Energy Efficiency Potential

San Antonio's Bright Energy Future

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Main Findings and Recommendations

CPS Energy has been making increasing commitments to renewable energy and to efficiency. It is already a leader in wind energy, since it has the largest wind energy capacity of any municipal utility in the United States. In June 2008, CPS Energy announced its intention to double its renewable capacity to 1,200 megawatts (MW) by 2020. This report examines the potential for energy efficiency and renewables to meet projected electricity demand in the CPS Energy service area up to 2020 – a process that would also clear the path for continued progress towards a more fully efficient and renewable system after that date. It also compares the investment cost in efficiency and renewables with the investment in a 40 percent share of the two nuclear units that NRG Energy, Inc. (NRG) is proposing to build at the South Texas Project site near Bay City, Texas.

Main Findings

CPS Energy is at a crossroads. If CPS Energy invests substantially in efficiency and renewables, especially solar electric generation capacity (concentrating solar with heat storage and solar photovoltaics), it will not need new nuclear capacity. If it decides to purchase 40 percent of the proposed NRG nuclear units, its surplus capacity at peak in 2020, attributing zero value to wind capacity, is estimated in this report to be almost 700 MW. Purchasing about 600 MW more of renewables (implied by CPS Energy's commitment to 1,200 MW of renewable capacity by 2020) and making investments in efficiency of several hundred MW would increase this surplus capacity and could double it, (depending on the type of renewables purchased). A doubling of surplus capacity to ~1,400 MW would lead to a reserve margin in the 35 to 40 percent range. This is very undesirable as it would impose significant added costs on ratepayers. If CPS Energy takes steps to firm up its substantial wind capacity, this would further increase surplus capacity. Moreover, investments in efficiency and renewables along with the purchase of nuclear capacity would keep reserve margins consistently well above its requirements. This means that cost penalties would not be transient, but rather persistent.

A course of investing in new nuclear capacity is financially incompatible with the substantial and already-announced CPS Energy commitments to efficiency and new renewable energy. Therefore, CPS Energy is truly at a crossroads – one path leads to more nuclear investment, the other to making efficiency and renewables the center of its program to meet its customers' needs. The latter is far less risky, more flexible, and more economical.

Other Findings

1. With visionary and determined leadership, San Antonio can meet its electricity requirements by relying on energy efficiency and renewable energy between now and 2020 and beyond.
2. The economic potential for efficiency, distributed storage, and combined heat and power in existing and new buildings to the year 2020 in the CPS Energy service area is well over 2,000 megawatts (MW). With strong and committed policies and strong programs,

about 1,000 megawatts can be achieved by 2020. Should the need arise due to faster growth, greater peak demand reduction would also be possible.

3. Relying on efficiency and renewables will lower costs, reduce financial risks, and make San Antonio a more attractive place to do business. It will also help meet air quality goals. It will put in place a flexible infrastructure able to maintain reasonable costs even in the face of a tax on carbon dioxide emissions by increasing the pace of efficiency improvements. The modular approach will be especially beneficial and contribute to reducing risk in the present turbulent national and global financial environment.
4. In the efficiency scenario developed here, which includes deployment of solar electricity generation, the cost of meeting demand growth is estimated to be between $1.4 billion and $3.1 billion less than the nuclear scenario, depending on whether the cost of the new reactors is at the low end of about $12.1 billion or at the high end of about $17.5 billion.

CPS Energy is at a major crossroads. CPS Energy is considering a large investment in a 40 percent share of two nuclear units that NRG is proposing to build at the South Texas Project site, where two nuclear units are already located. That would clearly be a higher cost and more risky option, especially in the present financial environment

Recommendations

CPS Energy and the City of San Antonio should

- Make installing solar electric generating capacity a high priority. Recent statements by CPS Energy indicate that it has decided to do so in regard to concentrating solar power.
- Set an exciting, determined direction that involves the public, business and political leaders, and CPS Energy.
- Build on CPS Energy's leadership in Texas and nationally in wind energy by adding ambitious and achievable goals in efficiency, CHP, and demand response. A goal of about 1,000 MW by 2020 is achievable, economical, prudent, and highly desirable.
- Take the first steps to a smart grid by beginning installing air-conditioning systems that store coldness in ice at peak times to determine whether it could be implemented on a scale large enough to be comparable to traditional peaking or intermediate generation capacity. If it proves successful, it should be expanded, creating an effective distributed storage technology. This distributed storage could also be used to firm up CPS Energy's substantial wind capacity.
- Create financial mechanisms in efficiency to maintain City of San Antonio revenue flow from CPS Energy investments.
- Create a permanent Task Force on Efficiency and Renewables – builders, architects, residents, policymakers, and CPS Energy.
- For renewable technologies, focus on solar technologies in the CPS Energy portfolio for renewable energy and approaches for firming up existing CPS Energy wind energy capacity.
- Move to time-of-use pricing to complement the smart meters that CPS Energy plans to install.

I. Introduction

San Antonio and CPS Energy are on the threshold of a critical decision that will shape San Antonio's electricity future and that could also profoundly influence the economic future of the city. Will San Antonio and CPS Energy make a commitment to energy efficiency that is serious and substantial enough for it to make a major contribution as an added element of CPS Energy's electric system capacity? Or will the effort remain secondary in financial and institutional terms to the acquisition of a 40 percent share of the two nuclear units that NRG Energy, Inc. (NRG) proposes to build at the South Texas Project (STP) site near Bay City, Texas? The proposed new units would total 2,700 megawatts (MW), which would make CPS Energy's share 1,080 MW.[1] CPS Energy owns 1,088 MW of the two currently operating units at the STP.

This study is the second of a series of reports on electricity systems commissioned by Sustainable Energy and Economic Development (SEED) Coalition. The Alamo Group of the Sierra Club also helped fund this report, which examines the economic potential of efficiency in the CPS Energy system, and explores its implications for CPS Energy and San Antonio. Specifically, it focuses on the peak demand reduction potential of efficiency measures. Some consideration is also given to combined heat and power (CHP) systems and demand response measures. Finally, this report briefly compares the investment in the two nuclear units that CPS Energy is considering with the possibilities for investment in efficiency and in renewable electricity sources, notably solar photovoltaics (solar PV) and concentrating solar thermal power plants (CSP).

Estimates of efficiency potential in the CPS Energy service area to 2014 are derived from a study by KEMA Inc. (KEMA) on this subject commissioned by CPS Energy. Estimates beyond that are based on KEMA estimates combined other literature, two studies of efficiency and renewables in Texas published in 2007 by the American Council for an Energy-Efficient Economy.[2]

The author of this report did an interview on March 18, 2008, with CPS Energy's Michael Kotara, Executive Vice-President for Energy Development. Notes of that interview were sent to Mr. Kotara for editing and approval. The final version of the notes, including his edits, is reproduced in Attachment A.

The author also interviewed his Takoma Park, Maryland, landlord, John Urciolo, on July 15, 2008, to gain insights at a field level regarding energy efficiency in rented spaces and the policies and incentives that might be used to promote greater participation in efficiency programs. The notes from that interview are reproduced in Attachment B.

[1] NRG 2007 and CPS Energy 2007-08
[2] KEMA 2004, ACEEE 2007, and ACEEE 2007b

II. Recent CPS Energy Electricity Sector Data

Figure 1 shows CPS Energy electricity sales in megawatt-hours (MWh) in the period from FY 2003 to FY 2008. The data are taken from CPS Energy annual reports cited below Figure 1. Note that all historical CPS Energy data, including data on generation and capacity by fuel type as well as financial data are derived from these reports, unless otherwise stated. The data are for CPS Energy fiscal years; FY 2008 ended on January 31 2008.

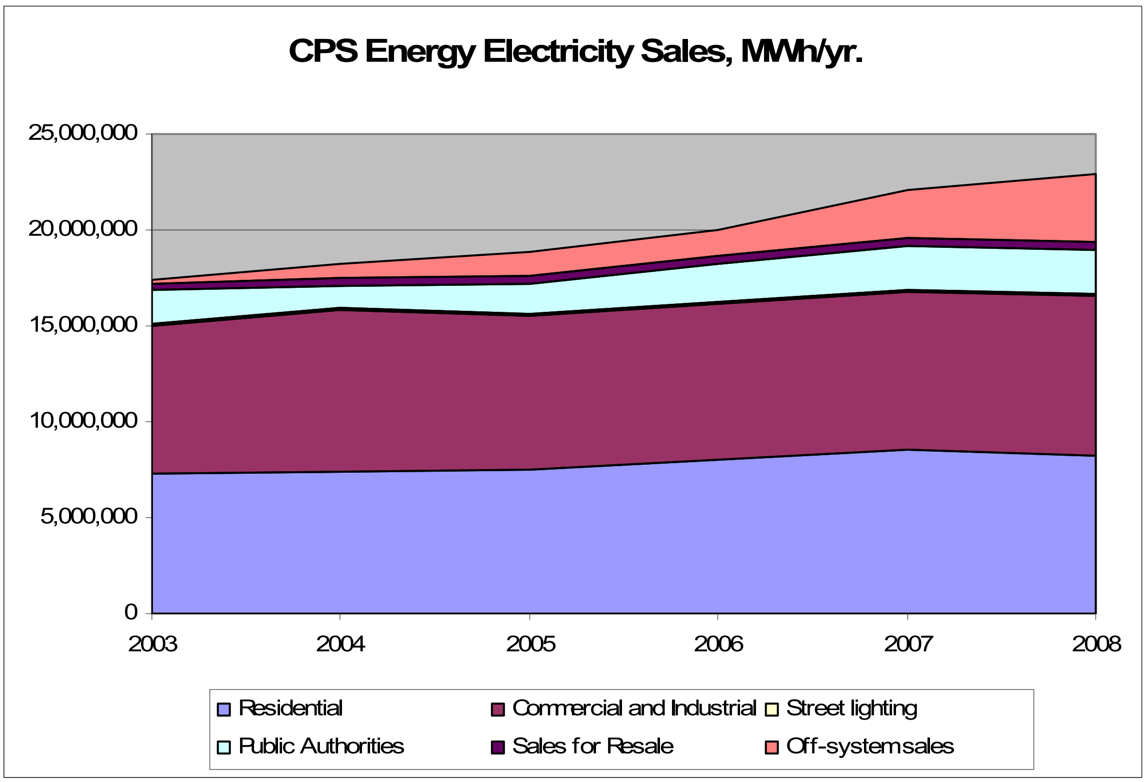

Figure 1: CPS Energy Electricity Sales by Sector, Megawatt-hours per Year (MWh/y), by Fiscal Year

Sources: CPS Energy 2004-05, CPS Energy 2006-07, CPS Energy 2007-08. A detailed table based on these sources is provided in Attachment C.

One of the more interesting features of the electricity sales by CPS Energy is the dramatic increase in off-system sales since 2003, when they were less than one percent of generation to nearly 15 percent of generation in 2008. These sales are not required to serve CPS Energy customers. One company defines off-system sales as follows:

> Sales of electricity from generation owned or contracted by the company that is over and above the amount required to serve retail customers and traditional wholesale contracts.[3]

[3] Pinnacle West 2008

Increases in off-system sales since FY 2003 correspond to over 85 percent of the increases in nuclear electricity generation since that time. CPS Energy's nuclear capacity increased from 700 MW in FY 2005 to 1,025 MW in FY 2006 due to acquisition of another tranche of the two existing units at the South Texas project. Off-system sales increases correspond to more than 80 percent of the increase in nuclear electricity generation of that 2006 acquisition. Growth of electricity sales to San Antonio customers was about 2.3 percent per year between FY 2003 and FY 2008, but total sales grew at 5.6 percent per year. The difference was essentially due to a 20-fold increase in off-system sales.

CPS Energy also purchases energy. While these purchases vary from year to year, they have not tended to increase over time. They were just above 2 million MWh in FY 2003 and FY 2008, but well below 2 million MWh in the intervening years. From fiscal years 2003 to 2005, purchases were greater than off-system sales. In 2006, when CPS Energy purchased additional STP capacity, off-system sales exceeded purchases for the first time since FY 2003. The excess of sales over purchases increased in FY 2007 and again in FY 2008.

Most of CPS Energy's generation comes from coal and nuclear, with almost all the rest being supplied by natural gas and wind. Figure 2 shows CPS Energy electricity generation by fuel.

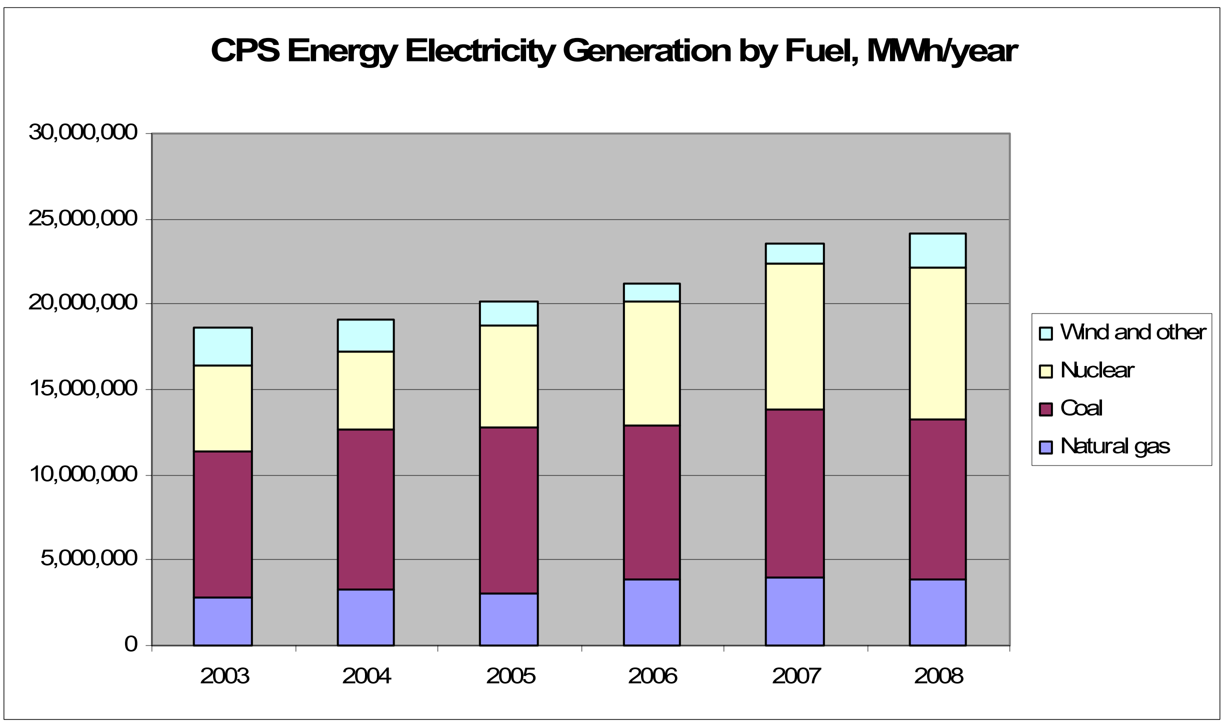

Figure 2: CPS Energy Electricity Generation by Fuel, MWh/yr, by Fiscal Year
Sources: CPS Energy 2004-05, CPS Energy 2006-07, CPS Energy 2007-08. A detailed table based on these sources is provided in Attachment C.

