Energy Use in Civano Residences —
Prepared for the Community of Civano, LLC

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* ANE, Inc. would like to thank Southwest Gas and Tucson Electric Power for providing data for Civano energy use and averaged data for residences in Tucson, and participating residents of Civano for permission to use utility data in this study. We are also grateful to Cari Spring, Ph.D., Global Professional Services, Inc.

Energy Use in Civano Residences

Contents

1. Codes and Terms, Multipliers, Correlations and Conversions

Model Energy Code (MEC; first adopted in 1995)*:* The Energy Standard for Tucson/Pima County new construction homes. Source energy used for heating and cooling is expected to be between 36-54 kBtu per square foot per home per year, with range dependant on home square footage. The (local) MEC has since been subsumed under international standards, the IECC without substantial change to date.

Sustainable Energy Standard (SES): The SES is the energy code governing energy use at Civano, with the current formulation predicting 50% less energy use than the MEC for heating, cooling and hot water heating. The (1995/1998) SES was used for analysis of the 2003-2004 Civano energy study. A modified SES (2003; currently out for public review) removed the prescriptive requirements (i.e., removed the stipulation of 50% the energy used by MEC). The 2003 SES is expected to be the standard for Civano Phase II and III. Civano is a case study testing the SES; changes to the SES result from lessons learned from Civano Phase I development. (See Appendix 2, Adoption of the SES by Mayor and Council, July 6, 1998, Resolution # 18082 for City of Tucson facilities.) A copy of the proposed 2003 SES is available on the Tucson web site:

http://www.ci.tucson.az.us/dsd/Codes___Ordinances/Building_Codes/Proposed_Codes/proposed_codes.html

The current SES code is also available on the Tucson web site:

http://www.ci.tucson.az.us/dsd/Codes___Ordinances/Building_Codes/building_codes.html

The heating and cooling energy for homes built to the 1998 SES was initially assumed to range between 18 and 27 kBtu/ year, depending on home square footage (see section 2 below). With Civano homes in the sample averaging 1,619 sq ft (section 2), 20 kBtu/square foot source energy/year is the target use under the 1998 SES.

Solar Hot Water is provided by a device that converts sun energy to heat water. The 1998 SES specifies hot water use to be 50% that of the 1995 Model Energy Code; figures for expected use under the MEC are not estimated. The Arizona Solar Center calculates energy avoidance of the Progressive Tube Solar Hot Water Heater (used in some homes at Civano; model PT-40 CN with 40 gallons in collector storage) at 2,200 kWh per year. Converted to 7,512 kBtu per year, the savings from solar hot water use represents approximately 4.6 kBtu per square foot/year for Civano homes using solar hot water. Other collectors used include the Sun Earth collector, which is similar to the PT-40 and is expected to have similar performance.

Multipliers

The Sustainable Energy Standard evaluates compliance with target energy goals using *source energy*. *Point-of-use* energy refers to amount of energy used at a location, in this case, home energy use (indicated on a utility bill). *Source energy* is the total amount of energy used to produce and transport energy to its point-of-use. The SES specifies multipliers to assess source energy use: point-of-use *electrical* energy is multiplied by 3.1 to calculate source energy, and point-of-use *gas energy* is multiplied by 1.11 to assess source gas.

Correlations

In Tucson

- Approximately 2.3 pounds of CO_2 are released per kWh of electrical energy (charts appear in *Benchmarking Air Emissions of Electric Utility Generators in the United States*, National Resource Defense Council, 1996);
- Approximately 1 pound of coal and approximately 0.65 gallons of water are used per kWh of electricity**.**
- 67.39 pounds of CO_2 are released per therm of coal powered electrical energy.

National Average

11 pounds of CO_2 released per therm of natural gas.

Conversions

kilowatt-hour (kWh): 1,000 watt hours
kilo British thermal units (kBtu): 1,000 Btu; 3.41 kBtu per kWh
Therm: 100,000 Btu or 100 kBtu; 29.3 kWh per therm

2. Introduction: Civano and the 1998 Sustainable Energy Standard

A. The Civano MOU

This third year of evaluation of Civano home energy use as the case study to evaluate Tucson's 1998 Sustainable Energy Standard (*SES*; April 22, 1998) puts us in position to evaluate both the formulation of the 1998 SES and the evaluation strategies used to verify compliance with it. This result is important to stakeholders of Civano: The Community of Civano, LLC, the City of Tucson, the Metropolitan Energy Commission, Pulte Homes, Pima County, Tucson Electric Power Company, Southwest Gas, Tucson Water Company, Civano homeowners, active homebuilders at Civano—T. J. Bednar, Solar Built, Doucette Homes and Pepper-Viner—and the many other participants who contributed to the vision of sustainable community development initiated at Civano.

