LOW CARBON LIVING CRC

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Influencing change through a low carbon schools community program

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This research is still in the initial phases and thus has not yet collected, aggregated, verified and analysed the results of the data being collected from the schools. What is presented here is preliminary information.

Peer Review Statement

The CRCLCL recognises the value of knowledge exchange and the importance of objective peer review. It is committed to encouraging and supporting its research teams in this regard.

The author(s) confirm(s) that this document has been reviewed and approved by the project's steering committee and by its program leader. These reviewers evaluated its:

- originality
- methodology
- rigour
- compliance with ethical guidelines
- conclusions against results
- conformity with the principles of the Australian Code for the Responsible Conduct of Research (NHMRC 2007),

and provided constructive feedback, which was considered and addressed by the author(s).

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Acronyms

AAEE	Australian Association for Environmental Education
ASTA	Australia Science Teachers Association
ISCEA	Index of Community Socio-Educational Advantage
LCSPP	Low Carbon Schools Pilot Program
DOE	Department of Education

"Thank you to the Low Carbon team for outstanding and very useful professional learning. Your presentations are always full of useful information and delivered with excitement and passion. Even though my school thought it was a long way down the road of sustainability, we have learnt a lot more by being involved in these workshops.

The opportunity to hear and speak to specific area specialists has been a huge advantage along with the networking opportunities of like-minded educators and school community members that is the program has offered. Well done - my school team look forward to making a difference to the education of our students through involvement in this excellent program".

Hugh McCracken, Principal Palmyra Primary School, 2016

Executive Summary

In January 2016, a two-year Low Carbon School Pilot Program (LCSPP) was developed and launched in Perth, Western Australia. A total of 15 schools participated in the pilot - 10 primary schools and five high schools from around seven different local government areas.

The aim of the LCSPP was to enable, empower and facilitate schools to reduce their school's greenhouse gas emissions and utility costs while educating and upskilling the next generation to be more efficient with resources.

Four core activities underpinned the pilot: 1. workshops; 2. calculating and tracking performance; 3. creating action plans, and; 4. monthly Meetups. The five monthly workshops were delivered in the first six months to provide information on the program activities, as well as to invite guest industry speakers to provide information and advice on what key actions they could implement. Their progress was tracked over the two years using excel spreadsheets provided to them by the LCSPP team, which captured consumption, costs and carbon emissions from data on their electricity, gas and water bills.

An 'Action Plan' template was also provided, enabling each school to add and manage their own actions. All schools met monthly at one of the participating schools ('Meetups'), where they would share experiences and discuss actions they were implementing.

By the end of the program, the carbon emissions from all 13 schools dropped from a baseline of 3,352tCO_2-e in 2015 to 3,086tCO_2-e by the end of 2017, representing a reduction of 266 tonnes of carbon emissions (CO_2-e) or 7.5 per cent.

In contrast, the total utility costs for the 13 schools from electricity, gas and water increased from $1.48 million in 2015 and to $1.59 million by December 2017. This was an increase of approximately $120,000, representing an eight per cent rise. Four of the 13 schools reduced their total costs during the pilot. The financial savings between the four schools that reduced ranged between -$839 and $23,346.

The overall increase in costs was due to a variety of factors, the most significant being changes in student numbers. Between 2015 and 2017, total student numbers across the 13 schools increased from 7,386 students to 8,605, representing an average increase of 15%. This led to new demountable buildings being installed in some schools, increasing consumption and consequently costs. Therefore, to take into account the fluctuation in student numbers, results were also calculated on a per student basis.

While on a per school basis, 10 of the 13 schools reduced their total carbon emissions, on a per student basis, all 13 schools reduced their emissions. The average carbon savings per student across all 13 schools was 0.08 tonnes of CO_2-e, representing a 20 per cent reduction per student.

Similarly, in terms of costs, while nine of the 13 schools increased their total utility costs (i.e. across the whole school), 10 of the 13 actually reduced their costs on a per student basis. The average savings across those 10 schools (70 per cent of the program), was over $31 per student. The utility savings averaged across all 13 schools was $16 per student.

In addition to fluctuating student numbers, there were a number of other external factors that influenced the results. These included weather (though this was normalised), changes in electricity tariffs, changes in emission factors, leaks, among others. This made comparisons and correlations problematic and demonstrates how difficult it is to determine the impact of school-based sustainability programs.

Nevertheless, visualising and analysing the data provided important feedback and insights for the schools along the way, many who eagerly investigated anomalies in their data. These investigations also triggered schools to pursue a variety of low carbon actions and initiatives.

A total of 625 low carbon initiatives were identified amongst the 13 schools Action Plans. The majority (36%) of actions focused on energy, with waste coming second (26%) despite it not being tracked in the excel spreadsheets. Nineteen per cent of actions targeted water. Interesting, more than 70 per cent of the actions identified were considered low or no cost actions, demonstrating the vast potential for schools to reduce consumption in a cost-effective way.

A tree planting program was also initiated and delivered by a parent at one of the participating schools as a result of the LCSPP. Thirteen schools participated in the tree planting program. These students planted over 50,000 in 2017, which led to the baseline carbon emissions of all schools being completely offset –enabling all schools to become carbon neutral.

Considering the pivotal role schools play within society, the project also highlighted the opportunity that school-based carbon reduction programs have to influence community awareness, knowledge and action on climate change and decarbonisation, primarily through kids taking their knowledge home and influencing their parents and wider families.

At the conclusion of this pilot in December 2017, work began on the next version of the program. In January 2018, 'The ClimateClever Initiative' was developed and was launched nationally. The new program is underpinned by innovative, data-driven software that enables schools to calculate, track and compare their carbon footprint, audit their buildings and create personalised, evidence-based, online actions plans that are interactive and can be student-led.

Not only has this important research helped to inform the next stage of the program, the financial savings identified through this pilot have provided an opportunity to create a sustainable business model to ensure the longevity of the program into the future.

1. Introduction

1.1. Why Schools?

School buildings and facilities are rapidly aging and becoming increasingly inefficient (Rauland et al. 2014; 2018). A 2012 government study found that while the energy consumption has decreased over the last ten years in commercial and public buildings, energy consumption increased in schools, with further increases expected by 2020 (Council of Australian Governments, 2012). This is likely to do with the growing number of technology being used in classrooms, as well as the expectation that classrooms will be temperature controlled.

A report by ASBEC (2018), which examined how Australia's building stock could reach zero-carbon by 2050, identified the education sector as offering some of the most cost-effective carbon reduction opportunities within the built environment, largely based around efficiencies and solar generation. In addition to the carbon and cost benefits, there are also abundant co-benefits from targeting sustainability and implementing low carbon initiatives in schools, including significant improvements in health and productivity as well as learning opportunities (see Rauland et al. 2014; 2018).

School-based sustainability programs also provide significant potential to create community impact, as the learnings often extend far beyond the school walls. In many cases, students pass on their knowledge and skills into the home setting, educating their parents and families. Schools, therefore, can play a key role in connecting our communities and society, and thus, have the ability to touch a vast and diverse demographic.

Numerous sustainability programs already exist around Australia (see Rauland et al. 2014, for an overview). However, many of these programs, particularly in Western Australia, don't provide the ability to systematically collect and store data from the schools to measure and track resource consumption, nor convert it to carbon emissions. They also didn't provide a way to retain building audit information and use it in a meaningful way, i.e. to make comparisons or to inform decision making around what low carbon actions to implement and when. This gap led to the development of the Low Carbon Schools Pilot Program.

1.2. Low Carbon Schools Pilot Program

Between 2016 and 2017, an innovative two year Low Carbon Schools Pilot Program (LCSPP) was trialled with 15 schools in Perth, WA. The program aimed to empower, educate, and equip schools and their communities with the knowledge, skills and resources needed to reduce their school's consumption of energy, water and waste, as well as their associated carbon emissions and costs.

The pilot was developed based on years of research and was inspired by the author's experience in 2012, of helping to certify the first carbon neutral school in Australia. After seeing the vast benefits to that school, the aim of the program was to develop a process that could deliver similar assistance to more schools around Australia in a streamlined, systematic, efficient and cost-effective way. A new format was needed that was more scalable and did not require intensive human resourcing (i.e. regularly visiting schools, having one-on-one meetings, or consultants having to undertake building audits or the carbon accounting process).

It required a process that enabled, facilitated and empowered schools to undertake those activities themselves – that is, to manage the input of data that would allow them to measure their consumption and costs from energy, water and waste, calculate their carbon emissions and track their progress in reducing it. A more efficient process was also needed to help the schools create their own individualised action plans.

1.3. Aim of the Research

This research examines the delivery methods and analyses the results from the Low Carbon Schools pilot program.

The main objectives of the research were to:

1. Measure the extent of carbon reductions that can be achieved in schools using a structured and data-driven process and ;
2. Analyse the types of initiatives implemented;
3. Determine the extent to which schools are able to engage with, influence, and affect change within their local communities, specifically around decarbonisation.
4. Examine lessons learned, including aspects of the program that worked well and what could be improved.

The following report provides an overview of the participants and how they were recruited, the structure of the program, including the different phases and the activities that were conducted with the schools to assist them in their process of reducing their carbon footprint. This is followed by the results, challenges experienced and recommendations for overcoming these. The report concludes with recommendations for future research.

2. Participants & Partners

2.1. Recruiting Methods

In early 2015, the City of Fremantle made a commitment to subsidise 10 schools in their area to participate in the LCSPP. All schools in the Fremantle Local Government Area (LGA) were approached (by email and phone). Six schools were ultimately recruited through this process. Two other local Councils (the City of Melville and the City of Cockburn) also subsidised schools in their LGA. These councils advertised the program to schools in their area in order to recruit participants. A further three schools were recruited through this process (one in Melville, two in Cockburn).

The next recruitment process involved schools who had previously participated in workshops delivered through a 2014 CRC LCL research project (see Rauland et al. 2014). The LCSPP was also advertised through various school-related networks and associations, including the Australian Association for Environmental Education (AAEE), and Australia Science Teachers Association (ASTA). Several presentations were given at education conferences including CONASTA (the annual conference for ASTA), LEADing a Call to Action (Catholic Schools Curriculum Conference). A number of schools were also identified based on their size and contacted individually. In the end, a total of 15 schools were chosen for the pilot.

2.2. Overview of Schools

Of the 15 schools selected to participate in the program, ten were primary schools, and ten were secondary (see Table 1). It was believed that there would be greater incentive for private schools to participate than for public schools, as private schools often have larger consumption profiles, and thus, larger potential utility savings, as well as fewer obstacles then public schools who are often bound by much stricter protocols and processes in relation to their infrastructure maintenance. However, 14 of the participating schools were public/state schools, with only one small private primary school.

As highlighted in Table 2, several of the 15 schools increased significantly in size during the three year period.[1] This made it difficult to analyse and compare the results, and for this reason, some results are also calculated on a per student basis (discussed further in Sections 4 and 5).

Table 1: School Size by Year. PS = primary school, SS = secondary school.

School	2015 Student Numbers	2016 Student Numbers	2017 Student Numbers	% change 2015 - 2017
PS8	80	87	93	16%
PS5	125	135	112	0
PS4	177	187	214	21%
PS9	244	263	276	13%
PS7	330	334	345	4%
PS1	351	372	361	2%
PS3	522	501	459	-12%
PS6	440	423	465	5%
PS2	380	490	602	58%
SS3	745	753	845	113%
SS1	1435	1466	1485	3%
SS4	1465	1497	1597	9%
SS2	1092	1424	1738	59%

2.3. Local Government Areas

The 15 schools were located in seven different metropolitan areas in Perth. The local government areas in which the participating schools were located are shown in Table 3. These councils are diverse in their socio-economic standing, as well as their geography.

As mentioned, three local councils partnered with the program and subsidised schools in their local area to participate. These councils identified value in working with schools as a way to engage their community around sustainability, as well as helping them to meet the council's carbon reduction and climate change KPI's.

Table 2: Council areas where schools are located

Nr of Schools	Council Area
1	City of Belmont
1	City of Canning
2	City of Cockburn
6	City of Fremantle
3	City of Melville
1	City of Rockingham
1	City of Swan

2.4.

[1] The year before the program started (2015) was included as the 'base year' for all calculations.

2.5. Overview of Program Partners and Supporters

Throughout the program, several industry groups, NFP's and government departments were engaged or contributed to the program in some way.

Table 4 below highlights the different stakeholders and types of the relationship and/or their contribution.

	Industry Type	Name	Contribution
1.	Councils	City of Fremantle	Financial (subsidised schools to participate)
2.		City of Melville	
3.		City of Cockburn	
4.	Universities	Curtin University	Provided in-kind time from Research Manager and was the enrolling institution of the PhD student
5.		Melbourne University	Assisted with the provision and analysis of surveys to capture information about public attitudes toward Low Carbon Living (LCRI)
6.	Government School Programs	Waste Wise (Waste Authority)	In-kind-Workshop presentation, gifts & cross-promotion, sitting on CRC Advisory board
7.		Water Wise (Water Corp)	
8.		Travelsmart (Dept of Transport)	
9.	Industry Representatives	Synergy (Govt Energy Utility)	In-Kind provision of individual School Annual Energy Load Report
10.		Sustainable Action	Provided free onsite energy audits for participating schools
11.		Dolphin Lighting	In-kind-Workshop presentation
12.		Flowless (Water Auditing Company)	Provided information to schools, free flow restrictors & discounted water audits
13.		Josh Byrne & Associates	In-kind-Workshop presentation
14.		Lifecykel	Donated two Mushroom Boxes (as a fundraising option for schools)
15.		Solar Analytics	Free software to schools
16.		Moore & Moore Cafe	Discounted Venue Hire
17.	Government	Building, Management & Works (WA Dept of Finance)	In-kind-workshop presentation, ongoing discussion for managing schools planned Low Carbon Actions, sitting on CRC Advisory board
18.		Department of Education	Sitting on CRC Advisory board
19.	NFP's	Living Smart	In-kind-Workshop presentation – potential to get parents involved
20.		Millennium Kids	Nine In-Kind workshops with students at our schools, sitting on CRC Advisory board
21.	Financial Institution	Bendigo Bank	Donated $500 to cover workshop costs

Table 3: Partners, supporters and sponsors of the LCSPP

3. Overview of Program

The LCSPP had a number of requirements that participants had to meet in order to be eligible to participate in the program. These are discussed below. The program structure is then provided, including the core activities.

3.1. Participant Requirements

In order to participate, each school had to agree with the following set of requirements:

- Provide a letter of support from the school principal acknowledging the school's participation;
- Establish a school sustainability committee of at least three people including the business manager, a teacher and a parent/P&C representative;
- Commit at least one person from the committee to attend each workshop;
- Provide access to relevant records and utility bills;
- Commit to participating in research related activities such as surveys and interviews.

These full requirements can be found in Appendix 1.

These commitments were developed based on feedback and the experience of people working in the field of sustainability in schools.

3.1.1. Creating a committee

While it seems evident that schools would require the support of the Principal and/or school leaders in order to embark in any new initiative (particularly if it requires a financial commitment), school leaders also need to know that they have the support of the staff who will ultimately implement the program in their school. Rauland et al. (2014) highlighted the risk associated with relying on one sustainability champion. This led to the requirement that schools establish a committee to enable the workload to be distributed among several participants. Three key positions were identified as being critical to the success of the program and were thus required – at a minimum - sit on the committee. These include the business manager/office admin, a teacher and a parent/community member.

