



Country's Research Priorities in Energy

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Research in Energy

Generation

Country Resources
Hydropower
Coal
Nuclear

Renewable Resources
Solar (PV and Thermal)
Biomass
Wind

Transmission & Distribution

Losses
Improvements

Smart Grid

Consumption

Agriculture
Pumping Systems

Smart Buildings
Domestic and Commercial

Industries
Motors/Boilers/Lighting Systems

Energy Efficient Appliances

Cost of Generation per Unit

- Hydro Power 5-6 cents
- Coal 9-10 cents
- Nuclear 13-15 cents
- Solar 10-12 cents
- Biomass 8-9 cents
- Wind Power 12- 13 cents

Research Priorities in Energy

- Energy generation technologies with lowest unit cost
 - Utilizing country's resources
 - Hydel
 - Coal
 - Nuclear
 - Development of Renewable Energy Resources
 - Solar (PV and Thermal)
 - Biomass
 - Wind

Research Priorities in Energy cont...

- Transmission and Distribution Systems
 - Reduce losses in Grid and Transformers
- Demand Side Management
 - Building Energy Optimization
 - Commercial
 - Residential
 - Industrial Energy Optimization
 - Agriculture Energy Optimization

Generation Technologies

- Development of low head low flow rate small Hydro stations
 - Development of low speed direct drive generators suitable for low heads (<5m)
 - Development of permanent magnet excitation generators for hydro applications
 - Development of submersible turbo-generators
 - Improvement in construction materials of turbine making it lighter, long lasting, cheaper
 - Development of methods to increase water head at low head sites without environmental impact

Generation Technologies

- Coal Based Generation
 - Development of coal gasification suitable for local coal (Thar)
 - Thar Coal Analysis
 - Treatment methodologies
 - Development of methodologies for mixed fuel co-gasification
 - Biomass, agri-waste mixed with coal
 - Classification of gasification reactions
 - Analysis of reaction behavior, thermodynamic studies

