Low Carbon Growth in India

Bottom Up Capacity Building

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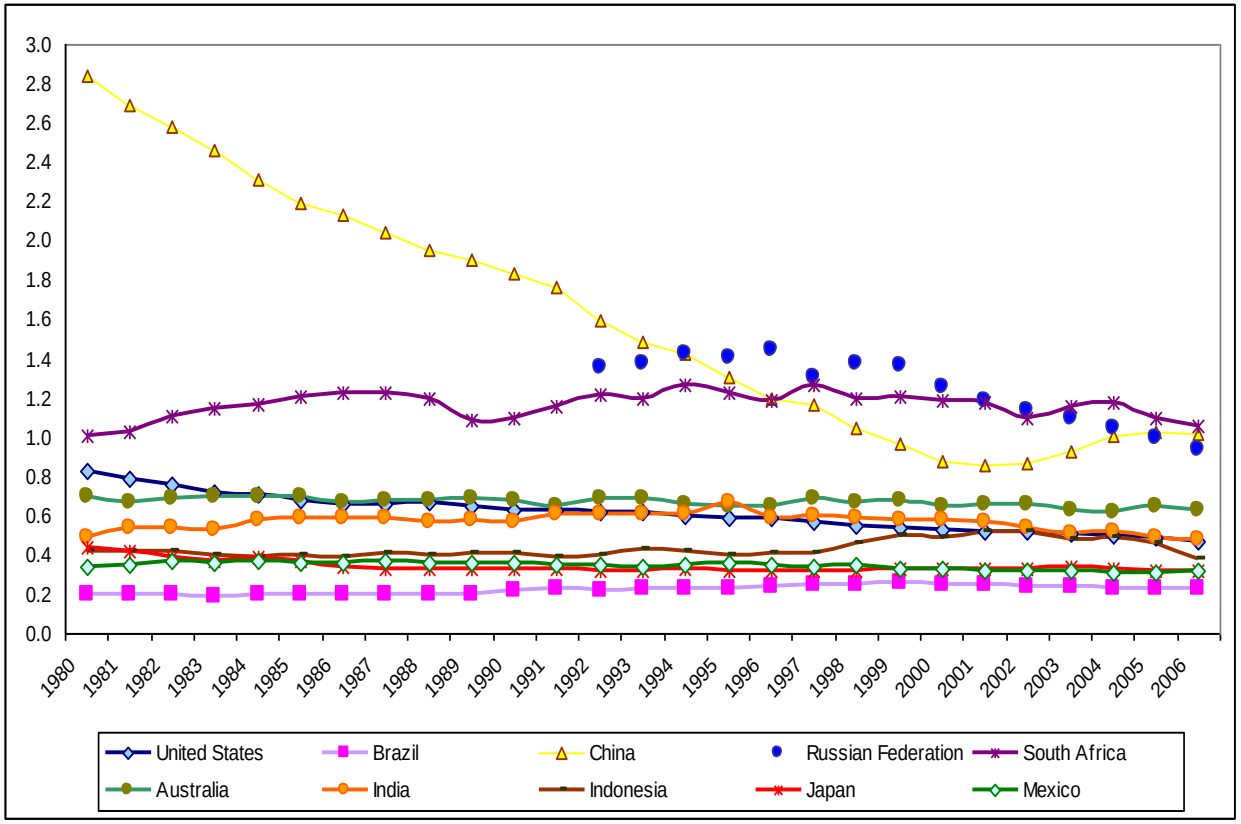
Objectives and Status

- **Low Carbon Growth Study Objectives:**
  - Articulate a cost-effective strategy for further lowering the carbon intensity of key sectors of the economy in ways that enhance national growth objectives
  - Raise national awareness and facilitate informed consensus on India's efforts to address climate change
- **Status**
  - Jointly developed a bottom up model with the GOI and assessed LCG potential in five sectors of the economy representing over 60 % of GHG emissions (2004), namely: electricity generation, household, nonresidential, and industrial sectors and on-road transport
  - Industries included are pulp and paper, refining, cement, aluminum, steel, and fertilizer
  - Covers mitigation potential until 2032; does not consider technologies that are not yet commercially viable such as carbon capture and storage
  - LCG report is a synthesis of modeling, expert assessment and ongoing sector dialog