The Business Manager was required as they are vital in accessing utility bills, which were needed to capture the data for tracking the success of the program. They are also involved in financial decision making at school, which is essential in terms of financing low carbon initiatives.

As parents and P&C representatives commonly drive sustainability initiatives in schools, they were also identified as being a key person to sit on the committee. Parents often have time to volunteer and, can help with fundraising activities, which can be critical for sustainability programs.

While the LCSPP wasn't explicitly designed to engage students in the initial two-year pilot (it was designed to upskill and enable the schools to lead the process themselves), there was the expectation that teachers would help to embed some of what they were learning into the curriculum and engage their students. For this reason, a teacher was also required to be on the committee.

3.1.2. Payment

A conscious decision was made to charge a fee for the program. This was necessary firstly because there was no funding available to deliver to the program. The fee, therefore, helped to cover the running costs. It also ensured that the program was based on a sustainable funding model and not reliant on inconsistent government funding or the uncertainty of grants. Secondly, it now generally accepted that people's perceived value of products and services is more significant when there is a cost attributed to them. The 'value' concept was highlighted several times throughout the program, often by guest speakers commenting on the high attendance rate at workshops and meet-ups, as well as among participants.

3.2. Program Structure

The program was split into two phases. Phase 1, which went for six months, included three main activities: 1. workshops; 2. calculating and tracking each schools carbon footprint and costs to measure progress, and; 3. creating personalised action plans for each school to reduce their emissions.

The second phase, which was the remaining 18 months, consisted of Meet-Ups with all schools monthly to assist with accountability and implementation of their action plans. These activities are further discussed below.

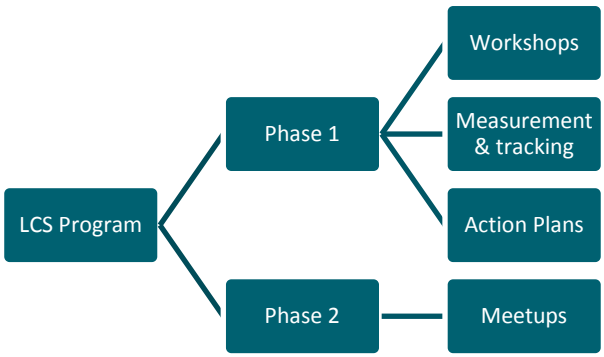


Figure 1: Program Structure

3.2.1. Phase 1

3.2.2. Activity 1: Workshops

Information workshops

During this first phase, five workshops were held on the last Wednesday of every month in Fremantle. Each workshop went for approximately three hours. Food and drinks were provided at each of the workshops, and a gift was given to each school aligned with the

topic/theme of the workshop. Five topics were covered in the workshops, including:

1. Policy and Getting Started;
2. Energy;
3. Waste & Well-being;
4. Water & Transport;
5. Implementation.

The format for each workshop included a presentation from the LCSPP team on that month's topic. Then guest speakers from industry and government gave presentations on specific areas to provide important information about what schools could potentially put in their action plans.

Stakeholders from the existing government-led sustainability programs such as Waterwise, Wastewise, and TravelSmart were also invited to provide information on their program. These were very successful and helped us to create stronger relationships with existing programs.

Millennium Kid Workshops

In December 2015, the Low Carbon Schools Pilot Program formed a partnership with Millennium Kids (MK), a youth-led organisation committed to improving the environment through constructive action (Millennium Kids, 2016).

The partnership enabled each of the 15 schools to participate in a full-day youth leadership workshop facilitated by MK. This was an in-kind contribution to the value of $15,000 to our program.

As the LCSPP focused predominantly on upskilling adult stakeholders associated with schools, the aim of the MK workshops was to empower young people to take action to reduce their school's carbon emissions. Using an inquiry-based learning approach, students came up with ideas and presented (or "pitched") them to the group. The students were then provided with a suite of tools to enable them to project manage and deliver their project at the school.

The MK workshops took place between May and June 2016. Ten of the participating schools chose to hold the workshops in their schools.

3.2.3. Activity 2: Calculating and tracking performance

In order to track the progress of the program, data from utility bills were collected. A baseline also needed to be set to track the reductions. The year before the program started – 2015 - was chosen as the base year. Three key areas were measured and monitored over the three year period (i.e. 2015 - 2017): consumption; costs, and; carbon dioxide emissions. The sources of emissions are discussed below.

Selecting the boundary for emissions

There are many different ways of calculating a carbon footprint. The size of the footprint is usually dependent on the boundaries set, which can be tiny or extensive. Rauland et al. (2014) reviewed several studies that examined the carbon footprint of schools, which highlighted significant variations in scopes of emissions included in their analysis. The scopes ranged from including various Scope 3 (indirect emissions) sources such the life cycle emissions of furniture to food miles, to purely concentrating on operational energy (Scope 2). This inconsistency in boundaries make comparisons difficult, if not impossible, and can, in some cases, lead to misleading claims (Rauland and Newman, 2015).

It was decided that in order to produce a program that was scalable and feasible for all schools, a boundary needed to be set that was not too difficult or daunting. The boundaries of emissions for this pilot project were therefore chosen based on the availability/accessibility and usability of data. The four central utility bills were therefore initially chosen, which included energy (electricity and gas), water and waste. However, the waste bills didn't provide the level of detail needed for the analysis and were therefore excluded from the GHG and cost analysis within the pilot. However, many schools still targeted waste in their action plans.

The three emission sources captured for each school as part of the LCSPP therefore included:

1. Electricity
2. Gas
3. Water

Carbon Calculation Template

The data was captured through an excel spreadsheet template, provided to all schools. It not only captured consumption and costs for each resource/utility but also converted the consumption data into carbon emissions.

The template was created to enable schools to enter and manage the data themselves. The template required schools to enter their base year data first (the year before starting the program), which allowed schools to then measure their progress against. The template underwent several iterations, as discussed in section 4.1. The template is available in Appendix 2.

3.2.4. Activity 3: Creation of Action Plans

Schools were required to complete a Carbon Emissions Reduction Action Plan (see Appendix 3) that identifies and tracks the initiatives each school intends to implement during the program. The first four workshops provided ideas that they could incorporate into their plan. This template also included a section for low carbon initiatives already implemented (i.e. to acknowledge previous successes and enable the Program Team to understand what level or stage each school is at). A final column allows them to record initiatives they tried to implement, but that didn't work. It is important to share these experiences to either help prevent others from making similar decisions/mistakes or see if others have found alternative ways to implement the initiative.

Similar to the carbon calculation template, this template also underwent several iterations, as discussed in section 4.2.

3.2.5. Phase 2

3.2.6. Activity 4: School Meet-Ups

The second phase commenced in August 2016 and focused on support for the implementation of the initiatives. Participating schools met monthly to share progress, challenges and foster a low carbon community. The meet-ups were held at each of the schools on a rotating basis allowing each school to showcase their sustainability progress to the rest of the group, celebrate achievements and discuss challenges. Industry specialists were often invited to these meet-ups to further clarify and explain low carbon initiatives and options.

Between Meetups, the schools were sometimes asked to count specific appliances (i.e. fridges, toilets, etc.), which were then discussed at the following Meetup. This process revealed interesting things, including how some schools had unusual numbers of certain appliances or were being charged for too many toilets on their Water Utility bills.

3.3. Additional Aspects of the Program

3.3.1. Program Communication Platform

The Low Carbon Schools Pilot Program's online platform was completed in January 2016, and all participating schools were invited to join the platform. The platform served as a communication medium between individual schools and the LCSPP team. The platform was separated into the following components (see left navigation in Figure 2):

- **Activity** – a page with constantly updated activities on the site – status updates, recent questions and recent forum replies.
- **Schools** – a directory of all of the participating schools. Each school has their own profile where they can upload their files and share updates. After each workshop, the schools were given "homework" and were required to upload their documents (such as their carbon excel sheet) into their school's folder.
- **Workshops** – each of the five workshop presentations and resources are available under each of the workshop headings.
- **Questions** – a forum where schools can ask questions about topics covered in workshops and other challenges or solutions they would like to share with the group. These are split into three primary topics: energy, water, waste.
- **Achievements** – a forum where schools can celebrate their successes.

While many of the participants did use the platform, feedback said it was at times a bit clunky, and lots of users kept forgetting their passwords. Further feedback is provided in Section 5.5.1 .

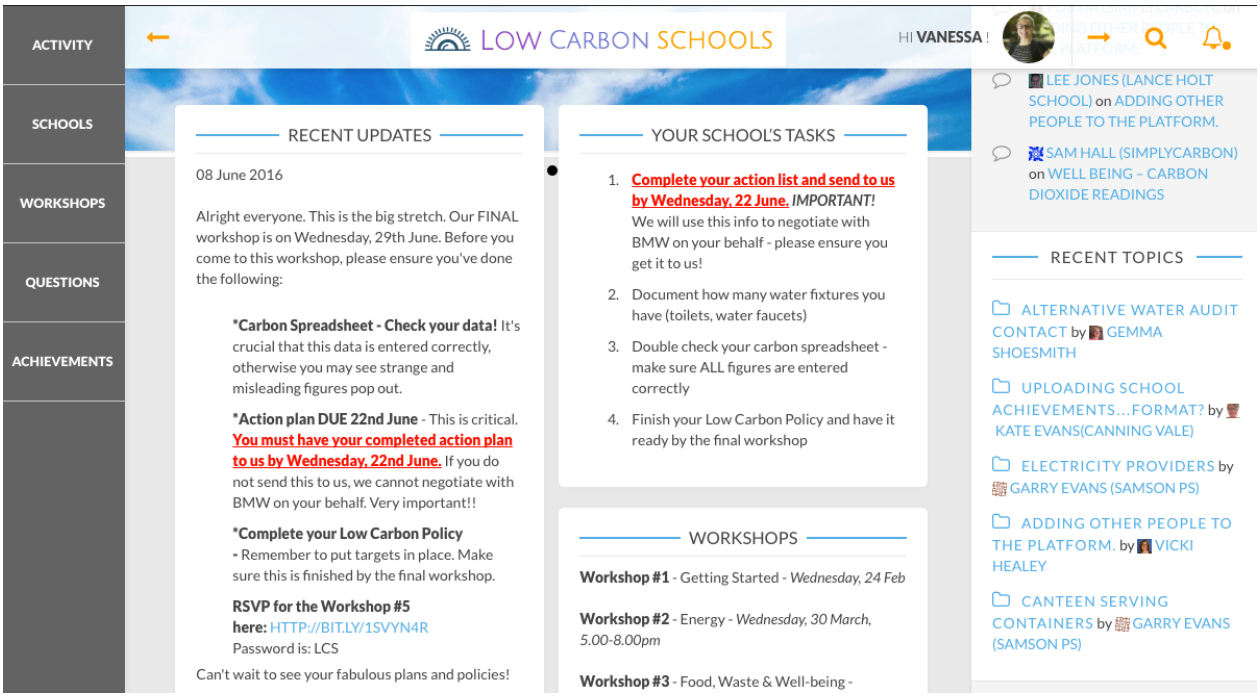


Figure 2: Low Carbon Schools Pilot Program Online Communication Platform

3.3.2. Low Carbon Policy

It is essential for schools to set targets. These can be embedded in a policy and should be made publicly available. This helps keep schools accountable to their commitments. In order to assist schools that do not already have a policy, the project team created a Low Carbon Schools Policy template, which the participants were invited to edit and adapt (see Appendix 4).

It aimed to provide inspiration for what could be included, although most schools adopted it as it was. Feedback from participating schools was that this document had to be approved by several layers of authority, including the school board, which proved too hard for several schools.

3.3.3. Tree Planting

One interesting, completely community-led project that emerged out of this program was around tree planting. A community representative (ex-parent) from one of the participating pilot schools - used the carbon calculations provided by the program to determine how many trees would be needed to be planted to offset the entire 2015 baseline emissions of all 15 schools. With a farming background and having already run a successful tree planting program at his child's school, he offered to organise and deliver a tree planting program for all the participating schools. He successfully applied for and won a grant through WA Natural Resource Management (NRM). This project resulted in over 50,000 trees being planted in 2017 by an army of enthusiastic students from 13 of the 15 schools. This more than offset all of the 15 schools baseline GHG emissions.

3.3.4. Steering Committee

Bi-annual meetings with the steering committee, which included a variety of stakeholders involved in the existing State Government-led programs and initiatives, were held over the two years, to ensure the best possible alignment between existing programs.

4. Methodology

Various sources of data were collected to evaluate the project. The method of data collection and analysis is outlined below.

4.1. Utility Data Collection & Analysis

Each participating school was given a specially designed excel spreadsheet template that enabled them to enter utility bill data on their school's consumption and costs for electricity, gas and water. Waste was excluded due to the extreme inconsistencies in the types of billing information schools received from their waste providers. The spreadsheet included complex carbon calculations, which used the data entered to calculate the carbon emissions associated with each area.

The spreadsheet was created by a carbon consultant commissioned by SimplyCarbon and was updated annually to reflect the changing emissions factors. There were several iterations of the spreadsheet, particularly within the first year of the program as improvements were made to the spreadsheet and bugs were fixed. Any changes made to the spreadsheets were documented. The final iteration of the spreadsheet included graphs that the schools could use for their own purposes.

The spreadsheets were filled in by various stakeholders at the school - most were completed by either a teacher or the registrar/business manager, with some spreadsheets being completed by parents.

In early 2017, after identifying anomalies, missing data and significant errors in the figures entered in the 2015 and 2016 spreadsheets, all schools were asked to provide their 2015, 2016, and 2017 bills so that they could be double-checked by the PhD Candidate to ensure accuracy of data collected.

Due to the errors identified in the data entry, the project team also decided not to ask the participating schools to complete the 2017 spreadsheet. Instead, the PhD Candidate entered the data herself from the bills provided by SimplyCarbon.

Issues also arose around obtaining all the required bills from the schools, and several attempts were made at contacting the school to locate missing bills. In some cases, bill data could be estimated based on units used between two periods. In early 2018, with permission from schools, water, gas and electricity providers were also contacted directly for the missing data. Where information was still lacking, estimations were made based on historical use.

Two schools were omitted from the final calculations. One primary school was omitted as they were unable to provide enough data for the analysis. A secondary school was also excluded from the analysis due to extreme fluctuations in utility consumption and cost as a result of the construction of a new major building on site, as well as a significant restructuring of the school facilities.

4.1.1. School Square Metres

The approximate square metres of each school was calculated using Google Earth historical satellite data and the Google Earth Polygon tool. This method was chosen as there was no record of square metre data available for use by the schools or the Department of Education WA.

4.1.2. Normalising gas consumption and costs

Weather can play a significant role in energy consumption (Eto, 1988; Psiloglou, Giannakopoulos, Majithia, & Petrakis, 2009) and therefore has the potential to distort consumption results making it challenging to discern the effectiveness of efficiency initiatives. When the carbon emissions results were first analysed, there was a significant increase in gas consumption for 2016 for all 13 schools. This was due to the unusually cold weather patterns for the Perth Metropolitan area for 2016 (Bureau of Meteorology 2018).

