Geopolitics of Energy Security:

Five framings from a global Indian perspective

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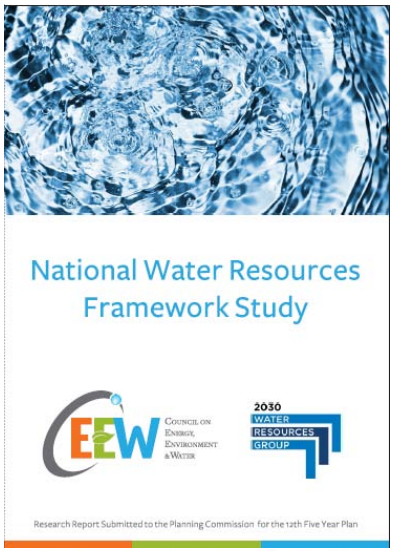
The Coming Energy Market
ESADEgeo and Aspen España
Madrid, 24 November 2011

CEEW connecting dots: integrated approach; international approach



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Seeking Coherence in Complexity? The Governance of Energy by Trade and Investment Institutions

Climate Change & Business Leadership in India

Cutting Both Ways? Climate, Trade and the Consistency of India's Domestic Policies

Maharashtra-Guangdong Partnership on Sustainability

India-U.S. Track II Dialogue on Climate Change & Energy

Harnessing the Power Shift

Governance options for international climate financing

Analysing the National Solar Mission

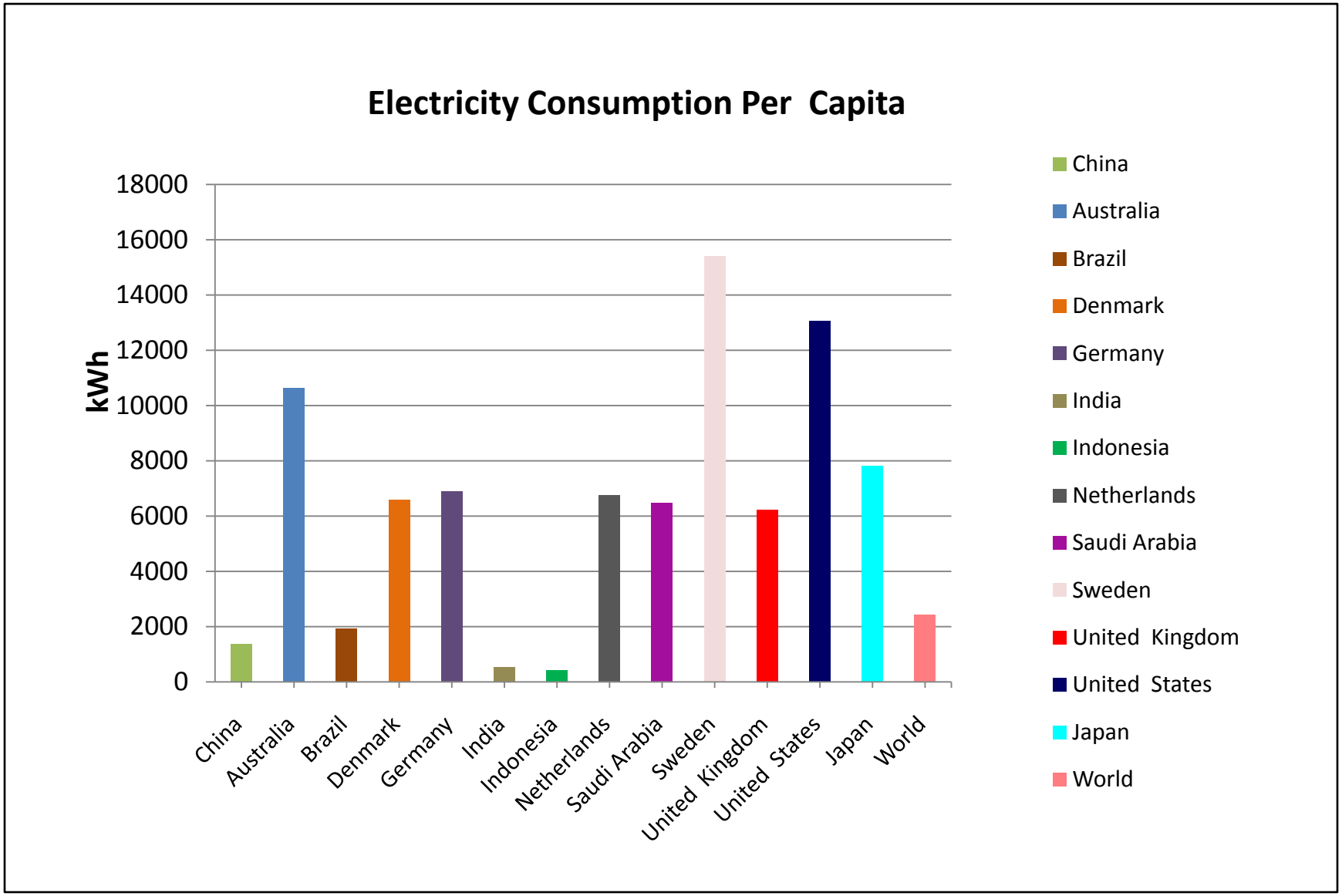
Governance of Geoengineering

India-U.S. Joint Clean Energy R&D Centre

Five ways to frame the energy security debate

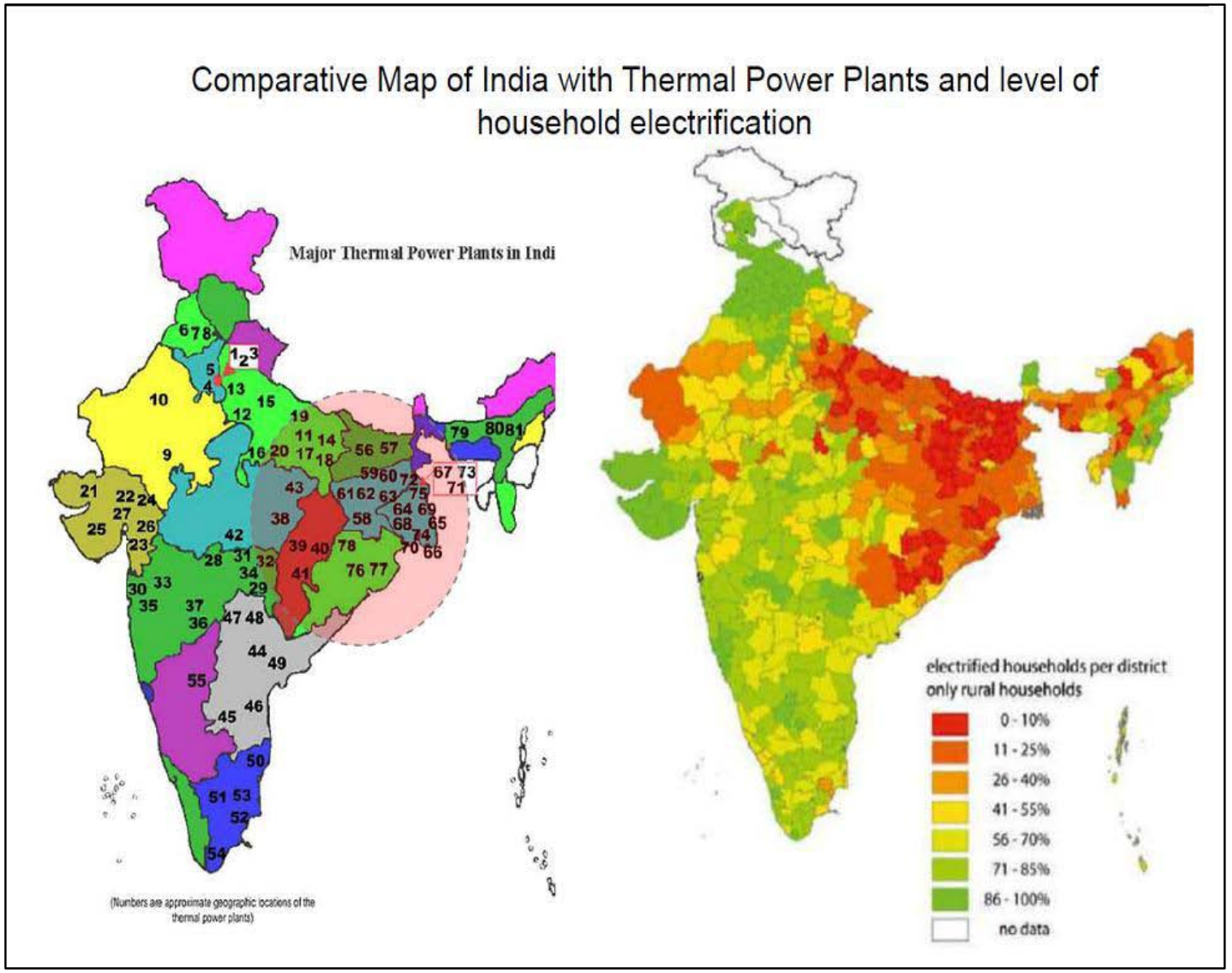
- Energy access: or how to lose (or win) an election
- Energy technology: or how to upscale efficiency
- Energy demand: or how to confront supply constraints
- Energy horizons: or how to promote renewable energy
- Energy cooperation: or how to avoid disputes and conflict

Per capita energy consumption is small for India



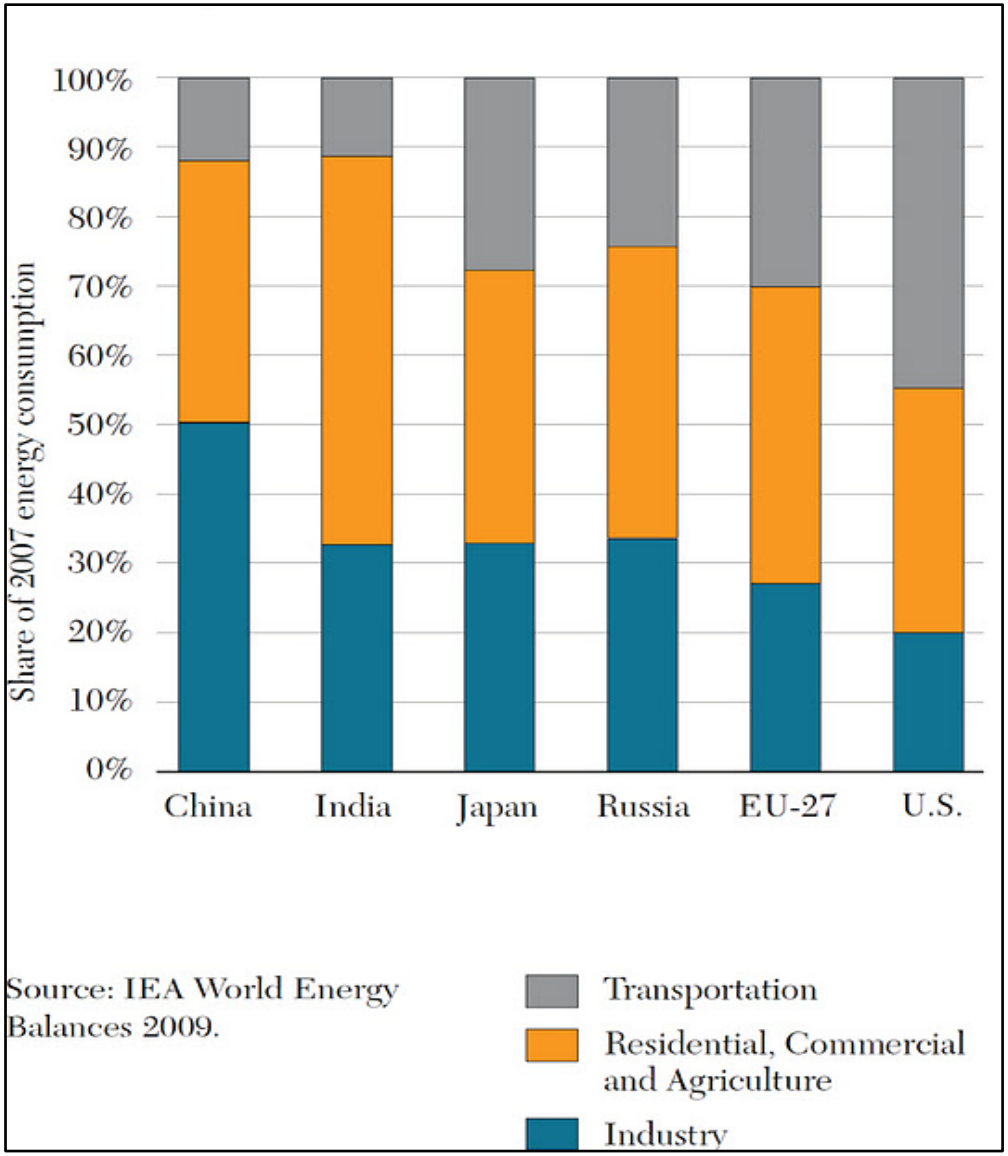
SOURCE: IEA (2005), Key World Energy Statistics 2005, International Energy Agency, Paris,2005

Energy inequality in India



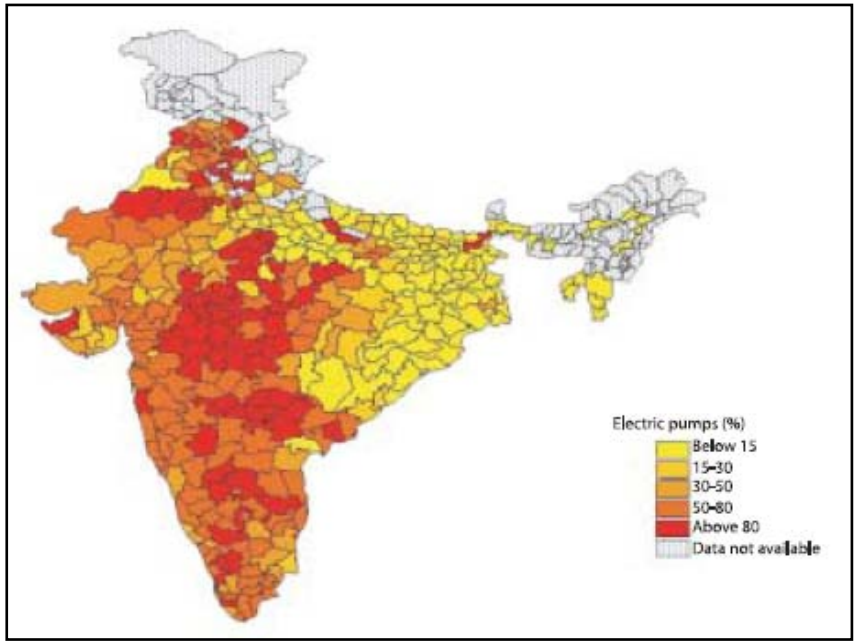
SOURCE: http://www.celsias.com/article/coal-wrong-for-world-bank-energy-strategy/, 2011

