Egyptian Experience:
From Energy Crises, to an agile Smart Grid

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Overview

- Introduction
- 2013-2014 Status
- Stakeholders
- Challenges
- Fast Solutions
- Current Status
- Future Strategy
- Moving toward Smart Grid
- Conclusion
Introduction

• Area of Egypt: 1.01 million km²
• Population: 95 M inside + 9 M outside
• Electricity in Egypt since 1893
• First Ministry of Electricity since 1964
• Total No. of Customers is 34 Millions (subscribers) (29.5 M Residential + 4.5 M Commercial)
• Installed capacity 52 000 MW
• Max Load: 25000 MW in Winter & 32000 MW in Summer

Over US$ 70 bn of public and private investments over 2015-2022 (Egypt moved from electricity deficit to sufficiency = from scarcity to abundance, and moving now toward Smart Grid)
EEHC Vision & Mission

The Vision:
World class leadership and excellence of sustainable electrical energy.

The Mission:
Provide sustainable electrical energy for all customers through available resources according to international standards at competitive prices by corporate effort adapting quality standards, resources utilization and environment conservation based on highly-efficient human potentials and technologies. Performing work in an ethically responsible manner for the benefit of our customers, employees and society.
Number of customers

Number of subscribed customers (Millions)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Customers (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016/2017</td>
<td>33.7</td>
</tr>
<tr>
<td>2015/2016</td>
<td>32.4</td>
</tr>
<tr>
<td>2014/2015</td>
<td>31.4</td>
</tr>
<tr>
<td>2013/2014</td>
<td>30.6</td>
</tr>
<tr>
<td>2012/2013</td>
<td>29.7</td>
</tr>
<tr>
<td>2011/2012</td>
<td>28</td>
</tr>
</tbody>
</table>
## Customers classifications

### 2016

<table>
<thead>
<tr>
<th>Purpose of Usage</th>
<th>No. of Customers (Thousand Customer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>152</td>
</tr>
<tr>
<td>Agriculture</td>
<td>110</td>
</tr>
<tr>
<td>Government &amp; Public Utilities</td>
<td>210</td>
</tr>
<tr>
<td>Residential</td>
<td>23308</td>
</tr>
<tr>
<td>Commercial</td>
<td>2020</td>
</tr>
<tr>
<td>Closed &amp; postponed</td>
<td>3730</td>
</tr>
<tr>
<td>Zero reading</td>
<td>2570</td>
</tr>
<tr>
<td>Others*</td>
<td>330</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32430</strong></td>
</tr>
</tbody>
</table>
### 3 - Number of Customers (on Medium & Low Voltages) According to Purpose

<table>
<thead>
<tr>
<th>Purpose of Usage</th>
<th>No. of Customers (Thousand Customer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>140</td>
</tr>
<tr>
<td>Agriculture</td>
<td>122</td>
</tr>
<tr>
<td>Government &amp; Public Utilities</td>
<td>211</td>
</tr>
<tr>
<td>Residential</td>
<td>28981</td>
</tr>
<tr>
<td>Commercial</td>
<td>3734</td>
</tr>
<tr>
<td>Closed, postponed &amp; zero reading</td>
<td>119</td>
</tr>
<tr>
<td>Public lighting</td>
<td>32</td>
</tr>
<tr>
<td>Others *</td>
<td>319</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33658</strong></td>
</tr>
</tbody>
</table>

#### July 2017

![Pie chart showing distribution of customers by purpose]
## Electric Consumption per purpose

### July 2016

<table>
<thead>
<tr>
<th>Purpose of Usage</th>
<th>Sold Energy (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>18838</td>
</tr>
<tr>
<td>Agriculture</td>
<td>6027</td>
</tr>
<tr>
<td>Government &amp; Public Utilities</td>
<td>12107</td>
</tr>
<tr>
<td>Residential</td>
<td>73361</td>
</tr>
<tr>
<td>Commercial</td>
<td>8216</td>
</tr>
<tr>
<td>Public lighting</td>
<td>5293</td>
</tr>
<tr>
<td>Others*</td>
<td>9778</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>133620</strong></td>
</tr>
</tbody>
</table>

