

PROSPECTS AND POTENTIAL OF RENEWABLE ENERGY RESOURCES IN PAKISTAN

By

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- Primary commercial energy supplies (2009) 65 MTOE
- Share (%)
 - Oil 32%
 - Gas 48%
 - Hydro 11%
 - Coal 7.50%
 - Nuclear 1.20%
- Non commercial energy resources 28%
- Per capita availability of energy 0.36 TOE
(equiv. to 1/5th of the world avg. of 1.77 TOE)
- Annual growth rate in energy demand 9-10%

➤ Oil Consumption

- **Daily consumption** 350,000 barrels per day (bpd)
 - Indigenous 20% (66000 bpd)
 - Imported 80% (284000 bpd)
- Import expenditure 14 billion US\$ per annum
- Oil exploration effort Poor, 0.76 wells per 1000 Km²
(world avg. 10 wells per 1000 Km²)

➤ Power Generation

- Installed capacity 19700 MW (67% Thermal, 30% Hydro, 2% Nuclear)
- Per capita availability 446 KWh (Japan 9700 KWh & USA 12500 KWh)
- Current shortfall 5000 MW (8 to 16 hours load shedding)
- Projected demand (2030) 162590 MW (including 9500 MW from RETs)

INDIGENOUS ENERGY RESERVES

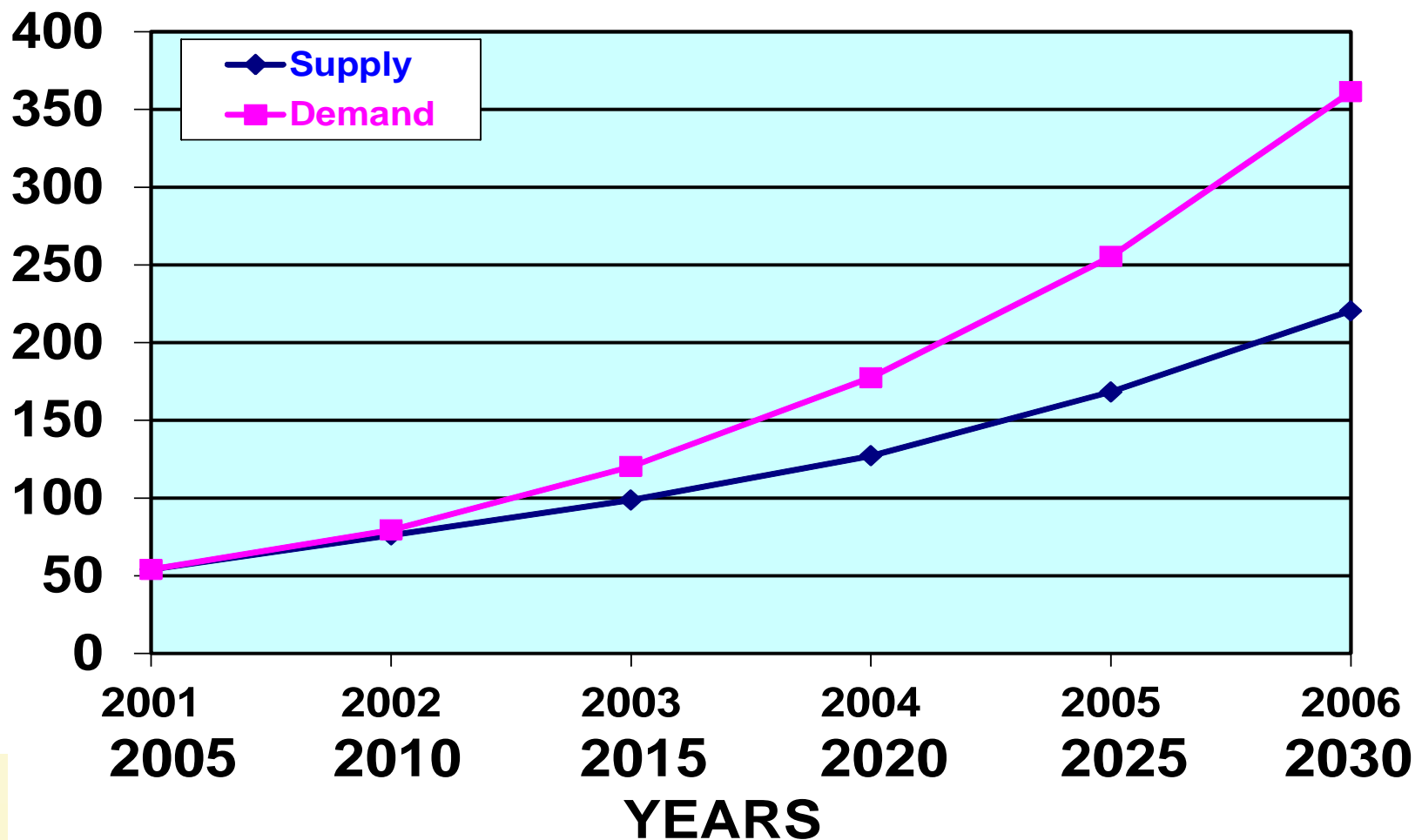


| Category | Oil MTOE (billion barrels, b.bs.) | Natural Gas, MTOE (trillion Cu. Ft) | Coal MTOE (bill.ton) |
|------------------------------------|--|--|-------------------------------------|
| Resource potential | 3622 (27) | 6849 (282) | 82695 (185) |
| Proven recoverable reserves | 113 (0.84) | 1,023 (53.54) | 886 (1.98) |
| Cumulative production | 72 (0.54) | 410 (24.64) | 89 (0.20) |
| Remaining reserves | 41 (0.31) | 612 (24.50) | 797 (1.78) |
| Annual production | 3.20 (66079 bpd) | 27.90 (1.35) | 2.10 (4.59 mill. ton) |
| Reserve / production ratio (years) | 3-5 | 20-22 | 400 + |

