Energizing the Public: Designing and Installing a Renewable Energy Demonstration in Riley Park

Theresa Cashore, Maegan Poblacion, Gopal Sharma
University of British Columbia
Department of Earth, Ocean, and Atmospheric Sciences
ENVR 400: Community Project in Environmental Science
Advisor: Dr. Tara Ivanochko
April 16, 2019
Executive Summary

Green technology has developed rapidly in the past decade in an effort to produce clean energy through renewables. A global initiative to slow the impacts of climate change is to reduce the use of fossil fuels and to promote sustainable energy production. This initiative is seen to be effective in certain countries, where installed renewable energy sources generate electricity at a levelized cost that is less than, or equal to, the price of buying power from the grid.

The Society for Promoting Environmental Conservation (SPEC) aims to promote practical solutions for urban sustainability to the local community. In order to meet SPEC’s Energy and Transportation committee’s objectives outlined through their zero-fossil fuel initiative, the Renewable Energy Demonstration (RED) was installed in Riley Park, Vancouver, British Columbia, which is a comparative and interactive demonstration involving four energy modules; solar, wind, mechanical, and hydro pumped storage. This project aims to raise awareness on viable renewable sources that can serve as alternatives to fossil fuels, through outlining the feasibility in installing each source into one’s own home, as well as their benefits in both energy return and cost.

In designing the demonstration, two main objectives were established, which were:

1. To create a renewable energy demonstration that is effective in engaging the community in exploring various renewable energy sources, and
2. Installing such a demonstration in a practical and cost-effective means given our budget constraints.

To meet these objectives, our project was organized into three phases. The first was the research phase. Preliminary research was conducted on energy production in Canada from renewable sources, as well as on renewable energy demonstrations installed worldwide and discussions on the subsequent outreach impact from each project. From this baseline research, a series of mini proposals were created. These seven mini proposals briefly outlined the benefits of each potential demonstration; which either was an individual renewable source, or a combination of more than one. In outlining the benefits and challenges of each proposed idea, a demonstration was finalized, which would involve integrating four energy modules where energy generated by each source could be compared in real time.
The second phase identified the funds and materials necessary for the demonstration and included applying for additional funding. Schematics were developed to identify how the components would interconnect to fit the proposed vision. The third and final phase was to purchase the required parts for the demonstration as well as installing the demonstration itself in Riley Park. Information placards were also drafted and created to be installed alongside the demonstration to deliver tangible facts on renewable energy, such as nationwide consumption, how each source works in converting natural energy into electricity, and the benefits of each renewable source.

Figure 1. The mind-map of the demonstration is provided above. The four modules (Solar Power, Pumped Hydro Storage, Mechanical Power, and Wind Power) are connected to a Display showing the energy created from each module. The battery will be powered by solar power and it will power the Pumped Hydro Storage module.

Through the installed RED, park visitors can view renewable energy in action, with the intent that it will encourage them to install renewables in their own homes when undergoing renovations. Community members can generate electricity themselves mechanically through an attached hand crank and compare this energy to the real-time energy generated from the other modules (solar, wind, hydro), which varies depending on the current weather conditions. This not only encourages expanding the use of renewables to the commercial level, but also allows the community to connect with nature through exploring usable energy that is derived directly from natural processes, such as from the sun, wind, or flowing water. In understanding how these energy sources function, it is brought to light how we are currently in an age where technology has developed to efficiently take advantage of harnessing these natural resources. Such advances have allowed for Canada’s abundance of renewable resources to provide 18.9% of total primary energy supply to power millions of homes across the country (National Energy Board, 2017b).
# Table of Contents