CPS Energy uses its nuclear capacity to the fullest, in terms of capacity factor (over 90 percent recently – maintained partly through off-system sales), followed by coal, the capacity factor of which has been over 70 percent. CPS Energy's natural gas units have run at overall annual capacity factors between 11 and 16 percent (rounded) since 2003 (table C-4, Attachment C).

Finally, CPS Energy generates electricity from wind and small amounts from its 10 MW landfill gas plant. CPS Energy's wind generation capacity was increased to 501 MW in 2008, up from 260 MW in 2007. CPS Energy is scheduled to add another 75 MW of land-based wind located in coastal Texas, where the winds tend to blow during the hot summer days when the CPS Energy system experiences its peak load.[4] CPS Energy is the leader in wind energy capacity among municipal utilities in the United States.[5]

Figure 3 shows CPS Energy's installed generating capacity by fuel. Total CPS Energy capacity stood at nearly 6,000 MW as of the end of its 2008 fiscal year, which occurred in January 2008.[6]

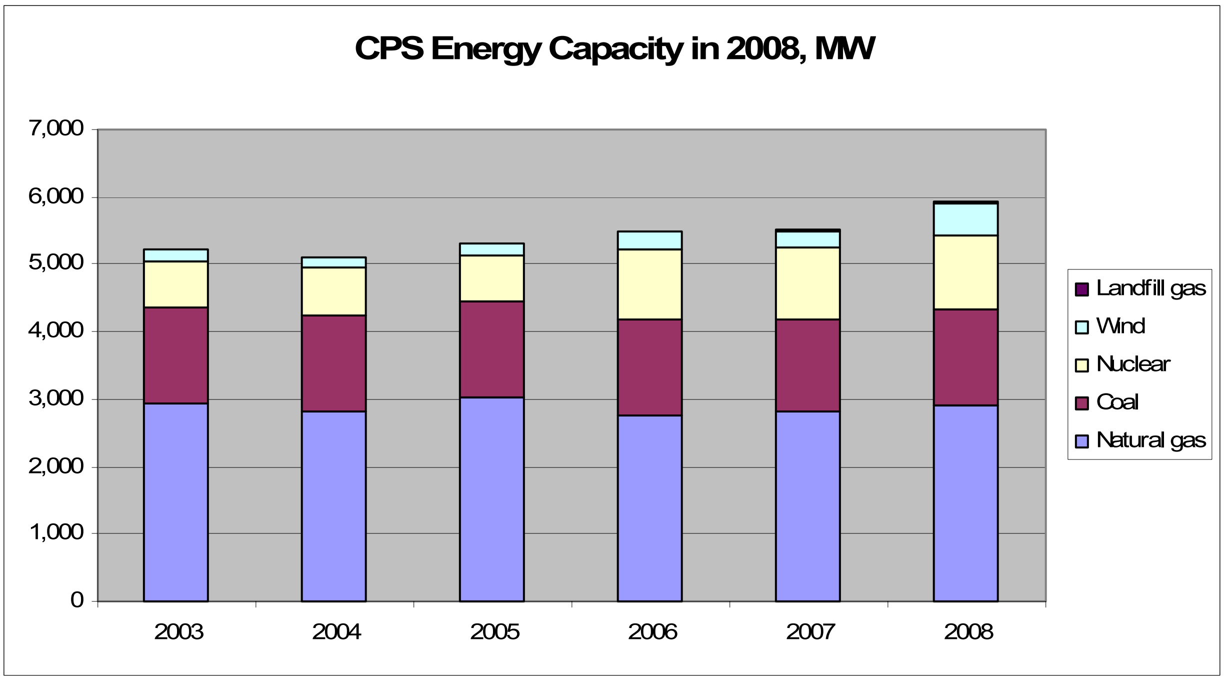

Figure 3: CPS Energy Generating Capacity by Fuel at the end of Fiscal Years since 2003, in MW

Sources: CPS Energy 2004-05, CPS Energy 2006-07, CPS Energy 2007-08. A detailed table based on these sources is provided in Attachment C.

The largest amount of CPS Energy's installed capacity is in natural gas (over 2,900 MW), though, as noted, the utilization of this capacity is limited to peaking and some intermediate load situations. CPS Energy is scheduled to add a 750 MW coal-fired unit, Spruce-2, in 2010. This will make its coal-fired capacity over 2,100 MW. As of 2008, CPS Energy has 1,088 MW of nuclear capacity as its share of the two units now operating at STP.[7]

[4] CPS Energy 2008-03
[5] CPS Energy 2008-06
[6] CPS Energy 2007-08 page 18
[7] CPS Energy 2007-08 page 18; CPS Energy 2008; Zachry 2005

III. The Crossroads

CPS Energy faces a number of pressing issues with major reliability, financial, and environmental implications, but the lack of baseload capacity is not one of them. CPS Energy's baseload capacity, defined as the sum of its nuclear and coal capacity in 2008 was about 2,500 MW. This will grow to 3,250 MW when the 750 MW Spruce 2 coal unit is added in 2010.

This conclusion can be derived from an examination of the pattern of CPS Energy's peak and minimum load days and projections of the patterns of these loads, assuming that they are not changed by demand-side management or by external efficiency measures that are different from historical patterns. The shapes of CPS Energy's load curves were derived from ERCOT data for peak and minimum demand for its entire service region for calendar year 2007, normalized to the CPS Energy peak load for the same year. Mike Kotara in his interview with the author stated that the CPS Energy load shape on the peak day was essentially the same as that of ERCOT and was about 6.5 to 7 percent of ERCOT demand (see Attachment A). The CPS Energy peak load for calendar year 2007 was about 7.1 percent of the ERCOT peak load.

Figure 4 illustrates shows the CPS Energy load on the peak day in calendar year 2007 (which occurred during CPS Energy's Fiscal Year 2008) derived from ERCOT data, normalized to the CPS Energy peak load for that year.[8] The load on the peak day was projected at the 2003-2007 growth rate for peak load of 2.86 percent per year, rather than the much lower 2003-2008 growth rate for peak load of 1.58 percent per year.[9] The 2010 baseload capacity and capacity at peak are also shown. The 501 MW of CPS Energy's wind capacity is entirely excluded from capacity at peak. This zero credit for wind is a conservative assumption, made here to illustrate the issues at hand. A portion of the 75 MW of wind capacity to be added in calendar year 2008 could be counted towards peak potential, however, since the turbines are in a coastal area where winds tend to blow during hot summer days. But no credit is taken for that in the calculations in this report. This assumption is common to both the nuclear scenario and the efficiency and renewables scenario and does not affect the financial comparison.

As an explanatory note, the 2010 capacity is used as a reference for both the New Nuclear and Efficiency scenarios, since CPS Energy has already made firm commitments for the addition new wind capacity (in calendar year 2008) and new coal capacity, currently scheduled for 2010.

[8] The reference ERCOT peak load day was August 13, 2007. The ERCOT data are on the web at http://www.ercot.com/content/gridinfo/load/load_hist/2007_load_by_load_area.xls (ERCOT 2008). The value of CPS Energy's peak load to which these data were normalized was 4,258 MW (CPS Energy 2007-08).

[9] The peak load decline in 2008 may have been weather related. Hence it is appropriate, if rather conservative, to use the 2003-2007 peak load growth rate of 2.86 percent. As discussed below, this can be applied to the peak load for 2007 or to the peak load for 2008.

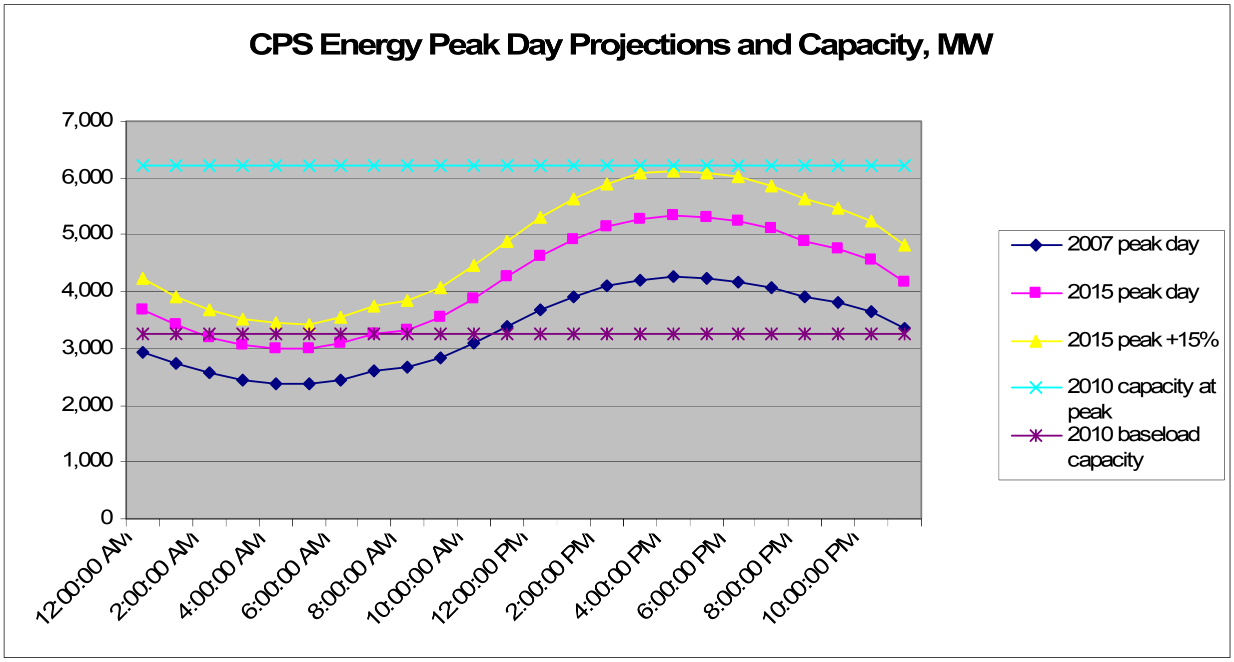

Figure 4: CPS Energy Peak Day Load Projections, Based on ERCOT Data Normalized to the 2007 Calendar Year CPS Energy Peak Load

Since we do not have data from CPS Energy regarding its electricity sales at peak times and since the exact peak time is inferred rather than actual, we have assumed that CPS Energy makes all its sales on the peak day to San Antonio customers. CPS Energy has consistently had about 200 MW or more of capacity available above its peak load plus 15 percent peak margin since 2003. If CPS Energy has made sales during peak times in 2007 or 2008, this would make the projections below even more conservative. Finally, this analysis is on a business-as-usual basis – it does not take into account any increases in efficiency that may be induced by changing energy market conditions and building practices or by factors outside the control of CPS Energy, such as a price on CO_2 emissions.

Figure 4 shows that the CPS Energy system will bump up against its peak load capacity in 2015, when a fifteen percent peak margin is added to the peak load estimate for that year. The ability to meet peak load is extended by one year, to 2016, if the peak margin is reduced to 12.5 percent, which is the minimum required by ERCOT. On the other hand, if the calendar year 2006 (CPS Energy FY 2007) is used as the base for projecting the peak load, the peak load plus 15 percent peak margin equals capacity in the year 2014 (excluding wind capacity, as noted above).

Figure 5 shows projections for the minimum load day for 2015 and 2020, assuming for simplicity that the minimum load day also generally follows the ERCOT load shape. Again, it is clear that the 2010 baseload capacity suffices to supply the main load on the minimum load day.

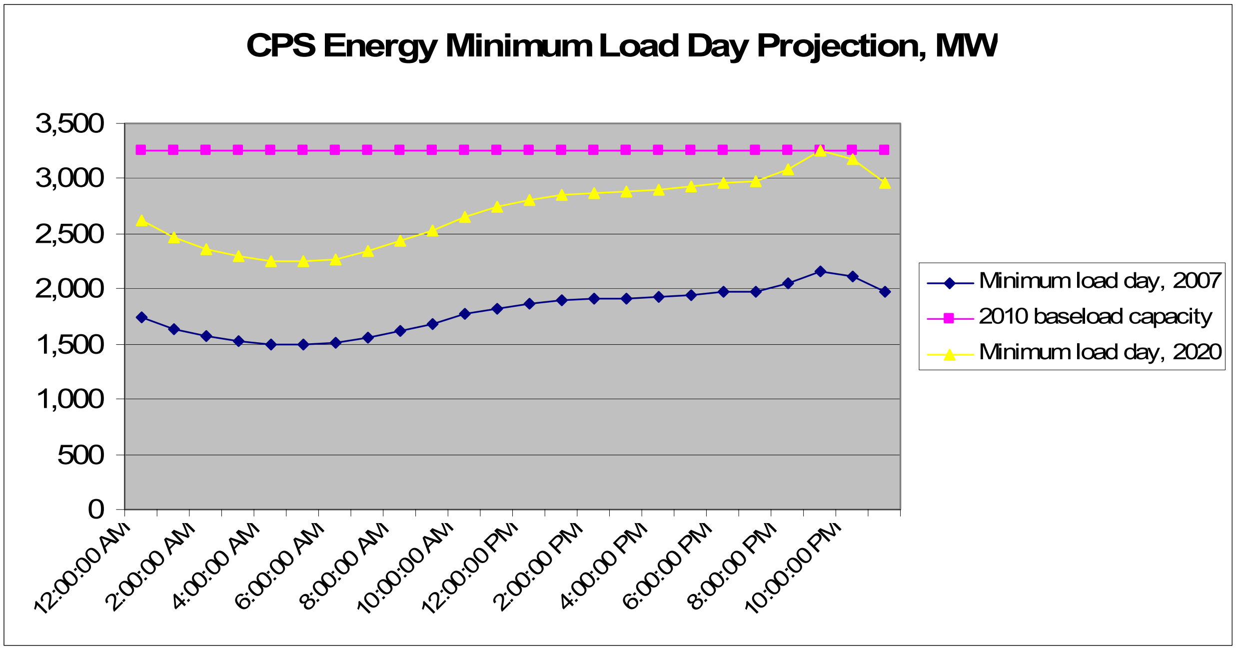

Figure 5: Minimum Load Day Projections, MW. Based on ERCOT load shape.

