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# JORDAN UTILITY PARTNERSHIP PROGRAM FINAL REPORT, 2009 - 2012

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# JORDAN UTILITY PARTNERSHIP PROGRAM FINAL REPORT, 2009 - 2012

USAID Cooperative Agreement  
# EPP-A-00-07-00008-00 for the  
USEA Energy Utility Partnership Program (EUPP)

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#### Disclaimer

The views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

## USEA/USAID Energy Utility Partnership Program (EUPP)

With funding from the U.S. Agency for International Development (USAID), the United States Energy Association (USEA) manages the Energy Utility Partnership Program (EUPP). EUPP assists developing countries with increasing environmentally sustainable energy production and use, as well as improving the operational efficiency and increased financial viability of their utilities and related institutions. The goal of EUPP is to increase access in USAID-assisted countries to environmentally sound energy services in the following ways:

- improving policy and legal frameworks to establish necessary market conditions for the private sector delivery of energy services and environmental management services;
- increasing institutional ability to provide or deliver energy and environmental management services in the new and enhanced markets; and
- increasing public understanding of, and participation in, decisions regarding energy delivery and environmental management services.

For almost 20 years, USEA and its members have led an effort to improve energy infrastructure and energy services in developing countries. Through our unique international energy partnerships and workshops, American utilities and energy service providers have volunteered their time and expertise to transfer utility and energy delivery best practices to their overseas utility counterparts. EUPP activities target utility executives and senior managers whose decisions and leadership heavily impacts the direction of their utility and, by extension, their country's electricity sector.

EUPP, in consultation with USAID, selects U.S. utilities to partner with developing country utilities and share best practices. Typically, a partnership is established for a two-year period, in which three to four executive exchange business trips are made per year, evenly divided between the U.S. and overseas partners. Since 1992, EUPP has managed over 80 utility partnerships and conducted hundreds of executive exchanges between U.S. and developing country utilities. These partnerships provide utility executives and senior managers from developing countries with pragmatic, industry-tested approaches to commonly-faced problems within the utility industry. EUPP also facilitates the transfer of documents between utilities, which reinforces lessons-learned and offers a practical model that developing country utilities can adapt to fit their business.

## Jordan Utility Partnership Program (JUPP)

The Jordan Utility Partnership Program (JUPP) falls under the Energy Utility Partnership Program (EUPP) umbrella. With support from the U.S. Agency for International Development in Jordan (USAID/Jordan), JUPP focused on improving the technical and operational efficiency of Jordan's electric utilities and electric grid. To reflect Jordan's electricity sector's composition, JUPP was divided into two major components: the Jordan Transmission Utility Partnership (JTUP) and the Jordan Distribution Utility Partnership (JDUP).

JUPP partnered Jordan's transmission and distribution utilities with U.S. utilities recognized for their excellence in technical operations, maintenance, safety and training. These U.S. utilities are leaders in encouraging, implementing and deploying renewable energy and energy efficiency programs with the support of their management, customers and regulators. By providing Jordanian utility executives with commercially-proven examples of best practices that can improve utility operations, JUPP facilitated some of the critical first steps towards modernizing Jordan's energy sector.

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## I. Jordan Energy Overview

### Energy Background

Energy insecurity is one of Jordan's most significant national problems. A developing country with limited conventional energy resources, Jordan imports 96% of its energy resources from neighboring countries. Under normal circumstances, Jordan generates roughly 80% of its electricity using Egyptian natural gas. The remaining 20% is generated by heavy fuel oil, diesel and, to a much lesser extent, renewable energy. Jordan also engages in electricity trading with Syria and Egypt, their only two interconnected neighbors.

Jordan's heavy dependence on imported fuels and electricity leaves the country exposed to many risk factors, including regional geopolitical instability and supply interruptions. Consumer energy price subsidies exacerbate these risk factors by shielding consumers from the real cost of Jordan's energy bills. Without any market-driven energy price signals, Jordanian energy consumers have little incentive to invest energy efficiency and conservation. Adding to the problem, electricity theft and network inefficiencies reduce utility and government revenues that otherwise could be reinvested in network upgrades and renewable energy power plants.

To address these issues, the Government of Jordan updated its energy strategy in 2007. This updated strategy seeks to enhance the country's energy security by diversifying its generation portfolio, encouraging renewable energy investments and reforming its energy sector. Subsequently, the Government of Jordan created a Renewable Energy and Efficiency Fund to support the development of renewable energy and energy efficient technologies in Jordan's power sector and consumer marketplace.

Jordan's electricity sector will play a key role in executing the Government's energy strategy. Jordan's utilities will be responsible for interconnecting new power plants, including intermittent wind and solar power facilities, expanding and strengthening the country's electricity transmission and distribution network and maximizing efficiency in the delivery and use of electricity. Yet in doing so, Jordan's transmission and distribution utilities will likely undergo significant changes to their management structures and corporate governance bylaws. Additionally, Jordan's electricity workforce will need significant retraining in order to meet the operational, maintenance and growth demands that investments in Jordan's electricity infrastructure will place on the utilities.

## II. Activities

### JUPP Focus Areas

With support from the U.S. Agency for International Development in Jordan (USAID/Jordan), the Jordan

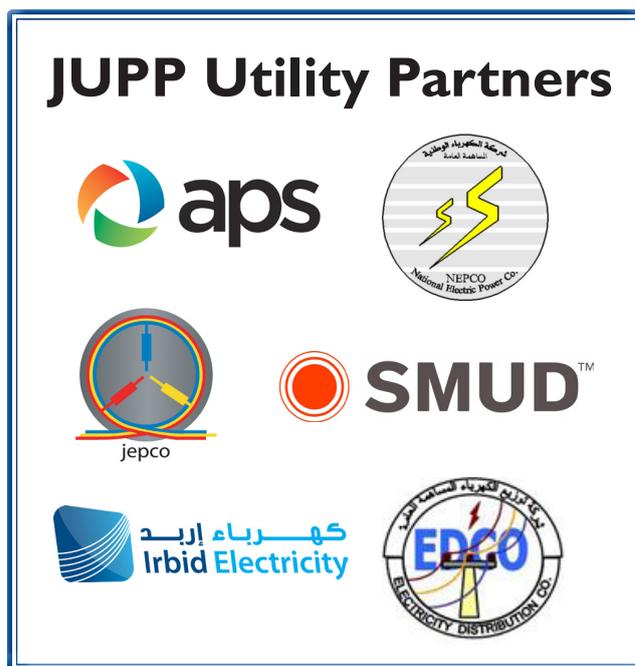


Utility Partnership Program (JUPP) was conceived to support efforts by Jordan's utilities to fulfill the goals of Jordan's energy strategy. Specifically, JUPP targeted improvements in Jordan's electric efficiency, reliability and affordability, as well as integration of renewable energy sources.

