



A Performance-Based Review of Solar PV

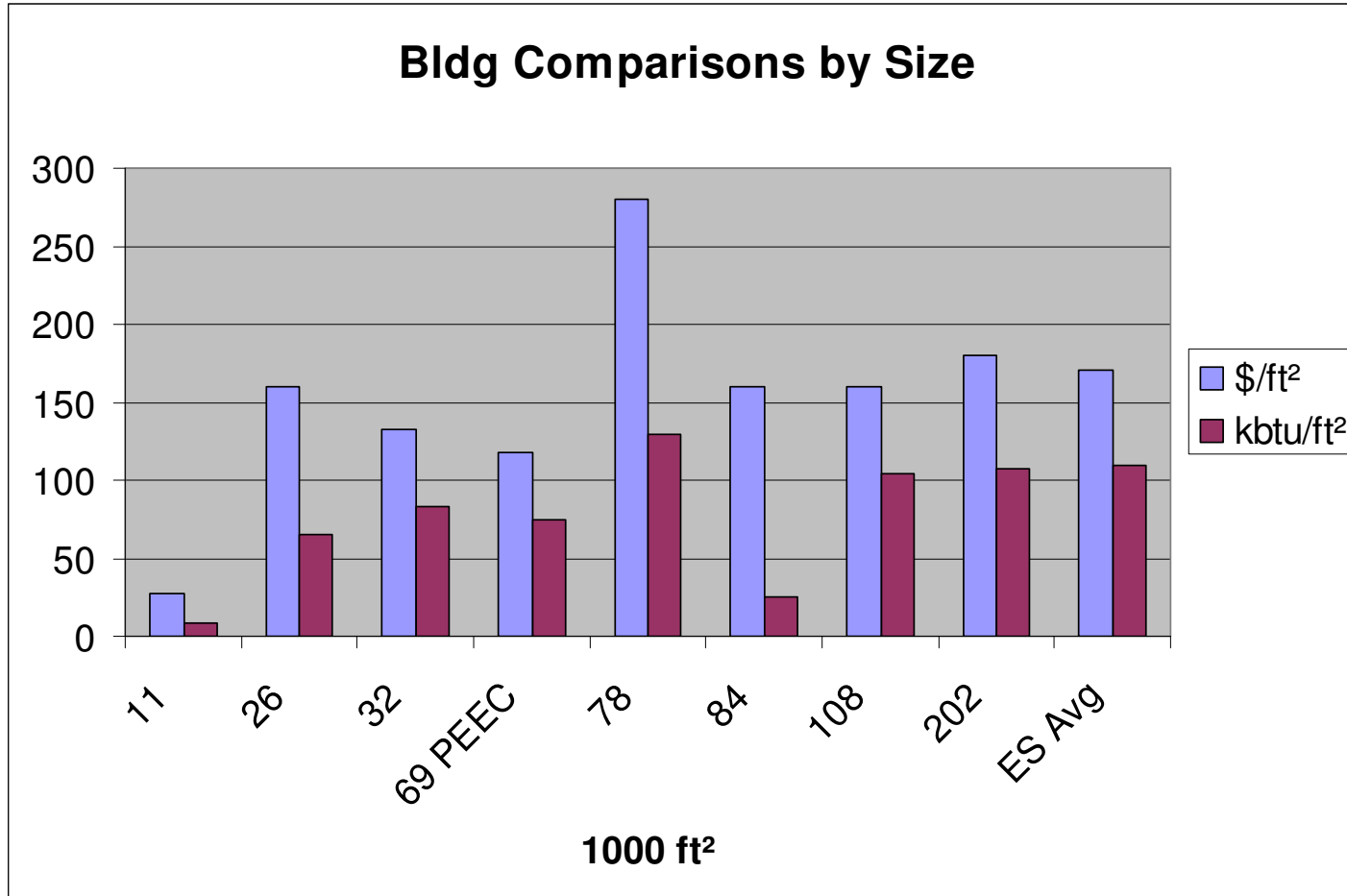
Tom Zarnke, P.E., C.E.M.,
C.E.A.

Zarnke Engineering, Inc.

