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James C. Liles

Building an Electric Grid that Wall Street Can Understand

A Tale of Two Networks: The Best of Times? The Worst of Times?

Over the course of the past five years energy has reclaimed its share of the public's limited attention. Energy prices have become volatile. Gasoline, heating oil, natural gas and electricity have all exhibited price run-ups. The California electricity situation has become front page news in the mass media. Indeed, national newspapers are now referring to "FERC" without bothering to spell it out. FERC has become mainstream. The news is not limited to tales of markets gone awry – there are stories about new technologies as well. Distributed generation, renewable energy and superconducting distribution lines have all been featured in the general media. Even advances in real-time metering and control technology have been written up in the popular press. And yet, through all of the big news stories, the electric transmission system has received only minimal attention. Yes, there have been "transmission stories" addressing bottlenecks and constraints (*e.g.*, the infamous Path 15 in California) and the role played by these in contributing to price spikes. There have been stories about the proposal for California to purchase the transmission facilities of the state's privately owned utilities. And there have been a few stories about FERC's policies toward Regional Transmission Organizations ("RTOs"). But beyond these instances – in which the transmission system impinges upon some other big story – the system has received little attention.

Perhaps the transmission system is too complex for easy exposition. Or perhaps the system appears so simple – like a collection of pipes and hoses – that detailed explanations of how it really works are not believed necessary. The economics of the transmission system are certainly complex and the legal and regulatory environment is as well. Whatever the reason, the transmission system is taken as a given quantity, when it is mentioned at all, in the public debate over energy. There's a sense of fatalism about the transmission system: it's vital to our modern economy but virtually impossible to expand or change. This viewpoint seems to have been accepted without serious debate.

It's noteworthy that while all of the energy news about price spikes, blackouts, allegations of market manipulation and demands for multibillion dollar refunds have been unfolding, another drama has been underway in the telecommunications industry. The telecom story has been equally dramatic, but with a different plot line. This was a story of unbridled optimism leading to a crash: a story of hubris followed by nemesis. A few years back, the notion of the internet revolutionizing the world was generally accepted as truth. City streets were repeatedly torn up by rival crews installing bundles of multi-colored plastic tubes for the purpose of bringing bandwidth to all. The ocean floors were criss-crossed with submarine fiber optic cables, each with a greater capacity than what had gone before. Similar expansions were underway in the wireless sector. The future, it was expected, would be a world of instant information, available 24 hours per day, seven days per week, just about anywhere in the world. When the crash came it was the result of too much money chasing the dream and leading to a speculative bubble. No one was accepting the internet as a given quantity.

Although the energy and telecom sagas have been major news events over the past few years they have each played out in largely separate worlds. The electrical demands of the internet did catch some of the early blame for California's electricity shortage, and a few big energy trading companies announced bandwidth trading as a coming profit center. But beyond these limited points of contact no lessons from one story have been applied to the other. Why should this be?

Both systems, after all, are networks. Both have a backbone of high capacity, long distance lines (or other assets serving the same purpose) connected to local networks that deliver the product to millions of consumers. The long distance lines are connected to the local networks by means of special facilities – full of switches, protective equipment and equipment for repackaging the product. The systems are operated from control centers that look remarkably alike: the walls are typically covered with maps showing the network while lights of varying colors show the status of the network's component parts. The local networks for both systems may be located under city streets or carried overhead on poles. And both systems confront economics of high installation costs followed by low operating costs.

And yet, one of these networks was the subject of a world-wide riot of speculative overbuilding, while the other network is viewed as static and virtually unchangeable. One network had competing work crews fighting (sometimes literally fisticuffs) to install rival distribution networks under city streets, whereas the other network drew a work crew only when something broke down, caught fire or (as in Washington, D.C.) blew up. In dry economic terms, one network is viewed as a contestable market; the other is viewed as a natural monopoly. The FERC's rules on RTOs require separation of ownership rights from control rights in order to protect the transmission systems' customers from market power. The Federal Communications Commission has not imposed the RTO model on the telecom industry.

