



USAID
FROM THE AMERICAN PEOPLE



PAKISTAN STUDIES U.S. ELECTRICITY MARKET OPERATION BEST PRACTICES

EXECUTIVE EXCHANGE IN ALBANY, NEW YORK & WASHINGTON, DC

JANUARY 2015 – The U.S. Energy Association organized an executive exchange for eight senior managers from Pakistan’s National Transmission Despatch Company (NTDC) to review best practices in electricity market operations, as well as renewable energy integration, with their U.S. counterparts.

The executive exchange visit was funded by the U.S. Agency for International Development (USAID) Energy Policy Program (EPP) through Advanced Engineering Associates International (AEAI). EPP is a multi-year initiative to increase power generation, decrease losses and increase cost recovery in Pakistan's power sector by working with selected energy infrastructure and facilitating Government of Pakistan reform efforts with technical assistance and new technology.



Delegation at **New York Independent System Operator (NYISO)**. From left to right (back row): Ken Klapp (NYISO), Saeed Ahmad, Azhar Saleem, Abdul Muqteet, Bilal Hussain, Sarah Blanford (USEA), Faiza Yaqub, Tariq Niazi (NYISO) Front row (left to right): Muhammad Salman Nazar Bajwa, Muhammad Yasir Hussain, Salahuddin Azam Kham.

EXECUTIVE EXCHANGE HIGHLIGHTS

Over the course of the exchange, the Pakistan executives met with their U.S. counterparts to examine best practices for electricity market design and operations. Topics centered on improving electricity supply, reliability and cost through an unbundled, regulated wholesale market, and on facilitating renewable energy integration. The delegates were shown U.S. models that utilize an independent system operator serving as the central manager of pricing and

dispatching generation through a clearing price mechanism. This model relies on multiple sellers (generators) and can accommodate a single or multiple buyers (distribution companies or end-users).

The Pakistan delegation met with a variety of entities in Albany, New York and Washington, DC to discuss electricity markets including:

- Covanta Energy
- Edison Electric Institute (EEI)
- Federal Energy Regulatory Commission (FERC)
- GE Energy Consulting
- Iberdrola Hardscrabble Wind Power Project
- National Grid US
- National Regulatory Research Institute (NRRI)
- New York Independent System Operator (NYISO)
- PJM Interconnection LLC (PJM)
- Schiff Hardin LLP



Pakistan delegation at **National Grid’s** Haverhill 1,016kW solar generation facility. The solar PV site, situated on a former manufactured gas plant site, has 3,565 solar panels and generates enough electricity for 200 homes annually. The site serves to save approximately 1.4 million pounds of carbon from entering the environment annually.

Meetings highlighted best practices in:

- Market organization, staffing and functions
- Market membership and governance
- Role of market participants (IPPs, power marketers, etc.)
- Bilateral, day ahead and real time transactions
- Transmission scheduling and power dispatch
- Commercial operations
- Settlement processes
- Market monitoring/surveillance and mitigation techniques
- Ancillary services
- Renewable integration & renewable markets
- Privatization

BACKGROUND ON PAKISTAN’S POWER SECTOR

Pakistan’s power sector is confronted by significant challenges, including limited availability of reliable and affordable electric power, aging and inadequate transmission and distribution networks, and utility policies and practices that lag those of advanced utilities. For utilities in Pakistan, these deficiencies translate into levels of financial performance that are not self-sustaining. Yet financial self-sufficiency is critical, as Pakistan’s power industry is undergoing sweeping changes, including transitioning from government-owned vertically-integrated utilities to fully autonomous entities that will engage in power generation, transmission, and distribution under the government’s reform agenda. A similar industry structure exists and functions smoothly in many other countries today. In Pakistan, however, outdated policies, procedures and work practices, as well as low investment in infrastructure, are barriers to a successful transition.

BACKGROUND ON NATIONAL TRANSMISSION & DESPATCH COMPANY (NTDC)

National Transmission & Despatch Company Limited was incorporated on November 6, 1998 and commenced commercial operation on December 24, 1998. It was organized to take over all the properties, rights and asset obligations and liabilities of 220 KV and 500KV grid stations and transmission lines/network owned by Pakistan Water and Power Development Authority (WAPDA). NTDC operates and maintains twelve 500 KV and twenty nine

220 KV grid Stations, 5077 km of 500 KV transmission lines and 7359 km of 220 KV transmission lines in Pakistan. NTDC was granted transmission license on December 31 2002 by National Electric Power Regularity Authority (NEPRA) to engage in the exclusive transmission business for a term of 30 years.