Jordan's transmission company, the National Electric Power Company of Jordan (NEPCO), was primarily interested in improving transmission planning and operations to help them prepare for a significant expansion of Jordan's transmission network. In addition, NEPCO wanted to learn how to prepare for large additions of intermittent renewable and non-intermittent base load power generation.

Jordan's distribution utilities, JEPKO, EDCO, IDECO and distribution holding company Kingdom Electric Company (KEC), were similarly interested in distribution system planning and operations with a strong focus on strengthening system efficiency. They also wanted to learn how to promote customer energy efficiency, conservation and distributed renewable energy.

To accommodate these interests, USEA recruited Arizona Public Service (APS) to partner with NEPCO and the Sacramento Municipal Utility District (SMUD) to partner with Jordan's distribution companies.



NEPCO delegates observing APS Control Center activities in April 2009.

### JUPP Activities

Over the course of the partnership, USEA conducted 16 JUPP executive exchanges, or eight executive exchanges for both JTUP and JDUP. These executive exchanges mobilized groups of American and Jordanian executives and senior utility managers to visit their overseas partner for 7-10 days at a time and share U.S. utility best practices with Jordanian participants. JUPP executive exchanges targeted Jordanian utility executives, senior managers and promising junior staff with technical, engineering and managerial backgrounds. Participants engaged in discussions on

key issues outlined in the partnership work plan, which addressed major challenges facing Jordan's energy sector. Over the course of the partnerships, USEA and the utility partners reviewed the partnership work plans and revised them to reflect some of the changing needs of Jordan's electric utilities.

JUPP executive exchanges provided Jordanian participants with a perspective on how U.S. utilities approach common technical and managerial problems faced by electric utilities worldwide. APS and SMUD were able to offer their experience on how they handled issues similar to those currently confronting Jordan's utilities. U.S. utility representatives facilitated lectures and hands-on workshops that allowed Jordanian participants the chance to ask questions and engage experts on key problems. APS and SMUD also arranged

for site visits to their power plants, substations, control rooms, utility training centers and customer facilities to give Jordanian participants a 360 degree view on U.S. utility operations. On several occasions, SMUD permitted Jordanian distribution participants to accompany line worker crews into the field to demonstrate field operations and procedures.

The topics addressed during JUPP were:

### Jordan Transmission Utility Partnership

- Accelerating the integration of renewable energy into the grid.
- Improving NEPCO’s integrated resource and capacity planning.
- Improving the reliability and stability of the transmission system by improving planning and operations.
- Introducing advanced techniques for operating the Jordanian electricity market and handling cross-border electricity exchange and cooperation.
- Strengthening NEPCO’s corporate governance and human resource development.

### Jordan Distribution Utility Partnership

- Improving distribution system performance through enhanced maintenance planning, operation procedures and system protection schemes.
- Improving utility energy efficiency, energy conservation and demand side management (DSM) programs.



NEPCO delegates inspect a high-voltage transformer at a 500-345 kV APS substation.

- Integrating renewable energy into the grid.
- Enhancing tariff pricing methods and regulatory relations.
- Strengthening training programs for professional / technical development and safety.

### U.S. Utility Partners

APS is a vertically-integrated, investor-owned utility based in Phoenix, AZ with over 3900 miles of high and medium-voltage transmission lines. As the major utility in what had been one of the fastest growing economies in the U.S., APS has a wealth of experience in building out their transmission system to accommodate strong electricity demand growth. They operate a large and diverse generation fleet, including the country’s largest nuclear power plant, and are preparing to add significant intermittent wind and solar power resources to their generation fleet. Due to its geographic location, APS operates under very similar climactic conditions as NEPCO. During their partnership with NEPCO, 103

\* \* \*  
\*\*\*\*\*

**“The partnership with SMUD provided technical training on the best international practices that cannot be found easily in the market.”**

**-Reem Hamdan**  
**Director General Assistant for Planning**  
**EDCO**

\* \* \*  
\*\*\*\*\*

APS employees participated in executive exchanges.

On the distribution side, SMUD is a vertically-integrated municipal utility that serves over 585,000 residential, commercial, industrial and agricultural accounts in the Sacramento metropolitan area. Much like APS, SMUD has built out their distribution network using state-of-the-art technology to maximize system efficiency, reliability and safety. Moreover, they are regularly recognized in the U.S. and internationally for their long-time leadership in customer-side energy efficiency and renewable energy programs. 169 SMUD employees participated in this partnership with Jordan’s distribution utilities.



JEPCO, EDCO and IDECO delegates inspecting SMUD safety gloves while observing a line crew in May 2011.

### III. Program Results and Impacts:

#### A. Utility Participant Training

Over the course of the transmission and distribution partnership programs, JUPP trained 262 people from seven different Jordanian electricity-related entities. JUPP received continuous participation from the four utilities (NEPCO, JEPCO, EDCO and IDECO) and intermittent participation from Jordan’s Ministry of Energy and Mineral Resources (MEMR) and the Electricity Regulatory Commission (ERC). MEMR and ERC are hugely influential in developing, implementing and enforcing Jordan’s laws and regulatory framework on renewable energy and energy efficiency. Consequently, JUPP deemed it extremely important to include them in discussions about the utilities’ efforts to implement their laws and policies. In addition, KEC, the holding company for EDCO and IDECO, actively participated in JUPP to harmonize efforts by its subsidiaries in implementing technical best practices and energy efficiency programs.

Participation Stats	Transmission	Distribution	Total
Total Jordanian participants	132	130	262
Total attendees (including repeat participants)	184	204	388
Total American participants	103	169	272
Female Jordanian Participants (% of total)	37 (28%)	10 (7.7%)	47
Participants in 2 or more exchanges (% of total)	40 (30.3%)	42 (32.3%)	82
Participants in exchanges to the United States (% of total)	36 (27.3%)	29 (22.3%)	65
Participants from organizations represented (% of total)	EDCO: 3 (2.3%) JEPCO: 3 (2.3%) MEMR: 2 (1.5%) NEPCO: 124 (93.9%)	EDCO: 42 (32.3%) IDECO: 27 (20.8%) JEPCO: 42 (32.3%) KEC: 6 (4.6%) ERC: 10 (7.7%) MEMR: 3 (2.3%)	262

As shown in Table I, JUPP involved senior utility executives from both the U.S. and Jordan, including each utility’s Chief Executive and many of their deputies. This strong executive support fostered greater participation from each utility partner and will help to ensure the continuity and sustainability of knowledge transfer that occurred during JUPP. Jordan’s utility executives also strongly encouraged their employees to participate in multiple executive exchanges, especially

those held in Jordan. As a result, roughly 30% of JUPP participants participated in two or more exchanges.