India's Unique National Circumstances and Challenges

- **A country with many poor but not a poor country**
  - 267 million living on less than $1 a day, 456 million living on less than $1.25 a day – numbers not falling
  - Over 75% of household energy consumption is for the basic human need of cooking, while traditional biomass continues to be the primary cooking fuel
  - 400 million without access to lifeline electricity (one fourth of the world's poor that have no access to electricity)
  - GOI intends to provide electricity to all by 2012
- **GOI committed to rapid and sustained economic growth**
  - According to the Integrated Energy Policy, India needs to sustain economic growth at 8 -10 % for the next 25 years if it is to eradicate poverty and meet its human development goals
  - Expansion needs are huge across most sectors as GOI strives to improve access to services, improve household income and electrification rates, and to cope with urbanization of the economy

India's GHG Footprint is Relatively Modest



Carbon Intensity 1990 – 2006

(metric tonnes CO2/ thousand GDP PPP (US $ 2000)
source: World Bank 2007

- India is fourth largest economy and sixth largest emitter – at 4 % of global GHG emissions, compared with ~25 % for both US and China
- Per capita GHG emissions among the lowest at 1.8 tCO2e - OECD avg. 14; China 4; EU 10: US/Canada 20;
- GHG intensity (CO2e per unit of GDP) at 20% below world average

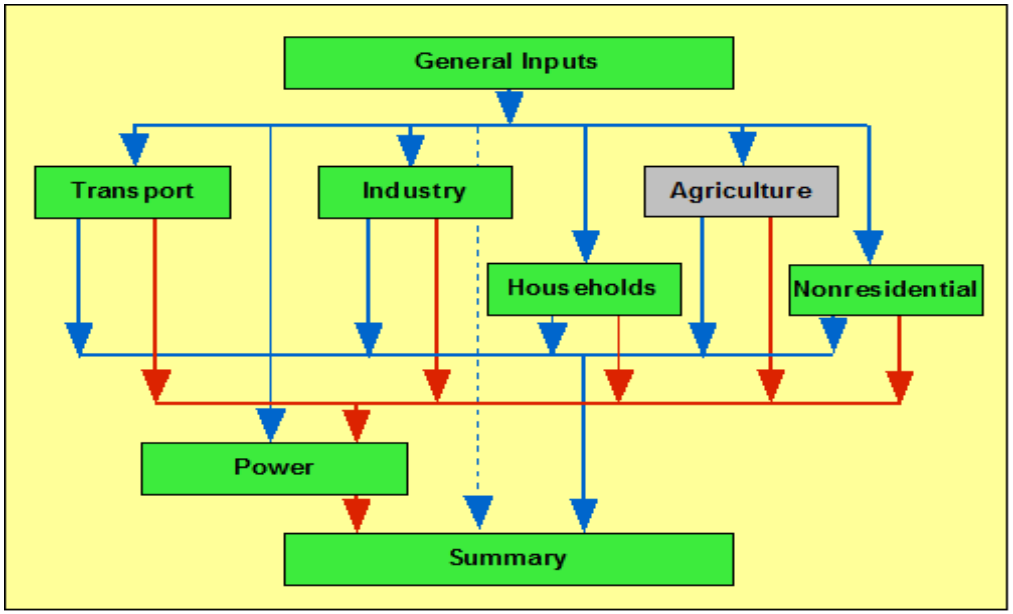
Indian GHG Emissions

Contribution to GHG emissions by sector, 2004

Sector	Energy	Non-energy
Energy production & transformation (power)	35%	
Agriculture		28%
Industrial	12%	8%
Transport	8%	
Residential sector	5%	
Land Use, Land use change and Forestry		2%
Others (including waste)		2%
Total	60%	40%

India LCG Model – What is It?

- Bottom-up engineering model to examine unlimited number of paired analyses to compare alternative scenarios
- Primary scenario that is modeled: planned interventions under 11th, 12th and subsequent plans as well as Integrated Energy Policy
- Other scenarios: improvements from current investment plans if such could be found, as well as deviations (including delays)



Current Challenges in the Indian Power Sector

For sustained & inclusive growth

Increase Access

- 20% villages (2004)/ 56% (at least 360-375 million in 2006) w/o electricity access (20 million in China in 2008)

