India’s Developmental Strategy Aiming at Energy Transitions: Renewable Energy
Mandvi Singh, Energy Programme
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Energy Transition: Why and How?
Energy Transition – Pivotal to Climate Change Goals

- Fossil fuels dominate energy production and use – account for 2/3rd of GHG emissions
- Electricity & heat generation – largest CO2 emitters

<table>
<thead>
<tr>
<th>CO2 emissions from fossil fuel combustion (Gt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others</td>
</tr>
<tr>
<td>Transport</td>
</tr>
<tr>
<td>Manufacturing &amp; construction</td>
</tr>
<tr>
<td>Energy industry own use</td>
</tr>
<tr>
<td>Electricity &amp; heat</td>
</tr>
<tr>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>3,295</td>
</tr>
<tr>
<td>6,551</td>
</tr>
<tr>
<td>6,066</td>
</tr>
<tr>
<td>1,655</td>
</tr>
<tr>
<td>13,541</td>
</tr>
</tbody>
</table>

- Switch to RE + EE can achieve 90% of emissions reduction effort needed by 2050 to keep global temp rise below 2°C
- Positives: Mature, reliable, affordable and immediately deployable + long-term economic and social benefits
- Minimum RE requirement by 2050: 85% of electricity, 2/3rd of energy
Global Trends and Targets
Renewable Capacity Expansion

- 26% of global electricity supply
- Capacity doubled in 10 years
- Avg. annual investments of $260
- 178 GW in 2017 – largest ever
- Solar centred – 55% of additions

Global Renewable Power Capacity, 2007-2017

Source: REN 21, Global Status Report 2018
Global Leaders

China leads in aggregate, followed by the US, Germany, India & Japan

Highest RE capacity per capita – Iceland, Denmark, Germany, Sweden & Finland

• Highest variable RE generation – Denmark (55%); Uruguay, Germany, Ireland & Portland (20-30%)
Targets: Growth Drivers

POWER

Targets for share of electricity generation from renewable sources in %

Source: REN21 Policy Database
Policy Landscape

**Regulatory Policies**
- Feed-in tariff/ premium payment
- Renewable purchase obligation/standard + tradeable RECs
- Net metering/ billing
- Competitive Tendering
- Market reforms to support flexibility

**Fiscal incentives/Public finance**
- Investment or production tax credit
- Reductions in sales, energy, CO2, VAT or other taxes
- Energy production payment/ GBI
- Public investment, loans, grants, capital subsidies or rebates
Renewable Energy in India
India’s Clean Energy Targets

- **175 GW by 2022** – large solar (60 GW), solar rooftop (40 GW), wind (60 GW), biopower (10 GW), small hydro (5 GW)
- **INDC Goal**: 40% installed capacity from non-fossil fuel-based energy sources
- **National Electricity Plan**: 275 GW by 2027
Changing Generation Mix

RE share up from 9% in 2009 to 12% in 2014 to 21% in 2018

Capacity growth in past decade @ 8.8% CAGR – Thermal capacity increase @ 9%; RE @ 18.2%

Source: Central Electricity Authority
Solar Centered Growth

Wind addition of 13 GW; CAGR of 10%

19 GW solar added in 5 years; CAGR of 53.28% > half of avg. annual RE investments of $10 bln

Source: Central Electricity Authority
Dominated by Utility-scale Installations

Unlike developed countries, India (and China) have used large-scale solar installations to quickly achieve scale and push down costs.

Source: Compiled from various sources

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage</th>
<th>Rooftop Solar</th>
<th>Utility Solar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>3%</td>
<td>97%</td>
<td>3%</td>
</tr>
<tr>
<td>Germany</td>
<td>27%</td>
<td>73%</td>
<td>27%</td>
</tr>
<tr>
<td>Spain</td>
<td>40%</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>USA</td>
<td>54%</td>
<td>46%</td>
<td>54%</td>
</tr>
<tr>
<td>China</td>
<td>82%</td>
<td>18%</td>
<td>82%</td>
</tr>
<tr>
<td>India</td>
<td>95.6%</td>
<td>4.4%</td>
<td>95.6%</td>
</tr>
</tbody>
</table>

Source: Compiled from various sources
Growth Driver: Policy Support

Electricity Act 2003: Feed-in tariff, RPO and OA

Generation Based Incentive introduced for wind

3% solar RPO by 2022; SECI established

GoI enhanced RE targets to 175 GW

Auctions introduced for wind; SRISTI Scheme approved

2003
National Electricity Policy further strengthens RE

2006

Generation Based Incentive introduced for wind

2009

3% solar RPO by 2022; SECI established

2010

GoI enhanced RE targets to 175 GW

2011

National Solar Mission and REC Mechanism introduced

2015

Solar Parks for 20 GW, several states introduced solar policies

2015

RPO increased to 10.5% solar & 6.75% non-solar by 2022

2016

Pre 2012
Moderate growth; Mainly dominated by wind

2017+

2012 onwards
Slow down in wind; Exponential growth in solar
Key Elements of National Solar Mission

