Regulatory Challenges for Emerging Economies

15th ERRA Summer School: Introduction to Energy Regulation

Presented by Ranjit Bharvirkar
India Program Director
The Regulatory Assistance Project (RAP)®

50 State Street
Montpelier VT 05602
USA

+1-510-508-7671
rbharvirkar@raponline.org
raponline.org
Unique aspects of electricity as a product

• Entire supply-chain exists for creating just one product that is not cost-effectively storable (i.e. produced and consumed instantaneously)
  • Mines, railways/ports, generators, T&D network are used primarily if not solely for serving the power system
  • All components of supply-chain are massive, capital-intensive, and long-lasting
• Product sold to every customer is identical and of extremely high quality
  • At least that is the aspiration all around the world!
• Pricing of the product is mostly homogeneous for large consumer categories (e.g. residential, C&I) irrespective of the diversity among the consumers in each category
Let’s get started...
Major points today

• Transitions and the uncertainty created by them
• Governance and regulatory frameworks may look the same on paper in two different locations (e.g. US and India) but can yield very different outcomes!
• Broader context matters... probably more than anything else!
• It is okay to explore ideas outside of the power sector to address power sector challenges!
Outline

• Transitions and uncertainties
• Similarities
  • Governance structure
  • Regulatory framework
• Differences in Outcomes
• Key reasons for these differences despite the similarities
• Ideas to explore to achieve outcomes within existing governance structure and regulatory framework
Social, economic, political, etc. transitions
Incomes are rising in developing economies faster, and at a greater scale, than at any previous point in history

<table>
<thead>
<tr>
<th>Country</th>
<th>Year 1700</th>
<th>Year 1800</th>
<th>Year 1900</th>
<th>Year 2000</th>
<th>Population at start of growth period</th>
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</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>154</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>United States</td>
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<td>Germany</td>
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<td>Japan</td>
<td>33</td>
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<td></td>
<td>48</td>
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<tr>
<td>South Korea</td>
<td>10</td>
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<td></td>
<td></td>
<td>27</td>
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<td>China</td>
<td></td>
<td></td>
<td>12</td>
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<td>1,023</td>
</tr>
<tr>
<td>India</td>
<td></td>
<td></td>
<td>16</td>
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<td>840</td>
</tr>
</tbody>
</table>

1 Time to increase per capita GDP in PPP terms from $1,300 to $2,600.

SOURCE: Angus Maddison; University of Groningen; *Resource Revolution: Meeting the world’s energy, materials, food, and water needs*, McKinsey Global Institute, 2011.
Per capita GDP has risen in tandem with increases in the urbanization rate

Per capita GDP and urbanization¹

¹ Definition of urbanization varies by country; pre-1950 figures for the United Kingdom are estimated.
² Historical per capita GDP series expressed in 1990 Geary-Khamis dollars, which reflect PPP.

SOURCE: Population Division of the United Nations; Angus Maddison via Timetrics; Global Insight; Census reports of England and Wales; Honda in Steckel & Floud,1997; Bairoch, 1975
Electricity-specific transitions
Solar Vs Fossil: Prices

Source: EIA, CIA, World Bank, Bernstein analysis
Electricity Storage Cost and Production

Total pack cost ($/kWh) vs Annual production (GWh)

Source: Bloomberg New Energy Finance

• Electric Vehicle Battery Price Index:
  - H1 2012: $689/kWh
  - H2 2012: $642/kWh
  - H1 2013: $599/kWh
  - H1 2014: $568/kWh

• Source: Bloomberg New Energy Finance
Each new computing cycle typically generates around 10x the installed base of the previous cycle.
Figure 5: The number of connected devices is increasing dramatically.

By 2020 there will be nearly 7 times more networked devices than people in the world.