9/16/2009



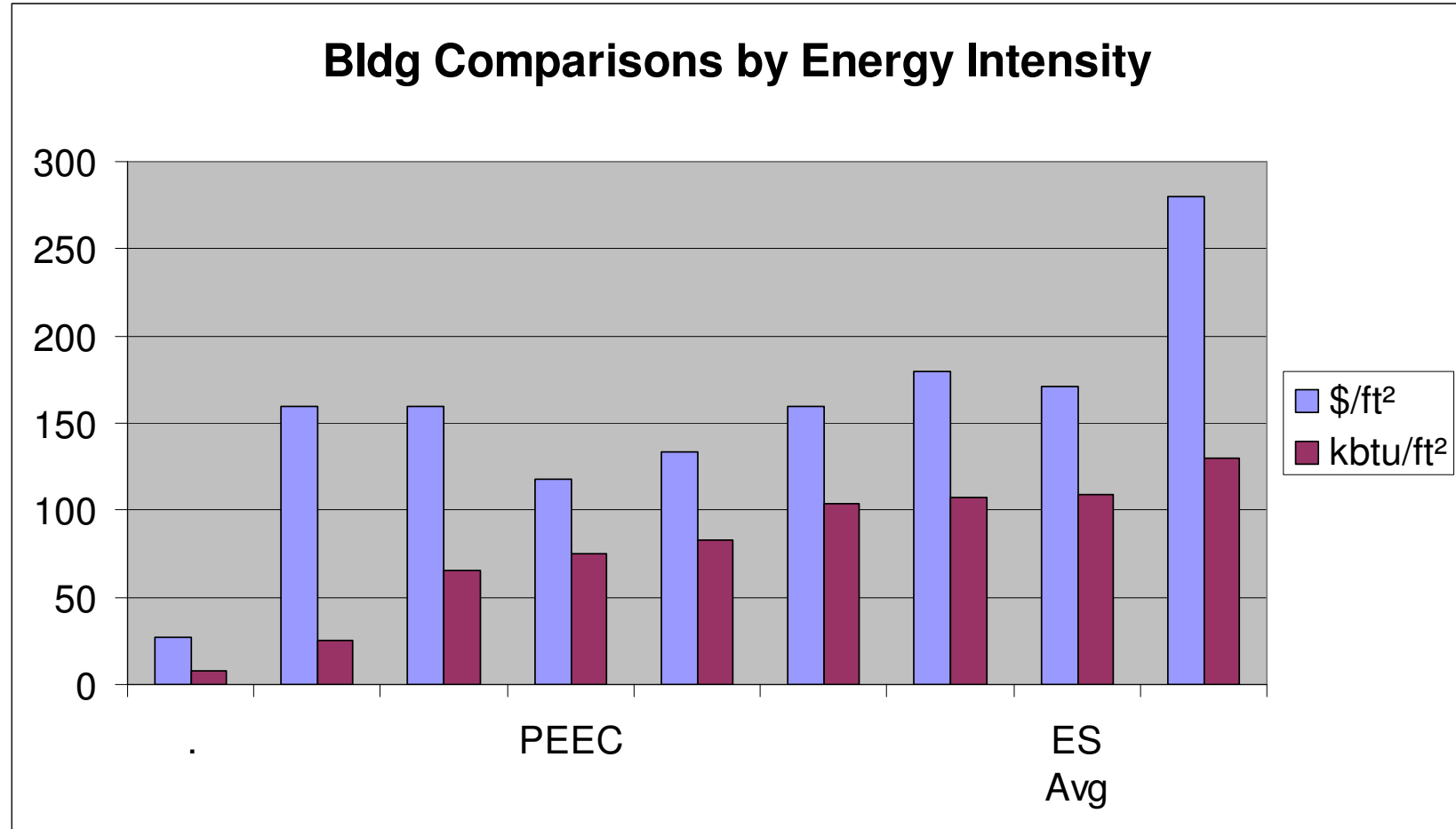
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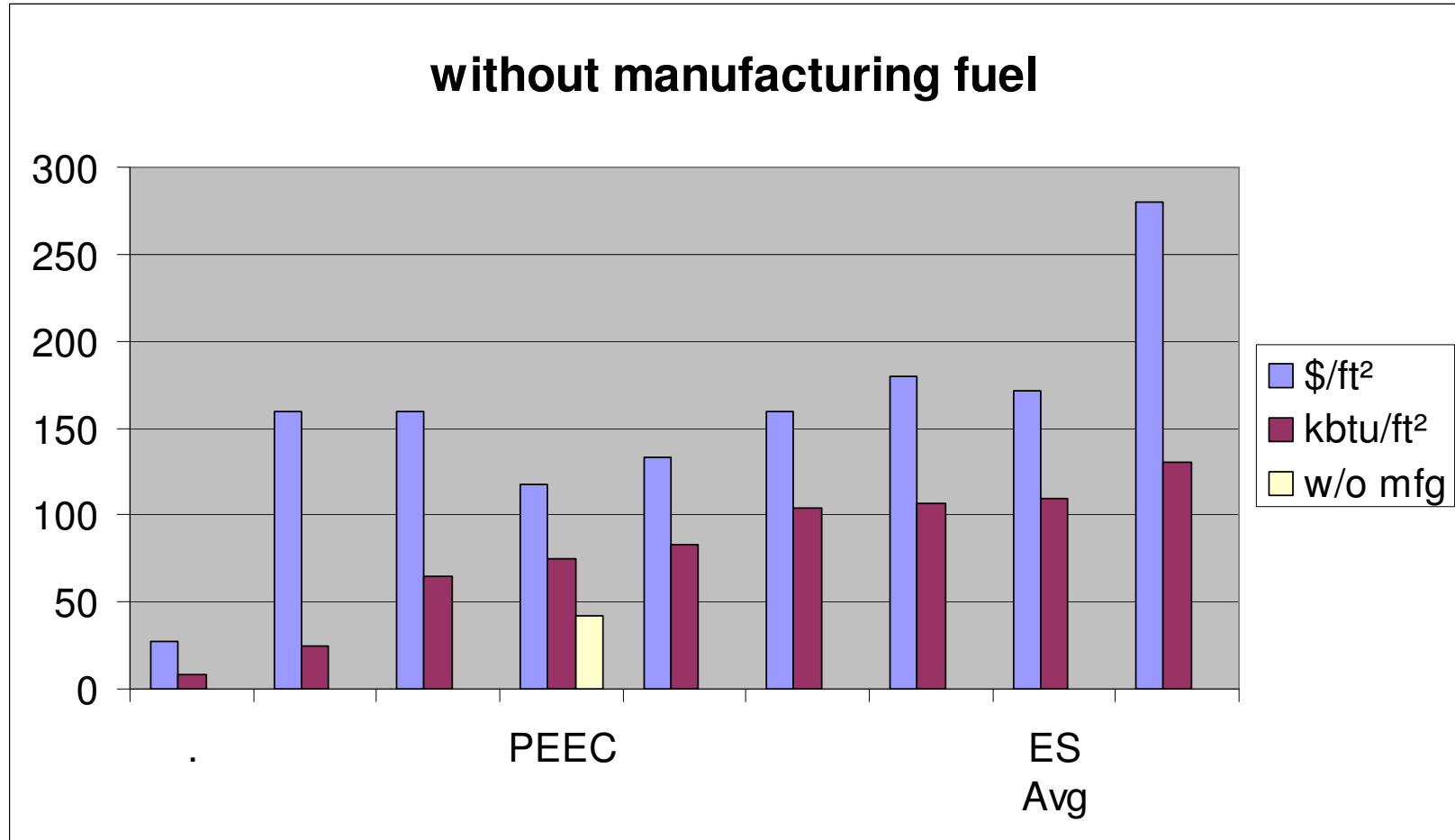
Bldg Comparisons by Energy Intensity





