India's Power Sector & Cross Border Linkages

Opportunities and Challenges

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Bishkek, 26 April 2007

India : Composition of Energy Supply (%)

	India
Conventional	33
Crop Residues(*)	21.8
Animal Dung	5.3
Fuel Wood	5.9
Commercial	6.7
Oil and Coal	39
Natural Gas	0.7
Hydel Power	27

Per capita commercial energy consumption : Rather low

Per Capita Commercial Energy Consumption

Country	Kg of Oil Equivalent (Kgoe)	
	1990	2000
India	424	494
South Asia	394	443
World	1705	1694
India as % of World Average	24.86	29.16

Energy security : most critical issue.

Frequent disruption of power :
lead to serious crisis affecting both human (food, employment and economy) and national security (environment, international trade, communications, transport and other services).

Policy makers and people :
aware of vulnerability of energy sources and supply.

India has undertaken series of reform measures in power sector.

Phased manner since last decade.

Significant developments : last few years :

introduce more competition in the sector

Skewed distribution of available energy
Situation more critical : divorce between supply zones and demand centres

India : Distribution of Energy Resources

Region	Coal (mt)	Lignite (mt)	Crude Oil (mt)	Natural Gas (mcm)	Hydro-power (TWH)
Northern	1.06	2.51	0.03	0.00	225.00
Western	56.90	1.87	519.47	516.42	31.40
Southern	15.46	30.38	45.84	80.94	61.80
Eastern	146.67	0	2.19	0.29	42.50
North-Eastern	0.89	0	166.17	152.00	239.30
Total	*220.98*	*34.76*	*733.70*	*749.65*	*600.00*

significant portion of society still donot have access to modern sources of energy : physical inaccessibility and affordability.

Number of consumers : only 44 % of rural households have access to electricity

Commercial energy front : dependence on import of petroleum has been steadily increasing
Cross subsidy issue : very critical today

Cross subsidies extended by industrial and commercial customers (they pay Rs 2.34 per kWh) to the agricultural and domestic customers

(who pay Rs 0.21 and Rs 0.91 per kWh respec-tively)
Electricity pricing : very crucial issue in both internal and external trading.
Large uncovered gap still exists between costs and tariffs of power supply in India.

The percentage of unit cost of supply recovered through consumer tariffs is estimated to be 64.66 %.

India: Restructuring and Policy Reforms

Major reasons
Deteriorating demand-supply balance
Adverse impact on the economy
No finances available to bridge this huge gap
Large scale sickness of the State Electricity Boards
Huge financial burden on the generating units particularly of the central sector
Distortion brought about by cross subsidies
Deteriorating quality and reliability of electricity supply

Policy Interventions
Induction of private investment into power generation which is most capital intensive
Segregation of the regulatory functions from the Government and vesting them in an Independent Regulatory Commission
Unbundling the various activities from a vertically integrated unit to distinct and separate units based on functions
Corporatisation of various units, namely, vesting the units in a company incorporated under the Companies Act, 1956
Tariff reform
Private sector participation, wherever the same is considered by the State to be advantageous
Electricity Regulatory Commissions both at the Centre (CERC) and the States (SERC) for rationalising tariff and other allied matters.

✔ Reduction in constraints in foreign equity participation, simplifying licensing and approval procedures and making rate of return for investments more attractive.

✔ Foreign investment allowed both as a joint venture or as a fully-owned opera-tion with 100 % foreign equity in thermal, hydel and wind or solar energy without any limitation to size.

✔ Foreign equity participation upto 74 % in generation and transmission automatically approved by RBI

✔ Captive power plants set to serve industrial are permitted to sell or distribute sur-plus power to SEBs.

✔ Mega power policy (over1000 MW) allowed free imports of capital goods

✔ The thrust of the reform programme is now in power distribution.

The Electricity Act 2003

- **To usher in an era of multi buyer-seller model.**
- **A thrust to complete rural electrification and provide for management of rural distribution by Panchayats, Cooperative Societies, non-Government organizations, franchisees etc.**
- **Generation to be delicensed and captive generation to be freely permitted.**
- **Transmission Utility at the Central as well as State level, to be a Government company-with responsibility for planned and coordinated development of transmission network.**
- **Open access in transmission from the outset with provision for surcharge for taking care of current level of cross subsidy with the surcharge being gradually phased out.**
- **Metering of all electricity supplied made mandatory.**
- **Provisions relating to theft of electricity made more stringent.**

Protracted Hurdles

Even after the reforms were initiated many of the past factors and trends that led to serious distortion in the power sector continue to be serious and confounded.

Huge Losses (excluding the subsidies) incurred by SEBs

State utilities have defaulted in payments to central PSUs including NTPC, Power Grid Corporation, NHPC, Coal India Ltd, Railways and have accumulated substantial arrears.

Reliability and accessibility continue to be a serious problem.

Energy and peak shortages of power have been around 7.5 percent and 12.1 percent respectively leading to brownouts and blackouts across the country. Scheduled power cuts, unscheduled outages and incorrect voltages are common in most states, leading to enormous disruptions in all aspects of economic life.

Basic problem : faced by the sector
gap between user charges and the cost of supply.