It is also important to note that roughly 25% of all JUPP participants participated in an executive exchange to the U.S. These utility representatives were hand-selected by each utility's senior executives for both their role in implementing key changes to utility technical or managerial practices, as well as their potential for growth within their utility. Through visits to APS and SMUD facilities, JUPP participants were able to ask their counterparts questions on issues impacting their roles and responsibilities. They also witnessed hands-on demonstrations of utility equipment, visited utility facilities and received informational resources and documents that could help them resolve critical problems in their jobs.



*Eng. Amani Al-Azzam and Mrs. Abeer Aladaileh discuss equipment used at an APS substation.*

## **B. Female Participation**

Under our cooperative agreement with USAID, USEA tracks the number of women that participate in its programs. These indicators are tied to the annual goals and objectives of USAID. In total, 47 women participated in JUPP (37 from JTUP and 10 from JDUP). JTUP achieved 28% female participation, surpassing its goal of 20%. JDUP set a goal of 5% female participation and achieved 7.7%. JUPP reached these numbers by encouraging participating utilities to promote female participation during each executive exchange, an initiative that senior utility management openly embraced.

Traditionally, in the U.S. as well as in Jordan, women are underrepresented in the energy workforce, especially in technical and engineering-related fields.

This paradigm is changing, however, and utilities worldwide have a distinct role to play in encouraging female participation in the energy workforce. NEPCO is already at the forefront of this movement in Jordan with several women in Assistant Managing Director and senior management positions. It further demonstrated its commitment to women in technical fields by nominating at least two women per executive exchange to the U.S., including at least one female engineer per exchange.

## **C. Indicators**

To measure its reach and effectiveness, JUPP kept a running record of several performance indicators that tracked USAID priorities for the partnerships. Tables 2 and 3 below reflect JUPP's exact performance indicators for organizational, subject matter and gender participation. It should be noted that for FY 2012, USAID required JUPP to account for individual participation differently than it had between FY '09 - FY '11. Also, it should be noted that Indicator A on Table 2 (i.e. the number of energy agencies participating in JUPP) remained constant for FY 2012.

JUPP regularly met or exceeded its performance indicator goals. Year on year, JUPP engaged one utility, NEPCO, in its transmission partnership. On the distribution side, JUPP exceeded its goal of three Jordanian utility partners by including an additional organization, KEC, in its activities. Furthermore, JUPP consistently exceeded its goals for Jordanian participants, ranging from 43% over the target during FY '09 - FY '11 to 134.7% over the target during FY 2012. Attendance during JUPP exchanges greatly surpassed

the program's goals, in particular for exchanges occurring in Jordan. Jordan's utility leadership found JUPP exchanges to be an immensely valuable training opportunity for their employees and consequently encouraged strong attendance.

Table 2 - JUPP Indicators: FY '09 – FY '11								
Indicator	Transmission			Distribution			JUPP	
	Target	Actual	% Above Target	Target	Actual	% Above Target	Total	% Above Target
a. Number of energy agencies, regulatory bodies, utilities and civil society organizations undertaking capacity strengthening as a result of USG assistance	1	1	0	3	4	33%	5	25%
b. Number of people receiving USG supported training in energy related policy and regulatory practices	80	124	55%	90	119	32.2%	243	43%
c. Number of people receiving USG supported training in technical energy fields	80	124	55%	90	119	32.2%	243	43%

Table 3 - JUPP Indicators: FY 2012 Only								
Indicator	Transmission			Distribution			JUPP	
	Target	Actual	% Above Target	Target	Actual	% Above Target	Total	% Above Target
a. Person hours of training completed in technical energy fields supported by USG assistance	1058	2752	160.1%	1191	2528	112.3%	5280	134.7%

Table 4 reflects female participation in JUPP executive exchanges. Women constituted 16% of overall JUPP participants. JUPP activities successfully engaged women at a rate that is more than proportional to their representation within their utilities. This is particularly true for female participation from NEPCO, which engaged a total of 37 women in executive exchanges to the U.S. and Jordan, or roughly 28% of total JTUP participation.

Table 4 - JUPP Indicators: Female Participation 2009-2012								
Indicator	Transmission			Distribution			JUPP	
	% Target	% Actual	Total # Women	% Target	% Actual	Total # Women	Total	% Total
a. Female participation as a percent of total Jordanian participants	20%	28%	37	5%	7.7%	10	47	16%

#### D. Additional Assessments

In addition to the performance indicators, USEA conducted general and detailed assessments to determine both participants' satisfaction with the partnerships and results obtained in part or fully due

to the partnerships. Jordanian participants were asked to identify their overall level of satisfaction with their partnership and its outcomes. The responses were very positive, indicating a high level of overall satisfaction. All participants indicated that they were either completely satisfied or mostly satisfied with the partnership experience and wanted the program to continue.

The assessments listed a broad range of potential results in each work plan topic. Participants indicated whether the partnership assisted them in the various issues and were encouraged to list specific results. All three

distribution utilities stated the partnership improved their understanding of regulation, energy efficiency programs and connecting renewable energy to their distribution networks. As regulation is a relatively new development in the Jordanian energy sector, the participants found the discussions on interactions with the regulators, rate making and customer dispute resolution to be particularly valuable.

Participants from IDECO and EDCO also noted the partnership has greatly assisted their utilities in improving system performance through enhanced maintenance planning, operation procedures and system protection schemes. EDCO and IDECO cited improved reliability and power quality through updating and installing equipment, improving distribution performance standards and improving maintenance practices to reduce unscheduled outages. IDECO also mentioned improved system operational performance through improved outage management systems, installation of more efficient transformers and better power system management procedures, such as calculating voltage drops. Both IDECO and EDCO also improved plans for handling voltage issues, such as overloading, to enhance system protection. All three utilities received critical information on live line maintenance that greatly improved their procedures and increased worker safety. Other maintenance improvements as a result of the partnership were improved maintenance manuals and procedures, such as reliability centered maintenance.