- Competitive auction of capacity
- Viability gap funding + bundling (not required any more)
- SECI (and NTPC) acting as intermediary off-takers, reducing discom and credit risk
- Payment security mechanisms to protect developers from payment delays by discoms
- Regulatory Provisions:
  - Exemption from environmental clearance
  - Must-run status in merit order dispatch of power
  - Exemption from transmission/wheeling charges
- Creation of solar parks – land and power evacuation availability removed a large part of the construction risk
- Also, state auctions – Karnataka, Andhra Pradesh, Telangana, Madhya Pradesh, Punjab
Policy-based Solar Projects

- **Central Government Procurement**
  - Private sector
    - SECI: VGF-based bidding
    - NTPC: Tariff-based bidding
  - Public sector units
  - Discom

- **State Government Procurement**
  - Private sector
    - Discom:
      - Fixed tariff
      - Tariff-based bidding
  - Public sector units
  - Discom
Phases of Solar Growth

- **Phase I 2009-10**
  - FiT scheme launched
  - High tariff of nearly Rs 19/kWh (against Rs 4-5/kWh of coal)
  - Nearly 1 GW set up

- **Phase II 2010-13**
  - Competitive-bidding and bundling introduced
  - Tariffs drop to Rs 15/kWh (Batch 1) & Rs 10/kWh (Batch 2)

- **Phase III 2013-15**
  - Bidding through viability gap funding (VGF) introduced
  - VGF: 142 lakh/MW
  - Tariff down to Rs 6-7/kWh

- **Phase IV 2016+**
  - Bidding with VGF continues but with lower VGF
  - Tariffs of Rs 2.5/kWh even without VGF
Growth Driver: Falling Project costs

- Costs of solar modules declined by 55% over 3 years
  - Price of Chinese modules - $480/kW in 1Q 2016 to $290/kW in 2Q 2017
- Land cost fell with introduction of solar parks
- Evacuation cost declined: Green corridors + waiving off transmission fee
## Declining Solar Tariffs

<table>
<thead>
<tr>
<th>Year</th>
<th>Region</th>
<th>Highest Bid (Rs per kWh)</th>
<th>Lowest Bid (Rs per kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>NSM Batches 1 &amp; 2</td>
<td>12.76</td>
<td>10.85</td>
</tr>
<tr>
<td>2011</td>
<td>KARNATAKA</td>
<td>9.39</td>
<td>8.05</td>
</tr>
<tr>
<td>2012</td>
<td>CHHATTISGARH</td>
<td>8.05</td>
<td>6.44</td>
</tr>
<tr>
<td>2013</td>
<td>SECI - DCR</td>
<td>7.76</td>
<td>6.42</td>
</tr>
<tr>
<td>2014</td>
<td>ANDHRA PRADESH, 2014</td>
<td>7.76</td>
<td>6.00</td>
</tr>
<tr>
<td>2015</td>
<td>TELANGANA, 2015</td>
<td>6.90</td>
<td>6.46</td>
</tr>
<tr>
<td>2016</td>
<td>MADHYA PRADESH, 2015</td>
<td>5.64</td>
<td>5.05</td>
</tr>
<tr>
<td>2017</td>
<td>TELANGANA - NSM, 2016</td>
<td>4.97</td>
<td>4.73</td>
</tr>
<tr>
<td>2018</td>
<td>AP - SECI, 2016</td>
<td>4.82</td>
<td>3.25</td>
</tr>
<tr>
<td>2019</td>
<td>CHHATTISGARH - SECI, 2016</td>
<td>4.39</td>
<td>3.29</td>
</tr>
<tr>
<td>2020</td>
<td>MADHYA PRADESH - SECI, 2017</td>
<td>4.82</td>
<td>3.29</td>
</tr>
<tr>
<td>2021</td>
<td>RAJASTHAN - BHADLA III, NSM, 2017</td>
<td>4.44</td>
<td>2.44</td>
</tr>
</tbody>
</table>

Continuous decline to less than Rs 2.5/unit without VGF

Cost-competitive with coal-based power

Solar Tariffs from auction in India (Rs per kWh)
Competitive Auctions for Wind

- **Generation Based Incentives I & II**

- **Auctions**
  - February 2017: SECI, Rs 3.46/kWh
  - December 2017: GUVNL, Rs 2.43/kWh
  - August 2018: SECI, Rs 2.76/kWh

