



LOW CARBON LIVING  
CRC

## Low Carbon, High Performance Schools

National Survey Results on Attitudes Toward the Role of the Built Environment and Sustainability on Learning Outcomes



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## Contents

Acknowledgements.....	3
Partners.....	3
Special Acknowledgement.....	3
Disclaimer.....	3
Peer Review Statement.....	3
List of Tables.....	6
List of Figures.....	7
Acronym.....	8
Executive Summary.....	9
About this Report.....	9
Key Findings.....	9
Research Implications and Conclusions.....	10
1. Introduction.....	11
1.1. Significance and Objectives.....	11
2. Methodology.....	13
2.1. Survey.....	13
2.2. Participants.....	13
2.2.1. Recruitment.....	13
2.2.2. Participant demographics.....	13
2.3. Research Scope and Limitations.....	13
3. Survey Results.....	14
3.1. Attitudes to Towards the Built Environment and Learning Outcomes.....	14
3.1.1. Can the Built Environment affect learning?.....	14
3.1.2. Perceived impact of aspects of the indoor environment on children’s ability to learn.....	16
3.2. Demountable Buildings.....	18
3.3. Sustainability Programs in Schools.....	19
3.3.1. What are schools doing around sustainability?.....	19
3.3.2. Types of sustainability programs.....	19
3.3.3. Tracking Resource Consumption in Schools.....	21
3.3.4. Schools Audits.....	21
3.3.5. School Action Plans.....	21
3.4. Influence of Students on The Household.....	22
3.5. Sustainability in The Home.....	24
3.5.1. Personal efforts and attitudes toward reducing emissions.....	24
3.5.2. Household goals and support to reduce energy and emissions.....	24
3.5.3. Perception of others’ efforts and attitudes towards reducing emissions.....	25
3.5.4. Impact of Quality of Life.....	25
4. Discussion.....	26
4.1. Impact of Built Environment on Learning Outcomes.....	26
4.1.1. Physical comfort and IEQ.....	26

4.1.2.	The suitability of spaces for learning.....	27
4.1.3.	Hands-on Learning Opportunities.....	27
4.2.	Demountable Buildings.....	27
4.3.	Benefits of Low Carbon, High Performance Schools.....	29
4.3.1.	Financial savings.....	29
4.3.2.	Environment and sustainability.....	29
4.3.3.	Carbon Emissions.....	29
4.3.4.	A better place to teach.....	29
4.4.	Creating Low Carbon, High Performance Schools.....	29
4.5.	Sustainability and Low Carbon Living.....	30
4.5.1.	Intergenerational Change.....	30
4.5.2.	Sustainability in The Home.....	30
4.5.3.	Quality of life not affected by reducing emissions.....	30
5.	Conclusions, Implications for Policy Makers and Further Research.....	31

## List of Tables

Table 1 - Ways the built environment can impact learning outcomes identified by participants.....	15
Table 2 - Examples of additional aspects of the built environment that impact on learning outcomes identified by participants.....	17
Table 3: Sustainability Programs identified by Participants .....	20
Table 4: Examples of intergenerational change.....	23
Table 5: Financial Benefits of Green Schools (US\$/ft <sup>2</sup> ).....	29

## List of Figures

Figure 1 - Do you believe the built environment can impact learning outcomes of students?.....	14
Figure 2 - Impact of different aspects of built environment on the ability to learn.....	16
Figure 3 - Proportion of schools with demountable buildings.....	18
Figure 4 - Satisfaction with demountable buildings .....	18
Figure 5 - Ratings of the impacts from demountable buildings .....	19
Figure 6 - Current sustainability programs in schools .....	19
Figure 7 - Types of programs school is participating in .....	20
Figure 8 - Did your school have any audits done in the last year? .....	21
Figure 9 - Does your school have a current action plan? .....	21
Figure 10 - Most common sustainability initiatives in place in schools .....	22
Figure 11- Personal attitudes and efforts towards reducing emissions .....	24
Figure 12 - Household goals and support for reducing emissions .....	24
Figure 13 - Perception of others attitudes to reducing emissions.....	25
Figure 14 - Impact on quality of life of reducing carbon emissions.....	25





## Acronym

CC	ClimateClever
GHG	Greenhouse Gases
LCHP	Low Carbon High Performance
IEU	Indoor Environment Quality
IEQ	Indoor Air Quality
VOCs	Volatile Organic Pollutants

## Executive Summary

### About this Report

Buildings are a major contributor to Australia's greenhouse gas emissions. School buildings and their precincts provide a low-cost, high-impact opportunity to reduce not only emissions but also to provide schools and Education Departments with significant financial savings. Many schools are unaware of the potential wastage and inefficiencies occurring within their school boundaries, which is leading to unnecessarily high utility bills, nor the abundant opportunities to increase their efficiency.

Currently, there is no national approach for measuring the performance of school buildings, nor mandated targets for improvement in this sector. There is also no national program that provides a systematic way for schools themselves to reduce their consumption of resources and production of emissions.

While the impact of poor building design on health, comfort, and learning, has been well documented in the literature, little is known around the lived experiences and beliefs held by people directly linked to schools.

This report therefore presents findings of a survey of 120 people across Australia who are connected to schools, and examines their beliefs, attitudes and experiences relating to the impact of the built environment on health and learning outcomes in schools. It also examines the uptake of sustainability and carbon emissions reduction programs in schools, and attitudes and behaviours toward low carbon living in the household.

### Key Findings

#### **Overwhelming agreement that the built environment impacts on learning outcomes**

Almost all participants believe the built environment impacts on learning outcomes of students (98%) and almost 90% rated elements including natural light, natural ventilation, air quality, temperature, and classroom layout as either extremely or very important. Two core issues or themes emerged on design aspects that have the biggest impact on learning: the suitability and flexibility of the space for children's needs, and the way exemplary buildings reinforce learning about sustainability.

#### **The results showed a high presence of demountable buildings and classrooms, and yet a large number of responses reported negative attitudes towards demountable buildings.**

64% of participants reported demountable classrooms at their schools, and more than half of our participants (55%) reported a "low" satisfaction rating with demountable classrooms. This was accompanied by a very strong negative rating of their perceived impact on environment and sustainability, physical health, mental

health, and student's learning (72% very or somewhat negatively impacted).

#### **Most schools are participating in some kind of sustainability program, but less than a third are using a formal tool or action plan to reduce their energy, water and waste consumption and carbon emissions.**

While energy forms the largest component of the carbon footprint, it is not targeted nearly as much (39%), as garden and waste programs (77%) or water (49%). Carbon rarely forms part of sustainability programs.

While there is near universal support for schools to be formally tracking their energy, water and waste production (94% agree), only 28% stated that they were tracking it. Few schools (19%) knew how their school compares to others in terms of its sustainability and/or carbon footprint. Very few (16%) knew they had completed an energy, water, waste or water audit in the last year. Only 27% had a current Action Plan in place to reduce their energy, water and waste consumption.

#### **Students participating in sustainability programs at school have a strong positive influence in their household.**

Considering the pivotal role schools play within our communities, this study also examined whether the participating schools (through their low carbon initiatives) can influence community awareness and knowledge.

58% of respondents reported their child has influenced their decisions at home based on sustainability or low carbon living programs that they are involved in at school.

#### **People are working hard to reduce their energy use and greenhouse gas emissions wherever possible and report feeling very bad if they fail to, but don't believe other people feel the same way**

A surprising finding was the gap between the level of effort and care participants reported they were making towards reducing their energy and emissions compared with the rest of the population: Most agreed "*they* work hard wherever possible" to reduce their energy use (84%) and greenhouse gas emissions (80%), and also reported they would feel "very bad" if they failed to reduce their emissions (77%). Yet, only 24% agreed with the statement "most people *think* it's very important to reduce their greenhouse gas emissions" and just 7% agreed that "most people *work hard* to reduce their emissions wherever possible".

#### **Impact on quality of life**

In another surprise result, when asked about the impact of reducing emissions on quality of life, only 2.5% strongly agreed with the statement "I believe my quality of life will suffer if I try to reduce my greenhouse gas emissions". A near universal 78% disagreed or strongly disagreed with the statement. These results are in strong contrast to the political narrative that actions taken to combat emissions will negatively impact our quality of life.

## Research Implications and Conclusions

### **The need for targets and a systematic approach for measuring and improving performance of this sector.**

The Education sector would benefit from having more stringent design and building codes for schools, as well as performance benchmarks, baselines and targets set to measure and improve performance within this sector over the coming years. This will be critical in order to achieve net zero emissions by 2050 in line with the Paris agreement.

### **Targeted, cost-effective programs to help schools reduce carbon and costs.**

While several states have leapt ahead and are paving the way for others in terms of implementing low carbon initiatives in their schools, the lack of a coordinated national program has meant schools in several states are left without much assistance. This also means there is little opportunity for schools to compare themselves with other schools across Australia.

There is a growing need for a cost-effective, nationally coordinated effort to empower schools to pursue carbon and cost reduction individually, rather than rely on government programs that are subject to political funding cycles. Programs that enable schools to pursue operational efficiencies themselves can dramatically reduce the cost to State Education Departments. Such programs can also provide significant learning opportunities for students around resource efficiency and low carbon living.

### **Innovation needed to improve the design, fit-out and operational performance of demountable buildings.**

Considering the near ubiquitous presence of demountable buildings and classrooms in schools, greater innovation is urgently required to ensure that they are designed to provide optimal learning spaces for students and staff. Demountable buildings have, and will continue play, a key role in dealing with fluctuating student numbers, which provide an ideal opportunity for innovation.

### **Greater dialogue with stakeholders who utilise these spaces.**

Greater research needs to be undertaken with stakeholders using school buildings (including children) to ensure that space designs, upgrades and technologies used within them are designed with their needs and requirements in mind.

### **Explore opportunities to create intergenerational change through students taking knowledge home.**

More research is needed to explore how schools can effectively educate and empower students to take sustainability knowledge gained in the classroom setting home to upskill their parents, families, friends and communities around resource efficiency and low carbon living.

A new data-driven, evidence-based online program was piloted in 2018 – **The ClimateClever Initiative**. It was a collaboration between Curtin University and the CRC for Low Carbon Living with the support from a variety of industry partners. In 2019, they will launch a home version of the tool, which will – for the first time – be able to track this intergenerational impact.

## 1. Introduction

Buildings have been identified as consuming up to 40% of the world's energy, 25% of the world's water, 40% of the world's resources (SBCI, 2012; Salleh et al 2015), and are attributable for around one third of global greenhouse gas (GHG) emissions (Ibn-Mohammed et al, 2014, cited in Rauland, Odell, Hall, Newman and Lewis, 2014).