More broadly, this evaluation of the 1998 SES and its methods is essential to ***evolve realistic conceptions of sustainability*** and to ***adequate formulate evaluation methods therein*****. The latter is an explicit goal built in to the Memorandum of understanding governing Civano.**

> The goal of the Memorandum of Understanding is to confirm the strategies for sustainable development and to implement and monitor the Civano IMPACT System…**Subsequent monitoring of performance…will provide the basis for determining the success in meeting the IMPACT System Standards as well as the basis for improving future conservation and sustainability strategies and standards** (Civano IMPACT MOU, Sections 1-3; bold added).

More precise specification and methods of compliance and evaluation are expected to motivate acceptance of the 2003 Sustainable Energy Standard, which will, among other changes, elucidate calculation of energy provided by solar electric energy (Photovoltaic energy) and solar thermal energy (solar hot water) use as a function of home use and number of people in the home. It is expected to specify workmanship standards and eliminate prescriptive quantities based on theoretical approximations (e.g., see Table 1 below).

B. Overview of the 1998 Sustainable Energy Standard

> The 1998 Sustainable Energy Standard: The calculated target annual energy consumption of the building shell and mechanical system and domestic hot water heating shall be less than the energy required by the present Tucson/Pima County Model Energy Code by 50 percent. (Sustainable Energy Standard, Chapter 1, Section 101.4.)

The Model Energy Code thereafter became the IECC 1998 when International Standards were adopted; hereafter, the Model Energy Code is co-identified as the IECC. Appendix 1 provides a history of the development of the 1998 SES and its initial basis; see also ANE, Inc. reports on Civano Energy use for 2001-2002 and 2002-2003.

Evaluation of energy use under the 1998 SES and throughout this report is in terms of *source* energy use, *not point-of-use* energy consumption, as detailed in section 1 above.

Foremost, by assuming cooling and heating energy use by homes built to the 1995 Tucson *Model Energy Code* to be approximately 36-54 kBtu/sq ft/year source energy (see section 1), the 1998 SES proposed that energy use for homes built to the SES be 50% of the MEC/IECC as specified in Table 1.

Building	kBtu/sq. ft./year/home as source consumption in kBtu		
Sq. Ft. Range	Heating	Cooling	Total
<1000	5	22	27
1000-1399	4	18	22
1400-1799	4	16	20
1800-2199	4	15	19
>2199	4	14	18

Table 1. Sustainable Energy Standard: Prescriptive Compliance Summary.

In fact, the (Tucson) *Baseline Study for Residential Energy Use 1998/1999* performed for the City of Tucson Energy Office released in 2002 by McKnight Consulting, LLC, confirmed for the year studied that cooling and heating in a sample of Tucson homes built to the 1995 MEC used approximately 40 kBtu per sq ft per home per year for heating and cooling for homes averaging 1780 sq ft. A current analysis of cooling and heating in Tucson homes for comparison to the Civano results for 2004 is not available, although this study is underway and its results are expected by September, 2004. At that point, current Civano data can be compared to current Tucson data. Throughout this report, where relevant, we reference the previous baseline for comparison to Civano.

C. Characteristics of the Civano 2003-2004 Study

Data characterizing Civano homes analyzed here were collected from homeowners on a voluntary basis, who permitted release of their utility data to ANE, Inc. for analysis. Tucson Electric Power Company (TEP) and Southwest Gas (SWG) provided data for May 2003-through April 2004. Of 41 releases provided to date, 38 sets of utility data were useable. One lacked energy use for 10 months of the year; one lacked data for two months and the third utilized photovoltaics (*PV*) for only part of the year—see below for problems with analysis of PV powered homes under the 1998 SES. Of the 38 samples, 18 returned information regarding number of occupants in the home ranging between one to five, with an average of 2.17 occupants per home (see section 4). Home square footage ranged between 1,144 and 2,070 and averaged 1,619 square feet, with square footage data available for 35 out of 38 residences. No homes utilizing PV were included in the sample.

