Increasing the Performance of Bifacial Systems: A “How-to” Discussion

The Most Counter-Intuitive Innovation

Credit: Kingsun Solar

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Why Bifacial ?

- Better Return on Investment (ROI) - if done properly
  > (extra cost offset by additional power)
- Better power density
- Cheaper bifacial panels (tariff lifted)
- Existing white roof : consider it
- Better looking carports/canopy

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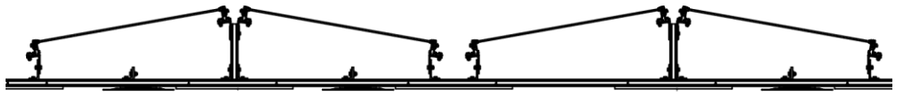
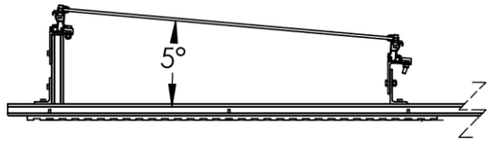
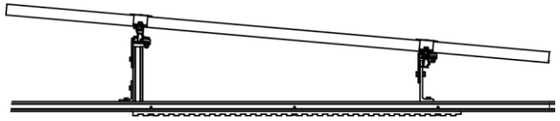
The Basics - Rooftop

- Albedo (gray or lighter)
- Tilt > 15º
- Height > 16”
  > (ideal height = module length, 39’’)
- Interrow Spacing
  > (Shading angle = 20º)
- NO RACKING SHADING