- **Industry**: 14.1%
- **Residential**: 54.9%
- **Government & Public Utilities**: 9.1%
- **Commercial**: 6.1%
- **Public lighting**: 4%
- **Agriculture**: 4.5%
- **Others**: 7.3%
4 - Energy Sold by Distribution CO’s (on Medium & Low Voltage) According to Purpose

<table>
<thead>
<tr>
<th>Purpose of Usage</th>
<th>Sold Energy (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>19660</td>
</tr>
<tr>
<td>Agriculture</td>
<td>6033</td>
</tr>
<tr>
<td>Government &amp; Public Utilities</td>
<td>14336</td>
</tr>
<tr>
<td>Residential</td>
<td>64125</td>
</tr>
<tr>
<td>Commercial</td>
<td>8272</td>
</tr>
<tr>
<td>Public lighting</td>
<td>5115</td>
</tr>
<tr>
<td>Others *</td>
<td>9529</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>127070</strong></td>
</tr>
</tbody>
</table>

* Others: power theft, youth centers, Gaza, …
2013-2014 Status

• Year 2013:
  Egypt faced its worst power crisis in power cuts
  Produced 24,000 MW but 29,000 MW were needed
  Load shedding was done daily (up to 5000 MW daily = up to 25%)
  This is to protect the electricity power system from a total blackout.

  Because of: Fuel Supply shortage, Lack of PP maintenance, Power generation shortage,
  Major delay in completion of some pending projects, Financing Subsidized electricity tariff,
  Miss of new laws for better investment environment and increase of power demand.

• Year 2014: Continue Load shedding was done countrywide.

The government was actively asking the public to economize their electricity consumption,
turn off air conditioning and use half of the light bulbs at home.
Stakeholders

- Political Leaders (Full Support)
- Citizens and customers
- Investors
- EgyptEra (Regulatory Authority).
- Economic Sector (Industrial, Commercial, Agriculture, …)
- Ministry of petroleum (Fuel)
- Ministry of finance
- Supreme Council of Energy
- Energy committee of Egyptian Parliament
- Army forces and Police (National Security)
- Manpower of Ministry of Electricity (EEHC)
- International Energy Companies
Great challenges faced Egypt, such as:
Fuel Supply shortage - Power generation shortage - Lack of PP maintenance - Major delay in completion of some pending projects - Miss of new laws for better investment environment - Increase of power demand - Inefficient governance structure - Financing the subsidized electricity tariff, Adversely affect on homes and business, in addition to the burden caused by the high capital investments needed by production, transmission and distribution companies.

And Also:
- Rise in the number of Air-conditioning units (200,000 in 2009 – 3 Million in 2010 – 6 Million in 2012 - 8 M in 2015 ..) = 20% of Consumption.
- Street lambs often left lit in day time..= 6% of Consumption
- Public awareness needed to reduce consumption.

Smart Grid Challenges: Infrastructure, Awareness, Budget, Security, And Operation and Maintenance
High cooperation among Gov. (Finance, Petroleum, Electricity, ..) under the umbrella of Political Leadership (as a national security issue):

1- Electricity Tariff Reform, July 2014 (was highly Subsidized)

2- Announcing the Feed In Tariff (FIT), Sep. 2014

3- Coordination with the petroleum sector for securing supply of different types of needed fuel.

4- Fast track project (Adding 3632 MW within 8 months), Dec. 2014

5- The new Egyptian Electricity Law, July 2015
5- Accelerating the pending projects and Maintenance activities (adding 3250 MW), i.e.: adding 6882 MW within one year 2015. and adding 16 GW within two years, adding more than 25 GW 2015-2018.

