INDIA as a Superpower?

1. Indian Polity and Economy
2. Energy & Climate Change
3. Reforms Needed

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Second Lecture

Energy and Climate Change

Energy and Climate Change - Overview

1. Per Capital energy Consumption
2. CO2 Emission Trends
3. Commercial Energy Requirements
4. Constraints
5. Burden of traditional fuels
6. Energy Efficiency
7. Scope for improvement
8. Regulatory Aspects in GHG mitigation
9. Renewables Potential

Land of Contradictions

- India seen as a fast growing major world economy, & by 2020, third in world; but
- Over 830 million live on below $ 2 a day, 370 million below $ 1 a day, 500 million without electricity
- In space age, with moon shots, remote sensing, weather satellites; dominated by bullock carts and two wheelers
- India has 17% of world population, Fifth largest consumer of fossil fuels, 3.7% of global energy supplies; but per capita energy consumption at 20% of world average, 4 % of USA, 28% of China
- Water and energy, two linked challenges to India becoming a middle-income country

INDIA-Energy Consumption Facts

- 600 million without electricity
- Over 700 million use traditional biomass as primary fuel for cooking
- Burning Biomass added 577 million tonnes to Emissions
- Women and girls bear drudgery of collecting biomass
- Health impact of burning biomass is on women and children, who are more indoors
- Lack of safe and convenient energy lead directly or indirectly to illiteracy, gender inequality, disempowerment, high infant and maternal mortality, lack of access to safe drinking water, poor health indicators
- To eradicate poverty, India needs consistent and inclusive 8% GDP growth over next 25 years
- Must improve access to modern commercial energy for all

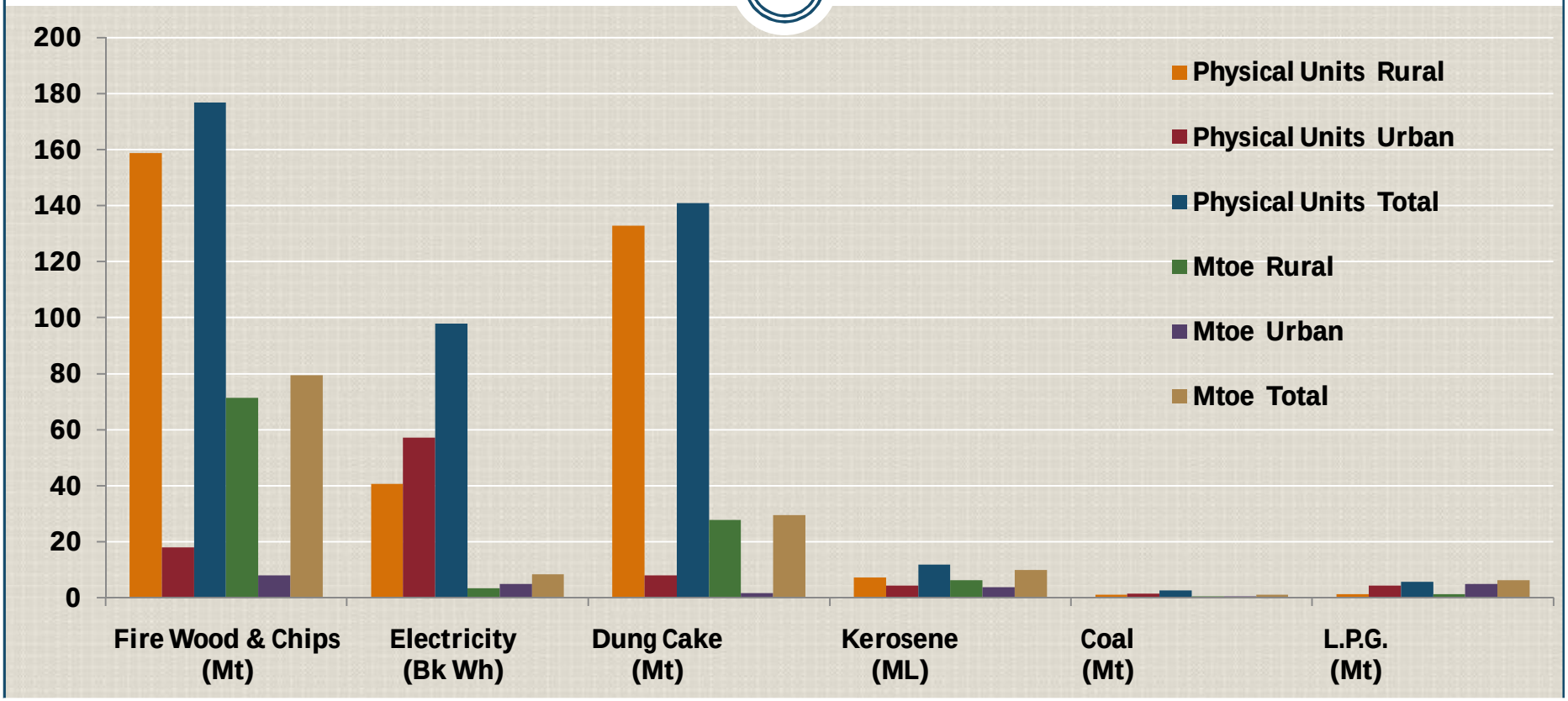
The Burden of Traditional Fuels in Rural India