- **Accelerated Depreciation**
Challenges and Outlook
Renewable Growth Outlook

• Positive, but not strong enough
• Plans to enhance targets: 500 GW by 2028
• **175 GW by 2022 appears challenging**
  • Widening gap – annual capacity increases (~15 GW in 2019) not keeping pace with annual goals – 100 GW in 3 years
• **Growth projections vary:** 50-100 GW of additional solar capacity to be added in 2018-19
• Number of issues hinder growth

*RE sector will continue to grow, even with hurdles; with the right set of policies, we can do much better.*
Discom: Biggest Risk

**Responsible for number of RE sector problems**

**Weak demand**: low RPO targets, high non-compliance

**Inefficient procurement**: Sizable share under long-term two-part PPAs; auction cancellation/resizing; PPA refusal/delays; arbitrary caps on auctions

**Curtailment** (often ~25%) & payment delays

**Open access** non-implementation

Reluctance to solar rooftop

**Reforming discoms**

• Discoms continue to underperform – high financial losses and operational inefficiencies

• Reform schemes (recent UDAY) have failed – cut AT&C losses and rationalize tariff

Need for fundamental retail and wholesale market reforms – Proposed EA amendment for carriage and content separation long way off
Policy Certainty and Funding: Crucial

Policy uncertainly/flip-flop triggered slowdown in solar capacity addition in late-2017 and 2018

- Safeguard duty of 25% on imported modules
- Flip flop on import custom duties
- Lack of clarity on GST; 18% slapped on ‘services’ component

Huge funding requirement to support renewable energy growth

- CSE estimates $25 billion needed annually during 2019-2022 to reach 175 GW
- So far, debt financing comes largely from Indian commercial banks and NBFCs – NPA concerns could impact credit availability to renewables
- PE has also been significant, especially for solar – but RoE low @ 9-11%
- Green bonds made headway – currency risks could dampen issuance
Balanced Growth

Wind – Facing the Headwinds

- Inadequate attention by govt
- Modest goals (60 GW) against potential
- Unpredictable policies
  - Introduction of competitive auctions in mid-2016 without comprehensive guidelines => plunge in auctions
  - Inadequate evacuation led to cancellations of auctions in 2018
- Bare-boned repowering, hybrid, offshore policies

Solar Rooftop – Untapped

- ~3 GW installed vs 40 GW goal; mostly C&I; despite environmental & economic benefits
- Consumer unease – high upfront costs; lack of financing; unsure about technology; discom hurdles (delays approvals and net metering connections)
- Incentives to discoms under SRISTI short-term solution
- Need for RESCOs, utility-driven models

Off-grid – Passive

- Mini-grids effective solution for rural electrification
- Unregulated / unsupported – poor service standards and high tariffs
Building Grid of the Future

- High wind/solar penetration (variable, unpredictable, modular) – System operation improvements, flexibility & short-term stability enhancements

- Key components of 175 GW integration plan:
  - Green Energy Corridor Phase-I and II
  - Improved real-time monitoring and control
  - Renewable Energy Management Centres
  - Forecasting and scheduling
  - Balancing support from coal-based plants
  - Developing reserves/ancillary services

- Assessment: Integration can be achieved at minimal curtailment (1.4%) without support from fast-ramping infrastructure

- Challenges: Implementation delays, especially in states

- Planning for higher penetration - Looking beyond 175 GW + increased distributed generation

- Will require a reworking of T&D architecture

- Significant additional of balancing capabilities:
  - PSHPs, gas-based
  - Battery technology
  - Smart grids
  - EVs
Energy Decarbonization: A Comprehensive Strategy

• 175 GW by 2022 was a game changer, but India’s longer terms goals are not ambitious
  • NEP, 2018 projects RE slowdown (100 GW in 2022-27 vs. 117 GW in 2017-22)
  • INDC goals “40% of RE capacity by 2030” easily achievable
• India needs bold target of 100% of electricity from non-fossil fuels by 2050
  • Falling cost of RE and storage makes it a practical reality
  • Balanced goals for sub-sectors, interim targets and clear strategy
• Plan for coal and gas-based plants
  • Old plants need to be shuttered – need incentives for state-owned plants and rehabilitation of employees
  • New investments need to be discouraged: already low PLF and NPAs
  • Gas-based plants for grid balancing
Conclusion

• Energy transition central to climate change mitigation policy
• Transition already underway globally, including in India, with increased investments in renewable energy capacity
• RE capacity growth in India led by solar, driven by favorable government policies and improving economics
• Growth projected to continue, however additional efforts required to sustain/accelerate momentum.
  • Key areas of intervention: Discom reforms, policy consistency/clarity, balanced sub-sector growth, grid integration/management tools
• Need for more aggressive targets
Thank you.