Source: Cisco Internet Business Solutions Group

Source: http://read.pwc.com/i/243985-pwcs-17th-annual-global-ceo-survey
CONSUMPTION SPREADS FASTER TODAY

Source: Nicholas Felton, 2008
http://www.nytimes.com/imagepages/2008/02/10/opinion/10op.graphic.ready.html
According to REN21 (2014) – “...most mainstream projections **did not predict** the extraordinary expansion of renewables that was to unfold over the decade ahead. **Scenarios from the renewable energy industry, the International Energy Agency, the World Bank, Greenpeace, and others all projected levels of renewable energy for the year 2020 that were already well exceeded by 2010.”
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Governance Structures
## Overall Governance Structure

<table>
<thead>
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<th>US</th>
<th>India</th>
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<tr>
<td>Democratic system</td>
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<tr>
<td>Universal suffrage</td>
<td>Universal suffrage</td>
</tr>
<tr>
<td>Constitution</td>
<td>Constitution</td>
</tr>
<tr>
<td>Federal structure</td>
<td>Federal structure</td>
</tr>
<tr>
<td>Three equal branches of government at national and state levels</td>
<td>Three equal branches of government at national and state levels</td>
</tr>
<tr>
<td>- Executive</td>
<td>- Executive</td>
</tr>
<tr>
<td>- Legislative: Two houses</td>
<td>- Legislative: Two houses</td>
</tr>
<tr>
<td>- Judiciary</td>
<td>- Judiciary</td>
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</table>
## Electricity Regulatory Framework

### US
- Federal
  - Department of Energy
  - Federal Energy Regulatory Commission
    - Inter-state trade of electricity
- States
  - State Energy Commissions
  - State Public Utility/Service Commissions
    - Intra-state trade of electricity

### India
- Centre
  - Ministry of Power + Coal + RE
  - Central Electricity Regulatory Commission
    - Inter-state trade of electricity
- States
  - State Energy Departments
  - State Electricity Regulatory Commissions
    - Intra-state trade of electricity
Outcomes
**US**

- Universal electrification
- Reliable grid – low/no outages
- Relatively (with respect to per capita income) low cost of electricity

**India**

- 300 million people still don’t have access to electricity AT ALL
- Unreliable grid – black-outs (scheduled and unscheduled) are routine
- Relatively (with respect to per capita income) high cost of electricity
Why are the outcomes so different?
CHAPTER 2: INSTALLED CAPACITY AND CAPACITY UTILIZATION

ENERGY STATISTICS 2017

Trends in Installed Electricity Generating Capacity from Utilities in India during the period 2006-07 to 2015-16

Installed Capacity (MW)

<table>
<thead>
<tr>
<th>Period</th>
<th>Thermal</th>
<th>Hydro</th>
<th>Nuclear</th>
<th>ORS</th>
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<td>31.03.2007</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>31.03.2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.03.2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.03.2013</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>31.03.2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Installed Capacity = 302.08 GWh on 31.03.16
ALL INDIA PLF (%) OF THERMAL POWER STATIONS
(COAL AND LIGNITE BASED)

* Provisional

Page 26
A. Broader State Political Economy

- **Electoral politics**: electoral competition, political salience of electricity, strength of unions
- **State finances**: fiscal space (e.g., per capita income, GSDP, debt etc.)
- **Structure of economy**: level of development, sectoral characteristics, rural/urban divide, population density
- **Environmental issues**: air quality, water resources, natural resources

B. Power-sector Specific Political Economy

- **Service Quality**
  - Access
  - Quality

- **Subsidies**
  - Implicit (sanctioned theft, collection inefficiencies)
  - Explicit consumer subsidies
  - Govt. subvention

- **Aggregated/Wholesale-level Political Economy**

- **Supply Characteristics**
  - Shortage/surplus
  - Contracts/lock-in
  - IPPs
  - RE

- **Load Profile**
  - % Industrial Load
  - Open Access
  - Captive Generation

C. Power sector Interventions/Policies

- **IPPs**
- **ERCs**
- **Unbundling**
- **Privatization**
- **Franchisees**
- **OA**
- **Bailout/Restructuring**
- **Unbundling**
- **Grid operation**
- **Managerial reforms**
- **Feeder Separation**
- **Transparency/Participation**