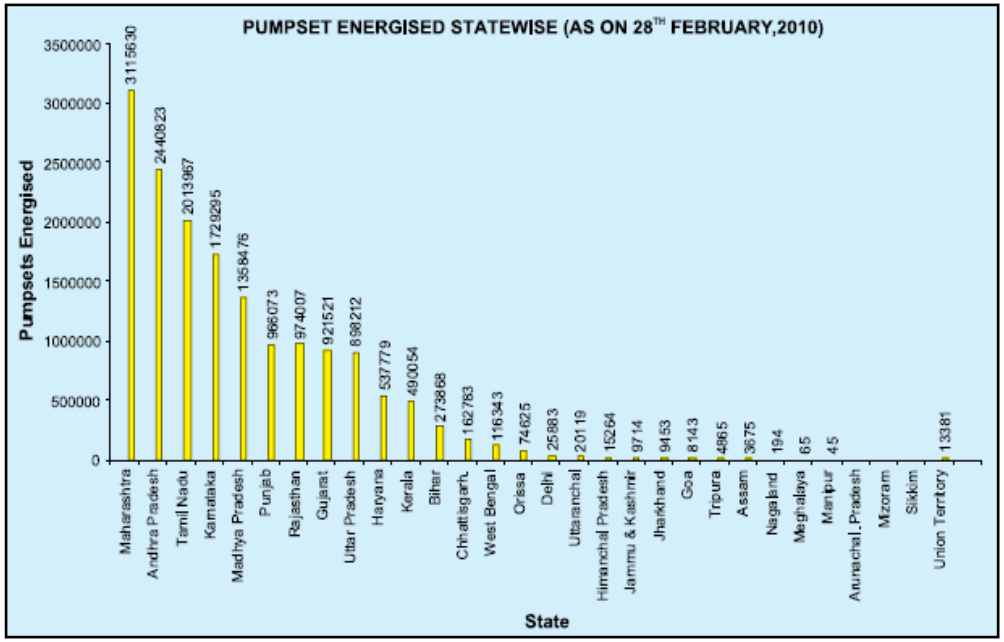
Agriculture still a major consumer of energy



SOURCE: http://earthtrendsdelivered.org/energy_consumption_by_sector_in_2007_china_usa_india_japan_russia_eu-27, 2009

Agricultural energy consumption

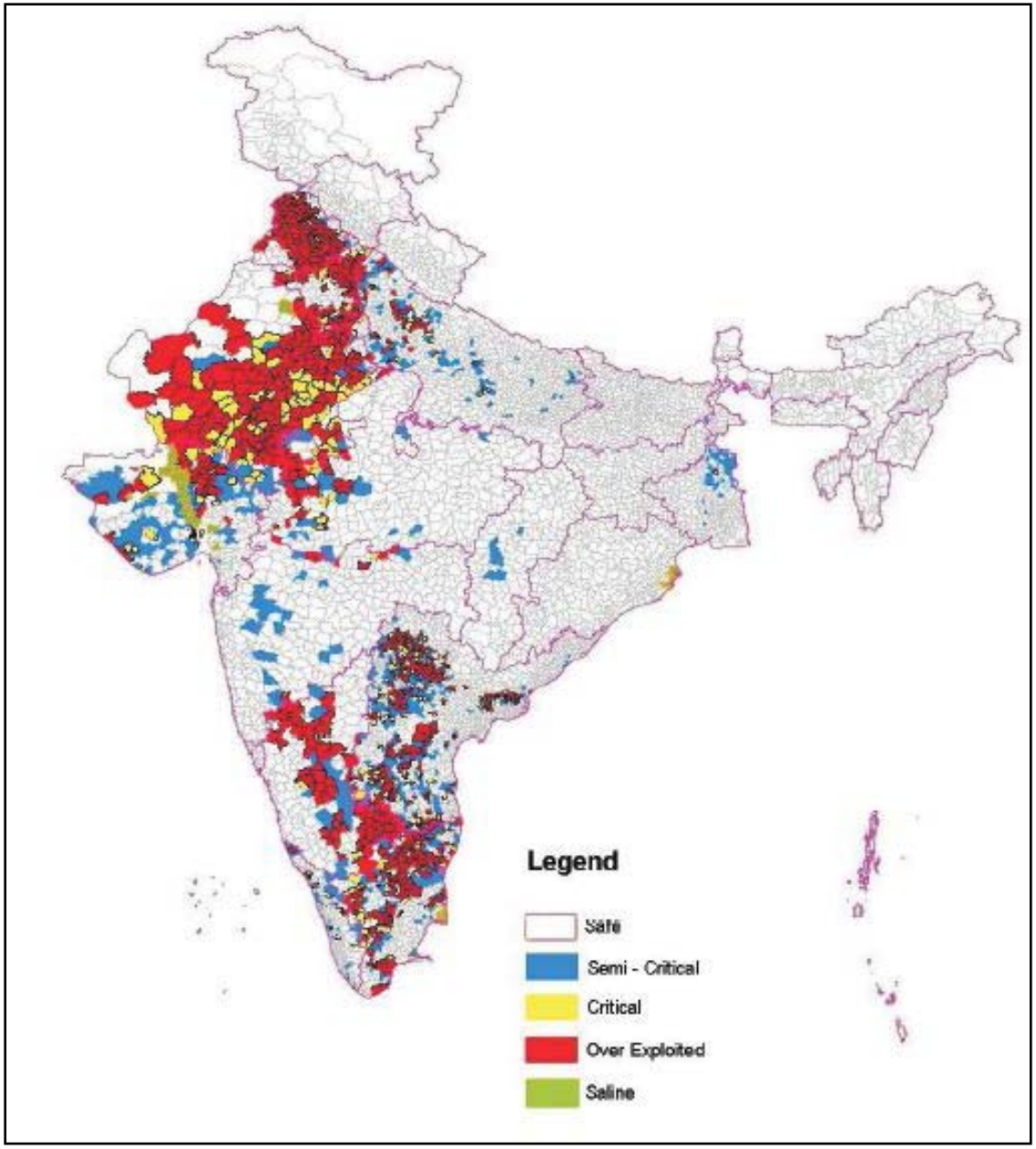




Geographical distribution of electric agricultural pump sets

SOURCE: CEEW (2011)

Energy-groundwater nexus: deepening crisis



SOURCE: CEEW (2011)

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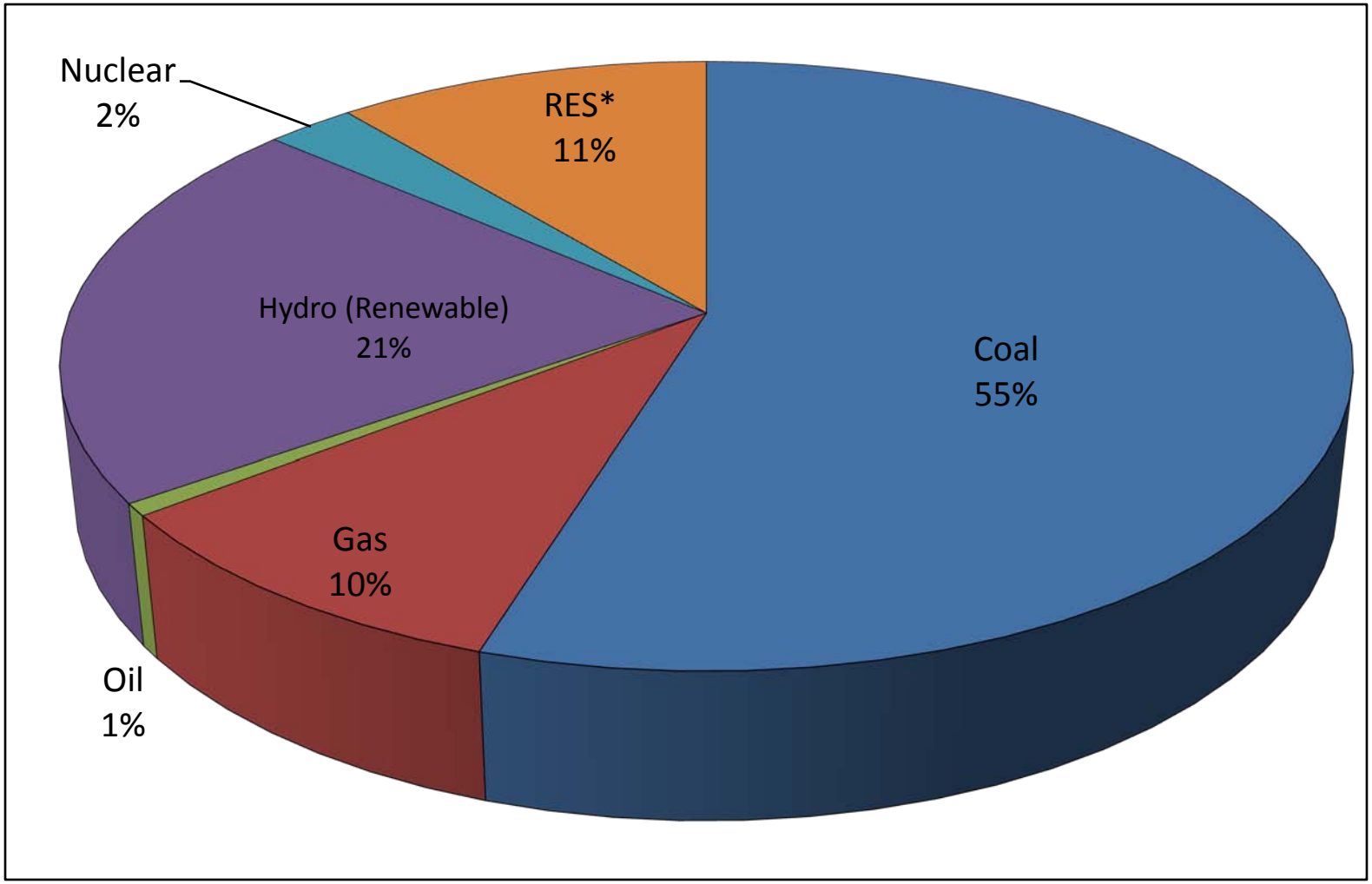
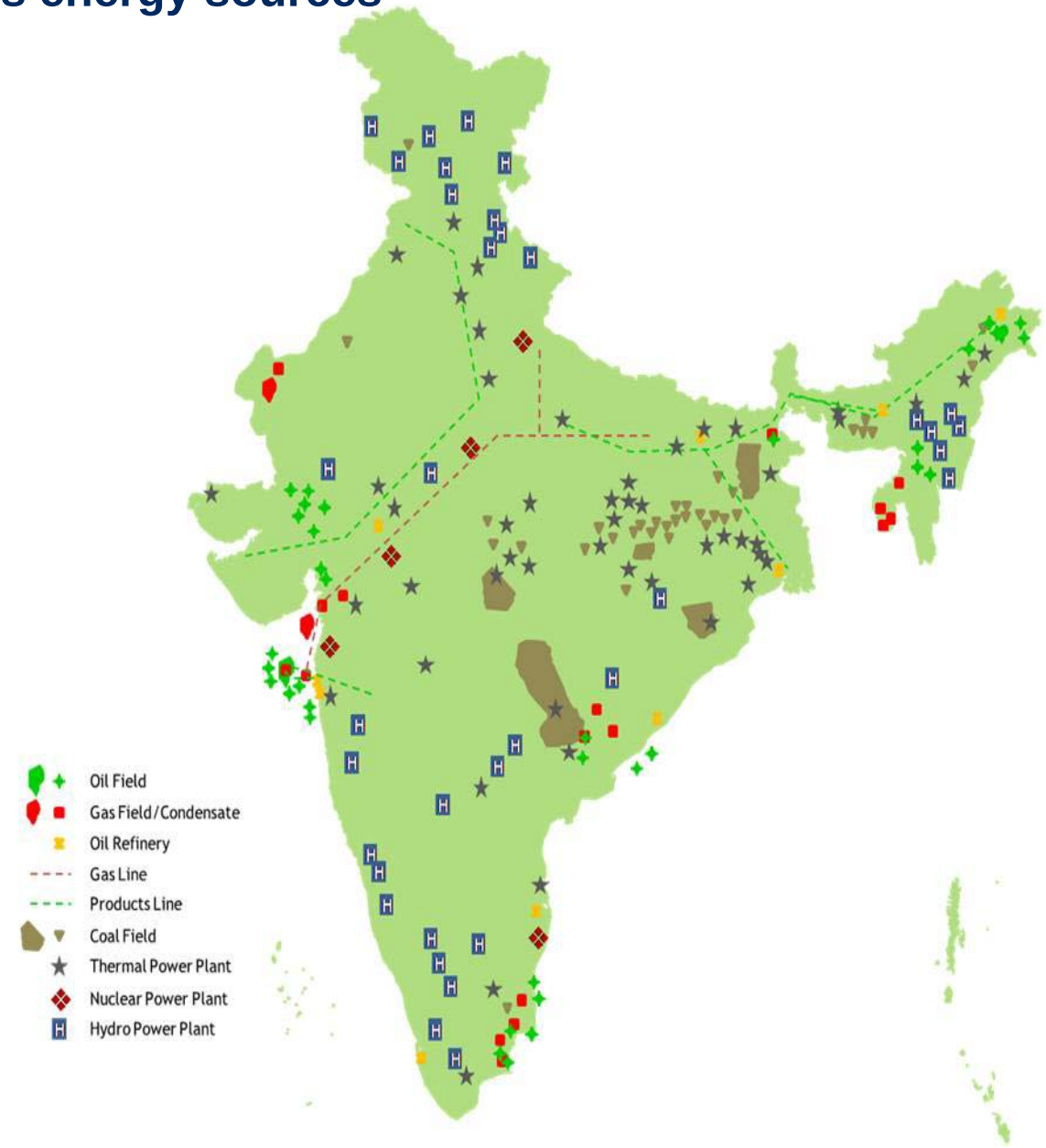
Fossil fuels dominate the power capacity for now



*Renewable Energy Sources(RES) include SHP, BG, BP, U&I and Wind Energy, SHP= Small Hydro Project , BG= Biomass Gasifier ,BP= Biomass Power,, U & I=Urban & Industrial Waste Power, RES=Renewable Energy Sources

