environmental studies | YORK UNIVERSITÉ UNIVERSITY

Welcome

SOLAR CHARGING OF EVS:

NEW STRATEGIES FOR DE-CARBONIZING TRANSPORTATION AND FOR ACHIEVING EXPERIENTIAL EDUCATION

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Sustainability Ambassador

Associate Professor Faculty of Environmental Studies

Co-Chair Sustainable Energy Initiative

Summary

This project was created for learning by doing, which is the basis of experiential education. We are very grateful to our project funders, the Toronto Atmospheric Fund and the Metcalf Foundation, which trusted us with startup money and the long time needed to develop a transformational project. We also thank our project partners, which have supported the evolution of our project into a versatile experiential learning and collaboration platform.

Our original goals were simply to design and build a photovoltaic solar charging (PVSC) station using made-in Ontario materials and know-how, to thereby inspire the university community about the great potential of using renewable energy to power transportation solutions that can lower GHG emissions while increasing local resilience. Originally, we were supposed to build our PVSC station and then simply use the data gained through our project to inform adhoc policy recommendations. But, as we became deeply engaged in learning by doing, we managed to do much more and ended working with people in several other countries that are now taking our original project ideas and goals much further than we first imagined.

Part One

Project Conception

The idea of charging shared electric vehicles was conceived during a 2014 visit to Woodstock, Ontario. Jay Heaman from Woodstock Hydro was at the time involved in the creation of photovoltaic (PV) canopies in old transformer sites scattered throughout Woodstock. Those PV canopies provided the original inspiration for our project.

Additional inspiration for our project came from a visit to the Energy Oasis project of the British Columbia Institute of Technology.

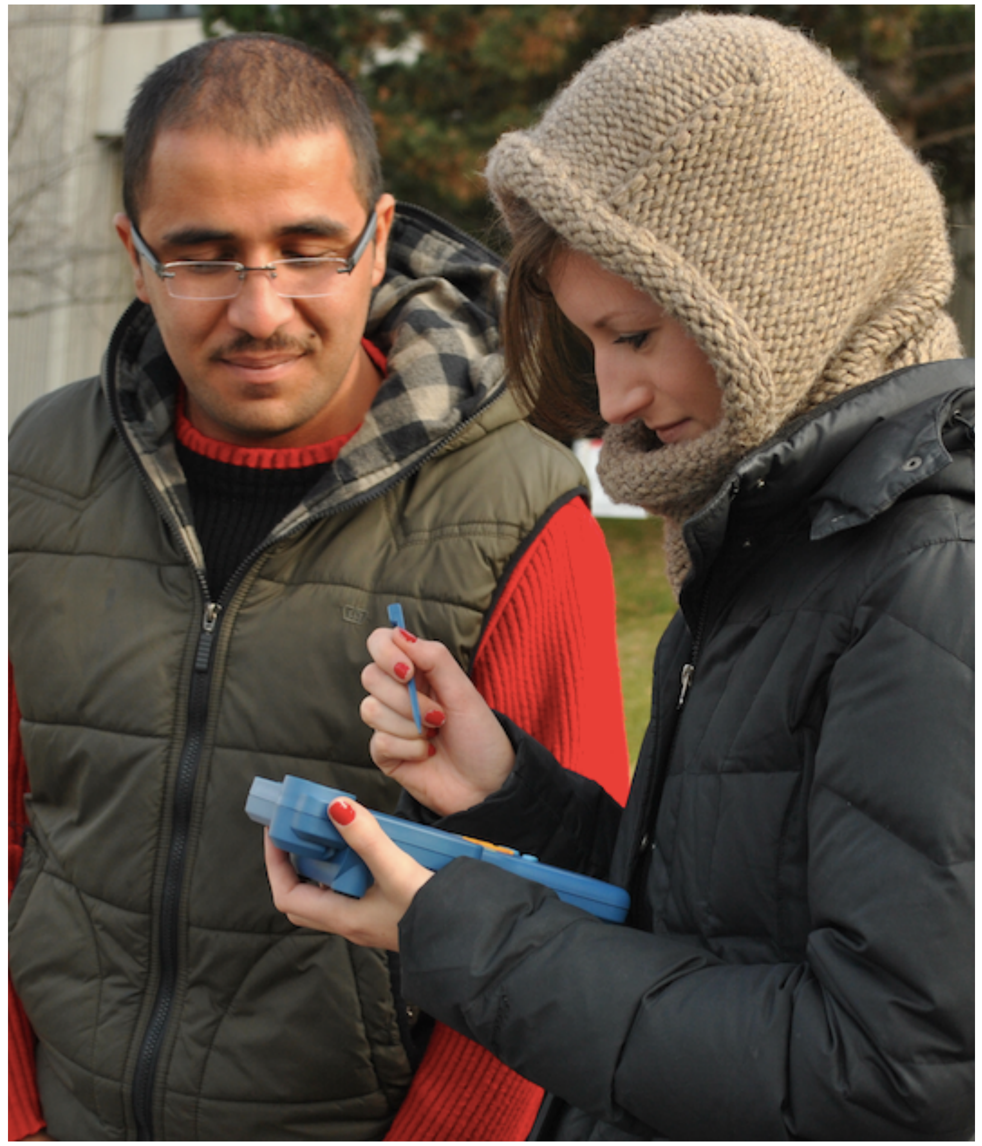
Part Two

Project Development

Experiential education, particularly learning by doing, was selected from the start as one of the foundations of our project. Knowledge mobilization became also a key approach to inform our design and implementation processes.

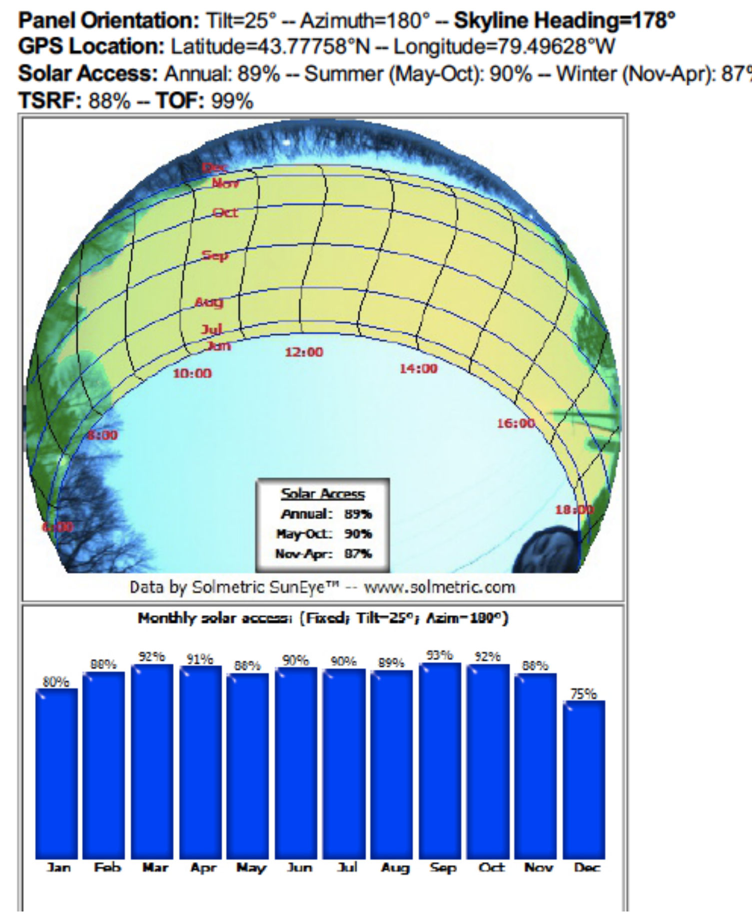
To build local support for the project we held many KM events to showcase the use of renewable energy as a transportation solution.