Energy bills were examined by month, and total energy use reported in kBtu were analyzed. The cooling/heating energy was determined by averaging “base” (or “plug”) loads for each month. Base loads are those devices that use energy throughout the year, not on a seasonal basis. The base load is expected to be consistent throughout the year and provides for the minimal energy use during all months. The calculated base load was eliminated to reveal the heating or cooling energy for the month. Section 3 below details methods for base identification. The energy use remaining after subtraction of base energy was assumed to be cooling energy for any month whose average temperature exceeded 65 degrees F, while heating was assumed for months with an average temperature below 65 degrees F.

3. Evaluation of 2003-2004 Energy Use at Civano and Comparison to Previous Years Studied

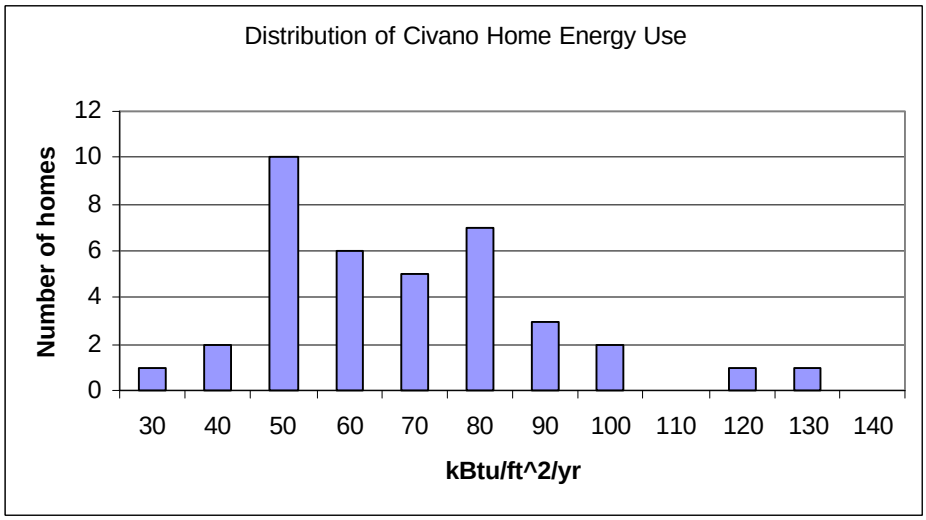
Results for Total Energy, Base Energy Use and Heating and Cooling

Results of total kBtu source energy use per square foot per year are reported in Table 2. As shown, an average of 74.75 source kBtu/sq foot energy per home was used in the 2003-2004 year studied. Of this, 19.31 source kBtu/sq ft was used for cooling and heating, with homes averaging 12.16 kBtu/sq foot and 7.15 kBtu/sq foot for each, respectively. Base energy, i.e. energy use for other applications, averaged 4.62 kBtu/sq ft per month, or an average of 55.44 kBtu source energy used per square foot per home per year. As can be seen from the histogram given as Graph 1, the data range from 30 kBtu/sq foot into the hundreds of kBtu with most homes using between 50 and 60 source kBtu/sq foot/year. Factors affecting the data range include number of people in the household, personal comfort preferences, numbers of computers, televisions, etc. In-home businesses, upgraded kitchen appliances, multiple electrical appliances—all contribute to what appears, by this analysis, to be an increase in plug loads over the year. We do not know how many and what types of electrical appliances were envisioned in the original prescriptions of base energy use in the 1995/1998 SES.

From this data set we see a mean, or average, of 74.75 kBtu per square foot. The distribution by house ranges from 30 to130 kBtu per square foot/year, as shown in graph 1. The data do not lend themselves to typical distribution techniques and thus the average only is used in this analysis.

