

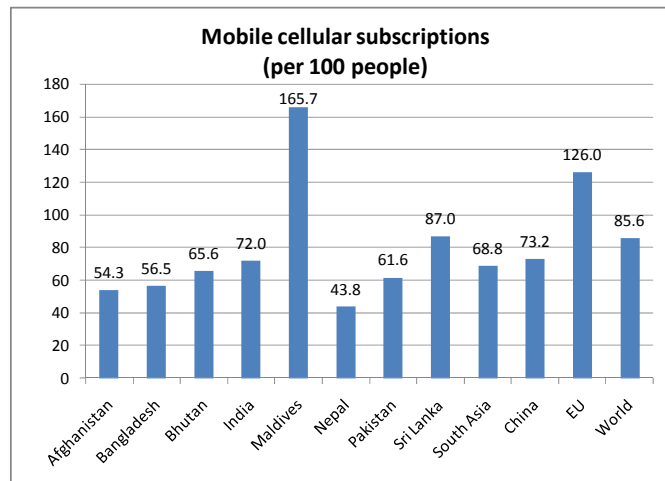
Department of Industrial and Management Engineering
Indian Institute of Technology Kanpur
7th Capacity Building Programme for Officers of Electricity
Regulatory Commissions
28-30 Jan., 2015

Developing a Regional Power Market in South Asia



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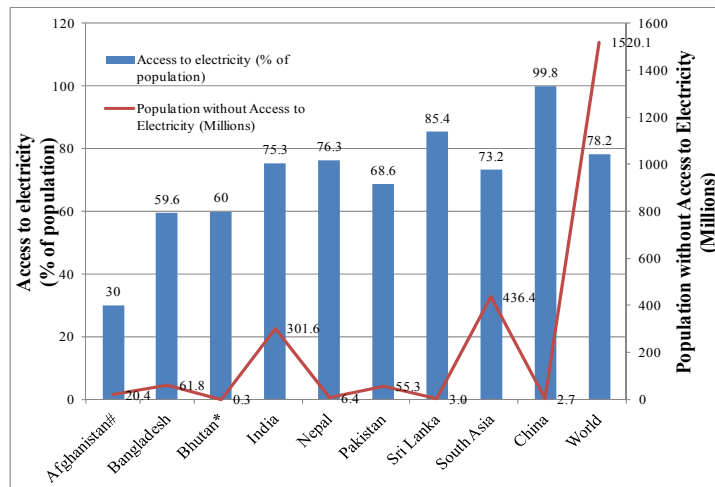
Mobile Subscriptions in South Asia