In Australia, buildings account for almost a quarter of national emissions, and more than half of the electricity use (Australian Sustainable Built Environment Council, 2018). The abundant opportunities to abate carbon in the built environment is well documented in the literature (McKinsey & Company, 2010; Energetics 2016; ASBEC 2018). Salleh et al (2015) noted that buildings have the potential to reduce their energy consumption between 30 - 80% through technologies that are easily available and low in cost.

As with most of Australia's buildings and infrastructure, the education sector has a large proportion of rapidly ageing and inefficient buildings, which have often been built to meet only minimum building code requirements (Rauland et al, 2014). Inefficiencies are often further exacerbated by wasteful behaviour by occupants. Furthermore, many schools are increasing in their energy intensity (Council of Australian Governments (COAG), 2012), often due to increased reliance on new technologies in the classrooms and the expectation of mechanised heating and cooling in school buildings. This requirement is likely to increase in coming years due to a changing climate.

There is also a significant and increasing prevalence of demountable (also referred to as transportable or portable) buildings at schools. These buildings, which were originally designed to be cost-effective, temporary structures, have become a mainstay at many schools. Because of their temporary nature, it is likely that there has been less focus on design, which has resulted in mixed feelings about their operational performance and health impacts.

According to the Green Building Council of Australia (GBCA) (2013):

*"Australia has 3.4 million full time school students in more than 9,500 schools across the country, with almost 280,000 teaching staff. A further 1.3 million students attend tertiary education facilities. Many of these students and teachers spend each day in schools with badly designed classrooms, poor indoor air quality and limited access to daylight. Evidence and experience shows that this affects student health and learning, teacher morale and school operational costs – as well as the environment."*

Over the last decade there has been a significant shift toward more sustainable schools, with many countries developing sustainable regulations and policies for school buildings (Green Building Council of Australia, 2014).

Schools designed to address and actively reduce their environmental impact through built infrastructure and design are often referred to as 'green' schools, and generally have lower operating needs resulting in fewer carbon emissions and environmental impacts, as well as lower utility bills. There are also a range of well documented health and learning benefits associated with green schools (Green Building Council of Australia, 2014).

Rauland et al, (2014) classify these types of schools as *low carbon, high performance (LCHP) schools*, which highlights the improvement in both the performance of buildings and physical infrastructure in reducing emissions and resource consumption, as well as improved academic performance due to the range of health benefits associated with better designed buildings and facilities. Other benefits of LCHP or 'green' schools is the significant potential for hands-on learning, as well as the engagement opportunities with the wider community on environment and sustainability issues.

Nevertheless, despite the benefits, uptake in improving the performance of school buildings nationally appears slow, and in many cases costly, and the process of how to engage schools and help them to improve their own efficiency and reduce their carbon footprint remains a challenge. This is likely due to the lack of a national approach and the disaggregated and often siloed nature of the programs, tools and initiatives available in the different States and Territories.

This paper presents the findings of a national survey designed to explore the attitudes and perceptions of the impacts the built environment has on the health and learning outcomes of students. It also examines the type of sustainability and carbon reduction programs currently available for schools, as well as school's engagement with these programs. It concludes by examining the general attitudes and beliefs towards low carbon living.

### 1.1. Significance and Objectives

Despite abundant research, including scientific studies, documenting the evidence around the impact of both poorly designed and well-designed buildings on a variety of factors, including student health, there has been limited research to date on the direct experiences and attitudes held by professionals working in, or linked to schools, and almost no literature around demountable buildings in Australia.

There is also only limited research on the importance people place on reducing greenhouse emissions in their own lives, and the impact such actions have on quality of life.

In light of the gap in the research highlighted above, the five objectives of the study are to:

1. Investigate attitudes of people directly linked to schools around the role of the built environment on teaching and learning outcomes in schools;

2. Identify attitudes toward demountable buildings and their impact on learning outcomes;
3. Identify the uptake of sustainability or low carbon programs and initiatives in schools;
4. Investigate the influence students have on their household in relation to adopting sustainability or low carbon behaviours;
5. Investigate sustainability in the home, including personal efforts to reduce emissions and energy use and the perception of efforts being made in the broader community; and the impact reducing emissions has on quality of life.

This research forms part of a CRC LCL project RP3020u1: Mainstreaming low carbon, high performance schools and classrooms. This builds on research from a previous CRC LCL Project RPRP3020: Carbon Tools & Frameworks for Institutional Precincts Stage 1, which documented the findings of a two-year Low Carbon Schools Project that was trialled in Perth, Western Australia with 15 schools between 2016-2017.

This report also uses several survey questions developed from another CRC LCL project RP3012: Environmental Attitudes - Low Carbon Behavioural Practice. The final report of the project, Transformation to Low Carbon Living - Social psychology of low carbon

behavioural practice (RP3012), (O'Brien, McNeil & Kashima 2018) details a theoretical framework developed and the instrument, Low Carbon Readiness Index (LCRI), used in this project. An academic publication (O'Brien et al., 2018) has reported the studies that validated LCRI.

This report seeks to articulate policy implications and strategies that will be effective in increasing the uptake of sustainable design and sustainability programs in schools.

## 2. Methodology

Curtin University and the University of Melbourne in collaboration with the CRC for Low Carbon Living, ClimateClever and Barry Du Bois (of 'the Living Room') conducted a national online survey on attitudes on the role of the built environment and sustainability on learning outcomes and knowledge acquisition between October 2017 to January 2018.

### 2.1. Survey

The survey had five aims. These included:

- Investigate attitudes of people directly linked to schools around the role of the built environment on teaching and learning outcomes in schools;
- Identify attitudes toward demountable buildings and their impact on learning outcomes;
- Identify the uptake of sustainability or low carbon programs and initiatives in schools;
- Investigate the influence students have on their household in relation to adopting sustainability or low carbon behaviours;
- Investigate sustainability in the home, including personal efforts to reduce emissions and energy use and the perception of efforts being made in the broader community; and the impact reducing emissions has on quality of life.

The survey comprised of 40 questions, mostly using single choice questions with rating answers.

In some cases, participants were asked to provide examples or reasons for some of their answers. On average the survey took 12 minutes to complete.

### 2.2. Participants

#### 2.2.1. Recruitment

Respondents were approached via email through networks such as various school associations and parent associations, as well as through online networks using social media. TV celebrity Barry Du Bois also helped with recruiting using his social media profile. A 'snowball methodology' was employed for survey distribution, asking participants to forward on to others.

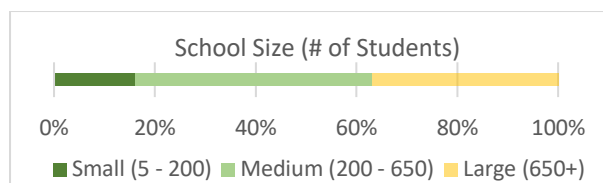
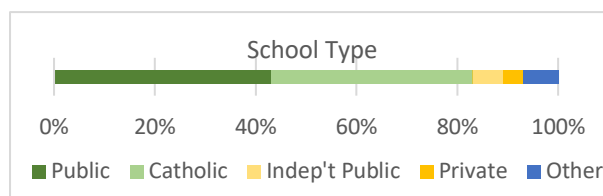
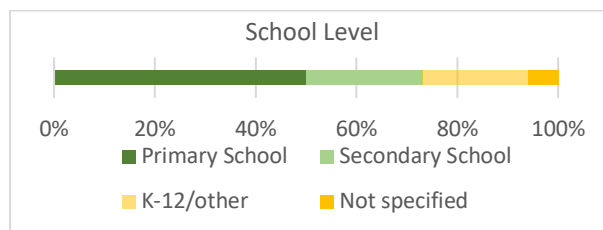
Participants who completed the survey were offered a 20% discount on the subscription fee for a new Low Carbon Schools Program (The ClimateClever Initiative) that launched in 2018.

#### 2.2.2. Participant demographics

A total of 120 people participated in the online survey. Of these, most were female (82%). Participants age range was between from 17-79, with an average age of 47. Most were born in Australia (88%), and spoke only English at home (89%).

The majority of respondents were from Victoria (32%) and NSW (29%), followed by WA (20%). QLD and SA were 7% and 6% respectively. TAS represented 2% followed by NT (1%). 3% did not specify their region.

82% were connected to a local school in some way. The majority (50%) of the respondents were connected to primary schools, with 23% to secondary schools and 21% K-12. There was a relatively equal split between public and catholic schools (43% and 40% respectively), with very few private school respondents. Most were from medium- and large-sized schools (47% and 37%).



### 2.3. Research Scope and Limitations

This survey targeted anyone connected to a school (i.e. teacher, parent, staff member, community volunteer etc). However, due to privacy concerns and research ethics, the survey did not specifically ask their role or their connection to the school, nor the name of the school they were connected to. This affected some participants ability to answer some questions, with a high proportion of responses throughout the survey listing 'unsure' or 'not applicable'. This limited the results of the study.

It is also likely that some respondents may be connected to the same school, which could lead to misleading results, primarily around the sustainability programs and actions, but also to the number of demountable buildings.

The survey represents a relatively small sample size in relation to the number of schools in Australia (approximately 9,500) and is therefore not representative of all schools, nor the demographics of people connected to schools.

### 3. Survey Results

The survey results discussed in this report are structured around five research themes:

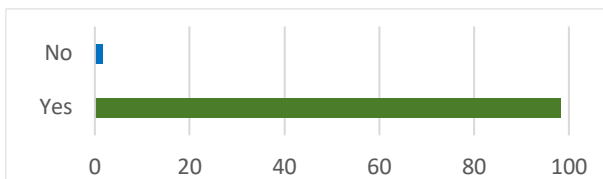
1. Attitudes to Towards the Built Environment and Learning Outcomes;
2. Demountable Buildings;
3. Sustainability Programs in Schools;
4. Sustainability in The Home, and;
5. Impact on Quality of Life.

#### 3.1. Attitudes to Towards the Built Environment and Learning Outcomes

##### 3.1.1. Can the Built Environment affect learning?

When asked if participants believed if the built environment can impact the learning outcomes of students, 98% of respondents answered yes.

Figure 1 - Do you believe the built environment can impact learning outcomes of students?



When asked to explain why they believed the built environment impacted learning outcomes, 110 examples were provided and generally fell into three categories:

- **Physical comfort** as it relates to indoor environmental quality (IEQ) elements including air quality, ventilation, lighting, temperature and acoustics;
- **Suitability of the space** for children's needs that allows the teacher to offer a range of learning experiences; and
- **Exemplary or best practice buildings that reinforce learning** about sustainability and good design.

Table 1 provides a selection of examples representative of those provided by participants across these themes (N=100).



