

STATE-OF-THE-ART BUILDING INTEGRATED PHOTOVOLTAIC SYSTEM INTRODUCED IN ZERO ENERGY HOME

Presentation to CSC Solar Forum

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Anaheim, California

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Solar Advantage Home Program

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SMUD'S ZEH Experience

- Beazer Homes (2001-2002)
- Morrison Homes (2003)
- Lessons Learned
- Potential Impacts



Residential New Construction

- Residential New Construction is PV's "Holy Grail"
- ZEH: Energy Advantage Plus with 2 kW PV Energy Roofs
 - Potential: 12+MW in District per year
 - 200+ MW Statewide
- At post-2003 costs, <\$3/W, energy cost of <8-10¢/kWh for delivered power
- Our customers want it!



Beazer Powerhouse Grand Opening



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• HOMES • BEAZER

- National homebuilder, based in Atlanta, Georgia
- Operates in over 40 markets
- One of only 50 builders to receive the prestigious Diamond Builder award for quality construction and customer service.
- Beazer Homes USA is listed on the New York Stock Exchange (NYSE: BZH).



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Beazer Homes Goal with Powerhouse

- Response to “Energy Crisis”
- Market Survey
- Looking for Market Differentiation
- Driven by Corporate /Regional CEO



SMUD Participation

- Residential Services programs
 - Energy Advantage Plus Efficiency Features (15 Hook-up fee discount)
- Buydown of the Atlantis Sunslate System
 - \$6.45/w ac PV buydown
- Marketing Support



Beazer Powerhouse Features

- Entry-Level Homes 1,200-2,300 square feet
- 3.3 kW AC BIPV System
- Advanced Energy Efficiency
 - Up to 75% > Title-24 Cooling Energy Stds



POWERHOUSE EFFICIENCY FEATURES

	Base	ZEH
<u>Envelope</u>		
Roof	R-30	R-38
Windows	metal	Vinyl, Low SHGC
<u>HVAC</u>		
A/C SEER	10	14 w/TXV
Duct Insulation	R-4.2	R-20
Duct Sealing	Standard	Sealed
ACCA Design	No	Yes -- Short Runs



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BEAZER POWERHOUSE PV SYSTEM

- Atlantis Sunslates (216-360 Slates)
 - SM-II or SP-A
- Multiple Source Circuits
- Low-Voltage
- SW and STXR 2500 Inverters
- PV System Sizing
 - Actual consumption (kWh) data
(5,500 kWh/yr less efficiency = 4000 kWh/yr)
 - SWA/Building Am Analysis



Piazza del Sol



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Morrison Lakeside Community ZEH Project

ZERO
Energy Homes



DOE's Zero Energy Home Program Goals

- Communities Built 2003 – 2004
 - 60% Reduction in Energy Bill
 - Annual Net-Zero Electricity Use
 - \$600 total annual energy bill
- Communities Built by 2010
 - Annual Net-Zero Energy Use



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Complementary Programs In The Lakeside Project



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Sacramento Municipal Utility District

- Energy Star
 - (15% better than Title 24)
- ComfortWise
 - Third Party Inspections and Tests, Mechanical Design
- SMUD Energy Advantage Plus Home
 - 50% reduction in Title 24 cooling energy budget



Morrison Homes

Morrison Homes is rated in the **top 5%** of all homebuilders in the United States for customer satisfaction, according to industry expert.



Morrison Homes is currently ranked as one of the top 30 homebuilders in the United States, with more than 2,700 home sales annually.



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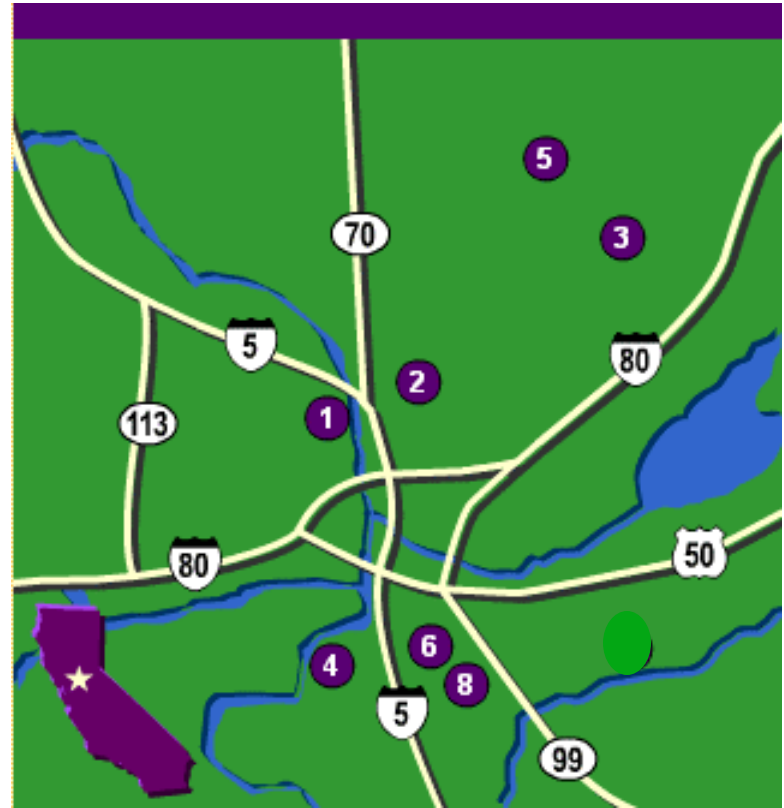
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Morrison Homes' ZEH Goal

