Country Report Presentation: Pakistan Energy Crisis and Solution

By
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Chief, Energy Wing, Planning Commission

Presented at:

JICA Training and Dialogue Program on ENERGY POLICY
8-28 May, 2011
Pakistan’s Capital: Islamabad
Faisal Mosque Islamabad
K-2: the second tallest peak
Karakuram mountains in North Pakistan
Mahdond Lake in Upper swat valley in north of Pakistan
The Kunar river in kaghan Valley North Pakistan
Spring time in Chitral, North Pakistan
Tomb of founder of Pakistan Quaid Azam M. Ali Jinnah in Karachi
Sunset at Clifton Beach, Karachi
Pakistan Tower in Lahore
Badshahi mosque at night in Lahore
Hanna lake in quetta Balochistan
Tarbela Dam with 3,478 MW Generation Capacity
1000 MW Mangla Dam Hydel Plant
Thar desert in Sind possessing 175 billion tonne of Lignite
Pakistan possesses all the Four Seasons with Extremes

• The **hottest temperature ever recorded in Asia** and the **Fourth highest ever in the world** was in Mohenjo-daro, Sindh 53.5 °C (128.3 °F) on May 26, 2010 and at least 18 people died as a result.

• Apart from scarcely populated glacial regions in North where temperature falls as low as -50 °C, the lowest temperature in inhabited area was recorded in Kallat in Balochistan a few years ago, which was -29 °C.
First Japanese manufactured nuclear turbine under license from GE is installed at KANUPP installed in 1972.

This turbine is still in perfect operating condition.
Pakistan’s Economic, Energy & Electricity Growth (1990 - 2009)

Pakistan’s Economic, Energy & Electricity Growth (1990 - 2009)

The close relationship between economic, energy and electricity growth shows the importance of sufficient and affordable electricity.

Pakistan’s Per capita Energy Consumption is very low

<table>
<thead>
<tr>
<th>Region/Country</th>
<th>Million BTU/Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>World average</td>
<td>72</td>
</tr>
<tr>
<td>Singapore</td>
<td>477</td>
</tr>
<tr>
<td>Canada</td>
<td>427</td>
</tr>
<tr>
<td>USA</td>
<td>334</td>
</tr>
<tr>
<td>Europe</td>
<td>146</td>
</tr>
<tr>
<td>Japan</td>
<td>179</td>
</tr>
<tr>
<td>Middle East</td>
<td>127</td>
</tr>
<tr>
<td>China</td>
<td>56</td>
</tr>
<tr>
<td>Central &amp; S. America</td>
<td>53</td>
</tr>
<tr>
<td>Asia &amp; Oceana</td>
<td>43</td>
</tr>
<tr>
<td>India</td>
<td>16</td>
</tr>
<tr>
<td><strong>Pakistan</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>
# Fossil Fuel Resource Potential of Pakistan

(as of 30 June 2010)

<table>
<thead>
<tr>
<th></th>
<th>Oil</th>
<th>Natural Gas</th>
<th>Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource potential</td>
<td>3,622</td>
<td>6,849</td>
<td>78,450</td>
</tr>
<tr>
<td>Proven recoverable</td>
<td>130</td>
<td>1,067</td>
<td>845</td>
</tr>
<tr>
<td>reserves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative production, so far</td>
<td>88</td>
<td>568</td>
<td>~89</td>
</tr>
<tr>
<td>Remaining recoverable</td>
<td>41</td>
<td>499</td>
<td>797</td>
</tr>
<tr>
<td>reserves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual production</td>
<td>3.3</td>
<td>29.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Reserves to production ratio</td>
<td>12 years</td>
<td>17 years</td>
<td>~528 years</td>
</tr>
</tbody>
</table>

Source: Pakistan Energy Yearbook 2010
Pakistan Natural Gas Infrastructure

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SNGPL</th>
<th>SSGC</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission (KM)</td>
<td>6,729</td>
<td>3,294</td>
<td>10,023</td>
</tr>
<tr>
<td>Distribution (KM)</td>
<td>52,932</td>
<td>30,173</td>
<td>83,105</td>
</tr>
<tr>
<td>Towns / Villages No.</td>
<td>1,019</td>
<td>1,533</td>
<td>2,552</td>
</tr>
</tbody>
</table>