Table 1 - Ways the built environment can impact learning outcomes identified by participants

Physical comfort & IEQ	Suitability of space	Exemplary buildings that reinforce learning about sustainability
<p><i>“Well ventilated, low odour, light and comfortable classrooms with natural heating and cooling enhance concentration and happiness for teachers and students.”</i></p> <p><i>“Because children react positively to bright, airy spaces with room to move and express themselves.”</i></p> <p><i>“Learning spaces are extremely influential on students. Students need a balanced and comfortable environment to reach their maximum potential.”</i></p> <p><i>“Pleasant surroundings that are climate controlled and acoustically designed with sufficient admin space for a teacher and other staff to interact with students, seems like a no brainer.”</i></p> <p><i>“The more comfortable students are the more they are willing to learn.”</i></p> <p><i>“In a current demountable classroom, the temperature can be extreme in summer. In a more comfortable and low-toxins environment, children can relax for proper learning.”</i></p> <p><i>Horrid, old, un-air-conditioned buildings are not conducive to good learning practices.”</i></p> <p><i>“Students need comfort in terms of temperature control, good (adjustable) lighting, fresh air etc to enable concentration.”</i></p>	<p><i>“At my school where I teach we asked the children about the learning spaces and how they would best be able to learn. They told us so we changed our equipment, furniture and spaces to suit them. We now have many different spaces within the one for different learning styles and ways.”</i></p> <p><i>“They need a variety of potential work places - desks, floor space, hard and soft floors. They need spaces where they can feel separate/ have privacy (to read quietly or take risks without embarrassment) and they need to be able to feel connected as part of their class and also multiple classes together. There needs to be storage for bags, books, resources and equipment and connectivity and power supply for ICT. There should be wall / shelf space for displays and ideally a source of water for hand washing, clean up and drinking. Everything needs to be hard wearing and multi-purpose.”</i></p> <p><i>“The environment needs to incorporate different leaning styles, needs to have space for hands on learning and needs different areas for different activities.”</i></p> <p><i>“Children with additional needs need space in order to function as do all children. Small cramped spaces that try to fit in 25+ children, desks and resources do not allow for calm learning environments.”</i></p>	<p><i>“Education about built environments can assist students to understand how the impact of human activity on the environment can be minimised and resources saved.”</i></p> <p><i>“Buildings can be exemplars of good design if the child is helped to understand the way that the building works. Understanding building design and the outcomes for those using it will assist students in their future decisions related to buildings. Students living and working in well-designed buildings can have their learning experience enhanced by greater comfort levels as well as direct engagement with concepts.”</i></p> <p><i>“Appropriate design that accesses natural light and air and uses passive and active solar options, and appropriate low impact building materials means students come to consider this as normal.”</i></p> <p><i>“As well as known positive or detrimental impact of building structures and architecture, the design of learning spaces that enable collaborative learning opportunities is an important part of student engagement.”</i></p> <p><i>“Schools need to model what they teach, so if they are encouraging energy efficiency they need to demonstrate that in the built environment.”</i></p>



### 3.1.2. Perceived impact of aspects of the indoor environment on children’s ability to learn

Participants were asked to rate how important a range of elements were in terms of their effect on children’s ability to learn (see Figure2).

In ranked order, the elements that were rated either extremely or very important were Natural light (92%), Natural ventilation (91%), Air quality (89%), Temperature (86%), Classroom layout/seating arrangement (86%), Visual sight of teacher (76%), Greenery (72%), Colour/texture of walls (69%), and Technology (63%).

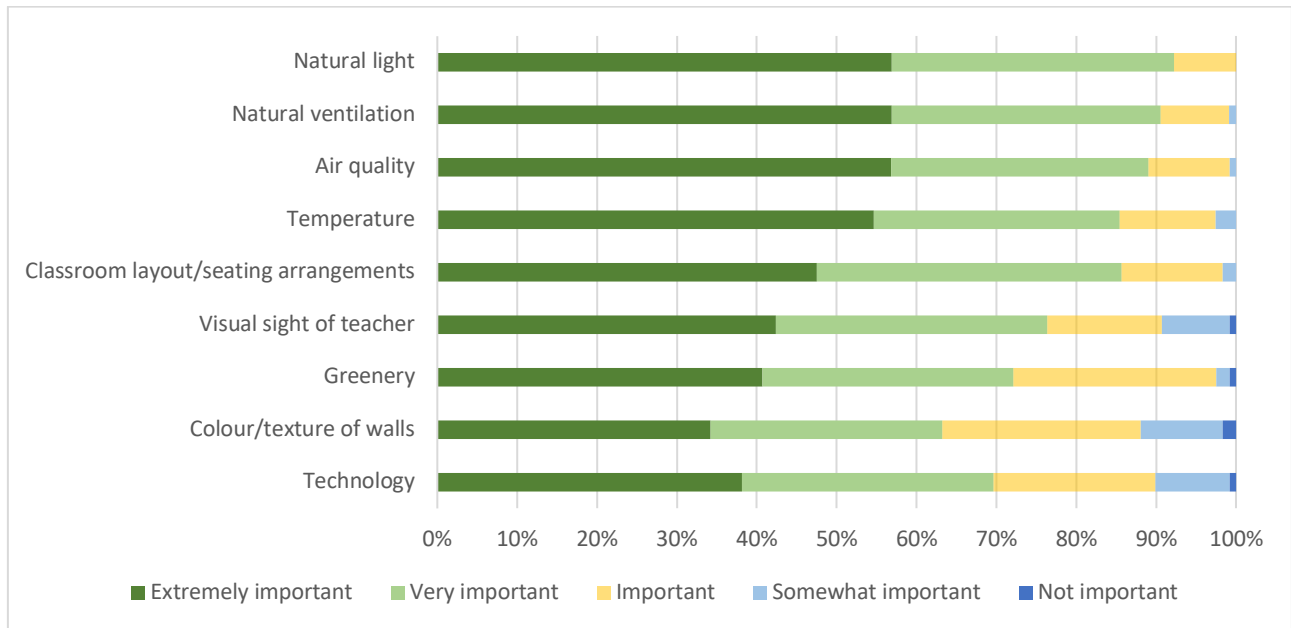


Figure 2 - Impact of different aspects of built environment on the ability to learn

#### **Other aspects that impact on the learning experience**

Participants were also asked if there was anything else from a built environment perspective they found impacted on the learning experience.

Their responses (n=68) typically fell into three categories:

- **Flexibility of the space**, and the need for more space, including the ability to modify it as needed;
- **Practical elements** including storage, acoustics, ventilation, air quality, and location of the classroom; and
- **Sustainability aspects** of the building.

Examples representative of these are at Table 2.

Table 2 - Examples of additional aspects of the built environment that impact on learning outcomes identified by participants (N = 68)

Flexibility of the space, and more space	Practical elements including storage, acoustics, ventilation and air quality, and location of the classroom	Sustainability aspects
<p><i>“Flexibility of space use, including movement of furniture, exclusion of light at times, control of incoming direct radiation, especially directly onto students and teachers as well as desk surfaces and ideally without darkening the room (not just blinds).”</i></p> <p><i>“Flexibility to modify the space. All teachers teach differently and different groups of students require more or less supervision, more or less structure, more or less instruction. The space needs to be able to accommodate all of these.”</i></p> <p><i>“Types and sizes and functional relationships between spaces/rooms etc is very important as it sets up opportunities for teaching and learning.”</i></p> <p><i>“Indoor outdoor flexible learning spaces. Wet areas. Time out/break/reading areas.”</i></p> <p><i>“A place for everything and everything in its place; ability to move around the classroom rather than fixed seating.”</i></p> <p><i>“Space - adequate and comfortable. Access to the bathrooms. Access for students with special needs.”</i></p> <p><i>“Flexibility of space - Can it be rearranged quickly to allow for a particular activity.”</i></p> <p><i>“Flexibility to allow change when needed.”</i></p> <p><i>“Variety of furniture, at different heights and levels; different groupings and arrangements for collaborating.”</i></p> <p><i>“Definitely more classroom space.”</i></p> <p><i>“Number of children actually in the classroom ratio should be taken into consideration.”</i></p>	<p><i>“Adequate storage for resources.”</i></p> <p><i>“Acoustics is an important factor and can affect the ability to connect learning spaces to natural ventilation, views, daylight.”</i></p> <p><i>“Reduce the use of indoor chemicals and VOC materials. Comfort furniture and finishes that help sound absorption.”</i></p> <p><i>“Sound quality when using things like interactive whiteboards, light glaring into kids eyes and off classroom surfaces as well as interactive whiteboards. Noise from neighbouring classrooms. The ability to have flexible walls to interact with neighbouring classes. Storage!!!!”</i></p> <p><i>“Location of classroom e.g. Large windows facing western sun on thirty plus degree days and poor evaporative cooling is not ideal for learning. Old evaporative conditioning units are extremely loud, making learning difficult for some. Some students with special needs are sensitive to temperature fluctuations, sensory input etc.”</i></p> <p><i>“The way sound travels in built spaces. High ceilings, low insulation, hard surfaces etc.”</i></p> <p><i>“Sound and Noise levels. These must be appropriate to the learning style/ability and is very important.”</i></p>	<p><i>A student’s understanding of sustainability issues related to energy and materials use as well as pollution from the manufacture of building materials in the school built environment can be reinforced and enable them to critique all other aspects of their built environment.”</i></p> <p><i>“Classrooms and furnishings should be made with non-toxic, healthier versions.”</i></p> <p><i>“Making these building fully sustainable, including solar power and rain water collection.”</i></p> <p><i>“To teach them why it’s important be kind to the environment, recycle and grow their own family food.”</i></p> <p><i>“Material choices for sustainability and design informed by pedagogical practices and design study.”</i></p> <p><i>“Reduce the use of indoor chemicals and VOC materials.”</i></p> <p><i>“To teach them why its important be kind to the environment, recycle and grow their own family food”</i></p>

### 3.2. Demountable Buildings

Participants with children at school were asked if their child's school had any demountable/transportable buildings. Of a total of 88 responses, the majority of participants (64%) answered yes, 31% said no and 5% weren't sure (see Figure 3).

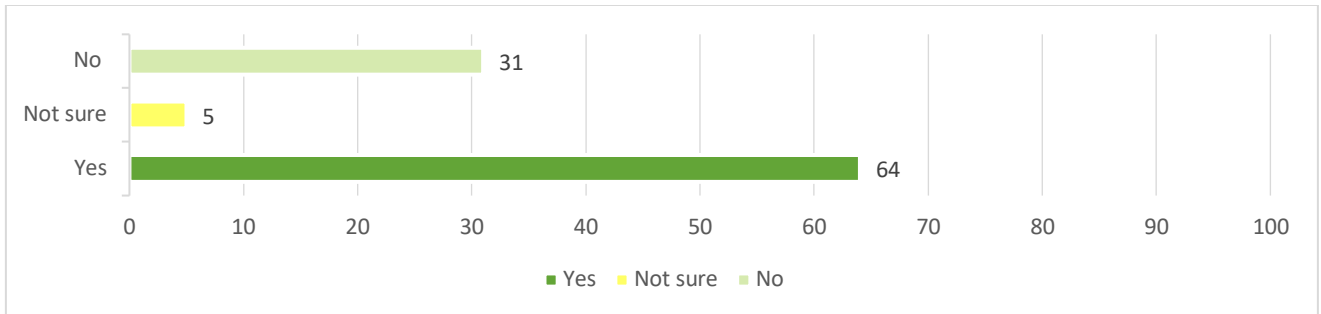


Figure 3 - Proportion of schools with demountable buildings

Participants were then asked how long, on average the majority of the demountable buildings had been onsite at the school for. Answers ranged from 1- 50 years, with an average of over 10 years.