PAKISTAN COAL RESERVES / RESOURCES AS ON JUNE 30, 2012

PROVINCE Coal Field	Seam Thickness Range(Metres)	Resources (Million Tonnes)					Status	Coal Quality Proximate Analysis (%)					Rank as per ASTM Classification	Heating Value Range (mmtf) (Btu/lb)
		Total	Measured Reserves	Indicated	Inferred	Hypothetical		Moisture	Volatile Matter	Fixed Carbon	Ash	Total Sulphur		
BALUCHISTAN:														
Barkhan-Chamala	0.3 - 2.0	6	1		5		Dev.	1.1 - 2.9	24.9-43.5	19.4-47.1	9.1-36.5	3.0-8.5	hvCb to hvAb	12,500 - 14,357
Duki	0.2 - 2.3	50	14	11	25	-	Dev.	3.5-11.5	32.0-50.0	28.0-42.0	5.0-38.0	4.0-6.0	SubB to hvAb	10,131 - 14,164
Mach-Abegum	0.6 - 1.3	23	9	-	14	-	Dev.	7.1-12.0	34.2-43.0	32.4-41.5	9.6-20.3	3.2-7.4	SubA to hvCb	11,110 - 12,937
Sor Range-														
Degari	0.3 - 1.3	50	15	-	19	16	Dev.	3.9-18.9	20.7-37.5	41.0-50.8	4.9-17.2	0.6-5.5	SubA to hvBb	11,245 - 13,900
Pir Ismail Ziarat	0.4 - 0.7	12	2	2	8	-	Dev.	6.3-13.2	34.6-41.0	19.3-42.5	10.3-37.5	3.2-7.4	SubA to hvCb	10,786 - 11,996
Khost-Sharig-														
Harnai	0.3 - 2.3	76	13	-	63	-	Dev.	1.7-11.2	9.3-45.3	25.5-43.8	9.3-34.0	3.5-9.55	SubB to hvAb	9,637 - 15,499
Sub-Total:		217	54	13	134	16								
PUNJAB:														
Makarwal	0.3 - 2.0	22	5	8	9	-	Dev.	2.8-6.0	31.5-48.1	34.9-44.9	6.4-30.8	2.8-6.3	SubA to hvAb	10,688 - 14,029
Salt Range	0.15 - 1.2	213	50	16	2	145	Dev.	3.2-10.8	21.5-38.8	25.7-44.8	12.3-44.2	2.6-10.7	SubC to hvAb	9,472 - 15,801
Sub-Total:		235	55	24	11	145								
SINDH:														
Lakhra	0.3 - 3.3	1,328	244	629	455	-	Dev.	9.7-38.1	18.3-38.6	9.8-38.2	4.3-49	1.2-14.8	LigB to SubC	5,503 - 9,158
Sonda-Thatta	0.3 - 1.5	3,700	60	511	2,197	932	Non-Dev.	22.6-48.0	16.1-36.9	8.9-31.6	2.7-52.0	0.2-15.0	SubC to hvBb	8,878 - 13,555
Jherruck	0.3 - 6.2	1,823	106	810	907	-	Non-Dev.	9.0-39.5	20.0-44.2	15.0-58.8	5.0-39.0	0.4-7.7	SubC to hvCb	8,800 - 12,846
Ongar	0.3 - 1.5	312	18	77	217	-	Non-Dev.	9.0-39.5	20.0-44.2	15.0-58.8	5.0-39.0	0.4-7.7	LigB to SubA	5,219 - 11,172
Indus East	0.3 - 2.5	1,777	51	170	1,556	-	Non-Dev.	9.0-39.5	20.0-44.2	15.0-58.8	5.0-39.0	0.4-7.7	LigA to SubC	7,782 - 8,660
Meting-Jhimpir	0.3 - 1.0	161	10	43	108	-	Dev.	26.6-36.6	25.2-34.0	24.1-32.2	8.2-16.8	2.9-5.1	LigA to SubC	7,734 - 8,612
Badin	0.55 - 3.1	850	150	0	200	500	Non-Dev.							11,415 - 11,521
Thar Coal *	0.2 - 22.81	175,506	2,700	9,395	50,706	112,705	Non-Dev.	29.6-55.5	23.1-36.6	14.2-34.0	2.9-11.5	0.4-2.9	LigB to SubA	6,244 - 11,04
Sub-Total:		185,457	3,339	11,635	56,346	114,137								
KPK:														
Hangu/Orakzai	0.43 - 0.6	82	1.0	4.5	76	-	Dev.	0.2-2.5	16.2-33.4	21.8-49.8	5.3-43.3	1.5-9.5	SubA to hvAb	10,500 - 14,149
Cherat/Gulla Khel	0.8 - 1.2	9	0.5	-	8	-	Dev.	0.1-7.1	14.0-31.2	37.0-76.9	6.1-39.0	1.1-3.5	SubC to hvAb	9,386 - 14,171
Sub-Total:		90	1.5	4.5	84	-								
Azad Kashmir														
Kotli	0.25 - 1.0	9	1	1	7	-	Dev.	0.2-6.0	5.1-32.0	26.3-69.5	3.3-50.0	0.3-4.8	LigA to hvCb	7,336 - 12,338
Sub-Total:		9	1	1	7	-								
Total:		186,007	3,450	11,677	56,582	114,298								

Development of Renewable Resources

- Photovoltaic Cell development (high efficiency, low cost)
 - Focus on Thin Film based technologies for low cost cell development
 - Fabrication of Solar Dye Sensitized cells
 - Achieved 7% efficiency (CERAD)
 - Working on improving efficiency
 - Development of local manufacturing and encapsulation technologies for cheaper solar cells
 - Hydrogen from Artificial Photosynthesis



Photovoltaic Generation Technology

- **Power Electronics and Control**
 - Development of low cost Indigenous invertor
 - Development of low cost VFD
- **Optimization of power storage devices**
 - Deep Cycle Tubular Battery,
 - Zinc Air Battery, rechargeable
 - Grid Scale Molten Metal battery



Solar Thermal Energy

- **Development of Solar Thermal Energy Generation Systems**
- **Solar Steam Turbine**
 - Development of Indigenous Solar Steam Turbine
 - Development of Hot Air Engine
 - Development of Sun tracking Helioscopes
- **Development Solar Sterling Engine**



