By Thomas Michael Power

Making Sense of Peak Load Cost Allocations

Usage of utility services is rarely uniform across the day, month, or year. Dramatic increases in loads often appear at particular times of the day or in particular seasons of the year. Telephone utilities may choose not to meet extreme peak demands, but electric, natural gas, sewer, and water utilities usually do not enjoy that option. Failure to meet peak demands can lead to catastrophic consequences for both the customer and the utility, and can draw the attention of regulators. For that reason, utilities adopt design criteria for their production, transmission, and distribution facilities to ensure that peak loads are met.

When it comes to cost allocation, common wisdom assigns costs in proportion to class contributions to peak loads. The justification is simple: Since the equipment had to be sized to meet peak day loads, those costs should be allocated on the same basis. Many different peak allocators have been developed on this assumption: single coincident peak contribution, sum of coincident peaks, noncoincident peak, average and excess demand, peak and average demand, base and extra capacity, and so on. Such pure peak-load allocators may not be politically acceptable, but conceptually, at least, they appear to offer the only defensible approach.

Nevertheless, where capacity can be added with significant economies of scale, making cost allocations in proportion to peak loads violates well-known relationships between economics and engineering. What is missing is any tracing of the way in which the peak-load design criteria actually influence the costs incurred.

The Logical Flaw in Peak Allocators

Simply to assert that a particular design criteria is always met does not demonstrate or quantify the resulting impact on costs. Consider an extreme example. Assume that some customers require certain stability and reliability criteria, but that the utility can meet those criteria without any additional cost under existing production and distribution technology. In that case, it would not make any cost-causal sense to use such "costless" design criteria in allocating costs, though they are important to the design of the system.

In developing cost allocations, one needs to know more than what design criteria were used in the development of the utility's system. One also needs to know how—*quantitatively*—those design criteria affected the costs the utility incurred. Were they a major or minor determinant of costs? Did the design criteria affect costs proportionally, or was the relationship more complex?

Economics and Engineering—Some Known Relationships

Public utilities tend to be capital-intensive. They incur substantial fixed costs, often with substantial economies of scale. In this environment, the costs associated with meeting peak demands tend to increase much more slowly that the peak demands themselves. That is, the costs of meeting peak do not increase in proportion to peak loads.

> Utility planners know that capacity costs do not increase in proportion to the peak. That's evident from the way they design transmission and distribution systems.

Consider the relationship between the delivery capacity of a pipe and the installed cost of the pipe. In general, the delivery capacity of a pipe bears a geometric relationship to the diameter of the pipe; the exponent lies in the range of 2 to 2.5. That is, the capacity of the pipe increases faster than the square of the diameter. The installed cost of the pipe, however, increases much more slowly than the diameter, for two reasons. First, the installation costs often are unrelated to the size of the pipe. Installation requires a right-of-way, opening and closing a ditch, and resurfacing. Most of these costs are not affected by whether the pipe diameter is 6, 8, or 10 inches. Secondly, the cost of the pipe itself often does not increase in proportion to the diameter. This certainly is true of smaller diameter pipes.

These two economic-engineering relationships compound the cost of capacity. If pipe capacity rises with

Attachment 1

the square of the diameter, and cost rises (very conservatively) only with the square root of the diameter, then the cost of delivery capacity rises only with the *fourth root* of capacity needs.

This relationship exists for electric transmission and distribution lines, too, where the peak capacity of the line increases with the square of the voltage, but the installed cost of a line increases much less than proportionally with voltage. As a result, the installed cost of electric lines can increase as slowly as the *sixth root* of the design capacity.

When economies of scale are significant, it's inappropriate to spread costs in relation to system demand.

Figure 1 contrasts the proportional assumption with a cube- or fourth-root assumption. While the proportional cost assumptions would suggest that costs rise rapidly as one seeks to meet peak loads, the fourth-root relationship suggested by actual economics-engineering relationships indicates that costs do not vary much with peak loads. Figure 2 applies these two cost-allocation approaches to the calculation of peak and offpeak costs using the base-excess approach widely favored in the water industry. For peak loads three times greater than offpeak loads, the proportional assumptions would suggest that peak costs per unit climb to five times the offpeak cost. If, on the other hand, we make use of the actual relationship, the peak costs per unit rise only 63 percent above offpeak costs—not 400 percent above.