- “In-fill” in Elk Grove
- Looking for Differentiation
- Lakeside Project (6)



SMUD's Participation

- Residential Services programs
 - Residential New Construction Rule 15 Hook-up fee discount
 - Lighting rebates
 - Energy Star Home (3rd party inspection) rebate
- Buydown of the AstroPower modules
 - \$4.75/w ac PV buydown (approx. 20 homes w/ 2 kW PV system)
- Marketing Support



LAKE SIDE ZEH FEATURES

Measure	Base	ZEH
Low Air Infiltration	No	Yes
Windows	Vinyl, Low-e	Vinyl, Low SHGC
<u>HVAC</u>		
FURN AFUE	0.78	0.92
A/C SEER	10	14 w/TXV
ACCA Design	No	Yes -- Short Runs
<u>Water Heating</u>		
Tank	50 gal storage	Tankless
EF	0.60	0.82
Distribution	Standard	Pipe insulation
Comfortwise Inspection & Tests		
Fluorescent Lighting		
2kW ac PV		



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Morrison ZEH PV System

- 48 AstroPower GT 55 BIPV Modules
- One Source Circuit
- High-Voltage
- SMA 2500 Inverter
- PV System Sizing
 - T-24/Engineering Analysis
 - 36% - 41% > Title-24 Standards



Generating Electricity



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Next Steps



- 2 year monitoring of energy savings and production
- Evaluation of PV system
 - Power production
 - “Fit” with Home Builder practices
 - Homeowner acceptance/market appeal
- Evaluate distribution system impacts
- Customer Satisfaction Survey
- Adopt into residential new construction program



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Next Steps - ZEH Community

- 94-Unit Subdivision with Premier Homes, 04
- Costs \approx \$7.76/watt AC Installed
- SMUD's Support
 - Residential New Construction Rule 15 Hook-up fee discount
 - Lighting rebates
 - Energy Star Home (3rd party inspection) rebate
 - \$3.40/watt AC (avg) PV Buydown
 - Marketing Support



Lessons Learned - General

- Schedule is King
- Builders and prospective new home owners clearly prefer building-integrated PV (BIPV) systems to roof mounted PV systems.
- Lack of trained and knowledgeable PV subcontractors (especially electricians)
- New home sales people deserve special training and on-going support
- New home buyers are unfamiliar with the benefits of owning their own PV system



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Lessons Learned – Beazer Powerhouse

- Expensive > \$10.45/w AC
- Complicated Installation
 - Counter Batten Roof
 - Lots of Pieces and Connections
 - Multiple Source Circuits
- Supply Problems
- Inverters
- Subcontractor Experience
- Sales Agents
- Buyer Expectations



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Lessons Learned – Morrison Lakeside ZEH

- Less costly than Sunslates, still higher than standard module installation \$8.75/w AC **BUT Lower than CEC Avg. Install Cost (\$9.85/w AC) and Falling!**
- Less Complicated Installation than Sunslates
 - Fewer Pieces (48 vs 216)
 - One Source Circuit
- PV meets/exceeds expected kWh production
- Subcontractor Experience
- Sales Agents
- Buyer Expectations



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ZEH Potential Impacts

- Demonstrated total annual energy bill reduction without losing Off-Peak electricity sales
- Potential Peak Demand Savings



Beazer Powerhouse Results

- Offered as optional upgrade in 4 communities
- 18 Homes built (approx. 60 kW)
 - 11 occupied by owner for 1+ year
- ZEH possible
 - **8 of 11 owner occupied homes produce more energy than they use**



