CEO, Timber Development Association NSW, put forward the case for engineered timber. It is the oldest material but also the future material, Dunn said.

It is an ideal material because is easily worked, has certainty of source, is strong as steel and concrete, is carbon positive and it looks good.

KEY QUESTIONS

Will it be eaten by bugs?

Dunn: Timber lasts for hundreds of years after use. A good example is the old timbers dug up from under the concrete at Barangaroo which were perfectly good for re-use.

What about adhesives and glues?

Dunn: There are new natural by products from the process of manufacturing wood that are now being used as adhesives. We need to move further in this direction.

Why did we move away from timber?

Dunn: Some people didn't. But I think it was the availability of timber and the size and height of buildings. We are now putting the wood back together and creating engineered timber to overcome this.

Does it burn?

Dunn: Wood burns at a predictable rate and has an inbuilt defence. Engineers can now calculate it all.


Andrew Dunn

Is there enough timber and do we want to cut it all down?

Dunn: Trees these days are grown like crops. They have a 25-year cycle. Any gaps will be filled by pulp and paper. There is no concern with shortage of wood.

VERDICT: HEAVEN. JUDGES AWARDED 4 HEAVENS AND 1 PURGATORY.

"Wood burns at a predictable rate and has an inbuilt defence."

Cement

Michael Lord, lead researcher at Beyond Zero Emissions, presented the case for **zero carbon cement**. The manufacturing of cement currently accounts for eight per cent of the world's carbon emissions and rising – more than is produced by all the cars on the roads.

These emissions can be brought down to zero by:

- using less cement through better building design and specification of timber instead
- using two alternative cements – one of those replaces clinker content in Portland cement with flyash, slag and clay, and the other is geopolymer cement

KEY QUESTIONS

Does this factor in carbon sequestration in cement?

Lord: I don't believe in carbon capture and storage; it's just a public relations exercise and doesn't work in practice. One of our strategies is carbon capture and use, where you take the waste carbon dioxide and make a commercialised material with market value. A company called Mineral Carbonation International in Newcastle is developing this technology for a cement kiln that will take the carbon dioxide and absorb 90 to 95 per cent of it to create magnesium carbonate, which is a building material, and also silicon.

Is the geopolymer solution scaleable?

Lord: We use about four billion tonnes of cement a year. It's scalable because in the Australian context if we only used a quarter of the flyash stockpiles from coal-fired power stations we've got enough for 25 years. In the long run we need to starting using clay in cement. There's enough clay in the world, particularly in tropical regions in the developing world, to make as much geopolymer as we want.

VERDICT: HEAVEN. JUDGES AWARDED 4 HEAVENS AND 1 PURGATORY.

The overall verdict from the judging panel:

- The materials industry needs to do more to move things forward
- There is a disconnect between what the industry is doing and recognition from engineers and architects. The building code needs to change so new materials can be specified for construction
- There needs to be a simpler way for engineers, designers and developers to make decisions on materials
- A more holistic approach to materials is needed across the construction industry

"There's enough clay in the world to make as much geopolymer as we want."

Session 3: The Investor Panel

(L-R)

- Peter Morley, head of office development, Dexus
- Peri Macdonald, executive general manager, retail, Frasers Property Australia
- Michael Cook, group executive, Investa
- Michelle McNally, general manager, commercial services, ISPT
- Liam Timms, fund manager, International Towers Sydney, Lendlease Investment Management
- Andrew Coutts, fund manager, real estate Impact Investment Group

The investors

In the final session, investors got to say what they expected from technology and materials. They also nominated which material, technology or solution they would be most interested in investing in.

Michael Cook: Investa has been number one for a long time so it's good to see others were now rising to the sustainability challenge and have "knocked us off our perch", Michael Cook said. He wanted to see more innovation and real disruption from technology and new ideas.

"We're trying to nail what's next. There's a lot of evolution taking place but no real disrupter."

Investa was looking to increase longevity of buildings and to invest in buildings that would attract people to work in them, including Millennials.

"People who work in tech companies, including Millennials, want to work in the city. In Sydney the new technology centre is Martin Place. It's important to invest where people want to be and CBDs are alive and kicking across the world."