D. Outcomes

- **24 * 7**
- **Financial Health**
- **Environmental quality**

Non-power Interventions

- Electrification of transport
- Demand-side Management
- Ag patterns – water, crops, etc.
- Fiscal space
- Direct Benefit Transfer
- Technology
Broader context is important!
National Political Economy

- Economic development
- Environment
- Geopolitics
  - Climate commitments
  - Global aspirations
  - Energy security
  - Trade

A. Broader State Political Economy

- **Electoral politics**: electoral competition, political salience of electricity, strength of unions
- **State finances**: fiscal space (e.g. per capita income, GSDP, debt etc.)
- **Structure of economy**: level of development, sectoral characteristics, rural/urban divide, population density
- **Environmental issues**: air quality, water resources, natural resources
B. Power-sector Specific Political Economy

Consumer/Retail-level Political Economy

Service Quality
- Access
- Quality

Subsidies
- Implicit (sanctioned theft, collection inefficiencies)
- Explicit consumer subsidies
- Govt. subvention
Andhra Pradesh
Bihar
Delhi
Gujarat
Jharkhand
Karnataka
Madhya Pradesh
Maharashtra
Odisha
Punjab
Rajasthan
Tamil Nadu
Uttar Pradesh
Uttarakhand
West Bengal

2001 Rural Electrification %
2011 Rural Electrification %
2011 Rural Population %
2014-15 Discom Debt as % of State Liabilities
2012-13 Per Capita GSDP (INR)
### B. Power-sector Specific Political Economy

#### Aggregate/Wholesale-level Political Economy

**Supply Characteristics**
- Shortage/surplus
- Contracts/lock-in
- Independent Power Producers (IPPs)
- Renewable Energy

