

RABIA SHOAIB AHMAD

DIRECTOR BUSINESS DEVELOPMENT, CLEAN POWER (PVT) LTD

DIRECTOR

GREENERGY PAKISTAN

DEPUTY DIRECTOR CORPORATE ADVISORY COUNCIL

NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

CLEAN ENERGY DEVELOPMENT IN PAKISTAN

CURRENT ENERGY CONSUMPTION, ENERGY
EFFICIENCY MEASURES, & AVAILABLE RE RESOURCES

SEQUENCE

- An Introduction to Pakistan & its Energy Scenario
 - ▶ Sources & sectors organization
 - ▶ Supply, consumption, demand, Shortfalls

- Energy Efficiency Measures in Pakistan
 - ▶ Areas & Range of Activities
 - ▶ Government Organs Responsible for EE / EC
 - ▶ Initiatives & Achievements

- RE & Pakistan
 - ▶ RE targets & Policy
 - ▶ RE Resources & Potential
 - ▶ Initiatives & Achievements

PAKISTAN – AN INTRODUCTION



Imran Ahmed

PAKISTAN – FACTS & FIGURES

- Total area: approx 810,000 km²
- Population: 180 Million, growing at 2.2% per annum
 - ▶ Rural population: 65%
- Climate – mostly dry
 - ▶ Monsoon rains July-Sep
 - ▶ The Western Disturbance Dec-Mar
 - ▶ Average annual rainfall: 255 mm
 - ◆ Increases to 600-750mm after rainfall increases
 - ◆ More than 750mm in the foothills & northern mountains
 - ◆ About 60% of rainfall occurs during monsoon

PAKISTAN – FACTS & FIGURES

■ Economy

▶ Agriculture-based

- ◆ 25% of Pakistan's total land is under cultivation – watered by one of the world's largest irrigation systems

- ◆ Agriculture accounts for 21% of GDP & employs 41% of the labor force

- ◆ Agriculture land: 34.82 million hectares
 - ◆ Forest area: 3.78 million hectares
 - ◆ Arable land: 31.04 million hectares
 - * **Culturable waste: 9.09 million hectares**
 - * **Cultivated area: 21.95 million hectares**

PAKISTAN – FACTS & FIGURES

■ Economy

- ▶ Agricultural hub is Punjab
 - ◆ Average annual rainfall < 250mm
 - ◆ Extensive irrigation makes Punjab a rich agricultural region
 - ◆ Agriculture land: 14.55 million hectares (Arable land: 14.01 million hectares)
 - ◆ The land of “five waters” - five tributaries of the Indus River flow through most of Punjab
 - ◆ 56% of country’s population

- ▶ Main agricultural exports: cotton & rice

- ▶ Main imports: petroleum products, industrial machinery, food items

ENERGY SCENARIO

- Increasing population & developing economy - increasing national energy needs
 - ▶ Power demand to reach 130,000 MW by 2030
- Supply-demand gap widening – energy infrastructure inadequate to meet demand
- Energy imports & import bill increasing

ENERGY SCENARIO

- Energy cost becoming prohibitive for consumer
- Limited energy access – rural areas mostly deprived of energy infrastructure
- Hurts national economy

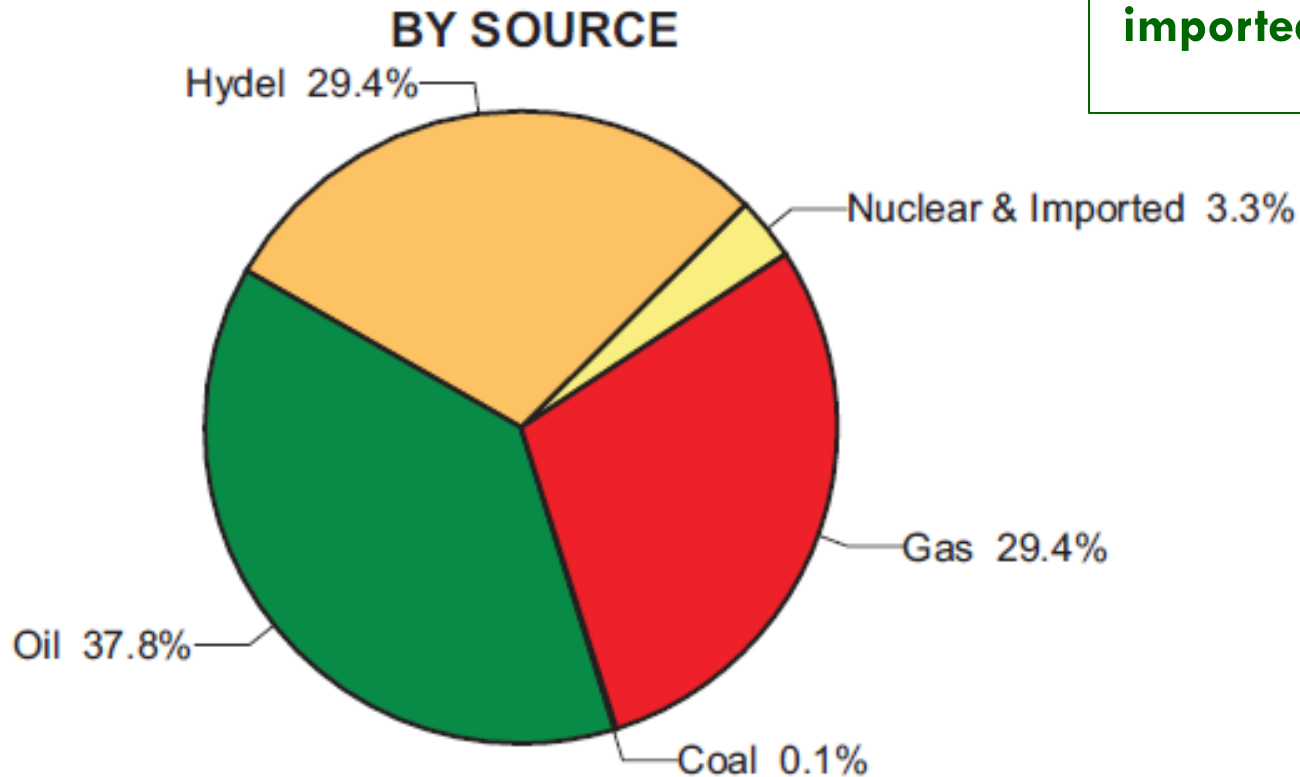
ENERGY SCENARIO

Sources of Electricity

ELECTRICITY GENERATION 2009-10
Total: 95,608 GWh

Thermal –67.3%

**0.3% of electricity
imported in 2009-10**



**SOURCE:
PAKISTAN
ENERGY
YEARBOOK
2010**

ENERGY SCENARIO

Sources of Electricity

- Most of our energy comes from fossil fuels

- Fossil fuel consumption in thermal power generation
 - ▶ Oil: 56.2%

 - ▶ Gas: 43.6%

 - ▶ Coal: 0.2%

- FO imported & expensive

ENERGY SCENARIO

Power Producers

- 03 major power producers
 1. *WATER & POWER DEVELOPMENT AUTHORITY (WAPDA) – 1958*
 2. *KARACHI ELECTRIC SUPPLY COMPANY (KESC) – 1913 (nationalized in 1952, reprivatized in 2005)*
 - ◆ Electricity generation, transmission & distribution to Karachi & parts of Sindh & Balochistan
 3. *PAKISTAN ATOMIC ENERGY COMMISSION (PAEC) – 1956*
 - ◆ Nuclear power generation

ENERGY SCENARIO

Power Producers

- Shift in GoP's policy – restructure Pakistan's power sector
 - ▶ Inefficiencies in WAPDA – no growth in power generation
 - ▶ In 1992, the GoP approved WAPDA's Strategic Plan for privatization of Pakistan's power sector
 - ▶ Aims:-
 - ◆ Deregulate power sector
 - ◆ Promote private power producers
 - ◆ Privatize selected entities

ENERGY SCENARIO

Power Producers

- Formal disintegration of WAPDA & bifurcation in responsibilities
 - ▶ WAPDA: Hydel generation & operations
 - ▶ The *PAKISTAN ELECTRIC POWER COMPANY (PEPCO)* was established
 - ◆ Manages transition of WAPDA from bureaucratic to a corporate, productive & commercially viable entity
 - ◆ Controls the thermal power generation & distribution companies that were earlier with WAPDA

ENERGY SCENARIO

Power Producers

- *PRIVATE POWER & INFRASTRUCTURE BOARD (PPIB)*
 - 1994
 - ▶ To promote private sector participation in the power sector – levelized tariff structure (tariff reduces with time)
 - ▶ Facilitates investors in establishing private power projects & executes Implementation Agreement (IA)
 - ▶ 27 IPPs are operational in Pakistan
 - ◆ 5 new added in 2009-10, increasing thermal installed capacity by 1,089 MW

