USAID/ERC/NARUC Workshop: Technical and Non-technical Electricity Losses from a Regulatory Perspective

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Opening Session:

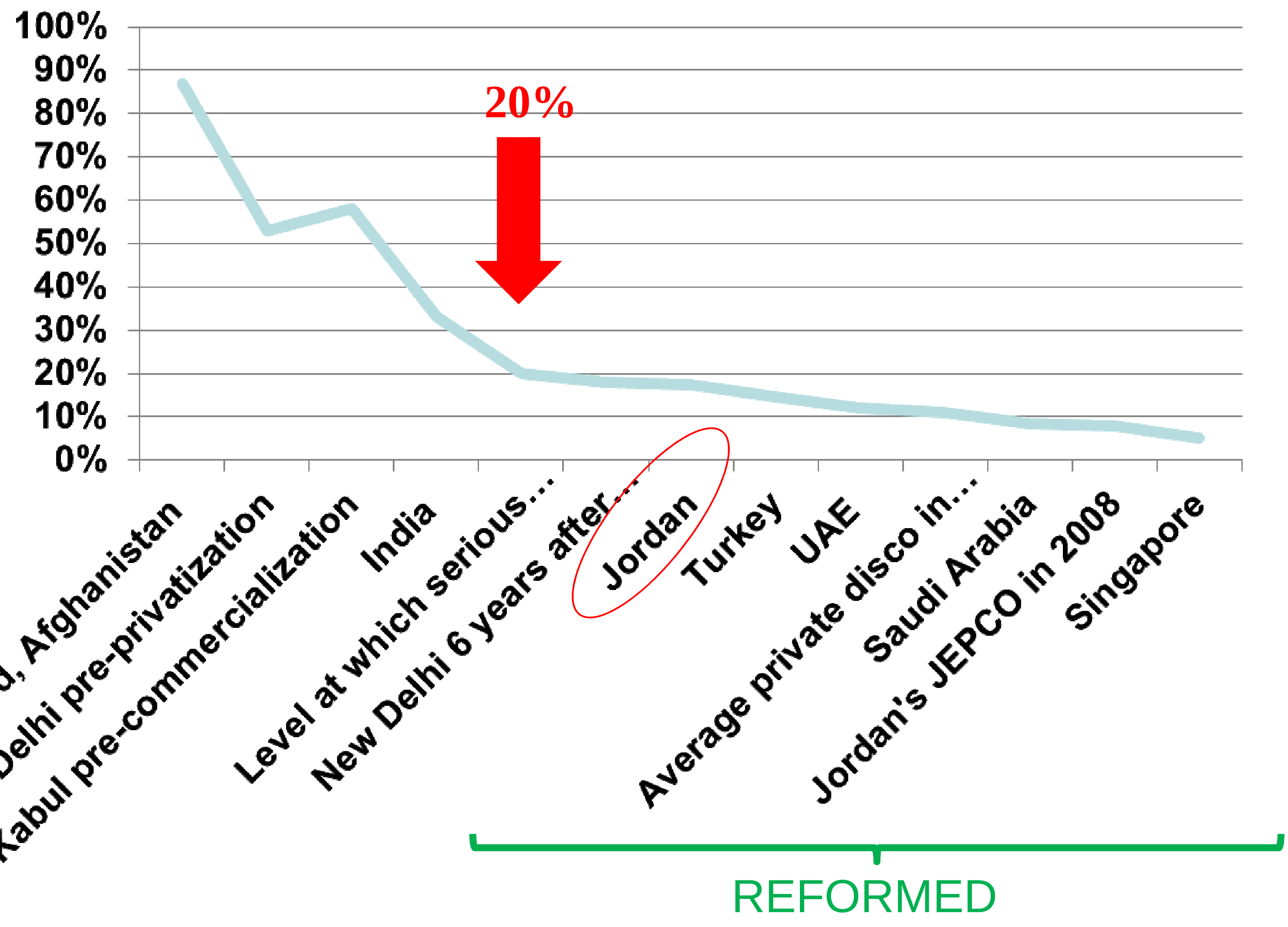
WORKSHOP OVERVIEW AND INTRODUCTION TO LOSSES

The Basic Idea:

SYSTEM ENERGY LOSSES =
ENERGY PURCHASED OR GENERATED
– ENERGY SOLD

(MEASURES SYSTEM TECHNICAL EFFICIENCY AND LOST REVENUE)

How Does Jordan Compare?



Funny Losses Arithmetic:

7% = 1.08

since approximately:

.08/1.08 ~ 7%

Creating or Reducing Losses?

Case Study (To Be Presented By ERC):

THE CURRENT LEVEL OF LOSSES IN THE JORDANIAN SYSTEM

Session One:

REGULATORY AND TECHNICAL ISSUES OVERVIEW

Regulatory Background

(a *really fast* history)

The “Natural Monopoly is Good” View

NATURAL MONOPOLY:

ONE COMPANY CAN SERVE THE ENTIRE MARKET AT LOWER AVERAGE COST THAN MORE THAN ONE COMPANY

SO, THAT’S GOOD RIGHT?

LET’S JUST MAKE ONE!

LET’S GIVE THEM A LICENSE.

THEN WHY DID THIS HAPPEN ....

Statute of Monopolies (England 1624)

BE IT ENACTED, that

all monopolies and all commissions, grants, licenses, charters, and letters patents heretofore made or granted, or hereafter to be made or granted to any person or persons, bodies politic or corporate whatsoever, *of or for the sole buying, selling, making, working, or using of anything* within this realm or the dominion of Wales, or of any other monopolies, … are altogether contrary to the laws of this realm, *and so are and shall be utterly void and of none effect*, and in no wise to be put in use or execution.

But they made some exceptions …

AND SO THEN A FEW CENTURIES LATER ….

The Famous Case: *Ira Y. Munn v. Illinois* (US 1877)

Since historically the British Parliament regulated business that is

"**AFFECTED WITH A PUBLIC INTEREST**"

Illinois and all the other US States inherited that power so could regulate such businesses as to:

- Prices
- Licenses (rights of entry)

Balancing Interests:

"JUST AND REASONABLE RATES"

an end-result "balancing test" standard

Bluefield (1923) and Hope (1944)

If the Regulatory Commission balances the consumer and company interests, allows the regulated utility to cover all proper costs, and earn a reasonable profit, then (almost) anything which does that is probably acceptable, if supported by the Commission in a reasoned statement based on evidence.

So, Our Overview of Regulation

- **Utility Regulation** is a process of
  constraining political tendencies
  that otherwise can harm both companies and consumers.

- **Public Utility Commissions (PUC)**
  protect the consumer
  from unconstrained natural monopoly
  protect the public utility
  from effects of unconstrained politics

- **PUC** must use processes that are assures the resulting tariffs
  "*just and reasonable*"
  for both the company and the consumers

Overview of Losses

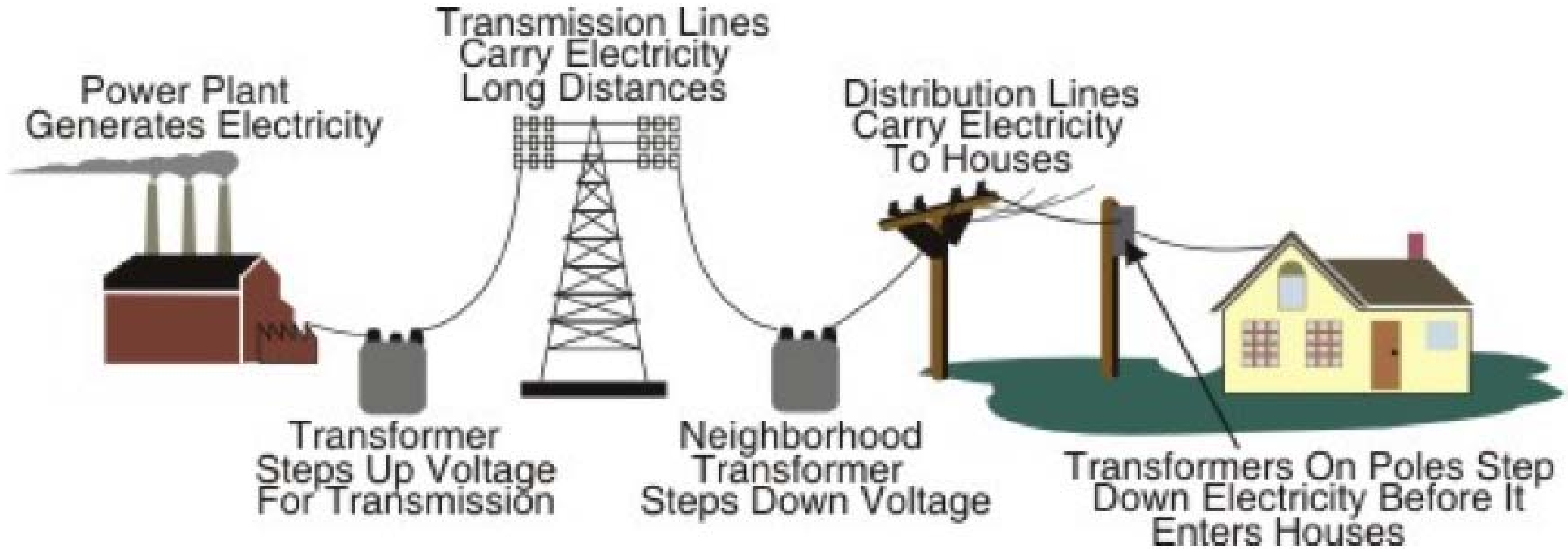
Overview of Losses

- The difference between the total amount of electricity entering the network from generation or purchases, and the total leaving it by passing through a meter to a customer.
- Someone has to pay for that difference.
- Some losses are unavoidable, but many can be reduced by various techniques and equipment

Source: Sohn Overview of Losses

Transmission and Distribution Overview - Basic

- Power losses occur in movement of electricity on the transmission and distribution system.
- The difference between what is injected to the network, and what is consumed = transmission and distribution losses.