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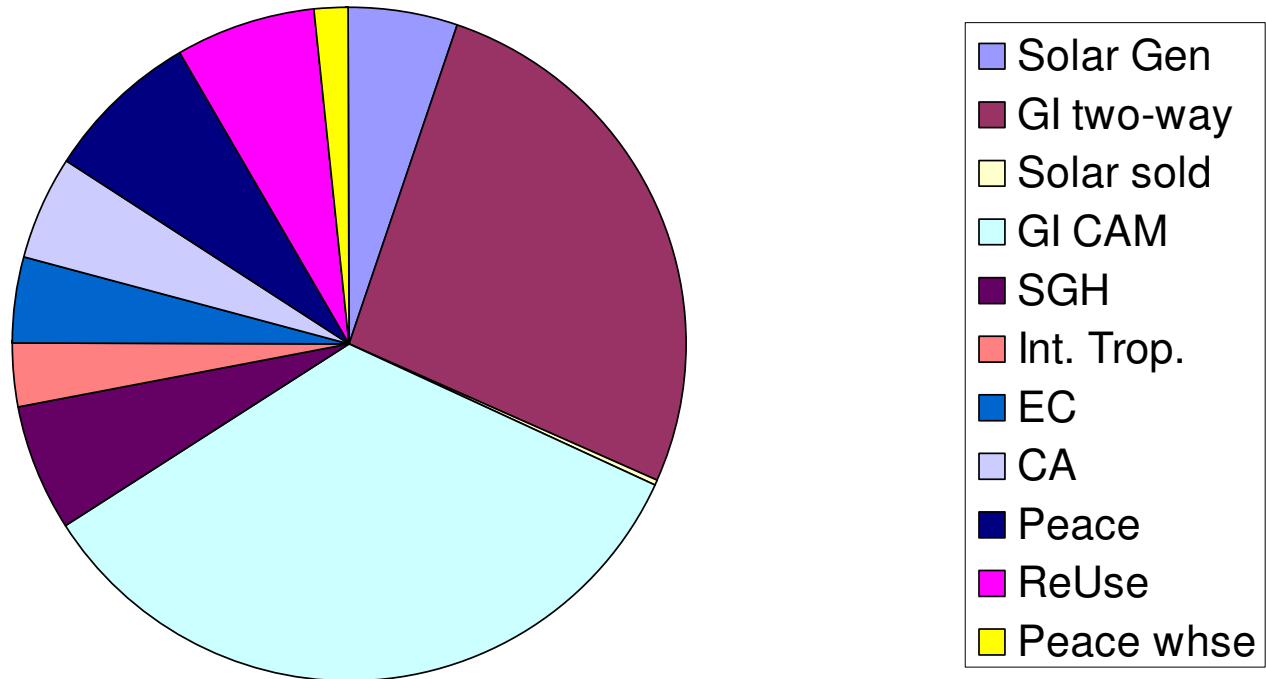
without manufacturing fuel





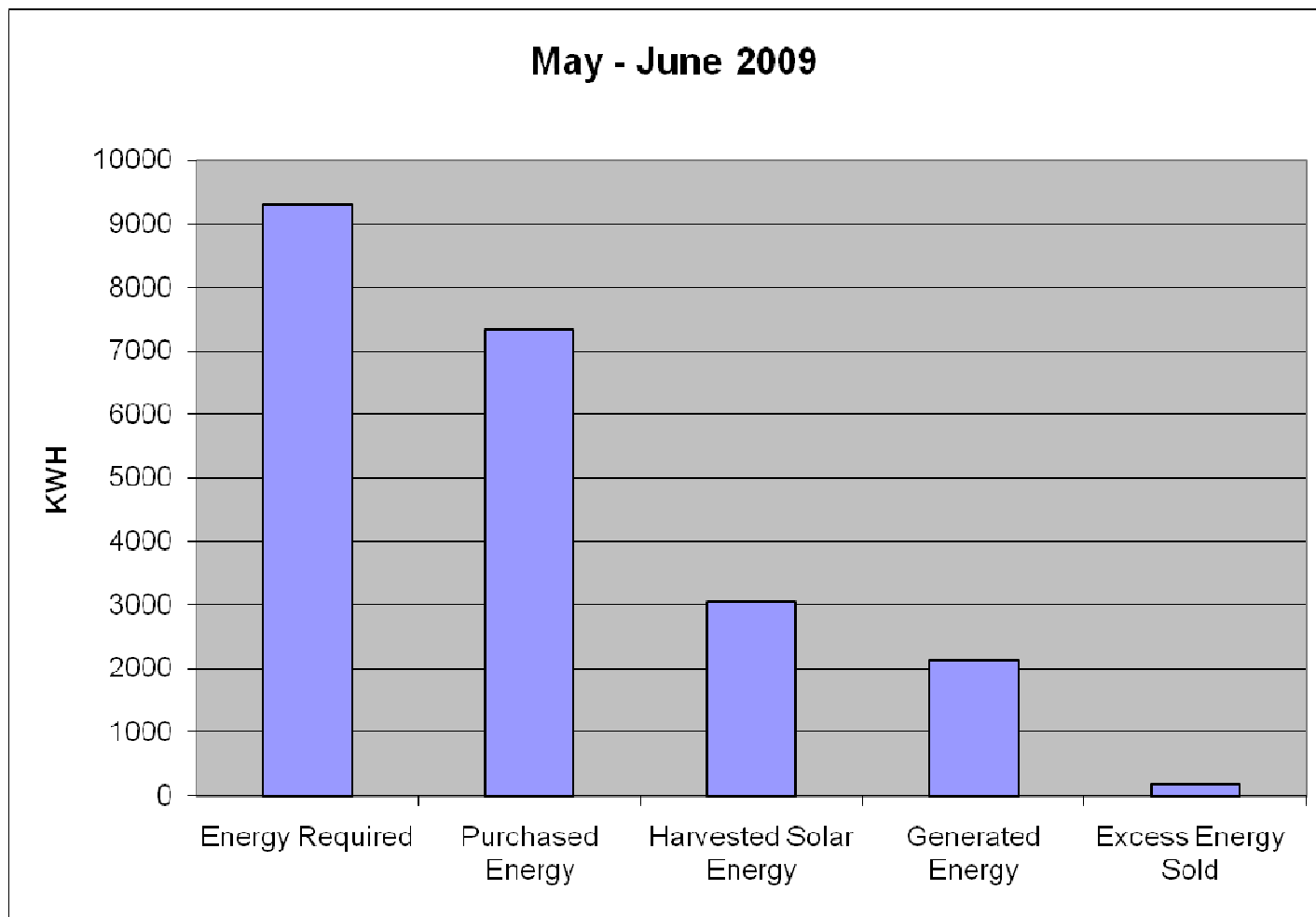
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PEEC KWH Distribution