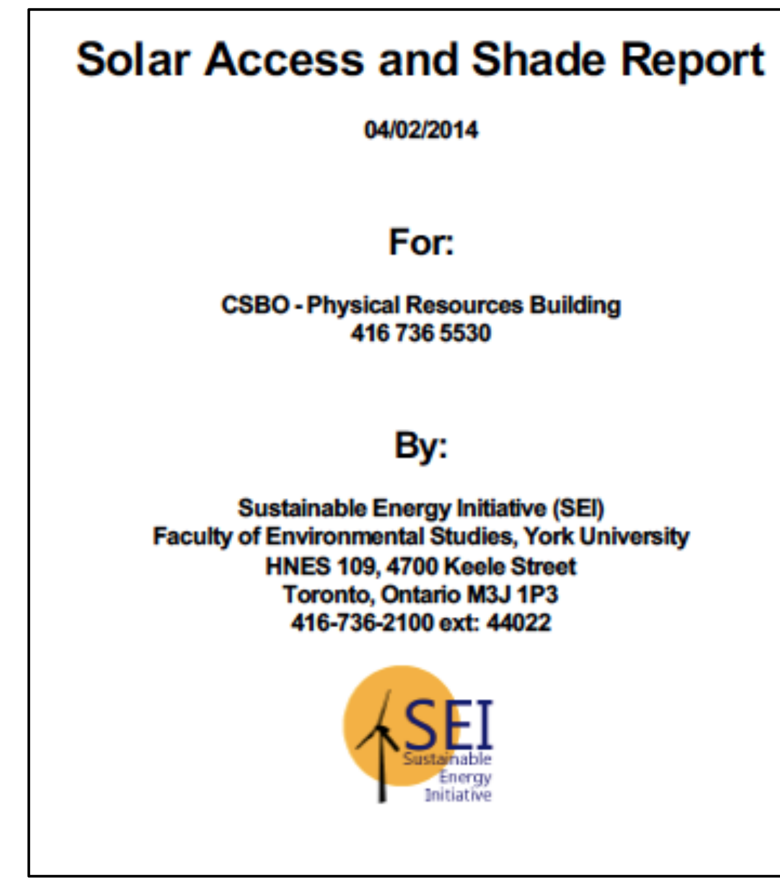
After securing project start-up funds from the Toronto Atmospheric Fund and the Metcalf Foundation we created at York University a team of professors, undergraduate and graduate students, facilities staff and private sector leaders to design and implement our own photovoltaic solar charging (PVSC) station using made-in Ontario materials and local know-how. Our first step was to assess suitable locations (i.e. places with good solar access plus strong knowledge mobilization potential).



Solmetric Equipment

Once a suitable site was selected we used Solmetric equipment to assess its solar potential. This equipment allows to assess shade problems throughout the year and define the suitability of a site for a solar project.





Solar Access and Shade Report

04/02/2014

For:

CSBO - Physical Resources Building
416 736 5530

By:

Sustainable Energy Initiative (SEI)
Faculty of Environmental Studies, York University
HNES 109, 4700 Keele Street
Toronto, Ontario M3J 1P3
416-736-2100 ext: 44022

SEI Sustainable Energy Initiative

Analysis

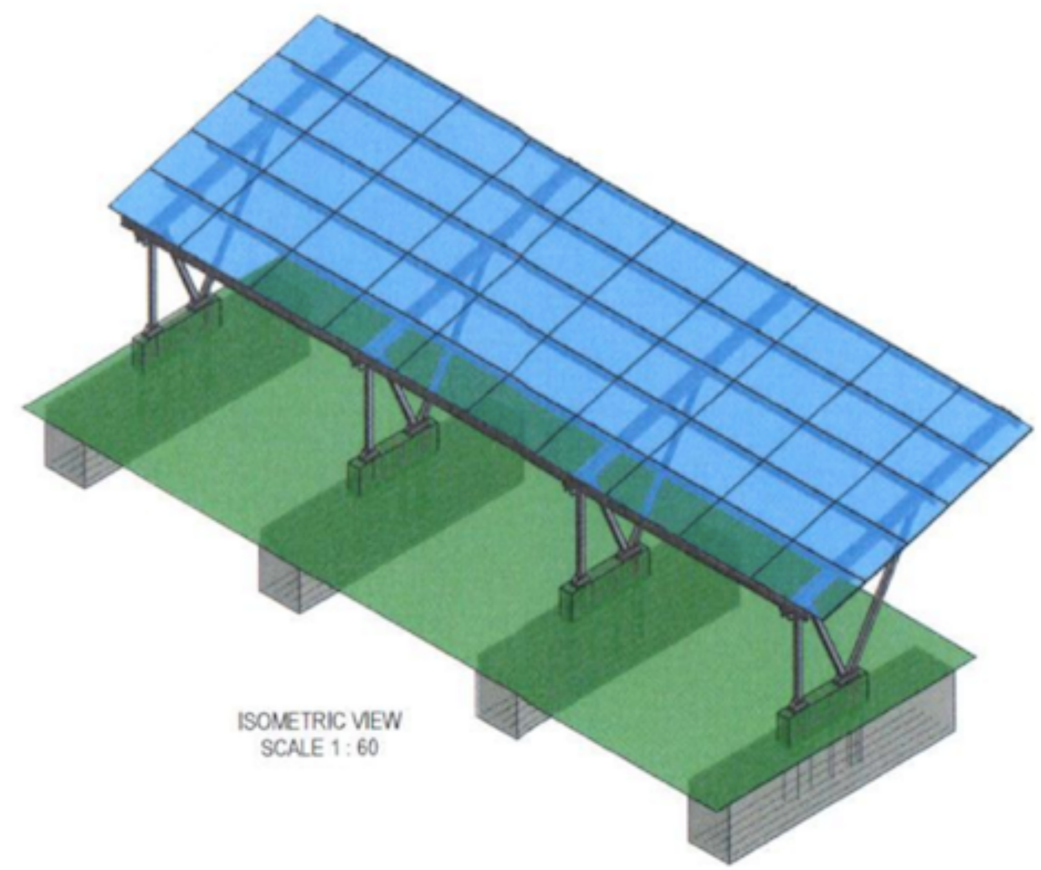
Once solar potential data is gathered at selected sites, it is straightforward to download it for analysis.

Solmetric software

This allows one to develop solar path diagrams and represent them as clear graphs of site-specific solar potential.

Solar Access & Shade Reports

The resulting reports make it easy to understand whether a site works or not for solar development.



Observations

After analyzing a number of existing solar structures, we concluded that they all used concrete as ballast. The problem with concrete foundations is that they require to dig a foundation or, if used as above ground ballast, parking space is lost making such conventional approaches undesirable for our selected project sites at York University.

Problems with Concrete Foundations

1 Digging in existing parking lots is not a welcome activity in a busy place like York University

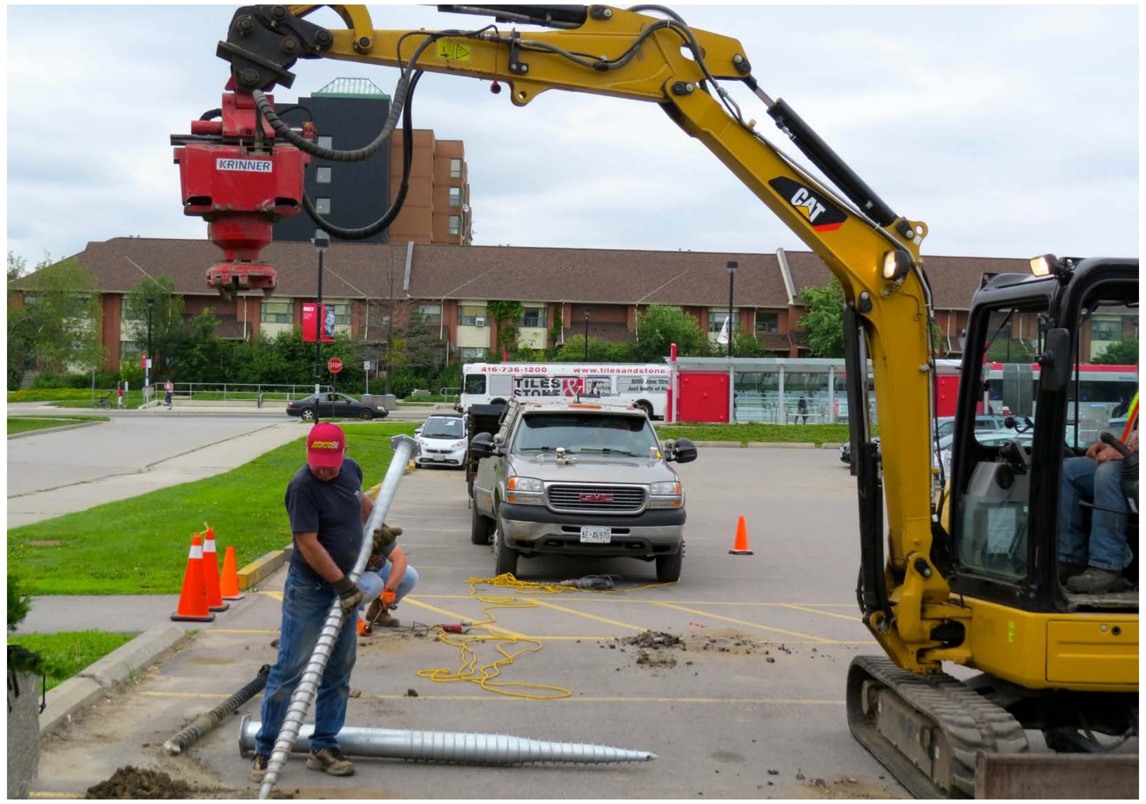
2 Losing parking space is also something that we could not afford in our project