- (***Sample of 15,293 rural households from 148 villages in three states of rural North India and one state in South India***.)
- 96% of households use biomass energy, 11% use kerosene and 5% use LPG for cooking. Most use multiple fuels.
  - Forests contribute 39 % of the fuel wood need.
  - 314 Mt of bio-fuels are gathered annually.
  - 85 million households spend 30 billion hours annually in fuel wood gathering.
  - Respiratory symptoms are prevalent among 24 million adults of which 17 million have serious symptoms.
  - 5% of adults suffer from Bronchial asthma, 16% from Bronchitis, 8.2% from Pulmonary TB and 7% from Chest infection.
  - Risk of contracting respiratory diseases and eye diseases increase with longer duration of use of bio-fuels.

The Burden of Traditional Fuels in Rural India

- Total economic burden of dirty biomass fuel was estimated to be Rs.299 billion
- Close linkage between gender and energy. Gender and energy issues have remained on the periphery of energy policy, and require greater attention and backing.
- **ESSENTIAL FOR THESE PEOPLE TO SHIFT TO CLEANER ENERGY**
- **Source: Parikh Jyoti et al (2005)** ***Integrated Energy Policy: Report of the Expert Committee Pg No7.***

Rural Household Energy Consumption mainly firewood and dung in rural, electricity in urban