Overall, we may conclude that CPS Energy faces critical decisions as to how it is going to meet its peak and intermediate load growth rather than its baseload growth in the next decade. Some measures to reduce peak load growth will also reduce intermediate and baseload components, while other measures will affect only the peak load, which occurs on summer afternoons as well as intermediate load during summer nights, weekends and some other times of the year. Installation of additional capital intensive baseload capacity will of course contribute to additional capacity at peak times. But it will also create a significant surplus of baseload capacity at other times of the year and greater pressures for larger off-system sales. This could create significant risks, if there are no markets for the power.

In light of CPS Energy's requirements for new peak load capacity, the primary metric that we will use in this study is the satisfaction of peak and intermediate loads using a combination of efficiency, storage, demand-side measures, and renewables compared to the purchase of a 40 percent share of the two nuclear units proposed by NRG. This 40 percent share would amount to 1,080 MW. In renewables, the emphasis is on solar capacity, since a part of this can be counted against firm peak and intermediate load capacity.

IV. Efficiency and Demand – Preliminary Considerations

The business-as-usual projection that is used as the starting point of this analysis does not take into account any energy efficiency considerations other than those being made in the market place prior to 2008. They would be reflected in the historical growth rate used here. Efficiency measures such as sealing ducts and installing high performance windows, insulation, and high efficiency equipment in the residential sector can substantially reduce the load at peak times as well as intermediate load times. In the commercial sector, the main measures relate to lighting and air-conditioning. To some extent, many of these measures also reduce demand at other times of the year. Other measures, such as high efficiency refrigerators, would reduce baseload, and hence also the load at peak times. Improved residential lighting would reduce load during peak days, but this contributes only a small amount (relative to commercial sector lighting) to peak load reduction at the peak time, which tends to occur on summer days in the late afternoon.[10] There are also efficiency measures such as geothermal heat pumps, which would substantially reduce electricity use in electrically heated homes in the winter, but not contribute to reducing the summer peak load.[11]

While improved building standards and guidelines will contribute to better efficiency overall, the assumption in this report is that the main efficiency measures in the residential sector implemented via CPS Energy would be related to air-conditioning, including better windows, insulation, etc. In the commercial sector, the peak contributions are made both by lighting and air-conditioning, and we assume that the focus of investments will be in these sectors.

Demand-side management measures, such as air-conditioner cycling could also reduce peak load. Demand response achieved through time-of-use pricing and smart meters (which CPS Energy plans to install) would be over and above the reduction in demand achieved through efficiency measures.

There are also demand-shifting measures, some of which may also save energy. Possibly the most important technology that has finally emerged as a commercial technology is storage of coldness in ice combined with central air-conditioning.[12] This approach also serves to create distributed storage. Ice Energy, Inc., makes such a device that can be backfitted into existing commercial air-conditioners. Carrier and Trane currently make central air-conditioners that have an extra heat exchanger that can be directly connected to the Ice Energy machine, while Lennox and York will soon market such devices. We understand CPS Energy has recently begun discussions with Ice Energy about possibly using this technology in the San Antonio service area.[13] This approach is discussed in a separate section.

Other measures to implement a smart grid could also contribute to demand response. For instance, with a smart grid, the timing of use of some appliances such as clothes washers can be controlled automatically to coincide with low demand periods. As another example, a concept similar to Ice Energy's is being developed in The Netherlands, as the Night Wind Project, to make wind energy available at peak times. In this approach, the cold storage temperature is reduced when wind-generated electricity is available, and the temperature is allowed to rise to the normal cold storage level during peak hours by turning off the freezer. A laptop and special software connect the cold storage with the utility. This device reduces cost and saves energy,

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[10] As noted, CPS Energy load shape observations are based on ERCOT load shape. See Attachment A.
[11] Geothermal heat pumps would reduce air-conditioning load as well, but that load reduction is assumed to occur in the KEMA analysis via higher efficiency air-conditioners.
[12] The data for air-conditioners combined with ice-making were provided by Ice Energy, Inc., both in a PowerPoint presentation (Ice Energy 2008) and by personal communication in a conference call on September 21, 2008. The notes from that call were verified by e-mail correspondence with David Prezioso, VP, Strategic Business Development and Ram Narayanamurthy, Director of Innovation (Prezioso and Narayanamurthy 2008).
[13] Prezioso and Narayanamurthy 2008

since it takes far less electricity to lower the temperature at night than in the day time.[14] It also lowers demand charges significantly, reducing electricity bills.

V. Efficiency – The KEMA Study

The 2004 KEMA study commissioned by CPS Energy made detailed estimates of the technical potential and costs of individual efficiency measures in existing and new residential and commercial structures as well as in industry. Since the industrial sector electricity use and efficiency potential was judged to be rather small in the KEMA study,[15] it is not addressed in this report, which deals with overall considerations of investment strategy at the crossroads at which CPS Energy and San Antonio find themselves.

The KEMA study made estimates of efficiency potential in terms of reduction in electricity use and reduction in demand. It provided estimates of costs of installation of the equipment associated with individual efficiency measures, such as improved lighting fixtures, high efficiency appliances and air-conditioners, in residential and commercial structures. KEMA's levelized costs did not include CPS Energy's program costs, such as rebates provided to consumers, or CPS Energy's costs to administer the program. This analysis includes program costs and uses an inflation rate of 3 percent (the same as the KEMA study).

The KEMA analysis did not consider combined heat and power systems or demand-side management and demand-side response. Renewable energy, except for solar thermal water heaters, was also outside the scope of the study. Finally, the avoided cost of capacity considered in the KEMA study was for a gas turbine power plant. While the focus of the KEMA evaluation regarding demand was on peak load, many of the measures evaluated, such as efficient refrigerators, reduce baseload and bring down the load at the peak time as well. Components of other measures, such as efficient water heaters and lighting, also apply to baseload reduction. In other words, an avoided cost comparison would need to take into account the avoided peak load, but also a portion of the avoided baseload and intermediate load.

Figure 6 shows the electricity use and demand in the CPS Energy service area residential sector, as estimated in the KEMA study. The estimates are for 2004 and were based on data provided by CPS Energy, Texas residential sector data, and national data on end-use characteristics.

[14] For information about the Night Wind Project see http://tno-refrigeration.com/pageID_4054349.html.
[15] Industrial peak demand was estimated at 179 MW (KEMA 2004 page A-7), or less than five percent of the total.

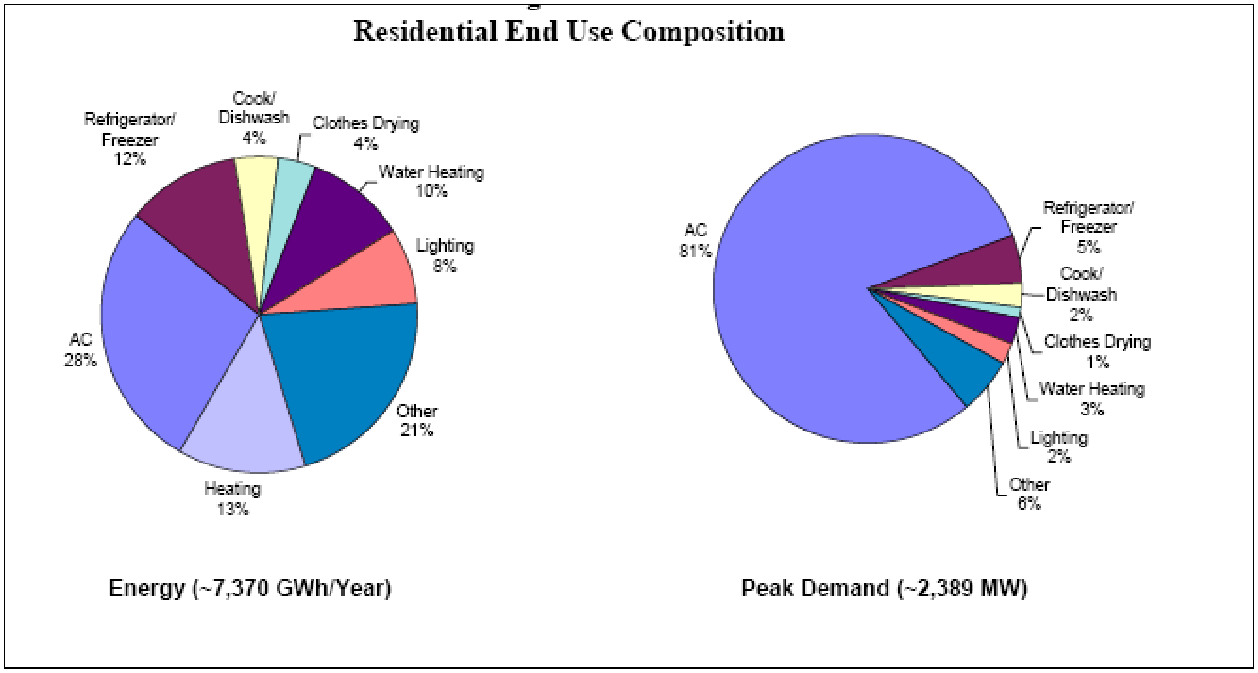

Figure 6: Estimates of Residential Electricity Use and Demand at the Peak Time for 2004
Source: KEMA 2004 Figure A-1 (page A-3)

The peak load share of the residential sector was estimated at about 58 percent of the total CPS Energy peak load, while the electricity use share was considerably smaller, at about 43 percent of sales in the CPS Energy service area. In other words, there would be a greater payoff in reducing peak load from measures related to air-conditioning; there would also be significant energy savings (and hence fuel cost savings for the utility). The peak demand per residential customer works out to about 4.5 kW, on average.[16] This is rather large. It is evidently driven mainly by air-conditioning. As can be seen from Figure 6, air-conditioning represents only about 28 percent of annual residential electricity use, but it represents 81 percent of the peak load at about the time of CPS Energy peak load. The KEMA electricity and peak demand savings potential reflect this.

Figure 7 shows the KEMA estimate of residential demand and electricity savings potential for 2014, with 92 percent of the estimated economic savings coming for air-conditioning related items.

[16] The number of residential customers in 2004 (about 536,000) was estimated from data in CPS Energy 2004-05.

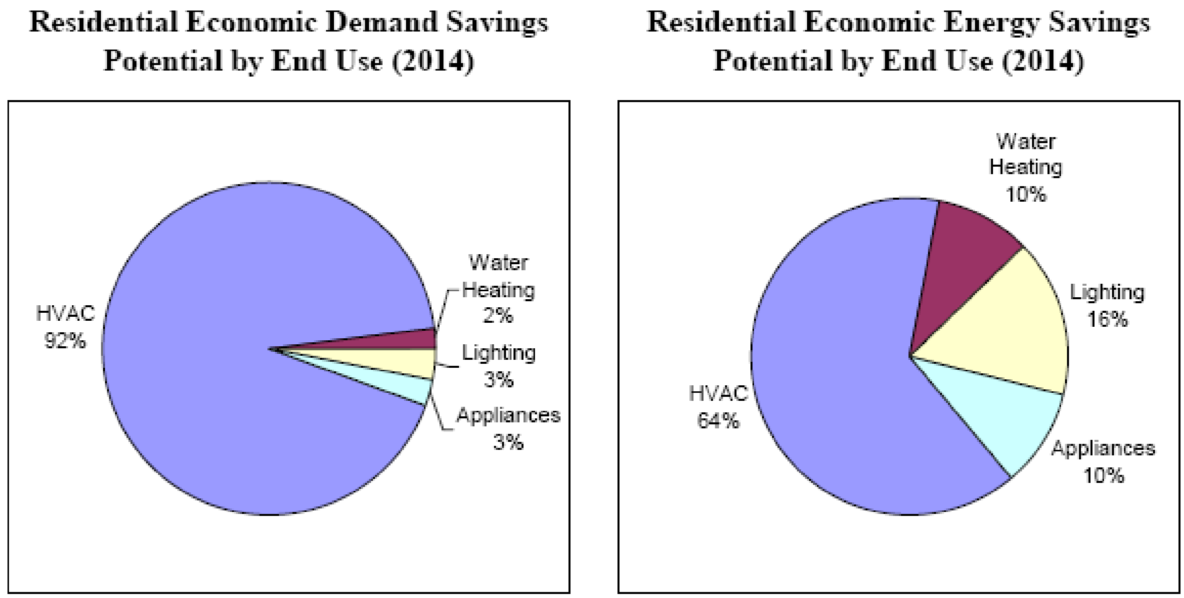

Figure 7: KEMA Estimates of Demand and Electricity Savings for 2004
Source: KEMA 2004 page 3-4

The KEMA study estimated the economic residential peak demand savings of 953 MW by the year 2014, almost all of it in existing housing. This amounts to about 1.8 kW per home. It represents about 30 percent of the total residential peak demand. The increase in the number of residential customers by about 10 percent from 2004 to 2007 would increase the potential to about 1,050 MW. We note in this context that CPS Energy's efficiency programs were still in their very early stages in this period, so that growth in this period was more along business-as-usual lines. We can therefore approximately shift the KEMA study results to the 2007 to 2017 time frame used in this study.

The main residential demand reduction technologies are as follows:

- High performance windows in homes with central or room air-conditioning
- Window film on homes with central and room air-conditioners
- Testing and repair of heating and ventilation systems with central and room air-conditioners as well as diagnostics and repair of duct systems
- Attic venting in homes with central and room air-conditioners
- Increasing ceiling and wall insulation
- Whole house fans in homes with central and room air-conditioners
- Ceiling fans
- High efficiency central air-conditioners (with a Seasonal Energy Efficiency Ratio of 16 compared to a base case of 13) and high efficiency ("Energy Star") room air-conditioners.
- High efficiency ("Energy Star") refrigerators

As noted above, increasing the efficiency of residential lighting produces significant and economical energy savings; however, its peak load reduction impact in the CPS Energy service area is modest since the peak load occurs on summer afternoons, during daylight. Other measures, such as heat pump water heaters and solar water heaters also produce peak demand savings. However, the KEMA estimate of the potential of solar water heaters in the overall scheme of demand reduction is less than one percent of the technical potential. The March 2007 study of Texas efficiency and renewable energy potential by ACEEE estimates that the potential for demand reduction due to solar water heaters at over ten percent.[17]

A Florida study with measurements done in low-cost housing backfitted with a solar water heater indicates that the potential may be larger than that estimated by KEMA and closer to that estimated by ACEEE. Figure 8 shows the before and after daily demand pattern for this solar water heater. The load profile was averaged over a long period – 1996 to 1998.

