Transition to 100% Renewable Energy by 2050 in India: Opportunities and Challenges?

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Use of Economic Modelling Tools Related to Economic Diversification and Just Transition of Workforce and Creation of Decent Work and Quality

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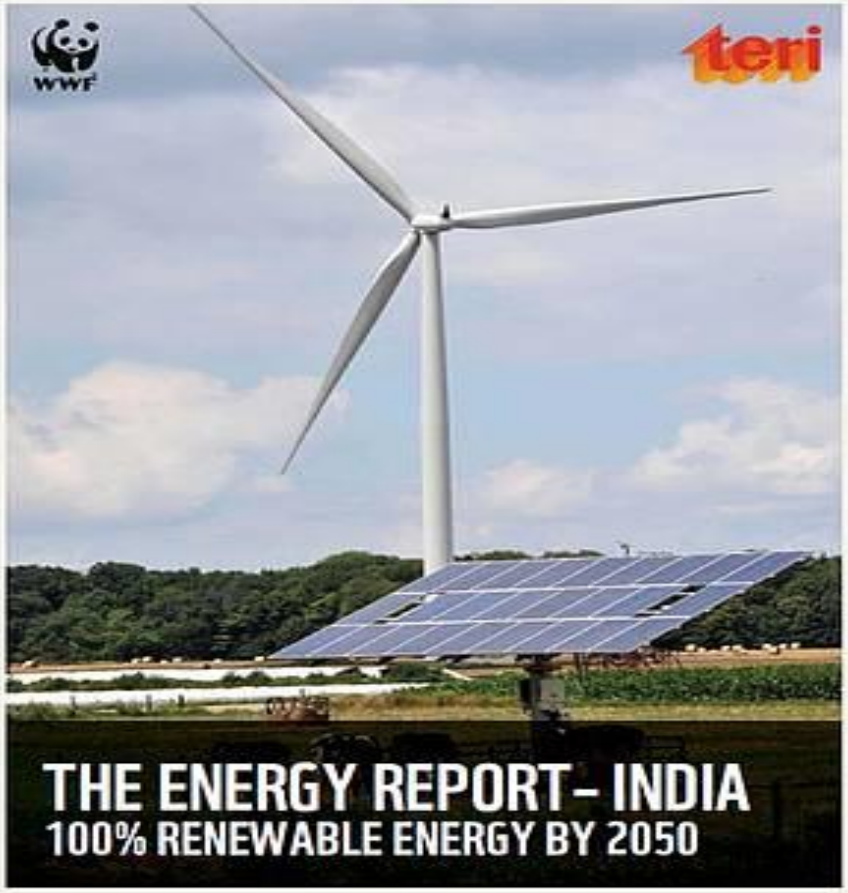
The Energy Report – India
100% Renewable Energy by 2050



- Why the study?
  - Renewables can provide centralized or decentralized energy solutions
  - With zero or negligible GHG emissions
  - Without the risk of resources depletion
  - Address energy access and energy security

India must look at alterative resources with a sense of urgency from energy security, energy equity as well as environmental perspective