Improve Efficiency & Governance of Distribution Sector

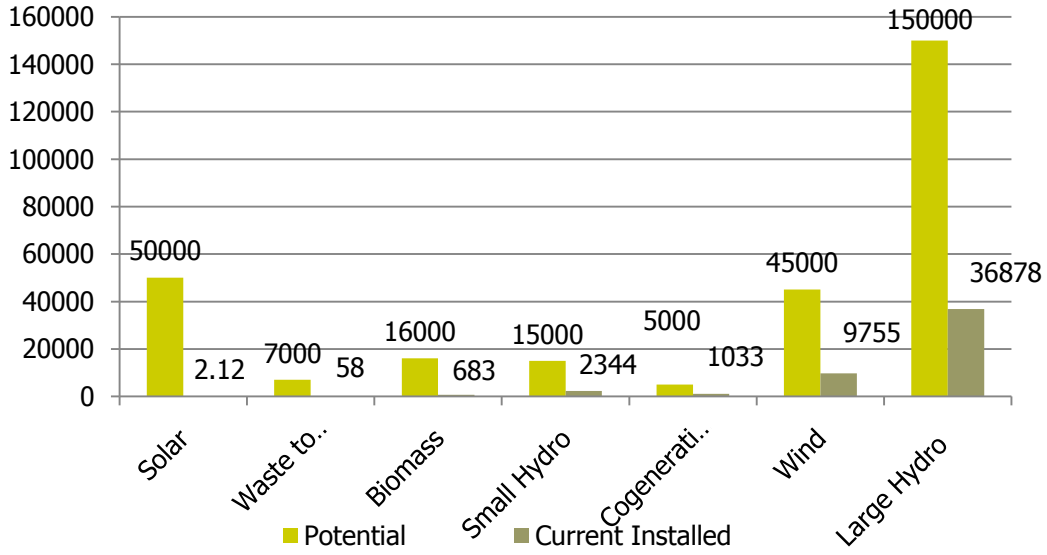
- 40% AT&C losses. Reducing to 15% => $4.4b addl. revenues/year
- Incomplete sector reforms reflected in low cost recovery from tariff (82% for FY2007)

Expand & Diversify Power Generation

- Current installed capacity of 145 GW vs. 800 GW (China)
- 60% of firms rely on captive power (21% in China)
- Peak Deficit at 16.6%, Energy Deficit at 9.9%,
- Economic cost of energy deficit estimated at 7% of GDP

India Has a Scarcity of Clean and Primary Fuels

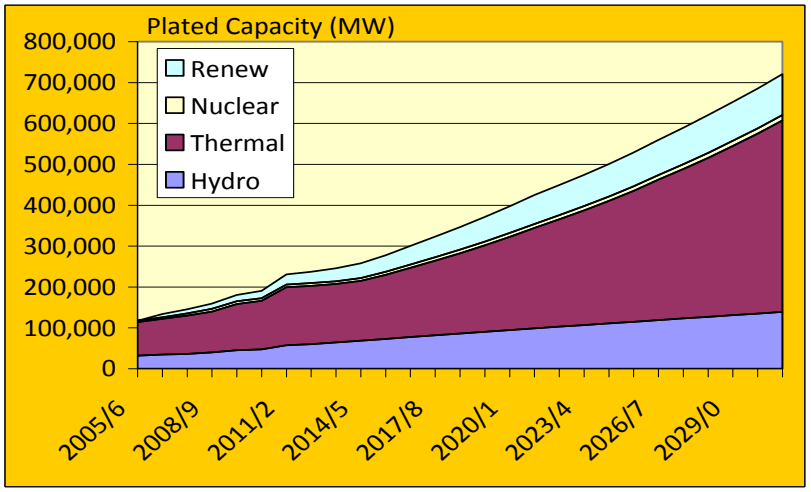
- Current installed capacity of 145 GW of which 77 GW (53 %) is coal-fired (contributing to 80 % of total generation) – to grow to 788 GW by 2032 (below the current capacity of China)
- While the private sector is actively developing the small renewable energy sector in India, the total renewable energy potential in the country is modest relative to energy needs.
- While India's reliance on imports of LNG may be reduced in the short term with successful operation of the fields in the Krishna Godavari Basin, as much as 30% of India's consumption of LNG will depend on imports in longer term.



source: Ministry of New and Renewable Energy and Integrated Energy Policy

Energy Supply Interventions to Reduce GHGs

- For a **high and sustained economic growth until 2032**, India will need to increase its **energy supply by a factor of 5-6**, and CO2 emissions would grow to 4-5 times from 2007-8 levels.
- Under this scenario, coal- fired generation dominates installed capacity, i.e. 55 to 65 % over a 25 year period
- this scenario **assumes a sustained effort to maximize all sources of renewable energy (as planned), as well as consistent effort in improving energy supply efficiencies**, i.e. substantial reduction in T& D losses and significant improvements in spinning reserves



Energy Supply Interventions to Reduce GHGs

Potential Constraints

Investments Required:

