Cooling Off While Utilities Heat Up in the Rockies

Chris Schroeder, Nexant, Inc.
Bob Zaragoza, Xcel Energy
Jon Little, Platte River Power Authority
James E. Gilroy, PacifiCorp

ABSTRACT

Over the past decade, the rapid increase in residential air conditioning in the Mountain West has been a major contributor to the explosive growth in summer peak demand requirements for electric utilities. In Colorado and Utah, annual energy sales have outpaced customer growth by 5% during this period, while peak load requirements have increased by over 40%. In 2002 alone, approximately 160,000 central air conditioners units were shipped to these two states, representing a new system for nearly 1 out of every 16 residential electric customers in the region and a connected load of over 580 MW.

Several local utilities in Colorado and Utah have instituted incentive programs aimed at increasing the efficiency of these installed systems. In a region of the country with a relatively short cooling season and where equipment sales are dominated by minimum efficiency equipment – nearly 75% of all units were 10 SEER models in 2002 – these programs offer incentives to help customers offset a portion of the incremental costs associated with higher efficiency equipment. Through additional program eligibility requirements, some programs also aim to achieve increased savings by addressing common equipment selection and installation mistakes such as over-sizing, improper airflows, and incorrect equipment refrigerant charging.

This paper explores the estimated impacts of increased residential air conditioning penetration rates on utility capacity requirements and summarizes the approaches of three separate utilities in addressing this issue in Colorado and Utah. A review of these programs and their realized impacts on reducing system demand to date are also presented.

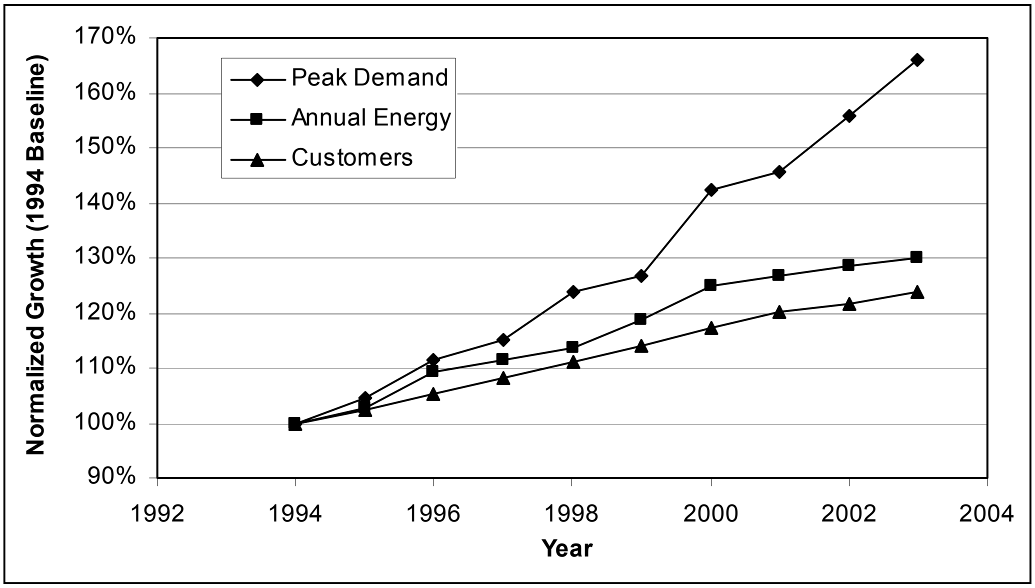
Introduction

In Colorado and Utah, where the high altitude and low humidity levels contribute to a climate with diurnal temperature swings of 25 to 30 ˚F during the cooling season, the use of compressor-based cooling equipment for residential dwellings was the exception rather than the rule – until now. In 2002 alone, approximately 160,000 central air conditioners were shipped to these two states, representing a new unit for 1 out of every 16 residential electric customers and a total connected load of over 580 MW (ARI 2003a).

While this may be good news for the local business economies, it's creating a challenge for the electric utilities that serve this region. From data tracked in Utah Power's 2003 Cool Cash Incentive program, it is estimated that over 85% of recent residential air conditioner sales within the region are first-time installations, contributing directly to utility peak load requirements. Increases in peak load requirements can lead to the purchase and installation of new generation resources that are only used for a minimal number of hours during the year. Alternatively, utilities may be required to purchase power on the wholesale market during volatile pricing periods. Both responses to increased peak loads can put upward pressure on rates.

Figure 1 illustrates the growth in system peak demand compared to underlying annual energy sales and the corresponding customer base for the utilities evaluated in this paper. As can be seen from Figure 1, energy consumption has increased approximately 5% faster than customer growth over the last decade, but peak demand requirements have exceeded customer growth by over 40% during this same time frame.