This study…

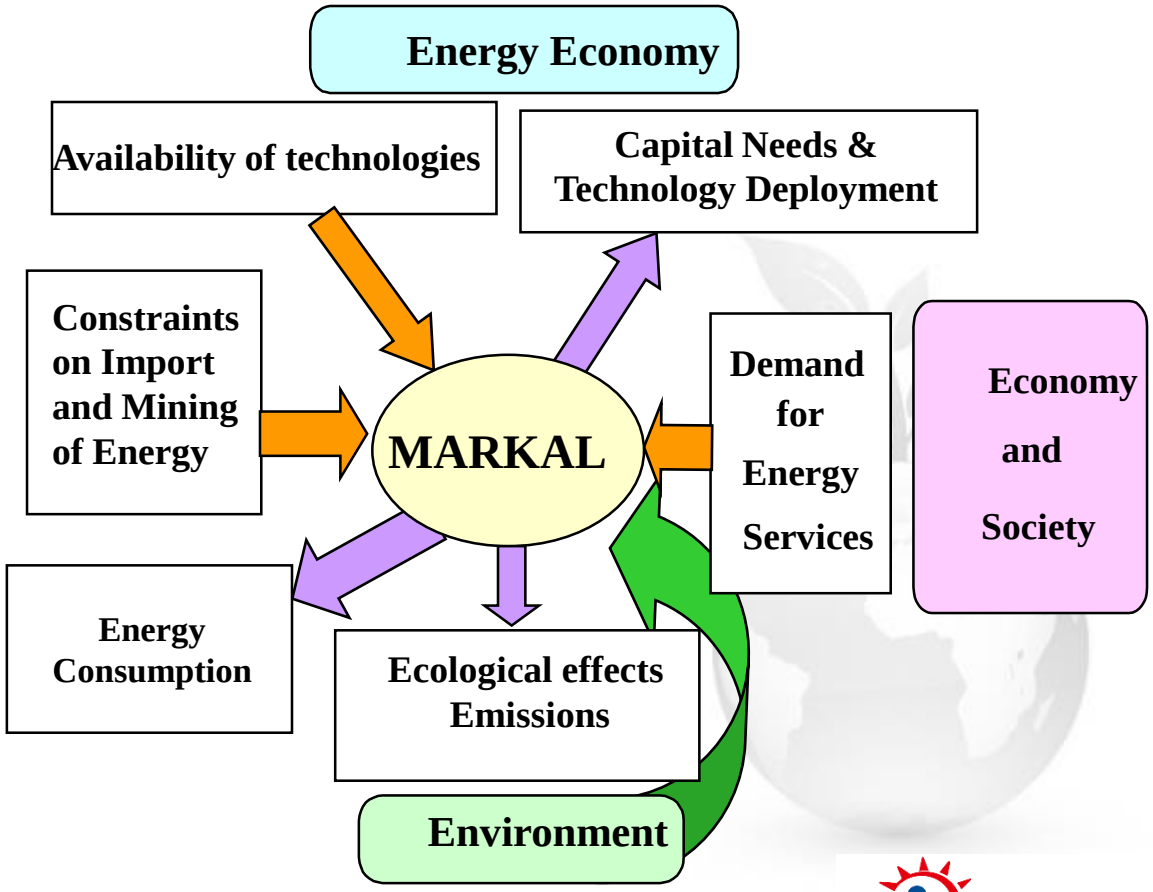
- Examines an ‘extremely ambitious’ scenario where 100% (~90%) of the primary commercial energy supply is obtained from renewable resources by 2050 (modelling period till 2051)

- This study takes in to account Indian policy concern such as
  - Energy access
  - Resource availability
  - Energy security considerations

- Technical potential of resources examined
  - Also discusses barriers, limitations, practical issues and implication on investments

Methodological Approach

- Detailed bottom-up technological representation of the energy system: over 300 technologies & ~ 100,000 variables
- Multi-time period, dynamic LP model extending from 2001/2-2051/52
- Objective function minimizes total energy system costs while incorporating elements of sustainable development



