

Internet Data Centers & Electricity Growth

Will the Emerging Power Crisis Burn Your Bottom Line?

Part 1 of 2

By Thomas J. Grahame and David Kathan

Internet data centers, specifically the large amounts of electricity they draw, have recently been blamed in part for tight electricity markets and rising electricity prices in several regions, notably California and the Pacific Northwest.

In this article and a companion piece in the June/July issue of *Broadband Wireless Business*, we will explore the context into which requests for large, dense electricity loads suddenly appear; how much electricity these "telecom hotels" are likely to draw; what these demands mean locally and nationally to electricity providers and regulators and how the broadband wireless community might be able to help the community of electricity planners and engineers understand longer range electricity needs of internet data centers.

Context: What's a Megawatt, and why is there a fuss about new data centers?

Electric utility planners and engineers think in terms of megawatts, or MW. For instance: 1,000 MW is enough power to serve roughly one million homes. One big nuclear power plant is about 1,000 MW, as are two 500 MW coal plants, 4 new 250 MW natural gas combined cycle units, or 10,000 distributed generation units of 100 kilowatts (kW) each (1,000 kW = 1 MW).

Electric utilities -- the ones who own the lines, hook up data centers, and usually have to supply them with electricity -- in the recent past have seen growth of about 1 percent to 3 percent per year. Thus for a medium sized utility of about 5,000 MW of capacity, growth might be expected to be about 50 to 150 MW per year. Capital spending plans (for new power sources, transformers, and/or transmission and distribution lines) would be geared toward meeting this type of load growth. Some utilities have agreed for any number of reasons to cap the rates they charge customers for several years. Therefore...large, unexpected requests for power, which may require unbudgeted utility expenditures to serve, may set off alarm bells with both utilities (which may not be able to recover larger capital expenditures due to the rate cap), and their regulators (virtually all electricity transmission and distribution lines, and much electric generation, are rate regulated).

Here's Why...

In December 1999, a medium sized utility outside of Seattle, Puget Sound Energy (PSE), had no requests for electricity to serve large Internet data centers. In August 2000, they had requests for 445 MW from such centers. By September, the requests had reached 700 MW. Briefly, requests ballooned to over 1,000 MW, until the economic slowdown and dot.com implosion came, reducing total requests to about 750 MW. Whatever load these centers actually draw will be added over about 4 years. And there may well be further requests in the next few years. Over 4 years, 750 MW would more than double the loads that PSE planned for.

Such growth becomes a political issue. Rates in the Pacific Northwest are low because of the substantial (but limited and variable) amount of hydroelectricity that is usually available. Any additional loads will have to be met either with new plants, which take a minimum of 3 to 4 years to plan and build, or on the wholesale electricity markets in the West -- and looking at California, you don't want to go there. Tacoma, Wash., recently has had to raise customer rates by almost 50 percent to reflect the need to purchase power on wholesale markets, and Seattle has also had to raise rates substantially.

Bottom line: in areas such as much of the West coast, new load means the addition of more costly capacity or power purchases, resulting in higher average rates for all customers, if the new loads and the existing ones pay the same rate. And higher average rates means consumer activists and politicians raising a ruckus. The ruckus may lead to demands for new data centers to shoulder the entire electricity price increase, or to supply much of their own electricity (not counting backup power). Data center loads are rapidly becoming a political issue in electricity-short California, despite the importance of data centers to the information economy ["Net Complex a Dilemma For San Jose: Server Farm Plant Would Tax Grid," *San Francisco Chronicle*, Thursday, March 22, 2001, contrasts San Jose's approval of a new data center requesting 180 MW, enough power for a small city, with its rejection of a new 600 MW power plant.]

How much load will data centers actually require?

We have contacted utilities in 17 of the approximately 35 localities that might be expected to have significant data center loads. Based on these contacts, maximum existing requests at these 17 locations are almost 10,000 MW, and the minimum expected loads from identified requesters are about 3,500 MW. We scale these numbers up by 50 percent to recognize that the remaining 18 localities will also have data center demands, but that they will likely be smaller than the average of the first 17 localities, which include San Francisco, New York, Seattle, and Los Angeles, in addition to smaller locations such as Austin. Recognizing that the maximum requests are unlikely to occur, we roughly estimate that in the next 4 years, there will be between 5,000 and 10,000 MW of new electricity demand from data center requests currently on the board.

