WORLD BANK EXPERIENCE ON ENHANCING ENERGY RESILIENCE FOR CLIMATE ADAPTATION

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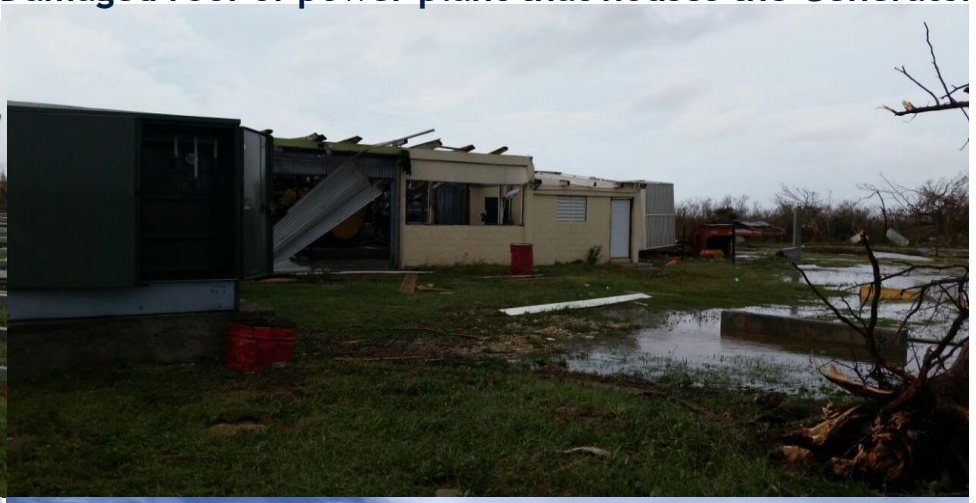
Hua Du, Ph.D
Energy Specialist Consultant
September 28, 2018

2017 Hurricane Irma (Barbuda): Damages on Power Generation

Solar plant completely destroyed

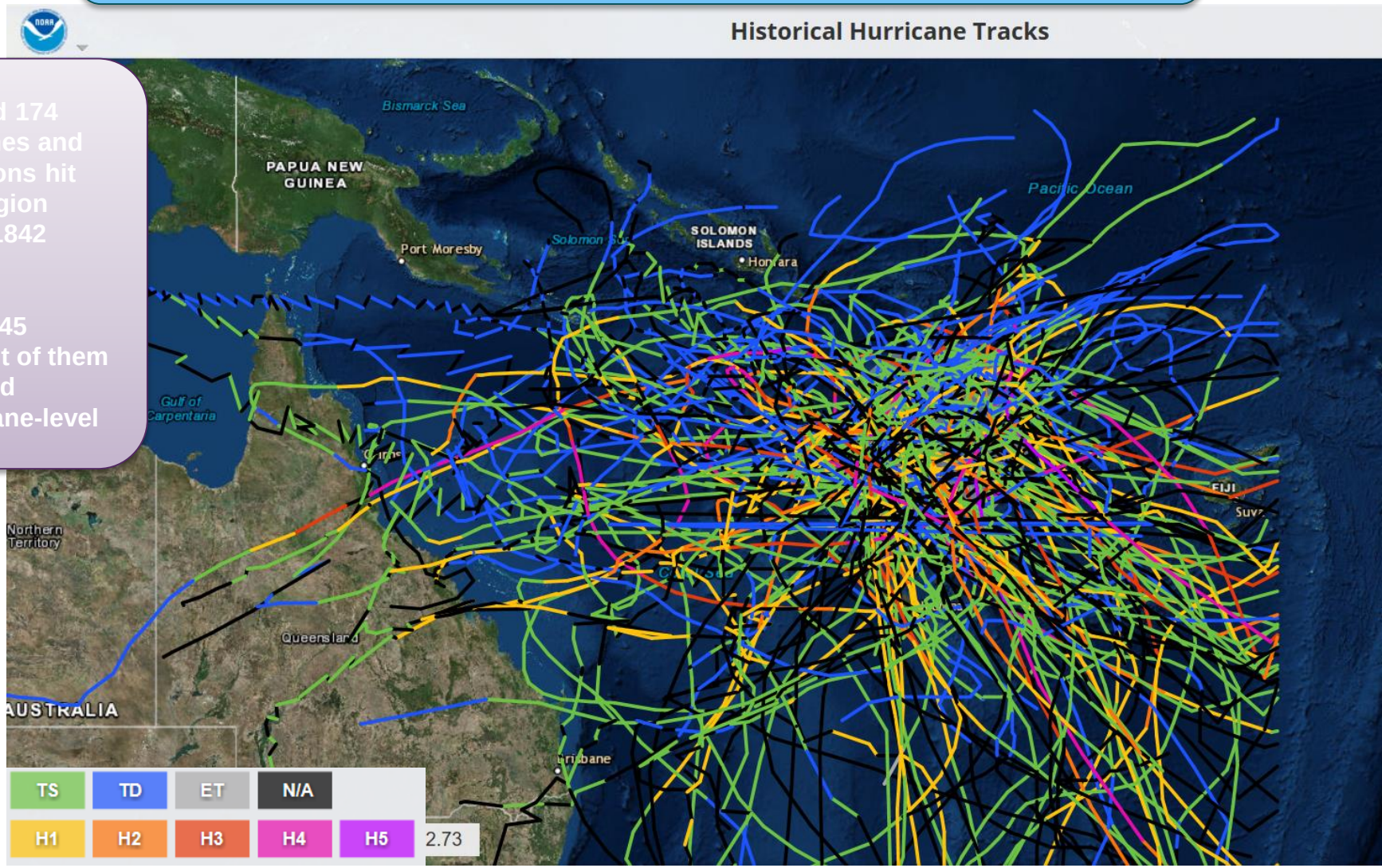
Damaged roof of power plant that houses the Generators