- 11th plan requires investments in the order of 1,33,000 crore per year
- Rs 44,400 crore in 2013/14 to Rs 1,90,000 crore in 2031/32, of which a cumulative 64% is for thermal followed by 17% for hydro, 14.3% for renewables and 3 % for renovation and modernization (R&M)

Hydropower potential:

- GOI plans to increase installed capacity by 46% by 2012 (additional 15 GW); add an additional 50 GW by 2025/26, and realize the entire hydro potential of 150 GW by 2031/32, of which 70 % will be run-of-river and 30 % dams
- However, targets difficult to achieve given lack of systemic approach to land acquisition as well as rehabilitation and restoration of any affected peoples, lead times difficult to maintain below 5 years

Renewable potential (biomass, small hydro and wind):

- GOI plans to increase renewable share to 10% of installed capacity by 2012 (from current 4%)
- According to current plans, India would have harnessed 88 percent of its available potential for wind and 43 percent of small hydro potential by 2022.
- Sustainable incentives required to realize full potential of ~50 GW given paucity of funds to sustain subsidy requirements and absence of coherent framework with predictable revenues

Energy Supply Interventions to Reduce GHGs

Potential Constraints

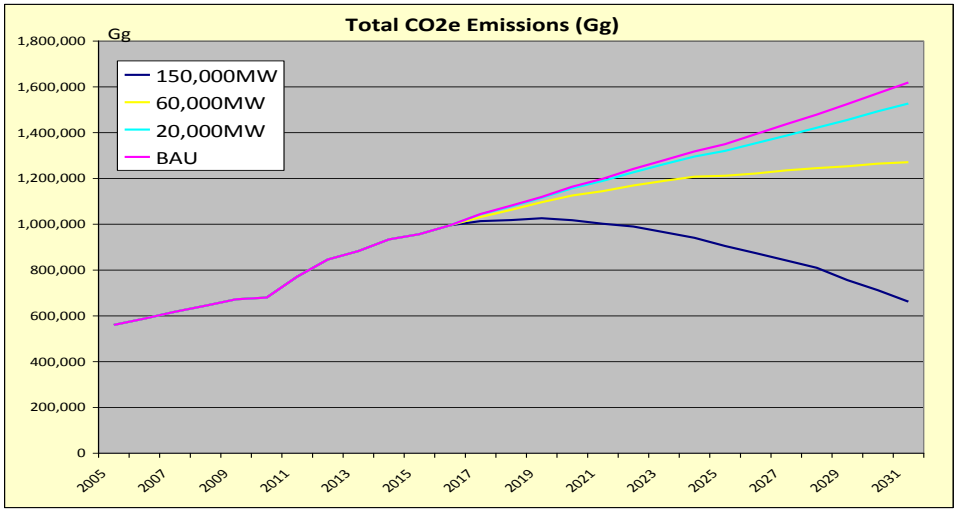
Improving Supply Efficiencies:

- GOI plans to reduce technical T&D losses from 29.3% to 15.05% by 2025/6, but additional investments required and absence of monitoring framework
- GOI plans to reduce load shedding, i.e. breakeven in 2010/1 and increase spinning reserve to 5.5% in 2012/3, but poor past performance

- **Coal**
  - GOI plans to retire most inefficient plants (7% of installed capacity) by 2012; additional 10 GW to be retired/ refurbished by 2017, but difficult to implement in energy deficit situation
  - GOI plans to increase share of supercritical - 20% of new installations in 11th plan, 50% in 12th, 70% in 13th and 90% thereafter.
- **Monitoring and Evaluation**
  - **As past performance of energy sector targets for 8th, 9th and 10th plan has been ~50%,** a strong monitoring and evaluation program is required in addition to proactive decision making to quickly address any shortcomings

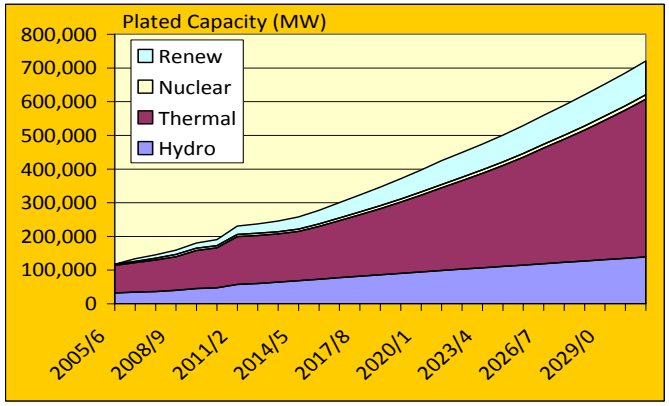
"Bending the Curve" Possible in High Growth Scenario ?