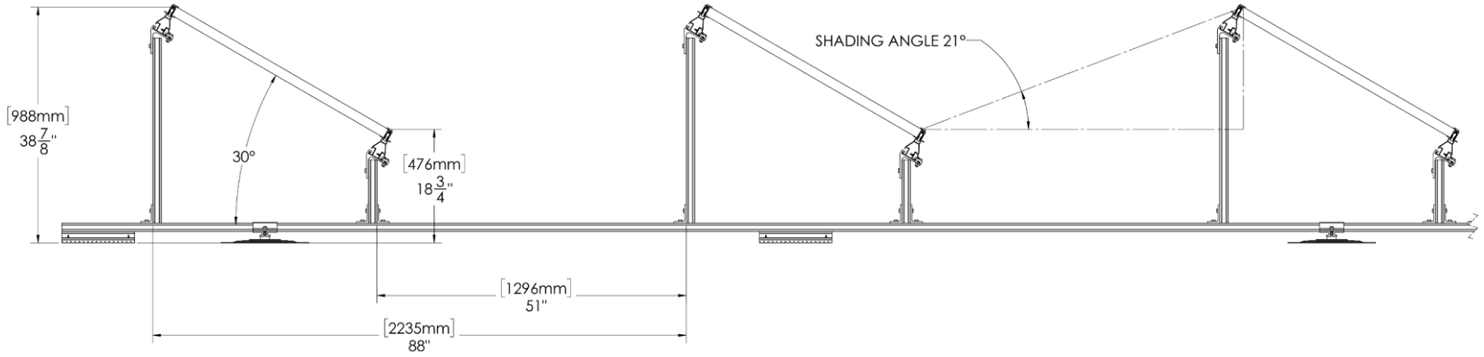
Sub-Optimal







Optimal



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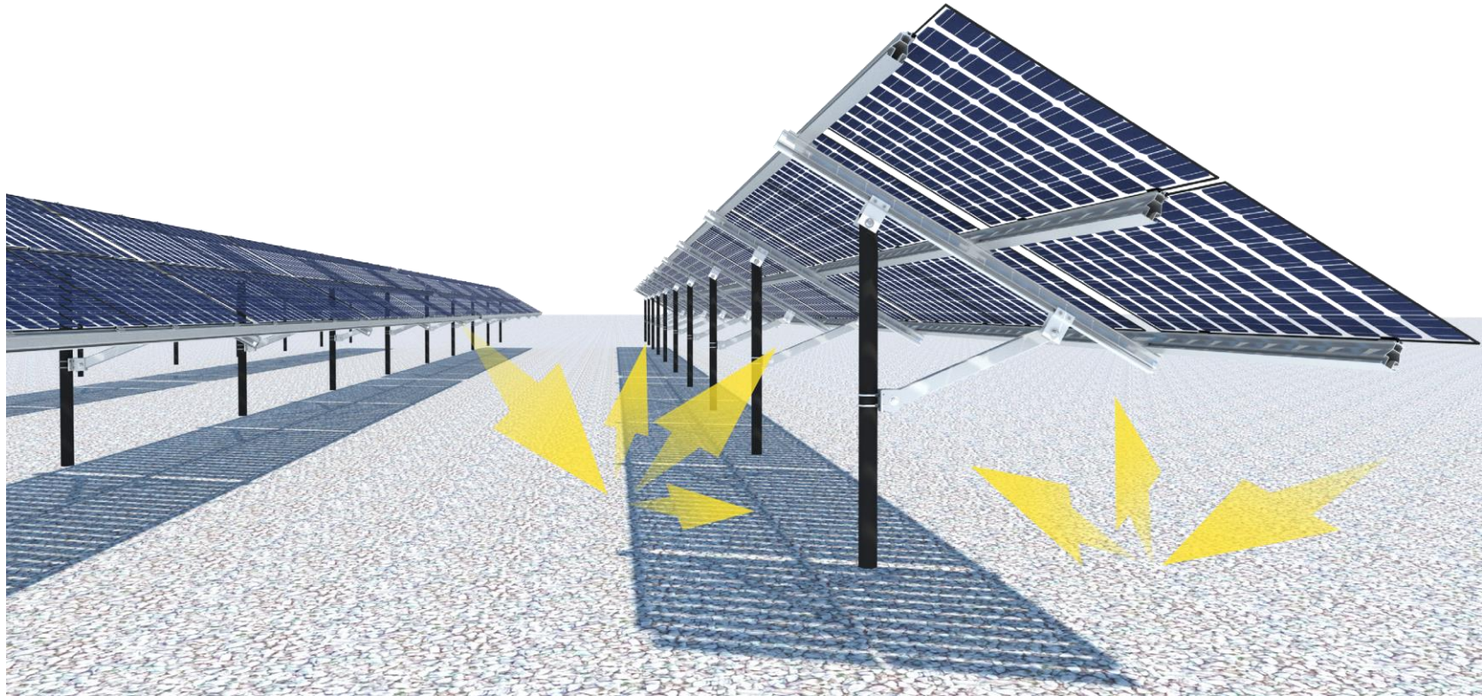
The Basics - Ground Mounted

- Albedo : rocks, sand, textile
- Tilt : optimal,
  > (No real reasons to increase)
- Height > 3 ft,
  > (ideally 6 ft, 2 rows)
- 2 rows > 4 rows
- Interrow Spacing
- Center post/rails between PVs



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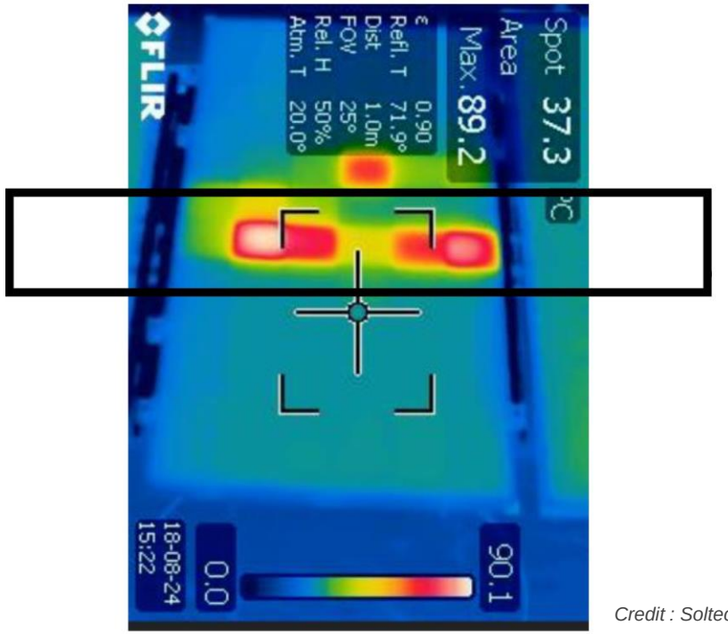
Beware of Hot Spots!