Nationally, these figures would add about 1/4 to 1/2 of 1 percent to national load growth. At the upper end, this is about a 20 percent to 25 percent increase in projected electricity loads: not huge, but a noticeable increment. It is at the regional level -- mostly on the two coasts, which have the tightest electricity supply and the largest Internet loads -- that these electricity needs may become quite large, relative to previous estimates of growth, and may pose the most contentious problems.

(Continued on page 36)



*(Continued from page 34)***What are the uncertainties?**

Four major ones are:

- How many of these requesters will drop by the wayside?
- How many centers will never be fully leased?
- What will be the electricity needs per square foot of future generations of servers, which likely will be more compact but also use more efficient chips?
- And will data centers really use the 100 watts/square foot that many of them request (for perspective, an office tower typically will use 4-to-6 watts/square foot.)

Most utilities we have contacted believe, as a planning assumption, that data centers will actually use 40-to-50 watts per square foot, partly because of concerns about full leasing, but also because limited tests of smaller data centers currently in existence support the lower numbers. Our sense, based on a limited number of very recent interviews, is that more additional data center space continues to be requested than the utilities had been planning on in the fall. Yet there are also concerns about whether the dot.com implosion and/or the economic slowdown may reduce the growth rate for data center space. The best summary at present might be that the situation is fluid.

There is another important uncertainty: how many more data centers, not on anyone's planning horizon at present, will materialize, ask for power, and end up as real projects in the next 4 years? In our informational requests, we have been steered to the utility planners and engineers whose job it is to build infrastructure to meet new loads under construction or very nearly so, in all but one case. In this last case, a vice president of a Pacific Northwest utility estimates, using 50 watts/sq. foot for electricity usage in data centers, that about three times as much power will actually be used at data centers in four years time (about 700 MW), than is currently estimated by the engineers meeting the needs of data centers being built or likely to start construction soon (about 200 MW). With such limited data, we have not included any estimates of what these "unseen" future data center loads might be, but it is an issue that bears watching.

How can the Broadband community help the electricity community?

In the long run, servers and routers may shift to optics instead of electricity (for instance, see March 26

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article discussing different electricity needs of optical switching vs. opto-electrical switching, at <http://biz.yahoo.com/smart/010326/200103261tech-mark.html>). It isn't utility managers who are best positioned to estimate how a change to a mostly optical system may affect electricity use, or to estimate how much internet traffic will grow, and what that will mean to electricity use. In general, the electricity community could greatly benefit from estimates of future electricity needs, driven by technological change, which can be provided and aggregated best by the Broadband community of wireless and wireline carriers.

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mate of the internet's electricity use (and thus needs) going forward. Utilities have longer lived equipment that is large and bulky and takes a long time to build (both generation and transmission equipment), as does the infrastructure to produce and transport fuel, such as natural gas pipelines and coal facilities. In large part because of these features of their world, utilities have had a different planning time frame than those in the Broadband community. But their plans need to be informed by what the Broadband world will require of them, and in what time frame, and you can help them. **BWB**

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Internet Data Centers: Demands for Electricity Proceed Unabated

Part 2 of 2

By David Kathan and Thomas J. Grahame

In this second part of our report on energy demands, two leading experts – one with the U.S. Department of Energy and the other with a prestigious consulting firm – further explore this issue.

In the last issue of *Broadband Wireless Business* (May 2001), we reviewed the large, dense electricity loads associated with Internet data centers. Based on a survey of key utilities, we roughly estimated that in the next four years, there may be between 5,000 and 10,000 MW of new electricity demand from data center requests currently on the board.

Increases of this magnitude, particularly since they are concentrated in key metropolitan areas, could produce important and serious impacts on electric utility planning, operation and financing. This article explores the dimensions of these impacts and presents what these demands could mean locally and nationally to electricity providers and regulators. This information should help the broadband community better understand why demand increases are significant for the electric utility industry.

Electricity Demands of Internet Data Centers

The electricity demands of the data center sector are characterized by rapid growth, high electric intensiveness, high load factors and the need for high reliability.

Rapid Growth

The 5,000- to 10,000-MW growth associated with Internet data centers translates into rapid increases in electricity demand in both the near- and long-term. The impact of this growth is magnified by its concentration in metropolitan areas, such as Chicago, Seattle, the San Francisco Bay area and Texas, and by the speed of the rollout. As reported in our earlier article, requests for service to support Internet data cen-

ters jumped from zero in 1999 to 700 MW by September 2000.

Companies and the developers of these facilities want to be up and running within months, with time to market being a key determinant of their eventual success. However, it is frequently difficult to get the necessary permits, order the necessary equipment, and complete distribution network upgrades within this timeframe.