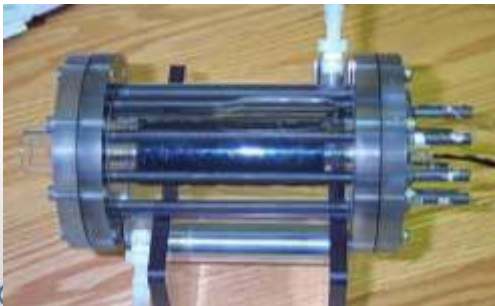
Bio Energy

- **Development of technologies for Biomass Gasification**
 - Rice husk
 - Bagasse
 - Wheat stock
 - Cotton stock
 - Municipal waste
 - Cow Dung
- **Gas treatment for purification**
- **Production of Bio Ethanol from Agriculture Waste**



Fuel Cell

- **Development of Hydrogen Fuel Cell**
 - Research on development of in-expensive membrane
- **Development of HHO Fuel Cell**
 - Upto 40% fuel saving achievable
- **Metal Air Fuel Cell**
- **Microbial Fuel Cell**
 - Research on new materials for capacity development



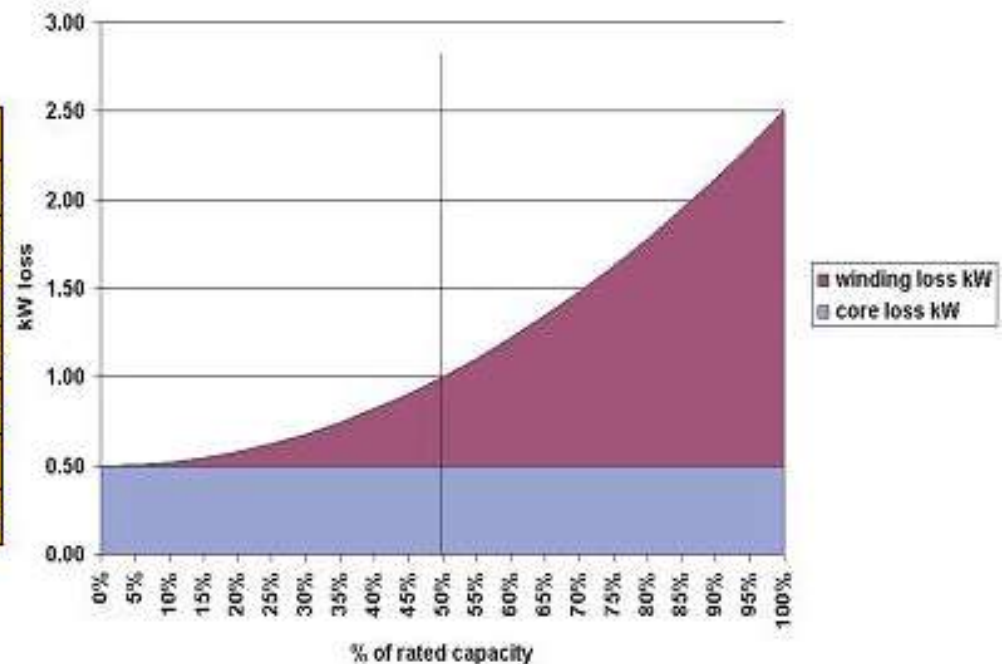


Transmission and Distribution

- Develop technologies for reducing losses in Transmissions (approx. 6%) and distribution (approx. 20%)
- Transformers are main source of losses in distribution
 - Develop diagnostics and prognosis techniques for isolating and replacing lossy components
 - Develop smart grid infrastructure for prevention of loss and theft

Transformer Losses

Pak Secretariat	Capacity kVA	Load %
	750 kVA	52.33
	500kVA	35.18
	750kVA	35.52
	500kVA	32.65
	500kVA	35.52
	630kVA	38.91
	550kVA	40.26