ELECTRICITY MARKET STRUCTURE

The United States' electricity sector includes a large number of players that provide services through electricity generation, transmission, distribution and marketing for industrial, commercial, public and residential customers. The electricity transmission network is controlled by Independent System Operators (ISOs) or Regional Transmission Organizations (RTOs), which are not-for-profit organizations that are obliged to provide indiscriminate access to various suppliers in order to promote competition. A regional transmission organization in the United States is an organization that is responsible for moving electricity over large interstate areas. Like the European transmission system operator (TSO), an RTO coordinates, controls and monitors an electricity transmission grid. An independent system operator is an organization formed at the direction or recommendation of the Federal Energy Regulatory Commission (FERC). In the areas where an ISO is established, it coordinates, controls and monitors the operation of the electrical power system, usually within a single U.S. state, but sometimes encompassing multiple states. RTOs typically perform the same functions as ISOs, but cover a larger geographic area.



The National Regulatory Research Institute (NRRRI) met with the delegation and provided them with lessons-learned on electricity sector restructuring and market formation. NRRRI serves as a research instrument to its dues payers. NRRRI coordinates its activities to support NARUC's (an association of state regulators) policy, research, educational and member-support service to state commissions.

The United States has a number of RTOs and ISOs, some of which operate an electricity market. During the course of the ten-day exchange, the delegation was given overviews of three U.S. ISOs/RTOs with markets – the New York Independent System Operator, PJM, and the Electricity Reliability Council of Texas (ERCOT).

The New York ISO, headquartered in Albany, has four key roles – reliable operation of the bulk electricity grid, administration of open and competitive wholesale electricity markets, planning for New York's energy future, and advancing the technological infrastructure of the electricity system. New York operates two wholesale electricity markets – the day-ahead market (DAM) and a real time market. The vast majority of transactions take place in the day-ahead market, with a much smaller portion remaining for the real-time market as a balancing mechanism. These two markets together reflect about 50% of total generation sales. The other 50% of generation sales take place through bilateral contracts, whose generation is still dispatched and overseen by the ISO. Bilateral contracts serve very important functions to reduce volatility in the market and serve as a hedging mechanism for distribution companies in case market prices drastically rise.

The New York ISO has a unique governance structure that has proven very successful. It is stakeholder driven with committees divided between generation owners, other suppliers, transmission owners, public power, and end-use consumers. Any operational decision requires a 58% majority, which is the equivalent to at least two of the stakeholder groups. This model ensures a high-level of stakeholder buy-in and ultimately leads to fewer disputes.

FORWARD CAPACITY MARKETS

In addition to day-ahead and real-time markets, some ISOs and RTOs operate forward capacity markets. These markets are intended to incentivize power (generation, import and DSM) supply needs years in advance of demand. Most U.S. markets conduct one FCM per year to obtain capacity three years out. This allows sufficient time to obtain the power and establish the appropriate pricing signals. FERC usually reviews forward capacity markets as part of their market surveillance.

PRICING

In the U.S., supply (generation) is a pass through cost – whether it's from the market or a bilateral contract. Utilities are not required to seek regulatory approval for this portion of the tariff. Instead, in the case of deregulated markets such as PJM Interconnection, ERCOT, New York, and the New England markets, they use locational marginal pricing (LMP) (sometimes known as clearing price or nodal pricing). Market price is determined by matching offers from generators to bids from consumers at each node to develop an equilibrium price, usually on an hourly interval, and is calculated separately for subregions in which the system operator's load flow model indicates that constraints will bind transmission imports. In practice, the LMP is a least-cost dispatch calculation with supply based on the generators that submitted offers in the day-ahead market, and demand based on bids from load-serving entities draining supplies at the nodes in question. Using this model, the end-user pays whatever the market price is and the distribution utility is not required to repeatedly seek approval from the regulator for this portion of the tariff.