One approach for weather normalising consumption is the use of Heating Degree Days (HDD) and Cooling Degree Days (CDD). HDDs and CDDs can be defined as the “difference between the average daily temperature and the BASE (comfort level) temperature” (Australian Government Bureau of Meteorology, n.d.). The BASE thermal comfort range for indoor environments is between 12 and 18 degrees Celsius for heating and 18 and 24 degrees Celsius for cooling. The upper limits of these ranges (18 degrees and 24 degrees) were used for this research.

When the number of HDDs for 2016 was analysed in relation to each school’s gas consumption, there was a significant relationship. The gas consumption per month was divided by the number of Heating Degree Days (HDDs) to give a consumption and cost per HDD. The consumption per HDD was then multiplied by the 10 year average HDDs for each month to provide a new normalised consumption and cost.

The equations used for the calculation of weather-normalised gas consumption can be seen in (1) and (2) where HDD_m^{ref} is the 10-year average of HDDs, P is gas consumption in kWh and $Q_{m,y}$ is the weather-normalised gas consumption (kWh).

$$HDD_m^{ref} = \frac{1}{n}\sum_{y=2005}^{2005+n} HDD_{m,y} \quad (1)$$

$$Q_{m,y} = HDD_m^{ref}\frac{P_m}{HDD_{m,y}} \quad (2)$$

Electricity consumption and cost was not adjusted because analysis showed there was an insignificant relationship between consumption and the number of CDDs in each month.

4.2. Action Plan Template

At the beginning of the program, each school was provided with an action plan template in a Microsft Word document form. The schools were asked to keep this document updated with the low carbon initiatives they planned to implement. This proved difficult to keep track of each school's progress as it relied on the schools uploading the newest document onto the online platform on an ongoing basis. To address this, the LCSPP team created an online 'Google Doc' version of each of the school's action plans. Using Google Docs enabled the schools to update their action plans online, while allowing the LCSPP team to track and monitor their progress.

During each of the initial five workshops, schools were provided with ideas and tips about what initiatives they could/should pursue in the key areas (i.e. energy, water and waste). These were provided in order of 'no-cost', 'low', 'medium' or 'high cost' actions. Acknowledging that each school was at a different stage of their journey, the LCSPP team encouraged schools to pick initiatives that were relevant to them and add them to their action plans. Over time, the schools added additional actions based on group discussions and knowledge shared at the monthly Meet-Ups.

While each school was encouraged on a monthly basis to complete actions and update their action plan (to discuss at each Meetup), two of the schools did not populate their action plans at all, despite several reminders and prompts. This is likely due to the school not having an individual willing or able to complete this task. Nevertheless, from discussions with these schools, it was noted that actions were identified and implemented.

4.3. End of Year Survey

In November 2016, an end of year survey was provided to all participating schools. The survey was sent to each school's low carbon committee members (principals, teachers or P&C members). The survey had a total of 39 questions, which asked for information about the school's low carbon committees, and their thoughts and feedback on the program so far. A total of 25 responses were received (four principals, 14 teachers and five parents). Fourteen of the 15 schools had at least one representative complete the survey. The results are provided in Section 5.

4.4. Program Logic Model

A logic model was developed for the LCSPP to help measure and track the success of the program in achieving its goals. A logic model is a visual representation of the theory of change for an organisation, which often entails a description of how the program will work and what the main outcomes are. The logic model can be found in Appendix 5 and analysis in section 5.6.

4.5. Additional PhD Data Collection and Research

Additional data was collected as part of the PhD research conducted by Portia Odell (see Appendix 6). The analysis and results will be accessible in her thesis through Curtin University in 2020. Below are additional areas of research will support the results of this study.

4.5.1. Parent Survey

A survey was distributed to all participating school's parents by each school's research liaison (the nominated school representative that was the primary point of contact for the research). The survey aimed to determine the parent's environmental attitudes and whether their children have influenced them as a result of the school's low carbon initiatives (i.e. the extent of intergenerational change). This survey also included the Low Carbon Readiness Index (LCRI), which was developed by researchers at the University of Melbourne that aims to measure people's readiness to transition to low carbon living (O'brien et al., 2019).

4.5.2. Committee Member Surveys

A survey was also sent to LCSPP committee members in an online format. The survey asked questions about each school's low carbon committee dynamics, their perceptions on various elements of the carbon reduction process and any enablers or barriers the school has encountered on their carbon reduction journey, as well as the aforementioned LCRI.

4.5.3. Case Study Schools

Four schools (two primary, two secondary) were selected as case studies to gain a deeper understanding of the factors that lead to successful carbon reduction.

In March 2018, interviews were conducted with three people from each school who were involved in the LCSPP – the principal and two other individuals who were most involved in the school's low carbon initiatives (staff, teachers or P&C members).

Focus groups were also held with students from each of the four schools that were involved in their school's sustainability/ green team to explore their perceptions, including whether they felt they influenced their peers or family.

5. Program: Feedback & Insights

This section reviews how the program was delivered. It includes program data and information provided by SimplyCarbon in the form of school utility data, feedback from participants through surveys, as well as insights from the researchers and the program team.

5.1. Committee Members & Participation

The numbers of low carbon committee members in each school ranged from 3 to 10 and mostly consisted of teachers. Two schools included up to 10 students on their committees and several also included Principals.

Nearly half (42 per cent) of the committee members who completed the survey said *everyone* on their committee played an 'active role' in implementing initiatives, with another 42 per cent saying *half of their members or more* played an 'active role'. Given the tendency for schools to have a single "champion" who often leads sustainability initiatives, it appears the schools participating in the LCSPP were able to effectively distribute the responsibilities associated with the program across multiple people in the school.

On average, schools spent around 10 hours per month on low carbon initiatives and most (65 per cent) believed that this was not enough time to complete tasks and initiatives.

5.2. Principal Support

Principal support for the program was very strong overall with almost 80 per cent saying that their Principal was either supportive, very supportive or extremely supportive (see Figure 2.) Four per cent responded that their Principal was not at all supportive.

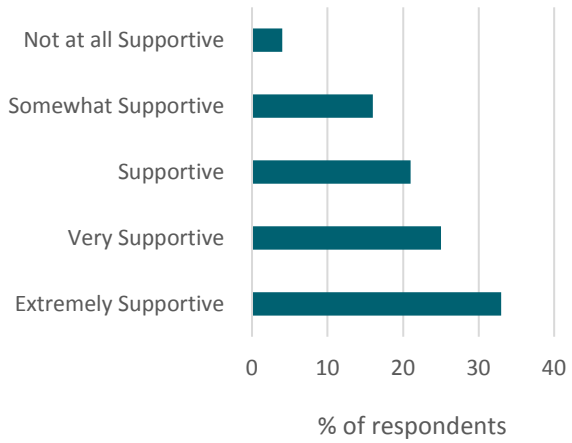


Figure 3: Amount of perceived principal support by low carbon committee members for the program

Asked if there was Principal support for implementing initiatives, more than 70 per cent said their Principal was either supportive, very supportive or extremely supportive (Figure 4), which is slightly less than the 'general support' shown by Principals.

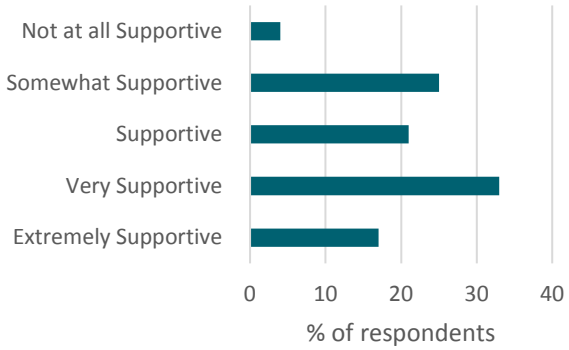


Figure 4: Amount of perceived principal support by committee members for implementing initiatives

5.2.1. Relief time for teachers

Participants were asked if their school provided relief time for teachers. Half of the respondents said teachers were not given any relief time to work on the program, while 25 per cent said they were. The remaining respondents weren't sure. This indicates that most committee members had to work on low carbon initiatives outside of their work hours.

5.3. Student Participation

The majority of schools involved students in the implementation of their action plans. Forty-two per cent responded that they were already incorporating students in these areas, and 21 per cent said they began involving students as a result of the LCSPP. There was near universal agreement (96 per cent) that students should have a more hands-on role in identifying and implementing initiatives.

5.4. Activities

5.4.1. Activity 1: Workshops

Workshop Participation

Workshop attendance at the LCSPP was high. A guest speaker from one of the free, WA Government-led sustainability program commented on the unusually high workshop turnout, stating how rare it is for so many school stakeholders to attend meetings/ workshops outside school hours on a regular basis.

As mentioned, the program required at least one representative per school to attend each of the five workshops. This would equate to 15 people per workshop and a total of 75 participants by the end of the five workshops. All up, a total of 186 people attended the five workshops - an average of 37 people per workshop. This is more than double the minimum required number. Only two schools missed a workshop due to unforeseen circumstances.

This demonstrates the appetite for such a program and also highlights the value placed on a paid program.

More than half of the survey respondents said they attended four or five workshops and almost three-quarters of respondents attended three or more. The majority of schools (76 per cent) found the workshops either extremely or very useful.

> *"The value in sharing is to problem-solve and evolve with best practice ideas. This was evident with all the stories from the schools and to use them as a sounding board to bounce ideas off." (Workshop Participant)*

Feedback for improvement for the workshops and meetups included making the meetups more focussed on particular topics (e.g. not combining topics such as energy and water) and having more data comparisons between schools (e.g. CO_2-e emitted per student).

5.4.2. Activity 2: Calculating and tracking performance

The utility information from the excel spreadsheets was analysed and graphed and provided back to the schools during the workshops and Meetups. The information was extremely enlightening and eagerly received by the schools who immediately began examining how they compared to the other similar schools, across the various resources streams (electricity, gas, water), as well as their total carbon footprint and costs.

Over 90 per cent of respondents found the carbon spreadsheet either useful (32 per cent), very useful (35 per cent) or extremely useful (24 per cent). The overwhelming majority also found knowing how they compared to other schools valuable (see Figure 5).

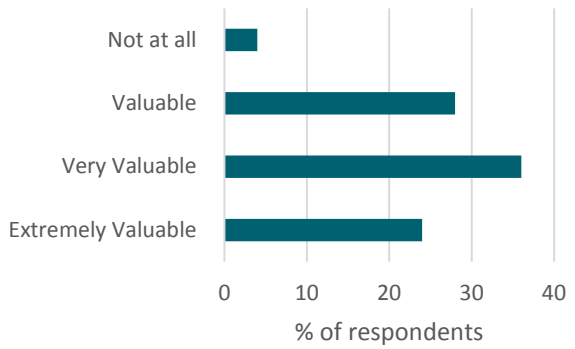


Figure 5: The level of value by committee members of knowing how their school compared to other schools in terms of resource consumption and cost

There were a number of challenges with the method of acquiring the utility bill data through the excel spreadsheets. To begin with, many people acknowledged they were unfamiliar with excel and were daunted at the prospect of entering the data. This may have been due to the amount of information provided in the excel spreadsheet. For example, despite not requiring input from the user, all the carbon accounting information/data was displayed for transparency (e.g. scopes of emissions, emission factors and calculations), which might have looked quite complicated to an unfamiliar eye.

Several minor glitches with the excel spreadsheet were also identified, which resulted in several new versions, which also caused inconvenience, hassle and minor delays with obtaining the data.

Further problems arose after checking some of the spreadsheets from the 2015 period against their bills to ensure all billing periods had been entered (i.e. no missing bills). Through this process, it became evident that many schools had made, sometimes significant, errors in data entry and bill interpretation. Examples of errors included entering the usage numbers incorrectly (e.g. reversing numbers) and entering only part of the bill such as the off-peak usage instead of both on and off-peak usage. The schools were subsequently asked to provide all their bills so that the researchers could double check all the data entered. It was also decided that the researcher would enter the bill data for 2017 straight from the bills, rather than getting the schools to enter the data.

Issues also arose around obtaining the required bills from the schools. Despite recommendations by the program team to implement a system of photo copying each bill and adding it to a separate Low Carbon Schools folder for the purposes of 'easy access' and double checking, not all schools followed the recommendation. The amount of time spent following up was extremely onerous and caused distress amongst some school business managers.

In the future, more emphasis should be placed on creating efficient systems and processes for data collection in schools. Another option could be obtaining permission from the school to receive bills directly from utility providers, in either a bill format or through live data feeds.

5.4.3. Activity 3: Action Plans

A total of 625 actions were identified by 13 schools (one school didn't complete an Action Plan), with the largest single focus (36 per cent) being on energy consumption (see Figure 6).

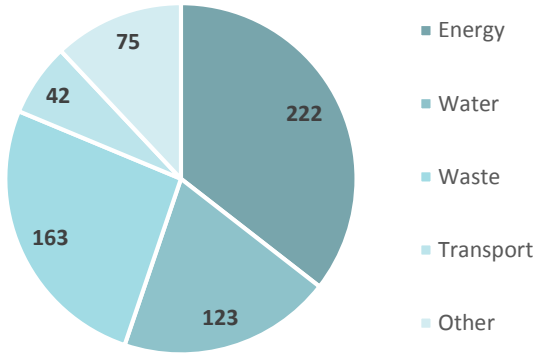


Figure 6: Number of Actions per area

Over 60 per cent of the actions that the schools identified had very little, or no cost and nearly 50 per cent of the actions actively involved students. The results revealed that there is significant potential for involving students at more stages of the carbon footprinting process, such as getting students to enter bills data into the carbon calculator. There is also significant potential to create more student involvement through initiatives such as audits in the school, as well as getting students to project manage the implementation of initiatives.

Forty per cent of the actions identified were completed by the schools themselves (i.e. were not outsourced to consultants or suppliers) and 17 per cent are continuous or recurring initiatives. The remaining are yet to be implemented.

Energy Actions

Nine of the schools undertook a free Type 1 Energy Audit[2] conducted by Australian Sustainable Action (ASA), a small company that partnered with the LCSPP and offered free energy audits for participating schools. The audits identified the most feasible energy reduction strategies, and most schools agreed to implement the lowest cost recommendations. Examples of recommendations that schools implemented included turning off cool rooms during school holidays, a well as school-wide switch off programs for other appliances, implementing an automatic switch-off program for computers in the evenings and over weekends and upgrading lighting to LEDs (Figure 8).