Building York's Ev Station

York's EV Station

Problems with Concrete Foundations

Building York's Ev Station

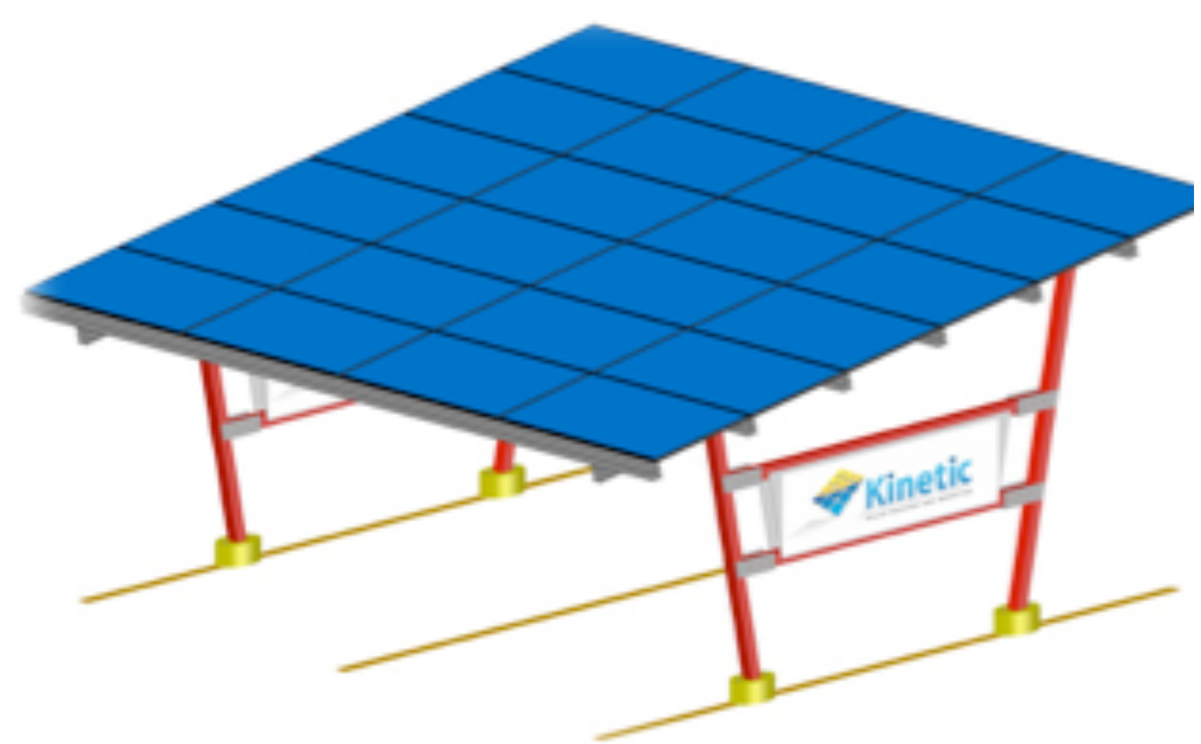


Since concrete foundations could not be used our team decided to innovate and create a new harnessing system that instead of concrete would use ground screws to harness our PV structure

As part of our design process we selected ten parameters to guide our design decisions and to use as evaluation considerations after design implementation

Solar EV Carport Design Criteria

- No parking spot loss
- Modular/Expandable
- Durable
- Universal
- Functional
- Secure
- Simple and Easy to Install
- Integrated
- Beautiful



Part Three

Project Implementation

After concluding our design, we had it engineer-stamped to proceed with its implementation in a very visible site at York University's Keele Campus and we partnered with leading Ontario firms to procure components and to implement the project (Silfab, Kinetic Solar, Canadian Energy, Daymak, Joshua Four, Telitnet).

To implement the project we assembled a team of Canadian and international students to enhance learning by doing

Specialized equipment was handled by experts that were brought into the university to teach us what we did not know.

Photos

Building the EV Charging Station

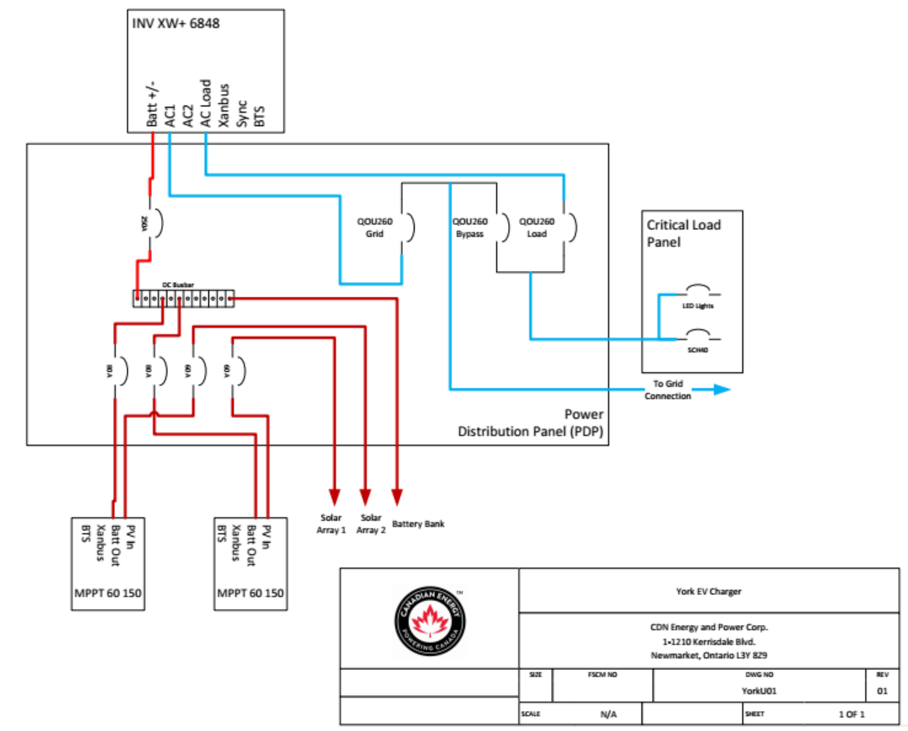



The Team

Team members were involved in all aspects of project implementation to learn by doing. To enhance learning and problem solving and to demonstrate that our system can be implemented anywhere in the world we did as much as possible ourselves without using machines.

Construction

After the screws were in we were able to assemble the support structure. Scaffolding allowed to easily install our solar PV modules.



