INDIA'S ENERGY AND CLIMATE POLICY: LESSONS FROM MODELLING STUDIES

POLICY BRIEF

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SUMMARY

Understanding India's likely energy future is important for both development planning and climate policy. This review of seven national energy and climate modelling studies finds energy use will increase substantially in the absence of additional policies: coal use may increase by 2.5-3 times current levels by 2030, electricity supply by 3-4 times, and greenhouse gases by 2-3 times. However, results diverge widely, even for reference cases, limiting their use for policymaking. Collectively, these studies also use high GDP growth rates and do not fully consider the implications on energy security and environmental concerns. India's energy and climate planning would be well served by complementary analysis of specific sectoral actions.

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Introduction

A sound understanding of India's likely energy future is important for development planning and climate policy. Future energy security, energy access, and local environmental considerations are particularly salient. India's climate policy also rests on an understanding of energy trends because energy accounts for 77% of India's greenhouse gas emissions.[1]

To inform these discussions, energy and climate models provide one potentially useful tool. This brief summarizes a review of seven recent national modelling studies[2] that cover the energy and industry sectors to explore energy and emissions futures until 2030. The analysis focuses in particular on reference scenarios that project effects of current policies, and also comments on low-carbon policy scenarios. A research report with full details on the method and results is available at cprindia.org.

Future trajectories of energy demand and supply

Energy Supply and Security

Overall, energy supply trends diverge considerably across studies, even in reference cases (*see Figure 1*). Nevertheless, all models foresee growing fossil imports.

By 2030, coal use is projected to be 2.5-3 times current levels in reference cases. Even under policy scenarios, coal use is projected by all but one study to be more than 2 times current levels. However, these projections do not account for possible constraints on coal development, whether from rising imports or due to local environmental consequences. For instance, a 2-3 fold increase in coal consumption could contribute to a doubling of local air pollutants such as particulate matter, leading to a doubling of health impacts (Conservation Action Trust, India and Urban Emissions, India, 2014). Factors such as these may, in practice, set limits to coal use in the future.

Oil use projections for 2030 diverge considerably (1.5-3.1 times current use) in reference cases, likely because of different transport sector assumptions. Gas use increases by 2.1-3.5 times current levels, reflecting varied assumptions about gas use for electricity. However, all policy scenarios, with the exception of IESS, project higher gas use compared to reference cases, suggesting that gas use is likely to be a major component of any future emissions reduction approach.

Available results for energy security (only 3 of 7 studies) in 2030 reference cases suggest import levels would increase significantly, to 40-52% for coal (26% today), 88-93% for oil (78% today), and 40-70% for gas (30% today). Notably, import shares are driven more by input assumptions rather than generated by the models. For instance, TERI-WWF assumes oil production will plateau by 2016/17 and IESS defines its maximum energy security scenario by a fixed import constraint (of 21%).

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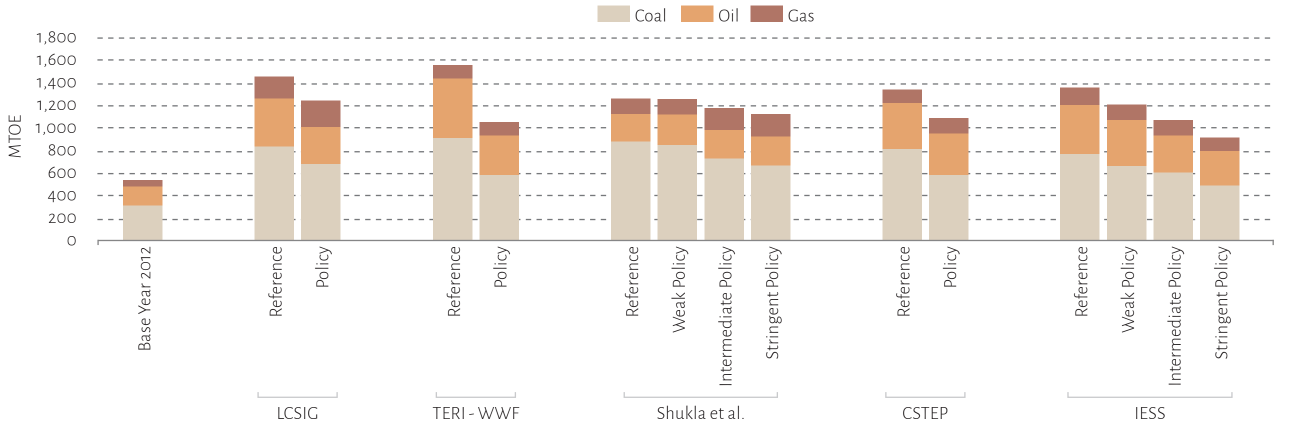
FIGURE 1: TOTAL PRIMARY FOSSIL FUEL ENERGY SUPPLY IN 2030*