Example of Losses*: If the transmission and distribution system has losses of 7 percent, 100 megawatt hours (MWh) of electricity produced at the power plant would provide only 93 MWh to the customer.*

Examples of Causes of Losses

- **Technical Losses** arise for physical reasons and depend on:
  - Energy flowing through the network
  - The nature of transmission lines
  - Transformers

- **Commercial/Non-Technical Losses** include:
  - Non-payment
  - Theft
  - Measurement inaccuracy
  - Timing differences

Other Concepts of Losses:

- Generation Plant Use
- Customer use patterns (peak vs. non peak for example)
- “Energy Efficiency” of Uses vs. “Losses” in System Operations
- Avoidance of Fuel Use vs. Losses of actual energy in system operations
- Utility System Use

  Jordan defines distribution company use in delivering its services as “losses”. Other jurisdictions might treat those as “costs” and place them in revenue and expense accounts in the income statement.

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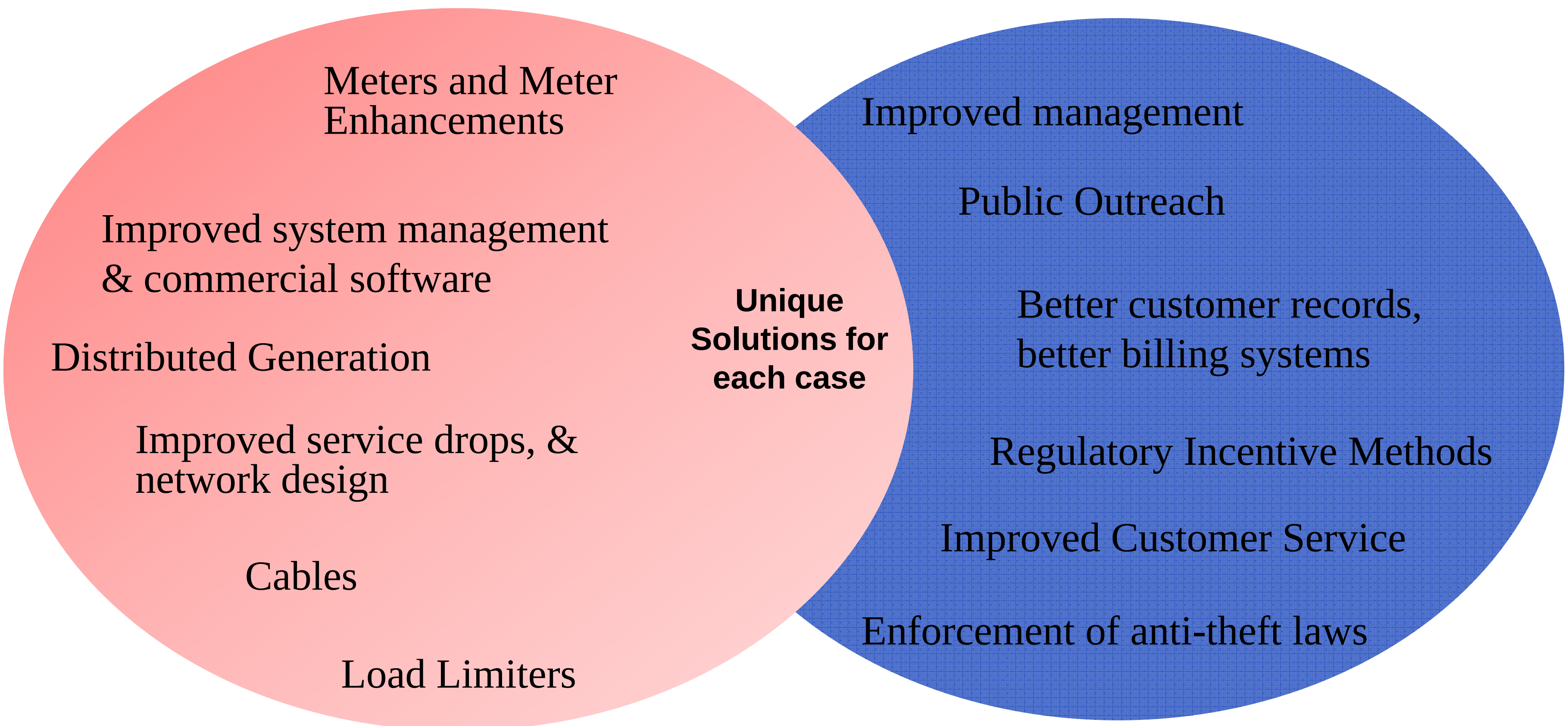
National Association of Regulatory Utility Commissioners

How are losses reduced?

Technical Solutions | **Non-Technical Solutions**



Losses in Jordan

Summary Of ERC Data, Based on ERC Annual Report, 2010 Table 15												
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Generation Losses	%	6.8%	6.7%	6.6%	6.6%	6.7%	6.2%	4.9%	16.9%	5.5%	4.3%	4.8%
Transmission Losses	%	3.3%	3.7%	4.0%	3.7%	3.7%	3.5%	3.2%	2.7%	3.1%	2.5%	2.0%
Distribution Losses	%	10.7%	10.9%	10.9%	11.7%	11.1%	11.7%	12.1%	13.9%	12.9%	13.3%	12.1%
Total System Losses	%	17.3%	18.1%	17.8%	18.2%	17.4%	18.1%	17.4%	19.0%	17.5%	17.0%	15.5%

What Can the ERC (Or Other Entities) Do?

What ERC Can Do (1 of 3):

(Citations from Temporary Law No 64 for year 2003)

Basic Procedures:

ERC Sets Tariffs:

Article 47 A … the Council shall determine the tariffs/prices for licensed services , according to methodologies it adopts for regulating electricity prices, and such tariff methodologies shall be specified in the license of the licensee.

The conditions of a tariff become part of the license of the regulated utility:

Article 30 E- 1 - The Council shall include in the license the tariff methodology applicable to the licensee and approved by the Commission pursuant to Article (47) of this Law.

To change the tariff, ERC must give notice and opportunity to speak for the utility:

Article 47 G - Before establishing a tariff methodology, other than a methodology to be established in accordance with paragraph (E) of this Article, the Council shall grant an opportunity to the licensee to make representations in accordance with such procedures as may be established by the Council pursuant to a directive.

What ERC Can Do (2 of 3):

(Citations from Temporary Law No 64 for year 2003)

ERC requirements in setting tariff methods:

Article 47-C- When determining the tariff methodologies , the following shall be taken into consideration:

1- allow a licensee that operates efficiently to recover the full costs of its business activities and to earn a reasonable return on the capital invested in business

2- provide incentives for the continued improvement of the technical and economic efficiency with which the services are provided, and for the continued improvement of quality of services

3- give to consumers economically efficient signals regarding the costs that their consumption imposes on the licensee's business

4- avoid undue discrimination between consumers of the same category and consumer categories; and

5- gradually phase out or substantially reduce cross subsidies, except while providing lifeline tariffs.

What ERC Can Do (3 of 3):

(Citations from Temporary Law No 64 for year 2003)

The tariff (set by ERC) must reflect the principles set by the Council of Ministers:

Article 5 B- the provisions to be incorporated in the Council of Ministers' decree pursuant to paragraph (A) of this Article shall specifically include the following:

1. The principles for determination of tariffs for sale and purchase of electric power, during the transitional period, and thereafter;
2. The incentives of which a licensee could benefit
3. The standards of performance to be observed by a licensee
4. The earnings that a licensee would be entitled to retain from its revenues
5. The arrangements, if any, for application of revenue of a distribution licensee from its distribution and retail supply businesses
6. The grant of subsidy from the Government to any person or licensee
7. Penalties that may be imposed on a licensee for failure to achieve standards of performance
8. The circumstances in which the transitional period may be terminated and the requirements therefore
9. Such other terms and conditions as the Council of Ministers may deem necessary.