Source: ETSAP, IEA

MARKAL: An economic optimization energy system model

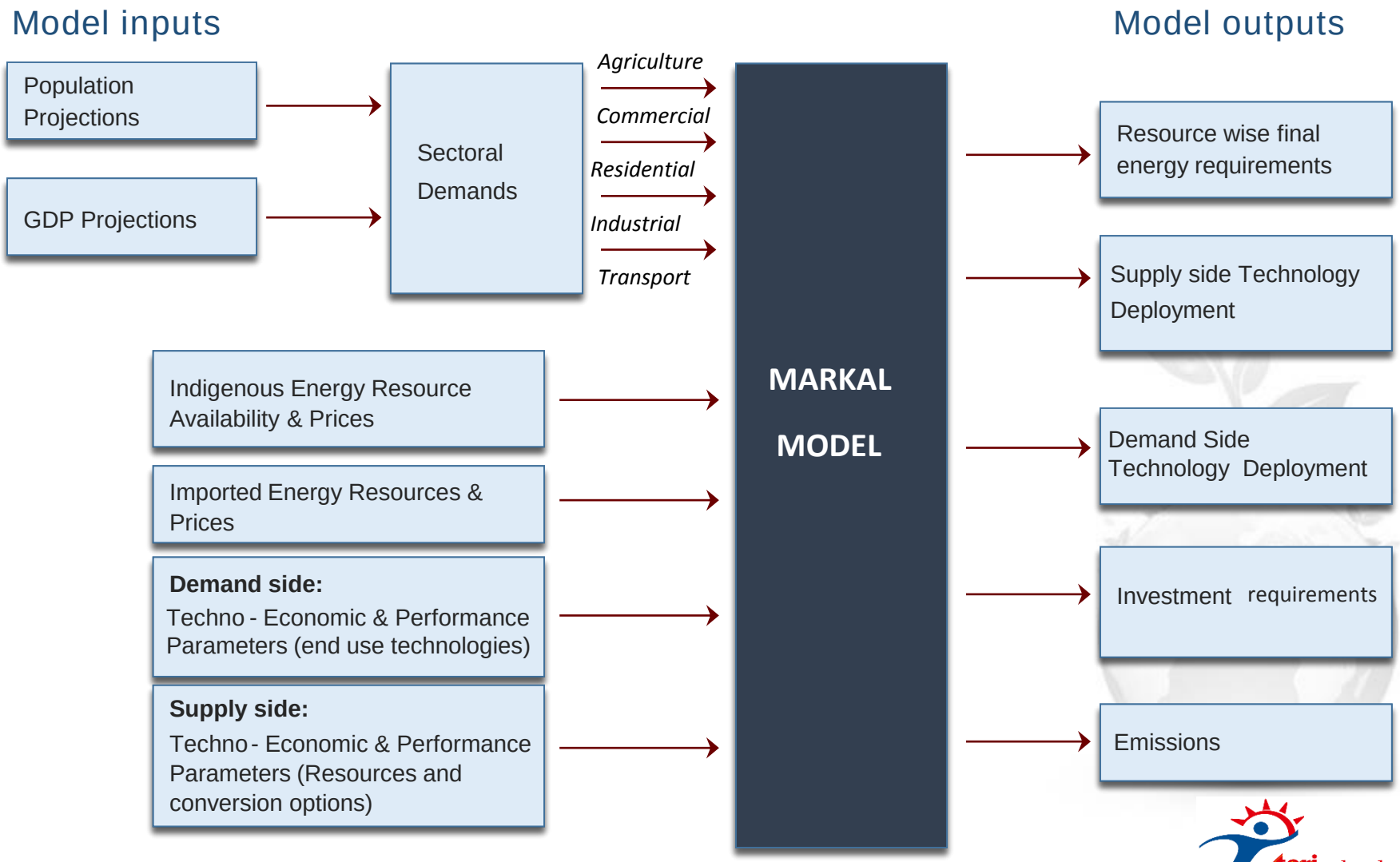
Objective function:

- MIN[discounted total system cost]
- Total system cost includes capital, operating, and fuel costs, plus any taxes assigned to environmental emissions

Constraints:

- System constraints: energy balance, demands, electrical system
- User imposed policy constraints, including emissions caps, technology portfolio standards, taxes and subsidies

Methodological Framework



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Key Assumptions

- GDP growth rate of about 8 % per annum till 2036, thereafter: 6%
- Structural shift towards services
- Population of 1.5 billion in 2031
- Electricity to all & living standard improvements over time

Reference Energy Scenario (REF)

- Provides a baseline that shows how the nation's energy trajectory would evolve if current trends in energy demand and supply are not changed.
- Takes into account existing policies and assumes that those recently announced are fully implemented
- Wherever necessary, a diversion from Government projections/ forecasts has been assumed