EXECUTIVE SUMMARY .................................................................................................................. 1  
AUTHOR BIOS ................................................................................................................................. 5  
COMMUNITY PARTNER BIO ........................................................................................................... 5  
1.0 INTRODUCTION ......................................................................................................................... 6  
2.0 METHODS .................................................................................................................................. 9  
  2.1 PRELIMINARY RESEARCH ................................................................................................. 9  
  2.2 CHOOSING A DEMONSTRATION ....................................................................................... 9  
  2.3 DESIGN OF CHOSEN DEMONSTRATION .......................................................................... 11  
  2.4 FINALIZING BUDGET AND PARTS ..................................................................................... 12  
3.0 FINAL DEMONSTRATION ......................................................................................................... 14  
4.0 DISCUSSION .............................................................................................................................. 17  
5.0 CONCLUSION ............................................................................................................................ 17  
ACKNOWLEDGEMENTS .................................................................................................................... 18  
REFERENCES .................................................................................................................................... 19  
APPENDIX ......................................................................................................................................... 20  
  APPENDIX A: PRESENTATION OF MINI PROPOSALS TO SPEC .............................................. 20  
  APPENDIX B: VISUAL TIMELINE ............................................................................................... 25  
  APPENDIX C: MATERIALS AND EXPENSES LIST .................................................................... 26  
  APPENDIX D: POSTER ................................................................................................................. 27  
  APPENDIX E: INITIAL DELIVERABLES OUTLINED BY SPEC ............................................... 28  
  APPENDIX F: INFORMATION PLACARDS ..................................................................................... 29
List of Figures and Tables

FIGURE 1. THE MIND-MAP OF THE DEMONSTRATION................................................................. 2
FIGURE 2. PROJECTIONS OF TOTAL ELECTRICITY GENERATION BY RENEWABLE SOURCES................................. 6
FIGURE 3. THE DEMONSTRATION IN THE RILEY PARK COMMUNITY GARDEN ........................................... 14
FIGURE 4. SCHEMATIC DIAGRAM OF THE INSTALLED DEMONSTRATION........................................... 15
FIGURE 5. A DIAGRAM OF THE MECHANICAL MODULE .............................................................. 16
TABLE 1. PROPOSALS NOT CHOSEN AS A DEMONSTRATION IN RILEY PARK........................................ 10
TABLE 2. PROPOSAL CHOSEN AS A DEMONSTRATION IN RILEY PARK............................................. 11
Author Bios

Gopal Sharma

Gopal is in his final year of environmental sciences in the Land, Air and Water stream. He has experience working at UBC in research. While in the industry he gained experience in research and improving energy systems.

Maegan Poblacion

Maegan is in her final year of environmental sciences in the Land, Air and Water stream. She has held work experience working with agricultural research and in industry. From her time working with industry, she holds project management experience.

Theresa Cashore

Theresa is in her final year of environmental sciences in the Ecology and Conservation steam. Theresa worked for the European Forest Institute in Bonn, Germany for her co-op program. From this position, she gained experience in community involvement and outreach.

Community Partner Bio

SPEC

The Society for Promoting Environment Conservation (SPEC) is the oldest environmental non-profit in Canada, whose mission is to raise awareness of environmental concerns. Over the course of their history, SPEC has built a long-lasting legacy in environmental protection. In striving to encourage the community to integrate renewable energy options into their own homes, SPEC has worked alongside UBC ENVR 400 students to plan, fund, and install an educational renewable energy demonstration in Riley Park.
1.0 Introduction

Canada has seen an overall increase in adoption of renewable power sources (National Energy Board, 2017a). This is primarily due to the growing interest in the demand for diversification of nationwide energy supply. The long-term commitment to clean energy has been an effort towards transitioning away from the use of fossil fuels. With Canada’s electricity generation being sourced from more renewable sources, it has been projected that the total energy generation by non-carbon emitting sources will increase to 84% by 2040 (Figure 2). While the public has seen this transition in action with the development of large-scale wind farms, hydropower dams, and rooftop solar panels, it is vital to encourage individuals to implement such sources into their own homes. In order to do this, renewable energy demonstrations play a role as an outreach tool to show to the public how these renewable energy infrastructures work.

Solar energy remains one of the most commonly used renewable energy sources worldwide. Solar panels consist of photovoltaic cells which capture sunlight and convert it into electricity. Solar panels are an especially attractive option due to low costs and increasing availability, as well as high levels of energy generation relative to other renewable energy sources. One major
drawback of solar power, however, is that energy is not produced at a constant rate, and is highly dependent on the weather conditions and time of day (Cengiz & Mamiş, 2015).