Next Steps & The Role of the Regulator

- Why is this issue important in Jordan?
- What are the current technical and non-technical losses in Jordan?
- What is the role of ERC in positively impacting technical and non-technical losses?
- Does the Cabinet have to be involved in ERC policies affecting losses?

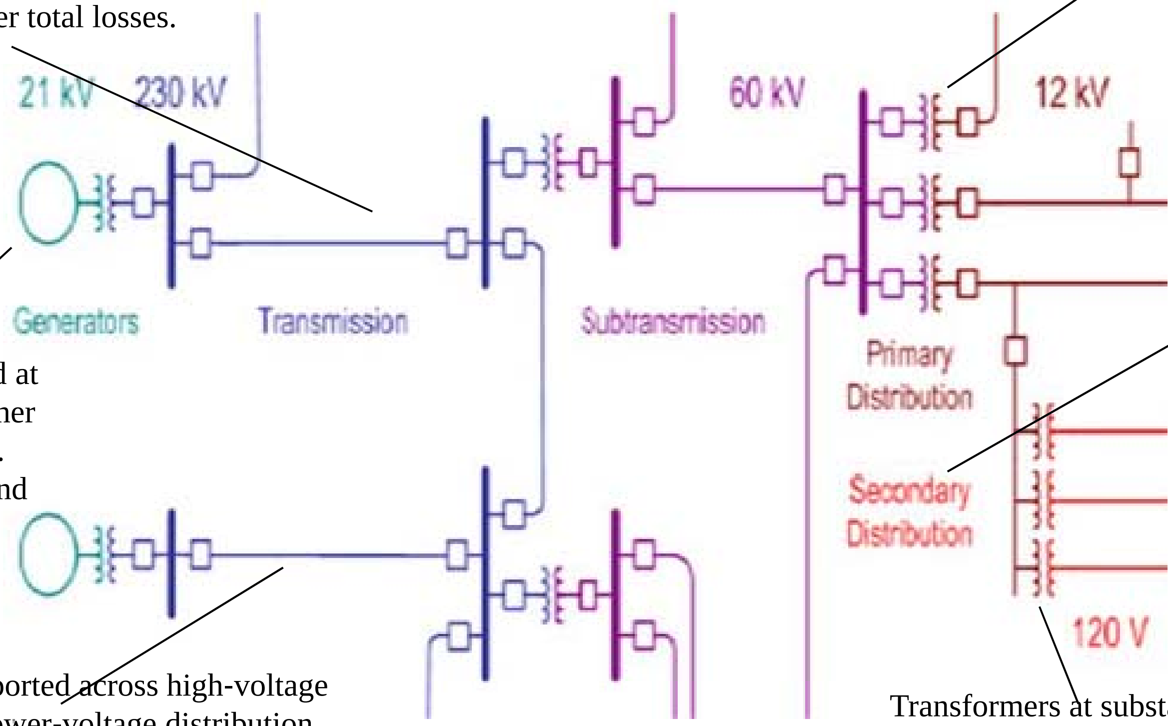
Session Two:

NETWORK DESIGN AND CONFIGURATION

Flow of Energy, and Locations of Losses

The transmission system operates at higher voltage levels to minimize power losses in long distance transmission. Longer lines mean higher total losses.

The distribution substation is a switchyard that connects the transmission system to the distribution system. But switchyard devices can incur losses.



The distribution system operates at lower voltage levels to provide safer delivery to the customer. Distribution devices can cause losses, but some can correct for power factors.

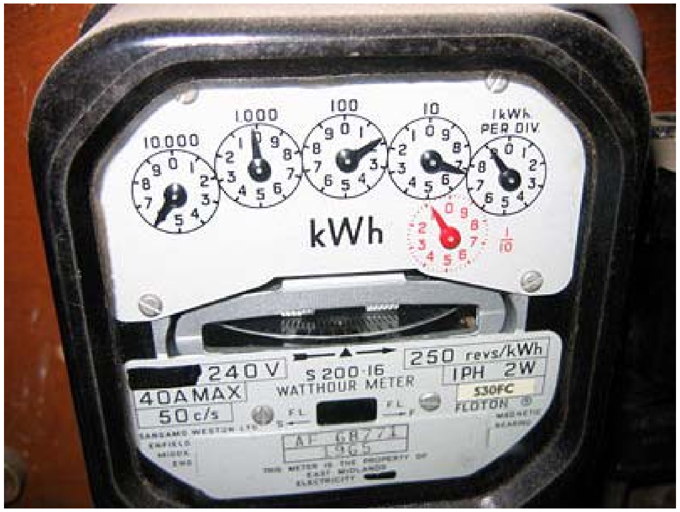
Electricity is created at power plants and other generating facilities. Plant "efficiency" and internal use induce losses.

Electricity is transported across high-voltage transmission and lower-voltage distribution lines to reach homes and businesses. But lines and transformers also induce losses.

Transformers at substations step the electric voltage up and down to deliver power efficiently to the customers. But these transformers also losses.

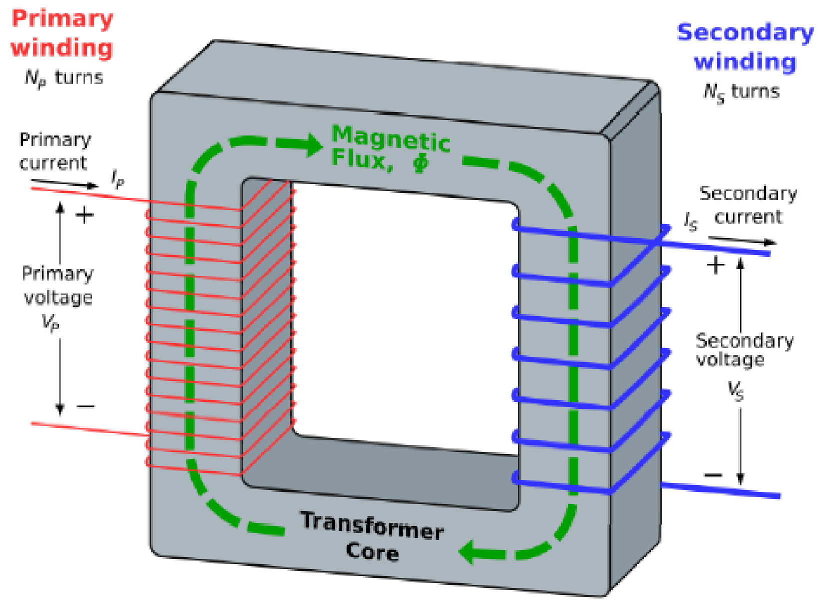
Technical Losses In Depth - Meters

- Meters consume a small amount of power regardless of consumption levels
- Electricity lost from meters represent 2-3% of the total electricity losses
- The accuracy with which the meter records losses will also affect losses – called non-technical/commercial losses



“Fixed” Losses

- Electricity is transported over long distances at different voltages, requiring a transformer
- Transformers work on alternating current which leads to losses from heat generation and eddy currents
- Losses that thus occur irrespective of the load are “<u>fixed” losses</u>



What is Load Balancing?

At each moment, total connected load must be balanced by total power injected to the grid.

- **Load balancing** includes the use various techniques by electrical power stations to reserve generating capacity, or store energy during low demand periods for use as demand rises.
  - Distribution network losses can vary significantly depending on the load (un)balance, which can also be harmful to the operation of the network, its reliability and safety.
  - Real power losses increase due to unbalanced loads
  - Location of load in relation to generation affects losses

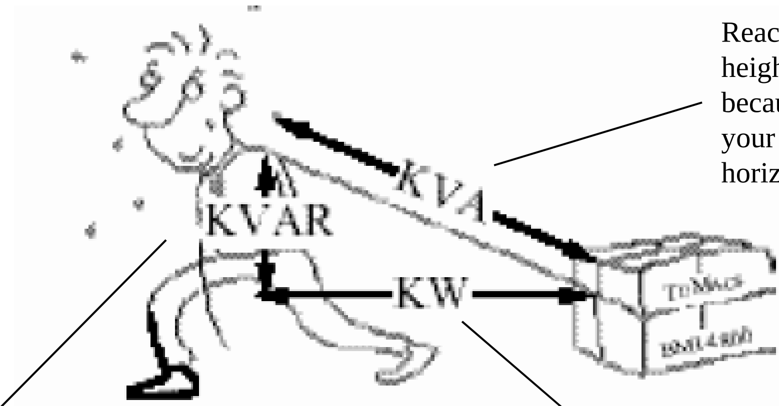
Coordinating Uses to Grid Costs

- **One Solution: Smart Grids**. In a basic balancing system, the power company sends a signal down the line or by a dedicated phone chip to turn on a special circuit in the consumer location. Perhaps a storage device for space heating or a water heater will be connected to this circuit. Electricity might be turned on after the evening peak demand, and turned off in the morning before the morning peak demand starts. The cost for such power might be less than the "on-demand" power which makes it worthwhile for the user to subscribe to it.