100% Renewable Energy Scenario (REN)

- Examines possibility of a mix that comprises of 100% renewable energy in the primary commercial energy supply by 2051.
- Fossil fuels and nuclear based technologies are phased out

And WE FIND……

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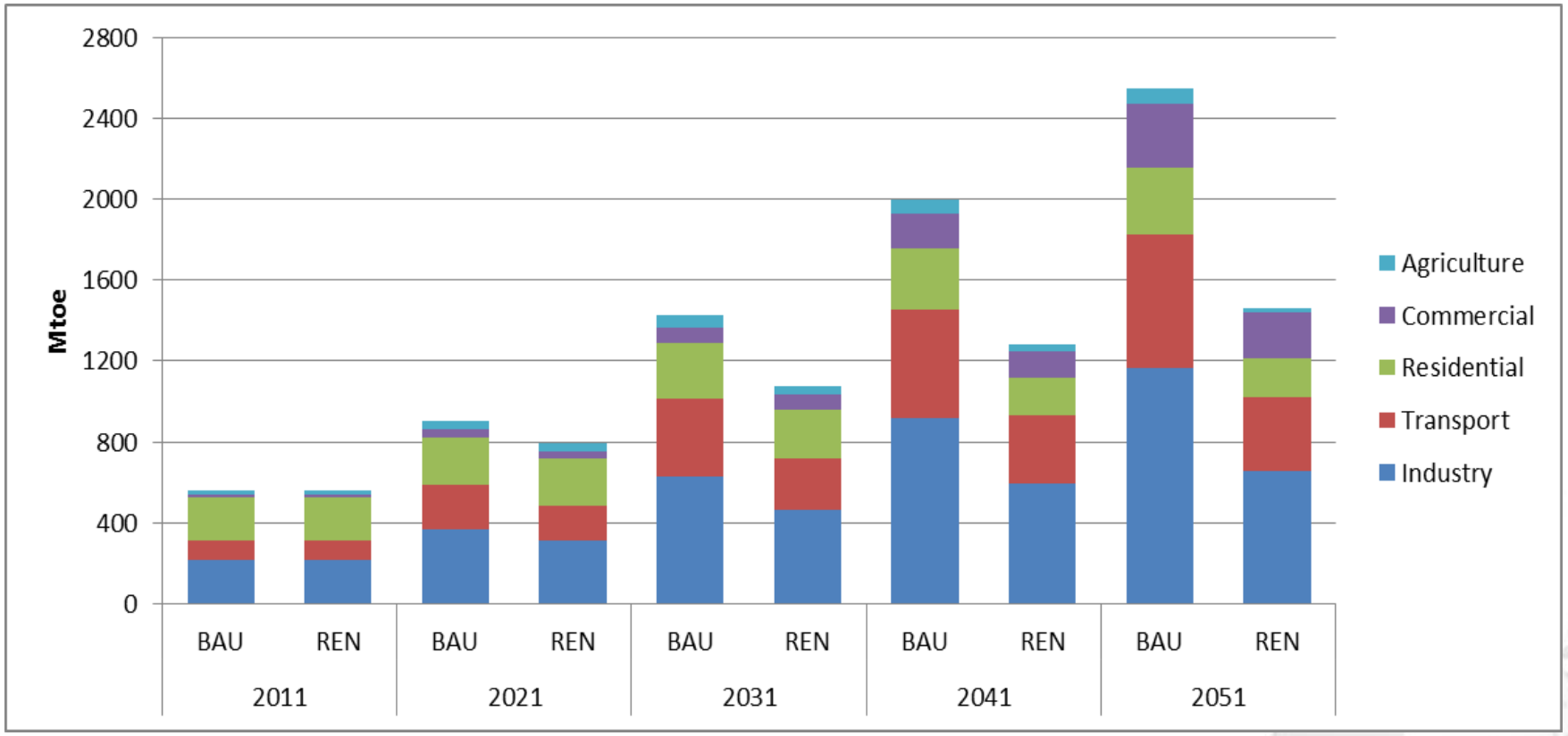
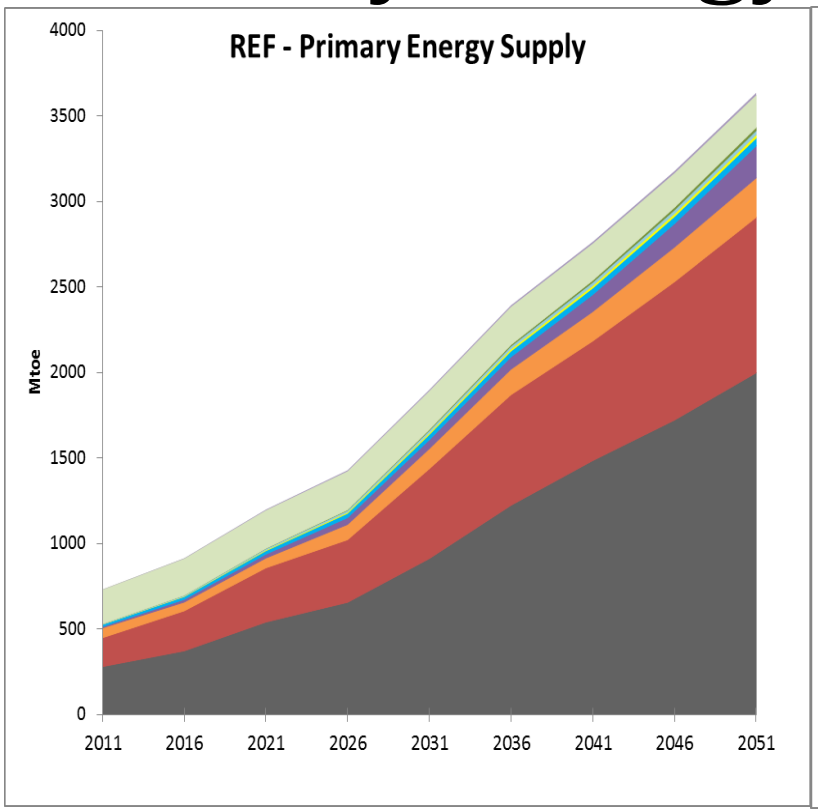
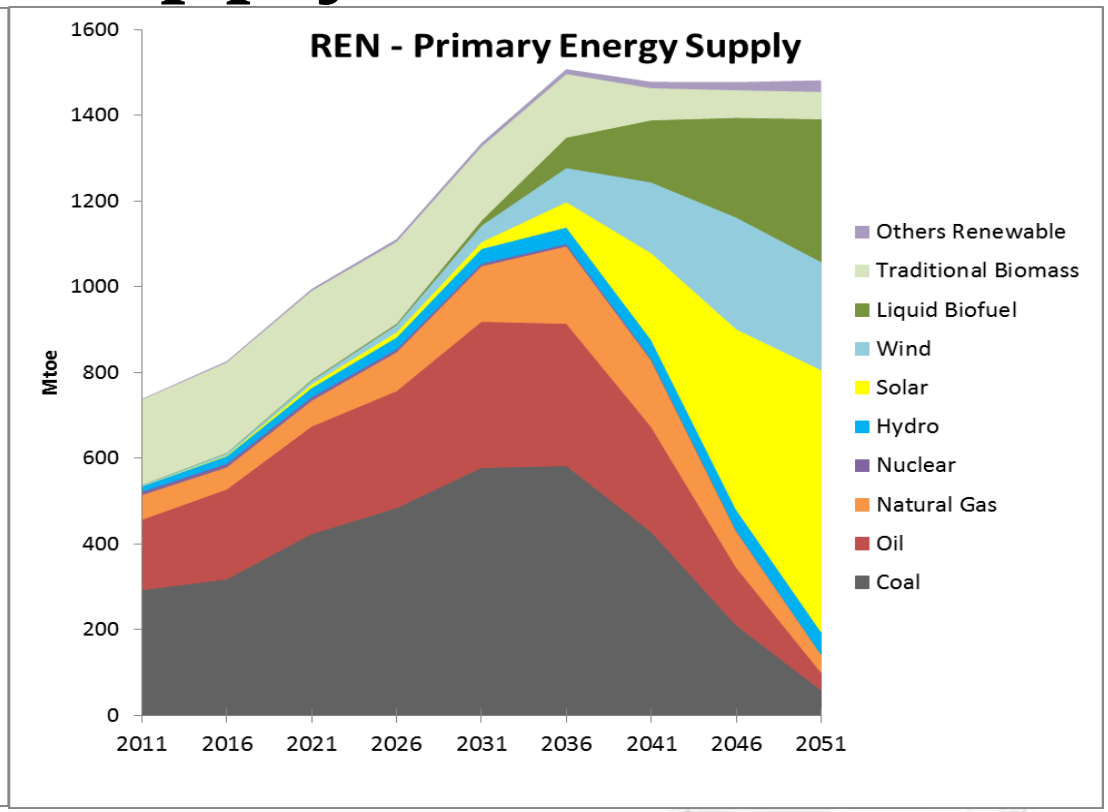
End-use Demand (including biomass)