Another popular renewable energy source is wind power. Wind power can be a realistic option, due to its low-cost, reliability, and flexibility. Wind energy is flexible, such that it complements other energy sources, at both large and local scales. This is most often seen as wind farms in rural areas, as well as offshore wind. The wind energy supply has grown to power approximately 6% of Canada’s electricity demand (CanWEA, 2017).

One common issue with renewable energy sources is that they are not consistent in the amount of energy they provide. Due to this, some sort of energy storage is needed to supplement when needed. Unfortunately, batteries are limited due to size and capacity constraints. An alternative to batteries is hydro pumped storage. Rehman et al. (2015) suggests that large scale pumped hydroelectric storage has between 70-80% energy efficiency. This makes it a valid alternative to batteries and one that could easily be combined with hydro dams.

Mechanical energy is another option for when the environment is unable to provide other such natural energy sources. This is seen in hand generators, where the voltage generated depends on how quickly the crank is turned, and more power is generated the longer energy is exerted. This type of energy generation is also seen in instances where an electric car stores energy through regenerative braking.

With the large variety of renewable energy sources available, this demonstration relays the benefits of renewable energy, through integrating multiple sources to display. The Society Promoting Environmental Conservation (SPEC) and students in their final year at the University of British Columbia (UBC) collaborated on this community based educational project around renewable energy. In fulfilling the goals outlined through their zero fossil fuel initiative, a Renewable Energy Demonstration (RED) has been installed on a newly constructed garden shed built in the Riley Park Community Garden in Vancouver, British Columbia. The intent of this demonstration was to commission an interactive, educational demonstration to engage the community in energy knowledge. Environmental Science students at UBC were given these parameters to create this demonstration. Through meetings, design workshops, and collaboration, these two groups have worked to design and implement this renewable energy demonstration in Riley Park.
Two main goals were set out to successfully accomplish this project, which were to design the demonstration such that it is:

1. Effective in attracting the public’s attention and encourages them in exploring various renewable energy sources and
2. Planned and completed in a practical and cost-effective way to fit the timeline of completion by April/May 2019, as well as within budget constraints.
2.0 Methods

2.1 Preliminary Research

Preliminary research was conducted with a focus on worldwide case studies in which renewable energy demonstrations were installed. This broad literature review was mainly outlined in the Bossink, 2017 review, an article which addressed the outreach impact of different sustainable energy demonstration projects. Baseline research also involved understanding large-scale energy sources that directly affect citizens within Vancouver, such as wind farms and hydropower dams in BC.

The RED aimed to educate consumers on renewable energy sources and the benefits of moving away from fossil fuels. It was therefore important that tangible values associated with energy costs were considered. National Energy Board statistics were consulted to understand the growing popularity of renewables and how they are used throughout Canada. This serves as a main source of facts the demonstration delivered to the public. An overview of how the different renewable energy sources operate were also researched, which we then condensed and delivered in a digestible way for members of the community to understand.

2.2 Choosing a demonstration

After conducting this research, seven demonstrations were recommended to SPEC (Appendix A: Presentation of Mini Proposals to SPEC), who provided feedback on these ‘mini proposals’ and outlined preference as to which demonstration to proceeded with. In each mini proposal, the feasibility of cost and the timeline was assessed.

A number of the potential demonstration ideas that were presented had immediate boundaries that ruled them out from the final decision. Bioenergy, for example, is substantially more expensive to implement than other sources and did not deliver an appreciable energy generation (Table 1). Other demonstration ideas, although feasible within our budget constraints, were not projected to have as significant of a social impact as our chosen demonstration, considering the overarching intent of the demonstration. The demonstration was directed towards engaging the community and increasing public interest in renewable energy. During deliberation, SPEC identified if certain proposals would accomplish this, given SPEC’s knowledge in past demonstrations they have implemented during their Renewable Experience (tREX) tour, as well as in climate change workshops they had facilitated to local elementary schools.
This analysis of the seven demonstration ideas led to choosing the final idea of an interactive and comparative demonstration of four sustainable energy modules. This provided a comprehensive understanding of different renewable energy sources and how they are comparable. The four modules are relatively cheap and simple to install, and with the live displays, provide some metric the public can observe and relate with.