Despite reform efforts, the gap between
supply and the average tariff has actually worsened.

India : Recovery of Cost through Tariff

Year	Average Cost/Unit (paise)	Average Tariff/Unit (paise)	% Recovery of Cost (paise)
1992-93	128.2	105.4	82.2
1995-96	179.6	139.0	77.4
2001-02	349.9	239.9	68.6

Reforms : Emerging Gains

***Impact* of reforms : distinct in some major operational areas.**
Plant Load factor (PLF), an important measure
of operational efficiency of thermal power plants,

improved significantly from 64.7 percent in 1997-98
to 73.6 percent in 2005-2006 implying
a secular improvement in the efficiency in generation .

Share of private sector in the total installed capacity
has gone up from 4.14 % in 1991 to over 11 % in 2006

Power Market : Nature and Implications

I) Remarkable increase in the demand for power burgeoning domestic demand; changing needs of consu-mers; rural electrification projects ; power driven industrialisation

India : Electricity Consumption by Economic Groups (Utilities) (percent)

Year	Domestic	Comme -rcial	Industry	Traction	Agricul ture	Othe rs
1950-51	12.6	7.5	62.6	7.4	3.9	4.0
1960-61	10.7	6.1	69.4	3.3	6.0	4.5
1970-71	8.8	5.9	67.6	3.2	10.2	4.3
1980-81	11.2	5.7	58.4	2.7	17.6	4.4
1990-91	16.0	5.9	44.2	2.2	26.4	4.5
2000-01	23.9	6.1	34.0	2.6	26.8	5.6

All India Projected Demand

Regions	Energy Requirement (Mkwh)			Peak Load MW		
	20006-07	2011-12	2016-17	2006-07	2011-12	2016-17
Northern	220820	308528	429480	35540	49674	69178
Western	224927	299075	395859	35223	46825	61966
Southern	194102	262718	354599	31017	42061	56883
Eastern	69467	90396	117248	11990	15664	20416
North-Eastern	9501	14061	20756	1875	2789	4134
All India	719097	975222	1318644	115705	157107	212725

India's Supply/Demand Scenario through 2012

Region	Present Demand 2001 (MW)	Projected Demand 2012 (MW)	Planned Capacity Addition by 2012 (Central Govt) (MW)	Surplus or Shortfall (MW)
Northern	21,000	49,000	14,000	(-)14,000
Southern	20,400	42,000	10,000	(-)12,000
Western	24,900	46,000	16,000	(-) 5,100
Eastern Northeastern	8,750	19,000	23,000	(+)12,750
Total	75,050	156,000	63,000	(-) 17950

Central Electricity Authority (CEA) :

Projected peak demand of 212725 MW peak demand in 2016-17,

over 32 percent : from Northern India,
29 percent : southern region,
26 percent : western
9 percent : Eastern region.

Power demand in India as a whole
is growing at around 10 percent per annum.
National level : consumption in
industrial sector is the highest (34 percent)

States : domestic sector constitutes the major segment.

Close match between seasonal capacity surpluses in Nepal
& Bhutan and shortages in India

India: Installed Generating Capacities in Power Utilities (MW)

	India
Thermal	75931
% Share	(72.3)
Nuclear	2700
% Share	(2.57)
Hydro	26329
% Share	(25.1)
Total	104960

South Asia region : richest sources of hydel power

South Asia : Installed Capacity and Potentials of Hydro Power

	Hydroelectric Total Potential [MW] (a)	% Installed Capacity [MW[(b)	Harnessed of the Total (b) as % of (a)
Bangladesh	555	230	65.71
Bhutan	30000	444	1.48
India	75400	25407	33.70
Nepal	83290	368	0.44
Pakistan	40000	5010	12.52
Sri Lanka	2000	1129	56.45
Total	231245	32588	14.09

Internal Power Exchange

The intra-country power exchange gives a broad indications about the :
nature of power trading within a country and various regions of a country

- → **geographical locations of load centers within a country**
- → **existing institutional mechanisms in power transfer and sales**
- → **trading mechanisms including the tariff fixations**
- → **potential regions of both power generation and market**

Inter-regional Power Exchange (MU)

From/To	North..	West..	South..	East ..	North-East..	Total
Northern		975.4		22		997.4
Western	299.1		798.9			1098
Southern		621				621
Eastern	1768	2380	4742		665	9555
North-Eastern						0
Total	2067.1	3976.4	5540.9	22	665	12271

Scope for Cross Border Energy Trade

Two primary hypotheses :

i) Cross border Energy trade with a comprehensive regional grid and pipeline network will act as a major confidence building project in making the process of economic integration in SAARC a reality

ii) Cross border energy trade could ultimately be a panacea for many of the development ills in this region particularly for the LDCs.

Basic Premise

Cross border energy trade can lead to :

- Bridging of seasonality gaps
- Reduced cost per unit of energy supplied and losses in the systems
- Accelerated availability of supplies to meet suppressed demand.
- Improved system reliability and quality of supply
- Integrated transmission and distribution systems that could reduce energy supply costs

Equally vital : generation of chain of stakeholders

Confidence Building :
New and sturdy agents and stakeholders :
power producers, distributors, traders,
transmission and grid operators , pipeline builders,
credit donors, technology exporters,
managerial and users like
industries, households, transports and agriculture.