Figure 4 outlines participants satisfaction with demountable buildings. When asked to rate their overall satisfaction, the majority (55%) reported "low", and 41% reported "moderate". Just 4% reported "high" satisfaction.

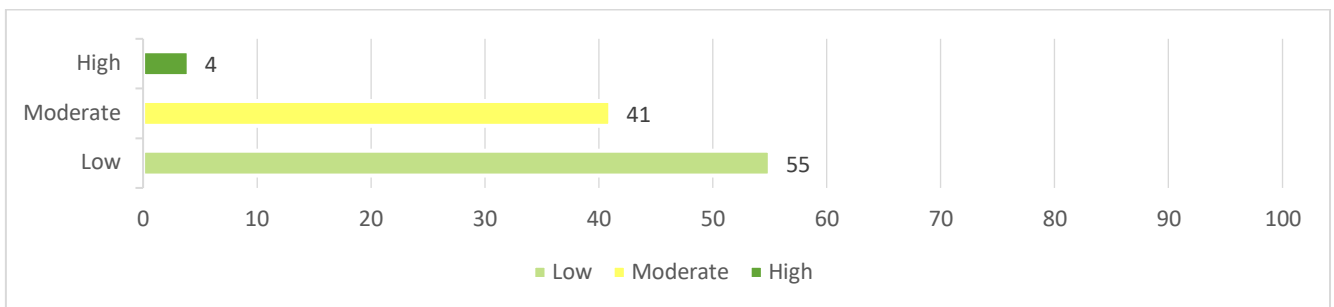


Figure 4 - Satisfaction with demountable buildings

Participants were also asked to rate demountable buildings in relation to their perceived impact on various aspects of health and environment (see Figure 5).

Overwhelmingly the impacts were rated negatively. In ranked order, the elements rated as very or somewhat negatively impacted were:

- Environment and sustainability (75% very or somewhat negatively impacted)
- Physical health (72%)
- Mental/psychological health (70%), and
- Student's learning (70%)

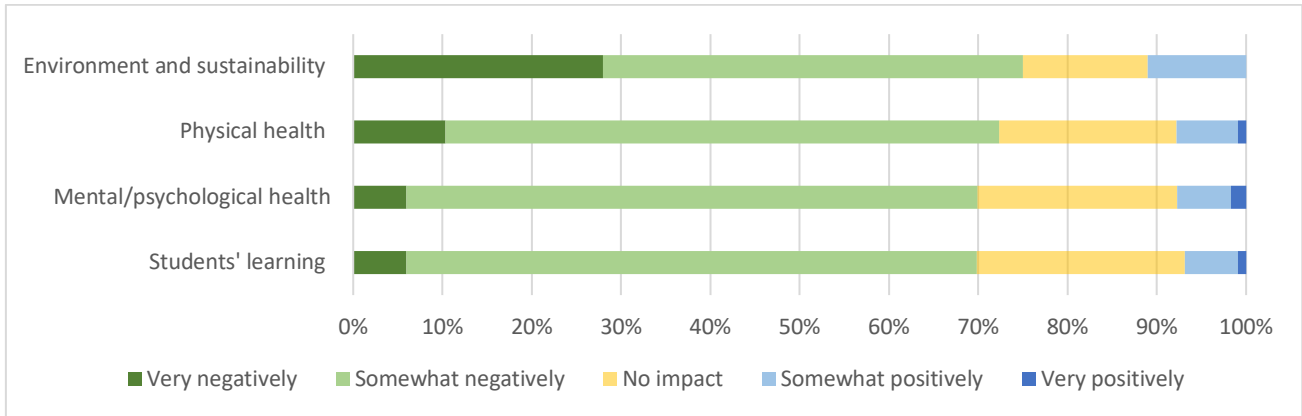


Figure 5 - Ratings of the impacts from demountable buildings

### 3.3. Sustainability Programs in Schools

#### 3.3.1. What are schools doing around sustainability?

From the 120 responses, 82% identified that they were connected in some way to a local school. Participants were asked about their school's participation (if any) in sustainability programs (see Figure 6).

Encouragingly, results showed that most schools (63%) are currently participating in some kind of sustainability program. Just over half (53%) are actively addressing sustainability and/or reducing carbon emissions and just under half (49%) have a student-led green/sustainability team. Almost one third (32%) have an active adult-led sustainability/environmental committee. Few schools (19%) knew how their school compares to others in terms of its sustainability / carbon footprint.

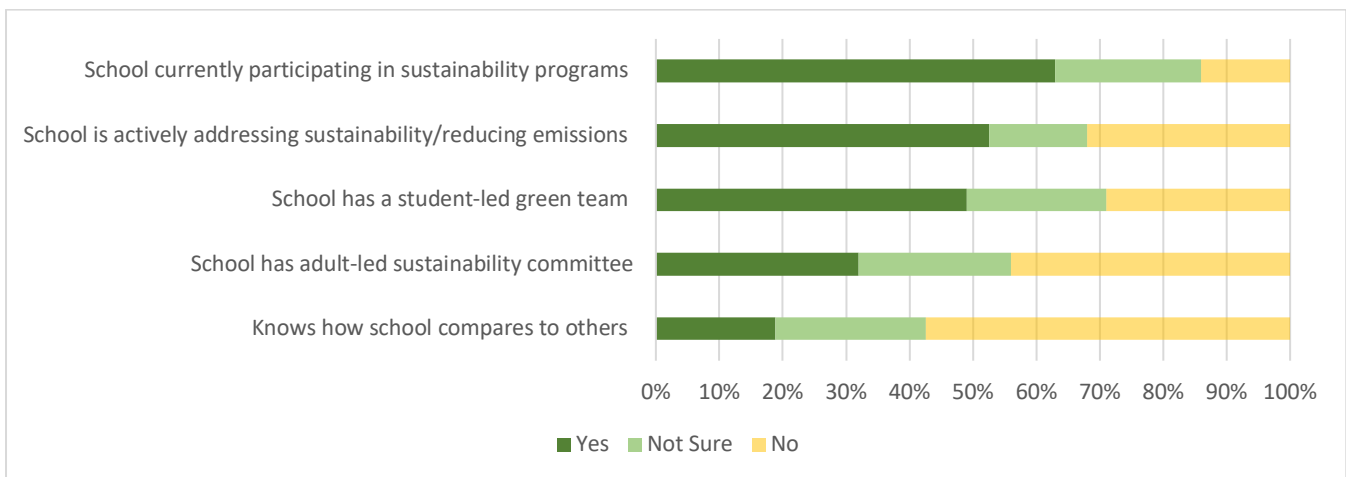


Figure 6 - Current sustainability programs in schools

#### 3.3.2. Types of sustainability programs

Those who reported participating in sustainability programs were asked to select which types of programs the school was participating in (See Figure 7). The most common types of programs were Garden programs (79%), Waste (75%), General sustainability (51%), Water (49%), Energy (39%), and Carbon (10 %).

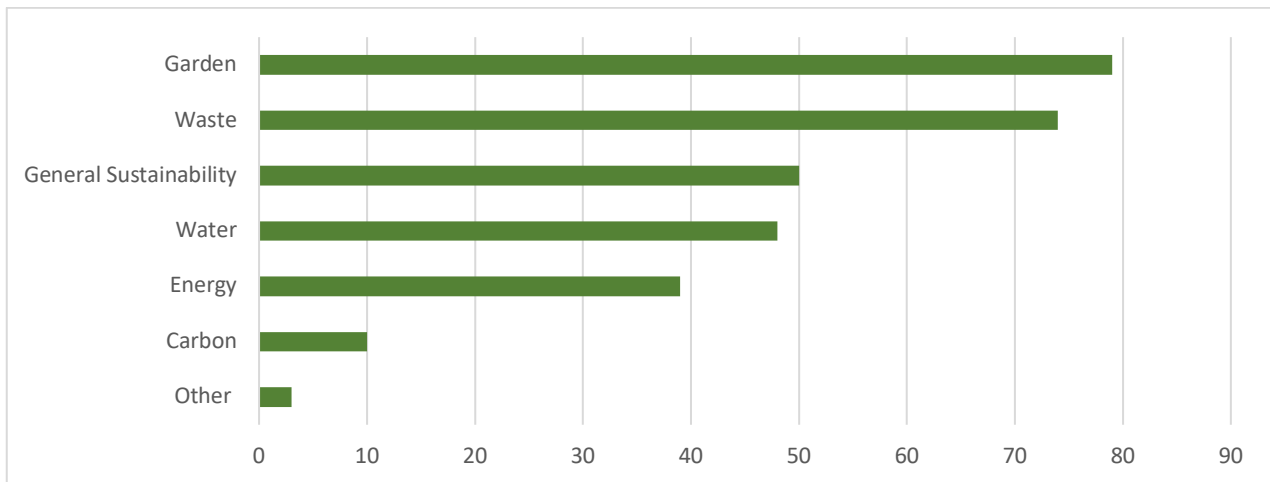


Figure 7 - Types of programs school is participating in

Participants were asked to list the names of specific programs (if they knew them). Respondents (s=49) listed the following programs, listed in alphabetical order (many schools were participating in the same program):

Australian Sustainable School's Initiative SA	NRM Tree Planting
Bush Care	NRM-Ed SA nature play
CERES	Partnership with Greening Australia
Cool Schools Australia	Resource Smart Schools Victoria
Drip busters	Ride to School
Earth Hour	River Detective
Ecowarriors,	Stephanie Alexander Kitchen Garden
Education for Sustainability Tasmania Initiative	Sustainability HUB
Enviro Club	SWEP
Envirofriends	Take 3 for the Sea
Environment House	Take2
Garden2Kitchen	Terracycle
Hands-up surveys	walktober
Keep Australia Beautiful	Waste free lunches
Kids Teaching Kids	Water Wise Schools
Mondo Recycle	

Table 3: Sustainability Programs identified by Participants

### 3.3.3. Tracking Resource Consumption in Schools

There was overwhelming support shown for schools to actively track and monitor their resource consumption (i.e. energy, water and waste), with 94% of respondents answering yes to the questions “Do you think schools should be tracking their energy and water consumption and waste production?”. However, when asked “Is your school actively tracking their energy, water and waste”, just 28% reported that they were. However, the majority (39%) weren’t sure.