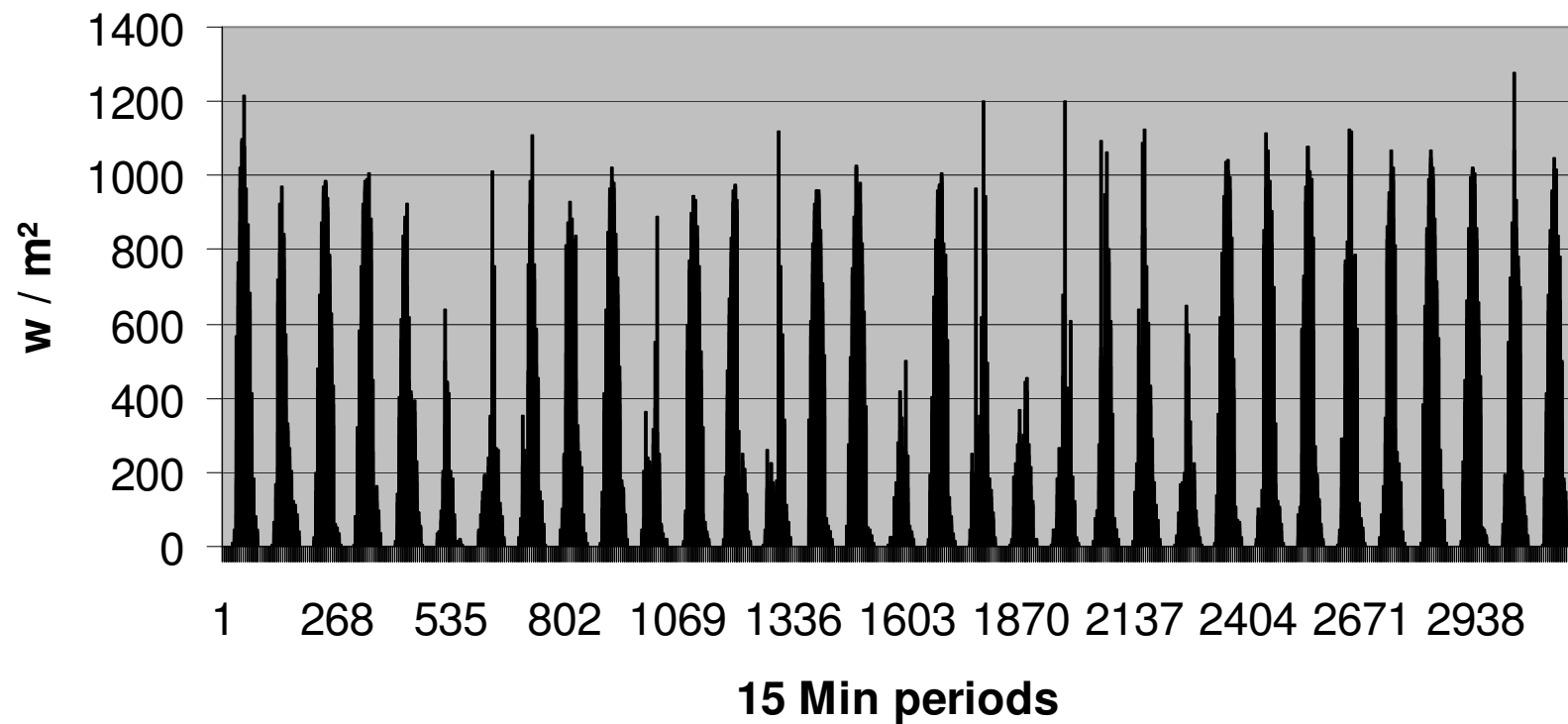
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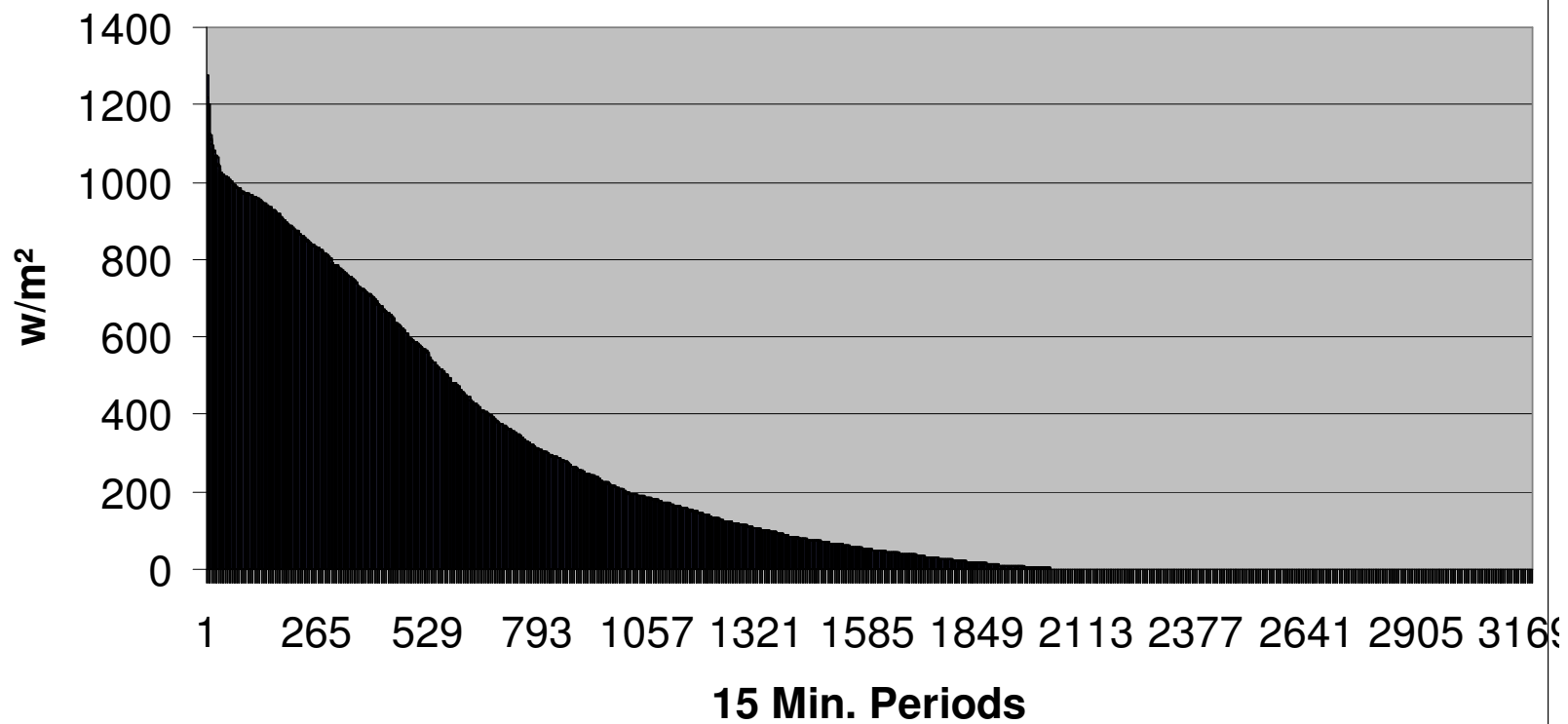
June 2009 Pyranometer