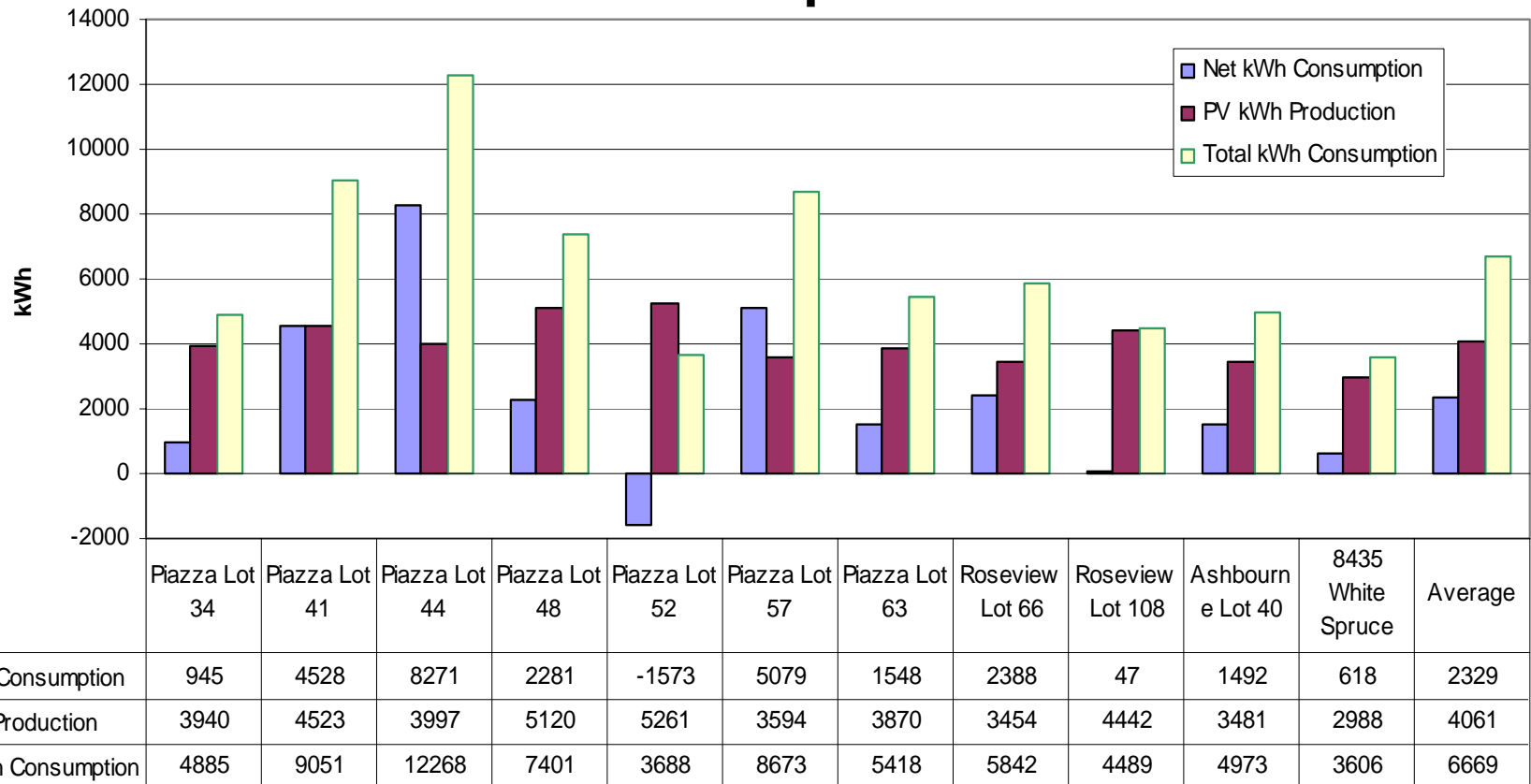
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