

ENERGY USE AT ARMORY PARK DEL SOL BY JOHN WESLEY MILLER COMPANIES

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Sustainability is our work in progress as building science matches high-efficiency homes with solar energy systems and with the use patterns of people living in these homes.

EXECUTIVE SUMMARY

THE GOALS OF THIS REPORT ARE TO

- **Document** elements of energy efficiency and quality of life **Benefits** to residents, utility companies, environment
- **Inform** the Building & Construction Industry
- **Promote** economic advantage, environmental gains and equity (culture)

ENERGY PERFORMANCE DATA AND ANALYSIS of standard Armory Park del Sol homes (“APdS” homes) is reported here based on three years of utility data (July 2003-September 2006). **The results? \$734/yr total energy cost (8,856 kWh, total average energy use/yr), \$301/yr for heating and cooling.** The first Zero Energy Home (“ZEH”) achieved its goal of **\$10/mo average energy cost**; it highlights the improvement through construction change inherent to the APdS success.

HOME, SITE AND PARTNERSHIP CHOICES FOR SUSTAINABLE DEVELOPMENT ACROSS THE SPECTRUM

SITE

- Urban in-fill, infrastructure in place;
- Medium density (seven/acre);
- Pedestrian-friendly, access to culture and adjacent old downtown.

HOMES

- Thermal mass (solid core-filled masonry) with exterior insulation;
- Superior ceiling and floor insulation;
- Solar hot water collector with on-demand back up;
- One kilowatt AC photovoltaic system (~1500 watts installed; minimum);
- High efficiency mechanical (SEER 14 heat pump standard);
- Energy efficient lighting.



PARTNERSHIP

- Tucson Electric Power utility: Created time-of-use electric rate and cooling/heating guarantee used with effective technologies; excellent PV rebate—\$3/installed watt;
- Collaboration for effective design and engineering: HUD—Partnership for Advancing Technology in Housing (PATH); US Department of Energy (DOE), Building America Program; National Association of Home Builders—National Research Center.

RESULTS: AVERAGE UTILITY ENERGY USE PER HOME PER YEAR*

*All details of data, assumptions, analysis and energy use standards are given in the body of the report.

1	2	3	4	5	6	7	8
	10/'05-9/'06	9/'04-8/'05	2/'04-1/'05	201C Rate '05-'06	East-west Axis	ZEH 10/'05-9/'06	ZEH 10/'04-9/'05
Sample size	37	23	16	30	5	1	1
Avg. sq feet	1,576	1,460	1,492	1,544	1,389	1,717	1,717
*Total average kWh/yr	8,856	9,456	9,920	8,495	6,956	630	1,956
*Source kBtu/sf/yr	59	68	70	58	53	4	12
Total cost (yr/mo)	\$734/ \$61	\$777/ \$65	\$821/ \$68	\$685/ \$57	\$599/ \$50	\$125/ \$10	\$262/ \$22
*Base kWh/yr	5,991	5,844	6,132	5,532	4,800	0	0
Base kBtu/sf/yr	40	42	48	38	36	0	0
*Total C/H kWh/yr	2,865	3,612	3,114	2,963	2,156	630	1,956
C/H kBtu/sf/yr	19	26	22	20	16	4	12
*C/H Energy Cost (yr/mo)	\$301/ \$25	\$295/ \$25	\$257/ \$21	\$303/ \$25	\$225/ \$19	\$125/ \$10	\$262/ \$22

Table 1. Energy use is decreasing over three years studied at APdS (columns 2-4, row 5). TEP Rate 201C—time-of-use—reduces use/costs more (column 5). Homes with east-west axis further reduce use (column 6). First ZEH achieves \$10/month goal (column 7) showing improvement through construction change valued in APdS process (compare column 7&8—section 8 in report). Cooling and heating (“C/H”) achieves the ‘50% benchmark’ common in ‘sustainable’ reduction standards for heating and cooling—average Tucson use* assumes 40 kBtu/sf/yr for heating and cooling; APdS uses about 20kBtu/sf/yr.

1	2	3	4	5	6	7	8	9
	Avg. total kWh	Avg. Bill	kWh ON-PK 1-6PM (\$0.184)	kWh SH 6-8PM (\$0.116)	kWh OFF-PK other times (\$0.058)	Total cost of kWh only	Avg. Cost/ kWh	Avg. kWh solar
June '06	989	\$98.13	156 (15.8%)	84 (8.5%)	749 (75.7%)	\$81.87	\$0.0828	172
July '06	1,165	\$110.90	160 (13.7%)	89 (7.7%)	916 (78.6%)	\$92.89	\$0.0797	158
Aug '06	880	\$88.16	128 (14.5%)	80 (9.1%)	672 (76.4%)	\$71.79	\$0.0816	177
	Avg. total kWh	Avg. Bill	ON-PK 7-11AM 6-9PM (\$0.094)	SH none	OFF-PK other hours (\$0.032)	Cost of kWh only	Avg. Cost/ kWh	Avg. kWh solar
Dec '05	805	\$49.97	189 (23.5%)	0	616 (76.5%)	\$37.47	\$0.0466	149
Jan '06	656	\$43.37	173 (26.3%)	0	483 (73.7%)	\$31.69	\$0.0483	121
Feb '06	535	\$36.61	138 (25.9%)	0	396 (74.1%)	\$25.69	\$0.0480	164

Table 2. Time-of-use data (TEP Rate 201C, APdS homes with solar electric, solar thermal and TEP Guarantee) with benefits to APdS homes shown. Summer (rows 3-5) and winter (rows 8-10) use for current year. Average total kWh (column 2). Average homeowner bill (column 3). On-Peak use (column 4), Shoulder use (column 5), Off-Peak use (column 6) with time period and cost/kWh shown for summer (row 2) and winter (row 7); data in cells show average kilowatt hours and percent of energy use in parentheses. Average fixed-cost for kWh, i.e., less service charge, taxes and non-fixed charges (column 7—column 3 is the bill, column 7 is the fixed energy charge in that bill). Average cost/kilowatt hour (column 8) reflects utility benefit of house construction paired with time-of-use plan and solar technologies. Column 9 shows TEP estimate of average monthly kWh contribution of the approximately 1 kW AC photovoltaic electric system on each APdS home supplementing the utility grid to achieve the win-win result for resident, utility company and environment.

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