What is Power Factor?

Power Factor is the ratio of Working Power to Apparent Power.

$$P.F. = \frac{KW}{KVA}$$



Reactive Power – shoulder height adds reactive power because you cannot drag your load on the perfect horizontal

Apparent Power – sum of KW and KVA

Working Power – or where you want most of your load to travel

- **KW:** working power, or the power that actually powers the equipment and performs useful work
- **KVAR:** reactive power, or the power that magnetic equipment needs to produce the magnetizing flux.
- **KVA:** apparent power, sum of KVAR + KW.

Causes for Lower Power Factor

- Large KVAR is caused by *inductive loads*, including
  - Transformers
  - Induction motors
  - Induction generators (wind mill generators)
  - High intensity discharge (HID) lighting
- Inductive loads are a major portion of the power consumed in industrial complexes
- But every consumer device affects power factor on the system

Power Factor Optimization: Correction

Sources of Reactive Power ***decrease* power factor**	**Consumers of Reactive Power** ***increase* power factor**
• Transformers • Induction motors • Induction generators (wind mill generators) • High intensity discharge (HID) lighting	• Capacitors • Synchronous generators (utility and emergency) • Synchronous motors

Power Factor Optimization: Improvement

Methods for lowering power factor, include:

1. Tariff Incentives
   - Consumers Reduce peak KW billing demand
   - Power Factor penalty so consumers improve own equipment

2. Increase network capacity to reduce system losses
   - Add capacitors (KVAR generators) to the system to improve power factor and increase KW capacity

3. Increase voltage level in electrical system

4. Consumers use cooler, more efficient motors

PUC Presentation

Next Steps & The Role of the Regulator

- Why is this important in Jordan?
- What is the role of a regulator in positively impacting power factor?
- What can be done now to positively impact power factor in Jordan?
- What is the role of a regulator in positively impacting load balance?
- What can be done now to positively impact load balance in Jordan?

Case Study:

THE PROBLEM AND ITS SOLUTIONS AS SEEN IN FLORIDA

Session Three:

DISTRIBUTED GENERATION AND THE ROLE OF RENEWABLE ENERGY

Overview of Distribution Planning and Design

Distributed Generation Overview

- **Distributed generation** is an electric power source connected directly to the distribution network, or to the customer side of the meter

- Relative distribution of generation in relationship to the design of the overall electric grid, **can affect the technical losses**

- Inappropriate selection of the location and size of generation may lead to **greater system losses**

Characteristics of Distributed Generation

- Generally, distributed generation takes place close to the point where the energy is actually used.

- Other features:
  - Might not be centrally planned
  - Might be mainly operated by independent power producers or consumers
  - Might not be centrally dispatched
  - Typically smaller than 50 MW (although some sources consider certain systems up to 300 MW to be classed as DG)
  - Connected to the LV electricity distribution network, generally 240/400 V up to 110 kV.

Distributed Generation Impacts

- DG can affect losses, reliability, poor power quality and congestion in transmission systems
- The optimal location of DGs in power systems is very important for obtaining their maximum potential benefits
- The penetration of DG may impact the operation of a distribution network in both beneficial and detrimental ways.

DG Positive Impacts	DG Negative Impacts
• Voltage support • Power loss reduction • Support of ancillary services and improved reliability	• Protection coordination • Dynamic stability • Islanding

Renewables Overview

- The term ‘renewable energy sources’ refers to ‘everlasting’ natural energy sources, such as the sun and the wind.
- Renewable energy systems convert these natural energy sources into useful energy
- Renewable energy sources include:
  - Hydro power (large and small)
  - Biomass (solids, biofuels, landfill gas, biogas)
  - Wind
  - Solar (photovoltaic, thermal electric)
  - Geothermal
  - Wave and tidal energy
  - Biodegradable waste

Distributed Generation Renewable Energy Sources

- Distributed generation (DG) and renewable energy sources (RES) are an increasingly popular combination

- The combination of DG and RES might be able to:
  - Increase security of energy supplies by reducing dependency on imported fossil fuels such as oil, natural gas and coal
  - Reducing emission of “greenhouse gases”

Renewables in Distributed Generation

- Popular Renewable Sources are:
  - Solar Panels on the roofs of buildings. Solar power has a low capacity factor, producing peak power at local noon each day. Average capacity factor is typically 20%.
  - Wind turbines. These have low maintenance, and low pollution. Wind also tends to be complementary to solar; on days there is no sun there tends to be wind and vice versa.
  - Many distributed generation sites combine wind power and solar power such as Slippery Rock University, which can be monitored online.
- Many renewable energy systems are also distributed generation systems. Large-scale hydro, offshore wind parks and co-combustion of biomass in conventional (fossil fuelled) power plants are exceptions.

Role of Jordanian Law on Renewable Energy & Energy Efficiency

Effects of Jordan Law on Renewable Energy

- **Under Article 4-a**: The Ministry shall identify … the geographical locations in the Kingdom of suitable nature, which demonstrate a high potential for exploiting Renewable Energy Sources, and shall establish a priority list for the development of such locations … for the development of Renewable Energy Sources adopted by the Ministry.

Effects of Jordan Law on Renewable Energy

- **Under Article 5 – a:** The Ministry may, in coordination with the Bulk Supply Licensee, issue tenders or attract proposals on competitive basis for the development of one or more sites included in the Land Use List
- **Under Article 5 – b:** The Council of Ministers, may issue a decision states that the Bulk Supply Licensee or Retail Supply Licensee is entrusted to issue tenders or attract proposals on competitive basis for the development of one or more sites included in the Land Use List approved in accordance with the provisions of this Law for the purposes of generating electrical power and connecting to the grid, upon recommendation of the Minister based on a report from the Commission illustrates the development of the exploitation of Renewable Energy Sources for generating electrical power exceeds the total of capacity of (500) Mega Watt of such sources,

Effects of Jordan Law on Renewable Energy

- **Under Article 6 – a**:… any person may submit a direct proposal to the Ministry or to whom entrusted by the Council of Ministers pursuant to clause (b) of that Article in order to develop any site for the purpose of exploiting Renewable Energy Sources, …

- **And if they do that then under Clause 6 b 3**, the person proposes a tariff (price) such that:

  3 - The proposed tariff included in the proposal for electricity to be generated and sold by the Renewable Energy Facility shall be a fixed tariff expressed as an amount per kilowatt hour, and within an acceptable range according to the Reference Pricelist.

Effects of Jordan Law on Renewable Energy

- And when any renewables are agreed by any of those processes, then **Under Article 9**:

  - a- The cost of interconnecting a Renewable Energy Facility to the Grid shall be at the expense of the Bulk Supply Licensee.
  - b- The cost of interconnecting a Renewable Energy Facility to the Distribution System of any Distribution Licensee shall be paid in accordance with instructions to be issued by the Commission.
  - c- The Commission may waive Renewable Energy Facilities from any provision of the Grid Code or of the Distribution Code where such waiver is necessary, in coordination with the relevant licensees.

Effects of Jordan Law on Renewable Energy

Article 10 requires the Commission to set a system of Feed-in-tariffs for small renewables:

- **Article 10-** Any person, including small Renewable Energy Facilities and homes that have Renewable Energy Systems for the generation of electrical power, may sell the generated electrical power to the Bulk Supply Licensees and to the Retail Supply Licensees. The size and nature of such Renewable Energy Facilities and the selling price of the generated electrical power shall be specified in accordance with instructions to be issued by the Commission. The selling price of such power should not be lower than the purchase tariff specified by the licensees.

Questions to Consider

- Has the Commission done a study whose result is that more than 500 MW of renewable energy has been identified, for purposes of reducing system losses, and sent this to the Ministry? Should they do that? And, what should the Commission and the Ministry advise the Cabinet to do?

- Has the Ministry done studies on renewables generation, for purposes of reducing system losses, and issued any tenders for such units?

- Has the Commission issued the rules on interconnection for renewables and the payments for such interconnection?

- Has the Commission issued the "feed-in-tariff" required by Article 10? Is it designed to encourage reduction of system losses? Would it be different if it were designed for that purpose?

PUC Presentation

- Discussion of Role of Renewable Energy in a PUC State, in Affecting Losses and Providing Supply

Session Four:

ROLE OF INCENTIVES

Overview on Incentives

Principle:

place duty to control losses

on the party most able to do so

- Consumers can control their loads, and load shapes.
- The licensees (the operators) can control the technical characteristics of their system.

Incentives to Licensees

- *Rates methods* to limit losses:
    - o choice of volumes to use for rate design.
    - o frequency of adjustment of those volumes.

      If losses can be made less than assumed, the profit margins are higher, and can be kept by the utility for some period of time.

- *Targets:* require licensees to set administrative "targets" for desired levels of measurements of losses, and imply some penalty for failure to meet them, or reward for doing so.