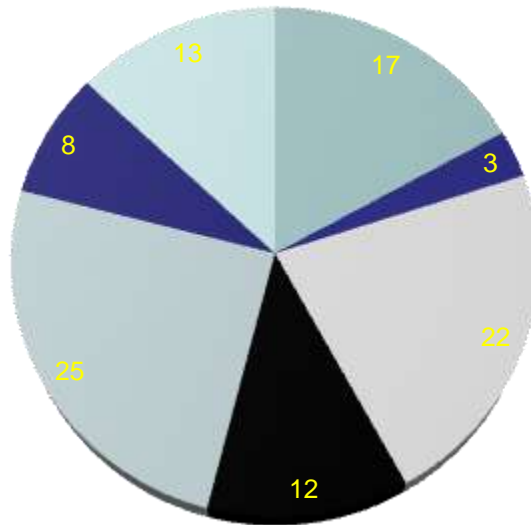
Over 50% loading, the winding losses increases. This point may be considered while installing Transformer.

Energy Conservations

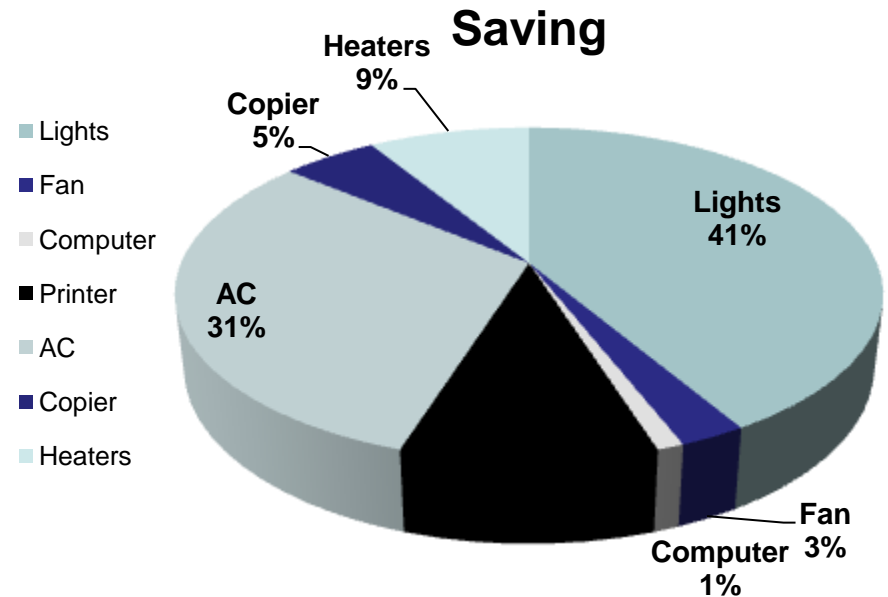
- Smart Building for Smart usage
 - Building Envelope
 - Building Type, Geometry, Location
 - Wall and Wall layers
 - Roof and Roof Layers
 - Window Glazing
 - Construction Building Material
 - Lighting
 - HVAC
 - Mechanical and Electrical System & Equipment
 - Service Water heating etc