Given the vast size and economic importance of the electric power and telecommunications industries it is worth taking a close look at the technologies of each with an eye toward treating the former more like the latter. Does the technology of electric power transmission and distribution inherently require the structural and regulatory treatment that has been applied?

"Let me tell you about the electric power network. It is different from other networks," said the electric utility engineer. "Yes, it operates at higher voltage than telecom networks do," said the telecom engineer.[1]

[1] The author apologizes to F. Scott Fitzgerald, Ernest Hemingway and Mary Colum.

Three Recent Merchant Transmission Projects.

In the past two years several independent, market-driven power transmission projects have been proposed. On October 1, 1999, TransEnergie U.S. Ltd. (an indirect wholly-owned subsidiary of Hydro-Quebec) ("TransEnergie") petitioned FERC for acceptance of a market-derived transmission tariff for a proposed 26 mile submarine direct current ("DC") cable running under Long Island Sound.[2] On June 1, 2000, FERC issued a carefully crafted order accepting the proposed tariff, subject to specified conditions.[3] FERC was careful not to endorse market-based rates for transmission projects generally and found that TransEnergie's pricing approach could be accepted under existing FERC precedent as a form of opportunity cost pricing. Subsequent to FERC acceptance of TransEnergie's rates, the company held a successful open season for subscription of the proposed facility's capacity.[4]

On May 23, 2001 Neptune Regional Transmission System LLC (the "Neptune Project") filed an application with FERC for approval of its tariff for open access transmission of power at negotiated rates pursuant to open seasons for subscription of available transmission capacity.[5] As described in its FERC filing, the Neptune Project would be constructed in four phases. The first phase would consist of two relatively short DC submarine cable systems, each sized at 600 MW, running from New Jersey to New York City and Long Island, respectively. Phase 2 would consist of a 1,200 MW DC submarine cable system linking the Canadian province of New Brunswick with New York City. Phase 3 would link the east coast of Nova Scotia with Boston, again with a 1,200 MW DC submarine cable system, and would interconnect both of these new points of service to the previous interconnections. The fourth and final phase would add 1,200 MW DC cable links to the coast of Maine and the coast of Connecticut.

The Neptune Project's FERC tariff filing explains that the system would provide a number of benefits. If fully constructed, the system would allow up to 3,600 MW to be transmitted from areas of excess generating capacity – Maine, New Brunswick and Nova Scotia – to generation deficient load centers in New York and New England. The Neptune Project would allow power generated from the newly developing gas fields of offshore Nova Scotia to be marketed directly in a number of regions. The system would also interconnect the New York, New England and PJM systems of the United States. Finally, generation diversity could be realized, as the Maine and Canadian load serving entities are all winter peaking, while the southern load serving entities are summer peaking.

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[2] Docket No. ER00-1-000.

[3] 91 FERC ¶ 61,230 (2001).

[4] See, FERC "Order on Reports" submitted by TransEnergie, 93 FERC ¶ 61,289 (2000). Additionally, on June 15, 2001, FERC approved a transfer of TransEnergie's rights and obligations to a partially-owned subsidiary, Cross Sound Cable Company L.L.C. 95 FERC ¶ 61,410 (2001).

[5] Docket No. ER01-2099-000.