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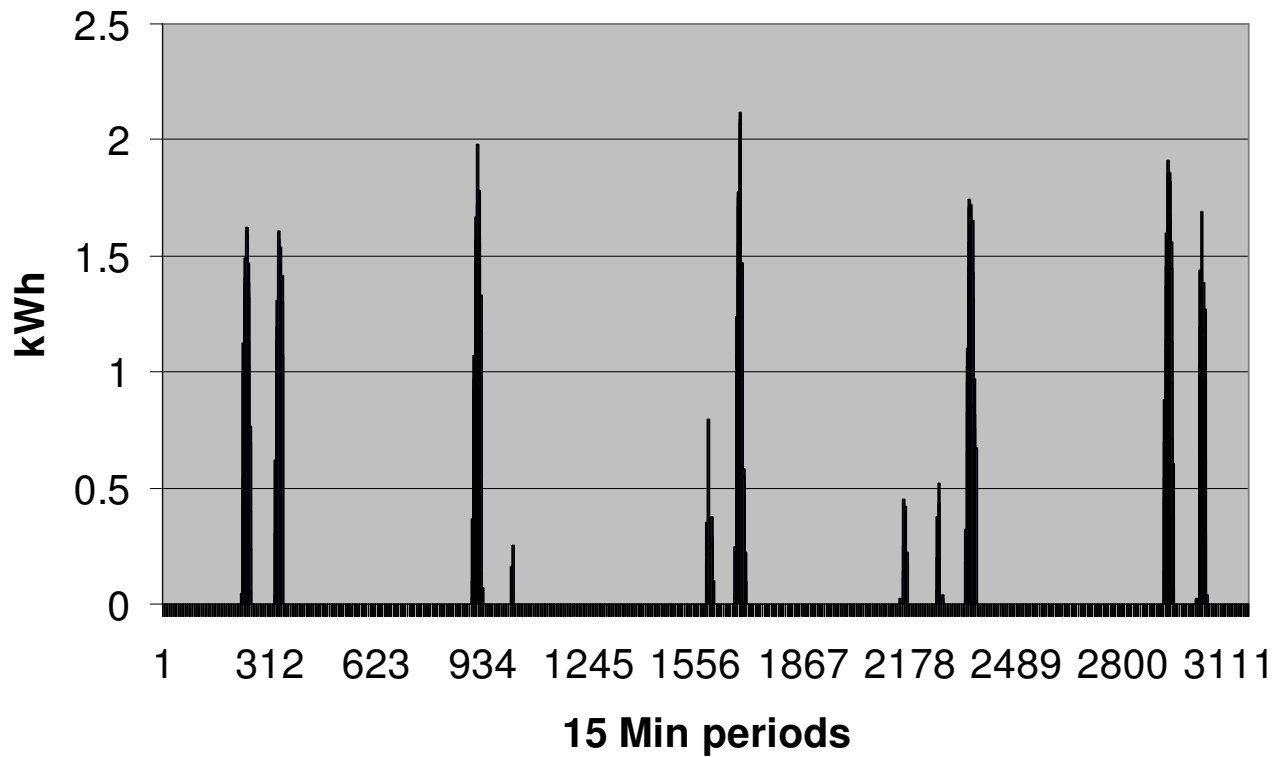
June 2009 Solar Intensity





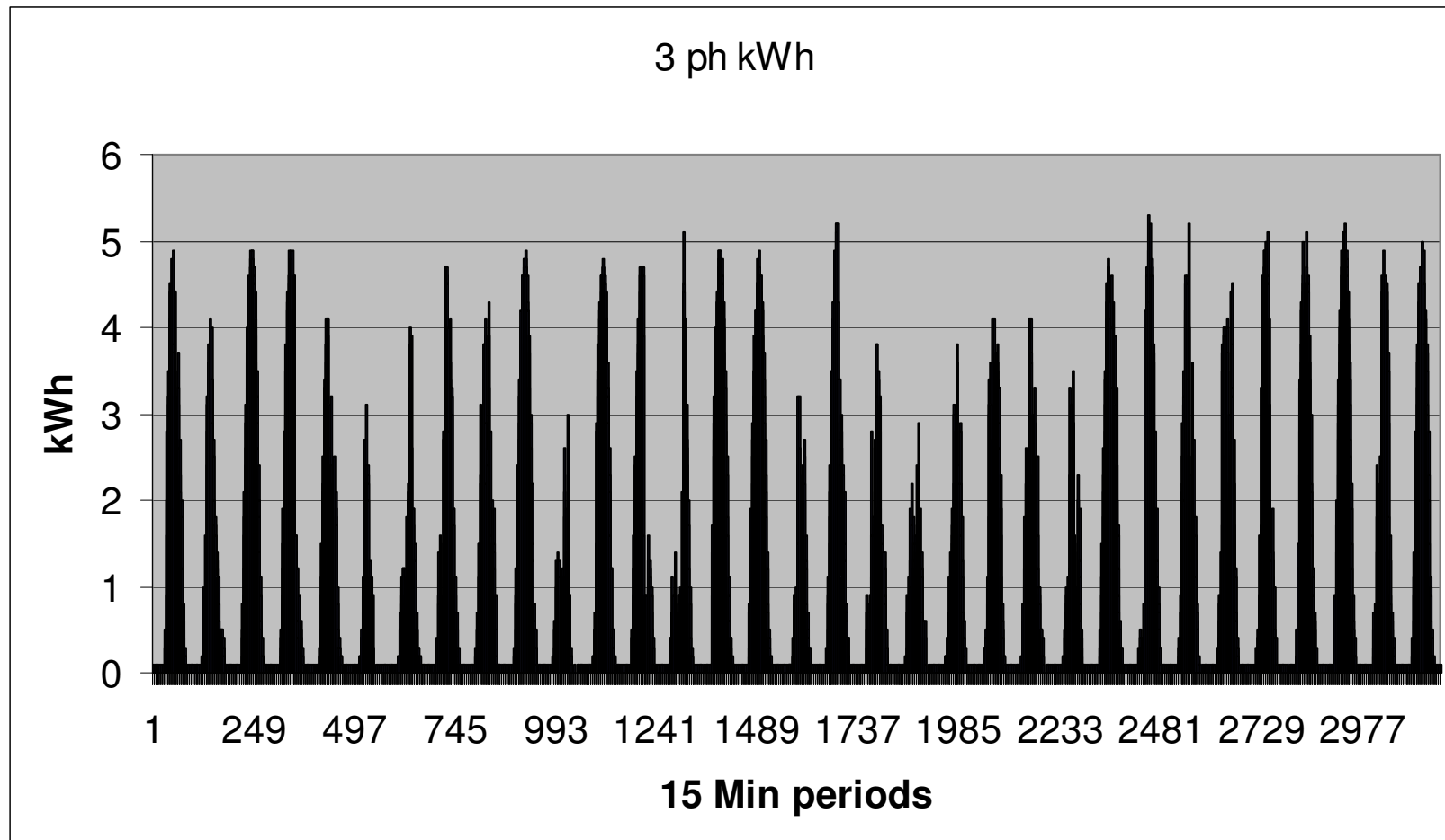
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Excess Solar Energy Sold Back



