ZERO ENERGY HOMES – TRANSFORMING SACRAMENTO'S NEW HOME MARKET

Presentation to ACEEE Symposium On Market Transformation

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SMUD

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SACRAMENTO MUNICIPAL UTILITY DISTRICT

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SMUD's Zero Home Experience

- SMUD's ZEH R&D Experience
- SolarSmart Homes
- Home of the Future
- Lessons Learned/Recommendations

SMUD Profile

- Service territory area: 900 sq mi (2331 sq km)
- Population: 1.4 million
- Board Members: 7 members elected by voters
- Revenues: $1.4 Billion
- Employees: 2,200+
- Summer Peak: 3299 MW in July 2006
- 2nd largest muni in California, 6th in nation

SMUD Profile

2006 Statistics

	Customers	GWh	Revenues
Residential	517,000	4,760	$515 M
Commercial	68,000	6,039	$567 M
Subtotal	585,000	10,799	$1,082 M
Sale of Surplus Power		3,964	$ 192 M
Sale of Surplus Natural Gas			$ 113 M
Total		14,764	$1.39 B

Average Annual Consumption and Cost

Residential	9,200 kWh	10.8¢/kWh
Commercial	89,000 kWh	9.4¢ /kWh

ZEH Drivers - Policy

- SB 1
  - 125 MW Goal
- PUC Big Bold Initiative
  - ZEH by 2020
- AB 32 GHG Emissions
- SMUD Efficiency Goals
  - 15% reduction in energy use in 10 years

ZEH Drivers - PV

- Residential New Construction is PV's "Holy Grail"
  - High volume drives down costs
  - Standardized system design
  - Builders masters of cost cutting
- New Solar Homes
  - Energy Efficiency with 2 kW PV Energy Roofs
  - Potential: 16+MW Capacity in District per year
- At <$3/W, energy cost of <8-10¢/kWh for delivered power
- Our customers want it!

ZEH Drivers - New PV Products Available

GE Energy

Open Energy

BP Solar

SunPower

Sharp Solar

Kyocera Solar

Building America/NREL

- Voluntary US Department of Energy Program
- CRADA w/ NREL
- Current Goals
  - 60% Reduction in Energy Bill
  - Target Annual Net-Zero Electricity Use
  - Use Commercially Available Technologies
- Annual Net-Zero Energy Use by 2020

ZEH Analysis

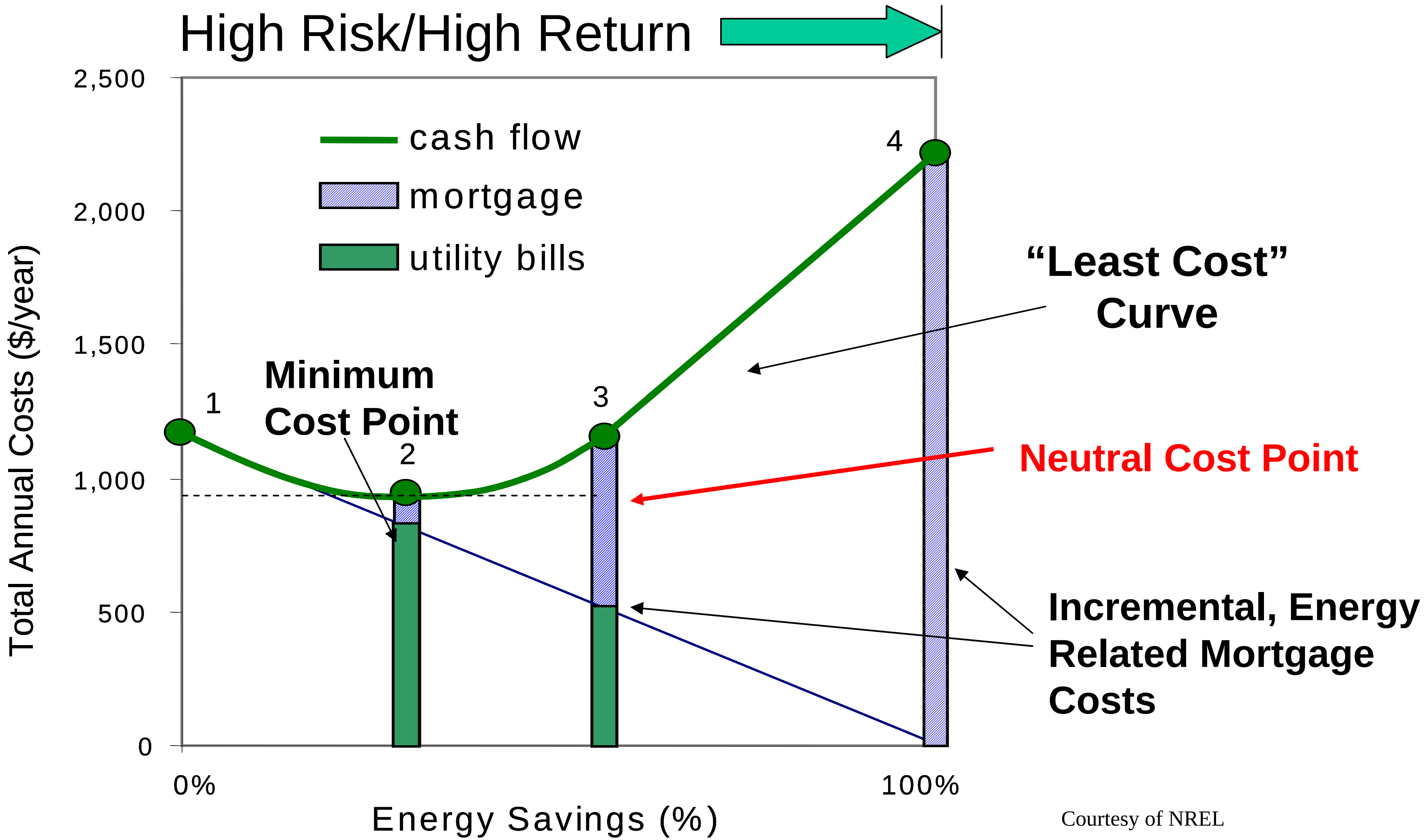
- NREL BEopt Analysis
  - Building America Benchmark Home
- Title-24 Analysis
  - ZEH Proforma
    - Energy Savings/Incremental Costs

General *BEopt* Capabilities

- Finds optimal designs for the entire range of energy savings from the base case to zero net energy
- Evaluates realistic (discrete) options for building efficiency and solar water heating
- Identifies near-optimal alternative designs
- Automatically implements the BA Benchmark
- Runs hour-by-hour physically detailed simulations:
- DOE2 and TRNSYS
- Accurately accounts for interactions across categories (e.g., glass type and HVAC)

