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Energy Demand Management

Green Growth Strategies for India

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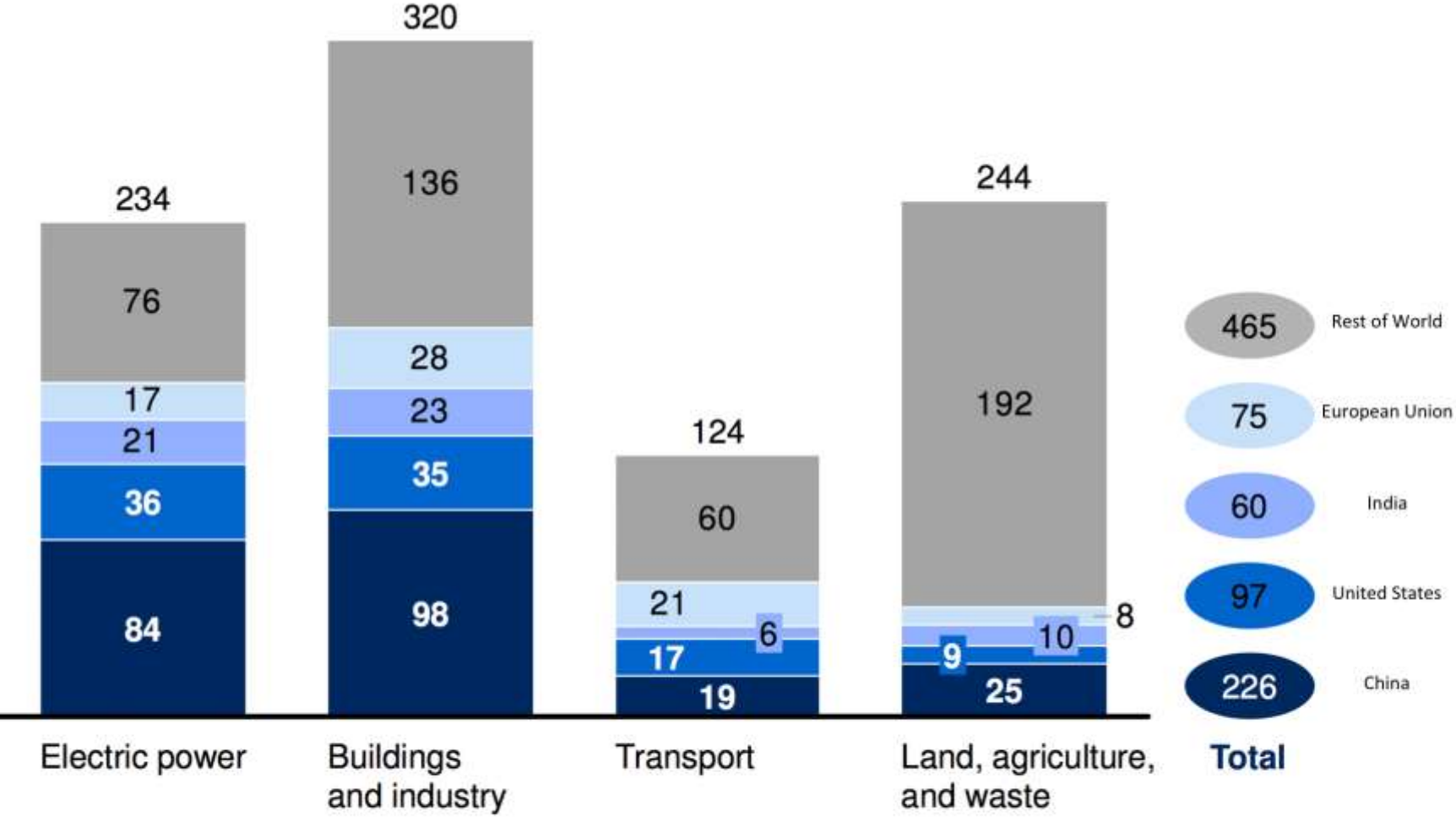
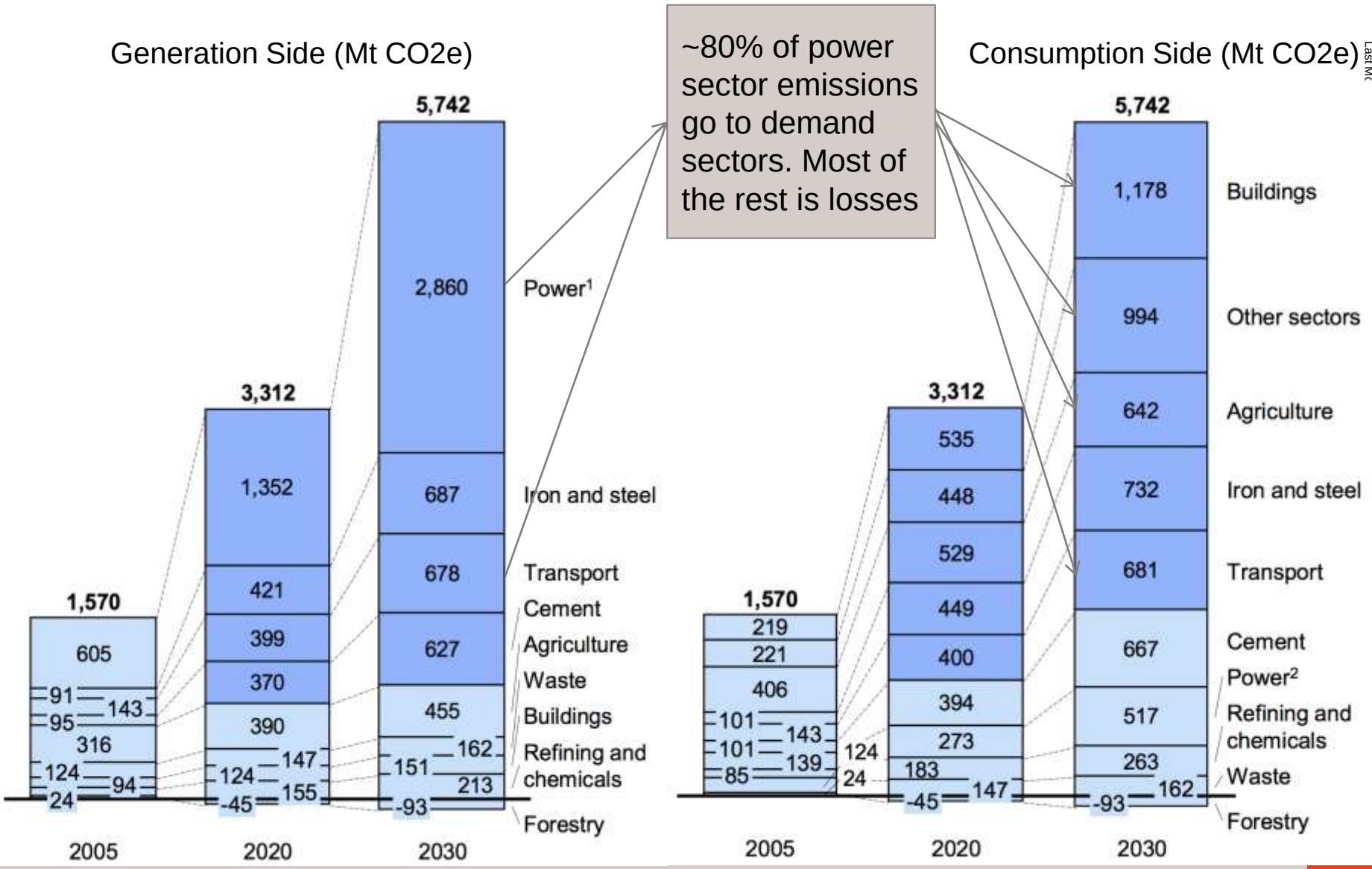
Why is India's growth trajectory so important to global climate action?

