PRIORITIES OF NATURAL GAS UTILIZATION ACCORDING TO ITS VALUE ADDED

“Egypt Case vs World; OECD as Best Practices”

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Palais des Nations, Geneva
Egypt depends mainly on Petroleum Energy (Oil & Gas) to meet its energy needs for sustainable development.

Petroleum Energy represents more than 95% of the Total Primary Energy Supply (TPES).

Natural Gas has its growing role in the Energy Mix in Egypt with more than 50% of the TPES.

Now, Priorities of Natural Gas Utilization has its Strategic Direction to be reviewed. The decision aims to allow spare more gas for the other categories of consumers that cannot shift away from gas for either technical or economic reasons.
Energy Security is one of the most important milestones of National Security which depends on diversifying and optimizing the use of energy sources.

One of the Strategic Direction for Egypt is to diversify the energy sources (Energy Mix) to achieve the energy security for the future sustainable energy and development.

We have excellent examples world-wide which represent Best Practices (BP) in Energy Security and Energy Usage Optimization especially in OECD and IEA Members.
Total Primary Energy Supply in Egypt

1981
- Crude Oil*: 76.73%
- Coal: 4.64%
- Hydro: 4.92%
- Natural Gas: 13.72%

2012
- Crude Oil*: 46.72%
- Coal: 0.66%
- Hydro: 3.65%
- Natural Gas: 48.71%
- Wind: 0.27%

* Including LPG and Condensates.
Total Primary Energy Supply in Egypt
2012

- Crude Oil*: 46.72%
- Natural Gas: 48.71%
- Hydro: 3.65%
- Coal: 0.66%
- Wind: 0.27%

* Including LPG and Condensates.

Fuel Share of TPES Worldwide
2013

- Natural Gas: 21.3%
- Coal**: 29.0%
- Oil: 31.4%
- Nuclear: 4.8%
- Hydro: 2.4%
- Biofuels & Waste: 10.0%
- Other***: 1.1%

* World includes international aviation and international marine bunkers.
** In these graphs, peat and oil shale are aggregated with coal.
*** Includes geothermal, solar, wind, heat, etc.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Number of unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household</td>
<td>Million</td>
<td>6.6</td>
</tr>
<tr>
<td>Commercial</td>
<td>Thousand</td>
<td>13.543</td>
</tr>
<tr>
<td>of which Bakers</td>
<td></td>
<td>5.753</td>
</tr>
<tr>
<td>Governorates</td>
<td>%</td>
<td>25 out of 27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>93%</td>
</tr>
</tbody>
</table>
Energy Mix in Transport Sector in Egypt

2012/13

Natural Gas 4%

Petroleum Products 96%
Electricity Generation By Fuel*-Worldwide

2012

- Coal/Peat: 40.60%
- Natural Gas: 21.40%
- Nuclear: 13.40%
- Hydro: 16.20%
- Oil: 5.10%
- Others**: 3.30%

20055 TWh

* Excludes pumped storage.
** other includes geothermal, solar, wind, biofuels, waste and heat
Electricity Production from fossil fuels Worldwide 2012

- Natural Gas: 33%
- Coal*: 60%
- Oil: 7%

* including peat and oil shale.
Main Points

- Egypt has its Energy Strategy to match with World Energy Mix through Energy Sources Diversification (Coal, Nuclear and Renewables especially Wind and Solar).

- Natural Gas represents about 50% in TPES, 72% in Electricity generation energy mix (57% of the total gas consumption), 61% in Industry energy mix, 12% in Household energy mix and 3% in Transport Sectors energy mix.

- Natural gas Consumption in Industry Sector (28% of the total gas consumption) is mainly by Energy Intensive Industrial activities (Cement, Fertilizer, Iron & Steel and Refractories.)
Main Points (Cont.)

- Egypt is working on using Coal instead of Natural Gas in Electricity Generation and Cement Industries.

- Nuclear is another source for Electricity Generation in the Future Expansion Plan.

- Renewable Energy Sources especially Wind with a good potential is considered for Electricity generation.

- Solar Energy is considered in the Future Energy Mix in all Electricity, Industry and Household Sectors.