They have tremendous absorptive capacity
of shocks emanating from any major
political actions, apprehensions
and dislocations. They prevent conflictual precipitations.

Energy availability & trade : all pervasive impact.

revenue generation,
foreign exchange savings,
transformation in the contents of export basket

health and education standards,

opportunities for income, employment generation &

cross border and internal migration

gross domestic income
environment
Gender equalities

Khatib and Munasighe (1992) estimated :
cost of power shortage to India
and Pakistan's industrial sector
to be 1.5 percent and 1.8 of GDP.

Increasing Demand-Supply Gaps in Power sector

Serious power shortfall

Likely to deepen further

SAARC countries : largely energy importers

Adversely affected
productive activities, social development and
investment climate.

Factors that could trigger energy trading

i) Policy Guidelines

SAARC countries : clearly expressed interest in Energy trading with the neighbouring countries Mentioned in policy documents :

India : Electricity Act 2003

A crucial provision : all distribution companies, traders and generating companies will have non-discriminatory "open access" to inter-state electricity transmission system
Will facilitate competition in the industry to usher in an era of multi buyer-seller model.

It permits trading in power

National Energy Policy (1995) of Bangladesh : "regional and international cooperation for importing electricity from neighboring countries under utility cooperation under the umbrella of SAARC"

ii) Seasonality in Power Generation

Peak hydel power generation in Bhutan and Nepal during June-September (wet season)

Matches peak demand in India, Pakistan and Sri Lanka

Power starved hot summer months

Generated a lot of interest :
cross border power trading

All these inter-connecting channels very well match Indian effort to have integration of all regions to form a National Grid by the end Eleventh Plan in 2012.

Once completed : cumulative inter regional power transfer capacity would increase to a level of about 30000 mw by 2012.

iii) Regional Re-affirmation

“Sub-regional power grid” idea approved : Xth SAARC (Colombo)

“Energy Ring” XIIth SAARC Summit (Islamabad) Declaration 2004

Existing Arrangements

i) India-Nepal Power Exchange

Systematic power exchange has been underway since the last three decades 50-150 MW

Exchange of Power between India and Nepal

	1993	1995	1997	2001
Bulk energy sale to India (GWH)	46.1	39.5	100.2	126.0
Bulk energy purchase from India (GWH)	82.2	113.8	154.0	226.5
Revenue from bulk sale to India (Rs million)	75.5	97.6	249.3	441.0

ii) Bhutan : Chukha Project

336 MW Chukha project : power exported to India
Earned Nu 2367 million ($ 52 million) in 2002-2003

45 percent of Bhutan's exports to India and
11 percent of Kingdom's GDP.

Chukha model : worked very well :
76 percent of generation exported .
Region should take note of this success story
Bhutan keen to diversify the power market

Clear situation of monopsony : India is the only buyer.
Number of hydel plants : North East region

iii) **West Seti Project of Nepal : New Direction**
Third type of power exchange (750 MW):
Likely to take place in the region.

Unique feature :
First dedicated export project by private agency
: Meant primarily for exports to India
Agreement designed if implemented : on schedule

Nepal realizes total revenue of Rs 1403 crore in 2007 and Rs 5681 crore in 2031.

Currently power trading : infancy in South Asia region.
Basically bilateral exchanges

IV) Option :

Regional Trading through a SAARC Grid

Bring Power from Generating Units in Bhutan, Nepal and the North East region of India

Pool them in a Regional Grid like Southern African Power Pool (SAPP)

Wheel them into Load centres of Sri Lanka, Bangladesh, Pakistan and even Afghanistan

Establish : Regional Power Trading Corporation "SAARC-RPTC".

Existing Regional Power Pools

Regional Arrangement	Member Countries
Union for the Coordination of Transmission of Electricity (UTCE)	Spain, Portugal, France, Belgium, Italy, Netherlands, Luxemburg, Austria, Germany, Switzerland and now extended to Poland, Czech Republic, Slovak Republic, Hungary, Slovenia and Croatia.
Nord Pool	Norway, Sweden, Finland & Denmark
North American Electric Reliability Council (NERC)	United States and Canada.
Southern African Power Pool (SAPP),	South Africa, Lesotho, Mozambique, Namibia, Malawi, Zimbabwe, Zambia, Botswana, Angola, Swaziland & Tanzania
The Commission of Regional Power Integration (CIER)	Jordan, Bahrain, Tunisia, Algeria, Saudi Arabia, Syria, Libya, Egypt, Morocco, Mauritania, Yemen, Iraq, Lebanon, Palestine, Dubai and Qatar
South America, power trading	Argentina, Paraguay & Uruguay.
	Central America

India's proposed Power Import from Pakistan

1998 Pakistan's offer to India to sale surplus power

Discussions : Power Grid Corporation of India Limited (PGCIL) and WAPDA led various independent power producers (IPPs) in Pakistan

2nd Draft of the Interconnection and Operating Agreement was discussed on 1 February 1999