Ribbon Cutting Event & More

Storage and Control Systems

After the PV modules were installed we turned our attention to the next step...implementing the storage and control systems

Battery Storage

Battery storage was implemented to maximize the use of the local solar resource

KM

The two boxes used to house our batteries and balance of system components are also used for KM

Ribbon Cutting Event

After the project was implementation we held a ribbon cutting event to celebrate the work accomplished

Figure 1

System Metrics	
Design	Design 1
Module DC Nameplate	6.84 kW
Inverter AC Nameplate	7.00 kW Load Ratio: 0.98
Annual Production	8.145 MWh
Performance Ratio	84.1%

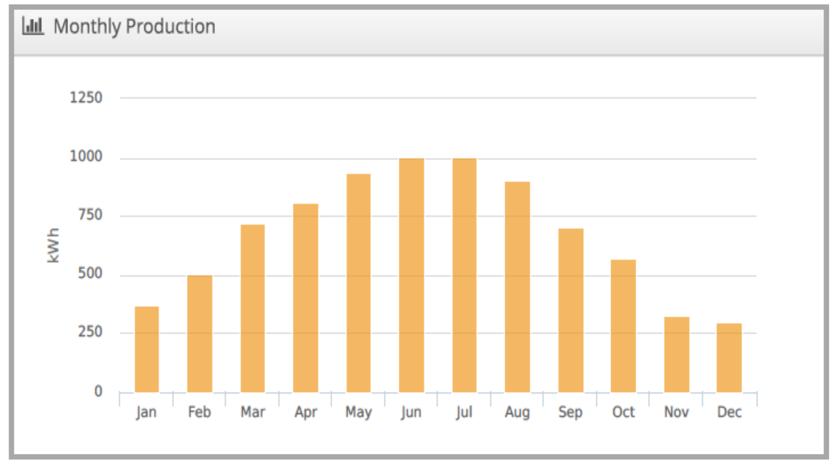


Figure 2

Month	Design 1 - MC250S22240 AC (kWh)
Jan	219.5
Feb	371.0
Mar	625.4
Apr	715.1
May	856.7
Jun	953.9
Jul	952.6
Aug	807.4
Sep	604.2
Oct	439.1
Nov	225.0
Dec	180.2
Annual	6950.0

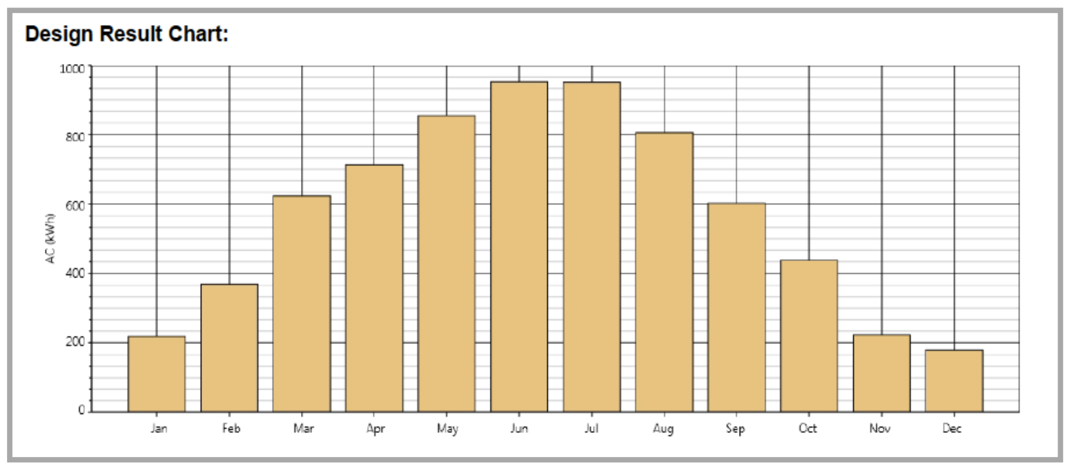
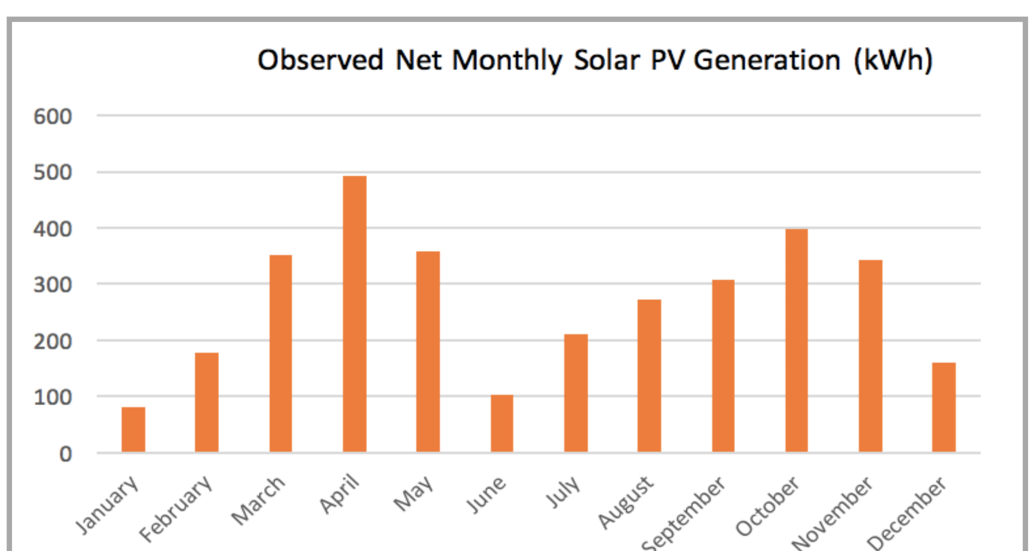


Figure 3

Month	kWh
January	80
February	177
March	352
April	492
May	358
June	103
July	211
August	273
September	308
October	397
November	342
December	161
Total	3254



Part Four

Project Results

Below, we provide an overview of two independent studies, which are provided to contrast with project data results. Figure 1 includes a simulation based on the geographic coordinates of the project site. Figure 2 provides an overview of a field study conducted to analyze shading at the project side. The independent studies were produced for this report to contextualize actual project results. Figure 3 summarizes the monitored net electricity generation at the project site for one year.

Please note that Figures 1 and 2 assume that all the potential solar electricity generation available at the project site is injected to the grid. Figure 3 provides an overview of the actual net solar generation in the non-grid connected site. Please note that the significant difference of electricity generated at the site (versus the simulations summarized in Figures 1 and 2), reflects the fact that once our batteries are fully charged (and/or if there is no electric vehicle charging at the site), any solar electricity generated by the PV modules is wasted.

Figure 1

Includes a simulation based on the geographic coordinates of the project site.

Overview of Independent Site Simulation using HelioScope.

System Metrics

Design	Design 1
Module DC Nameplate	6.84 kW
Inverter AC Nameplate	7.00 kW Load Ratio: 0.98
Annual Production	8.145 MWh
Performance Ratio	84.1%

