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Measuring and Improving Sustainable Resource Management at Byron Region Community College

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Environmental Studies

Mullumbimby, New South Wales, Australia

Submitted in partial fulfillment of the requirements for Australia: Sustainability and Environmental
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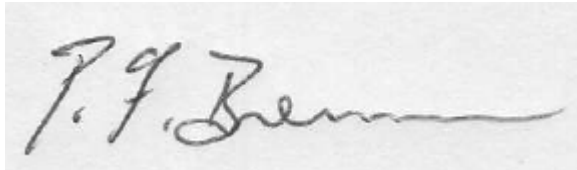
ISP Ethics Review

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Academic Director: Peter Brennan

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A handwritten signature in cursive script, appearing to read 'P. Brennan', written in black ink on a light-colored background.

Program: Australia: Sustainability and Environmental Action

Date: 2012

Abstract

The purpose of this study is to measure and report on progress made by Byron Region community College in relation to sustainable resource management as well as to observe, identify, and address and areas for improvement by developing recommendations in the categories of energy, waste and water. The college is dedicated in its vision to promote sustainability out of a sense of responsibility to the environment and future generations as well as a desire to train and prepare people for addressing 21st century problems such as climate change, drought, and peak oil. Energy, waste, and water make up a significant portion of how an institution interacts with the natural environment, and maximizing efficiency with these resources is paramount to achieving and promoting sustainability.

I assessed energy, waste, and water practices using information I gathered from a multitude of sources. I conducted an energy audit by observing energy use behaviors, measuring the electricity consumption of various devices, gathering data on solar energy production, interviewing staff, and assessing electricity bills from the local utility company. Information on waste management was gathered by sorting through and conducting weight comparisons on rubbish, recycling, and organic material as well as through observation and interviews with staff. Water use management was assessed by observing the behaviors and infrastructure of the campus and interviewing staff members while also using bills from the local water utility to estimate per person daily water use. I then developed recommendations based on the observations and information collected during the study and valued them based on their likely impact, cost, and feasibility.

In many ways, Byron Region Community College is doing an excellent job of managing energy, waste, and water efficiently. I determined that the Mullumbimby campus is a yearly net exporter of over 5 MWH of renewable electricity to the grid and consumes an estimated daily average of 8.7 L of water per person, which is considered efficient. All of the necessary mechanisms for proper waste management are in place but a significant portion of the landfill rubbish each week is improperly sorted recyclable or compostable material. While the college is doing extremely well in the three areas of energy, waste, and water, there are opportunities for continual improvement.

ISP Topics Codes

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Energy, waste, water, auditing, community college

Contents

Abstract	iii
List of Figures, Table and Abbreviations	vi
List of Abbreviations	vi
Acknowledgments.....	vii
Introduction.....	1
About Byron Region Community College	1
Sustainability at BRCC.....	1
Components of Sustainability: Energy Management	3
Components of Sustainability: Waste Management	4
Components of Sustainability: Water Management	5
Methods.....	6
Energy	6
Energy Audits	6
Determining Net Energy Use.....	7
Waste.....	8
Waste Audits.....	8
Water.....	9
Assessing Water Use Practices	9
Collecting and Analyzing Water Bills	10
Interviewing Staff Members	10
Interview Goals.....	11
Interview Questions	11
Bias and Perspectives.....	12
Developing Recommendations	12

Results.....	14
Energy	14
Results of Energy Audit and Analysis	14
Results of Net Energy Calculation.....	15
Waste.....	17
Observations Regarding Waste.....	17
Waste Audit Results.....	18
Water.....	21
Observations Regarding Water Use.....	21
Results of Water Bill Analysis.....	21
Interviews.....	24
On Thinking About Sustainability	24
On Personal Actions at the College	25
On Signage and Communication	26
Specific Ideas and commendations from Interviewees.....	27
Findings and Recommendations	29
Energy	29
Recommendations for Energy.....	29
Waste.....	31
Recommendations for Waste	31
Water.....	32
Recommendations for Water	33
Conclusion	34
References.....	35

List of Figures, Table and Abbreviations

Table 1. Net Energy Use at BRCC Mullumbimby.....	16
Table 2. Quarterly water usage at BRCC Mullumbimby.....	22
Table 3. Adjusted Quarterly Water Usage at BRCC Mullumbimby.....	23
Figure 1. Results of Waste Audit 1 at BRCC Mullumbimby.....	18
Figure 2. Results of Waste Audit 2 at BRCC Mullumbimby.....	19

List of Abbreviations

BRCC: Byron Region Community College

KW: Kilowatt (1,000 W)

KL: Kilo-Litre (1,000 L)

L: Litre

MW: Megawatt (1,000,000 W)

PV: Photovoltaic (solar panels)

W: Watt

WH: Watt-hour

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Before I go, I'd also like to say thanks to my parents, who have supported me through all my journeys, as well as my grandmother Doris and brother Richard.

Introduction

About Byron Region Community College

Byron Region Community College (BRCC) is an adult education center based in Mullumbimby, New South Wales. According to its website, the college has two campuses—one in Mullumbimby, and another in Byron Bay. The Mullumbimby campus is where the college's administrative staff conduct most of their business, and offers four well-equipped classrooms, a computer room, an art studio, and a workshop. The Byron Bay campus is open three days a week, and occupies the second floor of a commercial building on Jonson Street, a bustling area of town. Classes offered by the college range from accredited training courses such as First Aid and Responsible Service of Alcohol to general, unaccredited courses like soft cheese making or beginner's guitar. In a typical year, the college will have about 7,000 enrollments, although many of these enrollments are for small, one-time courses (About Us, 2012).

Sustainability at BRCC

Promoting sustainability is an important part of the college's goals and values. Recently, the college became a signatory to the Talloires Declaration, a set of principles developed in 1990 for universities pledging to build an institutional culture of environmental sustainability (The Talloires Declaration, 2001). Following these principles, the college has developed policies and strategies to provide education for sustainability and operate in a sustainable manner.

The college recognizes that as an educational institution it has an important role to play in promoting sustainability at the local level but also on a broader scale. The college's Sustainability Policy states that "as an Adult Community College we have an important role in fostering behavioral change towards social, economic and environmental sustainability and in building skill development for a low carbon future (2012)." According to BRCC's director, Richard Vinycomb, promoting sustainability should be a major part of everything the college does. In his view, seemingly unrelated courses, on childcare for example, should include education on sustainability within that industry, while other courses such as permaculture are intended to not only mitigate but also empower people to adapt to climate change. Vinycomb also said that the college works on the local level with other organizations such as the Sustain Northern Rivers Collaboration or the Byron Shire Council to promote and cooperate on sustainability related

matters. Meanwhile, Vinycomb and the college's Sustainability Coordinator Katrina Shields often seek ways to share what they learn about sustainability with the outside world by participating in and conducting webinars or attending and speaking at conventions, as well as developing training manuals and other documents for sustainability education (Interview, 18 April, 2013).

While BRCC is actively promoting sustainability through classroom education, the campus itself serves as an example of a sustainable building and workplace. The Mullumbimby building, retrofitted recently, features many sustainable features such as a 30 kilowatt capacity rooftop solar array, passive solar heating and cooling, solar hot water, low-flow toilets and waterless urinals, and rainwater-irrigated herbal tea gardens in the courtyard among many other features (Campus Features, 2012). Along with these infrastructural components, the campus features educational information in the form of plaques in various relevant locations advertising sustainable features and promoting good behavior.

