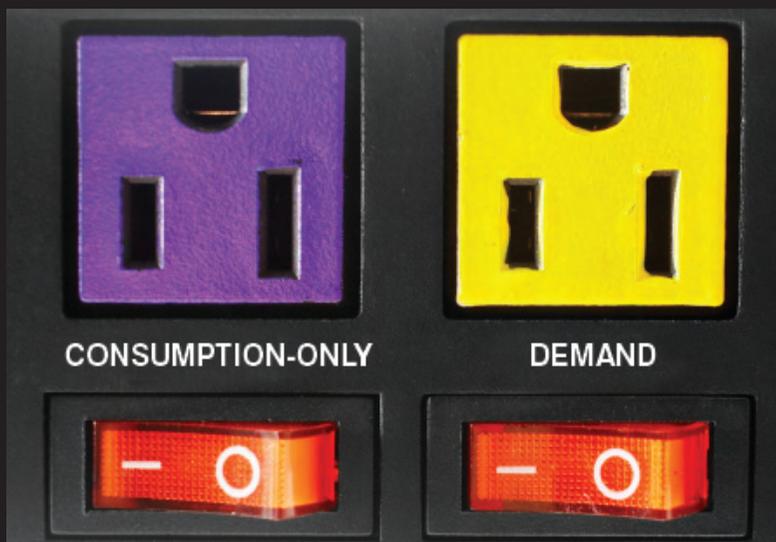


Demand or No Demand



Electrical Rates for Standard 90.1-2010

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During the development of ANSI/ASHRAE/IESNA Standard 90.1-1999, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, the standing standards project committee (SSPC) decided to use economics to help establish some of the standard's criteria. The committee had to make a number of decisions to pursue the economic path. One of the key decisions was to ascertain the appropriate electric rate to be used.

Electric utility rates vary considerably around the U.S., so the committee grappled with the methodology for establishing an electric rate suitable for use in developing the standard. The committee considered using average regional and/or local utility rates, but ultimately decided that even these varied substantially. As a result, the project committee decided to try and establish a single weighted electric rate to be used for all criteria setting.

For many years the U.S. Department of

Energy's Energy Information Administration (EIA) has tabulated prices for various fuels used in the commercial building sector. These tabulations represent a consistent sample of electricity prices from various utilities around the country, which could be used by the project committee to represent a weighted average electrical rate. The data provided by EIA represents the total electric bills for commercial customers divided by their total consumption in kilowatt-hours (kWh).

As such, all electricity costs for the commercial building are represented in the EIA numbers including the consumption charge in kWh, the demand charge in kilowatts (kW), other charges (e.g., monthly meter charge, fuel adjustment levies), and taxes. Therefore, the national average electrical rate used by SSPC 90.1 does include the effect of the demand portion of the electric bills.

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City	Flat Rate			Demand Rate		
	EER 9.2	EER 10.6	Savings	EER 9.2	EER 10.6	Savings
Miami	\$55,728	\$53,026	\$2,702	\$54,903	\$51,932	\$2,971
Austin, Texas	\$50,437	\$48,465	\$1,972	\$51,689	\$49,143	\$2,547
Atlanta	\$44,498	\$43,257	\$1,241	\$47,097	\$45,021	\$2,076
Baltimore	\$42,234	\$41,286	\$947	\$46,115	\$44,162	\$1,953
Chicago	\$40,196	\$39,463	\$733	\$43,696	\$42,016	\$1,680
Minneapolis	\$39,580	\$38,937	\$643	\$42,750	\$41,201	\$1,549

Table 1: Whole building electrical cost comparison of flat and demand rates.

Over the last five years or so when Standards 90.1-2004 and 90.1-2007 were being developed, the issue of electrical demand has become more important as electrical utility capacity has been taxed by the growth of the U.S. economy. As such, it has been argued that the project committee should use demand rates when establishing the criteria for Standard 90.1-2010. This article looks at the use of demand rates for criteria setting and provides some observations about the implications of such a choice. An example is provided to illustrate how using demand rate might impact the choice of criteria using simple payback as the metric for choice.