Figure 1. Electric Growth in Colorado and Utah



To address the rapid rise in demand requirements and help maintain their low energy prices, many utilities in the region now offer a wide range of incentive-based programs to promote the installation and use of energy efficient equipment. This paper looks at three specific programs designed to encourage the purchase and operation of more efficient residential cooling systems currently offered by three utilities in the region: Xcel Energy and Platte River Power Authority (Platte River) in Colorado; and Utah Power in Utah. Collectively, these three utilities serve over two-thirds of the residential population within these two states.

Where the (Demand) Relief Lies

Numerous articles and papers have been written on the subject of savings potential through proper air conditioning equipment selection, installation, and operation of residential air conditioning (Proctor et al. 1995, Proctor et al. 1996, Neme et al. 1999, CEE 2000). To help frame available options for utilities seeking to control peak load growth driven by residential cooling, brief summaries of the most prominent issues follow.

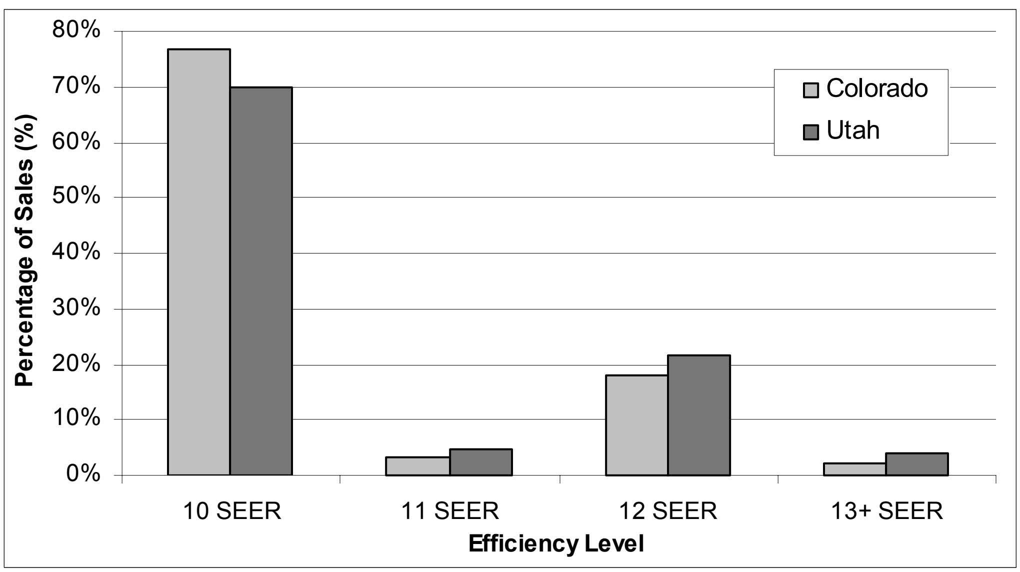
Alternatives to Central AC

Not surprisingly, the same climatic conditions that helped alleviate the need for residential central air conditioners in Colorado and Utah up until the last few years are still present. Avoiding the installation of a central air conditioner all-together presents the largest demand savings potential for utilities. Both Utah Power and Xcel Energy provide customers information about alternative cooling options such as ceiling and whole house fans. Customers are also encouraged to retain their existing evaporative coolers, or install them in lieu of a central air conditioning unit. In comparison to a standard 10 SEER air conditioner,[1] evaporative coolers were found to consume nearly 2,000 kWh/yr less in Utah (Dimetrosky et al. 2004). For the average unit, this corresponds to approximately 3 kW in demand savings.

Efficiency Ratings

Increases in equipment efficiency levels are often the first option considered when targeting demand savings. Significant demand savings are achievable over equipment manufactured to meet the current federal minimum efficiency standard of 10 SEER. For an average three-ton unit, demand savings of approximately 0.75 kW/unit are possible by installing a 13 SEER model.[2] Within Colorado and Utah, current customer purchasing behavior illustrates the significant potential that still exists to encourage customers to purchase higher efficiency equipment (see Figure 2).

Figure 2. SEER Distribution for Residential Air Conditioners



Source: ARI 2003a

Care must be taken not to focus exclusively on SEER levels alone, however. While current federal requirements only require manufacturers to list SEER ratings, it is not the best indicator of equipment demand. In fact, above 13 SEER, the relationship between equipment demand and SEER starts to deteriorate as advanced technologies such as variable speed and multiple compressors used to increase SEER ratings can actually result in higher demand requirements compared to lower SEER equipment (Stickney et al. 1994, ARI 2003b). This particular issue will be of even greater importance in the near future when the new Federal minimum efficiency standard of 13 SEER for central air conditioners becomes effective in 2006.