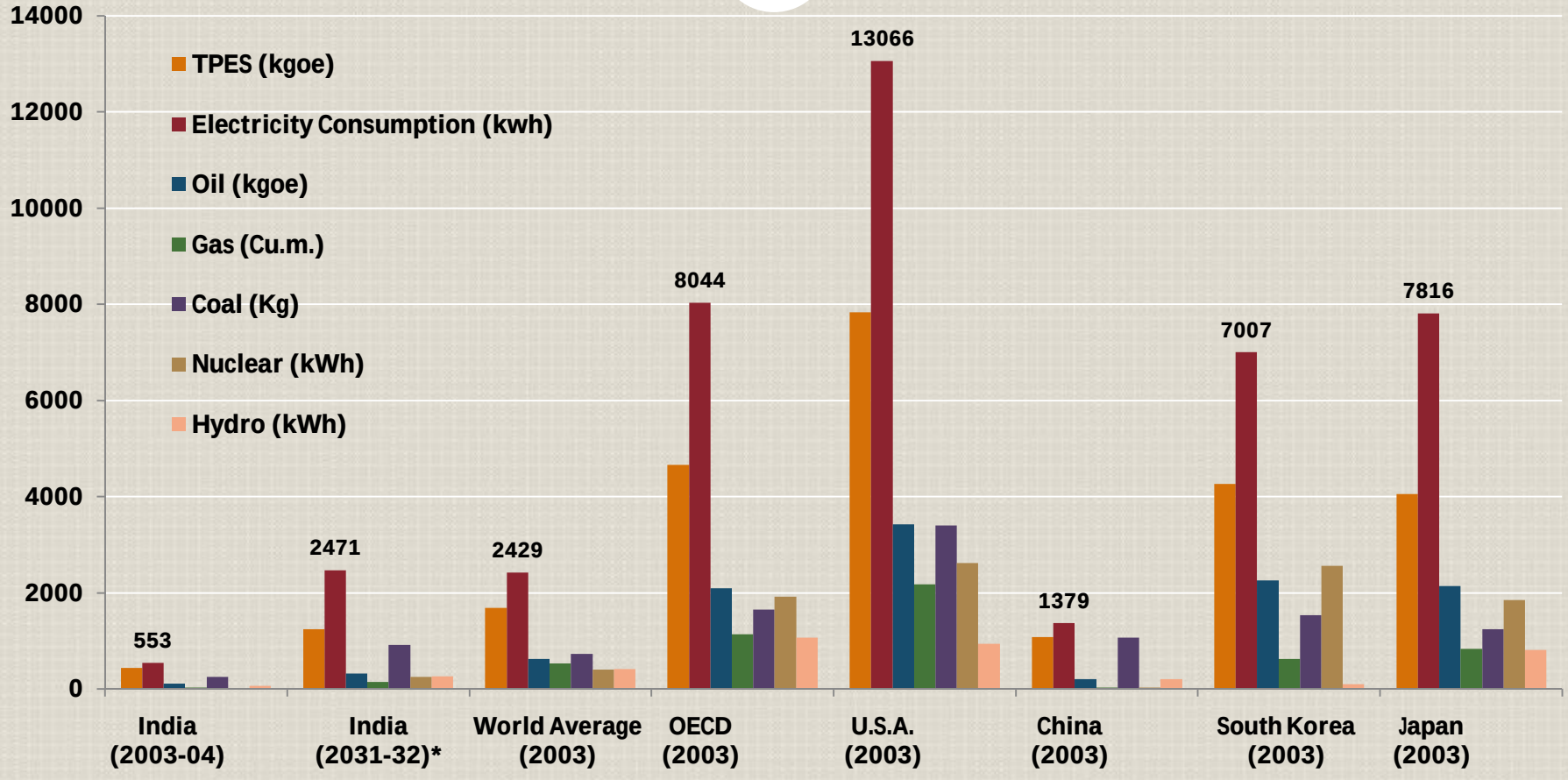


NSS 55th Round, (July 1999-June 2000)

1. Firewood and Dung cake dominate. Fuels mainly for cooking. In dim and dingy premises with no ventilation, leads to respiratory problems for women and children. , 2. Commercial fuels very ms all.
3. Electricity mainly for lighting

