Electricity Infrastructure

Section 5

Americans take electricity for granted. We do not worry about "generation capacity" or the "power grid" until the lights dim or air con no longer clicks on. But people who do think about these things see dark days ahead. "Thirty years ago, America had the best electrical utility grid system in the world," says Otto Lynch, the chair of the American Society of Civil Engineers' (ASCE) Structural Engineering Institute. The problem is that while the country has the same system today, "It's not the best anymore."

The nation's electric power grid is aging. Power lines with an expected life of 50 years are still in use 80 years after installation, and wooden poles that should have been replaced after 30 years are rendering as much as 20 additional years of service, Lynch notes. And this system is facing new challenges as the population grows, industrial activity increases, and the demand for power rises.[1]

The need for more generating capacity was starkly demonstrated by an electricity shortage in California in the first half of 2000, the most severe energy crisis in the U.S. for many years. This was followed in August 2003 by the most extensive blackout in U.S. history, affecting 50 million people across a wide swathe of the northeastern U.S. and southern Canada.

Electricity by the Numbers

16,924 electric utility generators in the U.S. (2007)
2.5 billion tons electric industry CO_2 emissions (2006)
49 percent coal's share of the nation's electric industry fuel (2007)
3 percent renewable (biomass, wind, solar, geothermal) share of electricity fuel (2007)
$5.1 billion annual cost of complying with federal environmental regulations
5 to 10 added cost factor of putting overhead power lines underground

Electric Distribution Spending
2005: $15 billion ($50.73 per capita)
2050 Projections (a)
$22.2 billion: at current population trends
$19.3 billion: at 50-percent reduction in immigration
$16.4 billion: at zero population growth immigration

Note: a. Assumes per-capita spending remains at 2005 levels.

Sources: Edison Electric Institute, Pew Foundation Research.

Without additional resources, many parts of the nation, especially California, the Rocky Mountain states, New England, Texas, the Southwest, and the Midwest, could again fail to meet the demand for power, warns the North American Electric Reliability Corporation (NERC) of Princeton, New Jersey.[2] While prolonged blackouts are expected to be rare, the power grid would be less capable of handling unexpected events, such as extreme weather or the sudden outage of a major plant.

When NERC surveyed 230 bulk power system users, owners, and operators in 2007, ranked first among the technical concerns listed in the survey was the "aging infrastructure and limited new construction."

The Problem: Too Many People

Why haven't electric utilities built sufficient supply? Many factors can be cited as explanations, but a good place to start is at the source of all power: electric generators. They are costly and must be sized according to the population served. Here are the ballpark figures:

> The purchase price of electric generators is something like $1 per watt. Coal plants may cost more, nuclear plants will cost a lot more, while natural gas turbines cost perhaps half of this. Let's use $1 per watt as

> the basis for some very simple calculations. As a rule of thumb, utilities need about 1,000 watts of capacity for one person. This means that for every person who moves into the service area of an electrical utility, the utility must spend about $1,000 in capital costs for the purchase of new electric generators. (This does not include fuel and other operating costs, nor does it include the costs of expanding the electrical distribution system that conveys electricity to the consumer. This is simply the cost of purchasing and installing the hardware that generates the electricity.)[3]

If a million people are added to the U.S. population, then utilities must come up with another $1 billion for a billion watts (one gigawatt) of new electric generators. If 142 million are added—the expected population growth between now and 2050—utilities must come with an added $142 billion *just to keep generator capacity at recommended per-capita levels.*

The dilemma facing utilities is perhaps best appreciated at the individual customer level. If a utility's population base is growing by 1 percent per year, then every person in the service area must pay an additional one percent of $1,000, or $10. This is the per-person cost of generators needed to keep capacity at the recommended 1,000-watt per-capita level.

The U.S. population is growing at 1 percent per year, on average. In areas of high immigration, higher rates are not unusual. If a utility's population base is growing at, say, 3 percent per year, then every man, woman, and child in the service area must pay an additional $30 per year to fund new generating plants. That is $120 a year for a family of four.

If bonds are used to finance the generators, the annual costs may triple.