6- Starting implementing a project for improving efficiency of distribution networks to decrease losses, by mounting of high tech. transformers, and mounting of 11715 MVAR capacitors to improve the power factor.

7- Activation of the customer service call center through a unified telephone number 121 and developing mobile applications, WhatsApp dedicated numbers, web services and SMS 91121.
8- Reinforcing and upgrading the transmission and distribution network, 2017-2019 with inv. cost of 42 LE billion.

9 - Smart Meters and Prepaid Meters.

10 - Converting some gas units to combined cycle (efficiency).

11 - Signing MOU for Pumped-storage hydroelectricity on Ataqa Mountain, Suez governorate (2400 MW).

12 - The Nuclear PP 4800 MW

13 - Clean Coal PP 6000 MW (will sign contract soon)

14 – Siemens (3 PP x 4800 MW = 6B$), 2015-2018
15 - Enhancing Energy Efficiency and Conservation programs through the following:

1- For streets lighting: Mounting of 1.8 million high pressure sodium and LED (out of 3.7 million). 4% consumption

2- Distributing more than 11.8 million LED lamps all over the country to the residential customers, (60 million LED lambs Sold in Egypt with Pr.Sec)

3- Implementing Energy Efficiency Projects at 28230 governmental buildings (LED + PV).

4- Installation of prepaid meters (5.8 million till now)
5- Installing 250 thousand of smart meters+ 1 milion / JICA

6- Installing prepaid temporary coded meters, to the facilities and buildings which are illegally fed from the electricity network (to reduce losses and theft).

7- Launching a large media campaign to increase customer’s awareness on the benefits of energy efficiency and conservation (Tips On media, street ads and social media )

8- Roof-top PV and Net Metering:
   For people that generate their own power at home—using a rooftop solar power system, for instance—net metering is an option already available in many states. In general, net metering involves the use of a meter that can record power flows back into the grid as a credit. Some mechanical meters will literally spin backwards, although today most utilities are using digital meters for net metering. The Smart Grid will open up countless new ways for you and your utility to interact on energy
Current Status

EEHC and its affiliated companies have succeeded in supplying electricity to different sectors of customers with high technical specifications, and overcame the shortage of electricity, with an adequate capacity reserve.

\textit{i.e. Remarkable improvement achieved}.


\textbf{No Load shedding any more since May 2015}
Future Strategy

To meet the fast growing rates of energy demand and peak load:

The Integrated and Sustainable Energy Strategy to 2035 – indicating how we produce, use and conserve energy in Egypt. It provides guidance on the best energy mix, and highlights the Renewable Energy future:

- Energy Mix.
- Strengthening the electrical grid (Transmission and Distribution)
- Energy Efficiency & losses reduction.
- Interconnection.
- Smart Grid.
Future Strategy (Cont’d)

Egypt National Energy Strategy 2035

**Energy security of supply**
To meet the increasing demand for energy, a resilient and diversified supply chain should be built which will optimise the use of the natural resources of Egypt and import are prudent;

**Long term sustainability of the energy system**
Sector institutions to be financially independent and self-sustaining through competition and efficiency;

**Good Governance Principles and Modernization**
The roles of all public and private participants in the energy system should be clearly defined and understood, natural monopolies should be held accountable for performance; energy markets should be fair, accessible and transparent.

**Energy Mix 2022**
- Solar: 6%
- Hydro: 2%
- Wind: 12%
- Thermal: 80%

**Energy Mix 2030**
- Steam: 49%
- Nuclear: 4%
- CSP: 6%
- PV: 10%
- Coal: 4%
- Wind: 10%
- Hydro: 3%
- Thermal (Simp.cyc): 3%
Future Strategy (Cont’d)

Energy Mix 2028

Energy Mix 2035

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ren. Energy</td>
<td>42 %</td>
</tr>
<tr>
<td>Coal (Clean)</td>
<td>33 %</td>
</tr>
<tr>
<td>Gas</td>
<td>17 %</td>
</tr>
<tr>
<td>Nuclear</td>
<td>8 %</td>
</tr>
</tbody>
</table>
Now:


- A contract has been signed with Siemens Company and its local partners 2015, to build 3 PP (3x4800MW).