Tariff : major stumbling block

WAPDA offered : US 7.2 cents/KWH

While Indian side offered : US 2.25 cents

Negotiations broke off

Transmission Arrangement

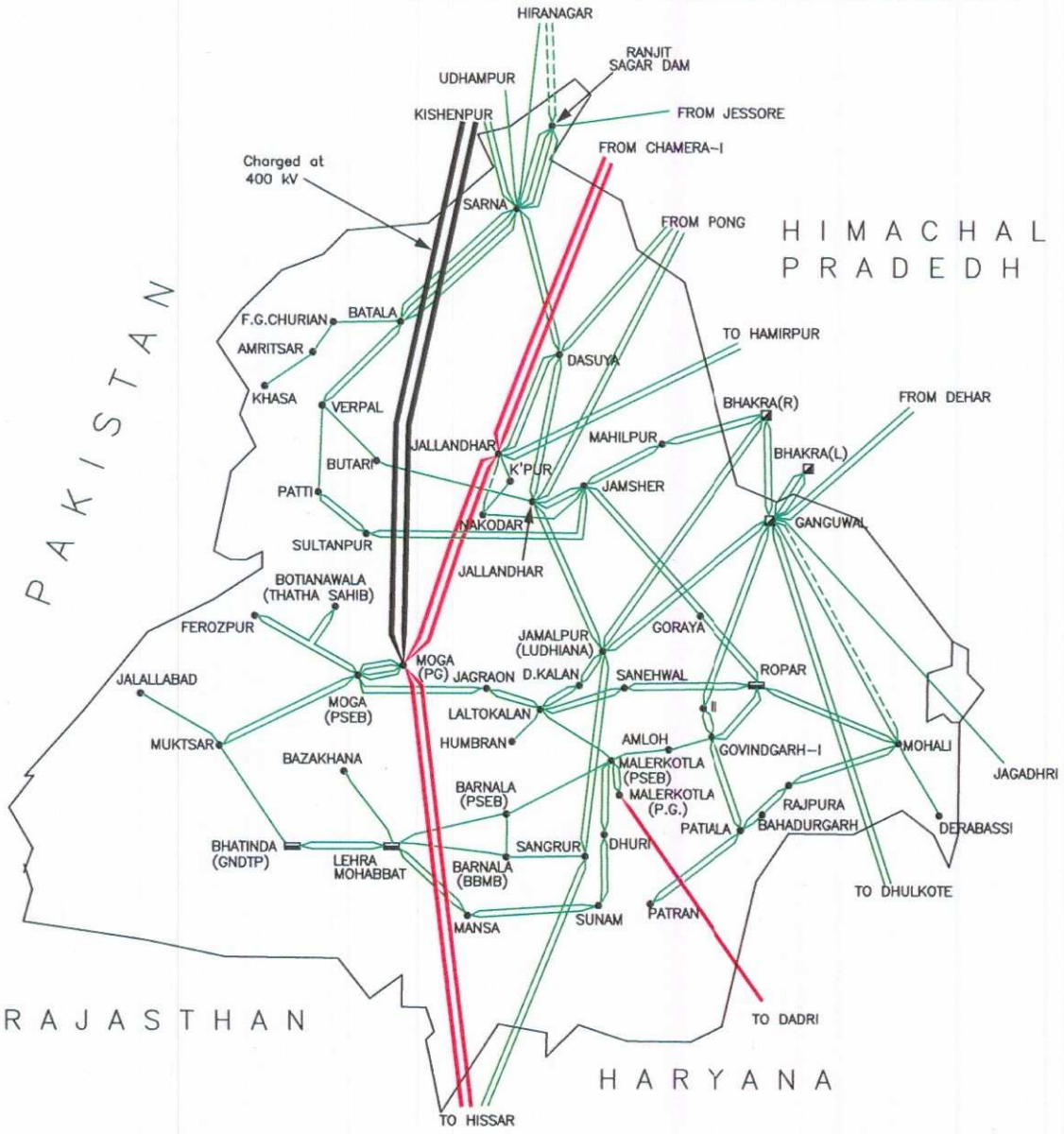
Pakistan - 500 KV primary transmission system Extending from Jamshoro in the south to Tarbela and Peshawar in the north.

Lines run very much near to the adjoining borders of India

May not require complex transmission extensions :

Designated substations
Dinanath (Lahore) in Pakistan and
Patti (Punjab) in India.