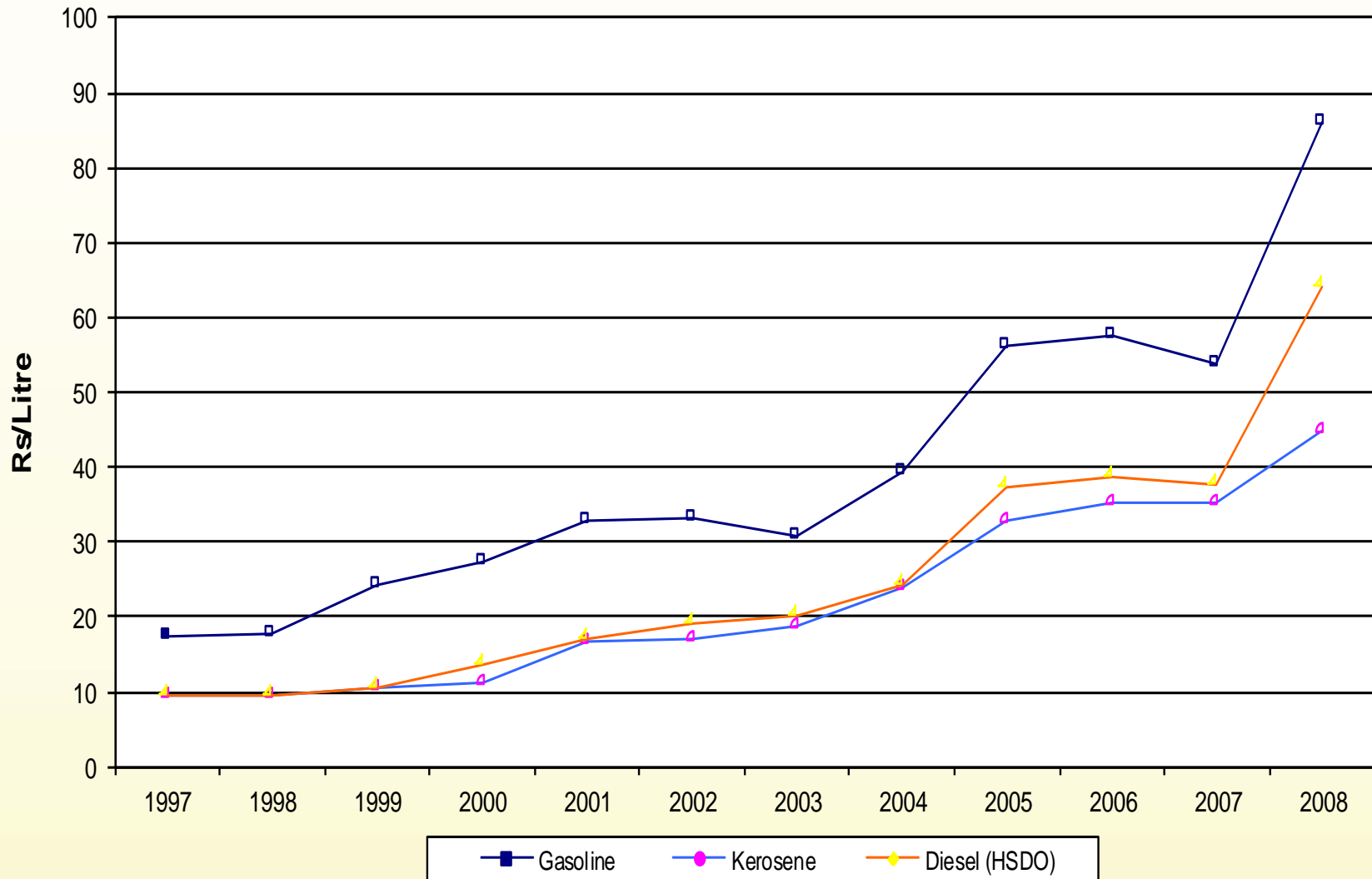
ENERGY SUPPLY & DEMAND PROJECTIONS



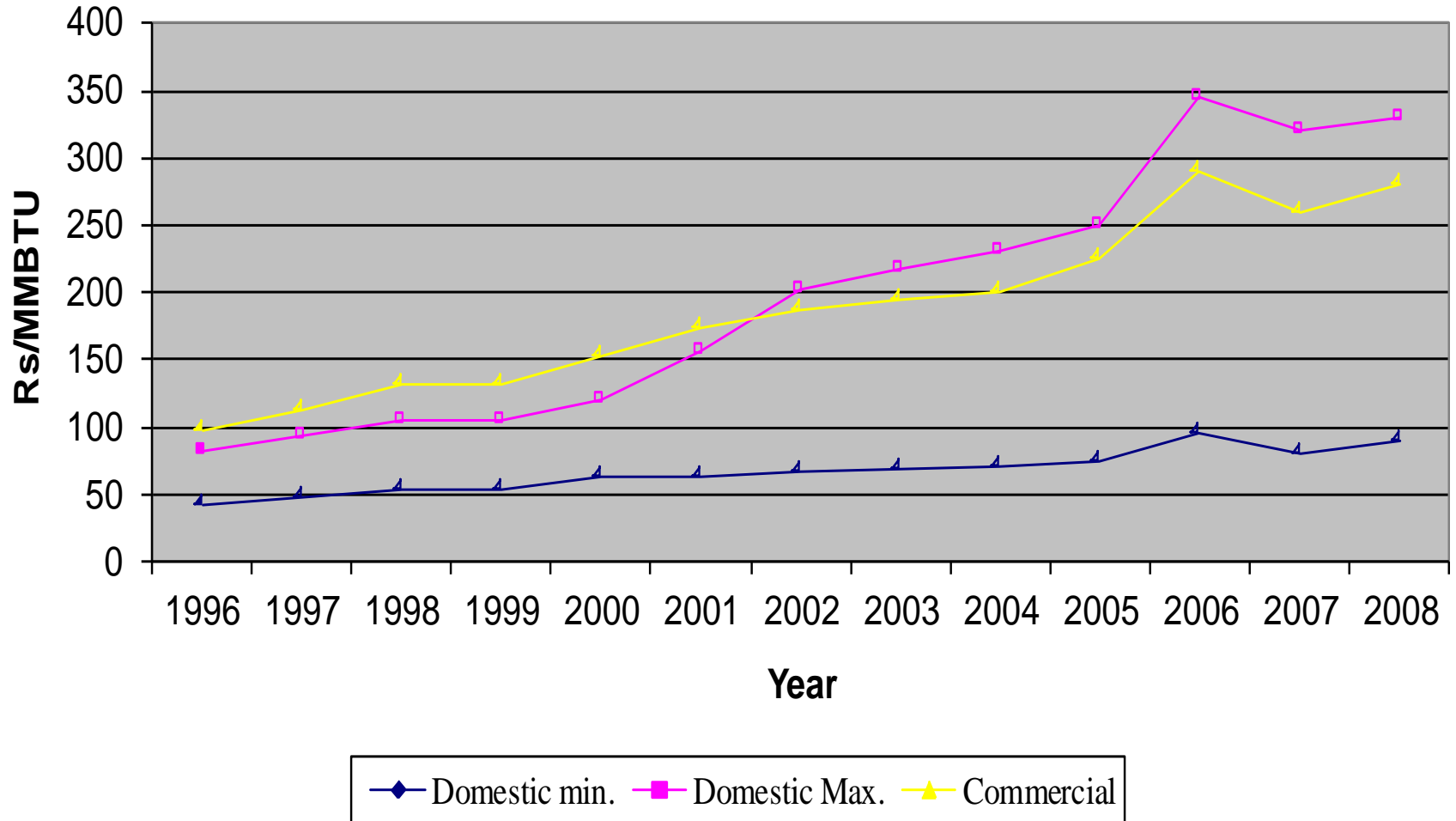
MTOE



PAKISTAN POL PRICES



PAKISTAN GAS PRICES UPTO JUNE 2008



WHY RENEWABLE ENERGY SOURCES?