- Egypt signed a contract with Russia to build the Dabaa nuclear power Plant 4,800 MW

- Signed a contract with Sinohydro (2400 MW0 PS)

- Egypt will sign a contract, to build a Coal project (6,000 MW) in Hamrawein area, Red Sea Gov.
Egypt has signed with 32 companies, to establish Solar stations, FIT, with total capacity of 1465 MW, in Binban, Aswan, upper Egypt.

30 million meters will be changed within 10 years to SM.

Egypt has a chance to generate about 80 GW of renewable energy sources (50 GW Solar, +30 GW Wind).

New laws have been passed to stimulate investment in the energy sector.

Points of sale, and counters, were provided, to pay the bills, and charge the meter balance, in cash and electronically.

Now, working on increasing the number of: distributors, transformers, lines and cables on the medium and low voltage.
Egypt is a Hub for Electrical Interconnection

Egypt Would be a central hub for electricity linkage between three continents.
Egypt and Nile Basin countries

**Sudan - Uganda, Eritrea, Kenya, Rwanda and, Congo**

**Cooperation:** PV – Training - Electric Interconnection
There are 54 countries in Africa today,
Population of Africa = 1.3 billion
Close to 600 million sub Saharan Africans are not connected to an electric network, with SG we can save significant amount of lost power supply to feed unconnected customers.
Yet more than on any other continent, Africa has considerable wind power, hydraulic and photovoltaic potential
Some Countries such as : Kenya, Tanzania, Nigeria, and Cameroon are highly dependent on hydropower (shortage during severe droughts), Kenya is also a leader in RE. and Egypt is building 1.6 GW biggest Solar Station, and 2.4 GW Pump and Storage PP..
In Rwanda, the Energy Development Corporation issued a tender 2017 for the supply of prepaid electricity meters( 36,000 single-phase and 2,000 three-phase electric meters.)
About Africa

• The South African power utility, Eskom: Eskom and Huawei team up to deliver smart grid by 2030, Eskom is currently rolling out Smart Prepaid Meters.
• In Nigeria, Huawei partnered with Ikeja Electric to build an advanced metering system, with smart meters.
• Egypt has solved the Generation problem (30GW/52GW) and will finish upgrading the T&D Network next year, also 20% RE by 2022
• RE investments in Africa are on the rise, and hydropower has a huge unlocked potential: while it already represents one fifth of the overall production, only 10 percent of the estimated potential is being utilized, according to The Wold Bank.
• Africa is heading to two modes of electricity supply modes: Traditional Central Generating Stations & Distributed Generating Stations.
**Smart Grid**

A smart grid (SG) is $= \text{ICT} + \text{Electric Grid} = \text{Two-way Flow of Electricity and Information}$.

(Self-Healing and Dynamically controllable), including:

- Smart Meters, SCADA control centers, Web services, Plug-in Electric Vehicles, Smart Phone Applications, Renewable Energy Integration (with storage), Sensors on Transm. and Distrib. Network (& RTUs), IoT, cloud, communications and Cyber security solutions.

- **SG** offers many opportunities for consumers to save energy and for utilities to operate the grid in a more efficient, effective, and reliable way. **SG** Provides Power Quality for the Digital Economy.

After installing the 1st 250K SM (with end of 2018):

**Egypt** aims to install 30 million Smart Meters during the upcoming 10 years (with an LE 60 billion budget) as part of the strategy to eliminate wrong readings and electricity thefts, and to move toward SG.
The Egyptian Experience with SG

- In Egypt, there are 9 distribution companies. The National Energy Control Center (NECC) co-related with all SCADA regional control centers. The regional centers gather data from subsidiary substations, transformers and lines, and then report any faults and other grid data to the national center NECC and all connected parallel centers in no more than 4 seconds.