- Bifacial PVs cannot be mounted with rails under the PVs
- Portrait to be avoided, unless rails run vertically
- SAT : Modules should not be placed over rotation axis
- Remember : string in series, permanent shading = permanent lower current on full string (loss)



Credit : Soltec/BiTEC Aug. 2018

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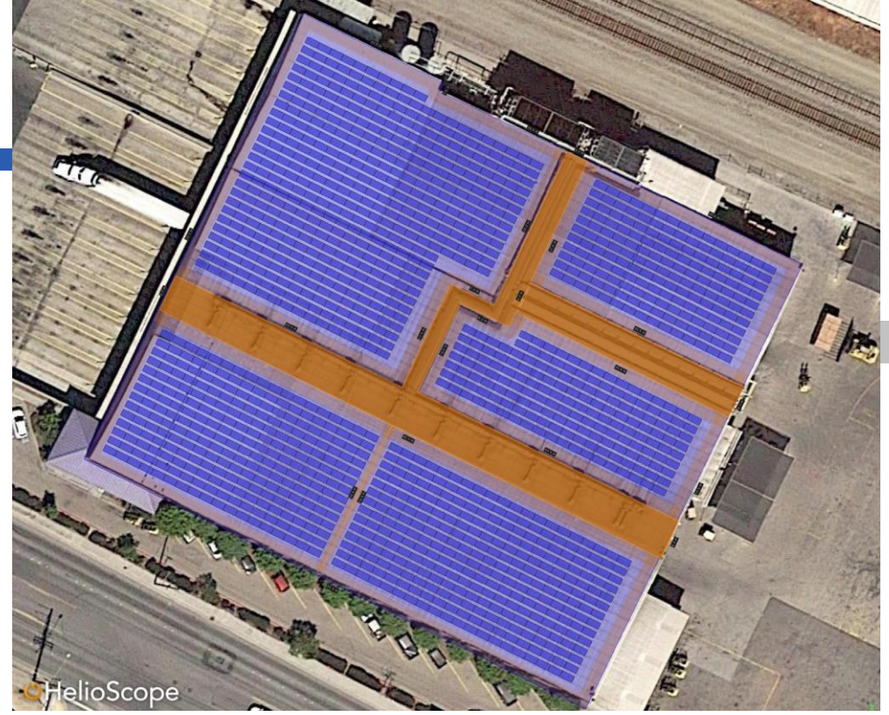
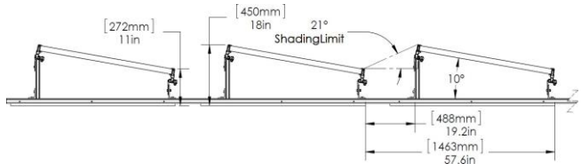
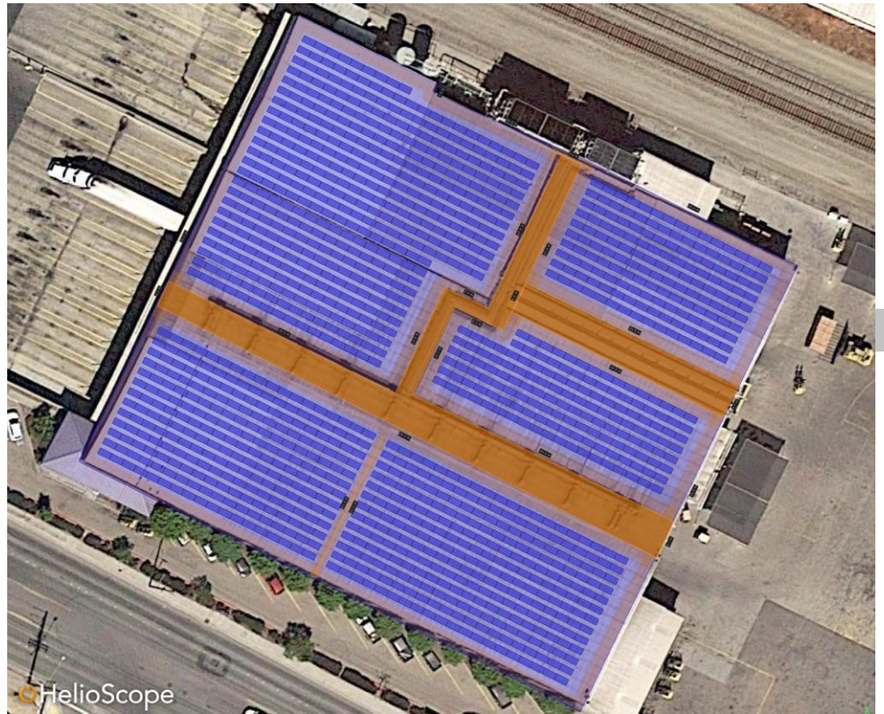
10° Vs 15° HP Bifacial