Courtesy of NREL

Overview of Key BEopt Results



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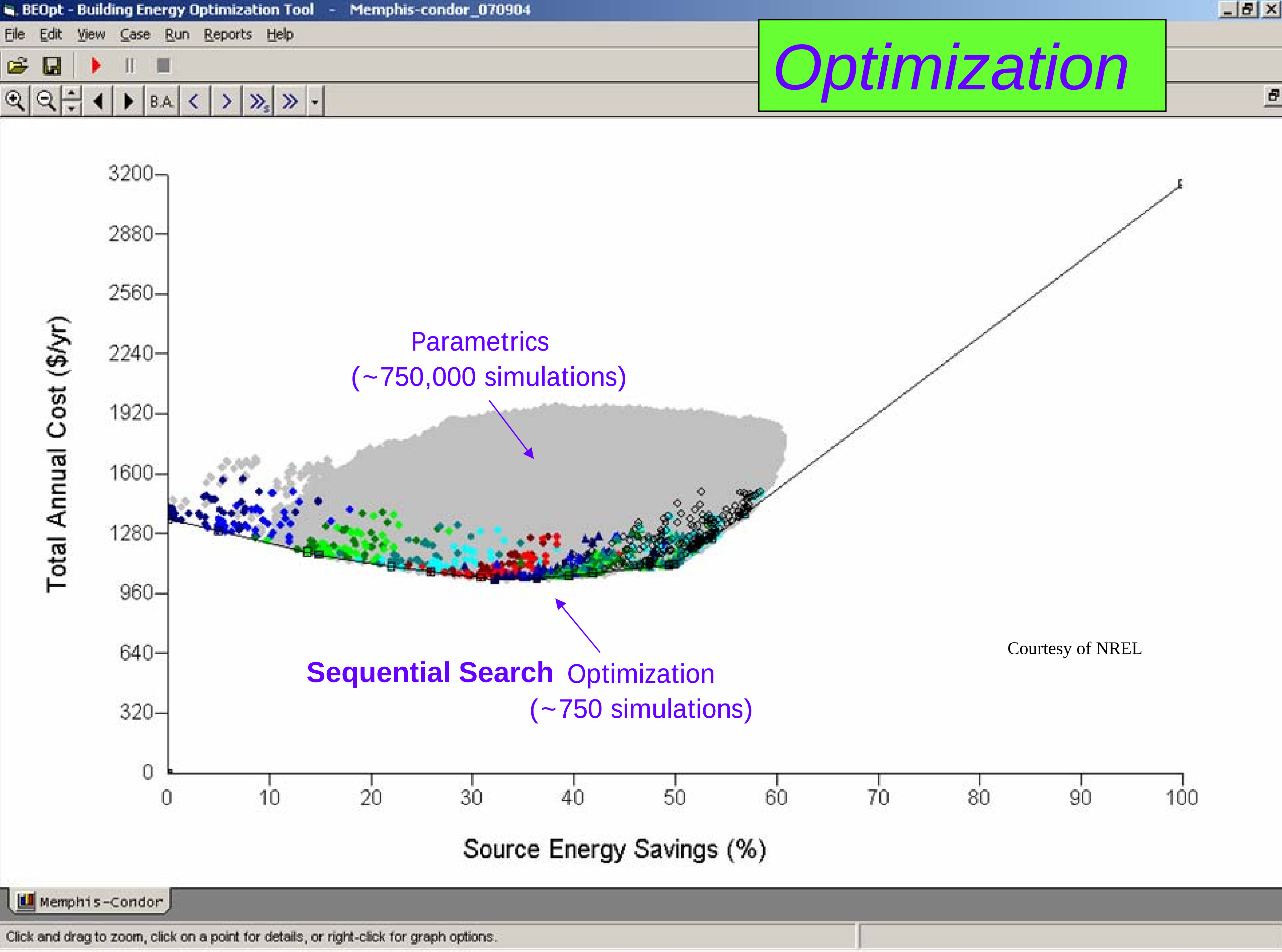
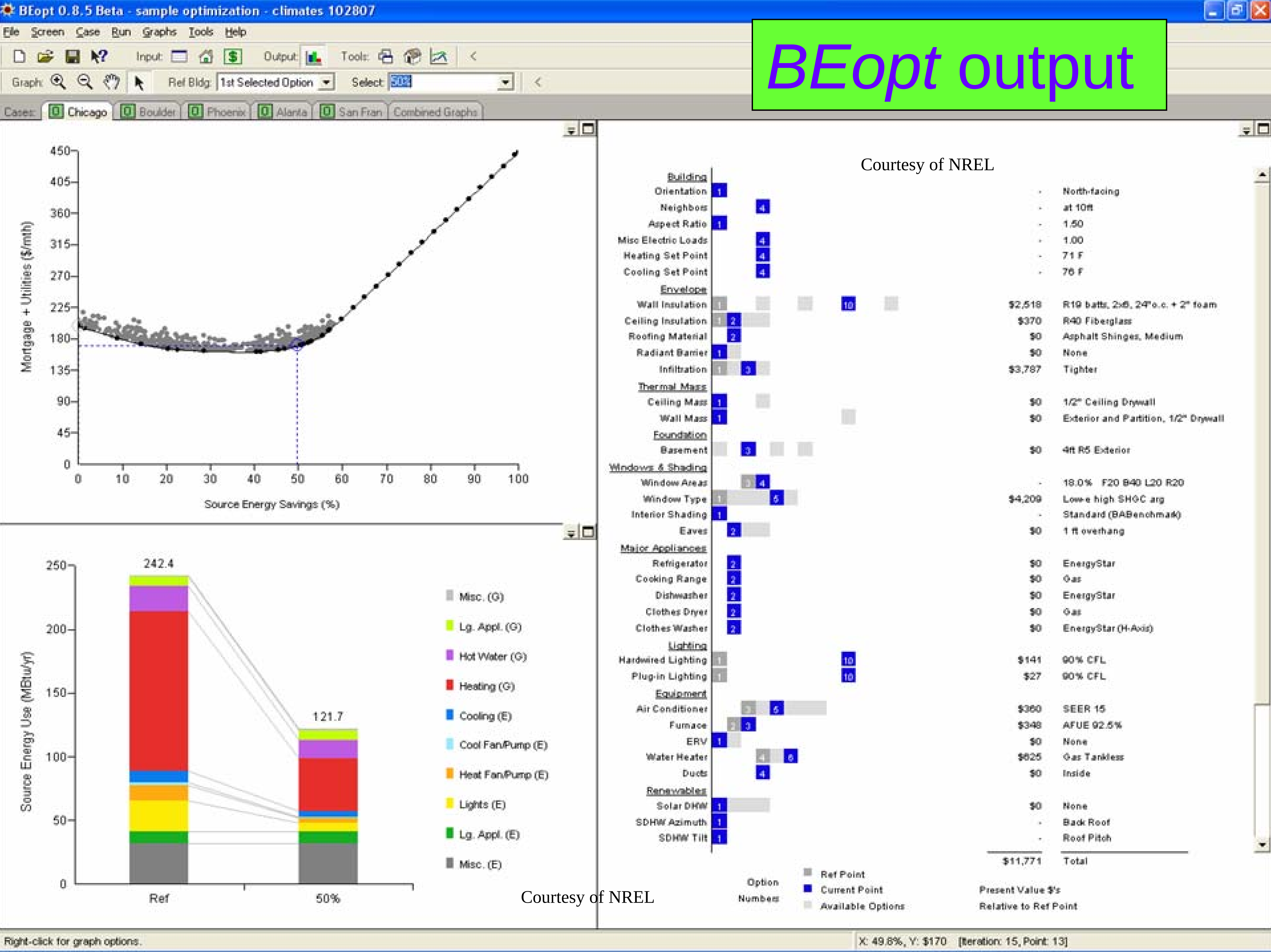
Optimization