However, the “delivery cost”, which is the cost of both transmission and distribution, is regulated by the Federal Energy Regulatory Commission (FERC) and is a fixed price. On average, supply accounts for about half of a consumer's bill, with the delivery cost accounting for the other half.



Separate rates are set for wheeling across transmission lines in areas where there is no market, such as the Northwest. These are areas where transmission is handled solely by bilateral agreements. The rates, called Open Access Transmission Tariff (OATT), are regulated by FERC.

The competitive market relies on open-access for distribution and transmission. Meaning, that if any utility has lines that participate in the market or OATT, then the utility has to allow power to be wheeled over their lines. The utility also cannot show favoritism.

BILATERAL TRANSACTIONS

The delegation was given an overview of how bilateral transactions fit into the market-based model. Bilateral transactions are conducted between a seller and the buyer. The bilateral transaction owner must pay for the transmission usage, any transmission losses, and any congestion costs incurred. However, it is the

On the final day of the executive exchange, the delegates met with representatives from Schiff Hardin LLP. Schiff Hardin has substantial experience in designing and implementing competitive electric markets in various regions of the country. The firm has actively participated in a number of cutting-edge electric issues that have arisen before the Federal Energy Regulatory Commission (FERC) as the energy industry has changed and pursued deregulation. Schiff Hardin provided the NTDC executives with valuable advice as they prepare their power sector for restructuring and an eventual market.

system operator that runs the grid, so the bilateral transaction owner must specify to the ISO the seller's point, the buyer's point, the MW amount, and a congestion cap limit. Bilaterals compete for transmission in the same manner as do generators on the system.

DEMAND RESPONSE

A key point of interest in many of the discussions was demand response – how it is conducted and its benefits to the grid. New York provides the end-user a payment equivalent to the amount saved in generation for participating in demand response. For instance, if an end-user cuts their load, saving the grid 2 MW in demand, then the end-user will be given the equivalent of 2 MW as priced by the market.

DISTRIBUTED GENERATION

Distributed generation, particularly renewable energy, is having an increasingly bigger impact on the grid and on the system operator's ability to balance and plan. A number of discussions were held regarding distributed generation and net metering. Every state in the U.S. handles it a bit differently but the general feeling is that every customer should pay some capacity fee as compensation for the security of supply the utility is offering them, as well as to support the transmission grid that the end-user requires.

PLANNING

Transmission planning is conducted continuously. Normally, the ISO or RTO leads the planning. Insight, studies and recommendations are first conducted and taken by the local transmission utility. This information is then fed to the ISO or RTO, who combine it with other regional information. Simultaneously, the Federal Energy Regulatory Authority (FERC) collects information from the ISOs and RTOs and examines it with their own studies. If it is found that additional transmission is required, steps will be taken to incentivize stakeholders to build. However, ultimately, the choice is voluntary. Transmission expansion is not mandated. However, the USDOE also conducts a national congestion study every three years and can designate national interest corridors if it sees an urgent need for a transmission line. FERC has backstop authority to permit the line in a national interest corridor if the state commissions do not make a decision within one year. USDOE also coordinates the construction of transmission lines when they have multiple jurisdictions or go over federal land.

TRANSMISSION INFRASTRUCTURE

Like many countries, the U.S. is experiencing a potential shortfall risk of transmission capacity. With the increase in renewable energy, additional transmission capacity needs to be built to transmit the power (often located in remote areas) to the load centers. For the U.S., the majority of the renewable power capacity is located in the middle of the country, but the majority of Americans live on the East and West coasts. Additionally, population centers, such as New York City, have high electricity costs since they not only don't have adequate local generation, but they have to pay congestion costs if the transmission capacity is inadequate to bring in sufficient supply. Therefore, the U.S. has begun to take steps to incentivize transmission expansion.

Most transmission infrastructure is built by the service area host utility. As mentioned above, the ISO/RTO and FERC can take steps to incentive transmission expansion. In these cases, FERC approves on average about 10% return-on-equity, which is considered a worthwhile return to incentivize the industry.

In most cases, transmission is built by the existing host transmission utility. However, there is an increasing role for merchant transmission companies as well, who are only responsible for building the transmission; they do not operate it.