In terms of what technology people want, it's not always what building designers expect: "I haven't met a client yet who wants a naturally ventilated building – they want control over building temperature."

Chosen technology, material or solution: Photovoltaics, maybe married with glazing.

Peri Macdonald: Taking a risk is often key to leaping ahead, McDonald said. Frasers Retail took that risk with using Living Building Challenge guidelines for its Brickworks shopping centre in Melbourne's Burwood East. Reaching LBC targets is difficult for any development, let alone a shopping centre, but after its success with the Brickworks Centre, Frasers plans to use LBC for all of its centres.

"It was a massive risk but we have now embraced it fully," McDonald said. "The Living Building Challenge is the world's greatest measurement of sustainability in the built environment. We want a better option for retail and so we created a new standard of retail fro Frasers. We will carry that signature to other retail developments."

It is the non-technical solutions that excite McDonald – those that encapsulate qualities such as beauty and spirit. Gardens and community aspects are important.

"We're very much looking long term – 20 to 30 years. We look for assets that will deliver value over that time. We're very focused on adaptability and making sure we have buildings than can respond to change."

Chosen technology, material or solution: One that delivers long-term sustainable returns.

Michelle McNally

Liam Timms

Peri Macdonald

Andrew Coutts

(L-R) Peter Morley, Peri Macdonald, Michael Cook, Michelle McNally

Michelle McNally: With responsibility for investing 50 per cent of Australian's retirement savings, ISPT is conscious of its need to invest wisely, McNally said. Risk must be carefully assessed and factor in to every investment.

"When we look at risk of building technology we think about things like: How complex is the technology? Is there a demand for it? Is it scaleable? Does it have more than one purpose?

"We need to invest wisely but we are aware with risk of investing in something new comes the risk of not investing.

"Our customers are complex and we have a complex investment matrix. We seek quality, longevity and sustainable benchmarks and take a long-term, 20-30 year view. The industry has an issue with the risk of flexibility and we need to change how we see value."

Chosen technology, material or solution: Something that delivers flexibility.

Andrew Coutts: Impact Investment Group wants sustainable outcomes "that are pushing the environmental envelope" but also those that could deliver very good returns, Coutts said.

IIG's model aims to combine the best of both capital and values-based investment principles to create a triple bottom line – good financial, social and environmental returns. The model is based on the understanding that the economy, community and environment are interdependent. That meant that economies cannot thrive if the resources essential to their growth – vital communities and a living environment – are treated as externalities.

"We look at older buildings and try to retrofit as much as possible, partnering with companies like Lendlease and Frasers," Coutts said.

Chosen technology, material or solution: Timber construction and zero-carbon cement.

Liam Timms: Property trusts operate in an environment that does not exactly encourage people to leap into the unknown, Timms said. "We operate in a highly structured environment. Highly regulated."

REITs must balance the conflict of investors wanting flexibility and dynamic behaviour – "moving up the operational curve" – against the additional risk that brings. Trusts must also restrict themselves to passive income.

"We're not a business; we're a trust for reasons that must be protected," Timms said.

Unlike Airbnb, which was unregulated and free to exploit the gaps in capitalism that leave excess capacity unused, property trusts are "dominated by tax law that came out of the 1980s in Canberra."

"Ultimately, though, flexibility is the main thing our customers want. Sustainability is a given."**Chosen technology, material or solution**: One that focuses on the community who occupies the building.

Peter Morley: It is important for buildings to be flexible, Morley said, pointing to the technology arms race of the past where developers competed to do the "next greatest thing".

This had resulted in unused blackwater recycling systems because the water they

"We're on the cusp of a quite significant evolution in how we build buildings."
– Peter Morley

generated "cost four times" more than water from a tap. And trigeneration plants that sat like white elephants in basements, never turned on because of the cost of gas.

"We're on the cusp of a quite significant evolution in how we build buildings … As a developer the bottom line is always the main thing. But the pace of change is so fast we need buildings to be adaptable, otherwise a building meant to last 50 years will only last 20 years."

The ever-growing demand for affordable housing was also likely to change the investment model for developers, Morley said.

"We are always looking to get more than we are entitled to. If we want to see more housing for essential workers in the CBD we need a model where something is created for the community but we're getting something back for the developer."

Chosen technology, material or solution: Adaptable re-use.