Demand Rates and the Goal for Standard 90.1-2010

ASHRAE has given the project committee a goal for Standard 90.1-2010 to achieve 30% energy savings compared to Standard 90.1-2004. This goal is aggressive and will likely challenge the project committee to reach beyond what it might have done otherwise in crafting the 2010 version of the standard. Since economics are being used in developing the standard's mandatory and prescriptive criteria, it follows that the economic parameters should also be more aggressive to reach the energy savings goal. Some have suggested that achieving the goal would be easier if demand rates were used in the economics. Although it may seem attractive, and perhaps appropriate to move in this direction, a number of questions need to be addressed.

A key question is: "what demand rate should be used by the committee?" Electrical demand rates, like energy consumption rates, vary considerably around the country. Unlike energy consumption rates, however, there does not appear to be an objective, citable source for a representative demand rate for the U.S. Also, the question exists of whether all commercial buildings are actually on demand rates. The EIA publishes the "Commercial Building Energy Consumption Survey" (CBECS) on a four-year cycle in addition to publishing representative utility rates.¹ A review of the 2003 version of CBECS indicates that roughly one-half of all commercial buildings, comprising 10% of total floor area, are 5,000 ft² (465 m²) or less. It is unlikely that many of these buildings would be on a demand rate tariff.

Notwithstanding the issues cited previously, it makes sense to evaluate the use of demand rates to see if there might be signifi-

cant differences in the resulting criteria when these are applied as compared to using just an energy consumption rate.

Example Application of Demand and Flat Rates

To evaluate the impact of using a demand rate versus a consumption only rate an example was constructed using energy simulations of a 32,258 ft² (2996 m²) two-story office building to evaluate simple paybacks for increasing the efficiency of the air-conditioning systems from an EER of 9.2 up to an EER of 10.6. The example building is similar to the prototypical building used in the development of Standard 90.1-1999. The building was simulated in six climate locations (Miami, Austin, Atlanta, Baltimore, Chicago, and Minneapolis), varying only the air conditioning EER in each location. Simulation output included the energy consumption in kWh and the monthly peak demand in kW.

The economic impacts of two electrical rates were compared. First, a flat energy consumption rate was examined that was assumed to be \$0.10/kWh. The flat rate is slightly above the \$0.0939/kWh that represents the 2006 average of state energy prices from EIA.² Second, a demand plus consumption rate was examined that was assumed to be \$0.06/kWh for the consumption charge and a monthly \$12/kW for the demand charge, subject to an 80% demand ratchet. The demand ratchet was calculated as 80% of the highest demand in any month from the simulations, and then applied to any other months during the year for which the actual demand was below the ratchet demand.

The energy consumption rate will be referred to as the flat rate, and the consumption plus demand rate will be referred to as the demand rate. Although both rates were created for this example, they do represent actual energy costs. As noted earlier, the flat rate is consistent with existing EIA published data. And the demand rate is consistent with the flat rate because when it is applied to the consumption and monthly demands from the simulations, and the resulting cost divided by the consumption, the result is close to \$0.10/kWh.

The comparison between the flat rate and demand rate for the six climate locations is shown in *Table 1*. As the climates move from Miami (hotter) through Minneapolis (cooler) the cost savings from enhanced cooling efficiency declines. The savings from higher cooling efficiency under the demand rate exceeded the savings from the flat rate for all climate locations, although

City	F.W. Dodge Construction Weightings	Cooling Capacity (tons)	Cost Premium for EER 10.6	Flat Rate Simple Payback (Years)	Demand Rate Simple Payback (Years)
Miami	0.042	75.4	\$42,224	15.6	14.2
Austin, Texas	0.239	76.2	\$42,672	21.6	16.8
Atlanta	0.259	73.1	\$40,936	33.0	19.7
Baltimore	0.201	72.5	\$40,600	42.9	20.8
Chicago	0.224	69.5	\$38,920	53.1	23.2
Minneapolis	0.035	66.5	\$37,240	58.0	24.0
Weighted	1.000	72.8	\$40,757	36.9	20.5

Table 2: Cooling capacity, cost premiums and simple paybacks by climate.

the annual utility costs are actually higher in all climates except for Miami for the demand rate assumed in this example.