1 Seasonal Energy Efficiency Ratio.

2 Estimated savings from a three-ton unit with a 10 SEER/9.2 EER efficiency rating as compared to one with a 13 SEER/11.3 EER efficiency rating.

Other System Savings Opportunities

Opportunities for reducing peak demand extend beyond those associated with just the efficiency level of central air conditioning equipment. The demand saving potential associated with correcting improper equipment sizing, installation and maintenance, and distribution issues varies widely based on the range of targeted measures. Interactive effects must also be considered, as demand savings from individual measures are not necessarily additive. Published studies have identified a demand saving range of 14 to 35% (Neme et al. 1999) for these types of measures. Additional information regarding these options is presented below.

Equipment sizing. It's no secret that residential air conditioners are typically over-sized by 50% or more (Neme et al. 1999). Reductions in equipment cooling capacities have a direct correlation with a reduction in compressor size, and hence demand requirements. Although demand reductions associated with properly sized equipment can be reduced when aggregated at the grid level due to longer equipment run times, the net effect is still positive.

The Air Conditioning Contractors of America's (ACCA) Manual J is generally accepted as the definitive guideline to properly sizing residential air conditioning equipment (ACCA 2002). The manual is updated on a regular basis and can be incorporated into a utility incentive program with little modification.

Installation and maintenance. In an ideal world, all air conditioning contractors would ensure proper refrigerant charging and air flow across the indoor coil, and homeowners would do their part by following suggested maintenance procedures. With these practices, sizable improvements in operating efficiencies and reductions in equipment run times can result, producing significant demand savings over a utility's service territory. The use of thermal expansion valves (TXVs) can effectively mitigate these inefficiencies, reducing efficiency losses of 15% and 10% associated with common refrigerant and air flow problems to 5% and 2%, respectively (Neme et al. 1999).

Distribution system. The most efficient cooling system can be penalized by an inefficient distribution system. The prevalence and effects of poorly insulated and leaky ducts are well documented (EPA 2001, Neme et al. 1999). Duct design is another component of the distribution system efficiency that is often overlooked in the residential market. Correcting these inefficiencies can be difficult in existing homes, where finished walls and limited access to the distribution system can make correcting deficiencies more challenging.

Utility Approach

Program Design

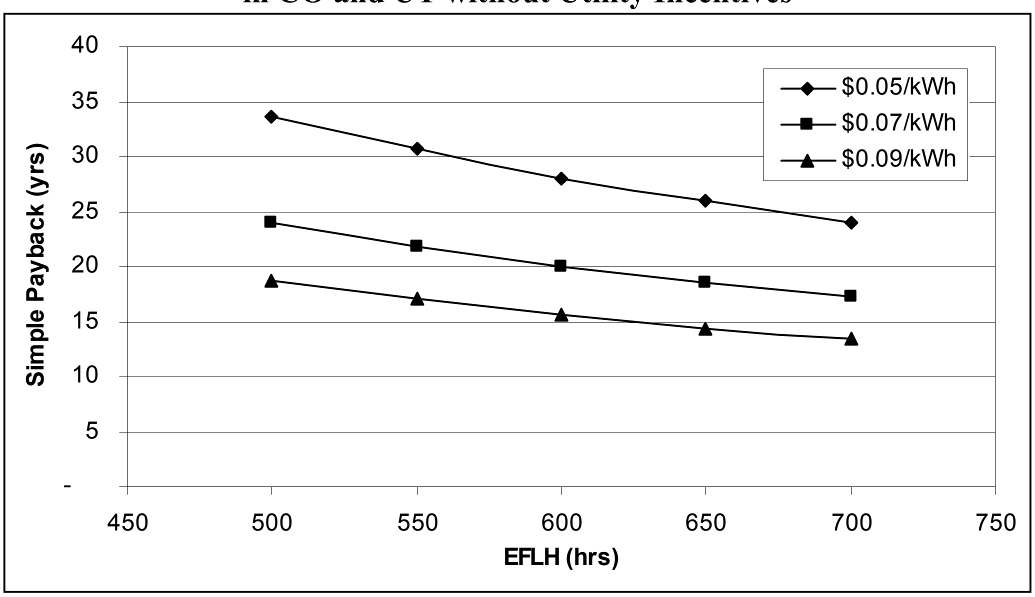
Xcel Energy, Platte River, and Utah Power have all utilized an iterative process to design their respective residential cooling incentive programs. While variations among the utilities exist, there are several objectives shared by each:

- *Maximizing the total demand savings realized through the program.* As outlined in this paper, the primary objective of these programs is to obtain critical peak demand savings.

