The Solar Compass

Principal Investigator: Michael D. Mehta, Ph.D.
Professor, Department of Geography and Environmental Studies, TRU
Email: mmehta@tru.ca Tel: (250) 852-7275

Project Description And Benefits

The Solar Compass project supports TRU's sustainability trajectory by incorporating a solar path/road in front of the Arts and Education (AE) Building [N 50 40.269, W 120 21.884] (see Figure 1). This would be embedded into the existing decorative compass and it would showcase, in an accessible and highly visible location, a new and innovative technology for electricity generation.

Figure 1. Location of Solar Compass on the south side of the Arts and Education Building at Thompson Rivers University, Kamloops, B.C.

This pilot project will enhance the operational performance of the university by providing "green" electricity for the Arts and Education Building on a net-metered basis, promote sustainability literacy and education by showcasing a novel approach for using existing infrastructure for environmental benefit, and advance applied research through strategic partnerships. The main benefit provided by the Solar Compass is to promote educational opportunities that showcase novel and transformative solar photovoltaic options.

Solar roads and paths are part of a global effort to use existing infrastructure for electricity production, and they are catalyzing a shift toward smart infrastructure that has potential to include embedded lighting and signage, incorporation of networked services for IT systems, navigation for self-driving vehicles, and dynamic in situ charging for electric vehicles.

The societal and environmental benefits of this approach are becoming more recognized as an option for reducing the rate of climate change by modifying existing infrastructure.[i] Furthermore, embedded solar panels shift application away from the use of arable land commonly used for solar farms, and they are minimally invasive from an aesthetic perspective. In the case of solar roads and paths, this technology aligns power production with power consumption through a series of micro-grids so that electricity produced near a home or business is used first by that user thus minimizing transmission line loss and other inefficiencies associated with large grid infrastructure.

Countries like The Netherlands have invested in such technology.[ii] For example, the Village of Krommenie (northwest of Amsterdam) operates a 70 m long bicycle path made from concrete slabs containing embedded solar photovoltaic panels.[iii] France has recently announced that it will pave 1000 km of solar roads over the next five years.[iv]

The Solar Compass will be a first in Canada, and it is likely to become a focal point for sustainability tourism in the region, and to be a model for larger-scale deployment of this technology in the City of Kamloops and elsewhere. Furthermore, this project will help launch a made-in-Canada approach to solar road and path development with assembly of modules being done fully in British Columbia, and 70% of components manufactured in this province.

The unique configuration and location of the Solar Compass (see Figure 2) lends itself well to this technological approach, and ties into the aesthetically pleasing design of the campus with a shape that is familiar and symbolic. The Solar Compass emblematically points us in the right direction; namely; toward a future based on innovation, renewable energy, sustainability, and social responsibility. The Solar Compass is a visible reminder that our collective future requires that we look in all directions for inspiration and guidance.

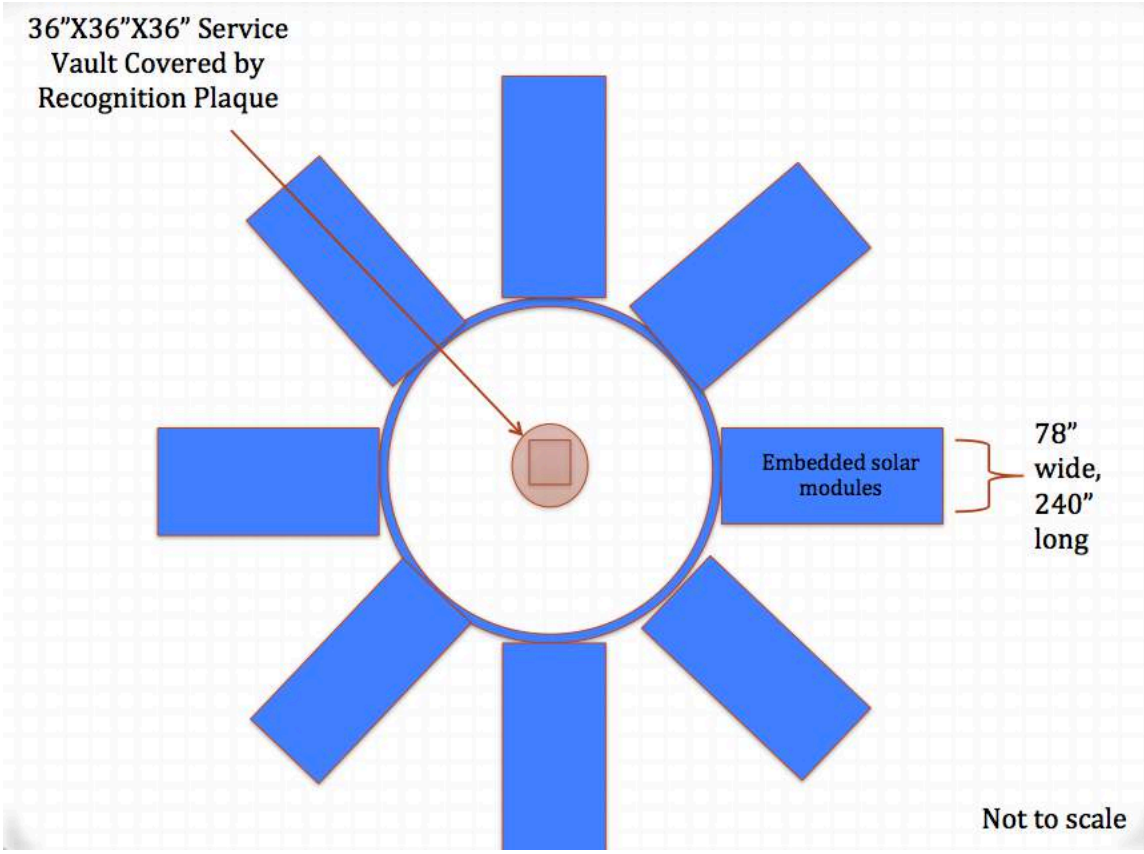


Figure 2. Lay-out of Solar Compass. Size of modules: 4' X 5' X 3" thick and designed to sit flush in existing path base: anti-slip surface, tough enough to handle snow removal, road salt, and vehicular traffic (up to 20 T). Installation may require thin expansion zones to minimize heaving risk from frost. Given that the center of the existing decorative compass is showing cracks and wear in the concrete - and to match concrete with the new work - replacement of the exposed aggregate in the center is required. It is anticipated that TRU will cover this work as part of regularly planned path maintenance.