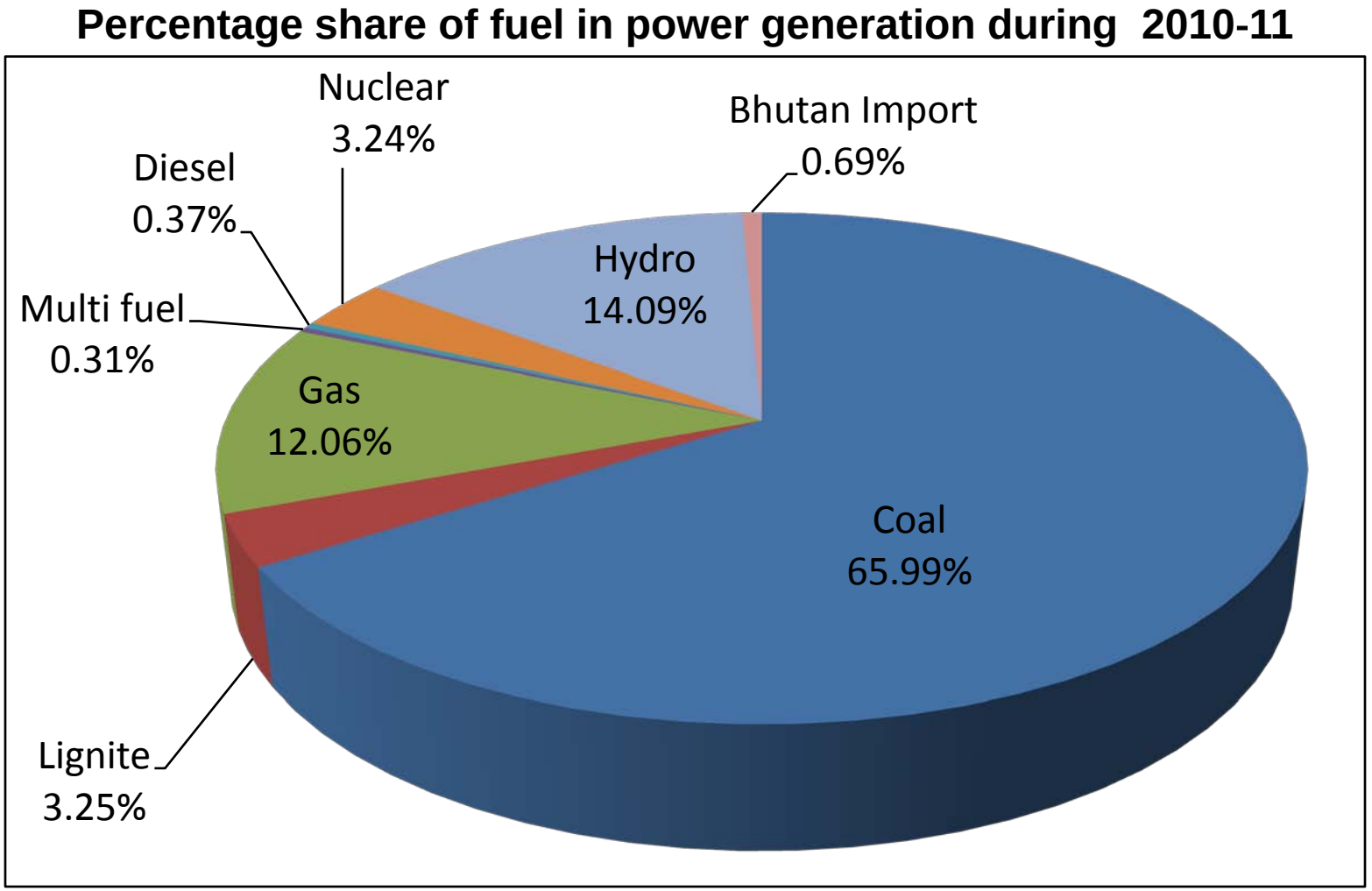
SOURCE: http://powermin.gov.in/indian_electricity_scenario/introduction.htm, 2011

Mapping India’s energy sources



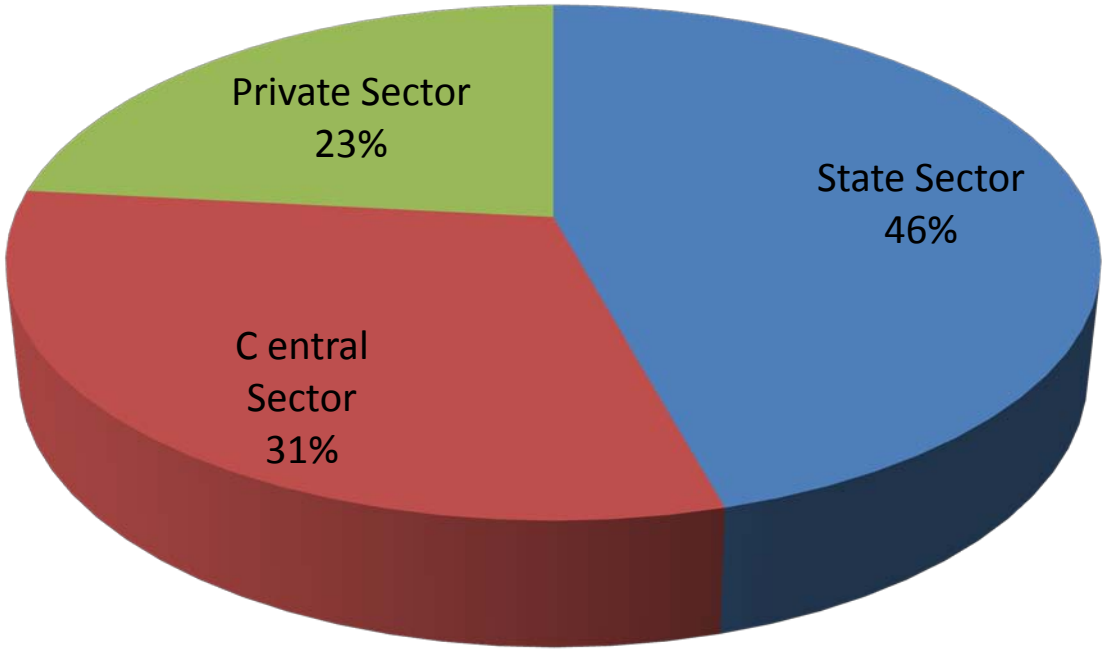
SOURCE: india-reports.in/energy-peak-oil/energy-map-of-india-sources-of-conventional-and-renewable-energy-in-india/1997 |

And coal dominates electricity generation



SOURCE: Central Electricity Authority Report, 2011

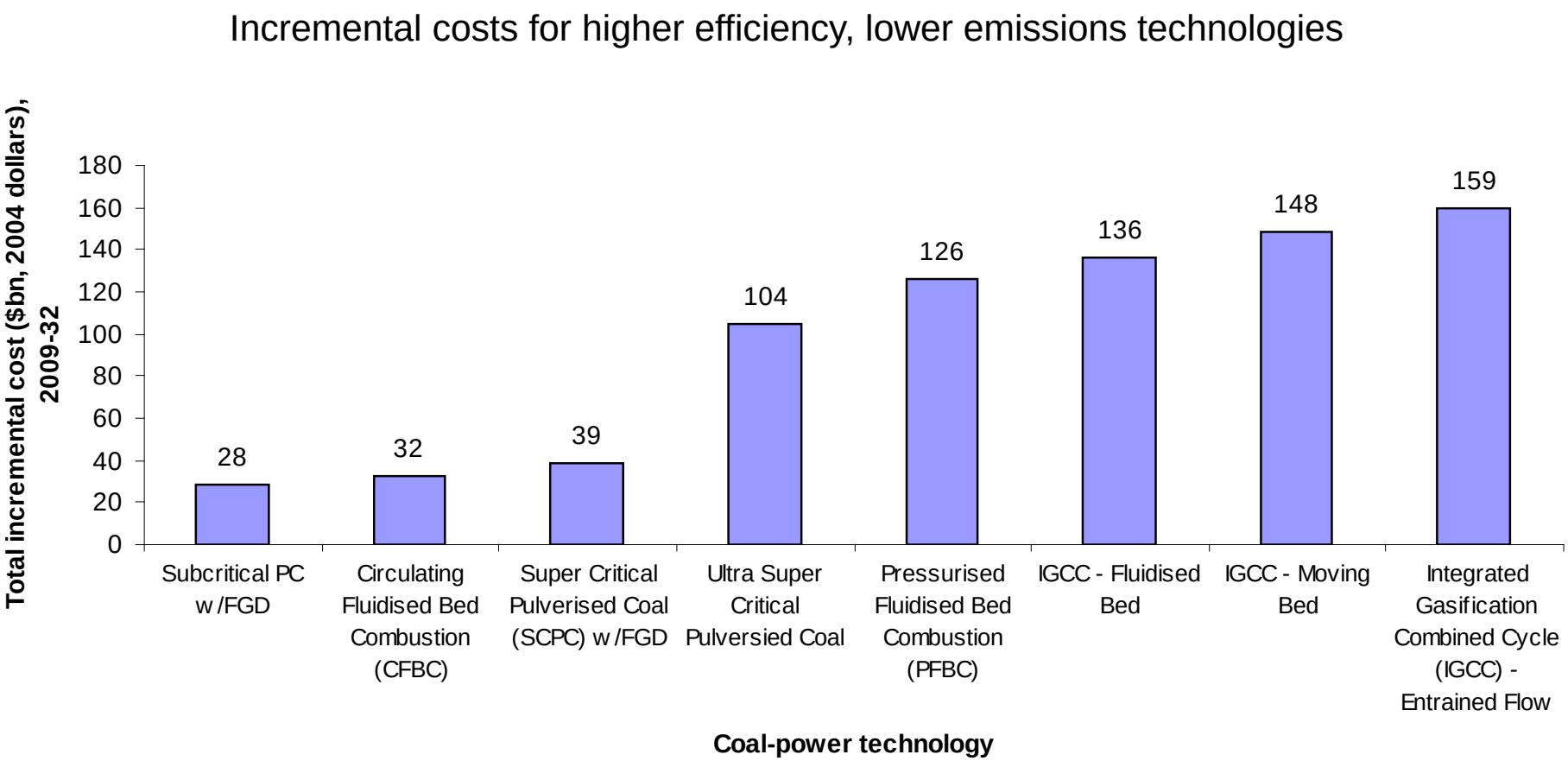
Private sector's share in electricity generation is gradually increasing



Sector	MW
State Sector	83563.65
Central Sector	56572.63
Private Sector	42553.34
Total	**182689.62**

SOURCE: http://powermin.gov.in/indian_electricity_scenario/introduction.htm, 2011

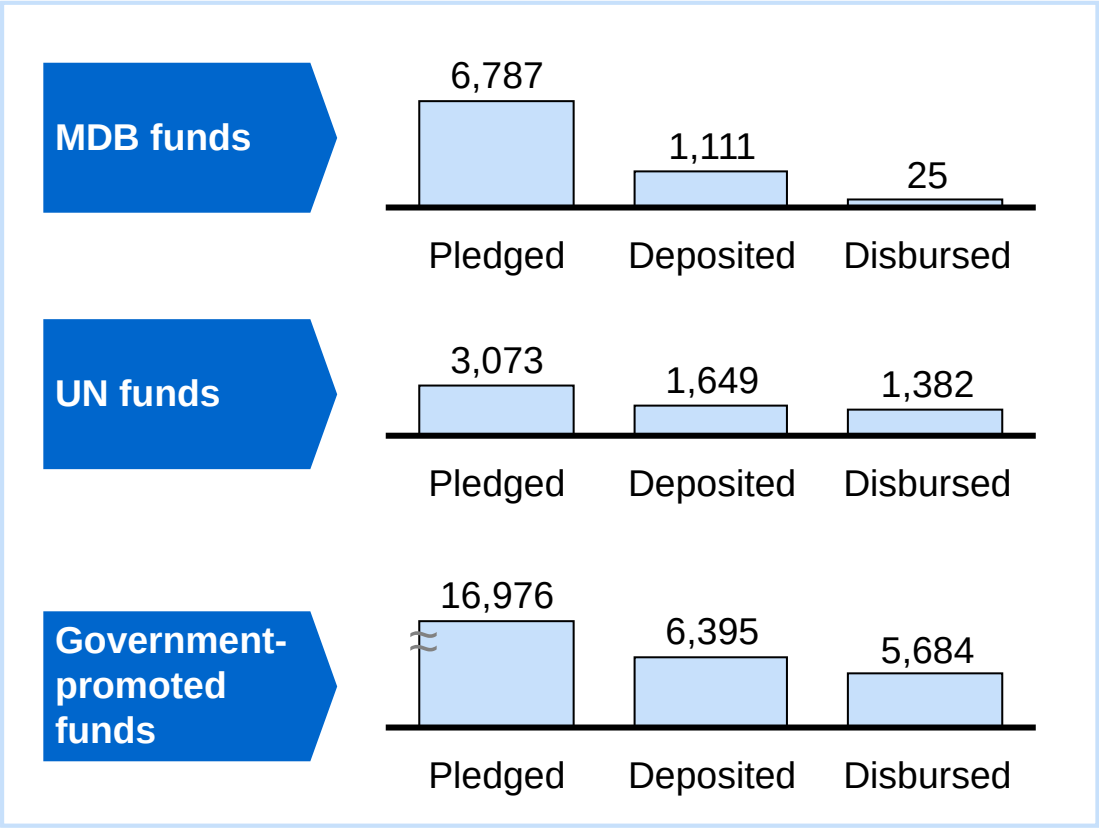
Efficient technologies cost money



SOURCE: Ghosh and Watkins (2009)

Many recent initiatives for climate financing but low ambitions so far

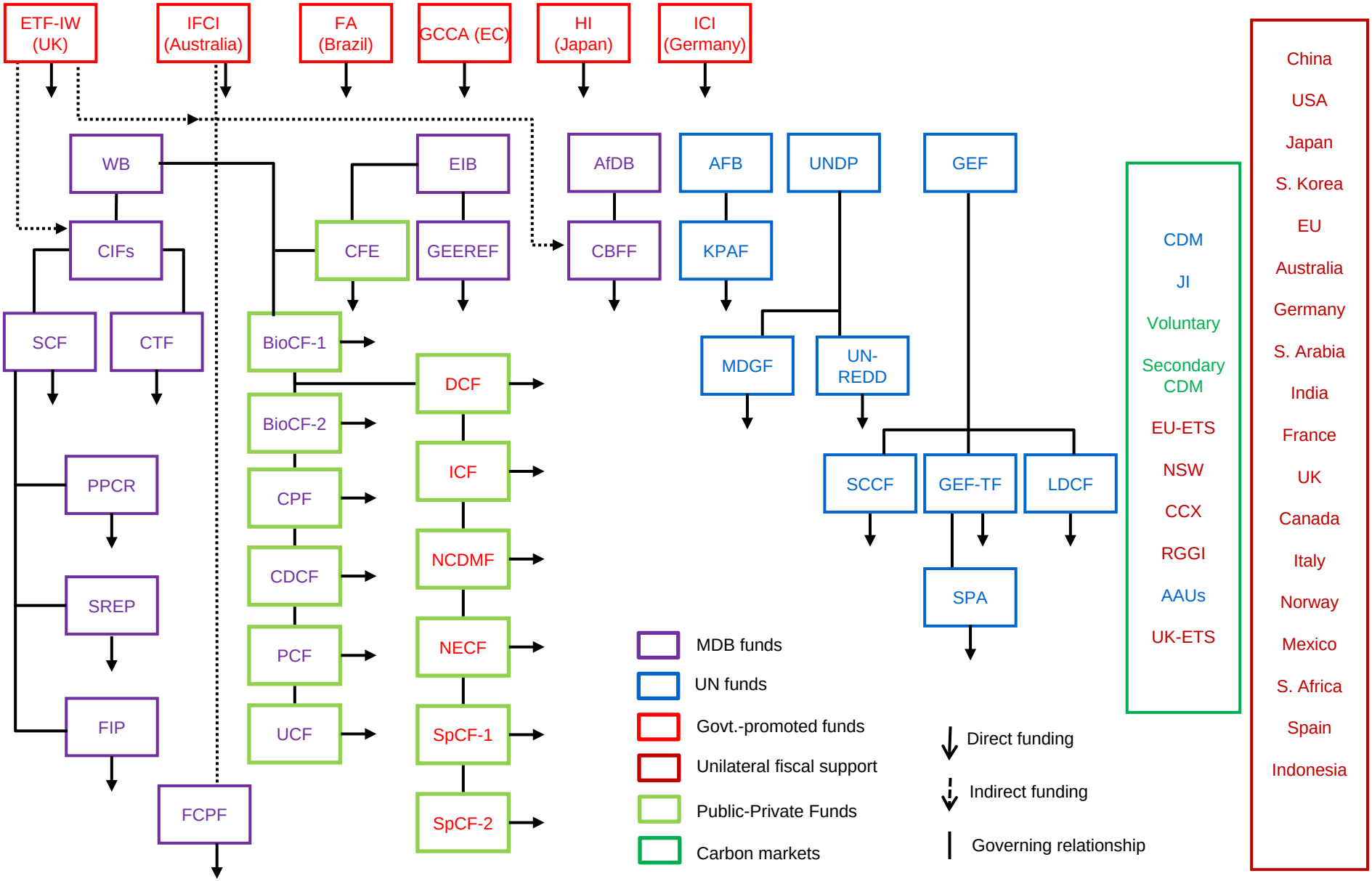
$ million, figures updated as of August 2010



Note 1: UK Environmental Transformation Fund – International Window: Funds channelled through CIFs, FCPF, and CBFF, hence not included separately.
Note 2: Strategic Climate Fund (MDB): Funds channelled through PPCR, FIP, and SREP, hence not included separately.
Note 3: For the Adaptation Fund (UN), the money raised from the monetisation of CERs is included under pledges.
Note 4: Funds for the Strategic Priority on Adaptation (SPA) are sourced from the GEF Trust Fund.
Note 5: For the GEF Trust Fund, only pledges/deposits under the climate change focal area for the fourth and fifth funding replenishments are included.