Table 1. Proposals that were not chosen for implementation as a demonstration in Riley Park.

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Description</th>
<th>Reason For Not Choosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Panel Charging Outlets</td>
<td>A system that converts solar energy to electricity and stores it in a battery bank.</td>
<td>The solar panel is not as interactive by itself as desire for a demonstration.</td>
</tr>
<tr>
<td>Rain Hydropower</td>
<td>Collecting rainwater from the roofs of structures and generating enough energy to power a small demonstration.</td>
<td>There is not enough rainwater to generate electricity, and the stagnant rainwater will potentially breed insect pests.</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>Heat taken from compost waste can be used to heat the garden beds from the microbial breakdown of compost waste.</td>
<td>The cost of creating energy from waste is much too large for the scale of this project (around $40,000 CAD), and would need more compost than the park provides.</td>
</tr>
<tr>
<td>Hydro/Solar Combo</td>
<td>A water tank will act as a natural energy source. The solar power will push the water back into the tank.</td>
<td>This was not chosen because it is similar to the final project, yet with less components. The group decided to go with the more interactive option.</td>
</tr>
<tr>
<td>Manual Energy</td>
<td>Keep a bike stationary and use the energy generated to power a battery.</td>
<td>This demonstration would have little efficiency, and would not likely excite the community about the uses of renewable energy. It also had a large maintenance component which didn’t fit SPEC’s abilities at this time.</td>
</tr>
<tr>
<td>Wind Power</td>
<td>A mini wind turbine that would serve as an example of how larger wind turbines work.</td>
<td>There may not be enough wind in Riley Park to make this a successful demonstration.</td>
</tr>
</tbody>
</table>
Table 2. Proposal chosen for implementation as a demonstration in Riley Park.

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Description</th>
<th>Reason for Choosing it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactive Energy Comparison</td>
<td>Interactive activity that includes four energy modules: solar, wind, hydro, and mechanical, that will be connected to displays that show how much energy is generated real time.</td>
<td>This demonstration allowed renewable energy sources to be compared, along with providing an interactive component where a community member can turn a crank and see how much energy they generate in comparison to other sources.</td>
</tr>
</tbody>
</table>

2.3 Design of Chosen Demonstration

The chosen demonstration idea involves four energy modules, solar, pumped hydro storage, mechanical power, and wind power, which each connects to its own display which will indicate how much energy is generated live (Figure 1). In the proposal stage of the project, the suggested demonstration would involve four modules that could be implemented separately. The flexibility of the demonstration was intended such that if not all modules could be installed within the time constraints of the environmental science capstone project, SPEC would be able to install the remaining modules at a later date. From discussion with experts, it had been suggested that the modules would generate energy in a means that is viewable by the public. Lights, batteries, and phone chargers were considered as options.

Schematics were created with feedback and review from engineers researching renewable energy systems, who also recommended how to best implement the design outlined in Figure 1. Each component of the project was determined to connect to a battery and a display power meter. This display meter would allow consumers to compare the difference between how much energy each module was creating.

The four modules were chosen to illustrate the potential for renewable sources to be used within households in British Columbia. Solar was chosen as it is one of the most well-known renewable energy sources. Furthermore, the cost of solar has decreased significantly, dropping by 86% since 2009 (Berke, 2018). It is significantly cheaper than coal which costs $52 per MWh more than solar (Berke, 2018). Solar is also easy to install on homes, making them a realistic source of power for the local community. Wind was also chosen due to its lowered cost (Hill, 2018). Much like solar, wind power can also be installed in a home. Moreover, wind power makes up approximately 2%
of B.C.’s total electricity generation (National Energy Board, 2016). Similarly, hydro pumped storage was chosen due to the importance of hydro power within B.C. where it accounts for 86% of the total energy generated (National Energy Board, 2016). The hydro module not only shows how a dam works, but also how water levels can be manipulated to produce energy. Finally, the mechanical module was primarily chosen to make the demonstration interactive and show a comparison of energy produced which did not just rely on numbers. The combination of these modules creates a demonstration that will hopefully encourage users to install renewable energy source within their homes.