People, Partnerships, and Performance Measurements

People and Partnerships:

Currently 27 people are on the Solar Compass team including domestic and international students, TRU alumni, staff, faculty, and community members (see Appendix 1). The project has one community partner and two corporate partners.

The Kamloops Chapter of the British Columbia Sustainable Energy Association (Kamloops BCSEA) is the community partner. The Kamloops BCSEA will play a role in promoting this technology and coordinate with media and other stakeholders to raise awareness of solar path and road technology options in British Columbia (see Appendix 2).

Solar Earth Technologies and Riverside Energy Systems are corporate partners. Solar Earth Technologies is a Vancouver-based company that has agreed to donate the embedded solar modules to the university for this pilot project – a value of up to $60,000 - and to provide ongoing consultation on installation and maintenance (see Appendix 3). They have agreed to monitor the integrity and optical properties of the optical layer over time, and to replace it as required if scratching or changes in opacity impact performance of the system.

Solar Earth Technologies has also partnered with the University of British Columbia – Okanagan's (UBCO) School of Engineering to test this technology for strength, slip resistance, optical properties of the tempered glass optical layer, and maximum power point tracking (MMPT) to optimize performance of the modules as they convert DC to AC with the inverter.

Riverside Energy Systems will be the consultant and installer of the electrical components for the project, and will provide ongoing maintenance and warranty work as required.

Performance Measurements:

The DC rating for the Solar Compass is expected to be 9600 Watts and no batteries are required. Using PV Watts calculations from the National Research Energy Laboratory, this array will produce on average 9700 kWh/year of electricity over its planned 25-30 year lifetime. At the end of its life, the Solar Compass can be removed as part of the university's ongoing path/road maintenance program, or simply be left in place as a decorative structure, and as an example of a technology from the second decade of the 21st Century.

The Solar Compass, like all solar photovoltaic modules mounted horizontally, will generate 20% less electricity than a fixed solar photovoltaic array facing south at a 40 degree tilt at this latitude. However, donated equipment, and no engineering costs, as are required for building-mounted systems, will make up this difference. Additionally, the modules will result in an installed 9.6 kW nameplate system for approximately $36,000 (including 10% contingency fee), and when de-rated by 20% for horizontal mounting, this is the equivalent of commissioning a system for $4.50/Watt – a figure comparable to standard roof-mounted arrays.

Table 1 compares tilt versus flush mounting with respect to power production. Sun path calculations have been conducted for the location as well as a preliminary survey of obstructions using an engineering application called Theodolite. Annual production is assessed as "very good" with some tree obstruction from shadowing in the winter months when photovoltaic production is lowest to begin with.

Furthermore, a three-year study conducted recently by the Northern Alberta Institute of Technology on two installed sets of solar arrays concluded that snow on solar panels only reduced solar panel output by approximately 5% on an annual basis – even for modules mounted horizontally.[v] Pedestrian movement is likely to have minimal effect on annual power production given that this technology is designed for road use, where traffic is the norm.

It is anticipated that the Solar Compass will provide enough power to offset annually up to forty computers in the AE Building operating 8 hours/day on average.

Tilt	**kWh/year/kW installed capacity**	**Percent of best**
40 degrees south	1261	100
20 degrees south	1195	94.8
10 degrees south	1119	88.7
0 degrees flat mount	1014	80.4

Table 1. Comparison of production based on module tilt and orientation using PV Watts data for location of the Solar Compass as a percent of optimal (best).

As a pilot project, ongoing data on system performance and other variables could be used by campus as a whole, and by the City of Kamloops and Thompson-Nicola Regional District, to inform decisions about wider scale deployment of the technology and to elucidate lessons learned. The website www.solarcompass.ca has been registered by the project team to expand this impact.

A monitoring system would be set-up in a display case in the Arts and Education Building, and an online interface would also be available to show power production in real-time, with searchable historical data easily accessible. This could be used in a wide range of academic and vocational courses on campus. Combined with other information (e.g., weather, air quality) it could provide data for energy modeling work, building design (e.g., ARET program), and for teaching and/or research in environmental studies, science, and nursing.

Other learning outcomes, and performance measurements, will be fulfilled by the installation itself. Cost-effective and robust installation options that can be scaled are critical for this technology to take off. Working with Solar Earth Technologies, their partner in the School of Engineering at UBCO, a general contractor for concrete work, electricians and engineers from Riverside Energy Systems, and on-campus support through Facilities, the project will involve the development of approaches for managing drainage, frost heaving, and simplified access options for ongoing maintenance. Figure 3 illustrates the technological platform for the Photovoltaic Mosaic System, Figure 4 shows the concrete base layer in which it sits, and Figure 5 provides examples of the non-slip surface optical layer options that are being tested. The concrete base layer would need to be poured on-site to minimize transportation and installation costs. The corporate sponsor, Solar Earth Technologies, will provide wooden framed moulds to use for fabrication purposes.