POWER MAP OF PUNJAB



LEGEND:–

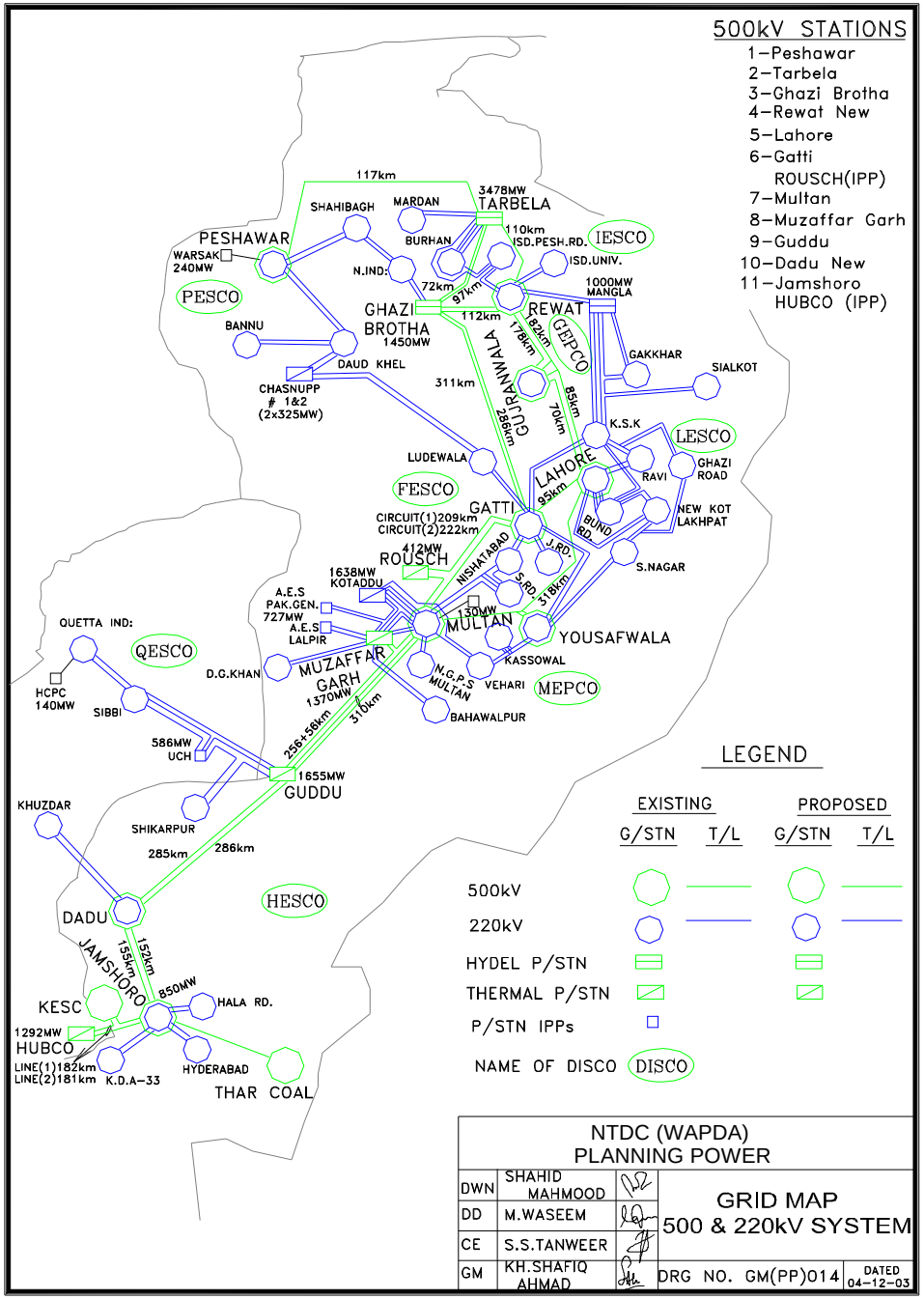
	EXISTING	PROPOSED
HYDRO POWER STATIONS	◪	◪
THERMAL POWER STATIONS	▬	▬
SUB STATIONS	•	○
765 kV TRANSMISSION LINES	▬▬	▬ ▬
400 kV TRANSMISSION LINES	▬▬	- - -
220 kV TRANSMISSION LINES	▬▬	- - -

