Renewable Technologies for Urban Resilience

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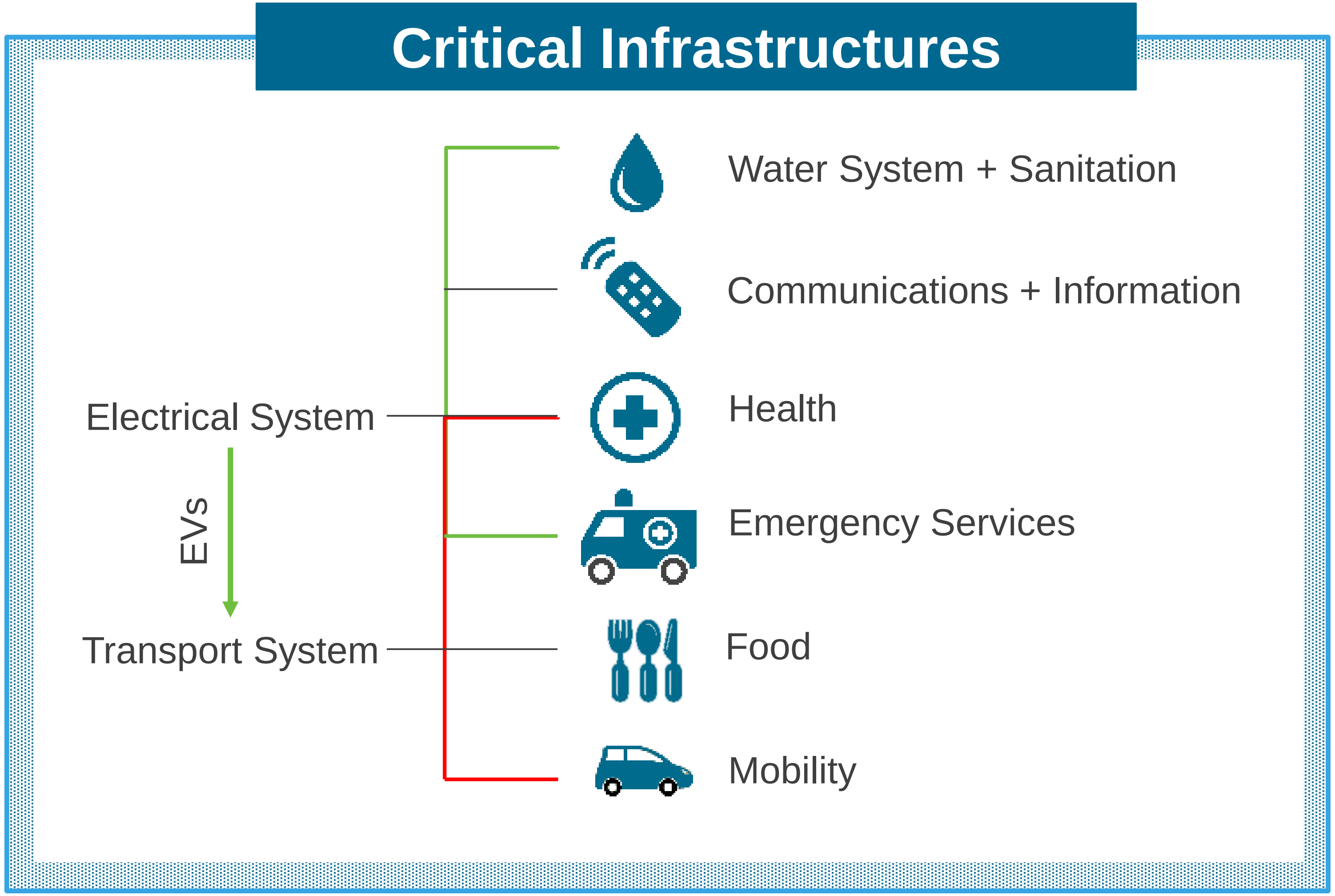
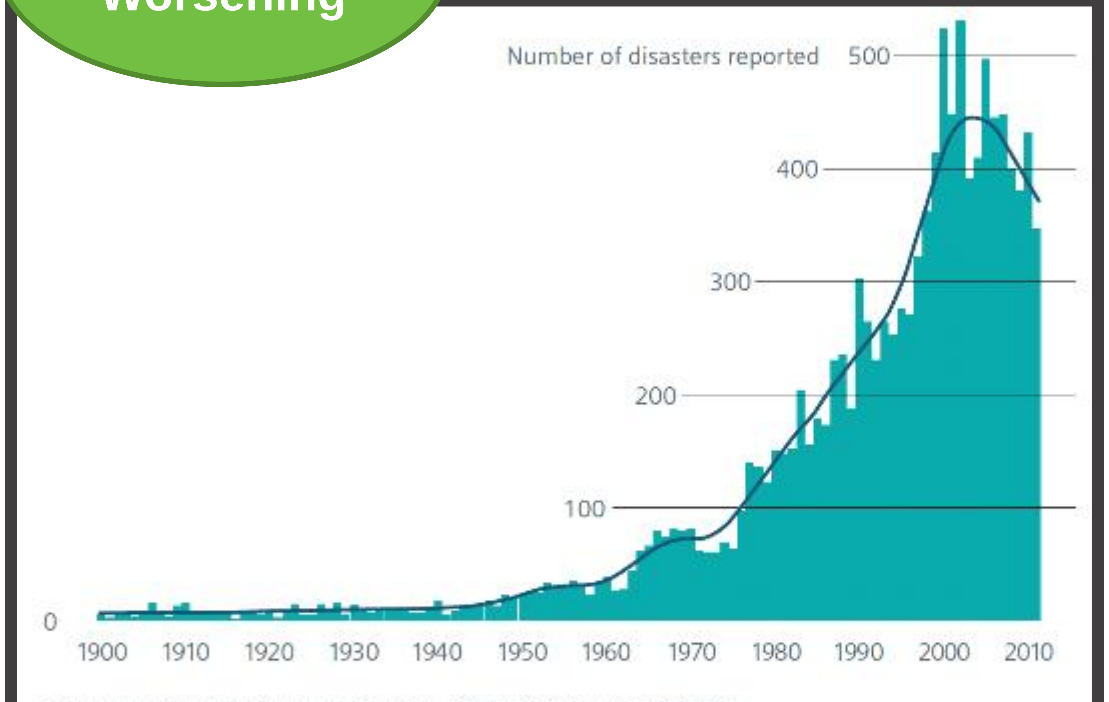
What is Resilience?