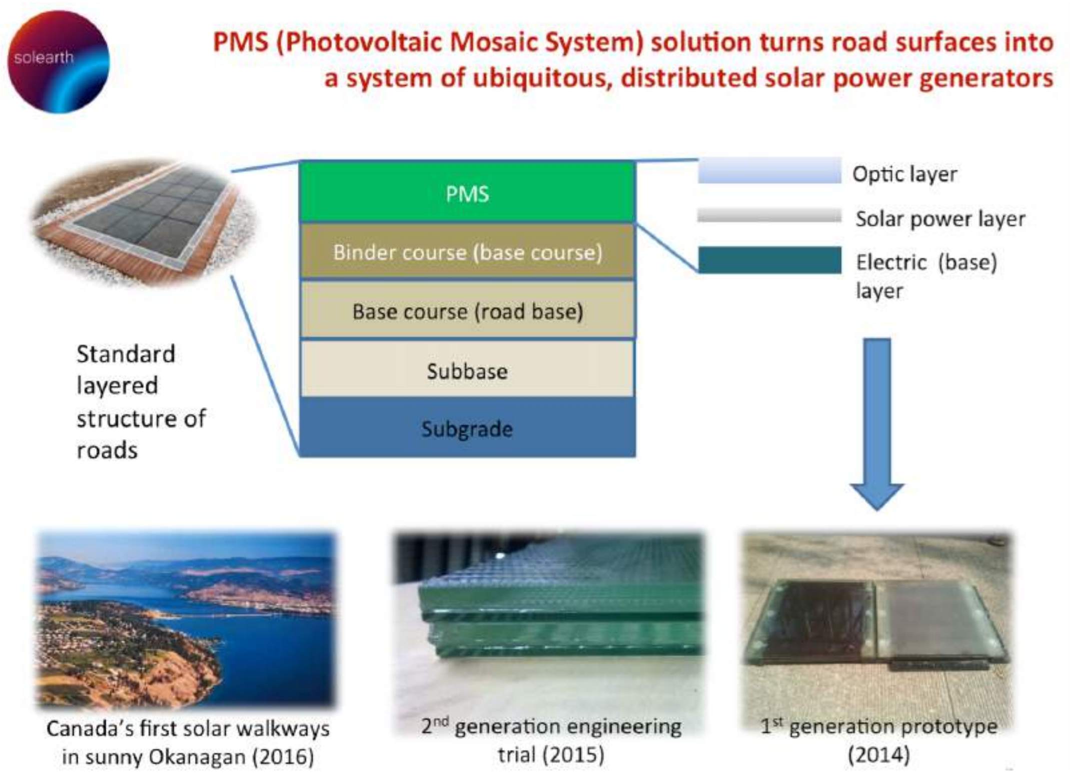


Figure 3. Photovoltaic Mosaic System from Solar Earth Technologies.

Figure 4. Base layer.

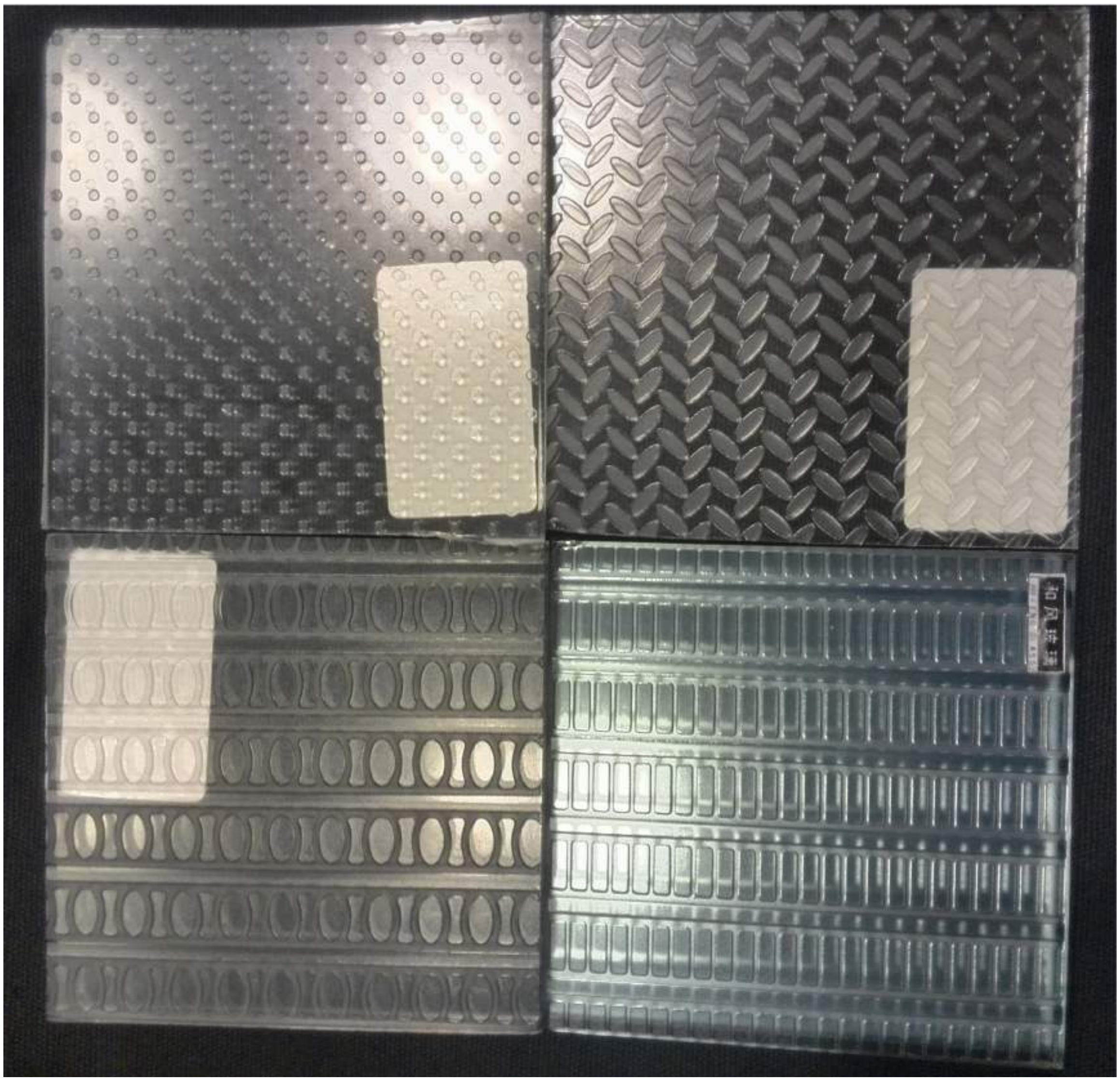


Figure 5. Four of several patterns of the optical layer undergoing testing by UBCO's School of Engineering.

Other performance measurements will involve development of wiring and conduit placement options, including work with electrical inspectors to ensure full compliance with the Canadian Electrical Code and all inter-connection requirements for net-metering through the university's electrical utility provider. Figure 6 illustrates a wiring and conduit configuration for solar sidewalks that will require modest modification to work in the Solar Compass, and Figure 7 is a rough schematic produced by Riverside Energy Systems of how the array will be configured with wiring, conduit, inverter, and optimizer technology to minimize the effects of shadowing and pedestrian/vehicle traffic on power production.