NRLDC/POWERGRID

POWER MAP OF PUNJAB

220 kV AND ABOVE

DRN. BY Ramjit | MARCH, 2004


500kV STATIONS
1-Peshawar
2-Tarbela
3-Ghazi Brotha
4-Rewat New
5-Lahore
6-Gatti
ROUSCH(IPP)
7-Multan
8-Muzaffar Garh
9-Guddu
10-Dadu New
11-Jamshoro
HUBCO (IPP)
117km
3478MW
TARBELA
SHAHIBAGH
MARDAN
110km
ISD.PESH.RD.
IESCO
PESHAWAR
WARSAK
240MW
BURHAN
ISD.UNIV.
N.IND:
72km
97km
1000MW
MANGLA
PESCO
GHAZI
BROTHA
1450MW
112km
REWAT
182km
118km
GEPCO
BANNU
GAKKHAR
SIALKOT
DAUD KHEL
CHASNUPP
1&2
(2x325MW)
311km
GUJRANWALA
85km
70km
286km
K.S.K
LESCO
LUDEWALA
LAHORE
GHAZI
ROAD
RAVI
95km
FESCO
GATTI
CIRCUIT(1)209km
CIRCUIT(2)222km
BUND RD.
NEW KOT
LAKHPAT
412MW
ROUSCH
J.RD.
S.NAGAR
NISHATABAD
S.RD.
318km
1638MW
KOTADDU
A.E.S
PAK.GEN.
727MW
A.E.S
LALPIR
130MW
MULTAN
YOUSAFWALA
QUETTA IND:
QESCO
KASSOWAL
D.G.KHAN
MUZAFFAR
GARH
1370MW
N.G.P.S
MULTAN
VEHARI
MEPCO
HCPC
140MW
SIBBI
BAHAWALPUR
310km
256+58km
586MW
UCH
1655MW
GUDDU
KHUZDAR
SHIKARPUR
285km
286km
HESCO
DADU
JAMSHORO
155km
152km
850MW
KESC
HALA RD.
1292MW
HUBCO
LINE(1)182km
LINE(2)181km
K.D.A-33
HYDERABAD
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EXISTING
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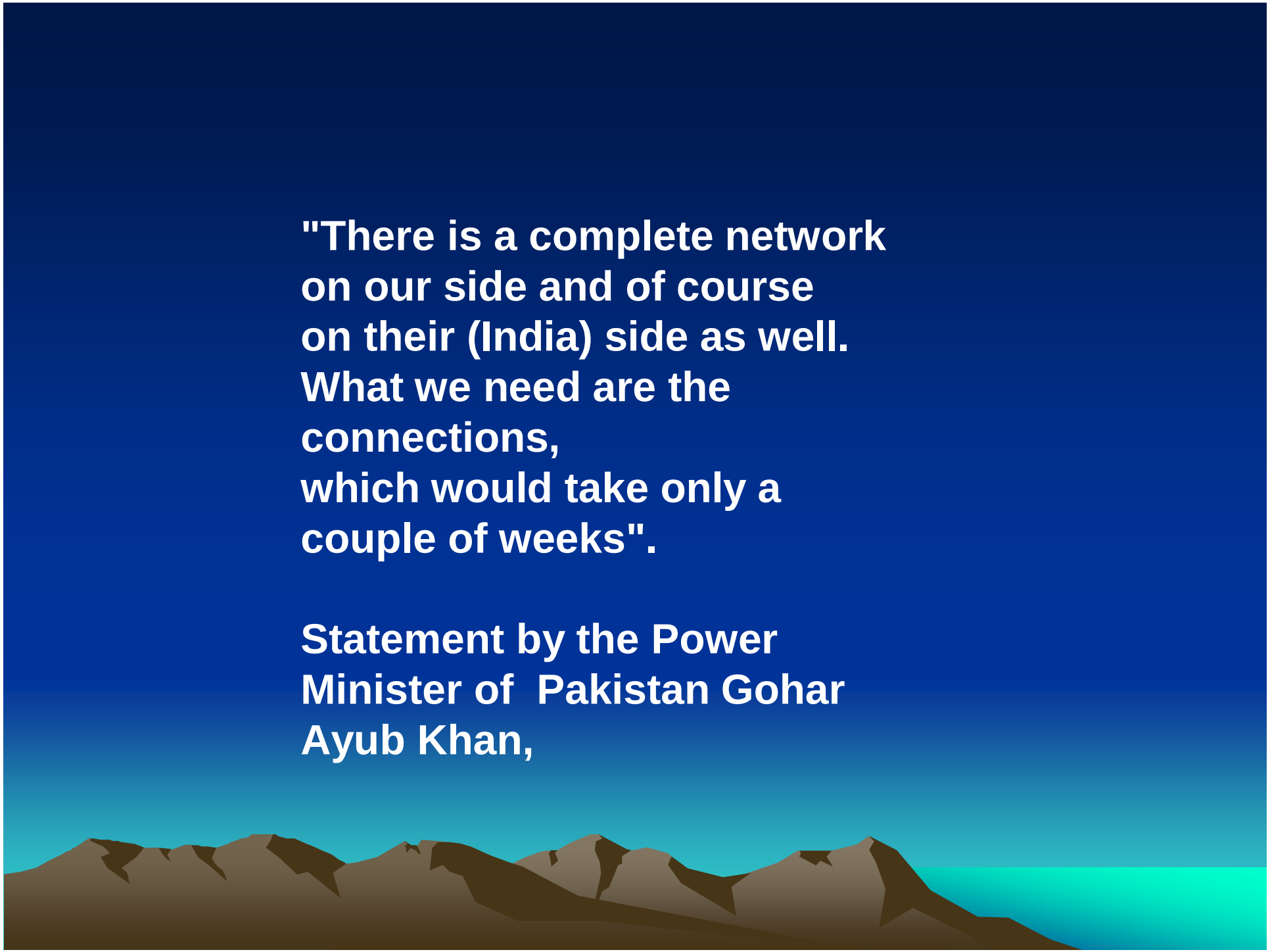
220kV
HYDEL P/STN
THERMAL P/STN
P/STN IPPs
NAME OF DISCO
DISCO
NTDC (WAPDA)
PLANNING POWER
DWN
SHAHID MAHMOOD
DD
M.WASEEM
CE
S.S.TANWEER
GM
KH.SHAFIQ AHMAD
GRID MAP
500 & 220kV SYSTEM
DRG NO. GM(PP)014
DATED
04-12-03


"There is a complete network
on our side and of course
on their (India) side as well.
What we need are the
connections,
which would take only a
couple of weeks".
Statement by the Power
Minister of Pakistan Gohar
Ayub Khan,