The Neptune Project requested FERC acceptance of its tariff prior to August 1, 2001, in order for the first phase to be placed in service before the summer peak of 2003. FERC responded with an order on July 27, 2001[6] accepting Neptune Project's transmission tariff, subject to certain specified conditions. On the positive side, FERC accepted the open season approach to capacity reservation and market-based pricing. This is a significant plus. FERC did require that all capacity on the Neptune Project be subject to the open season process (the sponsors had wanted to reserve up to 30 percent of the capacity for bilateral negotiations). On the down side, FERC denied Neptune Project's request for waiver of the Order No. 888 pro-forma tariff: the project was ordered to join an RTO and use the RTO's tariff, covering matters other than the open season and pricing terms. As matters play out, the Neptune Project will be participating in the Northeast RTO formation negotiations and may be able to achieve recognition of it's special circumstances in that process. At least the possibility remains open. Also on the negative side, FERC slammed Neptune Project's request for a tariff article addressing compensation for system benefits on the existing transmission system. Nevertheless, the project may be able to receive compensation for increased transmission capacity on the existing alternating current ("AC") system through the RTO tariff. Again, the door remains open to the Neptune Project realizing its objectives – everything depends on the RTO negotiations and the administration of the RTO in the future. Only after the open seasons will Neptune Project's sponsors know the magnitude of future revenues to cover the risks of the RTO process.

In addition to the projects described above, which have filed at FERC for acceptance of transmission tariffs, another large project has been publicly announced but, thus far has not made a FERC filing. On March 20, 2001, the TransAmerica Grid project ("TAG") was publicly announced at the National Energy Summit in Washington, D.C., sponsored by the National Chamber Foundation of the United States Chamber of Commerce. TAG is being jointly developed by Black & Veatch Corporation, an engineering firm headquartered in Kansas City, Missouri, and Siemens AG, the international electrical equipment manufacturer based in Germany.[7]

TAG is the most expansive of the stand-alone transmission projects thus far proposed: it would link one or more clusters of mine-mouth coal-fired generating plants to be built in Wyoming with electric load centers in the Chicago and Los Angeles areas. This would require a DC transmission line of approximately 1,010 miles running east, rated at 4,000 MW, and a 960 mile DC transmission line, rated at 2000 MW running west. The transmission lines are estimated to cost in the neighborhood of $2.25 billion, with a similar figure going to the cost of the DC converter stations – which convert the input AC into DC and accomplish the reverse process at the other end. The transmission part of the total project would thus amount to nearly 2,000 miles of lines, costing about $4.5 billion. In addition to delivering the output of the coal-fired generating stations to the nation's population centers, the system could also transmit power from the Chicago

[6] 96 FERC ¶ 61,147 (2001).

[7] The author wishes to thank Tim Leyshock of Siemens Power Transmission & Distribution, Inc. and O.H. (Dean) Oskvig of Black & Veatch Corporation for generously providing information on the TAG project.

area (nuclear generation, most likely) into southern California. The reverse flow could also be arranged if conditions warranted.

As grand as the basic TAG system is, the project also includes a number of expansion possibilities: (1) a 155 mile spur line running south from the Wyoming generation complex to the Denver area, (2) an 870 mile line running southeast from Wyoming to Dallas, (3) a 276 mile line running east from a junction on the Chicago line in Pierre, South Dakota, to Minneapolis and (4) several optional links in the West, which would connect the Los Angeles terminal to San Francisco and to Phoenix. The cost of these optional lines and the associated converter stations has not been revealed.

TAG is noteworthy – apart from its grand scope and huge cost – in that it would link the Eastern and Western interconnects of the United States with a transfer capacity measured in thousands of megawatts. This has never been done before. The optional expansion to Dallas would serve to link ERCOT with the Eastern and Western interconnects. Although ERCOT is currently linked with the Southwest Power Pool in the Eastern interconnect by means of two asynchronous ties, ERCOT is not linked directly to the Western interconnect, and additionally, the existing ties are generally fully committed.

If fully realized, TAG would constitute the beginnings of a true interstate grid. Its eastern terminus, near Chicago, would tie into the emerging Alliance RTO – which, in turn, would be tied to the PJM ISO, which itself may soon become an integrated Northeast RTO. Thus, TAG and The Neptune Project would be separated by only two intervening RTOs.