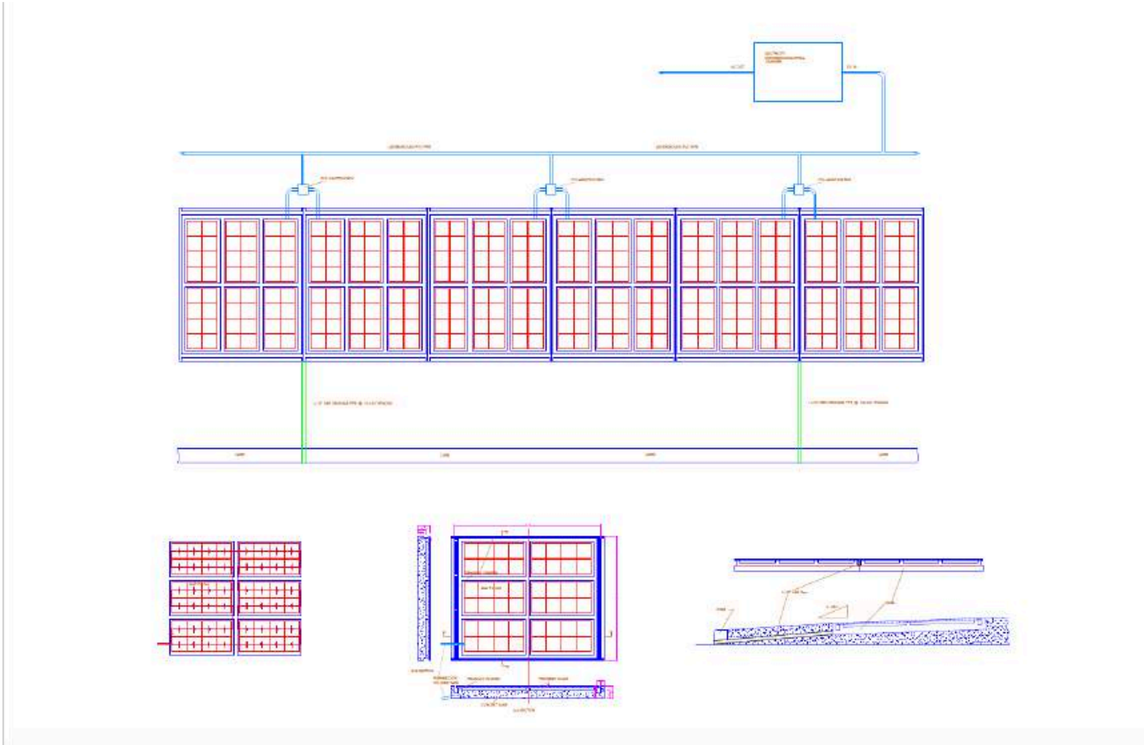


Figure 6. Wiring diagram with drainage indicated.

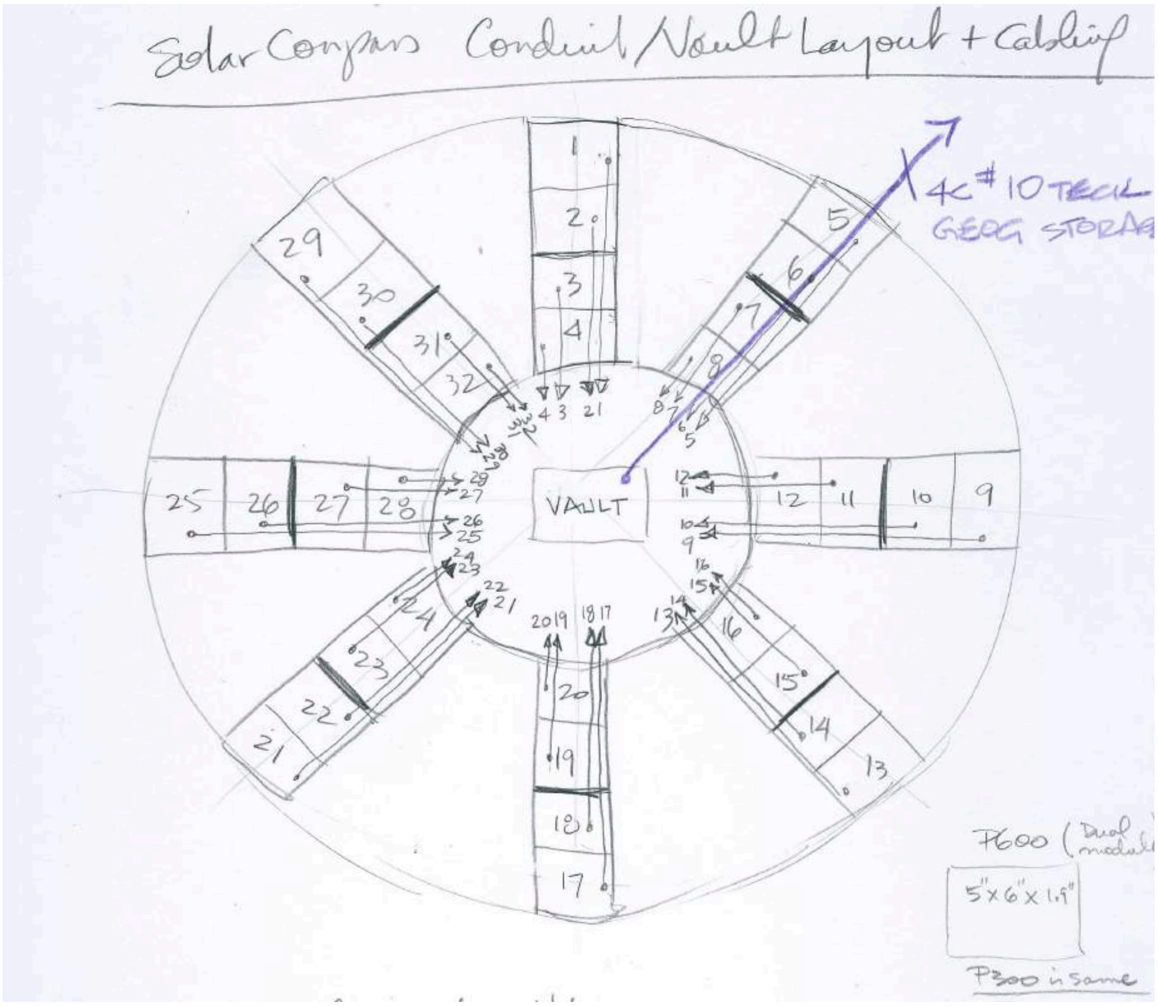


Figure 7. Wiring diagram for the Solar Compass with optimizers placed in a vault. This will require replacement of concrete in the middle as well as in the eight arms of the compass (dark exposed aggregate only).

Level of Impact

The Solar Compass project team is diverse and interdisciplinary in nature. There are 14 current and former TRU students on the team with backgrounds in Architectural Design, Geography and Environmental Studies, Fine Arts, Economics, Finance and Accounting, and English. These students have been involved in every stage of pre-proposal and proposal development, and they have taken on key roles in drafting these documents, assessing the site and technological platforms, logo development, producing a promotional Youtube video, and working with general contractors on construction costs and budgeting. With faculty, staff, and community members, students will continue to play a role in coordinating all aspects of construction and commissioning of the Solar Compass, and in promotional, marketing, and communication strategies for the project. A grand opening for the Solar Compass will be the culmination of the team's work, and a chance to recognize partners and sponsors. A ceremony may also be held to provide an opportunity for a First Nation's Elder to give a blessing.