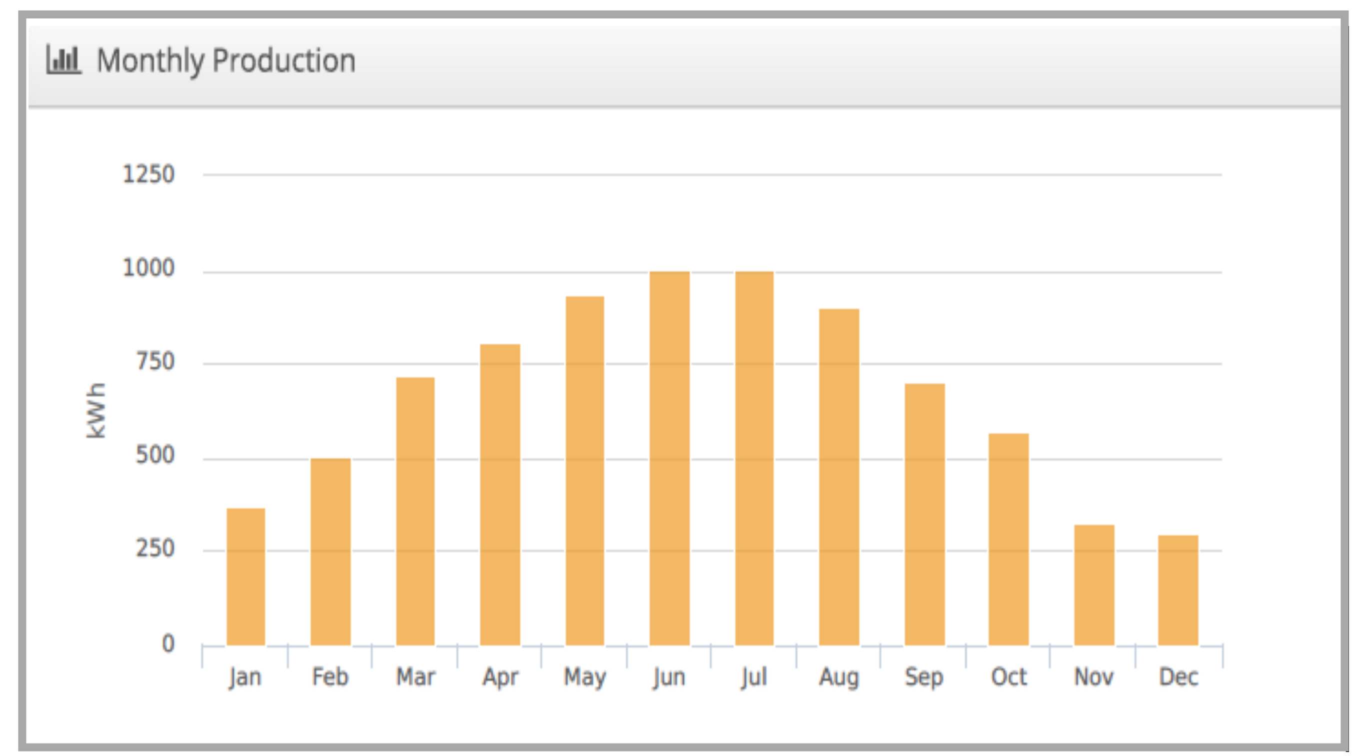
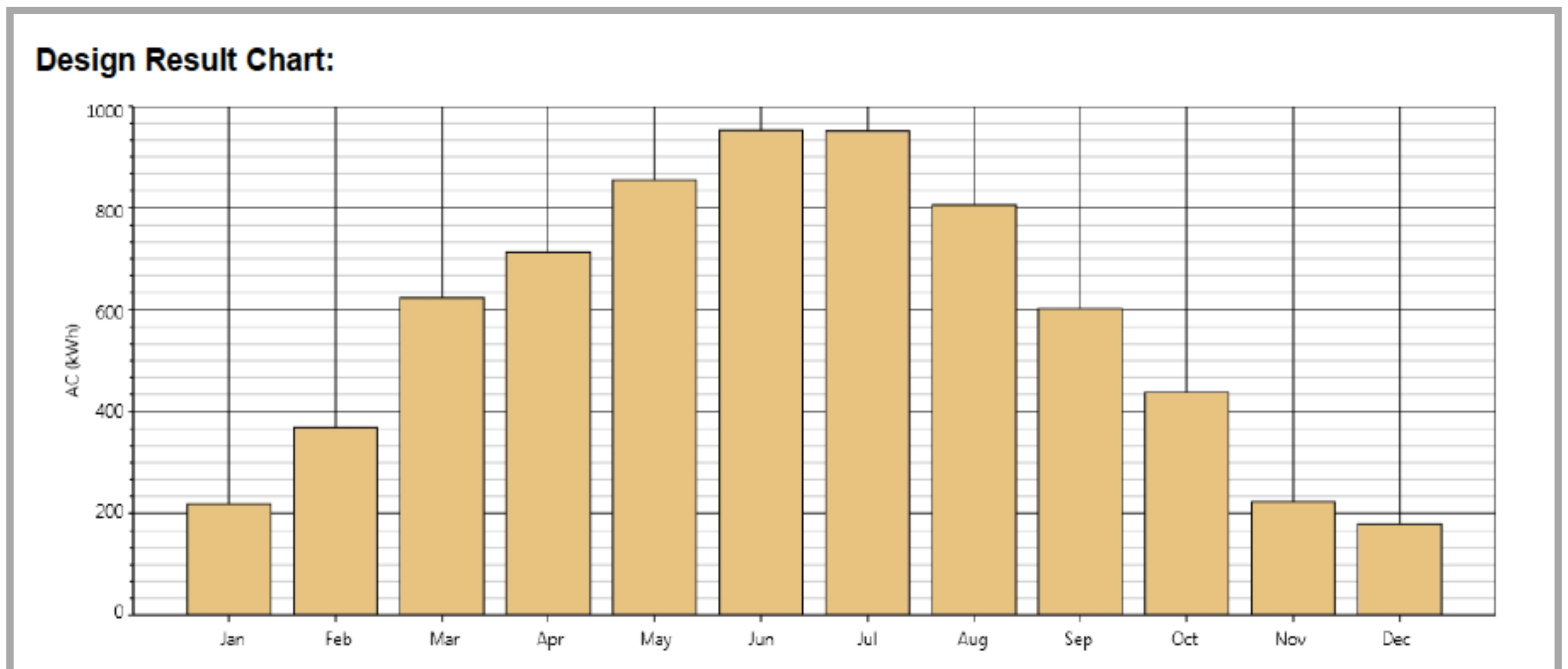


Fig 1, 2 & 3

Figure 2

Provides an overview of a field study conducted to analyze shading at the project side. The independent studies were produced for this report to contextualize actual project results.

Site Assessment Simulation using Solmetric and PV Design.



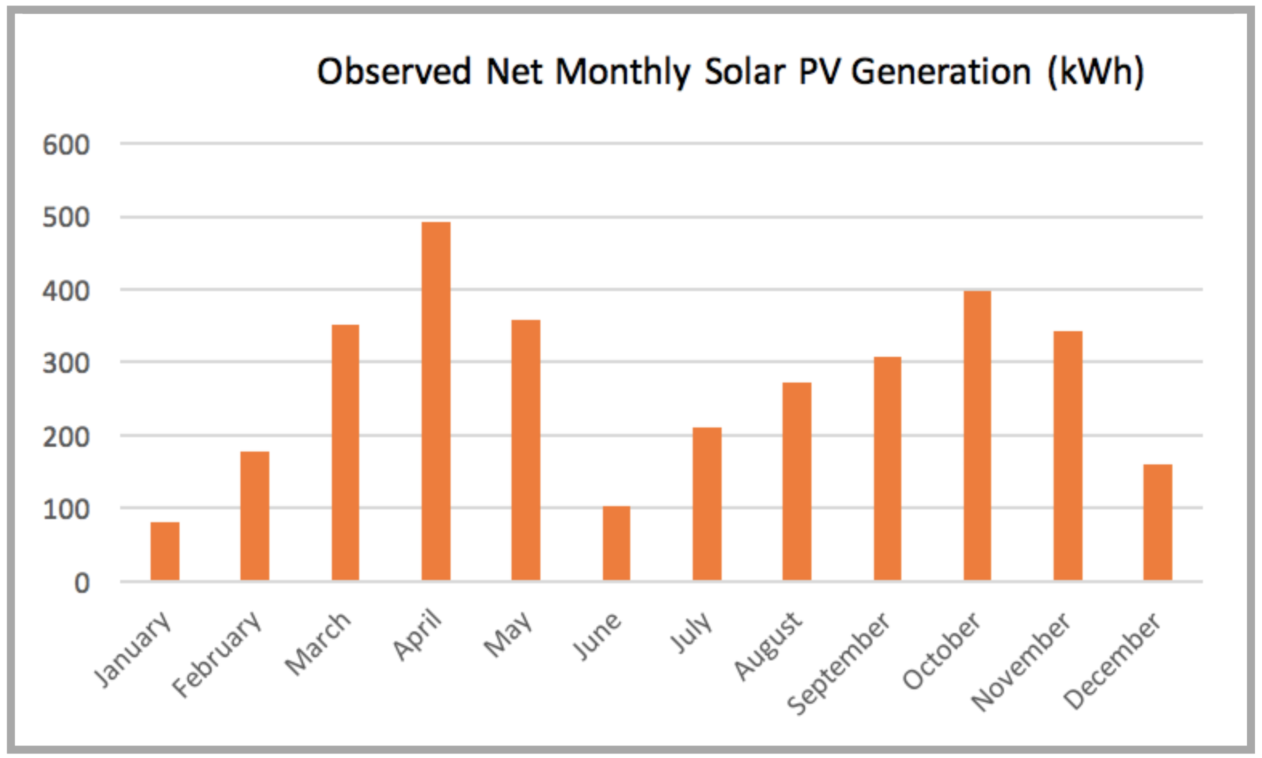
Month	Design 1 - MC250S2224 0 AC (kWh)
Jan	219.5
Feb	371.0
Mar	625.4
Apr	715.1
May	856.7
Jun	953.9
Jul	952.6
Aug	807.4
Sep	604.2
Oct	439.1
Nov	225.0
Dec	180.2
Annual	6950.0

Figure 3

Figure 3 summarizes the monitored net electricity generation at the project site for one year.

Net Solar PV Generation Monitored at Project Site.

(note that because the project site was not a grid-connected facility any solar generation that occurs at times when the batteries are fully charged, and/or when there is no electric vehicles present to be charged, cannot be stored and is therefore wasted).