**Load Profile**
- % Industrial Load (Cross-subsidy potential)
- Open Access
- Captive Generation
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>During financial year ending with</th>
<th>Domestic % to Total</th>
<th>Commercial % to Total</th>
<th>Industrial % to Total</th>
<th>Traction % to Total</th>
<th>Agriculture % to Total</th>
<th>Misc. % to Total</th>
<th>Total (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1947</td>
<td>423 10.11</td>
<td>178 4.26</td>
<td>2960 70.78</td>
<td>277 6.6</td>
<td>125 2.99</td>
<td>219 5.24</td>
<td>4182</td>
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<tr>
<td>2</td>
<td>1950</td>
<td>525 9.36</td>
<td>309 5.51</td>
<td>4057 72.32</td>
<td>308 5.4</td>
<td>162 2.89</td>
<td>249 4.44</td>
<td>5610</td>
</tr>
<tr>
<td>3</td>
<td>1955-56 (End of the 1st Plan)</td>
<td>934 9.20</td>
<td>546 5.38</td>
<td>7514 74.03</td>
<td>405 3.9</td>
<td>316 3.11</td>
<td>435 4.29</td>
<td>10150</td>
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<td>1960-61 (End of the 2nd Plan)</td>
<td>1492 8.88</td>
<td>848 5.05</td>
<td>12547 74.67</td>
<td>454 2.7</td>
<td>833 4.96</td>
<td>630 3.75</td>
<td>16804</td>
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<tr>
<td>5</td>
<td>1965-66 (End of the 3rd Plan)</td>
<td>2355 7.73</td>
<td>1650 5.42</td>
<td>22596 74.19</td>
<td>1057 3.4</td>
<td>1892 6.21</td>
<td>905 2.97</td>
<td>30455</td>
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<tr>
<td>6</td>
<td>1968-69 (End of the 3 Annual Plans)</td>
<td>3184 7.69</td>
<td>2126 5.14</td>
<td>29931 72.31</td>
<td>1247 3.0</td>
<td>3465 8.37</td>
<td>1439 3.48</td>
<td>41392</td>
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<tr>
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<td>1973-74 (End of the 4th Plan)</td>
<td>4645 8.36</td>
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<td>37791 68.02</td>
<td>1531 2.7</td>
<td>6310 11.36</td>
<td>2292 4.13</td>
<td>55557</td>
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<td>7576 9.02</td>
<td>4330 5.15</td>
<td>54440 64.81</td>
<td>2186 2.6</td>
<td>12028 14.32</td>
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<tr>
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<td>1979-80 (End of the 2 Annual Plans)</td>
<td>8402 9.85</td>
<td>4657 5.46</td>
<td>53206 62.35</td>
<td>2301 2.7</td>
<td>13452 15.76</td>
<td>3316 3.89</td>
<td>85334</td>
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<tr>
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<td>1984-85 (End of the 6th Plan)</td>
<td>15506 12.45</td>
<td>6937 5.57</td>
<td>73520 59.02</td>
<td>2880 2.3</td>
<td>20961 16.83</td>
<td>4765 3.83</td>
<td>124569</td>
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<tr>
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<td>1989-90 (End of the 7th Plan)</td>
<td>29577 15.16</td>
<td>9548 4.89</td>
<td>100373 51.45</td>
<td>4070 2.0</td>
<td>44056 22.58</td>
<td>7474 3.83</td>
<td>195098</td>
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<td>1991-92 (End of the 2 Annual Plans)</td>
<td>35854 15.51</td>
<td>12032 5.20</td>
<td>110844 47.94</td>
<td>4520 1.9</td>
<td>58557 25.33</td>
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<td>1996-97 (End of the 8th Plan)</td>
<td>55267 17.53</td>
<td>17519 5.56</td>
<td>139253 44.17</td>
<td>6594 2.0</td>
<td>84019 26.65</td>
<td>12642 4.01</td>
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<td>2001-02 (End of the 9th Plan)</td>
<td>79694 21.27</td>
<td>24139 6.44</td>
<td>159507 42.57</td>
<td>8106 2.1</td>
<td>81673 21.80</td>
<td>21551 5.75</td>
<td>374670</td>
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<td>15</td>
<td>2006-07 (End of 10th Plan)</td>
<td>111002 21.12</td>
<td>40220 7.65</td>
<td>241216 45.89</td>
<td>10800 2.0</td>
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<td>23411 4.45</td>
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<td>2011-12 (End of 11th Plan)</td>
<td>171104 21.79</td>
<td>65381 8.33</td>
<td>352291 44.87</td>
<td>14206 1.8</td>
<td>140960 17.95</td>
<td>41252 5.25</td>
<td>785194</td>
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<td>2012-13* (End of 1st year of 12th Plan)</td>
<td>185858 21.79</td>
<td>71019 8.33</td>
<td>382670 44.87</td>
<td>15431 1.8</td>
<td>153116 17.95</td>
<td>44809 5.25</td>
<td>852903</td>
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(* Estimated)
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<th>Sl.No.</th>
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<th>Hydro</th>
<th>Steam</th>
<th>Diesel</th>
<th>Gas</th>
<th>Sub - Total</th>
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<th>Total</th>
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<td>*</td>
<td>410.00</td>
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<td>2</td>
<td>31.12.1950</td>
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<td>*</td>
<td>*</td>
<td>*</td>
<td>587.85</td>
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<td>31.03.1956 (End of the 1st Plan)</td>
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<td>759.65</td>
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<td>*</td>
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<td>*</td>
<td>1001.37</td>
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<td>1001.37</td>
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<td>31.03.1966(End of the 3rd Plan)</td>
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<td>31.03.1979(End of the 5th Plan)</td>
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<td>1949.23</td>
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<td>3.60</td>
<td>4822.85</td>
<td>2754.48</td>
<td>425.51</td>
<td>8006.44</td>
<td>109.29</td>
<td>8115.73</td>
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<td>4.30</td>
<td>5377.10</td>
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<td>17145.20</td>
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<td>31.03.07 (End of 10th Plan )</td>
<td>60.50</td>
<td>11397.52</td>
<td>7901.02</td>
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<td>22335.04</td>
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<td>22335.04</td>
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<td>31.03.12(End of 11th Plan )</td>
<td>47.59</td>
<td>22615.39</td>
<td>10827.43</td>
<td>5884.95</td>
<td>39375.36</td>
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<td>17</td>
<td>31.03.13* (End of Ist year of 12th</td>
<td>52.00</td>
<td>24870.00</td>
<td>11906.00</td>
<td>6472.00</td>
<td>43300.00</td>
<td>0.00</td>
<td>43300.00</td>
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</tbody>
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- Includes Wind power capacity
- Breakup Not Available
- Regulatory Assistance Project (RAP)®
- Provisional
Usual "Theory of Change"
C. Power sector Interventions and Policies