The Solar Compass represents a unique opportunity for TRU to engage on-campus and external communities with respect to this technology in particular, and to heighten awareness of renewable energy options in general. With a dynamic and evolving website, an active social media presence led by student team members, and a media campaign strategy developed by the Kamloops BCSEA in consultation with TRU's Marketing and Communications Department and the Principal Investigator, the Solar Compass will have significant and lasting effects and it will likely garner international attention and recognition.

The Solar Compass supports TRU's goal of becoming a university of choice for sustainability by increasing environmental awareness of how electricity can be generated in a sustainable and renewable way while reducing the carbon footprint of the institution. This is reflected in the Campus Sustainability Action Plan (January 2012), the TRU Academic Plan (December 2011) in the theme on sustainability, and in the university's Environmental Policy (BRD-23-0) dealing with energy efficiency, carbon neutrality, and the need to play a leadership role in our community. The Solar Compass is also consistent with other solar technologies on campus including a solar photovoltaic roof-mounted array and solar thermal systems. The Solar Compass will not interfere with future developments as outlined in the Campus Master Plan.

Project Feasibility

The Solar Compass team has a rich, diverse and motivated set of team members, a community partner, and two corporate partners who are committed to making this project a success and a showcase of a new sustainability technology.

The Principal Investigator, Dr. Michael Mehta, has more than 20 years of experience working with renewable energy, and he founded and directs a B.C-based non-profit organization called GabEnergy. In less than two years, GabEnergy has installed more than 1000 solar modules in the province with many customized systems, and it has installed two of the largest residential arrays in the province. GabEnergy has recently secured a contract for the City of Nelson's Community Solar Garden with an initial array size of 60.46 kW nameplate capacity.

With an established company in Kamloops, Riverside Energy Systems, the likelihood of successfully building and commissioning the Solar Compass is very high. Riverside Energy Systems has commissioned solar arrays on campus already, and it is a trusted and professional company with vast experience and technical acumen.

Solar Earth Technologies is committed to the success of this project and sees this pilot project as the seed for future expansion of solar roads and paths in Canada.

The Kamloops BCSEA is an established and highly respected local non-profit with a parent organization that has made significant contributions to public understanding and policy development in B.C. The organization has 12 years' experience promoting sustainability initiatives in Kamloops and will be assisted by the BCSEA provincial office to reach a wider audience.

In terms of cost effectiveness, the Solar Compass will cost $4.50/Watt or less when installed. For a new technology like this, the cost is very low and the benefits of taking a leadership role with a new sustainability technology are demonstrable to the university. On a levelized cost of energy basis over 30 years, this array will produce electricity for 12.37 cents/kWh.

Detailed budget:

See Appendix 4

Project size and timeline:

Appendix 5 provides a detailed Flowchart of Implementation Steps. The goal is to begin this project immediately upon receipt of funding. Production delays for module delivery are a possibility but such delays are not anticipated to affect completion of the project in a substantial way, and certainly not beyond the expiry of the funding in February 2017.

Planning

Located in front of the Arts and Education Building, the Solar Compass has the potential to generate a lot of interest and perhaps some concern. In November and December of 2015, team members presented information about the Solar Compass to the two faculty councils representing academic divisions that primarily occupy this building; namely, the Faculty of Arts and the newly renamed Faculty of Education and Social Work. Without exception, there was full support from all present at these faculty council meetings, and faculty and staff expressed appreciation that their building may possibly host such an innovative and exciting project. Both Deans located in this building were also contacted and no concerns were expressed by them about the Solar Compass.

Team members also consulted with other groups and individuals including the following:

Faculty members in the Department of Geography and Environmental Studies were consulted early and often, and the Department supports the project and the use of the display cabinet on the ground floor for a monitor, as well as the map room adjacent to the front entrance of the building for the mounting of a grid-tie inverter.

Warren Asuchak from Facilities Services was contacted early in the pre-proposal stage. He indicated at that time that part of the University's ongoing budget for path maintenance might be accessible for some of the concrete work involved in building the Solar Compass. Team member Brandon Dallamore, a student and a staff member with Facilities, has been the point person for ongoing consultation and discussion with Facilities Services. Brandon has consulted with an on-campus electrician and determined that a simple interconnect to an electrical closet can work from the planned map room. As well, easy and accessible access to the display cabinet for the monitor exists for Ethernet or wireless connections.

Joanne Rosvick from TRU's Department of Physical Sciences is a frequent user of the telescope based in the nearby International Building. Dr. Rovick expressed concerns about the original idea developed in the pre-proposal of including a LED curated display in the middle of the Solar Compass due to light pollution. This curated display has been removed from the full proposal due to this concern, and due to other issues with respect to budget and identification of currently available and low-cost appropriate technology.

Team member Sandra Trawin contacted Paul Michel (Executive Director of Aboriginal Education) to discuss how to respectfully, and in culturally sensitive way, disrupt the Earth for installation of the Solar Compass. Mr. Michel spoke with three Elders on campus about the role First Nations' can play in the ground-breaking ceremony (tentative) and during the recognition/grand opening event.

Team member Charles Hays consulted with a group in Kamloops who are involved in amateur radio to explore concerns about radio frequency fields and related health and environmental concerns. Unintended electromagnetic interference (EMI) is an entirely avoidable consequence of the use of electronic equipment. Probably the "dirtiest" equipment in common use are switch-mode power supplies (common in many consumer and professional devices) and other power-conditioning equipment such as DC-to-DC converters and DC-to-AC inverters. Inverters are used in this project to convert the direct current (DC) output of the solar panels to alternating current (AC) to feed into the grid-tie. These steps can generate EMI that interferes with nearby equipment. Various consumer groups and trade organizations have been sounding alarms about "dirty" equipment – primarily from Chinese manufacturers – being sold in Canada and the US. Some of this equipment is type-accepted but not quality controlled, other examples are intended for commercial use and special installations but sold over the counter in home-improvement stores with no documentation.

