

India's Energy Sector Options & Challenges

TERI Presentation

Joint TERI ETSAP Workshop

***Energy Modelling Tools & Techniques to address
Sustainable Development & Climate Change***



21st January 2010

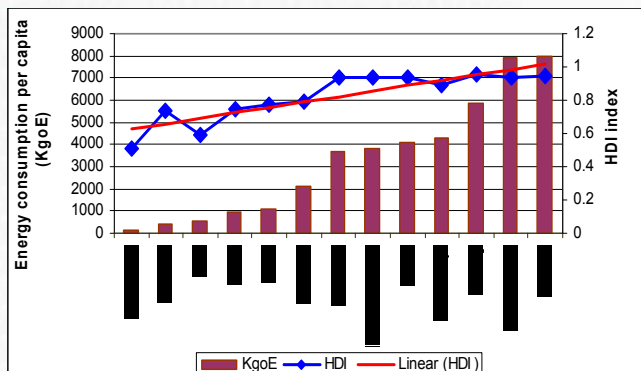
Recent MARKAL Applications: TERI

- National Energy Map for India: Technology Vision 2030
 - Principal Scientific Advisor to the Government of India
- Examining technological options & financing challenges for India
 - Mitigation Options for India – Role of the International Community (COP 14)
 - Toward a Global Climate Deal: An Integrated Science & Policy Approach for Real Impact (TERI-IIASA side event at COP -15)
- Detailed electricity sector analysis for MSEB
- Energy-Economic-Environment Modelling to support climate change assessment and policy-making in India
 - Ministry of Environment and Forests, Government of India



Mitigation Options for India – Role of the International Community

India Needs More Energy for its Development



Huge population with unmet demands

Developmental goals and energy access to all – a national priority

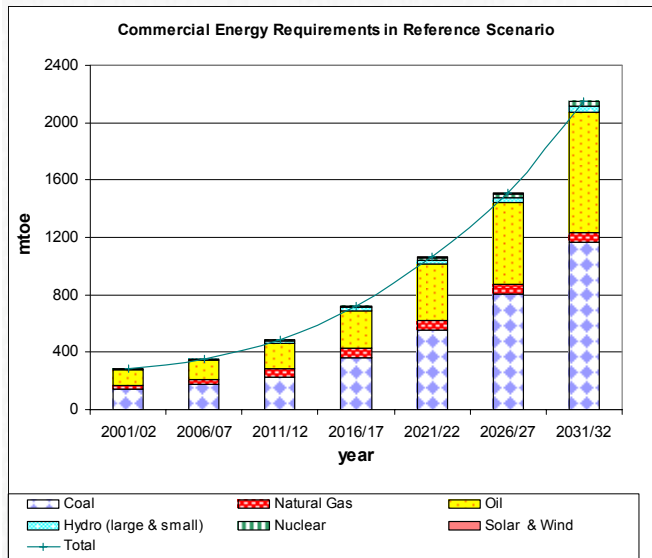
High targets for economic growth to address poverty

Challenge

- How to meet future levels of energy demand in a sustainable manner
- Technology and policy options under alternative scenarios
- Addressing local as well as global issues

→ Scenario based analysis

But can we sustain a continuation of past trends ?



Energy security:

Where will all the coal and oil come from?

Infrastructure:

How will all this energy be transported/handled?

Environment:

What will be the implications on local and global environment?



So What Shape Can The Future Take?

Scenario names	Storyline
Reference	Life continues pretty much as we know it with autonomous efficiency improvements taking place where feasible. Increase in use of renewable energy carries on at the same pace. Defined policy priorities are implemented with no real sense of urgency
Evolution	A determined effort is provided for efficiency improvements both on the supply and demand sides. Considers an accelerated push for renewable energy, nuclear and new technologies such as CTL (Coal to liquids) and GTL (Gas to liquids). Energy Security concerns are paramount in this scenario.
Resolution	This scenario honors the Prime Minister of India's commitment that India's per capita carbon emissions would never exceed those of the developed world and it is optimistically assumed here that the developed world would be able to bring down its emissions to a level of 2 tonnes/capita. Carbon emissions for India in this case would be around 38% of Evolution levels in 2031 to fulfill this commitment.
Ambition	This scenario considers that India sets aside its legitimate arguments on "common but differentiated responsibilities" & equitable per capita rights, and takes on even more stringent emission reduction targets (reaching 1.3 tonnes / capita in 2031) towards influencing global response to the climate change challenge.