While the college offers many different ways to learn inside and outside of the classroom, the college campus itself can have an important role in sustainability education. According to Anthony D. Cortese, it is incredibly important that an educational institution should "practice what it preaches" in addressing 21st century problems by incorporating sustainability into its physical campus and administrative operations. He says, "The university is a microcosm of the larger community," and therefore the way it operates "is an important demonstration of ways to achieve environmentally responsible living and to reinforce desired values and behaviors in the whole community (Cortese 2003)." Ideas like those expressed by Cortese are a major part of what BRCC strives to be as a sustainable institution. By modeling sustainable behavior and decision making, BRCC can promote sustainability to its students as well as the surrounding community. In this way, BRCC's Mullumbimby and Byron Bay campuses can be as important of an educational tool as the lectures held within its classrooms.

While the college has made many steps to improve their management of resources and the sustainability of their campuses, much of the progress they have made remains unquantified. The college has not determined how much solar electricity it has produced versus how much it has used, or how they are doing in waste management or water conservation. Taking the time to analyze and report on their progress provides the chance for the college to assess its own

progress, as well as report that to its stakeholders. Furthermore, the path forward is a bit unclear, and members of the college faculty have indicated that recommendations for improvements would be useful.

Components of Sustainability: Energy Management

The way energy is used at either campus has a tremendous impact on its overall sustainability, as well as its future resilience. Properly sourcing and conserving energy, in the form of electricity or fuels such as natural gas and woodchips, can have a major effect not only on the campus's environmental footprint, but also on its expenses. Electricity, for example, can make up a large portion of an institution's total expenses—over the past two years, the Mullumbimby campus alone used over \$2,000 in electricity even with a 30 kw rooftop solar array (Appendix A). Electricity also is often generated by the burning of fossil fuels such as coal and natural gas which produce high quantities of greenhouse gas and damage air quality. Furthermore, being reliant on energy utilities and fossil fuel economics makes the institution more susceptible to fluctuations in the energy market and as well as less independent due to a reliance on the stable condition of the electrical grid.

Producing clean, cheap electricity on-site using solar power is very desirable because it means less dependence on fossil fuels, a lower carbon footprint, and the potential to be self-reliant with energy use. Also, if more electricity is produced than is consumed on-site, the college becomes a net exporter of clean energy to the grid, thereby decreasing the need for fossil fuels to be burned elsewhere. In this way, the college can have a positive influence on the energy profile of the region.

Conserving electricity at the Mullumbimby campus, meanwhile, is important because it decreases the amount of energy the college uses and therefore helps to avoid the problem of having to draw on energy from the grid and also allows more electricity to be exported from the college's on-site production. It also reduces the college's energy bill. Conservation at the Byron Bay campus is even more important because there is no on-site electricity generation so energy costs more and all electricity consumed must come from the grid and therefore brings with it a higher carbon footprint in comparison to the Mullumbimby campus.

Devices that use electricity at an educational institution like BRCC mainly consist of computers, lighting, and any other devices that would need to be used in a typical classroom or office setting such as photocopiers or projectors. Climate control is also a major element, with devices like air conditioners, active ventilation systems, or space heaters consuming high rates of power. In addition, both campuses have one or more kitchen spaces which sometimes require electricity to heat water for the tap or to run refrigerators, microwaves, stoves, or electric tea kettles. Finding ways to accomplish necessary tasks with these devices while using less or no electrical energy is the goal of electricity conservation.

An energy audit is a "process to evaluate where a building or plant uses energy, and identify opportunities to reduce consumption (Thumann, Albert and Younger, W.J. 2008)." By conducting an energy audit, I hoped to find and address problems or weak points in BRCC's energy management.

Components of Sustainability: Waste Management

Finding ways to divert solid waste from its typical destination, the landfill, is very important in protecting the natural environment. When rubbish is sent to a landfill, it most often results in environmental degradation, and can produce tons of methane, a highly potent greenhouse gas. By recycling waste, valuable materials can be reused in the form of new products, which can often be a much cheaper and more environmentally friendly method of acquiring raw materials for goods. According to the Northeast Waste Forum, this can result in lower waste removal costs, and environmental benefits such as cleaner air and water (2006). Composting organic material is another alternative method waste management, whereby once-living materials can be biologically processed into soil through natural mechanisms. Composting methods such as using Bokashi Bins and worm farms or traditional bins produce usable, high-quality soil with many environmental benefits such as carbon sequestration and high fertility. BRCC has methods for composting and recycling at both the Mullumbimby and Byron Bay campuses.

Both the Mullumbimby and Byron Bay BRCC campuses are within the shire of Byron, and all solid waste is handled in conjunction with the shire's municipal waste collection services. According to the Byron Shire Council's recycling program website, almost everything from plastics 1-7, aluminum, steel, glass, and paper can be recycled. The main items that cannot be recycled are organic waste, styrofoam, and cellophane-like plastics (Recycling and Garbage).

Ideally, all of the recyclable waste that is produced at BRCC should be recycled, but behavior and information gaps can leave room for improvement.

Components of Sustainability: Water Management

Sustainable water management is an incredibly important task in an area like New South Wales, where a high level of economic development can be threatened by periods of extended drought. According to the New South Wales Department of Land and Water Conservation, "the demand for water has increased to a level where there is serious competition between water users and between the various water uses and the maintenance of sustainable ecosystems (NSW Water conservation Strategy)." Like most areas of Australia, New South Wales and Byron Shire Council are sometimes subject to extreme climate variability from the El Nino Southern Oscillation (Bureau of Meteorology, Living with Drought). Conserving water, therefore, is and should be an extremely important goal for Byron Region Community College.

Strategies for water conservation mainly involve promoting efficiency. Dual-flush toilets, water-efficient sinks, and water-efficient dishwashers and other appliances are important aspects of home or business water conservation. Finding uses for rainwater or greywater, meanwhile, offer ways to reduce the total amount of freshwater being used from the local utility company.

Methods

In order to study waste, energy, and water resource management at Byron Region Community College, I decided that it was important to work on site at the Mullumbimby Campus, which is where the majority of classes are held and administrative tasks are conducted. Being based in Mullumbimby would allow me to have a base of operations for conducting audits, but also as a way to be engaged in the culture and day-to-day goings on of the campus. I was given a desk space in a staff work room, where I would work during the day, conducting background research and audits, and observing the practices and needs of the college's employees and students. I also stored documents and materials I needed for the project, such as a scrapbook Katrina Shields lent me about sustainability at BRCC and the pair of rubber dishwashing gloves I would use during the waste audit.

Energy

Conducting an energy audit at Byron Region Community College depended on three categories of information: data collected from quantifying the number of electrical devices and their energy consumption at either campus, data collected from electricity bills charged to the college from the local utility company, and data on the amount of electricity produced at the Mullumbimby campus from the college's 30 kW rooftop solar array. Observations were also collected about workplace use and conservation of energy, and areas where improvements might be made.

