George C. Loehr
eLucem
4101 Killington Rd. NW, Albuquerque, NM 87114
Phone (505) 792-0643 ~ Fax (505) 792-0644 ~ e-mail: gloehr@eLucem.com

Hearings of the Senate Energy and Natural Resources Committee
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I wish to thank the members of the Energy and Natural Resources Committee for the privilege of speaking to you about several issues of great importance for the future of our nation, and of great concern to me personally. I especially want to express my thanks and appreciation to Senator Bingaman and Senator Dominici of my adopted state of New Mexico, and to Senator Casey of Pennsylvania – along with their staffs.

My name is George C. Loehr, and I'm an engineer with more than 45 years of experience in the electric power industry. My primary expertise is in bulk power transmission system planning and analysis, and electric power system reliability. I was deeply involved in various post-hoc studies following the major blackouts in 1965, 1977, and 2003.

I worked as Executive Director of the Northeast Power Coordinating Council (NPCC) from 1989 to 1997, and was very active in regional, national and international activities. I took early retirement from NPCC in 1997, and now do management consulting, appear as an expert witness, write, and teach a variety of courses on power systems.

I have been a Vice President and member of the Board of Directors of the American Education Institute (AEI), and a charter member of Power Engineers Supporting Truth (PEST). At present, I serve as Chair of the Executive Committee of the New York State Reliability Council (NYSRC), and as an Outside Director on the Board of Directors of the Georgia System Operations Corporation (GSOC).

I hold an advanced degree in English Literature along with my Bachelors in Electrical Engineering, and have been deeply involved in the arts for most of my life; for example, I recently published my first novel, *Blackout*, available through <lulu.com>.

A one-page bio is appended to this statement.

The opinions I express in my testimony are entirely my own, and do not necessarily reflect the views of any of my employers or clients, past or present.

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Arguably, nothing is more critical to the future of the United States and its citizens than a reliable electric power system. It can be said without exaggeration that electricity is the bloodstream that sustains our nation and allows it to live and prosper. As the major blackouts of the past have demonstrated, any interruption to power supply adversely affects our economy, our safety and comfort, and our national security. And the most vulnerable part of our power supply is the high voltage bulk power system – the grid. However, it is not the only critical part of a reliable electric system.

Actually, there are three separate "grids" in the continental U.S. – four, if we consider Canada as well. The Eastern Interconnection is the largest, stretching from the Atlantic Coast roughly to eastern Montana, Wyoming, Colorado, and New Mexico. It includes the Canadian Maritime Provinces, as well as Ontario, Manitoba, and Saskatchewan. The Western Interconnection runs from there to the Pacific Coast, and includes the Canadian provinces of Alberta and British Columbia, as well as a small portion of the northern Baja in Mexico. The ERCOT Interconnection comprises approximately 85% of the state of Texas, and the Quebec Interconnection consists of that province in its entirety.

The passage of the Energy Policy Act of 2005 (EPAct) was heralded as a major step forward in improving the grid and reducing the likelihood of large blackouts. One drawback, however, is its almost exclusive focus on transmission. It does not address generating capacity sited close to the load centers, or demand side management programs. These strategies are often preferable to transmission as a means of improving overall system reliability. They have the added benefit of adding to the system's installed reserve margin. My own experience over the years has indicated that a certain minimum amount of capacity – in the neighborhood of 80% of the peak demand – must be located within a load center to provide voltage/reactive power support, black start capability, network security, etc.

If we wish to address electric power energy issues, we must address them in a more comprehensive manner. At present, the EPAct, and policies adopted thereunder, encourages the construction of new transmission not needed for reliability. It subsidizes remote generators, discriminates against local and distributed generation and demand side resources, forces many customers to pay for someone else's benefits, increases the likelihood of blackouts, and makes our grids more vulnerable to terrorist attack.

I believe that decisions on whether particular transmission lines are needed for reliability are best addressed by the states and by the eight existing regional reliability councils. They have consistently done a good job on this in the past. I do not believe that either DOE or FERC has the experienced staff or other resources to do this as well as the regional reliability councils and the states.