- **Would require the introduction of ~150 GW of additional renewable or cleaner energy by 2032 using combination of:**
- **Gas/ Imported Hydropower:** international cooperation to facilitate access by India to gas resources in the Central Europe/South Asia region or hydro from Nepal/ Bhutan will be critical (roughly twice as much gas required than hydro to achieve GHG reductions relative to coal)
- **Nuclear:** rapid and unprecedented introduction with much shorter lead times and significant investments
- **Solar:**
  - NAPCC intends to add 20 GW by 2020 (half photovoltaics and half solar-thermal)
  - current installed solar thermal power worldwide is 14 GW



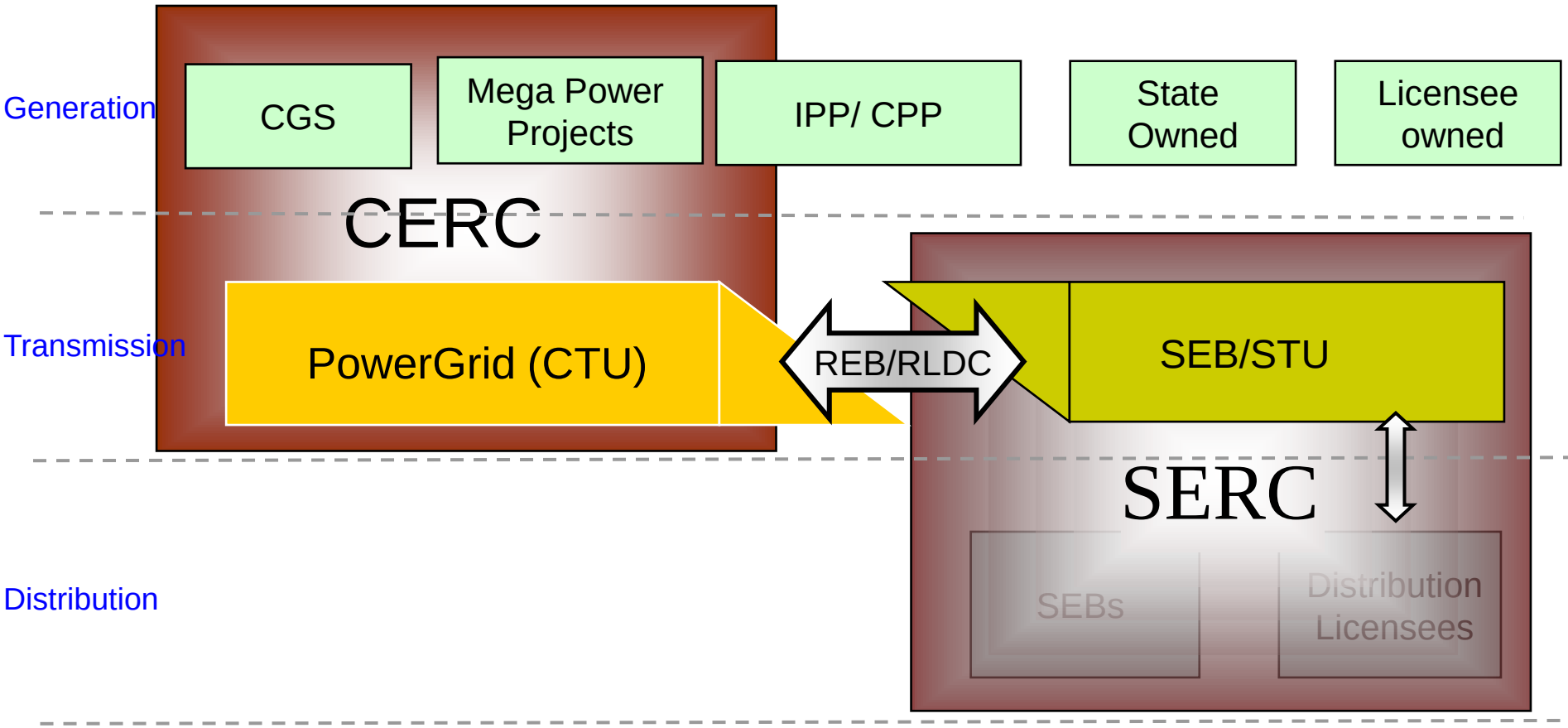
Impact of Plan Slippages

- If the impact of the **unfolding global financial crisis is factored in, and lower GDP growth rates** (peaking at 8 % in 2012, and lowered to 7.5 % in 2015-18, 7 % by 2020, 6.5 % by 2024 and 6% thereafter), the increase in **energy supply requirements by 2031/32 will be 4 times that of 2007/8**, with the associated high increase (3.4 times 2007 values) in CO2 emissions. Under the latter scenario, coal-fired generation plants will still dominates energy supply to the grid representing 53 to 55% of installed capacity and 73 -76% of supplied energy over this period.
- Should there be a five year slippage in the program to reduce transmission and distribution losses (from 29.3 to 15 percent), additional GHG emissions are important: 56 Mt CO2e per year, i.e. equivalent to ~one tenth of 2004 emissions in the power sector
- **If grid supply does not expand as fast as expected; GDP growth may be affected**