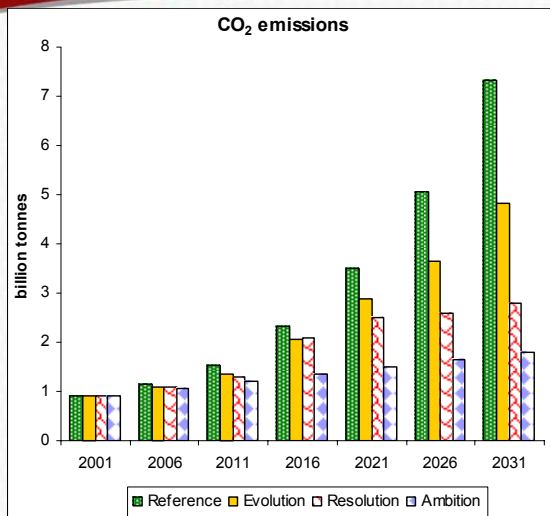
Key Modelling Results

- A large part of the driver for change in India's development pathway arises from its need to enhance its energy security
- Moving from the first two scenarios to the Resolution and Ambition, under current circumstances, infeasible
 - Achieving a feasible solution to Resolution and Ambition itself needed relaxations in several boundary conditions
- Tremendous efforts would need to be made to meet the targets set in Resolution and Ambition
 - Interventions here would not only include a major focus on barrier removal activities but are also premised on a global deployment of more energy efficient technologies.
- The technology options of coal-to-liquids and gas-to-liquids are important for India's energy security but may not be the most optimal choices when more stringent carbon targets are set

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CO₂ Emissions

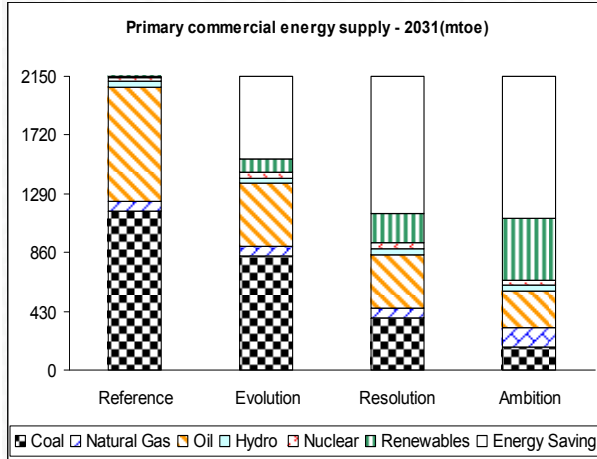


- Drop in CO₂ emissions dramatic with emissions in the Ambition scenario in 2031/32 only doubling from the 2001/02 levels against a nearly 8 fold increase in the Reference Scenario.
- In per capita terms, in the year 2031/32, India would have a CO₂ emission level of ~ 2 tonnes in the Resolution Scenario versus 1.3 tonnes in the Ambition Scenario!

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Energy Mix Under Alternative Scenarios

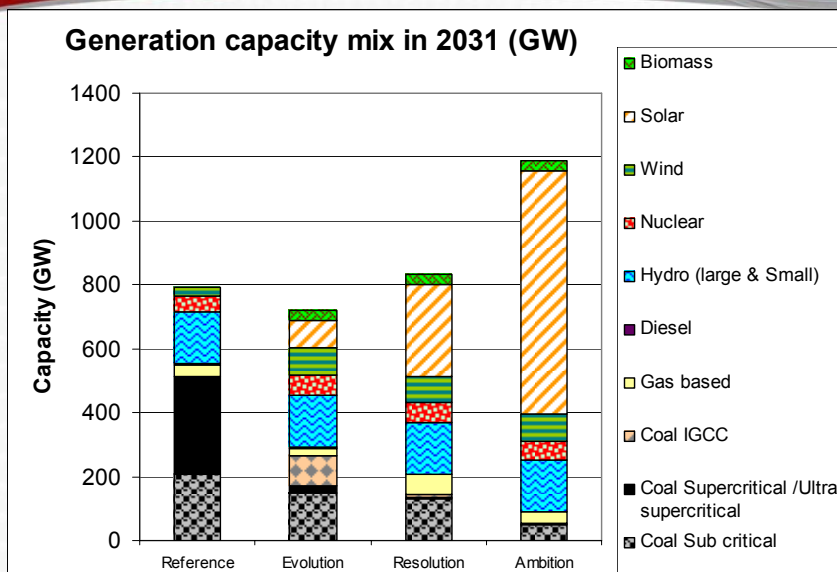


- The fuel mix would need to shift away from coal towards an increasing use of natural gas and renewable energy across the carbon scenarios (Resolution and Ambition)

- In the Ambition scenario, nearly 41% of commercial energy needs would need to be met by renewable energy sources!