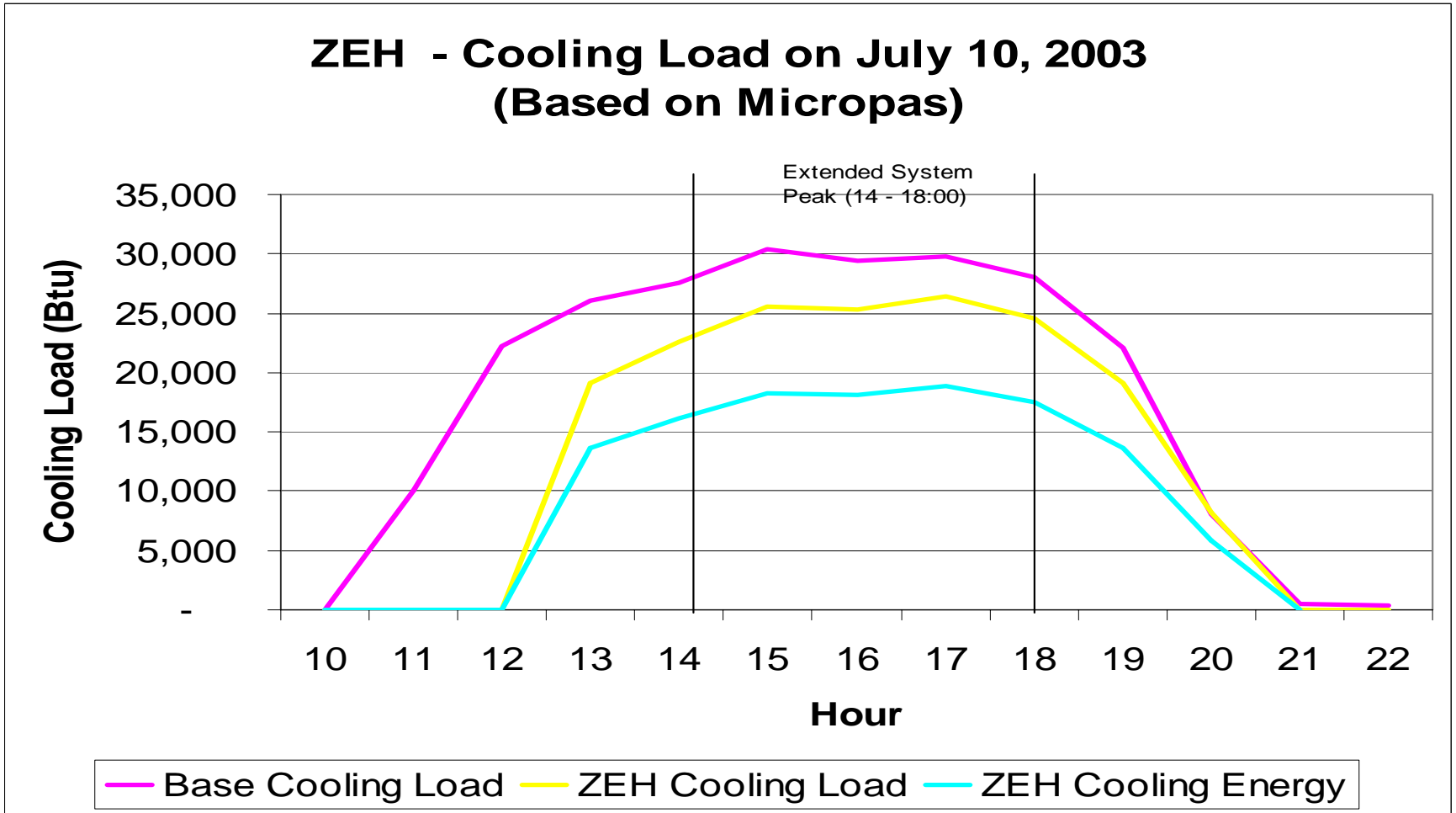
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Beazer Powerhouse kWh Consumption



