



Coldwater Solar Carport Pilot Project advancing sustainable infrastructure





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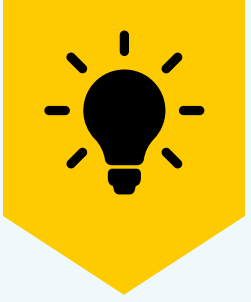
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Deliverables

Main Report

The Main Report includes the technical and economic feasibility of pilot solar carport systems, including scalability across different site types.

Solar Carport Guide

Outlines technical guidelines and decision-making tools needed for designing and deploying solar carports.

Outreach Material

Materials to engage the community and raise awareness about solar carport benefits.



Personalized Innovations



City of Detroit



-  **Array area**
-  **Landscape Buffer**
(evergreen + ornamental trees)
-  **Agrivoltaics**
-  **Clover**
-  **Enhanced Perennial Buffer**





City of Ann Arbor





Personalized Innovations



Scio Township

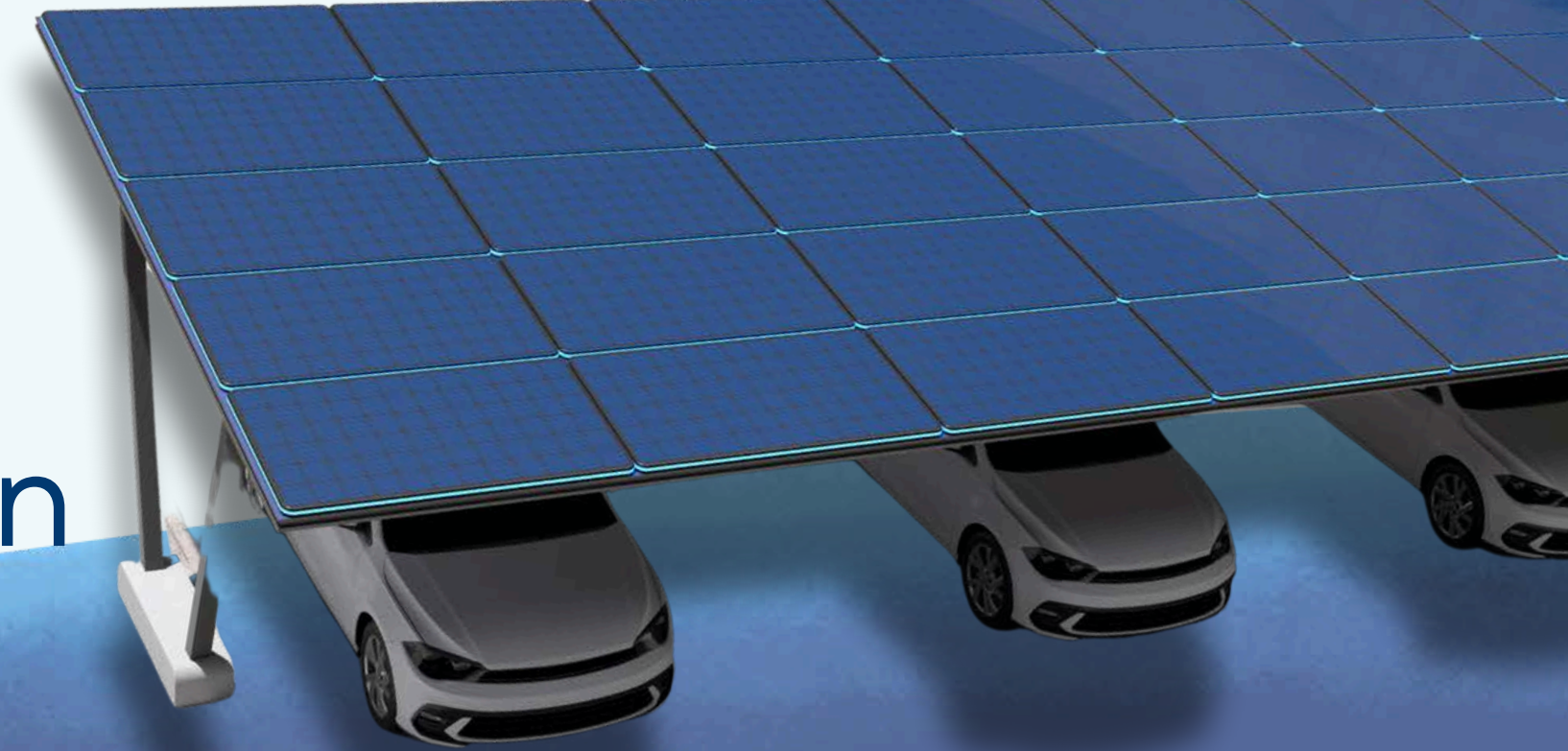


Michigan State University





Personalized Innovations



Solar Carports: Strategic Clean Energy Solution

★ What are Solar Carports?

Elevated solar PV structures installed over parking areas utilize existing developed land which is ideal for civic and urban settings

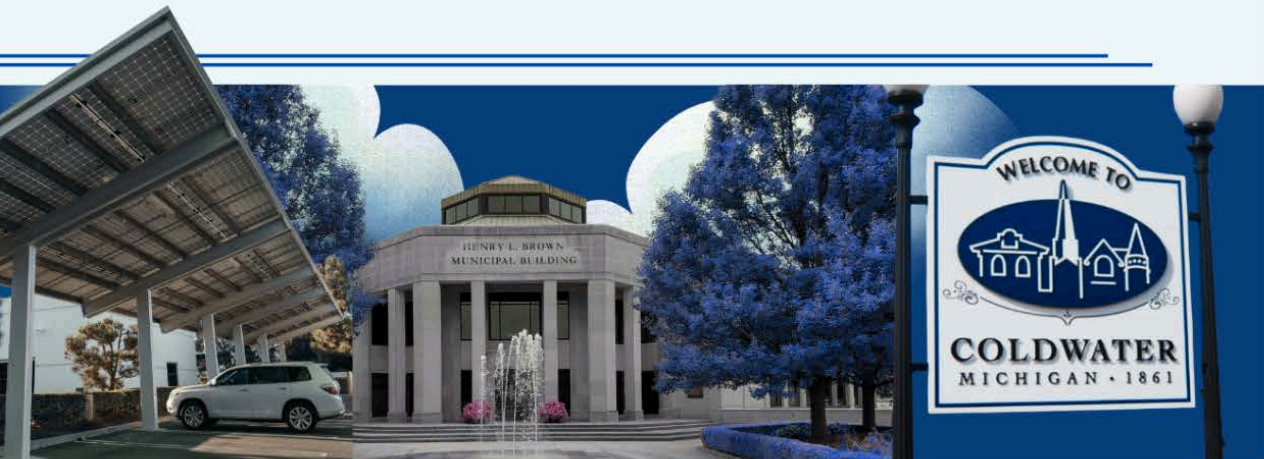
★ Key Benefits

- Land Preservation
- Urban Heat Mitigation
- Weather Protection
- Visual Integration
- EV-Ready Infrastructure



Solar Carport Planning Guide

Solar Carport Planning Guide: A Step-by-Step Guide for Michigan Municipalities & Institutions



A Step-by-Step Guide for Michigan Communities

Solar carports provide a practical solution for Michigan to generate on-site clean energy while maximizing infrastructure. By installing elevated solar canopies, municipalities and institutions can produce renewable energy, reduce energy costs, and offer year-round weather protection for additional land.