Coordinated Effort by Multitude of Institutions Will be Required

Power is concurrent subject under Constitution



Energy Efficiency and Demand Side Management

- Energy prices for commerce, industry and large households amongst the highest in the world on PPP basis
- GOI intends to increase energy efficiency by 20% by 2016/17, savings of 10 GW by 2012
- In addition, the energy efficiency mission under the National Action Plan on Climate Change will mandate specific energy consumption in large industries, and provide incentives for demand-side management and efficiency
- Still to be modeled under LCG Study: potential energy efficiency in non-residential buildings, industry and agriculture
- SME sector (which contributes to 40% of India's GDP) difficult to model, but could be source of energy efficiency gains – but barriers are significant

Significance of Increasing Household Demand

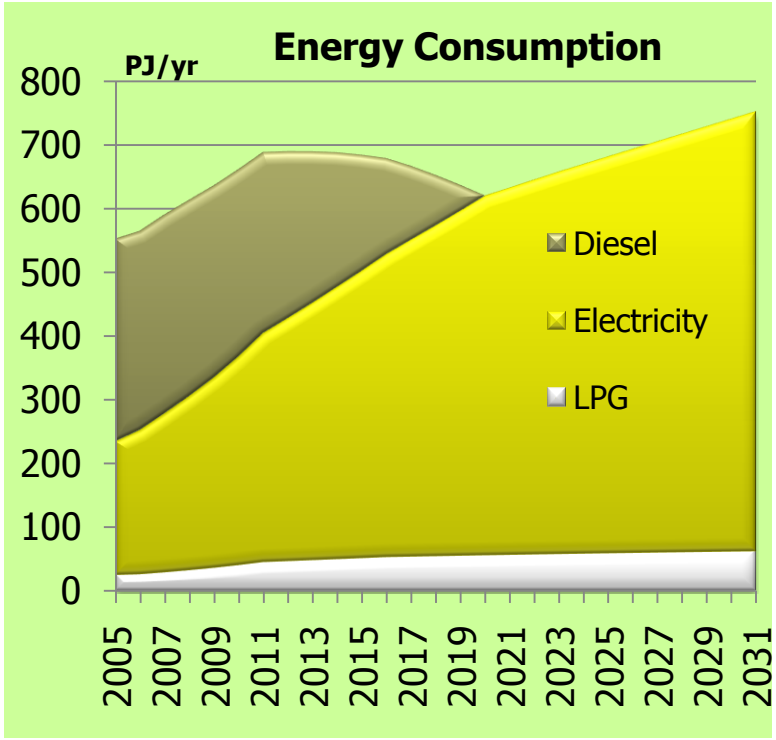
- Projected to accelerate to 3.5 times 2007-8 levels by 2031-2 due to increasing urbanization, electrification, and household incomes.
- Principally driven by **increasing consumption of the bottom two-thirds of the population**
- Top third of urban households in India are expected to average only 1,500 kWh/year in 2031-2. This is one third of EU-15 2004 average of 4,343 kWh/year
- Adoption of mandatory standards (US Energy Star 1) for following appliances: lighting, entertainment, kitchen and heating/ cooling would result in savings of **75 MtCO2e annually,** equivalent to 15 % of 2004 emissions in the power sector

Annual growth rates 2005/6 – 2031/2	
Lighting:	4.5%
Entertainment:	5.9%
Kitchen Apps	6.2%
Heating/Cooling:	7.4%
Memo: GDP ave	*7.8%*