Morrison ZEH – Efficiency Only



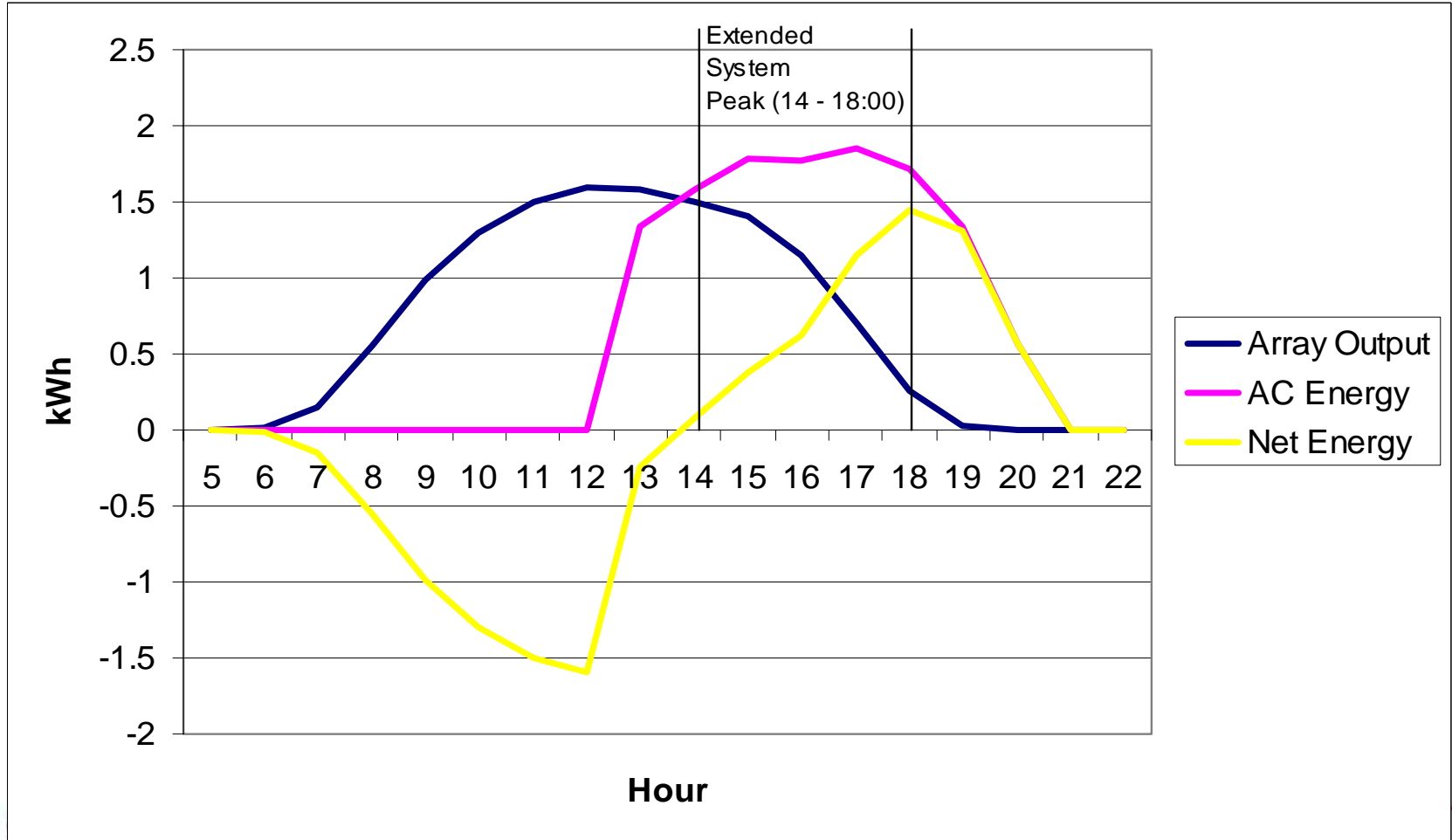
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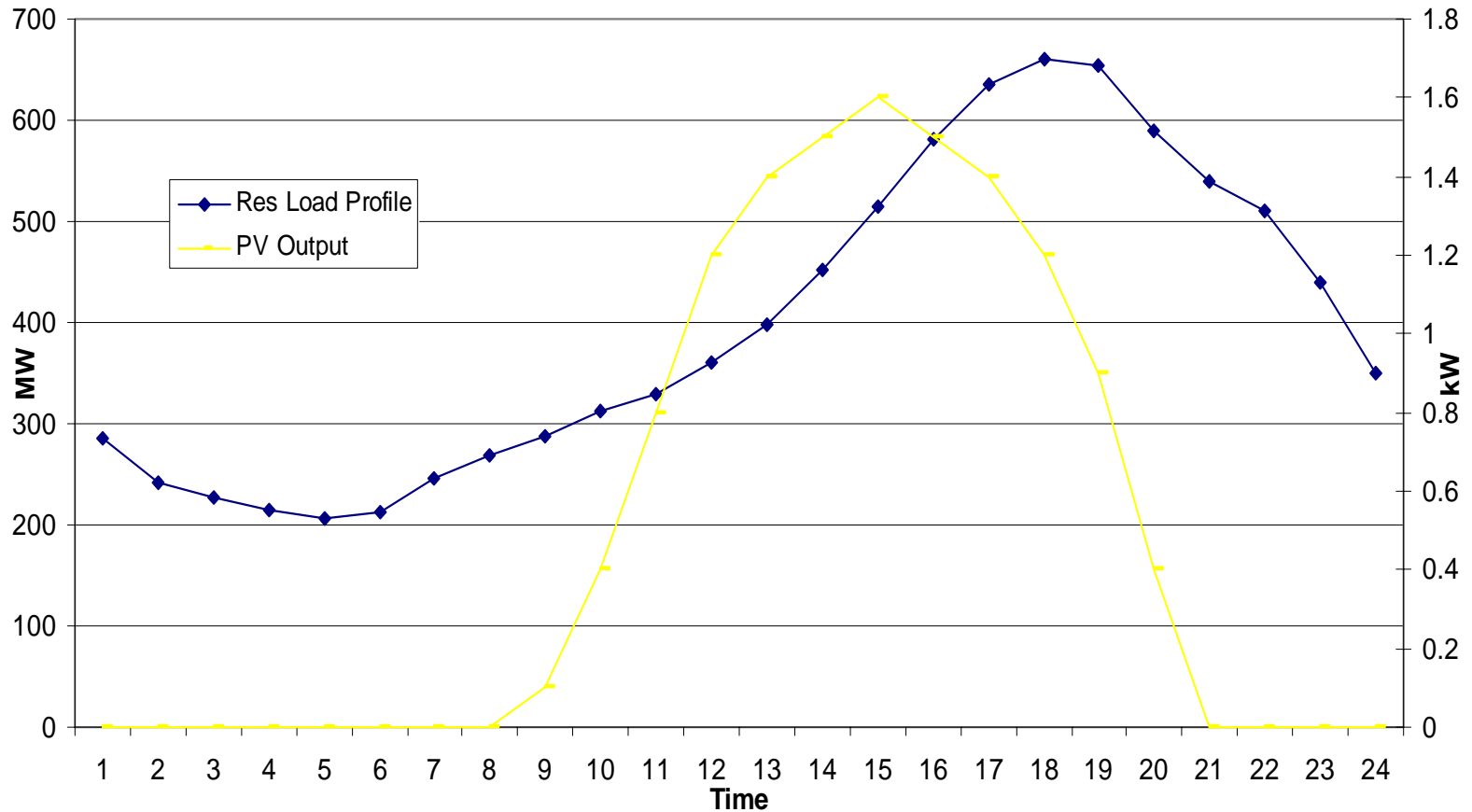
