Toward a Robust Development Focused INDC for India

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Motivation for this Project

• What should India submit as its INDC for Paris?
  • India’s development needs
  • Strategic
  • Robust

• Inform energy planning for multiple development objectives

• Collaboration between CPR, IIASA, and ERC in partnership with Prayas
  • Phase I: Review of climate/energy scenario studies
  • Phase II: Towards India’s INDC
    • Co-benefits analysis of future energy trends
    • Sectoral components of a possible INDC with attention to development benefits
Methodology

• Review of 7 energy/climate scenario studies
  • Recent India-specific studies with policy salience

• Synthesize results, examine drivers and model use
  • Represent data in consistent, comparable form
  • Common end year 2030/31/32
  • Common GDP PPP 2007 $
  • Interviews, data requests from modeling groups

• Distill lessons learned and gaps (process and outcome) for informing policy
  • Focus on lessons for policy, drawn mainly from reference scenarios

• DRAFT materials for discussion and feedback

• Identify next steps
<table>
<thead>
<tr>
<th>Study Name</th>
<th>Date</th>
<th>Institution/Authors</th>
<th>Model Type</th>
<th>Timeline</th>
<th>Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitigation Options for India: The Role of the International Community (TERI – Poznan)</td>
<td>2008</td>
<td>The Energy and Resources Institute (TERI)</td>
<td>MARKAL Model (Bottom-Up)</td>
<td>2001-2031</td>
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</tbody>
</table>
Outline

- Informing multiple objectives
- Emissions trends
  - Per capita emissions
  - Emissions intensity
- Energy sector representation
  - Total fossil fuel energy supply
  - Electricity mix
  - Final energy demand
- Costs of low carbon options
- Reflections on models to inform multiple objectives of policy
- Policy conclusions toward an INDC
## Multiple Objectives in the Study Outcomes

<table>
<thead>
<tr>
<th>Objectives</th>
<th>LCSIG</th>
<th>NCAER</th>
<th>TERI-Poznan</th>
<th>Shukla et al.</th>
<th>CSTEP</th>
<th>World Bank</th>
<th>IESS</th>
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<tbody>
<tr>
<td>Energy for growth</td>
<td>Supply</td>
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<tr>
<td></td>
<td>Demand</td>
<td>?</td>
<td></td>
<td></td>
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<td>Energy Security</td>
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<td>√</td>
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<td>Inclusive growth</td>
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<td>Local environmental objectives</td>
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<tr>
<td>CO₂ mitigation</td>
<td>Emission</td>
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<tr>
<td></td>
<td>Intensity</td>
<td>√</td>
<td>√</td>
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</table>

Note: Tick marks in cells represent a comprehensive picture of the relevant objective in the study outcomes

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CO$_2$ Emissions: Broad Range of Outcomes

Divergent Outcomes:

- Annual emissions vary: 4 to 7 Gtons (2030)
- Per capita emissions vary: 2.8 to 5 tons (2030)
- Some policy emissions > reference emissions

Why?

- Not just GDP: 7 - 8.75% vs. actual 6.1% (‘91-’00); 7.1% (‘01-’10); 5.5% (‘11-’13)
- Underlying energy sector scenarios and assumptions
- Dissimilar policy scenario construction
  - Sector efforts, macroeconomic targets, international targets
Emissions Intensity: Illustrative at Best

Outcomes are Illustrative:

• Relatively uniform clustering 25-35% below 2005 level (2030 reference scenarios)

• Policy scenarios cluster 45-55% below 2005 level (2030) (no outliers)

Implications for Policy? Not yet discernable.

• Emissions intensity needs to capture simultaneous changes in emissions and GDP through demand and price effects

• Starting point to impute emissions intensity from studies
Energy for Development: Risk of High Fossil Fuel Import Dependence

• Coal: Relative agreement on high future coal needs (reference)
  • 2123-3023 MT in 2030 vs. 600MT today
  • Coal import dependence 69% - 78% by 2030 (2 studies)
  • Driven by adoption of more efficient coal technologies

• Oil and gas: High divergence on future needs (reference)
  • Oil: 257-836 MTOE in 2030 vs. 169 MTOE today
  • Gas: 76-220 BCM in 2030 vs. 63 BCM today

<table>
<thead>
<tr>
<th></th>
<th>Range in CAGR (%)</th>
<th>Import Share % 2012-13</th>
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</thead>
<tbody>
<tr>
<td>Coal</td>
<td>5.6 – 7.2</td>
<td>19</td>
</tr>
<tr>
<td>Oil</td>
<td>2.4 – 8.8</td>
<td>84</td>
</tr>
<tr>
<td>Gas</td>
<td>1.0 – 7.2</td>
<td>32</td>
</tr>
</tbody>
</table>
Electricity Supply Mix in 2030