  For example, assume the "normal" rate of return is set at 10%. If they exceed their targets in loss rate reductions, the rate will be set at 10.5%. If they fall below the target, the rate will be set to 9.5%.

- *Required investment programs*, to improve operations, is also a return-based incentive method. The required investment also gets a guaranteed return.

  For example the utility can control power factor to some extent by placement of capacitors, and gets rewarded in the return component of rates for doing so. The utility can better measure losses by better use of (more or better) metering, with same consequence.

Incentives to Consumers

- **Power factor rates:** for larger consumers/ industries.

  Require the larger and usually industrial consumers to maintain at least a stated power factor. If they fall below, then they pay a penalty. Implicitly if they are above, their rates are lower.

- **TOU Rates**: set TOU rates that are higher on peak periods.

  Losses rates tend to be higher at peaks for technical reasons, so if can get consumers to reshape loads and reduce peaks and/or shift loads away from peaks, losses also reduce. This creates an incentive for the consumers to move away from high loss consumption.

- **Marginal Cost Rates**: Marginal cost rates are more accurate, and tend to be higher under the same conditions when peak losses occur.

  Typical rates systems use average costs, such as average allocated cost to a class of customers. MC rates, like TOU rates, induce consumer responses to relatively reduce consumption when marginal costs are higher.

- **Measuring vs. apportioning losses to consumer classes in design of tariffs**.

  More accurate apportionment of costs to customer classes leads to potential reductions in consumption by presently subsidized classes.

- **The distribution utility is a consumer of the wholesale supplier**.

  Wholesale pricing by TOU or marginal cost methods in place of average cost pricing, can have the same effect on the utility as on an individual consumer.

- **Matching rate designs at wholesale level to retail level.**

  This more accurate method of pricing better targets all forms of loss reduction.

Incentives to Reduce Non-Payment

- Simplified or special payment schedules.
- When large areas consume from common meter, make the community responsible in some form for the entire bill.
- Cut off non-payers.
- Cut off and punish illegal connections.
- Induce payment of unpaid by moderated schedules of cut-off or repayment.

Question to Discuss

- Do these powers and procedures adequately allow the ERC to create incentive methods for reducing losses?
- How involved must the Cabinet of Ministers become to implement any of these techniques?
- Which actions ones would you advise?
- Affecting which regulatory documents?

PUC Presentation

Question to Discuss:

- Do these powers and procedures adequately allow the ERC to create incentive methods for reducing losses?
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Session Five:

METERING AND BILLING

Overview of Metering

Overview of Meeting and Billing

- Metering Identifies power inflows and outflows in a network, and allows accurate accounting of electricity sales.

- Importance of (Accurate) Metering/Billing:
  - A commercially successful utility will meter, to the greatest extent possible, all electricity purchased and sold
  - Is the only way to ensure accountability for purchases, sales, and losses
  - Enables the utility to balance its loads, load shed when necessary, and implement a cost-based system of dispatch and purchases for optimal technical system efficiency.

Types of Metering

Revenue – Basic revenue metering, which accounts for kWh consumption, may be electronic or mechanical, read manually or automatically, and may have data storage and analysis capability.

Network – Advanced metering that not only measures kWh consumption, but also system characteristics such as: voltage, current, reverse and reactive power; and may compute such operating characteristics as: power factor, time-of-use, trends, peak and valley loads, etc.

Ratemaking – Additional enhancements to network meters that allow for the collection and analysis of system characteristics to support advanced ratemaking methodologies. Meters are always integrated with a SCADA and possibly DCS control systems.

Basic Strategy

Implement 100% revenue metering at supply and sales nodes throughout the distribution system.

Implement a data collection system so that the utility's billing and collection systems can effectively utilize this information.

Establish effective systems for meter security, calibration and maintenance to ensure the reliability and accuracy of the information collected.

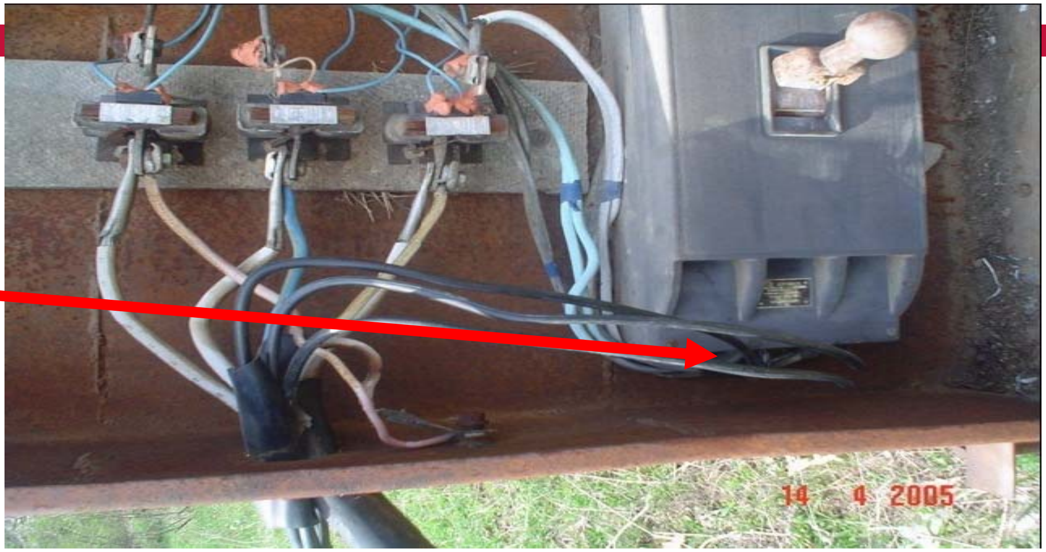
Implement advance metering for network system control, optimization, and to support advanced ratemaking methodologies as required.

Metering Strategies by Development Phase

Type/Phase	Developing Phase	Intermediate Phase	Mature Phase
Description	This phase is characterized by low collections, high losses, inadequate metering, and lack of capital and utility management expertise	Substantial revenue metering has been implemented and the utility is becoming commercially viable and able to concentrate on operational improvements	Well functioning utility with high collections, low losses, efficient network operations and seeking the highest level of efficient operations and customer service
Requirements for Improvement	New and/or upgraded metering for maximum accountability of inflows and outflows	Upgraded metering and associated systems for collection of network operating characteristics for monitoring and control	Upgraded metering and associated systems for collection of additional network operating characteristics to implement advanced methodologies
Constraints	Lack of capital and expertise for 100% metering	Capital and expertise for upgraded metering and SCADA systems	Capital for upgraded meters, expertise for advanced tariff methodologies, and regulatory incentives.
Expected Results to Progress to Next Phase	100% metered energy to consumers	Improved network performance and control	Incentive tariff mechanisms adopted for increased utility efficiency and lowest power rates with standards of service

Meter Tampering

Meter by-pass by illegally connecting to switch before meter

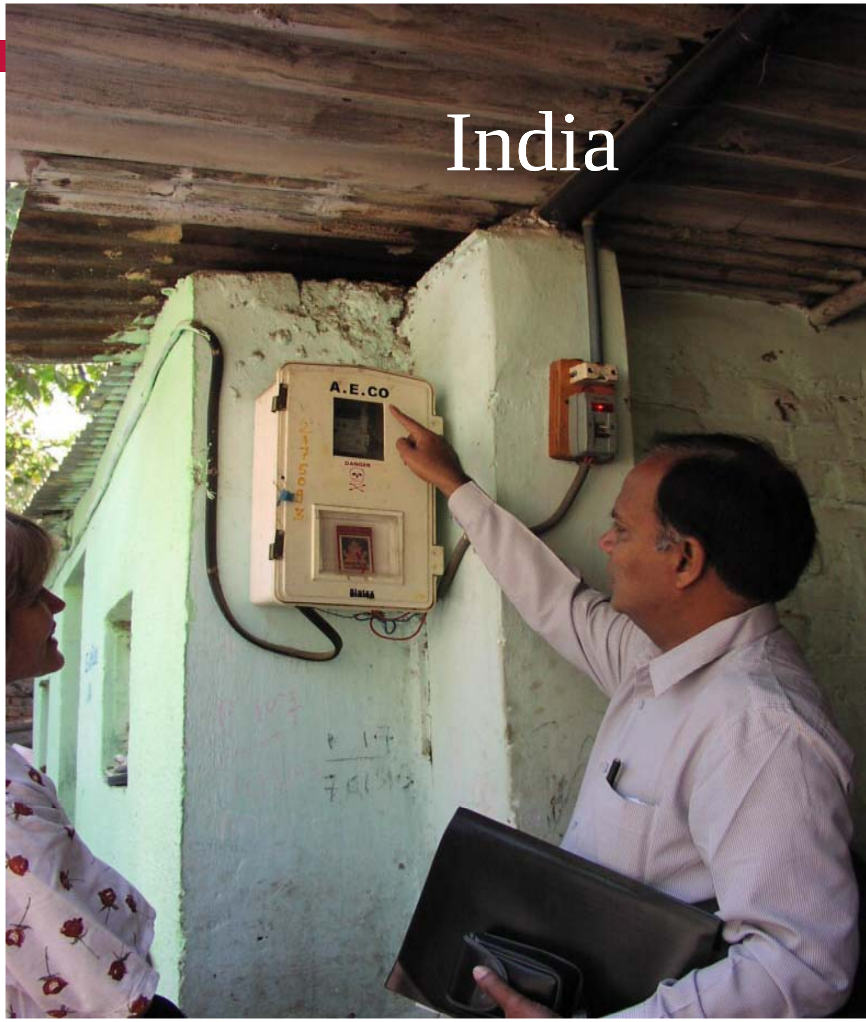


Mechanical block to rotating disk

Placing magnets

Meter tilting

“Low Tech” solutions can be effective



Essential: Meters must be visible and “clean” (easy to spot irregular situations)