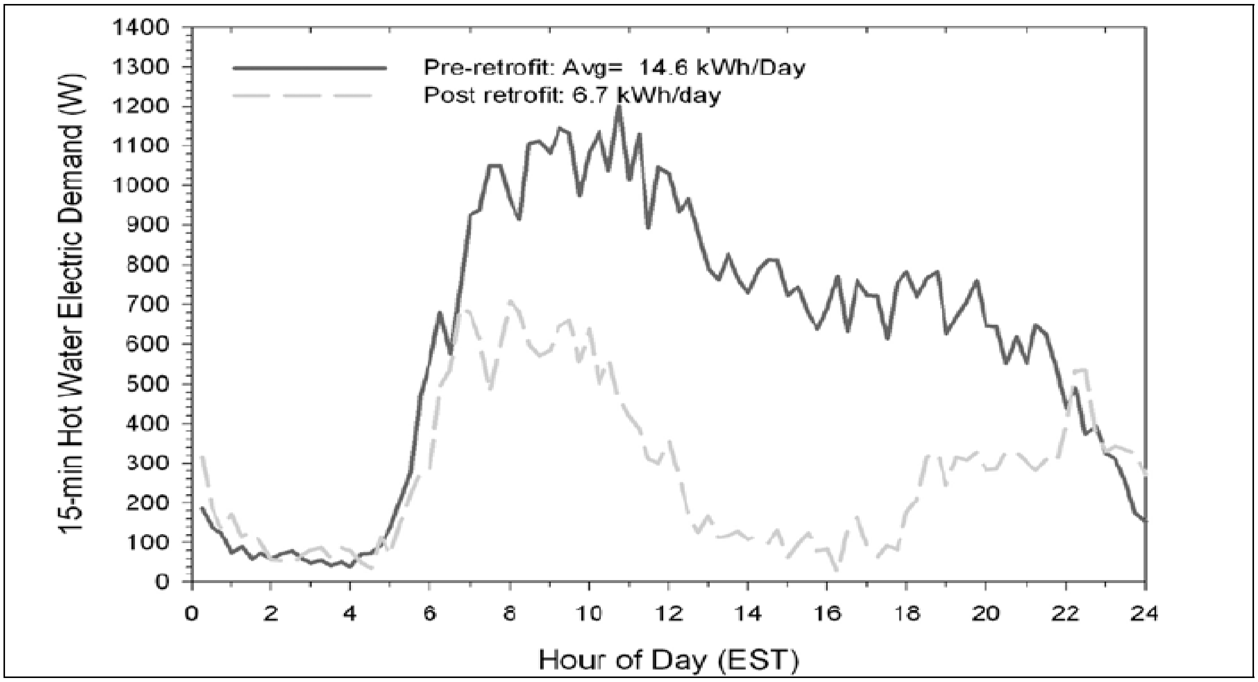

Figure 8: Measured Hot Water Heater Electricity Demand in a Florida Low-Income Residence, before and after Installation of a Solar Water Heater
Source: Reproduced from Makhijani 2007 page 82. Original source: Parker, Sherwin, and Floyd 1998.

Note that the reduction in demand at the time of system peak in the late afternoon is on the order of half-a-kilowatt. The annual electricity savings are substantial. The simple payback time in this case was 10.2 years at an electricity rate of 8 cents per kWh (which is similar to the residential rate in San Antonio).

So long as the peak load is in the afternoon, solar water heaters may enable a significant demand savings. These measured data were averaged from 1996 to 1998; the impact at peak on summer days cannot be derived from them. But they do indicate a need for a site specific evaluation of the potential of solar water heaters for demand reduction in San Antonio.

[17] ACEEE 2007 Table 5 (page 33)

A corresponding set of calculations can be done for the commercial sector. Figure 9 shows the commercial end use estimates for 2004 made by KEMA.

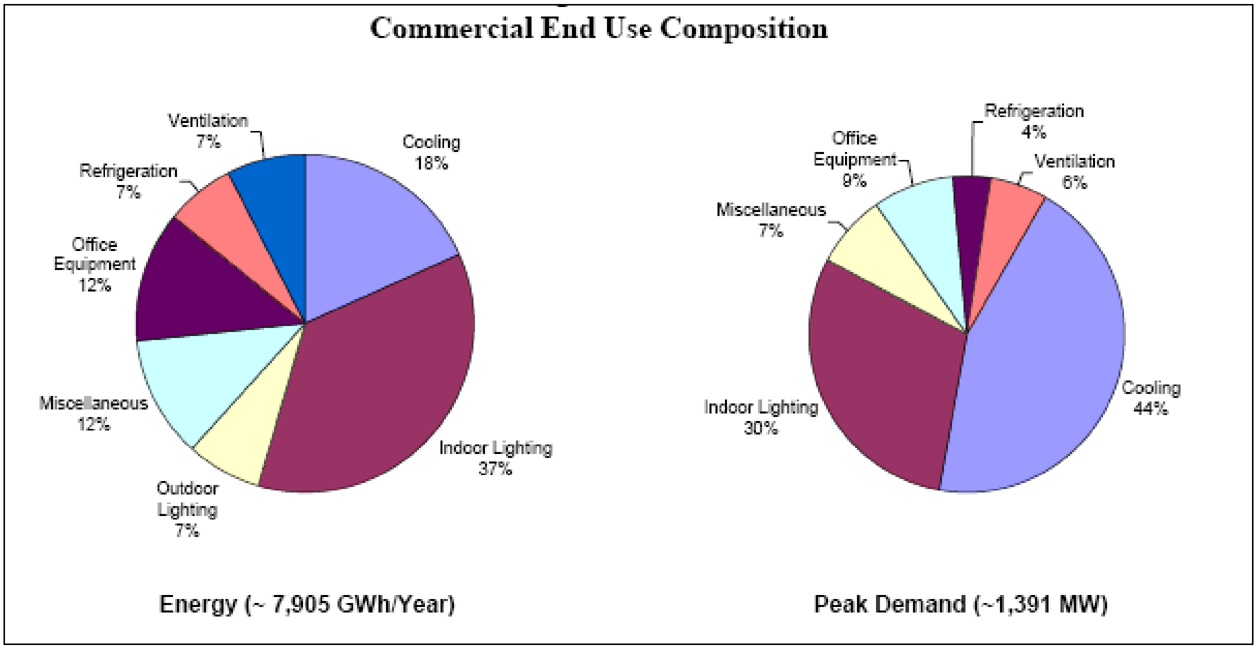

Figure 9: KEMA Estimates of Commercial Electricity Use and Peak Demand for 2004
Source: KEMA 2004 Figure A-2 (page A-6)

The KEMA study estimates the economical commercial peak demand savings potential in 2014 as 249 MW, achieved primarily through lighting measures and secondly through air-conditioning efficiency improvements. Figure 10 shows the results of the KEMA analysis. It is more difficult to extrapolate the commercial demand savings potential to 2007 since we do not have a breakdown of the number and types of commercial customers.[18] Commercial electricity use grew at about 1.7 percent per year in the 2003-2007 period. An assumption of an increase in peak demand savings potential of about 5 percent (1.7 percent per year over three years) is reasonable. This gives a total economic savings potential extrapolated to 2017 of about 260 MW (rounded).

[18] We have inferred the number of commercial and industrial customers by calculating the number of residential customers from data in CPS Energy 2007. However, the available data do not allow disaggregation of commercial from industrial customers.

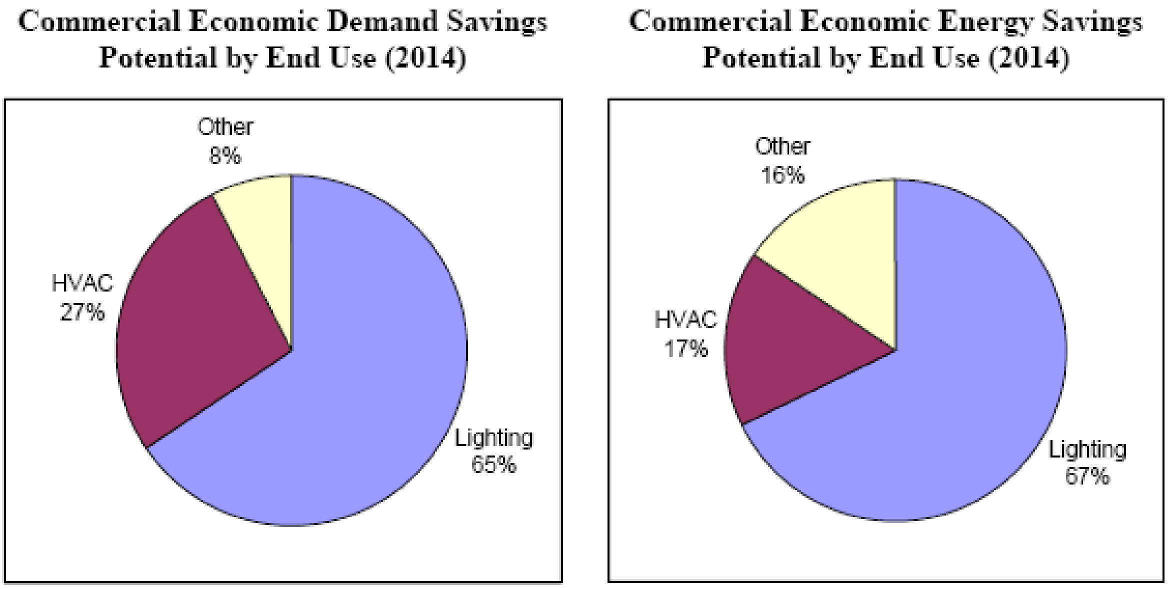

Figure 10: KEMA Estimates of Economical Commercial Sector Peak Demand and Electricity Use Savings for 2014
Source: KEMA 2004 (page 3-5)

The main technologies for peak demand reductions in the commercial sector, as estimated by KEMA are as follows:

- A variety of lighting improvements, such as compact fluorescent lamps, high efficiency luminaires, occupancy sensors that operate lighting, continuous dimming fluorescent fixtures, and halogen and metal halide lighting
- Building improvements, such as window film and improvement building energy management
- A variety of cooling system improvements, such as efficient chillers, motors, programmable thermostats, and compressors.

The combined economic savings potential of the residential and commercial sectors up to the year 2017 would be about 1,300 MW (rounded). The annual average increment economically possible is about 130 MW. Extrapolating on this basis yields a total potential of about 1,700 MW (rounded) by 2020. This would include new residential and commercial buildings. But it does not include technologies, such as combined heat and power or drastic reduction of peak demand via coldness storage in ice.

Note that since prices of power plants have increased faster than inflation, while residential real estate values have stagnated or fallen for the past two years nationally, the KEMA study estimates of economical savings potential may be underestimates. However, this cannot be determined with confidence without a detailed study specific to San Antonio. Any adjustment in demand savings due to differential changes in cost since 2004 have not been taken into account in this study.

The KEMA study used an avoided peaking capacity cost of $400 per kW for single stage gas turbines (the figure was provided by CPS Energy).[19] This cost would be inappropriate today. The rapidly changing cost picture, especially as regards differential cost of efficiency measures relative to peaking avoided cost made it desirable to use more recent cost estimates for efficiency. Hence, while we have used the KEMA efficiency measures as a starting point for the evaluation of efficiency measures, we have used a more recent Texas study (see Section VIII below) for cost estimates.

VI. Coldness Storage for Air-Conditioning and/or Wind Energy

One important new technology provides a controllable demand response measure that in some ways serves as a dispatchable power plant at times of peak load. The equipment on the demand-side is an ice-making machine combined with an air-conditioner and associated control equipment. This section is based on information from Ice Energy, unless otherwise noted.[20]

The basic machine now available can be backfitted onto to existing commercial compression air-conditioning systems. On average, the device shifts a 6 kW load from peak load time on a hot day with maximum temperature of 105° F, as is typical of the hottest days in San Antonio to an off-peak period. The unit costs $8,500 plus average installation costs of $3,000 to $4,000. Installation costs are a lot lower (up to 75 percent lower) if new machines have the second heat exchanger that is needed to integrate the ice unit with the air-conditioning system. In the context of a smart grid, it could also shift the load from the peak period to periods when the wind is blowing. This may be necessary in the context of using the technology to minimize CO_2 emissions, since off peak load in the case of CPS Energy would be natural gas or coal-fired capacity.

For large day-night temperature differences, the unit also saves between 3 and 15 percent in electricity use. At moderate night-day temperature differences, a kWh stored at night is recovered during the day. In other words, the modest efficiency improvement in performing the cooling at night is approximately equal to the amount of energy needed to operate the pump associated with the device at peak. In addition, transmission and distribution losses are avoided. The 15 percent of capacity needed as reserve at peak time is also saved. The approach not only serves to shift demand from peak to off-peak, but serves as a form of distributed energy storage.

The company is focusing on utility scale installations and aims to make the units in the markets where large capacity demand for the product (~100 MW or more) exists. The installation costs, as well as much of the manufacturing expenditures, would therefore remain in the area and create local jobs, much in the manner of many other efficiency improvements.

[19] KEMA 2005 page A-8
[20] Ice Energy 2008 and Prezioso and Narayanamurthy 2008

Ice Energy is only making a machine suitable for commercial applications (and very large homes), but the machine can be adapted for residential central air-conditioning applications, should sufficient demand exist.

Based on the analysis in KEMA, projected to 2007, we estimated that the commercial peak A/C load was about 650 MW in that year and the residential A/C peak load was about 2,100 MW (both rounded to the nearest 50 MW). The combined total of these loads under a business-as-usual approach would grow from ~2,800 MW to ~3,800 MW by 2020 (rounded, assuming no new efficiency or demand reduction measures). Well over 90 percent of the total by 2020 would either be residential central A/C (single and multi-family residential structures)[21] and commercial A/C. The amount technically available for displacement by ice-making devices, would of course be reduced by efficiency measures, such as improved lighting in the commercial sector and improved insulation and windows in the residential sector. But the technical potential would still be very large, possibly on the order of 2,000 MW after implementation of efficiency measures. Only ten percent of this has been assumed to be implemented in the efficiency scenario, focusing mainly on the commercial sector for which the current units are designed.

CPS Energy has substantial installed wind energy capacity (576 MW, of which only 75 MW is coastal capacity, indicating that the availability of most of it at peak times is uncertain). Air-conditioning with ice storage can be used as energy storage for wind. Since CPS Energy plans to install smart meters, this may become feasible system-wide. In effect, the combination of wind and distributed energy storage in ice could be the wind energy equivalent of concentrating solar thermal power with molten salt or other forms of heat storage.

Other demand-side measures, such as air-conditioner cycling, consumer behavior change due to adoption of smart meters, time-of-use rates, interruptible demand (also called "Load Acting as a Resource"), etc., also provide opportunities for reducing peak and intermediate loads in the summer. ACEEE estimates the demand response potential to be 13 percent of the peak demand of ~105,000 MW in the year 2023. This indicates a potential of roughly 8,000 MW up to the year 2020. This would correspond to a potential of ~560 MW for the CPS Energy system, or about 45 MW per year. However, the potential for demand response load reduction would be lower if substantial efficiency measures by 2020 are implemented throughout the system. Further ice-air-conditioning systems are also in the nature of demand response devices and can be integrated into time-of-use rates and utility systems with smart-meters. In the scenario developed in this report, the only demand-response measure taken into account on a significant scale is that of distributed ice-storage.

