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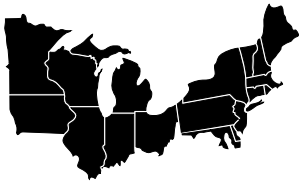
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The Northeast-Midwest Institute is a Washington-based, non-profit, and non-partisan research organization dedicated to economic vitality, environmental quality, and regional equity for Northeast and Midwest states. Formed in the mid-1970's, it fulfills its mission by conducting research and analysis, developing and advancing innovative policies, providing evaluation of key federal programs, disseminating information, and highlighting sound economic and environmental technologies and practices.

The Institute works closely with the Northeast-Midwest Congressional and Senate Coalitions. Formed in 1976, the House Coalition, co-chaired by Reps. Marty Meehan (D-MA) and Jack Quinn (R-NY), is a bipartisan group of 117 lawmakers who recognize the common problems facing their states. The Northeast-Midwest Senate Coalition was formed in 1978 and now is chaired by Sens. Susan Collins (R-ME) and Jack Reed (D-RI). Together, the Coalitions seek to influence those issues of greatest importance to the Northeast and Midwest.

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NEWS

Federal Formula Grant Spending in All 50 States

The Northeast-Midwest region's share of funding from federal formula grants in fiscal 2001 exceeded its share of the nation's population, according to a new Northeast-Midwest Institute report that analyzes how 158 federal government grant programs for state and local governments spent an estimated \$284.9 billion in 2001.

The 18 states in the Northeast-Midwest accounted for 42.8 percent of the total funding to all the states, while constituting 40.1 percent of the population of the 50 states, according to the 297-page report, *Northeast-Midwest Guide to Federal Formula Grant Programs*. Within the region, the Northeast fared better than the Midwest, receiving 25.5 percent of the fiscal 2001 federal grant dollars while accounting for 21.2 percent the country's population; the Midwest received 17.2 percent of federal grant dollars while constituting 18.9 percent of the country's population.

Northeast-Midwest Guide to Federal Grant Programs is available electronically on the Internet at www.nemw.org/FedGrant2001.pdf.

Contact: Matt Kane at the Northeast-Midwest Institute (313/582-6244).

State Brownfield Activities

The Northeast-Midwest Institute has released an updated review of brownfield initiatives and program impacts in the 50 states. The *Brownfield "State of the State" 2001 Report* presents information on the number of brownfield sites in state programs, innovative financing, regulatory incentives, liability provisions, and institutional controls. Economic benefits resulting from redevelopment — such as new

businesses, new jobs, and tax revenues — are also included. This report provides a common ground for analysis and comparison, while demonstrating the remarkable success many states have already achieved.

The updated report is available at www.nemw.org/brown_stateof.pdf.

Contacts: Charles Bartsch and Rachel Deane at the Northeast-Midwest Institute (202/544-5200).

Great Lakes Protection and Restoration Strategy

Great Lakes Task Force co-chairs — Senators Carl Levin (D-MI) and Mike DeWine (R-OH) and Reps. Steven LaTourette (R-OH), James Oberstar (D-MN), Vernon Ehlers (R-MI), and John Dingell (D-MI) — are asking the U.S. General Accounting Office (GAO) to review existing Great Lakes programs, and to analyze how well they are meeting their goals. The Task Forces earlier this year encouraged the region's governors to work with other stakeholders to help develop objectives for a broad Great Lakes protection and restoration strategy. This GAO study will provide important background on existing federal programs serving the region.

Although Congress has authorized several programs over the years to protect and restore the Great Lakes environment, there is concern that the piecemeal approach may result in gaps and duplications in the effort to minimize contamination and other environmental threats. A GAO review, the co-chairs argue, will provide important data for a Great Lakes restoration initiative.

Contact: Joy Mulinex at the Great Lakes Task Force (202/224-1211).

Transforming Electricity

by Thomas Casten and Sean Casten

Profound changes in the U.S. production of heat and power are underway that will dramatically enhance the economy, improve air quality, mitigate climate change, improve balance of payments, reduce system vulnerability, and save consumers \$170 billion per year. The 80-year paradigm of centrally generating most electric power is yielding to a hybrid system that will locate new electric generation plants near users. Distributed generation plants will avoid new transmission lines and, by combining generation of heat and power, will operate at twice the efficiency of the present system.

Recent headlines have trumpeted rolling blackouts in California, as well as nationwide electric and gas price spikes. In the past four years, North American electric grids have been broken by ice storms in Quebec and the American Midwest, as well as overtaxed by heat waves in New York, Chicago, and California. In 1998, Illinois's wholesale electric prices rose 80 times, from a range of 1.5 cents to over \$7.00 per kilowatt-hour. California's recent electric price increases and blackouts created economic and political chaos. Suddenly, the public is concerned about the electric power system. Titanic headlines hint at the iceberg beneath.

That iceberg is the growing illogic of primary reliance on centrally-generated electricity. The current arrangement causes the U.S. power system to burn too much fuel, to invest too much in transmission and distribution, to pollute too much, and to stifle innovation.

Power Problems

To understand today's power-related problems, consider the following:

- Cooling towers discard prodigious amounts of waste heat at a coal-fired power plant in Lemont, Illinois. Across the street, a CITGO refinery burns 8 percent of its crude oil feedstock to produce the heat just thrown away. Unlike their European counterparts, none of the 150 operating refineries in the U.S. recycles any significant portion of their waste heat.
- U.S. industry in 1999 flared enough tail gas to generate 5 percent to 8 percent of annual U.S. electric production, roughly equal to the annual electricity consumption of California.
- A recent study by the Electric Power Research Institute concludes that poor power quality cost the U.S. \$119 billion last year. This is more than a 50-percent addition to the approximately \$229 billion paid for all electricity.