## **E. Results**

Specific results from the transmission and distribution partnerships can be summarized as follows:

1. Increasing System Efficiency
2. Developing Customer Energy Efficiency Programs
3. Increasing Corporate Efficiency: Restructuring and Governance
4. Supporting Capacity Building
5. Reducing Electricity Losses and Power Outages
6. Improving Transmission Dispatch Center Operations
7. Enhancing Worker Productivity Through Safety
8. Interconnecting Renewable Energy and Distributed Generation

### **I. Increasing System Efficiency**

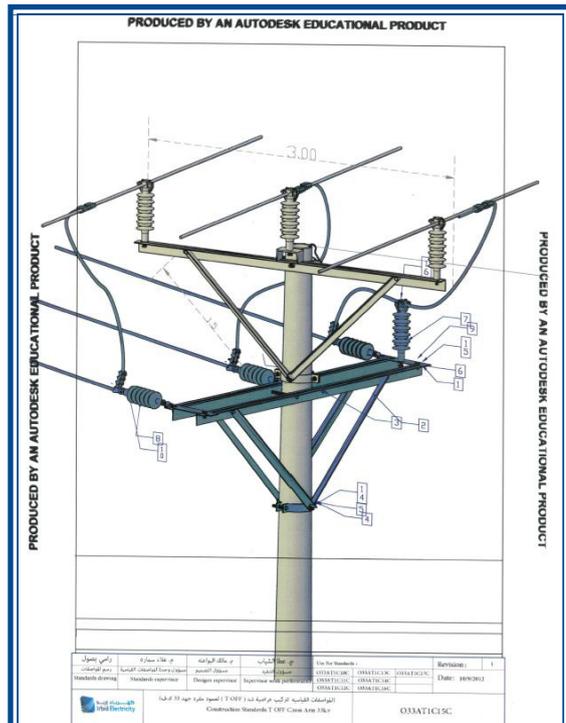
Due to the utility partnership with SMUD, Jordan's distribution utilities have identified multiple areas



in which they can increase distribution system efficiency and reduce electricity outages. Such areas include system automation, increasing the lowest voltage areas on the system, shortening secondary distribution lines and conducting preventative maintenance.

### Standardized Design

IDECO has made major advances towards standardizing its design and construction specifications for its 33 kV and 11 kV overhead and underground distribution networks. Management views this as a critical element in its long term plans to significantly increase distribution system efficiency. With the help of SMUD's standards department, IDECO developed a standards implementation plan to systematize the utility's design, construction and warehousing processes. IDECO estimates that Stage I of its implementation plan will be completed by the end of 2012 and will include the completion of its basic drawing and software standards.



This standardization effort lead IDECO to invest in other tools that will facilitate further standardization. IDECO hired a contractor to design its new geographic information system (GIS), Jordan's first computer-based land surveying tool. The company also plans to buy AutoCAD, a software program used by SMUD for design aggregation and documentation.

***“This is more than a drawing. It represents a system and SMUD taught us this system. IDECO will implement this system and it will spread to EDCO and JEPCO.”***

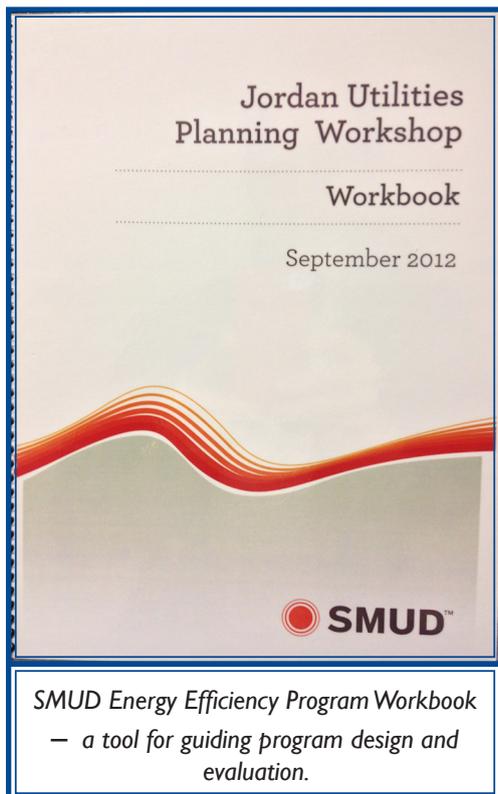
***–Bilal Jaradat  
Technical Audit and Safety  
Manager  
IDECO***

### System Components

IDECO is also in the process of documenting its medium voltage (33 kV) standards, focusing on system configuration, computer-aided design (CAD) drawings and materials lists for system components. Its aim is to design a unit configuration cataloguing system that integrates and tracks the location of warehoused supplies, system components and design specifications. This will enable construction crews, planning engineers and warehouse stock keepers to easily access information on the availability and location of component materials. It will also aid in the development of precise specifications to which a distribution system component must be designed and built.

Based on its experience with SMUD, IDECO is paving the path for all of Jordan's distribution companies to adopt common design and construction standards. By designing its systems to specified standards, Jordan's distribution utilities will be able to seamlessly interconnect to one another and, in the process, strengthen network reliability. Standards will reinforce quality control and safety for contractors and utility line workers, as well as reduce the amount of time needed for service and construction. This will also allow the distribution companies to share materials and inventory, as well as to achieve economies of scale when importing materials with common specifications. For example, IDECO recently announced a new distribution pole standard for .4 kV lines and is working with a manufacturing company to produce

these poles. Before the end of 2012, IDECO will release a tender for 6,000 solid wood poles, preferably made from Scandinavian fir trees.



## 2. Developing Customer Energy Efficiency Programs

Jordan’s distribution utilities are keenly interested in implementing customer energy efficiency programs and incorporating these programs into its rate base. While they work to gain support from the ERC for such programs, the utilities learned SMUD’s process for designing, implementing and evaluating customer energy efficiency programs.

JEPSCO, EDCO and IDECO worked with SMUD’s experts to develop prototype efficiency programs for residential lighting, commercial air conditioning and industrial water pumping. EDCO created an energy efficiency program based on information from SMUD to replace its customers’ florescent bulbs with LED lamps for a small fee added to the consumer’s bill. However, the ERC refused to approve the program so no energy efficiency programs have been implemented in Jordan to date.

The utilities also received SMUD’s energy efficiency program workbook, a guide to the process of designing tailored energy efficiency programs for targeted customer market segments. This workbook provides the utilities with the blueprint to easily create any tailored energy efficiency program and negates the

need for consultants to design future programs. Once the ERC embraces the utilities’ program proposals and provides an adequate cost recovery mechanism, Jordan’s distribution companies are now prepared to roll out pilot efficiency programs with the intent of scaling the programs over time.

## 3. Increasing Corporate Efficiency: Restructuring and Governance

To improve operational efficiency, Jordan’s electric utilities have begun the process of corporate restructuring.

### Utility Departmental Restructuring

In 2010, NEPCO consolidated its nine main departments into four and appointed the five remaining Assistant Managing Directors to a new strategic planning and governance committee. Using communications strategies on change management learned from its partnership with APS, NEPCO tried to gain acceptance from its employees on the restructuring process as they planned the restructuring of each department. NEPCO

executives also reviewed APS’s corporate structure and considered adapting its governance by-laws. By 2012, NEPCO had successfully managed the restructuring of its human resources department. APS supported NEPCO’s efforts and gave critical feedback that reinforced the decisions by NEPCO’s senior



management.