(GtCO2e: 2015-2030)

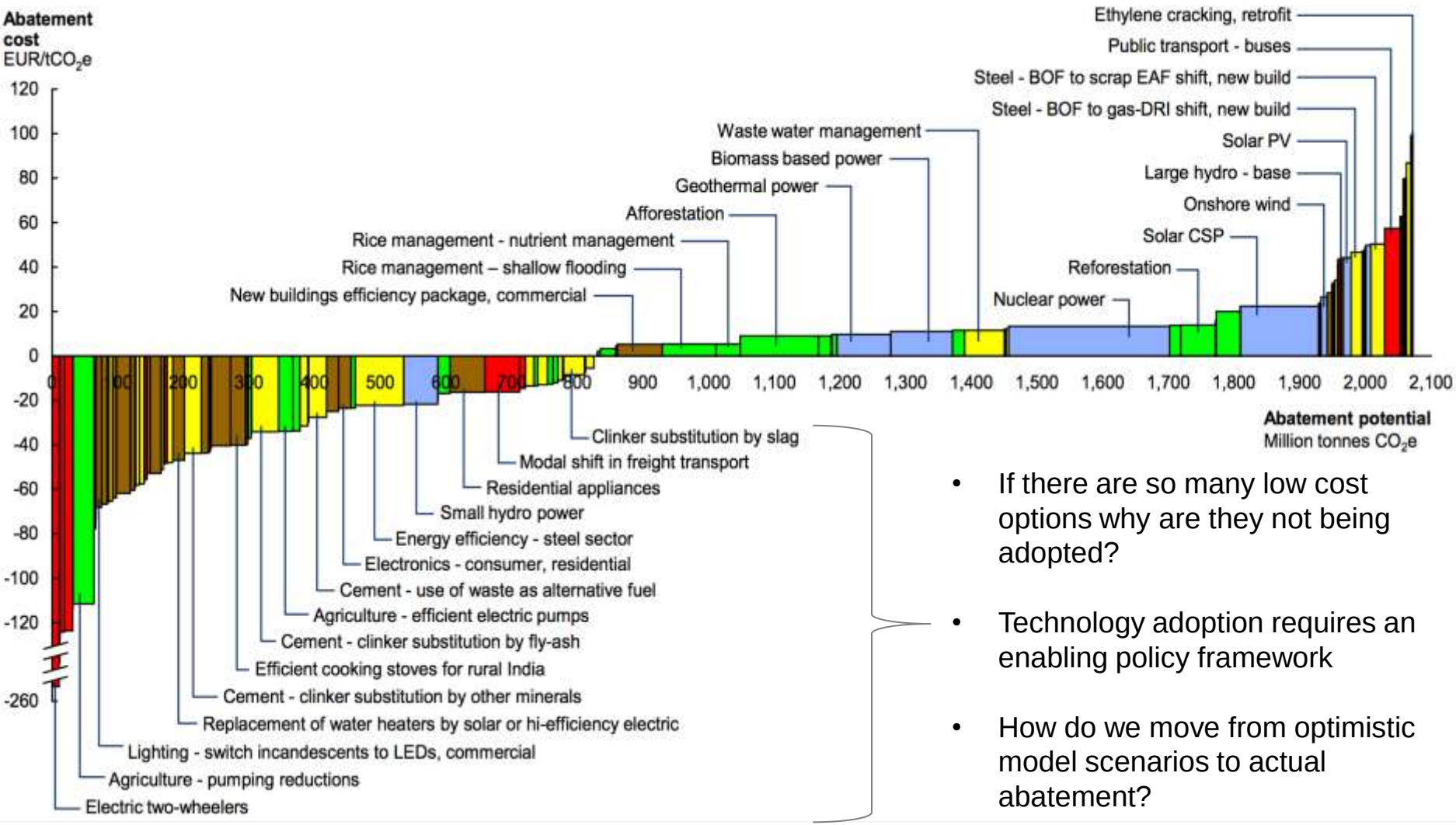


Why is energy demand management so important?



SOURCE: Environment and Energy Sustainability: An Approach for India (McKinsey 2009)

Are there low cost abatement options available?



- If there are so many low cost options why are they not being adopted?
- Technology adoption requires an enabling policy framework
- How do we move from optimistic model scenarios to actual abatement?