- Hydro is totally exploited except for some mini-hydro or pump storage.
Energy Security
Priorities of NG Utilization

Egypt vs World
World Natural Gas Consumption by sector*
2012

- Electricity**: 38%
- Other Transformation sector: 14%
- Industry: 18%
- Transport: 3%
- Non-energy use: 6%
- Other Final Consumption sector: 21%

* including CHP Plants.

Source: Key World Energy STATISTICS,IEA, 2014

** 48% of Natural for final energy consumption.
Natural Gas Uses in Egypt

1981/82

- Industry: 49.30%
- Electricity: 36.70%
- Residential: 0.10%
- Other: 13.90%

Natural Gas Consumption: 2.1 MTOE

2012/13

- Industry: 28.0%
- Electricity: 57.1%
- Petroleum: 11.0%
- Residential: 2.9%
- Transport: 1.0%

Natural Gas Consumption: 46.3 MTOE
## Priorities of Natural Gas Utilization by sector in Egypt 2012/13

<table>
<thead>
<tr>
<th>Sectors</th>
<th>% Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Electricity</td>
<td>57%</td>
</tr>
<tr>
<td>- Industry of which</td>
<td>28%</td>
</tr>
<tr>
<td>* Refractories and other Industries</td>
<td>10.10%</td>
</tr>
<tr>
<td>* Fertilizer</td>
<td>8.70%</td>
</tr>
<tr>
<td>* Cement</td>
<td>6.70%</td>
</tr>
<tr>
<td>* Iron and steel</td>
<td>2.50%</td>
</tr>
<tr>
<td>- Petroleum Sector</td>
<td>11%</td>
</tr>
<tr>
<td>- Household</td>
<td>3%</td>
</tr>
<tr>
<td>- Transport</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Natural Gas consumption in Industrial Sector in Egypt
2012/13

- Refractories & Other Industries: 36%
- Fertilizer: 31%
- Iron & Steel: 9%
- Cement: 24%

Natural Gas Consumption in Industrial Sector 12.3 MTOE
Petroleum Energy Mix in Cement Industry in Egypt in 2012

- Natural Gas: 71%
- Fuel Oil: 29%
Percent share of Coal in Cement Industries in some countries in 2006

World Fossil Fuel Pattern in Fertilizer Production in 2012

- **Natural Gas**: 60%
- **Coal (China)**: 27%
- **Other**: 13%

Source: Urea Outlook 2014/02 - www.fertecon.com
* Other represents Petroleum Products.
## Comparison of Natural Gas Consumption Pattern in Egypt Vs. World

<table>
<thead>
<tr>
<th>Sector</th>
<th>World</th>
<th>Egypt</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformation Sector</td>
<td>52%</td>
<td>68%</td>
<td>16%</td>
</tr>
<tr>
<td>- Electricity</td>
<td>38%</td>
<td>57%</td>
<td>19%</td>
</tr>
<tr>
<td>- Other Transformation</td>
<td>14%</td>
<td>11%</td>
<td>-3%</td>
</tr>
<tr>
<td>Final Consumption</td>
<td>48%</td>
<td>32%</td>
<td>-16%</td>
</tr>
<tr>
<td>Industry*</td>
<td>18%</td>
<td>19.50%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Non Energy Use*</td>
<td>6%</td>
<td>8.50%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Transport</td>
<td>3%</td>
<td>1%</td>
<td>-2.0%</td>
</tr>
<tr>
<td>Other Final Consumption</td>
<td>21%</td>
<td>3%</td>
<td>-18.0%</td>
</tr>
</tbody>
</table>

* Industry sector represents 28% including non-energy use for fertilizer in Egypt.
OECD and IEA as BEST PRACTICES
OECD & IEA Members

- Australia
- Austria
- Belgium
- Canada
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Italy
- Japan
- Republic of Korea
- Luxembourg
- The Netherlands
- New Zealand

OECD

- Norway
- Poland
- Portugal
- Slovak Republic
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom
- United States

IEA

* CHILE
* ICELAND
* ISRAEL
* MEXICO
* SLOVENIA
### OECD Heavy Importer Countries from Fossil Energy 2012