Month	kWh
January	80
February	177
March	352
April	492
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November	342
December	161
Total	3254

Fig 1, 2 & 3

Part Five

Project Analysis and Policy Implications

A key goal of this project is to help increase the adoption and the use of electric vehicles in general and at York University in particular. As Figure 4 (below) indicates those goals are informed by the significant environmental benefits that EVs can provide to society particularly if the electricity used to power them comes from clean renewable energy.

Figure 4

Vehicle emissions for different cars
(reproduced from Figure 1 Plug n Share)

Vehicle Type	Average GHG emissions per 20,000 km driven	Source of GHG emissions
Average Battery Electric Vehicle	233 kg	Electricity Generation
Average Plug-in Hybrid Electric Vehicle	1,294 kg	Electricity Generation and Gasoline
Average Compact Gas Car	3,948 kg	Gasoline
Average Mid-Size Gas Car	4,700 kg	Gasoline
Average Full-Size Gas Car	5,029 kg	Gasoline

Electricity

It is important that at the moment, Ontario electricity prices favour centralized generators, which receive premiums if Ontarians use electricity during mid and on-peak times (please see figure 5).

The type of solar charging station with battery back-up that we have built at York University does not yet receive any type or financial support or any other incentives in Ontario. In fact, all that is available in Ontario is a very modest incentive for installing a very simple charging system that cannot take advantage of the multiplicity of renewable energy resources available at the local level throughout our province nor maximize when we charge (or discharge) electric vehicles (which can help reduce grid congestion, provide frequency regulation and increase local resilience through back-up systems).

Figure 5

Ontario Electricity Pricing

(reproduced from Ontario Energy Board Site)

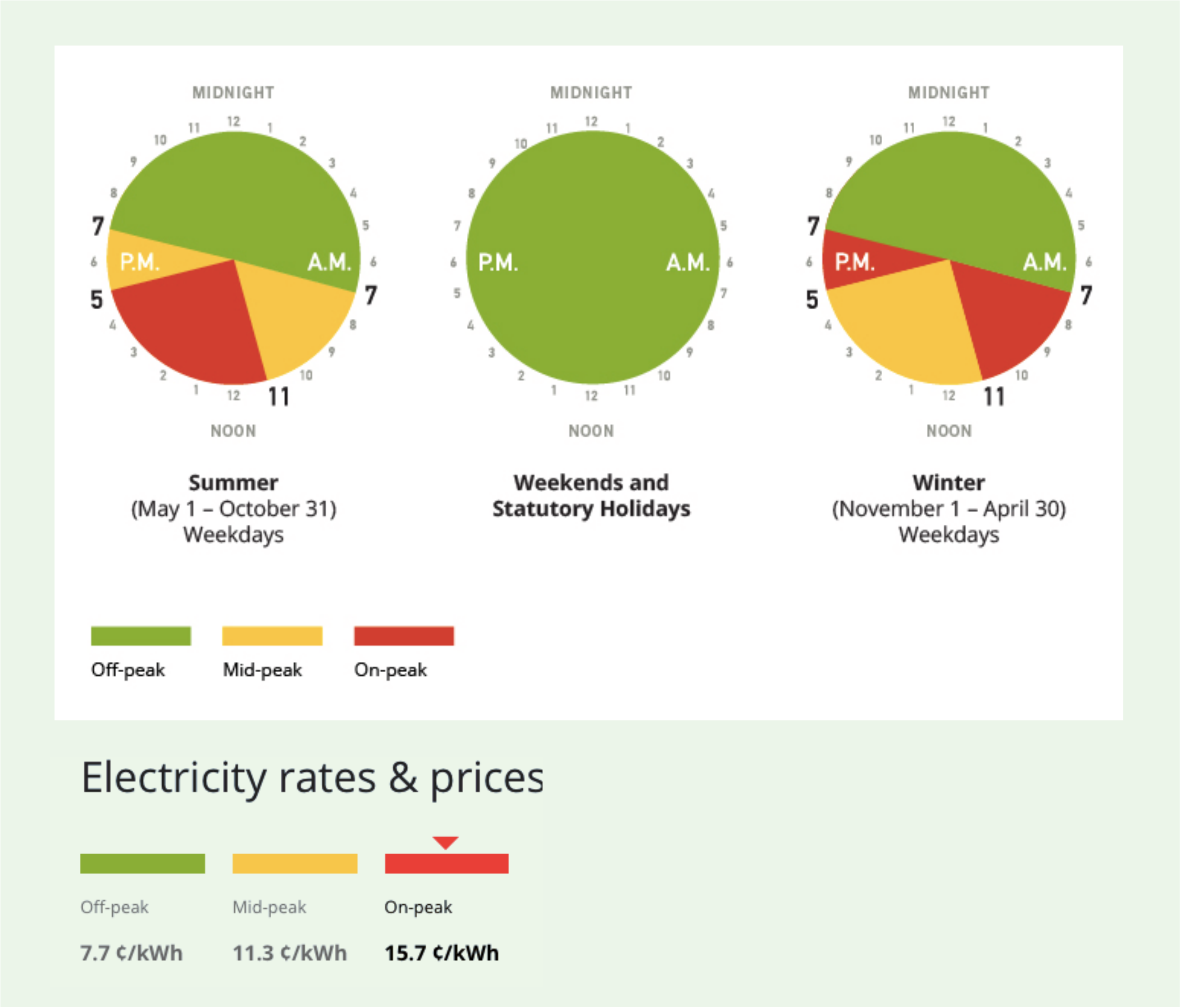

Fig 4 & 5

Policy Recommendations

- Provide a new Ontario incentive system to achieve a network of charging stations with dedicated renewable energy generation and battery systems for public electric vehicle (EV) charging
- Create a new program to help public sector facilities to learn by doing through the installation of renewable energy systems with battery back-up for EV charging and emergency supply purposes
- Expand the current EV incentive system to increase the adoption of electric motorcycles and electric bicycles which can provide new affordable EV solutions for Ontarians

Collaboration

York University | Chile | India | Algeria

Part Six

Unexpected Results

When we engaged in this project we anticipated many of the results that we have described thus far here. We also knew that we were going to help train many undergraduate and graduate students but what we did not anticipate was how far this project would reach thanks to the experiential education approaches that we employ. Because of the learning by doing focus that has guided our project we have been able to engage the York University community but also students from Algeria, Chile and India that now are actively applying what they learnt with us to develop a variety of new projects. Below we provide a brief overview of these unexpected and yet valuable project ripples.

Chile

In Chile, students from Universidad de Tarapaca that participated in our project have created a new company called Solar Trust and have implemented the first solar public high school in Chile. The Liceo Pablo Neruda is located in the City of Arica and now offers photovoltaic training and uses a battery system as a learning tool that can also provide back-up services in case of power failures caused by earthquakes or tsunamis.