Of course, TAG and the Neptune Project are only proposals. Neither is certain to be built. And even if development proceeds, the full interconnection potential of these projects may not be realized. Rather than focusing on the dream of a national grid, the reader should focus on what all of the projects described above have in common: they are all DC transmission projects. Developers are willing to pursue stand-alone, project financed transmission lines, but only if the lines use DC technology. There's a message here. Utility regulators, legislators, financiers and transmission customers would be well advised to consider the implications.

Why Developers of Merchant Transmission Projects are Opting for DC.

What is it about DC that makes a stand-alone transmission project feasible (or at least sufficiently feasible for the sponsors to make a public announcement or file a transmission tariff at FERC)? It certainly is not the cost. The converter stations of the TAG project would cost as much as the transmission lines. The benefit of DC lies in the ability of the project's operator to *control* the flow of power on the line. What you put in is what you get out, net of resistive losses. Loop flow is not an issue. Contrast this with the existing AC network, in which power flows freely throughout the system according to the impedance of the lines. On an AC system, loop flows (also called inadvertent flows) can fill up the available transfer capability ("ATC") of a line. Witness all of the grumbling about the poor quality of ATC figures posted on transmitting utilities' FERC-mandated OASIS[8] sites. More important, firm transmission capacity on an AC network does not mean physically firm. At best, the firm customer gets a promise by the transmitting utility (or ISO, or RTO) to make reasonable efforts to redispatch generation resources so as to accommodate the scheduled transfer of power. The cost of the redispatch, of course, will be unknown in advance but the transmission user can hedge this economic risk by transacting in a variety of derivatives.

Physically firm transmission capacity can be purchased and sold on a DC line. For DC lines, the contract path is the actual path over which the power flows.[9] The capacity of the line will be independent of the loading of other transmission lines and the operational status of interconnected generating plants. Prices will always be known in advance. Capacity on a DC power line can be bought and sold in much the same way as capacity on a fiber optic cable. The owner of a fiber optic cable may offer to sell bandwidth (measured in Giga-bits per second, "Gbps" or specified in terms of a number of wavelengths of laser light, each with a stipulated Gbps rating) to customers on a cable system, with the receipt and delivery points of the customer's data specified by contract. In the internet business, such contracts are known as indefeasible rights to use, or "IRUs." Alternatively, a customer with large data transmission needs may purchase a pair of optical fibers on a cable.[10] One can imagine a similar approach with a large DC power line, in which a large user would purchase a dedicated circuit of a multi-circuit line. Either way, the customer is buying a known quantity for a known price.

The ability to sell a known quantity for a known price is the key to project financing a power transmission project. Without this ability, the project's revenues would be subject to extreme uncertainty. What bank would be willing to finance an AC line that may fill up with unscheduled loop flow? Only if the line were equipped with

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[8] Open Access Same-Time Information System. See, FERC Order No. 889, FERC Stats. & Regs. ¶ 31,035 (1996), order on reh'g, Order No. 889-A, FERC Stats. & Regs. ¶ 31,049 (1997), order on reh'g, Order No. 889-B, 81 FERC 61,253 (1997).

[9] This point has been noted by others in this magazine: for example, see, George Loehr, "Take My Grid, Please! A Daring Proposal for Electric transmission" *Public Utilities Fortnightly*, May 1, 2000, pp. 44-50. Loehr states: "marketers could actually schedule power transactions to a point, over a specific HVDC line…an enormous advantage over the present system, since the power system would essentially emulate the way marketers like to think about the system." See, also, Bruce Radford, "The Grid is Dead" *Public Utilities Fortnightly*, June 15, 2001, pp. 4-6. Radford writes: "They say the contract path is a fiction, but guess what – the people want the contract path."

[10] Optical fiber networks always are comprised of fiber pairs, each carrying data in a single direction; DC power transmission lines are similar. Undersea cables are limited in the number of fiber pairs that can be carried by the technology of the cable's repeater units, which take up space and consume power. A state of the art undersea cable may have eight fiber pairs. In contrast, most DC power lines have only one or two pairs of conductors (although the conductors may consist of bundles of individual cables in order to reduce corona and increase the line's current carrying capacity. A multi-circuit DC line is not out of the question, however.

some new generation of FACTS[11] devices would a stand-alone line be capable of sufficient operational control to make project financing feasible. Given the existing state of the art, DC is the way to go for developers of merchant transmission projects.