Key issues

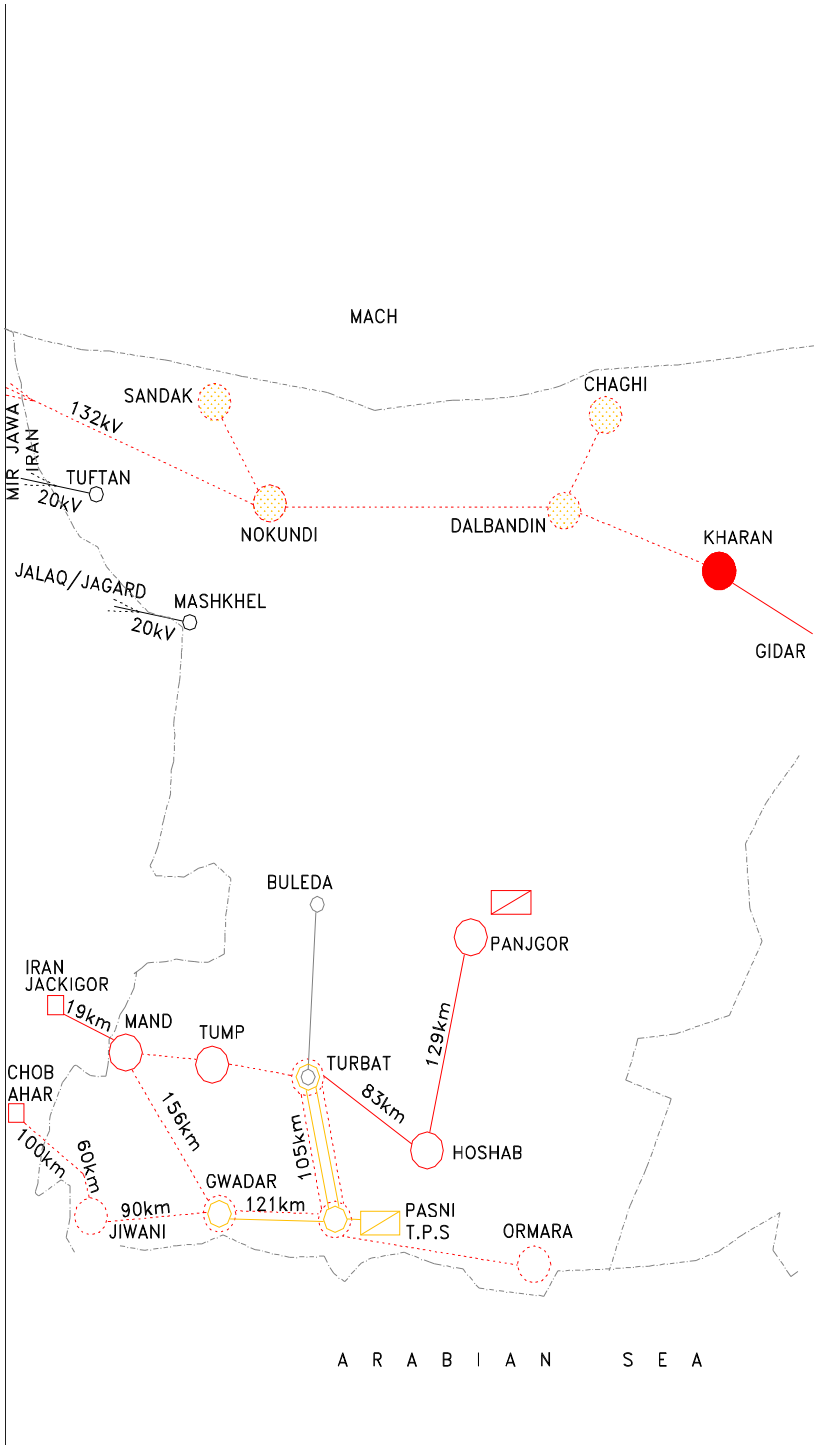
- cost of transmission line and sharing mechanism
- determination of power tariff
- payment mechanism
- power supply sustainability and
- Geo-political immunisation.

Urgent need to Prepare the South Asian :

Regional Energy Sector Master Plan
Feasibility Plan for establishing Regional Power Grid

New Feature : Non – SAARC Linkages
Import of Power from Iran by Pakistan

- Agreement signed in Nov 2002
- Voltage of inter connection
  - Jachigur (Iran) - Mand (Pakistan) : 132kV
  - Taftan 20kV
  - Mushkhel 20kV
- Maximum Power Demand
  - For Mand 30MW
  - For Taftan/Mushkhel 1MW
- Price
  - Price of electricity per kWh US$0.03 (for 3 years)
  - Min monthly invoicing US$210,000