Since the passage of EPAct, some misguided proposals have been made to advance corporate agendas rather than serve the well-being of ordinary customers – mainly by trying to get proposed high voltage transmission lines approved as essential to reliability. The most significant are:

- The <u>confusion of reliability with economics</u> – of reliability *needs* with economic *wants*;

• The assumption that the mere addition of transmission will improve grid reliability. It won't. In fact, more transmission can actually degrade reliability if it is used to accommodate higher power transfers over long distances;

• The misapplication of national reliability standards promulgated by the North American Electric Reliability Corp. (NERC), the organization designated by the Federal Energy Regulatory Commission (FERC) as the Electric Reliability Organization (ERO) mandated by EPAct;

• Blackout "scare tactics" intended to frighten customers and public officials, compelling them to endorse the construction of facilities or implementation of policies which are not required to preserve or enhance reliability.

Because of the confusion between economics and reliability, officials often commingle both inappropriately. A prime example is the 2006 Congestion Study conducted by the Department of Energy (DOE), as mandated by EPAct. [An updated 2009 Congestion Study is now under way.] As a result of its 2006 study, which did not properly consider non-transmission alternatives, the Department designated certain National Interest Electric Transmission Corridors where, according to DOE, consumers were adversely affected by transmission congestion or constraints. But the DOE's failure to properly consider non-transmission alternatives means that the congestion study has not even established economic congestion. In addition, congestion or constraints do not equal low reliability. Neither the 2006 study, nor the corridor designations, bear any resemblance to actual reliability problems. Economic *wants* were misrepresented as reliability *needs*. Reliability depends on standards, not the ability to move every megawatt from any generator anywhere on the system to any load center anywhere else on the system. Because the 2006 Congestion Study is fatally flawed, and does not draw a proper distinction between reliability and economics, it should not be used as the basis for approving new transmission lines that have been denied by the states.

In the deregulated electric power industry, the cost of new bulk power transmission facilities is often "socialized" if it can be shown that these facilities are needed to maintain reliability – to satisfy NERC reliability standards. "Socialization" means that the cost will be proportionally distributed among all customers within an Independent System Operator (ISO) or Regional Transmission Organization (RTO). If a reliability need cannot be proven, the cost will usually be assigned to those entities which will gain from the new facility. For example, if a new line is desired to allow the construction of new generating plants far removed from the load centers, and facilitate the transfer of their electrical output to the load centers, then clearly those generators will gain. But, if a reliability "need" could somehow be proven, the cost of the line would be borne by all customers in the region – an indirect but very real subsidy to the remote generators. Further, the skewing of costs and benefits would penalize resources located close to the load centers. It would also encourage the development of remote generating resources and discourage the development of more local or distributed generation, or demand side management programs.

The following points are generalizations derived from actual cases presented over the past several years.

In order to "prove" a reliability "need," some have misrepresented and misapplied the national reliability standards promulgated by NERC and supported by FERC. This misrepresentation sometimes involves ignoring key provisions of a national standard. For example, one of the key NERC planning standards calls for testing the system for the outage of a critical facility, allowing time for manual system readjustments to compensate for the outage, and then applying a second critical outage. The system must be designed to survive this sequence of events. However, some parties seem to have deliberately ignored the provision for manual system adjustments. This has the effect of greatly overstating the adverse consequences of the contingencies, in effect subjecting the system to two simultaneous contingencies. This, in turn, can indicate a failure to meet reliability standards – requiring a transmission reinforcement which is not really needed.

An even simpler example is the manipulation of generating units in the ISO or RTO queue in such a way that some committed units are excluded from planning studies. In some cases, units well along in the process have been deliberately excluded from studies because they would solve a reliability problem, while others *at the same place in the queue* were included, precisely because they exacerbate a reliability problem. In my opinion, this makes absolutely no sense.

Similarly, some have ignored readily available techniques permitted by the standards and widely utilized throughout the industry. They resist simple, straightforward fixes such as the addition of reactive power support, correction of minor limitations on lower voltage facilities, modification of outdated configurations, redispatch of generation, or manual load shedding following a contingency – all of which are permitted by the NERC standards and widely used in the industry.