More low tech solutions

Low cost service drop kit for all conditions

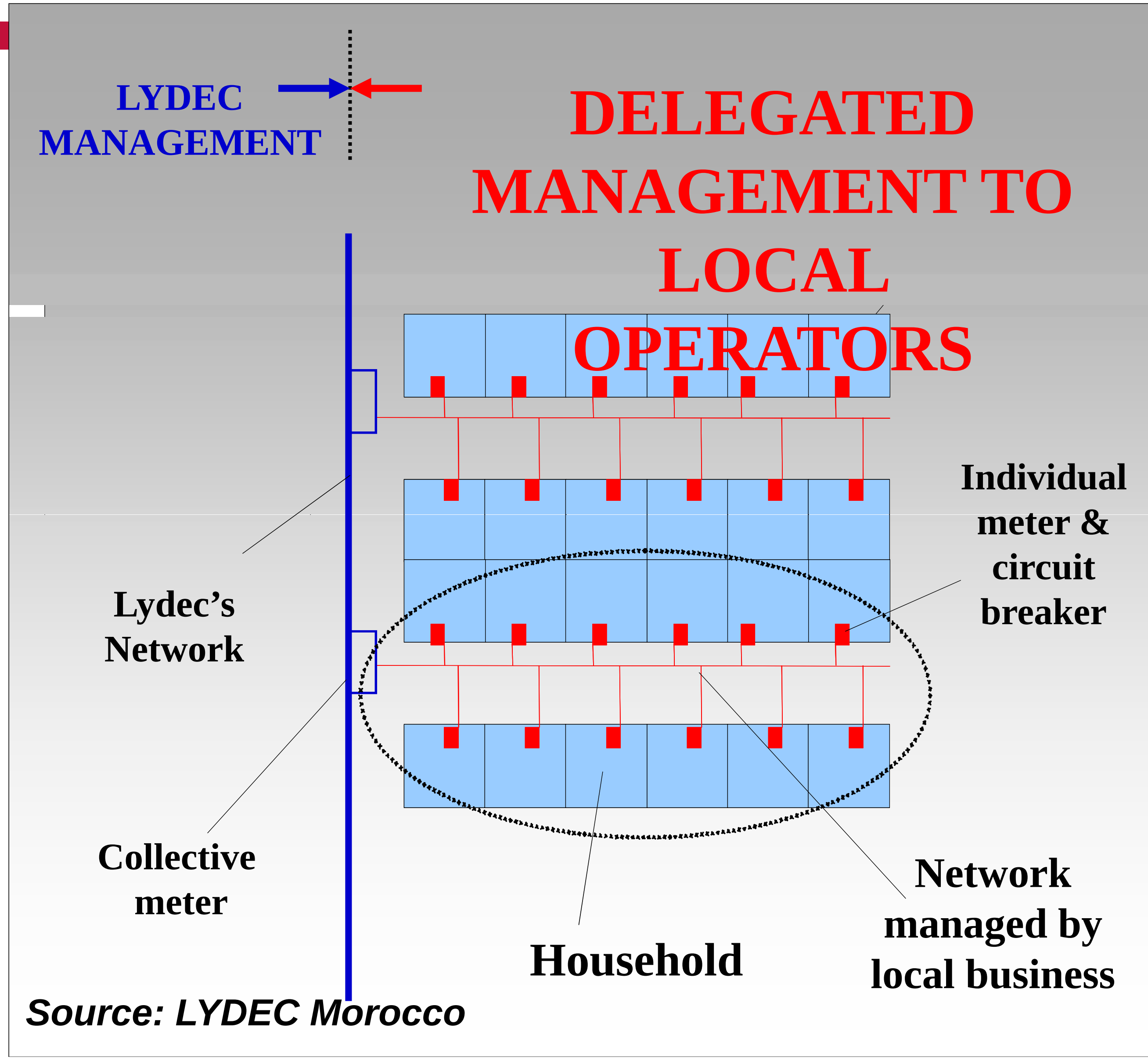
Shortest possible low voltage network, individual service cable (concentric/ coaxial) from pole to meter.

Load limiters

LYDEC "Temporary" Perimeter Electrification in Morocco

LYDEC created temporary zones with collective meters in difficult to serve areas

This decreased investment cost & involved community representatives



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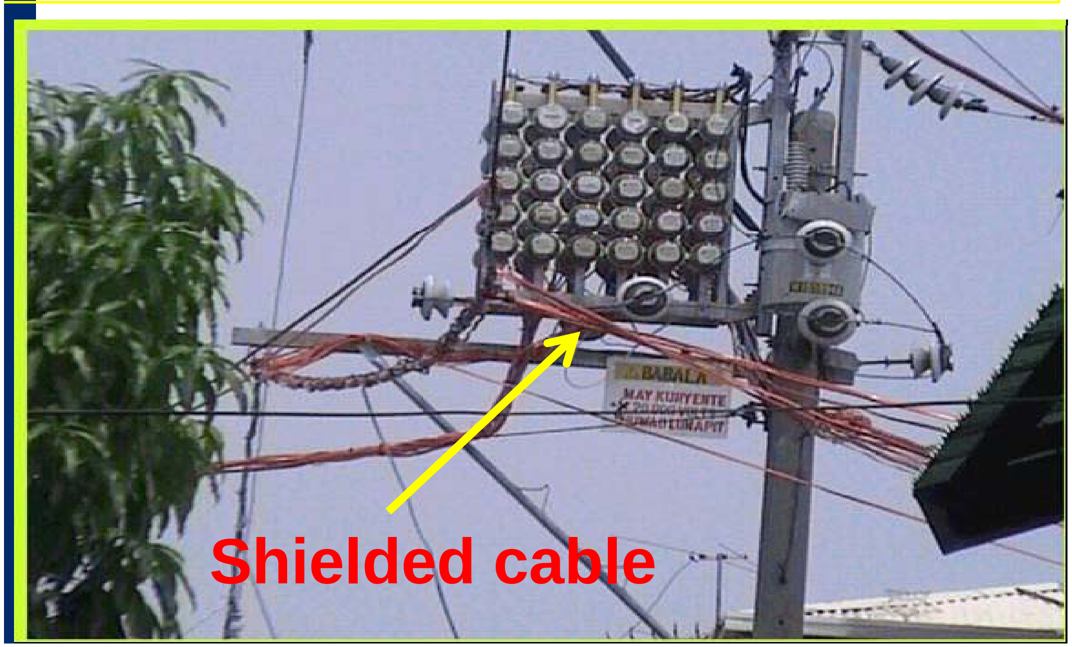
Individual Meters in Perimeter Panels



- Used by Meralco, Philippines in low income areas
- Quick and effective in short term
- Avoids right of way problems
- Losses reduced but opportunities for theft exist

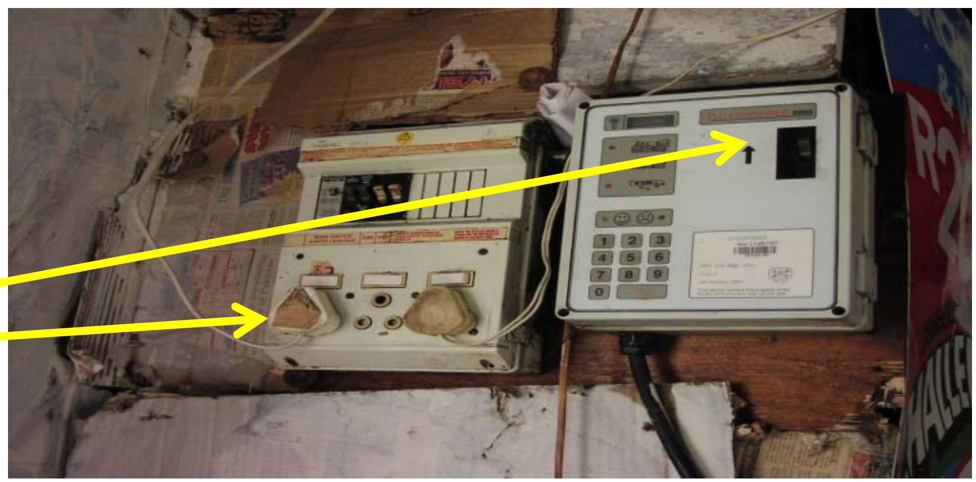
Prepayment systems

South Africa, Argentina, Venezuela, Colombia

Help consumer control electricity spending. Significant reduction in usage (40% in Argentina)