Program design elements must take into consideration the trade off between more savings per participant from more comprehensive programs with reduced participation levels due to program complexity.

- *Streamlining customer participation procedures.* Public relations and customer satisfaction are key considerations in every aspect of utility operations. Maintaining simple and straightforward participation requirements by avoiding excessive program requirements is a goal for all programs.
- *Minimizing administrative responsibilities associated with program implementation.* As most programs are funded in some capacity with ratepayer funds, limiting the amount of program administration and oversight through simplified program design maximizes the availability of incentive funds for distribution back to the customer base.
- *Providing sufficient monetary incentives to help reduce customers' incremental costs.* In Colorado and Utah, the combination of a short cooling season, approximately 500 to 700 equivalent full load hours (EFLH), and relatively low energy prices can result in simple payback periods for customers that approach, or even exceed, the estimated equipment lifetimes. Figure 3 illustrates the calculated customer simple paybacks associated with purchasing a 13 SEER central air conditioner versus a standard 10 SEER efficiency model, with an estimated incremental purchase price of $700 (ARI 2001).

Figure 3. Customer Simple Pay Back Periods for 13 SEER Equipment in CO and UT without Utility Incentives



- *Delivering a cost-effective program.* To ensure fiscal responsibility, most utilities design programs within the context of meeting minimum cost-effectiveness requirements set by utility commissions or governing councils.

Program Summaries

The current program delivery method used by all three utilities to meet these objectives is similar – residential customers are required to purchase and install a qualifying high-efficiency cooling system and then submit an application to the utility. Customers then receive an incentive check in the mail from the utilities. The post-purchase application procedure and availability of qualifying equipment lists help streamline the customer participation and administrative review processes. A balance of appropriate equipment efficiency and installation requirements help to ensure that a significant portion of the available demand savings opportunities are being captured, without creating eligibility requirements that are too restrictive and limit customer participation.

Xcel Energy, Platte River, and Utah Power all revisit and update their respective programs annually as necessary to ensure that these objectives are met. A summary of each utility's historical and current program offerings is provided below. Table 1 summarizes 2004 program information for each utility.

Table 1. 2004 Program Summaries

Utility	Program Name	Summary	Customer Incentive
Xcel Energy	Central AC Rebate & Evaporative Cooling Rebate	Customer incentives for purchase of 13+ SEER central air conditioners with TXVs or qualifying evaporative cooling equipment.	▪ $350 for 13+ SEER ▪ $25 bonus for properly sized AC units ▪ $250 for evaporative equipment
Platte River	Cooling Rebate Program	Customer incentives for purchase of 12+ SEER central air conditioners with TXVs.	▪ $150 for 12 SEER ▪ $300 for 13+ SEER
Utah Power	Cool Cash Incentive Program	Customer incentives for purchase of 12+ SEER central air conditioners with TXVs or qualifying evaporative cooling equipment.	▪ $150 for 12 SEER ▪ $250 for 13+ SEER ▪ $100 bonus for properly sized AC units ▪ $100 for replacement evaporative equipment ▪ $300 for new evaporative equipment ▪ $500 for premium, whole-house ducted evaporative equipment

Xcel Energy. Xcel Energy initiated their latest round of efforts targeting residential air conditioning usage in 2001 with a distributor-driven incentive pilot program for 12 SEER and higher equipment. It was subsequently found that the emerging residential air conditioning contractor market in Colorado was still in a high growth mode trying to keep up with demand. As such, dealers and distributors paid little attention to the available incentives. The program delivery structure was modified to target the end-use customer, and in 2002, program participation levels increased nearly 250%. Ongoing changes have been made since, including incorporating a TXV requirement to address installation and maintenance issues, providing an additional customer incentive for properly sized units, and updating minimum efficiency levels in 2003 to match ENERGYSTAR® levels. In the 2003 program, incentives for evaporative cooling equipment were also incorporated as a pilot offering, continuing as a full-scale offering for 2004.

Platte River. With adjoining service territory to Xcel Energy, Platte River initiated their residential program in 2002, providing incentives for 12+ SEER air conditioners. In 2003, TXV requirements were added to target savings potential associated with installation and maintenance issues. For 2004, participant incentives were restructured to encourage installation of 13+ SEER equipment.