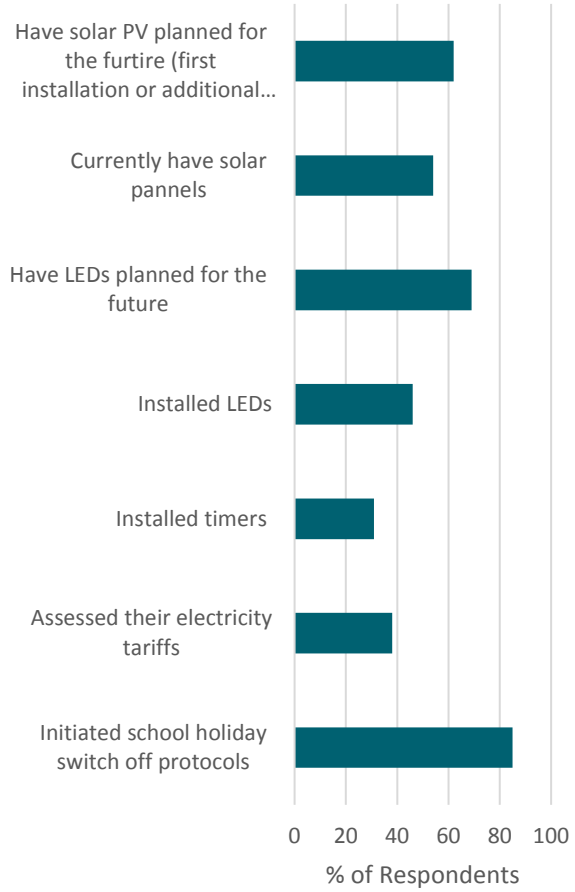


Figure 7: Examples of Low Carbon Actions

Before the end of 2016 (summer holidays), schools were encouraged to develop switch off protocols for the school holiday period. A number of schools also evaluated their energy tariffs with their energy providers to negotiate better deals.

One large secondary school discovered that their building management system (BMS) had never been officially tuned – that is, to ensure that their centralised systems such as lights and heating and cooling were coming on and off automatically at appropriate times. They spent $20,000 to have it tuned, and in the latter part of the second year of the program, they saved approximately $8,000 per bill, demonstrating a payback period of fewer than three months.

While most schools were extremely interested in installing solar, the upfront financial outlay was too much for most schools. Two schools that had access to funds (one secondary school had savings collected over a number of years, while a primary school had a very

[2] *A Type 1 Energy Audit is basic energy audit that analysis daily consumption with a high-level review to check for anomalies and efficiency opportunities.*

proactive P&C who had fundraised for them), participated in a State Government-led solar trial, prompted by the team from the LCSPP. While the schools had to pay for the purchase and installation themselves, the Department of Education, through Building Management and Works (BMW, created a new process for managing the tender process and the initial sizing requirements. Both schools were in the process of installing the solar systems at the end of this pilot.

Most schools (n=9) also sought to replace lighting with LEDs, however, most faced a similar upfront cost barrier as with solar. All schools plan to replace their lights gradually as they bulbs/tubes blow with the exception of one primary school that set aside a $5,000 budget to replace fluorescent lighting with LEDs throughout the school. The schools were also encouraged to replace their outdoor security lights with LEDs. There are often more outdoors lights than indoor lights, and they are often on for a longer period of time. However, many schools found the upfront cost too high and chose to replace them only once they fail.

While schools often look to their P&C organisations to fund various improvements at the school, some schools highlighted the difficulties in getting the P&C on board with funding sustainability initiatives for the school (pers comm).

Water Actions

Nearly half (46 per cent) of the schools completed a water audit provided by a partner of the LCSPP. The audit checked their site for leaks and inefficiencies. One school identified a water leak of 10,000 Litres a day. Most of the schools that had an audit subsequently installed flow restrictors on many of their taps (see Figure 9). Some schools got their students to count/audit the number of toilets and urinals onsite (their 'fixtures'), which led some schools to identify discrepancies with their fixture charge on their water bill, which saved them considerable money.

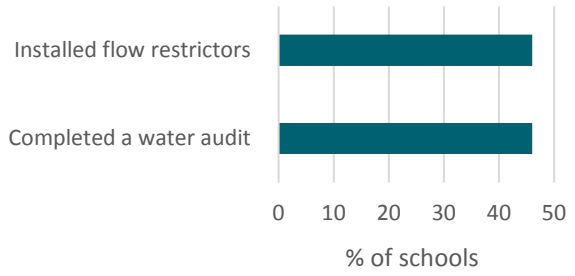


Figure 8: Snapshot of two water actions: percentage of schools that included the action in their plan

Many schools were already a 'Waterwise' school (a status earned through participating in the WA Water Corporation's WaterWise program) before joining the LCSPP, though several more initiated the process after finding out about it through the LCSPP.

Waste Actions

As previously mentioned, despite waste not being measured or included in the carbon calculations due to issues with obtaining sufficient data, most schools still addressed waste in their Action Plans. Over half of the schools introduced some kind of green waste collection (e.g. green rubbish bin or composting) and improved their recycling options onsite, such as increasing the number of recycling bins or introducing new recycling streams (see Figure 10).

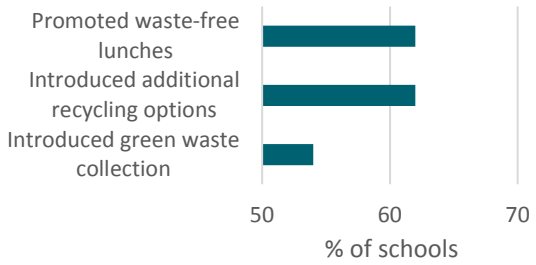


Figure 9: Snapshot of three waste actions: percentage of schools that included the action in their plan

Despite costing more money to add new recycling bins, in most cases, the reduced amount of general waste led to less general waste bins being collected, therefore becoming a cost-neutral transaction.

Transport Actions

Transport was also not included in the measurement process due to the difficulty in obtaining data. Little focus was therefore given to this during the official workshops and Meetups. Nevertheless, many schools chose to pursue some transport related initiatives. Many of the schools with transport actions were already involved in TravelSmart, a WA school educational and outreach program led by the Department of Transport. Most of the schools (n=11), had a walking school bus or walk to school initiative that was planned or underway.

Other Actions

A final category - "other" was listed on the Action Plan template where the schools were asked to put any actions that didn't fit in any of the other categories. Most schools noted actions related to revegetation, tree planting and gardens.

Participant Feedback

Overall all schools found the action plan template useful with the majority ranking it *very useful* (48 per cent). However, some found their school did not regularly keep up with their action plans.

5.4.4. Activity 4: School Meetups

Most schools found the Meetups very useful (68 per cent). Nearly all schools (88 per cent) agreed that they learned things from other schools as a result of attending the meetups.

Schools stakeholders enjoyed visiting other schools and seeing what others were doing, their progress, and hearing how other schools solved problems. They valued the opportunity to share experiences and appreciated the networking aspect and meeting like-minded educators.

5.5. Additional Aspects of the Program

5.5.1. Program Community Platform

There was a high level of interaction on the community platform by schools. Below summarises the key outcomes:

- A total of 55 school users were registered on the platform;
- A total of 31 "topics" or questions, were asked by school participants with 67 replies. Some participants replied to each other about problems or solutions;
- All schools uploaded the documents requested into their school files;
- To encourage participation on the platform, a prize was given at the end of each workshop to the "most improved" or "most active" user on the platform.

5.5.2. General feedback on the LCSPP

The last section of the survey asked schools for their overall feedback about the program. Ninety-six per cent of participants who responded to the survey would recommend the LCSPP program to other schools. Below are general comments left participants.

Barriers/Improvements Needed

- "I enjoyed the year. However it really does need the support of Admin to be really effective." Different principals have different priorities, and that alone makes a huge difference."
- "I love the project and want to see it work well in the school. We need the support of the Principal who pays lip service only. He won't stand up to the office staff."
- "The workshops were fantastic - I think that the school meetups were great in that we could see what other schools were doing, but I felt at times they lacked a bit of direction."
- "It was great to have teachers and kids pulling together. Trying to get the office staff on board, we found jolly hard."
- "Don't have meetings too early in term!!"
- "Break into two groups (HS and PS) for sharing time, then come back at the end to share key points. A HUGE thank you for your collective drive and enthusiasm...it's catching!"

General Feedback on Program

- "At the very least, it gets the school thinking about sustainable actions. At the most, it will allow schools to implement these actions to achieve savings in dollars and carbon emissions."
- "It has focused on the school community. Improved existing programs and enabled new initiatives to be implemented seamlessly. Even with a small committee and few committed staff, we have achieved a great amount in 12 months."
- "It is very important that school students start to understand that a low carbon future is critical to their wellbeing. Make low carbon or no carbon business as usual. It will take time for society to understand how to live within the resources of planet earth. This is an important work."
- "Good for all; school, community, the world."
- "It's an inspirational program to help the environment, learn about sustainability and implement important projects into our school."
- "Schools make up a huge part of our communities. If all schools came on board to improve sustainability, it can only be a positive."
- "I think it is important for the future generations to be involved in caring for the planet, even if they start small and care for their small patch of it."
- "Introduces the idea of Low Carbon and Sustainability very simply and softly, whilst ensuring action plans are drawn up and actions implemented to some extent. Informative and supportive to help people who may be new to the idea to take on board and collect data etc."
- "Taking control of carbon emissions and making reductions should be a priority for all schools."
- "…schools need to know ways in which they can connect to education for sustainability and these ways are authentic and effective and optimistic."
- "Well done for having the courage and perseverance to start this initiative. It will take a while before school Principals are boasting about their successes in lowering their carbon footprint and making their school and school community more sustainable. Stick at it. You are doing important work. You are creating the sustainability leaders of tomorrow."
- "I'm excited about moving forward with students ... they are our future. :-)"
- "Thanks for the opportunity to find out so much about this project. It was very practical with lots of information, resources and assistance. I learnt so much!"
- "Have admired the passion and dedication of the Low Carbon team."
- "Thank you for your commitment and contribution to making the world a better place - and minimising harm and maximising possibility to keep our kids hopeful in a world gone pretty made; to know that yes, you can make a difference - and that it can be a small thing that makes a big difference."
- "I hope many more schools create the opportunity to experience the LCSPP program."

6. Results: Utility Data

This section begins by outlining the characteristics of schools that have impacted the results. The overall carbon emissions are then highlighted, including the savings made, as well as a breakdown between the various sources. The consumption and costs for each of the three utilities are then presented to highlight variations between them. While the data shows some interesting results and insights, it should be acknowledged that the sample size for this pilot was too small to draw any significant conclusions.

6.1. School Characteristics

As mentioned in Section 4.1, the results presented here are from 13 of the 15 schools that participated in the pilot. The 13 schools ranged in school size from 60 – 1700 students and fluctuated over the three years, as shown in Figure 10 and Figure 11. The graphs are ordered from smallest to largest in terms of student numbers/size of the school in 2017 (the last year of the program).

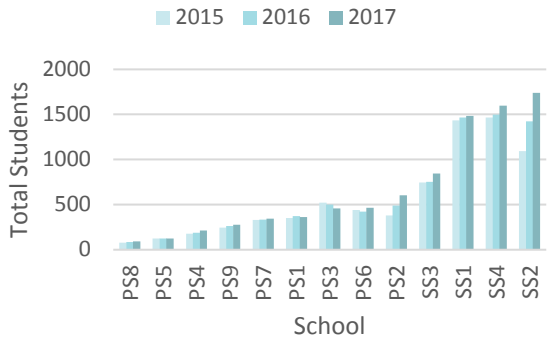


Figure 11: Total student numbers per school (2015 – 2017). PS = Primary School, SS = Secondary School

Two schools experienced an increase in students of over 50 per cent, with the average student increase 15 per cent across all 13 schools. Two schools slightly decreased in student numbers (see Figure 11).

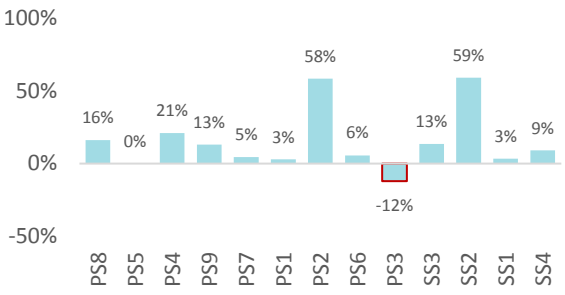


Figure 12: Percentage difference in student numbers 2015 - 2017

The schools also varied in terms of building footprint (square metres), with some schools having large campuses with low student numbers, and vice versa, as can be seen in Figure 12. Several schools also grew in square meters during the two-year program. For example, two schools each had over 10 transportable classrooms installed between 2015 and 2017 to accommodate their increasing student population.

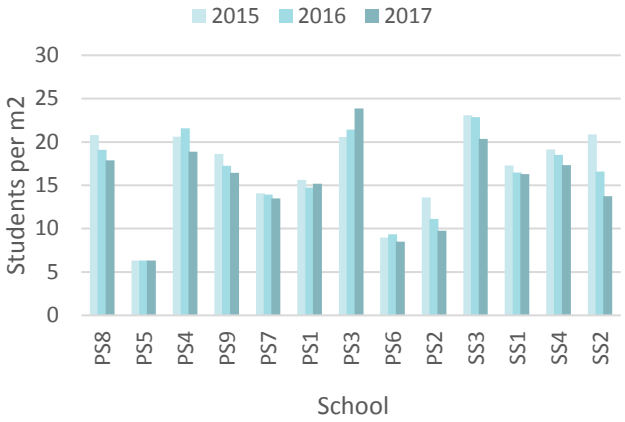


Figure 10: Students per m2 per school (2015 - 2017). Schools ordered from smallest (left) to largest (right)

One school had a theatre, which had performances several times a month, and was used almost daily for rehearsals. Some schools were also frequently used by members of the community outside of school hours.

6.2. Carbon Emissions

Overall, emissions from all 13 schools dropped from 3,352tCO_2-e to 3,086tCO_2-e, representing a reduction of 266 tonnes of carbon emissions (CO_2-e) or 7.5 per cent, illustrated in Figure 13.

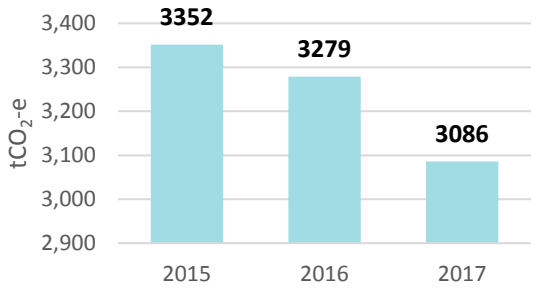


Figure 13: Total tonnes of carbon emissions (CO_2-e) for all 13 schools for 2015, 2016 & 2017

The percentage of each emissions source remained almost exactly the same between all three years, with electricity accounting for 95 per cent of total emissions and water accounting for only one per cent (Figure 14).

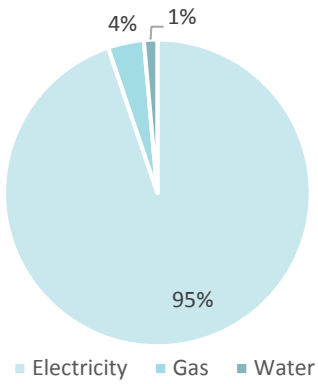


Figure 14: Average proportion of carbon emissions (tCO_2-e) for all schools

Overall, 10 of the 13 schools decreased their total carbon emissions, despite increasing student numbers. The three schools that did increase in emissions experienced significant growth in student numbers. Table 5 shows the total carbon emissions per school over the three years, along with their percentage change between 2015 and 2017. They are ordered from the smallest school to the largest.