JEPSCO and IDECO also restructured their human resources departments and cited information from SMUD, especially on recruitment and training, as being very helpful. In addition, based on their experience with SMUD, EDCO and IDECO made significant changes to their employee evaluation and compensation policies, which provide employees with performance incentives, regular (monthly or quarterly) evaluations and updated, uniform job descriptions. Both utilities have also linked employee performance to salary increases and bonuses and have implemented new performance appraisal forms to institute these policy changes. Furthermore, IDECO has linked individual performance metrics to department-level key performance indicators (KPIs) to measure how each individual employee contributes to the utility's strategic goals. By benchmarking employee performance against the utility's KPI's, IDECO hopes to identify additional initiatives to streamline workflow and enhance its overall operational efficiency.



#### *Utility Department Creation*

The distribution utilities created several new departments and committees to address energy efficiency and regulation. As a result of the first executive exchange to SMUD in May 2009, the distribution utilities created a joint Key Operational Plan (KOP) task force to find opportunities in energy efficiency. This task force met several times and eventually led to the creation of an energy efficiency department at IDECO. However, the KOP and IDECO's energy efficiency department were hampered in their ability to work on energy efficiency due to a lack of a regulatory framework and mechanism to recover costs. IDECO and EDCO (August 2009) also created regulatory affairs departments to improve relations with the ERC and work on tariff cases and other cases brought before the ERC.

#### **4. Supporting Capacity Building**

All three distribution utilities have committed to achieving efficiency gains and are retraining their workforce to be able to procure, build, install and maintain Jordan's next-generation distribution system. These retraining programs have a strong focus on worker safety, which increases worker productivity and reduces costs from worker compensation claims and damaged equipment.

#### *Live Line Maintenance Training*

To illustrate its commitment to workforce retraining, EDCO requested that the Electricity Regulatory Commission (ERC) increase its annual training budget from 50,000 JD to 500,000 JD. Much of its retraining efforts have concentrated on live line maintenance, or maintenance on energized distribution lines. Since the beginning of this training program, EDCO has reduced customer outages and also prevented catastrophic accidents by training operational staff on how to use new and safer equipment to conduct live line maintenance based on information received from SMUD.



*IDECO Managing Director Ahmad Thainat learns about SMUD's maintenance equipment from a line worker.*

### *Training Program Updates*

IDECO also modernized its training programs, mandating a training needs assessment for all employees, including new hires. Evaluations of training programs are completed by both instructors and trainees. IDECO instituted a yearly training plan with tailored courses for various levels of staff on safety, technical and non-technical subjects. In addition, IDECO has increased its minimum safety standards, updated safety manuals and provided training courses on these updates. Such courses include first aid, cardiopulmonary resuscitation (CPR), line worker emergency training and weather preparedness. As a result of this focus on safety training, IDECO experienced a 15% (year-to-date) improvement in its safety record. The biggest safety improvements occurred with construction projects.

### *Line Worker Training*

Recognizing the need for trained line workers to build the next generation of Jordan's distribution system, IDECO developed a pre-apprentice pilot program for incoming line workers. Established with Jordan's Ministry of Labor and modeled after certain aspects of SMUD's pre-apprentice training program, this pilot engaged 15 future line workers for four semesters of classroom theory, field observation, on-the-job training and training center practice. Motivated by their experience with SMUD, IDECO partnered with the Hakema Vocational Training Center, a government facility, to build Jordan's only distribution pole training yard. This training program is also intended to train Jordan's technical line workers on state-of-the-art maintenance techniques, especially live line maintenance, that will herald a new era of efficient, reliable and safe distribution operations.

## **5. Reducing Electricity Losses and Power Outages**

Senior executives at all three distribution companies reported that information received from SMUD will be used to reduce technical and non-technical (electricity theft) losses.

For instance, JEPSCO is currently in the process of evaluating the feasibility of using SMUD's network design for 33 kV and 11 kV distribution lines to upgrade their system from 0.4 kV and 4 kV. In the meantime, JEPSCO has committed to shortening the conductors on its secondary distribution system and has hired consultants to design a tender offer for ordering smaller transformers that will reduce technical line losses. JEPSCO has also instituted new policies to reduce electricity theft, including more frequent meter inspections and analysis of customer consumption patterns. However, JEPSCO noted that electricity theft has somewhat increased in response to electricity price hikes in 2012.

At SMUD's urging, EDCO has begun reconfiguring its distribution system to include 3.3 kV distribution lines with very small transformer capacity in an effort to move away from its lengthy low voltage 0.4 kV service lines. It has begun replacing and updating transformers, capacitors, conductors and switching equipment. EDCO also adopted numerous maintenance best practices, including scheduling preventative and reliability-centered maintenance. EDCO committed to expanding its medium voltage network



APS delegates touring NEPCO's new National Control Center in October 2011.

and has developed a long-term plan to convert the existing distribution system to medium voltage. In addition, EDCO is conducting live line maintenance to reduce customer outages, with an increased focus on worker safety. This was made possible through demonstrations of SMUD's highly-rated worker safety programs. Specifically, EDCO has invested in trailer-mounted mechanized cranes to replace ladders as the main tool for elevating workers to perform maintenance on overhead distribution lines.

### 6. Improving Transmission Dispatch Center Operations

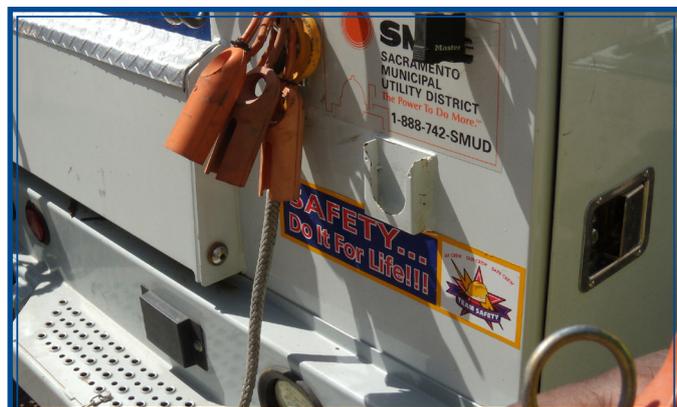
Prior to the beginning of the partnership with APS, NEPCO had commenced construction on its new National Control Center to operate the transmission system and dispatch power flows. NEPCO modified its control center blue prints to incorporate design elements found at APS's control center, including an observation gallery that allows visitors and managers to observe control center activities without interfering with dispatcher operations. NEPCO also adopted APS's control center desk layout in order to maximize dispatcher productivity and software system operability. Since these changes were implemented, NEPCO dispatchers have been able to better manage power flows on the transmission grid and thus ensure greater reliability and network stability.