The Bigger Picture: Benefits to Electricity Consumers and Benefits to the Nation.

The rationale for policymakers to encourage new merchant transmission systems may seem obvious: the systems would help relieve existing transmission constraints and would thereby encourage a more robust market for wholesale power. By relieving constraints the scope of the geographic market for wholesale power could be expanded. This would allow more generating sources to compete, and thus would exert downward pressure on power prices. Additionally, removing transmission constraints may remove "load pockets" – regions in which generation is inadequate to serve load and generating plants must be dispatched out of merit order for reliability reasons. Finally, removing constraints may reduce the possibility of market participants "gaming" the system. With a larger market and more market participants, it may become harder for an individual participant to raise prices by withholding output.

The benefits of relieving transmission congestion are real, but the arrival of merchant DC transmission projects may provide additional benefits not immediately obvious. As these project are announced and come to FERC with tariff filings there is more at stake – much more perhaps – than FERC or the U.S. Congress realizes. High-voltage DC transmission systems offer a public benefit that few persons have noticed. They offer the possibility of competition in the transmission sector. This is vitally important and must not be underestimated. Again, remember the world of submarine fiber optic cables and the telecommunications system generally: multiple parties have built competing systems. This has driven down prices and supported an astounding series of technical advances. Similar results may be had in power transmission, if policymakers do not stifle the emerging competition.

The author has spoken on numerous occasions about the potential benefits of for-profit electric transmission companies, a business concept often called a "Transco." The response of the audience to such a presentation has by now become predictable. A subset of the audience, young engineers for the most part, is highly enthusiastic. They have come of age professionally during the rise of the internet and they chafe at the lack of technical innovation in the power industry. Another subset of the audience, older utility engineers and managers, is more reserved. They will privately say that change may be a good thing but not at their stage of professional life. They feel entitled to some quiet time without disruptions or upheavals before retiring. A third subset of the audience, however, expresses hostility. "You're just going to create a huge *monopoly!*" they exclaim. These

[11] Flexible AC Transmission System. The ability of new, solid state power control technologies (generally thyristor-switched devices) to control the operation of AC lines is certainly worthy of attention. In the future it may be possible to control AC lines with almost the degree of flexibility with which DC lines currently can be controlled. Although project financing an AC line with FACTS devices would necessarily involve technology risk. This is a topic of sufficient complexity to merit a separate paper and will not be further addressed herein.

views are often voiced by power marketers and regulators. I have often responded that even a monopoly Transco, if properly regulated, would be superior to the world as it exists today. But the emergence of merchant DC transmission projects may allow an even better outcome – competitive, *i.e.*, non-monopoly, transmission companies. Policymakers must recognize the possibilities as they develop rules for the electricity industry.

As a thought experiment, think about the telecommunications world of a decade ago. Fiber optic cables had been developed, but were largely used for voice communications. The internet was a limited network, largely used for data transmission among government and academic entities. At this time, most countries had a state monopoly telecommunications company. The United States had the "Baby Bells" and GTE for local telephone service and three major long-distance carriers: AT&T, MCI and Sprint. Now, try to imagine how the past decade would have played out if Federal regulators had forced the nation's long-distance carriers to turn over operational control of their networks to a single RTO, administered by a board of disinterested parties. Imagine also how the world would look today if Federal regulators had forced the emerging wireless telecom networks and the satellite systems to surrender operational control to the same RTO. Think about it.