Energy Audits

In order to get a sense of how energy was being used by BRCC, I compiled an inventory of every electricity-consuming device being used at either campus. Items listed included everything from computers to light bulbs and hot water heaters. Devices that could be plugged into a standard electrical socket could be measured using a Power Mate Lite Energy Meter, which provides data on power usage. Devices that were most likely to yield room for improvement in practices or consumed the most energy were prioritized for taking power consumption measurements. For example, I often took measurements on computers to compare how much energy each used and how different settings affected power consumption. An inventory of electrical appliances was developed for each campus, with all of the devices in each room listed on a spreadsheet with any power consumption measurements included. This process

was conducted over several days at the Mullumbimby campus, and in one day at the Byron Bay campus. Once this information was collected, recommendations for changes and improvements were developed in order to decrease overall energy consumption.

Information on the power usage of computers was developed using the Power Mate Lite with the computers and monitors at different settings and statuses. Data was taken down on the power consumption of each computer as it was off, on, and sleeping, while power measurements were taken of the monitors at different brightness settings. Some computers, such as the iMacs or Asus All-in-one PCs had the monitor built in, in which case power measurements were taken on the power consumption of the entire machine with different monitor settings. Default settings on the Mullumbimby PCs were taken down based on observations of whether the computer was set to sleep or hibernate after a certain period of inactivity.

While every item could be listed in the inventory, it was not possible in most cases to determine how often that item would be used. This is a major factor in determining how much energy it consumes, and therefore whether or not it is of significance to the college's energy use practices. This information could only be developed through observation and guesses informed by the needs of student and staff.

Determining Net Energy Use

BRCC's Mullumbimby campus rooftop has a photovoltaic solar array with a total capacity of 30 kW. The energy produced from these panels are sold to the grid while the college is simultaneously billed for the electricity it consumes from the grid. The photovoltaic system includes a total of 6 inverters which store data about the array's electricity production. This data was collected using software provided by the solar firm that had installed the panels. Meanwhile, data on the campus' consumption of electricity from the grid was obtained by accessing the accounts and records of the college from the local electricity utility, Country Energy. By finding the difference between the college's billed consumption and its solar production, I could determine the net energy use of the building.

The solar inverters were accessed using one of the college's computers which was equipped with Bluetooth and the necessary Sunny Explorer software. The program and the inverters provided data as to the total electricity production in kWh for each day since the

inverters were installed. These figures were then summed to make a quarterly figure on energy use. The college's total electricity consumption for each quarter was taken from Country Energy's website, and the difference from each corresponding quarter became the net energy for that quarter. By taking the sum of all four quarters in a year, therefore, a yearly figure was produced for net energy use at BRCC.

Waste

Waste Audits

Waste auditing is the process of quantifying the "amounts and types of waste being generated by an organization" so that informed waste management decisions can be made (New South Wales Environmental Protection Authority, WRAPP Facts: Doing a Waste Audit 2001). In order to determine what changes might need to be made at BRCC, I conducted two waste audits at the Mullumbimby campus, and attempted to conduct audits at the Byron Bay campus as well. Upon visiting the Byron Campus, however, I found that the college's rubbish was not easily discernible from that of other businesses and was not suitable for conducting a waste audit with any kind of conclusiveness. I decided that the most useful figures I could provide the college would be on how much of their landfill-bound rubbish could have been recycled or organically composted because this would indicate how much room they would have for improvement.

While planning the logistics of the waste audit, Katrina Shields and I concluded it would be best to study an entire week's rubbish because it would provide a larger sample size. Therefore, I conducted the waste auditing processes on Wednesday afternoons which was the day before they would be picked up by the municipal rubbish collectors. I then gathered all of the rubbish that had been produced during the week from trash cans in the classrooms and office building, and brought it outside to my auditing area where I had also collected all of the rubbish which had already been placed in the bins ready to go out. Then, under the shade and raincover of the courtyard's overhang, I sorted through and separated all of the week's rubbish. Safety measures such as wearing thick rubber gloves and using a rubbish grabber were followed and the audit was conducted in open air and under cover to avoid harmful fumes and sunlight.

Trash was sorted into three different bins with liners. Each bin was for a different category of waste: landfill rubbish, recyclable material, and organic waste. Organic waste,

consisting mainly of food scraps, could be put into the college's worm farm to generate useable compost onsite while recycling and rubbish needed only to be sorted into their respective bins and placed on the curb for weekly rubbish collection. Once all of the waste had been sorted into their correct categories and weighed using either a digital bathroom scale or a kitchen scale. When the waste was too light for the digital bathroom scale to register, a kitchen scale was used instead which was more sensitive but could only handle up to 3 kg. The mass for each category was then totaled, with adjustments made for factors such as the weight of the bins and the liners. This information was then put into a spreadsheet using Microsoft Excel. Observations were also recorded concerning the content of the trash, an example being that people often threw coffee cups in the trash when they were actually recyclable.

The entire process was conducted twice at the Mullumbimby campus. The first experiment was conducted on April 10th, which was a week when staff and students were present on campus and classes were still frequently in session. The second experiment was conducted on April 17th, which was a much quieter week when most classes were not in session. As a result, there was much less trash produced the second week.

Because the waste audit was only conducted twice at the Mullumbimby campus, it is hard to definitively draw conclusions about waste practices at the college. The fact that the two audits were conducted during a short period of the year and when the college was relatively quiet does not allow for generalizations to be made about the college's waste profile for an entire year. It also makes it difficult to make conclusions about how much waste the college is producing. The audits were useful, however, in showing that there is room for significant improvement in recycling practices from students and staff, and for identifying certain items that could be prioritized in an educational campaign to improve waste practices.

Water

Assessing Water Use Practices

To develop an understanding of how water is used and managed at the college, I observed where and how it was being applied to various daily tasks. By taking a look around the facility and speaking with Katrina Shields and Richard Vinycomb, I gathered information about water use practices.

Collecting and Analyzing Water Bills

Collecting data from the water utility company was important in order to fully assess the quality of BRCC's water management strategies. Richard Vinycomb, the director of BRCC was able to provide bills for me on the four most recent quarters. The bills ranged from February 2011 to the end of January 2013, a full year.

While the college had used roughly the same amount (35 kL) for three of the quarters, about 15 more kL had been used during the winter months from August to October. Richard noted that this was during a particularly dry period when the gardens were newly planted and needed more water than usual while the rainwater irrigation system had also not been developed yet. The extra 15 kLs that likely went towards hand watering these plants, therefore, should not be necessary in the future. The measurement for August to October, therefore, was reduced to 35 kL, the quarterly average for the rest of the year so as to remove this outlier and provide a more useful figure.

A daily average was calculated by dividing the year's adjusted total consumption and accounting for a total estimated 285 days of activity. This produced a daily average of 498 L. With an approximation of 57 people (22 people in the incubators, 10 full-time staff each day, 25 students per day) based on Richard's estimates, the daily average per-head water consumption is 8.7 Liters.

In order to get an idea of whether or not per-person average of 8.7 L per person per day was acceptable, I contacted Barbara Jensen, who is the Community Education officer at Rous Water, the water utility company. While she couldn't provide much info in relation to adult education centers in the region, Barbara told me via email that primary schools are deemed water efficient if they use under 9 L per person per day. This is a useful comparison in seeing whether BRCC's Mullumbimby campus is doing well.