Taken in isolation, any one of these items could be interpreted as a minor market failure. Taken in combination, they hint at a larger problem. The broad causes of that problem are: 1) inadequate transmission, 2) failure to recycle heat, 3) rules and regulations that enshrine yesterday's approaches and block innovation, and 4) the increased power quality needs of a digital economy.

Power Problem #1 — Transmission

The U.S. is completely wired, but it has used up most of its spare transmission and distribution (T&D) capacity. Since 1990, when federal law allowed wholesale electric competition, both independent power producers and utilities have built new generation plants to

supply the growing electric load, but no one has built significant new T&D. The system has become transmission and distribution limited, and the country has experienced increasingly frequent power outages. Power developers build new generation capacity near interstate gas pipelines (for fuel) and near transmission wires with spare capacity (to deliver their power to local markets). The spare transmission capacity of 1990 has nearly all been absorbed. Peak U.S. loads have risen by 17.5 percent in the decade, but transmission capacity has barely grown. New central plants will become harder to locate without major and expensive T&D expansion.

There are deep concerns about how, or indeed whether, society will build new transmission and distribution. The public universally takes a "not in my back yard," or NIMBY, approach. People simply detest new transmission lines, and they regularly mobilize to stop or delay their construction. Lynn Draper, chairman and CEO of American Electric Power, says that it is easier to obtain a permit to build a new coal-fired generating station than to obtain the approvals and right-of-way to build new transmission lines. Most recent U.S. power problems were caused by lack of adequate T&D, and nobody close to the industry believes enough new transmission can be built. Federally-granted eminent domain might speed permitting of T&D rights of way, but it won't solve the problem. The problem is economics.

Consulting firm Arthur D. Little found that new transmission and distribution cost about \$1,260 per kilowatt of new capacity. While today's preferred central plant technology —

combined cycle gas turbines — cost only \$500 per kilowatt to build, someone must pay another \$1,260 to build new T&D to deliver the power. As spare delivery capacity is used up, consumers can expect real electric rates to rise by about 3.5 cents per kWh to cover T&D expansion. New urban power delivery can cost much more — up to \$10,000 per kW — if one can obtain rights of way. The U.S. needs a fresh approach.

Beyond the problems with permitting and financing new T&D, there is a tremendous uncertainty in the market. Over the past decade, energy market competition has been introduced in stages. While most states are now heading towards full deregulation, none have yet presented a clear “roadmap” with respect to the T&D system. Since utilities do not know whether they will ever be able to recoup their capital investments, the result has been a market-wide reluctance to make major investments in T&D.

These seemingly intractable problems are greatly eased by moving to distributed generation — smaller generating plants, located at or near users *and* connected to the grid. By meeting load growth with new distributed plants, no new T&D will be needed.

Distributed generation, furthermore, avoids the attendant 7.6 percent power losses. At central generation plants, power is transformed to high voltage and then moved through miles of transmission wires, transformed down to distribution voltage, moved through distribution systems, then again transformed down to user voltage levels. Power is lost in each transformation. Distribution generation avoids most of those losses. Distributed plants at user sites lessen power demand on the grid and eliminate related T&D losses. If the on-site plant produces excess power, then regardless of the contract of sale, that power will flow backwards through

existing distribution wires to the nearest node, and then flow to nearby power users, again in existing wires. The power loss caused by moving on-site power to nearby neighbors is less than one third of the losses moving power from central plants.

Each time a new distributed power plant is commissioned, the load on T&D wires is reduced. The remote T&D is only needed if a distributed power generator is out of service during peak loads. Given that today’s plants have average forced outage rates of 2 percent, 100 new distributed generation plants with ten megawatts each will supply 1,000 megawatts of load, but only require 20 megawatts of the existing transmission capacity. These new distributed plants will release 980 megawatts of existing T&D capacity.

Power Problem #2 — Failure to Recycle Heat

Early electric plants were poor at producing electricity from fuel but good at using waste heat. Thomas Edison extracted only 6 percent of the fuel’s energy as electricity, with 94 percent left over as heat, but he sold much of the heat. Today, the U.S. electric system converts 33 percent of the energy in fuel to electricity — more than five times better than 1880 — but recycles little waste heat.

The early central generation plants were located in city centers and fed waste heat into local steam systems. But there were good economic reasons to build larger plants, which could no longer be located in urban areas. Consider the diverse loads. Each streetcar company built a generating plant to power trams during the morning and evening commute, but produced little power during the rest of the day. Other generating plants supplied office buildings during the day, but produced little power at night. Street lighting had its own generating plants that produced

no power during the day. Rural areas had no electric power. Early power entrepreneurs built thousands of isolated generation plants, each serving one building or one factory. Recycling waste heat saved fuel costs, but isolated generation plants, designed for the peak load, had very low load factors, making electricity a luxury.