Gas Field
SSGCL Lines
SNGPL Lines
Compressor Stations
Major Load Centre
Comm. Energy Consumption by Sector

2009-10
Total: 38.8 Million TOE

- Industrial: 40.3%
- Agriculture: 2.2%
- Transport: 30.1%
- Domestic: 21.6%
- Commercial: 3.9%
- Other Govt.: 2.0%
Electricity Generation 2009-10

Total: 95,608 GWh

BY SOURCE

- Hydel: 29.4%
- Nuclear & Imported: 3.3%
- Oil: 37.8%
- Gas: 29.4%
- Coal: 0.1%
Electricity Consumption by Sector

2009-10
Total: 74,348 GWh

- Domestic 46.1%
- Industrial 26.7%
- Agriculture 13.0%
- Bulk Supplies 5.9%
- Commercial 7.5%
- St.Light, Traction & Ot 0.7%
<table>
<thead>
<tr>
<th>Sector</th>
<th>2003-04</th>
<th>2009-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>45.0%</td>
<td>46.1%</td>
</tr>
<tr>
<td>Commercial</td>
<td>6.4%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Industrial</td>
<td>30.2%</td>
<td>26.7%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>11.6%</td>
<td>13.0%</td>
</tr>
<tr>
<td>Others</td>
<td>6.8%</td>
<td>6.7%</td>
</tr>
</tbody>
</table>
# Pakistan Energy Security Plan 2030

<table>
<thead>
<tr>
<th>Year</th>
<th>Nuclear</th>
<th>Hydel</th>
<th>Coal</th>
<th>Renewable</th>
<th>Oil</th>
<th>Gas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing (2005)</td>
<td>400</td>
<td>6,460</td>
<td>160</td>
<td>180</td>
<td>6,400</td>
<td>5,940</td>
<td>19,540</td>
</tr>
<tr>
<td>2010</td>
<td>-</td>
<td>1,260</td>
<td>900</td>
<td>700</td>
<td>160</td>
<td>4,860</td>
<td>7,880</td>
</tr>
<tr>
<td>2015</td>
<td>900</td>
<td>7,570</td>
<td>3,000</td>
<td>800</td>
<td>300</td>
<td>7,550</td>
<td>20,120</td>
</tr>
<tr>
<td>2020</td>
<td>1,500</td>
<td>4,700</td>
<td>4,200</td>
<td>1,470</td>
<td>300</td>
<td>12,560</td>
<td>24,730</td>
</tr>
<tr>
<td>2025</td>
<td>2,000</td>
<td>5,600</td>
<td>5,400</td>
<td>2,700</td>
<td>300</td>
<td>22,490</td>
<td>38,490</td>
</tr>
<tr>
<td>2030</td>
<td>4,000</td>
<td>7,070</td>
<td>6,250</td>
<td>3,850</td>
<td>300</td>
<td>30,360</td>
<td>51,830</td>
</tr>
<tr>
<td>Total</td>
<td>8,800</td>
<td>32,660</td>
<td>19,910</td>
<td>9,700</td>
<td>7,760</td>
<td>83,760</td>
<td>162,590</td>
</tr>
</tbody>
</table>

## Electricity Generation Capacity (MW)

<table>
<thead>
<tr>
<th></th>
<th>Installed As In 2005</th>
<th>Planned for 2010**</th>
<th>Existing In 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>6,460</td>
<td>7,720</td>
<td>6,480</td>
</tr>
<tr>
<td>Oil &amp; Gas</td>
<td>12,340</td>
<td>17,360</td>
<td>13,204</td>
</tr>
<tr>
<td>Coal</td>
<td>160</td>
<td>1,060</td>
<td>150</td>
</tr>
<tr>
<td>Nuclear</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Renewables</td>
<td>180</td>
<td>880</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total Capacity</strong></td>
<td><strong>19,360</strong></td>
<td><strong>27,420</strong></td>
<td><strong>20,258</strong></td>
</tr>
<tr>
<td>Winter Capacity (actual)</td>
<td>12,400</td>
<td>19,636</td>
<td>13,832</td>
</tr>
<tr>
<td>Summer Capacity (actual)</td>
<td>15,600</td>
<td>23,536</td>
<td>17,878</td>
</tr>
<tr>
<td>Demand (Peak Load)</td>
<td>14,621</td>
<td>21,426</td>
<td>19,257*</td>
</tr>
</tbody>
</table>