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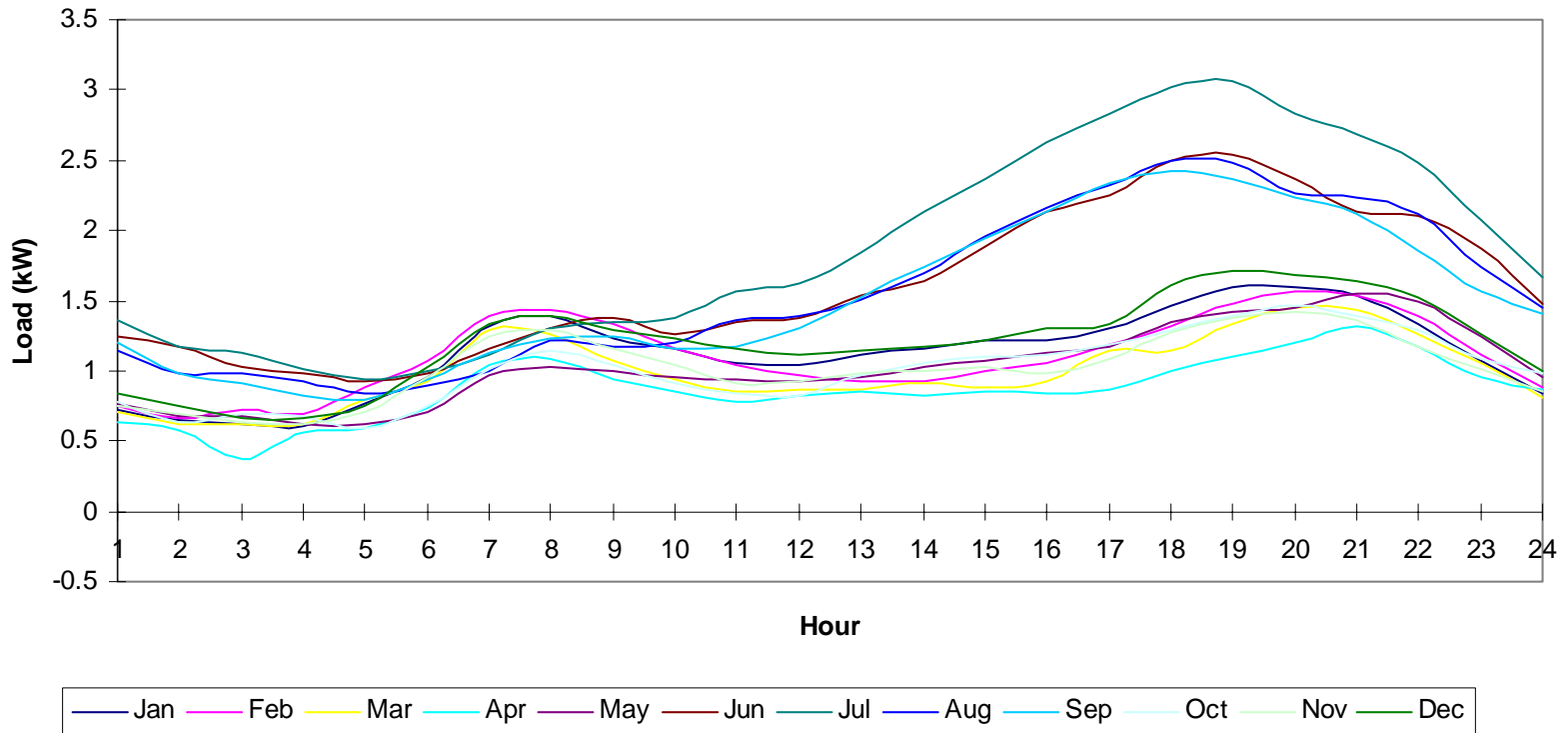
Morrison Peak Load Impact Estimate