- Abundant Supply
- Sustainable
- Environment friendly
- Mostly locally available and needs no networking
- Widely distributed & Can play a vital role in
 - Improving the socio-economic conditions,
 - Improving the health and;
 - Poverty alleviation of people living in remote areas

POTENTIAL OF RENEWABLE ENERGY RESOURCES



| Technology | Potential |
|------------------------|--|
| a. Solar Energy | |
| Avg. solar radiation | 4.7 to 5.20 KWh/m ² |
| Clear sky radiation | 250 to 300 days/annum, 3000 hours per annum |
| Technology status | Solar PV: Developed, reliable but costly, R&D under progress to reduce costs. 22–24% cell efficiency (Si), 14-18% system efficiency |
| | Solar Thermal: Simple / cheap, low cost e.g. solar water heater, solar dryer etc. system efficiency (40-50%) |
| Cost | PV Power: 6-10 million US\$/MW, Energy: 35-45 Cents /KWh |
| | Thermal Power: 4-6 million US\$/MW, Energy: 20-30 Cents /KWh |

POTENTIAL OF RENEWABLE ENERGY RESOURCES



| Technology | Potential |
|--------------------------------------|---|
| b. Micro-hydel | |
| Total (hydro) | > 45000 MW |
| AJK, N. Areas & canal falls | > 12000 MW |
| Technology status | Developed & reliable, micro-turbines manufactured locally |
| Cost | System: 1.2-2.50 million US\$ /MW, Energy: 7 Cents / KWh |
| c. Wind Energy | |
| Sindh, Balochistan and Coastal areas | 346000 MW (NREL, USA), including 50,000 MW at Gharo Ketī Bandar corridor (60 Km x 170 Km) & wind capacity factor 32%. |
| Technology Status | Developed & reliable, turbines (<=10KW) manufactured locally |
| Cost | System: 2 – 2.5 million US\$ /MW, Energy: 12 - 17 Cents /KWh |

POTENTIAL OF RENEWABLE ENERGY RESOURCES



| Technology | Potential |
|--------------------|---|
| d. Biomass | |
| Total | Municipal waste: 80000 tons / day (150 MW) at Lhr & Khi Agriculture waste: 156 million tons /annum |
| Technology status | Developed & reliable and in use world wide |
| Cost | System: 3.00 million US\$ /MW, Energy: 9 Cents / KWh |
| e. Biogas | |
| Resource potential | Huge, billions of cubic meter of gas can be produced |
| Technology Status | Developed & reliable, family size biogas plants are available locally |
| Cost | System: \$140 US\$/ m ³ of biogas plant (floating type gas holder) or 1.50 million US\$ /MW, Energy: 8 Cents / KWh |

COMPARISON OF RETs COSTS (USA)



| Type | Capital Cost (\$/KW) | Energy Cost (cents/ KWh) |
|-----------------------------|----------------------|--------------------------|
| Solar PV (100 KWp Plant) | 6000-10000 | 30 to 45 |
| Solar Thermal (Parabolic) | 4000-6000 | 20-30 |
| Micro hydel (300 KW System) | 3500-4000 | 10-13 |
| Wind power (10 KW System) | 3000 | 10 (+) |
| Biomass (1000 KW System) | 3000 | 9 (+) |
| Biogas Power Generation | 1500-1800 | 8-10 |
| Geo Thermal | 4000 | 10 |
| Natural Gas | | 7 |
| Diesel | | 10-12 |

COMPARISON OF RETs COST (PCRET)



| Type | Cost |
|---|---|
| Solar PV – Stand Alone System | Rs. 0.850 million per KW |
| Solar Water Pumping | Rs. 0.60 million per 4000 gallons per day |
| Micro hydel | Rs.0.10 million per KW |
| Solar Dryer (Forced convection, ac fan) | Rs.1.20 million per ton |
| Biogas (domestic) | Rs.10000 per cubic meter |
| Solar Water Heater (evacuated tube) | Rs. 40000 (270 liter) |
| Wind | Rs.0.30 million per KW |