This guide will walk you through the technical planning process, including energy performance modeling, site-specific photovoltaic system design, and important financial considerations specific to Michigan.



Step 1: Community Fit and Constraints

Before identifying a location or technical approach, think about how the solar carport aligns with your or your community's values, visibility, and practical limitations. These social considerations help ensure the project earns support and meets real needs. There are several key questions that could guide your decision such as:

- Who will benefit? Will it serve you, the general public, specific residents, staff, or underserved groups?
- Will it be visible and accessible? Sites like city halls, libraries, or schools can spark awareness and pride.
- Does it reflect community values? Could it double as a site for EV charging, farmers' markets, or emergency hubs?
- Are there physical or social constraints? Consider zoning rules, space competition, shading from trees, or local concerns.
- Will it support broader goals like resilience or public education?

Step 2: Project Vision and Scope

Once the community context is considered, define the purpose and size of the project. Knowing the technical intention will guide key planning decisions like layout and design.

Clarify the project's main objectives:

- Maximize renewable energy generation,
- Provide shaded or weather-protected parking,
- Support or incorporate EV charging infrastructure,
- Act as a public education tool or a visible commitment to sustainability.

Determine the project's size based on your goals, budget, and available space:

- Small-scale installation, such as a single canopy or part of a parking lot,
- Mid-scale installation, for a particular building or high-traffic area,
- Larger-scale or phased project, with the potential to expand coverage over time based on need, funding, or public support.

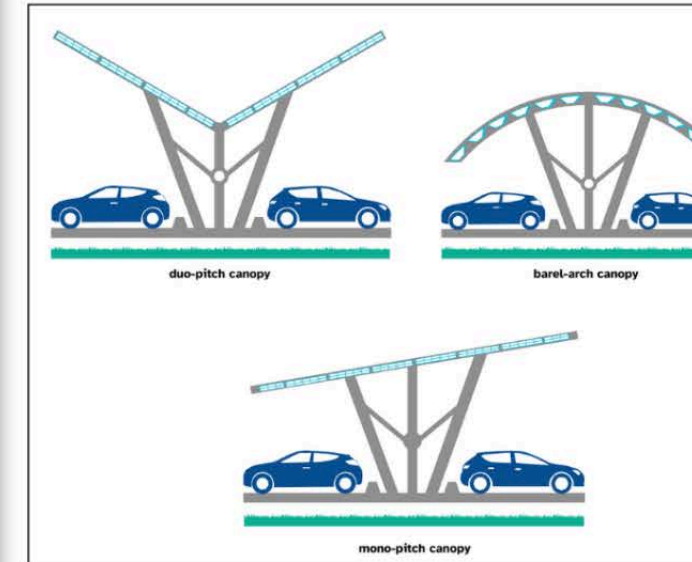


figure 2. Type of PV Configurations

Single-Slope (Single-Slope)
Panels are tilted one way, usually facing the equator (south in the Northern Hemisphere). This is essentially like a slanted shed roof over a row of parking spaces. Single-slope canopies are often used when covering a single row of parking spaces.

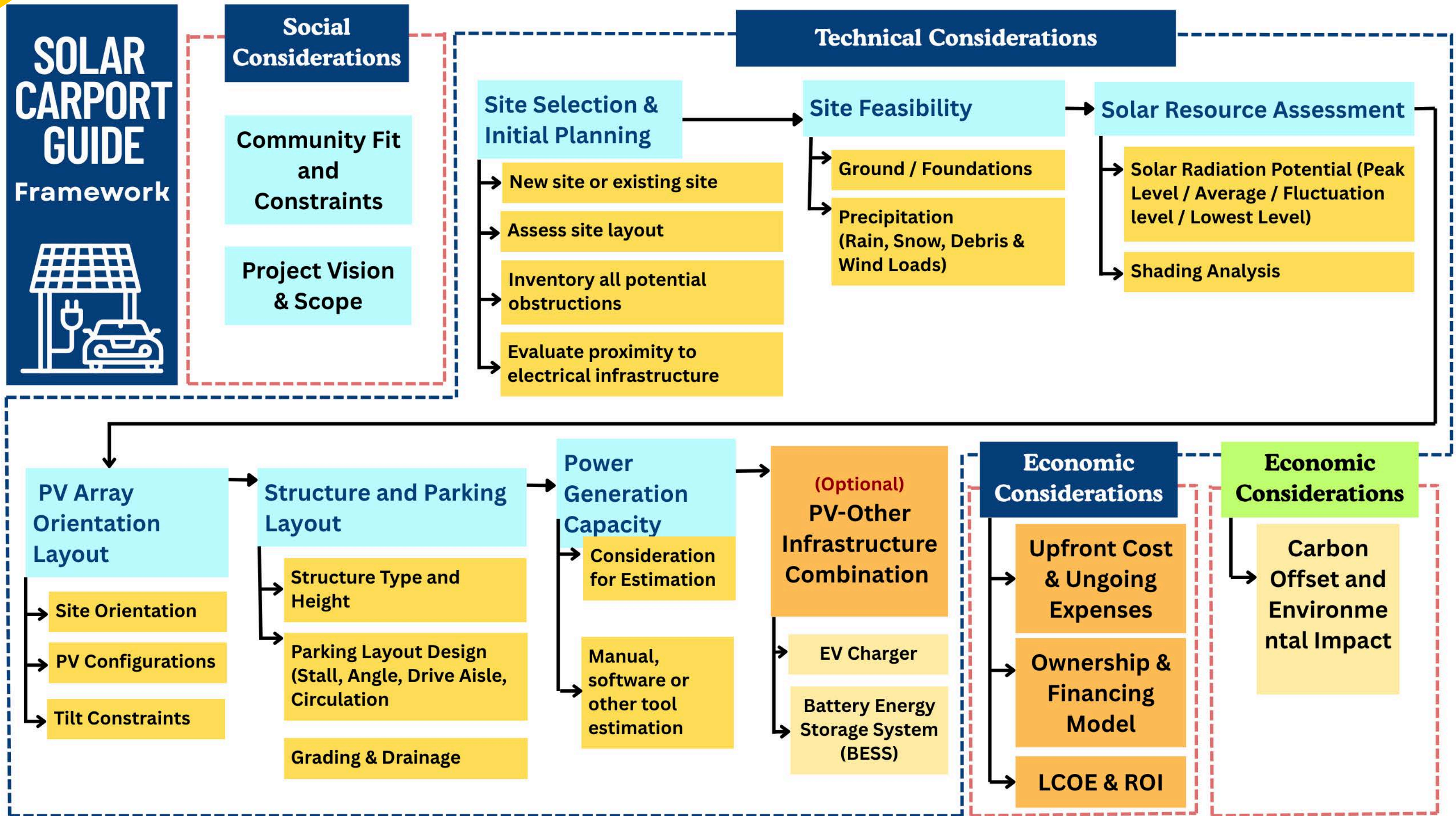
Barrel-Arch (Barrel-Arch)
Advantages: It provides a simple structure often used to maximize energy production. Only one edge will shed water and other load, so gutters are not needed. **Disadvantages:** For a wider or bigger scale of canopy it might not be the best choice compared to other structures.