So: World Development Indicators,
2012



Access to Electricity in South Asia

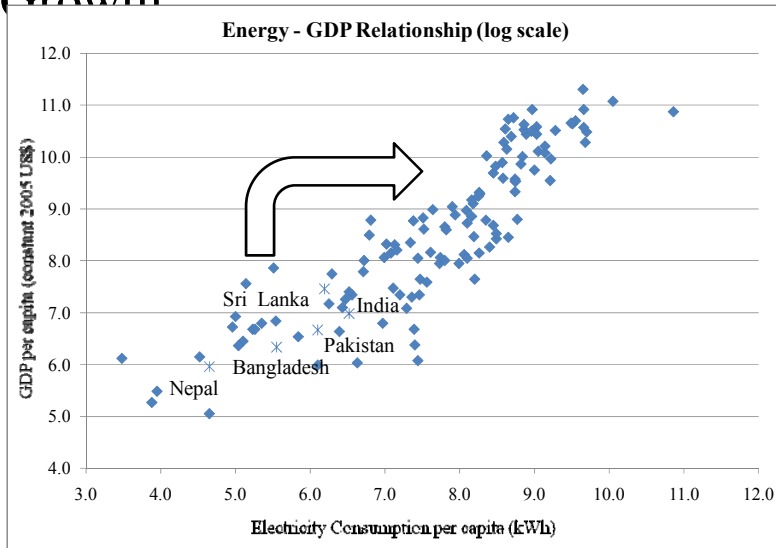


Outline

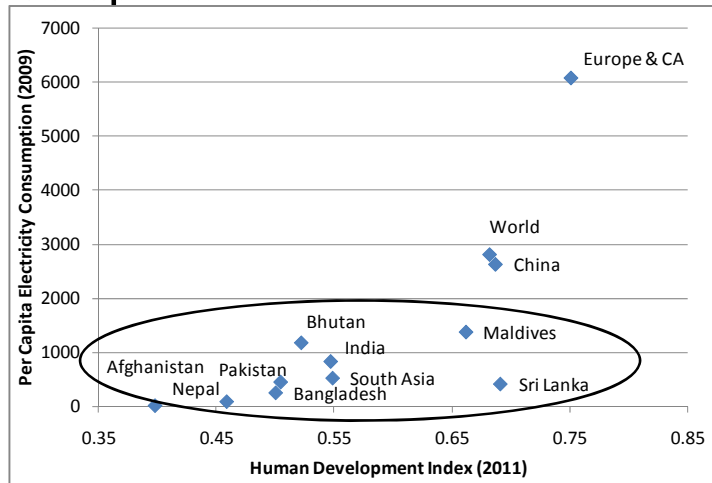
- Energy and Socio-economic development
- Drivers
- Opportunities
- International experience
- Key issues and some solutions

Energy and Socio-economic Development

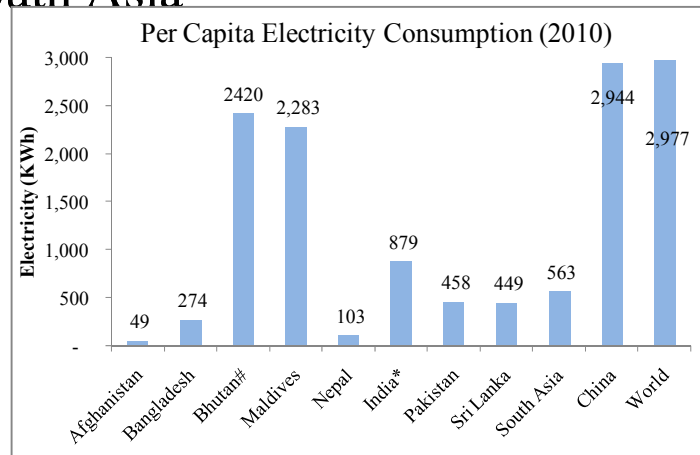
Electricity Consumption and Economic Growth



Electricity Consumption and Human Development Index



Per capita electricity consumption in South Asia



So: WDI (2013), RGoB (2012), CEA (2013)



Economic growth continues to suffer

Country	Value lost due to electrical outages (As a % of sales)
Afghanistan (2007)	6.49
Bangladesh (2007)	10.56
Bhutan (2009)	4.33
India (2006)	6.62
Nepal (2009)	26.95
Pakistan (2007)	9.16
Sri Lanka (2011)	3.0

So: World Development Indicators (2013)



Projected Electricity Demand (GWh)

	Demand (GWh)		CAGR
	Year 2010	Year 2020	
Afghanistan	2600	6750	10%
Bangladesh	28470	67400	9%
Bhutan	1749	3430	7%
India	938000	1845000	7%
Maldives	800	1300	5%
Nepal	3200	6910	8%
Pakistan	95000	246000	10%
Sri Lanka	10718	21040	7%
Total	1080537	2197830	7.4%

Source: ADB (2013)