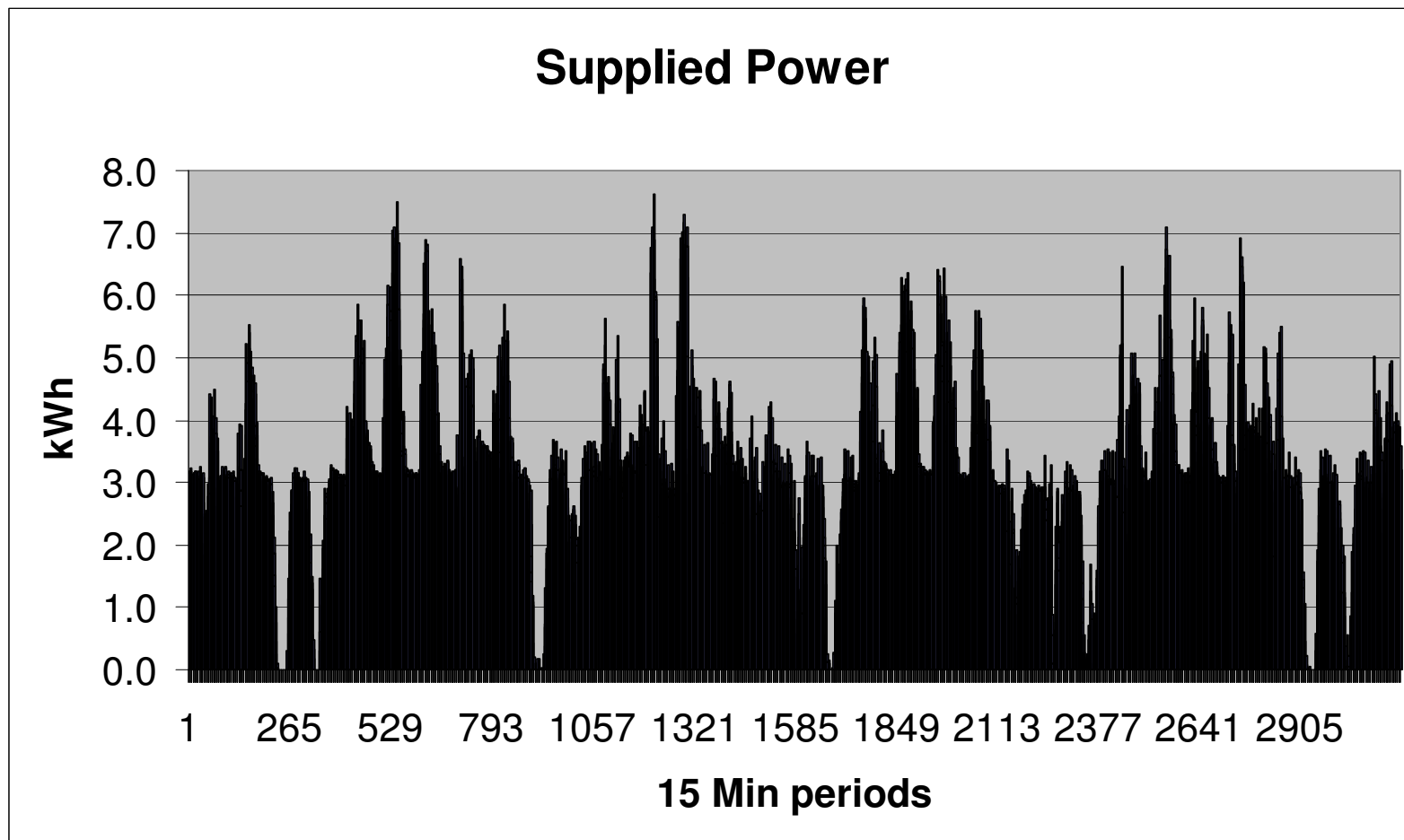


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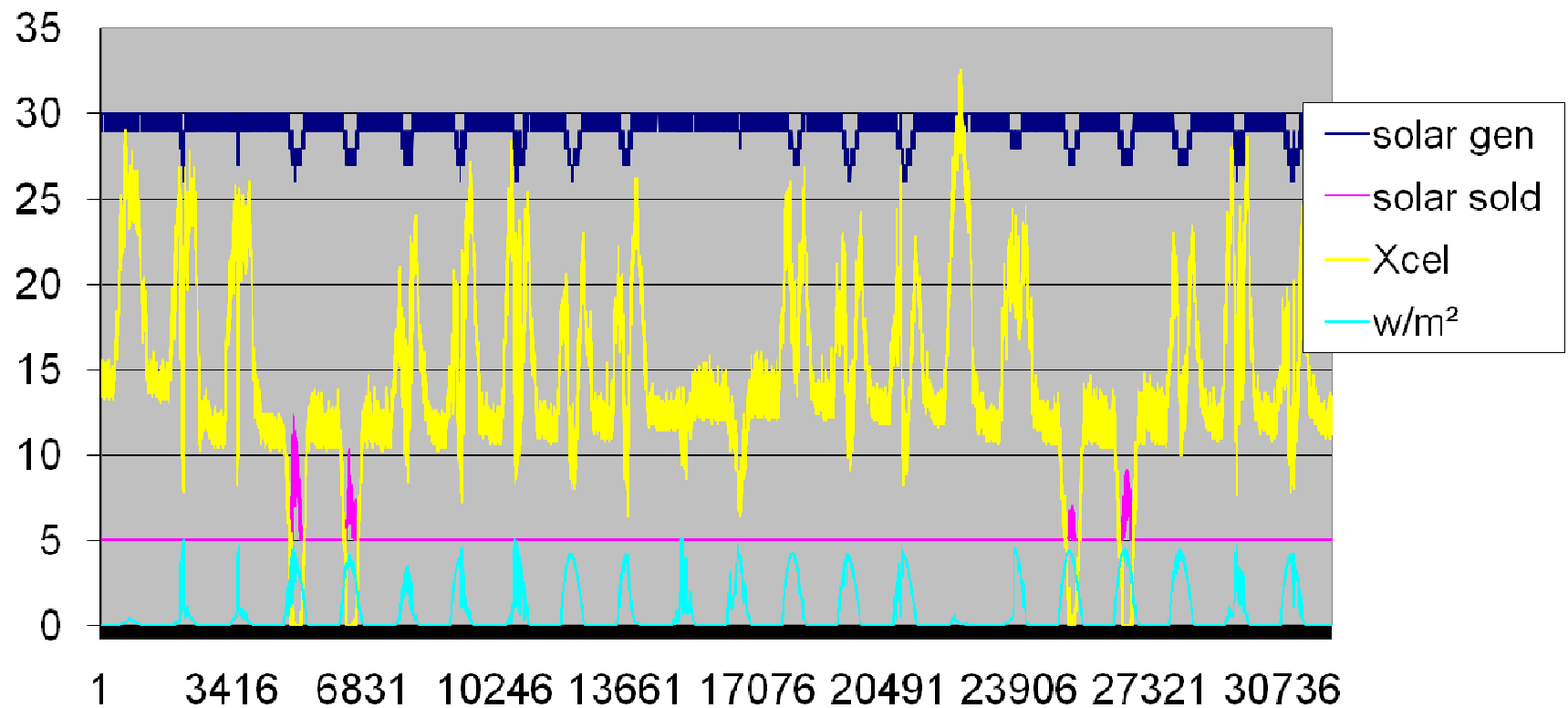