Source: Integrated Energy Policy : Report of the Expert Committee Pg No 8

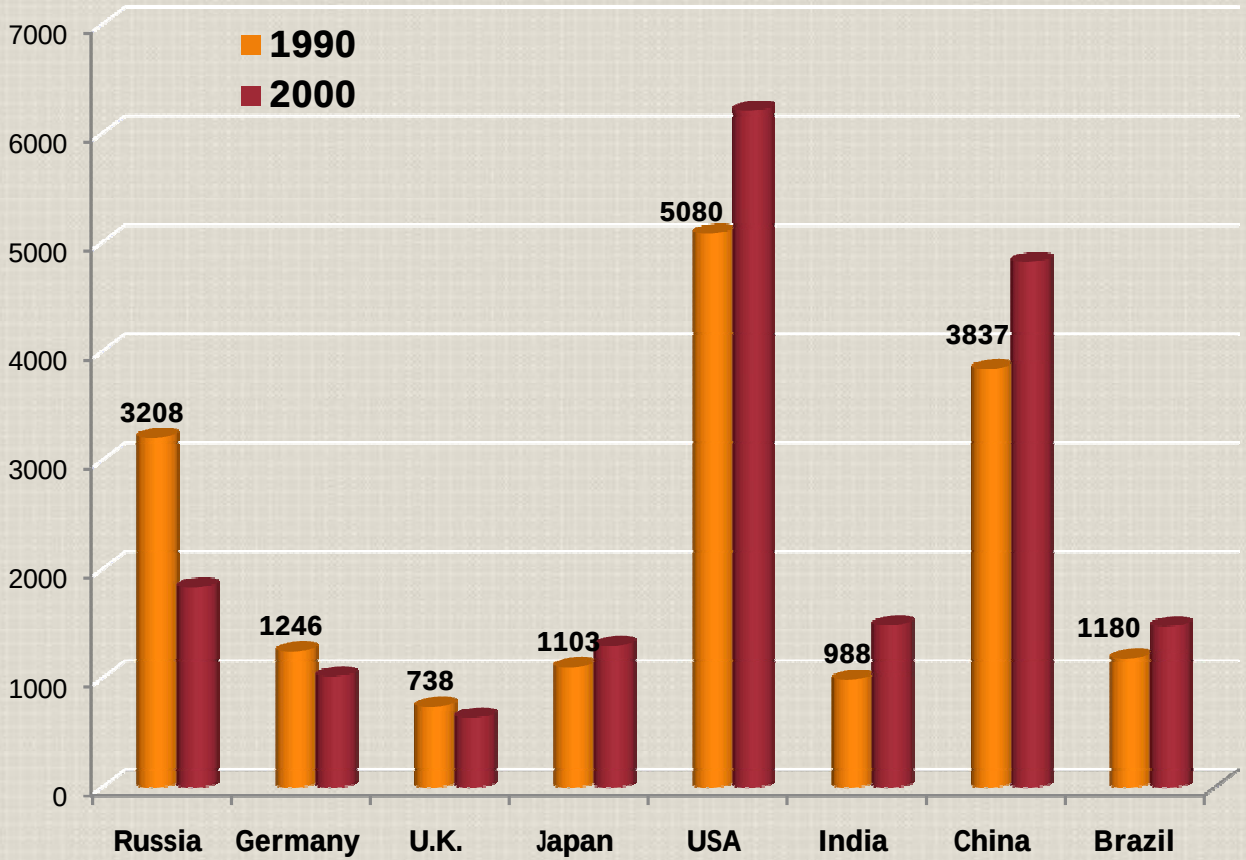
Per capita Energy consumption

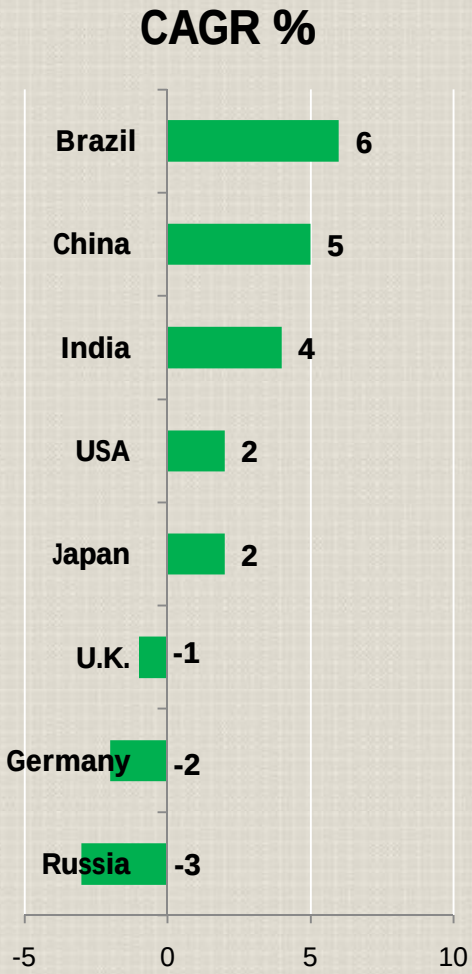


Note - *(projected @ 8% GDP growth), Coal consumption on calorific value of hard coal (6000 kcal/kg for india.

India lowest; crosses China's 2003 consumption in 2031-32; electricity goes up 5 times and coal 4 times

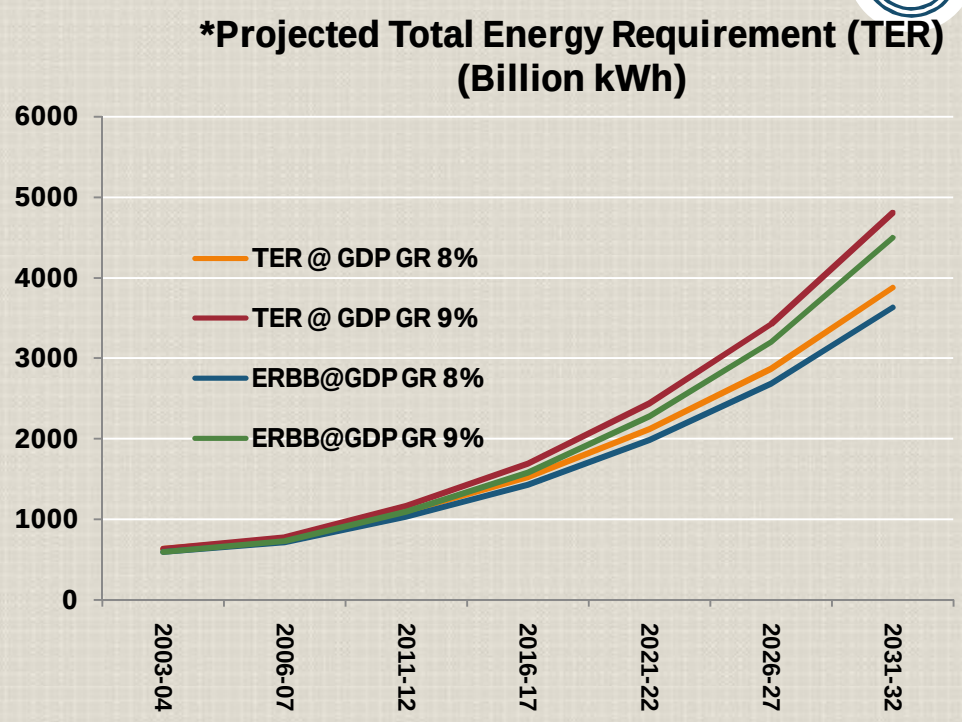
Trends of CO2 equivalent emissions in mmt