Interviewing Staff Members

In order to collect some data and opinions about sustainability at either campus, I conducted interviews with four staff members at BRCC. All four of the interviews were conducted at the Mullumbimby campus, but were in consideration of both campuses. In order to get a

comprehensive view, I chose to interview people who could represent most of the major roles of the college's faculty. For this reason, I interviewed Richard Vinycomb, the director of BRCC, Charlie Wilson, the IT coordinator, Aya Kato, who handles several jobs around campus from running the reception to handling course registration and logistics, and Katrina Shields, the college's Sustainability Coordinator. In this way, I was able to collect input and information from faculty representing different roles and specialties at the college. Interviews were conducted from the 16th-18th of April.

Everyone I interviewed, with the exception of Kato, also had some sort of background in environmental studies which made them desirable as an interviewee. Vinycomb has an undergraduate degree in Geology, while Wilson has an undergraduate degree in Environmental Science. Shields, meanwhile, has been working with sustainability most of her adult life and has a diverse background of environmentally-aware experience. Because of their background and interests, I predicted that these people would have a lot to offer in an interview in terms of recommendations and observations for improving the sustainability of either campus.

Interview Goals

The goals of conducting interviews with the people listed above are as follows:

- *To gather observations about how people think and interact with sustainability in their daily lives and at the college so as to develop an understanding of the culture of sustainability at BRCC,*
- *To gain a diversity of insight as to whether currently in place signage for things like waste management or energy and water conservation are effective, and*
- *To gather ideas and recommendations for further improvements at the college*

Interview Questions

With the hope of producing results that were comparable to one another, I formulated a series of questions pertaining to the three goals listed above. The questions I asked were as follows:

- 1. Do you think about sustainability often in your day-to-day activities?*
- 2. Are there any actions you personally take to be more sustainable at BRCC?*
- 3. How effective do you think the waste management signage is? Are the recycling and rubbish bins well marked and well explained?*
 - *How about for composting?*

- *Do you have any recommendations for ways to make the process clearer for people?*
 - *How about signage for other things such as energy and water?*
4. *Do you have any recommendations for ways that the college can improve its environmental performance?*
- *Probe: For example, measures to conserve electricity, water, and reduce waste.*

Guiding questions and probes were used in order to facilitate responses from the interviewees. Answers to questions and related notes were taken down under the heading of each question on separate interview sheets. Interviews were also recorded using a tape recorder with the interviewees consent for the purpose of reviewing content and were later destroyed.

Bias and Perspectives

Each interviewee brought with them insights from their own experiences and perspectives on the questions which provided a lot of useful information but also could produce some bias. Each interviewee responded in a different way to the first question of how they think about sustainability in their daily lives—Kato, for example, mainly thinks about sustainability when doing simple tasks such as recycling or using water, while Shields and Vinycomb think about sustainability in much more idealistic ways. Meanwhile, some respondents had different views as to whether or not behavior-related changes such as those relating to signage needed to be changed. Differing opinions and perspectives were valuable in acquiring lots of ideas and observations.

Developing Recommendations

Once a sufficient amount of information had been developed on energy, waste, and water management, it was time to begin developing recommendations. Immediately many possibilities for improvements that could be made at either campus became apparent from personal observation and the ideas of interviewees. Each idea could then be assessed based on the following criteria to determine its priority:

- Predicted impact (how much difference a proposition would make—for example, a measure that would conserve electricity would be more impactful than one conserving water because the facility is already highly water efficient)

- Cost (whether the improvement in question would require a lot of capital and whether or not a payback could be expected)
- Feasibility (whether a proposed idea would be likely to succeed)

Ideas that had a high impact, were of low cost, and were likely to succeed were prioritized in the recommendations list.

Results

Energy

Results of Energy Audit and Analysis

Taking an inventory of every energy-using device at either campus allowed me to develop an understanding of how energy is used at either campus and for what purpose, and was useful in developing recommendations because it required taking a through look at all of the college's appliances. While doing so did produce some findings, many of the appliances around campus did not yield noticeable room for improvements. This is because the college is already quite careful about its electricity consumption, and does not have much unnecessary equipment. Furthermore, much of the college's equipment is relatively new following the renovations that occurred at the Mullumbimby campus in 2010 and the college tried to buy efficient appliances.

One area for improvement that I did find, however, was in relation to the computers at either campus and their default power management settings. Both campuses have computer rooms, with about 10 computers each. The Byron Bay campus has iMac computers, while the Mullumbimby campus has desktop-style PC computers. I found that the brightness settings of the monitors on each computer was an important component of its power usage, and that decreasing the brightness on each monitor could save a substantial amount of electricity. By turning down the brightness on monitors could reduce the power consumption of the Byron Bay iMacs from approximately 80W down to 60W, and from 40W down to 16W on the Mullumbimby PC monitors. I observed that all of the computers I sampled were set to the highest possible brightness on the monitors. By changing these settings, the college could conserve a substantial amount of electricity on each computer.

I also observed that power management settings on some if not all of the computers in the Mullumbimby campus computer room could be improved by changing the time after which the computers go to "sleep" mode from "never" to something like after 30 minutes of inactivity. Doing so could prevent any unintended electricity consumption from occurring if a computer were accidentally left on over a weekend.

Another finding of significance was that the hot water heater under the kitchen sink in the Byron Bay campus was consuming a high amount of power. The hot water heater, which was a small electric tank plugged into an ordinary wall outlet under the sink, was consuming 2,050W. The temperature of the water it produced was hotter than necessary. By turning down the temperature of the heater, the electricity consumption could be reduced. Alternatively, the heater could simply be unplugged if having hot water is not necessary. In either case, the heater could be shut off when the campus is unattended and turned back on when needed.

Results of Net Energy Calculation

Given data on the total electricity production from the Mullumbimby campus's rooftop solar inverters and the college's total electricity consumption, it was possible to determine the campus's net energy use. From the period of March 2011 to February 2013, the Mullumbimby campus used 65.7 MWh of electricity while producing 77.1 MWh from the rooftop solar array, indicating that the college produced more electricity than it had consumed (Table 1).

The Mullumbimby campus was a net exporter of electricity to the grid during all quarters except for the winter months from June-August. This is likely because cooler temperatures required more electricity to be used for the purpose of heating. Meanwhile, there was also likely less sunlight for the PV panels to generate electricity from during the winter months, as the sunlight would not be as direct and there would likely be cloudier weather. The yearly average for the campus, however, is a positive export of 5.7 MWh, making the college a net exporter of electricity to the grid.

	Total kWh Produced from solar PV	Total kWh Billed	Net kWh
Mar-May 2011	8951.945	7835	1116.945
June-Aug 2011	8766.99	8860	-93.01
Sept-Nov 2011	10934.141	8286	2648.141
Dec 2011-Feb 2012	9392.793	7756	1636.793
March-May 2012	8978.183	7873	1105.183
June-Aug 2012	8482.751	8792	-309.249
Sept-Nov 2012	11717.881	7171.13	4546.751
Dec 2012-Feb 2013	9837.492	9125.87	711.622
Total for two years	77062.176	65699	11,363.18
Yearly Average	38531.088	32849.5	5681.588

Table 1. Net Energy Use at BRCC Mullumbimby. The above table shows total on-site electricity production from rooftop photovoltaic (PV) solar panels on the left column in pink with the total electricity consumption on the right in blue. The net kWh for each quarter is represented in the right-most column. Quarters with a net import of energy from the grid are represented in red with negative numbers, while quarters with a net export of energy are represented from yellow to green, green being the most positive export observed.