And the writer's verdict on the whole day: Optimism is intoxicating and self-perpetuating.

Out-of-the-box collaborative visions for our future

CAMERON JEWELL

After a long, jam-packed day of learning about the massive technological and sociological shifts facing property and construction, weighing up the pros and cons of a range of materials, and listening to what investors really want, *The Fifth Estate* asked our 100-plus guests to group together and have a little fun by coming up with their own visions for a "building of the future".

It's a testament to the collaborative nature of our industry that in little over 20 minutes we had a dozen outstanding, challenging (though sometimes outright bizarre) ideas for what that next building project would look like, who it would serve and how it would operate.

The winners were judged by our esteemed investor panel. What were they looking for? A project that incorporated the key themes of the day – something that cared for occupants and created community, something that was flexible and adaptable, something that responded to growing needs for ecological sustainability, and, because they're investors, something that promised to pay off.

In third place was a project called "Floating Mixed Use" – a somewhat bizarre "balloon-suspended world", according to our **MC Howard Parry-Husbands of strategic research consultancy Pollinate (left)**.

"The idea was a floating mixed-use development, or a nomadic neighbourhood, which is entirely self-sufficient. It's surrounded by a floating photovoltaic electricity farm and a floating productive food farm," Cundall's Hannah Morton told the crowd.

"It is resilient to rising sea levels [this got a lot of laughter from the audience], and therefore rising insurance costs. It is basically a connected community that is totally self-sufficient. It is constructed out of salvaged materials and can pick up and move at any time."

In second place was the "Meccano Set/Transformer" team, which utilised a "smart universal grid" and building blocks that could be rearranged and repurposed over the building's lifetime.

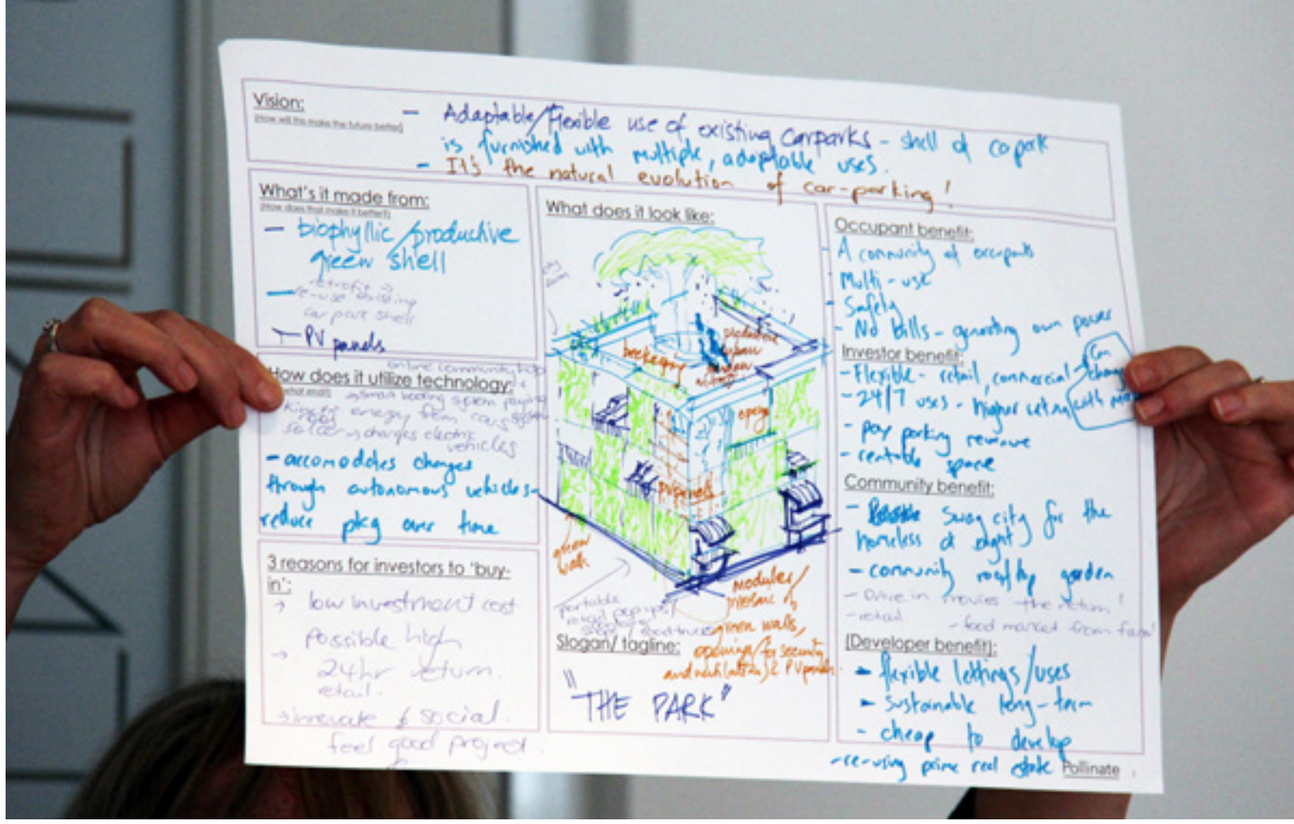
"From an investment proposition point of view you could either buy these materials or you could lease them," team member