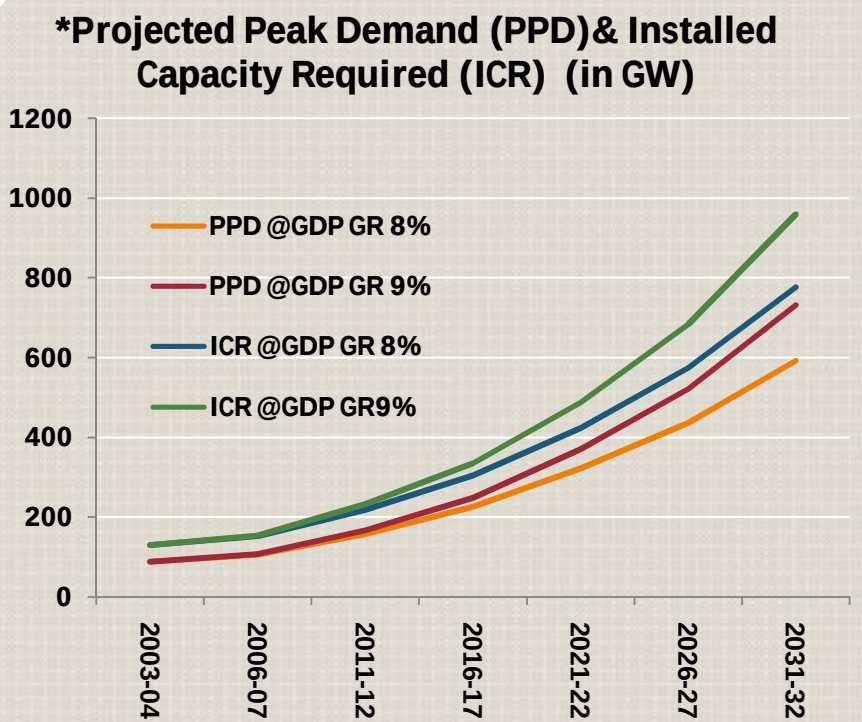




1. India lowest emission to population. , 2. Growth behind Brazil & China

Projected Commercial Primary Energy Requirements





1. Electricity generation and peak demand in 2003-04 = total of utilities and non-utilities above 1 MW size. Energy demand at bus bar assuming 6.5% auxiliary consumption. Peak demand assumes system load factor of 76% up to 2010, 74% for 2011-12 to 2015-16, 72% for 2016-17 to 2020-21 and 70% for 2021-22 and beyond. Installed capacity keeping ratio between total installed capacity and total energy required constant at the 2003-04 level. Assumes optimal utilisation of resources bringing down the ratio between installed capacity required to peak demand from 1.47 in 2003-04 to 1.31 in 2031-32.
2. Installed capacity for electricity must rise 6 times from 2004 to 2032
3. TER = Total Energy Requirement, ERBB = Energy Requirement at Bus Bar , GR = Growth Rate
4. * Based on Falling Elasticities