Energy Resource Endowments in South Asia

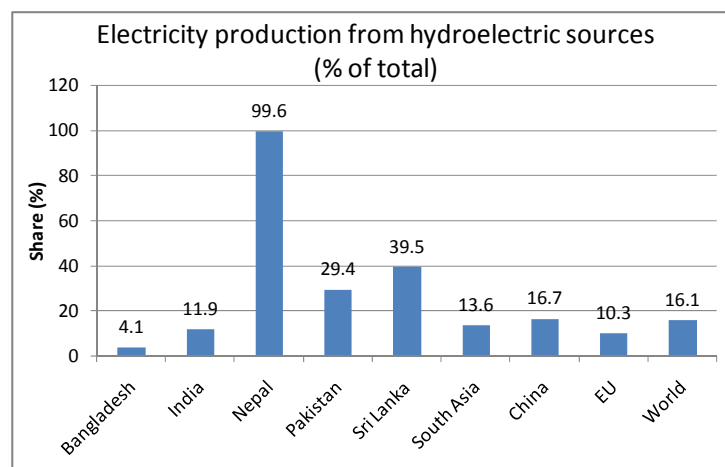
Country	Coal (million tons)	Oil (million barrels)	Natural Gas (trillion cubic feet)	Biomass (million tons)	Hydropower* (Gigawatts)
Afghanistan	440	NA	15	18-27	25
Bhutan	2	0	0	26.6	30
Bangladesh	884	12	8	0.08	0.33
India	90,085	5,700	39	139	150
Maldives	0	0	0	0.06	0
Nepal	NA	0	0	27.04	83
Pakistan	17,550	324	33	NA	59
Sri Lanka	NA	150	0	12	2
Total	108,961	5,906	95	223	349.33

Source: ADB (2012), SAARC Secretariat (2010),

CWC (2005), WAPDA (2011)



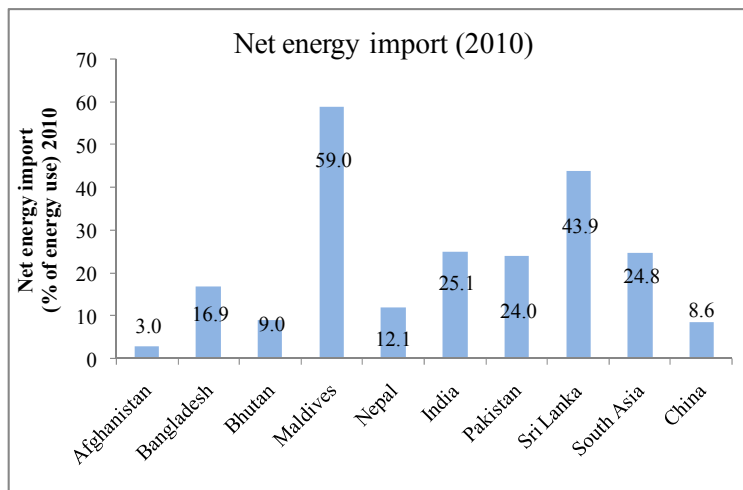
Development of Hydro resources



So: World Development Indicators,
2013

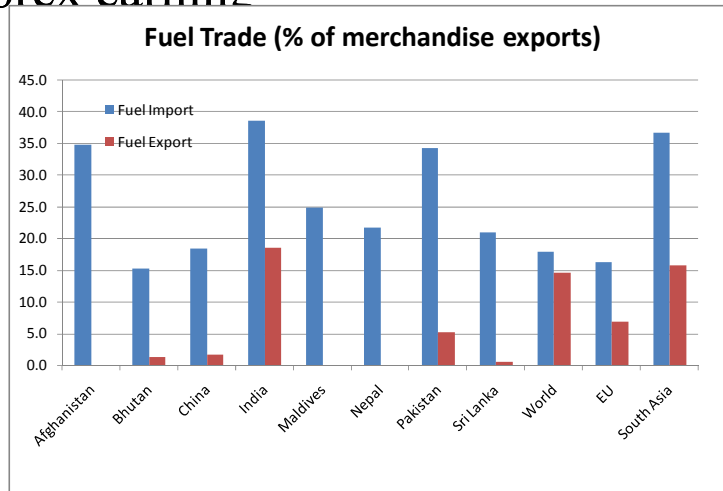
Drivers for Energy Cooperation in South Asia