Competition, of course, is not a goal in its own right but only a means to achieve other ends. Lower prices for transmission service is one desirable end result of competition. In this context, it is worth noting that both TransEnergie and the Neptune Project were willing to assume the financial risks of their respective projects. The sponsors were *not* asking FERC to accept a "cost plus rate of return" pricing model. In both of these cases, transmission customers will pay prices for service determined in part by the competing AC system. If the existing system were totally unconstrained, there would be little economic rationale for the new projects. Additionally, the fact that the new projects are not asking for traditional cost-based regulation should answer those critics who contend that Transcos will lead to economic inefficiency by "favoring transmission solutions where generation solutions may be lower cost." This undesirable outcome can only happen if regulators apply a monopoly pricing model to the Transco. Competition between new merchant generating plants, for which the developers assume the financial risks of their projects, and new merchant transmission projects developed under the same pricing principle will lead to the lowest cost option being selected.

Although competition may yield price reductions directly by affording customers with more choices, the potential for encouraging technological advances may yield even greater savings in the long run. This is probably the most important reason to encourage new merchant DC transmission projects. When speaking of Transcos, the author has from time to time noted the possibility of re-engineering the existing grid to provide a fully controlled system – a switched network. Thermal limits of power conductors could be monitored in real time, either by means of thermocouples (for measuring the conductor's temperature) or strain gauges (for monitoring elongation directly). FACTS devices of various kinds could actively monitor and control voltage effects, such as reactive power supply and power factor. FACTS devices may also be used to reroute power flows away from lines approaching their thermal limits. Finally, fast discharging energy storage devices could control stability problems and could act to isolate a fault on a particular transmission line. With such technologies, the throughput of the existing AC network could be vastly increased without new rights of way.

When the subject of re-engineering the grid comes up at transmission conferences, again the audience reacts in a manner that has become familiar with repetition. The junior engineers react enthusiastically; the senior utility management types remain reserved. But economists in the audience react with puzzlement. "Why would a monopoly accept the technology and business risks of installing all this new equipment?" they ask. Why indeed? Only competition from new entrants is likely to provide the necessary motivation. Only competition from fully controllable DC systems is likely to motivate the owners of the AC grid to move in the direction of a switched network. EPRI[12] can tell the industry "how" but cannot answer the "why" questions. The regulators cannot make the industry innovate.

And still there is more. The AC transmission system as it exists today depends upon the generation sector for essential elements of its control. Reactive power, on a moment by moment basis, is supplied from generators. If the generators do not supply it the system's voltage may collapse. And it is the generators that keep the frequency within specified bounds. A significant deviation in the system frequency could have catastrophic results. Indeed, the existing AC transmission system is incapable for controlling itself and must purchase essential ancillary services from the generation sector. Many of the recent allegations of market manipulation and "gaming" of markets have concerned markets for ancillary services. In a typical instance, generators have a choice of selling energy or some other product, such as operating reserves. At times, the market for particular ancillary services appears to lose liquidity; a few participants are alleged to have cornered the market. There is a underlying issue here for policymakers: if the transmission system is so critically dependent upon the generation system that a momentary interruption in the supply of any one of several ancillary services could cause a catastrophic failure of the entire interconnected system, can market forces be relied upon to yield a socially desirable outcome? Stated more simply, can you have competitive markets when the generators control so many key inputs and the inputs have to be supplied continuously?

DC transmission systems are vastly more robust than their AC siblings. Reactive power is not needed from generators because there is no reactive power on the system. Neither do DC systems operate at a frequency that must be kept within narrow limits. Competitive markets for generation will be much easier to rely upon, and will be much easier to police, when connected to DC transmission systems. And if competition from DC systems spurs the owners of the AC system to add the FACTS devices and energy storage buffers, the generators will lose much of the market power they now enjoy in the supply of ancillary services. The FACTS devices can provide reactive support; the generators will not have to. Similarly, the storage buffers can provide frequency support and regulation service, the generators will not have to. Policymakers who care only

[12] Formerly the Electric Power Research Institute, now simply EPRI.

about competitive markets for generation should nevertheless chose to support the entry of new transmission providers, using controllable DC technology, as a strategy for decoupling the transmission sector from the generation sector. Once decoupled, electric energy will be a commodity. Competitive markets for commodities are commonplace and uncontroversial.