- In REF scenario, India's final energy demand is estimated to increase from around 560 Mtoe in 2011 to around 2545 Mtoe in 2051, largely fuelled with fossil based energy forms.
- In 2051, the final energy demand in the REN scenario is decreased by 41 % as compared to the REF scenario
- Industry remain the highest consumer of energy (45% in 2051) followed by the transport sector (25% in 2051)

Primary Energy Supply





- In a REF scenario, India's primary energy supply could increase from 738 Mtoe in 2011 to 3613 Mtoe in 2051 (an increase of 6 times).
- Primary energy supply is 60% lesser by 2051 in the REN scenario vis-à-vis the REF
- In REF, fossil fuels contribute more than 90% of Primary commercial energy supply throughout the modelling period, coal and oil continue to dominate the energy mix in this scenario.
- In REN scenario around 10 per cent of the commercial fuel mix would need to be met by fossil fuels for niche uses such as feedstock in industry, for which there is currently no replacement

Key interventions and challenges: in energy supply

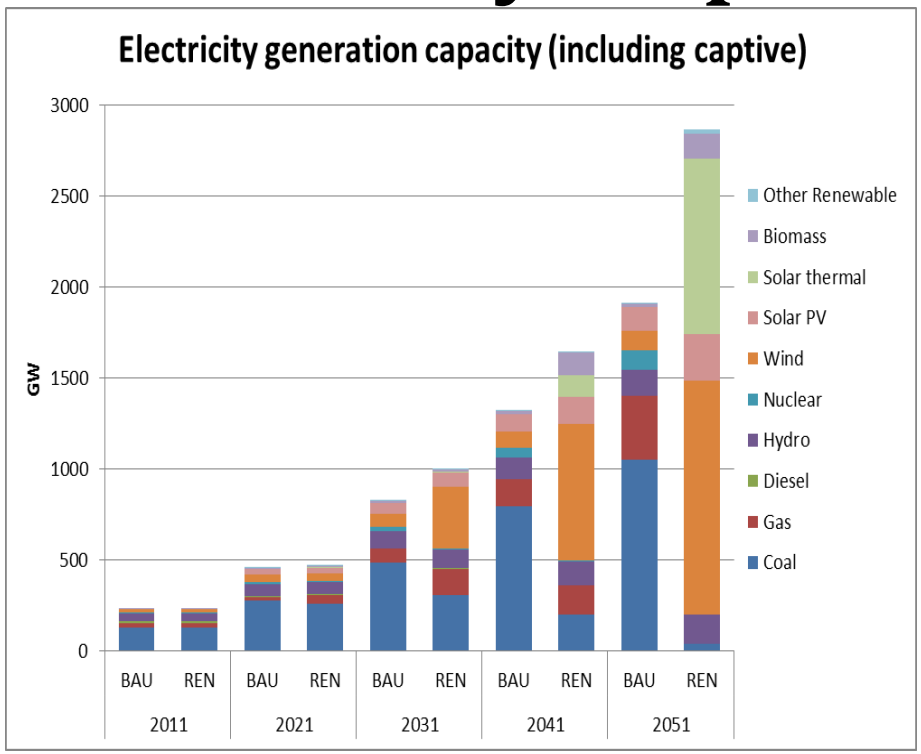
- In REN scenario liquid bio-fuels constitute 22.5% of the total primary energy supply, and serve to replace petroleum fuels requirements mainly for the transport sector
- Biofuels would have to account for 90 per cent of the transport fuel requirement by 2051 in order to move toward the REN scenario
  - Third generation biofuels could bring about a major transformation although this technology is still in the R&D stage.
  - This technology would have to become commercially viable beyond 2031
- Under the REN scenario, all industrial heating requirements up to 700°C are met through concentrated solar thermal (CST) technologies by 2051
  - This implies that CST technologies for thermal applications need to be commercially viable even for small to medium manufacturers by 2041