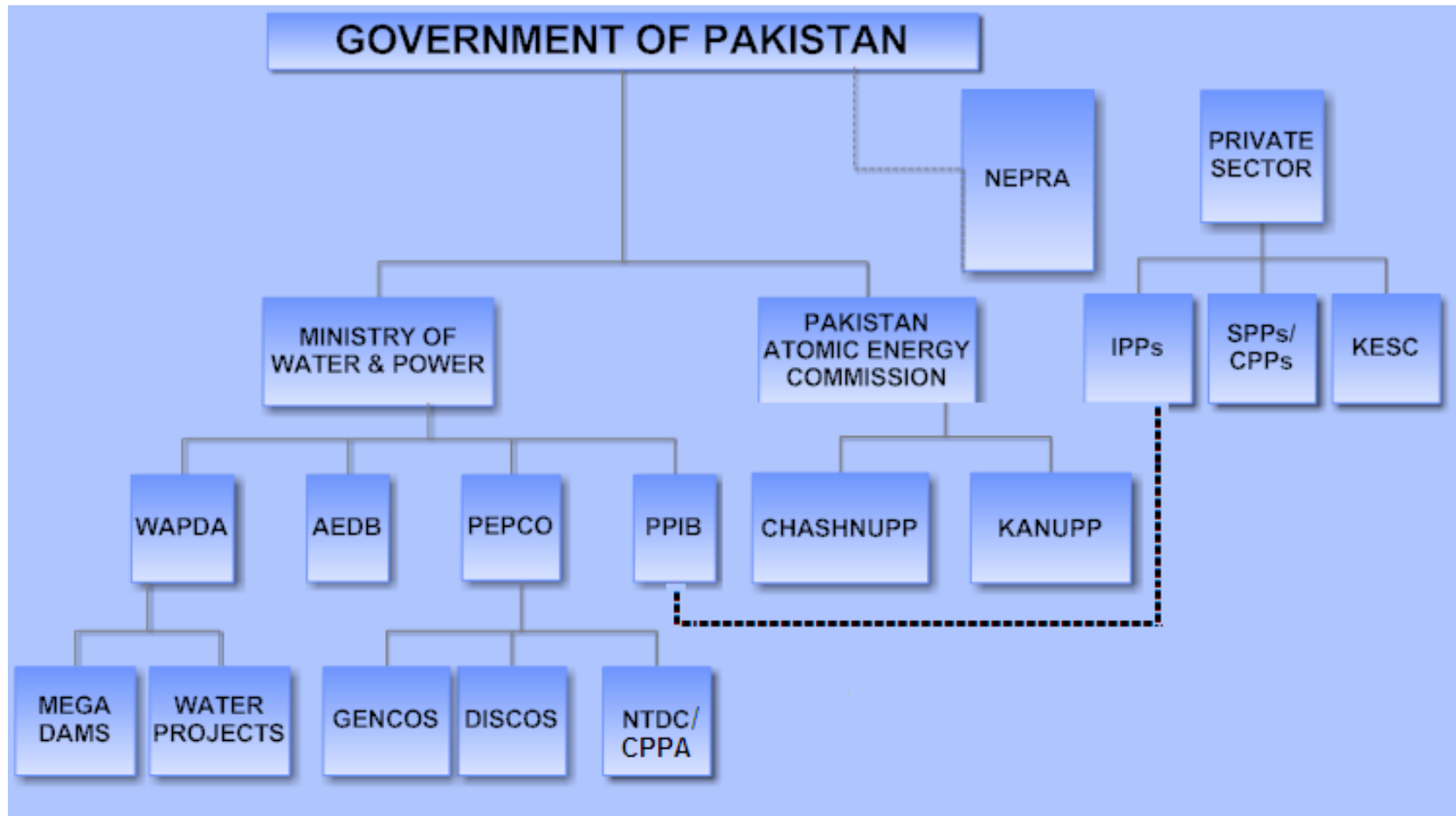
ENERGY SCENARIO

Power Producers

- The changed landscape of power production:
 1. *WAPDA*
 2. *PEPCO*
 3. *KESC*
 4. *PAEC*
 5. *IPPs*
 6. *Rental Power Plants (RPPs)*

ENERGY SCENARIO

Power Sector Players



ENERGY SCENARIO

Power Sector Players

- *NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA) – 1997*
 - ▶ Issues licenses for power production, transmission & distribution
 - ▶ Specifies electricity tariffs

- *NATIONAL TRANSMISSION & DISPATCH COMPANY (NTDC) – Aug 1998*
 - ▶ Operates under PEPCO
 - ▶ Central power purchasing agency
 - ▶ Operates & maintains grid stations & transmission lines

ENERGY SCENARIO

Power Sector Players

- *KEESC* – 2 M customers
 - ▶ Operates in the private sector
 - ▶ Generates thermal power

- 08 Distribution Companies (DISCOs) – 19.6 M customers
 - ▶ Under *PEPCO*

- *ALTERNATIVE ENERGY DEVELOPMENT BOARD (AEDB)* – May 2003
 - ▶ Central national body on RE

ENERGY SCENARIO

Installed capacities as on 30th June 2010

▣ Hydel

▸ Estimated potential according to *PEPCO*: 60,000 MW

▸ Major hydel power projects in Pakistan:

◆ Tarbela: 3,478 MW

◆ Ghazi-Barotha: 1,450 MW

◆ Mangla: 1,000 MW

Total Hydel capacity: 6,481 MW

Hydel electricity generated varies between 2,414 MW & 6,761 MW depending upon river flow

ENERGY SCENARIO

Installed capacities as on 30th June 2010

▣ Thermal

- *PEPCO* thermal (12 plants): **4,900 MW**

- *KESC* thermal (5 plants): **1,955 MW**

- IPPs thermal (27 plants): **7,123 MW**
 - ◆ 5 new IPPs were added in 2009-10, increasing thermal installed capacity by 1,089 MW

Total Thermal capacity

13,978 MW

ENERGY SCENARIO

Installed capacities as on 30th June 2010

▣ Nuclear

- 02 nuclear reactors (Sindh, Punjab)

Total Nuclear capacity

462 MW

- 3rd nuclear power plant in Punjab became operational in May 2011: 330 MW

TOTAL INSTALLED CAPACITY:

20,922 MW

PAKISTAN'S ELECTRICITY DEMAND:

14,500 MW

ENERGY SCENARIO

Installed capacities as on 30th June 2010

- ▣ Rental Power Projects (RPPs)
 - ▶ 19 RPPs committed to by GoP
 - ◆ Planned electricity production: 2,700 MW
 - ▶ 02 have come online
 - ◆ Added 272 MW of electricity to the national grid
 - ◆ 03 plants are in installation process
 - ▶ Much national debate over RPPs
 - ◆ Extremely expensive electricity

ENERGY SCENARIO

Electricity Shortfall

- Demand for electricity growing @ 9% annually
- Electricity supply growing @ 7% annually
- 15-20 hours of unannounced load shedding across the country

ENERGY SCENARIO

Electricity Shortfall

- Shortfall of electricity: 5,000-7,000MW estimated for summer 2011*
 - ▶ For May 2011:
 - ◆ Average peak supply = 12,818MW
 - ◆ Average peak demand = 16,446 MW

 - ▶ Generation-related factors
 - ◆ Water flow
 - ◆ Gas availability
 - ◆ Furnace oil import & circular debt issues

 - ▶ Demand-related factors – varied use

ENERGY SCENARIO

Cost per Unit of Electricity

Electricity produced from....	Cost per unit	
	(Pak Rs.)	(Cents)
Hydel	1.18 - 4 *	1.39 – 4.7
Thermal		6-30
- WAPDA		8.17
- IPPs	11.18	13
- RPPs		≥ 30 cents
Coal	6-7	7-8
Nuclear		12.2

*** WAPDA claims the cost per unit is Rs. 1.05**

ENERGY SCENARIO

Cost per Unit of Electricity

- Consumers pay a much higher price per unit of electricity consumed
 - ▶ Due to pilferages, surcharges, & high %age of thermal-based electricity on grid

- Price per unit: Rs. 6.5-9 (7.55-10.5 cents)
 - ▶ Varies with WAPDA & KESC
 - ▶ With usage bracket
 - ▶ & with type of user
 - ▶ Due to pilferages, surcharges, & high %age of thermal-based electricity on grid

ENERGY SCENARIO

Electricity Consumption by Sector

Sector	%age Share
Domestic	46.1
Commercial	7.5
Industrial	26.7
Agriculture	13.03
Street lighting	0.6
Bulk supplies, traction, & other Government	6.05