What can FERC Do?

In accepting the tariffs submitted by TransEnergie (as transferred to Cross Sound Cable Company) and the Neptune Project, FERC has demonstrated a cautious encouragement for merchant DC transmission projects. FERC might do more. By their nature, DC transmission lines are similar to gas pipelines as well as fiber optic cables, and unlike fiber optic cables, FERC has great experience with gas pipelines. With respect to questions of market power it is noteworthy that TransEnergie proposed to FERC that the cable's owner and operator would be independent of any generating capacity in the relevant market. Equally important, capacity rights on the cable would be assigned through an open season bidding process. And both TransEnergie and the Neptune Project stated that they would assume all of the financial risks of their projects. Under FERC's guidance, developers of gas pipeline projects follow similar approaches. Although FERC has a "full plate" of regulatory responsibilities at the present time, it might consider the benefits of a rulemaking that would spell out its treatment of merchant DC transmission projects. The rulemaking could address tariff issues, including affiliation with market participants, standards of conduct, open seasons for new capacity, secondary markets for existing capacity and integration with the surrounding AC networks. Rate issues might also be addressed in the rulemaking. TransEnergie sought to bear all of the financial risk, in return for market-based prices (or opportunity cost-based prices, in FERC's characterization). Others may ask for different ratemaking approaches, including for example, price cap methods. By offering firm guidance on what it would be willing to accept, FERC could remove a major area of uncertainty affecting new transmission projects.

Beyond initiating a rulemaking, FERC would be well advised to encourage its staff to consult with their counterparts at sister Federal regulatory commissions. FERC staff economists should actively be engaged in a dialog with the economists of the Federal Trade Commission and the Federal Communications Commission – the former because of their expertise in competitive analysis and the latter because the telecommunications industry holds some lessons for the electric power industry. This dialog should go beyond the long overdue re-examination of FERC's "hub and spoke" competitive analysis to consider questions of industry structure. The FERC staff should not shy away from asking whether its universal RTO model may be forcing a monopoly structure on a contestable market segment. And the FERC's engineering staff should invite the folks at EPRI to come in and explain how new technology can transform the power grid. The staff's senior management and key members of the staff's legal team should definitely budget some of their scarce time to attend these meetings. The engineers and economists cannot make it happen alone. During the past six months, the

FERC has made great strides in learning how power markets work. Now is the time to look at the road ahead.

What can Congress do?

And now for the controversial part. Few subjects have raised political passions as much as the topic of Federal eminent domain for new power transmission projects. Proponents have pointed to the example of the natural gas industry. The Natural Gas Act ("NGA"), which became law in 1938, grants certificate authority over interstate natural gas pipelines to the Federal Power Commission, which authority was transferred to FERC by the Department of Energy Organization Act. Section 7(h) of the NGA[13] provides:

> When any holder of a certificate of public convenience and necessity cannot acquire by contract, or is unable to agree with the owner of property to the compensation to be paid for, the necessary right-of-way to construct, operate, and maintain a pipe line or pipe lines for the transportation of natural gas, and the necessary land or other property, in addition to right-of-way, for the location of compressor stations, pressure apparatus, or other stations or equipment necessary to the proper operation of such pipe line or pipe lines, it may acquire the same by the exercise of the right of eminent domain in the district court of the United States for the District in which such property may be located, or in the State courts.

Few would argue that Section 7(h) of the NGA has not been crucial in the development of our nation's network of natural gas pipelines. But the history of the electric power industry is different from the gas industry: whereas natural gas is found in particular geographic regions, not generally co-located with the regions in which it is consumed, electricity can be generated from a variety of primary energy sources, which may often be transported to where generating capacity is needed.[14] Certificates of public convenience and necessity, and the right of eminent domain that may accompany such certificates, is reserved to the states.