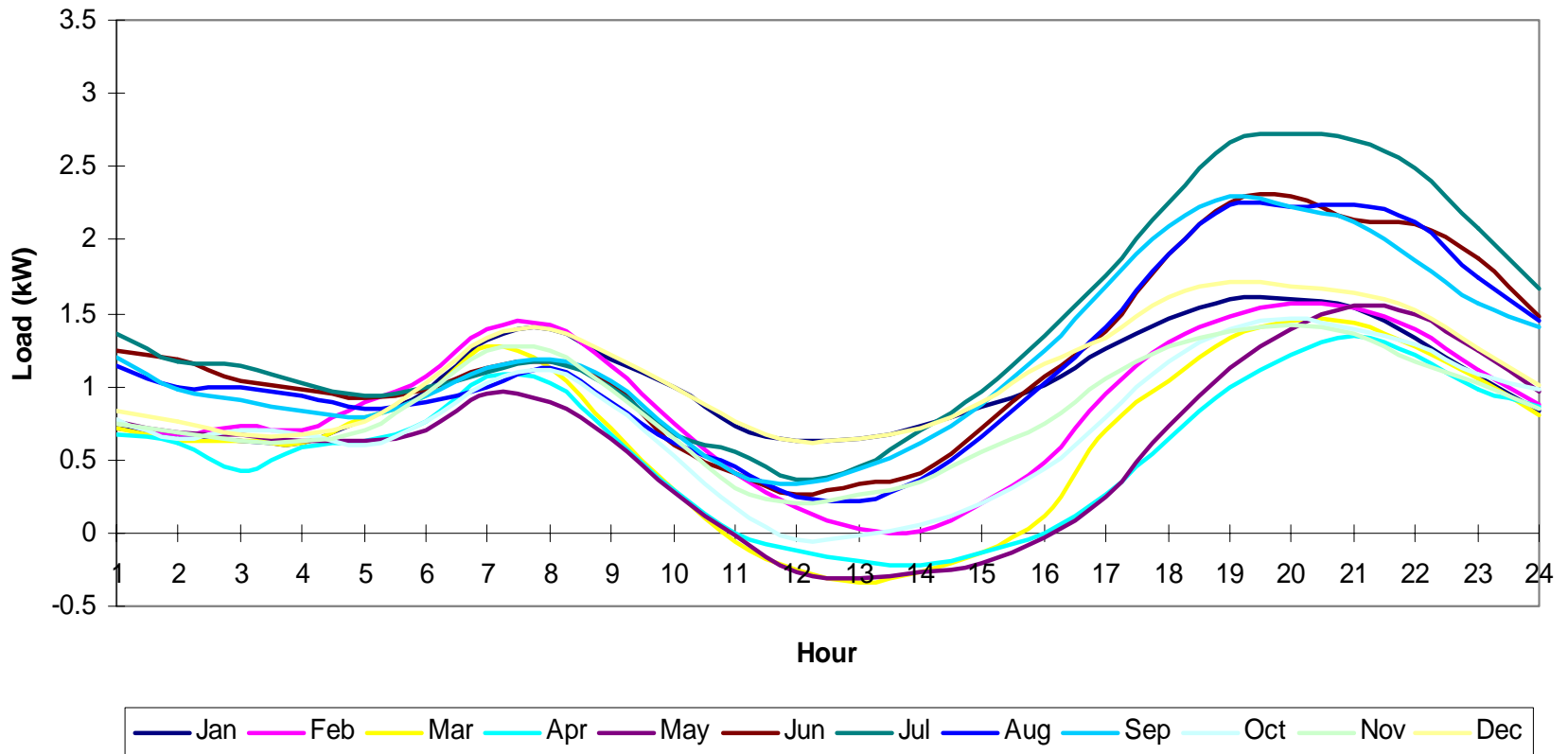
SMUD RESIDENTIAL GAS HEATED CUSTOMERS' LOAD PROFILE



ZEH Potential Impacts – Sample PV Customer Load



ZEH Potential Impacts – Sample PV Customer Net Load



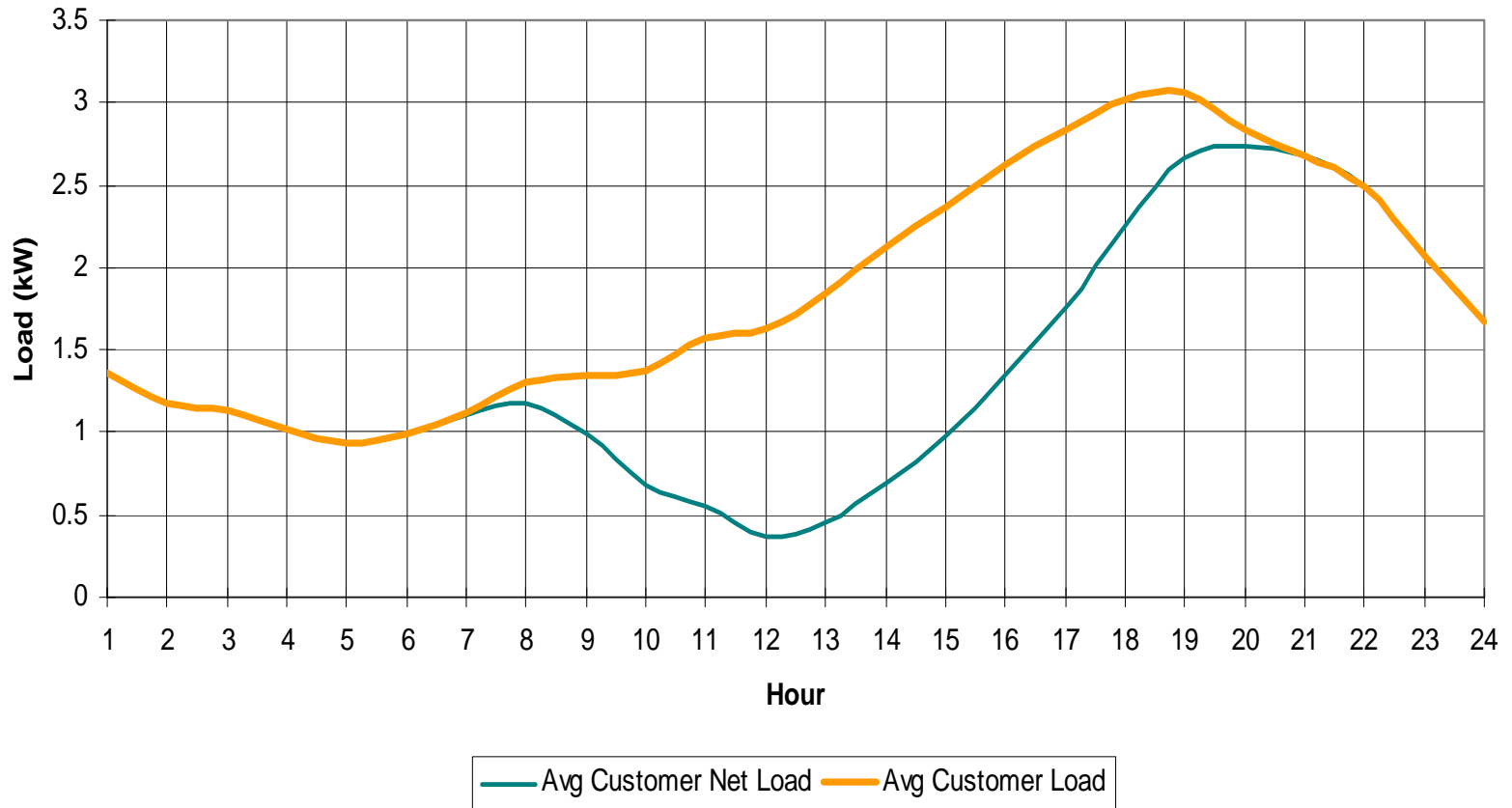
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SMUD Sample PV Customer Load Profile - July



Acknowledgements

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More Information

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