ELECTRIFICATION IN DEVELOPING COUNTRIES

UTILITIES, SCALING RENEWABLE GENERATION, AND ACCESS: CHALLENGES AND LESSONS LEARNED
USAID’S APPROACH TO POWER SECTOR REFORM (1)

1. Based on Strategic Analysis
   - Analysis of Trends & Strategic Opportunities
   - Private Sector and Development Partners
   - Develop Policy Options jointly with Host Country public and private sectors

2. Support for Sector Reform
   - Legal & Regulatory Framework
   - Policy & Regulatory capacity
   - Corporatization & good corporate governance
   - Professional management, concessions, and privatization

3. Commercialization
   - Customer enumeration and needs analysis
   - Marketing, distribution and business plans
   - Innovations – pre-paid metering & advanced metering infrastructure, mobile payments, finance
4. Capital Development
- Foundation: a flexible but strategically-driven plan
- Attract private participation when possible
- Host country contracting when possible
- Invest in critical systems, such as SCADA, MIS/ERP, metering (PPM and AMI), CIS, and Billing Systems

5. Evaluation
- Rigorous evaluations
- Analyze interim results and adjust
- Identify and train USAID/USG staff on best practices

6. Hand off To Host Country
- Use on-budget and host country contracting
- Establish agreements that require sustainability
ELECTRIC UTILITY REFORM AGENDA

• Typical Interventions:
  – Institutional Reform – State Company Best Practices/IPO of 15-20% of shares in 3-5 years
  – HR/Change Management/Training/Position Descriptions & Salaries/Promotions
  – Modern IT Platform/MIS/Enterprise Resource Planning (ERP)
  – CIS/Billing System/GIS/Customer Enumeration
  – Commercial Improvements/PPM/AMI Metering & Meter Reading/Anti-Theft Campaign
  – Technical Loss Reduction – Feeder Replacement, Congested Area Strategies
  – Cost of Service - Rates & Revenue Department
  – Corporate Communications/Consumer Services/Marketing
  – DSM/Load Management/Distribution-level SCADA
  – Finance/Internal Audit.
ELECTRIFICATION IN SSA: SCALE OF CHALLENGE

• The scale of the challenge is driving the search for solutions:
  – Approximate population of Sub-Saharan Africa is 1 billion.
  – 600-650 million people are without access to electricity. Millions more lack access to reliable power.
  – Massive dependence on wood and charcoal for cooking (estimated $1 billion spent in Kinshasa, DRC every year on charcoal alone; $700 million in Tanzania).
  – In relatively affluent parts of countries such as Nigeria, there is a large market for household and industrial diesel generators and fuel.
  – Electric utility grid extension, mini-grids, solar home systems, and propane are making inroads.
  – Countries have sovereign debt ratings below investment grade, sharply limiting access to capital for governments, state-owned enterprises, and investor-owned enterprises.
ELECTRIC UTILITIES IN SUB-SAHARAN AFRICA

CATEGORIZATION OF ELECTRIC UTILITIES:

• Level of Financial Viability
  o Level 1: Not covering existing opex.
  o Level 2: Utility covers at least existing opex.
  o Level 3: Utility covers opex plus financing costs on new concessional loans.
  o Level 4: Utility covers opex and capex on existing and new assets.

• Financeability/Bankability
  o Financially unviable, loss-making utility.
  o Dependent on government for capital.
  o Utility dependent on concessional loans.
  o Utility can attract non-concessional finance and private investment
  o Expands network and adds new customer connections at will.

EPC Contractors by Corporate HQ

Note: 2010-2015 Data gathered by OECD/IEA for projects above 10 MW excluding solar & wind

SCALING RENEWABLE ENERGY:
GLOBAL TRENDS AFFECTING DECISIONS
- Competition has driven down costs and prices
- Allowed the market to determine price
- Reverse auctions have streamlined the procurement process
- Led to an improved planning horizon for renewable energy developers
SCALING RENEWABLE ENERGY: THE BUILDING BLOCKS APPROACH

- Supporting the addition of thousands of MW of Renewable Energy
- Increasing the percentage of lowest cost Renewable Energy in total installed capacity (MW) and in total electricity delivered (MWh)
- Establishing the building blocks:
  - Strategic Energy Planning
  - Smart Incentives
  - Grid Integration
  - Competitive Procurement
  - RE Zones
  - Finance
ELECTRIFICATION VIA OFF-GRID SOLUTIONS: SEARCHING FOR SCALABILITY
Distance from central grid

Concentration of settlements

- Battery Charged with Grid Power, rechargeable portable lanterns
- Micro-Wind, Micro-Hydro, Biomass gasifier-based, community-managed mini-grids
- Grid Extension – Utility/REA and private investors
- Mini-Grid intended for future grid integration
- Solar PV mini-grid
- Anchor load/ Productive Use
- Mini-Wind, Mini-Hydro, and Diesel-based hybrid, privately operated mini-grids
- Solar home systems, solar portable lanterns