- Unbundling – separate entities for Generation, Transmission, Distribution, System Operation
- Privatization of entities – e.g. IPPs in generation sector, full privatization of distribution utilities, part-privatization of distribution utilities (e.g. franchisee model)
- Wires-only (Distribution) – Open Access (OA), Full Retail Competition
- Wholesale competition – energy, capacity, ancillary services markets
- Independent/Autonomous Electricity Regulatory Commissions – i.e. Transparency/Participation
- Bailouts/Restructuring
- Managerial reforms
US

- Substantial share of electricity sold to end-customers is through investor-owned utilities
  - Regulated by regulatory commissions
- Minority share sold through publicly-owned utilities
  - Governed through publicly-elected Boards

India

- Substantial share of electricity sold to end-customers is through utilities wholly-owned by respective state governments
  - Regulated by regulatory commissions
- Small share sold through investor-owned utilities
  - Regulated by regulatory commissions
Putting it all back together again...
A. Broader State Political Economy

- **Electoral politics**: electoral competition, political salience of electricity, strength of unions
- **State finances**: fiscal space (e.g. per capita income, GSDP, debt etc.)
- **Structure of economy**: level of development, sectoral characteristics, rural/urban divide, population density
- **Environmental issues**: air quality, water resources, natural resources

B. Power-sector Specific Political Economy

- **Service Quality**:
  - Access
  - Quality
- **Subsidies**:
  - Implicit (sanctioned theft, collection inefficiencies)
  - Explicit consumer subsidies
  - Govt. subvention
- **Aggregate/Wholesale-level Political Economy**
  - **Supply Characteristics**:
    - Shortage/surplus
    - Contracts/lock-in
    - IPPs
    - RE
  - **Load Profile**:
    - % Industrial Load
    - Open Access
    - Captive Generation

C. Power sector Interventions/Policies

- **IPPs**
- **ERCs**
- **Unbundling**
- **Privatization**
- **Franchisees**

D. Outcomes

- 24 * 7
- Financial Health
- Environmental quality

Non-power Interventions

- Electrification of transport
- Demand-side Management
- Ag patterns – water, crops, etc.
- Fiscal space
- Direct Benefit Transfer
- Technology
Way Forward (?)
Non-power Interventions

• Create more fiscal space
• Industrial demand growth
• Electrification of transport
• Behind-the-meter technologies
• Reduce power consumption by Agriculture
• Direct Benefit Transfer
• Retail tariffs based on concept of Insurance
In future… consumers may have the ability to choose how they want to use the Grid

“Behind-the-meter” Model
- Many providers
- Full ownership
- Full customization
- Onsite
- Relatively low externalities
- High innovation
- No variable costs

Existing Grid/Utility Model
- Monopoly provider
- No ownership
- No customization
- Remotely located
- Negative externalities
- Limited innovation
- Volatile variable costs

Possible Choice in Future?

Only Choice Now!

Values (?)
- Low Cost
- Clean/Green
- Resilient
- Ownership/Control
- Innovative
- Modular/scalable
- Onsite

In future… consumers may have the ability to choose how they want to use the Grid
Implications for Governance

Shift in Core Decision-making Process

- Centralized
  - Policymakers, industry
  - Homogeneity in attributes
  - Societal
- Decentralized
  - Millions of customers
  - Heterogeneity in attributes
  - Individual
Different Starting Points… Different Contexts… Same Destination?

**Developed**
- Economics relative to the grid
- Individual values: control, “green”, disaster preparation, etc.

**Developing**
- Economics relative to grid/diesel/batteries/etc.
- Reliability – Access, quantity, quality, etc.
About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org