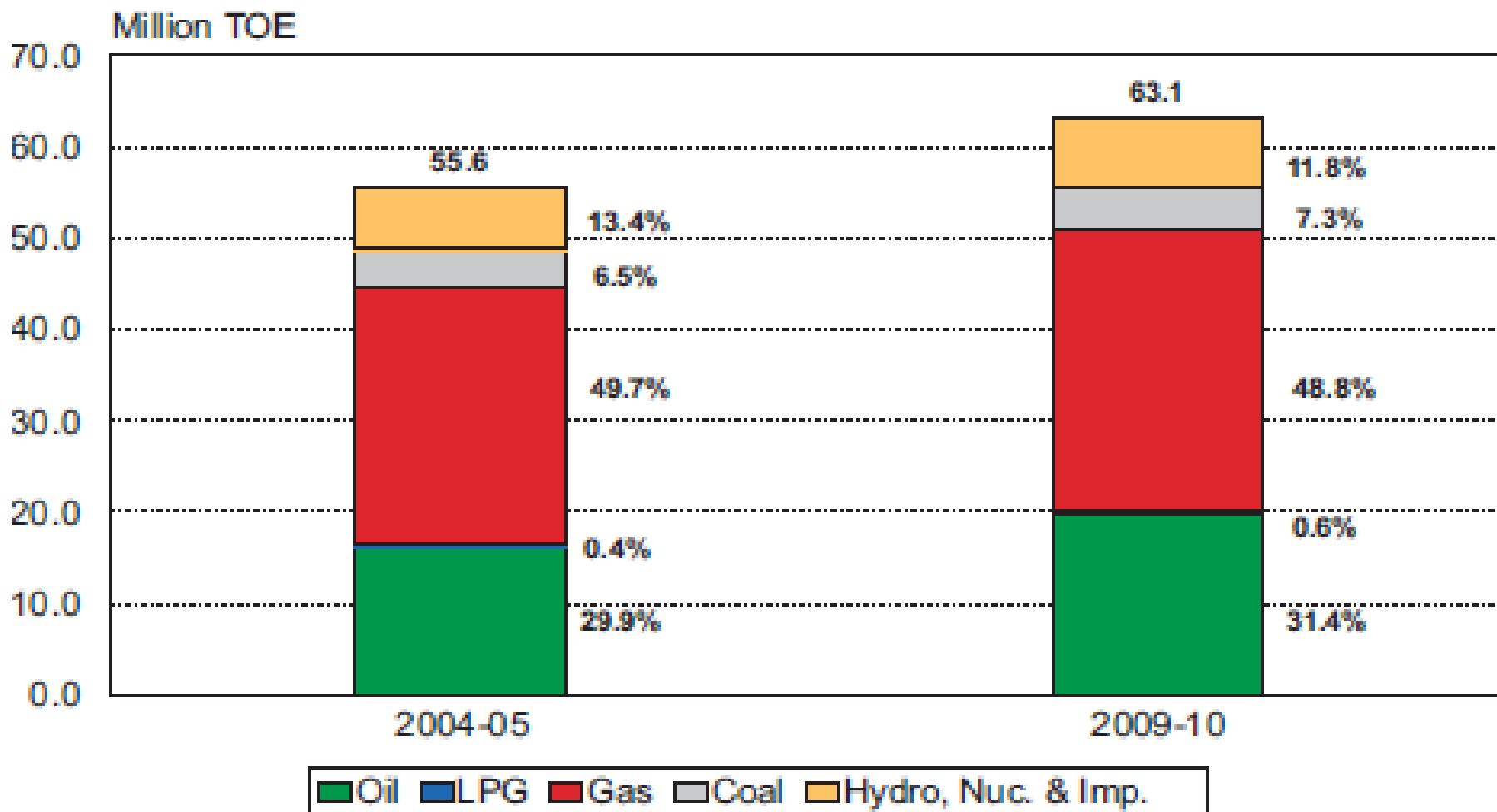
** Public Utilities Only*

SOURCE: PAKISTAN ENERGY YEARBOOK 2010

ENERGY SCENARIO

Energy Supplies by Source

PRIMARY ENERGY SUPPLIES BY SOURCE

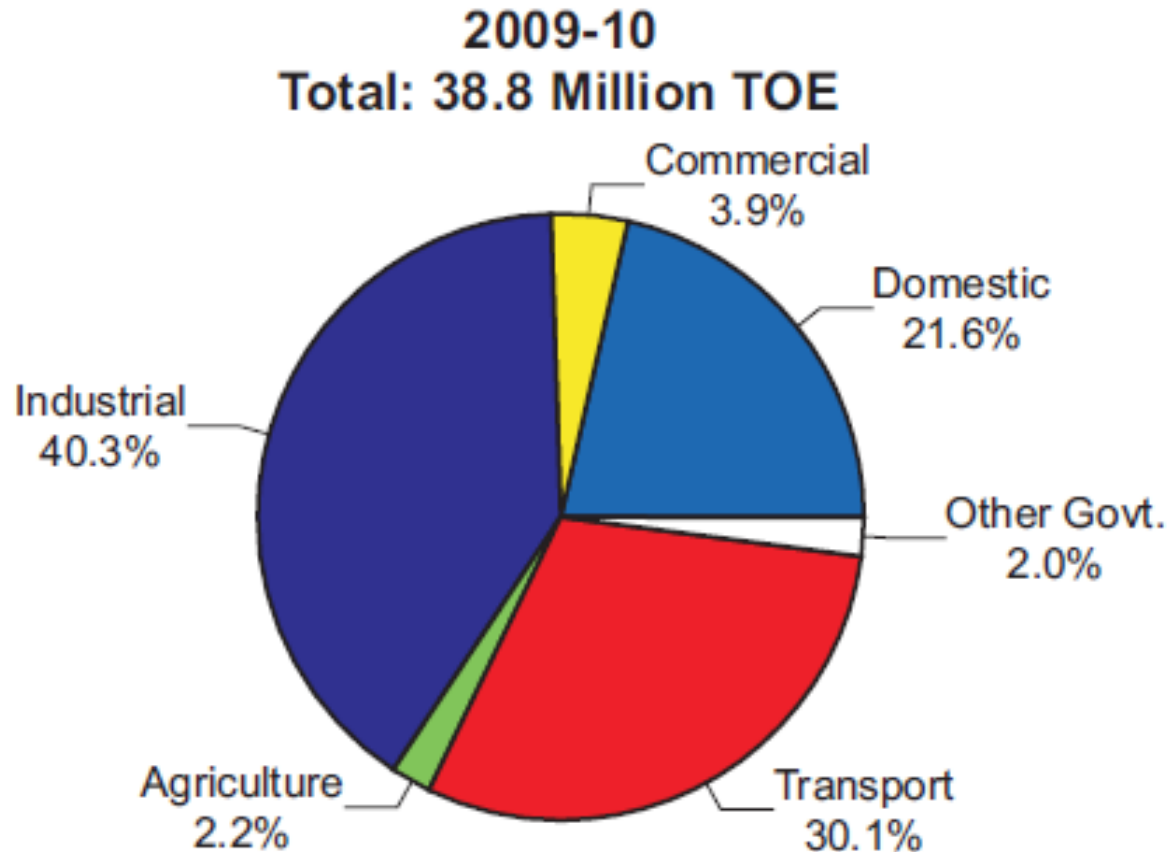


SOURCE: PAKISTAN ENERGY YEARBOOK 2010

ENERGY SCENARIO

Energy Consumption by Sector 2009-10

(Excluding fuels consumed in thermal power generation)



SOURCE:
PAKISTAN
ENERGY
YEARBOOK
2010

ENERGY SCENARIO

Production, Consumption, Demand

- ▣ Gas
- ▣ Oil
- ▣ Coal

ENERGY SCENARIO

Production, Consumption, Demand

▣ Gas

- ▶ Highest percentage as source in energy mix (49%)
- ▶ Pakistan's gas reserves as on 30th June 2010: **27.59 trillion cubic feet** *
 - ◆ Will last for 20 more years if used at the current rate of 4 billion cubic feet production per day
 - ◆ Balochistan has the major gas reserves: **19 trillion cu ft** **

* SOURCE: PAKISTAN ENERGY YEARBOOK 2010

** MINISTRY OF PETROLEUM & NATURAL RESOURCES (JAN 2010)

ENERGY SCENARIO

Production, Consumption, Demand

▣ Gas

- ▶ Gas production per year: **1.48 Trillion Cu Ft** *
- ▶ Consumption of natural gas in 2009-10: **1.278 Trillion Cu Ft**
- ▶ Demand for gas: **1.934 Trillion Cu Ft per year** **
 - ◆ Number of consumers in 2010: **5.95 M** **
 - ◆ Steadily increasing every year
 - ◆ Up 6% from 2009
- ▶ Gas shortages are causing heavy loss to industries

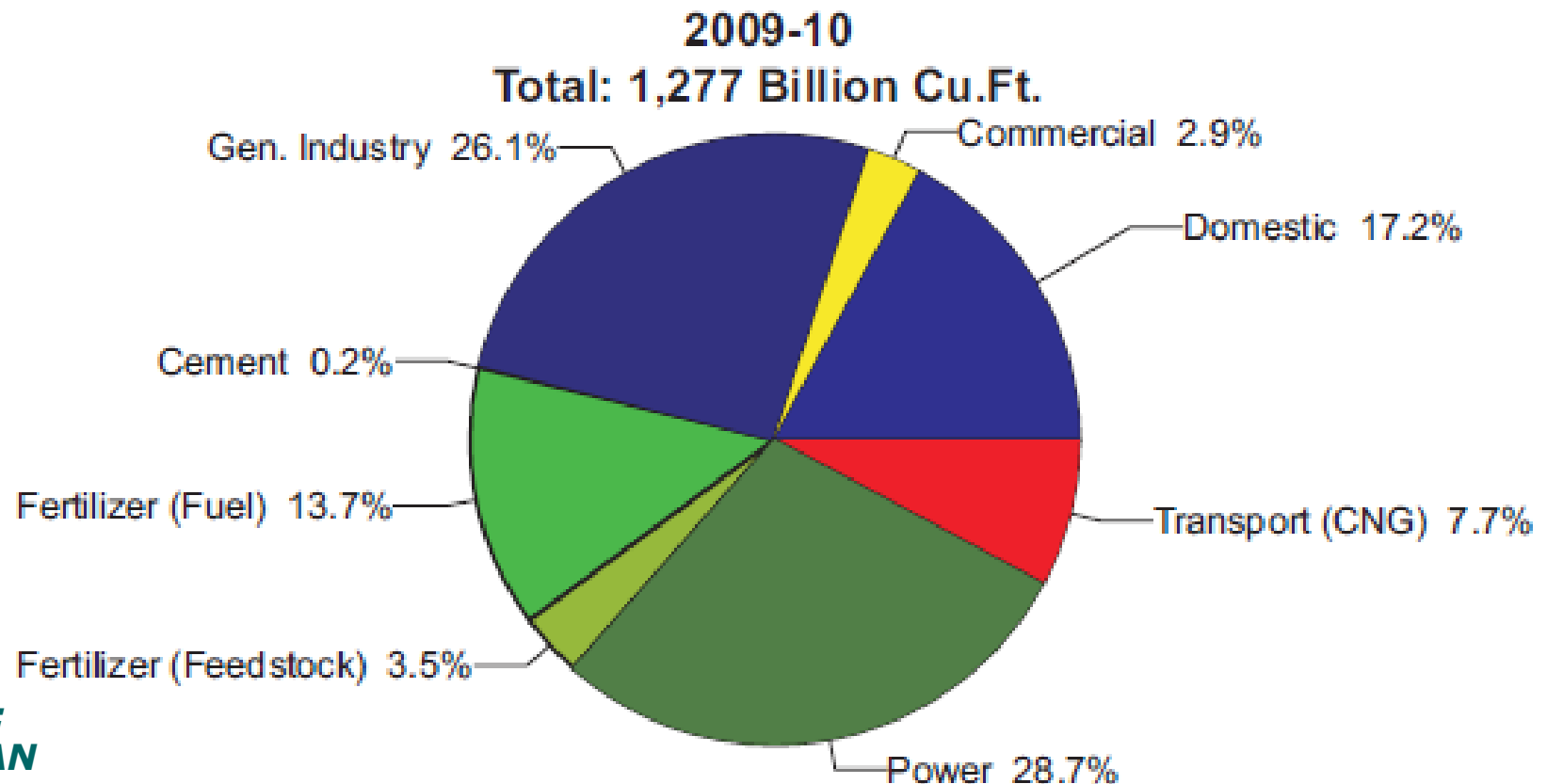
* **SOURCE: PAKISTAN ENERGY YEARBOOK 2010**