R. ENERGY TECHNOLOGIES AT GLOBAL LEVEL



PCRET

| Technology | Market Size / Capacity | Growth Rate (2007 to 2008) |
|---------------------------|-------------------------------|-----------------------------------|
| <u>Solar PV</u> | | |
| Grid Connected Capacity | 13 GW | 70% |
| Annual Module production | 07 GW | 88% |
| Solar Thermal (Hot Water) | 145 GWth | 19% |
| Wind Power | 121 GW | 33% |
| Micro Hydel | 85 GW | 10% |
| Geothermal | 10 GW | 4% |
| Biomass Power | 52 GW | 4% |
| Ethanol | 67 b.litre | 36% |
| Bio diesel | 12 b.litre | 25% |

- Pakistan Council of Renewable Energy Technologies (PCRET), M/o Science and Technology (MoST)
- Alternative Energy Development Board (AEDB), M/o Water and Power
- Provincial Govts (Dept. of Agriculture, Energy, AEED etc.)

PCRET - MISSION STATEMENT



Committed to research, develop,
promote, disseminate, impart training,
and create renewable energy culture in
the country

1. Solar

➤ *Photovoltaics*

➤ *Thermal*

2. Micro-Hydel

3. Bio-Gas

4. Wind

PV TECHNOLOGY SPECTRUM



- **Silica Sand / Quarts**



- **M.G.Silicon**



- **High purity Silicon**



- **Silicon Ingot**



- **As cut wafers**



- **Solar cells**



- **PV Module**



- **PV System**

PV PRODUCTS



Silicon Wafers

Silicon Solar Cells

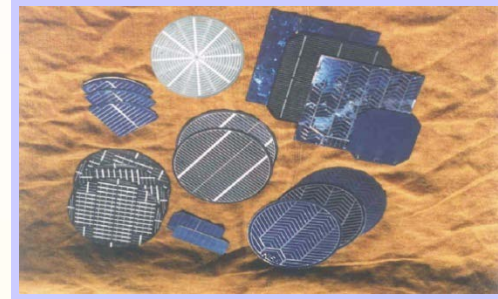
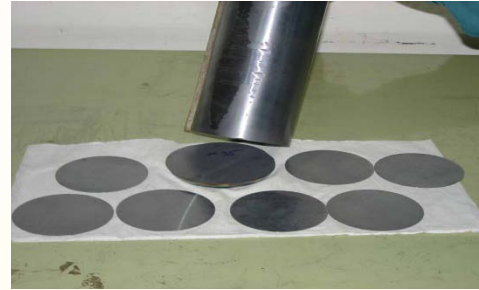
PV Modules

Solar Lantern/Torch

Solar Street/Park Lights.

Solar Cells/Battery Charges

Solar Mobile Charger



PHOTOVOLTAICS



| | |
|-----------------------------|--------|
| PV systems (300) installed | 100 KW |
| Mosques/Schools electrified | 120 |
| Houses Electrified | 500 |
| Village Electrified | 04 |