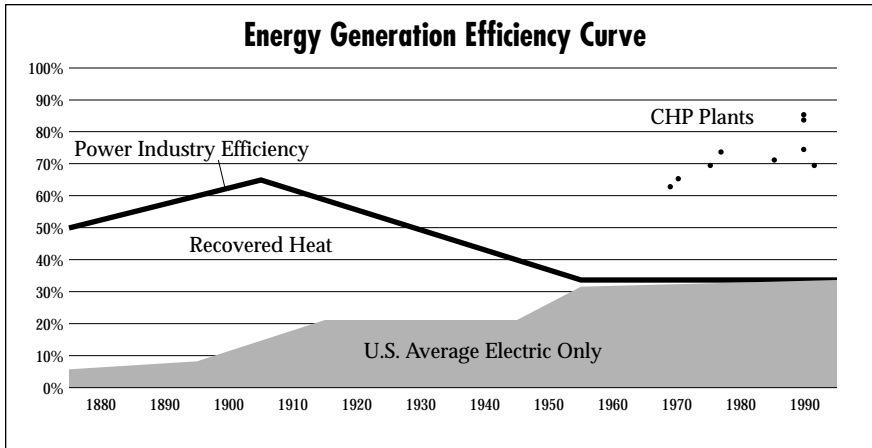
Enter Samuel Insull, principal creator of Chicago’s Commonwealth Edison. With a goal of affordable power, he interconnected different loads, increasing the daily output from each generating plant. He sold power to the streetcar companies, adding morning and evening load to his plants that supplied office buildings. Insull connected some rural communities to increase his summer sales of power. He bought and interconnected the street lighting generators to gain night loads. With each step, he reduced the price of electricity and increased the demand.

By 1925, Insull’s success caused universal embrace of central systems. The economic lesson seemed clear: central generation of electricity was cheaper than distributed generation. But the real lesson was that grid-connected generation is superior to isolated generation, regardless of size of generation plant.

As the optimal economic size of electric generation plants grew, plants had to be located further from population. Since steam cannot be moved economically more than about five miles, it became impossible to recycle the heat.

The 60-year push to central stations built an extremely useful nationwide grid. The industry provided universal access to power and dropped real prices by 98 percent between 1910 and 1970. But it also had two negative effects.

First, overall efficiency dropped, as the ever-larger central plants could no longer recycle heat. The graph on the next page shows the 90-year drop in overall efficiency of the U.S. electric



system. The bottom area shows the improvement in generating technology. Early plants only converted 6 percent of the energy in fuel to power, and the average rose to 33 percent by 1959, a five-fold gain. The upper line is the author's estimate of recovered heat from the early isolated plants, connected with an arbitrary straight line to 1959, when combined heat and power had declined to 4 percent of total U.S. production. The squares show a sample of 150 distributed combined heat and power (CHP) plants the author's companies have installed. The CHP plants all achieve at least twice the average efficiency of the U.S. power system.

The second negative effect of the long reliance on central generation was the enactment of a series of laws and regulations that assumed central power would always be optimal. Over time, however, technology and fuel availability changed, removing the negatives of small power plants. Coal, oil, natural gas, and biomass can all be burned in on-site plants that are clean and approach 80 percent efficiency — 2.5 times the U.S. average efficiency. Given that these distributed plants do not need new T&D, their total cost is the cost of the plant — about \$1,000 per kilowatt of capacity. A large new central plant can be built for \$500 per kilowatt, but will require two to three times that much more money for new

transmission and distribution, and will burn twice as much fuel.

Power Problem #3 — Impediments to Innovation and Efficiency

Given the fuel efficiency and capital cost advantage of today's distributed power plants, why aren't more of these efficient plants built?

First, the market is not free. The local monopoly has exclusive rights to: 1) move all power that crosses any public street, 2) approve interconnection designs and installations, and 3) sell backup power. Utilities want to keep their customers and have no reason to assist on-site generation. They generally demand expensive facilities to interconnect on-site generation to their wires. The utilities ask regulators to approve backup rates based on the assumption that each distributed plant will fail at the time of system peak, so that the charges pay for 100 percent spare generation and transmission capacity. State commissions allow such rates, even though the probability of outage is roughly 2 percent. The backup rates represent a 50 to 1 overcharge and discourage on-site power.

Second, obsolete laws block innovation. At the start of the electric age in 1880-1920, every government wanted to speed electrification. The average legislator was receptive to the local monopoly's suggestions, often buttressed with campaign contributions, that electricity

was a natural monopoly and would expand faster with protection from competition. By 1920, private wires had been banned everywhere, and none of the bans have been lifted.

Fifteen states went so far as to ban electric sales from an on-site plant to its host. These states said non-utility generators could only sell to the local utility, who then offered less than one third of the retail value of the power, effectively killing the economics of distributed power. Even federal laws blocked non-utility generation until 1978, and wholesale sales of power was restricted until 1996.

There are still more barriers. Ohio, Maryland, and other states have empowered boards to determine whether a new power plant is needed. These boards consider themselves responsible for preserving the monopoly and often take two years to render their decisions. They block new plants that would force old plants to close. No doubt they also discourage untold numbers of entrepreneurs from even entering the industry.

Even well-intentioned environmental regulations have played a roll in preventing increased energy efficiency. First, the current regulatory approach places most of the burden for clearing the air on new plants, giving the old plants a competitive advantage. Second, current Environmental Protection Agency rules seldom recognize efficiency as a pollution control strategy. Third, old plants have been prevented from modernizing to increase efficiency or recycle heat because these upgrades would be considered a major modification under new source review rules, which then would force the plant to lower its emissions to those of the best new sources — something the old plants cannot do.