SOURCE: McKinsey India GHG Abatement Cost Curve (2009)

Net Electricity Generation Required in 2020 (billion kWh)

Sector	Determined Effort for Efficiency Improvement		Aggressive Effort for Efficiency Improvement	
Appliances	80		147	
Agriculture	5		10	
Industry	20		60	
Total Savings (Billion KWh)	105		217	
Savings in Net Electricity Generation (Billion KWh)	124		255	
Growth Scenarios	**GDP 8%**	**GDP 9%**	**GDP 8%**	**GDP 9%**
Net electricity generation without DSM (Billion kWh)	1970	2208	1970	2208
Net electricity generation required after DSM savings (Billion kWh)	1846	2084	1715	1953

Green Growth Options to Reduce Energy Demand

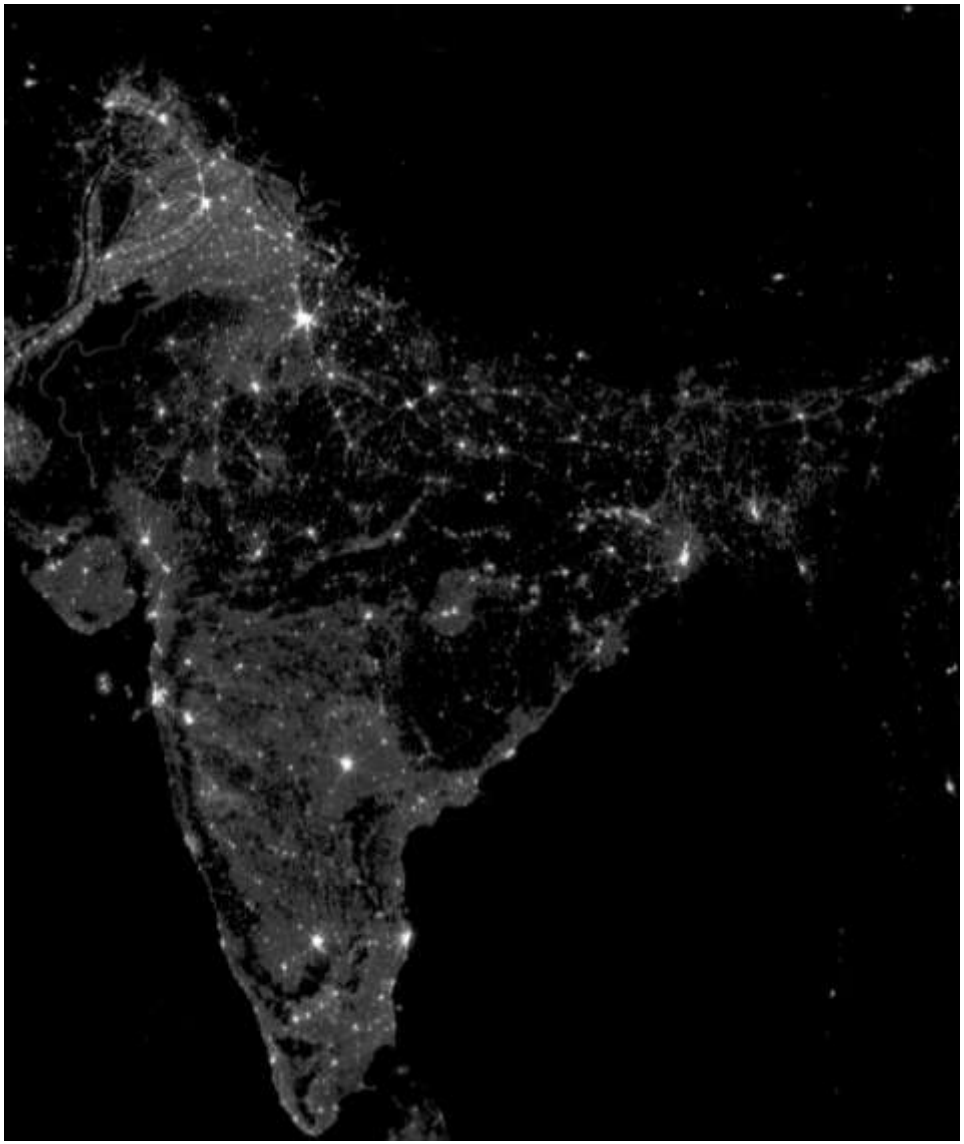
1. **Electricity Distribution Sector Reform: [201 MtCO2e +]**