One of SPEC’s proposed uses for this demonstration was a workshop for local elementary schools. The interactive component gives students a way to participate in the demonstration with the intention that a hands-on approach in sustainable education will inspire the next generation to take interest in renewable energy and eventually install it within their future homes. In addition to workshops, Riley Park is home to many events. The interactive component can draw interest in the park through events held within the community garden. For example, the Riley Park Farmer’s Market can involve the RED through having a hose onto the hydro portion of the demonstration and community members can generate energy as they clean vegetables. The RED project also serves to facilitate conversations as park visitors learn more about renewable energy options and diversifying energy generation. Furthermore, the idea shows renewable energy on a small scale, presenting to the community how renewable energy sources can be feasibly installed within their own homes and consequently make the overall community greener in moving away from fossil fuel sources to generate electricity.

2.4 Finalizing Budget and Parts

In the same consultation process with renewable energy experts on design and electronic connections, insight was also provided on parts required to have an adequate level of energy generated from the modules. It was outlined that there were areas where there may be a discrepancy in energy output which would be explained in the accompanying placards. It was found that there are many resources through hobbyists online that demonstrated how to install small scale renewable energy demonstrations in a do-it-yourself (DIY) manner. These resources became a starting point in determining materials needed for all four modules.

The parts were chosen based on price, shipping time and review ratings of each item. Parts that were cheap and had good reviews as well as an acceptable shipping time were chosen. A materials list was created which contained the list of parts that was needed for the
demonstration (Appendix C: Materials and Expenses List). The list contained the name of each part, quantity, cost and link to the online listing, and was shared with SPEC for input and review.

Due to the flexibility of the demonstration design, many parts were available at the consumer level. Furthermore, all modules were based on DIY designs and did not rely on a manufacturer creating a whole unique module. This allowed for the demonstration to be built in stages by module as parts arrived. The solar and wind modules were built first as those parts arrived first. In addition, the displays and the battery were also installed during this time. The hydro module is installed after the arrival of the two reservoirs, while the mechanical module and light bulbs are installed once the custom bike frame is completed. Placards were installed in their respective positions as each module was completed (Appendix F: Information Placards).

In addition, SPEC provided the project with a budget of $1000. To supplement this budget, an additional $1500 was obtained through applying to the Connect to Community grant with the Centre for Community Engaged Learning (CCEL). Minor changes were made to the demonstration to allow for the final project to fit within these budget constraints.
3.0 Final Demonstration

The final demonstration is installed on a garden shed within Riley Park. The modules and placards were installed on the exterior of the shed. The interior of the shed held the various wiring and internal workings such as charge controllers. This was to allow SPEC to open the shed when hosting school workshops to see technical components of the demonstration while keeping it protected from harsh weather conditions such as rain and snow.

![Image](image_url)

*Figure 3.* The RED housed on a newly built shed in the Riley Park Community Garden. (a) The wind turbine and solar panel are attached to the roof and to the side. (b) The wiring, wind controller (silver box) and solar controller (orange box) are mounted onto the inside of the shed walls. (c) The displays show the energy output each module produces in volts, wattage and ampere.

A solar panel is attached to the eastern side of the shed (Figure 3a), such that it would receive most of the sunlight in the morning. The solar panel is connected to a controller within the shed (Figure 3b). The controller is used to regulate the electricity and directs outputs into the battery and the displays. The solar power controller also has a USB header which has been extended using a USB extension, which is placed on the exterior wall of the shed.

The battery is primarily used to power the pumped hydro storage module. Water is contained within the upper and lower reservoirs. The upper reservoir is placed within the shed, on a shelf near the roof. A rain barrel, which serves as the lower reservoir, is placed outside. Two water turbines are placed on a wall (same wall as the solar panel) of the shed to show how the turbine spins and creates energy.
In addition to the pumped hydro storage, a wind turbine is also attached to the roof of shed (Figure 3a). The wind turbine is placed on the highest part of the shed using a custom bracket. The turbine connects to the controller which is placed inside the shed (Figure 3b).