* In 2005, was projected to be 17,904 MW.
** As in Medium Term Development Framework, 2005.
## Electricity Generation - Capacity Factors
### WAPDA/ NTDC System

<table>
<thead>
<tr>
<th>Type</th>
<th>No. of Plants</th>
<th>Capacity (MW)</th>
<th>Capacity Factor (%)</th>
<th>2005-06</th>
<th>2006-07</th>
<th>2007-08</th>
<th>2008-09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>14</td>
<td>6,444</td>
<td>54%</td>
<td>56%</td>
<td>51%</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>IPPs</td>
<td>17</td>
<td>5,923</td>
<td>53%**</td>
<td>63%</td>
<td>64%***</td>
<td>66%</td>
<td></td>
</tr>
<tr>
<td>GENCOs</td>
<td>10</td>
<td>4,779</td>
<td>54%</td>
<td>52%</td>
<td>49%</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>1</td>
<td>325</td>
<td>76%</td>
<td>68%</td>
<td>86%</td>
<td>37%</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42</strong></td>
<td><strong>17,471</strong></td>
<td><strong>54%</strong></td>
<td><strong>57%</strong>*</td>
<td><strong>56%</strong></td>
<td><strong>54%</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Had this been 70%, load-shedding would not be so severe.
** Due to lower demand?
*** Due to fuel shortage?

There is a need to improve the Capacity Factor.

*Incentive bonus related to production is one of the solutions.*

Source: GM (Planning), NTDC
Transmission & Distribution Losses and Theft (2007-08)

<table>
<thead>
<tr>
<th>DISCO</th>
<th>Transmission Losses (%)</th>
<th>Distribution Losses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LESCO</td>
<td></td>
<td>12.8</td>
</tr>
<tr>
<td>GEPCO</td>
<td></td>
<td>11.1</td>
</tr>
<tr>
<td>FESCO</td>
<td></td>
<td>11.2</td>
</tr>
<tr>
<td>IESCO</td>
<td></td>
<td>10.3</td>
</tr>
<tr>
<td>MEPCO</td>
<td></td>
<td>18.5</td>
</tr>
<tr>
<td>PESCO+TESCO</td>
<td>6.6%</td>
<td></td>
</tr>
<tr>
<td>HESCO</td>
<td></td>
<td>35.9</td>
</tr>
<tr>
<td>QESCO</td>
<td></td>
<td>20.8</td>
</tr>
<tr>
<td>Total WAPDA</td>
<td></td>
<td>18.5</td>
</tr>
<tr>
<td>KESC</td>
<td>5.1%</td>
<td>29.0</td>
</tr>
<tr>
<td>OECD Countries</td>
<td></td>
<td>Total: 7 – 8 %</td>
</tr>
</tbody>
</table>

The high losses need to be reduced.

i) Up-gradation of transmission & distribution system; ii) Electricity consumption bills on internet and iii) Incentives to personnel of better performance grids and publicity of worst performing grids.
Energy Losses in Power System (Generation, Transmission, Distribution & Consumption) and Improvements Possible

With half the fuel consumed, the circular debt phenomena could have been avoided.
Pakistan Integrated Energy Model (Pak-IEM)

Objective

To develop a sustainable planning capability employing an integrated energy system model that will enable a national team of experts to assess impacts of various strategies for meeting future energy requirements in an optimal manner.
Pak-IEM: Institutional Structure

Donor Agencies

Planning Commission
Define policy studies, integrate results into the planning process, and ensure ongoing funding

Technical Support for Model Improvements and Studies

National Integrated Energy Modeling Centre
Energy Wing staff who maintain the Pak-IEM database, perform policy analysis, and coordinate studies and model improvements

Pak-IEM Advisory Committee
Ministries, Agencies, Regulators & Other Stakeholders

Advisory Task Force
Experts from the Ministries and Industries to provide technical support and guidance

Research Centers & Universities
Analysts, professors and graduate students who use and improve the model