Courtesy of NREL

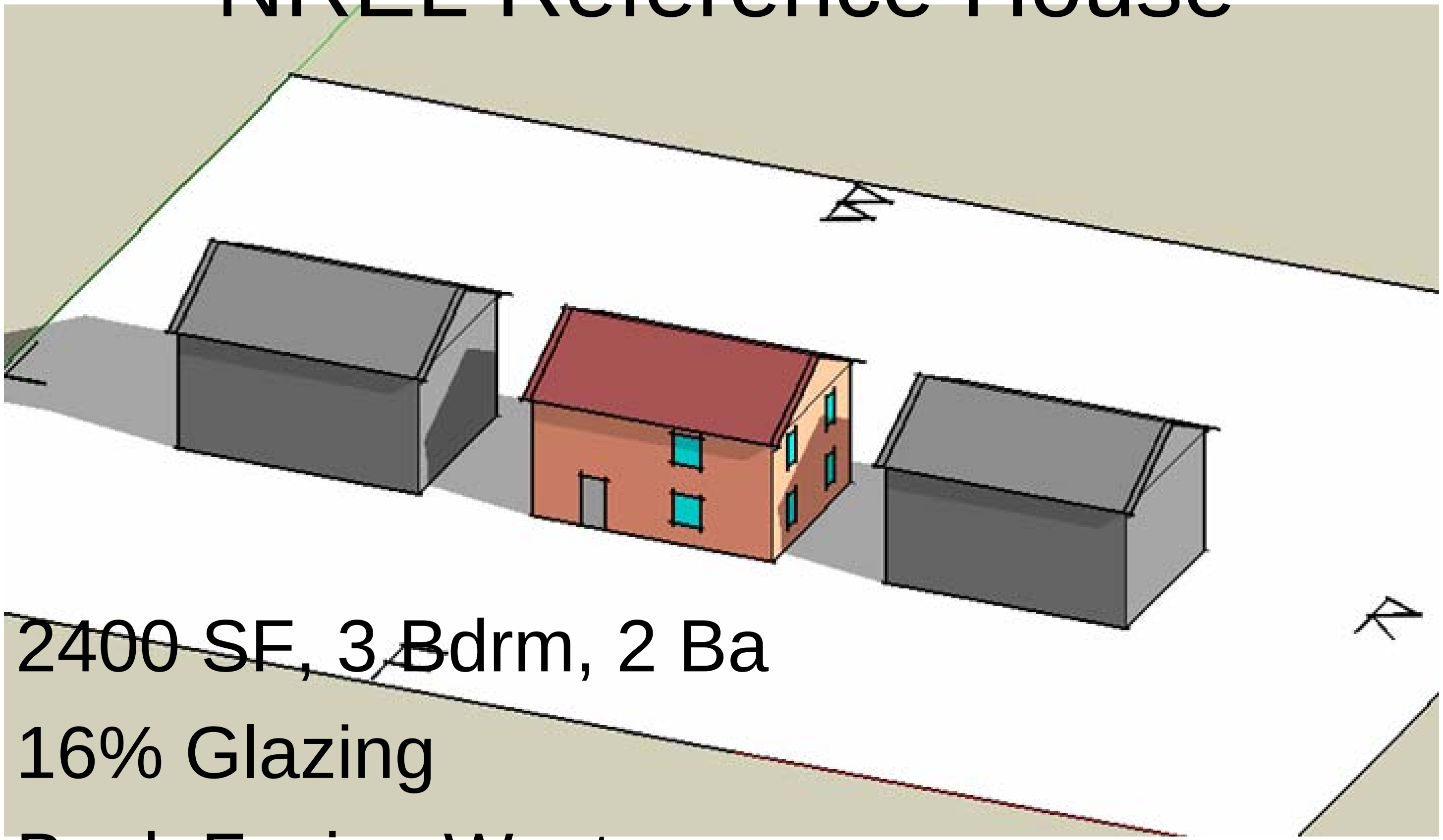
BEopt output



Courtesy of NREL

Courtesy of NREL

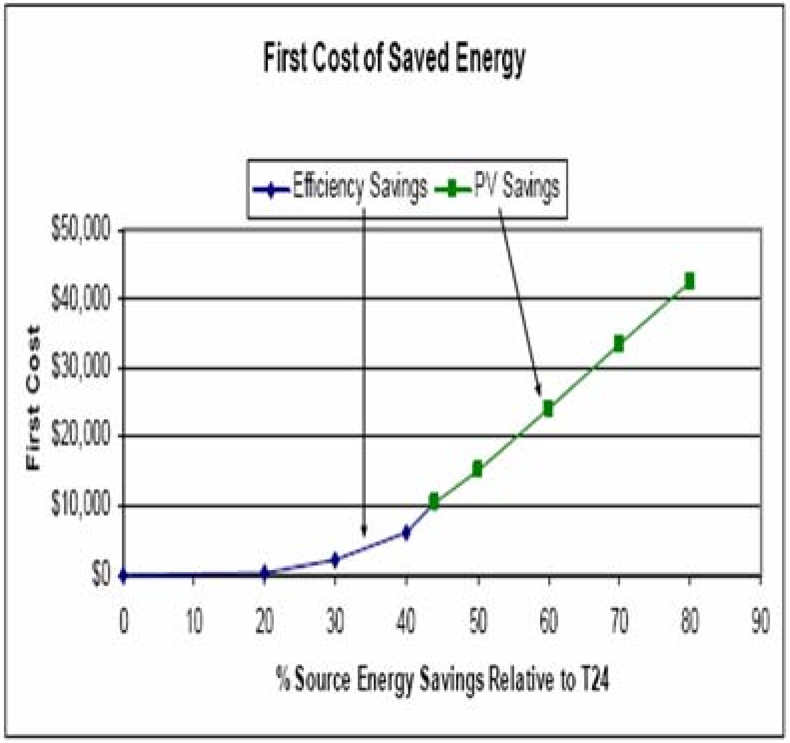
NREL Reference House

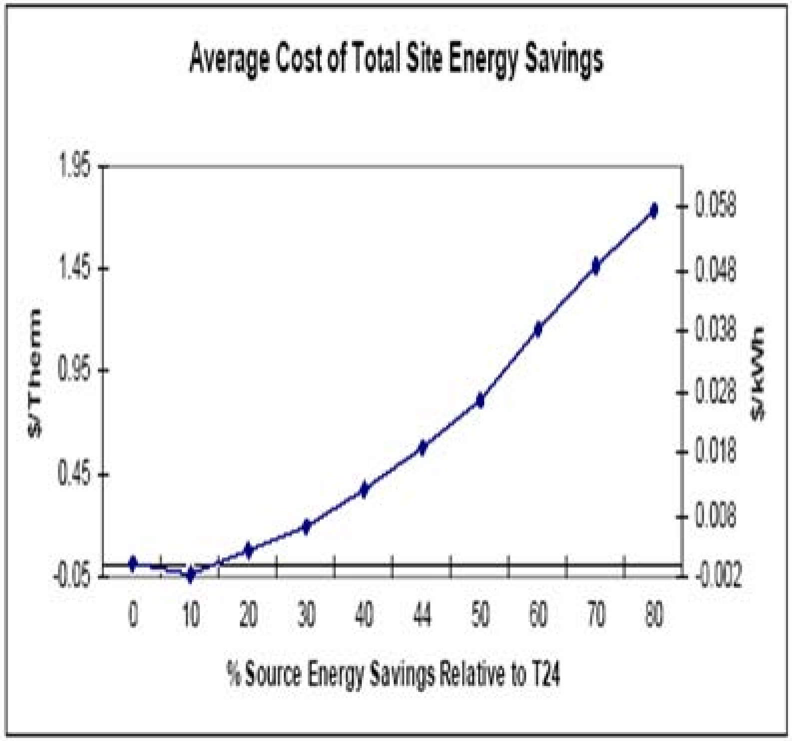


- 2400 SF, 3 Bdrm, 2 Ba
- 16% Glazing
- Back Facing West
- 4 Occupants

Courtesy of NREL

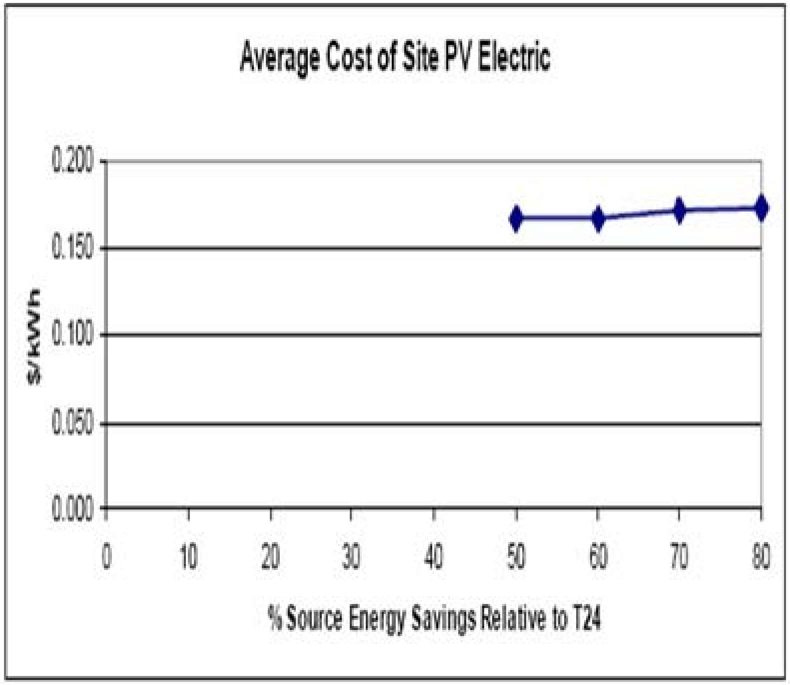
What Efficiency/Renewables Combination Maximizes Cost Effective Savings?