** **SOURCE: MINISTRY OF PETROLEUM & NATURAL RESOURCES (JAN2010)**

ENERGY SCENARIO

Production, Consumption, Demand

NATURAL GAS CONSUMPTION BY SECTOR

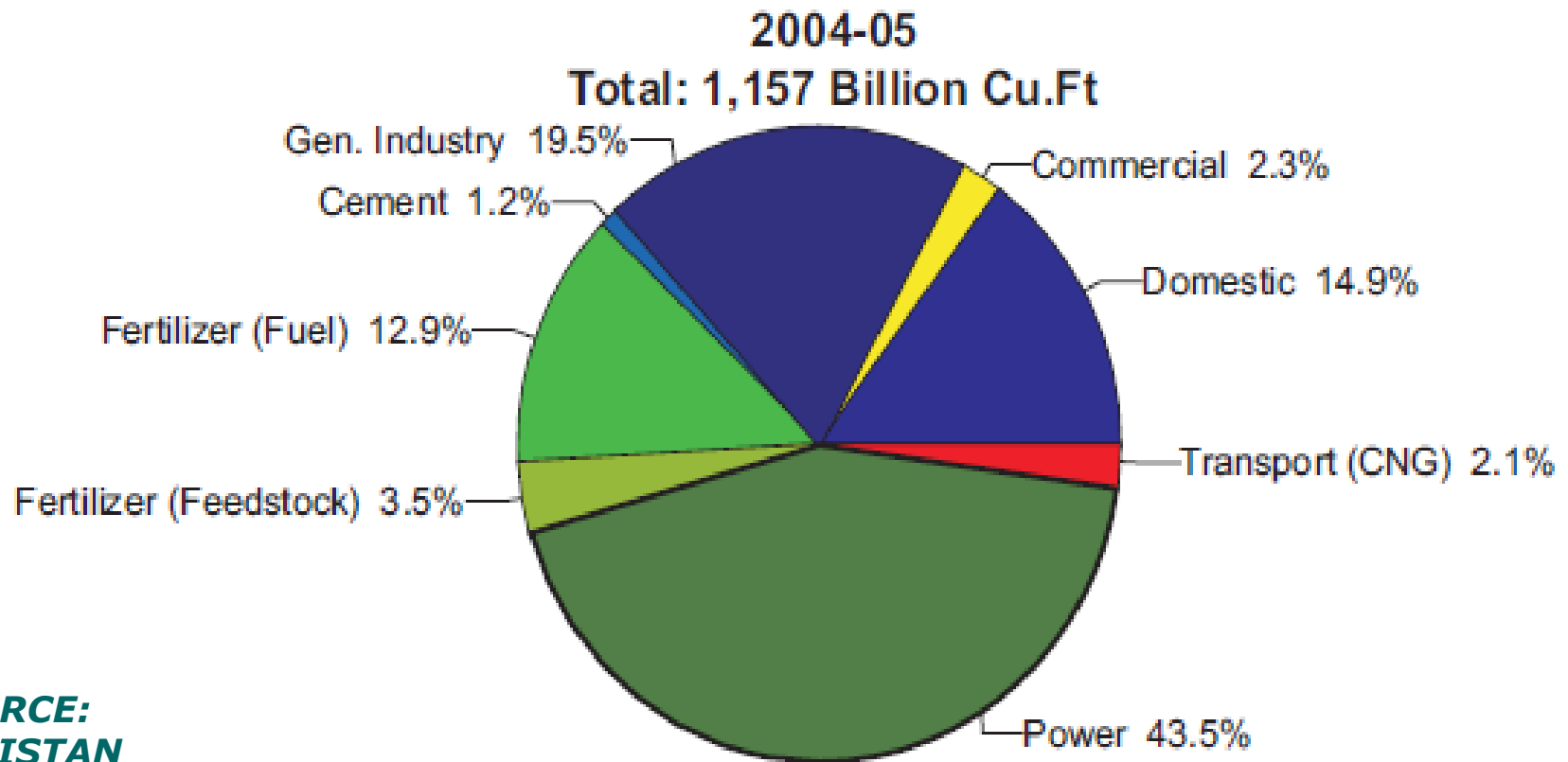


SOURCE:
PAKISTAN
ENERGY
YEARBOOK
2010

ENERGY SCENARIO

Production, Consumption, Demand

NATURAL GAS CONSUMPTION BY SECTOR



SOURCE:
PAKISTAN
ENERGY
YEARBOOK
2010

ENERGY SCENARIO

Production, Consumption, Demand

▣ Oil

- Biggest source after natural gas – mostly imported
- During 2009-10 oil consumption increased by 7% over the preceding year
 - ◆ 27% increase in use of gasoline consumption in transport sector
 - ✦ Consumption of E10 was added in transport sector during 2009-10 (**4,926 tonnes**)
 - ◆ 16% increase in furnace oil consumption in power sector

ENERGY SCENARIO

Production, Consumption, Demand

▣ Oil

▸ Reserves

- ◆ Proven oil reserves in Pakistan: **306.552 M US barrels** as on 30th June 2010 (**41.82 M tonnes**) *
- ◆ Some sources estimate Balochistan oil reserves at **6 trillion US barrels** (on-shore & off-shore)

6.8 – 8 US barrels in 1 metric ton (tonne). Used here: 7.33 US barrels in 1 tonne

** SOURCE: PAKISTAN ENERGY YEARBOOK 2010*

ENERGY SCENARIO

Production, Consumption, Demand

▣ Oil

▸ Production:

- ◆ Indigenous crude oil production for 2009-10: **23.7 M US barrels (3.23 M tonnes)** *
- ◆ **64,948 US barrels per day** (most of it comes from Sindh)

▸ Demand:

- ◆ Demand for oil: **19.2 M tonnes per year** **
- ◆ Indigenous oil production meets less than 20% of country's demands
- ◆ Reliance on imported oil

* SOURCE: PAKISTAN ENERGY YEARBOOK 2010

** SOURCE: MINISTRY OF PETROLEUM & NATURAL RESOURCES (JAN 2010)

ENERGY SCENARIO

Production, Consumption, Demand

▣ Oil

- Oil imports are estimated to rise to **32.5 M tonnes** by 2015
 - ◆ Imported from Saudi Arabia (lead importer), Kuwait, UAE, Singapore, Malaysia, India, Bahrain, Oman & Holland
 - ◆ Contributor to trade deficit – increasing oil prices not helping
 - ◆ Energy security vulnerability