1. Green Buildings

1. Appliance Energy Efficiency

2. Clean Transportation Fuels and Transport Efficiency

Electricity Distribution Sector Reform



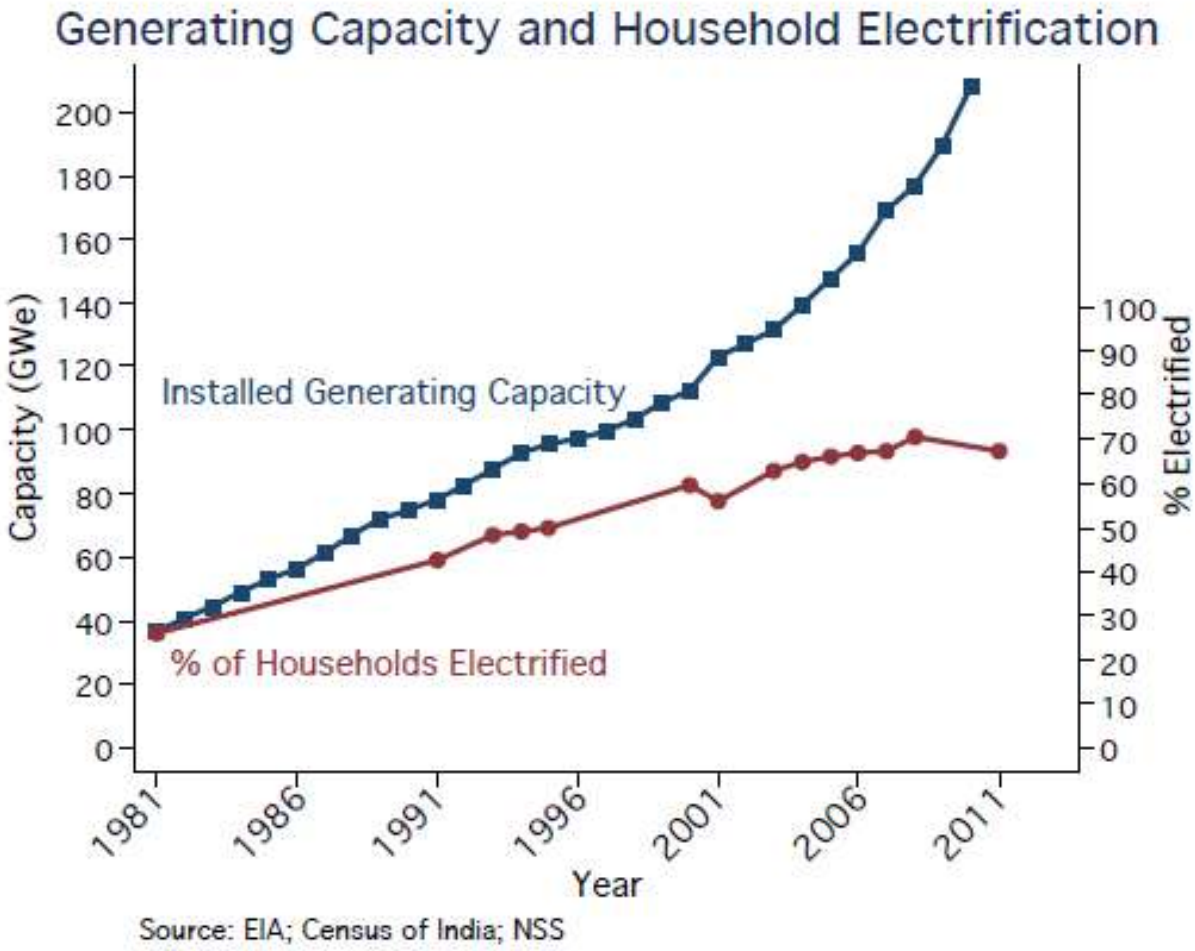
United States: 13,325 KWh per capita
India: 626 KWh per capita
Bihar: 122 KWh per capita

A primary challenge for energy policy in India is to provide access to electricity

A primary challenge for climate policy is to mitigate carbon emissions in the process

SOURCE: NASA Nightlights Satellite Data; EIA; CIA World Factbook

Is a focus on enhancing supply sufficient to enable electrification?

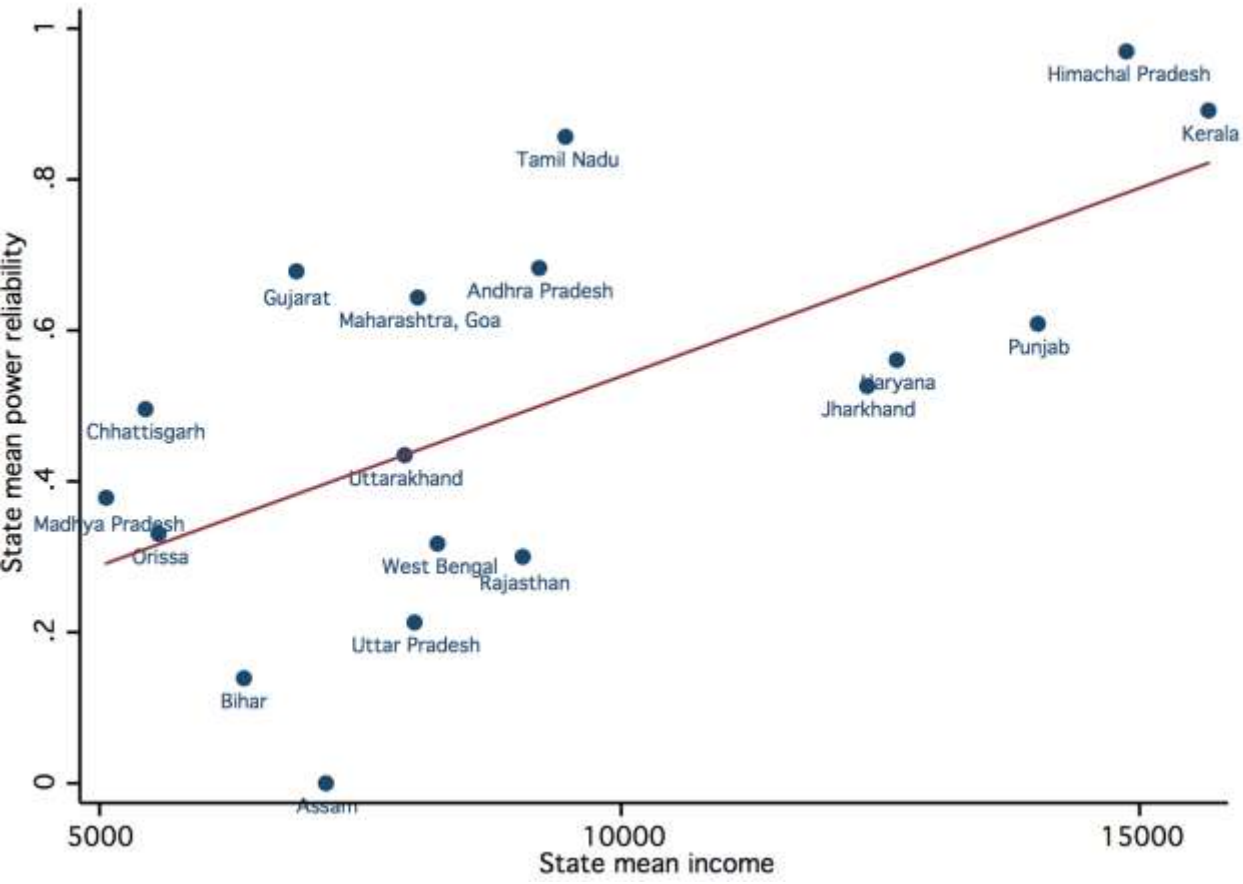


Customers entitled to free or subsidized power are supplied very intermittently

What are the implications of bankrupt utilities rationing power instead of rationalizing pricing?