Gull-Wing (Double-Slope or "Gull-Wing")
A canopy with two sloped surfaces that meet at a center ridge, forming a "V" shape. **Advantages:** Captures sunlight during both morning and afternoon, providing a more balanced generation curve; Well-suited for north-south orientations. **Disadvantages:** South-facing panels are not feasible; Offers a clean, symmetrical appearance. **Disadvantages:** Slightly lower total annual energy output compared to single-pitch designs (typically ~90-95%). Requires a central ridge to handle snow and water drainage, especially in climates with heavy snow.

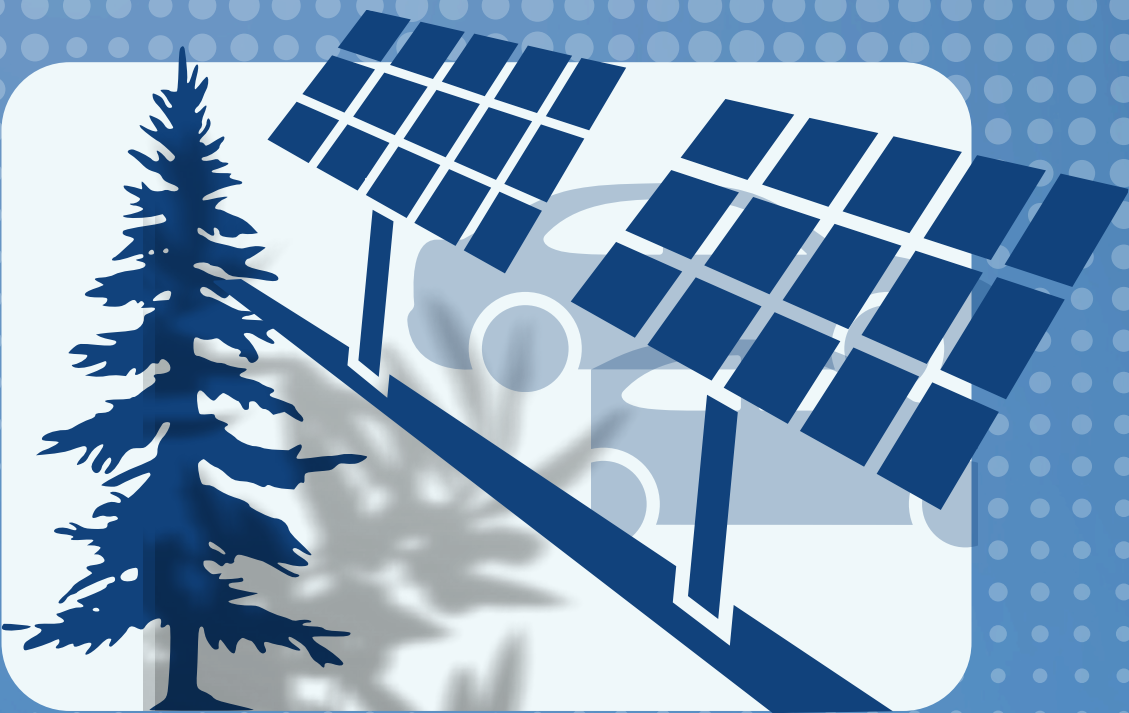
Other Configurations
Alternative designs such as curved (barrel-arch) or flat-roof canopies may be chosen for architectural or site-specific reasons. These designs may provide aesthetic benefits, respond to spatial constraints, or offer unique shading options when integrated thoughtfully into the overall site plan.



Assessment Flowchart



Site and Structural Considerations

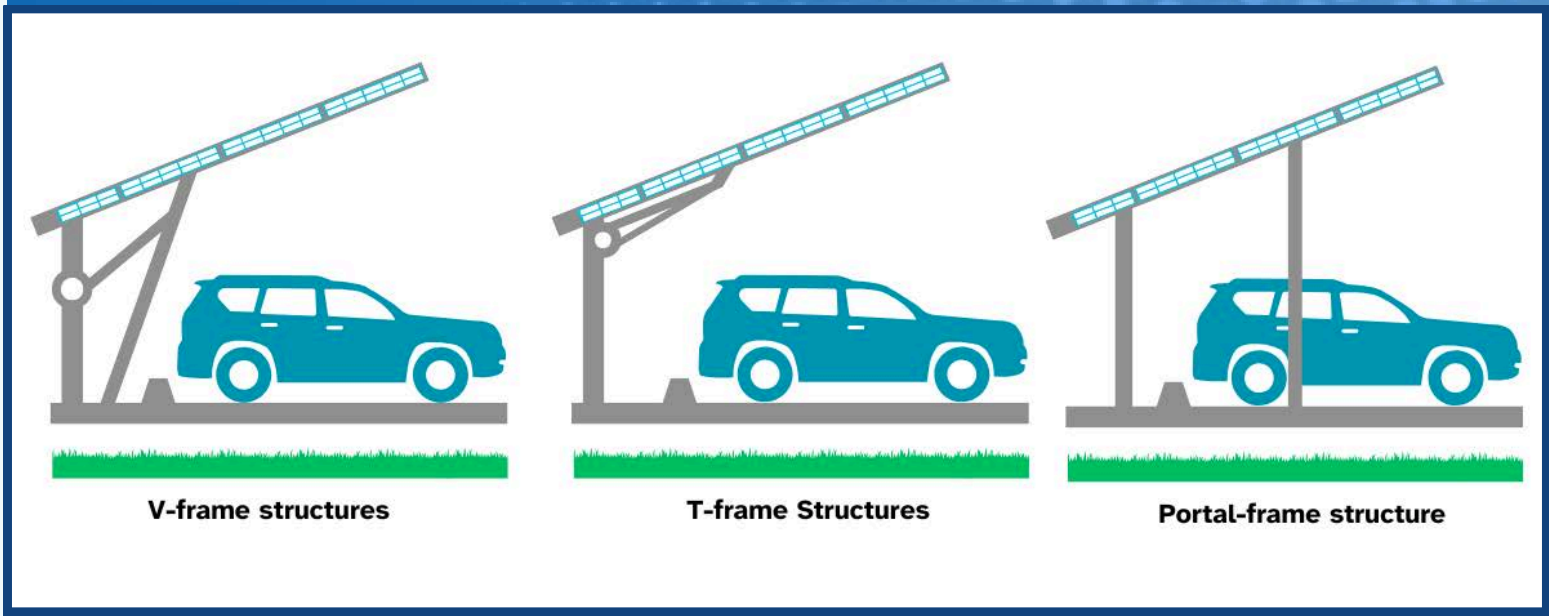


Shading: Avoid shading from trees or structures, as even partial shade greatly reduces energy output.