Waste

Observations Regarding Waste

There are bins for recycling and rubbish in almost all of the rooms at either campus, with the occasional exception of a supply closet. These bins are bright red and yellow, and marked as either "Landfill Only" or "Mixed Recyclables." Above some of the bins, in particular in classrooms, there are small signs explaining the "Do's and Don'ts" of each bin. These small signs include a list of which items go in each bin and which don't. The lists are fairly long and are printed in very small text, and include items and types of rubbish that don't correspond with the waste that would typically be produced in the classroom. New signage focusing on the most common types of waste produced in this setting could streamline the process of sorting for people.

At the Byron Bay campus, the recycling and rubbish bins are each stowed away in a separate pull-out cupboard. The "Do's and Don'ts" signs described above are placed on each corresponding cupboard. While this is a convenient space-saving technique, the visibility of the bins is decreased, which could make it harder for people to manage their waste. In an interview, Aya Kato, a member of the faculty told me that the bins might not be visible enough, and that she had even observed faculty members struggling to find the bins (16th April 2013).

Furthermore, there are a pair of bins in every classroom at the Byron Bay campus. This may be unnecessary because the college is only open three days a week and the classrooms are often not being used. This means that more liners and more signage have to be used for the bins. While the weekly cleaners are meant to tip the rubbish rather than take out the liner if the bin is not full or soiled, more plastic liners may be sent to the landfill each week than is necessary. Also, having various bins requires more signage.

Composting at either campus is largely handled on a voluntary basis. As a result, the Bokashi Bin at the Byron Bay campus fell out of service and is no longer operating while at the Mullumbimby campus people have raised the question of who should be responsible for bringing buckets in the offices out to the larger worm farm. Not many people seem to have the time or desire to contribute to the composting effort aside from sorting their own compost. As a result, attempts to make composting easier by putting buckets in the staff meeting room or

elsewhere have not been successful and instead everyone simply brings their food scraps across the courtyard to the worm farm.

Waste Audit Results

Waste audits were conducted at the Mullumbimby campus on the 10th and 17th of April. The process could not be conducted at the Byron Bay campus because of a mix-up where the week's rubbish had not been collected and placed in the dumpster properly, or rubbish had simply not been produced. In order to determine how waste management could be improved at the Mullumbimby campus, rubbish waste streams destined for the land fill were picked apart and re-sorted in order to do a weight comparison of how much of the previous week's rubbish could have been recycled or composted rather than be sent to the landfill.

The first waste audit, conducted on the 10th of April, was done with the 19.1 kg of rubbish that had been generated since the Wednesday before. All of the contents were sorted into either rubbish, recyclable, or compostable waste. While 12.4 kg, or 65% of the rubbish had been properly sorted, 5.7 kg or 30% of the rubbish could have been recycled while 1 kg or 5% of the rubbish could have been composted in the college's courtyard worm farm (Figure 1).

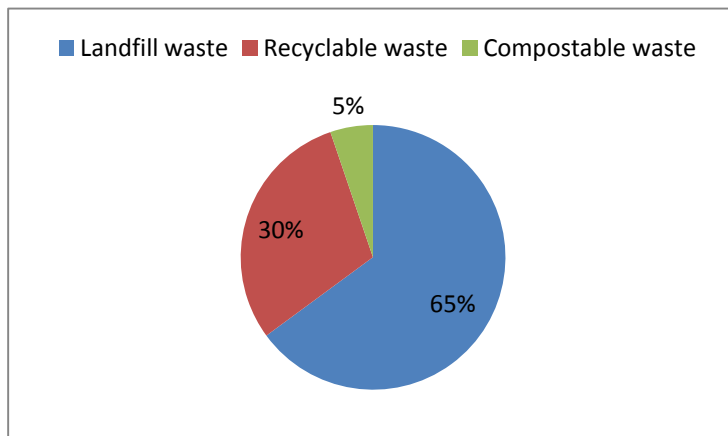


Figure 1. Results of Waste Audit 1. This chart shows the makeup of properly and improperly sorted rubbish from the Mullumbimby campus of the week leading up to 10/4/2013

The second waste audit was conducted the following week on the 17th of April, which was a time when many classes were no longer in session. Much less waste, only 7.6 kg, had been produced during this week. This time, only 1.3 kg of recyclable material had been placed in the

rubbish, making up 17% of the total landfill-destined waste. Compostable material, meanwhile was .75 kg taking up about 10% of the rubbish's total weight. Properly sorted rubbish made up 5.6 kg or 73% of the week's rubbish (Figure 2). During the week leading up to the second audit, a smaller proportion of the total rubbish had been improperly sorted. Improperly sorted recycling made up less of the total mass being sent to the landfill as rubbish, while the proportion of compostable waste being improperly sorted had increased. This audit was conducted on a much smaller amount of waste, however, which would affect the proportions of each category—for example, only a quarter kilo more of organic waste had been improperly sorted the second week, but it doubled in proportion because the total amount of waste was comparatively little.

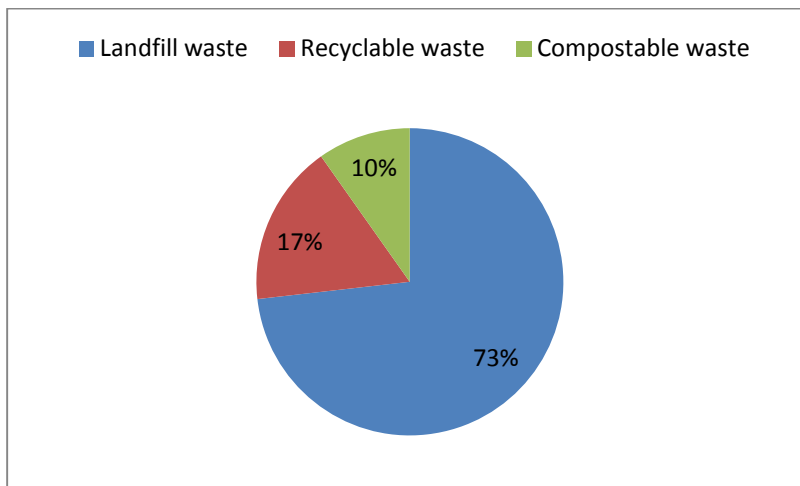


Figure 2. Results of Waste Audit 2. This chart shows the makeup of properly and improperly sorted rubbish from the Mullumbimby campus generated during the week leading up to 17/4/2013.

Much less waste had been produced at the college in the week of the second audit than had been produced in the first week most likely because there were fewer classes in session than during the previous week as the term was concluding. While there were still the normal amount of faculty present around the campus, the number of students would have been greatly reduced. This may have changed the total amount of rubbish output as well as the prevalent waste sorting practices at the campus. Because waste would have been mainly generated by faculty during this period, it's possible that the faculty are better at properly sorting their waste than the students are.

While conducting the audits, I made note of any items that tended to be mis-sorted and thrown in the trash while it could have been recycled or composted. Coffee cups were the most obvious item, usually left with the lid and cup unseparated indicating that people could not figure out whether the different parts had to be put into different bins and seemingly gave up to throw them in the trash. Also, they are likely an extremely common thing to have around a college campus. Another common item that took up a lot of bulk in the rubbish and could have been recycled was high-quality paper from the art studio. This made up a significant portion of the rubbish being generated from the studio.