SOURCE: Census of India (2001), EIA, NSS (various years)

How can reforming the electricity sector help?



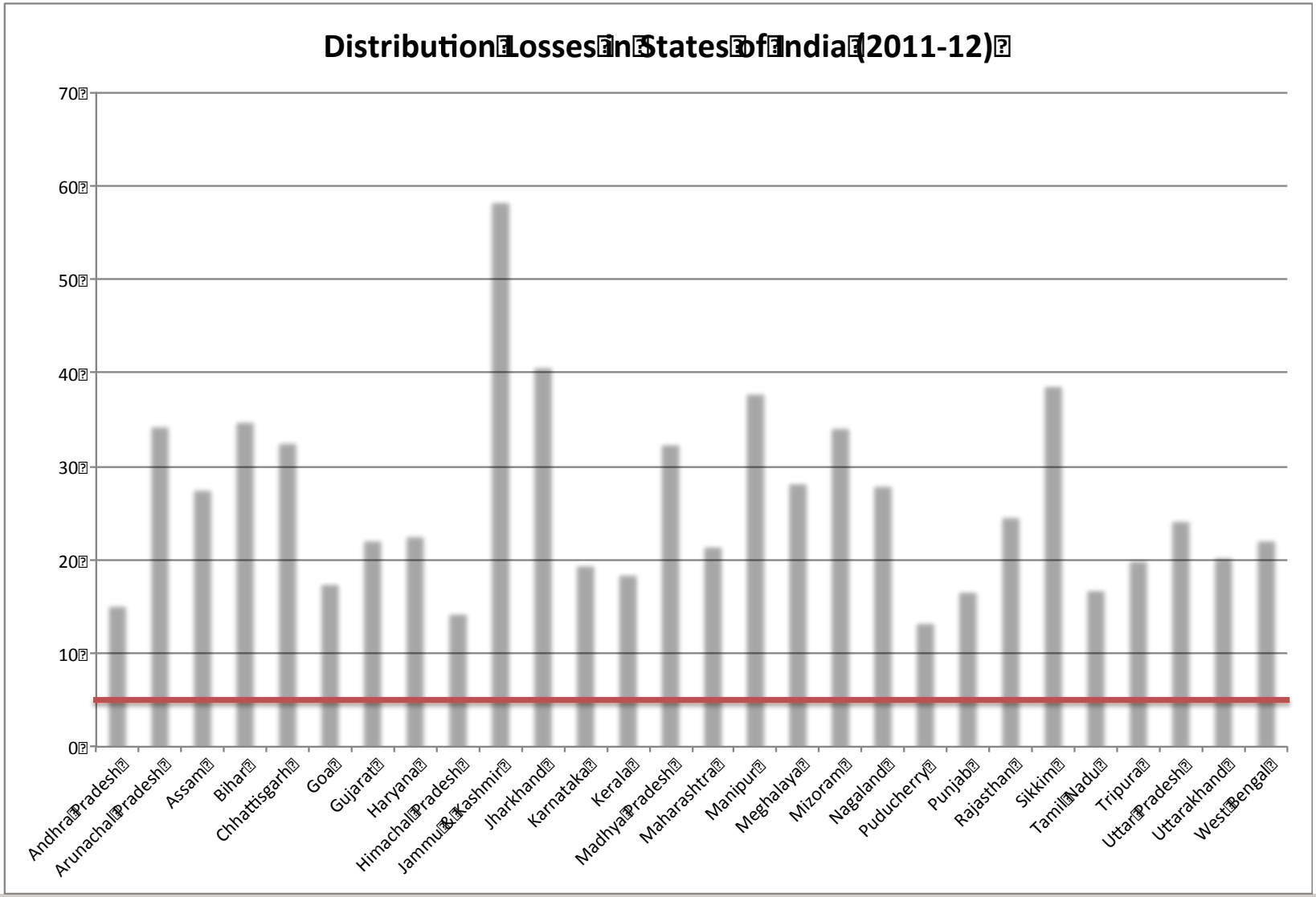
Unreliable power reduces the real return on energy efficiency investments