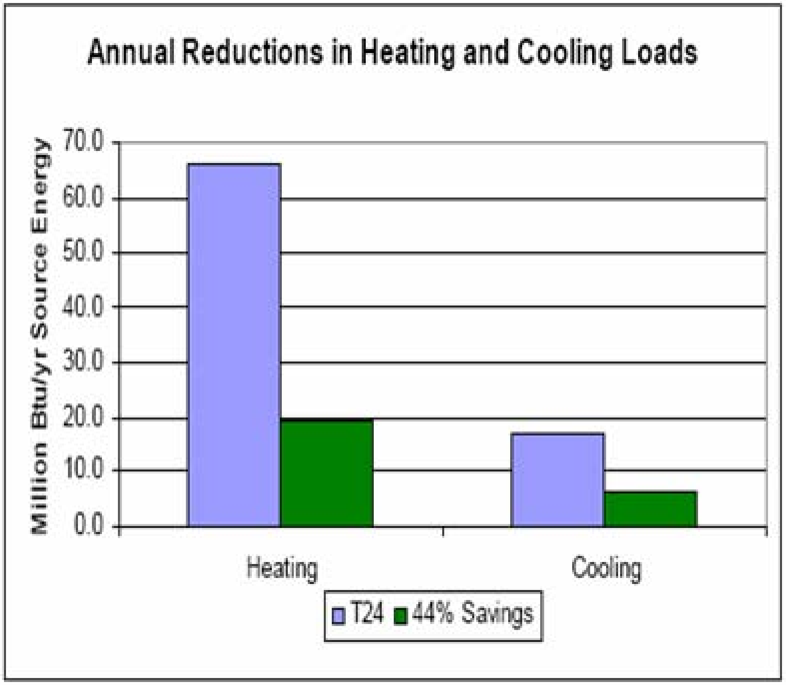




Courtesy of NREL

ZEH Strategy: Efficiency Minimizes Energy Use, PV Supplies the Rest!





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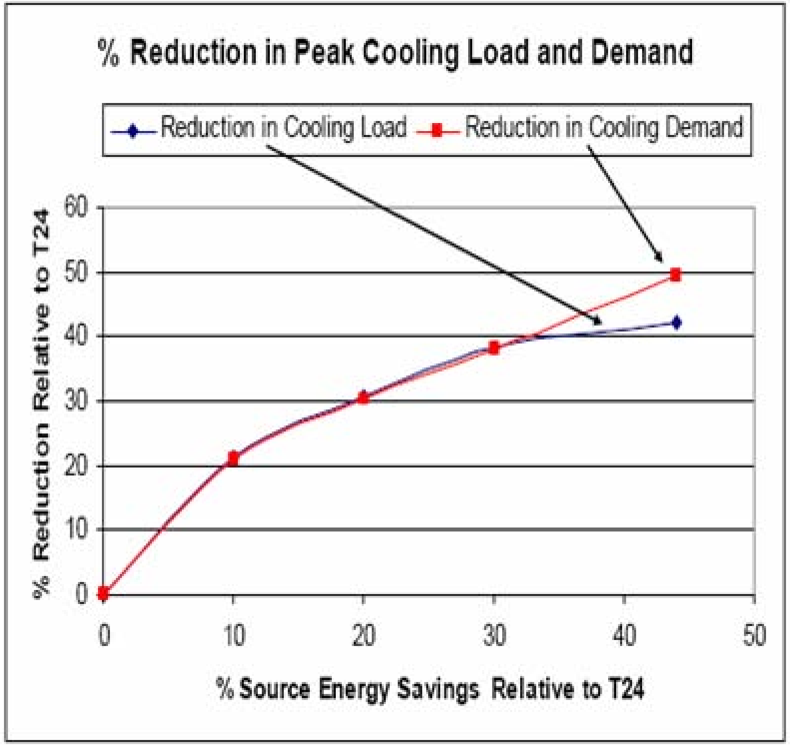
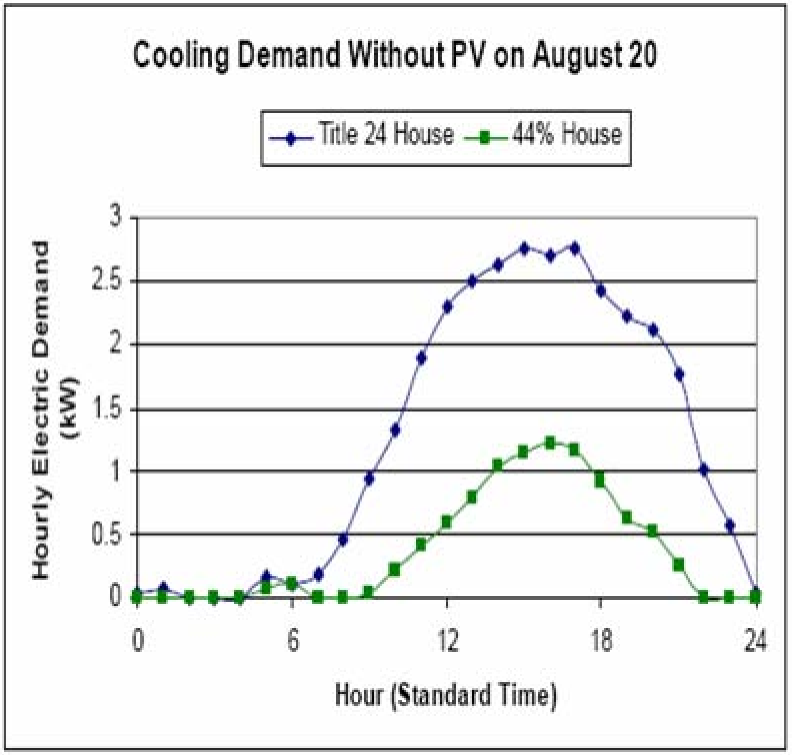
What About Impact on Peak Electric Demand?