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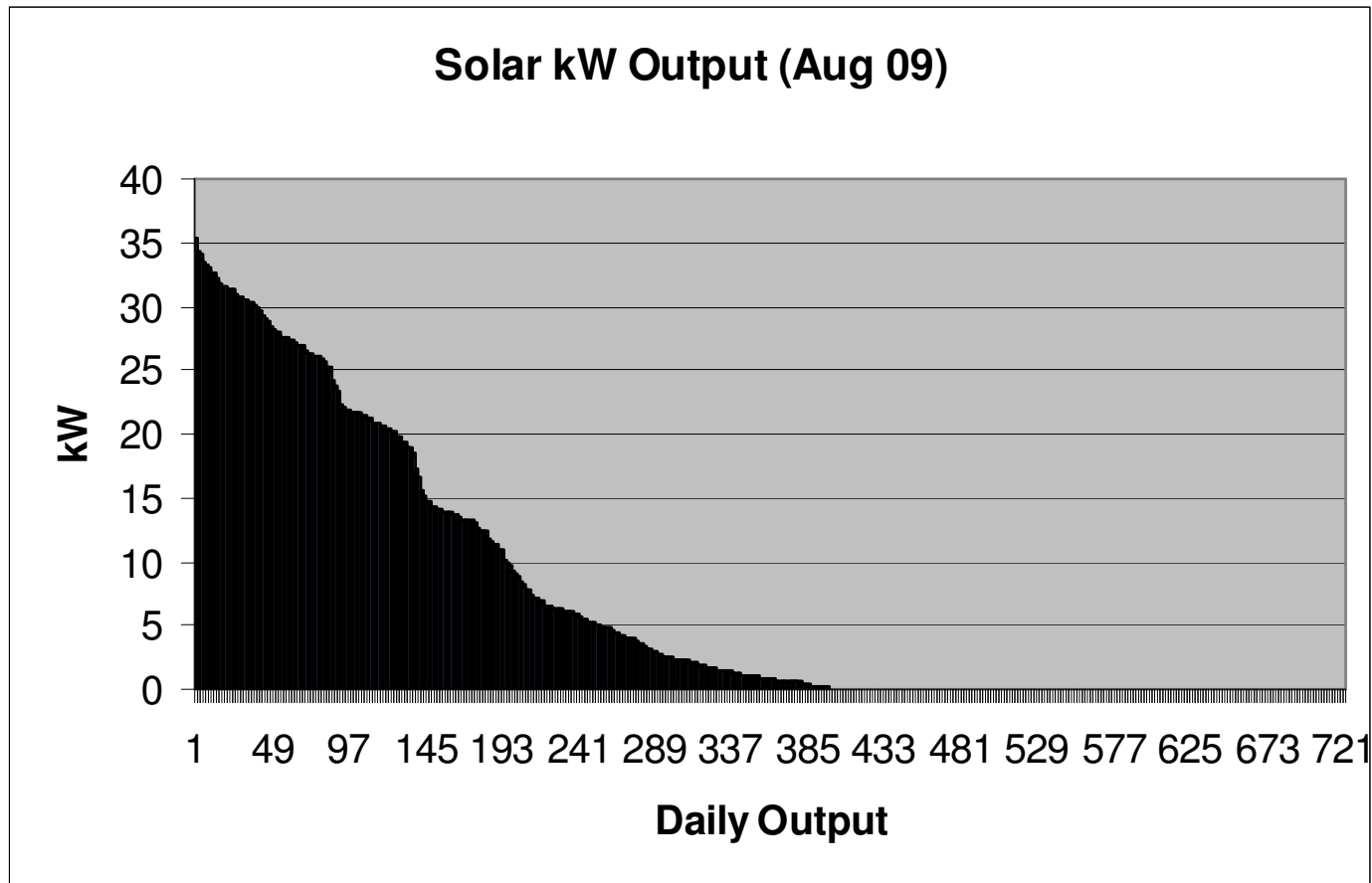
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February-March 2009