### 3.3.4. Schools Audits

Participants were asked if their school had undertaken any audits in the last year. The majority (56%) weren’t sure, and on average just 16% said they had either an energy, waste or water audit (See Figure 8). 20% had no audits undertaken.

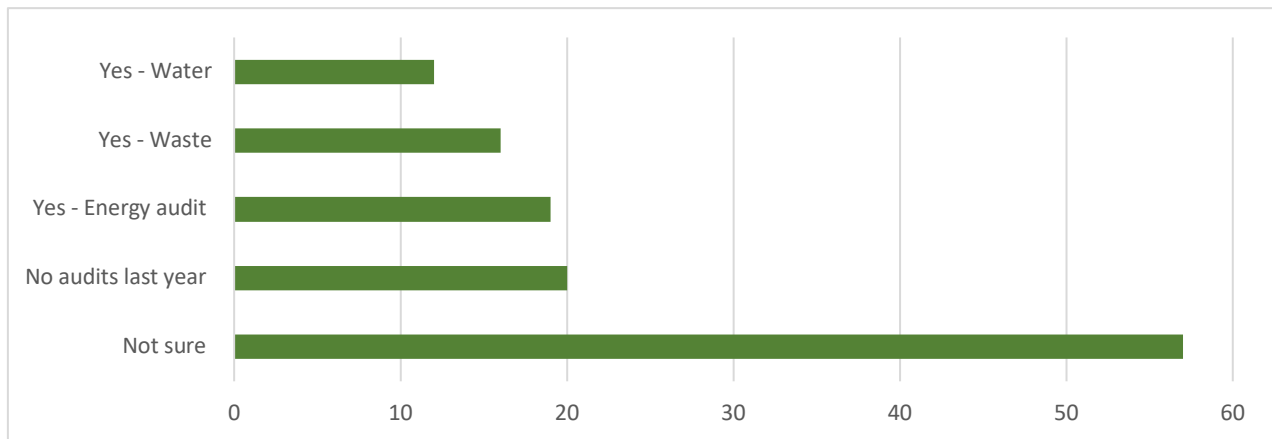


Figure 8 - Did your school have any audits done in the last year?

There is a strong feeling that students should be more involved, with 95% of participants responding “yes” to the question “Do you think auditing buildings and monitoring resource consumption and carbon emissions is something that students could be involved in?”.

### 3.3.5. School Action Plans

Participants were asked if their school had a current Action plan to reduce energy, water and waste. The majority (44%) weren’t sure, while 27% of schools said they had a current action plan (See Figure 9).

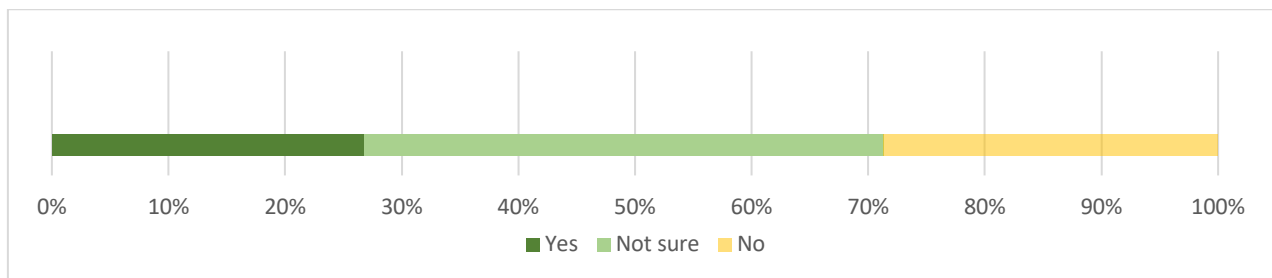


Figure 9 - Does your school have a current action plan?

For those with action plans, participants were asked how the initiatives are tracked. The respondents stated that:

- 54% are tracked or monitored online
- 15% were paper-based
- 7% weren’t tracked at all
- 23% weren’t sure

### Other Sustainability Initiatives in place

People were also asked if they were aware of any sustainability/low carbon initiatives currently in place at their school. Of 117 total respondents, 74 provided examples (63%), with most listing at least three separate initiatives in place.

Each was tallied separately and then ranked in order of uptake (see Figure 10). These were: Rainwater tanks (58%), Solar Panels (40%), Recycling programs (53%), LED or energy efficient lighting (24%), and Composting and vegetable gardens (18%).

Installing sensors or timers on lights (5%) and Lawn reduction and habitat restoration (8%) were mentioned, along with other energy efficiency measures such as timers on air conditioners and ensuring thermostats were set responsibly (2).

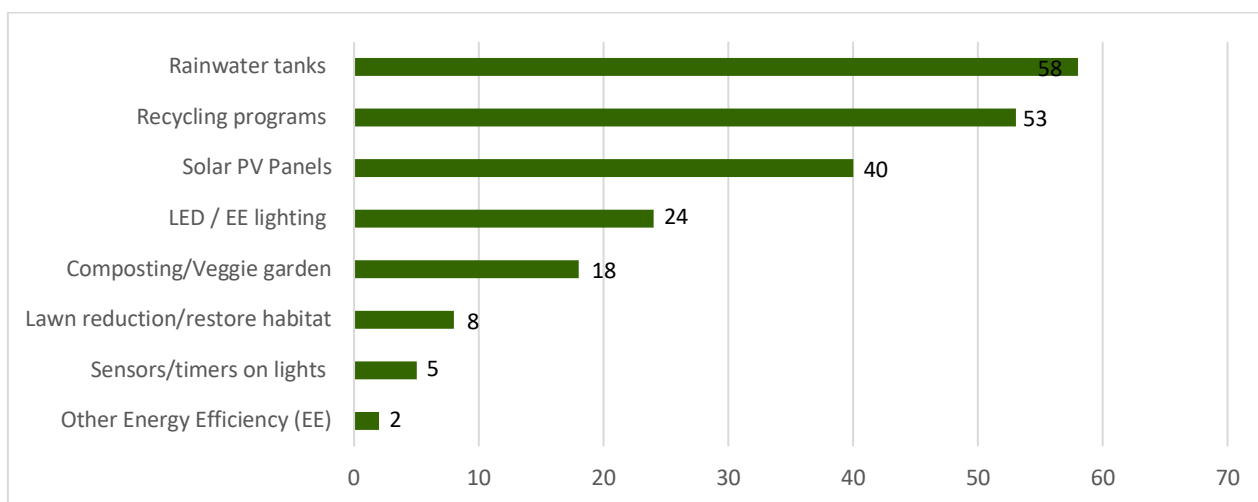


Figure 10 - Most common sustainability initiatives in place in schools

When completing this section, some participants also volunteered insightful details into the successes or barriers to their programs.

Some examples include:

*“The School Principle and School Council are working with Victorian School Building Authority to try and ensure the design and build of the new replacement school (~2020) will enable the school to minimise its lifetime carbon footprint. Currently have a school veggie garden, and a student-led EnviroClub.”*

*“We have Recycle SA Solar Panels and freshwater tank...worm farm and compost bins”*

*“We have a recycling program but the electricity bill would be high as most rooms have air conditioners”*

*“Papercut will be introduced to reduce photocopy waste. The recycling of drink containers program is a big flop. Even staff do not use the right bins.”*

*“We have been trying to install solar panels and LED lights since 2016, but the compulsory involvement of Programmed Facility Management has made it very difficult and expensive. We have a rain water tank from Water Wise school funding. We are finally reinstating free recycling pick up by the local Council after this free service was not allowed to continue three years ago following the state government changing waste tendering arrangements for public schools. The regulatory environment created by the state government has continued to be the biggest barrier to reaching the sustainability aims of this public school.”*

### 3.4. Influence of Students on The Household

Respondents with children at school were asked whether their child “ever brought back knowledge around sustainability, climate change or low carbon living, which has influenced your decisions at home”.

Of those who replied (n=64) 58% said ‘Yes’ (n=37) and 42% said ‘No’. The remaining respondents (56) either left it blank or selected “not applicable” to this question and were excluded from analysis.

They were then asked for examples. Some of these examples are listed in Table 4:

Examples of actions taken at home	Vehicles of knowledge dissemination
<i>"Reducing plastic in lunch boxes"</i>	<i>"I (as the child) recently did a term on sustainable design in my home economics class. It was extremely influential and educational."</i>
<i>"I [now] don't use plastic"</i>	<i>"War on Waste - impact on us as a family making a better effort to recycle. Waste wise lunches / buying less packaged goods / Litter free lunch ideas"</i>
<i>"Buy free range eggs. Think of food miles."</i>	<i>"Our children attend the kids teaching kids conference where they have run various sessions about water"</i>
<i>"I am a teacher and have feedback sent by parents and grandparents to me. Evidence of gardens at home; produce sent back to school"</i>	<i>"School vegetable garden which was cared for by students. Students sold Veggies at assembly. Also had a worm farm which provided worm wee for gardens. We also have a number of composting bins around the school."</i>
<i>"Use of "tupperware-type" of lunch container to replace non-recyclable food wrapping."</i>	<i>"My child was asked to complete a survey about our family's environmental footprint. It was a big learning experience for all of us."</i>
<i>"An understanding of how waste and cars effect the environment (but not necessarily and understanding of how buildings do!) Also, a fear of extreme weather events as a result of climate change, tidal waves, etc."</i>	<i>"Frustration that climate change is happening and that Australian Governments are not very proactive has encouraged us to be more vocal within our community and practice sustainability at a household level in ways that we can to show our support for their concerns."</i>
<i>"Opting to not use plastic straws or balloons due to them ending up in the ocean and killing sea life."</i>	<i>"Newsletters and School website"</i>
<i>"How the solar panels on the roof help the school."</i>	<i>"Assignment on sustainability"</i>
<i>"Turning off appliances and lights, recycle, rubbish free lunch, scraps etc"</i>	
<i>"Reminders to switch off lights in rooms as you leave."</i>	
<i>"Use of lights, and water consumption"</i>	
<i>"Litter free lunch ideas"</i>	
<i>"Buying less packaged goods"</i>	
<i>"Bringing home all food scraps and single use plastics"</i>	
<i>"Recycling"</i>	

Table 4: Examples of intergenerational change



### 3.5. Sustainability in The Home

#### 3.5.1. Personal efforts and attitudes toward reducing emissions

When people were asked about their efforts to reduce energy use and emissions, the vast majority agreed or strongly agreed that they tried hard to reduce and felt a positive effect by doing so (see Figure 11).