In any case, the results of Audits 1 and 2 demonstrate that recycling practices at BRCC are not perfect. Although many of the barriers to recycling have been reduced by including some signage and plenty of bins for recycling and rubbish as well as the worm farm, people are often mis-sorting their rubbish. Finding new ways to make the process of sorting waste easier or clearer are therefore important to improve the college's sustainable waste management practices.

Water

Observations Regarding Water Use

By looking around the campuses and speaking with Richard Vinycomb and Katrina Shields, I developed an understanding of how water is mainly used at the college. The Mullumbimby campus's freshwater supply, which comes from the local water utility company, is used in the bathrooms and kitchens. There is a male bathroom, a female bathroom, and a smaller private bathroom. In the male bathroom there are two waterless urinals, and all other toilets have dual flush capabilities. There are sinks in each bathroom, and six sinks for the kitchens and kitchenettes. Water is mainly used for flushing toilets, washing hands, making beverages, and washing cups. All of these fixtures exhibit water-efficient features such as dual-flush options on the toilets or aerators on faucets.

There have been times in the past when the college has had to use this water source to hand water plants in the garden, but this role has been fulfilled mainly by the rainwater tank and irrigation system in the courtyard. This can drastically cut down the amount of water that the campus uses to irrigate their gardens. Other purposes may be achievable with this rainwater system but the college is unwilling to use it in any way that may pose a health risk.

The Byron Campus has a kitchen sink and bathrooms for male and female. All of the faucets have aerators installed, and the toilets are dual-flush. There are no waterless urinals. It would be difficult to make substantial changes, however, because the college does not own the Byron Bay building.

Altogether, the college only needs water for a few basic purposes, and is doing so in an efficient manner with their water use infrastructure.

Results of Water Bill Analysis

Using data that Richard Vinycomb, BRCC's director, provided me in the form of water bills for the past year, I was able to estimate the per-day and per-head-per-day usage of water at the Mullumbimby campus. The data was provided in the form kLs of water usage for each quarter. For the entire year, the average per-quarter water usage was 39.25 kL (Table 2). Considering holidays and weekends when the college would not be open, the average daily use at the campus would be approximately 550 kL. The estimated per head usage would be 9.7 L per day.

	kLitres
Feb-April	35
May-July	35
August-October	50
November-January	37
Quarterly Average	39.25
Daily Average	0.550877
Average water use per person, per day	0.009665

Table 2. Quarterly water usage at BRCC Mullumbimby. The table shows how much water was used for each quarter of 2012, as well as the estimated daily average for the entire campus, and the average per-person, per day water use.

Vinycomb and Katrina Shields pointed out to me, however, that the high reading from August-October may have been because they were hand-watering plants in the gardens. Because during these months the rainwater irrigation system in the courtyard was not yet up and running or had not yet collected enough rain, they had to water the plants by hand. The plants had also only recently been planted, and therefore were particularly needy. Since this water usage ought not to be an issue moving forward since the installation of the rainwater irrigation system, I decided with the input of Vinycomb and Shields that it would be useful to make an adjusted figure for water use by reducing the August-October quarterly reading to 35 kL.

The average quarterly usage for the Mullumbimby campus, following the adjustment, would come out to 35.5 kL/quarter, a daily average of 498 L, and an average of 8.7 L per-head, per-day (Table 3). This is a useful figure to have because it can be reasonably expected that future water use will follow this pattern since the installation of the rainwater irrigation system.

	kLitres
Feb-April	35
May-July	35
August-October	35
November-January	37
Quarterly Average	35.5
Daily Average considering holidays, weekends	0.245614
Average water use per person, per day	0.004309

Table 3. Adjusted Quarterly Water Usage at BRCC Mullumbimby. The tables shows how much water was used for each quarter of 2012, including an adjustment for the August-October measurement.

At Katrina Shields' suggestion, I contacted Barbara Jensen, who is in charge of Community Education at Rous Water, the local water supply utility in order to see whether the rates described in Table 3 were reasonable for BRCC. Via email, I explained to her the above figures. She told me that while she couldn't provide any figures on how much water adult education centers are expected to use, she could tell me what the per-head daily water usage of primary and secondary level public schools must meet in order to be deemed water efficient. Primary schools are expected to have 9L per head per day or less, while secondary schools are expected to have 12L per head per day or less. Jensen told me that the per-head per-day consumption I had calculated was a good (water efficient) rate (2013, pers. communication, April 22-24).

Interviews

Conducting interviews with a variety of staff members had the advantage of producing a variety of results. This was useful for gauging the needs and behaviors of staff members as well as for collecting information on the things they had observed around the campus. Interviewing people from different backgrounds (environmental or otherwise) and responsibilities in the organization achieved this purpose.

The faculty members I interviewed were as follows:

- Aya Kato, Client Services and Data Support faculty, April 16th, 2013
- Katrina Shields, Sustainability Coordinator, April 17th, 2013
- Charlie Wilson, Information Technology coordinator, April 17th, 2013
- Richard Vinycomb, Director, April 18th, 2013

On Thinking About Sustainability

I asked each interviewee the question, "Do you think sustainability often in your day-to-day activities" and why? The most striking thing I noticed in the responses I received were that Richard Vinycomb, Charlie Wilson, and Katrina Shields, all of whom had either studied the environment at university or had built up substantial experience in environmental work and thought answered that sustainability was a part of their ideals and philosophy. Thinking about it was as natural, regular occurrence for them. Shields told me that she was "obsessed" about the matter, and that it related to everything she does in some way. Even breathing, she told me, causes her to think about sustainability and the environment. Vinycomb, meanwhile thinks about sustainability in "big ways," and seemed to have a particular focus on the theme of intergenerational justice. Wilson, meanwhile, described himself thinking about sustainability "all the time," and mainly in terms of how his work as the college's IT coordinator related to energy use.

Aya Kato, meanwhile, is very conscious of sustainability, but mainly thinks about it when performing related tasks such as sorting rubbish or shutting off lights. As a Japanese émigré, she also had a lot to mention about how behaviors in her home country differed from those in Australia. She takes many actions on a personal level to manage her environmental impact. The difference between the answers of Kato and the others may demonstrate that

sustainability need not be a central part of one's philosophy in order to behave sustainably, but it may help when looking at affecting change at an institution such as the college in the way that Shields and Vinycomb do.

On Personal Actions at the College

Most of the interviewees described the personal actions they take on a day to day basis as falling under the them of being mindful of how they use energy, manage waste, and use water. Shields, Wilson, and Kato all described acts of using the worm farm, shutting off lights and devices, as well as being mindful of paper printing. All of the interviewees mentioned a number of simple approaches they take to be more sustainable at the college.

Wilson mentioned one action in particular that cuts down on his need to use paper. He brings a small Android tablet device with him to work, and views PDFs, manuals, and other odds and ends with it. This allows him to avoid printing out paper, and he also described it as being more convenient. Also, he is taking steps to reduce the total amount of energy being consumed by the college's servers by consolidating the machines into fewer, more efficient set ups.

Shields told me a little bit about how her job as Sustainability Coordinator promotes sustainability at BRCC. She is often on the lookout for products that will be more sustainable than the ones they currently use. An example of this is finding an alternative for the disposable milk containers that students and staff use for coffee with a local option or something more recyclable/compostable. She looks for ways to continue improving sustainability at the college, both in terms of improving the ecological footprint of the campus and in sustainability education which is her particular specialty. She is also involved with sustainability in the community, and often puts her priorities into acting with the local community towards goals that meet a larger context.