*Figure 4. Schematic diagram of the installed RED. The schematic provides a visual representation of how the demonstration was connected. Each module is listed as a source (black square). A power meter (blue rectangle) acts as a display of the energy provided by the module. The converter (red triangle) converts the energy into a safe form to charge the battery (2 lines). Finally, the switch (line and 2 circles) allows for the hydro module to be turned off.*
Figure 5. A diagram of the mechanical module is pictured above. A bike wheel is attached to a custom mount (made from a bike frame) that is fixed to the shed. A crank rotates the wheel which causes the belt to move. As the belt moves, it runs the motor (also attached to the shed wall) which produces energy. All the wiring is inside the shed and everything but the hand crank will be placed behind a plexiglass acting as a guard.

The last module of the demonstration is a mechanical module. A custom frame was created for the shed (Figure 5), to house the motor, belt, and hand crank. It is attached to the same wall as the water turbines and solar panel. When the hand crank is rotated, it spins the motor within the shed. The motor is used to create electricity which is then sent through the displays to show the amount of energy being created at the time.

Each component are connected to backlit displays which show how much energy is being produced (Figure 3c). The hydro, wind and mechanical modules are all connected to light bulbs (Figure 4). The brightness of each bulb shows how much energy is being produced by each component. When the crank is turned, the brightness will depend on the speed of the crank and the length of time the crank is turned. In addition to the displays and the light bulbs, the informational placards will be installed which describe how each module operates. The placards also touch on how these renewable energy sources can be included in local homes to generate electricity.
4.0 Discussion

Demonstrations give the community the opportunity for hands on engagement. As one of SPEC’s goals as an organization is to involve the community in knowledge on energy, giving the community an engaging, interactive means to do so helps to accomplish these goals. The newly installed RED holds high potential as an outreach tool for community members through not only being a central piece of Riley Park, but as well as through several activities facilitated by SPEC. The Renewable Experience Tour (tREX) involves a walking tour by SPEC to explore renewable energy that has been implemented around the City of Vancouver, and will now encompass Riley Park with the newly installed RED. This demonstration will also play a vital role in climate change workshops brought to elementary schools. Students will be able to see the renewable energy sources in action. The demonstration will also be able to teach them how it works and what each source needs, an aspect that SPEC was not able to do in the workshops. The demonstration will play an important role in educating children about renewable energies and inspiring them to use them. Moreover, the demonstration will also show the importance of utilizing multiple renewable energy sources to produce energy to maximize energy security. Further studies on the impact of this demonstration amongst others in Vancouver could be crucial in understanding how to engage with the public on scientific matters.

5.0 Conclusion

The design components of the RED project contribute to the success of this demonstration. An interactive component that involves the mechanical energy module, along with digestible educational placards to accompany the display, allows for full integration of different modules. While the four modules that were included in the demonstration are already familiar to the general public, it is believed that current advancements in technology are at a stage where renewables can be more easily implemented into one’s own home. With the demonstration being housed on a garden shed, consumers can see the feasibility in diversification of installed energy sources, which has already been widely materialized across Canada, and bring this into their own homes. Solar, wind, and hydropower are all steps towards moving away from carbon emitting sources, and mechanical power is another exciting energy source which has been seen in electric cars. The RED project also adds onto the growing number of renewable projects that have been installed around Vancouver, which all contribute towards community members being able to experience firsthand the benefits of renewable energy demonstration in the nationwide initiative in moving away from fossil fuels.
Acknowledgements

The demonstration was created in collaboration with SPEC. We would like to thank our community partners at SPEC, Chris Gooderham and Ruth Briggs, who provided guidance, feedback, and technical knowledge on installing the renewable energy modules. We also thank SPEC for providing the initial $1000 budget for the RED project. We thank the Centre for Community and Engaged Learning (CCEL) at UBC for providing an additional $1500 of funding through the Connect to Community Grants. This has immensely helped in creating the demonstration to succeed in its full potential.