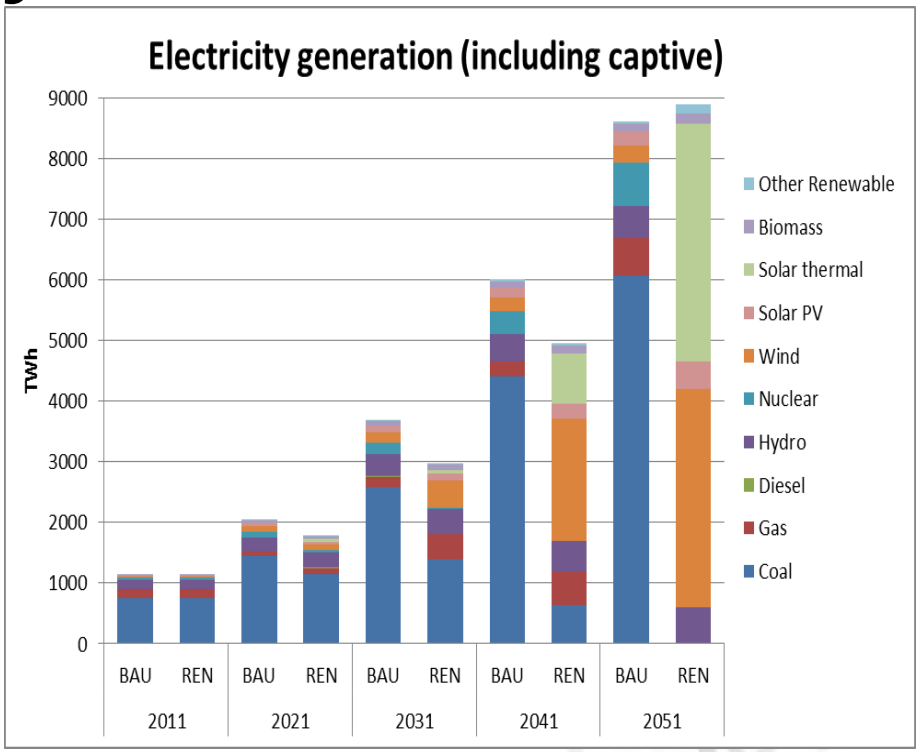
Increase use of electricity across sectors

- Higher penetration of electric vehicles (two wheelers, three wheelers, and cars)
  - Commercial availability with competitive prices and equivalent performance compared to conventional petroleum fuel based vehicles

- Increase use of electricity across sectors
  - Increase in power generation capacity and higher tariff to end users due to higher share of renewable technologies