Foundation & Subsurface Conditions: Perform a geotechnical survey and check utility maps to ensure foundation stability and avoid underground lines.

Snow & Wind Loads: Structure and Design frames, spacing, and tilt suited for the environmental conditions.

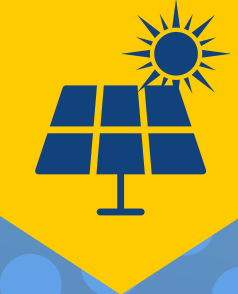
Parking Layout



Parking Stall Dimensions: Standard stalls prioritize accessibility; compact stalls save space; angled stalls improve maneuverability but must align with aisle and canopy layout.

Drive Aisles & Turning: Width varies by parking angle and traffic flow to allow safe entry and exit.

Parking Angles & Efficiency: Stall angles impact both land use efficiency and ease of vehicle movement.



Solar Resources & Adjustment



pvPlanner



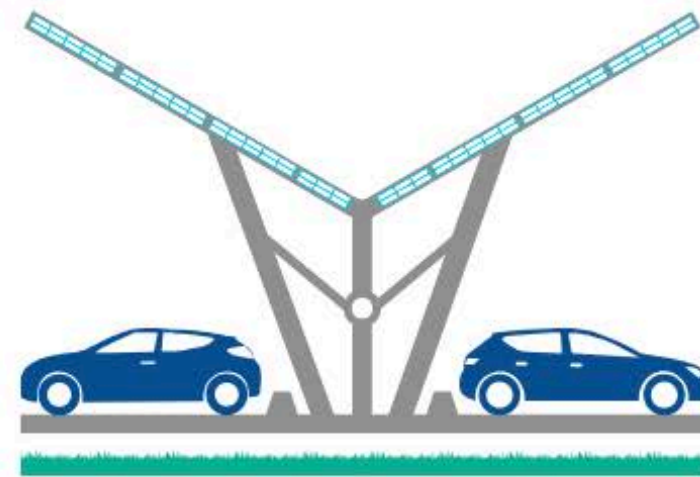
System Advisor Model



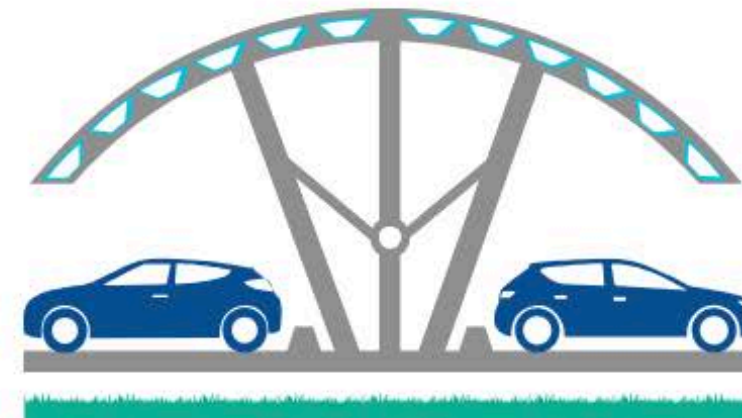
Solar Pro 4.3



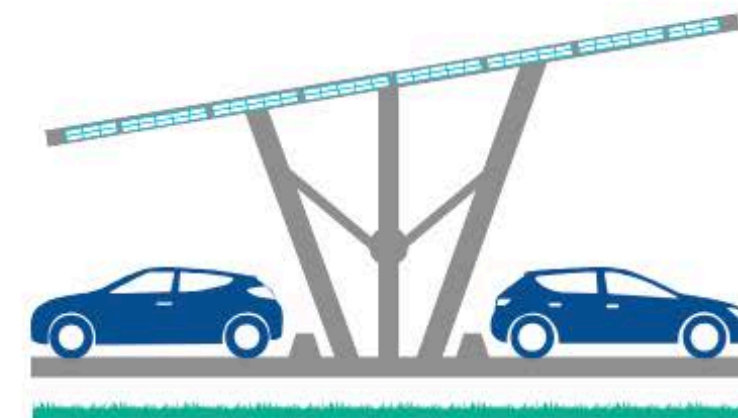
HelioScope



duo-pitch canopy



barrel-arch canopy

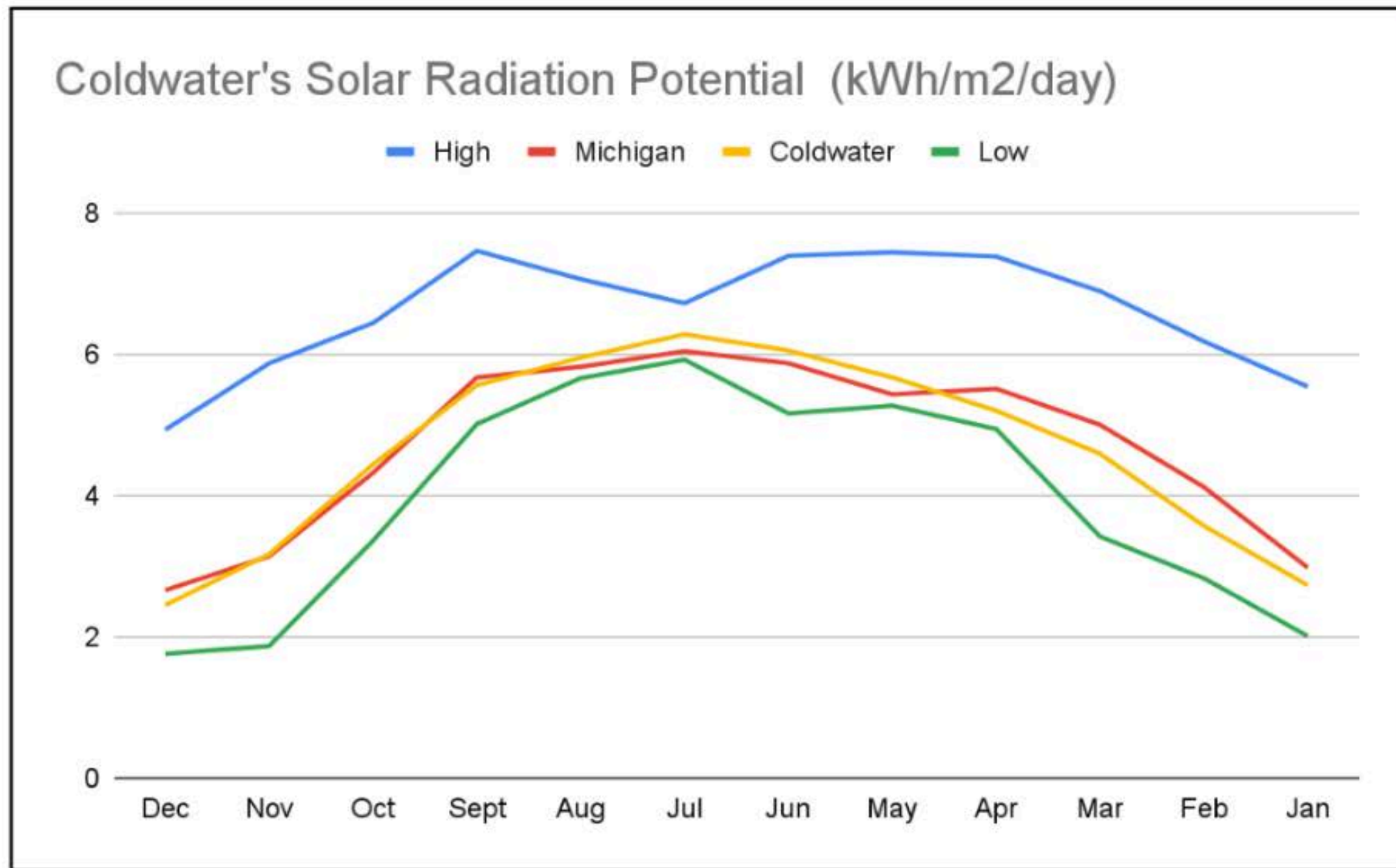


mono-pitch canopy





IS THERE A POTENTIAL FOR SOLAR IN COLDWATER?



- Year-round solar radiation ranges from **2.7 to 6.2 kWh/m²/day**
- Peak solar months: May to August (**over 6 kWh/m²/day**)
- Winter generation still viable with **~2.7 kWh/m²/day**
- Well-balanced solar profile supports **consistent energy output**