### 7. Enhancing Worker Productivity Through Safety

Worker safety is a critically important factor impacting worker productivity and overall utility operations. Jordan's utilities learned U.S. best practices in safety training from SMUD and APS. These best practices reduce injuries, health claims and equipment damage and increase utility efficiency. All three distribution utilities prioritized worker safety as a key issue during their partnership with SMUD and reported subsequent changes to their safety policies.

The following are a few illustrative examples of safety best practices implemented by the distribution companies:

- *Safety manuals:* EDCO and IDECO updated safety manuals and provided updated safety training courses to employees. Training courses included basic first aid, CPR, hydration and tree trimming safety.
- *Safety awareness:* EDCO and IDECO developed Accident Prevention Manuals and

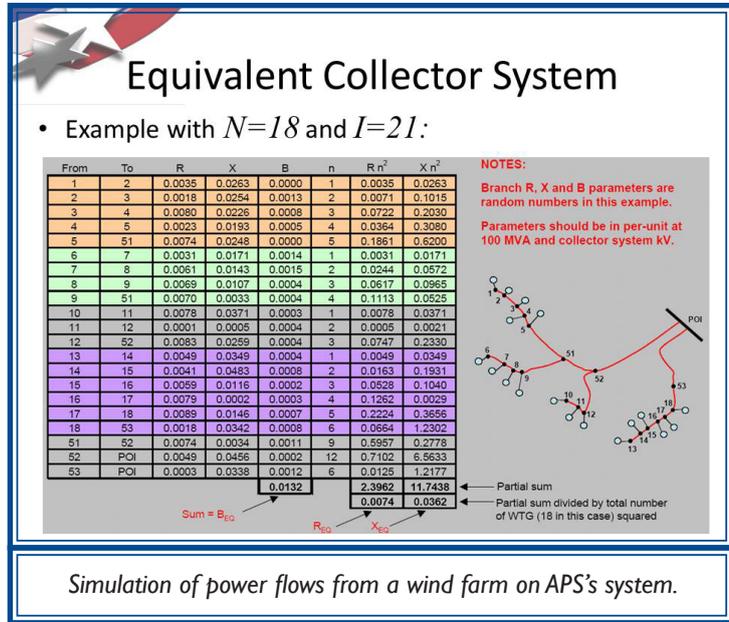


Safety reminder on SMUD bucket truck.

- Risk Assessment Forms to increase safety awareness and to strive for safety record improvements.
- “No name, no blame.” Employees are able to report near misses anonymously in order to limit retaliation from co-workers and reinforce the utility’s safety culture.
- *Life lines:* Workers are trained to use a life line to prevent life-endangering falls while performing maintenance on overhead distribution wires or pruning trees.

## 8. Interconnecting Renewable Energy and Distributed Generation

The transmission and distribution partnerships both focused on the process to interconnect renewable energy and distributed generation. All Jordanian utilities received detailed information and guidelines for interconnections such as the California Rule 21 that can be easily used in Jordan with minor alterations. JEPCO is already designing the process for customer applications for renewable energy projects to interconnect to its distribution network based on information received from SMUD. In addition, all three distribution utilities expressed more comfort with interconnecting renewable energy to their systems, especially relating to back-feed and worker safety.



Simulation of power flows from a wind farm on APS’s system.

The transmission partnership focused more on system operations and dispatch of renewable energy. NEPCO received valuable information from APS on how to deal with intermittent resources and how to manage power flows coming from wind farms in particular. The information and tools provided by APS in operating a transmission network with renewable energy generation will greatly assist NEPCO as it begins to integrate renewable energy.



## F. Best Utility Practices - Document Transfer

To reinforce the lessons learned during all executive exchanges, Jordanian delegates return home with copies of presentations, books, training manuals, regulatory guidelines and other documents that serve as resources for them and their colleagues on U.S. utility best practices. Throughout the partnership, Jordan’s transmission and distribution utilities received a total of 361 documents from their U.S. utility partners.

These document transfers were a major contribution of the partnership program, as they reflect commercially- and technically-proven examples of U.S. utility best practices. Rather than spend

**Table 5 - Illustrative List of Documents Transferred**

Transmission	Distribution
<p><i>Integrated Resource Planning and Renewable Energy</i></p> <ul style="list-style-type: none"> <li>• APS Load Forecast Methodology</li> <li>• Resource Planning Guide</li> <li>• Interconnecting Intermittent Renewables and Impacts on Transmission System Operations</li> </ul> <p><i>Maintenance</i></p> <ul style="list-style-type: none"> <li>• Substation Maintenance Scheduling System</li> <li>• Transmission Line Performance Indicators and Reliability Performance Indices</li> <li>• APS Substation Planned Maintenance Programs and Yearly Plans</li> </ul> <p><i>Training</i></p> <ul style="list-style-type: none"> <li>• Training program development methodology</li> <li>• APS Safety Management System</li> <li>• Line worker training certification requirements and apprentice schedule</li> <li>• Substation Maintenance &amp; Construction Qualification Requirements and Training Program Description</li> <li>• APS Operator Training Programs</li> </ul>	<p><i>Energy Efficiency</i></p> <ul style="list-style-type: none"> <li>• DOE Efficiency Standards for Distribution Transformers</li> <li>• SMUD's Energy Efficiency Organization and Program Development Process</li> <li>• International Performance Measurement and Verification Protocol</li> <li>• Energy Efficiency Program Design and Execution Workbook</li> </ul> <p><i>Operations and Maintenance</i></p> <ul style="list-style-type: none"> <li>• Diagrams of transformer configurations with a list of needed materials</li> <li>• System Operations Authorization and Switching Procedures</li> <li>• SMUD 2011-2015 System Maintenance Plan</li> <li>• Substation Electrician Procedure Manual</li> </ul> <p><i>Training and Safety</i></p> <ul style="list-style-type: none"> <li>• Fall Protection Guide</li> <li>• Introduction to Workforce Planning at SMUD</li> <li>• Distribution Services Course Catalog 2011</li> <li>• Fire Safety and Emergency Procedures 2011</li> </ul>

unnecessary amounts of time and money on hiring consultants to write manuals, develop training programs or establish policy guidelines, Jordan's utilities can adopt or adapt documents from their U.S. utility partners to suit their individual needs. Examples of documents transferred during these partnerships can be found in Table 5.