Finally, state public service commissions, in order to prevent monopoly profits by their protected utilities, base regulations on a cost of service plus

allowable rate of return philosophy. This approach has the perverse effect of requiring utilities to give their customers 100 percent of efficiency gains. As a result, it has dampened enthusiasm for efficiency investments.

Power Problem #4 — Power Quality

Today’s power system was built to serve yesterday’s needs. The old industry relied on large motors and human control. A short power outage caused by a falling tree branch touching two distribution wires was not terribly disruptive. The lights flickered, motors slowed, and power was restored. Several seconds of power outage was tolerable, and users could manage minutes of outage with relatively small costs. In fact, the electric industry’s statistics ignore outages under five minutes, as well as disruptions by acts of God, such as ice storms and high winds.

Today’s digital economy, in contrast, demands superb power quality. Ubiquitous computer chips manage industrial processes, telephone traffic, Internet communications, and financial transactions. They can tolerate only eight milliseconds of power outage before losing memory. For householders, a brief flicker of lights has become annoying. Clocks, video recorders, and computers demand resetting. The same flicker can shut down a modern industrial plant for hours, or even days. Financial sector losses can be catastrophic, and for medical researchers, one flicker can destroy a lifetime of work. Genetech’s Boston research center would lose over \$100 million if power were interrupted.

Operators of critical applications now demand a power supply with 99.9999 percent probability of not being interrupted, referred to as “six nines.” However, the practical limit for grid-only reliability is only four nines, or 99.99 percent reliability — two orders of magnitude below digital power quality needs.

Two technical solutions to power quality issues have emerged. One draws primary power and first backup from two grid feeders, and then adds costly banks of batteries, flywheels, and slow-to-start standby generators in order to achieve five nines of reliability. The second approach takes primary and secondary power from on-site generation, using the grid for tertiary backup. The latter approach profits by selling power to the grid, and can achieve six nines of reliability. Adequate digital power, therefore, can be achieved only through primary reliance upon on-site power, backed up by the grid.

The New Economic Calculus

Real electric prices rose 60 percent between 1969 and 1984. Several factors contributed. Environmental controls lowered efficiency and added capital cost to power plants. Most investor-owned utilities embraced nuclear generation, but nearly universal cost overruns increased electric prices. Costs to acquire rights of way for new T&D began increasing. Something had to be done.

In 1978, Congress enacted the Public Utilities Regulatory Policy Act (PURPA), which allowed generation competition from “qualified cogenerators” and “small power production” that was based on waste fuels. Four-

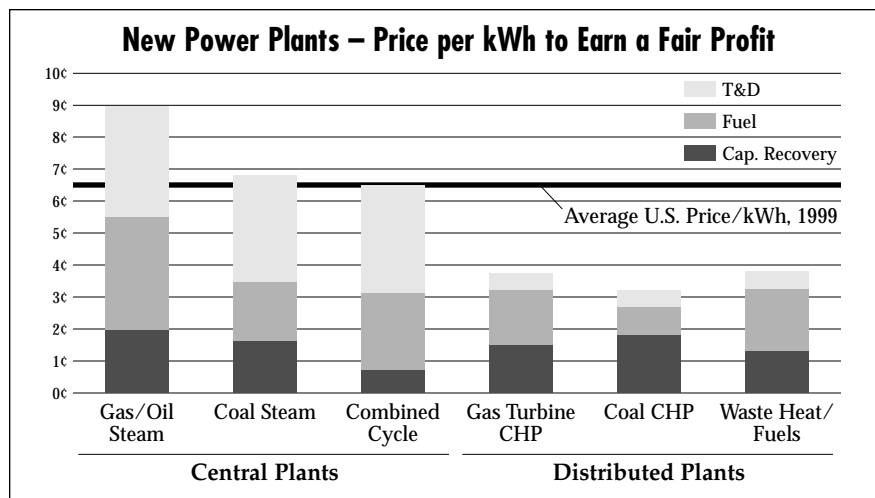
teen years later, Congress passed the National Energy Policy Act (EPACT), allowing more non-utility generation.

The new competition encouraged utilities to control spending. After PURPA, most new generation was competitively bid. The industry continued to cling to its central generation worldview, but embraced efficient combined cycle plants. Since 1984, real electric prices have declined every year — a 32 percent reduction.

A comparison of delivered power costs from six types of new plants — three central generation approaches and three distributed generation approaches — shows a further 50 percent price drop is possible.

The graph below shows six different new generation plants and what consumers must pay per kilowatt-hour to cover transmission and give the plant a fair return on capital. The chart depicts the three main central-plant technologies, all of which require transmission and distribution, and the three distributed-plant technologies, which do not require T&D.

In 1999, 61 percent of U.S. utility power was generated in the first two types of plants, the most expensive of current technology options. Both waste two thirds of the fuel’s energy. Combined-cycle gas turbines burn expensive gas, but have a lower capital cost and achieve better fuel efficiency.



They need to charge current average prices to earn a fair return.

The distributed generation plants use the same fuels or in some cases, waste fuel, and they use the same technology as central plants. But they produce power at or near the user of the power, and they recover and sell heat. All three distributed plants achieve 70 percent to 90 percent efficiency, greatly reducing emissions, especially of carbon dioxide. These plants can earn a fair return selling power for about half of current prices.

Good Questions

Several questions can be raised about the future described above.

First, are there adequate opportunities to build distributed power plants that recycle heat?