Coldwater Solar Carport Pilot Project Feasibility and Scalability Studies



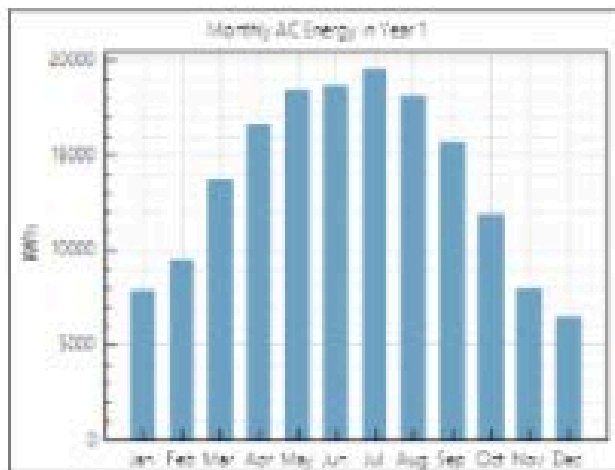
Summary of In-Depth Simulation Report

This report provides a side-by-side summary of the four solar PV system configurations evaluated (using System Advisor Model) simulations. Each design varies by module count (276 vs. 299), pitch (monopitch vs. duopitch), with performance metrics normalized for consistent comparison. Below highlights key outputs such as annual energy generation, capacity factors, and system sizing details.

Table 1: 299-Module Mono System

Table 2: Energy Output and Loss Breakdown – 299-Module Mono System

Month	Monthly AC energy in Year 1 (kWh/mo)
Jan	7849.06
Feb	9446.3
Mar	13658.4
Apr	16639.4
May	18379.4
Jun	18668.7
Jul	19496.1
Aug	18029.5
Sep	15644.8
Oct	11849.9
Nov	7906.1
Dec	6477.25



Metric	Value
Annual AC energy in Year 1	164,045 kWh
DC capacity factor in Year 1	15.7%
Energy yield in Year 1	1,373 kWh/kW
Performance ratio in Year 1	0.84

Table 3: Production and System Loss Breakdown – 299-Module Mono System

Energy (kWh)	Change from the Previous Stage	Main Causes of Loss
164,045	-	Incoming solar irradiance

Figure 5: Illustration of proposed design 1

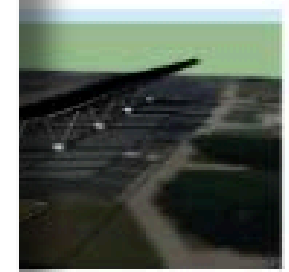
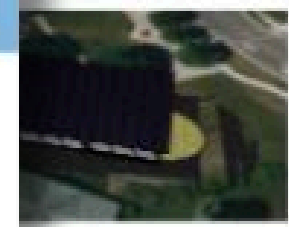
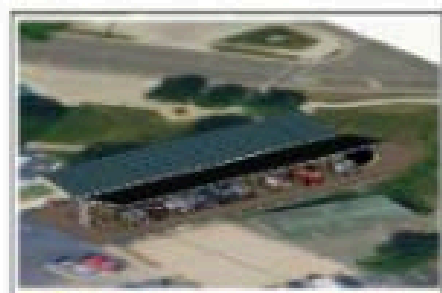