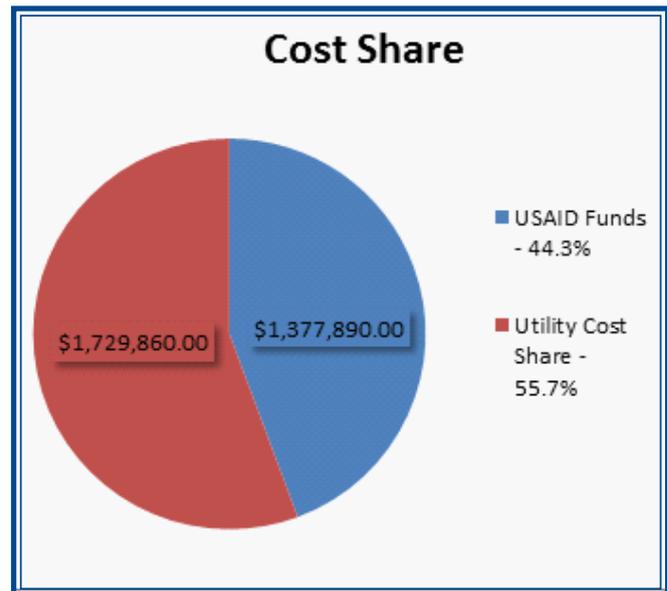
**G. Cost-Sharing and Leveraging of Resources**

USAID contributed \$1,377,890 to JUPP over the course of the program. Under our cooperative agreement with USAID, USEA is required to match USAID's financial contribution to the program with cost-sharing. Participating U.S. and Jordanian utility partners provided an estimated total of \$1,729,860 of shared costs, or in-kind donations of labor, meals, ground transportation, documents and other resources, during 16 executive exchanges.

All JUPP participants from the U.S. and Jordan were unpaid volunteers whose contributions to the partnerships were made on

top of their normal, full-time jobs. Neither APS nor SMUD had any financial stake in improving the technical or managerial performance of their Jordanian counterparts. Rather, JUPP dovetails with APS and SMUD's corporate social responsibility ethos and supports their commitment to improving global access to affordable, clean electricity. Cost-sharing helped to extend JUPP's duration to four years, creating greater value for JUPP participants, as well as USAID and U.S. taxpayers. USEA is immensely grateful to APS, SMUD, NEPCO, JEPCO, EDCO, IDECO and KEC for all their hard work and generous contributions.

In addition to in-kind donations, this partnership



spurred other activities between some of the U.S. and Jordanian utility partners. In January 2012, SMUD hosted two IDECO staff for a two week internship on human resources, training, safety, distribution system design and construction standards. The internship was jointly funded by both SMUD and IDECO and helped to dramatically accelerate IDECO's time line for implementing key human resources and distribution system planning reforms. Also, following the end of the partnership, IDECO requested that SMUD host four additional staff members for an internship on technical and regulatory issues related to renewable energy deployment. EDCO and JEPSCO have made informal requests to continue the partnership with SMUD as well.



APS executives visit NEPCO's Amman South substation.

## H. Barriers

Although Jordan's electric utilities have made laudable progress in transforming its utility workforce and management structures to accommodate future electricity demand growth, the country and its utilities face significant barriers to future additional reform.

### I. Institutional Barriers

Jordan's transmission and distribution companies expressed frustration at a lack of institutional capacity at Jordan's Ministry of Energy and Mineral Resources (MEMR) and Jordan's Energy Regulatory Commission (ERC). While the utilities applauded the government's actions to create renewable

energy and energy efficiency laws, they were often frustrated by the lack of clarity on questions related to cost allocation and interconnection obligations. This lack of clarity frequently results in project delays and fosters a negative investment climate for project developers.

Jordan's distribution utilities also observed a prevailing reticence amongst several ERC Commissioners who did not believe that utilities should play a role in encouraging customer-side energy efficiency. To illustrate this point, the ERC rejected a proposal submitted by EDCO and IDECO that would authorize them to communicate with their customers via their electricity bill about energy efficient household products and energy conservation techniques. Jordan's distribution utilities feel that they would be breaking the law by commencing any behind-the-meter energy efficiency project without the ERC's consent. By the same token, several ERC staff interviewed for this report insisted that the ERC would not make any final decisions on utility-run energy efficiency programs without the express approval of Jordan's MEMR and, by extension, Jordan's sitting Minister of Energy and Mineral Resources.

Hierarchical power structures within Jordan's utilities constitute another institutional barrier. Attitudes towards change varied among senior executives at Jordan's utilities. The leadership at several utilities embraced the need to change and welcomed the alternative operational methods presented by their U.S. partners. Other utilities were less progressive, largely in response to resistance from traditionalist Boards of Directors and/or political interference. Moreover, Jordan's utilities tended towards top-down control, leaving lower level managers and staff with fewer opportunities to change their work processes without consent from senior executives.

## 2. Uncertainty Due to Arab Spring

In January 2011, a protest movement that began in Tunisia erupted across the Arab world, inspiring millions of protesters to take to the streets and express their discontent and frustration with their government leaders. Jordan's version of the Arab Spring has proven mostly peaceful, with sporadic and regular protests throughout the last two years and democratic reforms instituted largely at the behest of Jordan's monarch, His Majesty King Abdullah II. Yet concerns about Jordan's internal stability remain among government officials and private sector executives. These concerns are reflected by their cautious attempts at piecemeal reforms.

The Arab Spring has affected many of Jordan's neighboring countries, which also impacts Jordan. Political crises in Egypt and Syria, two important energy trading partners for Jordan, have led to significant disruptions in energy supplies. These interruptions continue to have a significant impact on Jordan's public finances and on the availability of fuel for Jordan's power plants. The interruptions are also exposing weaknesses in Jordan's energy supply chain and underscore the importance of issues addressed in our partnerships, such as the need for fuel supply diversity, energy efficiency and conservation.



*NEPCO's Eng. Maha Al-Ramahi inspects a concentrated solar satellite during a site visit to an APS customer facility.*

## 3. Dependency on Egyptian Gas

Under normal conditions, Jordan generates roughly 80% of its electricity from natural gas-fired power plants. Jordan's only current source of natural gas is via the Arab Gas Pipeline, which crosses Egypt's Sinai Peninsula and connects to Jordan in Aqaba. This pipeline also services Israel via the Arish-Ashkelon Pipeline. Jordan began importing Egyptian natural gas shortly after 2003, when supplies of heavily subsidized Iraqi crude oil disappeared following the U.S. invasion of Iraq. Subsequently, Jordan built many of its newer power plants to accommodate fuel switching between natural gas and heavy fuel oil or diesel.



*SMUD executives at Um Qais after a site visit to IDECO's facilities in Irbid.*

Since February 2011, explosions along Egypt's pipeline network in the Sinai have caused serious interruptions to Jordan's natural gas supply, forcing Jordan's power plants to switch fuels. NEPCO is responsible for fuel procurement at Jordan's power plants and has incurred a heavy financial burden because it was forced to buy expensive crude oil-derived fuels from Saudi Arabia. At the same time, due to its own public financial constraints, Egypt increased the tariff on natural gas exports to Jordan, adding to NEPCO's financial obligations and putting a further strain on the utility's balance sheet.