Results showed:

- 84% agreed or strongly agreed they worked hard to reduce energy use and 80% agreed or strongly agreed they worked hard to reduce *greenhouse gas emissions* wherever possible
- 82% agreed or strongly agreed they feel very good when they are successful in reducing their greenhouse gas emissions
- 77% said they would feel very bad if they failed to reduce GHG emissions
- A small but consistent minority (5%) disagreed or strongly disagreed with the statements relating to working hard to/feeling good from reducing their GHG emissions.

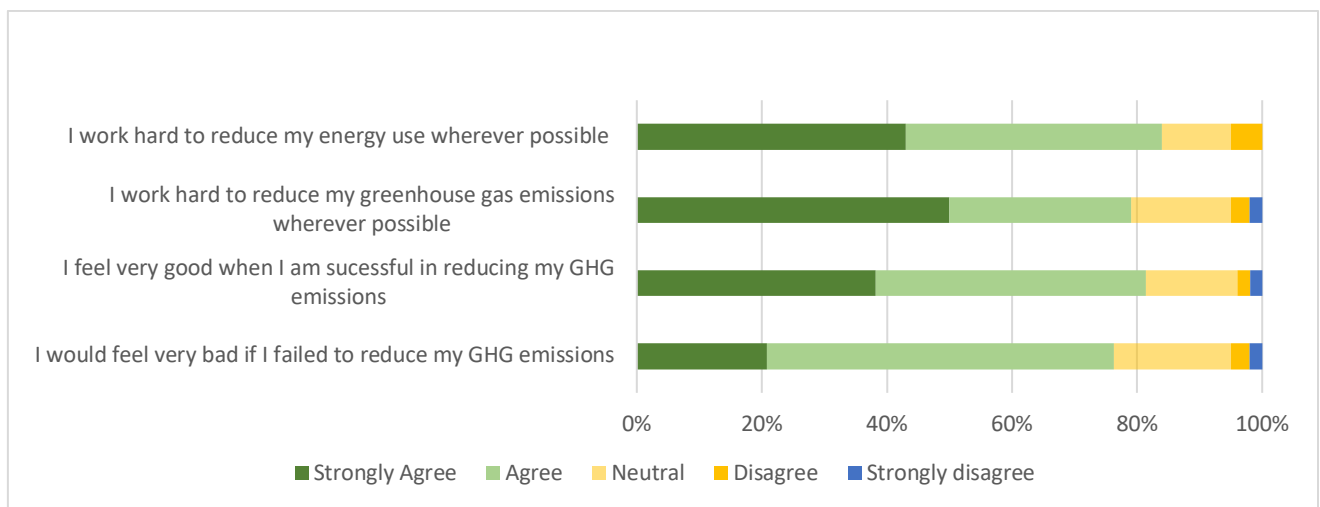


Figure 11- Personal attitudes and efforts towards reducing emissions

#### 3.5.2. Household goals and support to reduce energy and emissions

The survey also measured the degree to which participants keep track of energy or carbon emission goals and the level of support in the household to help each other achieve them (see Figure 12).

The survey showed:

- Almost half of the participants (45%) report members of their household keep track of what is happening to make sure the energy/emissions reduction goals are achieved; and
- Almost two thirds of the participants (64%) agreed that their household remind each other to behave in a way that helps achieve this goal.

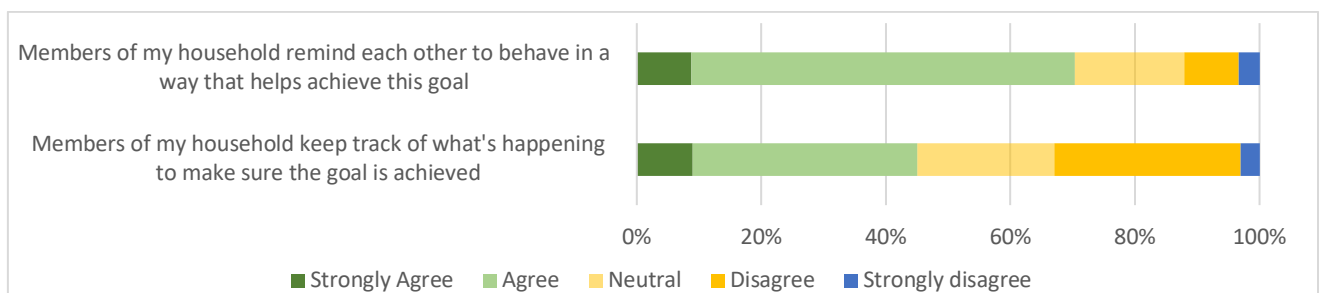


Figure 12 - Household goals and support for reducing emissions

### 3.5.3. Perception of others' efforts and attitudes towards reducing emissions

While the previous set of questions found people strongly agreed with the importance of taking personal action, most people didn't believe others felt the same way (see Figure13). Results showed that only around one quarter (24%) of participants agreed (21%) or strongly agreed (3%) with the statement "most people think it's very important to reduce their greenhouse gas emissions"; and just 7% believed that most people *work hard* to reduce their greenhouse gas emissions whenever possible.

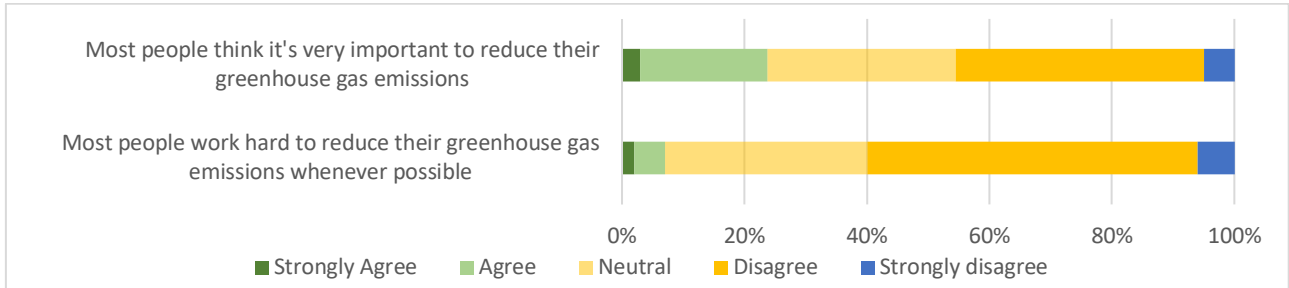


Figure 13 - Perception of others attitudes to reducing emissions

### 3.5.4. Impact of Quality of Life

When asked about the impact that reducing their emissions will have on their quality of life from, more than three quarters of respondents (78%) believe that it would not impact negatively. Only 2.5% strongly agreed that their quality of life will suffer (see Figure14).

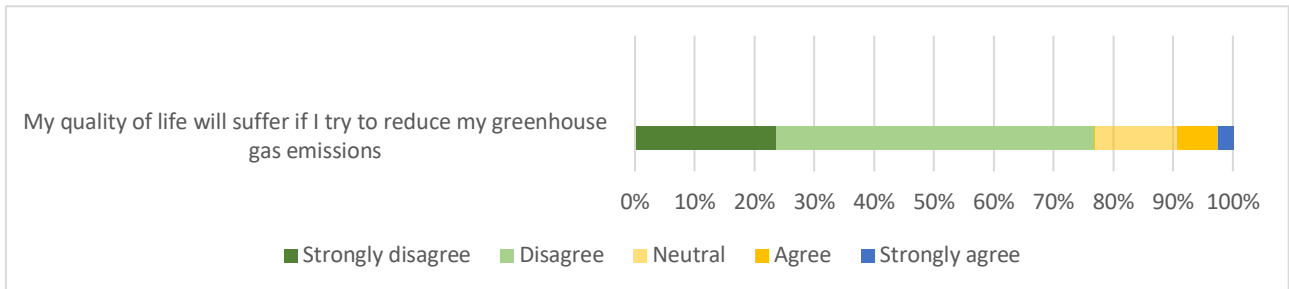


Figure 14 - Impact on quality of life of reducing carbon emissions

## 4. Discussion

### 4.1. Impact of Built Environment on Learning Outcomes

There was overwhelming agreement (98%) by participants that the built environment has an impact on learning outcomes of students. This supports the vast amount of academic literature that also links the built environment to learning outcomes (Branham, 2004; Green Building Council of Australia, 2014; Higgins et al, 2005; Kats 2006; Pereira et al, 2016; Rauland et al 2014; Uline & Tschannen-Morgan, 2008; Woolner, et al., 2007). The survey results offered over one hundred examples that contribute a significant qualitative and lived experience layer to the existing scientific research and literature.

Three core 'organising' themes emerged from the survey around aspects that affect a student's ability to learn, which included **1. Physical comfort and IEQ** elements including air quality, ventilation, lighting, temperature and acoustics; **2. The suitability of the space** for children's needs that allows the teacher to offer a range of learning experiences; and **3. Hands-on learning** - the way buildings reinforce learning or offer 'hands on learning' about sustainability and good design. These are discussed below.

#### 4.1.1. Physical comfort and IEQ

Numerous studies have demonstrated that school building environments can have a significant effect on students' health and sense of well-being (Pereira et al, 2016), and influence the performance of students and teachers (Higgins et al, 2005). This includes impacts from air temperature and outdoor air supply (Wargocki et al, 2005), ventilation (Coley and Beisteiner, 2016; Toyinbo et al, 2016), noise (Truchon-Gagnon and Bilodeau, 1990), lighting (Kats, 2006), air quality (Haverinen-Shaughnessy et al, 2015), acoustics, and greening and external views (Rauland et al, 2014). These characteristics are collectively described as the indoor environmental quality (IEQ), which has been a growing area of concern for the built environment sector.

In a holistic assessment of the overall impact of school building design on learning outcomes, the University of Salford and Nightingale Architects (as cited in Green Building Australia, 2014) found the classroom environment can affect a child's academic progress by as much as 25% over a year. Other studies have found significant correlations between low temperature and high ventilation rates with higher academic scores (Haverinen-Shaughnessy et al, 2015) and lower rates of respiratory illness and absenteeism (Wargocki and Wyon, 2007; Bako-Biro et al, 2008). The drop-out rate of schools with quality design and facilities is also significantly less compared to other schools (Branham, 2004).

When survey participants were asked to rate nine separate elements of indoor environmental quality (IEQ) by their importance, the four most important aspects

(those with the largest percentage of "extremely important" rankings) were natural light (57%), natural ventilation (57%), air quality (57%) and temperature (55%).

An overview of these and other links in the literature between IEQ and improved productivity and learning outcomes are summarised below.

#### **Daylight and Lighting**

Research has linked the use of natural light (known as 'daylighting') with positive effects on students in terms of both health and wellness and academic performance (Green Building Council of Australia, 2014; Pellegrino, Cammarano, Savio, 2015; Uline & Tschannen-Morgan, 2008). For example, a study of over 21,000 students also found that students in classrooms with the most natural daylight performed 20% faster progression in mathematics, and 26% faster progression in reading (Green Building Council of Australia, 2014).