Electricity Capacity & Generation





- In the REF scenario, electricity generation grows by 8 times the 2011 in 2051,
  - In the REF, electricity generation continues to be majorly (~70%) dependent on fossil fuels
- Electricity generation capacity is 50% higher in the REN due to lower capacity factors of renewable technologies
  - Share of renewable based capacity (inclusive of large hydro) drops from 27% (2011) to 21% (2051) in REF while renewables contribute to ~100% of the electricity generation in REN
- Solar (42%) and wind (44%) are the main contributors to generation capacity in REN by 2051

Cost implication (1/2)

- The total undiscounted technology investment cost for the REN scenario is 42 per cent higher than in the REF scenario,
  - **Would require an additional investment of US $ 9 trillion between 2011 and 2051**
  - **Accounts for around 4 per cent of the cumulative GDP during this period**

- The total undiscounted system cost in the REN scenario is only 10 per cent higher than that in the REF scenario.
  - **This, however, includes only technology-level substitutions and does not entail costs that may need to be incurred for supporting infrastructure**

Cost implication (2/2)

- Expand the Dedicated Freight Corridors across the country's quadrilateral (around US$ 50 billion investment requirement)
- Introduce High Speed Rail services across select corridors to retain railway passenger shares (for 12 routes around US$ 100 billion investment requirement)
- Metro rail network in all million plus cities by 2031 (60 cities) (around US$ 150 billion investment)

High interest rate

Sector focused lending rates (%) from NBFCs:

Institution	Lending rate for RE projects
IREDA	10.20%-11.40%
PFC	10.50%-11.5%
REC	10.5%-12%

Borrower	Interest on Loan (%)
Grade I	10.20
Grade II	10.95
Grade III	11.10
Grade IV	11.40

Source: IREDA, PFC, REC, Primary Research

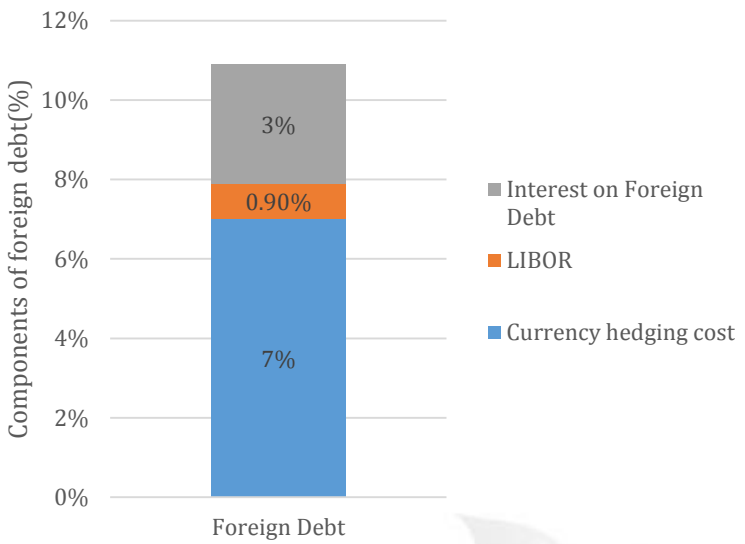


Figure: Breakdown of Foreign debt

Stakeholder speak:

1. *A large number of companies participating in the reverse auction mechanisms fall under Grade IV category, as per IREDA's internal risk assessment and rating system.*
2. *Foreign debt, although available at cheaper interest rates, but hedging costs to mitigate currency exchange risk reduces the benefit of lower interest rates.*
3. *Private sector banks usually offer loans ranging from 11-13%.*

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Conclusion

- The REN scenario is clearly desirable both from an environmental as well as from an energy security perspective,
- Achieving such a scenario poses considerable challenges at this point in time
- Avenues of regional cooperation
  - Hydro power from Nepal and Bhutan for balancing intermittent renewable
- Call for global effort and international cooperation on
  - Timely availability of alternative commercially viable and affordable technological solutions
  - Rapid scaling-up of these options together with accelerated build-up of supporting infrastructure,
  - Adequate availability of public finance at lower interest rate

Thank You!

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