SolarTrust
energía para un futuro sustentable

UNIVERSIDAD DE TARAPACÁ
Universidad de Verdad

Collaboration

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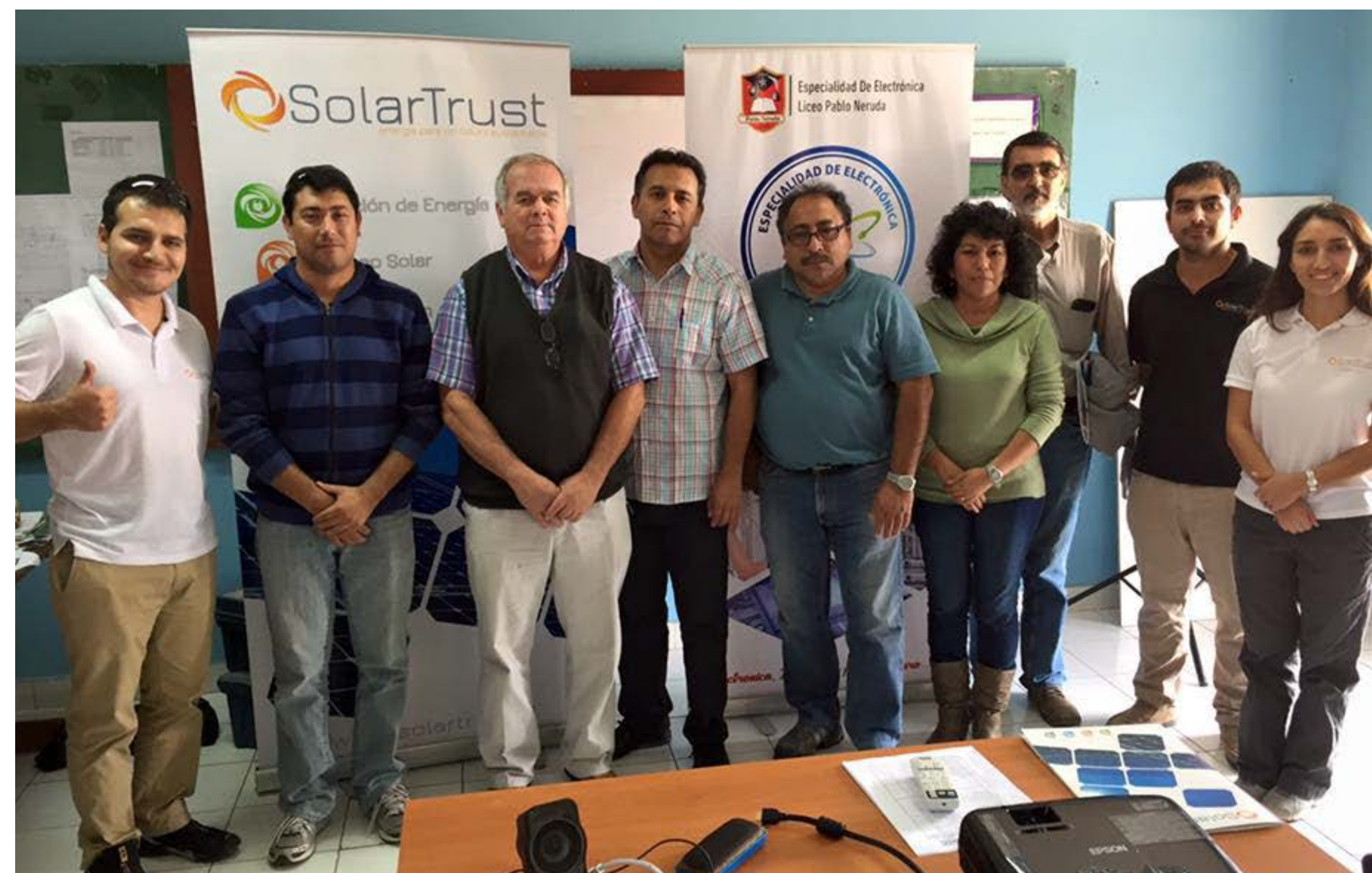
Experiential Learning

The Solar Trust team also implemented solar photovoltaic systems in Arica's Community College (Centro de Formación Técnica or CFT), Now graduates from the Pablo Neruda High School can continue their solar training at Arica's CFT.

Pablo Neruda High School
Arica, Chile



Chile

Experiential Learning

CFT – Technical Training Institute
Arica, Chile

Publireportaje

CENTRO DE FORMACIÓN TÉCNICA
CFT DE TARAPACÁ

Centro de Formación Técnica de Tarapacá ACREDITADO 4 Años
• Gestión Institucional
• Docencia de Pregrado
Desde 4 de diciembre 2013 al 4 de diciembre 2017

CFT de Tarapacá instala la primera planta solar educativa del país

Sobre el techo del pabellón Pacífico del campus Las Acacias se encuentra la primera planta solar educativa del país, la cual fue instalada por la empresa Solar Trust en conjunto a docentes y estudiantes de la casa de estudios.

El pasado viernes 19 de junio la Superintendencia de Electricidad y Combustibles (SEC) otorgó al Centro de Formación Técnica (CFT) de Tarapacá, la aprobación de la 3ra planta a nivel nacional en el marco de la Ley n° 20.571 de "Generación Distribuida", también conocida como Net Billing. La legislación permite a los clientes regulados del sistema de distribución eléctrica, poder inyectar a la red de distribución los excedentes energéticos generados por medios renovables no convencionales o de cogeneración eficiente.

La concreción del proyecto representa el compromiso del CFT de Tarapacá con el Medio Ambiente, a través de la promoción de una cultura de eficiencia energética y las energías renovables, lo que se expresa también, en la inclusión de competencias relacionadas con la energía solar en las carreras de TNS en Proyectos Eléctricos de Distribución, TNS en Prevención de Riesgos y TNS en Construcciones Metálicas. Otro aspecto muy importante del proyecto es la posibilidad que tendrán los estudiantes de la Educación Media Técnico Profesional de realizar visitas y/o práctica de observación, gracias a la articulación que realiza el CFT a través del Convenio de Desempeño Regional. De esta forma el proyecto del CFT de Tarapacá se convierte en el primero, a nivel nacional, en desarrollar una planta solar educativa con capacidad para inyectar energía a la red.

Para Edmundo Lazo, presidente del Directorio del CFT de Tarapacá, "el principal valor que tiene esta planta no es el hecho de poder generar nuestra propia energía y ahorrar dinero, sino que la posibilidad que tendrán los estudiantes de trabajar con una tecnología de punta, siendo pioneros en sus especialidades", señaló. Esta posibilidad se dará principalmente en las tres carreras ya mencionadas, las que incluirán en sus planes de estudios y perfiles de egreso, competencias respecto a la distribución de la energía solar, sobre las nuevas normas de seguridad en el trabajo con energía solar y la construcción de estructuras metálicas para el desarrollo de plantas solares. Los estudiantes, gracias a su formación, realizarán prácticas profesionales en las que harán crecer la planta y aumentar su capacidad año a año.

Miembros del Directorio del CFT visitando la planta solar educativa.

Ernesto Posselt, egresado de la carrera de TNS en Proyectos Eléctricos de Distribución, participó junto a otros estudiantes en la instalación de la planta. Él se acercó al mundo de los paneles solares gracias a una práctica que realizó en la empresa Solar Trust, donde aprendió muchísimo sobre el tema. "Es muy importante este aporte que está haciendo el CFT ya que sería la primera institución en Arica, y quizá en Chile, en entregar formación sobre esta importante energía renovable", dijo.

¿Cómo Funciona?

La planta fotovoltaica de 15 KW está compuesta por 60 módulos fotovoltaicos policristalinos de 250Wp cada uno, los que atrapan la energía solar para convertirla en electricidad de corriente continua, la que a su vez es transformada por un inversor Solar Max trifásico, en corriente alterna. Es esta corriente alterna la que puede ser utilizada en las dependencias del campus, mientras sea de día, y gracias a un medidor bidireccional los excedentes que se generan ingresan por el poste de línea de distribución hacia a la red.

Además de la planta que genera 15 KW, el proyecto incluye un sistema de seguridad energético sustentable con seis luminarias led de alta eficiencia y enchufes en caso de corte del suministro eléctrico. El punto energético que está ubicado en el centro de campus, respalda su energía en 4 baterías, lo que permite a estudiantes y funcionarios conectar sus equipos celulares y otros medios de comunicación durante una eventual emergencia. Una de las características a resaltar de este sistema de seguridad, es la utilización de un seguidor Lorentz Solar, el cual va orientando los paneles en relación al movimiento de sol, con la finalidad de maximizar la captación de la energía.

Estudiantes en visita a terreno a los trabajos de la empresa Solar Trust.

Punto energético de Emergencia en campus Las Acacias.

Pablo Godoy, Gerente General de Solar Trust, se refirió al novedoso sistema de seguridad y al aporte que significa la primera planta solar educativa. "Como concepto, este sistema de seguridad es único en Chile ya que, si bien mezcla tecnología existente en nuestro país, está construido con un diseño nuestro. Por otra parte, el aporte que está haciendo el CFT es muy importante ya que van a capacitar a personas con competencias en energía solar, y eso es lo que necesitamos para seguir desarrollando el uso de energías renovables", Finalizó.

Estudiantesdel CFT participaron de la instalación.

Rector del CFT de Tarapacá, David Alvarado Olmos.

"Nuestro proyecto mezcla dos aspectos fundamentales como lo son, por una parte, el cuidado del Medio Ambiente, a través de la promoción de una cultura de eficiencia energética y el uso de energías renovables, y por otro lado, la profundización de competencias ligadas a la energía solar en tres de nuestras carreras, lo que permitirá a nuestros estudiantes abrir más sus posibilidades laborales", dijo.