Professional engineers from Riverside Energy will bench-test and verify inverters and other equipment before installation. Solar Compass team members may undertake additional testing and verification (broad-spectrum RF sweep). Possible effects of EMI from this project include interference with nearby cellular signals; interference with Bluetooth and RFID applications; interference with nearby equipment unrelated to the project; and possible interference with communication equipment used by campus security personnel. It should be noted that EMI problems arising from this equipment, if any, are likely to be relatively simple to address. The primary concern is awareness of the issue and inclusion of this awareness in the design process.

Sustained funding:

The Solar Compass should require little ongoing maintenance. Like most solar photovoltaic arrays, periodic cleaning and removal of snow and debris will be required. This is normally done in the location given that it is a commonly travelled route to the Arts and Education Building. As indicated, Riverside Energy Systems as installer will be responsible for any warranty-based work resulting from issues associated with the grid-tie inverter, while the corporate sponsor Solar Earth Technologies will replace the glass optic layer if required over time as part of their commitment to the project, and deal with defective modules.

Appendix 1: Team Members

Terryl Atkins is a faculty member of the Visual and Performing Arts Department who teaches visual culture, drawing, curating, public art, and art theory. Her research background is the phenomenology of imagination and consciousness and the effects of embodiment, subjectivity and environment on perception.

Doug Buis is an Associate Professor in the Department of Visual and Performing Arts. His exhibition record includes galleries and museums across Canada, in Holland, Belgium, Korea, New York, Denver, Washington St and numerous venues in the Los Angeles area. Doug has also curated a number of exhibitions in many of the same locations. In his own work he investigates our malleable perception of landscape and environment through a series of different media and strategies including sculpture, video, kinetic art, installation, other time-based media, photography and some writing.

Ali Burnett is a third year student in the Architectural and Engineering Technologies program, with an interest in sustainable energy production and civil infrastructure design.

Brandon Dallamore is an Architectural Technologist student and long-term Facilities staff member at Thompson Rivers University. He has a strong commitment to building community, and to promoting positive environmental impact through sustainable development and planning.

Nancy Flood is a faculty member in the department of Biological Sciences, where she teaches ecology-related courses, including field biology courses at TRU's field station adjacent to Wells Gray Park. Her research focuses on the behavior, ecology and evolution of birds and on various topics related to the scholarship of teaching and learning. She has been involved in various ecological projects on campus, including planning for natural areas on TRU land, running worm composters that dealt with staff room food waste in the Science Building for a decade before TRU purchased its industrial composters, and assisting with the Films for Change series. In the community, she is a member of many environmental organizations and is particularly active in Kamloops 350 and Transition Kamloops.

Lee Giddens is a Landscape Consultant working with a landscape architectural practice in Calgary, Alberta. Involved in various LEED® registered and certified projects, her interest has always been captivated by innovative solutions to environmental design. Born and raised in Kamloops, Lee attended Thompson Rivers University and holds a Bachelor of Arts Degree in Geography with a Minor in Visual Arts. With experience in design, drafting and the approvals process, as well as a passion for renewable sources of energy and her hometown, she hopes to support the Solar Compass Project in several capacities. She sees the success of the project as a lasting imprint of Thompson Rivers University's commitment to sustainability and innovation within Kamloops and region.

Janis Goad teaches English as a Second or Additional Language and Adult Basic Education in the Faculty of Human, Social, and Educational Development. She is particularly interested in the Solar Compass project as a way to promote green technology practically and locally. She also sees its value in providing life learning experiences that allow Canadian, First Nations and international students to collaborate on a common task and develop cross-cultural and planetary understanding.

Kim Goodall is a third year Geography Major with an Environmental Economics and Sustainable Development Minor. She has one year of work experience with the Province of British Columbia's Regional Economic Operations, and she is interested in the application and expansion of renewable energy technology to support community resiliency and to diversify local business development and growth.

Amber Gudmundson is an undergraduate student at TRU.

Katherine Hawrys is a fifth year Geography and Environmental Studies major. The most notable project she have been involved in, up to this point, is an Indigogo campaign to raise money and awareness for the benefit of a TRU campus garden.

Dr. Charles Hays is Assistant Professor, Program Advisor and Practicum Coordinator in the Department of Journalism, Communication and New Media. He is also an organic farmer and supports the university's goal of environmental sustainability by composting waste from campus food outlets. He has written on community development, sustainability, and creative low-tech solutions to widespread problems.

Yumiko Hamano is an international student at TRU from Japan. She studied Economics for two years in Japan.

Claire Irvine is in her third year of university and is studying Geography and Environmental Studies. She is an extroverted scholar with an artistic inclination with a passion to protect the endangered, the oppressed, and the hungry. Her goal is to one day see the Earth on its way to restoration.

Cheryl Kabloona retired from a career was with BC Lottery Corporation, and she now chairs the Kamloops Chapter of the BC Sustainable Energy Association. She holds a Masters in Anthropology from UCLA and is certified as a Project Management Professional (PMP).

Eric Little is an undergraduate student at TRU majoring in accounting. Eric has a passion for technological innovation and ethical business.

Ian MacKenzie is a community member who was born on the B.C. coast in 1933. He retired from teaching in 1988 and spent much of his working and playing life in the interior mountains and forests yet he still yearns for the smell and sound of the ocean.

Dr. Courtney Mason is currently a Canada Research Chair in Rural Livelihoods and Sustainable Communities in the Tourism Management Department.

Ian McParland was born in 1992 in Burlington, Ontario. In 1993 his family moved to Kamloops, British Columbia, where he attended Kamloops Christian School, graduating in 2010. In September 2010, he began his studies at Thompson Rivers University, graduating from its Bachelor of Arts program with a major in English and a minor in Mathematics in June 2015. He is currently attending Thompson Rivers University's "Graduate Certificate in Business Administration" program and plans on pursuing his passion for law in September 2016 at the University of British Columbia.

Dr. Michael Mehta is Professor of Geography and Environmental Studies and he specializes in renewable energy. His non-profit organization GabEnergy (see www.gabenergy.com) has installed dozens of photovoltaic systems in BC including the largest and third largest residential arrays. He was on the Board of Directors of public utility SaskPower in the Province of Saskatchewan where he provided leadership for large-scale wind generation projects (>150 MW). He is on the steering committee of the Kamloops Chapter of the British Columbia Sustainable Energy Association.

Dr. Kim Naqvi is an instructor in Geography and Environmental Studies. A development and economic geographer, she specializes in studying and teaching the cultural impact of ideas about social and economic development. Her teaching includes courses on the geography of consumption, economic geography, cultural geography, development geography, colonial history and regional geography, and the history of geographic thought.