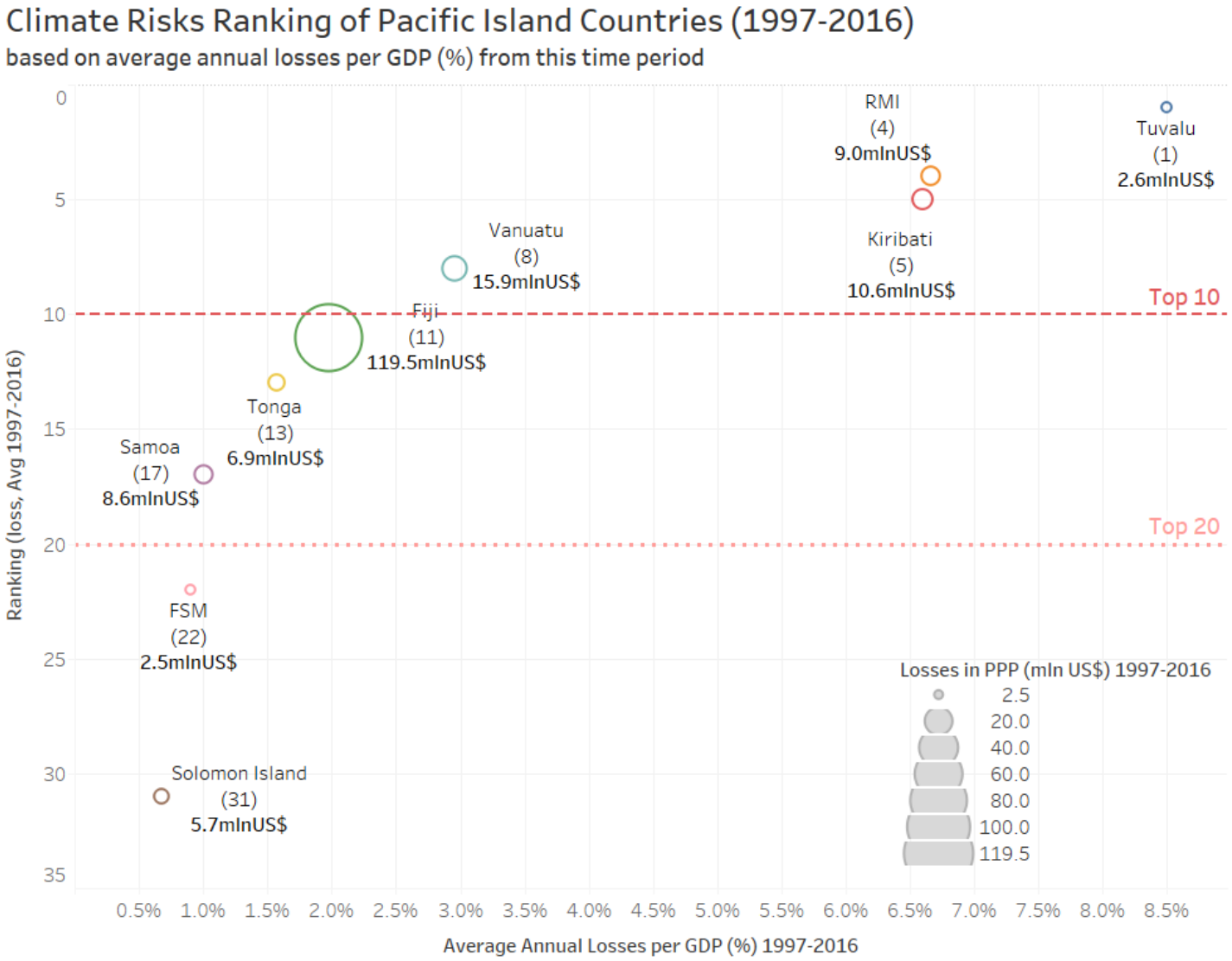
- 90% of poles broken or blown down; Some poles broken into three places
- All distribution transformers on the ground and completely destroyed
- 90% of the power lines damaged