Another device used by some to allege a reliability need when none really exists is to base system simulation studies on extreme conditions vis-à-vis generation dispatch. They will stubbornly insist on economic dispatch as a kind of mantra, ignoring the simple expedient of transmission constrained dispatch – using "out of merit" generation – to essentially replace less expensive remote generation with generation or demand side resources closer to the load, in effect working around any alleged transmission bottleneck by replacing remote generation with slightly higher-priced local resources. Many U.S. systems routinely operate in this manner. But some who are intent on "proving" a reliability need in their planning studies will refuse to make even minor adjustments to their initial dispatch in order to solve apparent reliability problems.

Those who misapply the reliability standards will often argue that NERC standards *require* that each ISO, RTO and transmission owner establish procedures that "stress" the transmission system in its planning studies. That's correct. But NERC standards do *not* require that the ISOs, RTOs and transmission owners use unrealistic base conditions, dismiss simple and obvious solutions to reliability problems, or ignore important provisions of the standards like manual system adjustments.

Some will maintain that the addition of new transmission facilities alone will inevitably increase reliability. This seems like common sense – but it's wrong. Addition of new transmission facilities will increase transfer capability, but reliability can only be improved by making the standards themselves more stringent. *Reliability is a function of the standards used, not the amount of wire in the air*. Further, transmission additions will not increase the reliability of the system if the increased transfer capability is used to accommodate increased power transfers. The same reliability standards would still be in place. The transmission transfer capabilities would be higher, but the higher transfer capability would simply be used to carry higher long-distance power flows.

There's another factor to consider. If more generation is built in remote areas, and less generation and other resources are built close to load centers, then the load centers will be increasingly dependent on distant generating capacity – located perhaps hundreds of miles away. It would be like running a long extension cord to a friend's house a block or two away to power your toaster, instead of plugging it into an electric outlet right in your own kitchen. The more major cities depend on long transmission lines, the more subject they will be to power outages and blackouts due to major contingencies on the transmission system. Indeed, this constitutes a national security problem, since these urban areas would be more at risk from terrorist attacks on transmission facilities.

Unfortunately, a lot of scare tactics have been used to justify proposed transmission lines. Perhaps the most egregious strategy used by those promoting new transmission when it really isn't needed for reliability involves raising the spectre of massive blackouts. The August 14, 2003 blackout has often been cited, for example. Even the California rotating blackouts of the 2000-2001 period have been mentioned. These incidents have *no bearing* on any of the cases I've seen. The 2003 blackout was the result of too many control areas (now known as "balancing authorities") in too small a geoelectrical area – so small, in fact, that none of them realized that a series of unrelated contingencies across a wide area over a four hour period was leading to a major interruption. In California in 2000-2001, poor state regulations, unscrupulous market manipulation, and unethical (sometimes illegal) activities by companies like Enron, all combined to manufacture an apparent shortage of generating capacity. No capacity shortage existed – nor was there a "blackout" *per se*. Brownouts and rotating feeder outages were necessary because of the market manipulation, but no widespread cascading outages occurred.

Let's think about how real-life systems would deal with situations involving overloaded transmission. System operators in real-time control centers act as balancing authorities over large geoelectrical areas, and would recognize any potential overload situation. More important, they would never operate the system in a mode where a first contingency would bring about overloads, low voltages, cascading outages, instability, system separation, or loss of firm customer load. That's the "Prime Directive" of every system operator. The bulk power system must always be operated such that, if any contingency specified in the applicable standards or criteria were to occur (e.g., a fault or short-circuit on a high voltage transmission line), the system would experience no overloads, low voltages, cascading outages, instability, system separations, or loss of firm customer load. In fact, to operate in any other way would be a violation or NERC's Operating Standards, subject to fines of up to $1 million per day.

Blackouts are usually caused by contingencies more severe than standards/criteria, by equipment failures, control system problems, human error, or by some combination of these. They always involve a break-up of the bulk power transmission system. Blackouts are not caused by shortages of generating capacity. Nor are they caused by an inability to transfer as much power as some might wish from remote locations to load centers. Blackouts can rarely be anticipated. They are almost always unexpected, and can happen at any time – few have occurred at or near peak load, for example, or coincident with a shortage of generating capacity. They develop in seconds or fractions of seconds rather than hours or days.