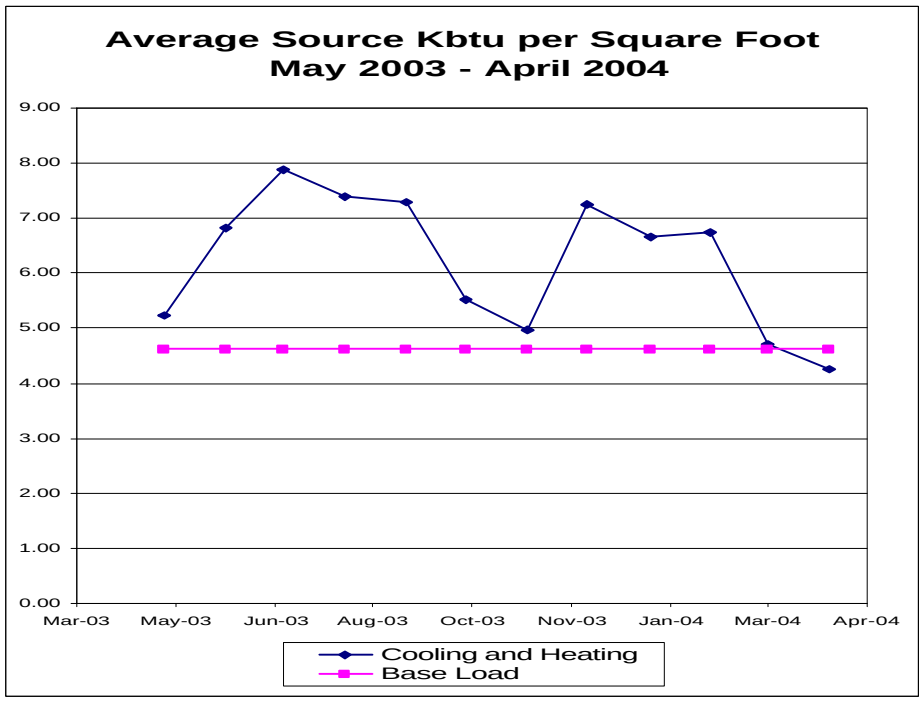
Month	Total Source kBtu per Square Foot	Base Load	Cooling	Heating	Total Heating and Cooling
May-03	5.23	4.62	0.61	0.00	0.61
Jun-03	6.83	4.62	2.21	0.00	2.21
Jul-03	7.89	4.62	3.27	0.00	3.27
Aug-03	7.39	4.62	2.77	0.00	2.77
Sep-03	7.29	4.62	2.67	0.00	2.67
Oct-03	5.52	4.62	0.90	0.00	0.90
Nov-03	**4.97**	4.62	0.00	0.35	0.35
Dec-03	7.25	4.62	0.00	2.63	2.63
Jan-04	6.67	4.62	0.00	2.05	2.05
Feb-04	6.74	4.62	0.00	2.12	2.12
Mar-04	4.70	4.62	0.08	0.00	0.08
Apr-04	**4.26**	4.62	-0.36	0.00	-0.36
Average	74.75	55.44	12.16	7.15	19.31

Table 2. Civano 2004 results in source kBtu per square foot (bolded figures are those months averaged to provide the base load of 4.62.



Graph 1. Civano energy use for all homes in the study.

Graph 2 shows average energy use per square foot per month and shows the two peaks of use arising from seasonal energy use for heating and cooling.



Graph 2. Civano energy use as cooling (summer months) and heating (winter months) compared with base use.

ANE, Inc. calculated base loads by following TEP's formula for base calculation: the lowest monthly energy use found during March/April is averaged together with the lowest of the two months October/November; that number is utilized as the base calculation. Table 2 bolds values

for April 2004 and November 2003 as those averaged to provide the base of 4.62. The base is then subtracted out to result in the heating/cooling calculation shown in Table 2.

In fact, base use is very difficult to measure and the method followed here is a good approximation. This procedure will always produce one month with negative numbers—by definition, as shown in both Table 2 and Graph 2 (April, 2004). As an evaluation measure, this procedure assumes little or no heating and cooling for the selected base months of the year, March/April, October/November, whereas it might be that *both* heating and cooling take place. In the latter case, some of the energy attributed to base load would therefore actually be heating and/or cooling energy.

Conclusions: With total heating and cooling under 20 kBtu source energy/sq ft/year, Civano home energy use for 2003-2004 complies with the total energy use prescribed in Table 1. By prescriptive standards in Table 1, heating is higher than expected while cooling is lower. See section 4 below for review of the evaluation methods of the 1998 SES.

