AZIMUTH ENERGY

Portfolio: 500 PV, 80 Battery Plants, 12 Microgrids


- # 77 National EPC
- # 9 Solar-plus-Storage

Licensed Engineering Corporation, IL DG Contractor
Hurricane survivability consultant to NREL
NABCEP-Certified Solar installer + Inspector

SAFETY – PERFORMANCE – AESTHETICS
**MasterCard O’Fallon Solar Carports**

Benefits of solar carports
Typical carport financials
Configuration options
Design & construction considerations
Project delivery options
Q & A

---

**MasterCard O’Fallon Solar Carports**

- Benefits of solar carports
- Typical carport financials
- Configuration options
- Design considerations
- Project delivery options
- Q & A

- Financial / marketing / environmental
- Greenhouse gas reduction goals
- Shade for employees’ cars
- Protection from rain and snow
- Limited, expensive real estate

---

3 kW Per Parking Space
Typical Project Financials, 150 kW Power, Financed

<table>
<thead>
<tr>
<th></th>
<th>ROOFTOP PV SYSTEM</th>
<th>SOLAR CARPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Project Investment</td>
<td>$270,000</td>
<td>$420,000</td>
</tr>
<tr>
<td>Incentives</td>
<td>$117,000</td>
<td>$162,300</td>
</tr>
<tr>
<td>Net Investment, After Yr-1 Credits</td>
<td>$151,000</td>
<td>$258,000</td>
</tr>
<tr>
<td>Owner Equity (20%)</td>
<td>$54,000</td>
<td>$84,000</td>
</tr>
<tr>
<td>Depreciation, After Tax</td>
<td>$51,000</td>
<td>$85,000</td>
</tr>
</tbody>
</table>

ASSUMPTIONS
- $0.10 / kWh retail cost of electricity
- 2% Energy cost escalator & CPI
- 6%, 10 years terms of commercial loan
- $0 Value of Carbon
- 27% Combined federal and state tax rate
- 8% Discount rate
- 7% Investment cap rate
- $3,200 Annual O&M

Typical Project Financials, 150 kW Power, Financed

<table>
<thead>
<tr>
<th></th>
<th>ROOFTOP PV SYSTEM</th>
<th>SOLAR CARPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Rate of Return (IRR)</td>
<td>48%</td>
<td>24% / 15%</td>
</tr>
<tr>
<td>Straight-Line Payback</td>
<td>1.3 Years</td>
<td>1.4 / 8.0 Years</td>
</tr>
<tr>
<td>Net Present Value (NPV)</td>
<td>$158k</td>
<td>$107k / 83k</td>
</tr>
<tr>
<td>Cash-on-Cash Return</td>
<td>32%</td>
<td>20% / 11%</td>
</tr>
<tr>
<td>Debt-Service Coverage</td>
<td>1.3</td>
<td>0.8 / 1.2</td>
</tr>
<tr>
<td>EBITDA or Net Operating Income (NOI)</td>
<td>$17k</td>
<td>$237k</td>
</tr>
<tr>
<td>Increase in Building Value</td>
<td>$0.02/kWh &amp; 85%</td>
<td>$0.05/kWh &amp; 50%</td>
</tr>
</tbody>
</table>

Levelized Cost of Energy & Reduction

![Annual Cash Flow](image1.png) ![Total Cash Flow](image2.png)
Solar Carport – Configurations

Long-Span Flat Table (East-West azimuth)
Long-Span Tilted Table (Single azimuth)
Tilted Cantilever (Single azimuth)

*Parking lot configuration may be the primary carport configuration driver!*

---

**Long-Span FLAT Table**

Solid "roof", most waterproof, no light penetration, more artificial lighting required
Close to 100% deck coverage; requires "rooftop" perimeter and isleway access
High energy production per parking space
Lower energy yield due to east-west orientation, lower tilt, higher temperature
Table arrangement – easier foundations
Easier snow removal & ice control
Pre-fab metal building without walls
**Long-Span TILTED Table**

Higher slope, tilted south, incomplete deck coverage, less lighting required
Decking possible for rain protection, using gutters and downspouts
Highest energy per parking space (no setbacks)
Higher energy yield due to south azimuth, higher tilt, lower temps
Table arrangement - easier foundations
Requires snow removal & ice control

---

**Tilted Cantilever**

Single and double parking row coverage
Driving lanes not covered
Tilt can range $5^\circ$ to $10^\circ$
Lower energy per parking space (no setbacks)
Well suited for parking lots that have narrow rows or curves
Higher foundation cost resulting from higher forces
Design & Construction Considerations

ENGINEERING
Desired height and appearance of the carport elevation
Foundation design and geotechnical
Foundation location with respect to parking spaces, medians, underground infrastructure
Height of foundation above ground, snow removal, corrosion
Decking or no decking, change from landscape to portrait
Water and snow management

CONSTRUCTION QC
Fall protection
Free-air wire management
Module alignment
Reading the directions is always important; more so for a carport steel assembly

Design & Construction Considerations

ENGINEERING
Desired height and appearance of the carport elevation

Grade of the land, slope of the parking deck
Relative height above the ground
Deck slope compared to ground slope
Design & Construction Considerations

ENGINEERING
Foundation design and geotechnical
Height above ground, snow removal, corrosion

Cantilever
Flush

Cantilever
Pier

Table

Grade beam

Design & Construction Considerations

ENGINEERING
Foundation location with respect to parking spaces, medians, underground infrastructure
Parking space – 9' x 18'

Single Cantilever – more steel
Foundations outside parking space

Single Cantilever – less steel
More foundations, between spaces

Double cantilever
MASTERCARD O’FALLON
Design & Construction Considerations

ENGINEERING

Decking or no decking, water and snow management

Construction fall protection – mostly decked configurations

---

Design & Construction Considerations

CONSTRUCTION QC

Free-air wire management

*All conduit runs (DC and AC) shall be symmetrical, rectilinear, and orderly. Penetrations of the conduit through decking or other surfaces shall be finished with grommets, bushings, or other Owner-approved materials to result in a finished appearance.*

SAFETY – PERFORMANCE – AESTHETICS
Design & Construction Considerations

CONSTRUCTION QC
Module alignment

SAFETY – PERFORMANCE – AESTHE TICS

Horizontal gap
Vertical gap
Bottom edge
Top edge

Reading the directions is always important; more so for a carport steel assembly

Project Delivery Options

Design-Bid-Build
Qualifications-based selection
Evaluating based on cost of energy and not the cost of power capacity
Construction Opportunity Curve

![Construction Opportunity Curve Diagram]

Marc Lopata, PE
314.378.1913
Marc@Azimuth.Energy

AZIMUTH ENERGY

www.Azimuth.Energy