Vinycomb, meanwhile, mainly described to me what he has done in his role as director. He did not make much mention of personal sustainability habits, but instead spoke about how he made the decision a few years previous to hire Shields as Sustainability Coordinator and to work closely with her in her projects. He wants sustainability to be an important part of academics and culture at the college, and also puts great emphasis on sharing ideas and practices that have been successful for them with other organizations that might find it useful. Some of the outreach that

the college has done includes visiting or hosting conferences and webinars on sustainability. Involvement with the community is of particular importance, and Vinycomb described how the community both receives and returns help from them. Vinycomb views the college as having an important role in promoting the adaptability of the area to climate change. He told me about possible plans to create an institute of sustainability in the Byron region.

In short, different people are taking different personal steps to approach sustainability at the college. Some of the solutions they find are unique adaptations to their ordinary workplace habits. Others, meanwhile, are making sustainability an important part of the culture and visions of the institution.

On Signage and Communication

In terms of waste management signage, most of the interviewees agreed that the process of sorting waste could be made more clear to the standard person. Shields mentioned that signage would be more effective if it was made more visual with specific examples of common items such as coffee cups being featured, while Wilson mentioned that knowledge gaps were eased with Sustainability Day—a whole day where the faculty learned about various aspects of sustainability in and around the office. Kato described how the Byron Bay campus is likely in need of attention, citing the difficult to find recycling and rubbish bins in the kitchen and the possibility that having lots of bins leads to lots wasted bin liners. Kato also said that she thinks the Mullumbimby campus has much better signage and that it is more prevalent and visible there compared to the Byron Bay campus.

As for signage and communication in relation to composting, Shields said that the worm farm could use some better, bigger signage to attract attention. Wilson thought that while the composting practices are likely well known amongst the staff, the students likely face a knowledge gap. Kato, meanwhile, mentioned that if composting information was included or more greatly emphasized in student orientation and in the orientation manual that this problem might be addressed.

The interviewees had various recommendations for how to improve the process of waste management and sorting for people. Vinycomb told me that there may be room for significant improvement by having the trainers and tutors include specific information about how to

properly recycle and compost or use energy in the classrooms as part of the "housekeeping instructions" at the start of each course. He also said that it might help to have them repeat this process at a point halfway through the semester to ensure compliance. Kato expressed ideas similar to Vinycomb's.

Wilson thought that it would be useful to develop a method for collecting and providing feedback to and from students. An example would be to provide figures from audits to the people on campus so that they could know where they stand in relation to their environmental performance.

Shields recommended that visual signage be made with specific items on display. An example of this would be a particular sign saying that coffee cups are recyclable (unless they are of the compostable variety) and should be put in the yellow bin.

The interviewees had different views on how effective the other forms of signage around campus are, such as the wooden plaques about sustainable building features or reminders to shut off computers. Some thought that the signage wasn't particularly important, while other said it was very important in triggering their own awareness. Shields thought new signage could be developed to address energy issues such as to how properly manage the climate controlling features of the new classrooms or how to best run the air conditioning units. Vinycomb thought that more signage would also be a good way to increase the reputation of the college as a leader in sustainability, and that the college may not advertise this quality enough.

Specific Ideas and commendations from Interviewees

Aya Kato

Kato told me that it might be a good idea to reduce the number of bins at the Byron Bay campus, and to replace paper towels with electric hand dryers.

Charlie Wilson

As the Information Technologies coordinator at BRCC, Wilson had a lot recommendations pertaining to the college's technological issues, He told me that the college is in need of a system to manage e-waste disposal. He told me that because the college is continually upgrading its technology, big piles of old computers begin to build up and the college does not have a clear

method for disposing of them properly. He also suggested that the college look into buying carbon offsets, and mentioned that the Byron Shire Council may be developing a program for that.

Richard Vinycomb

Vinycomb suggested that another 10 kW of solar capacity could likely be added to the tops of the incubator buildings. He also would like to showcase new sustainability technologies using the courtyard space as a way of educating the public about new technologies. An example of something that could be showcased, theoretically, would be a wind turbine or using new types of batteries to store electricity.

Katrina Shields

Shields had a lot of recommendations. She echoed similar thoughts to Vinycomb in saying that more effort could be put into making sure tutors integrate sustainability into their teaching and practices as well as the "housekeeping" measures. She suggested that updating and adding information on sustainability to the foyer's bulletin boards, the orientation videos, and the website would be a good idea. Implementing and consistently carrying out the sustainable purchasing policies already accepted by the college. Finding ways to decrease the number of cars going to and from the Byron Bay campus on behalf of staff would also be important. She also suggested removing more unnecessary lights around campus, although did not indicate any ones in particular, and that LED lightbulbs may be getting cheap enough to be affordable to the college. Reviewing products the college buys to get more sustainable products again would also be a good idea. Finding an alternative to the current milk provision situation would also be really nice, as the current method is to use the little disposable creamer cups.

Findings and Recommendations

Energy

Altogether, Byron Region Community College is demonstrating some very good energy management consumption practices. Most of the devices being used around campus are purchased and operated in an efficient manner, although there are some things that could be improved upon such as reducing the brightness setting on monitors or avoiding the use of electric hot water heaters at the Byron Bay campus. Staff and students could likely use reminders in the form of signage and education to operate these devices as efficiently as possible, and to always turn them off when not in use but the overall culture tends to be very good when it comes to using energy in an effective, environmentally-minded way. Small adjustments, therefore, can be made to improve on a behavioral and technological level, to improve the campus's sustainability.

The electricity production at the Mullumbimby campus from the rooftop solar array is enough to create a net-positive production of clean, renewable energy at that location. Judging by the success of the rooftop array so far, it seems clear that there is potential for the college to further expand its solar production by adding PV arrays to the other, currently unused rooftops at the Mullumbimby campus. While adding solar production to the Byron Bay campus would be great, the college itself does not own the building or plan to stay there indefinitely so expanding solar production at that campus would not be achievable. However, increasing the amount of environmental benefits being produced at the Mullumbimby campus could make up for unsustainable energy practices at the Byron Bay campus or elsewhere.

Recommendations for Energy

The following recommendations are intended to improve practices in the category of energy and include an assessment of impact, cost, and feasibility.

-Reduce brightness on monitors all around campus, but especially in computer labs.

- Impact: Save up to 25W (30%) of power on Byron Bay computer room iMacs by reducing brightness to half, save 14W or more (35-65%) by changing Mullumbimby computer room PC monitors from "dynamic contrast" to "custom" brightness settings at or below 50%
- Cost: Doing so would be free except for the short amount of labor time needed to make changes to settings and would save considerable amounts of energy.

- Feasibility: As long as the monitors are not set to a point that is too dim for people to effectively use (50% seemed sufficient on both types of computers), people will not likely notice a difference and likely will not go far out of their way to put the brightness on max again.

-Make sure all **computers are set to sleep** after an extended period of time of inactivity such as 30 minutes.

- Impact: Eliminate costs of computers being left on accidentally.
- Cost: None except labor of changing settings. Considerable energy savings.
- Feasibility: Easy, free.

-Include information on how to properly operate the passive and active heating and cooling methods for each classroom in tutor training materials or in the classrooms themselves.