Nonresidential Demand Increases Substantially

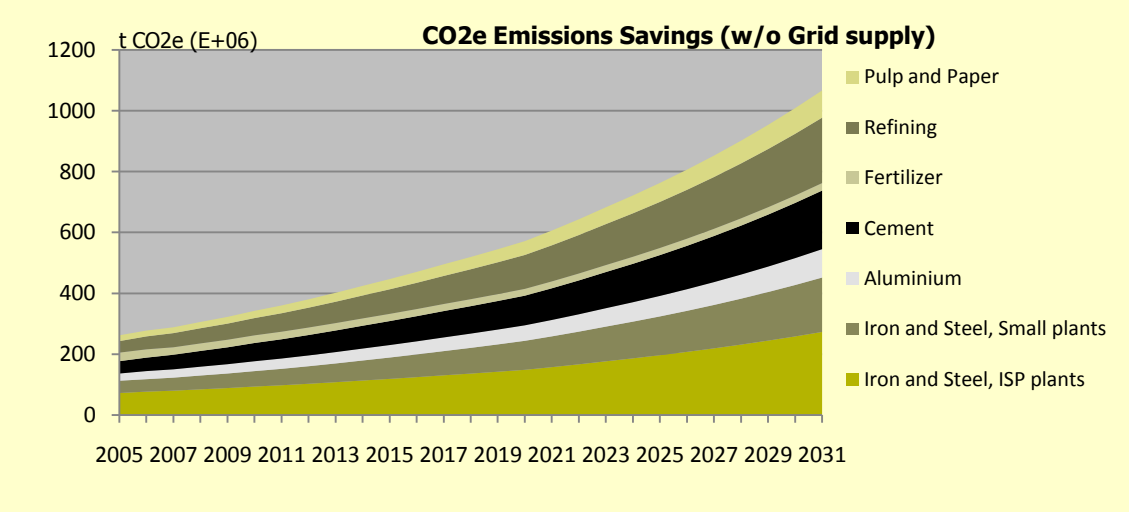
- New construction lighting and cooling patterns show an annual electricity use intensity of 173 kWh/m^2, 27% higher than the current average of 137 kWh/m^2 for existing stock.

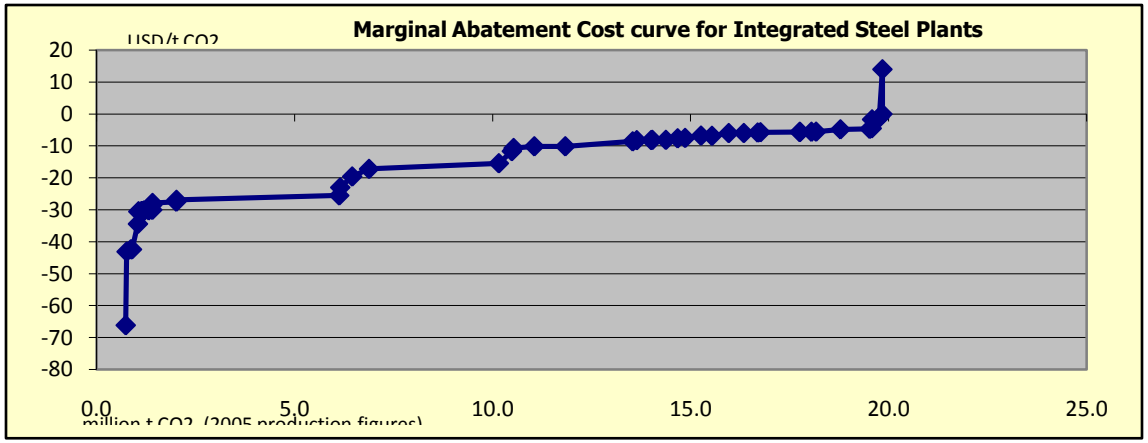
- In the BAU scenario, total electricity consumption doubles from 97 (in 2008/9) to 191 TWh by 2032.
- Aggressive efficiency measures in lighting and cooling can reduce the growth in consumption from new construction. Savings of 12 Mt CO2e (7%) per annum achievable by 2032.
- Under the high efficiency option, CO2 emissions grow from 113 Mt CO2 in 2008/9 to 187 Mt CO2 in 2031/2



Industry Follows Similar Growth Patterns

- The CO2e emissions from six industries are expected to increase from 306 Mt in 2008/9 to 1137 Mt in 2031/2 .
- Potential savings of 144 Mt CO2e per year by 2031/2 if 334 specific process improvements are systematically applied .