- Coal
- Gas
- Nuclear
- Hydro
- Solar
- Wind
- Biomass
- Other

*Other include non-biomass renewables, including geothermal, ocean, solar (PV and CSP), wind (Onshore and Offshore). Individual renewables shares not available.
Electricity Supply Mix: Inconsistent with Trends

- **Coal - high growth**: Agreement on high share and growth (reference)

- **Renewables underestimated**: Disconnected from recent trends
  - **Nuclear overestimated**: Broad range, with high growth estimates
    - 13-48 GW capacity addition predicted in 15 years, vs. actual 2 GW addition last decade
  - **Biomass neglected**: Despite 19% decadal growth in capacity

<table>
<thead>
<tr>
<th></th>
<th>Reference Range %</th>
<th>Policy Range % (most stringent)</th>
<th>Actual Growth %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>6.8-9.2</td>
<td>1.7-7</td>
<td>6 (last decade)</td>
</tr>
<tr>
<td>RE – Solar</td>
<td>8-21.2</td>
<td>30.1-34.8</td>
<td>-</td>
</tr>
<tr>
<td>RE – Wind</td>
<td>3-7.6</td>
<td>14.7-16</td>
<td>20 ('05-'06 to '13-'14)</td>
</tr>
<tr>
<td>Nuclear</td>
<td>-0.4-14.1</td>
<td>8.4-16.1</td>
<td>7 (last decade)</td>
</tr>
</tbody>
</table>
Final Energy Demand: Limited Information

- Two studies comprehensively characterize final energy demand
- Thin treatment of non-commercial energy
- Similar sectoral shares in 2010 and 2030 despite different historical growth rates

Why? Limited data
- Limitations (economic models) and lack of transparency (some bottom-up models)
- Demand specifics and growth assumptions not available

<table>
<thead>
<tr>
<th>Sector</th>
<th>Reference share %</th>
<th>Policy share % (most stringent)</th>
<th>2010-11 share %</th>
<th>Decadal CAGR % (‘01-‘02 to ‘10-‘11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>48-51</td>
<td>55</td>
<td>47</td>
<td>7.5</td>
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<tr>
<td>Buildings</td>
<td>21-22</td>
<td>19-21</td>
<td>14</td>
<td>5.1</td>
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<tr>
<td>Agriculture</td>
<td>5</td>
<td>4-6</td>
<td>6</td>
<td>2.6</td>
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<tr>
<td>Transport</td>
<td>22-24</td>
<td>18-21</td>
<td>20</td>
<td>7.4</td>
</tr>
</tbody>
</table>

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Cost and GDP Loss: Inconsistent Messages

Outcomes:

• Energy models: negative to low ($1.4 billion/yr) incremental costs
• Annual average GDP loss from macro models:
  • LCSIG: $62 billion
  • NCAER: $54 billion for $10/ton C tax
  • NCAER: $175 billion for $80/ton C tax

What does it mean for policy?

• Cost accounting within the models
• Model fixes structure of economy over 20 years
Understanding Energy Scenario (Reference)

Outcomes

• Relative agreement on growth of high efficiency coal, but limited discussion of imports
• Import dependence (coal, oil, gas) likely exacerbated
• Lack of clarity on basis for renewables and nuclear penetration
  • Renewables below current trends
  • Nuclear above current trends
• Demand side lacks transparency
Using Models to Inform Policy

• **Transparency and reasoning on key assumptions**
  • Energy demand trends and technology cost trajectories
  • Shared platform for assumptions based on expert opinion

• **Scenario construction**
  • Translate development objectives into model parameters
  • Specific scenarios to address key objectives: energy security, local environment, inclusion

• **Representing outcomes**
  • Clarity on outputs that are driven by exogenous assumptions
  • Sensitivity analysis on key input assumptions
  • Defining policy levers and assessing their relative influence
  • Better linkages between macro-economic (costs) and energy sector outcomes

• **Time frame**
  • Path dependency understated in the short-term
  • Longer time frame (2050) may better enable analysis of transformative change
Looking Ahead to India’s INDC

• Model results alone do not provide definite answers for economy wide INDC, but can provide a basis for exploring alternative energy and development futures

• Broaden capabilities to include sustainable development criteria
  • Energy security, inclusion, access, local environment

• Develop transparent process to build a common platform of assumptions and scenarios for cross model dialogue
  • Develop better linkages between bottom-up and macroeconomic models

• Deepen sectoral understanding to inform scenarios and form building blocks for INDC
Thank you!