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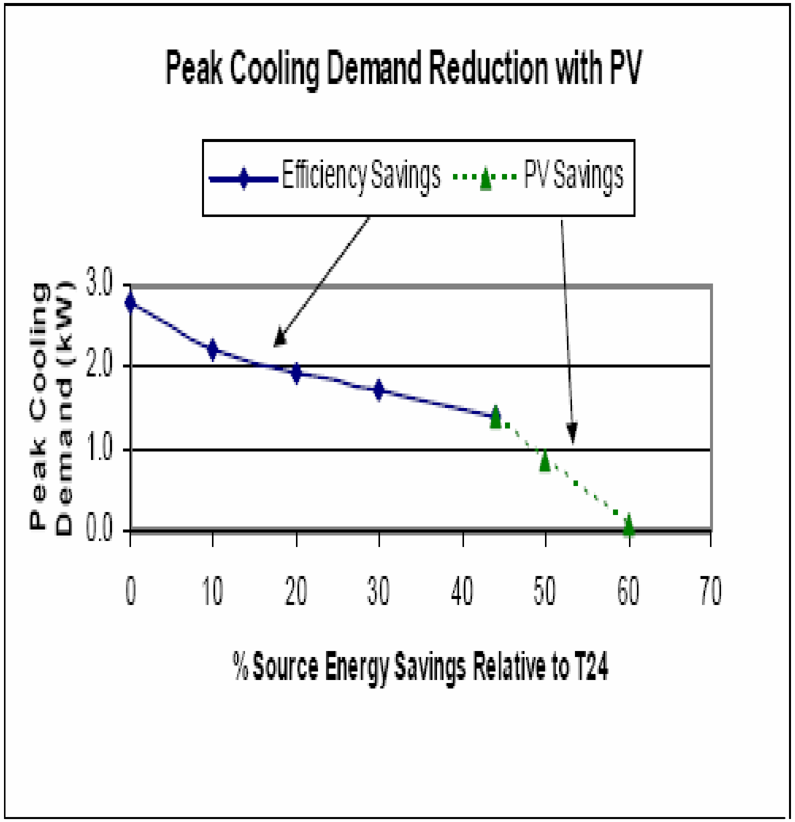
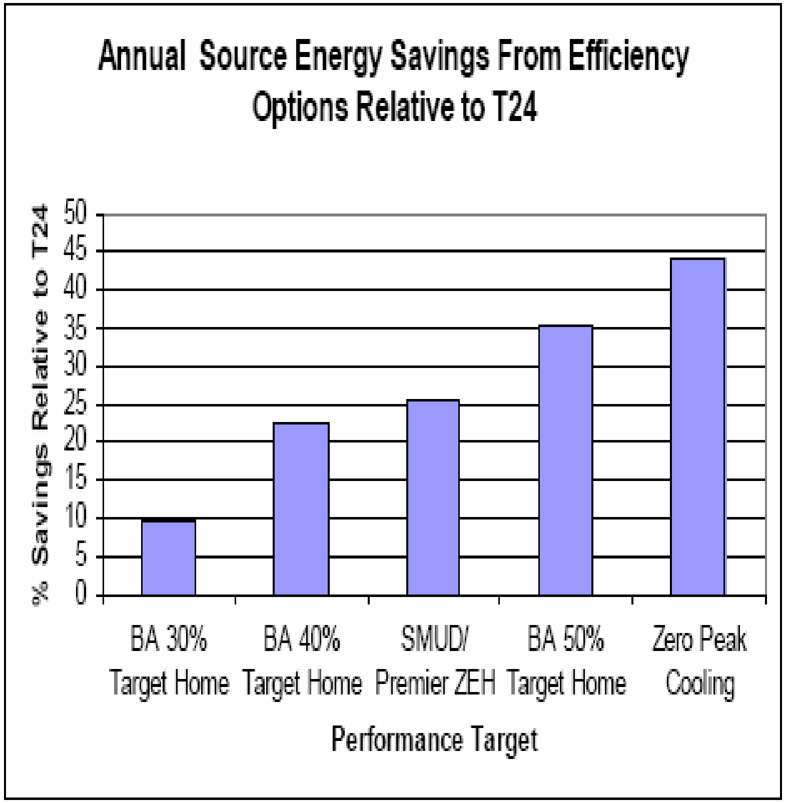
Zero Peak Cooling Strategy: Efficiency+PV+Thermal Storage





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BEopt Economic Assumptions

- 30 year analysis period
- 3% inflation rate
- 5% discount rate (nominal)
- 7% interest rate (nominal)
- $7.50/watt PV (installed cost)
- $1/Therm natural gas
- State average electric costs (EIA 2005)
- National average efficiency costs

SMUD ZEH R&D Projects

- Beazer Powerhouse 2000-02
  - 5 Subdivision/ 18 Units
  - Entry level
  - Optional feature
  - 3,300 Watt ac

- Morrison Homes Lakeside 2003
  - 12 units
  - Move-up, in-fill project
  - Spec'd and Optional Upgrade
  - >30% Title-24, 2 kW ac Solar

SMUD ZEH R&D Projects

- Premier Homes Premier Gardens 2004-05
  - 95 units
  - Entry level, in-fill project
  - >30% Title-24, 2 kW PV
  - Standard Feature

- Treasure Homes 2006-07
  - 32 units
  - Entry level, in-fill project
  - >40% Title-24, 2 kW PV
  - Standard Feature

Energy Efficiency Features

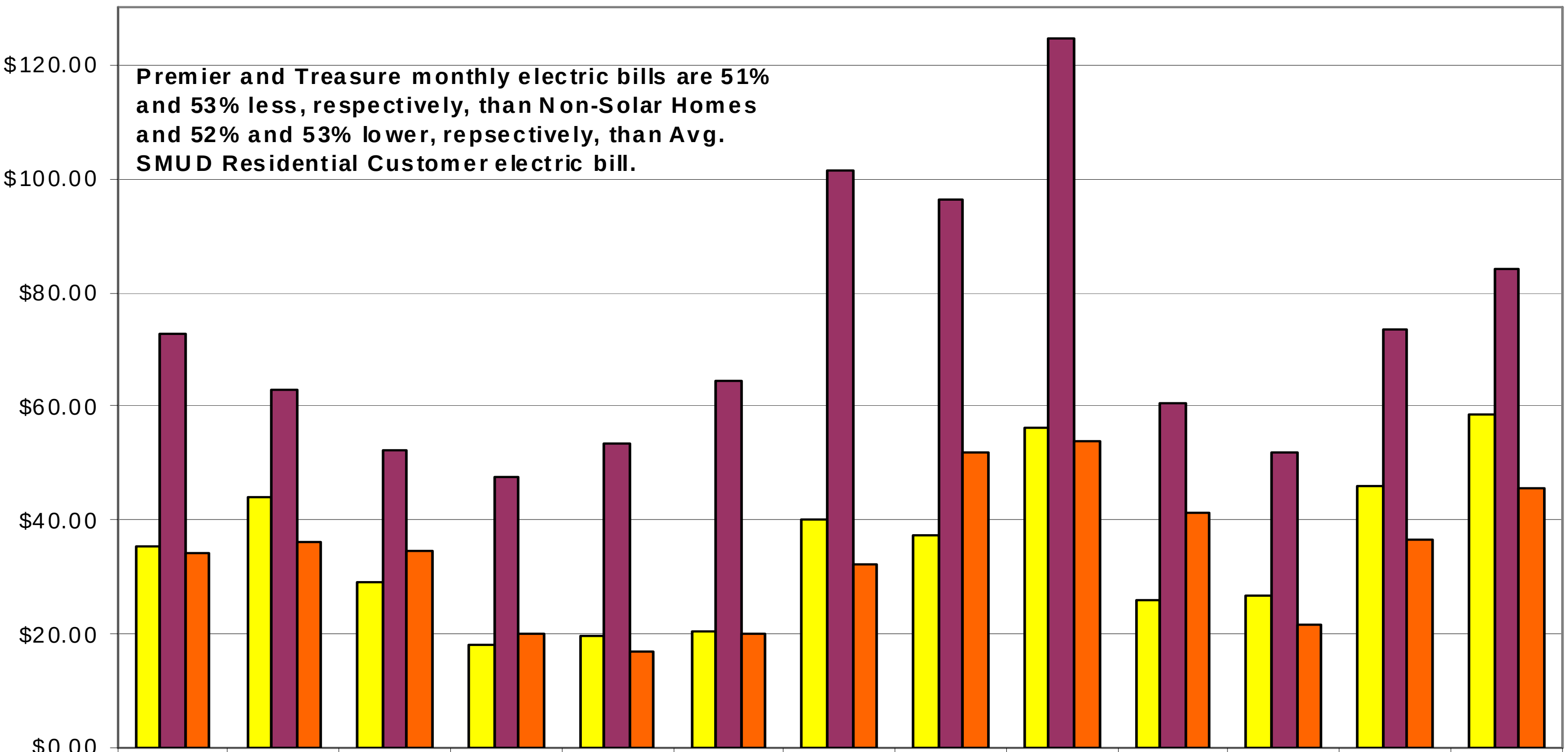
23-42% better than 2005 Title 24 plus solar

Measure	Base	ZEH
Attic Insulation	R-38	R-38
Radiant Barrier	No	**Yes**
Wall Insulation	R-13	**R-13 + 1" R-4.2 Foam**
Quality Installation	No	**Yes**
Low Air Infiltration	Yes	Yes
Windows	Vinyl, low U,SHGC	Vinyl, Low U, SHGC
FURN AFUE	0.80	**0.95**
A/C SEER	13 (3.7 ton)	**14 w/TXV (3.1 ton)**
ACCA Design	No	**Yes -- Short Runs**
Duct Testing	No	**Yes**
Water Heater	storage EF .60	**Tankless EF .82***
Distribution	Standard	**Pipe insulation***
Home Energy Rating	No	**Yes**
Fluorescent Lighting	Yes	**Yes (All fixtures)**
Solar Electric	NA	**2kW AC Solar System**