The U.S. currently generates only 7 percent of its total power in combined heat and power (CHP) plants. By contrast, Denmark generates over 50 percent of its total electricity in CHP plants. The U.S. Department of Energy (DOE) has estimated that 125,000 megawatts of combined heat and power plants could be built to supply existing steam systems on industrial and institutional campuses. This would represent an additional 20 percent of U.S. power from CHP. The DOE study, however, did not count opportunities to recover power from waste heat or waste fuel, which are estimated to exceed 100,000 megawatts. DOE also did not include combined heat and power to service new thermal distribution networks or to supply direct thermal energy to dryers and chemical processes. These additions could increase U.S. generation at CHP plants to over 50 percent of total power.

Second, what if large users leave the utility system? Isn't this "cherry picking," and won't it cause rates to small users to rise?

Yes, this is cherry picking. No, it will not increase rates to small users. Power

entrepreneurs will seek market niches, just as Herb Kelleher of Southwest Airlines pursued vulnerable segments of air travel. Cherry picking causes prices to drop. Faced with customer loss, incumbent suppliers struggle to cut costs and offer better value. Managers close inefficient plants and adopt best practices. Economist Joseph Schumpeter called this process "creative destruction," and argued it was how capitalism increases the standard of living.

Third, if distribution competition is allowed, will there be more wires?

Power from distributed generation either stays home or goes next door, never reaching transmission systems. Furthermore, allowing private wires will not necessarily lead to more local wires. Independent power producers will use the threat of installing a private wire to obtain a fair price for use of existing wires. Government allows private natural gas pipes to bypass the local gas distributors, but few new pipes have been built. The Philadelphia Gas Company, for instance, cut prices for gas transmission by 88 percent when Trigen threatened to build a bypass in 1997. The resulting savings made it feasible to build a \$175-million CHP project, supplied through existing gas pipes, and the gas company has profited as well. Wires seem no different.

Fourth, how would distributed generation affect global warming?

In public debates on global warming, it is commonly assumed that there are only two tools available: 1) reduce consumption, whether it be via "consumption taxes" or President Carter's sweater; and 2) shift to more ecologically and/or national security-friendly fuels, like natural gas, ethanol, and hydrogen. The debate ignores a third solution that will save money and achieve other political/environmental goals — use fuel more efficiently. Distributed power — that recycles waste heat, is powered by waste industrial

heat, or uses industrial flare gas for power — is more than twice as efficient as conventional central generation, and it saves money by burning less fuel.

Conclusions

Total reliance on central generation is causing power problems. Governments at every level have responded by easing monopoly protection and removing some barriers to efficiency.

Several results are encouraging. Real electric prices have fallen in each of the last 17 years and are now only 68 percent of the prices charged in 1984. Total tons of regulated air pollution began to decline in 1971 and have dropped to 1940 levels, in spite of the economy being 8.5 times larger.

Still, the U.S. power system is not optimal. Heat is seldom recycled. Transmission lines are full and will be difficult and expensive to expand. The digital economy demands higher power quality than central systems can deliver. The power system's frozen efficiency results in excessive fuel use, which exacerbates environmental and balance-of-payments problems. Finally, the central power system is needlessly vulnerable.

Obsolete laws and regulations continue to impede efficiency and stunt distributed generation. The rewards from removing these barriers can be enormous, cutting in half both fuel use and electricity prices and significantly reducing air pollution. Eliminating barriers and embracing interconnected distributed generation can, within ten years, save the U.S. economy \$170 billion per year.

Thomas Casten, chairman and CEO of Private Power LLC, is author of Turning Off the Heat: Why America Must Double Energy Efficiency to Save Money and Reduce Global Warming.

Sean Casten is president and CEO of Turbosteam.

Mercury and Power Plants:

Can Technology Meet the Challenge?

by Matt Little

Who would have thought that the silvery liquid in thermometers could cause so much harm? One drop of mercury is enough to potentially contaminate a 25-acre lake to the point where fish are unsafe to eat. Forty states now have warnings that limit fish consumption on more than 70,000 lakes and streams across the country. Of the 18 states in the Northeast and Midwest regions, 15 have fish advisories, including every Great Lakes state.

Furthermore, a March 2001 study by the Centers for Disease Control finds that as many as one in ten women of childbearing age may be at risk of having newborns with neurological problems due to mercury exposure in the womb. This translates to approximately 396,000 newborns each year.

Sources of Mercury

Mercury is present in trace amounts in the rocks and soil beneath us, and it is mined from concentrated deposits primarily in Spain, Kyrgyzstan, Algeria, and China. Mercury then is used in various manufacturing processes and is contained in a number of common household products, such as fluorescent lights, electric switches, thermometers, thermostats, and batteries. Inevitably, these products end up in the waste stream and can contaminate the environment through a number of mechanisms.

Coal also contains mercury, and when it is burned to provide us with electricity, mercury is released into the atmosphere. Eventually this mercury returns to earth in rain, snow, or dry deposition, and it can contaminate

both local and distant environments. In fact, rainwater collected in Illinois, Michigan, Minnesota, and Wisconsin has been found to contain average mercury levels six to 14 times the Environmental Protection Agency's (EPA) human health standard for water in the Great Lakes basin — with peaks as high as 73 times the standard.

Mercury is an element, and once it enters the environment, it remains there indefinitely because it does not break down. In addition, bacteria often convert mercury to a more dangerous form called methylmercury. This organic form of mercury easily enters the food chain and bioaccumulates in living organisms. At the top of the food chain, some predators have been found with mercury levels more than a million times higher than the surrounding environment. These concentrations can be poisonous to wildlife and humans by damaging the central nervous system and impairing reproduction and development.

