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Introduction

Joseph H Fagan, Becky M Bruner, Michael S Hindus and Robert A James

Pillsbury Winthrop Shaw Pittman LLP*

The current state of electric infrastructure in the US and the rest of the world is inadequate to serve future energy demand. Mindful of this trend, legislators and regulators in the US have adopted policies aimed at promoting the development of such infrastructure, while at the same time acknowledging that much of it will facilitate more widespread use of 'clean' renewable energy sources. By some estimates, the cost of building the new and replacement electric infrastructure projects to meet the anticipated demand by 2030 will be close to US$600 billion. Providing sufficient incentives for market participants to invest in these projects, while at the same time encouraging the use of renewable 'carbon-friendly' energy sources in as efficient and as cost-effective manner as possible, is illustrative of one of key challenges facing the US in the 21st century.

Status of electric infrastructure in the United States

Electricity consumption in the US is expected to increase by at least 40 per cent by 2030. To provide adequate and reliable electricity service to meet this projected demand, the US will need to invest heavily in all aspects of its energy infrastructure. The Energy Information Administration (EIA) estimates that 258GW of new generating capacity will be needed by 2030, at a cost of approximately US$412 billion (at 2005).

More than half of the electricity generated in the US comes from coal, and coal is projected to remain a vital energy resource. In response to concerns about global warming, new technologies are being developed to eliminate or capture harmful greenhouse gases (GHG) emitted from coal-fired power plants. The US is also encouraging development of renewable energy sources, such as wind, solar, geothermal, hydrogen and biomass. Currently, renewable resources are used to generate about 7 per cent of the total electricity produced in the US. Nuclear energy is the second-largest fuel source for electricity production in the US today and it is the largest source of emission-free generation. Natural gas, however, is projected to be the major fuel source for electricity in the next 20 years when 900 of the next 1,000 power plants are expected to be fuelled by natural gas.

Most of the US's existing transmission grid was constructed prior to the advent of wholesale competition and active market trading. This ageing transmission system must be expanded and upgraded to meet the needs of the growing US population, robust wholesale trading and the interconnection of distant generation resources, particularly wind and solar. The Edison Electric Institute reports that from 2000 to 2006, electric companies invested more than US$37.8 billion in the nation's transmission system, and that they are expected to invest an additional US$37 billion from 2007 to 2010.

Legislative developments

Federal

The Energy Policy Act of 2005 (EPAct 2005) made important modifications to US energy policy. Among them, EPAct 2005 directed FERC to promote the development of transmission infrastructure by promoting capital investment in the enlargement and improvement of the nation's transmission grid. EPAct 2005 also allowed federal income tax credits and accelerated depreciation for certain investments in transmission property.

The Energy Improvement and Extension Act of 2008 (Energy Improvement Act) adopted an extension and expansion of the tax incentives for renewable energy projects as well as a host of related tax incentives for energy development. Principal among these is an extension of the 'production tax credits' for renewable energy sources, which were otherwise due to expire at the end of 2008. Such extensions are critical to the industries affected, since the production tax credits are essential to the economics of the projects using the technologies. However, the relatively brief extensions will not accommodate longer-term projects. In addition, US$800 million of 'clean renewable energy bonds' were authorised to finance qualifying renewable energy facilities for governmental, public power and electric cooperative entities.

In contrast to the relatively brief extension of the production tax credits, the Energy Improvement Act provides for an eight-year extension of the 30 per cent investment tax credit for solar energy and fuel cells. This change is likely to act as a boost for the long-term planning and development of large-scale solar and fuel cell projects. Investment credits were also added for several resources, including, qualifying cogeneration systems, small wind and geothermal heat pump systems. In addition, investment tax credits were made available for qualifying coal and gasification projects. Credits are increased for those projects that achieve the greatest percentage of carbon dioxide separation and sequestration.