Concerns for Energy Security



So: World Development Indicators,
2013

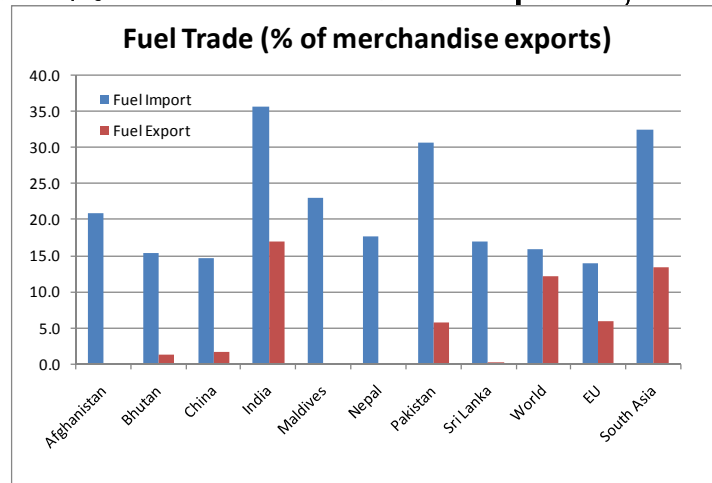
Fossil fuel led energy import draining forex earning



Economic Integation in South Asia – Share of Merchandise Trade



Energy Interdependence - Fuel Trade (As a % of merchandise exports, 2010)



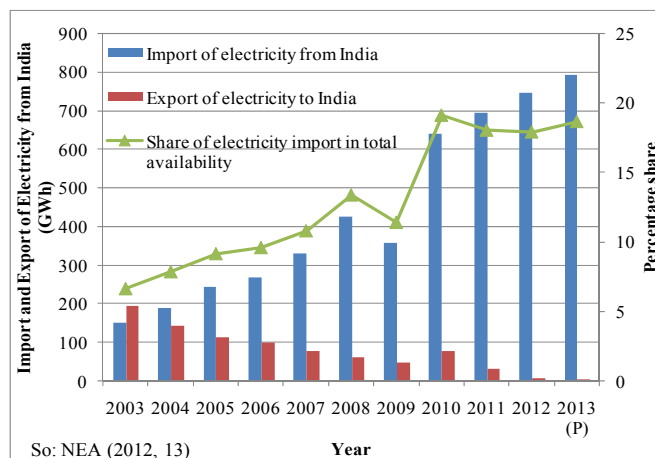
So: World Development Indicators, 2012

Common Energy Sector Goals for South Asia



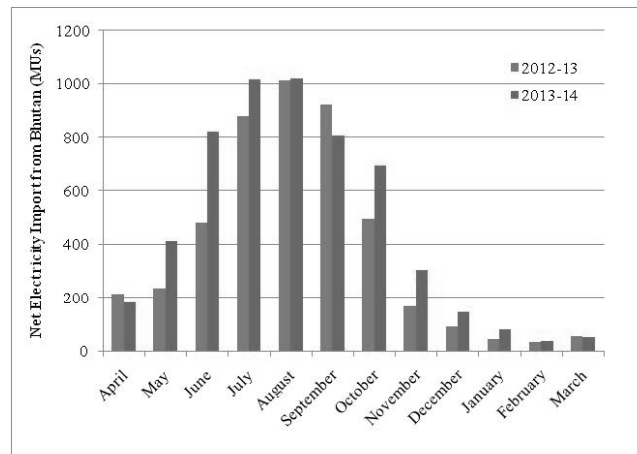
- Improve Human Development Index (through link to GDP, education and life expectancy)
- Sustainable Energy Access to All (2012 – UN’s “International Year of Sustainable Energy for All”)
- Improve energy security
- Optimal utilisation of region’s energy resources
- Greater economic and energy cooperation
- Share best practices in the energy sector

Opportunities for Electricity Trade





Non-winter Centric Electricity Export of Electricity from Bhutan



Regional Power Sector Cooperation – International Experience



Regional Electricity Arrangements

- Gulf Coast Countries (GCC)
- Greater Mekong Sub-region (GMS)
- Nile Basin Initiative (NBI)
- Nordpool
- Southern African Power Pool (SAPP)
- South East Europe (SEE)
- European Network of Transmission System Operators for Electricity (ENTSO-E)
- Central American Electrical Interconnection System (SIEPAC)