“The city is full of carparks. How about we take those shells of car parks in an adaptive reuse context and furnish them with multiple, adaptive uses?”

(and one of our presenters) Dr Caroline Noller from The Footprint Company said. “And every time you want to change them, because it’s on a universal grid, you can simply unclick the building and make a change to some of the forms. So it adapts to the community. It’s obviously a no-bills building. And it has lifelong adaptability and flexibility.”

Winning the competition, however, was “The Park” team, which conceptualised an adaptive reuse of an existing car park, which promise to become obsolete as autonomous vehicles take over.

“Our concept is that the city is full of carparks … How about we take those shells of car parks in an adaptive reuse context and we furnish them with multiple, adaptive uses," team member Toney Hallahan from Blue Mountains City Council said.



“It’s the natural evolution of car parking. It has a biophilic and productive green shell, a community garden on top, multiple uses including retail and food trucks. It can be used at different times of the day. So we’ve got parking during the week, but on weekends community markets, bars, drive-in movies.

“But also the great thing about it is it accommodates the changes that are happening with autonomous vehicles. So in the future, possibly we won’t need car parks. Cars will be going and parking themselves somewhere else, so we’ll actually start the precedent of using these spaces for something else.”

The winner’s all took home the signature TFE gift of pot plants (succulents because they are most resistant to climate change). It was a bit of fun to end a day of heavy learning regarding the future of our buildings.

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Are net zero buildings possible in Australia?

RICHARD STOKES, ARUP

As increasing numbers of property developers and owners, universities and policy makers strive to reduce energy costs and cut emissions for buildings, experts say targeting net zero is a logical next step, and one that is a realistic possibility in Australia in the very near future.

Net-zero buildings push the boundaries for sustainable design. At its simplest a net-zero building must generate as much energy as it uses, and sustain itself as much as possible using minimal external resources.

"There are many ways net-zero can be defined," NABERS national program manager Carlos Flores says. "Your definition of choice will be different depending on the type of change you seek. Some define net zero as largely self-sufficient buildings that generate more renewable energy than they take from the grid. Others define this as a very energy efficient building that purchases renewables through the grid. But no matter which way you define it, it all comes back to pushing the boundaries to create the most sustainable buildings we can."

The aspirational target of net zero is something the UK, Europe and US are all progressively working towards, through looking at implementing long-term targets and increasing levels of regulation through their own building codes.

According to Richard Stokes, senior sustainable building design consultant for Arup, this incremental and progressive approach to building regulations is not the approach that Australia has been taking.

"In terms of regulatory changes, we are seeing movements underway to update the National Construction Code, however this change (expected in 2019) isn't part of the long-term strategy to achieve net-zero; it's just recognition that the existing regulations are inadequate and in need of an overhaul. Also, just waiting for our politicians to define long-term targets on sustainability is unrealistic due to a lack of cross-party support," Stokes says.

Despite the lack of progress on the regulatory side of Australia's net-zero story, our approach to sustainability in the building sector – via a market-led performance focused strategy – is extremely effective and that this approach places us in a potentially better position than our European and American counterparts to move towards a net-zero future.