School	2015	2016	2017	per cent Change 2015/2017
PS8	25.8	24.1	22.3	-13 per cent
PS5	21.2	21.3	18.2	-14 per cent
PS4	37.0	43.2	42.5	15 per cent
PS9	88.9	76.6	70.7	-20 per cent
PS7	115.8	86.3	84.0	-27 per cent
PS1	81.0	76.7	66.8	-18 per cent
PS3	165.3	158.3	145.0	-12 per cent
PS6	136.5	120.8	112.5	-18 per cent
PS2	120.8	137.8	141.2	17 per cent
SS3	566.3	528.9	494.3	-13 per cent
SS1	696.9	702.7	652.5	-6 per cent
SS4	698.3	647.6	625.3	-10 per cent
SS2	598.5	654.3	610.5	2 per cent

Table 4: Total carbon emissions (tCO_2-e) per school (2015 - 2017) and percentage change between 2015 and 2017

It should be noted that there are various reasons why emissions fluctuate, which are not always correlated with consumption or growth in students. For example, the carbon intensity of the electricity grid changes year to year based on the amount of renewable energy feeding into it. This affects the emission factors associated with electricity, which can lead to a situation where a school's consumption stays the same, but their emissions decrease due to a lower grid emission factor for that year (or vice versa).

Nevertheless, changing student numbers are often the main factor behind fluctuating consumption patterns and, considering nearly 80 per cent of the schools increased in student numbers over the three-year period. It is important to analyse the data using other metrics. Emissions, consumption and cost are therefore also considered on a per student basis. Figure 15 shows the CO_2-e emissions per student per school across the three years, demonstrating that all schools reduced on a per student basis, except one, which stayed the same (PS3).

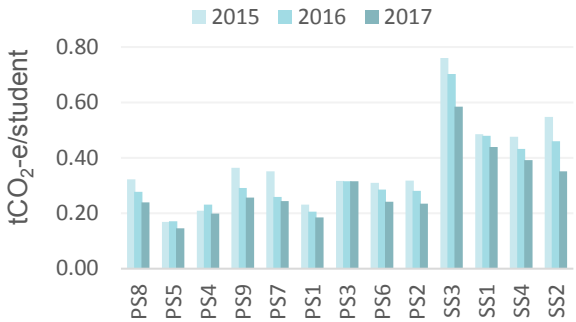


Figure 15: Carbon emissions (tCO2-e) per student for each school (2015-2017)

Table 6 shows the CO_2-e emissions per student for the base year (2015) and at the end of the program (2017), for each school, along with the percentage change.

Table 5: Carbon emissions per student (tCO_2-e/student) per school in 2015 and 2017 and per cent change.

School	2015	2017	per cent Change 2015/2017
PS8	0.32	0.24	-26 per cent
PS5	0.17	0.16	-4 per cent
PS4	0.21	0.20	-5 per cent
PS9	0.36	0.26	-30 per cent
PS7	0.35	0.24	-31 per cent
PS1	0.23	0.19	-20 per cent
PS3	0.32	0.32	0 per cent
PS6	0.31	0.24	-22 per cent
PS2	0.32	0.23	-26 per cent
SS3	0.76	0.58	-23 per cent
SS1	0.49	0.44	-10 per cent
SS4	0.48	0.39	-18 per cent
SS2	0.55	0.35	-36 per cent

This data reveals that every school reduced their CO_2-e emissions on a per capita basis, apart from one school which stayed the same.

The per student carbon footprint, averaged across the 13 schools in 2015, was 0.37 tonnes. This decreased to 0.29 tonnes in 2017 (see Figure 17), representing slightly over a 20 per cent reduction per student in CO_2-e emissions.

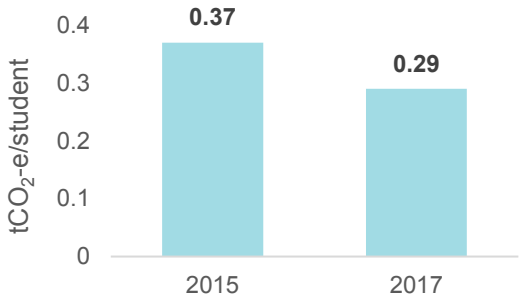


Figure 16: Average carbon emissions per student (tCO_2-e/student) for all 13 schools

6.3. Total Utility Costs

The overall breakdown of the average costs per utility area (electricity, gas and water) is highlighted in Figure 18 and reveals a much different picture from the emissions profile shown in Figure 15. While water made up only 1 per cent of schools average emissions, it represented one-third of the total costs. Electricity was by far the greatest cost for schools representing just under two-thirds (62 per cent) of the total costs, with gas costs represented almost exactly its share of emissions (5 per cent and 4 per cent respectively).

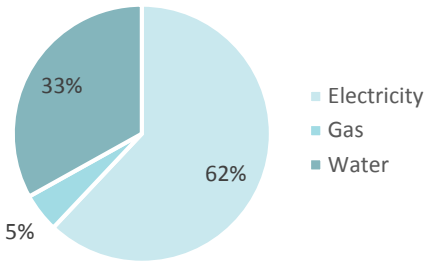


Figure 17: Average total costs by utility (2015 - 2017)

Figure 19 shows that total utility costs from electricity, gas and water increased between 2015 and 2017 by $119,269.68, representing an eight per cent rise. This was due to a variety of factors, one of the most significant being changes in student numbers. As mentioned, almost all schools increased their number of students during the program, which in some cases led to new buildings being constructed or transportable classrooms being installed, resulting in increased resource consumption. There were a number of other variables and external factors such as this, which impacted the outcomes of the program but were outside the program's control. These are discussed further in 6.4 and highlight the complexity involved with analysing data and determining the impact from programs such as this one.

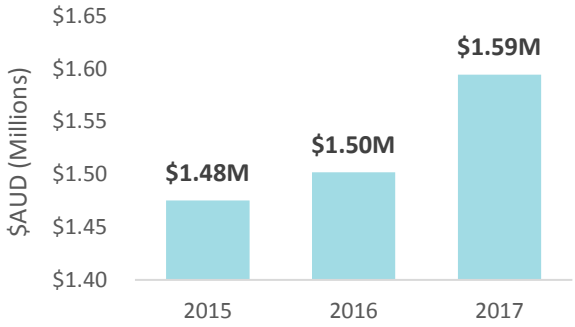


Figure 18: Combined total utility cost (electricity, gas and water) for all 13 schools

Overall, nine of the 13 schools increased in total utility cost between 2015 and 2017 (see Figure 19), while four schools saved between $839 and $23,346 (see Figure 20).

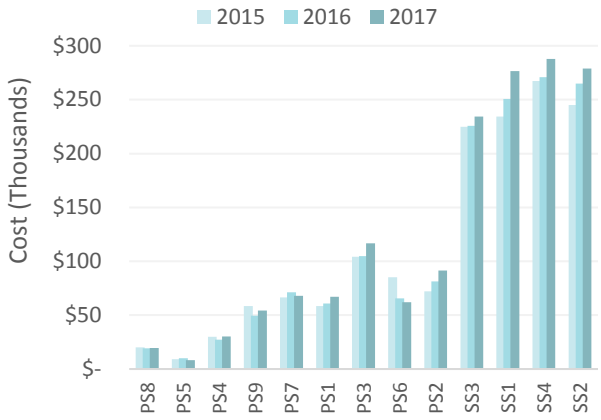


Figure 19: Total utility costs per school (2015 -2017)

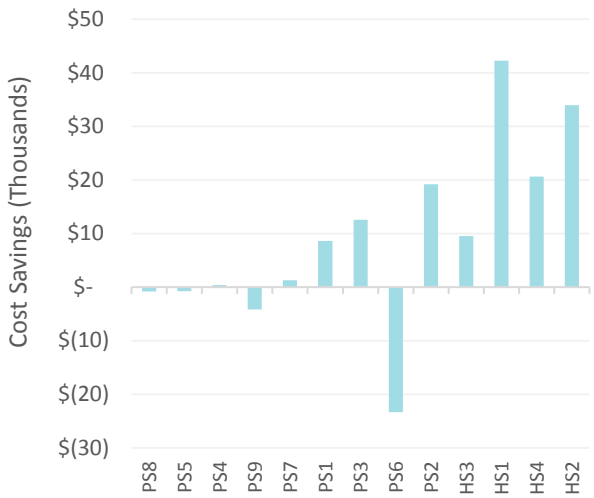


Figure 20: Utility cost savings per school (2015 - 2017)

Again, however, when analysing the data on a cost per student basis, the majority of schools reduced their costs between 2015 and 2017 (see Figure 21) with only three schools increasing, as highlighted in Figure 22.[3]

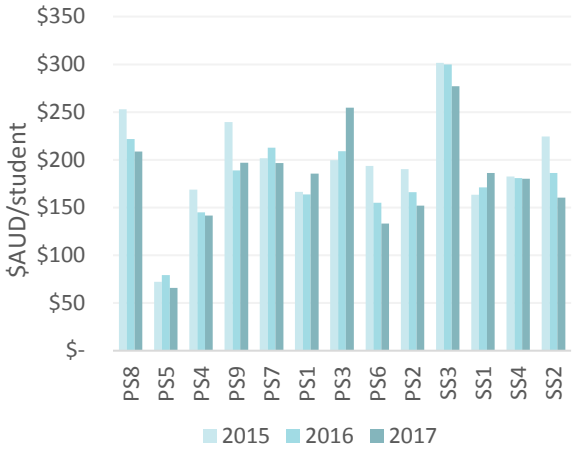


Figure 21: Total utility costs per student (2015 - 2017)

As seen in Figure 21, the overall utility costs per student vary quite significantly between the schools, with several clear outliers. This highlights the value of comparing costs on a per student basis.

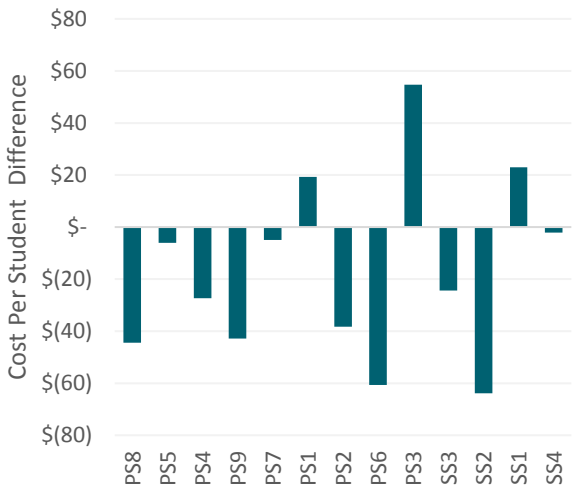


Figure 22: Utility cost savings per student difference between 2015 & 2017.

Schools that reduced their costs per student (n=10) saved an average of $31.49 per student, representing a 15 per cent savings. The average cost saved per student across all schools (n=13) was $16.79 (see Figure 24).

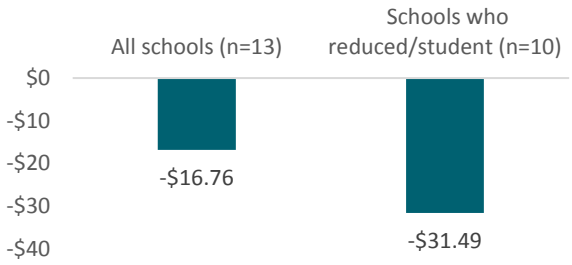


Figure 23: $AUD saved from utility costs per student across all schools (n=13) and schools that reduced per student costs (n=10) and between 2015 – 2017

6.4. Data Analysis Per Utility

6.4.1. Electricity

Entering 2015 data enable schools to not only create a baseline against which they could measure their progress, but this also enabled schools to compare themselves before any interventions.

Figure 24 shows the size of the school and their consumption of electricity in 2015. The data shows that while school size and electricity consumption are generally correlated, there were also anomalies where some schools consumed significantly more or less than others of similar size. For example, while PS1 had more students than PS7, they used less electricity, while SS3 consumed a similar amount to SS2, despite having significantly fewer students.

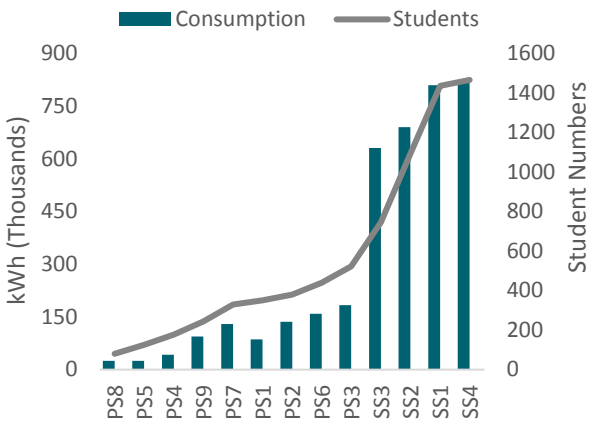


Figure 24: Electricity consumption (kWh) and student numbers for all schools for their baseline year (2015).

There are sometimes logical reasons for differences in consumption, such as a school having energy-intensive infrastructure such as heated swimming pools or trade training centres, but this is not always the case: it can also be indicative of inefficiencies occurring within a

[3] Figures are now based on 2015 student numbers - the baseline of the program - and ordered from smallest (left) to largest (right).

school such equipment being left on unnecessarily (i.e. overnight, weekends or holidays) or having an abnormal amount of common appliances such a fridges.

Overall, between 2016 and 2017, nine schools decreased their total electricity consumption, while four schools increased (see Figure 25). Two of the schools that increased consumption (PS2 & SS2) experienced significant student population growth and had new transportable classrooms installed, thus increasing electricity consumption and costs. A new building also came online in one school (PS4) in 2016.

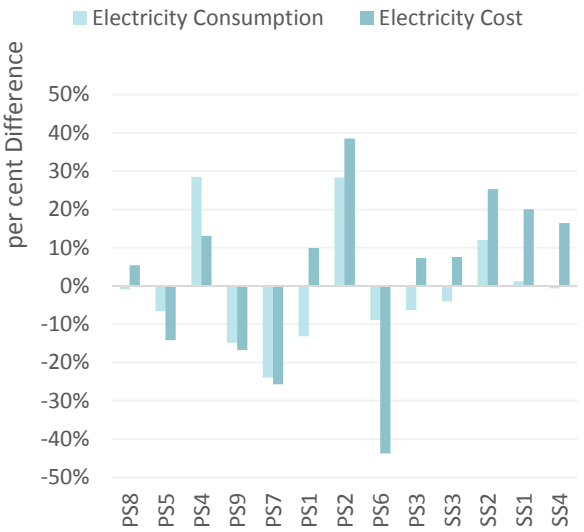


Figure 25: Electricity consumption (kWh) & cost ($) percentage difference between 2015 and 2017.

While PS2 and PS3 had similar electricity consumption, as seen in Figure 27, PS2 grew significantly in student numbers (58 per cent) between 2015 and 2017 (see Figure 11). Despite this, the school only increased it's electricity consumption by 28 per cent, and significantly decreased on a per student basis.

Changes in electricity tariffs during the three years also affected the results, in some cases decoupling consumption from costs. For example, in 2016, electricity prices for Synergy customers increased by approximately 15 per cent. Most of the schools participating in the program were customers of Synergy. To further complicate the issue, some schools changed their pricing tariff, which benefitted some schools, while disadvantaging others. As a result, significant differences were observed when comparing electricity consumption and costs over the years, as shown in Figure 25.