SOURCE: Ghosh (2010)

Climate funding sources are many but governance is often interlinked



SOURCE: Ghosh (2010)

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Meanwhile, energy demand is rapidly rising

- Presently, over 84% of the villages are electrified; but only 43.5% of the rural households have access to electricity
- Demand for power has been growing at the rate of 5.74% in recent years
- Demand for oil doubled in a decade to 2.9 mbpd in 2008; projected to reach 7 mbpd by 2030
- India imported 17.8% of its commercial energy in 1991; today, it imports more than 30%
- Indian Strategic Petroleum Reserves: 36.7 mb or 10 days of consumption by 2012; plan for 90 days of reserves

SOURCE: ADB (2007); Carl, Rai, Victor (2008); Lala (2011)

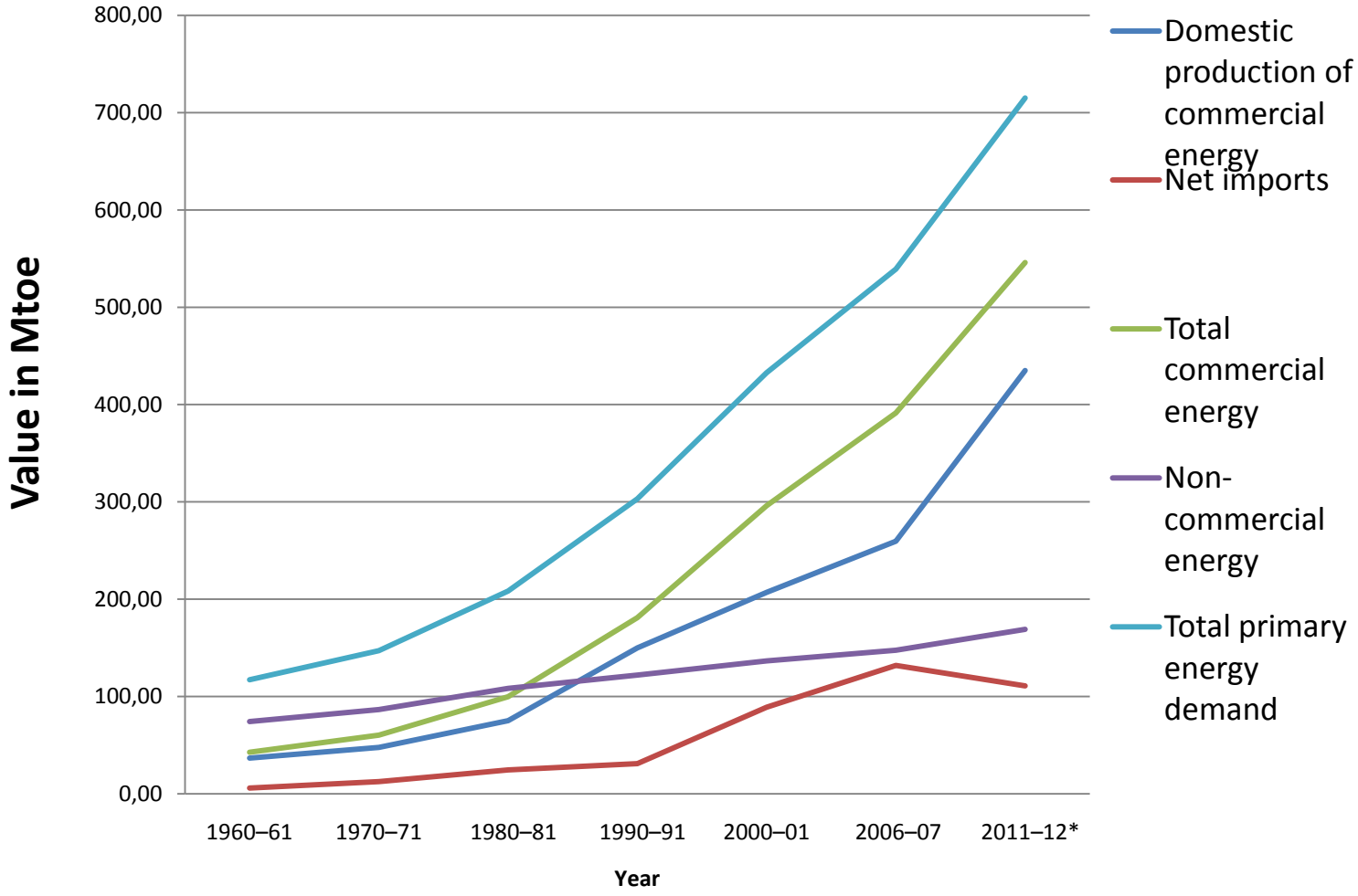
India's energy demand

	Trends in Demand and Supply of Primary Energy (All in Mtoe)						
	1960–61	1970–71	1980–81	1990–91	2000–01	2006–07	2011–12*
Domestic production of commercial energy	36.78	47.67	75.19	150.01	207.08	259.56	435
Net imports	6.04	12.66	24.63	31.07	89.03	131.97	111
Total commercial energy	42.82	60.33	99.82	181.08	296.11	391.53	546
Non-commercial energy	74.38	86.72	108.48	122.07	136.64	147.56	169
Total primary energy demand	117.20	147.05	208.30	303.15	432.75	539.09	715

* Projected requirement at the end of the Eleventh Plan as per the IEPC report.

SOURCE: Integrated Energy Policy Report (IEPR), 2006

India's energy demand



SOURCE: Integrated Energy Policy Report (IEPR), 2006

Hydrocarbon reserves: coal is king

Resources	Unit	Proved	Inferred	Indicated	Production in 2004-05	Net imports in 2004-05	Reserve/Production ratio	
		P	I		Q	M	P/Q	(P+I)/Q
Coal (as on 1.1.2005)	Mtoe	38114	48007	15497				
Extractable Coal**	Mtoe	13489	9600-15650		157	16	86	147-186
Lignite (as on 1.1.2005)	Mtoe	1220	3652	5772				
Extractable Lignite	Mtoe	1220			9		136	136
Oil (2005)	Mtoe	786*			34	87	23	23
Gas (2005)	Mtoe	1101*			29	3(LNG)	38	38
Coal Bed Methane	Mtoe	765		1260-2340				
In-situ Coal Gasification***								
Total		**56695**			**229**	**106**	**283**	**344-383**

* Balance Recoverable Reserves, ** Extractable coal from proved reserves has been calculated by considering 90% of geological reserve as mineable and dividing mineable reserve by Reserve to Production ratio (2.543 has been used in 'Coal Vision 2025' for CIL blocks); and range for extractable coal from prognosticated reserves has been arrived at by taking 70% of indicated and 40% of Inferred reserve as mineable and dividing mineable reserve by R:P ratios (2.543 for CIL blocks and 4.7 for non-CIL blocks as per 'Coal Vision 2025'). *** From deep seated coal (not included in extractable coal reserves) Note: Indicated Gas resource includes 320 Mtoe claimed by Reliance Energy but excludes the 360 Mtoe of reserves indicated by GSPCL as the same have not yet been certified by DGH.

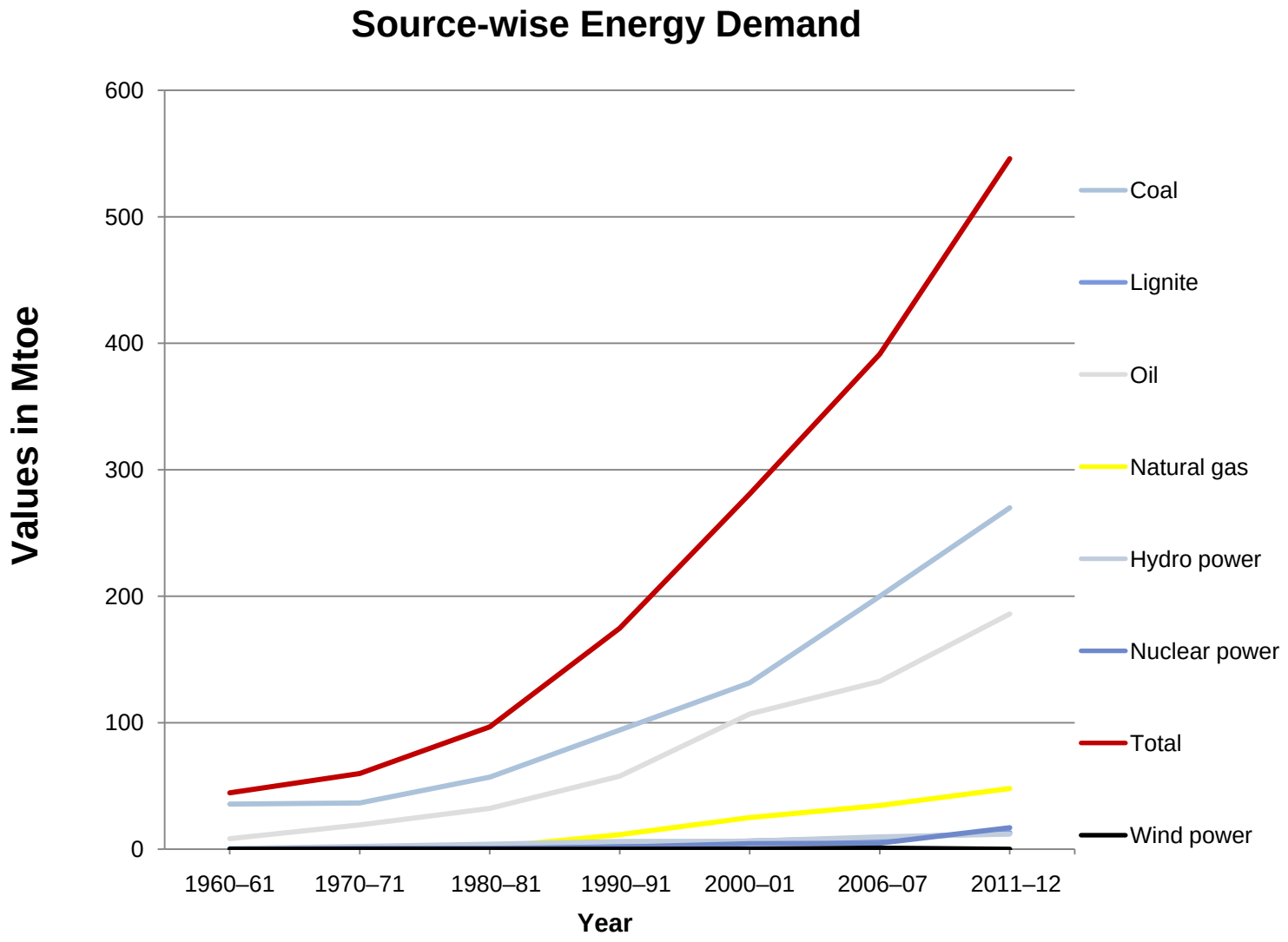
SOURCE: Integrated Energy Policy Report of the Expert Committee, Planning Commission,2006

Hydropower potential in India

Region	Principal Hydro			Pumped Storage Feasible Installed Capacity in MW	Small Hydro (up to 15 MW) Potential in MW
	Potential at 60 % Load Factor	Feasible Installed Capacity in MW	Potential in billion kWh per year		
Northern	30155	53405	225	13065	3180
Western	5679	8928	31.4	39684	661
Southern	10768	16446	61.8	17750	801
Eastern	5590	10965	42.5	9125	530
North Eastern	31857	58956	239.3	16900	1610
Total	**84044**	**148700**	**600**	**95524**	**6782**

SOURCE: http://expert-eyes.org/power/hydro.html

India’s energy demand, by source



SOURCE: Planning Commision (2006)