Coal-Fired Power Plants

According to the Energy Information Administration, coal accounts for 44 percent of our nation's electricity production, followed by gas (18 percent), nuclear (14 percent), water (14 percent), and petroleum (9 percent). Coal is mined in 29 states and consists of three major types: bituminous, sub-bituminous, and lignite. Bituminous is the most common coal, mined in the eastern U.S. and Midwest, while sub-bituminous coal is mined in the West and lignite is mined in the Northern Great Plains and Texas.

There are 464 coal-burning power

plants in the U.S., with 127 in the Northeast and 137 in the Midwest. Measured in megawatts attributable to coal, the Northeast-Midwest region produces 39 percent of the U.S. total, with 34 percent produced in the eight Great Lakes states alone.

Coal-fired power plants emit 48 tons of mercury each year, which accounts for one third of all U.S. anthropogenic mercury emissions. Plants in the Northeast-Midwest region produce 20 tons of mercury annually, with 18 tons originating in the Great Lakes.

Clean Air Standards

In 1990, Congress passed the Clean Air Act Amendments to further reduce air pollution from various industries. Section 112 of the act listed 189 hazardous air pollutants and required the Environmental Protection Agency (EPA) to categorize and regulate all their major sources. Mercury was one of these pollutants, but utilities were given an exemption from regulation until EPA fully reviewed mercury's sources and health effects. Today, utilities remain the last major unregulated source of mercury emissions in the U.S.

In a 1998 report to Congress, EPA stated that out of 67 air toxics emitted from coal-fired electric utility boilers, mercury was the pollutant of greatest concern. In 1999, EPA required all power plants to report the mercury content of their coal and some plants to monitor their mercury emissions. From this data and other reports, and urged by a court order, EPA made a determination in December 2000 to issue regulations for the utility indus-

try by 2004, with actual mercury reductions required in 2007. The road to regulation is not paved, however, since legal action and political maneuvering already have been initiated by utility groups against EPA's efforts.

As a potential back-up to these efforts, a number of congressional members have introduced legislation addressing mercury emissions. Senators James Jeffords (I-VT), Joseph Lieberman (D-CT), and Patrick Leahy (D-VT), and Reps. Sherwood Boehlert (R-NY), Thomas Allen (D-ME), and Henry Waxman (D-CA) have introduced bills that require 90 percent reductions in utility mercury emissions. Senator Jeffords, as chairman of the Senate Environment and Public Works Committee, is pushing his bill as part of a larger effort to address four pollutants: sulfur dioxide (SO₂), nitrogen oxides (NO_x), carbon dioxide (CO₂), and mercury. The Bush Administration is currently working on a similar bill, minus CO₂, which many are watching to see what mercury reduction targets it will contain.

States also have begun to take matters into their own hands. Wisconsin recently has proposed the first state rule on mercury emissions, requiring a 90-percent reduction over 15 years. Massachusetts, Connecticut, and Illinois also are working on regulations, while New Hampshire, New York, and North Carolina have legislation pending.

At the regional level, the U.S.-Canada Great Lakes Water Quality Agreement calls for the virtual elimination of mercury in the Great Lakes. As first steps, the 1997 Great Lakes Binational Toxics Strategy aims for 50 percent mercury reductions in the U.S. by 2006, and, this summer, the New England governors and Eastern Canadian premiers committed to 75 percent reductions by 2010. Also, the U.S. and Canada joined Europe in signing a 1998 Protocol to the Convention on

Long-Range Transboundary Air Pollution to reduce mercury emissions below 1990 levels.

At the global level, the United Nations Environment Programme recently called for a global study of mercury's health and environmental

“Coal-fired power plants emit 48 tons of mercury each year, accounting for one third of all U.S. anthropogenic mercury emissions.”

risks and a cost-effectiveness review of mercury control technologies. These actions may one day lead to an international agreement similar to the successful Persistent Organic Pollutants (POPs) Treaty.

The Technologies

In order to meet governments' mercury reduction goals, utilities will depend greatly on technology. Luckily, most utilities already have made mercury reductions without much effort. The Clean Air Act required utilities to install technologies to reduce SO₂, NO_x, and particulates, but according to EPA, these technologies also have reduced mercury emissions by approximately 35 percent across the industry. Some technology combinations have even achieved more than 98-percent reductions.

However, achieving 98-percent reductions with existing technology is not currently practical at many power plants, so new technologies need to be developed to address the remaining 48 tons of annual mercury emissions. This is not an easy task. Depending on the type of coal burned, mercury emissions can exist in elemental, oxidized,

and particulate forms — each requiring different technology strategies for effective control. Of today's utility mercury emissions, 54 percent are elemental, 43 percent oxidized and 3 percent particulate.

These facts make up a complex technology equation that scientists and engineers must solve. Despite the high hurdles, a number of entrepreneurs believe they have cracked the code. Various companies have developed technologies that not only aim for 90-percent reductions, but also reduce emissions of other pollutants as well, lowering overall costs for the utilities.

The Department of Energy (DOE) has been instrumental in this process by providing funding to test the most promising technologies on full-scale power plants. The goal is to develop mercury control options that are cost-effective and can reliably reduce emissions 50-70 percent by 2005 and 90 percent by 2010. The following is a summary of these technologies, organized by their corporate promoters and their performance.

Powerspan Corp.