RENEWABLE INTEGRATION

Integrating renewables and intermittent resources is a large concern for NTDC as Pakistan begins to develop wind. Currently, Pakistan has 250 MW of wind capacity, but an additional 1700 MW is planned by 2017. With peak load at approximately 30,000 MW, wind represents a significant contribution to the overall supply. Participants discussed the successful integration of renewables with National Grid, PJM and the NYISO, Schiff Hardin, Covanta and GE and how it impacts the market.



Edison Electric Institute

Power by AssociationSM

While in Washington, the delegation met with the Edison Electric Institute (EEL) – an association that represents all U.S. investor-owned electric companies. EEL provides public policy leadership, strategic business intelligence, and essential conferences and forums to its U.S. and international members. EEL provided some valuable insight to the delegation on how to handle net metering and distributed generation so that it is fair and minimizes adverse impacts to the grid.



Pakistan delegation standing in front of a GE wind turbine blade at GE's headquarters in Schenectady, New York.

GE Consulting focused their presentation on the impacts of renewable energy on the U.S. electricity markets. GE led the delegation through a useful overview of the “duck curve.” The duck curve was first developed by the California Independent System Operator to describe how massive amounts of distributed generation photovoltaic systems could cause problems to the state’s supply-demand balance on its electricity grid. In many cases, renewable energy is given a must-run status, as in Pakistan. However, GE Energy warned that this rule can be problematic as the overall percentage of renewables increases, forcing the system operator to shed load to keep the grid stable.

Schiff Hardin led a discussion on the legal and financial aspects for designating renewables as must-run facilities. The must-run status is important to ensure that the facilities receive a reasonable rate of return and don’t go bankrupt. The alternative is that the facility is not utilized, therefore does not make enough money and goes bankrupt. In that case, transmission was built that is now useless and there is an incurred cost that falls ultimately on the taxpayer. However, on the flip side of this is the scenario of a grid that has integrated large amounts of renewables to the point that traditional generation is no longer making enough revenue to survive. It is government and the ISO/RTO’s responsibility to find a happy balance between these two scenarios.



The delegation visited the Hardscrabble Wind Project, which generates more than 74 megawatts of electricity, produced by 37 Gamesa G90 2 MW turbines. The wind farm, located in Herkimer County, New York, was built and is owned and operated by Iberdrola Renewables. In addition to the turbines, the project consists a 34.5 kV collection system feeding into a 230/34.5 kV collector substation that interconnects to National Grid. POWER Engineers provided complete detailed design for the underground and overhead collection system, the collector substation, and the SCADA/communications system. POWER Engineers also developed procurement specifications for project components. Hardscrabble features wind turbines stand on 100-meter towers. The project produces enough electricity to power over 25,000 typical New York homes each year. The clean, homegrown energy produced at Hardscrabble has a pollution-offset equal to removing an estimated 26,000 cars from the road each year. The project came online in January of 2011, and will make a number of one-time and recurring payments to landowners and local jurisdictions over the life of the project.

While in Washington, DC, the delegation toured the Covanta Lorton Resource Recovery Facility, a mass-burn waste-to energy-plant connected to a local utility’s transmission grid. The facility operates through a revenue sharing arrangement with Fairfax County, Virginia, who supplies the majority of the waste. The waste-to-energy plant reduces the volume of garbage by 90% and the weight by 75% and results in a one ton reduction of CO2 for each ton of garbage used. The facility has a series of water wall furnaces with reverse-reciprocating grates and ash handling system that process 30,000 tons of solid waste. Through two 62.5 MW turbines, the plant can produce up to 100 MW. 80 megawatts of renewable energy is sold to Dominion Virginia Power Company through a Power Purchase Agreement (PPA). Dominion participates in the day-ahead market (DAM) and provides Covanta with the DAM price. Covanta is then provided with the market real-time price for any generation exceeding 80 MW.

ELECTRICITY MARKET MONITORING AND OVERSIGHT

Oversight was a key topic mentioned throughout all the meetings and was the main focus of the delegation's meetings with the Federal Energy Regulatory Commission (FERC). FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC discussed how it regulates the transmission and wholesale sales of electricity in interstate commerce, protects the reliability of the high voltage interstate transmission system through mandatory reliability standards, monitors and investigates energy markets, and enforces FERC regulatory requirements through civil penalties and other means. FERC stressed the need for violations and market manipulations to be enforced and penalized in proportion to the severity of the violation.