"UK, Europe and the US are driving the sustainability agenda by looking at minimum standards and while we don't talk about net zero explicitly in Australia, and we aren't necessarily looking at our minimum standards, we are looking at how we can make sustainability attractive through voluntary tools such as NABERS and how marketing plays a huge role in sustainability within Australia."

UNIQUE NABERS

NABERS is a unique rating tool that measures the performance of buildings. It's Australia's market driven operational building assessment metric, where developers and asset owners compete to have the most sustainable buildings in line with tenant demands.

Arup's team has extensive background with NABERS, and a strong portfolio of projects which serve as a solid foundation for the firm to move towards net-zero, working on more green certified buildings than any

Carlos Flores

other consultancy in 2016. Companies like Arup, and the NABERS tool, are pushing the boundaries of new building design and although there are no specific regulations called "net zero", there are policies and programs that encourage good design to come into reality.

And come into reality they are. Recently released data confirms that in the commercial office market, the amount of buildings aiming for an energy efficiency target (NABERS) – and achieving that target – is very impressive compared with most countries around the world.

"In 2016, the number of 6 star NABERS Energy ratings doubled from the previous year, to 10, while over 370 office buildings have achieved 5 stars or more," Flores says. "We have seen an unprecedented rate of change in this market. A decade ago 5 stars was very difficult to achieve, but in 2017 this is a relatively standard target for a new building."

IS IT TIME FOR 7 STARS?

Flores is acutely aware of the importance of the NABERS scale to continue to provide challenging targets for people trying to push boundaries of sustainability.

"It doesn't matter how smart the NABERS scale is, with buildings improving at this rate, we need to continue to provide targets for high-achievers. Most people agree that NABERS should add carbon neutral or net-zero targets to our scale in the future. So the question is not so much about whether we should do this, but more about when is the right time."

Although it would be a big leap to go beyond the maximum 6 Star NABERS rating, Stokes believes the NABERS tool is already calibrated towards net-zero and ponders the addition of a seventh star.

"The system is calibrated on a star scale from zero to six, and a seventh star (which doesn't formally exist) would be positioned on that scale effectively at net-zero ... so by operating on this scale of 0-6 stars we are already ultimately aiming towards net zero."

A 3-STEP HIERARCHY

Waving a 7 star NABERS carrot to the Australian market could lead to some interesting sustainable building designs that push the boundaries and increase an already developing market for offsets, but Richard Stokes believes that to achieve this level of performance, Australia would do well to apply strategies developed overseas.

"The UK framed the regulations by following a simple but effective three-step energy hierarchy," he says.

This three-step hierarchy is:

- **Be Lean:** Reduce energy demand through passive design
- **Be Clean:** Reduce energy consumption through energy efficiency
- **Be Green:** Generate renewable energy from onsite sources

"This hierarchy acknowledges that there is no point in providing onsite renewable energy until you've exhausted all your passive design and energy efficiency measures … essentially prioritising insulation, high performance glazing, shading, massing and air leakage over renewable energy."

After pushing this energy hierarchy in the UK, a raft of "allowable solutions" were developed – that is, ideas for offsetting the remaining emissions which can't be achieved by looking at a site alone. Options included making payments to upgrade other existing buildings in the locality or purchasing green power for a site – which is doing great things for developing the green power market.

In line with this, NABERS has recently announced the ability to achieve a carbon neutral rating as part of the NABERS rating – where a building can purchase renewable energy or carbon offsets for the emissions that building uses internally.

Stokes believes this will be a positive catalyst for the industry as it heads towards net-zero.

"Most people agree that NABERS should add carbon neutral or net-zero targets to our scale in the future. So the question is not so much about whether we should do this, but more about when is the right time."

"NABERS Carbon Neutral awards buildings that offset their remaining emissions, effectively achieving net zero through offsite measures, which will encourage buildings to deliver even better performance operationally onsite," he says.

Flores adds: "Meaningful change requires time, and no change affects a market all at once. If we want to see net zero buildings all across our sector, we need the sustainability pioneers to move first and prove it is possible. We are lucky to work with world-leading companies in building sustainability, so if we work together, Australia could lead the world in net-zero buildings."