6.4.2. Gas

One school did not have a gas connection. Figure 26 shows the size of the school and its consumption of gas in 2015. As can be seen, there were considerable differences between the schools, demonstrating no clear correlation between gas consumption and size of the school.

This is likely due to schools having very different heating and cooling infrastructure. For example, while some schools used electricity for heating - often reverse cycle air conditioning systems, others used gas for heating, dramatically increasing their gas use. Furthermore, one school (SS3), which had gas heating realised that their gas pilot lights were lit much earlier than necessary, leading to a considerable amount of gas being used unnecessarily.

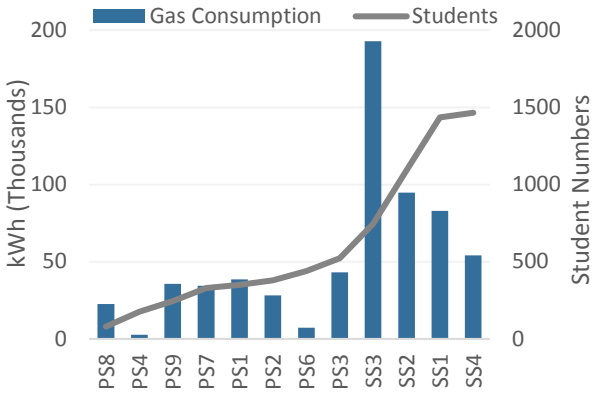


Figure 26: Gas consumption (kWh) and student numbers for all schools for their baseline year (2015)

As discussed in 4.1.2, 2016 was also an uncharacteristically cold year for the Perth region, and therefore, gas consumption was significantly higher than the base year (2015). The gas consumption and costs were therefore normalised using the Heating Degree Day (HDD) method to give a more accurate understanding of each schools' gas consumption. Figure 27 shows that, once the data is normalised, most schools reduced both their consumption and costs during the program, though there were still some anomalies, which might be to do with changes in gas tariff or provider.

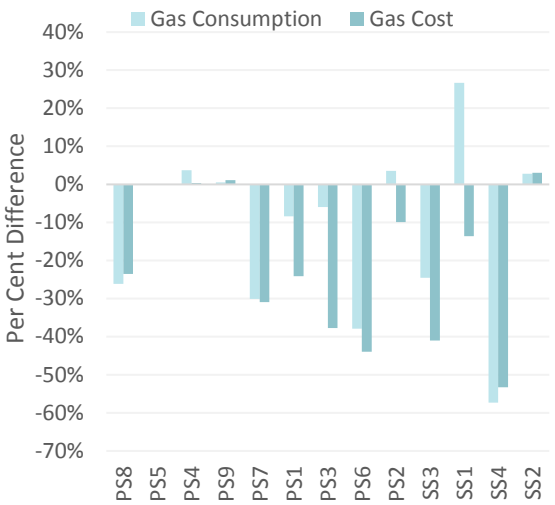


Figure 27: Gas consumption (kWh) and cost ($) percentage difference between 2015 and 2017

6.4.3. Water

Figure 28 shows the size of each school and their consumption of water in 2015. Again, there are some significant anomalies. For example, PS9 had significantly higher water usage in 2015, which was due to a water leak that was subsequently discovered and fixed. PS2 and PS3 both had higher consumption than PS6 and SS3 respectively, who both had higher student numbers than their counterpart.

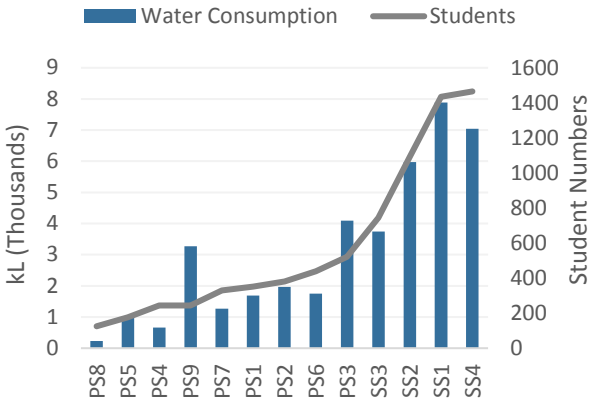


Figure 28: Water consumption (KL) and student numbers for all schools for their baseline year (2015).

Overall, as shown in Figure 29, six schools decreased their water consumption during the program. One school significantly increased their water usage between 2016 and 2017, which was partly attributed to pipeline works in the school's neighbourhood.

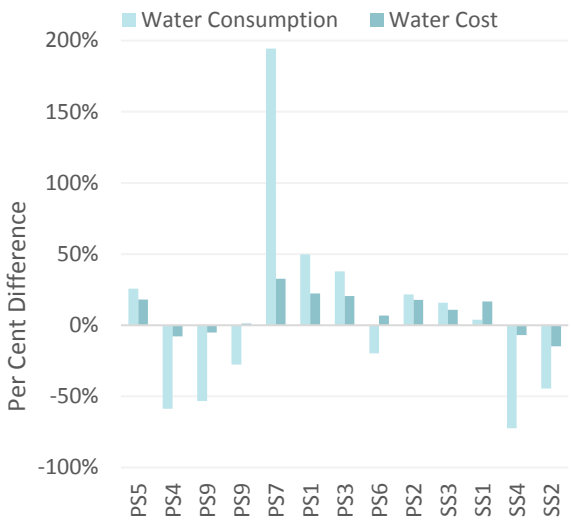


Figure 29: Water consumption (kL) and cost ($) percentage difference between 2015 and 2017

Several water leaks were identified during the program. However, frustratingly for schools, this was often only detected after the bill was received. Several schools argued that such a delayed, 'reactive' approach was unhelpful and unfair for schools. One school also identified that they were being overcharged on their water bills for an incorrect number of fixtures (discussed in 5.4.3), which, when rectified, reduced costs but not consumption.

6.4.4. Total Carbon Emissions and Costs

Figure 30 shows the total carbon emissions, as well as the student numbers for each school, for the base year (2015). It is interesting to note that some smaller schools (i.e. PS7) had a larger carbon footprint than larger schools (PS1) (Figure 30).

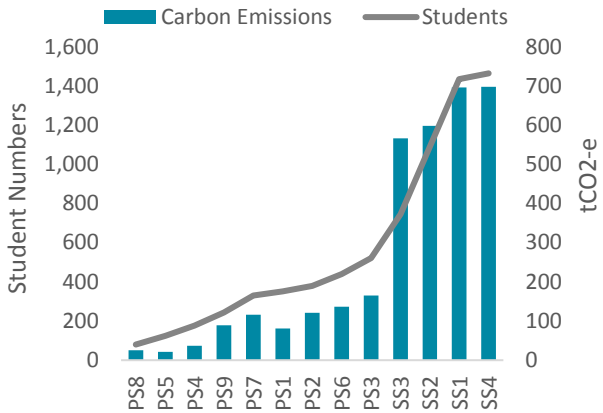


Figure 30: Student numbers and carbon emissions for all schools for 2015.

Other schools, who had a similar carbon footprint, had significantly different costs (i.e. SS1 and SS4) as shown in Figure 31. However, this no longer appears unusual, given the differences between carbon emissions (Figure 14) and costs (Figure 17) for each of the utility areas. That is, a school might consume slightly more energy (higher carbon emissions) than another school, though significantly less water (very little carbon emissions but a reasonable cost), creating the discrepancy between carbon and costs.

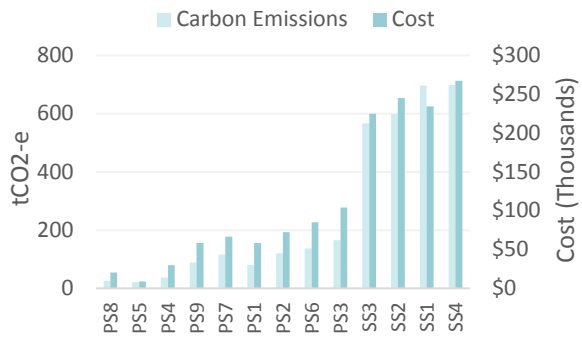


Figure 31: Carbon emissions and costs (2015)

Nevertheless, becoming aware of these variations motivated and encouraged the schools to further investigate their bills for each of the utility areas.

7. Discussion

7.1. Insights, challenges and lessons learned

7.1.1. Interpreting results

As demonstrated by the results and analysis, many factors contribute to and affect the consumption, costs and carbon emissions associated with resource use in schools. Despite having a structured program designed to specifically assist in reducing emissions, there were various external influences that affected results such as increasing student numbers or changes in electricity tariffs.

Examining the total combined utility results - while useful in highlighting some general patterns and variations between schools, does not give an accurate comparison between schools since the three utility areas are so different in terms of their costs and carbon emissions. Therefore, changes in any one of them can provide misleading results when comparing overall data. For example, because carbon emissions associated with electricity are more emission intensive than emissions associated with water, a slight decrease in electricity consumption may completely dwarf a significant increase in water consumption (i.e. a leak) in terms of overall carbon emissions.

Furthermore, emission factors for each utility area (electricity, gas, water and waste) can also change year to year, depending on the amount of renewable energy in the grid (electricity), the amount of potable water produced by desalination processes (water), or changes to waste emission factors (NGERS). This can lead to changes in carbon emissions, despite no change in consumption.

Comparing emission and cost data together can also provide intriguing results, which are not necessarily correlated. For example, some schools experienced issues with their water meters (i.e. malfunctioning) during the program, which led to consumption data not being recorded. However, costs were still billed based on historical data, creating an incomplete and thus, inaccurate data set.

This report does not attempt to highlight all the factors or drivers contributing to the changes identified in the data. While more detail on this will be provided in the PhD student's thesis, the results have nonetheless demonstrated the importance of measuring and monitoring school resource use to begin to understand these variations and begin to investigate anomalies.

7.1.2. Obtaining and entering data from schools

As mentioned in section 4.1, a number of schools had issues collating their utility bills and entering it into the excel spreadsheet. Despite being encouraged to place a copy of each utility bill in a separate 'Low Carbon Schools' folder to ensure the relevant person had access the bills to enter the data into the excel spreadsheet, few schools managed to do this consistently. Many schools missed monthly bills due to inadequate record keeping. This became a significant challenge when the PhD student attempted to gather all the bills from each school at the end of the program to verify the data. Moving forward, the data management process in schools (i.e. collecting and filing their utility data) needs to be improved. This could be changed to storing an electronic copy of the bills in a special program folder in the cloud or within an App. Other options could involve aligning the financial account systems to carbon accounting systems or collecting data through smart metering.

Incorrect data entry was another challenge faced by the LCSPP team. Several spreadsheets had small data errors (i.e. missing whole bills to forgetting a zero in the data input). In the future, changing from excel format to an online system for data entry could help to minimise mistakes being made, by creating algorithms to highlight unusual data entry and/or alert people to missing bills. It would also help to address issues around version control, preventing various (outdated and/or incorrect) versions of the template being used.

7.1.3. Sharing between schools

Several schools commented on how beneficial the industry presentations and workshops were, however, one of the most discussed and appreciated aspects of the program was the ability to visit other schools and sharing experiences and learning from each other.

7.1.4. Financial and policy barriers

There was a range of challenges schools faced when trying to implement various actions. For example, despite nearly all schools being interested in installing solar, only two schools had the upfront funds to pay for them. Solar Power Purchase Agreements (PPA's) were quickly identified and discussed from the outset of the LCSPP as an ideal opportunity for schools without cash on hand. However, it became apparent early on that these were not allowable by the WA Education Department, primarily due to accounting rules (i.e. the PPA was considered a long-term debt). The WA Department of Education (DoE) also had issues around third-party financing. Representatives at DoE suggested that they schools be provided with a pool of funding (i.e. $1 million) from, i.e. the State or Federal Government, which could then be used as an internal, revolving energy fund within the DoE, to fund solar for schools. For example, individual schools could apply for a loan through the fund, and pay DoE back through their savings.

Another issue that was identified and solved during the LCSPP was around policy processes for installing solar. At the beginning of the LCSPP in January 2016, there was no formal process for schools to follow to implement solar. As a result, there had been several problematic installations that were led by proactive school Principals, which were ultimately removed from schools as they did not meet Australian standards. After the LCSPP team approached the DoE and highlighted the need for an official process due to the interest of the 15 participating schools, a policy protocol was created and trialled with two schools within our LCSPP.

Similar issues existed with implementing LED lights. Some suppliers had provided a misleading return on investment calculation, which DoE had subsequently rejected. It is likely that a similar policy process will be created to guide schools through this process in the near future.

7.1.5. Gaining Research Ethics Approval for Government Education Departments

In addition to the ethics approval required by the university (Curtin), the Department of Education (DoE) also required a formal research project ethics application. This process turned out to be far longer than anticipated and put serious strain on the timeline for the data collection and analysis. Further restrictions were placed on the analysis of the results, which prevented the PhD student from publishing any journal articles within the allocated timeframe. Future research in this area should consider these potential delays in approval in their research timeline.

7.2. LCSPP Evaluation – Logic Model

As mentioned, to track and evaluate the success of the LCSPP in achieving its aims, a logic model was developed for the program (see Appendix 5). The immediate and medium-term outcomes were measured using the results of two surveys administered to each school's low carbon committee, as well as the carbon emissions data collected.

One of the key aims of the LCSPP was to educate and empower schools to reduce their carbon emissions. Over 78 per cent of school stakeholders said they learned a lot or a great deal about how to reduce school carbon emissions, and 84 per cent said they had an increased understanding of school resource use. Seventy-three per cent of school stakeholders also said they experienced changes in their low carbon living attitude or behaviour because of their school's participation in the LCSPP. Examples of the ways that participants felt they changed included becoming more motivated to reduce carbon emissions in their personal lives, as well as more aware of how to address carbon emissions, and becoming aware of the importance of a strong leader to help lead low carbon initiatives.

Another major aim of the program was the facilitation of shared experiences and a sense of community between participating schools. All schools said their school shared advice or experiences with other schools in the LCSPP with 42 per cent saying this took place at the monthly school meet-ups and 29 per cent saying it took place at the workshops. The vast majority of school stakeholders (90 per cent) also agreed that sharing experiences and forming relationships with other schools is important because it allows for sharing of ideas and solutions (38 per cent) and enables conversations with like-minded people (37 per cent). Just over 15 per cent said they were in contact with other schools outside of the workshops and meetups.

The program also succeeded in encouraging schools to create new partnerships with businesses and organisations with over half of the schools (62 per cent) saying these partnerships were created because of the LCSPP. Examples provided included partnerships with their local government, the company that provided electricity audits, local plumbers and other schools participating in the LCSPP. Twenty-three per cent of school participants said they learned a lot about the partnership, 26 per cent received valuable help or expertise from partners, 26 per cent suggested that partners enabled them to provide additional learning opportunities for the students, and 21 per cent thought the partnerships opened the door for other opportunities for the school.

