Energy Transition in India: A Summary of TERI's Findings

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Creating Innovative Solutions for a Sustainable Future



Context – India

- Reduce emission intensity of GDP by 33 % to 35 % by 2030 from 2005 levels
- Increase the share of non-fossil fuels to 40 % of total installed capacity
 Targets 175GW of RE by 2022 and 450GW by 2030
- RE generation has increased considerably during the last 5 years (more than 100 GW solar capacity installed or under installation/bidding)
- However, fossil fuels continue to account for ~60 % of the total capacity
- Improvements in network infrastructure have also aided integration of RE
- Despite increasing integration of RE and achievement of near universal energy access in rural areas, providing affordable, reliable, three phase power supply and adoption of clean cooking remains a challenge.

Energy Transition in India

Public procurement has discovered that:

- Solar electricity at INR 1.99 (\$0.027) /kWh, & wind electricity at INR 2.44 (\$0.033) per kWh, are the cheapest electricity in India, but only when the sun is shining & the wind is blowing
- A small amount of somewhat-firm RE (solar + batteries) may be available in 2022 at a price competitive with coal electricity
- Electric buses, running at INR 25-40 (\$0.34-0.55)per km, are cheaper than diesel or CNG buses in providing urban mobility services

TERI analyses indicate that:

- Electric 2-W and 3-W are cheaper on a per km basis than petrol models
- Electricity is cheaper than diesel/petroleum products for industrial thermal use

Solar costs have fallen by a factor 5, and are now decisively cheaper than coal

Solar PV winning bids



Select duration

Mar'12 to Dec ..

Source: Lok Sabha Standing Committee Energy report Demands for Grants of the Ministry of New and Renewable Energy for the year 2018-19, Ministry of New & Renewable Energy, and PEG analysis based on SEC.

"Round the Clock" Bids have delivered low bid prices, but Rely more on Oversizing + Resource complementarity



Modelled Project Set Up To Reach 400 MW of "Round the Clock" RE with 80% Annual CUF Requires Oversizing By A Factor 3.3-3.5 & Relatively Little Storage

Electric Buses & 2-W are less expensive than Petrol/Diesel

AC Electric Bus total cost bid without Subsidy INR/ km lower than of Diesel Bus today:





Diesel Bus = INR 60-80/ km; Electric Bus (AC) = INR 30-55/ km (without Subsidy)

Note: Daily distance travelled = 170-200 kms

Cost includes capita repayment at 10% interest, electricity, O&M costs & battery replacement for purchased buses in year 8. FAME subsidy is excluded in these estimates. *Gross Cost Contract (GCC) & Outright Purchase (OP)



2-W Running Cost (INR/km) of TVS Scooty Pep vs. Hero Maxi Electric ^{1.67}



Note: Daily distance travelled = 40 kms; Battery replacement costs are included

Source: TERI, 2021

Forging industry: Replacement of FO furnaces with electric induction billet heaters

- India is a major producer or forgings (~ 3.7 M tons/yr)
- Heating accounts for a major share (80-90%) of energy consumption
- FO fired batch type furnace widely used
- Cost of heating can be reduced from INR 9300 (\$127) per ton to INR 5100 (\$70)/ton by switch-over to electricity
- Simple payback period 2-3 years
- Other benefits include: reduced maintenance, almost no scale loss, quality improvement, no air pollution & increased productivity



FO furnace



Electric heater

The Transition Pillars

We are observing that:

- Energy efficiency continues to increase, largely driven by technical energyintensity reduction across sectors
- Renewables are emerging as the electricity source of choice; from a system perspective, RE is already cost effective/would be cost effective before 2030
- Electrification of fossil fuel use (e.g., in transport) will accelerate especially as system-wide cost-effectiveness increases
- Green hydrogen and biomass-based fuels will predominate in applications where electrification is not viable; this shift will depend on international carbon emissions reductions efforts
- Resource efficiency in user sectors, driven by economic considerations would increase substantially, and lead to further decline in energy demand.

The Total Final Energy Intensity of India's GDP Has Fallen 30% Since 2011

Final Energy Intensity of India's GDP



Source: TERI, 2021

Even at Today's Costs, RE Systems of ~35% are Cheaper in India, due to the Substitution of Fixed & Variable Costs



Levelized System Costs, Fixed and Variable, as a Function of RE Penetration

Source: TERI, 2021

Energy transition on this scale would drive a dramatic but achievable growth in electricity demand



Source: TERI, 2021

Our Assessment of the Energy Transition

- Renewables will continue to be the overwhelming source of capacity addition for electricity generation in India;
 - Coal demand may rise till the late 2020s; however, need for additional thermal capacity is dim
- Firm, cost-effective RE would be viable by 2030; the speed of price reduction of batteries will determine when this occurs
- Almost all (>80%) new vehicles in urban areas in 2030 will be electric (or based on hydrogen and fuel cells)
- Gas-based cooking (LPG/PNG) & Electric Cooking will be dominant by 2030
- We are not yet clear about the:
 - Speed of EV transition in rural areas
 - Speed of transition to electric cooking
 - Nature and speed of the energy transition in the industry sector

Our Assessment of the Energy Transition

- In the rural areas, despite near universal electrification, the income constraint reduces elasticity of the user to support higher consumptive loads
 - Energy efficient devices, promoted with incentives, and DSM to keep monthly electricity charges low will be the key
- PV-electricity based agricultural pumping would be dominant before 2030 (but we are not clear about the level & speed of penetration)
 - PV based agri pumping is already cost effective, and will be the preferred option, especially as excess electricity is bought from farmers, or LT-level PV generation is set up at rural substations.
 - Potential to revitalize the finances of the distribution sector thus contributing to faster energy transition across the sector

Thank You



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