Study Teams
Assembled by Planning Unit for specific studies or tasks
Pak-IEM: Contributing Stakeholders

M/o P&NR
- Resource Supply
  - DG Oil, Gas & PC

Upstream
- Refineries
- SNGPL & SSGCL
- HDIP

Regulators
- NEPRA, OGRA

Future Technologies
- IEA, USDOE
- Local Experts

Power Sector
- M/o W&P
  - WAPDA, KESC, PPIB
  - NTDC, DISCOs
  - AEDB
  - Thar Coal & Energy Board

Demand Sectors
- Agriculture
  - NARC
- Commercial
  - HB-Pak
- Industry
  - MEC, ENERCON
- Demand Projections
  - M/o F, PIDE
- Residential
  - UETT, HB-Pak
- Transport
  - NTRC

Future Technologies
- IEA, USDOE
- Local Experts

Power Sector
- M/o W&P
  - WAPDA, KESC, PPIB
  - NTDC, DISCOs
  - AEDB
  - Thar Coal & Energy Board

Demand Sectors
- Agriculture
  - NARC
- Commercial
  - HB-Pak
- Industry
  - MEC, ENERCON
- Demand Projections
  - M/o F, PIDE
- Residential
  - UETT, HB-Pak
- Transport
  - NTRC
Pak-IEM: Reference Energy System

**Primary Energy Supply**
- Mining, e.g.
  - Crude oil
  - Natural gas
  - Coal
- Imports, e.g.
  - Crude oil
  - Oil products
- Exports, e.g.
  - Oil products
  - Coal
- Renewables, e.g.
  - Biomass
  - Hydro
  - Solar
  - Wind

**Conversion Technologies**
- Fuel Processing Plants, e.g.
  - Oil refineries
  - Hydrogen
  - Ethanol
- Power Plants, e.g.
  - Conventional
  - IGCC
  - Solar
  - Wind
  - Nuclear
  - CCGT
  - Fuel cells
  - CHP

**End-Use Technologies**
- Industry, e.g.
  - Steam boilers
  - Machinery
- Commercial, e.g.
  - Air conditioners
  - Light bulbs
- Households, e.g.
  - Space heaters
  - Refrigerators
- Agriculture, e.g.
  - Pumps
  - Tractors
- Transport, e.g.
  - Gasoline car
  - Fuel cell bus

**Demand for Energy Service**
- Industry, e.g.
  - Process steam
  - Motive power
- Commercial, e.g.
  - Cooling
  - Lighting
- Households, e.g.
  - Space heat
  - Refrigeration
- Agriculture, e.g.
  - Water supply
- Transport, e.g.
  - Person-km

**Resource Supply-Cost Curves**
**Technology Cost and Performance**
**Device Cost and Performance**
**Demand Projections**
Current Energy Crisis: Causes

- Weak planning & Implementation
- Unfavorable policies/ environment for private investment due to past policy reversals.
- Indecisiveness of the relevant departments causing delays.
- Lack of coordination among stakeholders.
Current Energy Crisis: Bottlenecks

- Many players involved in Thar coal development.
- Delay in implementation of mega hydel projects.
- Single supplier for nuclear power technology/projects (China).
Current Energy Crisis: Short Term Measures

- Immediately Implement Energy Efficiency measures
- Campaigns for energy conservation
- Improve Fuel (Oil & Gas) supply by addressing Circular Debt problem.
- Control Electricity Theft and improve Tariff regime.
Current Energy Crisis: Long Term Measures

• Rationalize gas prices and its inter-sectoral use.

• Develop Base Load Capacity based on Hydel, Coal and Nuclear power.

• Discourage use of Oil for power generation.

• For credible balance between demand and supply, develop integrated energy modeling system.

• Supply side should be kept consistent with the expected national growth.

• Involve private sector in energy policy formulation.

• Close Coordination among various stakeholders in the energy sector

• Market forces to work in the Energy sector with strong regulator.
Expectations from The Training Course

• Pakistan is going to establish Pakistan Energy Research & Information Center
• We will appreciate if Japan can help us in its establishment
• What is experience of Japan in this area
Thank You

ありがとうございます (Arigatō)

Contact : report@tky.ieej.or.jp