In addition to engaging the external community, there was also a focus on engaging the internal school community, particularly the students. Eighty per cent of schools said they actively engaged their students in the carbon reduction process. Most schools involved their students with the tree planting activity organised by a parent at a participating school. One school started a new student low carbon group, and several schools involved students through waste audits, water conservation and electricity consumption activities. Despite most schools engaging students in some way, over 80 per cent thought there was scope to include students more in the carbon reduction process. Low carbon living knowledge from the program also filtered through to the parents of students. When the parents of all schools were surveyed, nearly half of the parents (47 per cent) said their child discussed low carbon living topics with them, and 38 per cent per cent of parents said they noticed a change in their child's attitude or behaviour around low carbon living with 67 per cent of them attributing their child's change in attitude/behaviour to the school (e.g. classroom, excursions or activities).

Outcome	Evidence
A sense of community for sustainability within schools	• The creation of a low carbon committee within each school as required by the LCSPP
Shared knowledge, strategies and experiences between schools	• 72 per cent of school stakeholders said they have learned from the experiences of other schools implementing low carbon initiatives • 88 per cent said they learned something from other schools • 72 per cent said they thought sharing knowledge between schools was extremely or very useful
Community of practice connecting stakeholders from all schools	• 100 per cent of school stakeholders said their school shared advice or experiences with other schools in the LCSPP

Committee members have the knowledge and skills to reduce CO_2-e	• 84 per cent of school stakeholders said they have increased knowledge about how to reduce school carbon reduction through their participation in the LCSPP
Increased stakeholders' understanding of school resources use & utility costs and how they compare	• 84 per cent of school stakeholders said they have an increased understanding of school resource use • 54 per cent of school stakeholders thought knowing how their school compared to other schools was extremely or very valuable
Twenty per cent reduction in CO_2-e and/or utility costs	• Overall all 13 schools reduced their carbon emissions per student by 20 per cent
Information sharing & knowledge influence with members of the broader community	• 60 per cent of schools formed new partnerships with businesses or community organisations because of the LCSPP • 53 per cent said that their partnerships contributed a lot to the success of their school's low carbon initiatives • 50 per cent of parents said they were aware of the low carbon initiatives taking place at their child's school
Increased student knowledge and/or action for CO_2-e reduction	• 80 per cent of schools said they actively engaged their students in the carbon reduction process
Students influencing parent behaviour on CO_2-e reduction	• 47 per cent of parents reported that their child spoke with them about climate change or carbon reduction topics in the last 12 months • 38 per cent per cent of parents said they noticed a change in their child's attitude or behaviour around low carbon living • 67 per cent of parents attributed their child's change in behaviour to the school (e.g. classroom, excursions or activities)

7.3. Limitations

Given the limited time of the school staff and the limited resources of the LCSPP, only electricity, gas and water usage, cost and GHG emissions were calculated. This, therefore, does not provide a complete picture of each school's total carbon footprint, as it omits the other important areas usually required in carbon accounting, such as waste, transport and procurement.

The inability to obtain accurate school square metre data and more detailed information about the building features of each school also limited the level of analysis that could take place.

Finally, it should be acknowledged that due to the small number of participating schools, as well as the limited number of surveys, workshops and interview participants, it is hard to draw any significant conclusions or correlations with the data.

7.4. Next Steps: ClimateClever Program

Using the findings and insights gained through the LCSPP, an innovative, new online program - 'The ClimateClever Initiative' - was designed, developed and launched nationally in January 2018.

The new program is underpinned by innovative, data-driven software that enables schools to calculate, track and compare their carbon footprint, audit their buildings and create personalised, evidence-based, online actions plans that are interactive and can be student-led. Feedback from LCSPP participants suggested the need for greater student involvement, so the new program also provides learning resources to ensure the activities can be embedded into the curriculum and classroom. The Web App is designed to be very 'user-friendly' and simple enough to be led by students.

The program enables participating schools to celebrate and share their achievements with a growing community of schools to motivate and inspire action on climate change and to create a sense of collaboration and joint commitment to achieve a common goal.

The new program charges a fee of $8/student/year but is capped at $6,500 for large schools. This fee was determined based on the financial savings identified in this pilot. The rationale is that schools who actively partcipate are likely to save more than double the fee for the program (or up to four times more for 70% of cases). These findings have helped to create a financially sustainable business model for the ongoing delivery of the program, meaning it does not need to reply on research or other grants.

In 2019, a ClimateClever 'Home' App will be released to facilitate intergeneration change and community impact. The 'Home' App will enable students and staff from participating schools to calculate and reduce their own household emissions and cost of living. The de-identified data will be linked to the school, so schools can measure – quantitatively for the first time – what impact they are having on their local community in terms of carbon emissions reduction. For more information, see https://climateclever.org/.

8. Conclusion & Recommendations

This research examined the delivery and outcomes of a two-year Low Carbon Schools Pilot Program in Perth, Western Australia.

Overall, the program saved a total of 266 tonnes of carbon emissions across the 13 schools over a three year period (the base year compared to the final year of the program). While 10 of the 13 schools reduced their *total* carbon emissions, *all* 13 schools reduced their emissions on a per student basis by an average of 20 per cent.

Furthermore, due to a community-led tree planting program delivered in the second year of the program, the total carbon emissions of all 13 schools for the base year of the program (3,352tCO_2-e) were completely offset, enabling all schools to become carbon neutral.

While *total* costs increased during the program, each school reduced their *per student* cost by an average of $16. Seventy per cent of schools saved, on average, $31 per student.

The primary reason for the overall increase in costs was due to growing student numbers, which rose by an average across all schools of 15 per cent, leading to new buildings being constructed in some schools, thereby increasing consumption. Fluctuating student numbers, along with a variety of other external influences, made it complicated to compare and analyse results or draw definitive conclusions. Despite this, simply having access to the utility data in graphical format encouraged conversations to occur between schools, as well as motivating them to implement actions.

The per student financial savings, together with the fact that more than 70% of the 625 identified actions were considered low (under $150) or no cost, demonstrates the significant potential for schools to reduce emissions on a cost neutral (or positive) basis. This supports ASBEC's (2018) report that identified the education sector as offering some of the most cost-effective, carbon abatement opportunities within the built environment.

Considering the pivotal role schools play within society, the project also highlighted the opportunity that school-based carbon reduction programs have to influence community awareness, knowledge and action on climate change and decarbonisation, through kids taking their knowledge home and influencing their parents and wider families. Further research on this will be available through Portia Odell's PhD research, available in 2020.

Not only has this important research helped to inform the next stage of the program – The ClimateClever Initiative – but the financial savings identified provided an opportunity to create a sustainable business model to ensure the longevity of the program into the future.

9. References

Australian Sustainable Built Environment Council (ASBEC). (2018). *Built to Perform: An industry-led pathway to a zero carbon ready building code*. ClimateWorks. Melbourne.

Bureau of Meteorology. (n.d.) Annual and monthly heating and cooling degree days. Available at:

http://www.bom.gov.au/climate/map/heating-cooling-degree-days/documentation.shtml. Accessed 18 June 2019.

Bureau of Meteorology. (2018). Weather station directory. Available at: http://www.bom.gov.au/climate/data/stations/. Accessed 19 April 2019.

Council of Australian Governments [COAG]. (2012). The Green Lease Handbook. National Strategy on Energy Efficiency. Retrieved from https://www.energy.gov.au/sites/default/files/green-lease-handbook-2012.pdf. Accessed 18 June 2019.

Eto, J. H. (1988). On Using Degree-days to Account for the Effects of Weather on Annual Energy Use in Office Buildings. *Energy and Buildings*, 12, 113–127.

Brien, L. V. O., Meis, J., Anderson, R. C., Rizio, S. M., Ambrose, M., Bruce, G., … Kashima, Y. (2018). Low Carbon Readiness Index : A short measure to predict private low carbon behaviour. *Journal of Environmental Psychology*, 57(July 2017), 34–44.

Psiloglou, B. E., Giannakopoulos, C., Majithia, S., & Petrakis, M. (2009). Factors affecting electricity demand in Athens, Greece and London, UK: A comparative assessment. *Energy*, 34(11), 1855–1863.

Rauland, V. Caruso, C., Perry, B., Kashima, Y. (2018). *Low Carbon High-Performance Schools: National survey results on attitudes toward the role of the built environment and sustainability on learning outcomes*. CRC for Low Carbon Living. Available at: http://www.lowcarbonlivingcrc.com.au/resources/crc-publications/peer-reviewed-research-publications/rp3020u1-national-survey-results. Accessed 18 June 2019.

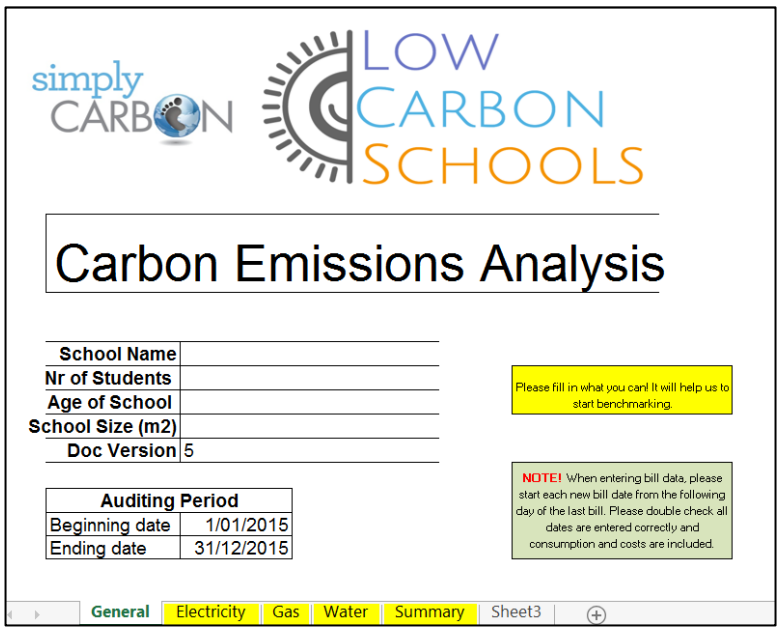
Rauland Rauland, V., Odell, P., Hall, S., Newman, P., & Lewis, A. (2014). *RP3020: Carbon Tools and Frameworks for Institutional Precincts. Stage 1: Low Carbon, High-Performance Schools. Scoping Study.* CRC for Low Carbon Living. Available at: http://www.lowcarbonlivingcrc.com.au/sites/all/files/publications_file_attachments/rp3020_low_carbon_high_performance_schools_report.pdf. Accessed 18 June 2019.

Rauland, V. and Newman, P. (2015). *Decarbonising Cities: Mainstreaming Low Carbon Urban Development*. Switzerland: Springer.

Appendix 1 - Summary of Participant Requirements

1.	A signed letter from the school principal indicating their support for the school's participation
2.	A commitment to participate for the entirety of the two-year program
3.	A commitment to pursue retrofit opportunities and measures that have a realistic payback period
4.	Establishment of a school sustainability committee consisting of at least three people – principal, deputy principal or registrar/business manager, a teacher and a P&C member. Secondary schools are also encouraged to include one or more student representatives
5.	Commitment to at least one person from the committee in attendance at each workshop
6.	Provide SimplyCarbon with access to the relevant records and utility bills
7.	Commitment to actively participate in the program and share learnings with other participants
8.	Completion of annual surveys to determine past and current sustainability initiatives at the school
9.	Participation in an evaluation of the program at the conclusion

Appendix 2 - Carbon Calculation Template



simply CARBON

LOW CARBON SCHOOLS

Carbon Emissions Analysis

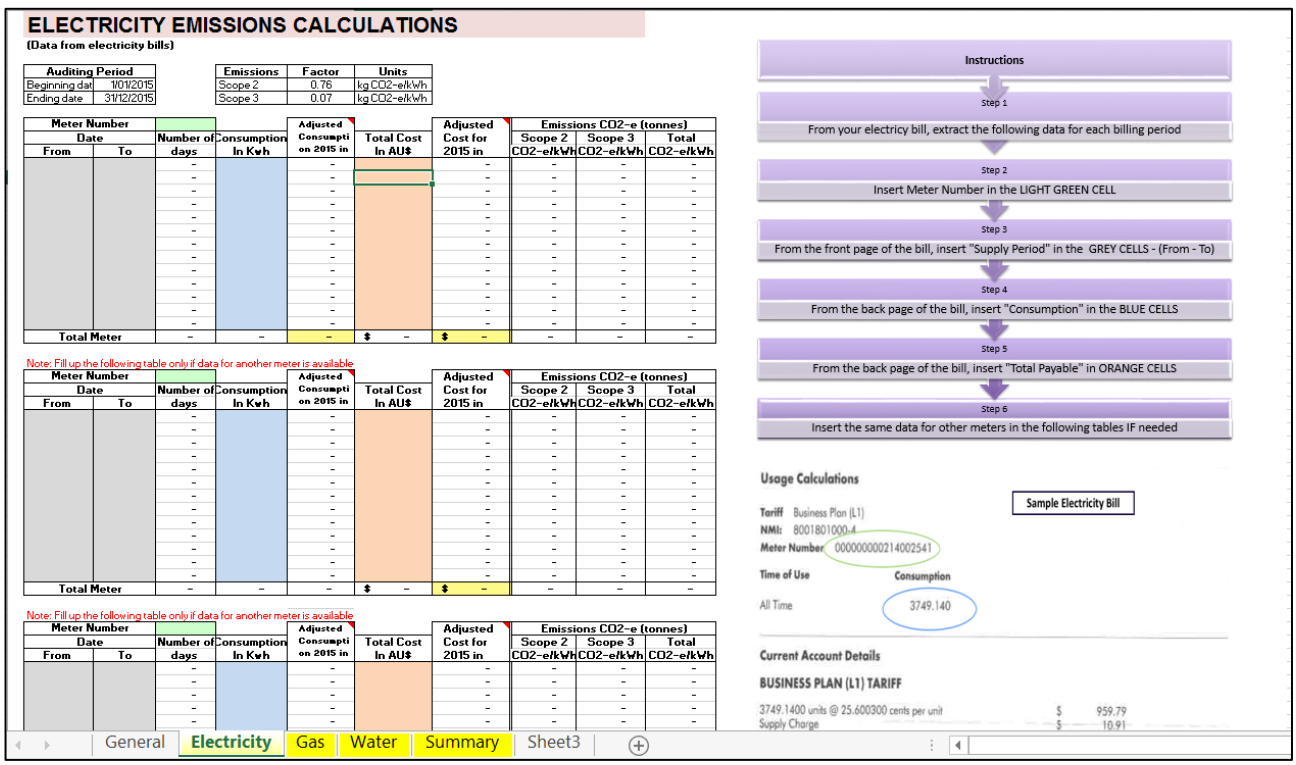
School Name	
Nr of Students	
Age of School	
School Size (m2)	
Doc Version	5

Please fill in what you can! It will help us to start benchmarking.

NOTE! When entering bill data, please start each new bill date from the following day of the last bill. Please double check all dates are entered correctly and consumption and costs are included.