In the US and around the world, governments are moving to reshape their energy policies, regulate GHG emissions and otherwise implement measures aimed at curbing the effects of global warming. In the coming years, it is anticipated that initiatives will be adopted in the US aimed at reducing GHG emissions that may include establishment of a cap-and-trade programme or a carbon tax.

State

Many state governments have not waited for comprehensive federal action and have instead acted on their own. They have developed measures to reduce GHG emissions that include initiatives to conduct emissions inventories, project future emissions based on population and economic growth, and identify areas where emissions can be reduced and develop reduction goals. States and regions are very active in promulgating legislation and taking decisive, discrete action that will impact the electricity generation sector.

In addition to climate change legislation, more than two dozen states have implemented renewable portfolio standards (RPS) aimed at reducing carbon emissions and encouraging the development of renewable resources. RPS guidelines require that affected electricity

providers (such as electric utilities) include a specified amount of renewable energy as part of their generation portfolios.

Regulatory developments

Pro-transmission policies

In recent years, the US has developed a number of pro-transmission policies, including development of an incentive base rate structure for transmission facilities as well as identification of areas of transmission congestion.

EPAct 2005 directed the Federal Energy Regulatory Commission (FERC) to establish, by rule, an incentive-based rate structure for the transmission of electric energy in interstate commerce. Specifically, the incentive rate structures must provide a return on equity (ROE) that attracts investment and allows recovery of all costs prudently incurred in complying with new reliability standards. The rulemaking resulted in Order No. 679, essentially affirmed by Order Nos. 679-A and 679-B. Order No. 679 established a framework for incentive-based ROEs available to all public utilities for new investments in transmission that benefit consumers by ensuring reliability or reducing the cost of delivered power by reducing congestion. In Order No. 679-A, the FERC specifically stated that the 'most compelling case' for incentive-based ROEs is new projects with special risks or challenges, not routine investments made in the ordinary course of expanding the system to provide safe and reliable transmission service. FERC has approved close to a dozen of such proposals under its new transmission incentives policy.

In addition, EPAct 2005 directed the Department of Energy (DoE) to identify transmission congestion and constraints and to conduct a nationwide study of electric transmission congestion every three years. Geographical areas where transmission congestion or constraints adversely affect consumers may be designated as national interest electric transmission corridors (national corridors). The DoE has designated two national corridors: the Mid-Atlantic Area National Corridor and the Southwest National Corridor. This action puts the states and the industry on notice that there are transmission congestion problems in such areas that must be addressed. It also provides the FERC with new federal 'backstop' siting authority to issue construction permits for facilities located in a national corridor under certain circumstances. For example, if an applicant does not receive approval from a state to site a proposed new transmission project within a national corridor within a year, the FERC may consider whether to issue a permit and to authorise construction.

Interconnection policies

Interconnection policy is a priority for all advocates of locationally constrained electric power generation, including wind, solar and biomass resources. In order to make these technologies work on the scale necessary to achieve long-lasting rewards, they must be integrated into the existing transmission system. Before these resources can be interconnected, the transmission provider must perform a series of impact studies and consider alternatives for interconnection points. The FERC's existing set of rules are based on its Order No. 2003, as reflected in each transmission provider's interconnection procedures and agreements for large generators and small generators of 20MW and below. The FERC also formalised a rule specifically for wind power facilities larger than 20MW.

With the steep rise in applications from small renewable projects, predominantly wind, the normal queuing process that traditionally subscribed to a 'first-come-first-served' philosophy is being overwhelmed and bogged down. Many transmission operators are being forced to adjust their queuing rules in an attempt to alleviate the resulting backlogs. The FERC facilitated an industry-wide review of queuing practices by holding a technical conference in late 2007. In March 2008, The FERC issued an order requiring regional transmission operators (RTO) and independent system operators (ISO) to evaluate their queue management policies. Other transmission providers, outside the realm of ISOs and RTOs, are facing similar issues. Going forward, numerous reforms are being considered, including changes to reservation priority, increase to up-front payments, open seasons and temporary rule suspensions to allow RTOs and ISOs to clear the queue more often than the three-year grace period that was adopted under Order No. 2003.