Table 2 shows the peak cooling capacity of the air-conditioning units by climate location. The cost premium for moving from an EER of 9.2 to and EER of 10.6 is estimated as \$400 per ton per unit of EER increase. A simple payback is calculated for the efficiency enhancement for each climate location. The project committee uses a discounted life-cycle payback rather than a simple payback, so the payback values shown here are not necessarily reflective of values that might be used by the

project committee. However, they do give an indication of the relative results that would be expected when the discounted life-cycle paybacks are applied. The simple paybacks for the demand rate are always shorter than the simple paybacks for the flat rate, and the differences between the two grow substantially larger as you move to colder climates.

Payback periods are more sensitive to climate variations for the flat rate as shown in Figure 1. The payback period for the flat rate increases by a factor of 3.7 to 1 as you move from Miami to Minneapolis. This reflects the fact that in the colder

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climates the need for cooling, particularly in non-summer months, is substantially reduced, so higher efficiency cooling equipment is less cost effective. However, under a demand rate, the payback periods vary less than they do under the flat rate. The reason for this is that the buildings in the colder climates operate at a lower load factor and for approximately seven months of the year the demand ratchet is triggered. Triggering the ratchet raises the cost of the electric bills for over half the year, which tends to keep the payback periods more consistent across all climates.

Using construction activity data from F.W. Dodge for 1999–2005, the payback periods in *Table 2* can be combined to arrive at an overall weighted payback period across climates.³ When this is done the weighted payback period for the flat rate is roughly 37 years versus roughly 20 years for the demand rate. This data shows that paybacks are roughly half as long for our example case when the demand rate is used. The implication of this finding is that for equipment or measures that contribute substantially to peak demand the use of a demand rate when establishing minimum efficiency criteria likely will justify higher levels of efficiency.

Criteria Versus Compliance

Utility rates are used in two contexts in the standard. The first context is that of establishing the mandatory and prescriptive

criteria for the standard. In the past the project committee has done this for electricity use by applying a life-cycle discounted payback using a weighted average electricity consumption cost (in other words, a flat rate) for the U.S. As noted previously, this weighted average electricity cost did include some of the effects of demand since it represented the total electric bill divided by the total consumption. It was not a true demand rate; however, it was certainly easier to apply and, perhaps, defend. The second context of utility rates in the standard is when a designer or owner decides to achieve compliance with the standard through the use of the Energy Cost Budget (ECB) compliance approach contained in Section 11 of the standard.

When a design professional elects to use the standard's ECB compliance path, the annual energy cost of a budget building design is compared to the annual energy cost of a proposed building design. To comply, the proposed building design must have an energy cost that is not higher than that of the budget building design.

The budget building and proposed building designs must have identical conditioned floor areas, exterior dimensions and orientations. The budget building design's building envelope and mechanical/electrical systems must meet the prescriptive requirements of the standard. However, although the proposed building design must meet the standard's mandatory

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requirements, it does not have to meet the prescriptive requirements—with the proviso that the overall design must have an annual energy cost that does not exceed that of the budget building. In other words, design features that do not meet the standard’s prescriptive requirements must be offset by other design features that, in terms of energy cost, exceed the standard’s prescriptive requirements for those features.

The energy cost comparison is achieved by running energy simulations for the budget and proposed building designs, using the rules set out in Section 11 of Standard 90.1. Among other things, these rules stipulate that both simulations must use the same climatic data and the same purchased energy rates.

For ECB purposes, Standard 90.1 does not mandate the use of the national average energy rates. Instead, it stipulates that the purchased energy rates shall be those “approved by the *adopting authority*, defined as the agent or agency that adopts the standard (e.g., state or local code agency.” Three major reasons exist for this. First, it allows the use of rates applicable to the local area. They may be representative of the area, or they may be the rates that are applicable to the specific project, at the adopting authority’s discretion.