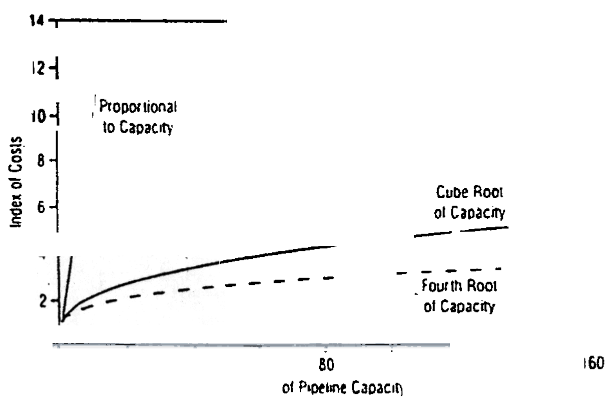

Figure 1. How costs v with pipeline capa the impa differen assumptions

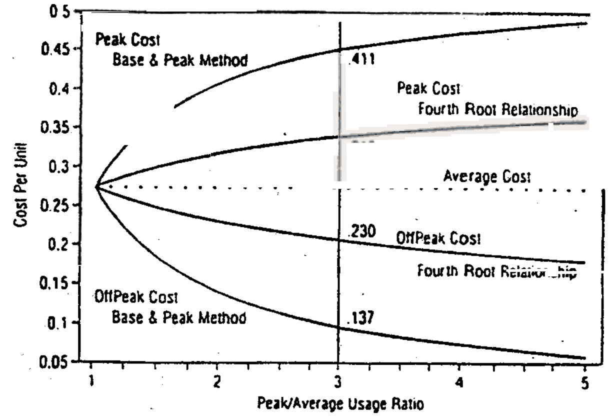

Figure 2. Peak and offpeak costs under alternative cost assumptions

Utilities Understand Their Capacity Costs

Utility planners *know* that capacity costs do not increase in proportion to the peak. This is evident, for instance, in the choices utilities make in designing transmission and distribution systems. Because additional delivery capacity can be obtained so cheaply by laying a somewhat larger line, utilities almost always install what is at the time redundant capacity in their delivery systems. The cost of removing and replacing transmission and distribution lines is so much higher than the cost of initially installing a slightly larger line that utilities as standard practice install the next larger line than projections of future demand indicate as appropriate.

If utility planners recognize the significant economies of scale associated with increasing delivery capacity, why should cost analysts not do the same? They should allocate costs on the same empirical economics-engineering relationships that are used to plan the delivery system.

Significant economies of scale are not limited to pipeline systems. One can find them in electric transmission and distribution, in natural gas storage, and in water treatment, to name just a few. Consider the water treatment plant costs in Table 1:

Table 1

Water Treatment Costs

Total Cost ($MM)	Capacity (MM gallons/day)
$14.8	8
$18.2	16

In this example, the utility testified that much of the $14.8-million cost of the initial capacity of 8 million of gallons/day (MMgd) was fixed and would have been incurred regardless of the capacity of the plant because the "laboratory, laboratory equipment, control room, control system, administrative area, chemical feed area, maintenance shop, river intake, pumping chambers, site improvements, etc. are necessary no matter what the production capacity of the plant might be." This cost information supports the basic idea that as daily demand rises, so does the cost of meeting that demand, though much less than proportionally. One can interpret this cost data either linearly—assuming a large fixed cost ($11.5 million) and a very low linear (proportional) incremental cost ($400,000 per MMgd)—or using a power function (sixth root). The proportional assumption implicitly assumes that the cost of additional capacity was $1.9 MMgd when, in fact, the cost of additional capacity was $200,000 to $400,000 MMgd. That is, using a proportional assumption could skew the result by a factor of five to 10.

Implications for Rate Design

When significant economies of scale are present, it is clearly inappropriate to allocate costs and set rates in proportion to the demand placed on the system. The less-than-proportional nature of the cost relationship has to be taken into account. One way of doing this would be to simply replace the proportional assumption with the appropriate n-th root assumption. Consider the example in Table 2:

Table 2

Water Utility Plant Alternative Allocators

Customer Group	Average Daily Use (MMgd)	Maximum Hour Consumption (MMgd)	Avg. Use Allocation	Peak-Hour Allocation (Proportional)	Peak-Hour Allocation (Fourth Root)
Residential	20	60	44%	62%	49%
Commercial	15	26	33%	25%	32%
Industrial	10	10	22%	10%	19%
Fire Service	0	3	0.2%	3%	0.4%

Residential peak demand is three times average use, while industrial use is flat across the year. The commercial class falls in between. An allocation of costs in proportion to peak load would boost the residential cost share by 40 percent compared to an allocation based upon average or commodity use. Industrial customers, on the other hand, would see an allocation only half as large as suggested by commodity usage under a proportional peak load allocator. Traditionally, such divergent allocations would be justified on the basis that the delivery system "had to be designed to meet peak loads." But if the cost of meeting peak loads increases only with the fourth root of the capacity, an allocation much closer to the commodity allocation would be appropriate. The residential peak allocator would rise only 11 percent above the commodity allocation, not 40 percent above it. The industrial allocation would fall 14 percent below the commodity allocator, not 50 percent below it. *(Note: The fourth root allocator is calculated by taking the fourth root of the ratio of peak to average usage, then multiplying this times the average use. The sum of these class values is then used as the denominator in calculating the percentage allocator for each class.)* Clearly, the economic-engineering assumption makes a significant difference in cost allocation.