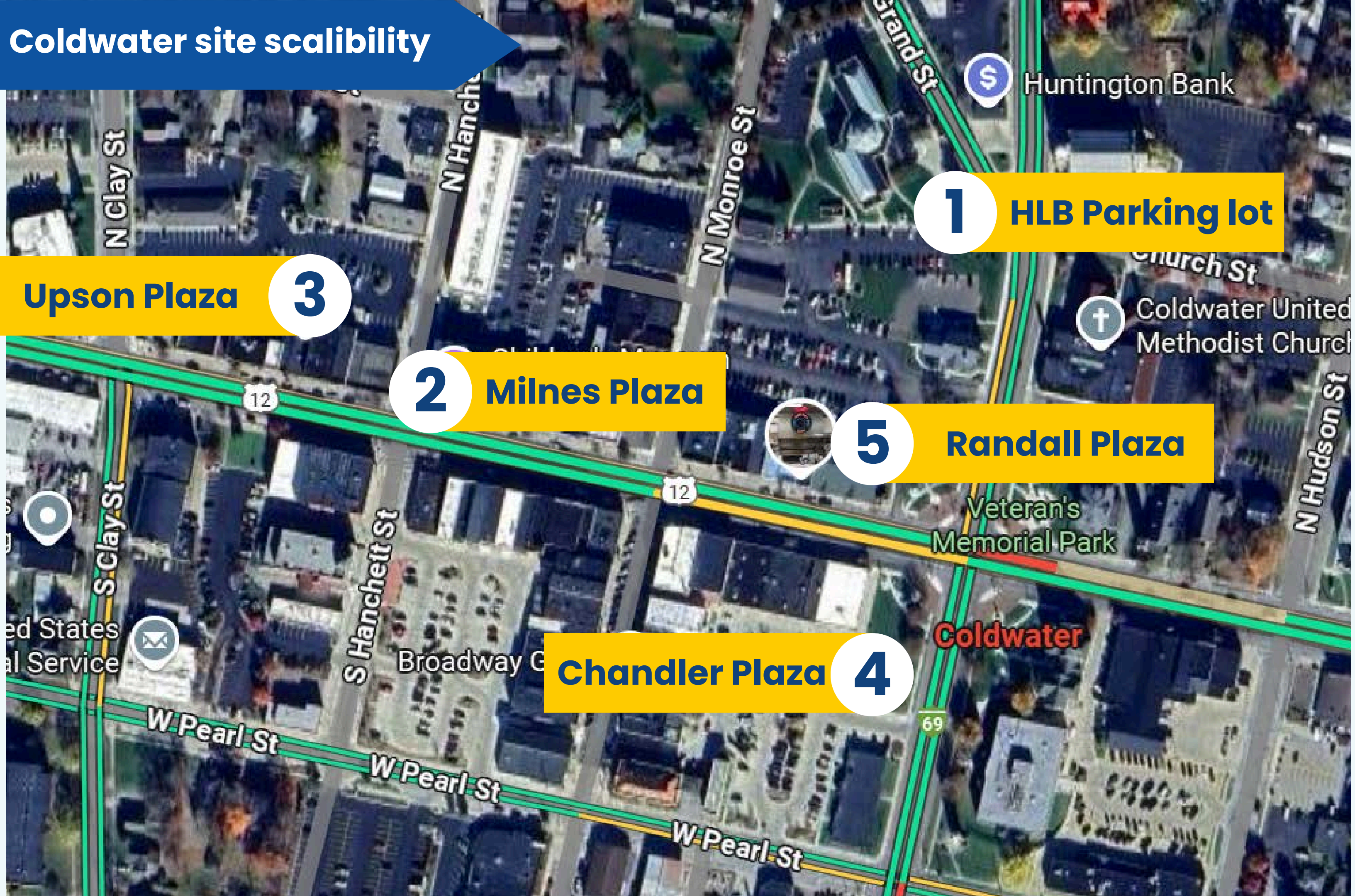
Figure 6: Illustration of proposed design 2



	Proposed Design 1	Proposed Design 2
Configuration	Monopitch: unified array with all panels facing south	Duopitch: split array with panels facing both north and south
Canopy Structure	Asymmetrical canopy, sloped in a single direction	Symmetrical canopy with a central ridge
Capacity	110.4 kW–119.5 kW	110.4 kW–119.5 kW
Drainage	Gutter and downspout system along the lower edge, run-off to the green space.	Central valley drainage via engineered swale or gutter, run-off to the green space.
Snow Management	Promotes faster snow shedding and runoff	Balanced snow accumulation and shedding on both sides



Coldwater site scalability



1 HLB Parking lot

3 Upson Plaza

2 Milnes Plaza

5 Randall Plaza

4 Chandler Plaza



Site Overview

- Two parking rows (24 total spaces),
- Lot supports a 50–200 kW PV system, depending on panel layout and structure.

Monopitch (All South-Facing)

- Pros: Maximizes solar yield, simple structure, efficient snow and water runoff.
- Cons: Uneven canopy height, less symmetrical coverage.

Parking Layout & Structural

- 30° vs. 45° angled parking analyzed for efficient flow (one-way traffic only).
- Turnaround loop at the end recommended for smooth circulation and plow/service access.

Duopitch (North-South Split)

- Pros: Balanced appearance, generates across morning and afternoon periods, even coverage.
- Cons: ~5–10% lower annual energy than optimized south-facing design

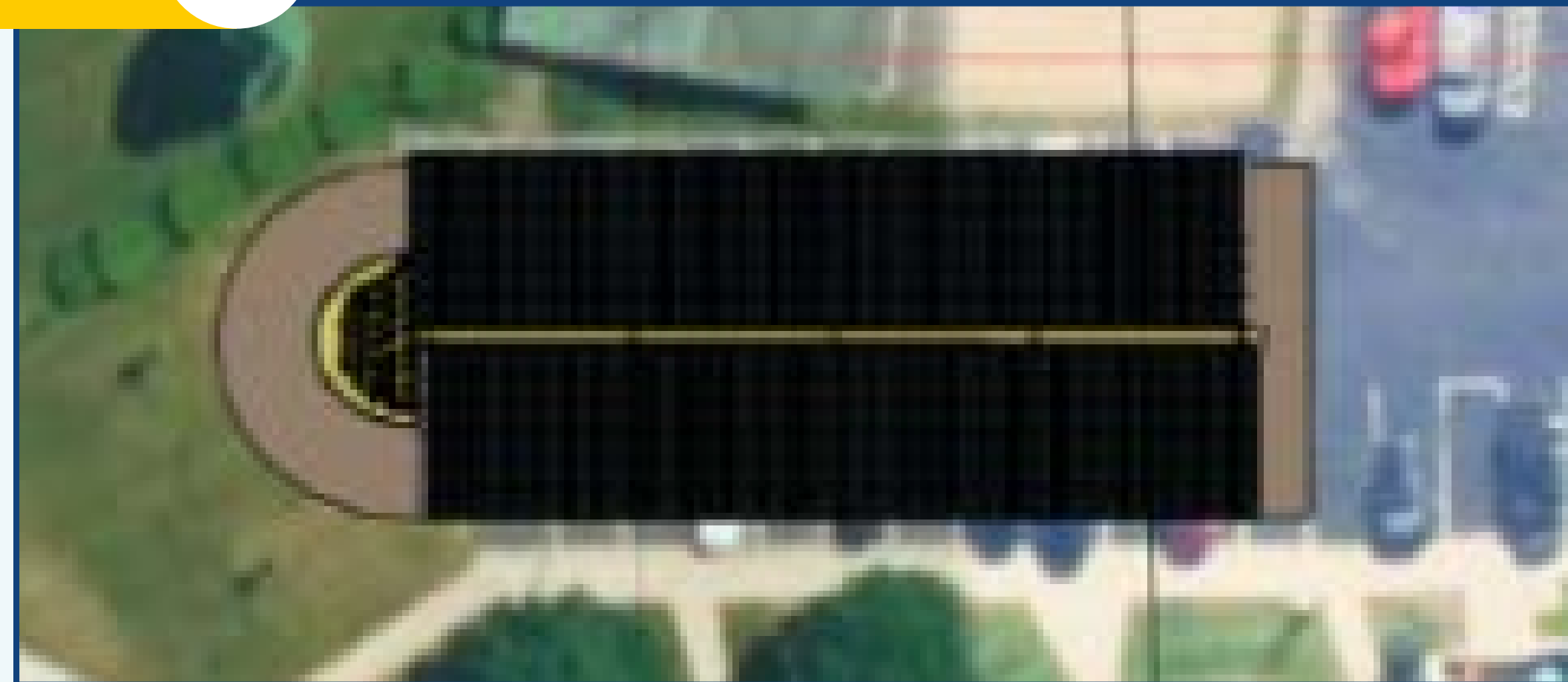


Coldwater Pilot Project



Metric	Value
Annual AC energy in Year 1	131,559 kWh
DC capacity factor in Year 1	13.6%
Energy yield in Year 1	1,193 kWh/kW
Performance ratio in Year 1	0.84