Power Generation Technology Deployment...



Way Forward Strategies

▪ Accelerated Renewable Energy Use

- With ~ 80% of its capacity needs to be added between now and 2031/32 and 60% between 2017/18 and 2031/32, India's electricity sector lends itself well to clean interventions. Renewable energy technologies of solar, wind and biomass and nuclear power plants most desirable
- Need to move towards solar thermal with storage to meet the base load requirements.
 - Technology development, demonstration & deployment required
 - Need cost reductions
- Technology development: manufacture of wind turbines to suit India's wind profile and large capacity wind turbines of over 5 MW needed
- Need for mapping & exploiting India's off-shore wind energy potential

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Way Forward Strategies

▪ Energy Efficiency and DSM

- A large scale program, supported by multilateral organizations, and well-designed market mechanisms could further accelerate deployment of energy efficient technologies.

▪ Biofuels

- Address productivity enhancement & R&D in second generation technologies

▪ Moving to cleaner transport

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Challenges to be addressed

- Incremental Finance
 - Alternative energy paths imply higher capital costs but lower operating costs
- Technology

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Analysis of Carbon Budget Approach for India

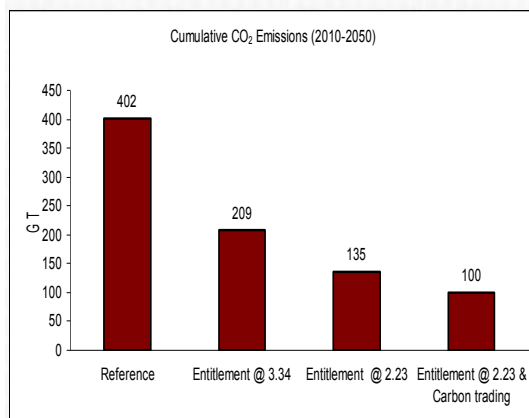
2 deg Guardrail

- The agreement at the MEF forum (L'Aquila) in 2009 to contain global temperature increase to not more than 2 degrees celsius above pre-industrial levels created a new momentum
- Scientists responded by estimating the carbon budget that would ensure meeting this goal at different levels of probability
 - At a 2/3 probability and a 3/4 probability of achieving the 2 deg C guardrail, the global carbon budget has been estimated to be 750 GT and 600 GT respectively
- How could this overarching goal translate into options for a country like India?

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India's Carbon Budget



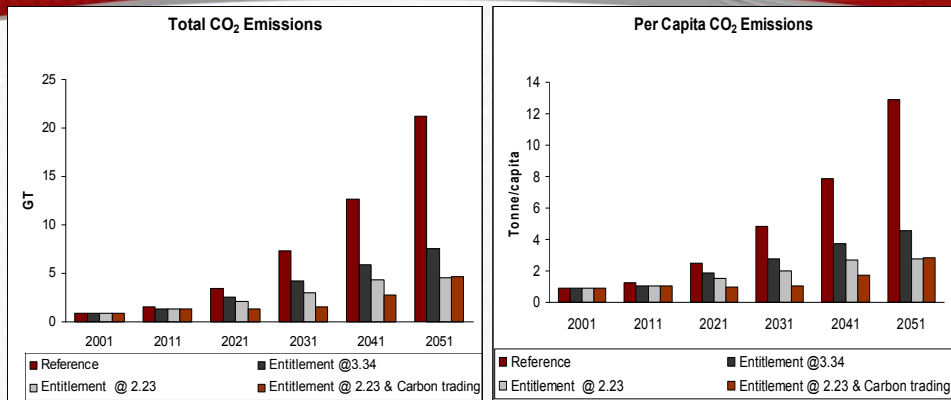
- Accepting the argument of equal per capita rights from 2010 onwards, India's carbon budget for the period 2010 to 2050 is ~ 135 GT
- It must be noted that in a fully fair and just world India's carbon budget, not accounting for its past under-utilisation, would be ~ 209 GT

•Reduction from Reference Case

- Entitlement @3.34: 48% ; Entitlement @2.23: 66%
- Entitlement @ 2.23 & CO₂ trading (35 GT): 75%