Daylighting from windows and sky lights has shown to have greater light quality compared to electrical lighting, providing greater visibility for tasks and learning (Heschong Mahone Group, 1999).

#### **Air quality and Ventilation**

Children spend a considerable amount of time indoors. Classrooms are often quite densely occupied and windows are often kept closed in classrooms to keep outside noise out, preventing natural ventilation (Wargocki & Wydon, 2007). If there is no, or too little, mechanical ventilation, the low levels of air exchange can result in high concentrations of CO<sub>2</sub> and other pollutants, which can cause drowsiness and impact on concentration (Smeglie, Mattsson, Walinder, 2011; Bak'o-Bir'o et al, 2011).

Air temperature and air quality are two of the most important factors that affect the academic performance of students. It also impacts a teacher's ability and performance in the classroom (Uline & Tschannen-Morgan, 2008).

A literature review of 11 studies on the link between ventilation and learning found that performance improvements including increased speed and accuracy of tasks increased by 2-15% in maths and reading tests (Fisk, 2017). By contrast, when ventilation rates are at or below minimum standards an associated decrease of 5 – 10% occurs in certain aspects of student performance tests (Berkeley National Laboratories, 2018).

Increasing ventilation rates have been linked to lower rates of respiratory illnesses. For example, a Californian study found asthma rates in elementary students reduced by 65% when the indoor environment quality of the school was improved (Meng, Babey & Wolstein, 2012).

Studies have also found links between ventilation and absence rates (Berkeley National Laboratories, 2018). A study of 162 classrooms across 28 schools found a 1.6% reduction in illness absence for every additional litre per second per person of ventilation (Mendell et al, 2013). The same study also found that more than half of the classrooms did not meet state ventilation standards

(Berkeley National Laboratories, 2018; Mendell et al, 2013; Fisk, 2017).

### **Temperature and Comfort**

Studies show a direct link between the temperature in school classrooms and student's performance. Climate comfort have been proven to have greater effect on student's outcomes compared to structural building factors (Uline & Tschannen-Morgan, 2008).

In particular, elevated indoor temperatures in schools have been linked to impaired performance. For example, two numerical and two language-based tests were significantly improved in 10-12-year-old students in Denmark when the temperature was reduced from 25C to 20C (Wargocki and Wyon, 2007). A U.S study on the effects of ventilation and temperature on academic achievement found maths scores increased by up to 11 points per litre per second per person increase in ventilation, and an additional increase of 12-13 points for every 1C decrease in temperature within the range of 20-25C (Haverinen-Shaughnessy and Shaughnessy, 2015).

### **Greenery and External views**

Studies have demonstrated a benefit to students' academic performance if students are within close proximity to greenery when learning (Wu et al, 2014). Selhub and Logan, (2012) found contact with nature, or even pictures of nature, can lower stress reactions in the brain and body.

Plants have also been found to act a natural air filter, improving the quality of air. Yang et al, (2009) found that volatile organic pollutants (VOCs) recorded in indoor environments were as much as 12 times greater polluted compared to the outdoor and their study that tested 28 types of plants found some had the ability to remove these harmful VOCs.

### **Noise**

Research showed that the exposure to chronic noise (i.e. transport noises, industrial noise, plant noise and people outside the school) can effect on their intellectual performance (Shield & Dockrell 2003). Children perform greater in quiet environments compared to being exposed to noise whilst learning (Maxwell & Evans, 2000).

### **4.1.2. The suitability of spaces for learning**

When participants were asked to nominate any other aspects from a built environment perspective they found impacted on the learning experience, three further themes emerged: **Flexibility** of the space, **Practical elements** including storage, acoustics and location of the classroom, and **Sustainability** aspects of the buildings.

Montazami et al's (2015) comprehensive review of environmental design in UK schools highlights "global design issues", which included a lack of buildings' adaptability and a lack of understanding of the occupant's preferences and priorities. This survey, which provides evidenced-based, 'lived-experience' of people

linked to schools, helps to address this by highlighting the issues and concerns of the occupants, which strengthens the academic literature around the need to ensure school buildings are well designed and operated to provide optimal learning outcomes for students.

### **4.1.3. Hands-on Learning Opportunities**

There was a surprising emphasis in survey responses around hands on learning, with it being listed as one of the three most important ways the built environment can impact on learning. As one participant noted, "Students living and working in well-designed buildings can have their learning experience enhanced by greater comfort levels as well as direct engagement with concepts".

Schools have a unique opportunity to be able to use their buildings and facilities as a living laboratory to create hands on learning opportunities around sustainability and resource efficiency, as well as for a variety of core subject such as Maths and Science. Studies have shown that teaching methods that use a hands-on approach with real-life activities lead to better understanding and higher test scores than purely learning from text-books (Riskowski, Todd, Wee, Dark & Harbor, 2009).

Tucker & Izadpanahi (2017) also note how good building design can reinforce learning about sustainability. Research findings by Ramli et al (2012); Green Building Council of Australia, (2014); Rauland et al,(2014) and others also support this - highlighting 'hands on learning' as one of the key benefits of green buildings.

Considering the concept of 'Sustainability' is one of three core cross-curriculum priorities in Australia (i.e. teachers are *supposed* to integrate it into a number of subjects), buildings can provide an ideal opportunity to use real life data and examples around sustainable practices to teach sustainability. Taylor and Enggass (2009) refer to the physical environment as a 'three-dimensional textbook' or 'silent curriculum', which can influence and impact on learning experiences.

Ramli et al (2012, p 465) describe the green school itself serving as a teaching tool – "*demonstrating to students, faculty, and parent's practical ways and it can turn back the clock on global warming while creating healthier, more efficient, and less costly learning environments.*"

Tucker and Izadpanahi (2017) explored the connection between building design and environmental beliefs and attitudes among primary school students. They found that schools that were designed with sustainability features, and which used these features to teach and engage students, resulted in greater pro-environmental attitudes among students.

## **4.2. Demountable Buildings**

The number of demountable classrooms in Australian schools has steadily risen since they were first introduced in the 1960s in New South Wales (NSW), in response to sudden population growth in the baby boomer years, higher school leaving ages, and a broader curriculum (Bisset, 2015). Demountable

classrooms were designed to provide a 'deployable' classroom to keep up with the increasing number of students in schools. They were also designed to be able to withstand any type of climate in New South Wales (Slee and Hyde, 2015a).

By the early 2000s demountable classrooms were being commonly used in the United States, England, Canada, Israel and Australia. While they were originally intended as a temporary and cost-effective option to accommodate rapid rises in student populations and school expansions, as time has passed, demountable classrooms have become permanent – and ubiquitous fixtures, “*the temporary building that lasted a century*” (Bisset, 2015).

The survey results from this study showed that demountable classrooms were present in almost two thirds (64%) of schools with the majority being there for an average of ten years. In NSW, one in ten government classrooms are demountable classrooms, and one third of those have been there for over ten years (Robertson 2017). One third of Queensland's demountable classrooms have been there for more than 20 years (“Queensland Demountables”, 2018).

Despite their prolific – and somewhat permanent – presence, demountable classrooms are almost universally disliked, with over half the participants (55%) reporting a “low” satisfaction rating. Almost three quarters of participants rated the impact of demountable buildings on environment and sustainability, physical health, mental health, and student's learning as either very or somewhat negative (72% on average across these four variables).

Studies from the late 90's and early naughts had also began reporting that due to poor quality construction, most demountable classrooms deteriorate quickly, frequently needed repairs, which in turn create a burden on school maintenance departments (Chan, 2009; Fickles 1998). They also identified possible health risks, particularly related to poor ventilation associated with breathing difficulties and physical discomfort (Shendell et al, 2004).

While the results on the number of demountable classrooms in schools cannot be extrapolated to a national snapshot given the small sample size, the findings on the perceived negative impacts strongly suggests further research and engagement with educators is needed on ways to improve satisfaction with demountable classrooms and reduce their negative impacts.

The low levels of satisfaction could strongly correspond with our finding that the **suitability** of the space and **flexibility** of a classroom was ranked as one of the three most important aspects that impact the learning experience, described in the previous section. For teachers who need a flexible and adaptable space, demountable classrooms designed for last century may no longer fit for purpose, especially given many of the

classrooms in use were designed last century for a much different teaching style and pedagogy.

For example, Slee and Hyde (2015a) explain,

“Pedagogy has also changed significantly since the demountable school was originally introduced from a “chalk and talk” approach, led by a teacher instructing pupils sitting in rows, to a student led approach to learning that requires “break out” spaces for group work and more traditional class arrangements for instruction. The development of pedagogy has led to the need for larger more flexible classrooms to accommodate the new teaching methods.”

This might help to explain the shift in community attitude towards demountable classrooms and their design in Australia, moving from 'innovative' to 'adequate', particularly for Australia's changing climate (Slee and Hyde 2015a).

The findings suggest further research on the low level of satisfaction and the strongly perceived negative impacts of demountable classrooms is needed, particularly in line with Chan (2009) recommendations for further studies including a consideration of elements like age, deterioration and maintenance as factors contributing to negative perceptions, rather than the overall concept of a demountable classroom.

Further to this, Chan (2009) points out that - while dissatisfaction and negative attitudes towards demountable classrooms and buildings appear common, particularly around the impact on student and achievement and teacher performance (Patterson et al, 2009), little empirical research has been undertaken to formally validate perceptions. His studies examining the impact portable classrooms have on the teaching and learning process, and found no significant impact on teacher perception, teacher morale, teacher job satisfaction, student achievement, or behaviour (Chan, 2005; 2006; 2009).

A comprehensive literature review by Slee and Hyde, (2015a) also confirmed the absence of any detailed studies of the building performance or IEQ of demountable classrooms in NSW or more generally across Australia and the limited international research into the performance of demountable classrooms (Slee and Hyde, 2015a; Slee and Hyde, 2015b).

While portable buildings continue to have their issues, Slee and Hyde (2015a) maintain that the demountable classroom system was, and remains, a radical building solution that offers the communities and governments an opportunity to develop a high performance, adaptable and low carbon piece of education infrastructure, particularly given the ongoing demand for them.

Fortunately, some great innovations are taking place, including a new trial of transportable classrooms that are considered energy positive - providing more energy than they consume, while also monitoring and examining the impact of the indoor environment with abundant sensors (Henebery 2018).



### 4.3. Benefits of Low Carbon, High Performance Schools

Regardless of whether a classroom is within a fixed, permanent building or a transportable one, there are abundant benefits - in addition to the positive impact on learning outcomes already discussed - of well designed, low carbon, high performance, green schools. These include financial benefits, environment and sustainability outcomes including emissions reduction and creating a better place to teach (Kats 2006; Green Building Council of Australia, 2013; Rauland et al, 2014).