International Experience

Regional Entity	Formal Creation	Participating Members
ENTSO-E	2011	41 Transmission System Operators (TSOs) from 34 countries
GCC	2001	(6) United Arab Emirates, Bahrain, Saudi Arabia, Oman, Qatar, and Kuwait
GMS	1995	(7) Cambodia, PRC (Yunnan and Guangxi Zhuang), Lao PDR, Myanmar, Thailand, and Viet Nam.
NBI	1999	(9) Egypt, Sudan, Ethiopia, Uganda, Kenya, Rwanda, Burundi, DR Congo and Tanzania. Eritrea (Observer)
SAPP	1995	(9) Botswana, Democratic Republic of the Congo, Lesotho, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe; (3 non-operating members)
SEE	2005	(9) Albania, Bosnia & Herzegovina, Bulgaria, Croatia, Kosovo, Macedonia, Montenegro, Romania, and Serbia
SIEPAC	1999	(6) Guatemala, El Salvador, Honduras, Costa Rica, Nicaragua and Panama

International Experience (contd.)



Regional Entity	Motivation / Drivers	Trading Status
ENTSO-E	Security of supply, seamless pan-European electricity market, secure integration of renewable resources ,and reliable future-oriented grid and adequate to meet energy policy goals.	428161 GWh (2012)
GCC	Share reserve capacity, thereby reducing generation investment needs in the region.	First in 2010 and intermittent
GMS	Efficient, environmentally sound growth of power sector; support to regional projects and electricity trade.	34139 GWh (2010)
NBI	Coordinated investment in power sector to meet region's social and economic development objectives in the region.	
SAPP	Development of a safe, efficient, reliable, and stable interconnected electrical system and of a regional power trading mechanism.	10409 MWh (2011-12)
SEE	Create a regionally integrated electricity market, forming part of the wider EU single market.	Dry run (2006 – 09), 2010
SIEPAC	Create an integrated regional electricity market in Central America.	



Sr. No	Regional Cooperation	Reference	Period of analysis	Methodology	Approach to estimate benefits	Estimate of benefits	Savings of CO2 emissions
1	SIEPAC	Gomez et al. (1994)	1993-2004	Optimal capacity expansion plan	PV of economic benefits from savings in investment and operation cost in an interconnected system (in 1993 prices)	\$ 121 million (low demand growth) \$ 370 million (medium demand growth)	
2	SIEPAC	A feasibility study cited in IADB (1997)	1996-1999		Savings from fully coordinated operation of the interconnected grids (without any additional links)	\$ 110 million	
3	SIEPAC	Analysis cited in IADB (1997)	1996-2015		PV of net benefits from savings in investment and operation cost in an interconnected system	\$57 – \$993 million with centreline estimate of \$381 million	
4	SIEPAC (draft PDD for CDM)	MDL - SIEPAC (2007)	21 yrs. crediting period beginning 2009	-	SIEPAC line with interconnections with Colombia and Mexico against the base case of no regional transmission expansion	-	22 million tonnes
5	SIEPAC	UNFCCC (2009) (PDD for CDM)	2009-18 (Crediting period)	-	SIEPAC line with interconnections with Colombia and Mexico against the base case of no regional transmission expansion	-	6.17 million tonnes



Electricity Trade in GMS Region (GWh) - 2010

	Import	Export	Total Trade	Net Imports
Cambodia	1,546	–	1,546	1,546
Lao PDR	1,265	6,944	8,210	(5,679)
Myanmar	–	1,720	1,720	(1,720)
Thailand	6,938	1,427	8,366	5,511
Viet Nam	5,599	1,318	6,917	4,281
PRC	1,720	5,659	7,379	(3,939)
Total	17,069	17,069	34,139	

So: ADB, 2012



Bilateral to Regional Approach

- SAPP was built upon historical bilateral interconnections in the 1950s and 1960s which witnessed development of interconnections projects between Democratic Republic of the Congo (DRC) and Zambia, and Zambia and Zimbabwe. Later, in 1975, between Mozambique and South Africa
- GMS' historical foundations can be traced back to 1971 with export of power from the Nam Ngum hydropower plant (HPP) in Lao PDR to northeast Thailand.