Auditing Period	
Beginning date	1/01/2015
Ending date	31/12/2015

General | Electricity | Gas | Water | Summary | Sheet3



ELECTRICITY EMISSIONS CALCULATIONS

(Data from electricity bills)

Auditing Period	
Beginning dat	1/01/2015
Ending date	31/12/2015

Emissions	Factor	Units
Scope 2	0.76	kg CO2-e/kWh
Scope 3	0.07	kg CO2-e/kWh

Meter Number				Adjusted Consumption on 2015 in		Adjusted Cost for 2015 in	Emissions CO2-e (tonnes)		
Date		Number of days	Consumption In Kwh		Total Cost In AU$		Scope 2 CO2-e/kWh	Scope 3 CO2-e/kWh	Total CO2-e/kWh
From	To								
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
Total Meter		-	-	-	$ -	$ -	-	-	-

Note: Fill up the following table only if data for another meter is available

Meter Number				Adjusted Consumption on 2015 in		Adjusted Cost for 2015 in	Emissions CO2-e (tonnes)		
Date		Number of days	Consumption In Kwh		Total Cost In AU$		Scope 2 CO2-e/kWh	Scope 3 CO2-e/kWh	Total CO2-e/kWh
From	To								
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
Total Meter		-	-	-	$ -	$ -	-	-	-

Note: Fill up the following table only if data for another meter is available

Meter Number				Adjusted Consumption on 2015 in		Adjusted Cost for 2015 in	Emissions CO2-e (tonnes)		
Date		Number of days	Consumption In Kwh		Total Cost In AU$		Scope 2 CO2-e/kWh	Scope 3 CO2-e/kWh	Total CO2-e/kWh
From	To								
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-
		-		-		-	-	-	-

Instructions

Step 1: From your electricy bill, extract the following data for each billing period

Step 2: Insert Meter Number in the LIGHT GREEN CELL

Step 3: From the front page of the bill, insert "Supply Period" in the GREY CELLS - (From - To)

Step 4: From the back page of the bill, insert "Consumption" in the BLUE CELLS

Step 5: From the back page of the bill, insert "Total Payable" in ORANGE CELLS

Step 6: Insert the same data for other meters in the following tables IF needed

Usage Calculations

Sample Electricity Bill

Tariff Business Plan (L1)
NMI: 8001801000-4
Meter Number 000000000214002541

Time of Use	Consumption
All Time	3749.140

Current Account Details

BUSINESS PLAN (L1) TARIFF

3749.1400 units @ 25.600300 cents per unit	$	959.79
Supply Charge	$	10.91

General | Electricity | Gas | Water | Summary | Sheet3

NATURAL GAS EMISSIONS CALCULATIONS

(Data from gas bills)

Auditing Period	
Beginning date	1/01/2015
Ending date	31/12/2015

Emissions	Factor	Units
Scope 1	51.33	kg CO2-e/GJ
Scope 3	4.00	kg CO2-e/GJ

Meter Number				Adjusted Consumption on 2015 in		Total Cost In AU$	Adjusted Cost for 2015 in	Convertion to GJ	Emissions CO2-e (tonnes)		
Date		Number of days	Energy Units Used (kWh)						Scope 1 CO2-e/kWh	Scope 3 CO2-e/kWh	Total CO2-e/kWh
From	To										
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
Total Meter		-	-	-		$ -	$ -	-	-	-	-

Note: Fill up the following table only if data for another meter is available

Meter Number				Adjusted Consumption on 2015 in		Total Cost In AU$	Adjusted Cost for 2015 in	Convertion to GJ	Emissions CO2-e (tonnes)		
Date		Number of days	Energy Units Used (kWh)						Scope 1 CO2-e/kWh	Scope 3 CO2-e/kWh	Total CO2-e/kWh
From	To										
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
		-		-			-	-	-	-	-
Total Meter		-	-	-		$ -	$ -	-	-	-	-

Note: Fill up the following table only if data for another meter is available

Meter Number				Adjusted Consumption on 2015 in		Total Cost In AU$	Adjusted Cost for 2015 in	Convertion to GJ	Emissions CO2-e (tonnes)		
Date		Number of days	Energy Units Used (kWh)						Scope 1 CO2-e/kWh	Scope 3 CO2-e/kWh	Total CO2-e/kWh
From	To										
		-		-			-	-	-	-	-

Instructions

Step 1
From your gas bill, extract the followind data for each billing period

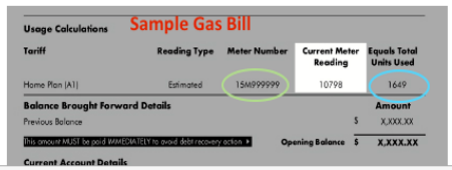
Step 2
Insert Meter Number in the LIGHT GREEN CELL

Step 3
From the front page of the bill, insert "Supply Period" in the GREY CELLS - (From - To)

Step 4
From the back page of the bill, insert "Consumption" in the BLUE CELLS

Step 5
From the back page of the bill, insert "Total Payable" in ORANGE CELLS

Step 6
Insert the same data for other meters in the following tables IF needed



General | Electricity | Gas | Water | Summary | Sheet3

WATER EMISSIONS CALCULATIONS

(Data from electricity bills)

Auditing Period	
Beginning da	1/01/2015
Ending date	31/12/2015

Number of Fixtures

Emissions	Factor	Units	
Scope 3	0.78	kg CO2-e/GJ	
Discharge Facto	15%		
Electricity per unit of water	1.5	MWh/ML	Reticulated Water
Electricity per unit of water	0.8	MWh/ML	Waste Water

Meter Number				Adjusted Consumption on 2015 in KL		Total Cost In AU$	Adjusted Cost for 2015 in	Sewer Volume (kL)	Discharge Volume (kL)	Reticul Water Emissions CO2-e/kWh	Waste Water Emissions CO2-e/kWh	Total Emissions CO2-
Date		Number of days	Water Units Used (kL)									
From	To											
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
Total Meter		-	-	-		$ -	$ -	-	-	-	-	-

Note: Fill up the following table only if data for another meter is available

Meter Number				Adjusted Consumption on 2015 in KL		Total Cost In AU$	Adjusted Cost for 2015 in	Sewer Volume (kL)	Discharge Volume (kL)	Reticul Water Emissions CO2-e/kWh	Waste Water Emissions CO2-e/kWh	Total Emissions CO2-
Date		Number of days	Water Units Used (kL)									
From	To											
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-
		-		-			-		-	-	-	-

Instructions

Step 1
From your water bill, extract the followind data for each billing period

Step 2
Fill in the number of Fixtures on your bill in the LIGHT PURPLE CELL

Step 3
Insert Meter Number in the LIGHT GREEN CELL

Step 4
From the front page of the bill, insert "Supply Period" in the GREY CELLS - (From - To)

Step 5
From the back page of the bill, insert "Water Used" in the BLUE CELLS

Step 6
From the back page of the bill, insert "Total Payable" in ORANGE CELLS

Step 7
From the back page of the bill, insert "Sewerage Volume" in YELLOW CELLS

Step 8
Insert the same data for other meters in the following tables IF needed

General | Electricity | Gas | Water | Summary | Sheet3

GREENHOUSE GAS EMISSIONS INVENTORY

EMISSIONS SOURCE	Consumption Units	Consumption	CO_2-e tonnes	Proportion % Total Inventory
Direct Emissions (Scope 1)				
Purchased natural gas for water heating	GJ	-	0.00	0.00%
Total Scope 1 Emissions			**0.00**	**0.00%**
Indirect Emissions (Scope 2)				
Purchased electricity	kWh	-	0.00	0.00%
Total Scope 2 Emissions			**0.00**	**0.00%**
Optional Emissions (Scope 3)				
T&D line losses for purchased electricity	kWh	-	0.00	0.00%
Reticulated water supply	kL	-	0.00	0.00%
Wastewater emissions	kL	-	0.00	0.00%
T&D line losses for all purchased natural gas	GJ	-	0.00	0.00%
Total Scope 3 Emissions			**0.00**	**0.00%**
Total Scope 1+2 Emissions			**0.00**	**tonnes CO_2-e**
Total Scope 1+2+3 Emissions			**0.00**	**tonnes CO_2-e**

This GHG inventory has been developed according to the GHG Protocol and following the Operational Control Approach

General | Electricity | Gas | Water | Summary | Sheet3

Appendix 3 – Carbon Emissions Reduction Action Plan

2016 Carbon Reduction Action Plan

School Name	
Address	
Age of School	
Number of Students	
Low Carbon Committee Members	
Carbon Reduction Target	
Total Nr of Planned Actions	
Total Nr of Actions Completed	
Total Nr of Trees to be Planted	
Carbon Offet Plan	

ENERGY ACTIONS

	Action Item	Description	Approximate Cost	Who	Due date	Status
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

ALREADY IMPLEMENTED (pre 2016)

	Action Item	Description	Approximate Cost	When	Case of Implementati...
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

THINGS THAT DIDN'T WORK

	Action Item	Why it didn't work	Approximate Cost
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

*The Water and Waste Tabs were identical to the Energy sheets above.

PURCHASED OFFETS

Offset Company	Type of Offset	Number of offsets bought	Price per tonne	Total Price	Notes

CARBON SEQUESTERED THROUGH TREE PLANTING

Date	Number of Students involved	Year Level	Number of trees planted	Type of trees	Carbon sequestered

Appendix 4 – Low Carbon Policy Template

[School] Carbon Reduction Policy

Policy statement

[School] is committed to reducing carbon emissions through the responsible management of electricity, gas, water, and waste.

We commit to:

Targets

- Reducing our consumption emissions from electricity, gas, water and waste from a 2015 baseline by 20% by Dec 2018.

Measuring, monitoring and reporting

- Measuring and monitoring our electricity, gas, water and waste annually,
- Monitoring the success of initiatives that are being implemented in our school to reduce consumption in energy, water and waste;
- Reporting our performance to our community to demonstrate our commitment and inspire others (i.e. in Annual Report and/or on Website);

Consumption

- Continually seeking opportunities to reducing energy and water consumption and waste minimisation through technical initiatives and behaviour change;
- Pursuing all technical energy, water and waste reduction retrofits and upgrade initiatives/opportunities with a payback less than a year (at minimum), as well as considering initiatives with longer term paybacks;
- Conducting energy, water and waste audits (this includes student-led audits) every ..... to identify wastage and other areas that we can improve;

Renewable Energy

- Continually seeking cost-effective opportunities to produce and/or purchase renewable energy at our school;

Low Carbon/Sustainability Fund

- Creating a revolving sustainability fund, where (INSERT) % of utility savings are reinvested to support further carbon reduction measures in our school;

Procurement

- Procuring appliances (white goods and office equipment) that have the highest energy/water efficiency rating;
- When retrofitting, ensuring that we choose the most environmentally friendly alternative available;
- Where possible, choosing products which have a positive environmental and/or social co-benefit;

Curriculum

- Supporting teaching and learning in the curriculum that emphasises the reduction of resource consumption and the benefits of renewable energy;

Awareness

- Increasing awareness within the school around our carbon reduction commitments by adopting a whole of school approach to reducing emissions. This involves creating awareness-raising initiatives that are run by, and target both, staff and students;
- Increasing awareness about carbon reduction in our community through various initiatives run by students, staff and our P&C members;

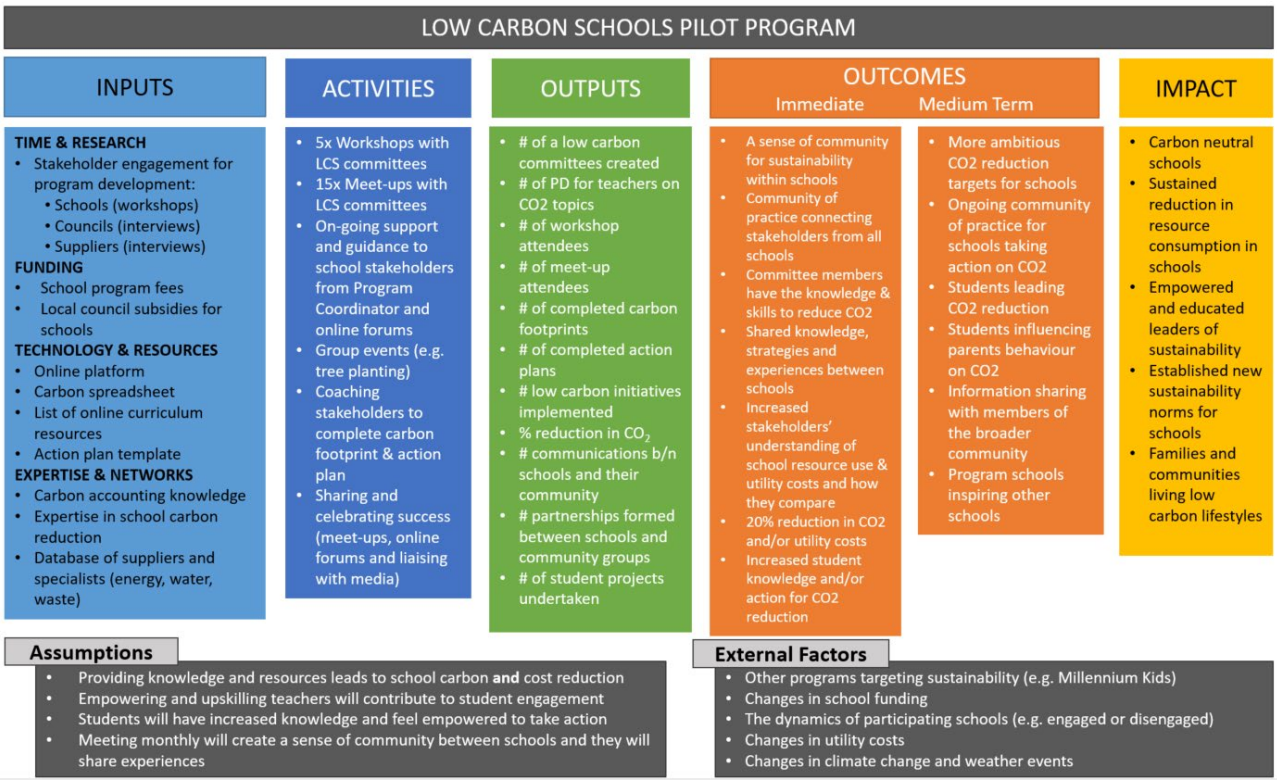
Action Plan

- Creating a Low Carbon Schools Action Plan with identified actions to implement over a 12 month period
- Update plan on an annual basis

Policy and Target Review

- Reviewing and updating our targets and this Policy (bi-) annually to ensure continual improvement.

Appendix 5 – Low Carbon Schools Pilot Program (LCSSP) Logic Model



Appendix 6 – Additional PhD Data Collection

Type of Data Collection	Who	Aim
In-Person Interviews	**Case Study Schools (x4)** • Principal • 2x Committee Members	To understand each school's carbon reduction journey in more depth
Online Survey	Low Carbon Committee members at the participating schools	To determine: • types of partnerships formed & experiences • new initiatives • if the LCSPP has influenced knowledge • role of committee & meet-ups – what worked, what didn't • key success factors and elements of failure
Online survey	Parents of participating schools	To determine if knowledge has been passed on and/or if they have actioned any initiatives in their own homes
In-person Focus Group	**Case Study Schools (x4)** • Students participating in the student green team	To understand student perceptions about school carbon reduction and if/how students influence their household's low carbon living attitudes or behaviour.
File sharing via the online platform	Participating schools (x13)	• Carbon excel data (usage and cost for electricity, water and gas) • Action plans – to track initiatives implemented and success • Policy plans – to track carbon reduction commitments