#### 4. Lack of Adequate Financing for Utility Sector

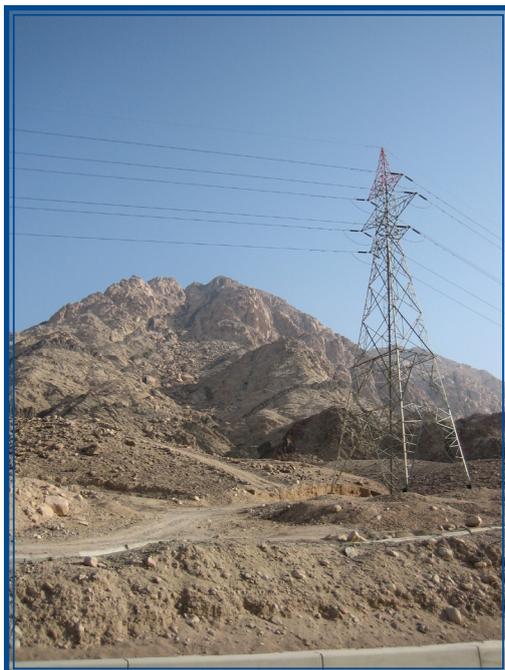
As NEPCO is still a publically owned company, all of its loans are backed by the Jordanian government. Consequently, the real financial burden of Jordan's natural gas crisis will fall on the Jordanian public treasury and Jordanian consumers. In 2011, the Jordanian government spent over \$1.8 billion on additional crude oil and refined petroleum products. Its total budget deficit rose to almost \$5 billion, or roughly 17% of GDP. Added fuel costs for electricity generation were expected to total \$4.5 billion to \$5.6 billion in 2012, an unsustainable amount given Jordan's slowing economic growth.



*Distribution lines in Northern Jordan.*

To offset some of the extra costs incurred by fuel switching, Jordan's electricity regulators approved several electricity rate increases designed to disproportionately impact the largest electricity consumers and thus protect the country's poor.

For many years, the Jordanian government subsidized electricity costs and shielded consumers from the real price of the country's energy insecurity. (Electricity price signals are often viewed as the most effective tool for encouraging customer energy efficiency and conservation.) Their efforts to weaken energy subsidies were unsurprisingly met with much public resistance, as wage stagnation coupled with rising inflation and unemployment have stifled improvements in living standards across Jordan. In the wake of the Arab Spring, additional energy costs have put tremendous strain on the government's ability to find socially acceptable solutions to its financial problems.



*Transmission lines in Southern Jordan.*

At a company level, Jordan's financial crisis has had a crippling effect on NEPCO's ability to invest in itself. NEPCO has identified numerous areas in which it needs to make significant infrastructure upgrades and build connections to accommodate planned intermittent solar and wind resources. In addition, NEPCO has virtually ceased all training programs for existing staff and has frozen hiring since early 2011.

#### 5. Grid Interconnections

Prior to the Arab Spring, Jordan regularly engaged in electricity trading with its interconnected neighbors Egypt and Syria. NEPCO was working on a project to interconnect all countries bordering the Mediterranean Sea, as well as several other neighboring Arab countries. Electricity trading was seen as a key part of its strategy to meet domestic electricity demand growth.

This strategy, however, has been temporarily shelved due to difficult circumstances in Egypt and Syria. Since the Arab Spring,

Egypt's domestic gas production has increasingly been redirected towards its power generation sector as domestic power demand continues to increase. As a result, Egypt has had significantly less gas and electricity to send to Jordan.

In addition, since mid-2011, NEPCO has experienced erratic, spontaneous surges of electricity coming from Syria that NEPCO's operators attributed to irregular forced regional outages in Syria. NEPCO's transmission system operators did their best to ride out these power surges, which oftentimes amounted to several hundred megawatts of superfluous power, and were sometimes forced to temporarily isolate themselves from Syria's network. Finally, in mid-2012, Jordan suspended electricity trading with Syria until further notice.



*APS President Don Robinson and NEPCO's Assistant Managing Director Eng. Abdelfattah Aldaradkah after signing a Memorandum of Understanding between APS and NEPCO.*



*Managing Directors from Jordan's distribution utilities pose for a picture with SMUD and USAID executives after signing a Memorandum of Understanding.*

## **I. Lessons Learned**

### ***1. Involvement of Policy Makers is Critical***

All four partner utilities and the distribution holding company KEC were enthusiastic about enacting changes and best practices learned from their U.S. counterparts. However, they often experienced road blocks due to unclear policies. Both the transmission and distribution partnerships attempted to involve the MEMR and the ERC in partnership activities. USEA found that it is critical to engage the utilities along with their regulators to ensure that all interested parties receive the same information and have a similar understanding of the issues.

### ***2. Higher Voltage and Shorter Lines to Reduce Losses***

SMUD strongly recommended that the Jordanian distribution utilities reduce the size of their service lines and shift to higher voltage lines to reduce technical losses. JEPSCO and EDCO are actively working to follow these recommendations.

### ***3. CEO Receptivity to Change is Key***

The willingness of the managing directors and top management at the utilities to implement new ideas varied among Jordan's utilities. USEA found that management's mindset was critical to facilitating change, as utilities with more progressive leadership adopted more best practices than those with more traditional views.

### ***4. Utility Interest Higher in Improving Operations than Energy Efficiency***

While the distribution utilities were very interested in promoting energy efficiency programs, they were more interested in improving operational efficiencies. This was mostly due to the ease with which they receive approval from the ERC for operational changes, as well as their historical regulatory challenges

with proposing energy efficiency program to their regulators.

### **5. Private Utilities Faster at Enacting Change**

Both the state and private utilities were actively interested and engaged in adopting best practices. However, the private utilities seemed to be able to act more quickly in part due to management structure and the internal approval processes.

### **6. Funding is Critical**

A major impediment to the adoption of best practices learned through the partnership activities was a lack of funding. As NEPCO is responsible for purchasing increasingly expensive imported fuel, it has no extra money to spend on new projects. The distribution utilities have to get approval from the ERC to spend money, which has been increasingly challenging over the last several years. Both the transmission and distribution utilities are unable to collect adequate funds through current electricity tariffs to support their operational and capital needs. This lack of funding was a major reason many ideas were not implemented, in particular improvements to training programs.

### **7. Training Budgets Need to Be Increased**

In both partnerships, it quickly became clear that training budgets at all utilities need to be increased to move toward more modern practices and systems. Improved training is greatly needed for capacity building at the operational level on issues such as hot line maintenance, GIS and other operating systems and dispatch.

## **J. Financial Report**

The financial report will be sent to USAID under separate cover.