SOLAR POWER AT SCHOOLS



Bachoo Goth, Lasbella



Tardos, Thar



Juman Moosa, Thatta



Usman Kot, Sanghar

SOLAR POWER AT MOSQUES



Tardos, Thar



Umar Goth, Lasbela



Padiaro, Sanghar



Bhoori, Keti Bunder

SOLAR THERMAL



➤ **Water Heaters**

➤ **Dryers**

➤ **Cookers**

➤ **Desalination**



SOLAR THERMAL



**a) Water Heaters Installed : 30 units (6000 liters)
(Since 1997)**



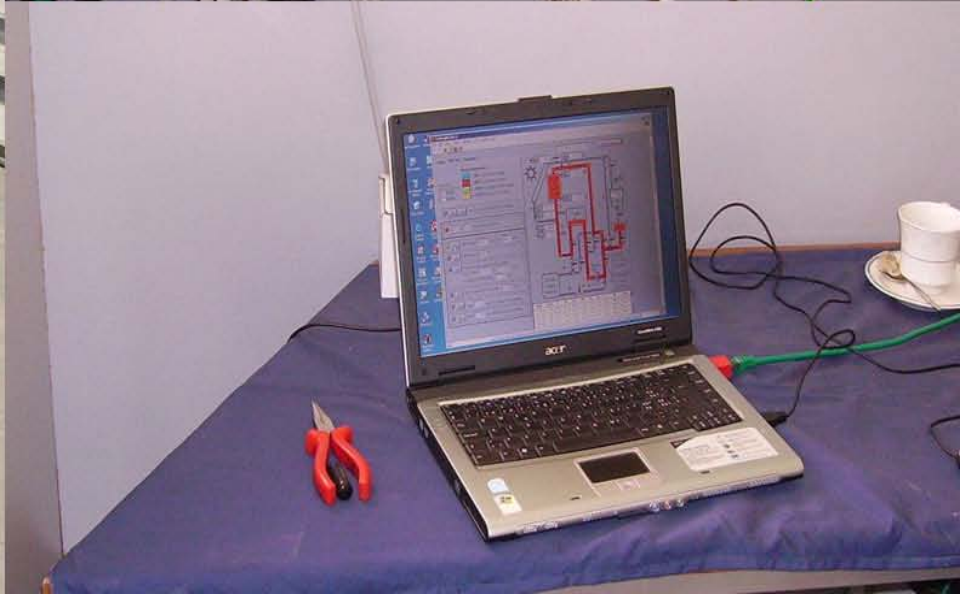
SOLAR THERMAL

b) Dryers Installed (2005-07)

11 (@0.5 ton each)



TESTING OF SOLAR APPLIANCES / SYSTEMS



a) Perennial Falls

Systems Installed

**360 units (5.0 MW)
(in 25 years)**

Under Execution

100 units (52 operational)





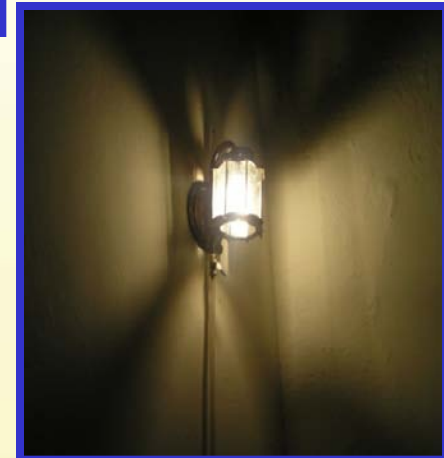
BIOGAS

Plants Installed

2500 (3.5 million m³/year)

In Pipeline

1500 (2.5 million m³/year)





WIND ENERGY



Units Installed (2004-07)

130 Units (0.5-10 kW)

Net Capacity

143.1 kW

Houses electrified

1430



Wind turbine (5 KW) for power supply to house holds at Kemari Town Karachi



Wind turbine (5 KW) for battery charging at Kemari Town Karachi



**A Panoramic View of Village Gul Muhammad, Showing some of the Wind Turbines installed by PCRET
(April 2005)**

PCRET NEW LABS AND WORKSHOP



PCRET NEW LABS



PCRET NEW LABS



PCRET NEW LABS



PCRET NEW LABS



➤ Functions

- To act as facilitator for the development and promotion of RETs thro mega projects by private sector
- To develop strategies, policy and plans for utilization of renewable energy resources in Pakistan
- Dissemination of RETs thro pilot projects
- Rural electrification thro renewable energy power projects (off-grid applications only)

AEDB ACHIEVEMENTS



➤ **Wind Power**

- Installed / in operation: 6 MW (Zorlu Energy Ltd.)
- Under Construction: 56 MW (Zorlu Energy Ltd.)
50 MW (Fauji Fertilizer Power Ltd.)

➤ **Solar PV**

- 5000 homes in Sindh (Mithi) supplied with PV lights and fan @ 80-120W each.
- Solar Water pumps (18) installed for drinking purposes

➤ **Biomass Power**

- 34 MW power generation from sugar mills, molasses & bagasse, at DI Khan and Jhang

➤ **Capacity Building**

○ **Human Resource Development**

- Highly qualified and trained manpower
- Career progression
- Training workshops and seminars
- Exchange visits with developed countries

○ **Strengthening RE Institutions**

- Up-gradation of labs. & workshops thro induction of modern state of the art equipment
- Establishment of testing and calibration facilities
- Establishment of RE institutes of excellence in Provinces/ Universities

➤ **Linkages Between R&D, Academic & Industry**

- R&D on emerging areas of RE
- Involvement of private sector in commercialization of RETs / products

➤ **Policy Matters**

○ **Incentives to Industry and End Users**

- Subsidy on capital cost
- Soft loans to industry / entrepreneurs
- Exemption from taxes

○ **Market Development**

- Attractive incentives for private sector dealing in RE products
- Public awareness regarding RE products through print / electronic media



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THANK YOU