Chile

India

In India, our former trainee Shreyas Prakash is developing solar and other renewable energy solutions and recently collaborated with the Barefoot College of India in the development of a reliable and inexpensive gravity-based LED system that can provide much needed illumination for users of communal sanitary latrines. Shreyas learnt by doing with us in Toronto and was also inspired by the transformative movie Solar Mamas to develop practical solutions that can improve the quality of life of low-income people in collaboration with Barefoot College.

Collaboration

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India

Algeria

In Algeria, students and professors from the École Nationale Supérieure de Technologie (ENST) have partnered with our Sustainable Energy Initiative to develop experiential education tools to teach solar energy to over a thousand ENST engineering students. Through experiential education workshops held in Toronto and in ENST we have collaborated to design and implement a new solar charging station for electric bicycles at ENST using as many made-in Algeria components as possible and applying the experience achieved as part of our York U solar charging station.

Collaboration

Algeria

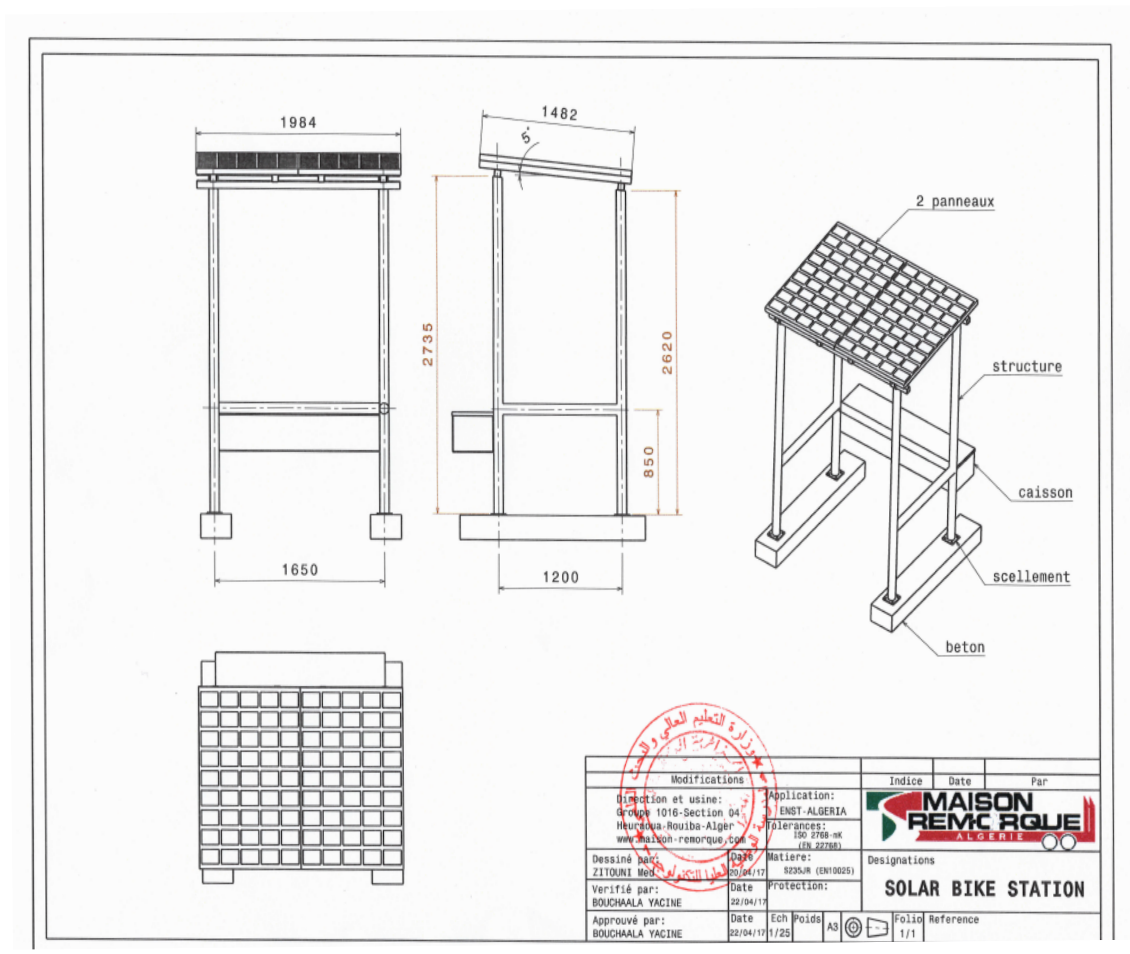
Visit to École Nationale Supérieure de Technologie

ENST, Algiers – Sep 25 2015

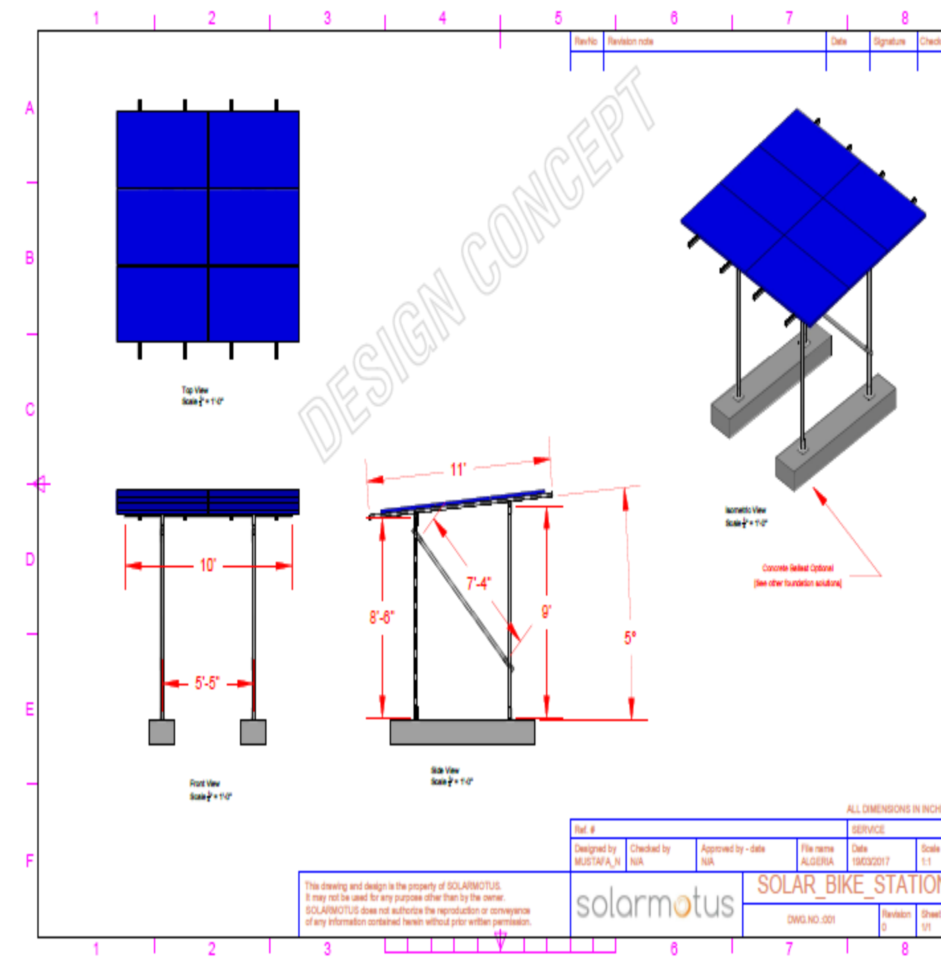
Mechanical Study

Design Conception of the Solar Charging Station

ENST team proposition



York University team proposition



ENST’s Campus

Solar charging station and Solar Lighting panel on the ENST’s Campus showcasing practical solutions to address climate change, and enabling experiential learning opportunities for students.

Concluding Project Reflections

Maximizing the use of renewable energy (RE) in the transportation sector is essential to address climate change. The active participation of local communities is also essential to achieve that goal and deep RE penetration in other sectors (e.g. in the building, industrial and electricity sectors). To achieve the 100% RE goals needed to decarbonize the energy systems of our planet we recommend that as many new projects as possible focus on providing experiential learning opportunities to test technologies, train new trainers, expand local capacity, and to help nurture the new generations of local champions that are needed to change the toxic energy status quo.