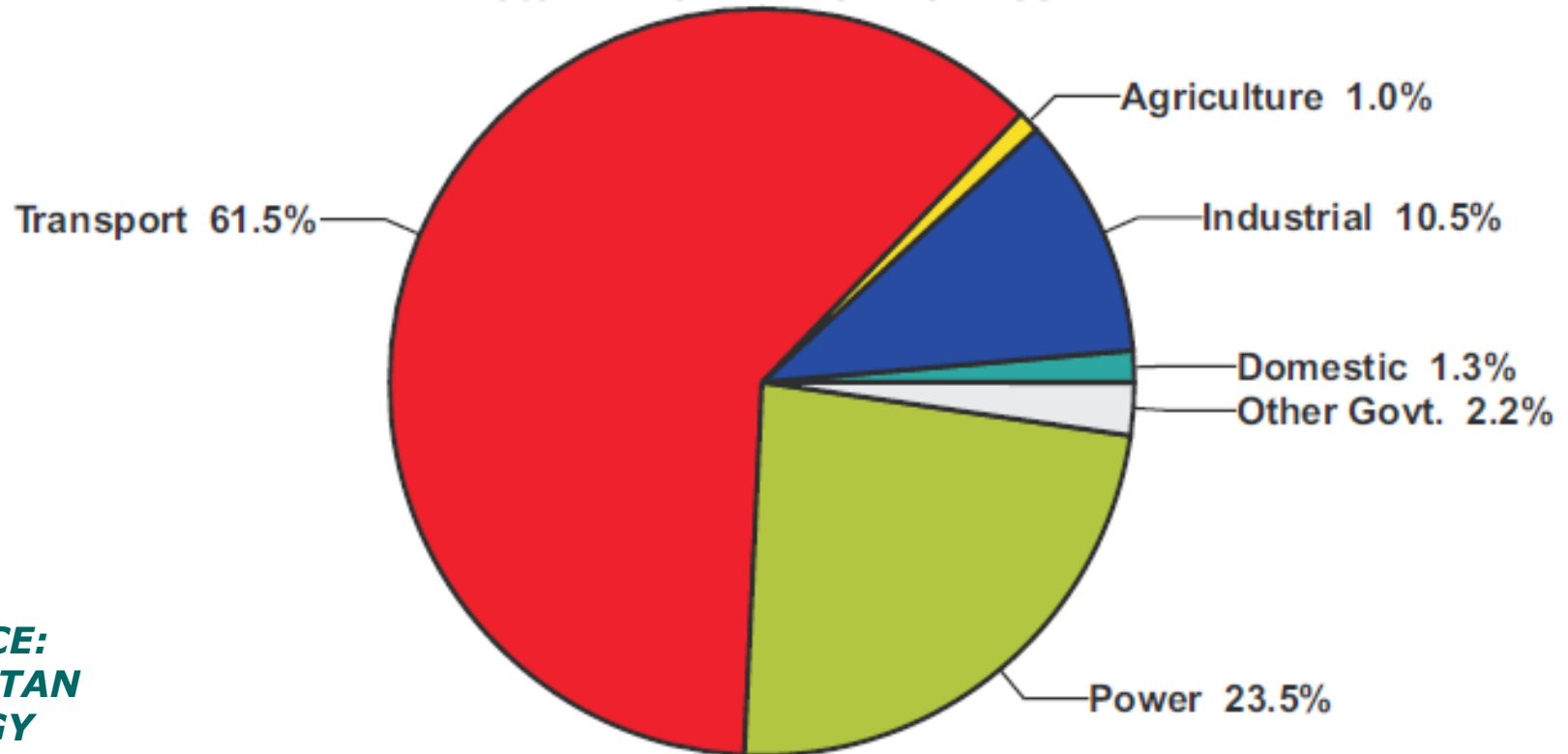
ENERGY SCENARIO

Production, Consumption, Demand

PETROLEUM PRODUCTS CONSUMPTION BY SECTOR

2004-05

Total: 14.67 Million Tonnes



SOURCE:
PAKISTAN
ENERGY
YEARBOOK
2010

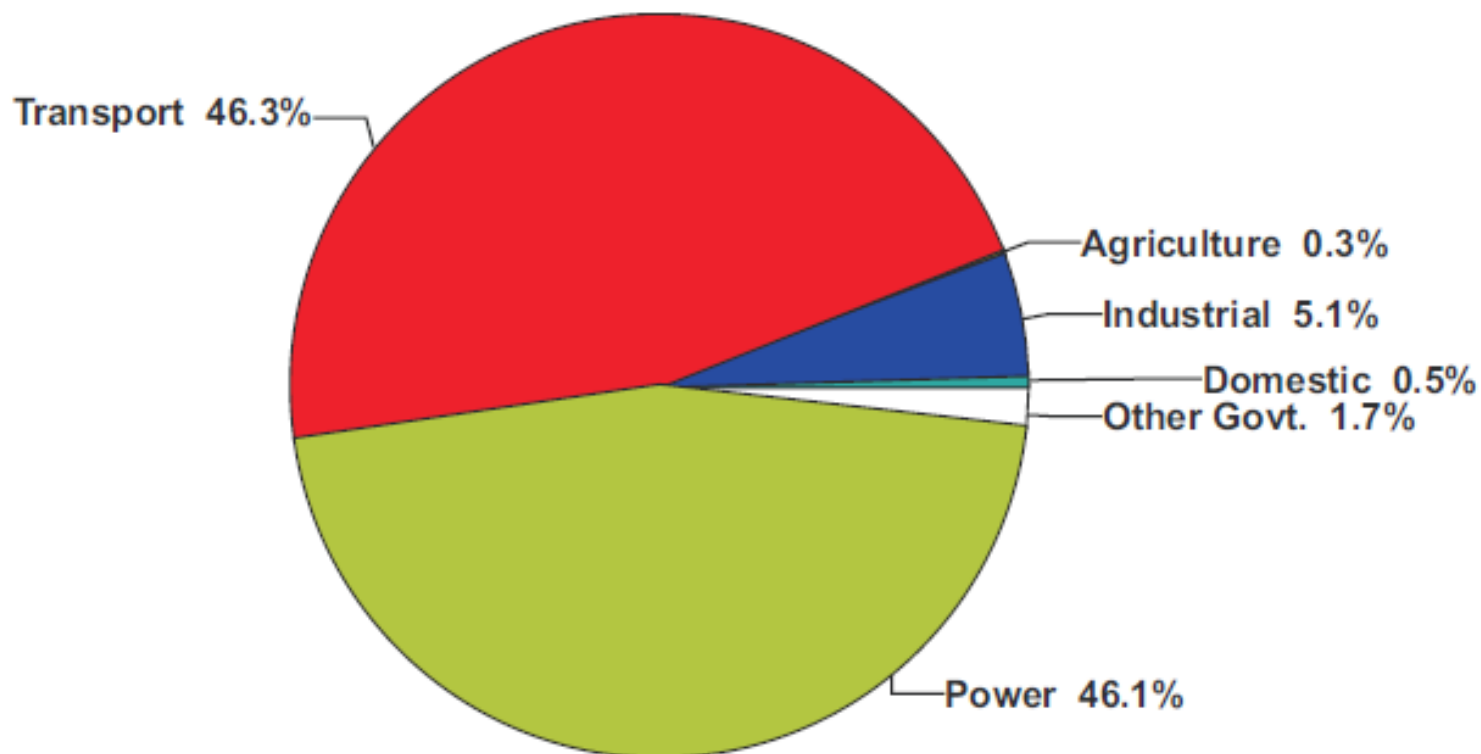
ENERGY SCENARIO

Production, Consumption, Demand

PETROLEUM PRODUCTS CONSUMPTION BY SECTOR

2009-10

Total: 19.13 Million Tonnes



SOURCE:
PAKISTAN
ENERGY
YEARBOOK
2010

ENERGY SCENARIO

Production, Consumption, Demand

- ▣ Huge consumption for power generation
 - ▶ Has steadily been rising since 2004-05
 - ▶ Our economy can be richer by billions of dollars if power generation is supplemented with alternate / renewable means

ENERGY SCENARIO

Production, Consumption, Demand

▣ Coal

- ▶ Plays a minor role in Pakistan's energy mix
- ▶ Numerous studies have concluded that all coal reserves in Pakistan are suitable for electricity generation

▶ Coal reserves in Pakistan

◆ Punjab (Salt Range, Makerwal)	<u>235 MT</u>
◆ Balochistan	<u>217 MT</u>
◆ KPK	<u>99 MT</u>

ENERGY SCENARIO

Production, Consumption, Demand

▣ Coal

▸ Coal reserves in Pakistan:

◆ Sindh

✦ Thar desert (discovered in 1992)

175,506 MT

✦ Other locations

9,951 MT

185,457 MT

Total coal reserves

186,007 MT

(186 Bn T)

ENERGY SCENARIO

Production, Consumption, Demand

▣ Coal

- Production of coal in Pakistan in 2009-10: **3.48 MT**
- Import of coal in 2009-10: **4.657 MT**
- Consumption of coal in 2009-10: **8.138 MT**

ENERGY SCENARIO

Production, Consumption, Demand

▣ Coal

▸ Thar reserves

- ◆ Has attracted foreign & domestic development interest - preliminary studies suggest that Thar is capable of generating 100,000MW for 2 centuries

▸ Underground Coal Gasification (UCG) project in Thar desert in development stages

ENERGY EFFICIENCY MEASURES



ENERGY EFFICIENCY (EE)

- The huge energy shortfall in Pakistan has led to:
 - ▶ Extended blackouts
 - ▶ Energy becoming a very expensive commodity
 - ▶ Non-provision of energy to critical areas
- Imperative to design better systems that minimize energy consumption & improve efficiency
- Areas in which EC / EE measures are being taken:-
 - ▶ Industry
 - ▶ Building
 - ▶ Agriculture
 - ▶ Domestic
 - ▶ Transport

ENERGY EFFICIENCY (EE)

- Range of activities
 - ▶ Identification of EE/EC opportunities
 - ▶ Technology demonstration & pilot projects
 - ▶ Information & outreach, training & education
 - ▶ Plans & policies

- Governmental organs responsible for EE/EC
 - ▶ *NATIONAL ENERGY CONSERVATION CENTRE (ENERCON)*
 - ▶ *PAKISTAN ENGINEERING COUNCIL (PEC)*
 - ▶ *NATIONAL PRODUCTIVITY ORGANIZATION (NPO)*

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

▣ *ENERCON* – 1987

- ▶ The national focal point for EE & EE activities

▶ Projects:-

- ◆ Barrier Removal to Energy Efficiency Standards & Labeling – BRESL
 - ✦ Accelerate adoption & implementation of energy standards & labels (ES&L) in Asia
 - ✦ Bring energy savings from use of energy efficient appliances/equipment
- ◆ Establishing Model MVE certification centers in collaboration with private sector

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

▣ *ENERCON* – projects

▸ National Awareness Campaign on Energy & Environment Conservation (Project ACE) in 2003

◆ Achievements

- ◆ Boiler furnace tune-ups
- ◆ Industry & building energy audits
- ◆ Building Energy Code
- ◆ Training & education workshops

▸ Energy Conservation Through Training & Mass Awareness Campaign – Project TMAC

◆ Imparting EC Training on:

- ◆ Agriculture
- ◆ Buildings
- ◆ Transport
- ◆ Industry & Power
- ◆ CDM

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

▣ *ENERCON & PEC*

- Jointly developing the Building Code of Pakistan
 - ◆ Energy provisions to be made an integral part
 - ◆ Purpose: provide minimum requirements for energy-efficient design & construction of buildings
 - ◆ Energy provisions shall apply to:
 - ◆ Building envelopes
 - ◆ Heating, ventilation & air conditioning (HVAC)
 - ◆ Water heating
 - ◆ Lighting
 - ◆ Electrical power & motors

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

▣ *PEC*

- ▶ Converting *PEC* buildings to “Green Buildings”
 - ◆ *PEC* building employs LEDs instead of conventional light bulbs – a model for other organizations
- ▶ Awareness programs on EE & RE