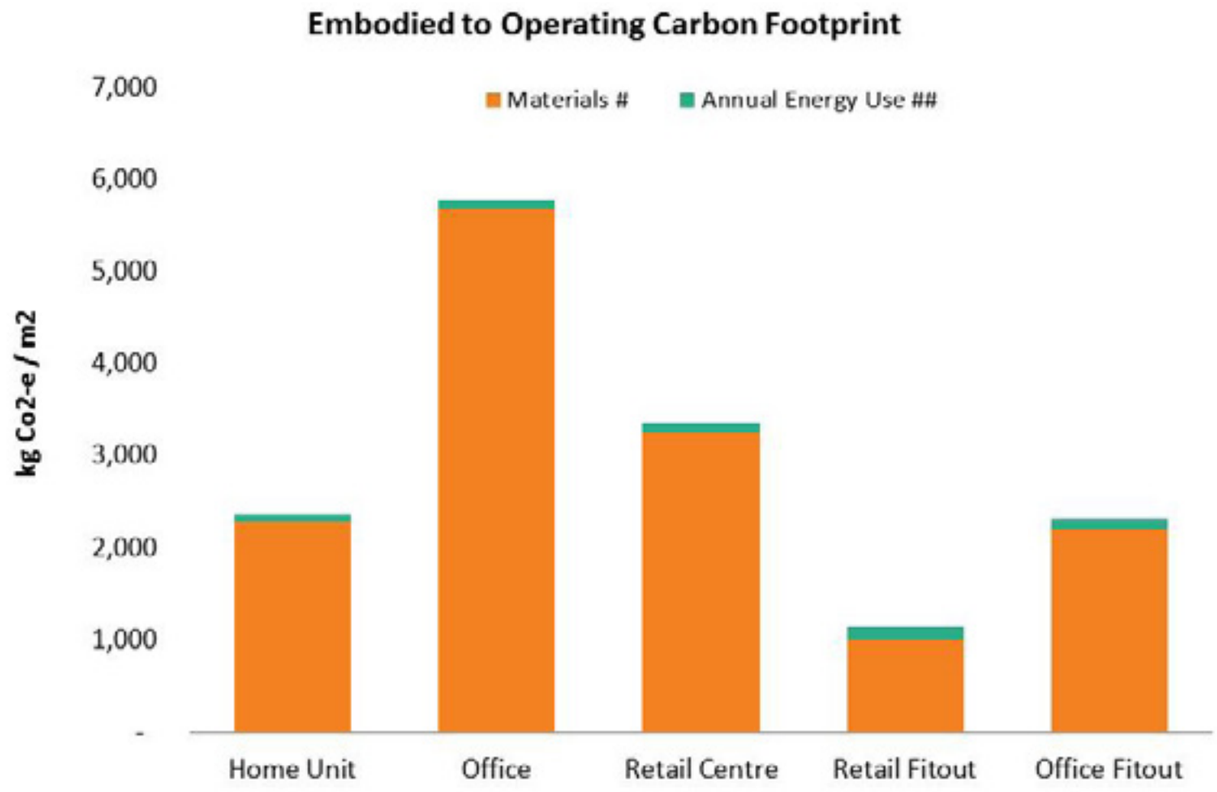
Achieving net zero carbon buildings in four steps

CAROLINE NOLLER,
THE FOOTPRINT COMPANY

The pathway to net zero carbon buildings has been extended to include embodied carbon (materials carbon). This is because the embodied carbon content can be more than 40 times the size of operating carbon emissions. Chasing operating carbon mitigation frequently has the effect of bringing carbon forward and may never in reality be "paid back". The net result: more carbon, not less.

This demonstrates the significant improvement in access to and quality of materials' carbon data. While still somewhat a "black box", there are four simple lessons to adopt and strategies to avoid to deliver substantial whole of life carbon reductions without cost.

By 2030, over 135 billion square metres of new building is needed just to accommodate growth in global population. This could account for over 350 gigatonnes of embodied carbon emissions. Consistently halving the embodied carbon content of new buildings and adaptively reusing a sizeable proportion of existing stock, is possible when design is supported by strategic LCA and adopting most of the four main pathways to low carbon design. Achieving this reduction could contribute about half of the overall emission reduction needed to achieve the Paris Agreement targets.



