

Solar PV Electricity Generating System – Performance Assessment

- Project:** Parkland Net-Zero-Energy House
- System Owners:** Dennis and Christy Cuku
- System Location:** south of Spruce Grove in a forest
- System:** Your 16.5 kW solar PV system using 60 Suntech STP 275 24/Vd modules and 2 SMA Sunny Boy SB
- Comments:** 8000U 8 kW inverters is expected to generate 23,130 kWh of electrical energy per year with a minimum savings starting at \$2,293 per year based on 2010 electrical energy prices.

Goal: To size the PV system to supply the amount of electrical energy that the house imports from the grid over the year

| | | |
|-----------------------|------------------|-----------|
| Latitude | Longitude | Elevation |
| site: 53° 25' 34.81 N | 113° 52' 03.87 W | 707 m |
| data: 53° 32' 48" N | 114° 06' 59" W | 766 m |

6. **Location of solar energy data:** Edmonton Stony Plain weather station, Alberta

7. Equipment Specifications

| Solar PV Module | |
|-------------------------------|------------------------|
| Manufacturer: | Suntech |
| Technology: | multi-Si |
| Module model #: | STP 275 24/Vd |
| Rated power: | 275 W |
| Gross area: | 1.94 m ² |
| Efficiency: | 14.2% |
| Height: | 1,956 mm |
| Width: | 992 mm |
| Weight: | 27.0 kg |
| Mounting pressure: | 13.9 kg/m ² |
| Normal Operating Cell Temp: | 45° C |
| Pmax temperature coefficient: | -0.440 %/K |
| Nameplate rating tolerance: | 0.0% |

| Solar PV Array | |
|--------------------------------|-----------------------|
| Module quantity: | 60 modules |
| Capacity: | 16.5 kW |
| Area: | 116.4 m ² |
| Weight: | 1,620 kg |
| Module mis-match: | 2% w/ string inverter |
| Diodes and connections: | 0.5% typical |
| Angle of solar incidence: | 0% typical |
| Soiling (5% urban, 10% rural): | 5.0% typical |
| MPP Tracking error: | 2% typical |
| 1st-light degradation: | 1.3% typical |
| Array de-rating factor: | 10.4% |
| Array efficiency: | 12.7% |
| Location: | in field |

| Grid-dependent Inverter | |
|-------------------------|-----------------------|
| Manufacturer: | SMA |
| Model Name: | Sunny Boy |
| Model #: | SB 8000U |
| Rated power: | 8.00 kW |
| Efficiency: | 96% average |
| Quantity: | 2 inverters |
| Total: | 16.5 kW |
| DC wiring losses: | 0.5% |
| AC wiring losses: | 1.0% |
| Inverter location: | inverter shed |
| Panelboard ID: | main |
| Panelboard locn: | mechanical room |
| Type of loads: | net-zero-energy house |

| Solar PV Array Mounting | |
|-------------------------|---------------------------|
| Module orientation: | landscape |
| Mounting system: | rails, poles and trackers |
| Array tilt angle: | variable with tracking |
| Array azimuth angle: | variable with tracking |
| Azimuth angle is: | variable with tracking |
| Mounting: | Two-axis tracking |
| Clearance: | n/a |

| Solar PV Array Optimisation | |
|------------------------------------|---------------------------------|
| Optimum fixed-tilt angle: | 46° without snow |
| Optimum fixed-azimuth angle: | 0° CW from S |
| Optimum fixed-angle yield: | 1,293 hours/year |
| Difference from optimum to actual: | 8.4% |
| Difference from actual to optimum: | -7.8% = -\$178 /year |
| Difference is due to: | 2-axis tracking, forest shading |

| Solar PV System | |
|--------------------|-----------------------------|
| Design de-rating: | 15.3% total |
| System efficiency: | 12.0% annual |
| System yield: | 1,402 hours/year |
| System yield: | 3.84 hours/day |
| System yield: | 199 kWh/year/m ² |
| Capacity factor: | 16.0% in a year |
| Performance ratio: | 62% |