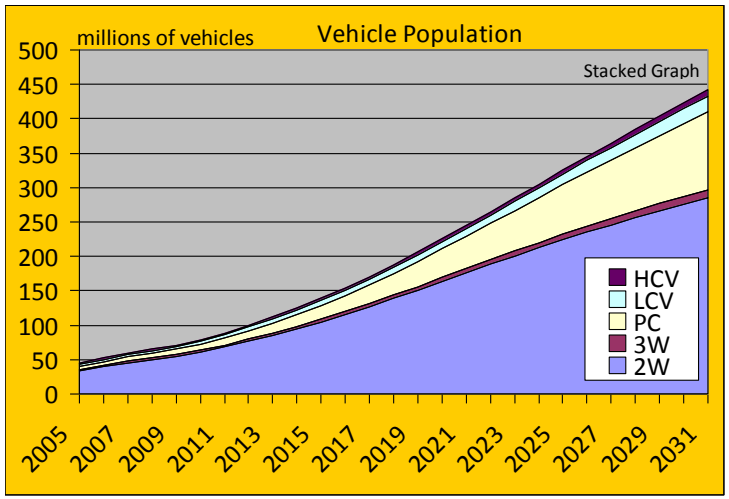


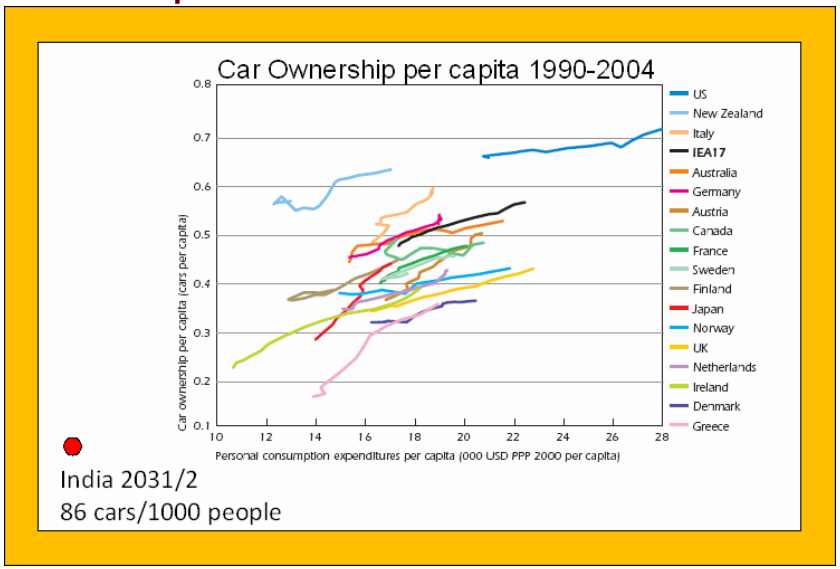


Note: Grid Supplied Electricity is not included in the CO2e emissions calculations to avoid double counting

Is it Possible to Affect the GHG Emissions Trajectory in On-Road Transport?

- CO2 emissions to grow at least to 6.5 times 2007-8 levels by 2031-2
- Ownership in India in 2031-2 of 86 cars per thousand people. This is one sixth of EU-15 2004 average of 489 cars per thousand; 756 in US
- CO2 emissions could grow to only 4.9 times 2007-8 levels in 2031-2 by implementing standards for new cars of 128 g/km in 2020-1 and 100 g/km by 2030-1 (which is close to EU targets for 2012 and 2020 respectively) plus 175 g/km in 2022/3, and 160 g/km in 2028/9 for light duty vehicles
- With corresponding mitigation of 911 million tons possible between 2007-2032 at a cost of US$75/t CO2





What Have We Learned So Far?

- India's energy needs are significant and will likely generate substantial growth in GHG emissions by 2032
- While India has a good LCG strategy taking into account the 11th and subsequent plans, Integrated Energy Policy and National Action Plan on Climate Change, past performance suggests that targets are unlikely to be achieved without significant resources including financial, technical, institutional and skills
- The scarcity of primary and clean fuels in India and its reliance on growing fuel imports make it incumbent to rapidly accelerate the thrust on energy efficiency
- As energy is emerging as a binding constraint on growth, efforts towards meeting existing plans are crucial to support India's growth strategy

Challenges And Next Steps of Bottom-Up Capacity Building

- Significant Data Requirements (Availability & Quality)
- Coordination between Sector Institutions by an Apex Body (Critical Success Factor)
- Institutional Arrangements for the Maintenance and Further Development of the Model (to be firmed up)
  - Model – Planning/Trade Off Analysis Tool (Planning Commission)
  - Model – Monitoring Tool (Ministry of Environment and Forests)
  - Model – Assessment Tool (Bureau of Energy Efficiency)

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