Source: Energy Policy Report of the Expert Committee

Sources of electricity Generation- One Possible Scenario

Year	Electricity Generation at Bus Bar (BkWh)		Hydro (BkWh)	Nuclear (BkWh)	Rene-wables (BkWh)	Thermal Energy (BkWh)		Fuel Needs					
								Coal (Mt)		NG (BCM)		Oil* (Mt)	
	8%	9%				8%	9%	8%	9%	8%	9%	8%	9%
2003-04	592	592	74	17	3	498	498	318	318	11	11	6	6
2006-07	711	724	87	39	8	577	590	337	379	12	14	6	6
2011-12	1026	1091	139	64	11	812	877	463	521	19	21	8	8
2016-17	1425	1577	204	118	14	1089	1241	603	678	33	37	9	10
2021-22	1981	2280	270	172	18	1521	1820	832	936	52	59	12	12
2026-27	2680	3201	335	274	21	2050	2571	1109	1248	77	87	14	15
2031-32	3628	4493	401	375	24	2828	3693	1475	1659	119	134	17	20

*includes secondary oil consumption for coal-based generation

Source: Integrated Energy Policy : Report of the Expert Committee Pg No 22

Alternative Models

- Business as Usual & Hybrid (energy efficient, aggressive adoption of renewable energy, maximum nuclear)-@ GDP 8%
- **Assumptions** in Hybrid: Advanced gas-based power generation by 2016; Renovation & Modernization of old coal plants only till 2011; unrestricted coal technology transfer, more local R & D
- Efficiency improvement in end-use, faster displacement of non-commercial fuels & kerosene by LPG, etc, more rail vs road, more public transport, energy savings in industry
- Small Hydro potential of 16 GW achieved by 2016; & wind-gross potential 49 GW, technically feasible 13 GW, by 2036 12 GW installed
- Solar-2036 20 GW
- Biomass-16 GW potential, 234 MW so far
- Hybrid makes extremely favourable assumptions-likely scenario somewhere in between

Model Results- Commercial energy requirements

- BAU-from 391 MTOE in 06-07 to 2123 in 2031-32, of which coal rises from 193 to 1176
- Hybrid-from 391 to 1503 in 2031-32 with coal from 193 to 767
- Energy intensity in BAU scenario falls from 0.022 kgoe per Rupee of GDP in 2001 to 0.017 in 2031 fall of 23%
- In Hybrid-from 0.022 to 0.012, fall of 29%

Constraints

- With just 4% of global GHG emissions, India under pressure to curb fossil fuel consumption
- India must find ways to decouple growth in GDP and fossil fuel for energy, but ensure universal lifeline access

Primary Energy in million tonnes	2005-06	2031 -32
Oil equivalent	513	1536 to 1887
Of which, Non-commercial	28%	
Coal	38%	
Oil & Gas	8%	
Hydro & Nuclear	26%	

Energy Efficiency – must improve further in India

- **Indian energy intensity is =Japan & Brazil**
- **Below U.K. at 0.14, Denmark-0.12**
- **India can improve energy efficiency by at least 20% based on currently available technologies**
- **Can improve especially in some industries, buildings, transport,**