*** Water Heating Measures Optional under SolarSmart**

Real Bill Savings

Solar vs Non Solar Avg Monthly Bills 2007



	Avg. Mo. Bill	Jan, 07	Feb, 07	March, 07	April, 07	May, 07	June, 07	July, 07	Aug, 07	Sept, 07	Oct, 07	Nov, 07	Dec, 07
Premier Homes	$35.30	$44.12	$29.27	$18.37	$19.88	$20.33	$40.31	$37.30	$56.32	$26.20	$26.81	$45.92	$58.76
NON ZEH AVG BILL	$72.77	$62.77	$52.50	$47.46	$53.63	$64.49	$101.55	$96.43	$124.57	$60.41	$51.75	$73.46	$84.17
Treasure Homes	$34.27	$36.33	$34.59	$20.04	$16.83	$20.11	$32.21	$52.03	$53.77	$41.44	$21.75	$36.57	$45.59

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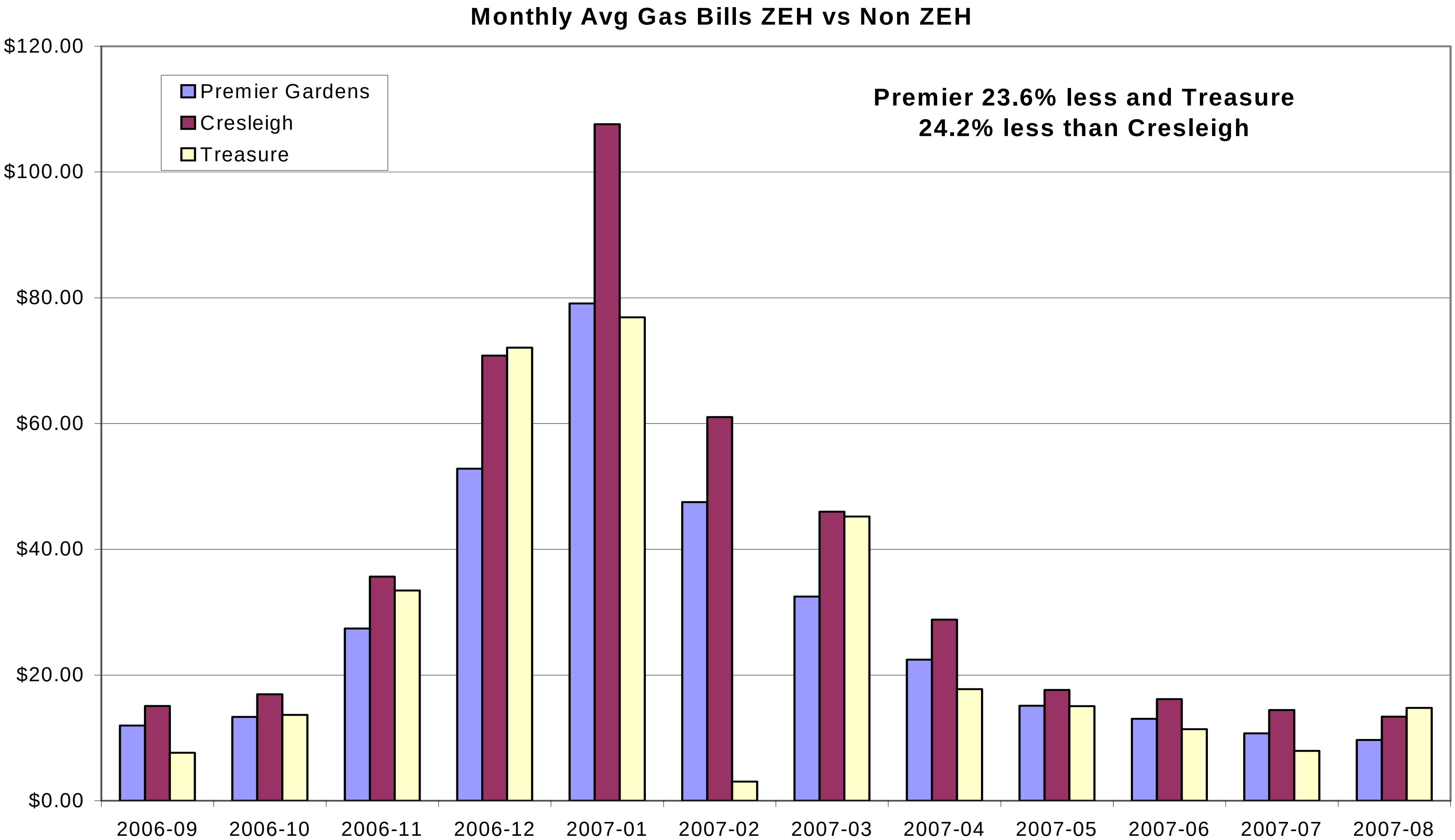
Real Bill Savings



Courtesy PG&E

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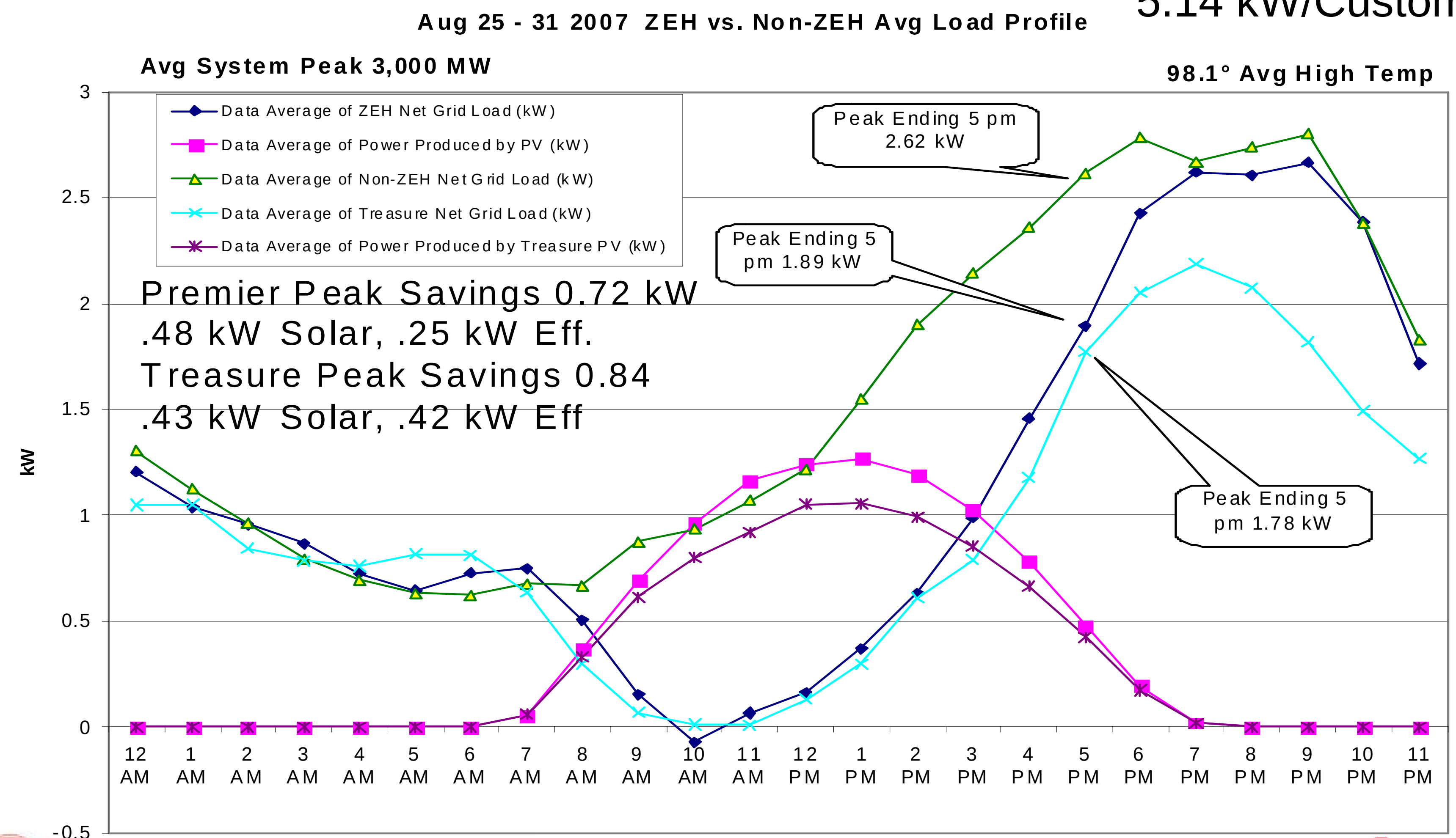
Real Peak Demand Savings