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>World Imports 2012</th>
<th>Imports of OECD Countries</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of OECD Countries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude Oil* (Mt)</td>
<td>2051</td>
<td>8</td>
<td>1090</td>
</tr>
<tr>
<td>Natural Gas** (bcm)</td>
<td>836</td>
<td>9</td>
<td>508</td>
</tr>
<tr>
<td>Coal*** (Mt)</td>
<td>1270</td>
<td>6</td>
<td>470</td>
</tr>
<tr>
<td>Oil Products*** (Mt)</td>
<td>460</td>
<td>5</td>
<td>114</td>
</tr>
</tbody>
</table>

Source: Key World Energy Statistics 2014, IEA.

*United States, People’s Rep. of China, India, Japan, Korea, Germany, Italy, Spain, Netherlands, France.

**Japan, Germany, Italy, Korea, People’s Rep. of China, Turkey, France, United States, Spain.

***People’s Rep. of China, Japan, India, Korea, Chinese Taipei, Germany, United Kingdom, Turkey, Malaysia, Italy.

****Japan, Indonesia, People’s Rep. of China, Mexico, France, Brazil, Singapore, Australia, Germany.
<table>
<thead>
<tr>
<th>Item</th>
<th>OECD Total</th>
<th>OECD Americas</th>
<th>OECD Asia Oceania</th>
<th>OECD Europe</th>
<th>Egypt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>24.90%</td>
<td>26.90%</td>
<td>20.6%</td>
<td>24.1%</td>
<td>49.0%</td>
</tr>
<tr>
<td>Coal</td>
<td>20%</td>
<td>19.5%</td>
<td>27.2%</td>
<td>17.2%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Oil</td>
<td>36.30%</td>
<td>36.8%</td>
<td>40.5%</td>
<td>33.3%</td>
<td>47.0%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>10.20%</td>
<td>9%</td>
<td>7.5%</td>
<td>13.5%</td>
<td></td>
</tr>
<tr>
<td>Hydro</td>
<td>2.30%</td>
<td>2.4%</td>
<td>1.3%</td>
<td>2.5%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Other**</td>
<td>6.30%</td>
<td>5.3%</td>
<td>3.0%</td>
<td>9.5%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Total MTOE</td>
<td>5305</td>
<td>2678</td>
<td>878</td>
<td>1749</td>
<td>87.1</td>
</tr>
</tbody>
</table>

* Includes 34 Country

** Includes Geothermal, Solar, Wind, Electricity & Heat & Waste.

Sources: Natural Gas Information, IEA, 2012
Energy Mix in OECD Countries*
for Total Primary Energy Supply (TPES) in 2011

Total OECD
- Natural Gas: 24.9%
- Coal: 20.0%
- Other**: 6.3%
- Hydro: 2.3%
- Nuclear: 10.2%
- Oil: 36.3%

OECD Americas
- Natural Gas: 26.9%
- Coal: 19.5%
- Other**: 5.3%
- Hydro: 2.4%
- Nuclear: 9.0%
- Oil: 36.8%

OECD Asia Oceania
- Natural Gas: 20.6%
- Other**: 3.0%
- Hydro: 1.3%
- Nuclear: 7.5%
- Oil: 40.5%

OECD Europe
- Natural Gas: 24.1%
- Coal: 17.2%
- Other**: 9.5%
- Hydro: 2.5%
- Nuclear: 13.5%
- Oil: 33.3%
Natural Gas consumption by sector in OECD Countries 2010

- Electricity*: 38%
- Industry: 21%
- Other Final Consumption sector: 35%
- Non-energy use: 3%
- Transport: 2%
- Other Transformation sector: 1%

* including CHP Plants.
Source: Natural Gas Information, IEA, 2012

Natural Gas Uses in Egypt 2012/13

- Electricity: 57.1%
- Industry: 28.0%
- Petroleum: 11.0%
- Residential: 2.9%
- Transport: 1.0%