Can be combined with electric outlets for simple electric "kit"

Keyboard for prepayment code & digital kWh readout (Caracas)

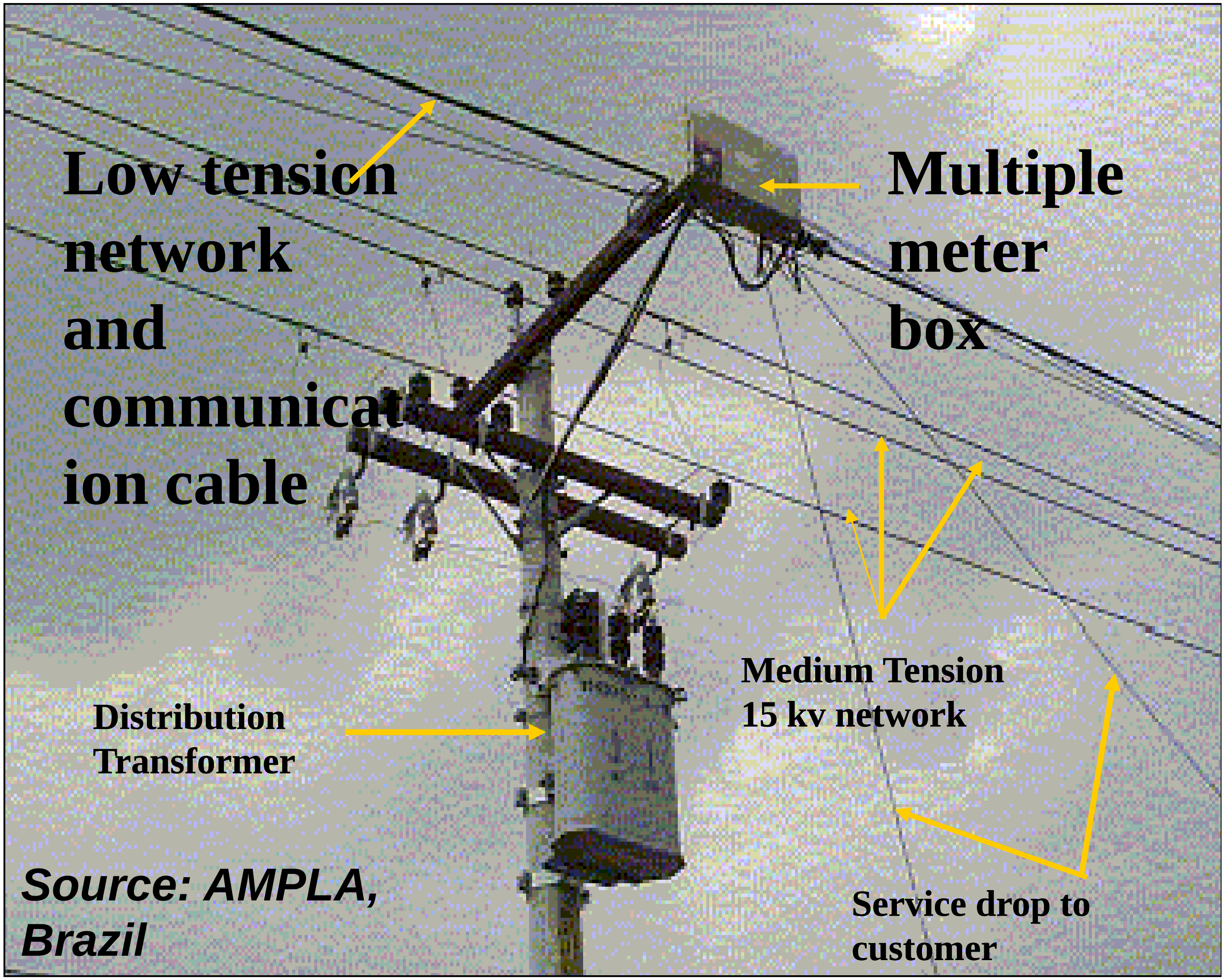


"Ready board" & pre-payment readout (South Africa)

High Tech Anti-Theft Cables

Costly but impossible to illegally tap

Elevated meters require remote reading capability



Items to Consider in a Metering Program

- **Organizational Issues**
  - o Assemble a project task force that draws upon many organizational units for staff and acts as a center for information and coordination
- **Implementation**
  - o Successful metering program requires diligent implementation and coordination with customers, external organizations, and suppliers.
- **Equipment Selection and Procurement**
  - o Appropriate equipment selection will have a significant effect on the cost/benefit of any metering program.
- **Design Features**
  - o Selecting appropriate metering technology is one of the most important decisions facing a utility, primarily because of the cost.

Billing Technology

A Metering and Billing System is Part of a Comprehensive MIS System.

A Management Information System (MIS) is an essential component of billing and should include all data necessary for corporate decision-making, including:

- Accounting and financial recording and reporting systems
- Human resources management
- Management systems for materials (i.e., inventory)
- Maintenance
- Project development, and working capital
- Customer information system (CIS)
- Decision support systems

CIS Basics for Utilities (1 of 2)

The major elements of a CIS system include:

1.A **customer information and billing system** must track detailed information regarding personal customer data, sales, collections and receivables, and meter information. What follows is a summary of high level generic features for a “typical” billing system, that is, functionality and capabilities of the CIS.

2.Customer Information: Personal data, account type, feeder and transformer information.

3.Meter Readings and Information: Meter manufacturer, type, ratings, and factors, reading value and date, reading history, maintenance records including calibration.

4.Connections, Disconnections, and Reconnections: List of customers to be connected for the first time, customers to be disconnected or face temporary shutoff for non-payment, and reconnection and dates for scheduled services.

5.Customer Invoices: Company name, customer name and address, account type, current usage, tariff schedules, reading date, billing date and due date, aged debt, notice of disconnection if applicable and disconnection date.

6.Receivables Sub-Ledger: Current, aged, and total receivables.

MIS Basics for Utilities (2 of 2)

The major elements of a CIS system include:

6. **Payments and Receipts Modules**: Cash register, checks and bounced checks, payment types, prepaid amounts and partial payments, payment locations, credit history, receipt printing.
7. **Cash Control and Reporting**: Cash books and daily cash reports.
8. **Customer Security Deposits**: Amount, date paid, date refund is due to customer.
9. **Customer Project Risk Deposits:** For large customer hook-ups non-refundable prepayment, refundable deposit, number of years to be credited against account.
10. **Report Module:** Reports by account type, daily payments, daily breakdown by area/book, lists of clients with credit or in arrears, ad hoc reports, etc.
11. **Portal to General Ledger:** Aggregated receivables and accounts due.

Questions for Discussion

- Overview of Jordan’s current metering and billing system
- Analysis of gaps/issues
- Why is this important
- What can be done to improve metering/billing in Jordan?
- How can ERC help?

PUC Presentation

Session Six:

MEASURING AND RESEARCH

Why Study Losses?

- Minimize Cost of Energy and
- Maximize Value (Minimize Cost) of Capacity

  (Losses used in demand forecasting and capacity planning)

- Difficulties in siting new generation

  (What needed, where, and why?)

- Pressure from regulators and system security requirements

  (Thus, defensible load forecasting)

- Better understand customer behavior

  (Better load forecasting; Identify existence and location of theft)

- Better understand entire system behavior

Data Sources for Losses Evaluation

- Utilities may record and estimate losses at four levels of service:
    - Transmission
    - Sub-transmission
    - Primary distribution
    - Secondary distribution
- More Comprehensive Analysis of Power Systems Losses May Also Analyze Generation Losses, and Consumer Patterns and Power Factors

Physical Data Sources for Losses Evaluation

Locations of Losses include:

- Substation Power Transformers
- Voltage Regulators
- Distribution Lines
- Distribution Transformers
- Secondary/ Service Conductors
- Consumer Metering
- Generating Stations
- Consumer Premises and Equipment

System Data Sources for Losses Evaluation

- GIS Systems (data ideally available) - Detailed information for each piece of equipment and conductor installed across the system down to the customer meter
- AMI Systems - Typically, meter readings are received at the central office once per day for the previous 24 hours of usage. Ability to collect interval load data for each meter
- Billing Systems, including CIS and MIS
- SCADA Systems

Losses-Related Snips from ERC Regulations (1 of 3):

- Standard Transmission License (to NEPCO as transmission provider) Article 30:
  - The Licensee shall achieve efficient electrical losses on its transmission system. In complying with this Article, the Licensee may have standard levels of transmission losses established by the ERC as Minimum Performance Standards.
- Standard System Operation License (to NEPCO as operator)Article 5.1
  - Licensee annual report shall include "transmission system losses"
- Distribution Performance Standard
  - Article 5.1.1. Defines "Distribution Energy Losses" as the "difference between the total energy purchased by the Distributor during such period from the Bulk Power Supply Licensee and from Generation Connected to Distribution, and the total energy invoiced to consumers independently on whether the energy (purchased or sold) has been paid or not."
- Article 5.1.2. Distribution Energy Losses classified into three categories:
  - Technical losses: occur due to the current flowing into the distribution system, including conductor losses and core losses on transformers.
  - Administrative Losses: "Energy used by the distributor for its own consumption in order to carry out the distribution and retail activities".
  - Non-Technical losses: The difference between the Distribution Energy Losses and the sum of (a) plus (b).