These numbers suggest why, in recent decades, electric utilities in high immigration areas of the U.S. have been reluctant to purchase new generating capacity. They do not want to hit customers with rate hikes of this magnitude. In many locations, utilities were not allowed to pass these costs on to customers.

Is 1,000 Watts per Person Too Much?

Little by little, Americans are learning to conserve power. Case in point: California's per-capita electricity demand actually decreased 5 percent during the 20 years before the electricty crisis hit, from a carrying capacity of 7,292 kwh in 1979 to 6,952 kwh in 1999.

Let's assume that the "rule of thumb" for generator capacity in California also dropped by 5 percent, or from 1,000 to 950 watts per person. Where would that have left the state's utilities?

Answer: Still behind the curve.

That is because the state's population grew by 43 percent, or more than 8 times the decline in per-capita demand, over the same period (1979 to 1999). Rate hikes in excess of $1,600 per year for a family of four would have been required to maintain per-capita generator capacity at recommended levels over that period of time. That is obviously unthinkable—even in a deregulated market. The resulting energy shortage was, by comparison, easier to accept.[4]

Bottleneck Ahead: the Power Grid

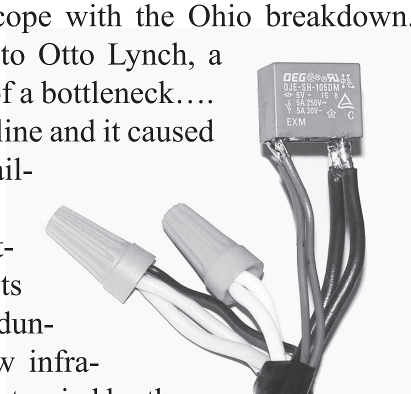
If you generate power, will they receive it? At one time this was a silly question. The U.S. had the most extensive power grid in the world, full of redundancies that insured uninterrupted power flow. Those days are over. ASCE's latest infrastructure *Report Card* was decidedly pessimistic on the U.S. power grid:

> The U.S. power transmission system is in urgent need of modernization. Growth in electricity demand and investment in new power plants have not been matched by investment in new transmission facilities. Maintenance expenditures have decreased 1 percent per year since 1992. Existing transmission facilities were not designed for the current

> level of demand, resulting in an increased number of 'bottlenecks' which increase costs to consumers and elevate the risk of blackouts.[5]

Problems with the U.S. power grid have been apparent for most of this decade. The extensive blackout of August 2003, for instance, started with a shorted-out power line in a remote area of Ohio. The subsequent event plunged approximately 50 million people into darkness from New York City to Toledo, Ohio, and from Ottawa to Windsor, Ontario.

The cascading disaster demonstrated just how fragile our interconnected power system is. The electrical grid across America relies heavily on individual power lines and did not possess the redundancy needed to cope with the Ohio breakdown. It was, according to Otto Lynch, a "perfect example of a bottleneck…. They lose a single line and it caused a catastrophic failure."



Making matters worse, attempts to provide such redundancy through new infrastructure are often stymied by the not-in-my-backyard (NIMBY) reflex. During the 1990s, American Electric Power, of Columbus, Ohio, proposed a new transmission line to serve Virginia and West Virginia. Construction of the line, which crossed several areas of federal land, took just two years. But the approval process lasted 14 years.

This is not an isolated incident: politicians and regulators in one state or region often will not allow expansion of the power grid for fear of angering their constituents or activist groups.

The electric power grid is arguably in worse shape than electric generation infrastructure. This is not surprising, given the possibility that urban and suburban sprawl —the area over which electricity must be conveyed—is growing faster than the overall demand for electricity. By displacing residents from central cities, immigration could well be a contributing factor.

California's Energy Debacle

The California power crisis was triggered by a fundamental imbalance between the growing demand for power and stagnant power supply. It can be argued that the state's accommodative policy toward illegal immigrants was a major factor behind demand growth. At the same time, state regulation artificially reduced electricity supply.

The energy crisis was characterized by a combination of extremely high prices and rolling blackouts lasting from May 2000 to September 2001. Due to price controls, utility companies were paying more for electricity than they were allowed to charge customers, forcing the bankruptcy of Pacific Gas and Electric and the public bailout of Southern California Edison. This led to a shortage in energy and subsequently to the blackouts.