Metric	Value
Annual AC energy in Year 1	143,980 kWh
DC capacity factor in Year 1	13.8%
Energy yield in Year 1	1,205 kWh/kW
Performance ratio in Year 1	0.84

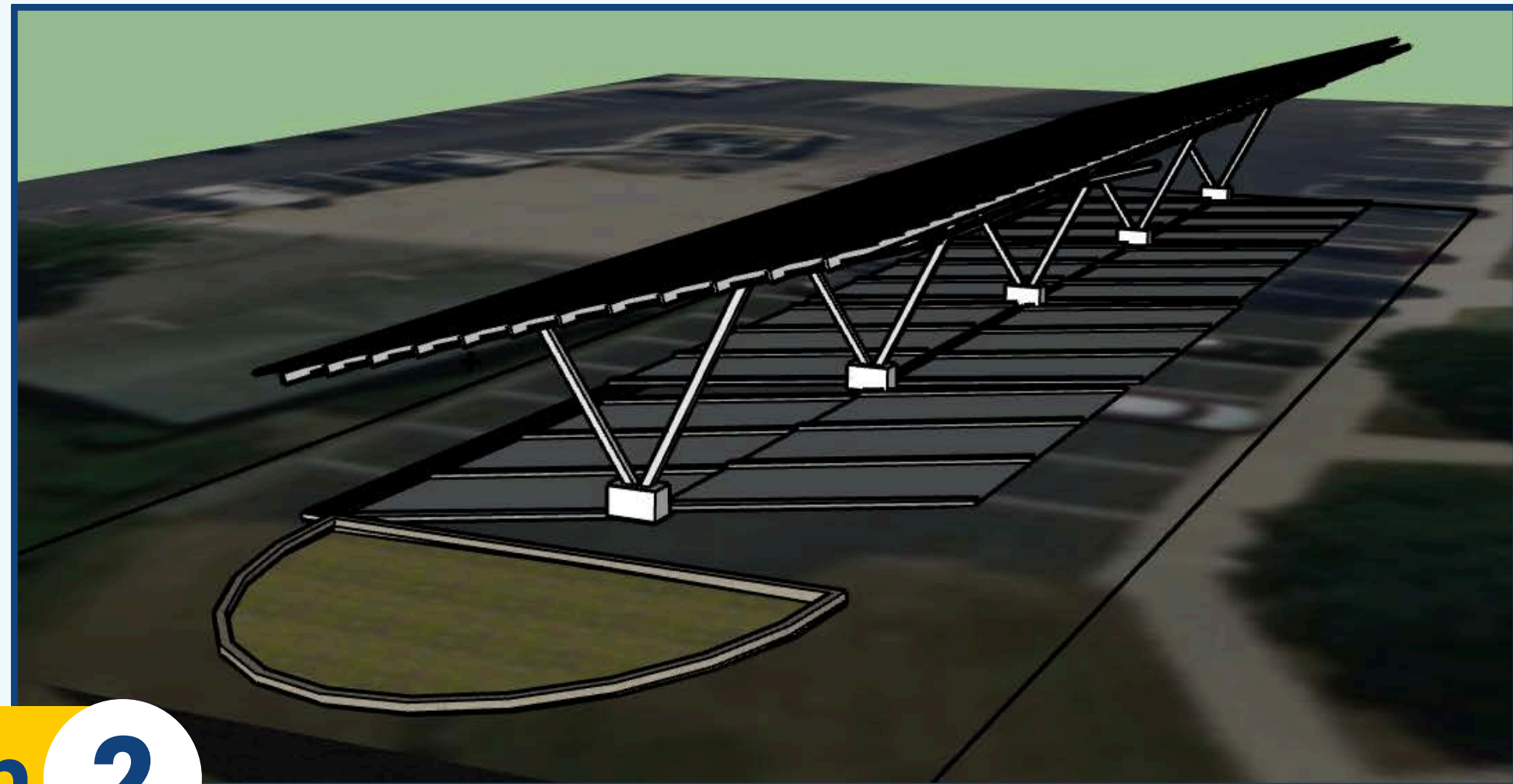




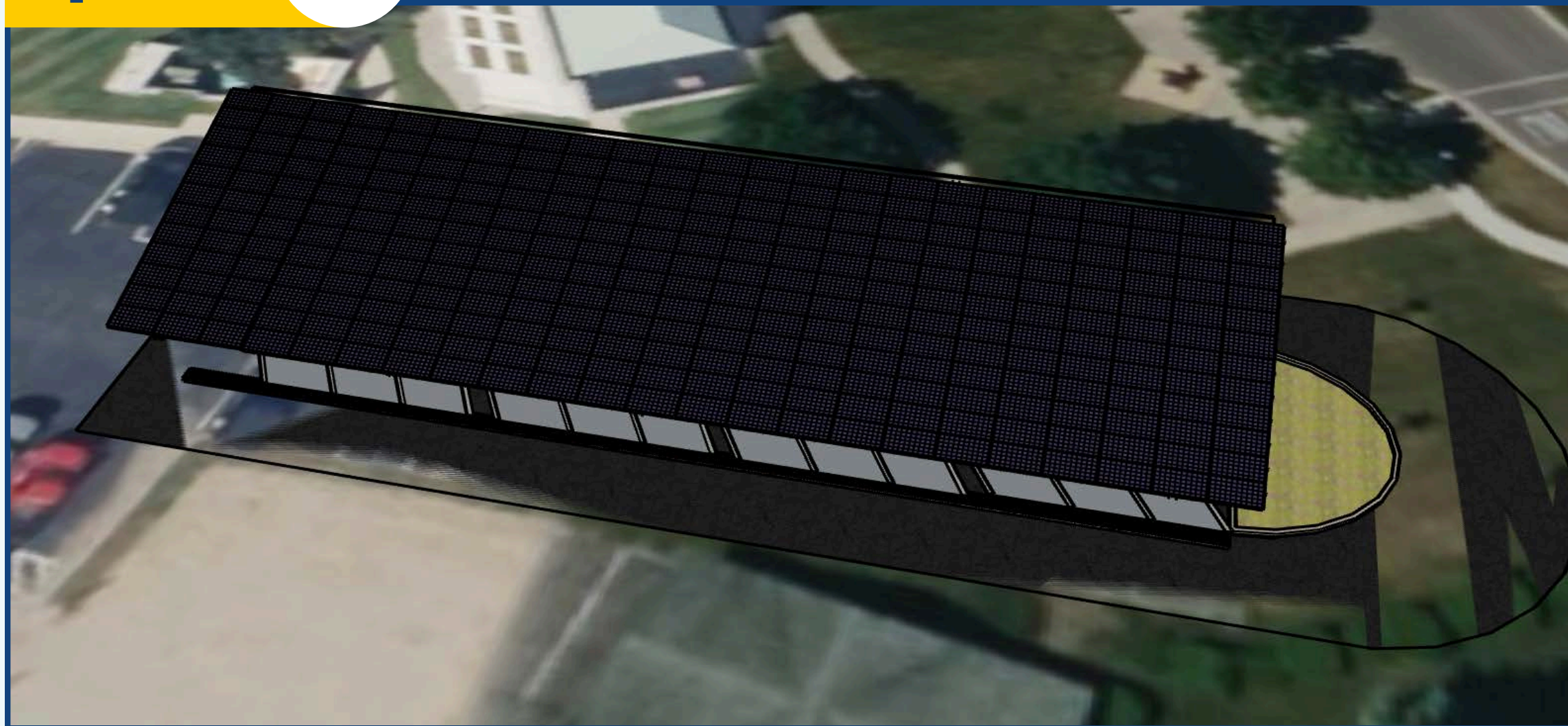
Coldwater Pilot Project

Metric	Value
Annual AC energy in Year 1	151,278 kWh
DC capacity factor in Year 1	15.7%
Energy yield in Year 1	1,372 kWh/kW
Performance ratio in Year 1	0.84

Metric	Value
Annual AC energy in Year 1	164,045 kWh
DC capacity factor in Year 1	15.7%
Energy yield in Year 1	1,373 kWh/kW
Performance ratio in Year 1	0.84



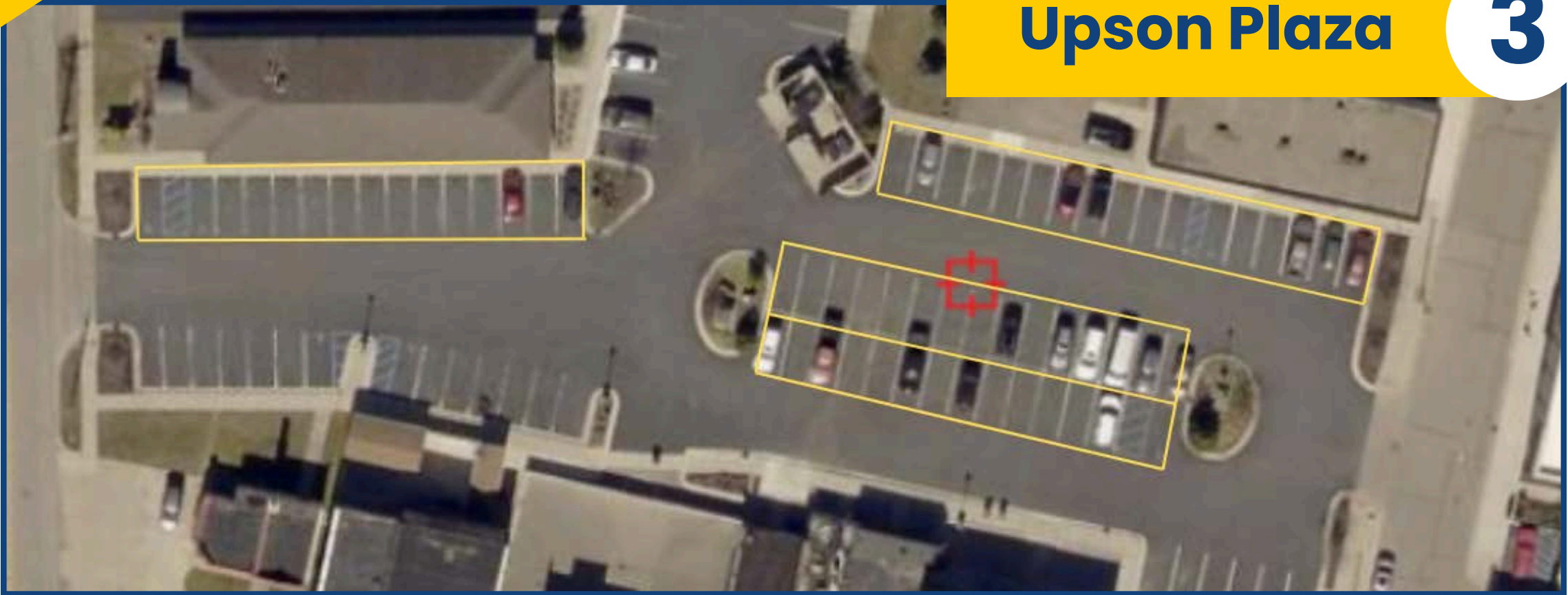
option 2





Coldwater site scalability

Upson Plaza 3



2 Milnes Plaza



Chandler Plaza 4



5 Chandler Plaza





Coldwater Project Combined

Site	Capacity (kW DC)	Annual Output (kWh)