VII. Combined Heat and Power

Texas is the leader in combined heat and power (CHP) in the United States. This technology generally uses waste heat from a reciprocating or gas engine for heating and absorption air-

[21] The KEMA study indicates about 90 percent of the residential peak A/C demand as attributable to central A/C units. KEMA 2005, p. A-2.

conditioning.[22] CHP systems not only use energy much more efficiently than the electricity production, electric compressor-driven air-conditioning, and space heating done separately, they also reduce summer peak demand in systems with summer peaking and winter peak demand in systems with winter peaking.

The KEMA study did not make an estimate of CHP potential in the CPS Energy service area. The March 2007 ACEEE study points out that the very large amount of electricity generated in CHP facilities in Texas is primarily from the industrial and electric power sectors.[23] Very little of it is produced in commercial sector buildings or in large residential apartment buildings, both of which have significant potential for application of CHP systems. The recommendation of the report for a Texas-wide CHP target was as follows:

> Because of the benefits from expanded CHP, we recommend that Texas set a target for additions to CHP capacity, much as the state has done for energy efficiency and renewable energy resources. Therefore we propose that the state establish a target of 250 MW per year of new CHP capacity for the next 15 years. This policy would reduce the state's system peak by a corresponding amount and reduce the need for grid-supplied electricity by almost 2 billion kWh each year.[24]

Since CPS Energy is about 6.5 to 7 percent of the ERCOT demand at peak, a commensurate goal for its service area would be 15 to 17 MW per year. However, industrial demand in the CPS Energy service area is low. An approximate target of 10 MW per year between 2011 and 2020 is suggested here for preliminary planning purposes, pending a site-specific evaluation in the CPS Energy service area.

Adding the CHP recommendation to the efficiency potential, yields a total demand reduction potential of 1,800 MW.

The ACEEE reports estimated the cumulative cost of 1,900 MW of new CHP capacity in Texas, including program and administrative costs at about \$3.2 billion, or about \$1.7 million per MW (2006 dollars), which gives a figure of \$1.75 million per MW in 2007 dollars, assuming 3 percent inflation. ACEEE estimates that there is an almost one-to-one reduction in peak load corresponding to installed CHP capacity,[25] which includes absorption air-conditioning.

VIII. The Texas-wide ACEEE Estimate

The overall graph ACEEE analysis for Texas peak demand is reproduced in Figure 11.

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[22] CHP plants with fuels cells are also coming into use, for instance, at the 292,000 square foot Verizon office building in Garden City, NY (Verizon 2008 and CNET 2006).
[23] ACEEE 2007 page 17
[24] ACEEE 2007 page 30
[25] ACEEE 2007 pages 17-18

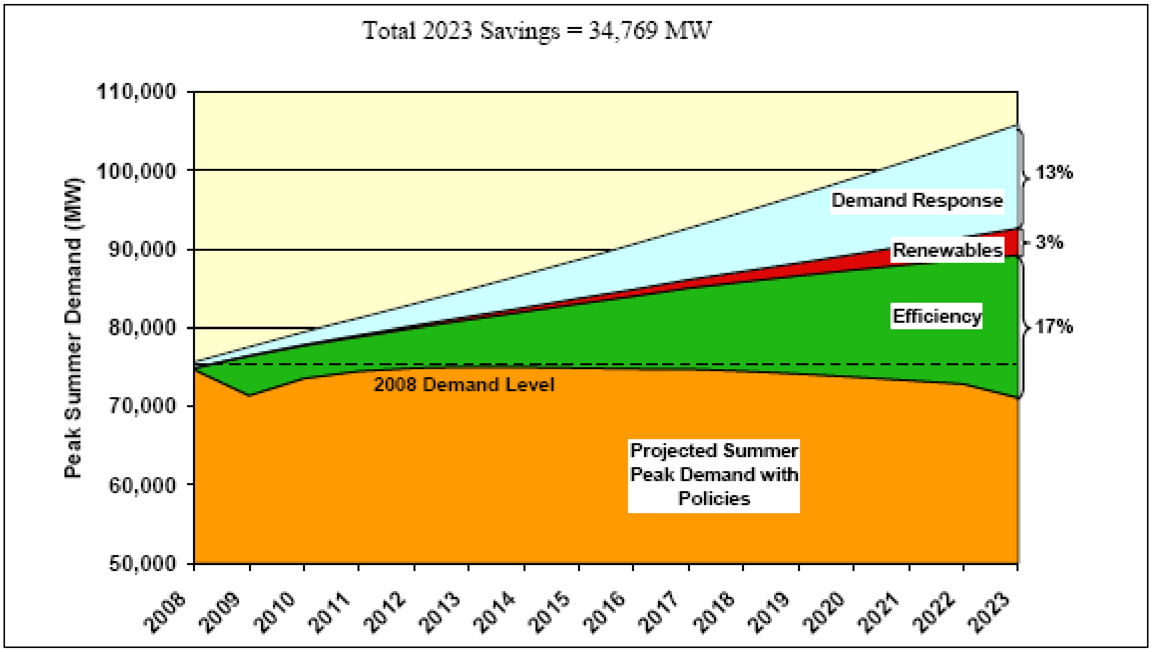

Figure 11: Overall Impact of Efficiency, Demand Response, and Renewable Measures Recommended by ACEEE for Texas
Source: Reproduced from ACEEE 2007 page 22, with permission

Excluding the renewable energy portion of 3 percent, a total demand reduction of about 31,000 MW was projected to be achieved over 15 years, for an annual average reduction of about 2,100 MW per year (rounded). An indicative estimate for the CPS Energy service area can be derived by noting that the CPS peak load is about 7 percent of the ERCOT load. By this measure, the ACEEE study indicates an achievable economic demand reduction of about 150 MW per year. Of this, ~100 MW would be efficiency measures, while the rest would be demand response. This is lower than the 170 MW per year estimated from the KEMA report above because the latter is economic potential rather than achievable potential. The ACEEE figures are much higher than the achievable potential estimated in the KEMA report because the former are based on policies that go far beyond voluntary adoption and rebates (see below).

The overall cumulative cost of all components of the program recommended by ACEEE (efficiency, renewables, demand response) was $48.5 billion over 15 years, including customer investments and program and administrative costs.[26] This averages out to about $1,400 per kW. The efficiency components alone work out to $1,476 per kW. The ACEEE study was done using 2006 costs; hence this 2006 value was escalated by 3 percent to arrive at the value of $1,520 per kW in 2007 dollars used in the calculations in this report.

[26] ACEEE 2007 Table 6 (page 34)

IX. Putting It Together

Since the basic issue confronting CPS Energy for the next decade is peak and intermediate demand, the metric adopted here for analysis is the cost of efficiency, demand-side measures, and renewable energy sources that would address the need for capacity at that time. Wind energy is conservatively assumed not to contribute to reliable capacity at peak. Of course as noted, wind energy can be firmed up using coldness storage, but that explicit connection is not assumed for CPS Energy by 2020 in this report.

We have created two scenarios, extending out to the year 2020:

1. The New Nuclear Scenario
2. The Efficiency Scenario (which also includes solar PV and concentrating solar thermal capacity additions).

In order to keep the scenarios comparable, we have kept the overall supply curves as close as is practicable, within the constraint that any practical efficiency and distributed storage program must be implemented in a modular way, with capacity being built up smoothly over time. In contrast, the addition of the new nuclear capacity of 1,080 MW in the new nuclear scenario is by its nature lumpy. Half of it is assumed to come on line in 2016 and the other half in 2017 (since the capacity would come from two units). Since no efficiency or demand-side response measures would be needed in the new nuclear case to meet capacity requirements to 2020, none are assumed (see Section X for further discussion). To factor in additional efficiency measures in the new nuclear scenario would simply increase the cost of both cases (given the constraint of comparable cumulative surplus capacity).

In sum, the assumption that there are no added costs for efficiency and demand-side measures in the new nuclear scenario provides a reasonable comparison, since no added capacity is needed on the nuclear side up to 2020 and somewhat beyond.

Efficiency and demand-side measures have generally not been implemented on a large enough scale to be major elements of an overall electricity services supply strategy. In other words, efficiency has not been pursued on a scale and with the technical thoroughness needed to make it comparable to large-scale generation units. This is because systems that use combinations of rebates, incentives, and voluntary adoption typically have low penetration compared to the economic potential. Further, such a system of rebates and incentives represents a net cost to the utility and the costs can increase rates (though typically very slightly). The expenses are not worked into the rate base as investments. There are no revenues to CPS Energy – and hence also no revenue to the City of San Antonio, although there are remedies that could be implemented. CPS Energy appears to be headed in a direction that could result in a large-scale implementation of efficiency. This needs to be done in a manner that would make it technically and financially comparable to new generation capacity. The policies needed are discussed in the Section XI.

The difficulty in improving the efficiency of existing homes is generally considerably greater than that of new homes, for which improved building codes can be put into effect. A similar approach that encourages (and eventually requires) efficiency increases and demand-reduction improvements in existing homes within a few months on either side of a sale could gradually but substantially improve the housing stock. In 2007, about 4.7 percent of existing homes were sold, despite the fact that the market slowed down considerably from the year before. Assuming a 4 percent turn-over rate, about 250,000 homes would be sold in the CPS Energy service area cumulatively to the year 2020. In addition, over 100,000 new homes would be expected to be built (assuming that housing can be projected from historical data).

In estimating the actual implementation of efficiency in a manner that would be compatible with including efficiency in the rate base, we assume that residential efficiency measures would largely be realized by energy audits and financing of improvements at the time of sale and by working with landlords of rental units (see Attachment B for an interview as to incentives for landlords).

The fraction of the total economic potential of 1,700 MW captured by 2020 will depend on the policies adopted and the vigor with which efficiency measures are pursued. The current approach of rebates and voluntary adoption will be highly unlikely to capture a significant fraction of the potential. The City of San Antonio could authorize CPS Energy to issue efficiency bonds. Investments in efficiency can then be included in the capital base, and recovered either through electricity bills or a part of mortgage payments (if the cost of the improvements becomes part of the sale price of the home). The goal should be for the payments for efficiency measures and electricity to remain about equal to or less than the electricity bill without efficiency improvements. Other suitable financial arrangements could also be devised. *The main goal would be to make efficiency investments financially on a par with investments in generation both for CPS Energy and for the City of San Antonio.*

The efficiency scenario assumes that only about 35 percent of the efficiency potential of 1,700 MW would be achieved by 2020. Distributed storage of energy in ice for reducing peak demand and CHP installations would be in addition to that.

A reduction of load at the time of peak would also result in a correspondingly lower requirement for reserve margin. This increases the demand savings by 15 percent for the efficiency and distributed ice storage measures. We have not included a reduction in peak margin requirements due to CHP but used a one to one peak demand reduction between CHP installed capacity and peak load reduction. The characteristics of CHP in relation to peak load need to be established for San Antonio to verify this assumption. The overall conclusion as to cost does not depend significantly on it. The partition of demand reduction between efficiency, distributed ice storage, and CHP are shown in Figure 12.

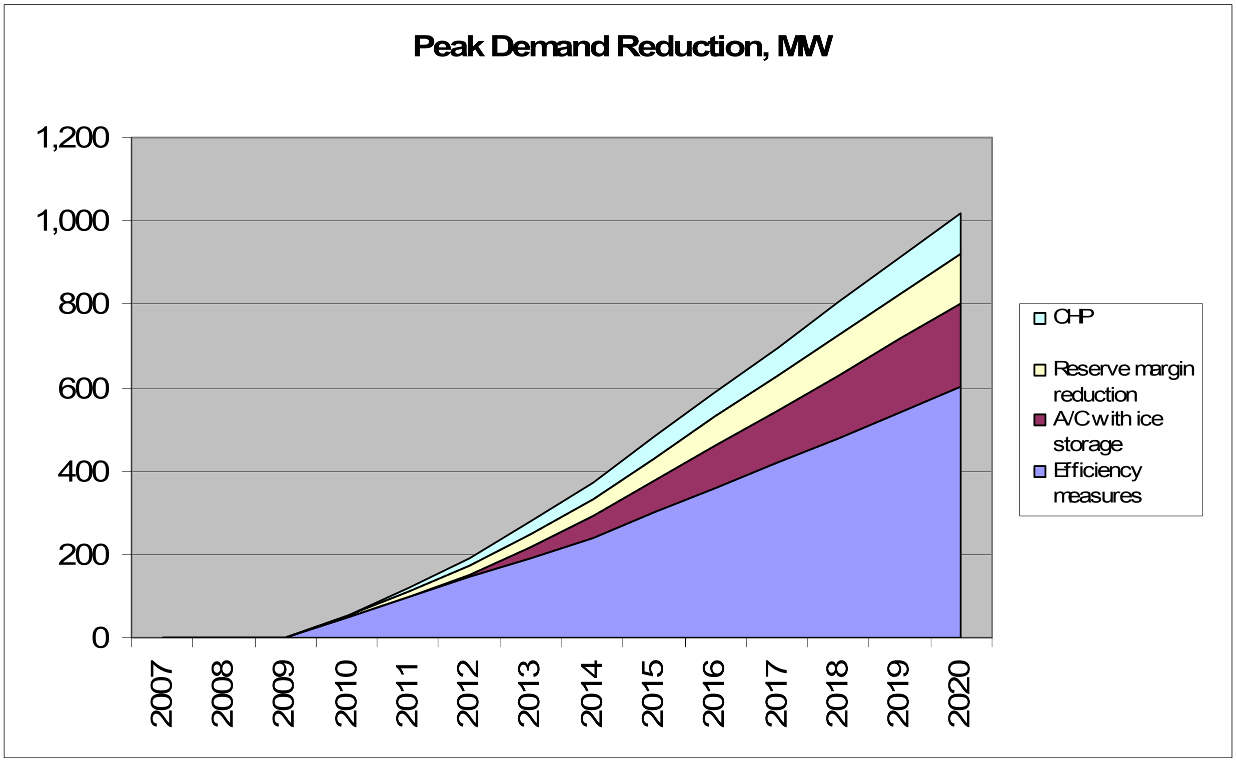

Figure 12: Peak Demand Reduction in MW, in the Efficiency, Distributed Ice Storage, and CHP Demand Reduction in the Efficiency Scenario

The total of these measures to 2020 would result in a reduction in generating capacity requirements at peak of about 1,020 MW.

If large-scale tests (of several megawatts) of distributed ice storage do not result in performance that is now indicated, greater emphasis can be place on efficiency measures and CHP to achieve a similar total result.