Utah Power. Utah Power rolled out a comprehensive program offering in 2003 that included incentives for both evaporative and central air conditioning equipment. Proper sizing and installation of TXVs were required for central air conditioner installations. Modifications for the 2004 program offering have included a shift from an absolute sizing requirement, to one where proper equipment sizing is strongly encouraged through the available incentive structure. A new tier of evaporative incentives was also incorporated for premium single inlet and direct/indirect units coupled to a distribution system serving the entire home.

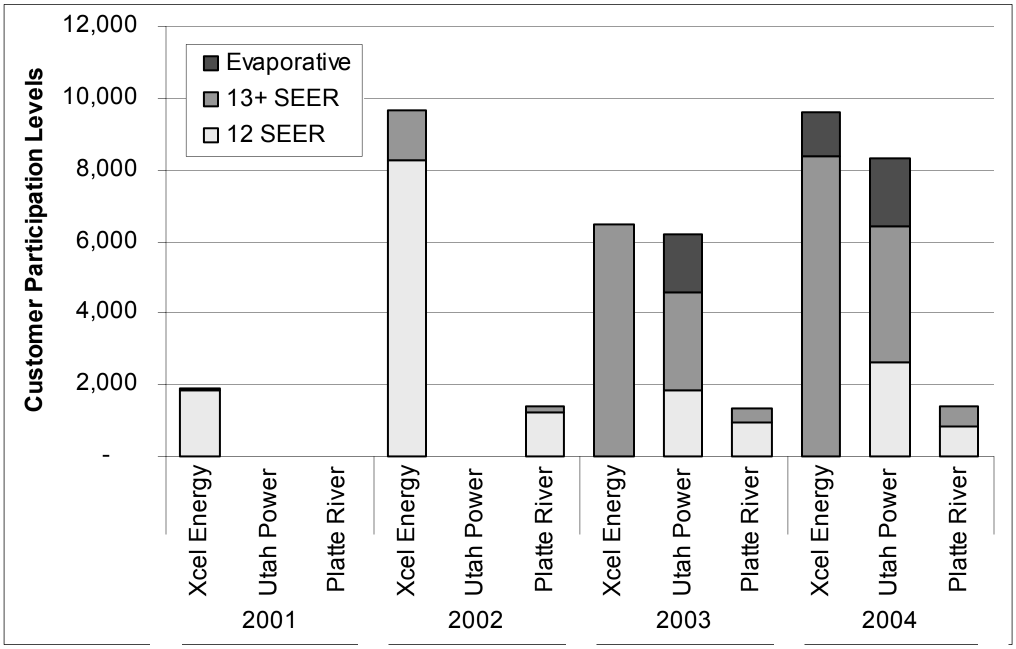
Impacts to Date

Collectively, nearly 13.5 MW of peak demand savings have been realized to date from the programs implemented by Xcel Energy, Platte River, and Utah Power. This equates to over 1% of the annual growth in peak demand for the region. Estimated savings are based on a combination of regionally adjusted engineering algorithms, nameplate equipment information, and utility billing analysis results (Dimetrosky et. al. 2004). Table 2 summarizes the estimated savings impacts by year and by utility. Corresponding information regarding the program participation rates by equipment type is shown in Figure 4, including projections for 2004.

Table 2. Program Peak Demand Savings Estimates

Utility	Year	Peak Demand Savings (kW)	Percentage of Peak Demand Growth (%)
Xcel Energy	2001	679	0.7%
	2002	4,132	1.1%
	2003	3,984	1.1%
Platte River	2002	535	1.7%
	2003	534	1.5%
Utah Power	2003	3,598	1.3%
	Total	**13,461**	**1.1%**

Figure 4. Program Participation Levels by Equipment Type



Conclusions

Efforts by utilities in the region to address the rapid growth of peak load requirements, and the contribution by residential cooling systems in particular, have demonstrated good success, saving nearly 13.5 MW of peak demand. These savings equate to just over 1% of overall system demand increases during the same timeframe. However, the explosive growth of residential air conditioning in the Rocky Mountain States shows no signs of subsiding. The increased penetration of residential air conditioners, and corresponding system demands incurred by utilities, will likely continue for many years to come. Driving factors behind this trend such as a prosperous economy, influx of out-of-state residents unfamiliar with alternative cooling techniques, and societal expectation of "creature comforts" such as central air conditioners will continue to fuel the fire.

To combat this tide of expensive load growth, diligent activities by utilities to realize demand savings opportunities will likely continue to play a key role in utility planning efforts. Starting in 2006, the updated Federal standards for central air conditioners establishing 13 SEER as the new minimum efficiency level are scheduled to become effective. Appropriate consideration and modification to traditional residential cooling program offerings will be especially critical during this transition to ensure that peak demand growth is effectively targeted.

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