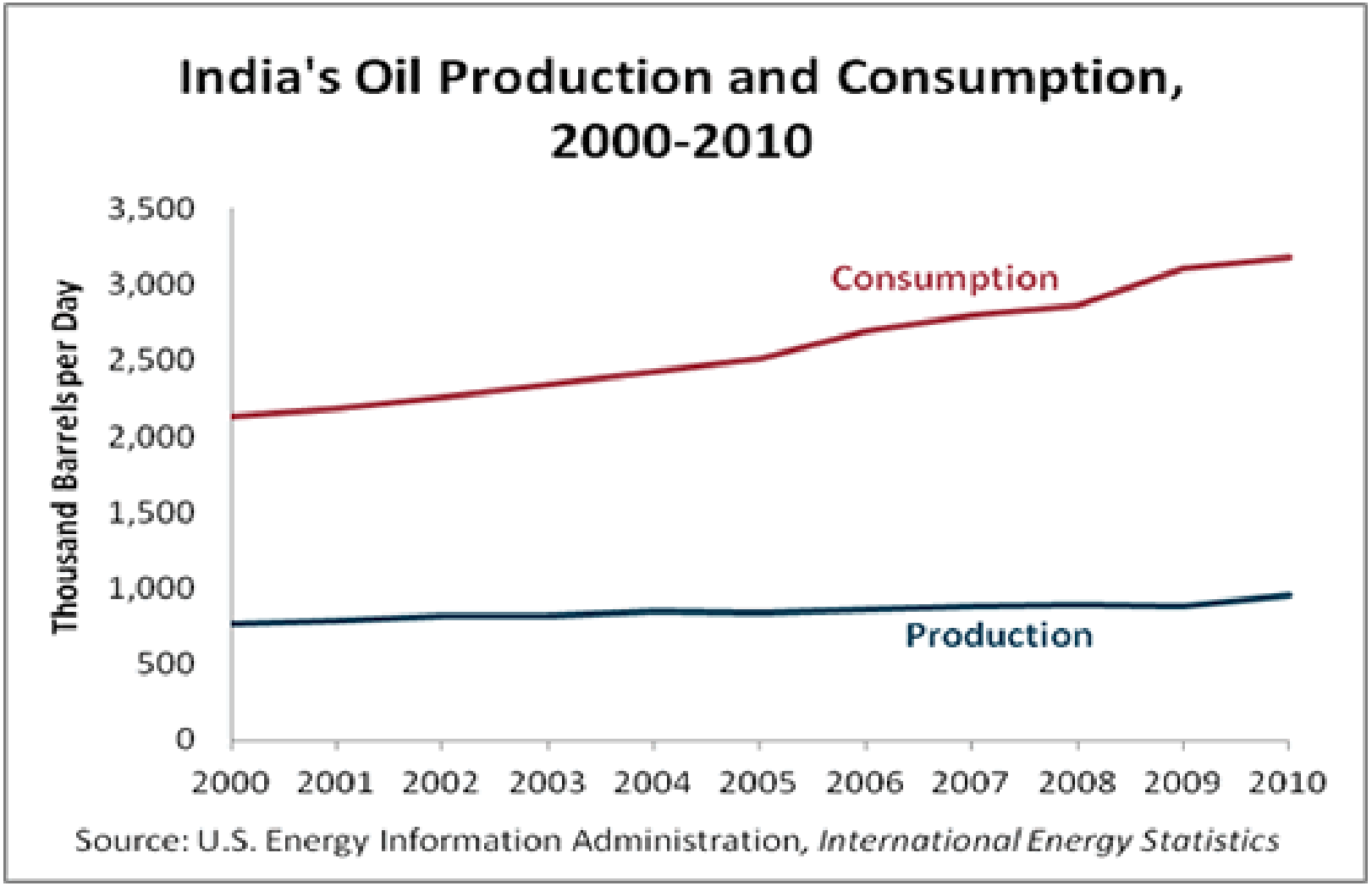
But growth in coal production is slow

Coal Production (in million tonnes)

Company	Target 2010-11	Actual upto Dec. 2010	Achievement (%)	2009-10 Actual up to Dec. 2009	Growth (%)
CIL	460.50	299.52	65.04	295.51	1.36
SCCL	46.00	36.33	78.98	36.55	-0.60
Others	65.87	33.56	50.94	33.60	-0.12
Total	572.37	369.41	64.54	365.66	1.02

SOURCE: Annual Report, Ministry of Coal, 2011

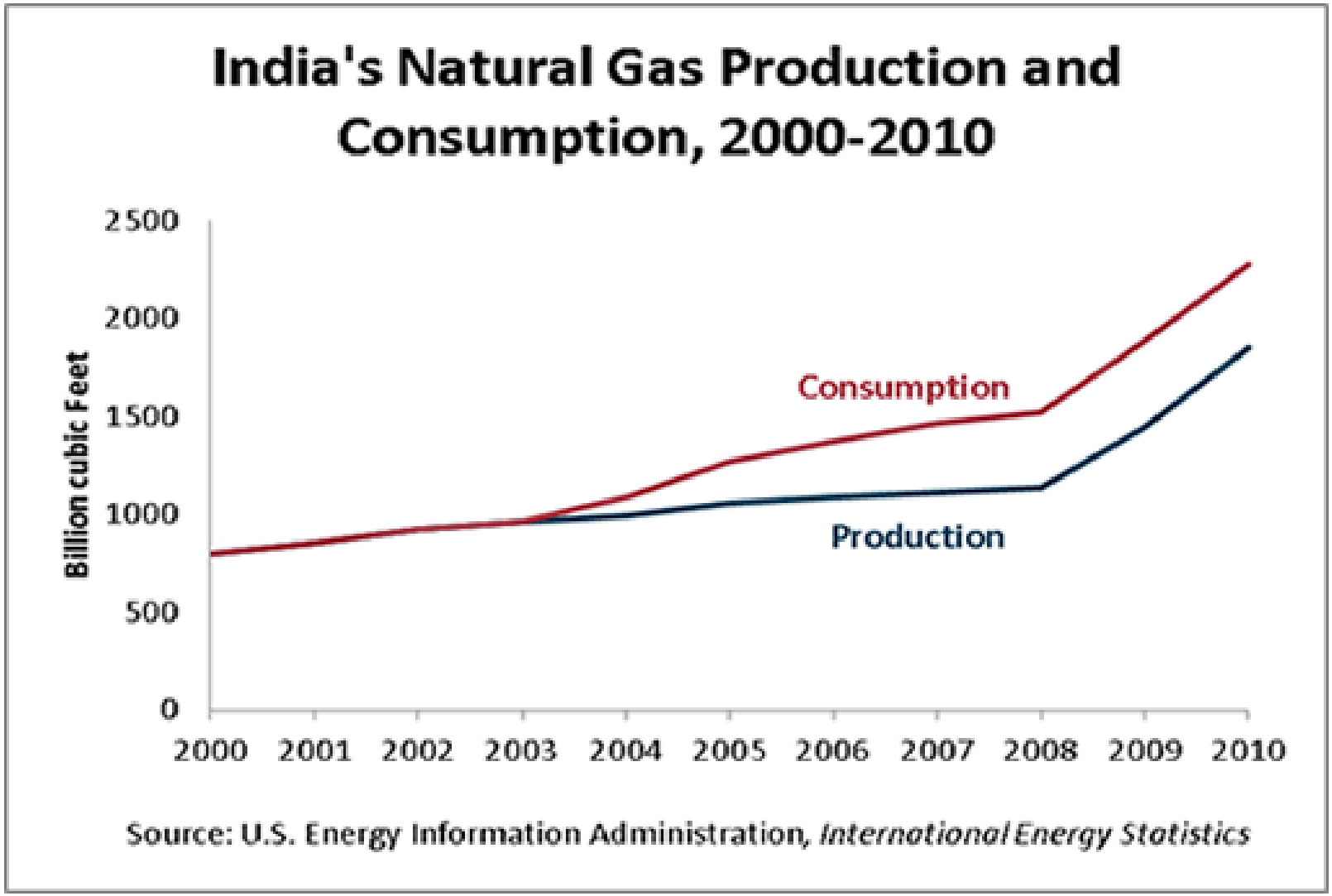
Oil production has not kept pace with consumption



But refining capacity trebled from 51 mmtpa in 1991 to 148 mmtpa in 2007

SOURCE: http://www.eia.gov/cabs/India/Full.html, 2011; Joshi (2009)

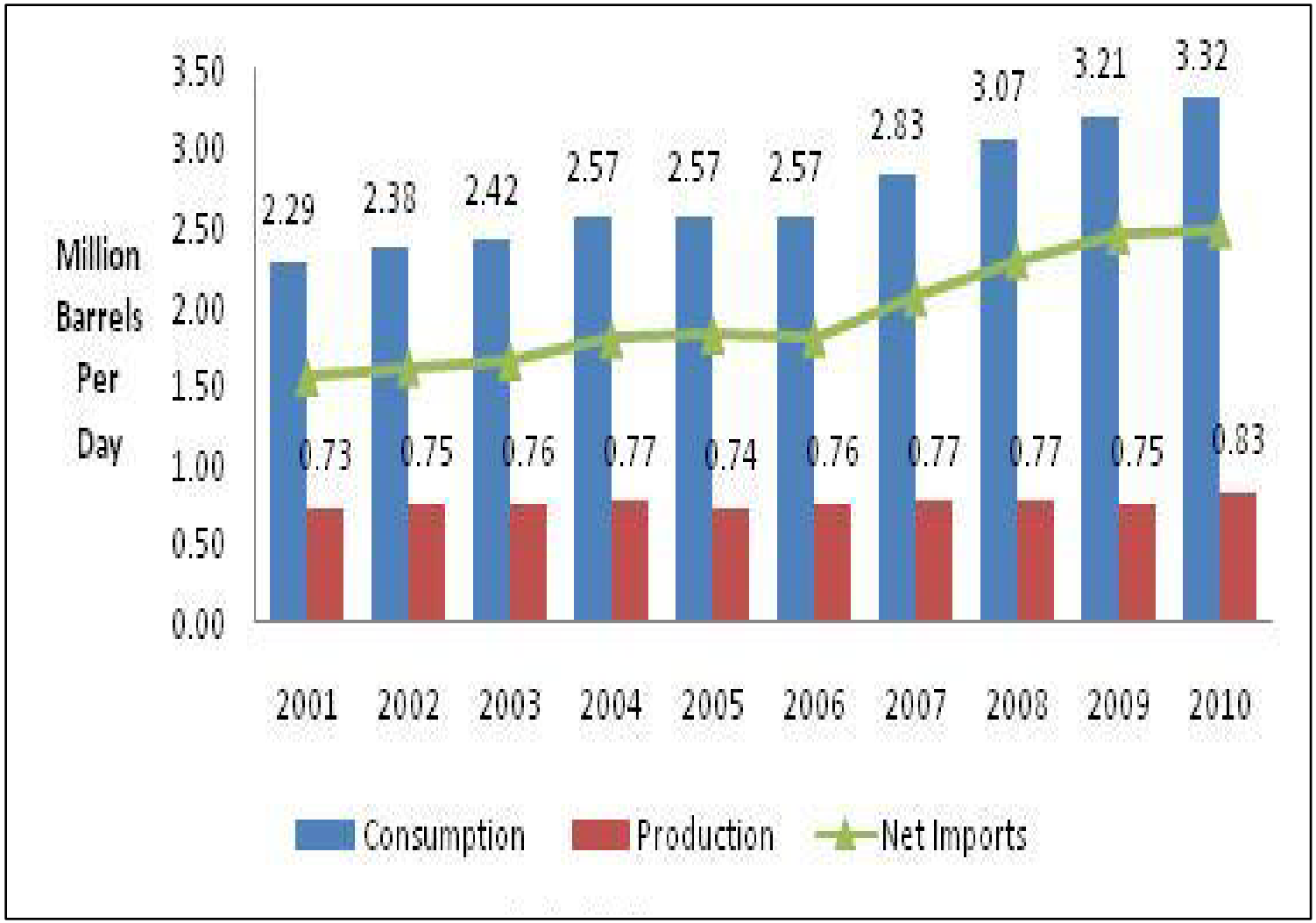
Natural gas has struggled with finding new sources



30% of gas produced is feedstock for urea; 40% is for power generation;
Late entrant: first LNG terminals only in 2004

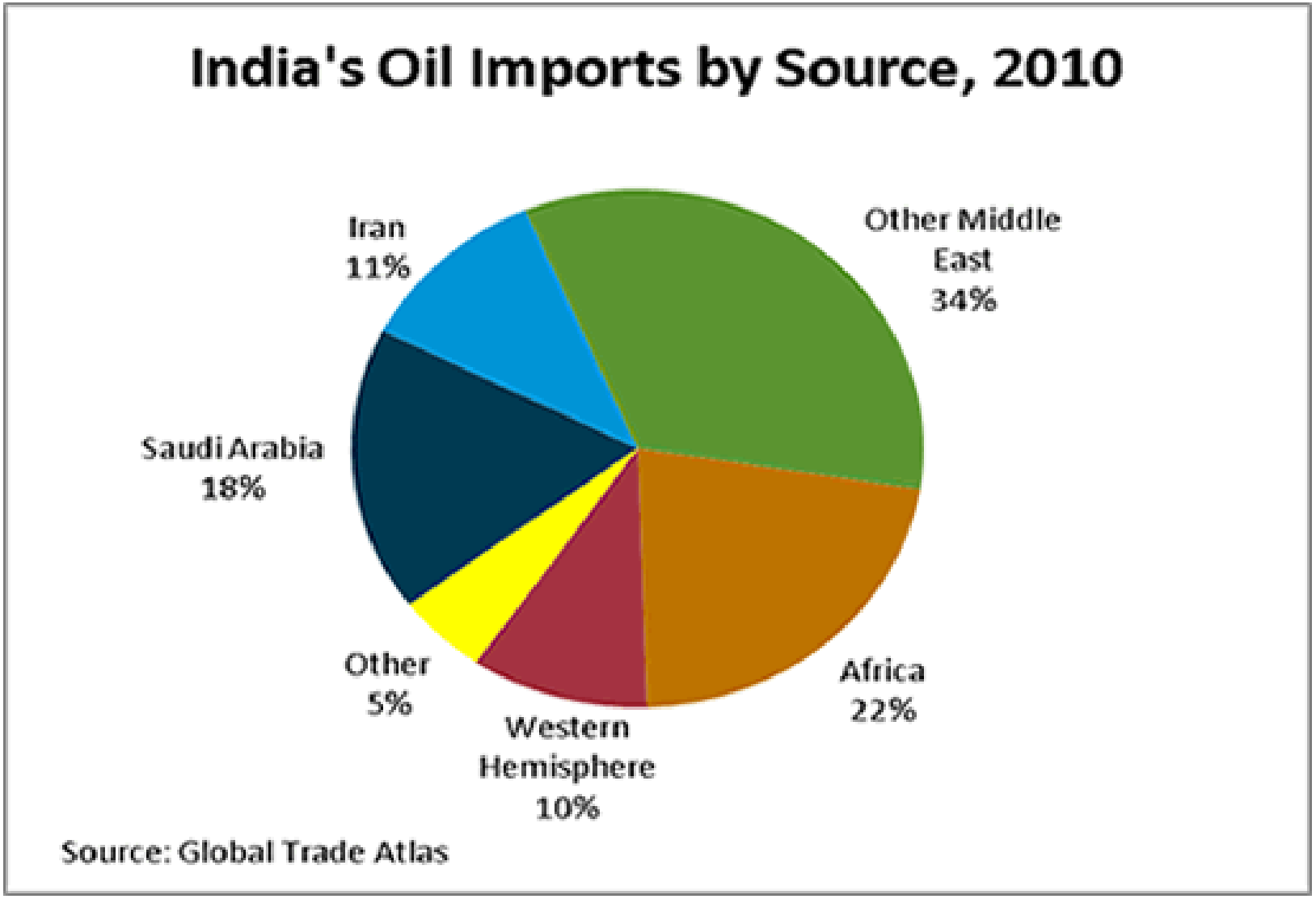
SOURCE: http://www.eia.gov/cabs/India/Full.html, 2011; Joshi (2009); Joshi (2011)