* The range of study end-years is 2030/31/32.
Reference scenarios are not equivalently defined, but in general, attempt to reflect full implementation of currently committed policies.

Energy Demand

While understanding demand trends is essential for energy planning and in particular for assessing the scope for energy efficiency, 4 of 7 studies do not provide comprehensive data on final energy demand. From the available data, transport and industry are projected to increase their share of total demand in reference scenarios. However, the buildings sector (including cooking) share is projected to decline considerably and agriculture to reduce to a lesser extent.

These projections depart from recent trends, for reasons that are unclear. For example, slowing down of growth in the buildings sector may be due to a projected shift from biomass to LPG. Notably, besides TERI, none of the studies explicitly discuss non-commercial biomass.

Electricity Supply

Electricity production accounts for 38% of total primary energy use in India (2010) [3], and 47% of CO_2 emissions (2007).[4] Projections of the electricity mix in 2030 diverge widely, even in reference scenarios (*see Figure 2*). The ranges are particularly large for renewables, with implications for India's share of fossil fuel free electricity.

By 2030, total electricity supply is projected to increase 3-4 times in reference cases. Even the lowest policy scenario projects an increase of 2.5 times current levels.

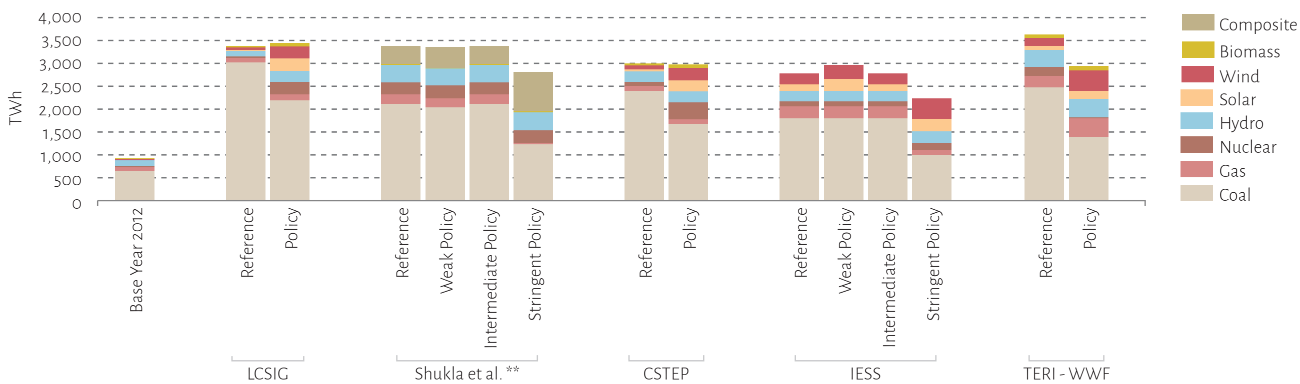
In 2030, the projected share of coal in electricity output ranges from 56-90%, compared to 70% in 2012. Nuclear power appears to be systematically overestimated; the studies project additions of 15-42 GW by 2030 (from a current base of 5 GW) although only 2 GW were brought on line in the last decade. Gas and hydro at most retain their current shares under reference scenarios, or, at the low range of the scenarios, decline. In the policy scenarios, the share of gas increases from 9% to at most 14%, and hydro marginally increases.