- Typical PV installs at 5°, 10°
- Going from 10° to 15° : loss of 10-15% PVs
- Bifacial 15° Vs 10° std PVs : 15-18% more energy
  > **EXAMPLE (California, white TPO):**
  > 9% fewer panels
  > 17% more energy per panel (bifacial gain)
  > Cheaper bifacial PVs than ever
  > Necessarily more profitable

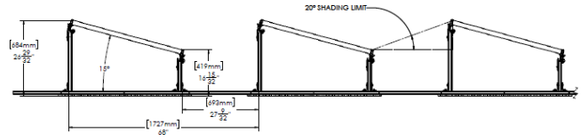


10° Standard
- 1323 PVs (LG 400W)
- 1537 kWh/kWpeak
- **813.38 MWh**





15° Bifacial, 16” height
- 1213 PVs (LG 400W-Bifi)
- 1799 kWh/kWpeak
- **872.87 MWh/yr**



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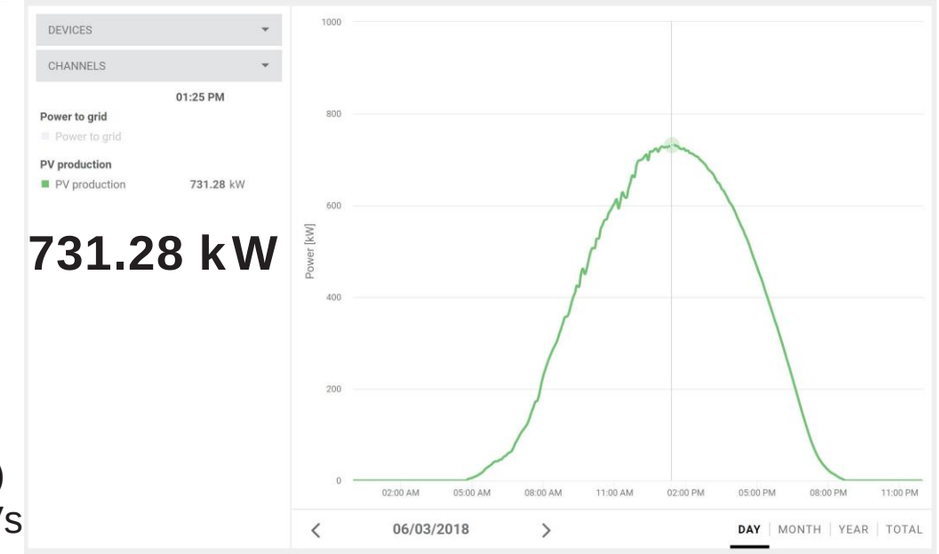
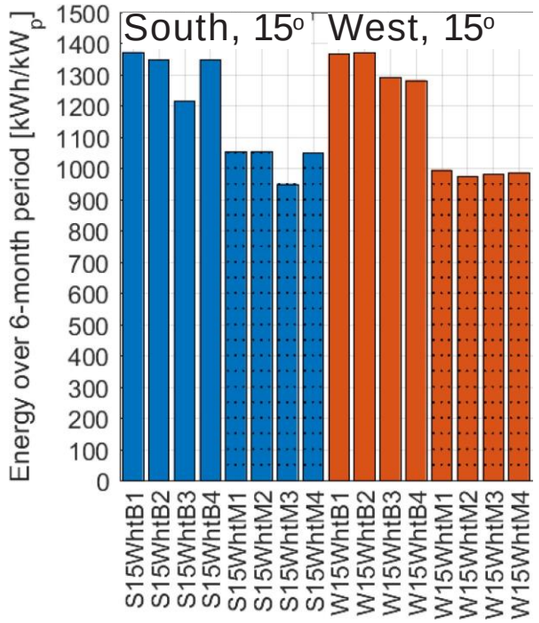
Other Important Elements

- Done properly, your bifacial system will generate a lot of extra kwh at noon!
- P/R close to 100% (all losses offset by bifacial gains)
- AC:DC - closer to 1:1 than 1.3:1
- Albedo in PVSYST : be conservative (include soiling, lower membrane reflection by 10-20%)
- Azimuth not as important as with standard PVs *(SANDIA research)*
- P-Type Vs N-Type
  > P-Type = 55-65%
  > N-Type = 80-95%



30° Bifacial, 16" height
Québec, Canada

- 687 kW Peak
- Reaches 731 kW at noon
- 106.5% AC:DC
- Clipping is lost energy!