HLB	119.6	164,045
Milnes Plaza	312	360,000
Chandler Plaza	288	395,000
Upson Plaza	172	324,000
Randall Plaza	280	500,000
Output	1171.6	1,743,045

Phase 1: HLB Pilot Project

\$13.5–13.8k/year

At 164,000 kWh/year, this system will offset roughly **38%** of the HLB building's annual energy use

Phase 1 & Phase 2



Homes powered for one year

188 homes (electricity use)



Environmental Impacts

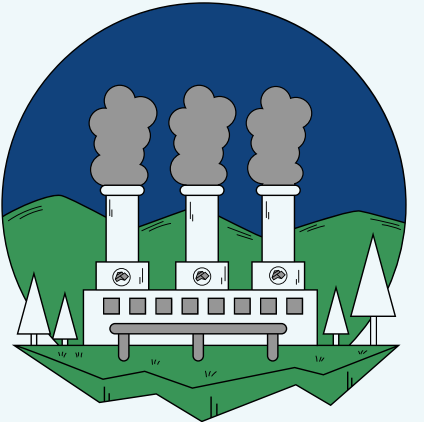


Gasoline-powered passenger vehicles removed

310 vehicles

Gallons of gasoline avoided

149,777 gallons



Pounds of coal not burned

739 tons



Tree seedlings grown for 10 years (carbon uptake)

22,009 seedlings

Acres of U.S. forests preserved (carbon uptake)

1,335 acres



Barrels of oil not consumed

3,082 barrels

THANK YOU