Free and unreliable power encourages inefficient use

Distribution reform essential to introducing a price signal AND improving access

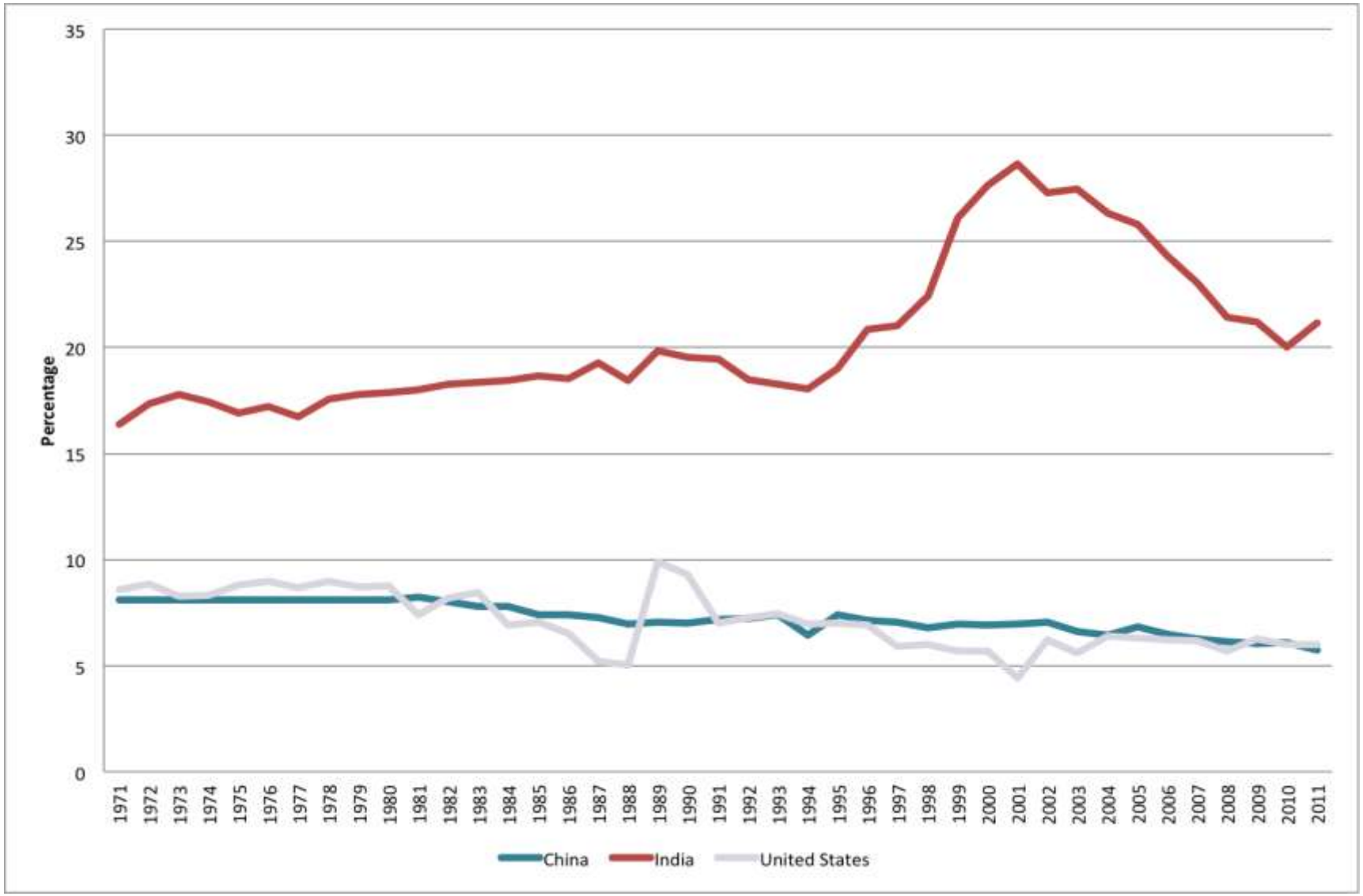
SOURCE: Impacts of Reliable Electricity Supply: Evidence from India, Chakravorty, Pelli and Marchand (2012)

States of India Transmission and Distribution Losses (Percentage)



SOURCE: Planning Commission, World Bank Development Indicators

India Distribution Losses compared to US and China (%)



Measures to enable more efficient distribution

Technical Steps

1. High voltage transmission
2. Minimizing the length of 11KV and 0.4KV distribution lines
3. Conductor sizing
4. Transformer location and sizing
5. Load balancing and increasing load factors

Other Measures

1. Improving billing and metering
2. Smart meters and pre-paid metering
3. Privatization and franchise models
4. Feeder separation
5. Energy auditing and grid metering
6. Incentives and monitoring to reduce theft (feeder regulation)
7. Behavioral methods of changing consumption

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1. Electricity Distribution Sector Reform

1. **Green Buildings**

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Green Buildings and Building Efficiency

- Experimental studies suggest that cooling energy reductions of between 10 to 20 percent can be achieved when cool roofs are used instead of unpainted concrete roofs, with larger gains where cool roofs replace black tar (LBNL).
- **Over a fifteen year period, savings across India from cool roof usage might reach 19.8 million tons of CO_2e in 2030**
- Introduce mandatory building standards with cool roof requirements

	Roof without Insulation (KWh/m2/annum)	Roof with Insulation (KWh/m2/annum)
Hyderabad	15.69	2.86
New Delhi	16.28	3.01
Mumbai	16.79	3.13
Bengaluru	16.48	3.07
Chennai	18.48	3.32

SOURCE: Garg (2011)

Cool Roof Payback Periods

Insulation Thickness (mm)	Cost of Insulation (INR)	Ahmedabad		Bangalore		Mumbai		NewDelhi		Shillong	
		Savings/ yr (INR)	Payback (years)	Savings/ yr (INR)	Payback (years)	Savings/ yr (INR)	Payback (years)	Savings/ yr (INR)	Payback (years)	Savings/ yr (INR)	Payback (years)
5	40	57	0.70	43	0.92	43	0.93	54	0.74	22	1.79
10	80	75	1.07	55	1.47	56	1.43	70	1.14	35	2.26
15	120	85	1.42	59	2.03	63	1.90	79	1.52	44	2.74
20	160	92	1.74	62	2.60	67	2.39	84	1.90	49	3.25
25	**200**	**96**	**2.08**	**63**	**3.17**	**70**	**2.84**	**88**	**2.28**	**53**	**3.79**
30	**240**	**100**	**2.41**	**64**	**3.73**	**73**	**3.31**	**90**	**2.67**	**55**	**4.37**
35	280	101	2.76	65	4.30	74	3.78	92	3.05	56	4.98
40	**320**	**104**	**3.07**	**66**	**4.87**	**76**	**4.22**	**93**	**3.44**	**57**	**5.59**
45	360	106	3.40	66	5.44	77	4.69	94	3.85	58	6.25
50	**400**	**107**	**3.73**	**67**	**6.00**	**78**	**5.14**	**94**	**4.24**	**58**	**6.92**
55	440	109	4.05	67	6.57	78	5.62	95	4.63	58	7.60
60	480	108	4.45	67	7.13	79	6.09	96	5.02	58	8.30
65	520	109	4.78	68	7.70	79	6.55	96	5.41	58	9.01
70	560	110	5.11	68	8.27	80	7.01	96	5.80	58	9.73
75	**600**	**110**	**5.44**	**68**	**8.84**	**80**	**7.48**	**98**	**6.11**	**57**	**10.46**
80	640	112	5.74	68	9.40	81	7.94	98	6.50	57	11.19
85	680	112	6.07	68	9.97	81	8.41	99	6.89	57	11.94
90	720	113	6.40	68	10.54	81	8.88	99	7.28	57	12.69
95	760	113	6.73	68	11.10	81	9.34	99	7.67	57	13.44
100	800	113	7.05	69	11.67	82	9.81	99	8.06	56	14.20