As a comparison from previous studies, note that for 2002-2003, Civano homes used an average of 8,919 kWh/year and 100 therms/year whereas Tucson homes for 2001-2002 averaged 11,275 kWh/year and 393 therms/year (the latter data are taken from the Tucson Baseline reported in ANE, Inc. 2002. The Tucson Baseline study of 2002 reported average Tucson home square footage at 1,748-1,789 square feet, ranging between 1,111 and 3,552 square feet).

Contribution of Solar Hot Water Heating to Energy Reduction

An approximate 4.6 kBtu per square foot reduction (per home per year) at Civano results from the use of solar hot water heating. See section 4 for evaluation of the 1998 SES method for calculation of solar hot water.

Economic Costs for Energy at Civano

Total utilities, cost for utilities per year and cost for heating and cooling per year is averaged per home in Table 3. Gas costs were collected from 21 samples and averaged across 38 homes in the sample.

Type	units	cost
electricity	10,302 kWh	$ 921
gas	109 therms	$ 171
total		$1,092

Table 3. Costs associated with energy use for an average Civano home (given as annual costs).

Resource (Water and Coal) use and CO_2 Production Associated with Home Energy Use at Civano

Average resource use associated with energy use at Civano homes is provided in Table 4. Figures given are reflected as units per home per year (all data were averaged across the 38 homes in sample; i.e., gas was not averaged across the 21 gas/electric homes in sample). Water and fuel use, and CO_2 release associated with mining and transportation of fuel were not evaluated; rather numbers reflect associations with energy on utility bills only.

	Water associated with production	Coal associated with production	CO_2 released from use
of electricity	6,696 gallons	10,302 lbs	23,694 lbs
of gas			121 lbs
Total	6,696 gallons	10,302 lbs	23,158 lbs

Table 4. Resource use and CO_2 production from Civano Energy Use.

Section 1 provides multipliers and conversions for figuring water, coal use and CO_2 production associated with energy use. Figures in Table 4 are based on average energy use reported in Table 3.

For 2002-2003, ANE, Inc. found that with approximately 300 homes occupied at Civano, these resource savings across 300 average Civano homes compared to 300 average Tucson homes was as follows. 300 average Civano homes would avoid release of 2,592,300 pounds of CO_2 each year as compared to Tucson 98/99 homes built under the Model Energy Code/IECC.. 300 Civano homes would avoid use of 459,600 gallons of water/year associated with the production and transportation of electrical energy as compared to Tucson homes built under the 1995 Model Energy Code. The coal use associated with electrical energy generation for 300 Civano homes accrues as a savings of 1,038,900 pounds per year of avoided coal relative to 300 Tucson homes. This is coal which therefore does not have to be mined and transported to Tucson from non-local origins at an additional energy/CO_2 and water cost.

Comparison of Energy Use at Civano for 2002-2004

Total Civano energy use reported for years 2002, 2003 and 2004 is compared in Table 5. Total energy use is up with base loads rising (people are using more appliances for more hours) while heating/ cooling energy remains relatively constant. Figures in Table 5 are given as annual source kBtu/sq ft.

Year	Total kBtu/sf	Base KBtu/sf	Heating kBtu/sf	Cooling kBtu/sf	Total Heating and cooling
2002	62	40	9.5	12.5	22
2003	64.	44	7	13	20
2004	75	55	7	12	19

Table 6. Comparison of average Civano home energy use from 2002-2004.

An accurate, current and comprehensive baseline analysis of residential energy use in Tucson homes is critical to identify actual energy use of homes built to the 1995 Model Energy Code/IECC and outside of Civano.

4. Evaluation of the 1998 Sustainable Energy Standard

Energy savings in the 1998 Sustainable Energy Standard can be evaluated, and therefore demonstrated through use of a prescriptive method or through use of comparison to homes built to the 1995 Model Energy Code (MEC). The prescriptive method meets the 1998 SES through reductions stipulated in Table 1. In practice, verification of energy savings using sampling methods can be accomplished through analysis of energy bills. The latter strategy was used here to evaluate Civano homes' 2003-2004 residential energy use. However, this method of verification, along with assumptions and methodologies of the 1998 SES are not without issue.