LAVE, Matthew et als. (2016), "Performance Results for the Prism Solar Installation at the New Mexico Regional Test Center: Field Data from February 15 - August 15, 2016", Sandia National Laboratories, p. 30.

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Anchors Vs Ballast

- As an industry, we have to better under-stand the advantages of anchoring
  > Less dangerous than apparent
  > Few leaks in history
  > Similar cost

- Inherent unknowns with ballasts
  > Concrete degradation
  > Sliding
  > More drastic failures modes

- Ballast will cast shadows

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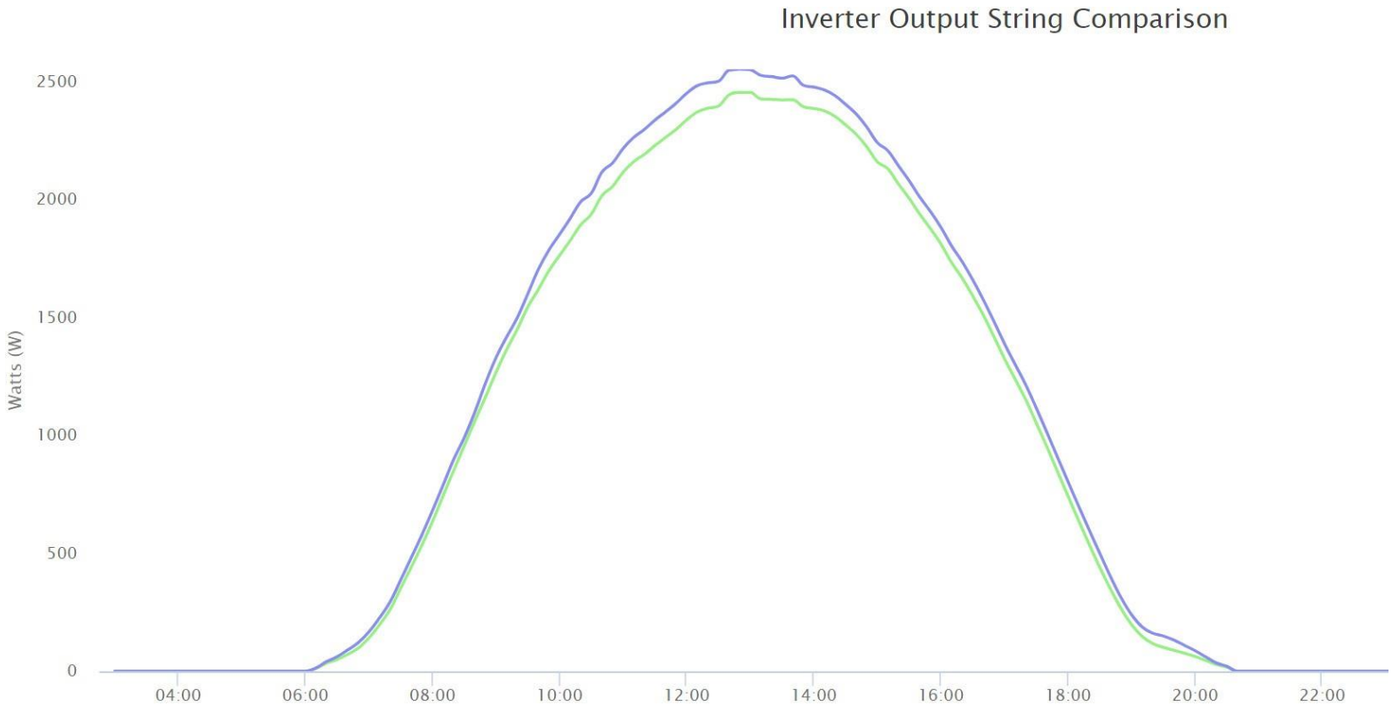
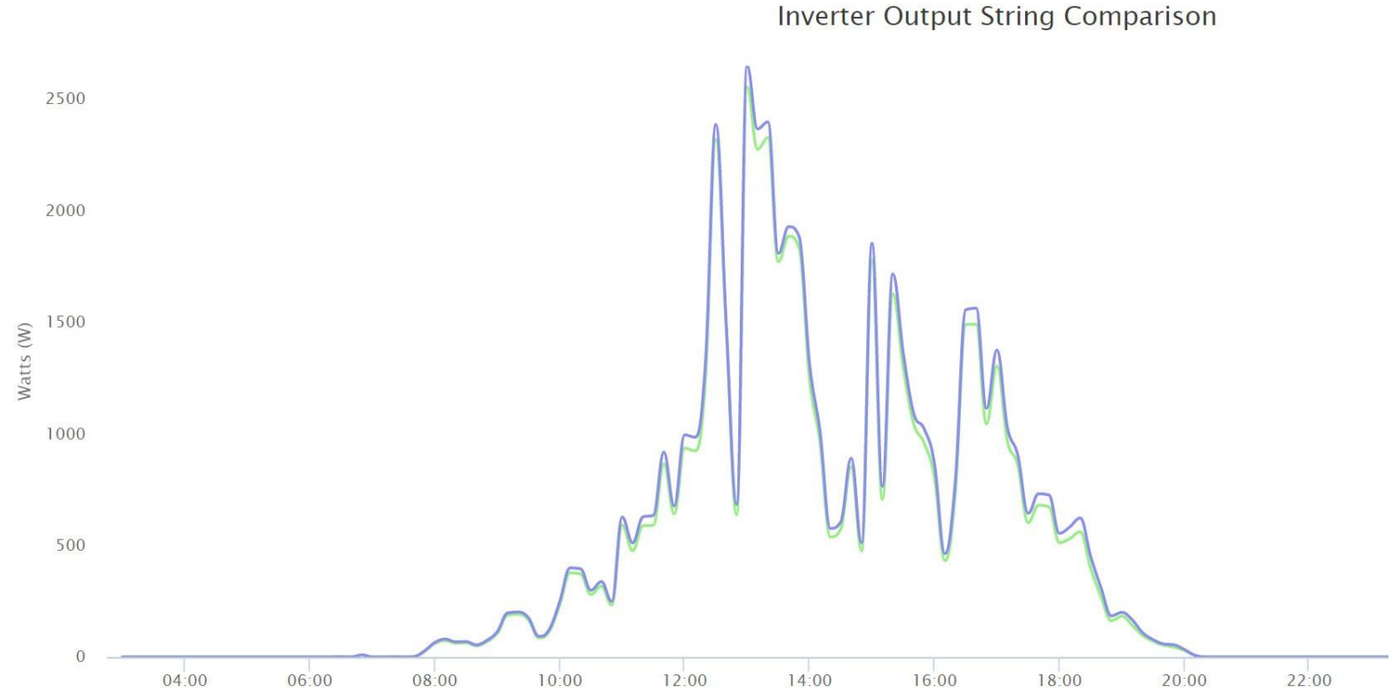
Daily Performance