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

- *NATIONAL PRODUCTIVITY ORGANIZATION (NPO)*
 - ▶ Operates under *MINISTRIES OF INDUSTRIES & PRODUCTION*
 - ▶ Objective: enhance productivity & competitiveness of Pakistan's industry by reducing cost of energy
 - ▶ Energy audits in 6 units of textile sector under Renewable Energy & Energy Efficiency framework to enhance productivity & quality

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

- Initiative by GoP (2010) to replace incandescent bulbs with Compact Fluorescent Lights (CFL) or energy savers
 - ▶ Import & free distribution of energy savers
 - ▶ Effort to use 75-80% less electricity

- Commercialization of CNG as a transport fuel
 - ▶ Project implemented by the *HYDROCARBON DEVELOPMENT INSTITUTE OF PAKISTAN (HDIP)*
 - ▶ Cleaner than petrol & diesel
 - ▶ Cost savings for consumers
 - ▶ CNG kits easily available across Pakistan

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

- Development of environmentally friendly rickshaw oil
 - ▶ HDIP & state-owned OMC PAKISTAN STATE OIL COMPANY LIMITED (PSO) developed a blend of two-stroke lube oil to be used in the recommended dosage with super-petrol
 - ▶ Would reduce:
 - ◆ Smoke & noise level
 - ◆ Fuel consumption by more than 30%

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

- CNG rickshaws
 - ▶ Rickshaws converted to CNG in different cities
 - ▶ Up to 1,200 converted

- PM program for 8,000 CNG buses
 - ▶ July 2008: The Federal Cabinet announced launch of 8000 CNG buses for major urban cities of Pakistan for efficient, environment friendly & affordable public transport

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

- Replacement of lighting with LEDs across federal & provincial capitals, & other cities
 - ▶ Street & part lighting
 - ▶ Traffic lights
 - ▶ Indoor lights (private / public sector)
 - ▶ LEDs are being assembled in Pakistan
 - ▶ High demand because of rising electricity costs

- Energy-efficient stoves
 - ▶ *PCRET* has developed stoves that save 30-40% energy
 - ▶ Used extensively in rural areas

ENERGY EFFICIENCY (EE)

Initiatives & Achievements

- Awareness & outreach program for EE / EC
 - ▶ Print & electronic media campaigns encouraging consumers to save energy & switch to energy-efficient appliances
 - ▶ Conferences, workshops, leaflet distribution, etc.

- To clip demand peaks & encourage efficiency, GoP:
 - ▶ Announced closure of commercial markets at 8pm during summers
 - ▶ Introduced daylight savings; heavy media campaign
 - ▶ Highest consumption slab pays three times more than first slab

ENERGY EFFICIENCY (EE)

Private Sector EE / EC Initiatives

- Energy-efficient / instant gas geysers
 - ▶ Initially were imported
 - ▶ Now SKD kits are being imported & assembled in Pakistan
 - ▶ Demand increasing due to rising gas prices

- Energy savers in domestic use
 - ▶ Demand on the rise
 - ▶ Significant short & long-term cost savings for consumers

- Import of LEDs & assembly / integration in Pakistan
 - ▶ Replacing conventional lighting running on-grid with LED lighting
 - ▶ Using LED lighting in solar solutions

RENEWABLE ENERGY & PAKISTAN



RE TARGETS SET BY GoP

	2005	2010	2015	2020	2025	2030
RE (Electrical) Installed Capacity (MW)	180	880	1680	3150	5850	9700
Renewable Energy Supplies (MTOE)	0.17	0.84	1.60	3.00	5.58	9.20
RE Mix in National Energy Supplies	0.3 %	1.1 %	1.3 %	1.7 %	2.2 %	2.5 %

SOURCE: MEDIUM TERM DEVELOPMENT FRAMEWORK

RE POLICY OF PAKISTAN

- Wind Risk - responsibility of GoP
- Guaranteed Electricity Purchase
- Grid provision at doorstep
- Attractive Tariff (17%-18% ROE)
- Counter Guarantee by the ADB for first few projects
- Special Incentives by the State bank for up to 10 MW plants
- No Import Duties on Equipment
- Zero Sales Tax
- Net Metering
- Carbon Credits

RE RESOURCES IN PAKISTAN

- High potential exists for use of renewable resources for indigenous energy production
- Abundant resources in Pakistan for energy generation through:
 - ▶ Small hydel
 - ▶ Wind
 - ▶ Solar
 - ▶ Cogeneration / Biomass / Waste-to-Energy
 - ▶ Biofuels

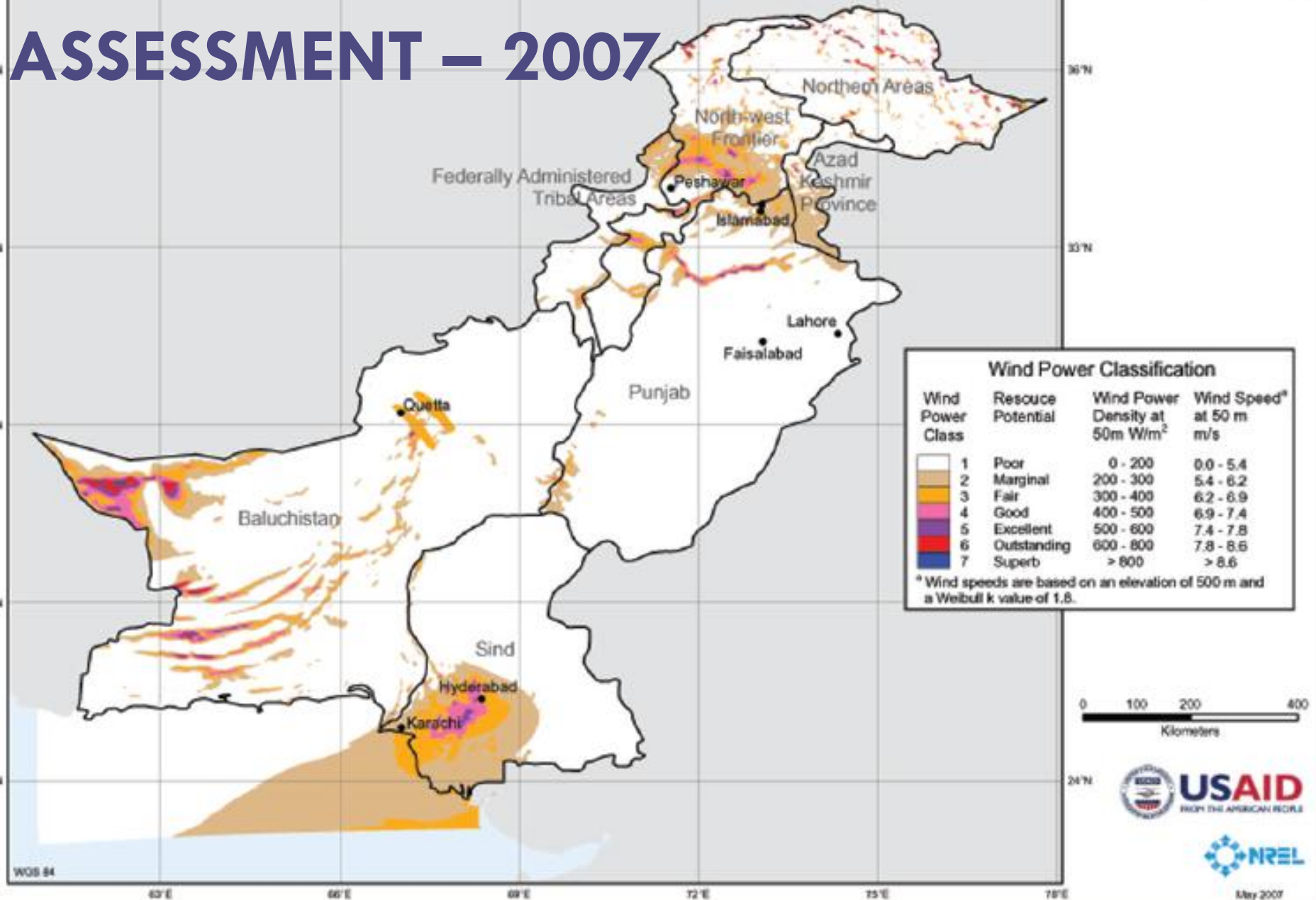
RE RESOURCES

Small Hydel

- Natural waterfalls & canal heads available in Pakistan with a potential of 4,500 MW
 - ▶ 171 microhydel units in Hindukush mountain range by the *AGA KHAN RURAL SUPPORT PROGRAM (AKRSP)* - a donor-funded integrated rural support program
 - ◆ Providing electricity to around 17,000 houses
 - ▶ 03 small hydro projects completed using low head small flow rate mini hydro turbines
 - ▶ *WORLD BANK* project to install 103 micro-scale hydro power stations in isolated northern Himalayan villages

NREL WIND RESOURCE ASSESSMENT – 2007

Pakistan 50 m Wind Power



RE RESOURCES

Wind

- ▣ Wind grading as per *NREL*
 - Pakistan's total land area: 877,525 km²

Wind Resource Utility Scale	Wind Class	Wind Power (W/m ²)	Wind Speed (m/s)	Land Area (km ²)	Percent Windy Land
Good	4	400 – 500	6.9 – 7.4	18,106	2.1
Excellent	5	500 – 600	7.4 – 7.8	5,218	0.6
Excellent	6	600 – 800	7.8 – 8.6	2,495	0.3
Excellent	7	> 800	> 8.6	543	0.1
TOTAL					3%

SOURCE: NREL WIND MAPPING DATA

RE RESOURCES

Wind

- Class 4+ = good-to-excellent for utility-scale applications
 - ▶ 26,400 sq km (3% of Pakistan's total land area)
 - ▶ Potential for 132,000 MW of power generated from wind energy (based on assumption of 5 MW/km²)
- Almost 9% of Pakistan's land area has Class 3 or better wind resource
 - ▶ Good potential for small-scale off-grid hybrid applications (wind/diesel or wind/solar)