5.14 kW/Customer



Premier Gardens Distribution System Study

- Impacts on Distribution System
  - Indiscernible impact on substation voltage and transformers
  - Significant impact at peak July/Aug
  - West facing PV has more impact

SMUD/Lennar Partnership

- 1,254 Single Family Homes in 14 Communities over 4 years (2007-10)
- Maximum SMUD contribution ~$10.8 Million
- 2,410 kW installed solar
- Peak Reduction
  - 1.51 kW avg. from 1-9 pm, per home
  - Total of 1.89 MW
- Energy Savings
  - 5,147 kWh/yr avg., per home
  - Total of 6,454 MWh
- Access to valuable real world data (R&D)

SMUD Solar Smart

LENNAR

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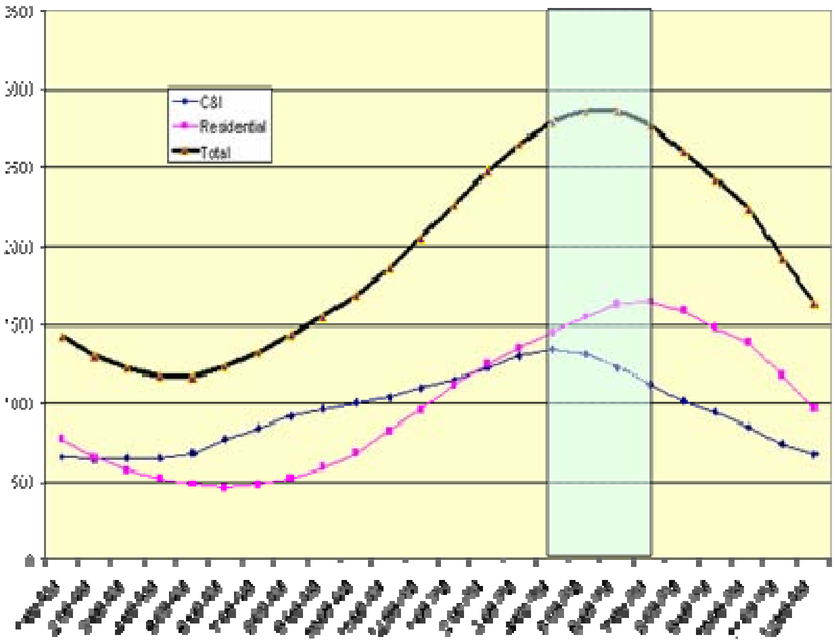
Sacramento Area Partnerships

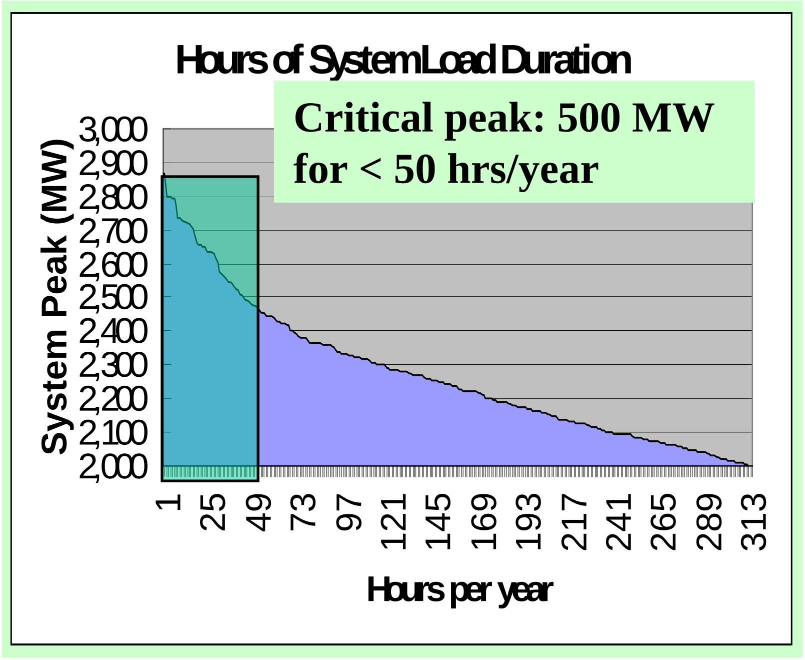
Market momentum - 46 Communities, over 4,000 new homes over next 4 years

- Sunrise Lofts LLC
- Tim Lewis Communities Multiple
- Homes by Towne Multiple
- Regis
- Centex
- 49 Mile Development
- DR Horton
- Standard Pacific Homes
- Woodside Homes

The Need at SMUD
Zero Energy or Zero Peak?