1) Energy use stipulated by the 1998 SES was predicated on total square footage and was assumed to be inversely proportional to square footage: the larger the house, the less energy per square foot would be required to heat and cool the house. It is possible, however, that larger homes tend to have more people in them. People use energy. In fact, contribution of number of people in the home to heating and cooling energy use was not considered in the formulation of the 1998 SES. The current sample provided sporadic data regarding home occupancy (18 out of 38 surveys specified number of people in the home). As occupancy data become available, they will be incorporated into analysis to determine the contribution of people in the home to the energy use therein. Tables 6 and 7 illustrate the effects of occupancy on home energy use (these facts are intended to be illustrative only). Number of occupants are shown in column 2 with number of samples shown in column 1. Average total energy is given in the third column with the range of the sample in the fourth. The fifth column provides individual samples in rows a-e to be compared in Table 7 with respect to individual energy use.

# Samples	# Occupants per home	Average Total (source kBtu)	Range	See Table 7
3	1	69,381	59,198-79,283	
12	2	106,016	63,003-171,268	Table 7 a,b,c
1	3	124,131	none	
1	4	164,184	none	Table 7d
1	5	225,691	none	Table 7e
18 Samples	Avg: 2.17			

Table 6. Total average source energy use and range of total energy use per home as a function of home occupancy.

	People	Total Energy	Relative Total Energy Use	Total Base Use	Heating and Cooling	Home Square Footage	Heating and cooling per sq ft
a	2	63,003	Low	38,688	24,315	1,227	19.81
b	2	110,097	Mid	73,920	36,177	1,700	21.28
c	2	171,268	High	143,292	27,976	1,834	15.25
d	4	164,184	One sample	132,408	31,776	2,056	15.46
e	5	225,691	One sample	150,324	75,367	1,850	40.74

Table 7. Total, heating and cooling energy use for 5 individual homes.

Tables 6 and 7 demonstrate a broad range of energy use and a range of heating and cooling energy for: the same number of people in a home (rows a-c); a range of heating and cooling use/sq foot of homes with same number of people (rows a-c); relative contribution of people to a home's heating and cooling energy in same size home (compare last column of row c with that of row e). As data become available, the effects of occupancy per square foot on heating and cooling energy use under a sustainable energy standard will become evident.

2) In the 1998 SES (Table 1) heating energy was stipulated to be 4-5 kBtu per square foot per home per year. Data from the last three years at Civano show that heating energy use is substantially higher than initially assumed. Patrick McKnight, in (Tucson) *Baseline Study for Residential Energy Use 1998/1999* noted the pervasive fallacy underlying the common belief that Tucson's cooling burden would be many times greater than its heating burden (as stipulated in Table 1, heating was expected to be about ¼ the energy of cooling):

> "Note that yearly electricity and gas consumption are approximately equal per square footage—a counter-intuitive finding given the common view that Tucson's cooling months far exceed Tucson's heating months." (Baseline Study for Residential Energy Use 1998/1999; Page 3)

Civano homes show a different ratio, with heating accounting for about 1/3 of the heating/cooling burden; still heating is higher than expected in Table 1.

3) Evaluation of energy use by the 1998 SES is, practically speaking, accomplished by review of utility bills. But current utility metering for homes using solar electric energy (by PV electric panels) does not show the actual energy used by the home, rather only accounts for the "net" amount supplied by the electric utility. In other words, all the energy supplied by solar electric PV panels that is offset by utility energy supply is not tabulated in a study utilizing utility bills for evaluation. As PV panels become more prevalent, the problem will be exacerbated. Studies utilizing utility bills will, all else being equal, under-report energy use and as critically, will be incapable of evaluating the contributions of solar to the energy use on a monthly basis.

4) Energy used for hot water is a base load since hot water is a year-round application. Solar hot water collection panels are frequently—but not always—used at Civano. Other energy

reduction methods are used which include heat pump and instant electric or gas water heaters—which also have demonstrated a 50% reduction in energy use. This means that in the summer months, hot water tends to be supplied by heat from the sun and incoming water temperature while in winter the electrical or gas utility contributes more energy to hot water heating. This figure is not separable from the peaks of heating and cooling in winter and summer. The issue is that the 1998 SES formulation requiring 50% reduction in hot water use over the 1995 MEC/IECC cannot be evaluated given the optional use of solar hot water heating at Civano, nor given the inclusion of hot water as a base load. This is because no metric in the utility bill can indicate the use of solar hot water, nor its actual contributions. By use of the prescriptive methods of water heating required by the 1998 SES and the plan review process by Civano LLC, it is assumed that the water heating standard has been met and contributes to the overall reduction of the home operating cost.