RE RESOURCES

Wind

- Gharo~Keti-Bandar corridor (1,046 km coastal belt from Sind to Balochistan) alone has a potential of about 50,000 MW
 - ▶ Average wind speed: 7 m/s at 50 meters height
- Sites in Baluchistan, Punjab & Northern Areas being identified

RE RESOURCES

Wind

▣ Projects

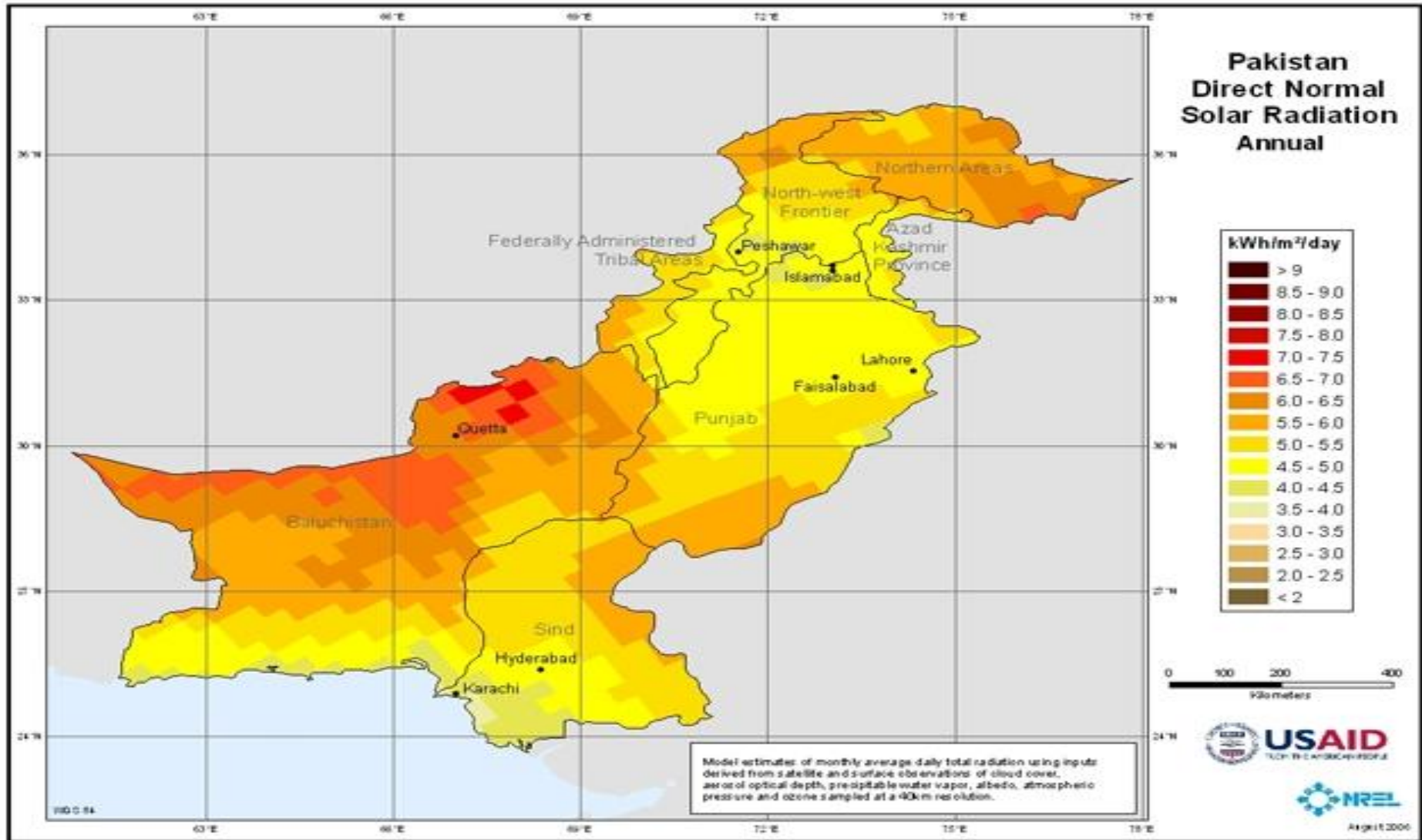
- 1 project of 6MW installed by *ZORLU ENERJI* (existing tariff: 14.9 cents per unit which will come down to 4 cents after 10 years)
- Recently *FFC ENERGY* has achieved Financial Close for 49.5 MW
- In process – Energy Purchase Agreement
 - ◆ *ZORLU ENERGI* for 56.5 MW
- Land & LOI issued to 18 companies
 - ◆ 7 at advanced stages
 - ◆ Rest at feasibility stages

RE RESOURCES

Wind

- GoP is encouraging IPPs to enter the sector
 - ▶ Incentives
 - ◆ Wind risk taken by GoP
 - ◆ 100% power purchase guaranteed
 - ◆ Grid access on doorstep
 - ◆ Land facilitation by GoP
 - ◆ Fiscal incentives: tax rebates, asset depreciation, etc.
 - ◆ 18% ROE in dollar terms
 - ◆ Upfront tariff of 16 cents per unit has been proposed for wind power plants which will be set up with rupee loans from Pakistani banks & 13 cents per unit for plants which will be set up with dollar loans from foreign banks
 - ◆ Levelized tariff

NREL SOLAR POTENTIAL ASSESSMENT



RE RESOURCES

Solar

- Excellent conditions for deployment of solar energy solutions
- Potential for solar (PV & thermal) – 5 to 5.5 kWh/m²/day
- 5-7 years payback for commercial applications (where no grid electricity is available)

RE RESOURCES

Solar

- ▣ Solar PV
 - ▶ Telecom BTS sites converted to solar
 - ▶ Solar lighting projects done
 - ▶ Solar irrigation & lighting projects in tribal area to encourage economic activity
 - ▶ *AKHTER SOLAR PLC* – the first solar PV modules manufacturing facility in Pakistan – 2005
 - ◆ A source of high-quality solar panels for solar-based solutions across Pakistan

RE RESOURCES

Solar

▣ Solar PV

- Pakistan's First On-Grid Solar Power System (Smart Grid system) by *PEC* – 2008
 - ◆ Collaboration with *NUST*, *PCRET*, & *AEDB*, grant from Japan
 - ◆ *PEC* Islamabad will be converted to Green Building using an on-grid solar unit of 180 kw
 - ◆ Excess electricity to flow to the national grid
 - ◆ Project has entered implementation phase
 - ◆ In the next step, the *PLANNING COMMISSION* building will be converted similarly

RE RESOURCES

Solar

- ▣ Solar Thermal
 - ▶ Scarce availability of gas to industry – huge gap between supply & demand

 - ▶ Industrial scale solar water heater developed for industries in need of hot water
 - ◆ Capacity: 5,000 – 30,000 liters per day of water
 - ◆ Temperature range: 55°C - 85°C
 - ◆ Indigenous design
 - ◆ Cost-effective
 - ◆ Viable solution to industry fuel shortages

RE RESOURCES

Solar

▣ Solar Thermal

- Use of domestic solar water heaters on the rise
 - ◆ Production / assembly in Pakistan
- Solar food driers
 - ◆ Pilot projects started by GoP
 - ◆ Helps the agricultural sector & boosts export

RE RESOURCES

Cogeneration/Biomass/Waste-to-Energy

- Vast agricultural base providing biomass
- Biomass is abundantly used as an energy source in rural Pakistan
 - ▶ Wood
 - ▶ Grass, leaves, & bushes
 - ▶ Crop residue
 - ▶ Cow-dung & poultry-waste
 - ▶ Organic waste
- No formally recorded data available of the amount of biomass used / energy produced at rural level

RE RESOURCES

Cogeneration/Biomass/Waste-to-Energy

- Bagasse-based power generation
 - ▶ An important element of GoP's AE strategic plan
 - ▶ Advantages:
 - ◆ Power generation cost is very low as the fuel (bagasse) is available virtually at no cost
 - ◆ The fuel is available on site & fuel transportation infrastructure is not required
 - ◆ Transmission losses are reduced; bagasse co-generation power plants are decentralized
 - ◆ Net zero emission of CO₂
 - ◆ Sugar mills have decades of experience of related technology

RE RESOURCES

Cogeneration/Biomass/Waste-to-Energy

- Bagasse-based power generation
 - ▶ Pakistan's sugar industry crushes **30-40 M tons** of sugarcane per year
 - ▶ Yields about **12 M tons** of sugarcane waste – bagasse – captive biomass
 - ▶ Potential of bagasse-based co-generation power estimated at over 2,000 MW
 - ▶ Surplus electric power generated by sugar mills can be provided to national or local grid
 - ▶ A sugar mill crushing 2,000 tons cane daily can generate 11 MW, of which 2 MW will be its own consumption & the rest can be sold

RE RESOURCES

Cogeneration/Biomass/Waste-to-Energy

- *AL-MOIZ BAGASSE CO-GENERATION PROJECT, D.I. KHAN – 2008*
 - ▶ Established by *AL-MOIZ INDUSTRIES*, producers of sugar & sugarcane by products
 - ▶ A 27MW grid connected co-generation biomass power plant project
 - ▶ Estimated average emission reduction of 23,319 tons of CO₂ equivalent per year
 - ▶ Plant has been validated on the basis of *UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCC)* criteria for CDM

Contd..