SOURCE: Garg (2011) – Cool Roof Savings Calculator

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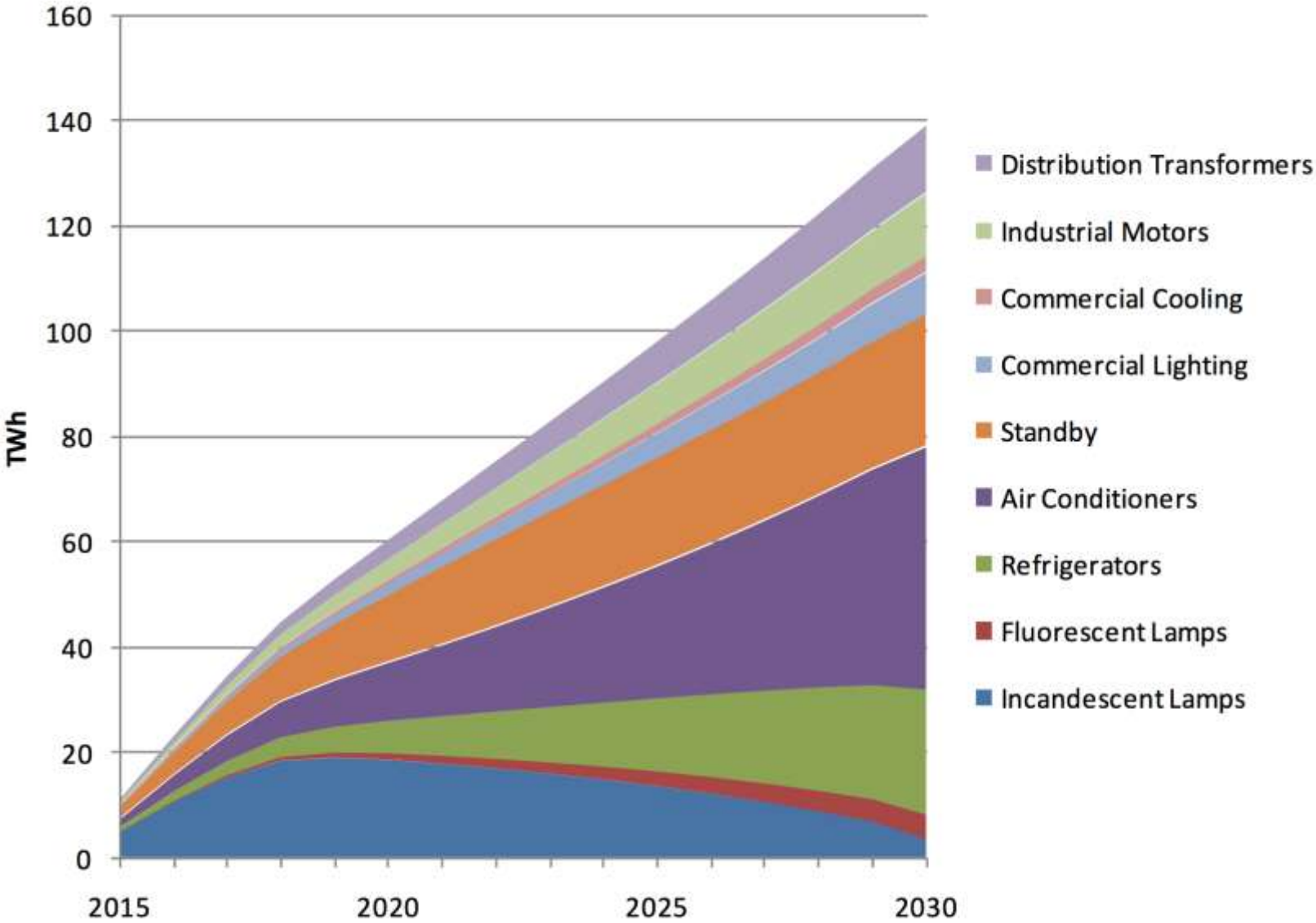
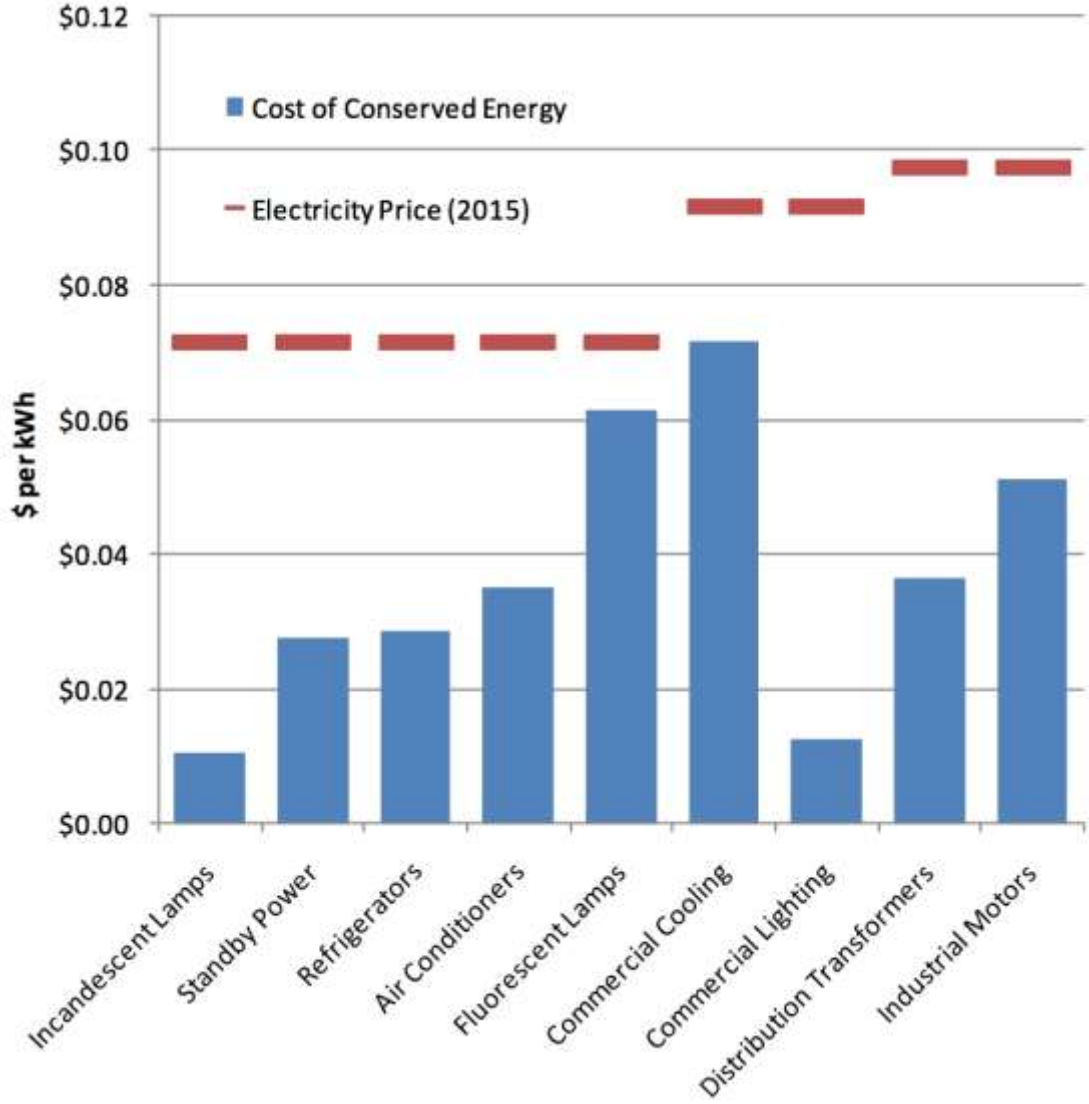
Can energy efficiency policy make a difference to energy use?