This New Hampshire company's multi-pollutant control technology, Electro-Catalytic Oxidation (ECO), bombards a power plant's flue gas with electrons. This process oxidizes the pollutants, changing their chemical compositions into ones that can be more easily collected and recycled.

This approach has been tested on a coal-fired plant owned by FirstEnergy, a utility in Ohio. Initial tests reduced mercury beyond 81.6 percent, which was as far as the monitoring equipment could measure. At the same time, ECO reduced NO_x emissions by 76 percent, SO₂ by 44 percent, total particulates above 99.94 percent, fine particulates at 96-97 percent, and a number of heavy metals by more than 99 percent. Subsequent tests have pro-

duced even more promising results, which will be publicized in the next couple months.

Powerspan estimates that the capital cost of installing a single ECO device will be about one-third the cost of installing separate controls for each pollutant. ECO should be ready for commercial installation in 2004.

Babcock & Wilcox with McDermott Technology Inc.

Ohio-based Babcock & Wilcox and its research affiliate McDermott Technology, Inc. have developed a cost-effective mercury removal technology for power plants already equipped with SO₂ wet scrubbers. The process involves adding a chemical to the scrubber solution that enhances the capture of oxidized mercury.

Testing has just been completed with Michigan South Central Power Agency, and further tests are planned this month with Cinergy in Ohio. Goals are 90 percent removal, with costs predicted to be less than half those of commercially available activated carbon technologies.

Since approximately one-fifth of power plants use SO₂ wet scrubber systems and with this percentage growing, McDermott's technology has great potential. The companies expect to be able to discuss commercial applications in 2002.

ADA-Environmental Solutions

With the ability to remove mercury from all types of coal, this Colorado company has a promising technology that requires little equipment and minimal downtime for installation. Flue gas is cooled with a fine water mist and then injected with a sorbent of activated carbon to combine with the mercury so that it can be removed by an electrostatic precipitator (ESP) or filter. Because all coal-fired power plants already are fitted with one of

these devices for particulate control and because incinerators have been controlling mercury with activated carbon for years, this technology has great potential. ADA's technology also includes a control system for a corrosive substance called sulfur trioxide that is formed when flue gas is cooled.

Based on full-scale tests at a plant owned by Alabama Power, ADA's technology can remove up to 90 percent of mercury with a filter and an estimated 70 percent with just an ESP. Other tests are ongoing with Wisconsin Electric Power Company and PG&E National Energy Group. ADA hopes to have a few full-scale systems running on a continuous basis by 2004 so that guaranteed commercial systems can be provided to meet EPA's regulatory schedule.

Energy and Environmental Research Center

The University of North Dakota is developing a technology called an Advanced Hybrid Particulate Collector (AHPC). This system combines features of the ESP and fabric filter to remove 90 percent of the mercury while greatly enhancing fine particulate collection efficiency. Since ESPs currently have difficulty collecting excessively fine particulates and filters have trouble with high energy consumption, this technology promises to solve multiple problems at once.

Pilot-scale testing has begun at Otter Tail Power Company's Big Stone Power Plant in South Dakota, with larger-scale tests planned for the future. The center hopes to have AHPC ready for commercial application by early 2003.

URS Group, Inc.

This Texas company places a honeycomb of catalysts in the flue gas to oxidize elemental mercury so that SO₂ wet scrubbers can remove it. Because of the

wide range of coal properties and plant configurations, wet scrubbers currently remove 33 to 96 percent of the mercury in flue gas, but elemental mercury is not readily scrubbed. This technology will ensure that scrubbed plants can consistently remove at least 80 to 90 percent of the mercury.

The Electric Power Research Institute (EPRI) is a partner in this venture, and testing will begin soon with Great River Energy in North Dakota and with City Public Service, a utility in San Antonio. If successfully commercialized, this technology could be applicable to approximately 180 individual coal-fired units currently equipped with wet scrubbers, representing about 90,000 megawatts of U.S. generating capacity. URS hopes to have systems ready for the market in late 2003 or early 2004.

CONSOL Inc.

This company, based in Pennsylvania, is demonstrating a concept that is similar to ADA's, but instead of introducing activated carbon to remove mercury, CONSOL is using the existing smoke particles, called fly ash. When flue gas is cooled sufficiently, fly ash has been shown to collect 80 to 90 percent of the mercury. In addition, cooling the flue gas and recycling the heat makes the plant burn more efficiently, which reduces all pollutants. Any corrosive build-up of sulfur trioxide also will be prevented with the addition of a chemical agent.

CONSOL plans to test this system at Allegheny Power's Mitchell Station in Pennsylvania in June 2002, and it hopes the technology will be ready for initial commercial deployment in 2004. Other partners include Ahlston Power and Environmental Elements Corp.

Southern Research Institute

SRI's technology, developed in Alabama, promises to remove both

mercury and SO₂ emissions by injecting calcium-based sorbents. Like URS, SRI's goal is to oxidize the mercury and then collect it, but SRI will use a dry scrubber instead of a wet scrubber. In other words, it will use high concentrations of solid particles to remove the mercury instead of the liquid droplets used in wet scrubbers.

SRI estimates that using calcium-based sorbents instead of activated carbon will reduce costs by more than 50 percent for the mercury reductions alone. Testing will begin with Southern Company this winter, and partners include ARCADIS and the Tennessee Valley Authority. SRI hopes that its technology will be marketable in 2002.

Apogee Scientific Inc.