- System with one string of LG Monofa- cial (**Green**) and one string of LG Bifacial (**blue**) - 2.5 kW
- Barry, Ontario

- Obvious over-performance of bifacials
  > More energy earlier in the day
  > More energy later in the afternoon
  > Much more energy at noon (can reach 20%+, and over 100% DC power)

- Low Light performances
- Diffuse light performances
- Snow melts faster





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Bifacials Melt Snow better

- Backside never covered with snow
- Additional gains in snowy regions
- (Not if panels are buried in snow!)
- Hard to quantify (more research needed)
- Highly location sensitive (too cold = ice)

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This is what it looks like

- 2290, 300W Prism Panels
- 687 kW
- Fronius Inverters (24 kW)
- Grid-tied
- Fully anchored
- Store is Net-Zero

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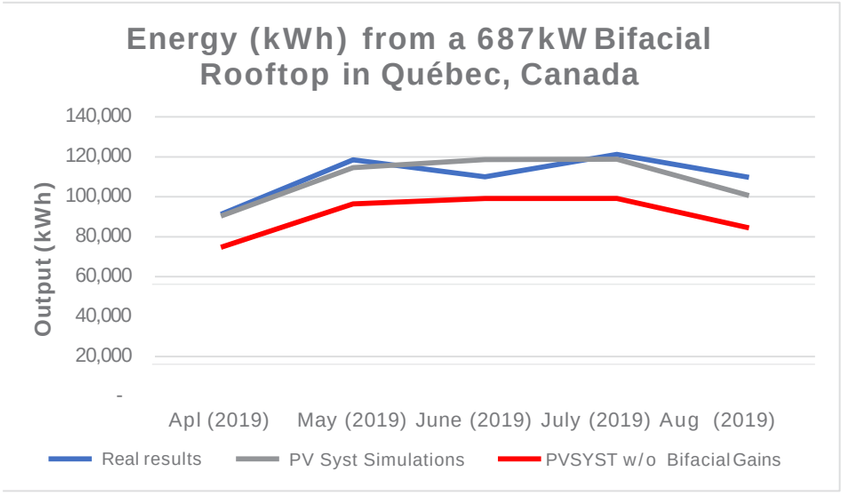
Case Study

- **Rooftop**
  > Prism Solar Panels, G/G, 300W bifi
  > 2290 units
  > 687 kW
  > Fronius inverter, no optimizers
  > No rails under the PVs
  > Installed in march 2018
  > PVSYST Albedo : 60%
  (Light Gray asphalt)

- **Carport**
  > Prism Solar Panels, G/G, 360W bifi
  > Sealed Structure
  > No rails under the PVs
  > Fronius inverter, no optimizers
  > PVSYST Albedo : 15% (black asphalt)

- **Both systems over-perform PVSYST!**
  > Albedo?
  > Chaotic diffuse light hard to model

ROOFTOP



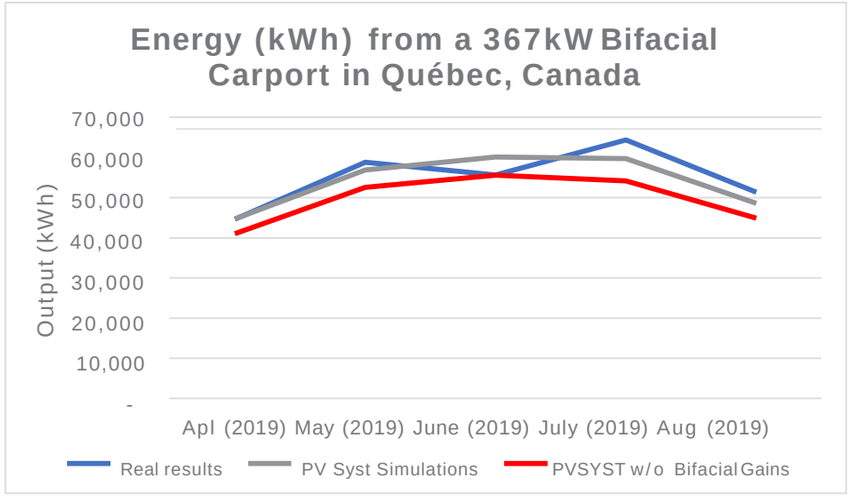
Real Performances scale well with PVSyst (summer, 2%)

- Real : 800 kWh/kW_{peak}
- PVSYST : 784 kWh/kW_{peak}

Without Snow (full year):

- Bifacial : 1451 kWh/kW_{peak}
- W/O Bifacial : 1207 kWh/kW_{peak}
- Bifacial Gains : > 20-22%

CARPORT



Real Performances scale well with PVSyst (summer, 2%)

- Real : 748.5 kWh/kW_{peak}
- PVSYST : 735 kWh/kW_{peak}

Without Snow (full year):

- Bifacial : 1165 kWh/kW_{peak}
- W/O Bifacial : 1068 kWh/kW_{peak}
- Bifacial Gains : > 10-12%

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Bifacials Look Great!

- Transparent
- Cells visible from underneath
- Much more elegant than a standard white backsheet

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Discussion

- Why have you not tried Bifacial?

  > Difficulty in financing?
  > Unknowns in Simulations?
  > High profile systems can bring new engineering challenges
  > Anchoring too risky?
  > Panels hard to source?

(All images from our projects. Ask us anything!)

Hurricane-rated system in Bahamas

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