Oil imports already meet about 80% of demand



SOURCE: BP review, 2011

India is heavily reliant on West Asia



SOURCE: http://www.eia.gov/cabs/India/Full.html, 2011

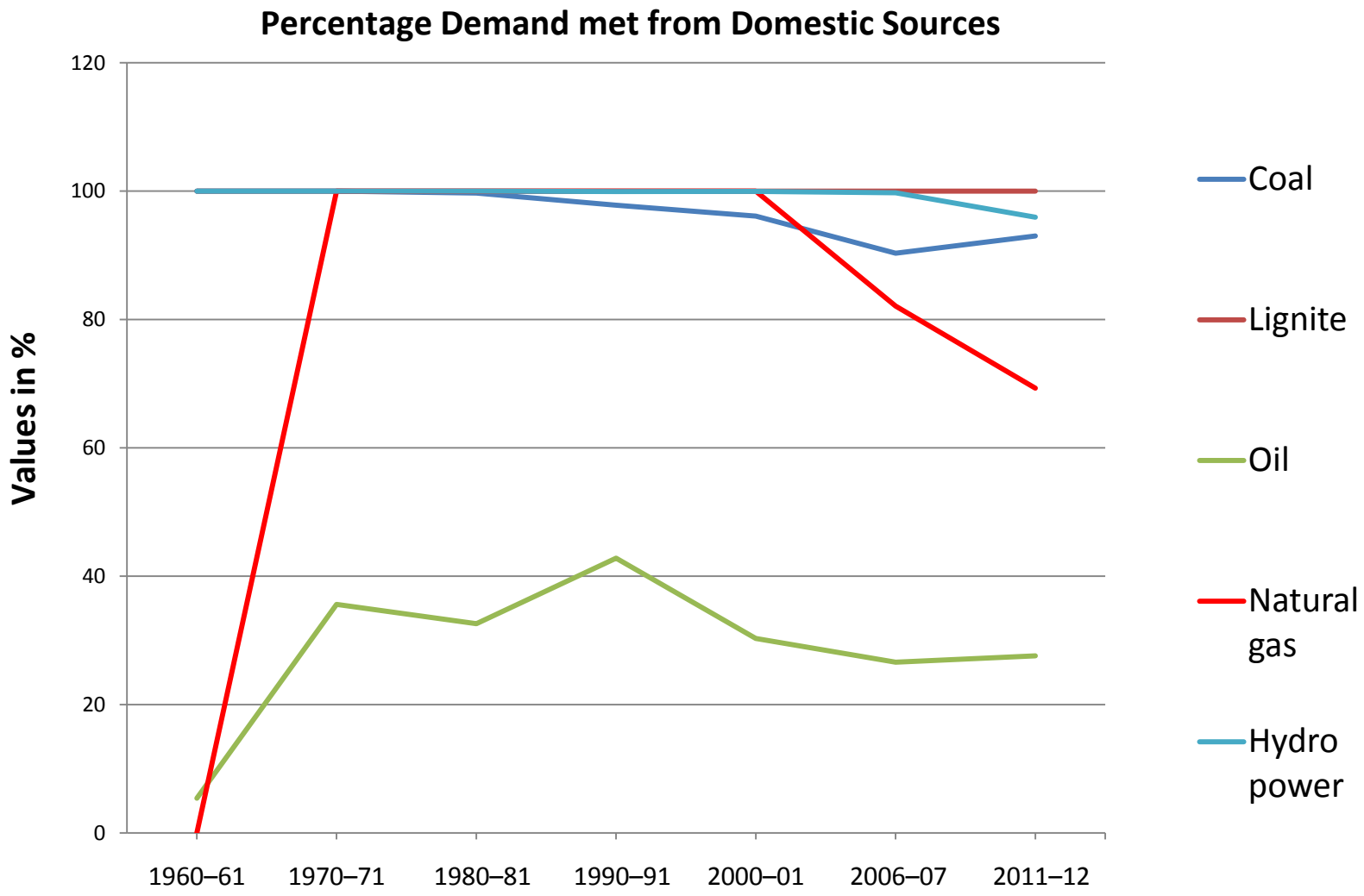
Self-reliance no longer feasible for India

Percentage Demand met from Domestic Sources (All in %)							
	1960–61	1970–71	1980–81	1990–91	2000–01	2006–07	2011–12*
Coal	100	100	99.7	97.8	96.1	90.33	93.02
Lignite	100	100	100	100	100	100	100
Oil	5.4	35.6	32.6	42.8	30.3	26.6	27.59
Natural gas	–	100	100	100	100	82.08	69.3
Hydro power	100	100	100	99.93	99.96	99.74	95.94

* Projected requirement at the end of the Eleventh Plan as per the IEPC report.

SOURCE: Planning Commision (2006)

Self-reliance no longer feasible for India



SOURCE: Planning Commision (2006)

Fuel imports are expected to keep rising

Projected Primary Energy Requirement for India, 2030 (All in Mtoe)				
Fuel	Range of Requirements	Assumed Domestic Production	Range of Imports	Import (%)
Coal including lignite	632–1022	560	72–462	11–45
Oil	350–486	35	315–451	90–93
Natural gas including coal bed methane (CBM)	100–197	100	0–97	0–49
Total commercial primary energy	1351–1702	–	387–1010	29–59

Note: Range of imports is calculated across all scenarios by taking the minimum requirement and maximum domestic production as the lower bound and maximum requirement and minimum domestic production as the upper bound

SOURCE: Integrated Energy Policy Report (IEPR), 2006

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India's renewable energy potential

Resources	Unit	Present	Potential	Basis of Accessing Potential
Hydro-power	MW	32,326	1,50,000	Total potential assessed is 84,000 MW"" at 60% load factor or 1,50,000 MW at lower load factors
Biomass				
Wood	Mtoe/year	140	620	Using 60 million Ha wasteland yielding (20) MT/Halyear
Biogas	Mtoe/year	0.6	4	In 12 million family sized plants
		0.1	15	In community based plants if most of the dung is put through them.
Bio-Fuels				
Bio-diesel	Mtoe/year	-	20	Through plantation of 20'million hectares o wasteland or 7'million hectares of intensive cultivation
Ethanol	Mtoe/year	<1	10	From 1.2 million hectares of intensive cultivation with required inputs.
Solar				
Photovoltaic	Mtoe/year	-	1,200	Expected by utilising 5 million hectares wasteland at an efficiency level of 15 percent for Solar Photovoltaic Cells
Thermal	Mtoe/year		1,200	MWe scale power plants using 5 million hectares
Wind Energy	Mtoe/year	<1	10	Onshore potential of 65,000 MWe at 20 percent load factor
Small Hydro-powe	Mtoe/year	<1	5	

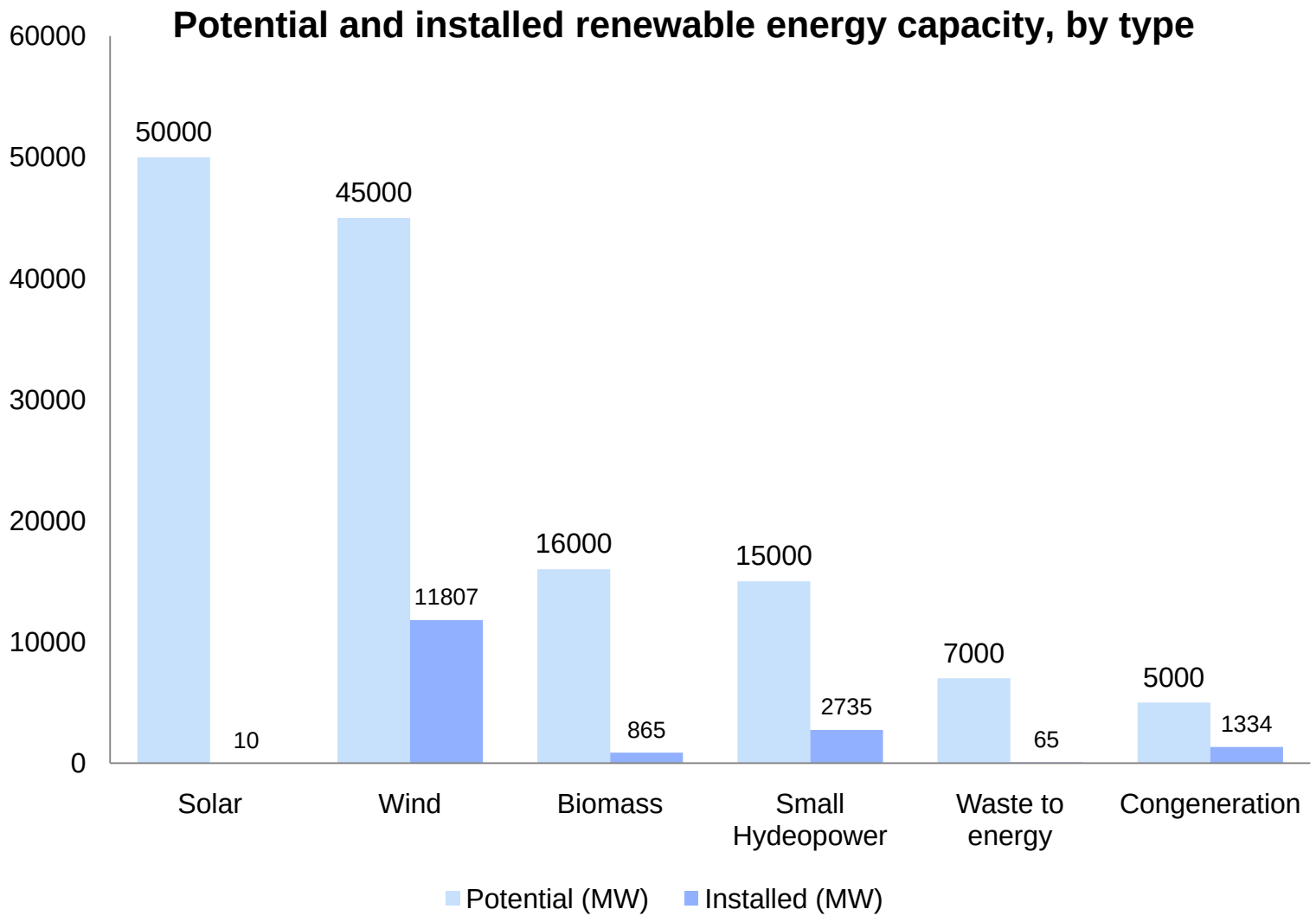
SOURCE: Integrated Energy Policy Report of the Expert Committee, Planning Commission,2006

Small but growing share of renewables

Annual Achievement 2010-11 and Cumulative Achievement by June 2010			
No.	**Source/System**	**Achievements during 2010-11 (up to 30.6.2010)**	**Cumulative achievements (up to 30.6.2010)**
A	**Grid-interactive renewable power**		
1	Biomass Power (Agro residues)	45.5 MW	901.1 MW
2	Wind Power	202.73MW	12009.48 MW
3	Small Hydro Power (up to 25 MW)	31.64 MW	2767.05 MW
4	Cogeneration-bagasse	67.5 MW	1411.53 MW
5	Waste to Energy	7.5 MW	72.46 MW
6	Solar Power	2.0 MW	12.28 MW
	Total (in MW)	356.87 MW	17173.9 MW
B	**Off-Grid/ Distributed Renewable Power (including Captive/ CHP plants)**		
7	Biomass Power/Cogen.(non-bagasse)	6.0 MW	238.17 MW
8	Biomass Gasifier	4.0 MWeq.	125.44 Mweq
9	Waste-to-Energy	6.0 MWeq.	52.72 MWeq
10	Solar PV Power Plants	0.0 MWp	2.92 MWp
11	Aero- Generators/ Hybrid System	0.0 MW	1.07 MW
	Total (in MW)	16.00MWeq	**420.32 MWeq**

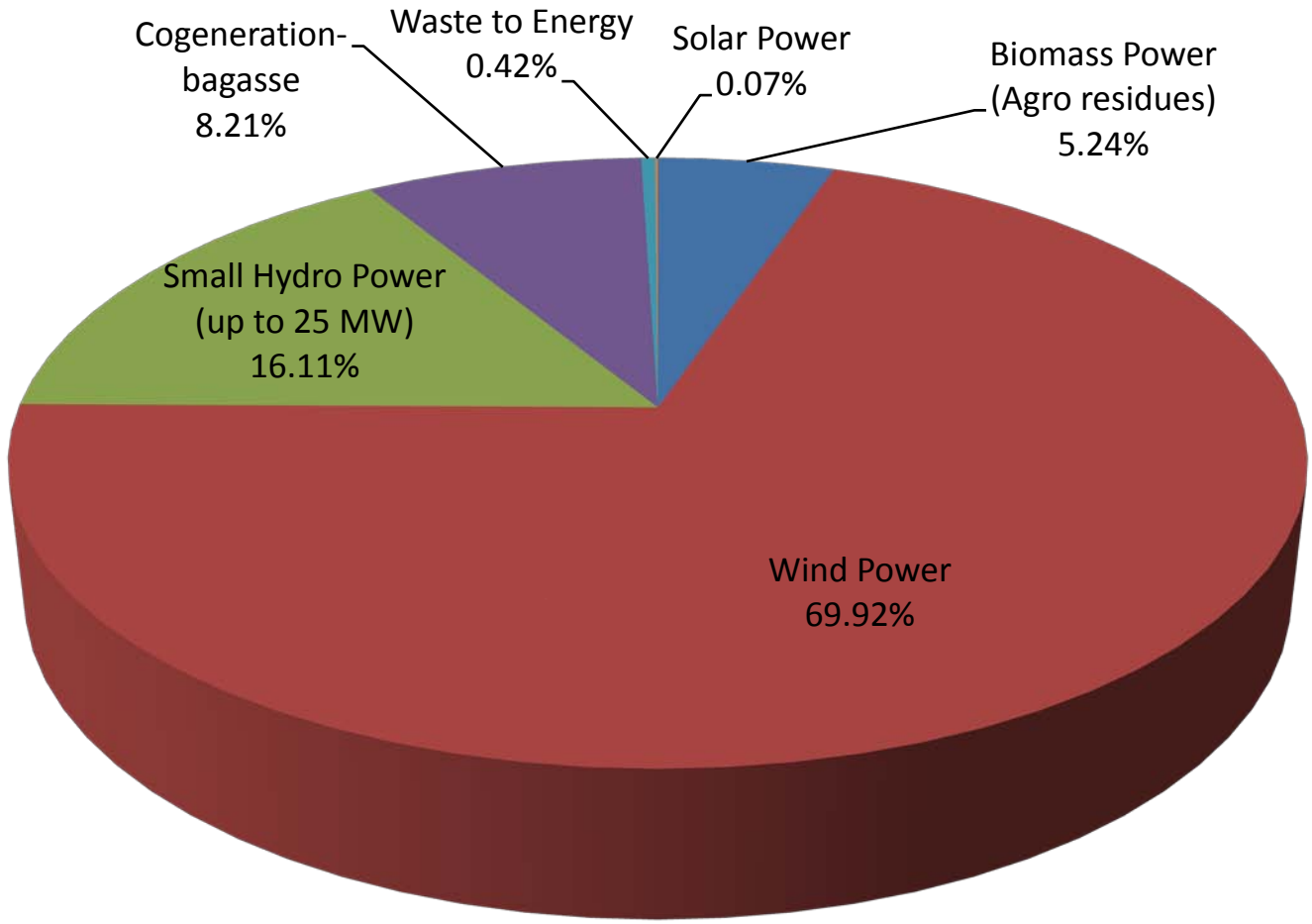
SOURCE: Conventional and Renewable Energy Scenario of India: Present and Future, Canadian Journal on Electrical and Electronics Engineering Vol. 1, No. 6, October 2010