The compounding factors identified above indicate a need for reformulation of the SES, and in particular practical, accurate and complete evaluation methods for analysis of residential energy use. Contributions of people and houses can be identified, as can contributions of solar, electric and gas sources of energy. We have the technology and computational power, however, we lack an adequate evaluation strategy. The 2003 IEEC SES, to be available for review in late 2004, should resolve these issues.

Appendix1. History of the SES and Methods of Compliance at Civano

The Community of Civano is a mixed-use 371 acre community (Phase I; the entire project totals 820 acres) incorporating traditional and new-urbanism neighborhoods with resource conservation in home design and construction. The Civano *IMPACT System Memorandum of Understanding on Implementation and Monitoring Process* (June 26, 1998) requires regular assessment of energy and water use at Civano to evaluate the results of Civano's resource use and reductions, and to assess compliance of homes with the Sustainable Energy Standard ("SES"; below).[1]

> The goal of the Memorandum of Understanding is to confirm the strategies for sustainable development and to implement and monitor the Civano IMPACT System…Subsequent monitoring of performance…will provide the basis for determining the success in meeting the IMPACT System Standards as well as the basis for improving future conservation and sustainability strategies and standards (Civano IMPACT MOU, Sections 1-3).

The Civano MOU (Exhibit 2) requires inspection of plans with a certificate of compliance with the Sustainable Energy Standard upon successful plan inspection. These are kept on file at Civano. Additionally, Section 102.1.3 requires verification of proper installation of insulation (thermal barrier) before drywall installation, completion of the "Insulation Installation Warranty" and a signature by a representative of the developer and/or builder.

Before the inception of Civano, Dr. Nader Chalfoun (University of Arizona) and his students performed a limited evaluation of homes constructed in the 60's and suggested that those homes could have been 65% better in energy use with small changes in their construction.[2] Passive solar orientation was assumed in the calculations—a feature which does not uniformly occur for Civano homes. The Civano IMPACT Statement and MOU cite this study; however, at the point of sale prior to Civano construction, the City required a method to evaluate building standards to assure that the energy component of the MOU could be evaluated after build out. The Metropolitan Energy Commission engaged a team to write the energy standards that would become the Sustainable Energy Standard adopted by Civano. At that time, the City had also adopted the national Model Energy Code, which provided a base by which to compare MEC energy with energy savings as were expected to accrue from the Sustainable Energy Standard. The team agreed that the new Model Energy Code had improved buildings by about 15% for heating and cooling energy. Thus, the team concluded that a standard achieving 50% more savings than a home built to the 1995 Model Energy Code would accomplish the original goal of 65%.

The 1998 Sustainable Energy Standard was thereafter adopted to build Civano homes; use of energy bills to calculate energy use is the stipulated method by which evaluation is performed (below).

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[1] See also ANE, Inc.'s 2002, 2003 *Report on Civano and Tucson Residential Energy Use*, and 2002, 2003 *Civano and Tucson Residential Water Use*.

[2] For details of the study, consult Dr. Nader V. Chalfoun of the University of Arizona CAPLA, School of Architecture 1040 North Olive Tucson, Arizona 85721. (520) 621-6751.

At inception, Civano served as the model for Tucson's Sustainable Energy Standard. This initial formulation of the SES prescribed energy use reductions for heating, cooling and hot water by 50% over homes built in conformance with the 1995 Tucson Model Energy Code.

Current methods to satisfy the 1998 SES

Civano homes strive to satisfy the SES through use of the following features in home construction:

Superior wall and ceiling insulation;
Sealed and tested ductwork;
Blower door testing;
High-performance windows;
High-efficiency heating and cooling systems;
Solar technology.