Towards Regional Power Market Development in South Asia

Prerequisites for Development of a SA power market

- Accessible Energy Resources & easy licensing
- Transmission inter-linkages (who would invest?), and its access
- Coordinated scheduling and despatch
- Treatment of imbalances from schedule
- Metering and Energy Accounting
- Clearing and Settlement, and banking transactions
- Export / Import licensing
- Common currency and currency risk
- Treatment of export tax, import duty and transit tax
- Harmonised regulatory and policy framework
- Dispute Settlement

Evolving cross-border electricity trade



- Government to Government – Bhutan & India
- Power utility and trader (short-term) - Nepal & India (PTC)
- Power utility and trader (long-term) - Bangladesh (BPDB) & India (NVTN)

- Traders can offer relatively long-term supply contracts but price discovery is an issue. Useful for medium to long-term agreements.
- Indian experience demonstrates short-term opportunities. PXs can play a crucial role – transparent and competitive price discovery.
- SA Contractual breakthrough - PPA between NVTN and BPDB, as it addresses many critical issues including currency, balancing & UI.

Supra-national PX vs participation in Indian PXs vs Regional contracts in Indian PXs



- 1. South Asian Power Exchange (SAPX) - Supra-national PX where all buyers and sellers from all participating countries bid. Clearing and settlement as per existing mechanism on PXs.
 - More buying capacity can suck in power even from deficit countries – an undesirable outcome especially in existing shortage conditions.
 - Long gestation period to develop a coordinated approach.
 - Existing cross border interconnections congested to serve ‘other’ countries demand.
 - Some solutions – allocation of cross-border inter-connections to serve pre-identified ‘beneficiary’ countries based on investment share in cross-border transmission investment, or a regional mechanism for allocation.
 - Can perhaps be a long-term goal.



Supra-national PX vs participation in Indian PXs vs Regional contracts in Indian PXs (Contd.)

- 2. Regional contracts on Indian PXs
 - Which one is to be cleared first - national or regional ?
 - May be feasible in medium term if there is sufficient volume at regional level.
- 3. SA countries can join the Indian PXs as new ‘areas’ or participate as if located in the areas in which cross-border interconnections are located
 - Relatively easy to implement



India - Import Policy of Electricity

- DGFT Notification No 09/2009-2014, Dated 10th Sept., 2009 for Electrical Energy ITS(HS) Code 27160000,
- “Import subject to license to be issued by DGFT in consultation with Ministry of External Affairs, Ministry of Power and Department of Commerce, Government of India.”



Approach to Develop Regional Power Market

Socialising initial investment in cross-border inter-connections backed by medium/long-term bilateral between governments/government entities.

- Early demonstrated ‘benefits’ to bring in political acceptability.
- From ‘power exchange’ to ‘Power Exchange’.
- Different stage of reform and unbundling
 - Accommodate differences in terms of licensing and market access
- Long-term regional transmission plan
- Regional coordination forum to harmonise technical, and regulatory framework.
- Dispute settlement mechanism



Importance of Institutional Support

- SAARC, SEC
- ADB
- World Bank
- USAID/ SARIE, SARIEI
- Program based Support – institutional, capacity building, background studies, feasibility etc
- Project Based Support – Funding of cross-border inter-connections, possibly ‘regional’ generation projects
- Why is it important?
 - Helps to reach inter-governmental cooperation
 - Risk sharing
 - Policy leverage with recipient nations



Suggestions on the table!

- Coordinated Investment in Generation (South Asia Power Generation Co Ltd.?)
- Agreement for transit of (hydro) power between India and Bangladesh reciprocated with easing physical congestion at the chicken's neck for setting up transmission linkages.
- Multi-country owned cross-border transmission interconnections to reduce exposure to financial and operational risk. (South Asia Power Transmission Co Ltd.?)
- Regional mechanism/forum for coordination and dispute resolution.