SOURCE: McNeil (2013): LBNL BUENAS Energy Model

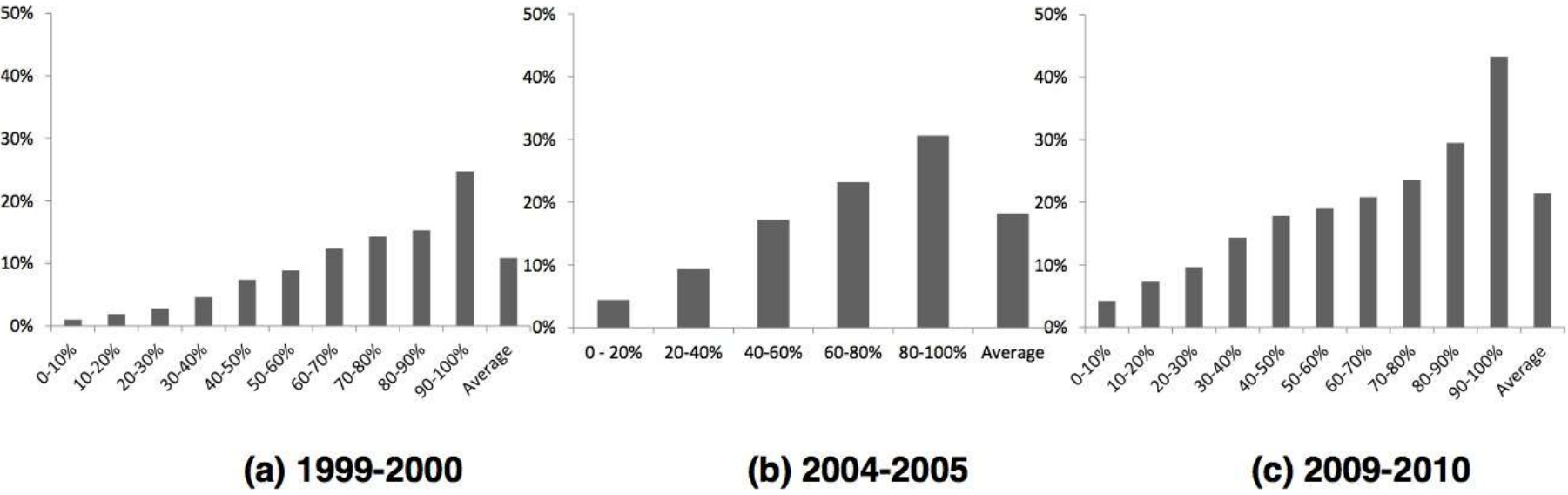
And would these energy savings make economic sense? The cost effectiveness ($/KWh) of saved energy



SOURCE: McNeil (2013)

Low appliance saturation rates present a unique **but closing** window of opportunity to avoid inefficiency lock-in

Figure: Air conditioner saturation by income decile in India



(a) 1999-2000 **(b) 2004-2005** **(c) 2009-2010**

SOURCE: Abhyankar, Phadke and Shah (2013): Avoiding 100 New Power Plants by Increasing Efficiency of Room Air Conditioners in India: Opportunities and Challenges

Policy decisions to encourage appliance energy efficiency

1. Increase the minimum energy efficiency standard (BEE 1 star rating)

1. Expand BEE star rating to more appliances

1. **Test and evaluate the effectiveness of different financial and behavioral incentives**

2. Expand market based approach to encourage industrial efficiency

Green Growth Options to Reduce Energy Demand

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Transportation Energy Demand

$G\ (\text{Emissions}) = A \times Sk \times Ek,j \times Fk,j$

A represents total transport activity in passenger-km,
S represents mode shares (from 1 to k),
E represents energy used per passenger or tonne km for mode k using fuel j
F represents the carbon content in each fuel j.

Focus on reducing E and F

Policy options to increase efficiency and clean fuels in transport

1. Rationalize fuel pricing

1. Expand BEE star rating to automobiles

1. Introduce environmental taxes / subsidies and reduce sales taxes on fuel