Western & Central Pacific Region is highly Vulnerable to Extreme Weather and Climate Risks

- Around 174 Cyclones and Typhoons hit this region since 1842
- About 45 percent of them reached hurricane-level



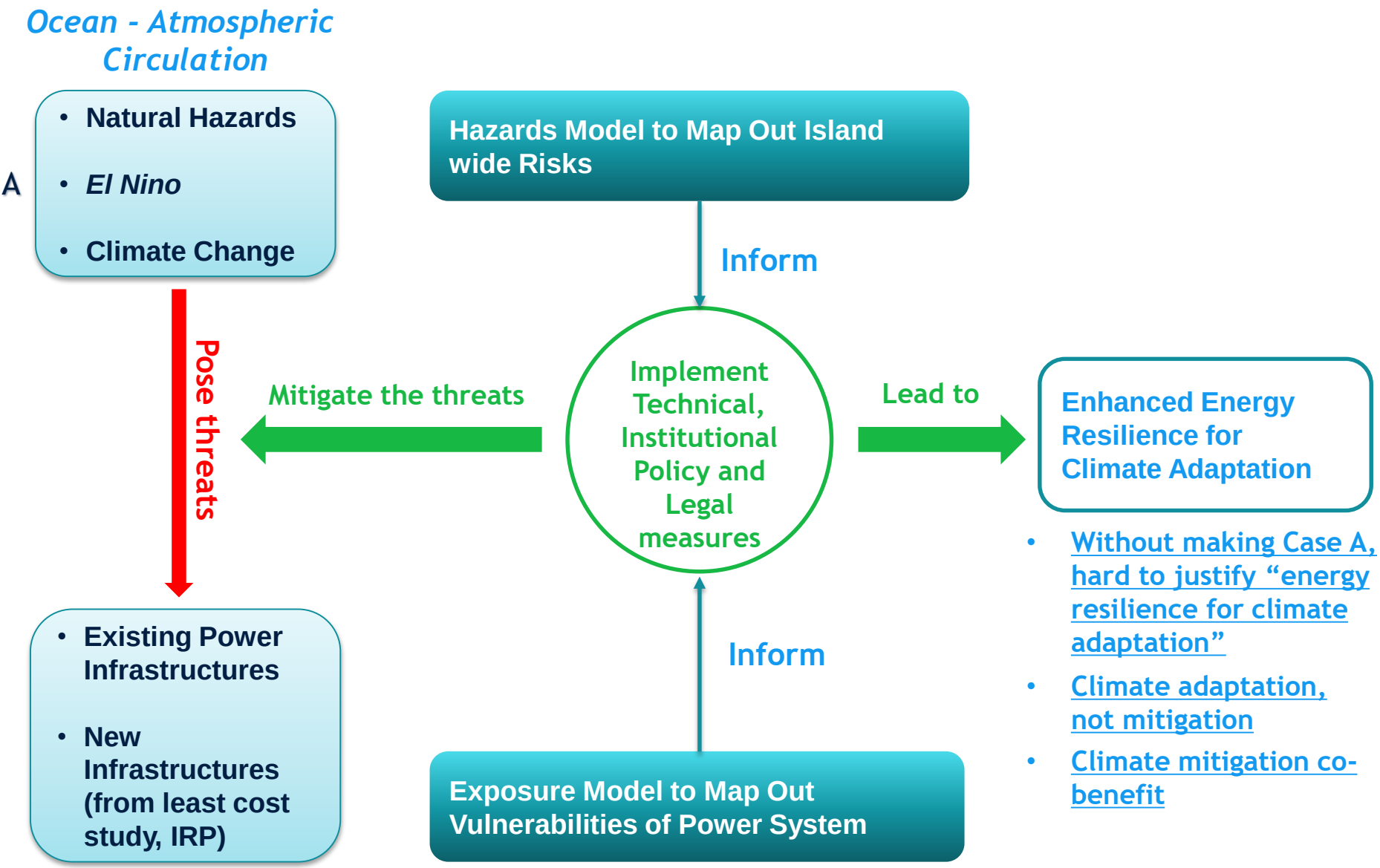
Resulting Economic Impacts are High



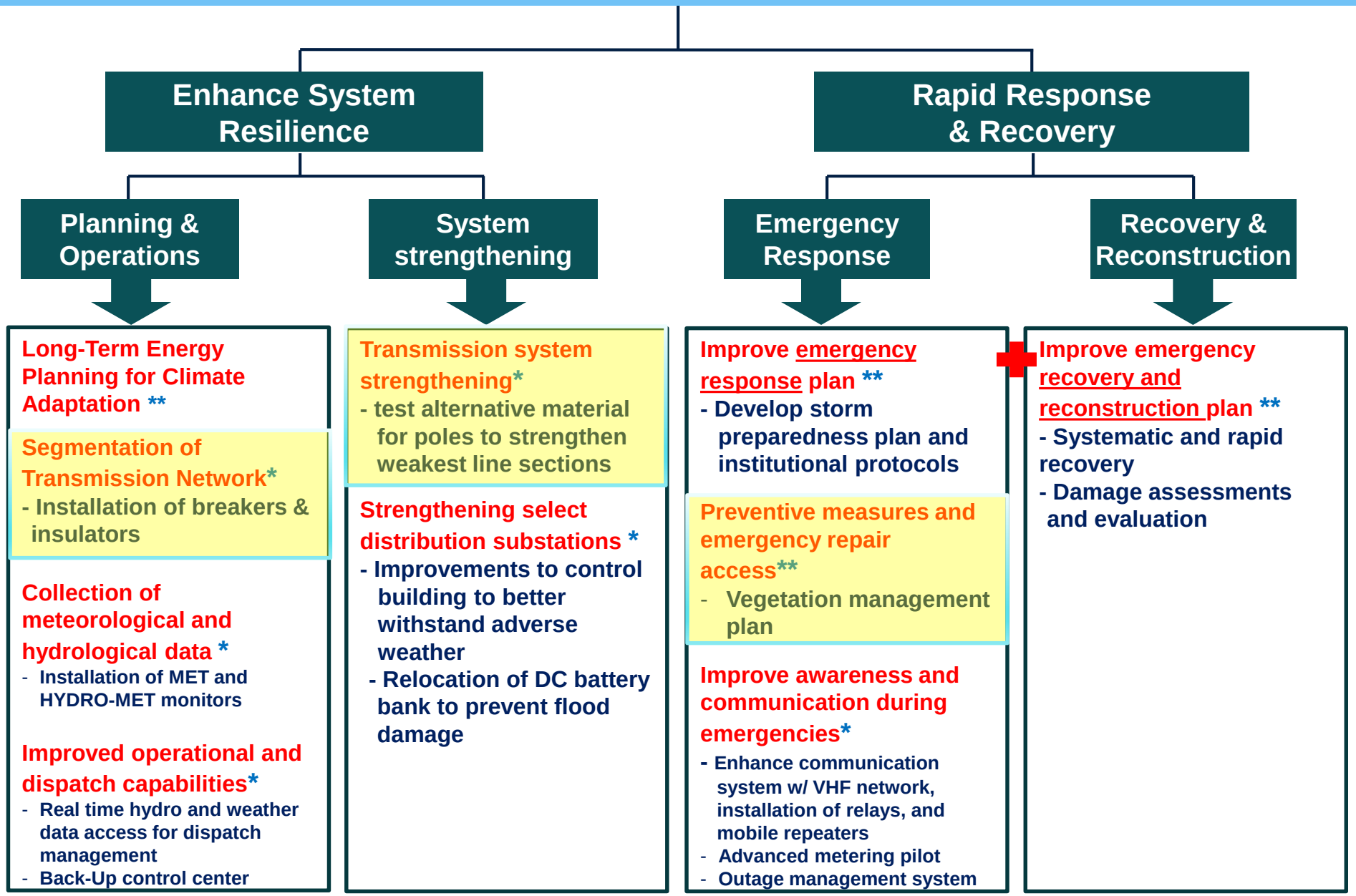
4 PICs are within Global Top 10 most affected countries