As noted above, CPS Energy already has 576 MW of wind capacity. Apart from 75 MW in the coastal area, the rest of this capacity does not appear to be well suited to providing firm capacity (unless it is backed up by standby capacity, coldness storage, or similar technical measures). The installation of solar PV and concentrating solar thermal power would complement the investments in efficiency and demand-side measures as well as the wind capacity. In the scenario for efficiency and CHP described above, CPS Energy could add 10 MW of solar PV capacity per year, mainly in large parking lots and on commercial rooftops and a 200 MW concentrating solar power plant (to come on line in the latter part of the next decade). The resultant capacity scenario is shown in Figure 13.

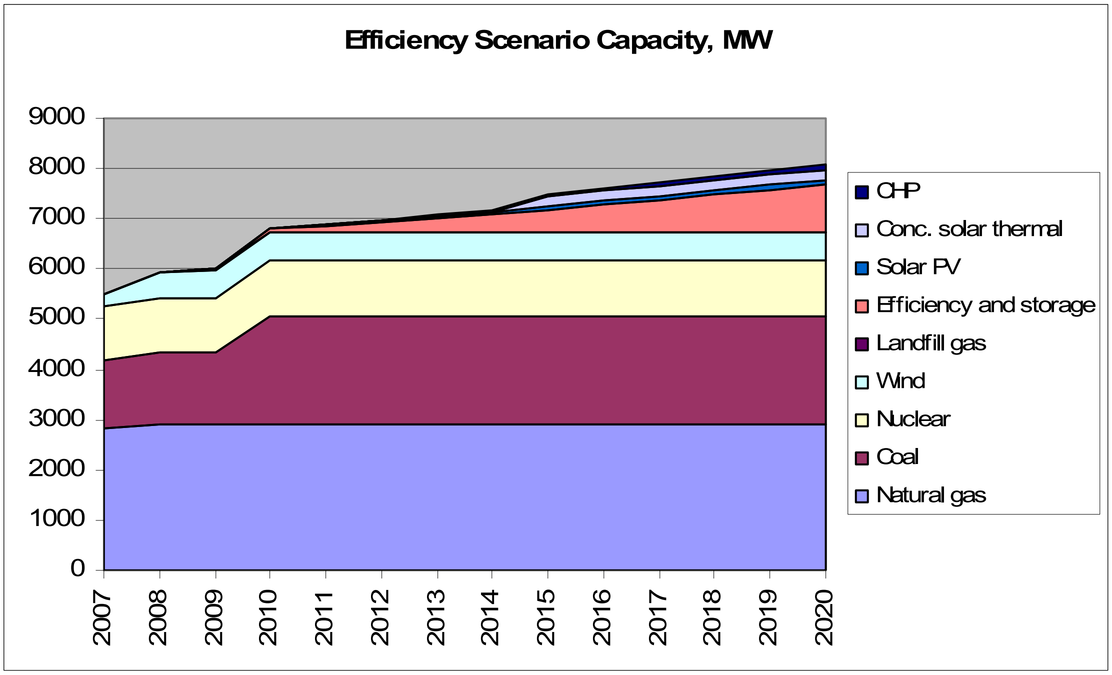

Figure 13: Capacity in MW, in the Efficiency, Distributed Storage, and Renewable Energy Scenario for CPS Energy

Note that in computing the capacity of renewable energy available to meet peak demand, no credit is taken for CPS Energy's wind capacity. Solar PV is credited at 50 percent of installed peak capacity and concentrating thermal solar power with heat storage is credited at 90 percent of installed peak capacity.

The above reference scenario emphasizes a mix of approaches to incorporate diversity in the efficiency, storage, and renewables portfolio and to allow San Antonio to build up the physical and economic infrastructure that would enable it to continue to rely on efficiency, storage, and renewables in the years beyond 2020.

X. Comparison of the New Nuclear and Efficiency Scenarios

In a previous IEER report, the capital cost of the 2,700 MW nuclear project proposed by NRG is estimated at about \$12.1 billion to \$17.5 billion in 2007 dollars.[27] For the purposes of the comparison between efficiency and renewables on the one hand and nuclear on the other, a portfolio of efficiency, solar photovoltaics, and concentrating solar thermal power plants was compiled and its present value calculated. A nominal discount rate of 7 percent is assumed for all calculations.[28] The inflation rate assumed is 3 percent (same as the KEMA study). One nuclear unit is assumed to come on line in 2016 and the other in 2017. In other words, no delays

[27] The values are rounded in this report. A correction to the Makhijani 2008 report increasing the lower bound cost from \$12 billion to \$12.1 billion is being issued.
[28] This discount rate is lower than that assumed for a utility discount rate in the KEMA study (KEMA 2005 Appendix C). This is because CPS Energy is a municipal utility with excellent credit ratings.

or costs attributable to delays are assumed. The range of capital cost for the nuclear project is taken as $12.1 billion to $17.5 billion,[29] and the same discount rate of 7 percent is used, with the CPS Energy share being 40 percent of this amount for the purposes of the calculation.

All costs in both scenarios are escalated at a 3 percent inflation rate from the year 2007 to the date of expenditure. Figure 14 shows the results. The present value of 40 percent of the NRG project capital cost (that is, of CPS Energy's share) works out to between $3.7 billion and $5.4 billion in 2007 dollars (using a discount rate of 7 percent).[30]

The costs of the various elements in 2007 dollars in the efficiency scenario per megawatt are as follows:

1. Efficiency improvements -- $1.52 million per MW, including program costs, based on the ACEEE 2007 Texas efficiency study, as discussed above. This includes program and administrative costs.
2. Solar PV: $3.50 per peak watt, starting in 2010 installed in megawatt-scale units[31]
3. Concentrating solar thermal power plant with molten salt storage: $3,500 per kW, [32] plus $270,000 per MW for transmission costs (based on ERCOT $4.9 billion for about 18,000 MW)
4. CHP: $1.75 million per MW
5. Ice Energy's ice-storage complement to central A/C: $2 million per MW installed.

In addition, an annual expenditure of $5 million in 2007 dollars is assumed for measurements, verification, prizes for landlords and architects, publicity, and other promotions. The 2007 year costs have been escalated at 3 percent per year to the year of expenditure, to account for inflation. They are then discounted at 7 percent to yield a present value in the year 2007. The total present value of investments in the efficiency scenario amounts to $2.3 billion.

The total present value investment in efficiency, storage, and renewables is about $2.3 billion (rounded). The overall conclusion is that in this approach, the nuclear option would cost between about $1.4 billion and $3.1 billion more than the efficiency, storage, and renewables option.

Detailed tables for capacity and costs, both in current dollars and in present value discounted to 2007 are provided in Attachment D. Note that no capacity retirements are assumed in either scenario.

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[29] Makhijani 2008

[30] The present value is less than the simple capital cost in 2007 dollars, since expenditures to build the plant will take place in future years. These expenditures have been discounted at 7 percent. See Table D-3 in Attachment D for detailed calculations.

[31] Southern California Edison's project to install solar PV on warehouse rooftops starting in 2008 is expected to cost about $3.50 per peak watt, installed (RenewableEnergyWorld.com 2008). No transmission investment is required. Southern California Edison has chosen First Solar as its solar PV supplier. First Solar's cost of making solar panels is about $1.25 per peak watt (exclusive of installation and balance of system costs) – see First Solar 2007.

[32] There are a variety of references for concentrating solar thermal power costs. See for instance, ACCIONA 2007, APS 2008, Ausra 2007, and BrightSource Energy 2007. Additional information is also available at the California Energy Commission website, http://www.energy.ca.gov.

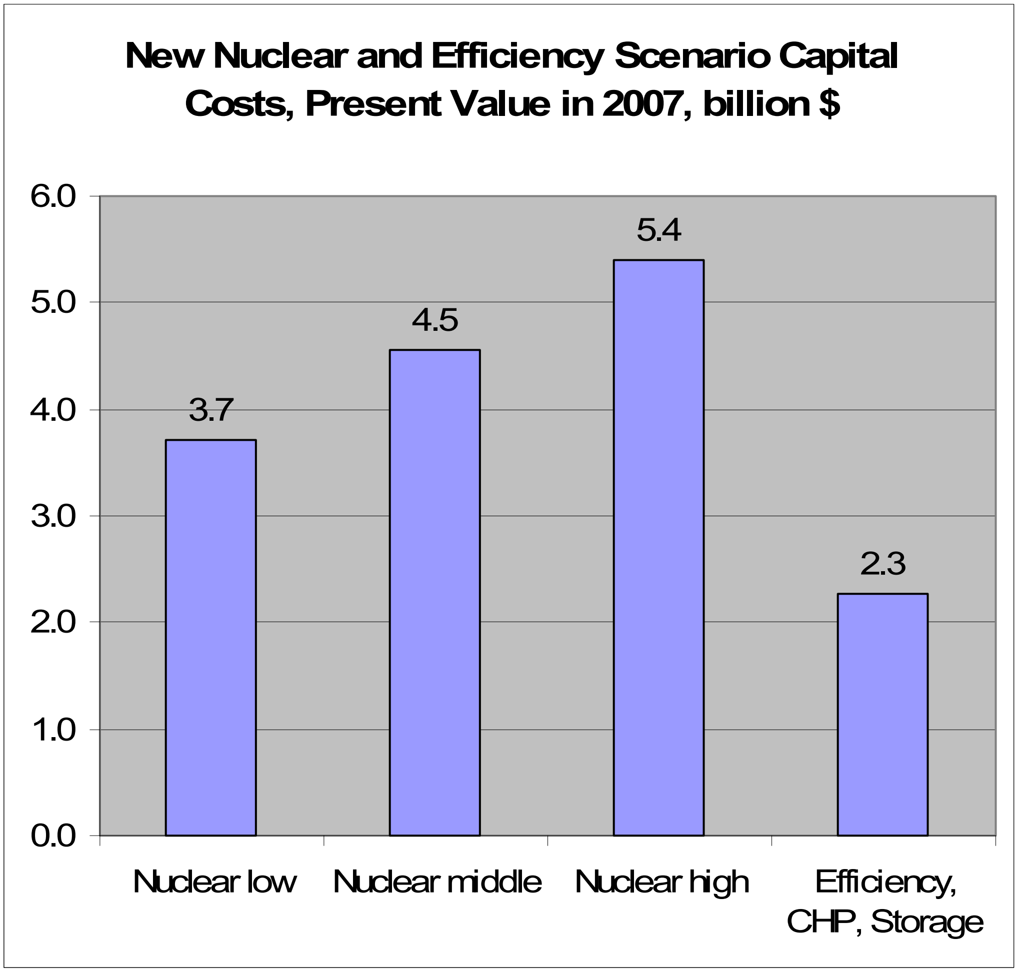

Figure 14: Comparison of the Present Value of the Capital Cost of an Efficiency and Renewable Portfolio with a 1,080 MW Nuclear Power Plant

Figure 14 shows that the nuclear option would require between about 1.4 and 3.1 billion dollars more investment in the coming decade. The result shown in Figure 14 is but one possible scenario for combining efficiency, CHP, coldness storage, solar PV and concentrating solar thermal power. Were greater emphasis to be put on existing homes, for instance by working with landlords to retrofit rental properties and having greater coverage of existing and new buildings in the commercial sector, new generation capacity may not be required at all. On the other hand, a larger emphasis on solar generating capacity, especially with heat and coldness storage could be combined with lower efficiency targets. The scenario shown is a mix of efficiency, demand reduction, especially using A/C driven by ice at peak times, and CHP. The path implied by this scenario has the great advantage that San Antonio would have the infrastructure in the most important areas in a twenty-first century efficient, renewable electricity system, especially as it has already decided to install smart meters.

One of the major differences between the new nuclear scenario and the efficiency scenario is that in the latter case capacity addition is modular, while in the former a large amount is added in over a very short period of time. This leads to a sudden excess of capacity in the new nuclear scenario that would exist at the very time that the new capacity is being added to the rate base. The potential for rate shock at that time is therefore considerable. Further, a large amount of excess capacity is likely to create pressures for off-system sales, making revenues dependent on the state of the market. In times of steady growth and predictable fuel prices, this would not be a large issue. However, in the present turbulent financial situation, there are added risks to a single large investment relative to the modular approach that is inherent in the efficiency scenario.

Should economic conditions deteriorate and growth rates change, the investments in the various elements that comprise the efficiency scenario can be scaled back. In the nuclear case, capacity addition could, in theory, be delayed, but this would have the perverse effect of increasing costs. Interest costs associated with delays once construction has begun are very substantial for nuclear plants. Estimating the value of the risk reduction that is created by the modular approach of the efficiency scenario would be complex under any circumstances, but is even more so in the present uncertain environment. However, given that delays associated with a twin reactor project could be on the order of a billion dollars per year towards the end of construction, the reduction in risk to CPS Energy from pursuing a modular approach in the present financial environment could be very substantial and should be considered and quantified prior to a decision to pursue the nuclear option.

Some cautionary notes as to the nature of this comparison are in order. We have not factored in energy and fuel cost savings to CPS Energy in the efficiency scenario relative to the nuclear scenario. At the same time, the nuclear units would generate electricity throughout the year, while the efficiency scenario investments are largely (though not completely) oriented towards peak and intermediate loads. The effect of a price on carbon dioxide under a tax or cap and trade system has also not been considered. This is a complex matter in its own right and beyond the scope of the present report. It should be noted however that both approaches would result in a reduction of CO_2 emissions relative to pursuing fossil fuel capacity. But again, the modular approach of the efficiency scenario allows for much greater flexibility in response to changing conditions, including fuel prices and penalties for CO_2 emissions.

The issue of baseload capacity in the long-term needs to be viewed in a different context. In the long-term, defined here as more than ten years, the development of a smart grid will mean that the notion of baseload capacity would itself undergo significant change. The one-way communication infrastructure of the present grid, with the consumer sending a signal for more or less power when consuming devices are switched on or off will be replaced by two way communication that would encompass a wide range of electricity system configurations. For instance, as discussed briefly above, ice storage in the commercial sector, where air-conditioning is used for most of the year, could enable wind energy to be firmed up by distributed storage of coldness. Demand response in a smart grid would not only include the commercial and industrial sectors over the next ten to fifteen years, but also the residential sector. Heat storage at concentrating solar thermal plants, use of existing natural gas capacity as standby, optimization of wind and solar for the specific climate of San Antonio so as to reduce the need for storage and standby capacity, would all be elements of a renewable, efficient, smart grid. Seen in this light, a focus on peak and intermediate load in this comparison to new nuclear capacity is not a significant limitation of this study, provided that CPS Energy makes a determined effort to transition to a smart grid. It appears to have decided to go in this direction since it will install smart meters in its service area.

Finally, it is important to review the constraints of this comparison between the new nuclear and efficiency scenarios. We did not include any investments in efficiency improvements or in renewable energy in the new nuclear scenario. This is, of course, contrary to the announced intentions of CPS Energy, which include both investments in efficiency and in expanding renewable capacity vigorously.

However, it is easy to see that this would only add greatly to surplus capacity, since the addition of 1,080 MW of nuclear capacity in the middle of the next decade would be sufficient to carry CPS Energy well past the year 2020 even without efficiency measures. The projected capacity without any new efficiency or renewable investment is shown in Figure 15.