re•sil•ience
noun
1. the ability of a system to survive large-scale, complex disruption



Why is Resilience Important to the Future of Renewables?

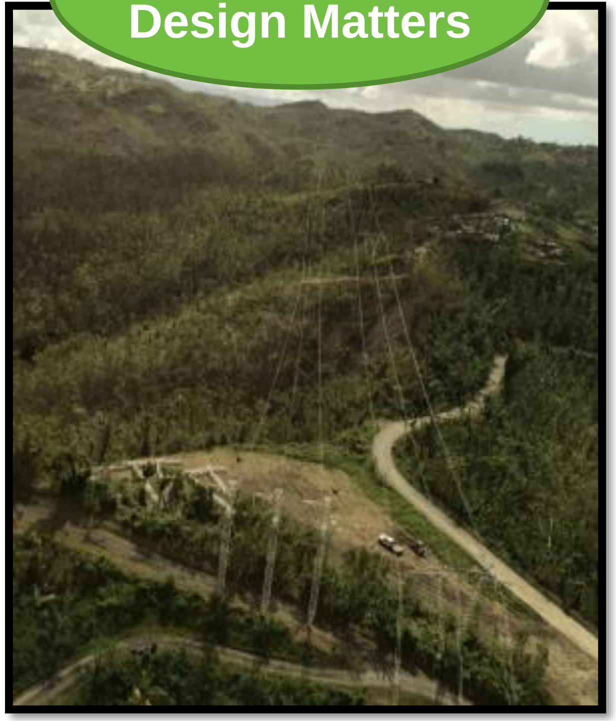
Climate Events Worsening



Frequency of reported natural disasters, 1900-2011 (source: EM-DAT)

Siting Matters

Transmission Design Matters



Lessons from Puerto Rico - Resiliency

T&D Design Basis - Withstanding extreme Category 4 storms with sufficient design margins to ensure high survivability for Category 5