The figure above shows the average embodied (materials) and operating carbon content of various Australian building types. These figures show the absolute amount of embodied carbon for the base building and fitout creation against one year of operating carbon. It can been seen that the ratio of operating to embodied carbon varies between 55 for office to 40 for retail and residential. That is, the building needs to exist and be operated for 55 years for the annual emissions to equal the material impact of development. Interestingly, the reality in Australia is that over 55 per cent of all residential stock is less than 30 years old and commercial stock 27 years, and retail tenancies less than five.

To halve the embodied carbon content of new buildings, there are four key steps:

STEP 1: REALISTIC LIFE CYCLE

Most structures and facade are specified with a lifespan of more than 50 years. This can add more than 20 per cent to the embodied carbon footprint. As shown, the average life span of buildings in Australia is less than this. The key here is to consider, a) the realistic service life and design to this, and b) to adopt a design strategy which allows for the majority of the structure and facade to otherwise be adaptively re-purposed or amended "in situ". Adopting this approach for the structure and facade has the potential to avoid 15-35 per cent of future carbon impact.

STEP 2: ALTERNATIVE SOLUTIONS

It is possible to reduce the carbon intensity of buildings by over 30 per cent

by adopting key design strategies. The structure, facade and services of most buildings account for 30-45 per cent of the total building carbon impact and each of these has alternative solutions, which may vary more than 50 per cent depending on the approach. A simple cross laminated timber structure can reduce total impact by 40 per cent compared with a traditional concrete structure.

STEP 3: RECYCLED CONTENT

Adopting high recycled content in many materials can reduce carbon footprint by more than 60 per cent. Care is needed as even some 100 per cent recycled content materials may still have more carbon than a virgin material for the same use (e.g. polyester insulation over recycled glass or recycled nylon carpet versus timber planks).

STEP 4: LOW CARBON SUPPLY CHAIN

Five years ago the concept of supply chain of custody for timber products was unknown. Today it a requirement. Procuring key building materials from low carbon sources can avoid 50 per cent or more of the carbon impact. Knowing which materials to focus on and what to specify is essential to get a result. For example, the difference between aluminium fully produced in Australia, versus Western Europe or Canada, is three to one in terms of embodied carbon content per tonne.

CONCLUSION

Almost half of the embodied carbon footprint of buildings gets "locked away" within the very first few days of schematic design so adopting all of these strategies is essential in order to at least halve the carbon footprint of new buildings. Achieving this could provide a no-cost/low-cost solution to achieving a fair measure of the Paris Agreement targets.

Ideally, designers and owners need ready access to simply data and visual guides much like those you could expect in Cordell's Cost Guides or Riders Digest. The GreenBook and The Footprint Calculator by The Footprint Company are two possible sources of this sort of information.

"Procuring key building materials from low carbon sources can avoid 50 per cent or more of the carbon impact. Knowing which materials to focus on and what to specify is essential to get a result."

Reimagining property in a digital world

NICOLA WALT AND MATT LOW, ARUP

Take a moment to imagine a world where buildings expand and contract, anticipating the demands of a modern-day workforce. Imagine a combination of sensors and data analytics that improve buildings' operational performance across every metric. Imagine saving time and money, while ensuring consistency with critical standards and sustainability outcomes. Imagine gaining actionable data, empowering a portfolio now and into the future. And now – imagine if this could all be realised through a transformation in strategic thinking, and the impact this would have on the building users, and ultimately on a portfolio.

"Digital [technology] is a great tool for building owners to listen and adapt to what occupants want," Arup strategic designer Nicola Walt says.

"A layer of devices, connectivity, cloud-based processing, and rich pool of data can enable a building to react, either instantaneously or based on insights gathered over time."

WE HAVEN'T COMMITTED

Digital is adopted in part throughout the property sector, affecting the way buildings are designed, built and used – but full benefits are yet to be realised, owing to a disjointed approach. In essence, the sector hasn't fully committed to operating digital property portfolios across building lifecycles, and focusing on the building users' experience.

"User engagement is no longer a one-off, narrow exercise to appease the planning process years before the building is built. It needs to be central to the whole design process and ongoing operation of the building, linking together systems from the outset," Walt says.