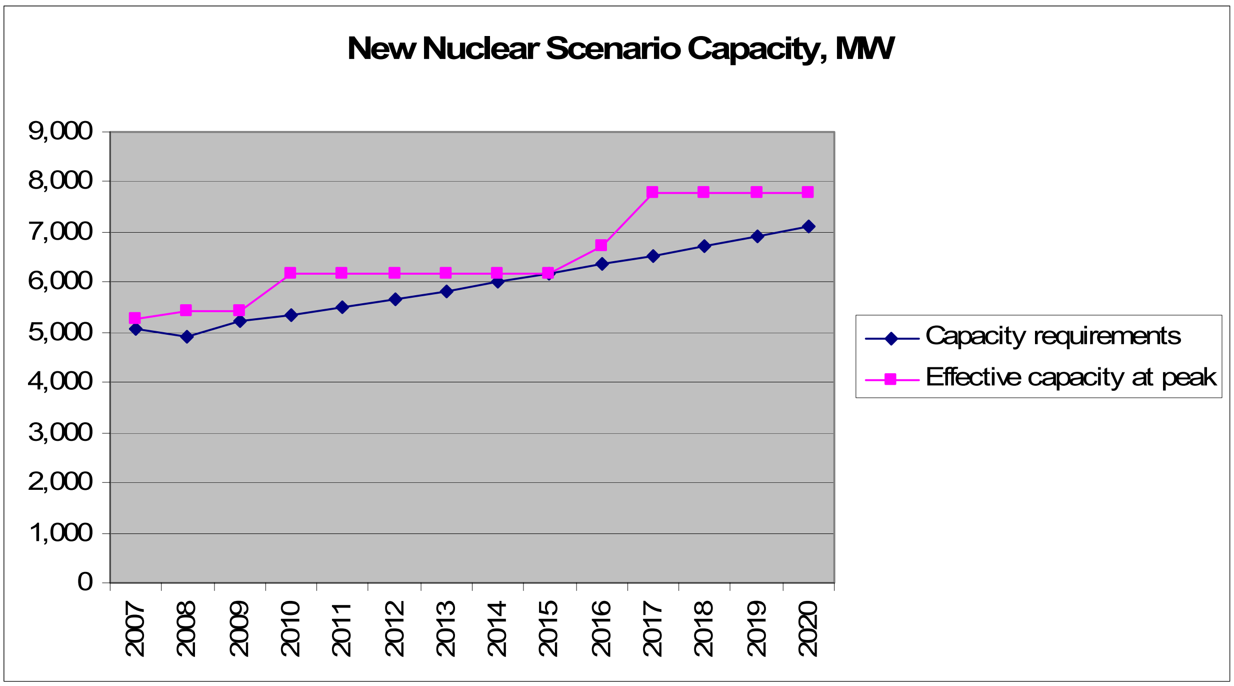

Figure 15: CPS Energy Capacity with the Addition of New Nuclear Capacity (1,080 MW) Without Efficiency Measures

The surplus capacity at peak in 2020, attributing zero value to wind capacity, is estimated to be almost 700 MW. If CPS Energy invests substantially in efficiency and renewables, especially solar electric generation capacity (concentrating solar with heat storage and solar PV), it will not need new nuclear capacity. If it decides to purchase 40 percent of the proposed NRG nuclear units, its surplus capacity at peak in 2020, attributing zero value to wind capacity, is estimated in this report to be almost 700 MW. Purchasing about 600 MW more of renewables (implied by CPS Energy's commitment to 1,200 MW of renewable capacity by 2020) and making investments in efficiency of several hundred MW would increase this surplus capacity and could double it, (depending on the type of renewables purchased). A doubling of surplus capacity to ~1,400 MW in 2020 would lead to a reserve margin in the 35 to 40 percent range. This is very undesirable as it would impose significant added costs on ratepayers. If CPS Energy takes steps to firm up its substantial wind capacity, this would further increase surplus capacity. Moreover, investments in efficiency and renewables along with the purchase of nuclear capacity would keep reserve margins consistently well above its requirements. This means that cost penalties would not be transient, but rather persistent.

Seen another way, a course of investing in new nuclear capacity is financially incompatible with a substantial commitment to efficiency and new renewable investments. Therefore, CPS Energy is truly at a crossroads – one path leads to more nuclear investment, the other to making efficiency and renewables the center of its program to meet its customers' needs.

XI. Policies

The main policy decision needed is for CPS Energy to set forth on a course of achievable, economical, and ambitious targets for efficiency, storage, and renewable energy. CPS Energy is already a leader in wind energy. Doing the same in solar energy, efficiency, and steps towards a smart grid, would establish it firmly in a forward looking, flexible direction that will enable it to cope with uncertain times, potential restrictions of carbon, fluctuations in economic growth and fuel prices, and capital market uncertainties. As noted, the approach recommended here is inherently modular and therefore very well suited to dealing with uncertain times.

The City of San Antonio and CPS Energy need to put in place mechanisms that will move it away from the voluntary, rebate-oriented model of efficiency that is suitable for starting such programs but not for achieving goals on the scale that is needed. CPS Energy should have the authority to issue bonds specifically for investments in efficiency, distributed storage, and CHP, the same way that it can now invest in large-scale power generation. This will not only allow CPS Energy to integrate these elements into its capital base, but also allow the City to have its share of the revenue.. As noted above, whatever specific financial arrangements are devised, the main goal would be to make efficiency investments financially on a par with investments in generation both for CPS Energy and for the City of San Antonio. This will also allow CPS Energy to work with landlords in the residential and commercial sectors to make efficiency improvements and devise ways to recover that investment. Overall, the City of San Antonio and CPS Energy should set an exciting, determined direction that involves the public, business and political leaders, and CPS Energy. A goal for the year 2020 of about 1,000 MW of capacity in a combination of efficiency, distributed storage, and CHP is achievable, economical, prudent, and highly desirable. In addition, CPS Energy should make installing solar electric generating capacity a high priority. Recent statements by CPS Energy indicate that it has decided to do so in regard to concentrating solar power.

In addition, the following policies would set the City of San Antonio and CPS Energy on the recommended course:

- Build on CPS Energy's leadership in Texas and nationally in wind energy by adding ambitious and achievable goals in efficiency.
- Take the first steps to a smart grid by beginning installing air-conditioning systems that store coldness in ice at off-peak times to determine whether it could be

implemented on a scale large enough to be comparable to traditional generation. A large-scale test of several tens of megawatts would appear to be in order before a full program of implementation is adopted. The use of energy storage in ice to firm up wind energy can also be field tested at this time. In addition, CPS Energy might consider negotiations with Night Wind to test its software for wind energy storage in freezer warehouses.

- Create financial mechanisms in efficiency to maintain City revenue flow from CPS Energy
- Create a permanent Task Force on Efficiency and Renewables – builders, architects, citizens, CPS Energy.
- Focus on solar technologies in CPS Energy portfolio for renewable energy
- Move to time-of-use pricing to complement the smart meters that CPS Energy plans to install.
- Being planning for implementation of a smart grid, so that the combination of renewables, efficiency, storage at the generation and consumer ends of the system, distributed generation, and demand response in all consumer sectors (including residential) can function seamlessly as the fraction of renewably-generated electricity in the system grows.
- Establish prizes, publicity, and incentives for landlords (residential and commercial) so that improving efficiency becomes the norm rather than the exception.
- Set a goal for new residential buildings and low-rise commercial buildings of net electricity production equal to electricity consumption.[33] Ways to recover distribution system costs would need to be established.
- Set a goal of average electricity production at least equal to use for new residential and low rise commercial developments by 2020. Multi-building solar (parking lots and commercial rooftops) and CHP systems can be part of meeting this goal
- Steadily improve building codes and guidelines to make progress towards the 2020 goal, including Btu/square foot/year guidelines (by type of building). Cities are strengthening codes – e.g., Dallas, 15 percent better than international code for efficient buildings,[34] could be a good baseline code to start with.
- Create forums to allow volume builders to learn from advanced customer builders.
- Awards and other events that can provide third party credibility for builders and architects. Publicity is critical – even more than award money.
- Establish voluntary guidelines and education for mortgage loan qualification to include energy costs.
- Encourage voluntary green building measures above the code, matched with utility based incentives.
- Target retrofits neighborhood by neighborhood.

[33] The scenario developed here does not assume that such buildings will be the norm by 2020. It is recommended here as being highly desirable to firmly set forth a new course for San Antonio.
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Attachment A

Notes of Conversation Between Mike Kotara,
Executive Vice President, Energy Development, CPS Energy
and
Arjun Makhijani, IEER
18 March 2008

Final version with all of Mike Kotara edits incorporated (Draft sent to Mike Kotara for review on 18 March 2008 and returned by him to Arjun Makhijani with edits on 23 March 2008).

Arjun asked whether CPS Energy was reviewing the latest nuclear power plant costs, as put forth by Florida Power and Light and Progress Energy, ranging from $5,000 to $8,000 per kW. Mike was familiar with those estimates.

Arjun asked about NRG's estimated costs of $7 billion for two ABWRs [about $2,600 per kW] and Mike said that CPS Energy was not relying on NRG's estimates and that it had completed its own study on nuclear costs and compared them with alternatives. CPS Energy's study was conducted from July 2006 through January 2007, with adjustments being made through September 2007. The study used probability distributions for many key variables such as fuel costs, capital costs, etc. Mike explained that the study concluded that new nuclear generation has lower overall risks than the alternatives for large-scale generation including natural gas, coal, and coal gasification. Arjun agreed that coal gasification has considerable risks and probably will not be a factor for 20 years or more.

CPS Energy's study was done in-house with consultant support. CPS Energy is updating its study taking into account cost escalations for all forms of generation, including new nuclear generation. Mike said that CPS Energy is working on more detailed analysis of commodity costs which are approximately ¼ of the total capital costs for new nuclear generation. Some of these commodities can be hedged to manage part of the cost uncertainty. Mike said that availability of skilled labor in future years is also being studied in more detail.

When asked about CPS Energy's approach to developing its Strategic Energy Plan, Mike explained the approach has been to first consider conservation and energy efficiency, then to include renewable energy, and then to consider its environmental commitment before finally considering alternatives to maintaining San Antonio's competitive advantage with low-cost electricity.

Arjun asked whether this study was public and whether the City Council had been briefed.

Mike said that the study was competitively sensitive because it contained information about costs and that it was important to keep this confidential to maintain San Antonio's competitive position on cost issues to attract business to the area. The City Council has been briefed in Executive Session a number of times. CPS Energy has a governing board that has reviewed the study.

Arjun said that independent review of such studies was very important, and especially so for a municipal utility. Independent review of costs of such a critical and expensive project and alternatives is very important and could provide a check either affirming the view of CPS Energy or providing technical points worth considering. For instance, Arjun stated that the degree of efficiency that CPS Energy was pursuing is far below the KEMA study. He requested that Mike take his request to make the study or at least a summary public to Milton Lee or other appropriate person in CPS Energy. He also pointed out that San Antonio's competitive position on costs of electricity needs to be public in order to attract business.

Mike pointed out that CPS Energy is a leader in renewable energy in Texas, primarily in the form of wind energy with more than 500 MW of wind energy in its portfolio. CPS Energy is actively evaluating solar technologies including solar photovoltaic and solar thermal with molten salt heat storage. He mentioned that CPS Energy intends to remain a leader in renewable energy, but due to the intermittency of solar and wind energy, Mike said that CPS Energy believes that additional generation plants which can be relied upon to meet the energy needs of the community are still needed.

Arjun said that this did not take into account the vast potential of renewables, the untapped potential of efficiency or the fact that the KEMA study did not consider solar thermal water heating, which can reduce peak loads, as well as electricity use, solar HVAC, or combined heat and power. He pointed out that we don't need to wait for molten salt storage to have solar thermal supply in the evening hours. Natural gas can be used and has been used in the California plants for decades. Or existing natural gas capacity could be used in conjunction with solar thermal plants.

Arjun pointed out that in normal times this would be fine, but in the context of what will need to be done for reducing CO_2 emissions, it may not be enough. He asked for typical peak load data.

Mike said that ERCOT peak data was pretty typical of San Antonio and could be used. San Antonio was 6.5 to 7 percent of ERCOT.

Arjun asked for a contact person at CPS Energy on conservation and energy efficiency.

Mike gave him a contact and phone. CPS Energy is working on an energy efficiency summit. It will be held on June 4, at Pearl Stables. CPS Energy held a similar Energy Summit last June with energy efficiency being about a quarter of the agenda and it was well attended.

Attachment B

Interview with John Urciolo,
with Arjun Makhijani, about Landlords and Efficiency Investments[35]
15 July 2008

Arjun Makhijani explained that he was doing this interview to gain insights into the point of view of landlords about energy efficiency programs.

Makhijani: What will it take for landlords to invest in efficiency?

Urciolo: There are two kinds of landlords -- landlords who are owners and landlords with business partners who do not actually run the rented properties.

When the landlord owns the place, he can improve and he says I will benefit. If partners own most of it, the partners will ask: what's in it for us? A lot of investors are looking purely at the [financial] numbers. They are not involved with the tenants and so they have no concern about the energy bills. There is no sympathy for the tenants there.

I am speaking as a small landlord. In a large building where the landlord is paying for a large portion of the energy bill, he starts to look at the efficiency of the common areas because that affects his bottom line. In most cases the tenants get billed for common area expenses. There are pass throughs like decorations, etc. Again in that case there is little incentive for an owner to be more efficient.

A prime example of that is LED Christmas lighting – it saves a ton of energy but it costs two to three times as much.

A: So what kind of incentives will it take for a landlord other than when he is paying the bills?

Urciolo: In this day and age, prospective tenants find properties with low utility bills attractive. It is now a tough market for office space and retail [space] may get that way too. A lot of it has to do with people working at home full or part-time – they have computers at home and they telecommute more. This is putting pressure on the [rental] market.

For example, I have a tenant down the street to whom I rented two parts of the building. She rents a basement which is efficient – 2000 square feet which is efficient enough to have a utility bill of $100. The same amount of space on the second floor incurs a utility bill of $500 a month. She has asked me to put in efficient windows. I want to, but the historic district does not want the original windows changed. So the tenant is thinking of leaving. I could have new wood windows, but they [the regulators] are talking about first growth wood. The key to my wanting efficiency in this case is that I will lose a tenant and I may not be able to rent the space as it is. A new tenant will ask about the utility bill these days, and at $500 a month, they may not rent it,

[35] John Urciolo owns the building where the Institute for Energy and Environmental Research rents space.

Makhijani: Can't you make other efficiency improvements?

Urciolo: Well, we did put in some improvements, but it reduced the fresh air in the space. We sealed the air conditioning duct penetrations. We have limited room to put insulation in the crawl space. I put in a screen over the skylight in the summer to reduce the cooling load.