Projected Trend of Total and Per Capita CO₂ Emissions



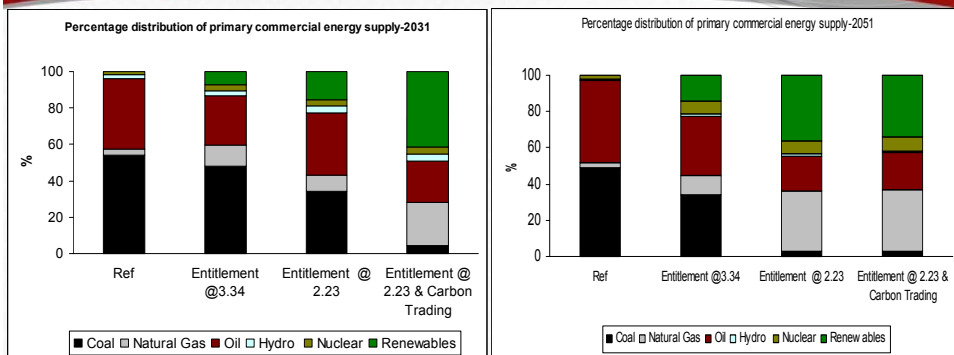
- Large deviation required from reference scenario but no peaking till 2051

- Per capita CO₂ emission in 2051

- Reference: 12.9 tonnes; Scenario @ 3.34: 4.6 tonnes; Scenario @ 2.23: 2.8 tonnes; Scenario @ 2.23 & trading: 2.8 tonnes



Fuel Mix in 2031 & 2051



- Substantial shifts are required to achieve the desired level

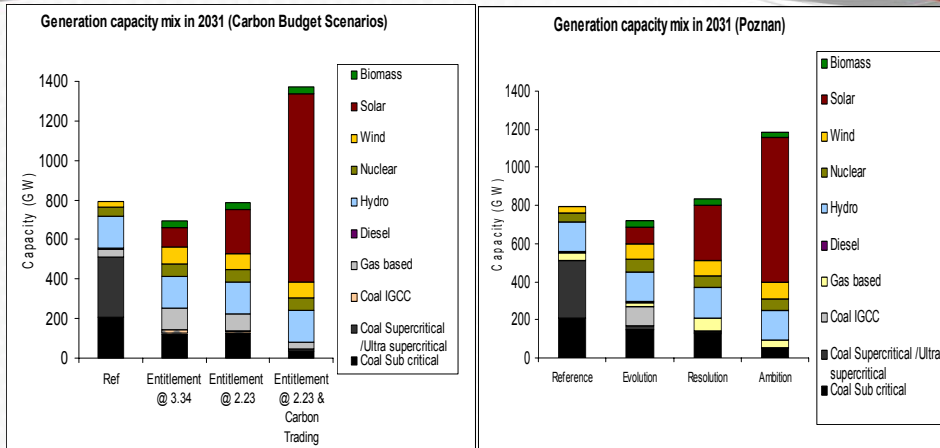
- Significant capacities would need to be forcibly retired towards the end

- Move away from coal in longer time frame with stringent carbon constraint

- Renewable is the key for achieving low carbon growth in longer term along with energy efficiency and advance technologies



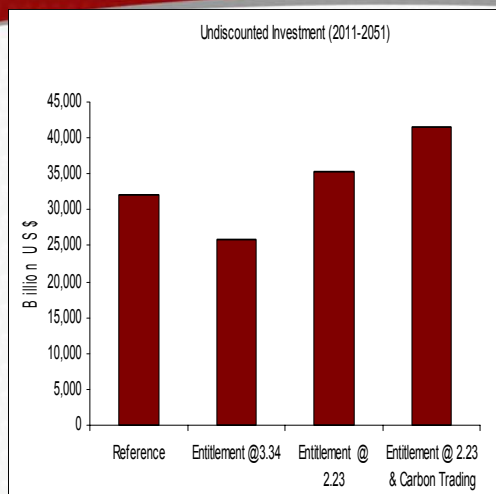
Comparative results of generation mix in the 2 studies



• In medium term Entitlement @ 3.34 scenario is inline with Evolution Scenario; Entitlement @ 2.23 scenario is comparable with Resolution scenario; carbon trading scenario is even more stringent than Ambition scenario



Long Term Investment Requirement (2011-51)



• Additional investment of US\$ 3.14 Trillion is required to move towards Entitlement @ 2.23 Scenario in next Forty years (~ US\$ 79 Billion per Year)

• Much higher additional public finance would be required:

- Power sector: Additional investment requirement: US\$ 13 Trillion (in Entitlement @ 2.23 scenario over the reference case)

- Public transportation facilities (Metro, high speed rail, dedicated freight corridor, good quality bus, etc) would require additional investment of US\$ 1.13 trillion (in Entitlement @ 2.23 scenario over the reference case)



Conclusions

- Sustainable development pathway is the way forward
- Choice of technologies would play a critical role
- Flow of substantial investment is essential

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Thank You

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