Within this framework, interconnection policy is quickly evolving. Significant regional variations exist, with queuing practices becoming part of the discussion of forward capacity markets in the north-eastern US and in the PJM Interconnection (encompassing such states as Pennsylvania, New Jersey, Maryland, Delaware, Virginia and West Virginia), and with different solutions being implemented in California. In the end, the laudable, if distant, goal of 'grid parity' for renewable generation resources will be little more than an illusion without efficient and safe procedures for incorporating numerous types of new generation into the existing transmission system.

Current challenges to electric infrastructure development

Significant investment in all aspects of electric infrastructure is needed to meet the projected demands of the economy and the growing population in the US for reliable, efficient and affordable electricity. Development of new, emission-free generation facilities and expansion of the nation's bulk power transmission grid to connect new generation, relieve congestion and ensure reliability are essential. Development and integration of new generation resources, including renewables, to the transmission grid face many obstacles. Construction of new backbone transmission lines is needed along critical corridors where existing facilities are constrained or new facilities are needed (or both). While substantial efforts to expand the bulk power transmission grid are underway, these projects face substantial challenges.

Transmission constraints

Transmission constraints are often an obstacle to integrating new generation resources. The geographical location of renewable resources, for example, is often far removed from the population centers that the new infrastructure is intended to serve. The areas best suited for wind power are located in the Midwest from north-western Texas to the Dakotas, as well as coastal areas and mountain summits; the best solar regions, not surprisingly, are located in or near the American south west. In many instances, these location constraints present financial and commercial obstacles as the necessary level of transmission investment required to link these resources to distant load centres can be quite substantial. Indeed, this is a key challenge that has become even more pronounced with the implementation of RPS programmes throughout several dozen states. Numerous studies, including one by the DoE entitled '20 per cent Wind Energy by 2030, Increasing Wind Energy's Contribution to US Electricity Supply' have concluded that electric transmission must be regarded as 'a critical infrastructure element needed to enable regional delivery and trade of energy resources, much as the interstate highway system does for the nation's transportation needs'.

Challenge of bringing intermittent resources online

Renewable resources, such as wind and solar are not only locationally constrained but also face the obstacle of being uncontrollably variable, or intermittent in nature, providing electricity only when the wind is blowing or the sun is shining. The sporadic nature of intermittent resources can potentially destabilise the grid and impair system reliability if, for example, significant declines in renewable generation occurs simultaneously with rising load. For these reasons, among others, the penetration of intermittent renewables in most power grids is low; however, technology advances and regional planning decreases the variable nature of intermittent resources. For example,

by aggregating renewable units located in different geographic areas through dynamic scheduling, the overall variability of output is decreased. In addition, the variability associated with wind power and solar power may be managed through the use of conventional power generation assets that are dispatchable. When the wind stops blowing, a conventional power generation resource, such as a natural gas generator, is ramped up to compensate for the shortcoming.

Siting

State and local siting authorities have long had a negative impact on the prospects of most proposed transmission capacity expansion projects. With the exception of projects proposed in Alaska, Hawaii or parts of Texas, all transmission expansion projects have beneficial effects in multiple states. Yet, each state in which the proposed project would be implemented has the power to block the project, and some state agencies are required by law to consider only in-state benefits when deciding whether to approve a project. To make matters worse, at least 22 states allow localities to block transmission expansion projects, which often elicit powerful NIMBY-based local opposition. This problem has become so severe in many parts of the country that developers have become unwilling to even propose a transmission expansion project.

