Feasibility Study of Solar Canopies Over Parking Lot E-14

Ryan Day, Marie Hubbard, Ben Manaugh, Will O'Brien
CEE 398-PBL Semester Project

ENGINEERING AT ILLINOIS

CEE ILLINOIS
Department of Civil and Environmental Engineering
College of Engineering
University of Illinois at Urbana-Champaign

Project Introduction

- CO2 emissions increased by 90% since 1970
- iCAP goal of 25,000 annual MWh of solar energy
- Solar projects on campus include panels installed on ECE building and Solar Farms 1.0 and 2.0
- Federal Solar Tax Credit reduces solar construction cost by 26%, Business Energy Investment Tax Credit by 30%
- Arizona State, Michigan State, & UIUC completed canopy systems and solar farms through power purchase agreements with solar vendors and sold the Solar Renewable Energy Credits (SREC)

Project Objectives

- Determine economic and engineering feasibility of solar canopies in a UIUC parking lot with EV charging stations
- Reduce greenhouse gas emissions and cut electricity costs

Methodology

- Investigated design logistics
  - Determined location
  - Evaluated panel orientation/tilt and type
  - Determined EV charging station model
- Investigated emissions impact
  - Calculated emissions reductions
- Economic analysis
  - Determined UIUC's costs
  - Calculated revenue/money UIUC can save
  - Estimated total offset

Results

Location

- Site investigation of five parking lots determined the optimal location for the solar canopy system

Table 1: Location Criteria of the Selected Parking Lots

	Size (acres)	Sun Exposure	Condition	Usage	Relative Location	Public Visibility
B-1	1.2	Moderate	Fair	High	Good	Very High
D-1	0.7	Moderate	Fair	High	Good	Very High
E-14	18.5	Very High	Very Good	High	Very Good	Very High
E-24	1.5	High	Good	Moderate	Good	High
F-23	6.5	Very High	Fair	Moderate	Poor	Moderate

Electricity Production

- Used NREL PVWatts calculator
- Input location, optimal panel tilt/orientation, solar panel type information

Table 2: NREL PVWatts Calculator Inputs and Output

Location and Station Identification	
Requested Location	1600 South Oak Street, Champaign, Illinois
Weather Data Source	Lat, Lon: 40.09, -88.26 1.1 mi
PV System Specifications	
DC System Size	9894.3 kW
Module Type	Amorphous (standard)
Array Tilt	40.09°
Array Azimuth	180°
Inverter Efficiency	96%
Results	**13, 810,000 kWh/Year**

Emissions Reductions

- UIUC emitted 383,000 tons of CO_2 in 2018
- Solar canopy system reduces campus CO_2 emissions by 10,300 metric tons (2.7%)

Table 3: Carbon Dioxide Emission Equivalencies

CO_2 emissions from:	1,100,000 gallons of gasoline consumed	10,600,000 pounds of coal burned	1,703 homes' electricity use for one year	1,170 homes of energy use for one year
	22,000 barrels of oil consumed	400,000 propane cylinders	0.003 coal –fired power plants in one year	2,070 passenger vehicles driven for a year

Results Continued

Economic Analysis

- UIUC currently pays $1,096,000 per year for electricity; would pay $635,000 under 20 year PPA

Table 4: UIUC Costs and Revenue/Savings by Year 1 and Year 20

	Cumulative Cost		**Cumulative Revenue/Savings**		**Offset**
	EV Charger Installation (fixed cost)	EV Energy& Maint. Cost	Difference in Electricity Cost	SREC Revenue	Total Revenue and Cost Difference
By Year 1	$225,000	$1,700	$460,000	$69,000	+ $304,000
By Year 20	$225,000	$34,000	$9,230,000	$1,380,000	+ $10,350,000

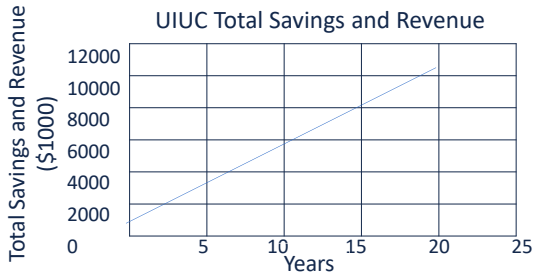

Figure 1: UIUC Cumulative Savings and Revenue over 20 Years

- UIUC savings and revenue accumulates at constant rate over the course of the PPA

Conclusions

- Solar canopy expected to produce 13,800,000 kWh per year
- Reduce campus emissions by 2.7%
- Potential to save $461,000 in electricity costs per year
- Yields a 20 year profit of $10,350,000

Acknowledgments

- Prof. Roesler and Prof. Schmidt
- Morgan White, Director of Sustainability for Facilities & Services
- Mary Hays
- Michael Neal