We would also like to acknowledge Matthieu Amyotte and Rouhollah Shafaei with the Renewable and Alternative Power Conversion Group in the Department of Electrical and Computer Engineering for sharing their expertise on renewable energy systems.

Lastly, we are very grateful to our instructors, Dr. Tara Ivanochko and Dr. Michael Lipsen for their support throughout the course.
References


Appendix

Appendix A: Presentation of Mini Proposals to SPEC

Mini Proposals
Options for the Renewable Energy Demonstration Implementation in Riley Park, Vancouver

Theresa, Gopal, Maegan

OCTOBER 2018

Goal of The Presentation

After consulting with experts and doing in depth research on different renewable energy options, we have created a list of 7 different options for the demonstration which we will explore in more depth.

Content
1. Solar Panel Charging Outlets
2. Interactive Energy Comparison
3. Rain Hydropower
4. Bioenergy
5. Hydro/Solar Combo
7. Wind Power
Solar Panel Charging Outlets
Solar Energy (photovoltaics)

01 Description
A system that converts solar energy to electricity and stores it in a battery bank.

03 Costs
Photovoltaic cells, rechargeable battery, charge controller, inverter.
~$1000

02 Timeline
After obtaining parts, we assume this would take about a week to set up and implement.

04 Additional

Interactive Energy Comparison
Solar, Wind, Manual,

01 Description
Interactive activity that allows public to compare energy sources visually.

02 Timeline
~ 2 weeks for building

03 Costs
LED lights
Bicycle
Generator
~$1000
01 Description
Collecting rainwater from the roofs of structures and generating enough energy to power a small demonstration.

02 Timeline
After obtaining parts, we assume this would take about a week to set up and implement.

03 Costs
Gutters to collect rainwater, tank to store water, peloton turbine, piping for directing water, dynamo
~$2000

Rainwater Hydropower
Hydropower - rainwater

04 Additional
Equation: $P \text{(in W)} = g \cdot Q \cdot H \cdot \text{turbine efficiency} \cdot \text{generator efficiency}$

Bioenergy
Renewable energy from living sources

01 Description
Heat taken from compost waste can be used to heat the garden beds from the microbial breakdown of compost waste.

02 Timeline
~Not able to generate a viable option at this point.

03 Costs
Potential ready made solutions
~Piping
~Anaerobic machine
~$20,000+
Hydro/ Solar Combination
Renewable Energy from multiple sources

Description
A water tank will act as a natural energy source. The polar power will push the water back into the tank.

Timeline
Installation
- Solar panels - 1 day
- Piping and tank - 2 days
- Turbine - 1-2 weeks

Costs
- Solar panels - less than $500
- Tank - Under $500
- Turbine - Varies
- Piping - Under 100
- Total: ~$1500

Manual Mechanical Energy
Manually generated energy converted to Electricity

Description
Keep a bike stationary and use the energy generated to power a battery.

Timeline
After obtaining parts, we assume this would take about a week to set up and implement.

Costs
- Bike Power Generator $700
- Bike $100
- Battery $200
- DIY:
- Treadmill motor $50-$150
- Diodes $50
- ~$1000

Additional
Hand crank and/or pedal could be an alternate option for this set up.
Wind Powered Demonstration

Wind

01 Description
A mini wind turbine that would serve as an example of how larger wind turbines work.

02 Timeline
~ 1 day to a week depending on which version is decided on

03 Costs
PVC pipes, battery, assorted parts
~$1000

Decision Time

Thank you
Appendix B: Visual Timeline

Timeline set up for the RED project, divided into three stages (Research, Proposal, and Installation). Last updated March, 2019.
Appendix C: Materials and Expenses List

The materials list and expenses breakdown. * indicates estimated costs.