Opponents of Federal eminent domain authority for electric transmission lines raise a number of objections. Conservatives voice a general concern with any government sanctioned taking of private property. Liberals are worried about the environmental impact of transmission lines. And representatives of state governments (regulatory commissions in particular) voice a concern with Federal pre-emption of their authority. While proponents speak of building an "interstate highway system" for electric power, the skeptics ask how "interstate" may be distinguished from "intrastate."

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[13] 15 U.S.C. 717f(h).

[14] Hydroelectric resources are an obvious exception to this general rule. Historically, governments at both the Federal and state levels have opted to become directly involved in the generation and transmission of hydroelectric power by means of such agencies as the Federal Power Marketing Agencies, the Tennessee Valley Authority, and state agencies such as the New York Power Authority.

A slippery slope policy is feared, under which all transmission siting will end up being federalized.

DC transmission lines appear to present a compromise on the interstate/intrastate question. Unlike AC lines, in which each part of the grid influences every other part, a DC line could reasonably be treated as interstate simply if it crosses from one state into another. Although environmental and property rights issues would remain,[15] a right of Federal eminent domain for DC lines that cross from one state into another would not raise a slippery slope concern with state officials. State public utility commissions would continue to have authority over the AC system, which by reason of its synchronous operation with the distribution system, is closely tied with maintaining reliable electric service for the public.[16]

If the Congress is unable to find the votes for the compromise outlined above, more limited action might still be possible. In this author's experience, public opposition to new electric transmission lines derives in significant part from their intrusive appearance. Additionally, some members of the public may fear the possibility of health effects resulting from electric and/or magnetic fields. When new lines are proposed, the public often responds by demanding the lines be placed underground. For technical and economic reasons, underground lines are often not feasible. However, DC lines are somewhat easier to place underground than AC lines. A Federal statute extending to FERC the authority to certificate interstate underground DC power lines would reserve to the states the authority to site overhead lines and the AC system. There is a certain logic to this: projects that create real or perceived major impacts on private property owners would require authorization at a level of government close to the affected parties. Projects that create lesser impacts and demonstrably serve interstate markets could be authorized by the national government. Moreover, FERC has a large staff with experience in the environmental review of underground pipeline projects.

Such a Federal statute may not fix all of the nation's transmission constraints, but it may help facilitate offshore DC systems by allowing FERC certification of short underground links between the offshore system and the terrestrial AC network. And such a statute may prove to be an incubator for technological innovation. It would be better than nothing.

Some Final Thoughts.

This paper has argued the many apparent benefits of encouraging development of new merchant DC transmission projects. Although the potential benefits appear

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[15] For what it's worth, one might note that the electric and magnetic fields surrounding a DC line are not the time-varying fields that some members of the public fear may cause health problems.
[16] Connecting a Federally-certificated interstate DC transmission project to the AC grid would raise the same sort of issues that routinely arise in connection with interconnecting a Federally-licensed hydroelectric project (which projects have a separate Federal right of eminent domain under Section 21 of the Federal Power Act (16 U.S.C. 814)), or interconnecting an unregulated qualifying facility under the Public Utility Regulatory Policies Act of 1978.

compelling, the ability of such projects to compete for capital and attract financing remains an open question at this time. Lawmakers and regulators can offer encouragement and remove barriers, but ultimately private parties will have to decide whether the investment makes sense in light of the technical and business risks. At the present time, action by Congress and FERC would appear to offer great potential and relatively little risk. In private conversations, the author has found considerable enthusiasm for new transmission investments, if the barriers can be reduced. And to those who respond to the example of the telecommunications industry and the internet with fears of a speculative bubble – the possibility of billions of dollars pouring into speculative transmission projects – I can only wish we would be so lucky.

James C. Liles
Regulatory Advisor
Milbank, Tweed, Hadley & McCloy LLP
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