- Deployment of 250K SM - EEHC

- PrePaid meters (6 milion till Aug. 2018)
Generation Opportunities:

• About 90% of the total generation plants are thermal (steam, gas, combined cycle). 8% comes from Hydro Power sources, and only 2% comes from Renewables.

• Egypt has solved the Generation problem (30 GW / 52 GW).

• According to Solar and wind Atlas: Egypt can generate 50 GW solar and 30 GW wind.

• Egypt aims to have 20% RE of total energy generated in 2022, where hydro power represents 5.8%, wind 12% and 2.2% from solar energy. In addition to Energy Mix in 2035 strategy.
Transmission and Distribution Opportunities:

- Egypt is working on strengthening the electricity grid, on Transmission & Distribution network (LE 42 billion – 2017/2019)
- Egypt would be a central hub (Jordan, Lybia, KSA, Sudan, Greece)
- Installing 250 K Smart Meters (up to end of 2018)
- 6 M PrePaid meters installed
- **Lighting** loads account for approximately 23% of country load:
  - For streets lighting: Replaced & Mounted 1.8 million high pressure sodium and LED (out of 3.7 million).
  - Residential lighting: Distributed more than 11.8 million LED lamps all over the country to the residential customers, (60 million LED lambs Sold in Egypt with Priv.Sec.t (Residential loads= 47%)
- Activation of the customer service call center through a unified telephone number 121 and developing mobile applications, What Sapp dedicated numbers, web services and SMS 91121.
- Automated Billing Centers: Payment of bills is available through ATM machines, internet banking, Post offices, and retail stores through “FAWRY” Network and e_Finance Network
- **JICA** started to implement 1 million Smart Meter in 3 distribution companies + Upgrading 3 Control Centers.
Control Centers

With the rapid growth of the Egyptian electricity Network, a hierarchical control structure is established to monitor the grid, to remotely detach and reconnect electricity, to support decision making, and to achieve soft and economical grid operation, as shown here: (20 Control Centers)

* The National Energy Control Center (NECC).
* The Regional Control Centers (RCCs).
* The Distribution Control Centers (DCCs).

- The NECC is responsible for monitoring and controlling the 500 kv and 200 kv transmission networks and generation PP all over the country, as well as the exchange with neighboring countries.
- The RCCs are responsible for monitoring and controlling the high voltage transmission network (132 kv and 66 kv) up to the boundaries of 11 kv and 22 kv.
- The DCCs are responsible for monitoring and controlling the medium/low voltage.. As one of the smart grid solutions.
EEHC started in applying the smart and pre-paid meter system aiming to improve the network potentials, managing the energy demand more efficiently, in addition to other benefits including the decrease of network losses.

1- Smart Meters:

- Cooperating with private sector Companies to implement a pilot project to install 250,000 smart meters in the geographical range of six distribution companies, in addition to the establishment of the main Data Centre at EEHC. The pilot project is expected to be completed by the end of 2018.
- JICA started to implement 1 million SM in 3 distribution companies + Upgrading 3 Control Centers.
- EEHC aims to install 30 million Smart/Prepaid Meters during the upcoming 10 years (with an LE 60 billion budget) as part of the strategy to eliminate wrong readings and electricity thefts, and to move toward SG.
The use of this type of meters has been expanded since 2011 and was generalized in 2014, with about 4.3 million meters installed by Oct. 2017.

Till May 2018:

- 5.8 m prepaid meter installed
- 2.8 m coded prepaid meter installed
3- Pre-Paid Coded Meters:

- On 9/5/2016 the Ministerial Decree no. 254 of 2016 was issued, regulating the installation of temporary prepaid coded meters at the facilities and buildings which are illegally fed from the electrical network, to decrease power loss and limit the phenomenon of electrical current theft,

- 2.8 m coded prepaid meter installed till now
On 19/6/2016, a contract was signed for preparing a unified program for pre-paid meters’ management.