Losses-Related Snips from ERC Regulations (2 of 3):

- **<u>Article 5.2 CAP to Distribution Energy Losses</u>**:

  - Article 5.2.1.   ERC determines a cap on each of the three categories in each Tariff Review Period, and is allowed to pass those through the tariffs the amounts corresponding to the three caps.
  - Article 5.2.2.   Caps are used for tariffs, and are placed into Performance Indicators
  - Article 5.2.3.   Caps stated are placed into Annex 4.
  - Article 5.3.1.   Reports losses to ERC each 6 months by the three categories, and by voltage level (medium and low level voltages)
  - Article 5.3.2.   Distributor proposes a method to determine losses within six months from issue of license.
    - [Did they do that? What are the methods proposed?]
  - Article 5.3.4.   Annual report shall include information on losses. Methods used to resolve losses. Areas were losses exceed Performance Indicators. Any study or Plan carried out to reduce losses. Plan for the next 24 months to reduce losses.

Losses-Related Snips from ERC Regulations (3 of 3):

- Distribution Code Draft Version 3
  - Article 3.4.5 requires the distributor to use devices to reduce reactive power and improve power factor, to improve system losses.
  - Article 3.4.6 requires to place substations so as to rationally reduce losses.
  - Article 3.4.7 requires voltage regulation to minimize level of losses.
  - Article 3.5.1 (d) requires studies of system losses.

- Metering Code:
  - Article 2.11.1 (d) says the Distributor “shall” “apply adjustments to metering data to account for system losses and unaccounted for energy”.
  - Similarly on billings at Article 2.12.1.(h).
  - [What does that mean? What “adjustments” do you do?]

- Transmission Performance Standards:
  - Article 5 deals with Transmission Losses

Jordan – Losses by Source

Generation Losses		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Generated Energy	gWh	7,122	7,349	7,828	7,679	8,657	9,332	10,835	12,750	13,551	13,995	14,477
Sent Out Energy	gWh	6,636	6,856	7,309	7,175	8,073	8,756	10,300	10,599	12,807	13,392	13,788
Losses	gWh	486	493	519	504	584	576	535	2,151	744	603	689
Losses	%	6.8%	6.7%	6.6%	6.6%	6.7%	6.2%	4.9%	16.9%	5.5%	4.3%	4.8%

Source: ERC Annual Report 2012, Table 15, Page 52

* Excludes large industrial companies consumption.

Transmission Losses		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Sent Out Energy to Trans. Line	gWh	6,535	6,897	7,616	8,123	8,767	9,555	10,643	12,191	13,441	13,848	14,546
Bulk Sales	gWh	6,321	6,642	7,310	7,820	8,446	9,219	10,307	11,864	13,028	13,503	14,259
Losses	gWh	214	255	306	304	321	336	336	326	413	345	288
Losses	%	3.3%	3.7%	4.0%	3.7%	3.7%	3.5%	3.2%	2.7%	3.1%	2.5%	2.0%

Source: ERC Annual Report 2012, Table 15, Page 52

Distribution Losses		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Sent Out Energy to Dis. Line	gWh	5,643	6,021	6,404	6,922	7,656	8,416	9,425	10,777	11,729	12,490	13,454
Sold Energy	gWh	5,038	5,366	5,707	6,113	6,808	7,431	8,280	9,276	10,218	10,835	11,823
Losses	gWh	605	655	697	809	848	985	1,145	1,501	1,510	1,655	1,631
Losses	%	10.7%	10.9%	10.9%	11.7%	11.1%	11.7%	12.1%	13.9%	12.9%	13.3%	12.1%

Source: ERC Annual Report 2012, Table 15, Page 52

Jordan – Total Losses

Total System Losses		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Energy	gWh	7,415	7,809	8,453	8,963	9,791	10,636	11,621	13,035	13,998	14,452	15,295
Sold Energy	gWh	6,135	6,394	6,949	7,333	8,090	8,713	9,595	10,559	11,555	11,993	12,920
Losses	gWh	1,280	1,415	1,504	1,630	1,702	1,922	2,026	2,476	2,443	2,458	2,375
Losses	%	17.3%	18.1%	17.8%	18.2%	17.4%	18.1%	17.4%	19.0%	17.5%	17.0%	15.5%

Source: ERC Annual Report 2012, Table 15, Page 52

Jordan - Generation Send Out Plus Net Imports

Generation Send Out Plus Net Imports, Compared to Total Retail Sales												
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Imported From Egypt	gWh	45	267	322	972	788	741	472	199	534	363	446
Imported from Syria	gWh	-	-	-	-	38	241	42	8	13	20	224
Total Imports	gWh	45	267	322	972	826	982	514	207	547	383	670
Total Exports	gWh	5	2	1	4	3	-	13	172	318	139	58
Net Imports - Exports	gWh	40	265	321	968	823	982	501	35	229	244	612
Generation Sent Out	gWh	6,535	6,897	7,616	8,123	8,767	9,555	10,643	12,191	13,441	13,848	14,546
Total Gen. + Net Imports	gWh	6,540	6,899	7,617	8,127	8,770	9,555	10,656	12,363	13,759	13,987	14,604
Total Dist Sold Energy	gWh	6,135	6,394	6,949	7,333	8,090	8,713	9,595	10,559	11,555	11,993	12,920
Losses	gWh	405	505	668	794	680	842	1,061	1,804	2,204	1,994	1,684
Losses	%	**6.2%**	**7.3%**	**8.8%**	**9.8%**	**7.8%**	**8.8%**	**10.0%**	**14.6%**	**16.0%**	**14.3%**	**11.5%**

Imports Data From ERC 2010 Annual Report Table 6

Jordan – Wholesale to Retail Sales

Comparison of Wholesale to Retail Sales												
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bulk Sales (off Trans.)	gWh	6,321	6,642	7,310	7,820	8,446	9,219	10,307	11,864	13,028	13,503	14,259
Retail Sales (off Dist.)	gWh	6,135	6,394	6,949	7,333	8,090	8,713	9,595	10,559	11,555	11,993	12,920
Sales-Losses	gWh	186	248	361	487	356	506	712	1,305	1,473	1,510	1,339
Sales-Losses	%	**2.9%**	**3.7%**	**4.9%**	**6.2%**	**4.2%**	**5.5%**	**6.9%**	**11.0%**	**11.3%**	**11.2%**	**9.4%**

The Real Losses Problem in Jordan? (1 of 4)

What is the significance of the losses computed by ERC?

- Are real losses the total system losses of 15.5%? Or the claimed distribution losses of 12.1%?

- Or are “total” losses the difference between total generated and sent to transmission plus imports (all using ERC data from that same Annual Report), minus total retail sales, of 15.1%?

.

The Real Losses Problem in Jordan? (2 of 4)

What are the actual distribution system losses?

- Are losses the difference between total Wholesale (Bulk Power) sales, which should be everything placed onto the transmission system, and total retail sales, of 9.4%?
  - Why is that last number different from the computed distribution losses of 12.1% on ERC Table 15
  - Why is the Difference between the Bulk vs. Retail sales different than the sum of generation onto the transmission line plus imports, less retail sales?

The Real Losses Problem in Jordan? (3 of 4)

<u>Is electricity used by the operating companies to run their offices and facilities properly considered a “loss”,</u>

<u>or is it an operating expense?</u>

- Article 5.1.2. Distribution Energy Losses classified into three categories:
    - Technical losses: occur due to the current flowing into the distribution system, including conductor losses and core losses on transformers.
    - <u>Administrative Losses: “Energy used by the distributor for its own consumption in order to carry out the distribution and retail activities”.</u>
    - Non-Technical losses: The difference between the Distribution Energy Losses and the sum of (a) plus (b).

The Real Losses Problem in Jordan? (4 of 4)

Industrial Consumers Losses and Power Factor

- ERC Statistics Report the Industrial Consumers as a Separate Category. Some may have own generation. But they are also integrated to the system, probably for both supply and for reliability. Because of that interconnection, their operational characteristics including internal losses, and power factors, also affect total system losses and system power factor.

- How are those matters accounted for at present? How should they be treated, in order to minimize their impact on system losses, and to avoid inadvertent cross subsidies with other consumers?

The Real Losses Problem in Jordan?

How can you find out?

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