"We use digital information in the design and construct phase, but this doesn't often get carried on when operating the building. For example, we need [building information modelling] to be used in the operation phase; that way we can test designs digitally before implementing them."

KEY DRIVERS

So, what are the key drivers for this digital change? Most simply, a digital society wants digitally enabled spaces. And, the falling price of technology is changing how we can embrace digital when looking at the design of the workplace.

Organisations realise enabling workforces to work remotely and come together when needed for collaboration leverages productivity and a positive work culture. The Internet of Things (IoT) is enabling ubiquitous digital integration – something the modern workforce has come to expect.

Open protocols enable new forms of integration and control, and cloud-based computing and storage caters for faster set-up and scaling. Digital and physical environments are merging to form hybrid spaces and environmental regulation will drive demand for improved asset performance. The sharing economy is disrupting the economics of ownership and usage.

USER EXPERIENCE

"More sophisticated tenants have a desire for digital and there is a growing expectation that offices provide for user experience," Arup Melbourne digital lead Matt Low says.

"This will grow as a trend in the next two years."

The property sector is on the verge of a huge leap forward in the way data-driven, digital products and services are used to make better decisions, construct better projects, and achieve better outcomes – ultimately responding to building users' needs.

"Companies seek prime locations close to rich innovation, and it's a really important interface connecting the outside to the inside, and bringing people into the building," Walt says.

"Digital helps this through good design and making people excited about coming into the building. Building user data informs this design but needs to be complemented by talking to people on an ongoing basis."

A RANGE OF BENEFITS

There is no doubt that digital transformation improves portfolio efficiency by increasing integration and automation of building operations. The facility manager's role becomes far more strategic, and it maximises use of the building and its assets. Plus it drives up

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tenant's and occupant's expectations about the experience produced, both functionally and emotionally. Users benefit from a range of integrated services that support individual needs and preferences.

Given buildings' long lifecycles, digital transformation offers more agility by giving property owners and managers new abilities to adapt to changing user needs over the lifecycle. Plus they gain a wealth of actionable data that allows for far better portfolio management and planning for the future.

Low describes the effect a digital strategy can have on a portfolio: "I have a client that owns a retail precinct and then on the next city block they own a commercial building. They're looking at how to use a digital strategy that will enable tenants in the commercial building to order catering from the retail precinct. Traditionally these haven't been connected."

JOINING THE DOTS

Comprehensive benefits can only be realised when property sector leaders join the dots across different stages of projects, and then do so at a portfolio level. At that point, a digital masterplan spans their entire property footprint – one that improves every aspect of their business, and the experience and productivity of their buildings' users.

Looking now and into tomorrow, every business needs its own digital strategy to improve operational performance, building user experience and produce higher long-term valuations. The digital performance of an asset is pivotal to both its long-term value and competitiveness.

Walt leaves us with food for thought: "Like the physical architecture of the building, this digital architecture needs to be carefully designed to support the experiences of its occupants and minimise the building's environmental impact. Not technology for technology's sake. Developers need to resist buying the latest shiny app, management dashboard, platform and sensor, and first clarify the human need."

KEY DIGITAL BENEFITS

PORTFOLIO STRATEGY

A data-driven investment strategy improves decision making and returns, and portfolio-level performance analysis creates operational cost savings.

PROJECT PLANNING

New forms of stakeholder engagement make better project delivery and outcomes, and data-driven analysis and visualisation means better site selection. The digital performance of an asset is pivotal to both its long-term value and your competitiveness.

DESIGN AND ENGINEERING

Digital delivers faster, cheaper and more accurate existing conditions modelling, and digital design simulations improve the future user experience.

CONSTRUCTION AND FITOUT

A digitalised approach enables faster, more cost-effective and accurate project delivery, and process virtualisation enables a more efficient transition between design/ engineering and construction. And digital allows for safer, smarter construction.

ASSET OPERATION

Digital transforms asset operations through digital infrastructure and processes, enabling a more detailed understanding of the occupant experience. Plus it increases flexibility and integration through open building systems. New value-added service propositions result from digital / data infrastructure.

ASSET RENEWAL

Digital aids portfolio-wide intelligence meaning smarter asset renewal. Online platforms enable the sharing, sale or reuse of valuable materials at their end of life. Digital knowledge platforms streamline renewal projects.

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