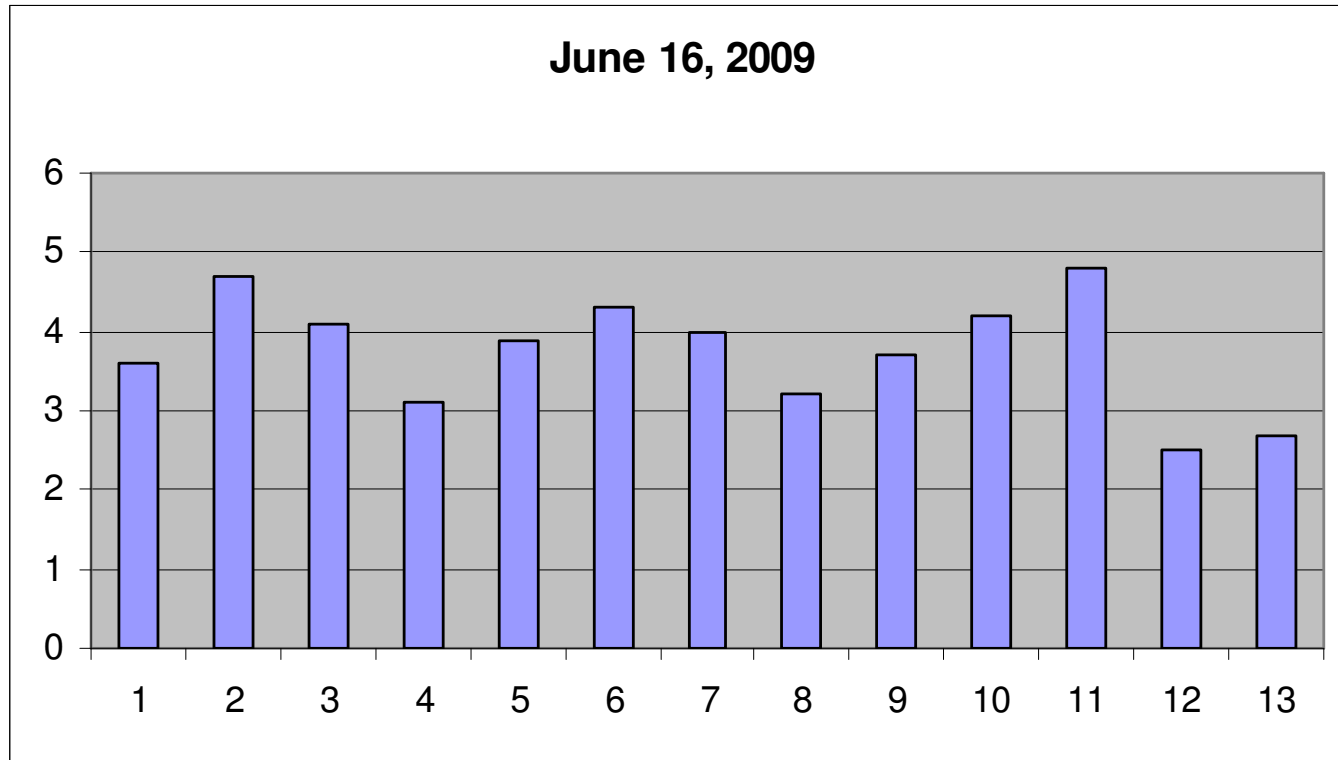
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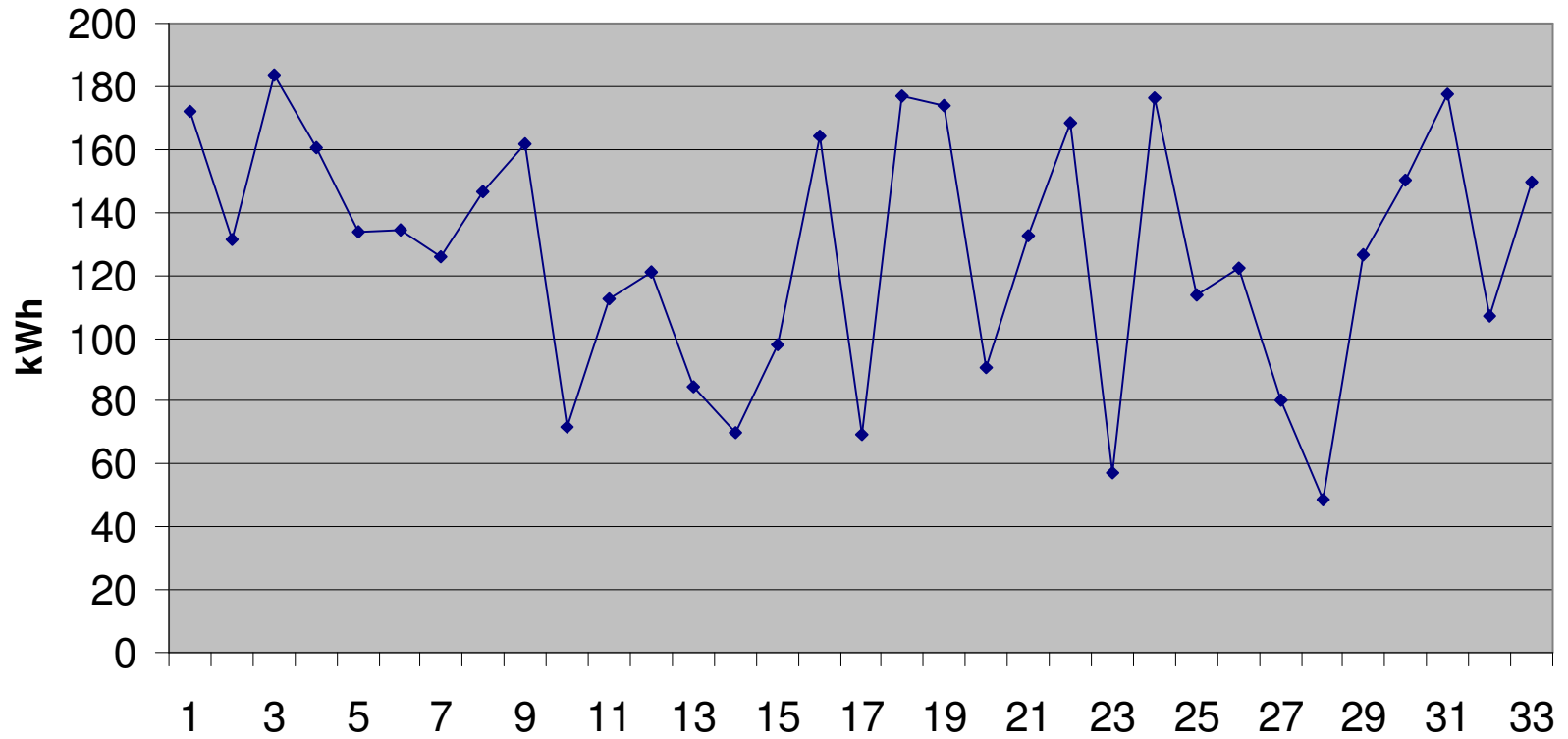
June 16, 2009





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Solar Production





Solar System Performance Review

PEEC Solar Collector Panels (ratings)

- At 800 w/m² one panel receives 595 watts which yields an output of 31.8 watts (4 watts per sq ft)
- About 5.34% of sun energy converted to electrical power for this panel design (under optimal conditions)

Present Technology

- Panels put out 10 watts/sq ft
- Web estimators show an average solar insolation in the Twin Cities as 4.73 kWh/day/m²
- PEEC has 588 m² of collectors (6,336 sq ft)



Solar System Performance Review (June to July 2009)

32 Days

•Solar energy estimates:

- 32 x 4.73 x 588 89,000 kWhrs on the panels
- 21 x 8 x 10 x 6336 / 1000 10,644 kWhrs approx output
- 4,258 kWhrs prorated for PEEC collectors output to inverters

•PEEC Measurements/Recordings

- 100,000 kWhrs on the panels
- 4,200 kWhrs into the inverters 4% converted energy
- 3,600 kWhrs output to building 86% 14% loss

Facility Used:

13,612 kWh for the month (for this portion of the building)

10,222 kWh provided by Xcel

3,390 kWh supplied by solar 25% supplied by solar

210 kWh excess sold back to Xcel

ONLY 10,012 kWh had to be purchased from Xcel 74% of elec. need was purchased



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Summary

- The PEEC Solar System is working very well.
- By today's standards and technology, this system is not very efficient in converting solar energy to usable electric power.
- The PEEC Solar and Geothermal Systems have demonstrated the potential for practical commercial use of renewable energy.
- PEEC has achieved EnergyStar achievement through the use of renewable energy, even while supporting light manufacturing.



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