But renewable energy potential largely under-utilised



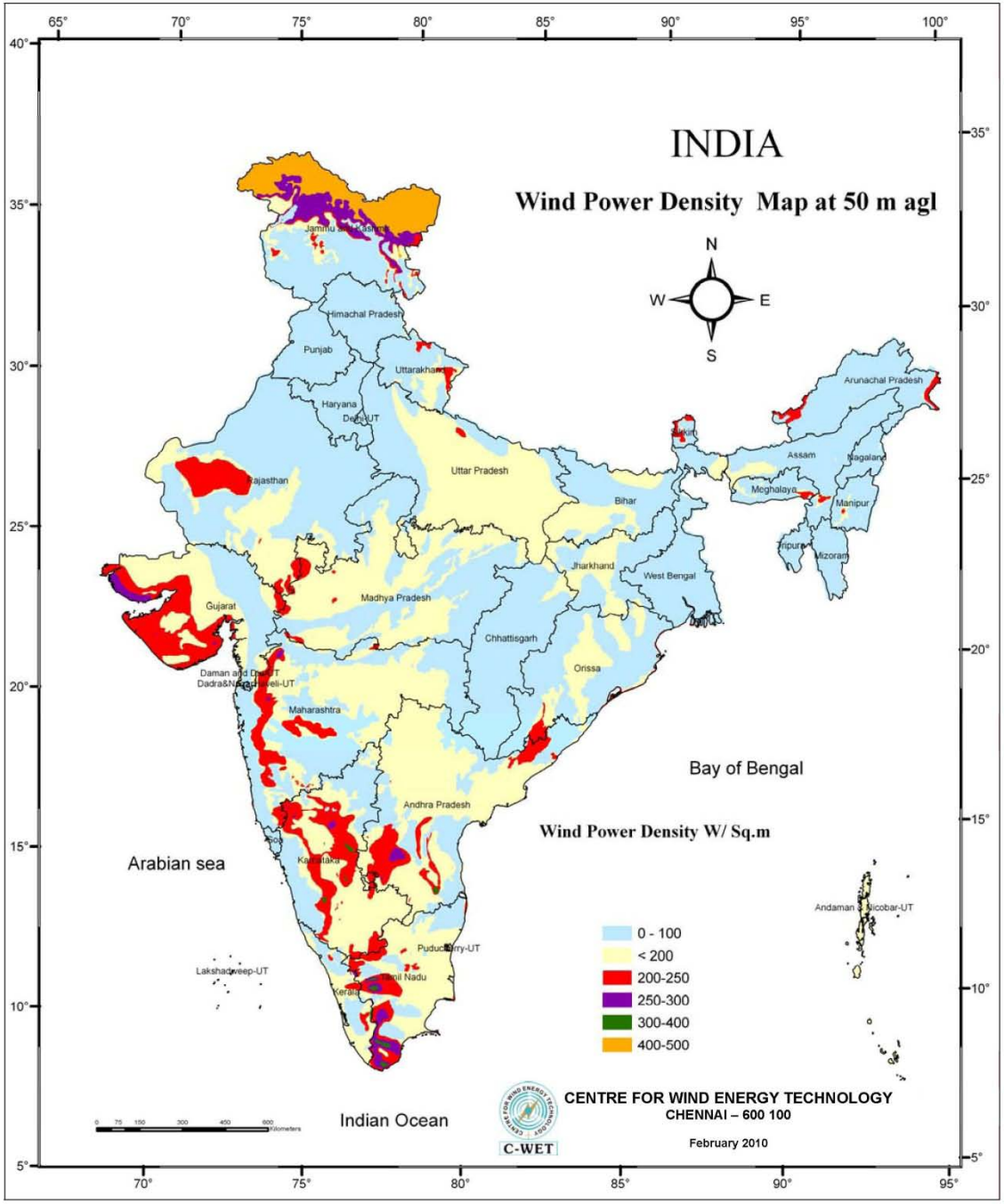
SOURCE: MNRE (2009)

Grid-interactive renewable power: wind dominates so far



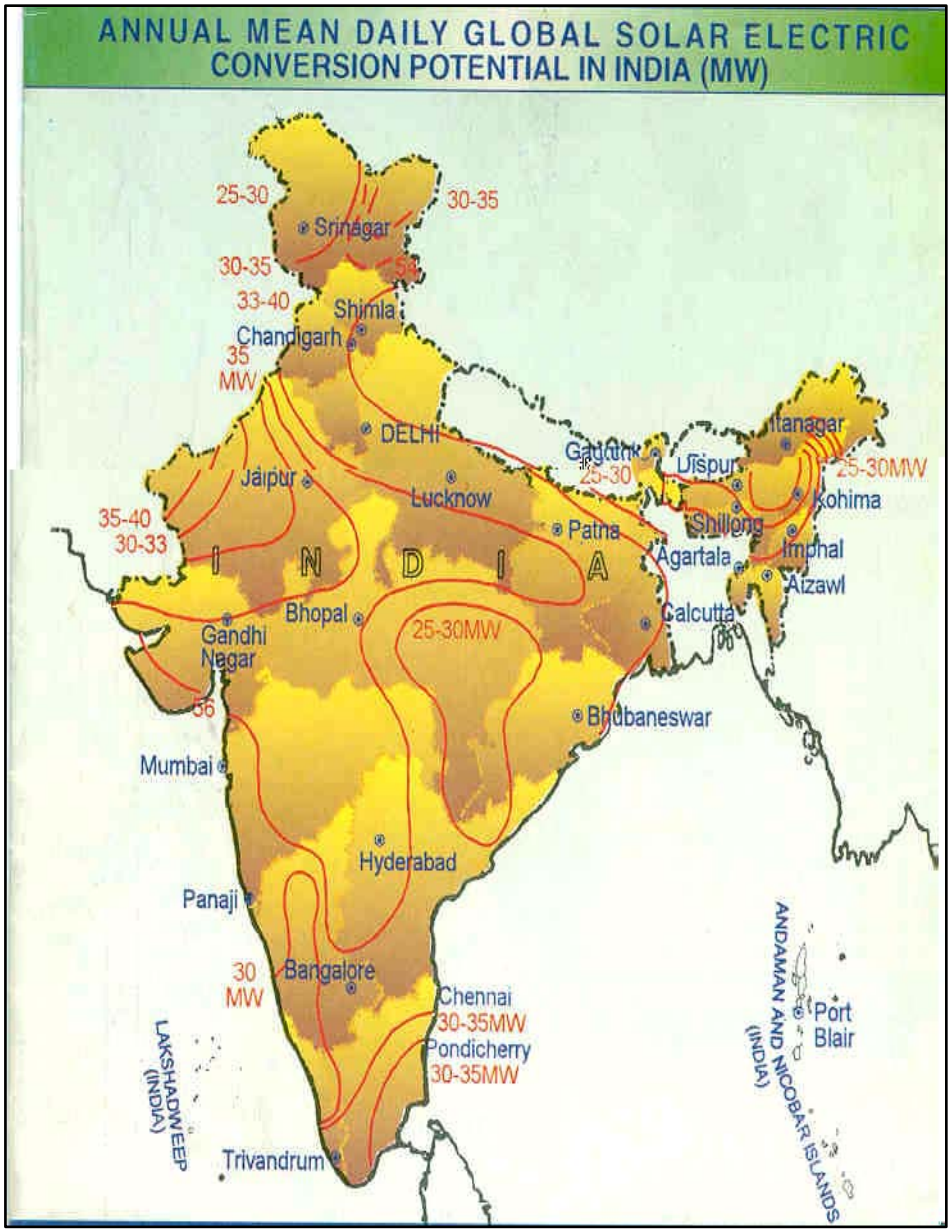
SOURCE: Conventional and Renewable Energy Scenario of India: Present and Future, Canadian Journal on Electrical and Electronics Engineering Vol. 1, No. 6, October 2010

Wind energy potential



SOURCE: http://www.cwet.tn.nic.in/html/departments_wpdmap.html, 2010

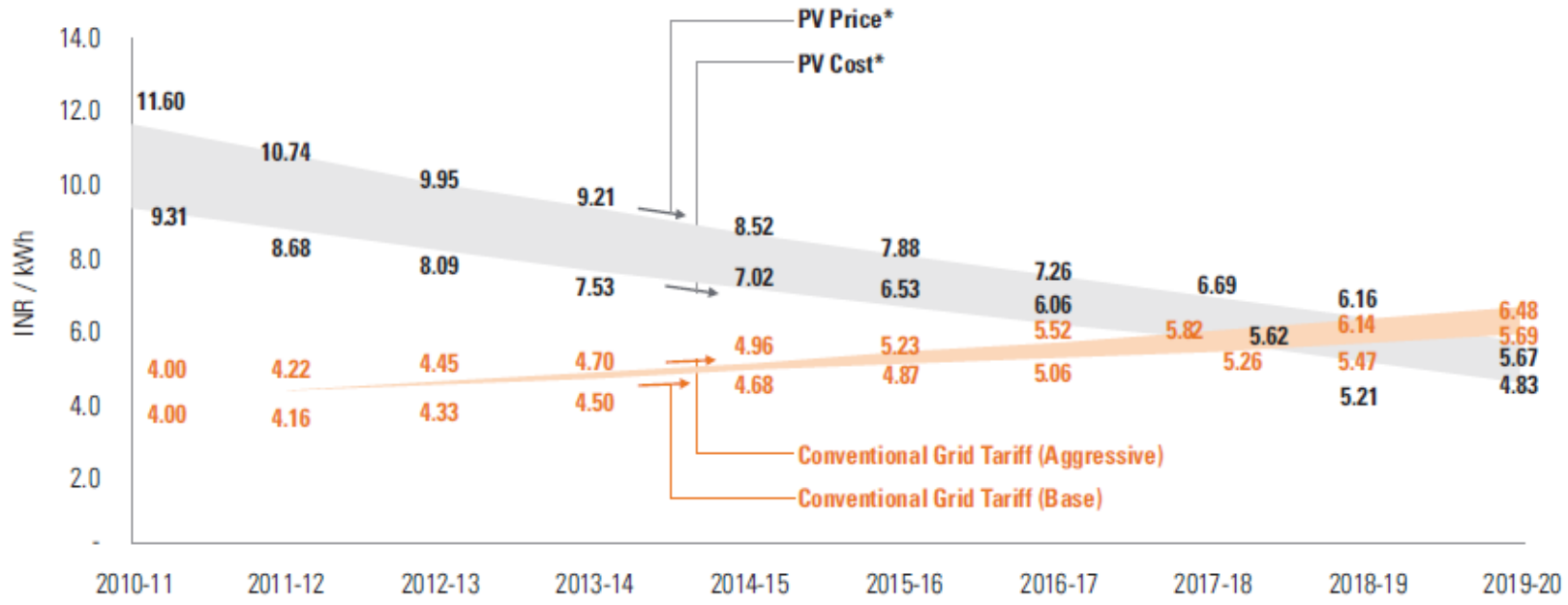
Solar energy potential



SOURCE: http://www.geni.org/globalenergy/library/renewable-energy-resources/world/asia/solar-asia/solar-india.shtml, 2005

Need for policies to match the real with the potential

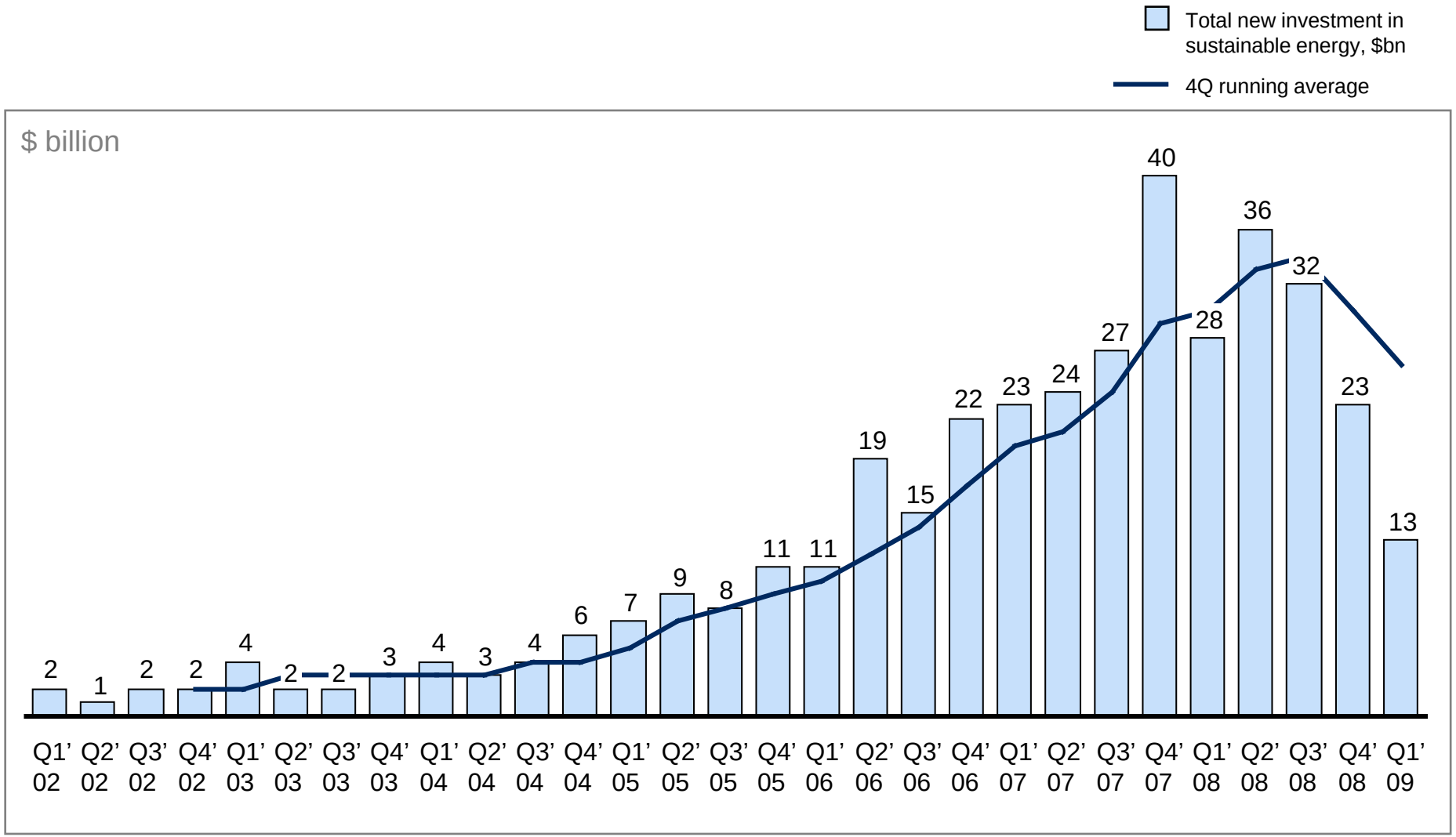
Levelized Cost Comparison of Utility-scale PV and Conventional Power at Grid