- Upgrade and relocate the 230 kV transmission system

Hardening – Instituting measures to reinforce substations, upgrade poles and wires; microgrids for critical infrastructure and remote communities

Modernization – Fault sectionalizing switches, network communications, and modern control systems technology to operate DERs and encourage development

Standards – Incorporate Department of Energy standards on hardening and resiliency

Generation – Incorporate Distributed Energy Resources (DER), microgrids, and renewables, and update the Integrated Resource Plan to optimize and right-size the generation fleet


Hardened Transmission – Monopole Design

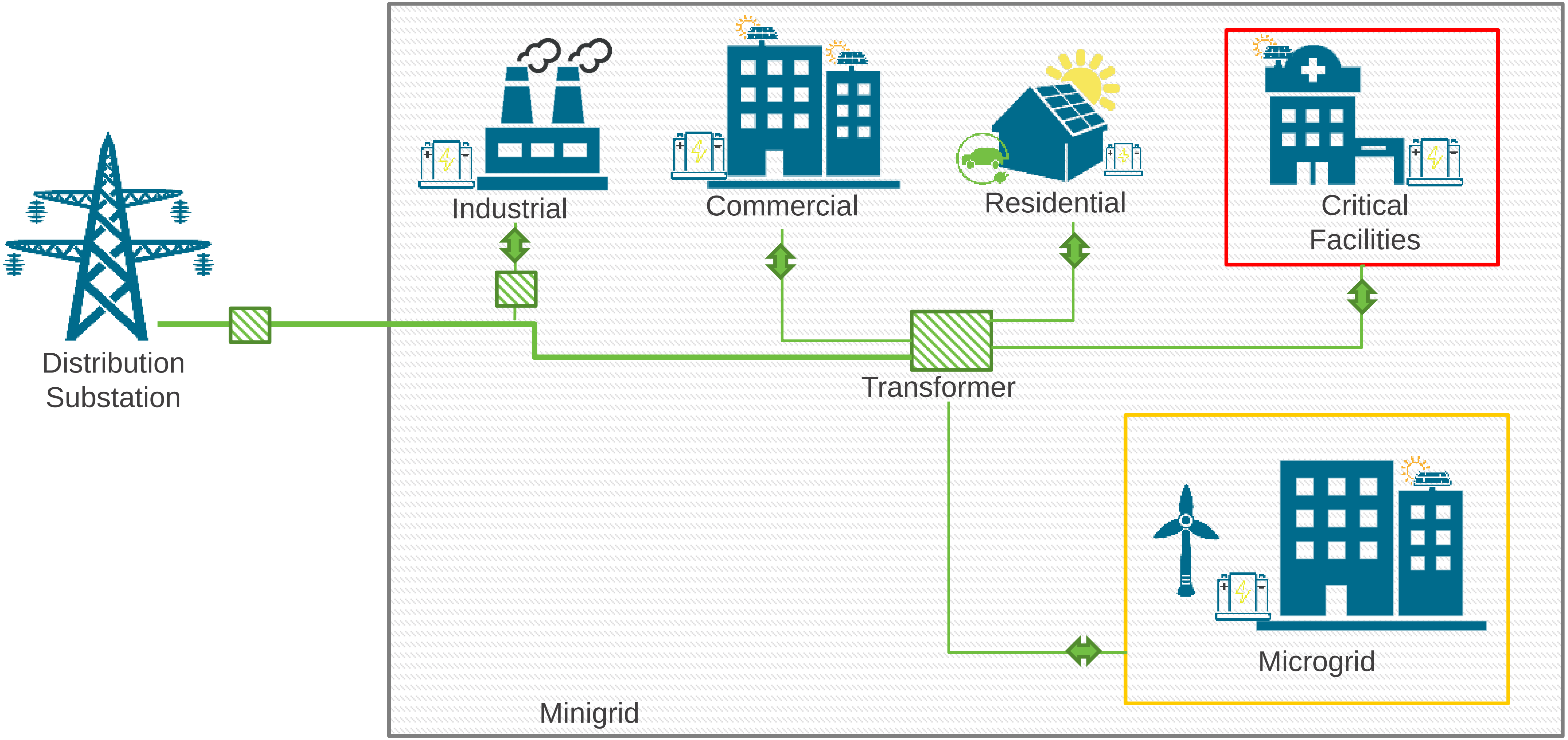

Modular, Raised Control Buildings


Substation Flood Barriers

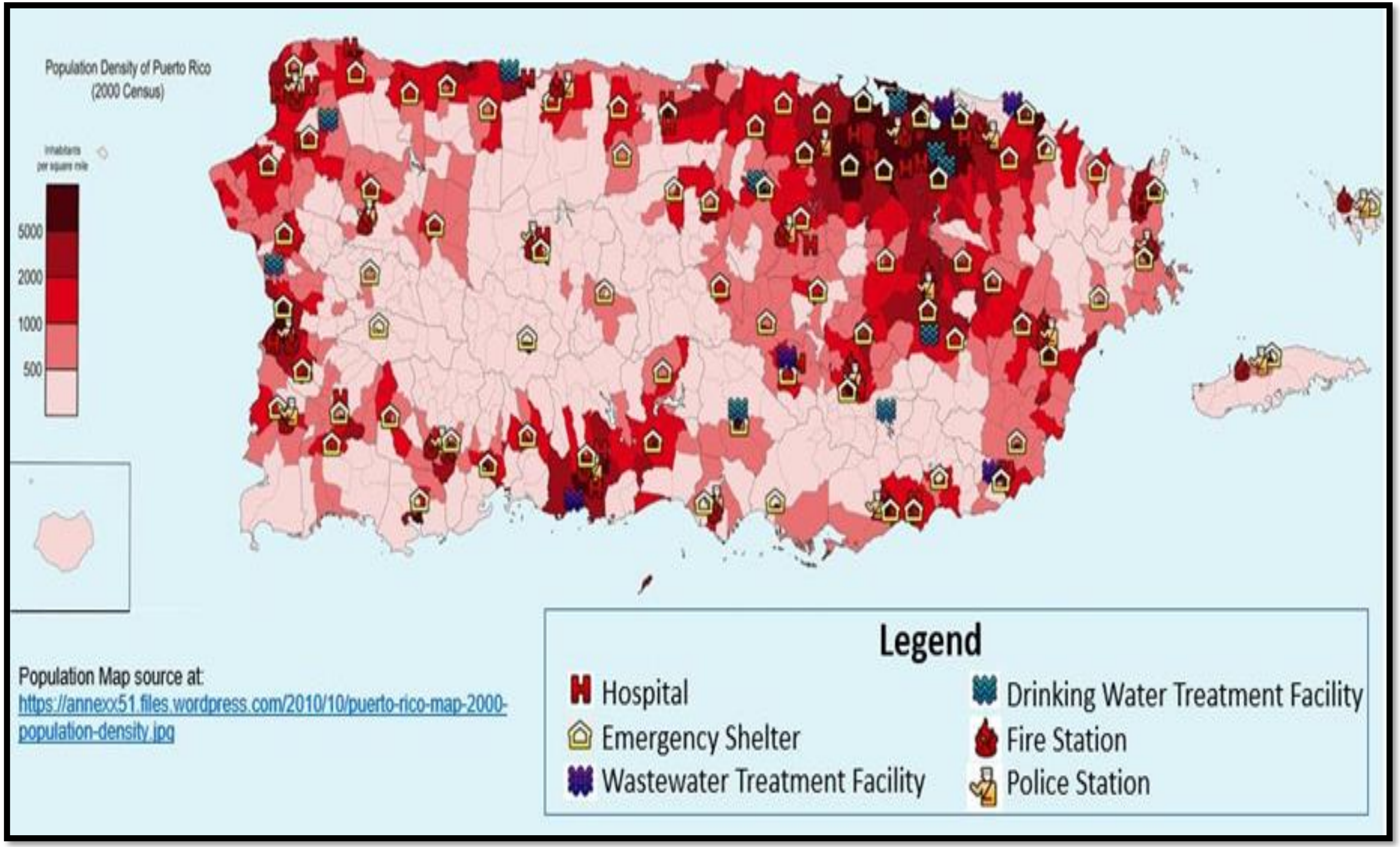
How Can Renewables Improve Resilience?