Tavis Knox is an undergraduate student at TRU majoring in Finance. Tavis has a passion for solar energy and sustainable building design.

Calum Palmer is a first year science student aiming for a major in Ecology and Environmental Biology. He is interested in assisting in a societal shift toward low ecological impact alternatives and in helping to achieve mutualistic relationships for the betterment of non-humans and humans.

Sean Pain is an undergraduate student at TRU.

Rob Purdy is with the Ministry of Forests, Lands and Natural Resources and on the steering committee of the Kamloops Chapter of the British Columbia Sustainable Energy Association.

Carley Rookes is a third year Arts student majoring in Geography and Environmental Studies. She has previous experience in promoting and raising funds through Indiegogo for a TRU Environment and Resources Undergraduate Research Award. Currently, she is the Geomorphology Supplemental Learning Leader at TRU.

Jesse Sheppard-Perkins completed the Outdoor Adventure Naturalist program at Algonquin College in the Ottawa Valley. He is currently enrolled in the Bachelor of Interdisciplinary Studies program at TRU and is interested in green building and small-scale food production.

Sandra Trawin works for the School of Nursing as the Academic and Administration Coordinator. She completed an undergraduate degree in business and is working on her final paper for a Master's of Public Administration at the University of Victoria.

Appendix 2. Letter Of Support from the Kamloops Chapter of the British Columbia Sustainable Energy Association

Kamloops Chapter, BC Sustainable Energy Association
#412-1120 Hugh Allan Drive
Kamloops, BC V1S 1T4

February 4, 2016

To Whom It May Concern,

The Kamloops Chapter of the BC Sustainable Energy Association (BCSEA) and its members are pleased to support the Solar Compass proposal at Thompson Rivers University (TRU).

From our perspective, the project achieves several goals that align closely with our mandate. It has the potential to reduce TRU's dependence on electricity from the grid; it showcases an innovative solar technology; and it builds awareness and acceptance of renewable energy sources.

We will commit to taking the lead role in developing and executing a marketing and communications plan for the project. We have 12 years' experience in organizing sustainability initiatives in Kamloops and good relationships with local media. We will work with other members of the Solar Compass team and with TRU's Marketing and Communications to make sure the project has good exposure via TRU and BCSEA websites, press releases, email and social media. Our chapter will promote the project and its technology to our 1500 supporters in the Kamloops region, and the provincial BCSEA office will help by sharing the information with thousands of citizens and influencers across British Columbia through its widely circulated newsletter, an educational webinar, and ongoing promotion to a social media community of over 5,000 followers.

Sincerely,

Cheryl Kabloona

Cheryl Kabloona
Chair, Kamloops Chapter
BC Sustainable Energy Association
250-372-0277, Cherylkb@shaw.ca

Appendix 3. Letter Of Support from Solar Earth Technologies

SOLAR EARTH TECHNOLOGIES

February 1, 2016

Dr. Michael Mehta
Professor, Department of Geography and Environmental Studies
Thompson Rivers University
900 McGill Road
Kamloops, BC, Canada
V2C 0C8

Dear Dr. Mehta:

Re: Letter of Intent Proposal – Paving the first Canadian Solar Roadways: Engineering trial on TRU Campus

Solar Earth Technologies is the proponent of the SPREV (Solar-Powered Roadways and Electric Vehicles) initiative. This is a system level technology with a goal to pave Canada's roadways with photovoltaic materials thus turning them into a vast distributed solar electricity generator, and to provide surrounding dwellings and electric vehicles with ubiquitous access to this clean electricity.

SPREV consists of two major subsystems: PMS (Photovoltaic Mosaic System) and IMCS (In-Motion Charging System). We shall focus ourselves on PMS pilot runs throughout 2016-2017, split into Engineering Trials and Commercial Trials.

We are currently inviting universities and colleges in South Central British Columbia to participate in Engineering Trials, to work with our team on systematically testing the electric, mechanical, material, and civil specifications of PMS under various weather and environmental conditions.

We are pleased to have UBC Okanagan sign on to this program, with a group of professors, graduate and undergraduate students from the School of Engineering to study the PMS design, and to build and test a solar sidewalk segment on UBCO's campus in Kelowna.

We hereby invite TRU to join this exciting program, for reasons that Kamloops is a key city to represent the environmental characteristics of BC's southern interior, and that this program provides a unique opportunity for researchers and students of the University to take part in this engineering practice to address scientific, technical and engineering, environmental, and social challenges with first-hand experiences. The outcomes of this trial will serve as an important base for later deployment of the PMS system in Kamloops and surrounding areas, to serve the families, communities, and public functions of the area with economic and environmental benefits.

We project this trial to begin in spring of 2016 and to last for about a year. We propose that we co-fund this project in the way that the company shall provide the PMS (photovoltaic mosaic system) modules at our own cost (at a capped value of $60,000 CAD) to replace and that TRU is responsible for the civil work at its own cost. We'd appreciate that the University identifies a spot on campus for this trial, at an approximate dimensions of 5' by 100'-160', mainly for pedestrians and bikes but not for heavy load trucks. The civil engineering work would include site preparation, installation, and necessary wirings to connect this demo project to BC Hydro's grid.

The company will work together with the TRU team throughout this project. We shall provide support to ensure the sustained operation of this project, including replacing defective and sub-optimally performing modules, and upgrading the optic layers over time.