The same would be true in the design of peak-period prices. If the demands in excess of the average annual level are assigned solely to peak-period usage, as Figure 2 indicates, peak period rates dramatically exceed offpeak levels—by 200 percent where the peak load is twice the average load, as in the example above. If the fourth root relationship is used instead, the peak period rates would total only 38 percent above the offpeak rates.

Real World Examples

Testimony advocating these ideas was presented by the author in the following cases:

Electric:
Idaho Pwr. Co., Case No. IPC-E-94-5 ((Idaho P.U.C. 1994).

Natural Gas:
No. Illinois Gas Corp., Dkt. No. 88-0277, June 21, 1989, 103 PUR4th 290 (Ill.C.C.).
Cascade Nat. Gas Corp., Cause No. U-86-100, May 20, 1987, 84 PUR4th 119 (Wash. U.T.C.).

Water:
Boise Water Corp., Case No. BOI-W-93-3, July 14, 1994, 153 PUR4th 320 (Idaho P.U.C.).

The Case Against Customer Charges

These results may simply confirm the logic of a "minimum system" approach to distribution cost allocation: Economies of scale flow from the high fixed costs associated with any distribution system, no matter what its design capacity. This view holds that delivery system costs are fixed and should be collected not on the basis of peak demands but through monthly fixed "access" charges that are not usage-sensitive.

The alternative view finds these costs incurred to sell profitable volumes of commodity throughout the year. Most utility line-extension policies confirm this cost-causal utility motivation, tying the investment the utility is willing to make to the revenues the utility expects to receive on sales volumes throughout the year. Advocates for this approach would point out that a competitive economy rarely enables any business to collect high fixed costs through fixed "per-customer" charges. Almost all competitive businesses must collect their "fixed overhead" costs in usage-sensitive charges. Competition tends to bid down any customer "access" fee such as entrance charges or annual service charges. Only businesses with significant monopoly power can cover their fixed costs through a fixed customer charge.

If regulation seeks to reproduce the results of a competitive economy, rate designs containing high fixed charges are inappropriate. Usage-sensitive rate design would then be appropriate for collecting delivery system costs. Because of the substantial economies of scale, even after accounting for the impact of peak loads, the cost allocation would largely resemble a volumetric or commodity allocation. This may explain the significant role that volumetric allocations have always played in utility rate design. ▼

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Courts Reject FCC's Flexible Pricing Again

The Federal Communications Commission (FCC) has been rebuffed yet again by the courts in its effort to relax tariff filing requirements for nondominant common carriers. The U.S. Court of Appeals for the District of Columbia Circuit thwarted the FCC's latest attempt, rejecting proposed rules that would permit the nondominant carriers to file a range of rates rather than fixed rates tied to a schedule of charges.

The courts had earlier overturned a series of FCC rulings. In those cases, the courts denied the FCC authority to allow the detariffing, citing the Federal Communications Act of 1934: "[e]very common carrier . . . shall . . . file" tariffs with the FCC. In its recent case, the FCC argued that the Communications Act does not precisely define the type filing required, and therefore permits a tariff containing a range of rates. As in the past, the FCC claimed that strict tariff requirements were counterproductive and inhibited price competition in the marketplace. The circuit court rejected this argument, however, finding that the Communications Act clearly requires all carriers to file "schedules showing all charges." Relying heavily on a 1994 decision by the U.S. Supreme Court concerning FCC authority to modify legislative requirements *(MCI Telecommunications Corp. v. AT&T 114 S.Ct. 223)*, the circuit court ruled that the FCC must take its case to the Congress if it believes that existing legislative mandates are inadequate under current market conditions. *Southwestern Bell Corp. et al. v. Federal Communications Commission, Nos. 93-1562 et al., Jan 20, 1995 (D.C.Cir.).*

Florida Approves Decoupling Mechanism

Florida Power Corp. has won approval for a three-year experiment to remove existing disincentives to investment in conservation programs by "decoupling" residential revenues from sales for ratemaking purposes. The mechanism permits customer surcharges and refunds if revenue levels vary from targeted levels.

The new mechanism relies on a per customer revenue target figure based on the allowed revenue and average residential customer count used in the company's last rate case. The target is then adjusted to account for projected per customer revenue growth and changes in personal income. According to the utility, the adjustments assign more of the economic risk to shareholders. Customer surcharges or refunds are permitted if revenue levels vary from targeted levels, but will only be implemented to the extent that company earnings remain within a specified range.