- Local, not dependent on ports
- Siting and hardening
- Transmission architecture matters
- Distributed with grid modernization
- Electrification of transportation

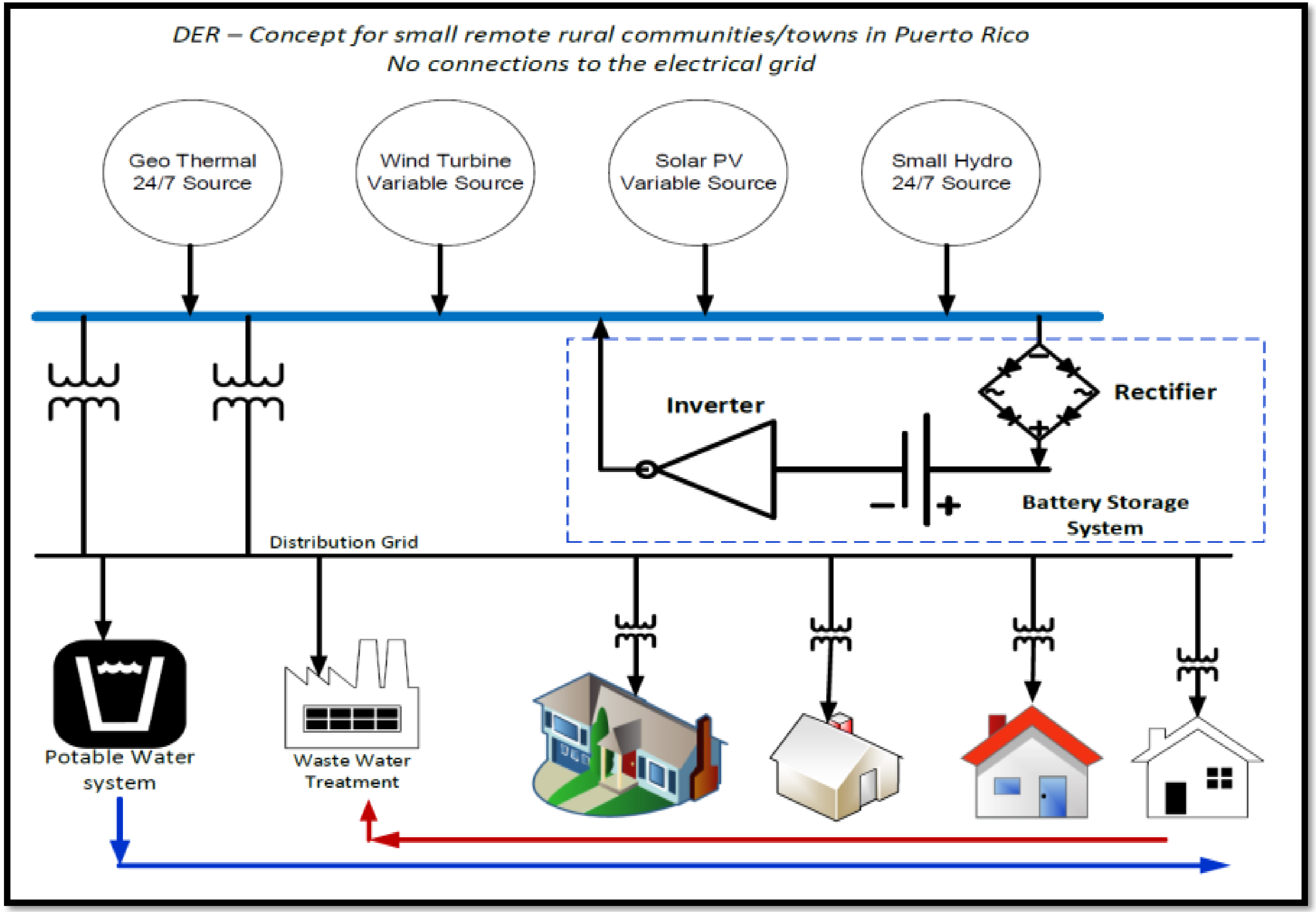
Distributed, Renewable & Resilient



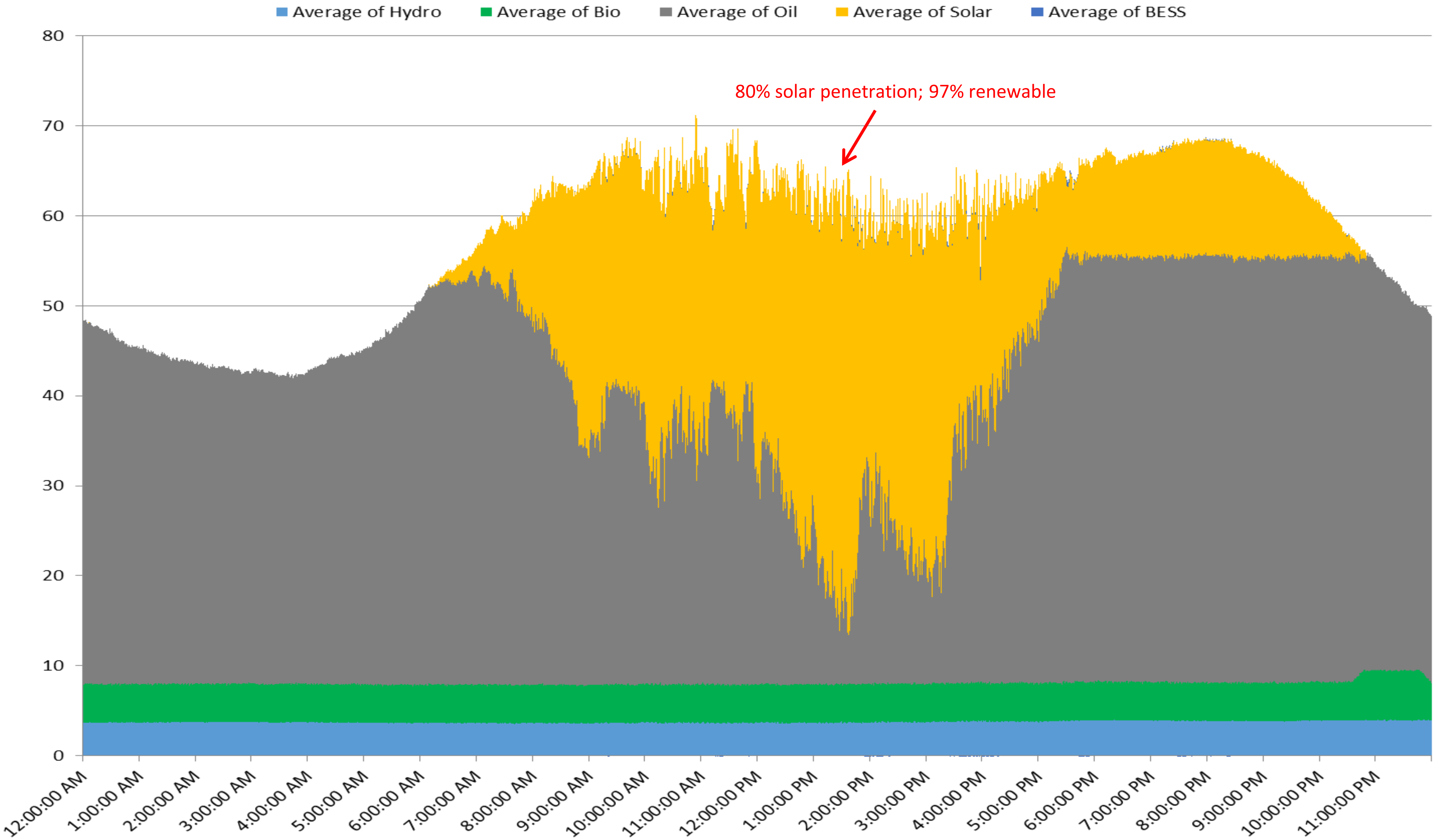
Microgrids for Critical Infrastructure



Distributed Utilities for Remote Villages



Kaua‘i: 98% Renewable Power During the Day



System-Level Risk & Reliability Improvements

- Lower energy volatility exposure
- Reduced terrorism risk
- Improved reliability from storage
  - BESS
  - Pumped hydropower
- Electrification of transportation and demand response to address curtailment
- Strategies for managing weather output risk

Where Do We Go From Here?

- **Explicit quantification** of the costs and value of resilience
- **Co-optimization** with traditional planning reliability and cost criteria
- **Careful siting** of renewables with expectation of climate disruption
- **Hardening** of solar installation to withstand hurricanes
- **Cellular approach** to grid modernization with distributed resources / microgrid as the default architecture

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