Sincerely

Jason WANG

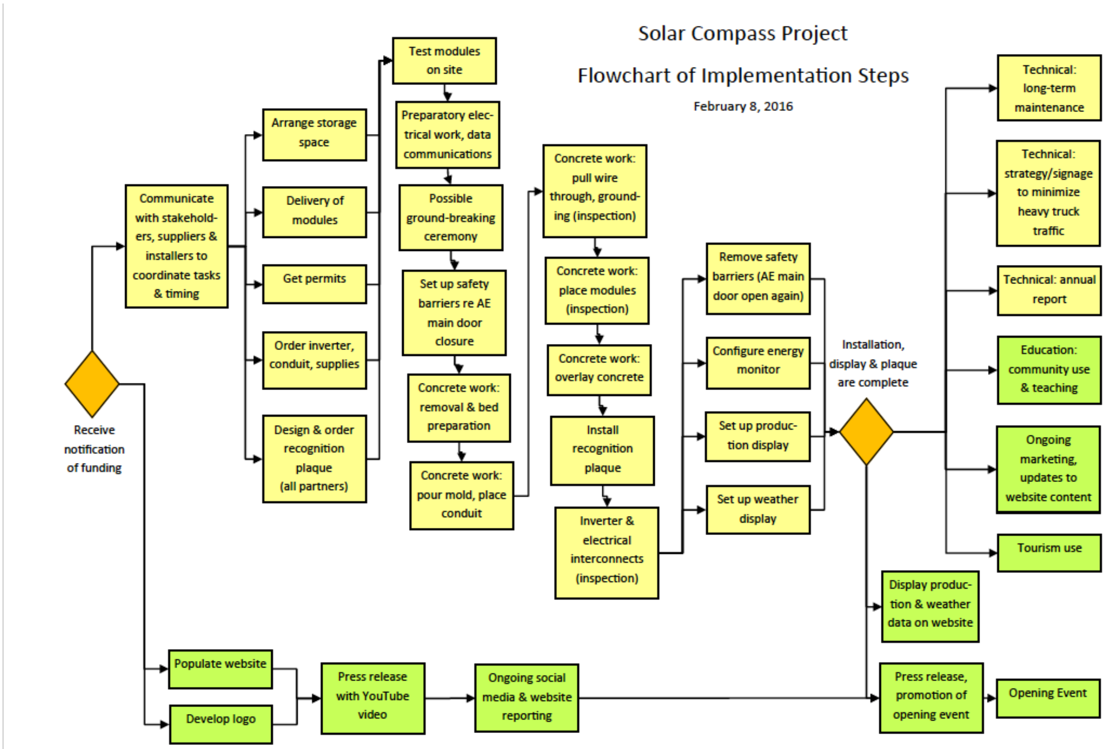
CEO, Solar Earth Technologies

Appendix 4: Budget

TRU Sustainability Grant Fund Budget Template				
Application Name: The Solar Compass	Column A	Column B	Column C	Comments
EXPENDITURES (Round to nearest dollar)	Total project cost	Amount of project cost supplied by applicants	Amount in Column A requested from the Sustainability Grant Fund	Explain how the total costs in Column A were derived at (attach additional documents if needed)
Equipment/Labour Costs For Solar Array				
Photovoltaic Mosaic System - 32 Modules	$60,000	$60,000	$0	Equipment donation from Solar Earth Technologies - see Appendix 3
Electrical equipment and Supplies	$11,165	$0	$11,165	See next page of Appendix 4 for quote
Installation	$7,758	$0	$7,758	See next page of Appendix 4 for quote
GST	$946	$0	$946	
TRU - Electrician	$1,000	$0	$0	Estimate - In-kind contribution from Facilities Services for final interconnect with electrical service in AE Building and network drop for data communications to display
Sub-total:	$80,869	$60,000	$19,869	
Costs For Concrete Work				
Site Preparation: Concrete removal and surface leveling	$8,000	$0	$8,000	Quotes from Hardaker Contractors and SEI
TRU - Concrete work	$5,000	$0	$0	Estimate - In-kind contribution from Facilities Services for removing and replacing exposed aggregate concrete in center of solar compass. Worn and cracked already and should be part of ongoing maintenance program at TRU
Display monitor in hall cabinet	$1,850	$0	$1,850	Based on Costco price including taxes for Sony Bravia KDL-65W850C 65-in. SMART 1080p LED Android TV
Sub-total:	$14,850	$0	$9,850	
Communications				
Web site/Social Media sites design/production	$100	$0	$100	Based on ten year renewal with GoDaddy for www.solarcompass.ca
Ground-breaking event and Opening event	$400	$0	$400	Includes appetizers, beverages and gifts to Elders
Recognition plaque	$2,500	$0	$2,500	Based on quote for 38" diameter circular aluminum plaque with logo, dates, partner names in raised silver lettering
Communications Sub-total:	$3,000	$0	$3,000	
ADD ALL SUB-TOTALS	$98,719	$60,000	$32,719	
Contingency Amount (please include 10% of the Sub-Total as a contingency amount):	$9,872	$6,000	$3,272	
TOTAL OF ALL COLUMNS	$108,591	$66,000	$35,991	

TRU Solar Compass			
Approximate Electrical/Inverter Equipment Costing			
3 Phase Optimized String Inverter with Dual Module Optimizers			
	Rating	**Num**	**Totals**
Inverter/Optimizers/Datalogging/TCOM			$ 6,777.45
Solar Edge SE14.4kUS 3Phase Inverter	14.4	1	
Solar Edge P600 Dual Module Optimizers		16	
Electrical Equipment, Cable, Switchgear, Supplies			$ 4,387.21
In-ground Vault 36x36x36 (Estimated)		1	
Cantrus and spring nuts			
1" PVC 10' Conduit		32	
1" PVC Sweep Elbows		56	
6x6 PVC JBs		16	
1.25" PVC 10' Conduit		1	
1.25" PVC LB		1	
4C-#10 Teck Armoured Cable - metres		30	
PV Wire - feet		1200	
MC4 Connectors		64	
3P AC Disconnect Switch		1	
NEMA 4X Vault JB		1	
Weatherproof Teck Connectors		2	
Bonding Lugs		8	
Bonding Conductor		3	
Total Equipment and Supplies			**$ 11,164.66**
Approvals and Installation			
BCSA Electrical Permitting ($50k-$100k Project Value)			
Install Inverter			
Install AC Disconnect and AC Connections			
Install Teck Cable			
Install Vault			
Install PV Tile Conduits			
Lay PV Tiles and connect Tile Wiring			
Install Optimizers			
Vault wiring and bonding			
Testing and Commissiong			
Installation			**$ 7,758.00**
Total Equipment and Installation			**$ 18,922.66**
GST			$ 946.13
Total with Taxes			**$ 19,868.80**

Appendix 5: Flowchart of Implementation Steps



References

[i] Hargroves, Karlson; Beattie, Colin; Wilson, Kimberley; Newman, Peter; Matan, Annie and Desha, Cheryl (2014), "Key opportunities for the future of roads to contribute to Australia's climate change response." Practical Responses to Climate Change Conference 2014. Barton, ACT: Engineers Australia, pp. 56-67.

[ii] Keijzer et al. (2015), "Carbon footprint comparison of innovative techniques in the construction and maintenance of road infrastructure in The Netherlands." Environmental Science and Policy, 54:218-225.

[iii] See http://www.cbc.ca/news/technology/solaroad-generates-more-power-than-expected-1.3069371

[iv] See http://www.wattwaybycolas.com/en/

[v] http://www.nait.ca/docs/NAIT_Reference_Array_Report_March_31_2015.pdf