RE RESOURCES

Cogeneration/Biomass/Waste-to-Energy

- *SHAKARGANJ* bagasse-biogas-natural gas cogeneration project – 7MW
 - ▶ *SHAKARGANJ SUGAR MILLS (SML)*, Jhang, has 5 boilers that consume bagasse, biogas & natural gas to generate steam for the process & power generation
 - ▶ The energy produced is consumed by the sugar mill & ethanol distilleries
 - ▶ Soon *SML* will be giving electricity to the grid

- Landhi Cattle Colony Biogas Project
 - ▶ Pilot Phase completed
 - ▶ Full scale project (48 MW plus 1.25 Million CERs) being prepared with assistance from *ADB*

RE IN PAKISTAN

Biofuels

- Pakistan rich in resources for Biofuels – Ethanol & Bio-Diesel
- Ample land available – cultivatable & marginal – for plantation of energy crops

Contd..

RE IN PAKISTAN

Biofuels – Ethanol Resources

- Feedstock used for ethanol production in Pakistan
 - ▶ Sugarcane & molasses
 - ▶ Pakistan is the world's 7th largest sugarcane producer – **49.37 M tonnes** in 2009-10
 - ▶ Area with sugarcane plantation: **942,870 hectares**
 - ▶ Molasses production in 2009-2010: **1.557 M tons**

RE IN PAKISTAN

Biofuels – Bio-Diesel Resources

- Pakistan has several indigenous plant species that are fit for Bio-diesel production

- Criteria for selection of Bio-diesel resources
 - ▶ Must be native
 - ▶ Non-competing with food crops & agricultural land
 - ▶ Chemical profile – oil, fatty acids
 - ▶ Quality & quantity of crude oil & Bio-diesel
 - ▶ By-products utilization
 - ▶ Non-allergic & non-toxic to other life forms
 - ▶ Yield of NTFPs for rural / industrial development

RE IN PAKISTAN

Biofuels – Bio-Diesel Resources



Pongamia Pinnata – the native Bio-diesel resource

RE IN PAKISTAN

Biofuels – Bio-Diesel Resources

- ▣ The Pongame tree
 - ▶ Height when fully grown: 40-50 feet

 - ▶ Span: 10-15 feet

 - ▶ Exists in large numbers in Pakistan, though scattered

 - ▶ Grows in:
 - ◆ Federal capital area
 - ◆ Central & Upper Punjab
 - ◆ Sindh

RE IN PAKISTAN

Biofuels – Bio-Diesel Resources

▣ The Pongame tree

- Native to Pakistan ; tried & tested as a hardy plant
 - ◆ Requires little water
 - ◆ Goats do not like it
 - ◆ Leaf litter is good organic fertilizer
 - ◆ Biodiversity home for living biota
 - ◆ Protects soil from erosion
 - ◆ Protects soil from water logging & salinity – twin problems for most Pakistani land

- Yield from 5th year onwards

[Yields of different sources-REVISED.xlsx](#)

RE IN PAKISTAN

Biofuels – Bio-Diesel Resources

- Other non-edible resources native to Pakistan
 - ▶ Cotton seed
 - ▶ Castor bean
 - ▶ Mesquite (wild arabic gum tree) – a local shrub
 - ▶ Jojoba – a shrubby plant
 - ▶ Wild Carthame (Wild Safflower)

RE IN PAKISTAN

Biofuels – Bio-Diesel Resources

- **Jatropha**
 - ▶ Not native to our part of the world
 - ▶ Cannot grow in very hot or very cold climates
 - ▶ Needs 1000mm annual rainfall
 - ▶ Jatropha plantation pilot projects being undertaken by private / public sector companies in Pakistan

- **Supplemental resources:**
 - ▶ Waste Vegetable Oil (WVO) & Animal Fat (AF)
 - ◆ Yield of Bio-diesel > 90%
 - ◆ Large quantities available in urban areas
 - ◆ Collection mechanism somewhat established
 - ◆ Production process simple

RE IN PAKISTAN

Cost Per Unit – Various RE Source

Energy Source	Cost Per Unit (cents)
Wind	13-14 cents
Solar	21 cents
Small Hydro	6-7 cents
Waste-to-Energy	5-7 cents

RE IN PAKISTAN

Initiatives & Achievements

- ▣ Major players
 - ▶ Government sector
 - ▶ Semi-Government
 - ▶ Non-Government
 - ▶ Private sector

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

- ▣ Ministries
 - Environment

- ▣ *AEDB*

- ▣ *PCRET*

- ▣ *PEC*

- ▣ Universities – industry-academia collaboration

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

▣ *MINISTRY OF ENVIRONMENT*

▸ Established a *CDM CELL*

- ◆ Awareness program on CC potential in various sectors
- ◆ Granted host country approval to 36 CDM projects
- ◆ 11 registered from Pakistan with *CDM EXECUTIVE BOARD (EB)*
- ◆ The largest CDM project: *PAK ARAB FERTILIZER*, Multan, generates more than 1 million CERs / year
- ◆ Anywhere from \$8–\$20 per CER can be earned

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

▣ *MINISTRY OF ENVIRONMENT*

- Set up the *PAKISTAN ENVIRONMENTAL PROTECTION AGENCY (PEPA)*
- ◆ Responsible to implement the Pakistan Environmental Protection Act, 1997 – the act provides for:
 - ✦ Protection, conservation, rehabilitation & improvement of environment
 - ✦ Prevention & control of pollution
 - ✦ Promotion of sustainable development
- ◆ Conducts environmental assessment studies of various installations & projects

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

▣ *MINISTRY OF ENVIRONMENT*

▸ *PEPA*

- ◆ Initiative to avail carbon credit facility for all Brick Kilns owners in Pakistan
 - ✦ Pakistan has hundreds of brick kilns operating in clusters in rural & sem-urban areas of the country producing fired clay bricks
 - ✦ A valuable industry - indigenous & providing employment in rural areas where agriculture may not be enough to sustain all the people
 - ✦ Environmental & health hazards of brick kilns
 - ✦ Potential to reduce GHG emissions & claim Carbon Credits

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

▣ AEDB

▸ Mandate:-

- ◆ Implement policies & projects through private sector in Alternative Energy (AE)
- ◆ Assist & facilitate development & generation of AE to achieve sustainable economic growth
- ◆ Encourage TOTs & develop indigenous manufacturing base
- ◆ Undertake RE projects on commercial scale (AEDB Act 2010)

▸ Played a pioneering role in RE in Pakistan

- ◆ Awareness building
- ◆ RE Policy
- ◆ Developing & mobilizing the private sector
- ◆ Research in academia & other institutions

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

■ *PAKISTAN COUNCIL OF RE TECHNOLOGIES (PCRET) – May 2001*

▶ Mandate:

- ◆ Conduct research in RE
- ◆ Establish facilities & expertise
- ◆ Awareness building

▶ Projects:

- ◆ Biogas for rural development
- ◆ Pilot-scale production of solar cells & modules
- ◆ Testing lab for solar PV & solar thermal appliances
- ◆ Electrification of remote villages in FATA & northern areas through installation of 70 microhydel plants
- ◆ Rural / urban electrification using solar energy

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

- ▣ *PAKISTAN ENGINEERING COUNCIL (PEC)*
 - ▶ Launched the Alternative Energy Resource Portal
 - ◆ Database of Pakistan's public & private sector organizations & individuals in alternative energy development
 - ◆ Caters information needs of individuals & organizations interested to switch to alternative energy, especially solar

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

- ▣ *NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY (NUST)*
 - ▶ Pakistan's leading R&D university – S&T prowess
 - ▶ High level of commitment to scientific research
 - ▶ Activities seen as key change factors in the national scenario

- ▶ *CORPORATE ADVISORY COUNCIL (CAC), NUST* – a think tank in the making

Think.Collaborate.Build

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

▣ *NUST*

▸ CAC

◆ Mandate

- ◆ Bridge gap between academic research & business requirements
- ◆ Create effective linkages & collaboration
- ◆ Assist in commercialization of *NUST* projects
- ◆ Be advocates for policy & industry direction through the role of a premium think tank
- ◆ Build knowledge repository & database for industry to use

◆ Power & Energy sector

RE IN PAKISTAN

Govt. Sector Initiatives & Achievements

▣ *NUST*

- Carries out valuable industry-specific research in RE
 - ◆ Solar
 - ◆ Bio-Diesel
 - ◆ Energy Efficiency (improving industrial motor efficiency)
 - ◆ Efficiency improvement of micro-wind turbines
 - ◆ Curriculum development & HRD

RE IN PAKISTAN

Initiatives & Achievements

- ▣ Semi-Government sector
 - ▶ FATA Development Authority
 - ◆ Solar PV pumping for irrigation & drinking water – collaborative project with *NUST*
 - ◆ Solar PV lighting purposes

 - ▶ Thar Development Authority
 - ◆ Solar PV lighting
 - ◆ Use of solar energy for water pumping & filtering for drinking purposes

RE IN PAKISTAN

Initiatives & Achievements

- ▣ Semi-Government sector
 - ▶ Gwadar Development Authority
 - ◆ Solar PV street lighting
 - ◆ Solar Thermal for converting sea-water to drinking water

 - ▶ Housing authorities in government & semi-government sectors
 - ◆ Outdoor lighting
 - ◆ Solar geysers for domestic use

RE IN PAKISTAN

Initiatives & Achievements

- Private sector companies offering RE solutions in Pakistan
 - ▶ Due to early incentive by GoP, private sector giants & small entrepreneurs have ventured into RE
 - ▶ Covering various areas in the value chain
 - ◆ Raw material supply (import, distribution)
 - ◆ Equipment Assembly / Manufacturing
 - ◆ Consultancy
 - ◆ Audits

WE NEED TO COLLABORATE!!!!

- ▣ Data / information sharing
 - SARI/E Resource Portal
- ▣ Industry linkages
- ▣ University linkages
- ▣ Help ourselves & each other develop RE
- ▣ Become the “model region” in RE