Second, for electrical rates, it allows for the inclusion of separate consumption and demand components in the overall rate. Therefore, an incentive exists for the designer to include lower lighting power density and HVAC systems with low electrical demand in a proposed design and further improved envelope designs as lower demand charges will reduce annual energy cost.

Third, it permits the use of energy rates that are as close as possible, and may be identical to, the energy rates design professionals need to use in evaluating alternative designs or systems from a project economic optimization perspective, rather than from an energy standard compliance perspective.

It could be argued that allowing the inclusion of demand charges in ECB simulations could result in a proposed design with a reduced electrical demand

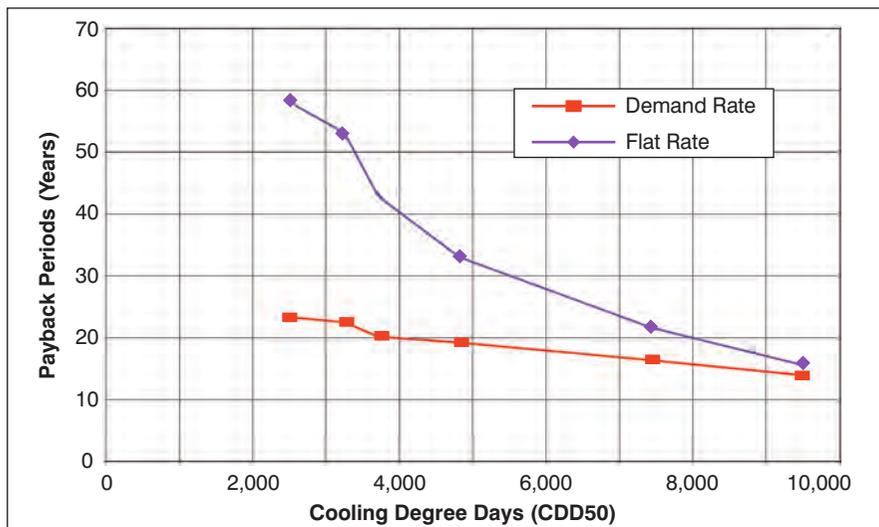


Figure 1: Air-conditioner payback vs. cooling degree days (CDD50) for flat and demand rates.

that complies with the standard, even if its overall energy consumption exceeded that of the budget building design. This could occur, but there is a wider perspective at play. The summation of electrical demand from all buildings in an electrical service area determines the generating, transmission, and distribution capacity that must be provided by electrical utilities serving the area. To the extent that buildings have lower peak demand, fewer resources need to be applied to construct and operate the electrical system infrastructure.

Conclusions

The simple example shown indicates that the use of a demand rate for setting criteria could result in higher levels of efficiency being selected by the 90.1 project committee for the prescriptive criteria for the 2010 version of Standard 90.1. This, of course, suggests that perhaps the committee should use demand rates, since their use might assist in reaching the goal of a 30% energy savings over Standard 90.1-2004. As pointed out previously the committee would need to establish a credible demand rate that could be used for all of its analysis, and this could be difficult to accomplish.

Assuming that a credible demand rate can be established, the committee could then consider applying it to those measures that contribute substantially to peak demand. However, doing so would increase the already considerable cri-

teria evaluation demands on the project committee. Additional resources must be made available for this additional work. Re-evaluating all mandatory and prescriptive criteria for a demand rate is probably not feasible for Standard 90.1-2010, but could be completed in the course of its continuous maintenance revisions.

Alternatively, the committee could calculate a new “effective” consumption rate that embodies, to a larger extent than at present, the effect of demand. This rate will be higher than the weighted average rate that the committee otherwise would use, which would have the effect of helping to cost justify higher levels of efficiency. In either case, the project committee should take a serious look at demand rates for electricity in formulating the requirements for Standard 90.1-2010.

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