- Impact: Improve comfortability of classrooms, improve energy efficiency
- Cost: None except for printing, distributing, or teaching the materials. Considerable energy savings.
- Feasibility: Emphasizing that tutors should understand how to operate the rooms should ensure compliance.

-Turn down or shut off **hot water heater at Byron Bay** campus as it is overheating water and may be unnecessary altogether. Turn off as part of closing up at the end of each day.

- Impact: Turning off the heater would save 2 kW/hour. Turning down the heat could substantially reduce consumption as well.
- Cost: None.
- Feasibility: People may need hot water for sanitary purposes so it may not be possible to go without hot water entirely. Turning down the heat will only help prevent people from being burned by the overly hot water.

-De-lamp areas of the building with excess lighting.

- Impact: Substantially reduce lighting power usage.
- Cost: None. Electricity savings and bulb replacement savings.
- Feasibility: As long as bulbs are only removed in places where they are not necessary, there shouldn't be a problem.

-Expand solar PV electricity production at the Mullumbimby campus by adding arrays to the incubator rooftops.

- Impact: Increase the amount of renewable electricity being exported to the grid.
- Cost: High initial cost with a likely payback over time.
- Feasibility: Would take considerable effort and funding.

Waste

Considerable progress has been made at both campuses to make recycling straightforward and easy to understand for people. Inhabitants of either of the college campuses generally do not have to go far to properly dispose of their waste, and there are some directions on how to properly sort waste into its respective bins at most of the locations. Judging from the results of the waste audits I conducted, however, there is significant room for improvement to be made in the behaviors of students and likely staff as well.

There were some items that were commonly improperly sorted into the rubbish when they could have been recycled. The most apparent were to-go coffee cups and high-quality paper that was likely from the Laneway art studio. Targeting these items in particular to raise awareness about recycling practices could significantly reduce the amount of improperly sorted rubbish being sent to the landfill each week from the college.

Composting participation, meanwhile, could likely be improved substantially. There is hardly any signage for composting around the building with the exception of at the worm farm itself. The staff members I interviewed all mentioned that they went out of their way to compost their food scraps, but there was quite a bit of compostable food in the rubbish each week. Ways to increase compliance or participation could be achieved by raising awareness about how, where, and why to compost at the Mullumbimby campus. This would also be a good step to take at the Byron Bay campus if the Bokashi Bin could be brought to working order again

Another element to the composting arrangement, however, is to figure out a better way to manage the entire system. Something may need to be done to delegate a person as being responsible for the worm farm or for transferring small buckets of compost from the classrooms and offices to the bin.

Recommendations for Waste

-Develop **visual signage** for the following common culprits of improperly sorted waste and place where they would most likely be generated.

- To-go coffee cups as being recyclable (unless they are compostable) in classrooms and kitchen.
- Paper as being recyclable or re-usable in the Laneway Art Studio.
- One-sided paper as being re-usable above a few trash and recycling bins.

- Impact: Directly address some of the most commonly mis-sorted items.

- Cost: Cost of signage.
- Feasibility: Will need enough wall space for enough attention to be given.

-Implement a **carry-in, carry-out system** at the Byron Bay campus whereby there are no trash or recycling bins in the classrooms but instead one centralized station in the foyer along with the Bokashi Bin.

- Impact: Centralizing rubbish could make people more conscious of their sorting habits as well as decrease the total amount of signage needed. Would allow for the opportunity to put lots of signage up in one area rather than some in several areas. Placing Bokashi bin the same area could increase composting rates. Would decrease the number of liners needed.
- Cost: None.
- Feasibility: People might find it less convenient. Bokashi Bin needs to be tended to.

-Organize a system for **e-waste management** to bring e-waste to the Myocum landfill during regular business hours.

- Impact: Properly recycle electronics that are no longer needed.
- Cost: Drop-off is free according to the Byron Shire Council website.
- Feasibility: Would require substantial effort from an employee or volunteers.

-Improve composting rates by installing bigger signs for the Mullumbimby worm farm

- Impact: Increase awareness and use of the worm farm.
- Cost: Signage costs.
- Feasibility: Would require time to design and make the sign.

Water

All observations indicate that the Mullumbimby campus is being highly efficient in regards to its water use. The college does not have very many uses for water besides in kitchens, bathrooms, and for watering plants but it meets all of these needs in an environmentally-conscious way. All of the fixtures in the bathrooms and kitchens are fairly new and water efficient, with aerators on the sinks, waterless urinals, and dual-flush toilets. Meanwhile, watering the plants is accomplished using the new rainwater irrigation system. The estimated water use per day of the college is about 8.7 litres per person per day, which is good according to Barbara Jensen from Rous Water Company, the local utility. Some new purposes may be achieved using the rainwater system, but the college is doing a very good job at the Mullumbimby campus of conserving the water provided to it by the local utility.

The Byron Bay campus uses water for similar purposes as the Mullumbimby campus, with the exception of the garden. While waterless urinals and other improvements might be installed there by the owner of the building, the college itself has no real power to make transformative infrastructural changes there.

Recommendations for Water

-Install **signage** about water conservation in bathrooms and kitchens.

- Impact: Further conserve water.
- Cost: Cost of printing.
- Feasibility: Requires time to design and print.

-Find other potential uses for rainwater such as an aquaponics system or an outdoor shower.

- Impact: Offset water usage in other areas. Provides educational value.
- Cost: Tubing, installation, materials.
- Feasibility: Would require considerable labor, and also electricity for running pumps.

Conclusion

In summary, Byron Region Community College has already made much progress in the sustainable management of energy, waste, and water resources. The college's Mullumbimby campus, with its 30 kW capacity rooftop solar array, is a net exporter of over 5 MWH of electricity to the grid annually and is doing a decent job of efficiently using and conserving energy within the building itself. The Byron Bay campus could have significant improvements in energy management if more transformative adaptations could be put in place. In terms of waste management, there are ways in which the college can improve the recycling and composting practices of its students and faculty mainly by addressing behavioral components but also by making slight changes in the way rubbish, recycling and trash are accessed by its users. It was observed that up to 35% of waste was that had been sorted as landfill rubbish could have been either composted or recycled. Water management, meanwhile, is highly efficient and effective at the Mullumbimby campus with a per person daily usage of about 8.7 L although practices at the Byron Bay campus are not conclusive.

By measuring and reporting back the results of performance on energy, waste, and water management, the staff and faculty of the college can then decide on how to proceed in improving in these areas. Recommendations were developed in each of these three categories in the hope of improving performance.

Similar studies could be conducted at many institutions in the region. BRCC is ahead of its class in its approach to sustainability, and other similar colleges will likely be right behind in seeking to make changes for the betterment of the environment.

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Appendix A

Year	Billing Date	Charge
2011	6-Jun	-63.15
2011	2-Sep	595.82
2011	30-Nov	-168.94
2012	2-Mar	59.15
2012	1-Jun	266.07
2012	5-Sep	823.51
2012	30-Nov	288.97
2013	6-Mar	269.4
	Total	2070.83

Appendix A. Combined Electricity Bills for ACE and CLIC Accounts, BRCC Mullumbimby. This shows the quarterly charges for a two year period at BRCC Mullumbimby as well as the total charge. Negative charges represent periods where more value was sold back to the grid than purchased.