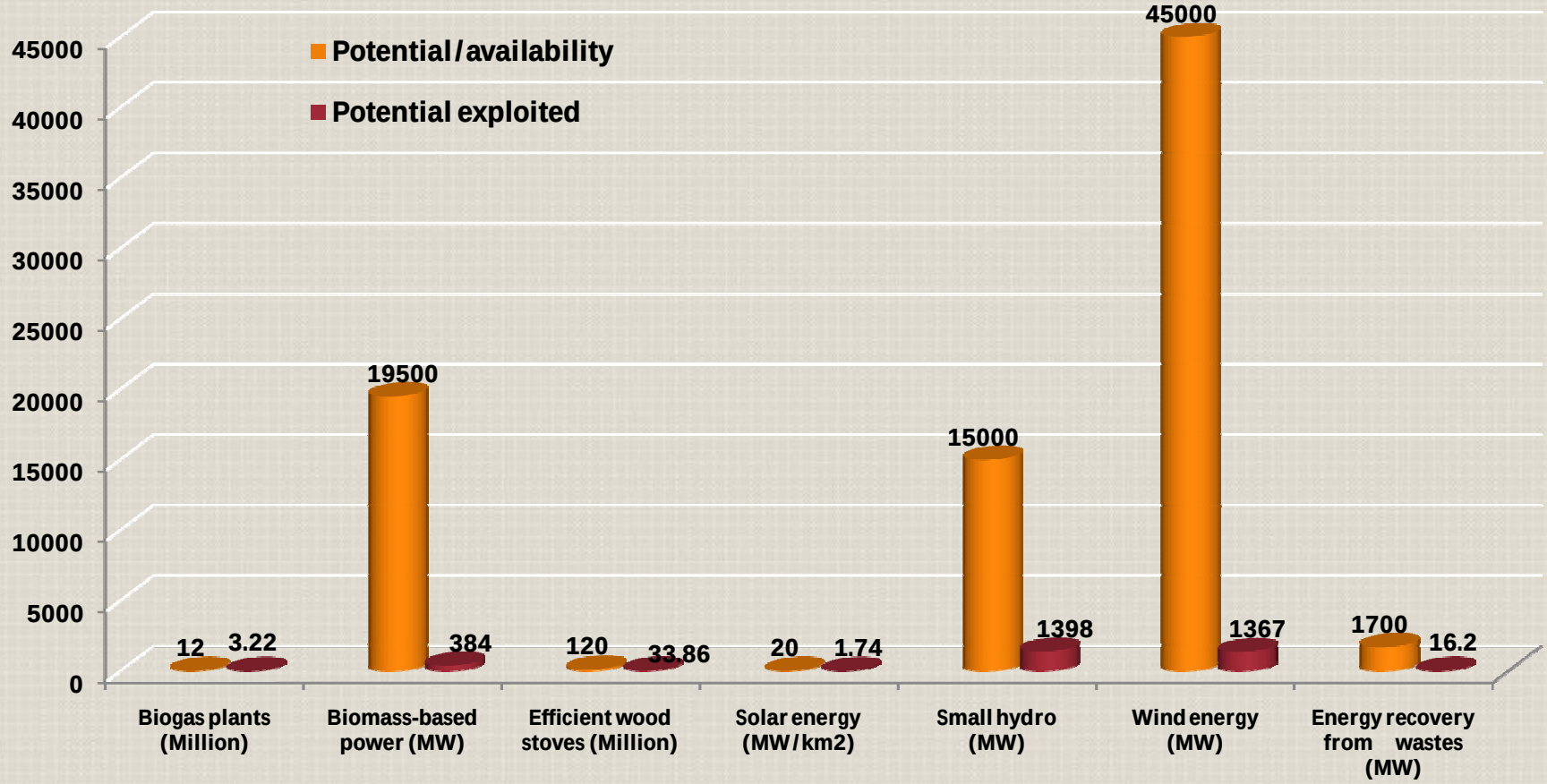
Energy efficiency

- Ratio of Total Primary energy Consumption to GDP in PPP terms-2005:
- India 0.15;China 0.22;USA 0.21; Russia 0.47
- Only India has shown in 2001-06: Av GDP +8% p.a. & 3.7% annual energy consumption growth
- India's population 3,5 times USA and 3 times EU20, but GDP growth is double theirs & lower absolute incremental consumption of fossil fuels
- China grew faster but on incremental basis; but in absolute terms, since 2002, it consumed over 9 times fossil fuel compared to EU20, 10 times of USA, and 11 times India
- India has achieved this result by denying modern commercial fuels to over half its population