California's energy regulations did not allow utilities to hedge against future price hikes by purchasing forward contracts. This gave energy suppliers enormous leverage over their utility customers. By keeping their capacity low relative to demand, suppliers could effectively hold the state hostage by shutting down their plants for "maintenance" in order to tip the demand-supply balance in their favor. These critical shutdowns often occurred for no other reason than to force utilities to purchase electricity on the "spot market," where private suppliers could charge astronomical rates.[6]

Middleman wholesalers such as Enron exacerbated the crisis. In a market technique known as megawatt laundering, for example, Enron bought up electricity in California when prices were low to sell out of state, creating shortages. In some instances, Enron deliberately timed the out-of-state sales to create congestion and drive up prices in California.

Under California's bizarre regulatory regime, utilities no longer owned their own generators. They thus had no incentive to continue funding demand-side management programs as a means of avoiding generator costs. The California Energy Commission estimates that Demand-Side Management (DSM) programs helped reduce California's electricity loads by about 10,000 MW, the equivalent of 20 medium-sized power plants. California was the U.S. leader in energy efficiency. During the 1990s, power consumption in the U.S. grew at 2.2 percent per year, more than twice the annual growth in the nation's population, and 0.7 percentage points higher than California's growth rate.[7]

Could demand reduction have prevented the crisis? Not a chance. As noted, California's population growth more than offset the reduction in per-capita electricity demand.

Bottom line: California's flawed energy deregulation scheme only masked the primary culprit—explosive population growth.

Green Electricity?

Al Gore wants the U.S. to generate 100 percent of its electricity from zero-carbon energy sources within a decade. This is achievable, he claims, because the cost of power from renewable sources, like wind and solar, has been rapidly reduced in recent years while fossil fuel prices have skyrocketed. Further technological advances could obliterate the cost advantage of conventionally produced electricity altogether, making green power both economically and environmentally optimal.

Reality check, please.

Fossil fuels are used in 71 percent of U.S. electricity production, led by coal (49 percent), natural gas (20 percent) and oil (2 percent). Nuclear power underlies 19 percent of electric output, and hydropower 7 percent. That leaves the carbon-free renewables—wind, solar, geothermal, and biomass—at 3 percent.[8]

The inexorable reality is that a 90-some fold increase in renewable energy infrastructure would be required to realize Gore's goal. This in inconceivable, especially given the unfunded needs of existing (conventional) power plants.

If any place is capable of going 100-percent green, it is California. The state is well endowed with wind and solar energy sources. Hydropower already constitutes about 15 percent of California's in-state production—more than twice the national average. And over the past three decades Californians have managed to keep their per-capita energy usage, already the lowest on the nation, essentially flat, even as energy use per-capita rose 50 percent in the rest of the country.

But population growth overwhelmed the good wrought by efficiency and green electricity initiatives. Carbon emissions from the Golden State are higher than ever.

Former Vice President Al Gore

Gore should learn from California's experience, and add population—and immigration—control to his green agenda.

Indeed, anyone concerned about the sustainability of America's power grid should make immigration control a top priority.

The Terrorist Threat

When the largest power failure in U.S. history struck the U.S. and Canada in August 2003, terrorism was among the initially suspects. That fear proved unfounded—but the vulnerability of the power grid to attack is real and has not been adequately addressed since 9/11.

Although nuclear plant security has been the focus of most anti-terrorism efforts in the energy space, Al-Qaeda and other terrorist groups are known to have considered all power facilities as possible targets. Extremist groups around the world often attack power lines.

Cyber attacks against the programs that orchestrate power plant operations would be equally disruptive. According to Richard Clarke, a former National Security Council member, a Chinese general has said they would reach out through cyberspace and turn off our electric power grids before any conflict with the United States.[9]

Increased surveillance, employee background checks, strengthened physical barriers, and computer firewalls, are all part of the standard anti-terrorism response. Immigration policy should be on the list also: All the 9/11 terrorists entered the country legally – some as students, some as "tourists." [10] ■

Endnotes

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