ON-GRA:G

OFF-GRA:G
Brazil’s GDP & Electricity Access Rates with Power Sector Reforms

- Uniform Elec. Tariffs (1977)

Military Rule & Brazilian Economic Miracle

Post-Military Rule & Liberalized Market Era
Nepal's Installed Electricity Capacity & Electricity Access Rates (1960-2010)

- **Panchayat System Era**
  - Urban-Based Import Substitution Strategy
  - Nepal Electricity Authority [NEA] (1985)
  - Electricity Act (1992)
  - Foreign Employment & Tech Transfer Act (1992)

- **People’s Movement & Mixed Liberalized Economy**
  - Hydropower Dev. Policy (2001)
  - Water Resources Act (1992)
  - ESAP I (1998)
  - ESAP II (2007)
  - AEPC & REDP (1996)
  - NPDP (2003)

- **Modernization Era**
  - 5th Five Year Plan & Nepal Electricity Corp (1975)
  - Urban-Based Import Substitution Strategy

- **Foreign Employment & Tech Transfer Act (1992)**
- **Water Resources Act (1992)**
- **Hydropower Dev. Policy (1992)**
- **Hydropower Dev. Policy (2001)**
- **AEPC & REDP (1996)**
- **NPDP (2003)**
- **ESAP I (1998)**
- **ESAP II (2007)**
Common Features of Successful Access Initiatives

- Consistent, centralized funding and support and ongoing sector reform
- “walking on two legs” – Decentralized and centralized approaches
- Prioritized agricultural production areas
- Consolidation of mini- and micro-grids on to integrated grid system

Other Features of Successful Programs

- Investment in large-scale Generation and Transmission assets to drive distribution investment (Brazil, Ghana)
- Emphasis on productive use, especially industrialization (Brazil, Ghana, China)
Governance Models – Grid Expansion

• Private Concessionaires: Chile, Brazil, Guatemala
• Cooperatives: U.S., Costa Rica, Bangladesh
• Government REA Led: Tunisia, Thailand, Vietnam
## Micro-grid Management and Ownership Models

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<thead>
<tr>
<th>Model</th>
<th>Strengths</th>
<th>Challenges</th>
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<tr>
<td><strong>Cooperatives</strong></td>
<td>• Investment by communities in cash and kind.</td>
<td>• Attracting financing. • Capacity for O&amp;M • Can’t raise tariffs</td>
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<td><strong>Sri Lanka, Mali, Nepal, Philippines</strong></td>
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<tr>
<td><strong>Private Investors</strong></td>
<td>• Attracts private investment</td>
<td>• High tariffs, need to earn ROE. • Community buy-in and conflict.</td>
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<td><strong>Cambodia, Mali, Senegal, Tanzania</strong></td>
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<td><strong>Utility/REA</strong></td>
<td>• Experienced in utility operation</td>
<td>• Low priority. • Private investment difficult</td>
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<td><strong>Indonesia, Tanzania, Colombia, Ghana</strong></td>
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<td><strong>Hybrid</strong></td>
<td>• Benefit from strengths of multiple models.</td>
<td>• Added complexity and increases tariff.</td>
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<td><strong>Nepal, Pakistan</strong></td>
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Technology Challenges

• Load Management/System control (Voltage, Power Quality)
• Hybrid system control electronics
• Storage
• DC standards and appliances
• Low cost wiring solutions
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Vietnam's GDP & Electricity Access Rates with Power Sector Reforms

**Central Planning** (1960-1970): Limited Electricity Data


**Doi Moi Market Reforms** (1986):
- 35kV MV lines to commune & LDUs
- 1,920 MW Hoa Binh Plant (1994)
- Socialist Market Reforms (1986)

**Mixed Liberalized, Competitive Market** (1992-2010):
- Vietnam Electricity (1995)
- Decision 21 (2009)
- BOT Decree (2007)
- Decision 22 (1999)
- Decree 45 (2001)
- Electricity Law (2004)
- 500 kV Trans. Line (1992)
- 35kV MV lines to commune & LDUs

**Decision 21 (2009)**
- Limited Electricity Data

**Hoa Binh Plant (1994)**
- 1,920 MW

**Priority:** electricity to ag. production

**Electricity Law (2004)**

**500 kV Trans. Line (1992)**

**35kV MV lines to commune & LDUs**

**Vietnam Electricity (1995)**

**Decision 22 (1999)**

**BOT Decree (2007)**
China's GDP & Electricity Access Rates (1960-2010)

- **Self-Sufficiency Policy**
- **Central Planning Era**
- **Great Leap Forward Ends (1961)**
- **Rural Elec. Bureau (1963)**
- **Cultural Revolution**
- **Open Door Economic Policy**
- **7 Year Priority Poverty Alleviation Program (1994)**
- **Household Contract Responsibility System (1981)**
- **TVEs (1984)**
- **Uniform Elec. Tariffs in Same Grid (1998)**
- **‘End’ of TVEs (1996)**
- **Western rural grid improvement program (2004)**
- **Breakup of State Power Corp. (2002)**
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