High Electric Intensiveness

The Internet data center sector is particularly electric intensive, with usage per square foot at least 10 to 15 times more than typical office buildings when

fully built-out. Some utilities are concerned that a potential oversupply of data centers, and an associated prospect of data centers being unable to fill their built space, might mean that these high-power densities cannot be achieved in practice.

Utilities are also concerned about the permanence of data centers at these sites. If a data center closes down or moves to new location, the cost of the upgrade (which is typically written off over 20 to 30 years) would not be recovered through revenue from the facility. As a consequence, costs of upgrades may end up being stranded. Also, with data centers located in suburban office parks or in downtown buildings, these new facilities place an unusually large load on distribution systems not designed for this usage.

High Load Factors

Internet data centers have high load factors. The always-on nature of the Internet translates into the need for 24/7 operation for companies and services associated with the Internet, especially with regard to servers and storage facilities at Internet data centers. Load

research on data centers suggests a load factor of over 95 percent.

High Reliability

Internet data centers require highly reliable power. Servers require high quality and reliable electricity, as electronic equipment cannot tolerate interruptions in electricity for more than a couple hundredths of a second. This translates into a need for an electricity supply that is at least available 99.9999% (also known as "six nines") of the year. The need for highly reliable electricity is even more acute for the services that Internet data centers support. E-commerce firms and B2B markets will lose millions of dollars and customers if they fail while transactions are occurring.

When electricity is unreliable, web-hosting services, along with other high technology and new economy companies, may choose to relocate. The ongoing electricity crisis in California has led many new economy companies to rethink their California operations. Web hosting companies, such as Rackspace, are actively marketing their non-California-based locations to gain new business and steal business from California hosting sites.

Implications for the Electric Power Industry

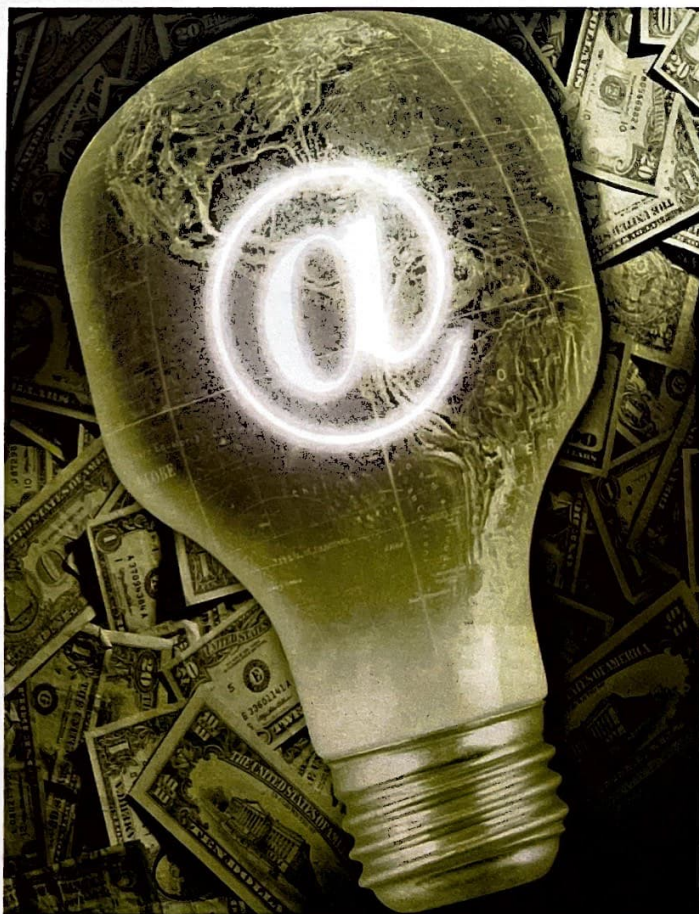
Rapid growth in the data center sector has important implications for the electric power industry. In particular, demand from this sector will likely put additional stress on regional grids and local distribution networks that have already been severely stressed during the summers of 1999 and 2000. The ability to respond to this new demand is further constrained by the half-deregulated status of the electric system. Specific implications include:

- Need for new generation capacity;
- Need for new transmission capacity;
- Need for upgrades to distribution systems;
- Increased interest and role for distributed generation; and
- Possible revisions to existing tariffs to recovery upgrade costs.

Generation Capacity Needs

Increased electricity demand associated with Internet data centers may require new generation capacity, particularly in key regions. New generation capacity is in the pipeline nationwide, but actual construction has lagged, partially due to siting concerns.