Natural Gas Consumption: 46.3 MTOE
<table>
<thead>
<tr>
<th>Item</th>
<th>IEA</th>
<th>Egypt</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Total</td>
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<tr>
<td>Hydro</td>
<td>2.30%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Other**</td>
<td>6.10%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Total MTOE</td>
<td>5043</td>
<td>87.1</td>
</tr>
</tbody>
</table>

* Includes 29 Country

** Includes Geothermal, Solar, Wind, Electricity & Heat & Waste.

Sources: Natural Gas Information, IEA, 2012
Energy Mix in IEA Members for Total Primary Energy Supply (TPES) in 2011

**Total IEA**
- Natural Gas: 24.9%
- Coal: 20.5%
- Other**: 6.1%
- Hydro: 2.3%
- Nuclear: 10.7%
- Oil: 35.6%

**IEA Americas**
- Natural Gas: 26.8%
- Coal: 20.6%
- Other**: 5.0%
- Hydro: 2.5%
- Nuclear: 9.7%
- Oil: 35.4%

**IEA Asia Oceania**
- Natural Gas: 20.7%
- Coal: 27.1%
- Other**: 2.9%
- Hydro: 1.3%
- Nuclear: 7.7%
- Oil: 40.3%

**IEA Europe**
- Natural Gas: 24.3%
- Coal: 17.0%
- Other**: 9.3%
- Hydro: 2.4%
- Nuclear: 13.5%
- Oil: 33.5%
Natural Gas consumption by sector in IEA Members Countries 2010

- Electricity: 37%
- Other Final Consumption sector: 37%
- Industry: 21%
- Other Transformation sector: 1%
- Non-energy use: 2%
- Transport: 2%

* including CHP Plants.
Source: Natural Gas Information, IEA, 2012

Natural Gas Uses in Egypt 2012/13

- Electricity: 57.1%
- Industry: 28.0%
- Petroleum: 11.0%
- Residential: 2.9%
- Transport: 1.0%

Natural Gas Consumption: 46.3 MTOE
US Natural Gas consumption by sector
2011

- Electric Power: 31%
- Residential: 19%
- Commercial: 13%
- Transportation: 3%
- Industrial: 34%

Electricity Generation by Fuel Type in OECD Countries 2012*

- **Coal**: 38%
- **Natural Gas**: 24%
- **Nuclear**: 24%
- **Oil**: 4%
- **Hydro**: 6%
- **Other Sources**: 4%

* Calculated.
** includes peat and oil shale.
*** includes biomass, waste, geothermal, solar thermal, wind, tide and others.
## Natural Gas Technical Losses in Thermal Electricity Generation worldwide 2012

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2012/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Natural Gas Consumption</td>
<td>MTOE</td>
<td>1167</td>
</tr>
<tr>
<td>(2) Total Thermal Electricity Generation</td>
<td>TWh</td>
<td>5100</td>
</tr>
<tr>
<td></td>
<td>MTOE</td>
<td>439</td>
</tr>
<tr>
<td>(3) Efficiency</td>
<td>%</td>
<td>38%</td>
</tr>
<tr>
<td>(4) Technical Losses*</td>
<td>MTOE</td>
<td>729</td>
</tr>
<tr>
<td>(1) - (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Value of Natural Gas Losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value of Natural Gas Losses**</td>
<td></td>
<td>355</td>
</tr>
<tr>
<td>Value of Natural Gas Losses***</td>
<td>Billion $</td>
<td>304</td>
</tr>
<tr>
<td>Value of Natural Gas Losses****</td>
<td></td>
<td>89</td>
</tr>
<tr>
<td>Value of Natural Gas Losses*****</td>
<td></td>
<td>73</td>
</tr>
</tbody>
</table>


** According to Average German Import Price 11.03$/MMBtu

*** According to UK NBP Price 9.46$/MMBtu

**** According to US Henry Hub Price 2.76$/MMBtu

***** According to Canada Alberta Price 2.27$/MMBtu
Electricity Generation in Egypt 2012/13

- Natural Gas: 71.73%
- Gas Oil: 0.27%
- Fuel Oil: 19.12%
- Hydro: 7.97%
- Wind: 0.91%