There's another important point. <u>The mere fact of adding transmission does not of itself increase reliability</u>. Consider two hypothetical transmission systems: one a system with a lot of transmission lines, but planned and operated to <u>less</u> stringent reliability standards; the other a system with very little transmission, but planned and operated to <u>more</u> stringent reliability standards. The first system would be less reliable than the second system, because it uses less stringent reliability standards. As I said earlier: *Reliability is a function of the standards used, not the amount of wire in the air*.

Even if both systems were planned and operated to the same reliability standards, the system with more transmission lines might still be less reliable than one with less. This is because the addition of new transmission lowers the equivalent electrical impedance across the grid, in effect making it electrically smaller. Thus a given contingency could have a more widespread effect. For example, if Philadelphia is electrically closer to Chicago, a major disturbance on the grid in the Chicago area is more likely to cause outages in Philadelphia – and *vice versa*. This may help explain why the Aug. 14, 2003 blackout affected a much larger area than the November 9, 1965 blackout.

Again, transmission additions will not increase the reliability of a system when the increased transfer capability is used to accommodate increased power transfers between remote generating units and load centers.

To ensure reliability of the bulk power system, Congress would need to comprehensively address electric power supply issues. Congress would need to encourage local power generation and distributed generation close to the demand, and create incentives for conservation and demand side resources. Any consideration of transmission issues should make a clear distinction between facilities needed for reliability and those desired for economic reasons. In particular, *economic wants* should not be permitted to camouflage themselves as *reliability needs*. Such an approach would help avoid blackouts, and make our grids less vulnerable to terrorist attacks.

However, as set forth above, I believe the states and the eight existing regional reliability councils are in the best position to ensure a reliable electrical grid.

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These are my major points. I would also like to briefly enumerate a few other problems I see, either on the horizon or already with us:

• The "deregulation" or "restructuring" of the electric power industry is part of the problem. In essence, it greatly increased the complexity of the power industry, and added thousands of pages of new regulations. (As a matter of fact, even the term "deregulation" itself is an Orwellian misstatement.) Most important, though, it replaced the former culture of *coordination and cooperation* with one of *competition and confrontation*.

• In some parts of the country, there are what I would term "overlapping footprints" among the various entities involved in the planning and operation of both the physical power system itself and its markets. This overlapping is a prescription for blackouts.

• Some control areas, or balancing authorities, are too small. As mentioned earlier, this was arguably the underlying cause of the August 14, 2003 blackout.

• The present growth rate of electric power demand and consumption is sometimes identified as the culprit. Actually, there's nothing exceptional about present growth rates. The *NERC 2006 Long-Term Reliability Assessment (October 2006)* reported a forecast U.S. annual growth rate for the period 2006-2015 of 1.9%. This is quite low by historical standards – for example, in the early 1960s, when I began my career, peak loads were growing nationally at a 7 to 7½% rate. That wasn't a short-term phenomenon, either. According to U.S. Energy Information Administration statistics, retail sales of electricity in 1970 were *five times higher* than in 1950 – a compound annual growth rate in excess of 7%. It doubled again between 1970 and 1990 – approximately a 3% growth rate – despite oil embargoes, hyper-inflation, recession, and conservation efforts. The only thing unusual about today's growth rate is that it's so low. This, I believe, reflects the efforts of many people – dedicated environmentalists, government officials at both the federal and state level, large commercial and industrial customers, and the general public – to achieve higher efficiencies and genuine conservation. We can all take credit for this significant accomplishment. Bottom line: nothing about current growth rates automatically requires a massive program of new transmission construction.

• People are often told that one "silver bullet" or another will solve all of our energy problems. Examples range from capacity auctions to mandatory standards, from renewable resources to the so-called "smart grid." While some of these may be valuable in their own right, none can be, as St. Paul might say, "All things to all men." Simply put, there is no silver bullet.