Any up-tick in the need for new generation must also face a tight market for new gas turbines, the preferred technol-



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ogy for new power plants, as well as potential shortages of natural gas. There may not be sufficient reliable capacity to serve new data centers in the near term in regions such as California that are already capacity short.

Additional Transmission Capacity Needs

As has been found in California, construction of new generation facilities to serve growing demand is typically very difficult. Without local generation, the demand for additional transmission capacity to import power will become more crucial. However, the construction and/or upgrading of transmission lines to serve metropolitan areas can be more difficult than siting new power plants. For example, new transmission line construction required to serve data centers is being opposed in Northern Virginia, which, along with such areas as the Silicon Valley and Seattle, is a high-tech center of telecommunications/Internet companies.

Upgrades to Local Distribution Networks Will Be Required

Local distribution systems will also need to be upgraded to meet the increased demand of the new economy and Internet data centers. The dense electric intensity of Internet data centers will place increased demands on local distribution networks. The investments required for these networks will have to come at a time when many utilities are under rate caps and freezes as part of their restructuring or merger agreements.

New data centers may also create specific distribution network problems. Data centers are being built in downtown locations or in suburban environments, where they might draw, for example, 40 MW on a site originally

planned to draw 4 or 5 MW. In order to accommodate these facilities, distribution companies will need to upgrade their network and install additional feeders. In many cases, new transformers will be needed at the customer site to support the increased data center load, but the added load may propagate back through the system and require system-wide upgrades. For example, Commonwealth Edison is being asked to serve the load of multiple data centers that are being built within a four sq. mile area. Assuming that the data centers will use all of the power requested, this small area will require the addition of three new substations.

Increased Need of Distributed Generation

Another key implication of the new economy, and of data centers in particular, is increased use of distributed generation (DG). All data centers are designed to include onsite backup generation to provide uninterrupted power. Indeed, the needs of e-commerce companies and the uncertainties created by electric restructuring have produced record demand for onsite power.

Increased use of DG will require further development of regulatory policy to facilitate operation of onsite generators, particularly interconnection standards and environmental regulation. Operation of onsite backup generators is generally limited by local environmental policy to only emergency periods or below a set amount of hours. For example, as of May 2001, environmental regulators in New York narrowly define emergency periods to include only those periods where there is a power interruption or outage. Operation of these generators during capacity emergencies announced by the New York Independent System Operator is not allowed.

Adequacy of Tariffs

The distribution upgrades and new generation capacity requirements created by the new economy, particularly data centers, raises the question of whether existing tariffs and policies are sufficient to recover the additional investments required to serve this load. Due to vacancies at data centers, technology shifts that reduce the need for data centers, or relocation of data centers, there are concerns that data centers may not ultimately achieve the power densities originally requested at their original sites. Consequently, the investment in the excess service capacity may become stranded, and may not be recoverable through rates. These stranded investments will eventually be recovered from all customers or from shareholders.

Depending on the jurisdictions and the adequacy of existing tariffs and policies, electric utilities have several options available. First, new tariffs and rate classes can be developed solely for the customer segments creating the need for upgrades. This option makes the most sense where the additional demand creates an identifiable incremental change in system operation and costs, e.g., need for baseload generation in a capacity-short area. The Seattle City Council and the Washington Utilities and Transmission Commission have examined proposals by Seattle City Light and Puget Sound Energy, respectively, to implement new tariffs for these large, dense loads. These proposed tariffs recover the necessary upgrades and need for new generation purchases through a combination of up-front payments and higher customer charges.

Second, since it is difficult to create new rate schedules or modify existing tariffs outside of rate cases, the other and more prevalent alternative is to

use existing line extension and dedicated facilities policies and rules. These rules allow utilities to recover upgrades that are above normal hookup costs or are associated with equipment dedicated to only one customer. These upgrade costs can be recovered upfront from customers as a lump-sum payment, amortized over several years, or collected above a minimum level of electric intensity, e.g., 20 W per sq. foot. These upfront payments are generally refunded through rates over time as the facility reaches full occupancy and achieves the level of service originally requested.

Summary

The rapid growth of the Internet data center sector has important implications for the electric industry. Chief among these implications is the need to upgrade local distribution networks to support the large, dense load of Internet data centers.

Electric utilities are reluctant to invest significant sums of money on these upgrades without assurances that the load will develop and will be in existence in five to 10 years or longer. These concerns have led to the use of policies that can involve significant upfront payments from Internet data center owners. Given these concerns and needs of the electric utility industry, the broadband community should work closely with electric utilities in the creation of upgrade recovery mechanisms that are acceptable for both parties.

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