<table>
<thead>
<tr>
<th>Module</th>
<th>Component</th>
<th>Qty</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crank Generator</strong></td>
<td>Electric Motor</td>
<td>1</td>
<td>58.99</td>
</tr>
<tr>
<td></td>
<td>Charge Controller</td>
<td>1</td>
<td>37.99</td>
</tr>
<tr>
<td></td>
<td>Belt*</td>
<td>1</td>
<td>20.00</td>
</tr>
<tr>
<td></td>
<td>Modified Bike Frame *</td>
<td>1</td>
<td>450.00</td>
</tr>
<tr>
<td><strong>Wind Turbine</strong></td>
<td>Wind Turbine</td>
<td>1</td>
<td>252.97</td>
</tr>
<tr>
<td></td>
<td>Turbine mount</td>
<td>1</td>
<td>210.00</td>
</tr>
<tr>
<td><strong>Hydro Pumped Storage</strong></td>
<td>Water Turbine</td>
<td>2</td>
<td>20.50</td>
</tr>
<tr>
<td></td>
<td>Switch to Power Pump*</td>
<td>1</td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td>Water Pump*</td>
<td>1</td>
<td>40.00</td>
</tr>
<tr>
<td></td>
<td>Rain Barrel</td>
<td>1</td>
<td>134.40</td>
</tr>
<tr>
<td><strong>Solar Panels</strong></td>
<td>Solar Panel Kit</td>
<td>1</td>
<td>286.82</td>
</tr>
<tr>
<td></td>
<td>Battery</td>
<td>1</td>
<td>179.19</td>
</tr>
<tr>
<td></td>
<td>Battery Box + Fuses</td>
<td>1</td>
<td>21.08</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Additional Displays</td>
<td>5</td>
<td>109.08</td>
</tr>
<tr>
<td></td>
<td>DC Watt display</td>
<td>4</td>
<td>52.75</td>
</tr>
<tr>
<td></td>
<td>LED Lighting and Motion sensors</td>
<td>1</td>
<td>76.96</td>
</tr>
<tr>
<td></td>
<td>Wires</td>
<td>1</td>
<td>64.54</td>
</tr>
<tr>
<td></td>
<td>Wires + Terminal Blocks</td>
<td>1</td>
<td>18.71</td>
</tr>
</tbody>
</table>

**TOTAL:** 2482.41
Appendix D: Poster

Poster submitted to SPEC and Little Mountain Neighbourhood House to advertise the RED project in its future home, the Riley Park Community Garden.
### Appendix E: Initial Deliverables Outlined by SPEC

| Expected Deliverables | • Baseline research on the existing technologies that are appropriate for an education renewable energy display  
|                       | • Summary of quoted costs for a minimum of two options  
|                       | • Project proposal including a detailed budget  
|                       | • Summary of available grants |
| Potential Deliverables | • Grant Proposal  
|                       | • Summary of communication with engineers/contractors  
|                       | • Method to track community engagement  
|                       | • Finished renewable energy demonstration |
Appendix F: Information Placards

The main poster that will be displayed in the front of the shed. This holds general information for members of the community to see the demonstration, as well as visually compare the parts. The electronic displays for energy output will also be placed in cut outs at the bottom of the poster.
PUMPED HYDRO STORAGE

The hydro power tank works as a way to store energy. This is an alternative to storing energy in batteries. Hydropower is most commonly known in the form of massive hydro dams. This demonstration presents another method - pumped hydro storage!

How does it work?

1. Water flows from an upper reservoir and causes the water turbine to move
2. The turbine produces energy as it moves, converting mechanical energy into electricity
3. The water is sent to a lower reservoir
4. A pump pushes the water back into the upper reservoir so more energy can be produced

Real World Applications

• Currently the energy produced from dams relies heavily on the reservoir levels
• By modifying the dams to have a pumped hydro storage, during non-peak hours water can be pumped back into the reservoir to increase flow rates and produce more energy

While pumped hydro storage requires energy to pump water between the reservoirs, they are beneficial by balancing load in the power system. While the energy produced may not be as much as the other sources, they can play an important role in our modern energy systems.

The pumped hydro storage placard which briefly explains the way this module operates. It also describes how the concept could be applied in real world scenarios.
The proposed placard for the solar module.

The proposed placard that will be placed next to the wind module.
The proposed placard that will be placed next to the mechanical module.