Renewable energy as a share of electricity supply in 2030 ranges widely from 2-12% under the reference scenarios (an underestimate compared to recent trends) and 12-31% under the policy scenarios. Fossil fuel free electricity sources are projected to provide 7-31% share under 2030 reference scenarios and 12-31% under policy scenarios, versus 20% today, which is largely driven by hydro.

CO_2 Emissions Projections

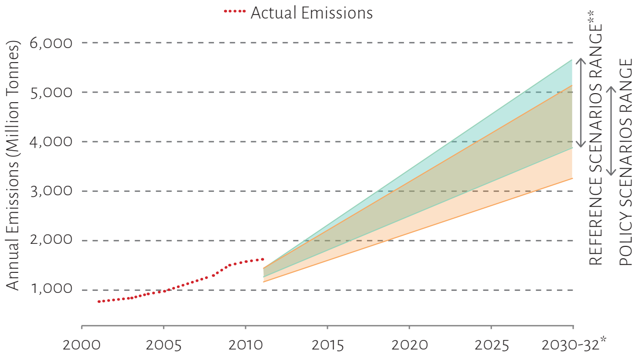
Figures 3 and 4 illustrate the range of emission futures for

FIGURE 2: ELECTRICITY SUPPLY MIX IN 2030*



* The range of study end-years is 2030/31/32.
** Composite includes non-biomass renewables, including geothermal, ocean, solar (PV and CSP), wind (onshore and offshore). Individual renewables shares not available.
Reference scenarios are not equivalently defined, but in general, attempt to reflect full implementation of currently committed policies.

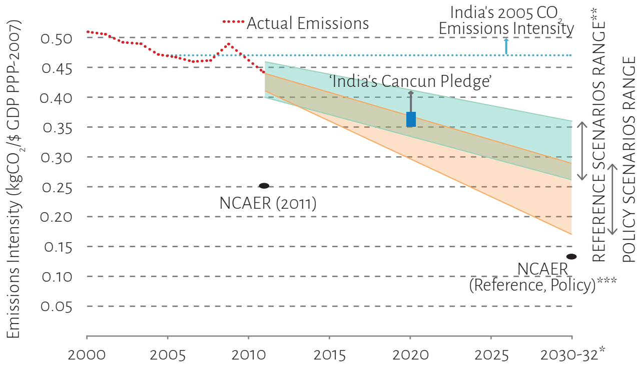
FIGURE 3: ANNUAL CARBON DIOXIDE EMISSIONS



* The range of study end-years is 2030/31/32.

** Reference scenarios are not equivalently defined, but in general, attempt to reflect full implementation of currently committed policies.

FIGURE 4: CARBON DIOXIDE EMISSIONS INTENSITY



* The range of study end-years is 2030/31/32.

** Reference scenarios are not equivalently defined, but in general, attempt to reflect full implementation of currently committed policies.

*** NCAER data have been plotted but excluded from the envelopes, because, since the study dates from 2009, the starting point falls substantially short of actual historical data.

total CO_2 emissions and emissions intensity. Each graph shows the range of projections for reference and policy cases for the 7 studies, by depicting an 'envelope' of possible trends using beginning and end year data.

Collectively, the studies project 2030 CO_2 emissions in the reference case at between 4000 MT and 5674 MT, an increase of 2-3 times 2011 emissions. In per capita terms, the range is 2.8-3.6 tonnes/capita, which, even in 2030, would be below the current global average of 4.6 tonnes/capita. Notably, the studies use sustained GDP growth rates of 7.0-8.75% over the next fifteen years, which are above historical averages. If growth rates are aligned with historical trends, emissions will be lower.

Emissions intensity trends can be derived from the model, but these must be approached with caution as in many cases they do not fully capture the relationship between emission reduction policies and GDP. With this caveat, India's Copenhagen/Cancun 2020 target of 20-25% reduction from 2005 levels falls within the overlap of reference and policy ranges. Equivalently, for 2030, the overlap between the reference and policy trends occur at about 40-45% below 2005 levels.

Cost Implications

Evaluating the costs of alternative policies is critical to policy choices. However, the studies offer insufficient data or insight to inform a robust discussion on costs.

