Explaining Differences Between DSM Predictions and Actual Savings for Fluorescent Lighting Systems

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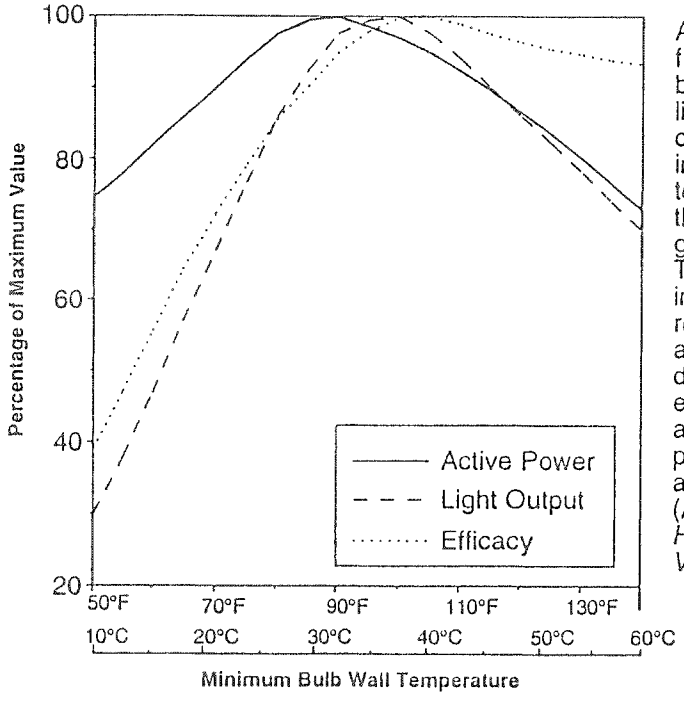
Introduction

Utility predictions for savings from lighting DSM programs are often based on performance data which are acquired using industry-standard test methods as prescribed by the American National Standards Institute (ANSI). However, performance of fluorescent systems in actual installations can vary a great deal from the predicted performance based on the ANSI test method. The ANSI test methods for measuring wattage and light output from fluorescent lamp-ballast combinations are based on bare lamps operated in still air. The resulting data generally represent performance near the peak of the thermal characteristic curve shown in Figure 1. But when installed in a luminaire, both power and light output decrease due to the increased temperature, roughly as shown in Figure 1. High wattage technologies operate at a higher temperature in a recessed enclosed luminaire than a low wattage replacement. In both cases, the actual wattage in the installation will be less than that predicted by ANSI test data; however, the differential is greater for the higher wattage technology. Thus, the difference in measured wattage in a luminaire between a "standard" technology and a reduced-wattage retrofit technology will be less than the difference indicated by open-air test data. Specific examples are given below.

Methodology

To establish the baseline data from ANSI test methods, lamp-ballast wattages reported in ballast manufacturer



As the temperature of a fluorescent bulb increases, both the light output (dashed line) and the active power consumption (solid line) also increase. However, as the temperature rises above 32°C, the power consumption gradually begins to decrease. The light output continues to increase until the temperature reaches approximately 38°C, at which point it begins to drop dramatically. The system efficacy (dotted line), defined as light output divided by active power, is therefore maximized at approximately 40°C. (Adapted from the *IES Lighting Handbook: Reference Volume*, 1984).

(Davis, 1992)

Figure 1. Effect of Temperature on Performance Characteristics

catalogs were used. The wattages measured for the "in-luminaire" conditions are those reported in the Advanced Lighting Guidelines: Luminaires and Lighting Systems publication (California Energy Commission, 1990). These in-luminaire data are specifically given for a recessed enclosed four-lamp fluorescent luminaire; other luminaire types will perform differently. Table 1 summarizes the ANSI and the in-luminaire data for a number of lamp-ballast combinations. We have tested a number of lamp-ballast combinations using both open-air and "in-luminaire" conditions, and have found results similar to those shown in Table 1 (Davis 1991, 1992).

Table 1. ANSI Versus In-Luminaire Data

Lamp-Ballast Type	ANSI Watts	In-Lum. Watts
4 40-watt T12 lamps w/ 2 energy-efficient (EE) magnetic ballasts	172	160
4 40-watt T12 lamps w/ 2 electronic ballasts	144	138
4 34-watt T12 lamps w/ 2 EE magnetic ballasts	144	138
4 32-watt T8 lamps w/ 1 electronic ballast	110	105

Results

Table 2 provides direct comparisons of three typical retrofit scenarios: replacing 40-watt fluorescent lamps with 34-watt lamps, replacing a magnetic ballast with an electronic ballast, and replacing 40-watt T12 lamps and magnetic ballasts with 32-watt T8 lamps and electronic ballasts. For each of the cases, the wattage reduction which would be predicted by using the ANSI data is given, with the actual wattage reduction indicated by the in-luminaire measured data. Then, the error which results from using the ANSI data for predicted savings is shown. In all cases, the error results in predicting greater wattage reductions than the reductions which actually occur.

Table 2. Comparisons for Typical Retrofit Options

Retrofit Option	Savings Predicted	Savings Actual	Error
40-watt T12 lamps to 34-watt T12 lamps (EE mag. ballast)	28	22	21%
Magnetic ballasts to electronic (40-watt T12 lamps)	28	22	21%
40-watt T12 lamps w/ EE magnetic to 32-watt T8 lamps w/ electronic	62	55	11%

Summary

Predicted savings from DSM programs are an important element in electric utility planning. For fluorescent lighting systems, basing these predicted savings on ANSI test data for lamp-ballast combinations can lead to exaggerated predictions of the wattage reductions which will result. This paper has shown how the thermal effects in fluorescent luminaires tend to reduce the actual wattage difference between retrofit technologies and the systems they often replace.

References

California Energy Commission, *Advanced Lighting Technologies Application Guidelines: Luminaires and Lighting Systems,* March 1990, p. 13.

Davis, R.G., ed. *Specifier Reports: Electronic Ballasts.* National Lighting Product Information Program, Lighting Research Center, Rensselaer Polytechnic Institute, December 1991.

Davis, R.G., ed. *Specifier Reports: Power Reducers.* National Lighting Product Information Program, Lighting Research Center, Rensselaer Polytechnic Institute, April 1992.