Regulatory Aspects of GHG Mitigation

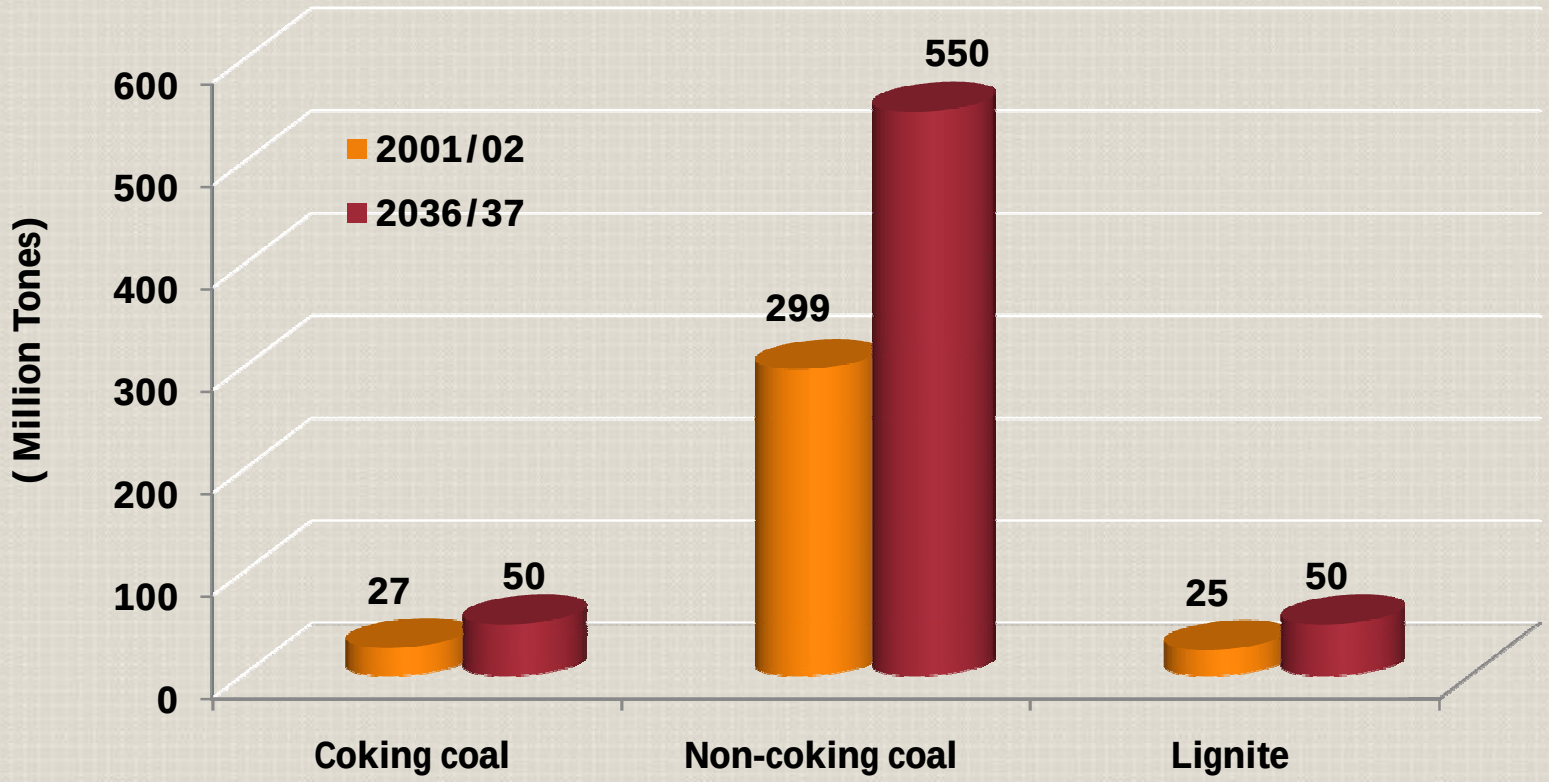
- **EXISTING:** Programmes for energy efficiency in industry, appliances, buildings, municipalities
- UMPP-supercritical boilers
- Created Bureau of Energy Efficiency
- Notified norms for vehicle exhaust emissions from 2010
- Minimum 10% by 2012 of total energy sales as R.E.
- **REQUIRED:** Trading in certified energy savings in excess of mandated savings
- Incentives for Energy efficiency-e.g., differential taxation on certified energy efficient appliances
- Financing of energy efficiency through public private partnerships

Renewable Energy Source Potential



Source: National Energy Map for India: Technology Vision 2030: Pg.No. 134

Maximum Values of Domestic Coal Availability



R.E. too small for requirement; domestic coal not enough

Source: National Energy Map for India: Technology Vision 2030:

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Barriers to GHG mitigation - TRANSPORT

- Need for tough regulatory standards-e,g, fuel economy on auto manufacturers
- Huge investments required
- MRTS- divert resources from other priorities; & no door-to door connectivity
- Need to change lifestyles and individual preferences

Barriers to GHG mitigation - POWER

- High upfront capital cost per MW of Power & hence tariffs, cross-subsidies
- Lack of experience and technical know-how in advance power generation technologies
- IGCC not demonstrated commercially for high ash Indian coal
- Lack of funds with states for R & M
- Renewables-high generation cost

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Energy Imperatives

- India among lowest emitters per capita, in relation to GDP
- Among best in energy efficiency
- Major efforts on R.E. and other measures
- **NON-NEGOTIABLE-**Economic growth and consequent energy growth, with the poor moving to commercial energy
- To further reduce energy to GDP, India will need funding and technology

Conclusions

- Large part of population not served by commercial energy
- Limited potential for Gas, Nuclear, HGydro, Renewables
- Major fuel is and will be Domestic and imported Coal
- India's exemplary energy efficiency and emissions record India in search of eergy resources
- India can only do be more efficient and make maximum use of R.E.
- Reductions in emissions out of the question; but emissions growth might be slowed