The two macroeconomic models report GDP losses from low-carbon policies, but cannot capture details of the energy sector. The Government's low-carbon study (LCSIG) estimates annual average undiscounted GDP loss of $62 billion in 2007 prices (about $26 billion discounted at 10%), if spread equally across the period, or an annual GDP decrease of 0.16% over the period. NCAER estimates annual discounted GDP losses in the range of $54 to $175 billion. These numbers too lack direct comparability, because they represent the energy sector differently and model different policies.

Only 2 (of 5) of the bottom-up energy models report incremental energy investments for particular low-carbon scenarios. However, their costs are not comparable since they represent different alternative energy futures. Further, they do not have the capacity to quantify the economy-wide impacts of higher energy prices.

Lessons for Policy

By generating long-term projections of energy demand, supply and related emissions, models can potentially provide useful inputs for policy. However, taken collectively, existing modelling studies have limitations that make their use for policymaking a challenge.

First, the models provide limited information on simultaneously achieving the multiple development benefits of energy for growth, energy security, inclusion, local environmental goals and addressing climate change (*see Table 1*), which is India's stated approach to energy and climate planning (Planning Commission, 2013; PMCCC, 2008). For example, both energy security and local environmental concerns carry implications for future coal use, but these are not factored into coal projections. The failure to explicitly address these issues risks calling into question the utility of the projections.

Second, using model results for policy is hampered by the wide range of projections, even in reference cases. Studies would better inform policy if accompanied by greater explanation of their results, points of divergence (e.g., renewable and nuclear penetration) and more information on particular areas (e.g., energy demand and overall cost accounting). Going forward, it will be important to develop a credible reference scenario for all studies based on a common set of key assumptions, such as on GDP growth and expected impact of current policies, informed by expert and stakeholder opinion. Common policy scenarios to enable comparison across models should also be developed.

Third, since existing studies provide a limited basis for energy planning, a precise assessment of alternative economy-wide pledges as part of India's climate contribution is difficult. Therefore in addition to any economy-wide targets, India's energy planning and climate contribution should be informed by complementary analysis of specific actions in different sectors.

TABLE 1: INFORMING MULTIPLE OBJECTIVES

Objectives		LCSIG	NCAER	TERI-WWF	Shukla et al.	CSTEP	World Bank	IESS
Energy for growth	Supply	●	●	●	●	●	●	●
	Demand	o		●		●		●
Energy Security				●		●		●
Inclusive growth		o						
Local environmental objectives					o	o		
CO_2 mitigation	Emissions	●	●	●	●	●	●	●
	Intensity	●	●					
Costs		●	●	o			o	

● Full coverage: Reasonably comprehensive and transparent treatment
o Partial coverage: Addressed to an extent, but falls short in some respects, including accessibility

ENDNOTES

1 Data on emissions trends for India are sourced from WRI-CAIT 2.0, available at http://cait2.wri.org/wri. Data on trends of energy supply and demand, and electricity production are sourced from the Ministry of Statistics and Programme Implementation, Ministry of Coal, Ministry of Petroleum and Natural Gas, Department of Commerce, and the Central Electricity Authority.

2 Seven studies have been considered for analysis. Abbreviations/short forms are used to refer to the study throughout the brief. For each study we have designated a reference scenario (identifying current policies/targets and their full implementation) and one or more policy scenarios, categorized as weak, intermediate, and stringent (based on emissions profile) where there are three or more scenarios. 1. Expert Group on Low Carbon Strategies for Inclusive Growth (LCSIG); 2. Climate Change Impact on the Indian Economy – A CGE Modelling Approach (NCAER); 3. The Energy Report – India. 100% Renewable Energy by 2050 (TERI – WWF); 4. Energy-Emissions Trends and Policy Landscape for India (Shukla et al.); 5. A Sustainable Development Framework for India's Climate Policy (CSTEP); 6. Energy Intensive Sectors of the Indian Economy: Path to Low Carbon Development (World Bank); 7. India Energy Security Scenarios 2047 (IESS).

3 Computed from 'India: Balances for 2010', Statistics, International Energy Agency. http://www.iea.org/statistics/statisticssearch/report/?year=2010&country=INDIA&product=Balances (accessed April 7, 2015).

4 See Planning Commission (2011).

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