Colorado-based Apogee and its test team will evaluate up to 12 different low-cost sorbents for their effectiveness at removing mercury. The three most promising sorbents, as determined by performance and projected cost, will be injected into the flue gas to remove mercury with ESPs and fabric filters. Mercury reductions may exceed 90 percent levels, and costs are predicted to be 40 to 75 percent lower than today's activated carbon technologies.

Testing will be conducted at Wisconsin Electric's Valley Power Plant and at Midwest Generation's Power-ton Station in Illinois. Besides DOE, funding is provided by EPRI, the host utilities, and industry partners.

Waste Products

All of these mercury control techniques use existing air pollution control technologies, or modifications thereof, for the final capture of combustion by products and pollutants. Therefore, the waste products are very similar to those produced by power plants without mercury controls. For years, these wastes either have been landfilled or

recycled into useful products such as wallboard, cement, and fertilizer.

Many believe that the minute addition (0.1-0.5 ppm) of mercury in a solid, stable state will not harm these products. However, there are concerns that mercury might volatilize later and escape into the environment. There is also concern that activated carbon in fly ash may render by products like cement unmarketable. Both of these issues are being researched to determine whether current practices can continue.

Costs

According to EPA, costs for today's developing mercury controls range from 0.31 to 1.92 mills/kWh, which is comparable to costs associated with technologies currently used to reduce NOx — low NOx burners (0.21-0.83) and selective catalytic reduction (1.85-3.62).

However, it is reasonable to assume that mercury control costs will continue to decline for a number of reasons. As described in this article, at least eight technology vendors promise lower costs and plan to complete testing in the next year or so. Also, EPRI is currently evaluating over 1,000 potential sorbents and processes for mercury control, many of which are cheaper than activated carbon.

Finally, once regulations are set, control technology costs almost always go down because more entrepreneurs enter the business and more capital is expended in research and development. For example, costs for selective catalytic reduction were reduced 80 to 90 percent between 1989 and 1998. Also, projected costs of the Clean Air Act's Acid Rain Program fell two-thirds between 1989 and 1997.

Conclusion

Recognizing the lack of public information on the state of mercury control

technologies and in light of proposed legislation for the utility sector, the Northeast Midwest Institute and the Environmental Council of the States recently held a Capitol Hill briefing on these technologies. Congressional staff heard presentations from two mid-western utilities, three technology developers mentioned in this article, EPA, the Institute of Clean Air Companies, and the Northeast States for Coordinated Air Use Management. To see their full presentations, go to www.nemw.org/mercury.htm.

The issue of whether technology can meet regulatory requirements in a cost-efficient manner is very relevant today since all levels of government are looking for technological solutions to environmental problems. Luckily, in the case of mercury, technology has a head start. With the help of DOE and various utilities, a number of entrepreneurs have jump-started the process and committed significant resources to developing solutions that are both cost-effective for utilities and protective of human health and the environment. So far, technology demonstrations on actual power plants are achieving close to 90-percent mercury reductions at costs that are competitive with other well-established air emission controls. Since most of these research ventures have received DOE funding only this year, it is likely we will see even better results and lower costs in the near future.

Under most projections, coal will remain the nation's predominant source of electricity for some time. Therefore, we must continue to support the development of technologies and regulations that aim to reduce its most toxic emissions. If we do not, mercury will continue to jeopardize the long-term health of our lakes, streams, wildlife, and even ourselves.

Matt Little is a policy analyst at the Northeast-Midwest Institute

Northern Border

The United States and Canada enjoy the world's largest bilateral trading relationship. More than 45,000 trucks cross the border every day, and some 200 million people cross the border each year. The U.S. exports to Canada more than it does to China, Germany, Japan, Korea, and the United Kingdom combined.

Despite the critical importance of U.S.-Canada relations, the U.S. is doing surprisingly little to facilitate cross-border trade and travel or enhance border security. Binational trade has soared sixfold since the 1980's, but the number of Customs inspectors along the northern border has not increased at all. At U.S.-Canada crossings, more than half of existing lanes are closed due to a shortage of inspectors.

Only 300 Border Patrol agents are assigned to monitor the entire 4,000-mile northern border, compared to 8,000 agents on the southern border. Yet compared to their southern colleagues, agents on the northern border are 14 times more likely to encounter aliens involved with smuggling weapons, and nine times more likely

to encounter aliens involved with smuggling drugs.

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The flow of goods and people, quite obviously, was impacted by the terrorist attacks of September 11th. Reports of multiple-hour waits at the border caused some travelers to cancel their visits and many manufacturers to worry about their just-in-time shipments.

Twenty-one senators recently asked the president to fund several measures authorized under the USA-PATRIOT Act. These include: 1) tripling the number of Immigration and Naturalization Service (INS), Border Patrol, and Customs Service agents and inspectors

along the northern border; 2) improving infrastructure and technology at key ports of entry in order to more meticulously search and efficiently move cross border traffic and persons; 3) providing the INS with greater access to the FBI's databases in order to determine whether visa applicants and applicants for admission have criminal records; and 4) implementing technological advances such as the non-intrusive inspection and automated fingerprint identification systems (e.g., the integration of the INS's IDENT system with the FBI's IAFIS system). Such enhancements will both protect the nation from dangerous individuals and freight, as well as reduce delays on the northern border to those engaged in legitimate business and travel.

The Northeast-Midwest Coalition recently sponsored House and Senate briefings examining some of these issues. For more information, visit www.nemw.org/NBorderBrfg.htm or contact Joe Abe or Fred Helmstetter at the Northeast-Midwest Institute (202/544-5200).

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