Thank You

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Selected Readings

(some accessible from www.iitk.ac.in/ime/anoops)

- “Towards a Competitive Market for Electricity and Consumer Choice in Indian Power Sector”, Energy Policy Vol. 38 4196-4208, 2010. (Elsevier)
- “A Market for Renewable Energy Credits in the Indian Power Sector”, Renewable and Sustainable Energy Review journal, Elsevier, 2009.
- “Economics, Regulation and Implementation Strategy for Renewable Energy Certificates in India” in India Infrastructure Report 2010, Oxford Univ. Press.
- “Analysing Efficiency of Electric Distribution Utilities in India: a Data Envelopment Analysis” (with Dilip Kumar Pandey), IAEE International Conference, Stockholm 19-23 June, 2011.
- “Modelling Economic Efficiency of Renewable Energy Policies: A Multi-State Model For India”, Accepted for World Renewable Energy Congress, 17-19 Oct. 2011, Bali, Indonesia. (with Sundeep Chowdary).
- “Economics of Iran-Pakistan-India Natural Gas Pipeline: Implications for Energy Security in India”, Economic & Political Weekly, V. XLIII, No. 7 2008.
- “Power Sector Reform in India: Current Issues and Prospects”, Energy Policy, Elsevier, Volume 34, Issue 16, November 2006.



Selected Readings (Contd.)

- “Estimating the Impact of Restructuring on Electricity Generation Efficiency: The Case of the Indian Thermal Power Sector”, NBER Working Paper 17383, 2011 (with Maureen L. Cropper, Alexander Limonov and Kabir Malik)
- “Analysing Efficiency of Electric Distribution Utilities in India: a Data Envelopment Analysis” (with Dilip Kumar Pandey), IAEE International Conference, Stockholm 19-23 June, 2011.
- “Directions for Effective Regulation for Renewable Energy: An Analysis of Renewable Energy Certificates”, India Energy Security Summit: Energy Security for a sustainable future, 3-4 March 2011, New Delhi, IPPAI.
- “At a Crucial Juncture: A perspective on development of electricity and REC markets in India”, 3 years of Indian Energy Exchange: Vision and Views of Industry Leaders, 2011, Powerline / IEX, New Delhi.
- “Economics, Regulation and Implementation Strategy for Renewable Energy Certificates in India” in *India Infrastructure Report 2010*, Oxford Univ. Press.

Selected Papers on Power/RE



- “Analysing Efficiency of Electric Distribution Utilities in India: a Data Envelopment Analysis” (with Dilip Kumar Pandey), IAEE International Conference, Stockholm 19-23 June, 2011.
- “Modelling Economic Efficiency of Renewable Energy Policies: A Multi-State Model For India”, Accepted for World Renewable Energy Congress, 17-19 Oct. 2011, Bali, Indonesia. (with Sundeep Chowdary).
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- “Power Sector Reform in India: Current Issues and Prospects”, Energy Policy, Elsevier, Volume 34, Issue 16, November 2006.

Courses, Workshops and Conferences



- Short Term Course “Challenges and Implementation Issues post Electricity Act 2003: Regulatory, Policy & Technical Solutions”, 10-14 April, 2004
- International Conference on “Power Market Development in India: Reflections from International Experience”, 19-21 April, 2005
- National Workshop on “Project Financing for Energy and Infrastructure Sector”, April 19-22, 2007
- 2nd National Workshop on “Project Financing for Energy and Infrastructure Sector”, April 24-27, 2008
- Capacity Building Programme for Officers of Electricity Regulatory Commissions, 30th June - 5th July, 2008



Courses, Workshops and Conferences (contd.)

- 2nd Capacity Building Programme for Officers of Electricity Regulatory Commissions, 3-8 August, 2009
- 3rd Capacity Building Programme for Officers of Electricity Regulatory Commissions, 23-28 August, 2010
- Energy Conclave 2010, 8-15 Jan. 2010
- 4th Capacity Building Programme for Officers of Electricity Regulatory Commissions, 18-23 July, 2011
- 5th Capacity Building Programme for Officers of Electricity Regulatory Commissions, 18-23 Oct., 2012
- 6th Capacity Building Programme for Officers of Electricity Regulatory Commissions, 9-15 Feb., 2014

For ppts of above programs, visit www.iitk.ac.in/ime/anoops