Post-Hurricane Renewables Opportunity in Puerto Rico

Rocky Mountain Institute | March 9, 2017

Transforming global energy use to create a clean, prosperous, and secure low-carbon future.
The Puerto Rican power system was struggling before the storms

### Poor reliability

<table>
<thead>
<tr>
<th>Category</th>
<th>Median</th>
<th>PREPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAIFI, FY17</td>
<td>1.0</td>
<td>4.8</td>
</tr>
<tr>
<td>SAIDI, FY17</td>
<td>1.9</td>
<td>14.4</td>
</tr>
</tbody>
</table>

### Minimal renewables

<table>
<thead>
<tr>
<th>Year</th>
<th>RE generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 RPS</td>
<td>12%</td>
</tr>
<tr>
<td>2016 Actual</td>
<td>2%</td>
</tr>
<tr>
<td>2020 RPS</td>
<td>15%</td>
</tr>
<tr>
<td>2035 RPS</td>
<td>20%</td>
</tr>
</tbody>
</table>

### Expensive energy

<table>
<thead>
<tr>
<th>Type</th>
<th>Average rates, July ‘17 $ / kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Res</td>
<td>0.19</td>
</tr>
<tr>
<td>Com</td>
<td>0.23</td>
</tr>
<tr>
<td>Ind</td>
<td>0.19</td>
</tr>
</tbody>
</table>

### Debt burden

$11.4 B

**Total PREPA liabilities**

Source: PREPA Fiscal Plan, January 2018; EIA
Puerto Rico’s electric grid relies heavily on North-South transmission over challenging terrain.
Puerto Rico Power Restoration Following Hurricane Maria

% of customers with grid power

Source: U.S. Army Corps of Engineers
Several plans are moving forward to drive Puerto Rico’s energy transformation

1. Privatize the island’s utility, PREPA
2. Implement new regulation enabling shared community microgrids
3. Resolve bankruptcy proceeding
4. Plan a new role for renewable energy and efficiency in a resilient grid
Renewable energy is cost-effective for Puerto Rico

Operating cost of existing power generation in Puerto Rico, $/MWh

Source: RMI analysis of PREPA data and benchmark PPA prices across Caribbean region
Renewable generation is resilient

**Resilience**: how quickly and how well an electric system can recover from a widespread outage

Post-hurricanes status of utility-scale renewable energy in Puerto Rico

- Operable: 82%
- Operating: 1%
- Damaged: 17%

75-95% of small scale / residential solar also ready to operate

Storm hardening can increase survival rates at approx. $0.05 to $0.15 per watt of installed capacity

Source: Pattern Energy
Elsewhere in the Caribbean, some solar installations survived well while others experienced significant damage.
St. Thomas, U.S. Virgin Islands
Turks and Caicos
The larger of two wind farms survived without damage

101 MW Santa Isabel wind farm suffered no material damage

23 MW Punta Lima wind farm suffered extensive damage
Microgrids can cost-effectively improve resilience

Hypothetical islanding of critical infrastructure (NYPA)

Costs may be less than storm-hardening remote communities and carry additional benefits:
• Minimized lost economic activity during outage
• Minimized land use and transmission requirements for central generation
• Deferred or reduced need for new plants
• Reduced dependence on imported fossil fuels

Increased penetration of renewables in U.S. has not reduced reliability

**Reliability**: the ability of generators and the grid to meet power requirements on demand, at all times

Balancing authorities with >20% renewables experienced the fewest, shortest outages, and less than .01% of all major electricity disturbances were caused by generation inadequacy.

Source: Rhodium Group
Island systems are already operating at much higher renewable penetrations than Puerto Rico.

Current and potential renewable energy penetration rates without loss to reliability.
Even as restoration continues to reach more customers, Puerto Rico is planning its energy transformation

- Power restoration to last customers unknown, at least late May
- Integrated resource plan from PREPA by June 2018
- Legislation to enable PREPA privatization by summer 2018
- Updates to microgrids regulation