Building and Domestic Appliances Load and Potential Saving

Load %age Contribution



%AGE SAVING POTENTIAL

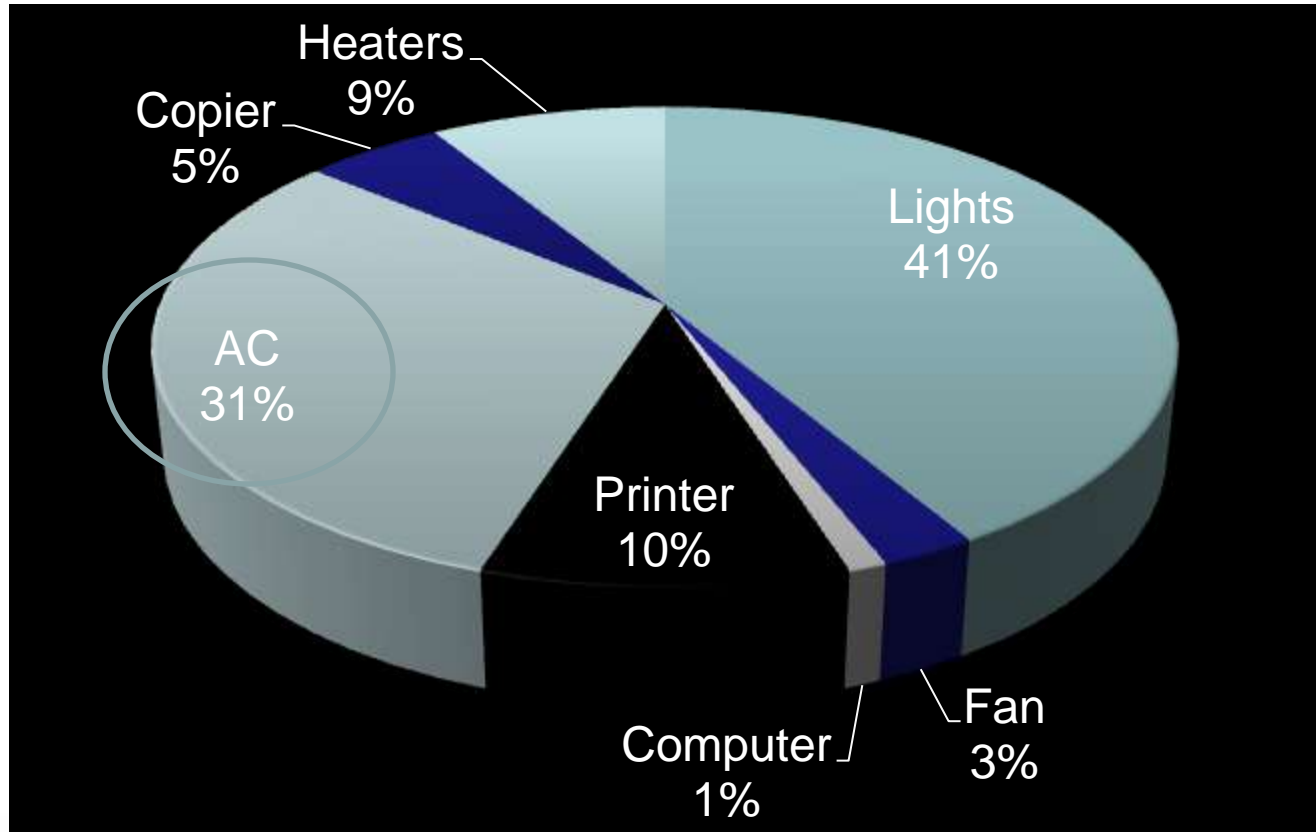


	Lights	Fan	Computer	Printer	AC	Copier	Heaters
Load	17	3	22	12	25	8	13
Saving	41	5	2	19	18	10	17

Energy Savings through Appliances

Appliances	%age savings	Details
Lights	30-80%	Use LED Lights Occupancy Sensors, Natural Lights, Change of Sitting Orientations
Fan	20%	Use energy efficient Fan with pure copper windings, Occupancy Sensors
Computer	5%	Use computer with standby ON/OFF option
Printer	50%	Use Network printers, Energy star printers
AC	45%	User solar AC, Double Glass Windows, Setting AC temp. at 25oC, Occupancy Sensors, Thermal Insulation
Photocopier	24%	Use Network printers, Energy star printers
Heater	41.5%	3hr Running instead of 5 hours, utilize natural heating

%age saving potential in AC



Reduce Heating and Cooling Load

- Minimizing the lavish life-style and maintain cooling capacity @ 25°C
- Develop Direct/Indirect Evaporative cooling System (save 80%)
- Develop Geothermal Heating and Cooling System (Save 60%)
- Develop Hybrid Solar Air-conditioning Systems
- Building Envelops



ENERGY CONSERVATION IN INDUSTRIAL SECTOR

Energy Efficient Thermal Utilities

- Development of high efficiency low cost components for
 - Boilers
 - Steam System
 - Furnaces
 - Insulation
 - Waste heat recovery

Industrial Sector

- Motor
 - 30 to 70% load consumption in industrial sector is due to motor load
 - By developing high efficiency motors, energy saving and pay back period is given below for a typical motor:

Electricity Consumed (MWh/year)	Electricity saved (MWh/year)	Million rupees	Payback years
3800	150	6.47	4.5

Agriculture

- Using Submersible Pumping System
- Highly Efficient Surface pumping system
- Use of VFD with surface pumps
- Introduction of solar pumping systems



Thank You