Grid Parity Year	Aggressive Case	Base-Case
Utility PV Price	2017-18	2019-20

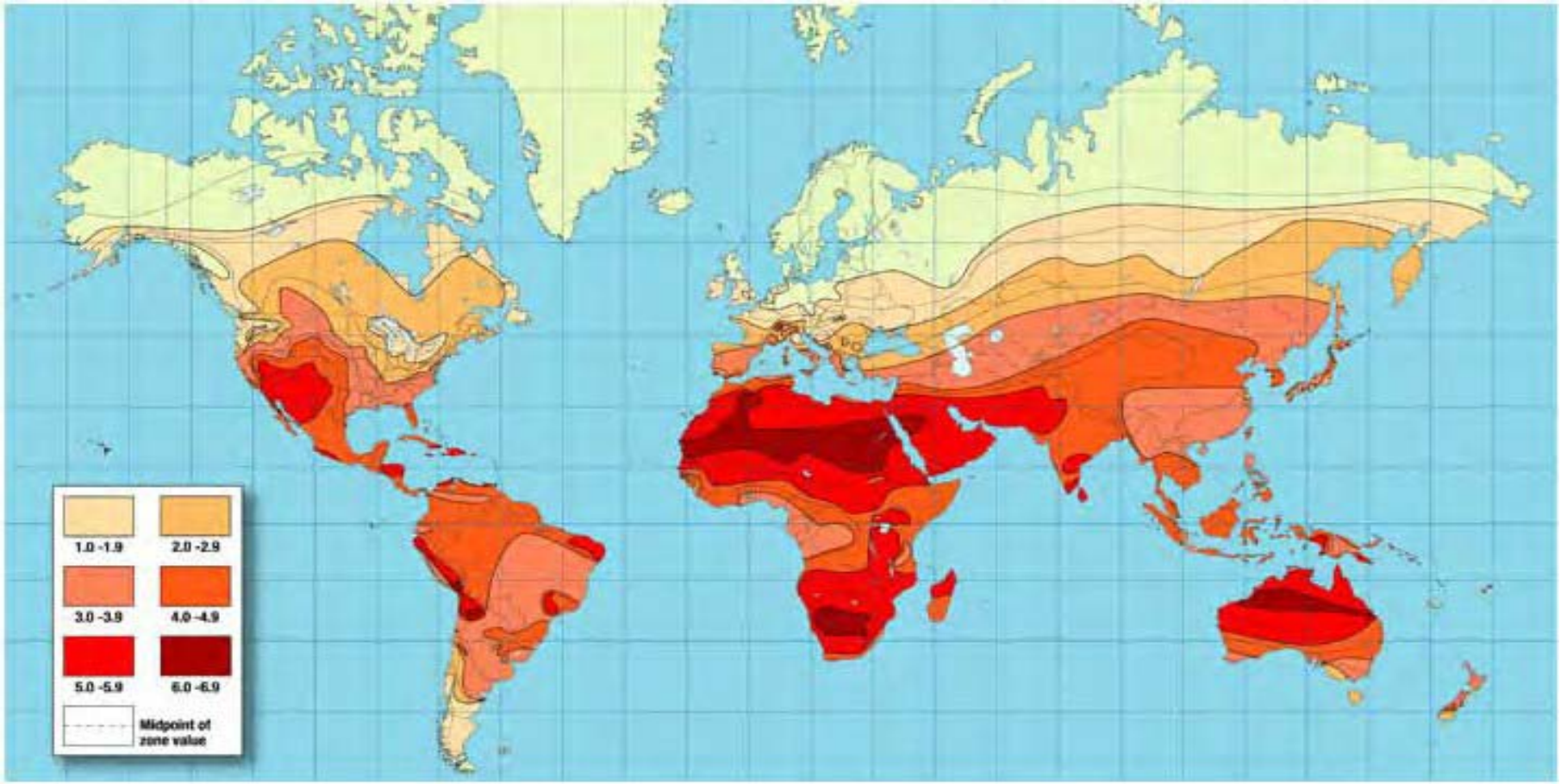
SOURCE: KPMG (2011)

Slowdown in sustainable energy investments began in early 2008



SOURCE: UNEP, Sustainable Energy Finance Initiative, New Energy Finance (2009)

Case for global cooperation?



SOURCE: OKSolar.com
NOTE: Based on yearly averages of daily hours of sunlight and ambient temperature; chart prepared on 16 July 2011

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Key actors in global energy trade

	1965–73	1974–81	1982–90	1991–2002	2003–10
Oil importers	United States	United States	United States	United States	United States
	Japan	Japan	Japan	Japan	Japan
	France	France	France	France	China
	Germany	Germany	Germany	Germany	France
	United Kingdom	Italy	Italy	Italy	Germany
Oil exporters	Venezuela	Saudi Arabia	Saudi Arabia	Saudi Arabia	Saudi Arabia
	Iran	Iran	USSR	Russia	Russia
	Saudi Arabia	USSR	Venezuela	Venezuela	Iran
	Kuwait	Kuwait	Iraq	Iran	Norway
	USSR	Venezuela	Iran	Norway	UAE

SOURCE: Ghosh (2011)

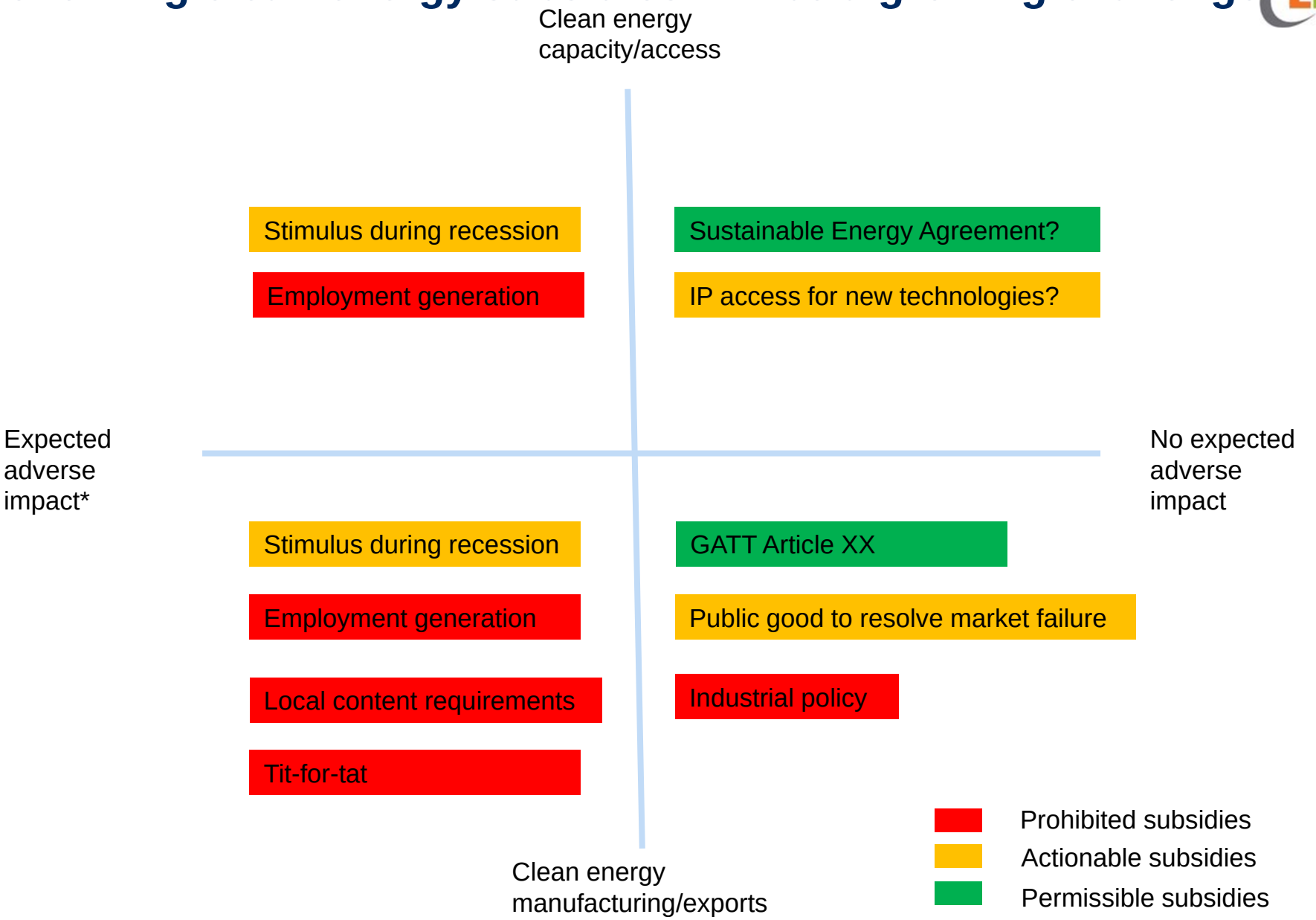
ECT membership has broadened beyond EU and Europe

Country	EU member	ECT member	WTO member
Albania		•	•
Armenia		•	•
Australia*		•	•
Austria	•	•	•
Azerbaijan		•	
Belarus*		•	
Belgium	•	•	•
Bosnia & Herzegovina		•	
Bulgaria	•	•	•
Croatia		•	•
Cyprus	•	•	•
Czech Republic	•	•	•
Denmark	•	•	•
Estonia	•	•	•
European Communities	•	•	•
Finland	•	•	•
France	•	•	•
Georgia		•	•
Germany	•	•	•
Greece	•	•	•
Hungary	•	•	•
Iceland*		•	•
Ireland	•	•	•
Italy	•	•	•
Japan		•	•

Country	EU member	ECT member	WTO member
Latvia	•	•	•
Liechtenstein		•	•
Lithuania	•	•	•
Luxembourg	•	•	•
Macedonia		•	•
Malta	•	•	•
Moldova		•	•
Mongolia		•	•
Netherlands	•	•	•
Norway*		•	•
Poland	•	•	•
Portugal	•	•	•
Romania	•	•	•
Russian Federation*		•	
Slovakia	•	•	•
Slovenia	•	•	•
Spain	•	•	•
Sweden	•	•	•
Tajikistan		•	
Turkey		•	•
Turkmenistan		•	
Ukraine		•	•
United Kingdom	•	•	•
Uzbekistan		•	

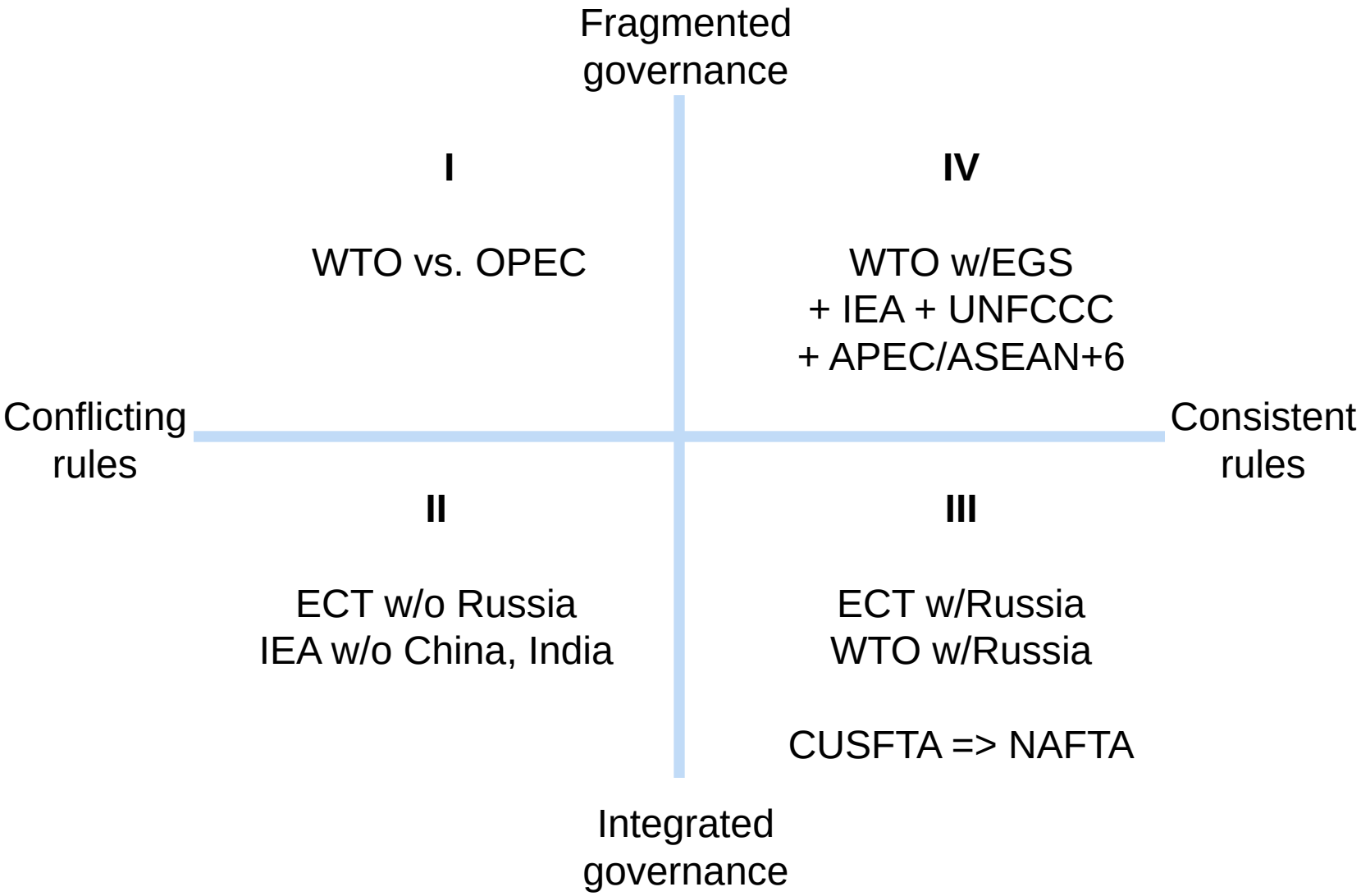
SOURCE: Ghosh (2011)

Governing clean energy subsidies will be a growing challenge



* As per WTO rules, adverse impacts could result from: injury; serious prejudice; or nullification of benefits

Alternative energy regimes for alternative priorities



SOURCE: Ghosh (2011)

Key takeaways

- Energy access will remain a political issue in India for decades to come
- Climate change has introduced complications in the energy security equation: India will seek out technology to increase fossil fuel efficiency
- India's fossil fuel infrastructure is increasingly dependent on foreign sources of supply: but without domestic reform, investments are unlikely to increase domestic capacity
- Renewable energy potential in India is under-utilised and is a tremendous market opportunity: India could take the lead in regional or plurilateral cooperation
- India is not party to any major energy governance regime: rules governing trade, climate and energy will need more coherence for investments and trade to increase

THANK YOU

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