The objectives of the project are:

- to establish a unified central system for charging the prepaid meters;
- to handle all types of meters through a unified program;
- to obtain standard reports at the level of all companies, or at the level of EEHC to help making decisions; and
- to facilitate the card-charging service to customers through electronic collection channels (FAWRY DAHAB-DELTA), or charge at any charging centre within the range of a distribution company with the possibility of operating new branches and the addition of different charging channels.
In Egypt, there is a factory manufacturing prepaid and basic meters, almost 30% of the production sold inside the European Union, and 17% sold in Africa. (In Mozambique- Zambia- Zimbabwe- Nigeria- Egypt – Sudan – and Togo).

www.iskraemeco.com
Call center customer services 121

- An electronic system to receive complaints in the Electricity Sector on the unified call number (121) with daily and monthly reports to follow up on the rate of closed complaints, where no less than 98% for technical complaints and 95% for commercial complaints should be achieved.

- Moreover, in case of any problem concerning electricity bills, a customer will be able to send an SMS to the number (91121) or send a photocopy of the bill and meter reading from the customer’s mobile WhatsApp application on 9 numbers of 9 companies.

- The one-window services (one stop shop) are now linked to the unified call number (121) system of receiving complaints and faults to respond to customers’ inquiries about the services provided by the distribution companies.
**EgyptERA** = The Egyptian Electricity Utility and Consumer Protection Regulatory Agency

To register their readings and calculate their bills based on their consumption

[www.egypterases.com](http://www.egypterases.com)

+ **egypterases** application
**Investment opportunities in Egypt**

Egypt has been successful in appealing to foreign investors and in creating prolific partnerships with the many international companies, because of:

- The location of Egypt is very favorable
- The dynamic growth of the Egyptian economy
- Easy availability of energy at competitive rates
- Financial stability and a strong banking sector
- Developed infrastructure; roads, electricity, ICT, airports and ports
- Easy availability of qualified labor force at relatively low wages.
- Access to the largest markets in the region & large domestic market
- Political and economic stability and Large local market
- Proximity to markets in north Africa, gulf region and Europe
- Investment incentives in investment law in Suez Canal Economic Zone and The Golden Triangle in Southern Egypt

**Related Web Sites:**

http://www.investportal.org/en/
http://www.miic.gov.eg/Front/Investment/Services.aspx
http://www.gafi.gov.eg/English/Pages/default.aspx
Conclusion and Recommendations

Egypt succeeded to overcome the shortage of electricity, and opened the investment door for the Private Sector (Local and foreign)

- 16 GW added within two years, and 450 billion EGP investments (May 2014-Jan 2017)
- Increased use of Prepaid Meters (more than 8 million) & Smart meters 250k AMI (1st pilot Project)
- Energy Efficiency (LED- PV-Tarrif – FIT-Meters - awareness)
- Electronic services (Web sites- E_payment – Billing Centers- S.Phoen App-SMS- Call Center 121) and 20 SCADA Control centers
- Egypt would be a Central Hub for electricity linkage between three continents, with Energy Strategy to 2035, and Energy Mix.
- All stakeholders work cooperatively to determine and define SG solutions, with a roadmap, and developing quick solutions for current challenges such as: Infrastructure, Awareness, Budget, and Cyber Security. Egypt intends to continue modifying ICT projects in order to achieve the smart grid architecture and communication, using SM, embedded sensors, IoT, SCADA, and software applications.
- Egypt moved from electricity deficit to sufficiency (from scarcity to abundance) and moving now toward **Smart Grid**
Africa Smart Grid Forum 2018
1 to 4 October 2018
Kigali, Rwanda

"Smart Grid: The key to sustainable development of Africa"

Mohamed Soliman
Dr-msm@live.com