#### 4.3.1. Financial savings

Various programs have highlighted the financial savings associated with sustainability and low carbon school programs. In Victoria, over 1022 schools participated in the ResourceSmart AuSSI Vic program, which documented over \$5.2 million in savings (Rauland et al, 2014).

The University of Melbourne's "Spot" building - a certified 5 Star Green Star Education Pilot building used 46% less energy in its first year of operation than comparable buildings across the rest of the university, and translated to savings over \$180,000 per year Green Building Council of Australia, 2014).

A US study found while green schools can cost 1-2% more to build than conventional schools the return on investment was 20 times the additional cost. Of 30 green certified schools built between 2003-2007 the average cost premium was 1.65% but the average energy savings were 33% and water savings were 32% (Kats, 2006).

In this study, the overall net cost savings from well designed, green school buildings was US\$71/ft<sup>2</sup> (see Table 5).

Table 5: Financial Benefits of Green Schools (US\$/ft<sup>2</sup>).

Energy	\$9
Emissions	\$1
Water and Wastewater	\$1
Increased Earning	\$49
Asthma Reduction	\$3
Cold and Flu Reduction	\$5
Teacher Retention	\$4
Employment Impact	\$2
<b>Total</b>	<b>\$74</b>
Cost of Greening	(\$3)
<b>Net Financial Benefits</b>	<b>\$71</b>

Source: Adapted from Kats (2006)

South Fremantle Senior High School, the first certified Carbon Neutral school in Australia, made savings on utility bills from implementing various energy and water

efficiency measure\ s were in excess of \$40,000 a year (Rauland et al, 2014).

Results from a two-year Low Carbon Schools Pilot in Perth, Western Australia, have demonstrated cost reductions of \$30 per student across 70% of the participating schools (CRC for Low Carbon Living 2018).

#### 4.3.2. Environment and sustainability

Analysis of 46 certified buildings under the GBCA Green Star Education rating tool showed that in comparison to existing education buildings, Green Star-rated education facilities delivered:

- 59% reduction in greenhouse gas emissions
- 70% reduction in electricity usage
- 46% reduction in natural gas
- 35% reduction in potable water consumption when compared with standard buildings
- 54% less construction and demolition waste to landfill (Green Building Council of Australia, 2013).

#### 4.3.3. Carbon Emissions

The Greening America's Schools costs and benefits report estimates that a green school could lead to annual emission reductions per school of: 265,352 kg carbon dioxide (CO<sub>2</sub>), 544 kg nitrogen oxides (NO<sub>x</sub>) a principal component of smog, 590 kg sulphur dioxide (SO<sub>2</sub>) a principle cause of acid rain, and 68 kg coarse particulate matter (PM<sub>10</sub>) – a principal cause of respiratory illness and an important contributor to smog (Kats, 2006).

The 2016/17 Low Carbon Schools Program demonstrated emission reductions of 266 tonnes from efficiency measures across 13 schools or an average of 20% reduction (CRC for Low Carbon Living 2018). They also offset 3,800 tonnes of the school-based emissions from a tree planting program with students, where over 50,000 trees were planted.

#### 4.3.4. A better place to teach

The architectural design and environmental characteristics of schools and classrooms has also been noted as affecting the performance of students (Clark, 2002; Woolner et al, 2007), with studies noting that well-designed classrooms can improve student engagement with learning activities (Tucker & Izadpanahi, 2017).

The colour of classroom walls has been proven to improve student's performance (Uline & Tschannen-Morgan, 2008).

Green schools have been identified as providing a more comfortable work environment and being a better place to teach, resulting in greater teacher retention rates. This translates into financial savings of about \$4 per square foot over 20 years (Kats, 2006).

### 4.4. Creating Low Carbon, High Performance Schools

Despite the abundant benefits of low carbon, high performance, green schools, progress in transforming the education sector towards this goal appears slow. This may be due to the fragmented, and often siloed nature of the programs currently operating around Australia to improve efficiency and building performance (Rauland et al, 2014), and the lack of innovation in building design.

The survey demonstrated that most schools are participating in some kind of sustainability program (63%), however, the majority were garden (79%) and waste (75%) programs, which – while very important – contribute little to the overall improvement of the school infrastructure, design, operational performance, cost and carbon emissions.

Almost half (49%) of the respondents said they were participating in water programs, and only were 39% involved in energy programs, which is the largest operational cost for schools and accounts for the majority of the school's carbon footprint. Considering only 10% of respondents said their schools were participating in carbon related programs, this is not surprising that schools are unaware of the impact of energy on their carbon emissions.

While there was almost universal agreement that schools should be actively tracking and monitoring their consumption of resources (and that students should be involved), less than 30% of schools were actively doing so. Also, less than a third were using a formal tool or an Action Plan to reduce carbon emissions and resource consumption.

This highlights a lack of a strategic focus on how to improve the operational efficiency of school buildings. The survey also highlighted a range of barriers preventing schools from pursuing sustainability initiatives and infrastructure upgrades including political and bureaucratic barriers.

## 4.5. Sustainability and Low Carbon Living

### 4.5.1. Intergenerational Change

Considering the pivotal role schools play within our communities, this study also examined whether schools (through their low carbon initiatives) can influence community awareness and knowledge in the home.

Many of the practical teachings from implementing sustainability in schools, particularly increasing the efficiency of energy, water and waste systems, can often be applied or translated to the home environment, making students important ambassadors and influencers of behaviour in the households they live in (Rauland et al, 2014).

Research around the concept of 'Pester Power' documents the significant influence children can have on family decision-making, particularly around consumption patterns (Anitha & Mohan 2016). This highlights a significant opportunity for students to take their knowledge home and influence their parent's decision-

making and behaviour patterns around low carbon living, creating intergenerational and societal change.

The survey demonstrated that this is indeed occurring, with 58% of respondents reporting that their child has influenced their decisions at home, citing a range of examples from making them prepare plastic free lunches to being more aware of lights and energy use.

There is an importance on sustainability education in early childhood education due to children being seen as the future of sustainability. As children start to form their own attitudes and behaviours, it is critical they are aware of their impact on sustainability, which can be taught through social learning and brought home with them (Borg, Winbery and Vinterek, 2017).

### 4.5.2. Sustainability in The Home

According to a nationwide survey on attitudes to climate change by the Climate Institute (2013), the majority of Australians agree that climate change is occurring, with 87 per cent of those thinking that humans are at least partly responsible. A majority remain concerned about climate change, with higher concerns about particular impacts of climate change.

The same survey found most look to governments and business for leadership on climate change (only 6-8% believe local, state or federal government should take "no action") but they also believe that the response to climate change starts at home (Climate Institute 2013). It shows that Australians generally seem to feel a personal responsibility - "doing my bit" - when it comes to contributing to climate change action, with a steady 65 per cent saying that they believe that individuals can contribute to addressing climate change.

This is supported by these survey results that showed that almost all people agreed that they work hard to reduce their energy use and greenhouse gas emissions wherever possible and feel bad if they fail. Interestingly, however, most don't believe that most other people feel the same way with less than one quarter agreeing with the statement "most people *think* it's very important to reduce their greenhouse gas emissions". Only 7% thought that others *work hard* to reduce their emissions wherever possible, demonstrating their belief that they do more than others.

45% of the survey participants belong to households that keep track of their goals and support each other by reminding each other to behave in a way that helps achieve their goals (64%).

### 4.5.3. Quality of life not affected by reducing emissions

Surprisingly, when asked about the impact of reducing emissions on quality of life, only 2.5% of participants strongly agreed with the statement "I believe my quality of life will suffer if I try to reduce my greenhouse gas emissions". A near universal 78% disagreed or strongly disagreed with the statement "I believe their quality of life will suffer if I try to reduce my greenhouse gas emissions".

## 5. Conclusions, Implications for Policy Makers and Further Research

This report presented the findings of a survey of 120 people across Australia who are connected to schools, and examines their beliefs, attitudes and experiences relating to the impact of the built environment on health and learning outcomes in schools. It also examined the uptake of sustainability and carbon emissions reduction programs in schools, and attitudes and behaviours toward low carbon living in the household.

The strong understanding of the impact the built environment can have on health and productivity provide – backed by the literature - demonstrates how important low carbon, high-performance schools are to educators and those connected to schools.

With sustainability being one of three national cross-curriculum priorities, the use of classrooms and school buildings as 'living laboratories' provides a unique opportunity to not only educate the next generation about sustainability and resource efficiency, but can also save the education sector millions of dollars on utility expenditure.

The incentives for reducing utility bills also varies between states. For example, in states and territories where utility bills are paid centrally by the Education Department, there is little financial incentive for individual schools to pursue reductions.

### **The need for targets and a systematic approach for measuring and improving performance of this sector.**

The Education sector would benefit from having more stringent design and building codes for schools, as well as performance benchmarks, baselines and targets set to measure and improve performance within this sector over the coming years. This will be critical in order to achieve net zero emissions by 2015 in line with the Paris agreement.

### **Targeted, cost-effective programs to help schools reduce carbon and costs.**

While several states have leapt ahead and are paving the way for others in terms of sustainable schools, the lack of a coordinated national approach has meant schools in several states are left without much assistance, or guidance on how to systematically reduce their consumption of resources, carbon and costs, thereby increasing their performance. There is also little opportunity for schools to compare themselves with other schools across Australia.

There is a growing need for a cost-effective, nationally coordinated effort to empower schools to pursue carbon and cost reduction individually, rather than rely on government programs that are subject to political funding cycles. Programs that enable schools to pursue operational efficiencies themselves can dramatically reduce the cost to State Education Departments. Such

programs can also provide significant learning opportunities for students around resource efficiency and low carbon living.

### **Innovation needed to improve the design, fit-out and operational performance of demountable buildings.**

Considering the near ubiquitous presence of demountable buildings and classrooms in schools, greater innovation is urgently required to ensure that they are designed to provide optimal learning spaces for students and staff. Demountable buildings have, and will continue play, a key role in dealing with fluctuating student numbers, which provide an ideal opportunity for innovation.

### **Greater dialogue with stakeholders who utilise these spaces.**

Greater research needs to be undertaken with stakeholders using school buildings (including children) to ensure that space designs, upgrades and technologies used within them are designed with their needs and requirements in mind.

### **Explore opportunities to create intergenerational change through students taking knowledge home.**

More research is needed to explore how schools can effectively educate and empower students to take sustainability knowledge gained in the classroom setting home to upskill their parents, families, friends and communities around resource efficiency and low carbon living.

A new data-driven, evidence-based online program was piloted in 2018 – **The ClimateClever Initiative**. It was a collaboration between Curtin University and the CRC for Low Carbon Living with the support from a variety of industry partners. In 2019, they will launch a home version of the tool, which will – for the first time – be able to track this intergenerational impact.



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