Total Electricity Generation 164 TWh
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2012/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Fuel Consumption</td>
<td></td>
<td>31.75</td>
</tr>
<tr>
<td>- Petroleum Products</td>
<td>MTOE</td>
<td>6.649</td>
</tr>
<tr>
<td>- Natural Gas</td>
<td></td>
<td>25.101</td>
</tr>
<tr>
<td>- Share %</td>
<td>%</td>
<td>21%</td>
</tr>
<tr>
<td>- Petroleum Products</td>
<td>%</td>
<td>79%</td>
</tr>
<tr>
<td>(2) Total Thermal Electricity Generation</td>
<td>TWh</td>
<td>148.58</td>
</tr>
<tr>
<td></td>
<td>MTOE</td>
<td>12.78</td>
</tr>
<tr>
<td>(3) Efficiency</td>
<td>%</td>
<td>40%</td>
</tr>
<tr>
<td>(4) Technical Losses (1) - (2)</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Petroleum Products (21%)</td>
<td>MTOE</td>
<td>4</td>
</tr>
<tr>
<td>Natural Gas (79%)</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>(5) Value of Natural Gas Losses*</td>
<td>MS</td>
<td>3306</td>
</tr>
</tbody>
</table>

* Estimated by the author 5$/MMBtu
Thermal Electricity Generation Using Petroleum Energy 2012/13

3- More Value Added Usages

MTOE 32

Thermal Electricity Generation

2- Avoided
Losses 19 MTOE

TWh 148.6
MTOE 13

1- Non - Petroleum Energy Sources
Wind, Nuclear, Solar, Clean Coal

Electricity Generation

Actual

Proposed
1, 2 & 3
Value Added of Natural Gas Usage in Different Activities

Value Added/ Million BTU of Natural Gas

<table>
<thead>
<tr>
<th>Activity</th>
<th>Value Added (MMBtu of N.G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymers (Final Product)</td>
<td>12</td>
</tr>
<tr>
<td>Basic Petrochemicals</td>
<td>6.5</td>
</tr>
<tr>
<td>Household &amp; Commercial</td>
<td>6.4</td>
</tr>
<tr>
<td>Methanol</td>
<td>5</td>
</tr>
<tr>
<td>LNG</td>
<td>4</td>
</tr>
<tr>
<td>Fertilizers</td>
<td>4</td>
</tr>
<tr>
<td>Iron &amp; Steel</td>
<td>4</td>
</tr>
<tr>
<td>Cement</td>
<td>2.2</td>
</tr>
<tr>
<td>Electricity</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Value Added of Natural Gas Usage Different Activities
Value Added / Million BTU of Natural Gas in 2014

<table>
<thead>
<tr>
<th>Activity</th>
<th>Value Added (US$/MMBtu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>-0.2</td>
</tr>
<tr>
<td>LNG</td>
<td>6.4</td>
</tr>
<tr>
<td>Methanol</td>
<td>7.6</td>
</tr>
<tr>
<td>Gas to olenfen</td>
<td>8.9</td>
</tr>
<tr>
<td>Urea</td>
<td>9.2</td>
</tr>
<tr>
<td>Poly etheline</td>
<td>12.0</td>
</tr>
</tbody>
</table>
Egypt has its strategy for Energy Security depending mainly on Best Practices World-wide:

1) Diversifying Energy Sources.
2) Revisit the Priorities of Natural Gas Utilization.

Natural gas is more valuable to be burned in electricity generation because the value of NG technical losses is higher than the cost of using an alternative energy source instead of NG.

Natural Gas should be replaced by other alternative energy sources as much as it is viable technically and economically according to its Value Added.
Now, Priorities of Natural Gas Utilization has its Strategic Direction to be reviewed. The decision aims to allow spare more gas for the other categories of consumers that cannot shift away from gas for either technical or economic reasons which should be allocated according to its Value Added.
Recommendations

Work to be Undertaken:

- Consideration of this topic at the annual sessions of the Working Party on Gas.

- Exchange information, experience, technical and economic knowledge and preparation of reports and studies on such specific issue world-wise and country-wise.
Thanks