MACH
SANDAK
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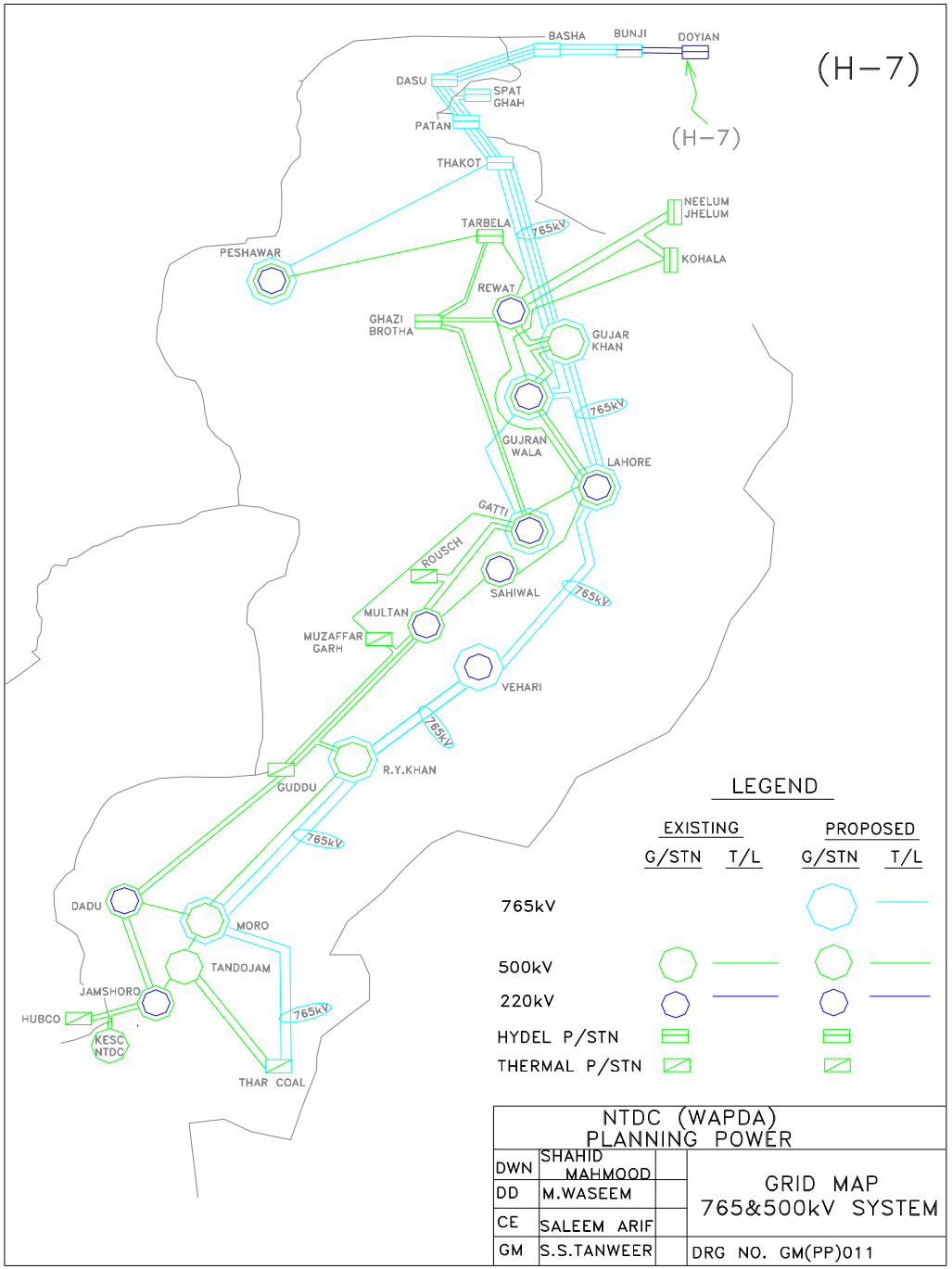
132kV
MIR JAWA
IRAN
TUFTAN
20kV
NOKUNDI
DALBANDIN
KHARAN
JALAQ/JAGARD
MASHKHEL
20kV
GIDAR
BULEDA
PANJGOR
IRAN
JACKIGOR
19km
MAND
TUMP
TURBAT
129km
CHOB
AHAR
156km
83km
105km
HOSHAB
100km
60km
GWADAR
90km
121km
PASNI
T.P.S
JIWANI
ORMARA
A R A B I A N S E A

Inter connection with Afghanistan

- Afghanistan is keen to have an inter connection with Pakistan for import of power
- 3 delivery points at 132 kV have been identified
- Commercial agreement and technical details are yet to be worked out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REWAT
GHAZI BROTHA
GUJAR KHAN
765kV
GUJRAN WALA
LAHORE
GATTI
ROUSCH
SAHIWAL
765kV
MULTAN
MUZAFFAR GARH
VEHARI
765kV
R.Y.KHAN
GUDDU
765kV
DADU
MORO
TANDOJAM
JAMSHORO
HUBCO
KESC NTDC
765kV
THAR COAL
LEGEND
EXISTING
PROPOSED
G/STN
T/L
G/STN
T/L
765kV
500kV
220kV
HYDEL P/STN
THERMAL P/STN
NTDC (WAPDA)
PLANNING POWER
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DD
M.WASEEM
CE
SALEEM ARIF
GM
S.S.TANWEER
GRID MAP
765&500kV SYSTEM
DRG NO. GM(PP)011

Regional Fund and Foundation

Create a SAARC Regional Energy Development Fund (REDF) with the help of international financial institutions to finance regional projects,

There are national level energy development funds including in Nepal and Pakistan

Establish a permanent institution – South Asia Regional Energy Foundation (SAREF) on the lines of ASEAN Energy Centre.

Thank You