Possible building upgrades (i.e., use of the component method) to satisfy the SES include improvements to the envelope (wall, roof) through increased insulation and superior installation techniques; window upgrades (increased R-value); use of high-efficiency appliances (e.g., high SEER or EER rating, and/or use of Energy Star appliances); and use of solar energy for heating and cooling (passive solar orientation, solar thermal and/or solar electric technologies).

Solar Technology

Additionally, the Civano MOU, Section 1 is committed to use of solar technology:

> The goal of the Civano project is to create a new mixed-use community that attains the highest feasible standards of sustainability, resource conservation and development of Arizona's most abundant energy resource—solar—so that it becomes an international model for sustainable growth. The State of Arizona through the Department of Commerce Energy Office has provided significant financial support for the planning and design of Civano. This funding was explicitly in support of the demonstration of the use of solar energy as a guiding, organizing principle of community development.

How, and to what extent the solar commitment is met, varies by builder. Four current builders offer homes at Civano: Solar Built, TJ Bednar, Doucette, and Pepper Viner. Original Contravest homes use solar daylighting (SolaTube technology) toward meeting the Civano solar commitment and a heat-pump hot water unit is a standard feature of Contravest homes. At this time, the new builders (including builders using the old Contravest models) have committed to using solar hot water heaters on all models. Photovoltaic electrical energy is offered as an option by Civano builders.

Appendix 3. Civano MOU (Excerpts)

5.3 Building Plan Requirements and Review

All plan submittals for building permits shall be determined in accordance with Section 7 to meet the following requirements in addition to all other applicable codes.

5.3.1 All building permit applications shall be certified in accordance with Section 7.0 as complying with the following:

5.3.1.1 Residential building plans shall provide a certification that the plans as submitted provide for a total energy use through the building shell, heating and cooling systems ("building energy use") of at least a 65% reduction for each dwelling from the 1990 Metropolitan Energy Commission annual energy use baseline commencing at the time of initial residential occupancy. The certification shall be in the form attached hereto as Exhibit 2.

5.3.1.2 Non-residential building permits shall provide a certification that the plans as submitted provide for a total energy use through the building shell, heating and cooling systems ("building energy use") of at least a 55% reduction for each structure from the annual energy use by a comparable non-residential structure in 1990 as established by the Metropolitan Energy Commission. The certification shall identify the 1990 level used, the method of determining that level and the source material documenting that level. The energy conservation shall commence at the time of initial occupancy. The certification shall be in the form attached hereto as Exhibit 2.

5.3.1.3 Building plans shall identify the manner in which the proposed structures will be designed to optimize solar orientation for passive heating and cooling purposes, consistent with Civano's goals.

5.3.1.4 Plans shall incorporate some beneficial use of solar energy to reduce the energy demands from heating, cooling and interior water heating. Solar devices such as currently found in A.R.S. § 44-1761 shall qualify as beneficial uses of solar energy will satisfy this requirement.

5.3.1.5 Landscape and hardscape coloration and/or vegetation shall be used to reduce the microclimate temperature adjacent to the structures. The average reflectivity of all major landscape and hardscape surfaces must be 0.5 or greater on the albedo scale or result in equivalent energy savings.

5.3.1.6 Plans shall identify procedures for preserving construction materials for recycling during construction and for the use of recycled construction materials in construction.

EXHIBIT 2

CERTIFICATION

The Community of Civano, LLC has reviewed the plan for _____(address), plan number _____to determine compliance of that plan with the conservation requirements for Civano as set forth herein.

The Community of Civano, LLC certifies it is familiar with and the plans meet the requirements of Memorandum of Understanding between the City of Tucson and the Community of Civano, LLC dated June 9, 1998 as indicated below:

_____ Sec 5.3.1.1 of the Memorandum of Understanding for Residential Buildings or the code requirements of the Sustainable Energy Standard attached to the Memorandum of Understanding.

_____ Sec 5.3.1.2 of the Memorandum of Understanding for Commercial Buildings or the code requirements of the Sustainable Energy Standard attached to the Memorandum of Understanding.

Compliance with section 5.3.1.1 or 5.3.1.2 has been determined by:

___ Prescriptive Method

___Component Method

___Systems Method;

____ Section 5.3.1.3;

____ Section 5.3.1.4;

____ Section 5.3.1.5;

____ Section 5.3.1.6.

Date:
Signature:
On behalf of the
Community of Civano, LLC