#### BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI BROOKINGS INDIA OUALITY, INDEPENDENCE, IMPACT

# Coal, Solar, and more – thinking of the Future of the Grid

Dr. Rahul Tongia

Fellow, Brookings India Tech. Advisor, Smart Grid Task Force, Govt. of India Adj. Professor, Carnegie Mellon University

August 28, 2015

**BROOKINGS INDIA** 

## BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI SINDIA India is (luckily) not the Wests india



For India, it's not renewables but theft and tiered slabs (tariffs) that can have similar impacts

## Where are we relating to the Utility Death Spiral?

- Per one study (Prayas) half the units sold in Maharashtra are more expensive than solar
- BUT is it right to compare wholesale with retail?
  - Tariff distortions exacerbate the pressures
- Many policies support RE vis-à-vis other generation
  - CSS waivers, free banking, no wheeling charges, etc.
  - A (new) push to ask thermal to cycle down to 55% out for RE

#### BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI Making Renewables Sustainable

- Cannot consider RE in isolation
  - Broader transformations matter
    - Pricing (incl. Time of Day)
    - Portfolio and alternatives
    - Workforce
    - etc.

(just like with Smart Grids)

• This is before considering issues such as Open Access, privatization etc.



Book on RE launched by H'ble Minister Jan 8, 2015

#### BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI SINDIA BROKEY Findings (subset) okings india

- India's grid at 6% RE is actually equivalent to Germany at 25%!
- RE will sink or swim based on the states
  - RE is concentrated in a handful
- Economics are an "it depends" issue
  - Peak is 7 PM(ish) mostly (or morning)
  - SO RE may not contribute to the peak
    - Treating it as negative demand?
      - Financial implications
- Grid integration needs work
  - We have no Locational Marginal Pricing (LMP) for transmission
  - Evacuation is a small subset of issues
  - Variability and stochasticity both matter; also evacuation, of course
    - Predictions (forecasting) are linked to this
  - Lack of ancillary services
    - Earlier CERC FSAS was limited; new draft is mostly similar

#### **BROOKINGS INDIA**

#### BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI SINDIA BROOKIN**REDKey: Findings** brookings india

- India lacks proper wholesale markets (with ToD components)
  - Even PPAs won't have ToD \*\*procurement\*\* components
  - No incentives for peakers, fast ramping, storage, etc.
  - Absence of Mark-to-Market pricing
    - Means RE won't lower costs (we're anyways not displacing as much since we are in shortfall)
      - Means all new power (including RE) is *disproportionately expensive*
- "Utility death spiral"
  - Not imminent but not irrelevant either
    - Tariff cross-subsidies make this more challenging

## BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA

FIGURE 1: Total Wind Power Output in Karnataka at 1-Minute Resolution



7

#### BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI S Variability of Wind in Karnataka



## Karnataka 2013 Load Duration Lurve



### BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI SINDIA BRODAILYDKNRLOAd Curve okings india



#### BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI SIN Economics of RE: "It Depends" DIA

- Multiple metrics of optimization
  - Carbon, cost, risk, etc.
- Multiple Stakeholders
  - Generator, State Load Despatch Center, POSOCO (aka ISO)
- One problem of RE and energy pricing a single metric of "cost" = often the LCOE
  - Levelizing rates matter, and levelizing itself is fraught with assumptions
  - Variances and rates will vary, e.g., coal auctions might stabilize or even reduce coal prices

#### FIGURE 1: Solar Photovoltaics versus Coal Comparisons (4 Scenarios, 2014) \_\_\_\_\_ Coal \_\_\_\_ So

Scenario 1: • Expensive Imported Coal • Full coal costs (incl. Capex)

kWh)

ost

Levellized

- Full coal costs (Incl. Capex)
- Single Best Open Solar



Levellizing (Discount) Rate

#### Scenario 3: • Domestic Coal

- Marginal Coal Costs
- Avg. Domestic Solar Category



Levellizing (Discount) Rate

Scenario 4: • Domestic Coal

Scenario 2: • Imported Coal

Marginal Coal costs

• Avg. Domestic Solar Category

• Full coal costs (incl. Capex)

Levellizing (Discount) Rate

• Avg. Open Solar Category



Comparing Coal and Solar

#### • Key issues

- Domestic vs. Imported coal
- Solar type
  - Domestic vs. Open
  - Best or average (bids)
- Marginal or avg. coal costs
- Trends of escalating inputs
  - Fuel
  - Inflation
  - Forex

#### BROOKINGS INDIA BROOKINGS INDIA BROOKINGS INDIA BROOKI S INDIA BROOKINGS DISCUSSION BROOKINGS INDIA

- What will the implications be if RE grows by 50% or 100%
  - Operationally on the grid
    - Need PEAKING POWER (a portfolio approach)
  - Financially
- How much backing down happens (and when)?
  - RE due to grid constraints
  - Thermal due to RE "must-run"
- What is an implicit cost or value of load-shedding?
  - Worst possible balancing mechanism
- Don't we have enough generation (somewhere)? Are the bottlenecks transmission and pricing?
- Anything is doable at a cost
  - Let's be transparent in numbers