In recent years, however, several pro-transmission policies have addressed this issue. Policymakers have begun a process providing for federal or, possibly, regional siting and eminent domain authority for interstate transmission projects. The first concrete step towards federal siting authority was section 1221 of EPAct 2005, which gives FERC limited jurisdiction over the siting of electric transmission lines that fall within an official DoE-designated national corridor. For example, if an applicant does not receive approval from a state to site a proposed new transmission project within a national corridor within a year's time, the FERC may consider whether to issue a permit and to authorise construction. Notably, however, obtaining a federal permit from FERC still would not in and of itself constitute a right-of-way across public or private property along a transmission route. Such rights of way must be separately obtained. Moreover, outside the confines of national corridors, the states' traditional siting authority over the electric transmission facilities remains as a significant barrier to expansion projects. Many observers are of the view that the lack of comprehensive federal siting authority for interstate electric transmission lines, in contrast to the current statutory scheme governing natural gas pipelines, will serve to handicap the expansion and replacement of the electric transmission grid.

Recovery of up-front costs of new technologies and new generation

Any investor in new energy infrastructure will require a reasonable opportunity to recover its costs, either through cost-of-service regulated rates or through market-based or negotiated rates. A critical factor in whether any such investment would be made is whether the regulator will allow for recovery of the associated costs. Some new generation technologies, such as 'clean coal' technologies that are intended to eliminate or capture harmful greenhouse gases emitted from coal-fired power plants, are highly complex, risky and expensive. Investors are often unwilling to invest in such technologies without some degree of up-front assurance of cost recovery from state regulators. Similarly, development of generation resources, such as wind and solar, in remote locations may involve considerable risk if interconnection to the transmission grid or transmission rights for delivery to load centres are questionable. The absence of a regional transmission planning process or procedures for determining cost allocation among jurisdictions, can pose a major obstacle to the development of major backbone transmission projects.

Access to capital

Further complicating efforts to build out transmission is the cost of raising capital for investment in transmission projects. For many utilities and merchant developers that have plans to invest in transmission, managing project costs is a constant battle. A critical aspect of managing such costs is the cost of borrowing to finance what are likely to be billion-dollar investments. With world credit markets having seized up in the fourth quarter of 2008, and with financial institutions from New York to London more risk averse, in the least, the case for transmission investment has become more financially uncertain. In the short term, in the absence of investment-grade credit ratings, would-be transmission infrastructure developers should be prepared to self fund projects if they want to have any realistic chance to meet their objectives along the time frames that they proposed prior to the current market crisis.

pillsbury

Joseph H Fagan **joseph.fagan@pillsburylaw.com**
Becky M Bruner **becky.bruner@pillsburylaw.com**
Michael S Hindus **michael.hindus@pillsburylaw.com**
Robert A James **rob.james@pillsburylaw.com**

50 Fremont Street
San Francisco
CA 94105, US
Tel: +1 415 983 1000
Fax: +1 415 983 1200

2 Houston Center
909 Fannin Street
Houston
TX 77010, US
Tel: +1 713 276 7600
Fax: +1 713 276 7673

2300 N Street NW
Washington, DC 20037
US
Tel: +1 202 663 8000
Fax: +1 202 663 8007

www.pillsburylaw.com

In addition, the costs of construction have increased substantially over the past several years, and while recent turmoil in the global commodity markets have tempered increases in the costs of raw materials for energy infrastructure projects, such as iron, steel and copper, any such lull is expected to be temporary given the unrelenting global demand for greater energy supply and the infrastructure with which to deliver it.

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Going forward, market participants must be prepared to address the numerous challenges facing electric infrastructure development today. While no one has a crystal ball, it is a near-certainty that the need for greater investment in power projects will continue unabated. In order to meet this demand, the role of government will be crucial, whether in passing legislation or in enacting policies that encourage this investment, or in removing bureaucratic and market barriers that would otherwise impede necessary development. The ability of market participants to react to, and to capitalise on such policies will go a long way towards determining whether domestic and global infrastructure needs are met in the coming decades.

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