31. Expected Solar PV System Performance

| (A) | (B) | (C) | (D) | (E) | (F) | (G) | (H) | (I) | (J) | (K) | (L) | (M) | (N) | (O) |
|----------------------------|--|--|---|---|---|-----------------------------------|-----------------------------------|--------------------------------------|--|---|---|--|---|---------|
| Month | Total Modelled House Electricity Consumption kWh/month | Average Solar Radiation on a Clear Array sun-hours/day | Solar array shading (% of solar radiation reduced) as shown | Snow Cover on Solar Array (# of days/month) = default | Snow Cover on Solar Array (reduced) default | Solar PV Energy Generation kWh/mo | GHG Emissions Reduced by kg/month | Solar Portion of House Electricity % | Estimated Monthly Exported Surplus kWh | Value of House Total Electricity \$/month | Actual Total Electricity Bill without Solar PV in 2010 \$/month | Value of Solar PV Electricity in 2010 \$/month | Estimated Total Electricity Bill with Solar PV in 2010 \$/month | |
| 35. January | 4,638 | 3.77 | 41% | 0.0 | 0.0 | 891 | 774 | 19% | 40% | 357 | \$696 | \$734 | \$109 | \$625 |
| 36. February | 3,584 | 5.66 | 31% | 0.0 | 0.0 | 1,440 | 1,250 | 40% | 50% | 720 | \$538 | \$575 | \$166 | \$410 |
| 37. March | 3,148 | 7.55 | 25% | 0.0 | 0.0 | 2,378 | 2,064 | 76% | 60% | 1,427 | \$472 | \$510 | \$257 | \$253 |
| 38. April | 2,173 | 8.00 | 26% | 0.0 | 0.0 | 2,488 | 2,159 | 115% | 80% | 1,990 | \$326 | \$364 | \$234 | \$130 |
| 39. May | 1,505 | 8.17 | 25% | 0.0 | 0.0 | 2,720 | 2,360 | 181% | 90% | 2,448 | \$226 | \$264 | \$237 | \$27 |
| 40. June | 1,230 | 8.40 | 25% | 0.0 | 0.0 | 2,752 | 2,388 | 224% | 90% | 2,477 | \$185 | \$222 | \$239 | -\$17 |
| 41. July | 1,202 | 8.80 | 26% | 0.0 | 0.0 | 2,976 | 2,583 | 248% | 90% | 2,679 | \$180 | \$218 | \$259 | -\$41 |
| 42. August | 1,237 | 7.61 | 25% | 0.0 | 0.0 | 2,602 | 2,258 | 210% | 80% | 2,081 | \$186 | \$223 | \$245 | -\$21 |
| 43. September | 1,451 | 5.67 | 24% | 0.0 | 0.0 | 1,847 | 1,603 | 127% | 60% | 1,108 | \$218 | \$255 | \$199 | \$56 |
| 44. October | 2,213 | 4.87 | 26% | 0.0 | 0.0 | 1,553 | 1,348 | 70% | 60% | 932 | \$332 | \$370 | \$168 | \$202 |
| 45. November | 3,322 | 3.31 | 38% | 0.0 | 0.0 | 817 | 709 | 25% | 40% | 327 | \$498 | \$536 | \$100 | \$436 |
| 46. December | 4,397 | 3.03 | 45% | 0.0 | 0.0 | 668 | 580 | 15% | 40% | 267 | \$660 | \$697 | \$81 | \$616 |
| 47. | | | | | | | | | | | | | | |
| 48. Monthly average | 2,508 | 6.24 | -27.8% | 0.0% | 0.0% | 1,928 | 1,673 | 77% | | 1,401 | \$376 | \$414 | \$191 | \$223 |
| 49. Annual Total | 30,101 | 2,278 | | 0.0 | 0.0 | 23,130 | 20,076 | 77% | 73% | 16,811 | \$4,515 | \$4,969 | \$2,293 | \$2,676 |

Notes:
 52. The amount of electricity generated will change from year to year with changes in solar radiation levels.
 53. The house electricity consumption is based on electricity consumption estimates.
 54. Listed snow cover reduces PV generation by 27.7% yearly from a clear array.
 55. The savings in the electricity bills will change, of course, with the price of electricity.
 56. Price of imported grid electricity includes delivery charges. Price of exported electricity does not.
 57. Shading values are provided by SunEye shading analysis.
 58. Amount of energy exported cannot be calculated but only estimated from experience.
 59. Amount of energy exported is a reasonable guess based on when house electricity is used.

| Annual house electricity emissions: | | Annual Value |
|--|-------------------------------|--------------|
| total emissions without solar PV | 26,126 kg | ignored |
| reductions because of solar | 20,076 kg | ignored |
| net emissions with solar PV | 6,050 kg | ignored |
| Value of Coal- & Gas-Generated Grid Electricity: | | Status: |
| Price of electrical energy imported from grid: | 15.00 ¢/kWh in 2010 | est. |
| Price of electrical energy exported to grid: | 8.00 ¢/kWh in 2010 | est. |
| Connection charges to electricity grid: | \$454 /year in 2010 | est. |
| Coal- & Gas-electric GHG emission rate: | 0.868 kgCO _{2e} /kWh | |
| Value of GHG emission reductions: | t _{CO_{2e}} | = not valued |
| Value of damage to health care: | ¢/kWh | = not valued |
| Environmental damage caused by coal- & gas-generated electricity has been ignored. | | |