Makhijani: If there were an offer of loans for improving efficiency would you take it since it improves your property value?

Urciolo: I would take a loan at a reasonable interest rate if it were without red tape. The value of the building goes up. If I could recover the paper and transactional costs of doing the thing by increasing the rent slightly, I would pay for the investment costs of improving the building. So, I am willing to take the loan that way. And the next time I rent it, it will be more attractive and I can have a higher rent, even if I don't increase the rent to the present tenant.

Sometimes, the loans are inefficient for banks when they are small loans. Banks are not interested in loaning small amounts. There is a grant program through the state that is a façade grant to make improvements on Main Street. If there is just a 10 or 15 percent grant to make improvements, it would be a big help. A grant program could be very effective.

Makhijani: Then you would not look to increase the rent?

Urciolo: Absolutely. I would not increase the rent for present tenants. Of course with lower utility bills, the property is more attractive and you can recover your investment over time, since people are more conscious of utility bills and the property is more competitive for renting.

Makhijani: What would you think about a requirement to disclose utility bills at the time of renting?

Urciolo: It would not bother me, but it would bother a lot of landlords. A lot of landlords do tend to downplay utility costs. I think I am in a minority on that one. A lot of landlords will say call the utility company and pass the burden of finding out on to the renter. Landlords shy away from the implication that the last time's utility bills will carry over since the new tenant may have different habits and have higher bills. A lot of tenants tend to leave lights on. I can't believe how many office buildings leave their lights on at night and there is not a soul in them. I have actually put timers in bathrooms – 15 minutes. That was cheap and easy for me.

Makhijani: If the disclosure requirement had a non-liability clause would it make a difference?

Urciolo: That would be better. You don't want the risk that the tenant will hold you to an estimate of utility bills.

Makhijani: What other kinds of incentives would be useful?

Urciolo: Other than a grant – even low percent – a tax credit or a building credit for expansion. For example, I want to build a 20,000 square foot building. The county requirement is 10 percent green space. I don't have that. I should be able to get credit for a green roof or efficiency measures that are "green" in the environmental sense but not actual green space. But most jurisdictions don't do that.

Makhijani: But kids can't play on a green roof.

Urciolo: Why is it not green to put green roof or a building that is green in efficiency? I am not saying that you remove the green physical space altogether. But if I make my building really green, I should be allowed to build a little bit bigger building so I can recover my added investment in that greener building.

Makhijani: So, you would be ready to make a building very green if you were allowed to build somewhat more area and have less green space?

Urciolo: Yes, my building will be more valuable at the time of sale. It will be appraised at a higher value. You might have heard the term Class A office space. Older inefficient buildings with old wiring etc. have lower resale value. If you have a greener building you get higher rent and you get more appreciation.

Makhijani: What kind outreach program would it take to reach the vast majority of landlords?

Urciolo: Landlords think cost to install efficiency is high. But that is not true any more. Changing light bulbs is cheap. Even insulating buildings has become cheap. For example, a very efficient vinyl window with argon gas is attractive. A vinyl window is probably half of the equivalent wood window in cost and probably 75 percent less maintenance. There is no paint, for instance. The replacement glass is more expensive. It costs half as much as the wood window. Landlords often don't think of that. They don't think in five years the maintenance alone will save them enough to pay for it.

Makhijani: If there were a competition program for awards to landlords who have done the most to improve existing buildings, what kind of program would you like?

Urciolo: Well, you should have different categories for small, medium, and large buildings and evaluate each separately. I don't know how much a prize should be to make it attractive. If it run by a city, for instance, the press and the events that publicize landlords for doing good things would be valuable, quite apart from any dollar award. Every time you get press, it is a big thing to a lot of people.

Makhijani: What should be the size of the award for small landlords to sit up and take notice?

Urciolo: For me a 100,000-dollar award would make me sit up and take notice. But for large landlords this is a drop in the bucket. Large buildings are often owned by say insurance companies and you have to get the attention of the building managers. But there are exceptions. Transamerica owns buildings all over the United States and they advertise how green their buildings are. But then they may not tell you about the buildings that are not that efficient. A small owner gets an edge if his building is efficient. I don't know what the award should be for large companies. Most large buildings are owned by pension funds, insurance companies and the like. So it is hard to say what might influence that.

Makhijani: What kinds of other things should be done?

Urciolo: Awareness is the big thing. I am amazed being in this business and I see new products on TV – like green sidings that don't rot or b\get mold that look as good as original products like shake shingles. Again maintenance alone is a tremendous motivator – it's a bottom line figure. As another example if you have synthetic carpets that are made of safe materials that don't get mold – you do get floods from pipe breaks and the like. Buildings can be zoned and you can heat just the space where someone wants to work at night. But you can do that in new buildings. Zoning for heating is tough in existing buildings. Ceramic tile is very good. It absorbs and holds the heat.

Makhijani: What kinds of informational materials would be useful for landlords?

Urciolo: I think a really good web page with links to the products that are out there that is updated would be very useful. The page should have FAQs. For instance it would answer questions like: How do I improve lighting? And then it would have the places where you could get the products.

If there were videos that could show you the application of the products – if the utility or the city gives you the link, the companies would make the videos because they would want to sell their produces. Showing the installation procedure and how easy or hard it is would be important. I buy stuff on the web now – everything. You could not have done that ten years ago. For example, I went to Google and got the tool that I saw on HDTV and hunted around till I got it. It can be fun too. If there were a really good updated web page that did that it would be very helpful to landlords keep up on efficiency.

Attachment C

Data and Analysis Tables[36]

Table C-1: Historical CPS Energy Electric System Sales and Generation, MWh, except Peak Demand, Ratios and Percent

	2003	2004	2005	2006	2007	2008	Growth '03-08	Rate %	Growth rate '03-07
Residential	7.25E+06	7.38E+06	7.45E+06	8.05E+06	8.55E+06	8.25E+06	1.14	2.61%	4.20%
Commercial and Industrial	7.73E+06	8.49E+06	8.03E+06	8.07E+06	8.27E+06	8.35E+06	1.08	1.53%	1.68%
Street lighting	9.71E+04	9.95E+04	9.96E+04	1.02E+05	1.13E+05	1.12E+05	1.15	2.84%	3.75%
Public Authorities	1.83E+06	1.10E+06	1.63E+06	1.97E+06	2.22E+06	2.24E+06	1.22	4.09%	4.92%
Sales for Resale	3.30E+05	4.44E+05	4.25E+05	4.55E+05	4.23E+05	4.03E+05	1.22	4.06%	6.41%
Off-system sales	1.73E+05	7.52E+05	1.20E+06	1.40E+06	2.53E+06	3.53E+06	20.4	82.85%	95.76%
Unbilled	No data	No data	-4.90E+03	2.50E+04	2.20E+04	-1.90E+04			
Total sales (incl. for resale and off-system)	1.74E+07	1.83E+07	1.88E+07	2.01E+07	2.21E+07	2.29E+07	1.31	5.59%	6.17%
Total Generation	1.64E+07	1.72E+07	1.86E+07	2.01E+07	2.23E+07	2.20E+07	1.34	6.08%	7.93%
Purchases and other power	2.20E+06	1.94E+06	1.38E+06	1.15E+06	1.24E+06	2.05E+06			
Total generation and other power	1.86E+07	1.91E+07	2.00E+07	2.12E+07	2.35E+07	2.41E+07	1.30	5.31%	6.03%
Total San Antonio sales	1.69E+07	1.71E+07	1.72E+07	1.82E+07	1.92E+07	1.89E+07	1.12	2.27%	3.18%
Implicit T&D losses percent (Note 1)	6.39%	4.39%	6.82%	5.46%	5.90%	5.14%	0.936	-1.32%	-13.20%
Number of customers	6.04E+05	6.02E+05	6.18E+05	6.39E+05	6.62E+05	6.81E+05	1.13	2.43%	2.32%
Sales per customer (Note 2)	2.80E+01	2.83E+01	2.78E+01	2.85E+01	2.89E+01	2.78E+01	0.992	-0.16%	0.84%
Peak Demand, MW	3.94E+03	4.12E+03	4.04E+03	4.32E+03	4.41E+03	4.26E+03	1.08	1.58%	2.86%

Note 1: Estimated from total sales and total generation and other power.

Note 2: Includes residential, commercial, and industrial customers. Sales per residential customer are roughly half the average for all customers.

Sources: CPS Energy 2004-05 page 3, CPS Energy 2006-07 pages 4 and 5, CPS Energy 2007-08 pages 18 and 19

[36] Unless otherwise specified, data are for CPS Energy fiscal years, which end in January. For instance, FY 2008 ended on January 31, 2008.

Table C-2: CPS Energy Generating Capacity, MW

Capacity, MW	2003	2004	2005	2006	2007	2008
Natural gas	2931	2831	3021	2766	2821	2916
Coal	1425	1425	1425	1424	1365	1410
Nuclear	700	700	700	1025	1054	1088
Wind	160	160	160	260	260	501
Landfill gas	--	--	--	10	10	10
Total	5216	5116	5306	5485	5510	5925

Sources: CPS Energy 2004-05 page 3, CPS Energy 2006-07 page 4, CPS Energy 2007-08 page 19

Table C-3: CPS Energy Electricity Generation by Fuel, Million MWh/year

	2003	2004	2005	2006	2007	2008
Natural gas	2.79	3.25	3.03	3.82	4.00	3.85
Coal	8.56	9.36	9.70	9.13	9.87	9.40
Nuclear	5.02	4.58	6.06	7.22	8.46	8.91
Wind and other	2.23	1.91	1.41	1.06	1.18	1.93
Total	18.6	19.1	20.2	21.2	23.5	24.1

Sources: CPS Energy 2004-05, CPS Energy 2006-07, CPS Energy 2007-08

Table C-4: CPS Energy Annual Capacity Factors, By Fuel, In Percent

	2003	2004	2005	2006	2007	2008
Natural gas	10.9%	13.1%	11.5%	15.8%	16.2%	15.1%
Coal	68.5%	75.0%	77.7%	73.2%	82.6%	76.1%
Nuclear	81.9%	74.8%	98.8%	80.4%	91.7%	93.5%

Note: Calculated from data in CPS Energy 2004-05, CPS Energy 2006-07, CPS Energy 2007-08

Attachment D: New Nuclear and Efficiency Scenarios

Table D-1: Capacity in the CPS Energy System, New Nuclear and Efficiency Scenarios, MW

New Nuclear Scenario	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Natural gas	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916
Coal	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160
Nuclear	1,088	1,088	1,088	1,088	1,088	1,088	1,088	2,168	2,168	2,168	2,168
Wind	576	576	576	576	576	576	576	576	576	576	576
Landfill gas	10	10	10	10	10	10	10	10	10	10	10
Total	**6,750**	**6,750**	**6,750**	**6,750**	**6,750**	**6,750**	**6,750**	**7,830**	**7,830**	**7,830**	**7,830**
Effective Capacity at peak	**6,174**	**6,174**	**6,174**	**6,174**	**6,174**	**6,174**	**6,174**	**7,254**	**7,254**	**7,254**	**7,254**
Efficiency Scenario											
Capacity without new nuclear	6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750
Efficiency and storage	55	112	172	250	334	432	529	627	725	823	920
Solar PV	10	20	30	40	50	60	70	80	90	100	110
Solar thermal with storage	0	0	0	0	0	200	200	200	200	200	200
CHP	0	10	20	30	40	50	60	70	80	90	100
Total	**6,815**	**6,892**	**6,972**	**7,070**	**7,174**	**7,492**	**7,609**	**7,727**	**7,845**	**7,963**	**8,080**
Effective capacity at peak	**6,234**	**6,306**	**6,381**	**6,474**	**6,573**	**6,866**	**6,978**	**7,091**	**7,204**	**7,317**	**7,429**

Table D-2: Details of Efficiency, Storage, and CHP Implementation, Cumulative MW

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Efficiency measures	48	96	144	192	240	300	360	420	480	540	600
A/C with ice storage	0	1	5	25	50	75	100	125	150	175	200
Total efficiency + storage	**48**	**97**	**149**	**217**	**290**	**375**	**460**	**545**	**630**	**715**	**800**
Reserve margin reduction	7	15	22	33	44	56	69	82	95	107	120
CHP	0	10	20	30	40	50	60	70	80	90	100
Peak demand reduction, total	**55**	**122**	**192**	**280**	**374**	**482**	**589**	**697**	**805**	**913**	**1,020**

Table D-3: Nuclear Investment Cost Calculations for 1,080 MW, in million dollars, annual investments and total

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Nuclear cost, base case, 2007 $	100	100	1,140	1,140	1,140	1,140	1,140	0	0	0	0	5,900
Nuclear cost, escalated	109	113	1,322	1,361	1,402	1,444	1,487	0	0	0	0	
Present value, 2007	**89**	**86**	**942**	**907**	**873**	**840**	**809**	**0**	**0**	**0**	**0**	**4,547**
Nuclear cost, low case, 2007 $	100	100	920	920	920	920	920	0	0	0	0	4,800
Nuclear cost escalated	109	113	1,067	1,099	1,131	1,165	1,200	0	0	0	0	
Present value, 2007	**89**	**86**	**760**	**732**	**705**	**678**	**653**	**0**	**0**	**0**	**0**	**3,703**
Nuclear cost, high case, 2007 $	100	100	1,360	1,360	1,360	1,360	1,360	0	0	0	0	7,000
Nuclear cost escalated	109	113	1,577	1,624	1,673	1,723	1,774	0	0	0	0	
Present value, 2007	**89**	**86**	**1,124**	**1,082**	**1,042**	**1,003**	**965**	**0**	**0**	**0**	**0**	**5,391**

Notes: 1. Cost escalations are at 3 percent, which is the assumed inflation rate in this report.
2. Present values are for the year 2007. The discount rate used is 7%.

Table D-4: Efficiency Scenario Investment Cost Details, in million dollars, annual investments and total present value

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Efficiency, escalated	80	97	106	142	157	188	194	200	206	212	218	
Ice assisted A/C, escalated	0	2	9	48	61	63	65	67	69	71	73	
Solar photovoltaics, escalated	0	42	44	45	46	48	49	51	52	54	55	
Solar thermal, escalated	0	0	0	418	430	0	0	0	0	0	0	
CHP, escalated	0	20	19	19	20	20	21	22	22	23	23	
Institutional infrastructure, escalated	5.5	5.6	5.8	6.0	6.1	6.3	6.5	6.7	6.9	7.1	7.3	
Present value, 2007	**70**	**127**	**130**	**452**	**449**	**190**	**183**	**176**	**169**	**163**	**157**	**2,265**

Notes: 1. Cost escalations are at 3 percent, which is the assumed interest rate in this report.
2. Present values are for the year 2007. The discount rate used is 7 percent.

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