



BY JOSHUA ISRAELSOHN, CONTRIBUTING TECHNICAL EDITOR

Honest energy

I had the honor and great pleasure of serving as a panelist at an APEC (Applied Power Electronics Conference, www.apec-conf.org) rap session in February in Austin, TX. Although the session's central theme was the power sector's focus on efficiency, I was intrigued to note that all of the panelists agreed on an issue concerning energy use that lies outside a strict definition of efficiency: watts out divided by watts in.

As typical household products become more sophisticated, the power factor of the load they represent decays—a trend that is exacerbating a growing stress on our electric-power infrastructure. The problem with low power-factor loads is that they tie up grid capacity in excess of the energy they use.

An analysis of a load that draws nonsinusoidal current represents the current waveform as a harmonic series with components that are either in phase or in quadrature with the voltage waveform. Because the power grid

must supply all of the current—the in-phase component, which the utility meter measures, and the out-of-phase or reactive component, which the utility meter does not measure—the grid load exceeds the metered load.

The so-called P_A (apparent power) is the product of the rms voltage and rms current—measures that ignore relative phase (Figure 1). P_{REAL} (real power) is the integral of the in-phase voltage-current product over each line cycle. P_{REAC} (reactive power) accounts for the quadrature-current component. The PF (power fac-

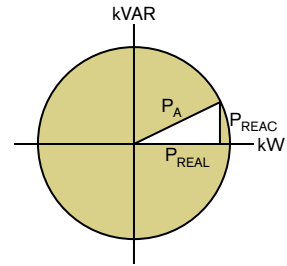


Figure 1 Power factor is the ratio of real-to-apparent power and is a measure of grid-use efficiency.

tor) is a measure of grid-use efficiency, which you can calculate as the ratio of P_{REAL} to P_A , or

$$\frac{P_{REAL}}{\sqrt{P_{REAL}^2 + P_{REAC}^2}}$$

Conversely, the excess grid capacity that a load uses is

$$\frac{P_A - P_{REAL}}{P_{REAL}} = \frac{1}{PF} - 1.$$

The figure shows a load with a PF of about 0.9, which corresponds to an excess grid use of about 12%. To put numbers to a few real objects, I measured some devices in my home (Table 1). Think of these numbers in the context of the electronic devices your company makes and consider the important role high power factors can play in electric-energy availability. **EDN**

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TABLE 1 POWER FACTORS, EXCESS GRID USE

Device	Power factor	Excess grid use (%)
Home computer	0.65	54
Computer-CRT display	0.65	54
Laser printer	0.73	37
Compact fluorescent lamp	0.56	79
Tungsten-filament lamp	1	0
Refrigerator compressor	0.91	10

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