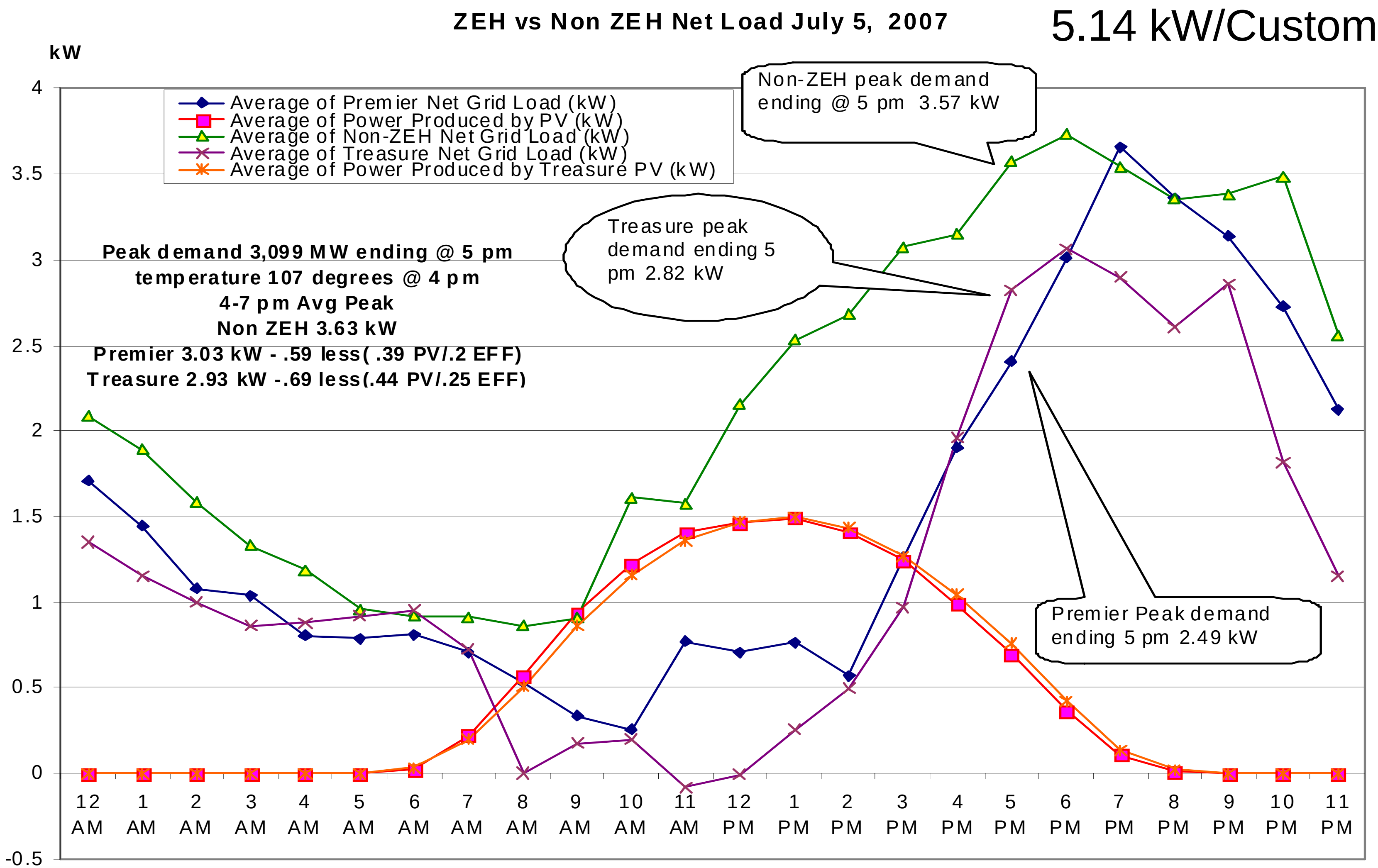
4-7 pm peak, July & August





Current ZEH Results

5.14 kW/Customer



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Home of the Future

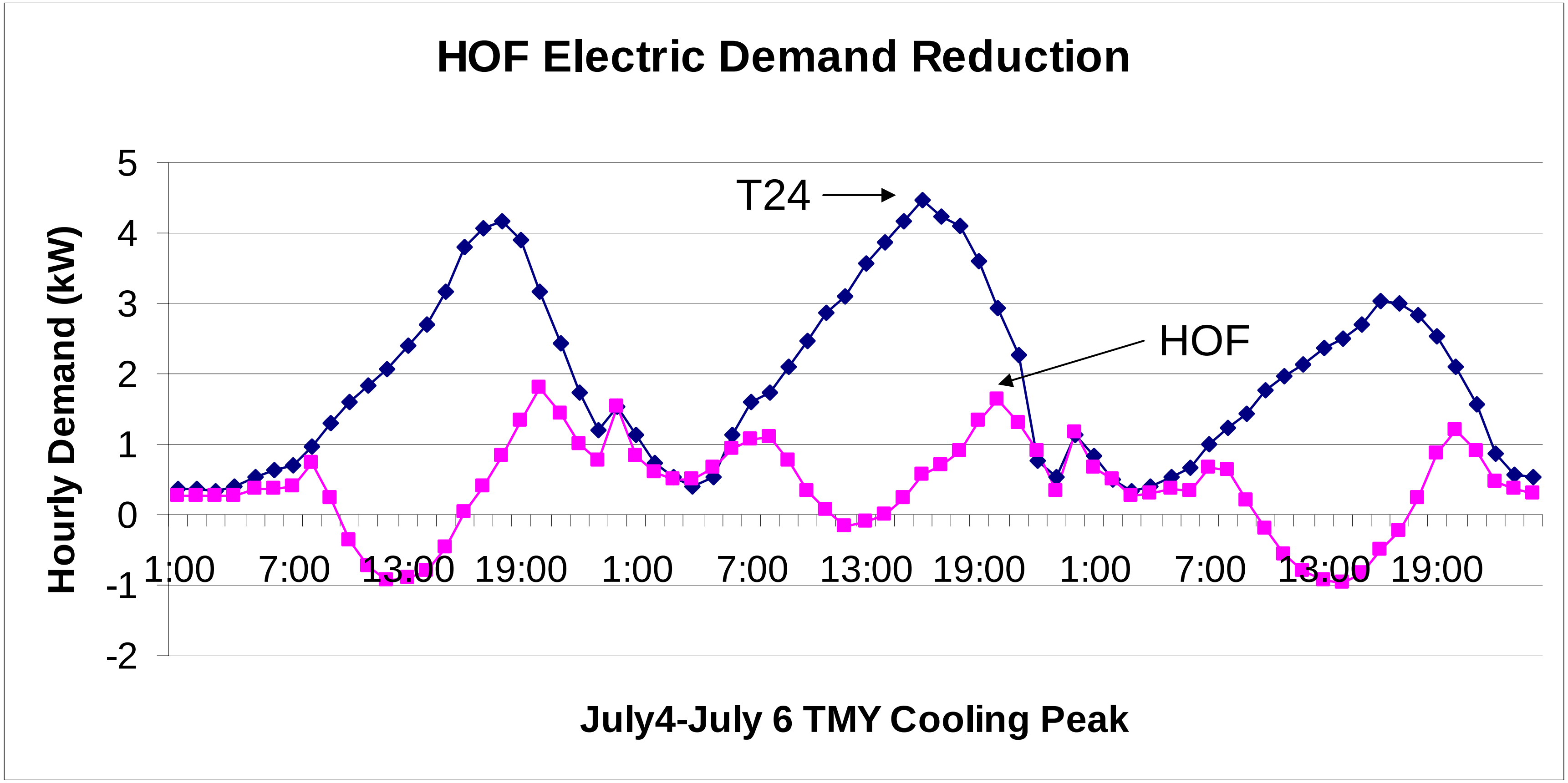
- Build a true Net Zero Energy Home with no annual electric or natural gas utility bill, and has zero net electric demand during summer peak periods
  - Annual Source Energy: 80% Reduction
  - Zero Net Summer Peak Electric Demand: 4 PM to 8 PM
- Demonstrate the features of the home to the public and builders

HOF Energy Performance Specs

- Advanced Framing 2x6/R19-R21cavity/R12 insulating sheathing (R30 wall assembly)
- R50 ceiling assembly
- Tight Envelope, .0002 SLA (4 ACH_{50})
- Low e/low SHGC glazing (0.3 U-value, 0.26 SHGC)
- 100% CFL/LEED Lighting
- SEER 18 or AC/Evap Condensor/2 ton
- AFUE 90+ furnace or solar assisted hydronic
- Solar hot water with tankless gas hot water backup (EF 0.80+) or Hi-Eff boiler
- Tight ducts, inside conditioned space (mastic, < 5% leakage)
- Gas (cooking, clothes) and Energy Star Appliances
- Third part testing and inspection
- 3.5kW AC PV, grid-tied (dispatchable) battery back up
- Home Automation System
- <u>Estimated cost increase relative to standard home</u>: +$20.00/ft2

<u>Notes</u>:
1. Equivalent packages may be substituted, based on specific builder preferences
2. Incremental costs estimated relative to minimum T-24

Peak Demand: HOF Base, 4kWac West Array



Program Challenges

- Current Real Estate Market
  - Slow sales, bldr consolidation
- PV and SDHW Costs (and supply)
- Builder Concerns
  - Market & product concerns
- Integration w/ State NHSP program
  - Lagging program, 2008 T-24 Changes
- QA Concerns

Lessons Learned - Buyers

- Significant utility bill savings
- Solar/Efficiency has little appeal as an option but immense appeal as a standard feature
- Energy savings needs to be sold on cash flow not payback
- New home buyers are unfamiliar with the benefits of owning their own PV system
- Solar and efficiency have not hit "critical mass," with buyers, but momentum is building

Lessons Learned - Builders

- Most builders in “wait and see” mode
- Builder skepticism regarding energy efficiency and solar is driven by concerns over cost and demand
- Builders believe demand is widespread but weak (“soft demand”)
- Clear builder preference for building-integrated PV systems over roof mounted PV systems
- Concerned about the **availability** of qualified manufacturers and installers of solar power systems
- Builders want to use their own subcontractors and/or have turn key solutions

Lessons Learned - Others

- UTILITIES
  - Peak Matters!
  - Significant peak demand reduction.
  - Potential Distribution System savings (yet to be proven)
- Engage and train Local Government
- PV manufacturers must be full service suppliers – installation support, sales training, warranty

Recommendations

- Partner w/ the Building America Program
- Focus early program efforts on "Pioneers" – builders willing to pursue solar and efficiency regardless of what other builders do
- Reward the Pioneers
- Approach builders from the same perspective as buyers – that solar/efficiency features make economic sense beyond its altruistic benefits
- Keep it Simple – Prescriptive Measures and **Min** Paperwork

Recommendations

- Assure builders about the availability of parts and installation expertise in the area
- Aggressive public education campaign
- Engage your local utility
- Work w/ local building association
- Sponsor comprehensive training
  - Builders, Subs, Bldg Officials, Solar Contractors

More Information

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