The delegation met with Sarah McKinley from the Federal Energy Regulatory Commission, or FERC. FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. While state regulators are responsible for intrastate transmission (transfers of power within state boundaries), FERC is responsible for the oversight of wholesale transactions (sales of energy for resale) and interstate transmission (transfers of power across state lines).

RESULTS

The Pakistani delegation discussed market operations and renewable integration with their U.S. counterparts for seven days. As a result of this program, the delegates learned:

- To improve reliability, the market needs to develop incentives to ensure generators are available to supply power during peak times. For example, the New York ISO uses “shortage pricing” in January (the month with the highest demand), which penalizes generators if they are unavailable.
- GE Energy Consulting recommended that Pakistan consider implementing a Renewable Energy Production Credit scheme, wherein the generator is given a tax credit for every megawatt of renewable energy produced. Some financial institutions are using this method to finance smaller IPPs.
- Retail competition is not necessary for a functioning market. However, adequate generation is required to ensure competition and provide an incentive for generators to offer their supply as cheaply as possible.
- As Pakistan is planning on implementing a market in the coming years, PPAs should be drafted in such a way that allows for future market participation, while still maintaining a healthy portion of supply to remain as bilateral contracts.
- GE offered to have their India office share their experiences with renewable integration into the market.
- The delegation held extensive discussions with its U.S. hosts on how standards are drafted, and what are the existing standards for construction, operation, and maintenance of the transmission system. In the U.S., industry usually creates the standard and it goes through member and FERC review before being finalized. Once it is final, it is mandatory and enforceable. Delegates were referenced to North American Electric Reliability Corporation standards, Occupational Safety and Health Administration, and other U.S. government guidelines.
- When opening up an area to retail competition, the original supplier and utility of the service territory is designated as the “supplier of last resort” (SoLR). If the retail choice supplier goes bankrupt or fails to provide supply to the customer, then the SoLR is legally obligated to fill that role. However, since this designation carries some financial and planning responsibility, it is important to provide financial compensation to the SoLR.
- The Pakistan delegation expressed the distribution companies’ concern that implementing supplier competition will hurt distribution companies’ profit. The U.S. institutions reassured them that allowing supplier competition rarely results in significant financial impact to the original host utility. Delivery costs for transmission and distribution are provided through a secure rate of return because they are regulated and supply is provided as a pass through cost. Energy Supply Companies (ESCOs), on the other hand, may be able to provide the customer with a lower rate, but they are also taking on considerable risk as they purchase

power through PPAs or the market, but sell power to their customers at a fixed price. In addition, in the U.S. experience, even if customers are given choice, most choose to stay with their original supplier.

- Schiff Hardin provided extensive tips in IPP contract construction. One of the warnings the law firm provided was to be certain that the contract is tied to the real developer/owner, not just to the owner of the individual generator. This way, if the generator fails to perform or follow the terms of the contractor, the actual developer/owner is held liable and not just the generator, who might have gone bankrupt.
- The transmission operator should be a facilitator, not a participant in a market.
- The wind forecast should be integrated in the control room and used in power flow analysis.

PAKISTAN NTDC EXCHANGE PROGRAM PARTICIPANTS

1. Mr. Saeed Ahmed, Dy. Manager, RCC NPCC
2. Mr. M. Salman Nawar Bajwa, Asst. Manager (Tech), CPPA
3. Mr. Bilal Hussain Asst. Manager, CPPA
4. Mr. M. Yasir Hussain, Asst. Manager, CPPA
5. Mrs. Faiza Yaqub, Dy. Manager, NPCC
6. Mr. Salahuddin Azam Khan, Dy. Manager, NPCC
7. Mr. Azhar Saleem, Manager Finance, WPPO
8. Mr. Abdul Muqet, Asst. Manager (Tech), CPPA

For additional information, please contact Sarah Blanford at sblanford@usea.org or at 1-202-641-6112.



Arthur Storey, a markets and bulk power system operations consultant, provided the Pakistan delegation with an overview of the power sector and market operations in the U.S.