Mainstreaming Renewable Energy: Complementary Market Design
India Perspective

DR SUSHANTA K CHATTERJEE
JOINT CHIEF REGULATORY AFFAIRS
CENTRAL ELECTRICITY REGULATORY COMMISSION
INDIA

LONDON SCHOOL OF ECONOMICS
12-13 NOVEMBER 2015
Current Scenario - India

Source-wise Grid Connected Installed Capacity (GW)

- Total: 278.7
  - Coal: 169.11, 61%
  - Gas: 42.28, 15%
  - Diesel: 24.09, 9%
  - Nuclear: 5.78, 2%
  - Hydro: 0.99, 0%
  - RE: 36.47, 13%

Source-wise Grid Connected 'RE' Installed Capacity (GW)

- Total: 36.47
  - Small Hydro: 4.06, 11%
  - Wind: 4.42, 12%
  - Solar: 4.1, 11%
  - Bio Mass /Co-gen.: 0.13, 1%
  - Waste to Energy: 23.76, 65%

Source: CEA's Executive Summary for Sep’ 15
Growth of RE in India

- Thrust on RE – in the wake of Energy Security and Climate Change concerns
- Target of 175 GW RE generation capacity by 2022
RE Sources: Challenges

- **Higher cost of generation**: Higher Capital Cost and Cost of Capital; lower capacity utilisation factor

- **Variability**: Infirm nature of Solar, Wind. Seasonal Variations

- **Disperse location**: Location-specific potential (concentrated in areas away from consumers or the grid).

- **Creation of Transmission corridor**: High evacuation cost due to remote location and low utilisation factor.

- **Financial Health of distribution companies (discoms)** – influences decision on expensive and variable RE.
• **Approaching grid parity in price:** Solar PV price from 30¢/kWh to less than 10¢/kWh now.

• **Handling variability:** remains the major challenge

**Way forward:**
*Forecasting, Scheduling and Deviation Settlement; and complementary market design*
Towards Mainstreaming RE.....

Handling variability: Forecasting, Scheduling and Deviation Settlement

- **Debate/Way Forward**:
  - Centralised vs Decentralised Forecasting;
  - Forecasting at what level?
  - Mandatory scheduling requirement!!
  - Payment as per actual or schedule?
  - Should there be a deviation penalty for variable RE?

Central Electricity Regulatory Commission (CERC) has provided a framework in this context
Towards Mainstreaming RE.....

Handling Variability: Complementary Market Design

- **Debate/Way Forward:**
  - Deviation Settlement/Accounting Framework.
  - Day Ahead / Intra Day Products.
  - Reserves/Flexible Generation.
  - Ancillary Services – Administered vs Market Mode?

**Gross Pool vs Net Pool – A Market Design Issue!!**

Key to questions around optimized dispatch of resources and issues around handling variation of RE
An ongoing debate in India....
THANK YOU

sushanta_chat@yahoo.com
jcra@cercind.gov.in
Towards Mainstreaming RE.....

Handling variability: Forecasting, Scheduling and Deviation Settlement

- **Debate/Way Forward (CERC framework):**
  - *Centralised vs Decentralised Forecasting;*
    - Initially forecasting at both Centralized and Decentralized levels.
  - *Forecasting at what level*
    - Forecasting at pooling station level in a State
  - *Mandatory scheduling requirement!!*
    - Scheduling is mandatory for proper accounting and grid discipline.
  - *Payment as per actual or schedule?*
    - As per ‘Actual’ at State level & as per ‘Schedule’ at National/inter-state level
  - *Should there be a deviation penalty for variable RE?*
    - No penalty within tolerance limit. Deviation charge beyond tolerance limit
Handling Variability: Complementary Market Design

- **Debate/Way Forward (CERC framework):**
  - *Deviation Settlement/Accounting Framework!*
    Requirement of deviation settlement / accounting at State level in line with that at inter-State level
  - *Day Ahead / Intra Day Products.*
    Day Ahead and Intra Day products for meeting short term / closer to real time energy needs.
  - *Reserves/Flexible Generation*
    Creation of reserves for meeting last mile imbalances.
  - *Ancillary Services – Administered vs Market Mode?*
    Ancillary Services being operationalized. Presently Ancillary Services are administered, but aimed at turning to Market Mode by 2017.
  - *Gross Pool vs Net Pool!!...ongoing debate...*
### Net Settlement

With Contracts Settled by the System Operator (all quantities in MW)

<table>
<thead>
<tr>
<th></th>
<th>Seller</th>
<th>Buyer</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Generation</td>
<td>110</td>
<td>10</td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>Actual Consumption</td>
<td></td>
<td>-120</td>
<td></td>
<td>-120</td>
</tr>
<tr>
<td>Contract Notified to System Operator</td>
<td>-100</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imbalance settled with system operator at the spot price</td>
<td>10</td>
<td>-20</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

### Gross Settlement

With Contracts Differences (CfDs) Settled Bilaterally (all quantities in MW)

<table>
<thead>
<tr>
<th></th>
<th>Seller</th>
<th>Buyer</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Generation</td>
<td>110</td>
<td></td>
<td>10</td>
<td>120</td>
</tr>
<tr>
<td>Actual Consumption</td>
<td></td>
<td>-120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contract Notified to System Operator</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Imbalance settled with system operator at the spot price</td>
<td>110</td>
<td>-120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contract Amount Settled Bilaterally*</td>
<td>-100</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference effectively settled at the spot price</td>
<td>10</td>
<td>-20</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

*This quantity is settled at the contract price minus the spot price – the difference between contract and spot. Hence the contracts are called “Contracts for differences” of CfDs.

Source: “Making Competition Work in Electricity” by Sally Hunt