• Technical expertise – or at least competent, objective technical input – has become almost totally absent in decision making. Decisions are most often made on the basis of economic principles, with little or no consideration (or even knowledge) of the scientific laws that govern electric power systems. The Laws of Physics make electricity flow, not the Laws of Economics. No rules, no regulations or procedures, and no market protocols, can override Mother Nature and her laws. As I tell the students who take one of my courses or workshops: *When the Laws of Physics and the Laws of Economics collide, Physics wins … always*.

Where should we go from here? Frankly, I believe EPAct is in need of an overhaul. Congress needs to address energy issues – even those energy issues focused on electric power supply – in a more comprehensive manner. At present, EPAct encourages the siting of new transmission not needed for reliability. By doing so, it subsidizes remote generators, discriminates against local and distributed generation and demand side resources, forces many customers to pay for someone else's benefits, increases the likelihood of blackouts, and makes our grids more vulnerable to terrorist attack.

I would like to conclude with a favorite and well-known quote from the 18th Century Anglo-Irish author, philosopher and politician, Edmund Burke: "All that is necessary for the triumph of evil is for good men to do nothing." Let's resolve *not* to "do nothing," but let's be sure that, whatever we do, we do the *right* thing.

George C. Loehr – July 2008

George C. Loehr
[bio]

George C. Loehr received a Bachelor of Electrical Engineering degree from Manhattan College in 1962, and a Master of Arts in English Literature from New York University in 1964. He began his engineering career in transmission planning with the Consolidated Edison Company of New York in 1962, and completed the GE Power Systems Engineering Course in 1965. Following the 1965 Northeast Blackout, he was actively involved in a wide range of follow-up activities, and chaired the committee which completed a computer simulation of the event – the first such successful simulation of a wide-spread power failure in North America.

Loehr joined the New York Power Authority as Chief Planning Engineer in 1969, and the Northeast Power Coordinating Council (NPCC) in 1972. He was very active in regional, national and North American Electric Reliability Council (NERC) activities, serving on numerous committees, subcommittees and task forces. He was named Executive Director of NPCC in 1989, and remained in that position until his retirement in 1997.

Now self-employed, Mr. Loehr does management consulting, appears as an expert witness, writes, and teaches a variety of courses on power systems to non-technical professionals. His clients have included organizations throughout the U.S., Canada and China. He has served as Vice President and member of the Board of Directors of the American Education Institute (AEI), and is a charter member of Power Engineers Supporting Truth (PEST). Loehr is presently Chair and an Unaffiliated Member of the Executive Committee of the New York State Reliability Council, which works in conjunction with the New York ISO, and previously chaired its Reliability Compliance Monitoring Subcommittee. He also serves as an Outside Director on the Board of Directors of the Georgia System Operations Corporation (GSOC). He is a recognized national expert on electric power system reliability.

Mr. Loehr has given expert testimony in the states of Pennsylvania, New York, Vermont, Kentucky, New Mexico, Mississippi, and in Washington, DC. He has done TV interviews with BBC, CNN, WPIX and CBC, and has been a lecturer, keynote speaker, and/or chair at professional conferences all over the U.S. and Canada. In addition, he has done audio tape lectures for various organizations, including the IEEE, "Professional Development Options," "Red Vector," and AEI.

Articles by Mr. Loehr have appeared widely in the trade press, including *Public Utilities Fortnightly, Electrical World, The Electricity Journal, Electricity Daily, Transmission & Distribution World, Energy Perspective, Restructuring Today, Energy Pulse, Natural Gas & Electricity, EnergyBiz*, and the Belgian magazine, *Revue E tijdschrift*. A recent op-ed piece was published in *The New York Times*. He is co-editor of and a contributor to the IEEE book, *The Evolution of Electric Power Transmission Under Deregulation*.

In addition to his engineering career, Mr. Loehr is a published author, has exhibited his art photographs at galleries in the New York metropolitan area, and has done stock photography for a world-wide photo agency. His photographs have appeared in numerous magazines, advertisements, business brochures, and several "coffee table" books, and one of his art photos was used as the cover for Sandra Brown's best-selling novel, *Fat Tuesday*. He recently published his own first novel, *Blackout*.