7 PICs are within Global Top 20

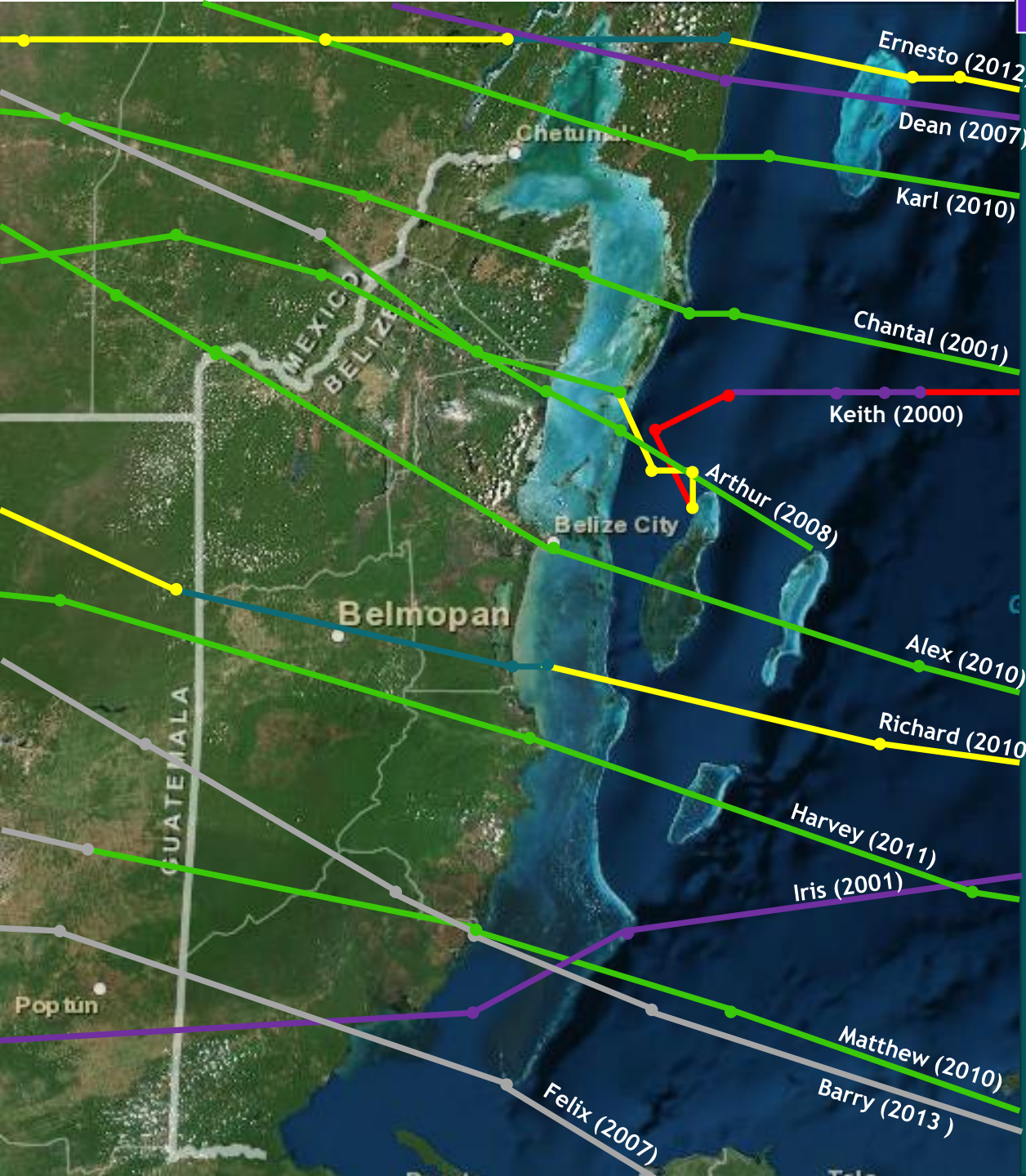
An Integrated Disaster Risk Management Approach



Belize: Energy Resilience for Climate Adaptation project



* indicates investment ** indicates technical assistance



H5 H4 H3 H2 H1 TS/SS TD/SD

2000

2001

2007

2008

2010

2011

2012

2013

Source: National Oceanic & Atmospheric Administration

Mapping the Storms to Evaluate Impacts & Identify Vulnerabilities in Power System

HURRICANE DEAN

H4 H3 H2 H1 TS/SS TD/SD ET

Hurricane Dean (2007)

1. Segmentation of Transmission Network

Caused Near Black-Out of System

1) Fault in CFE substation in Mexico

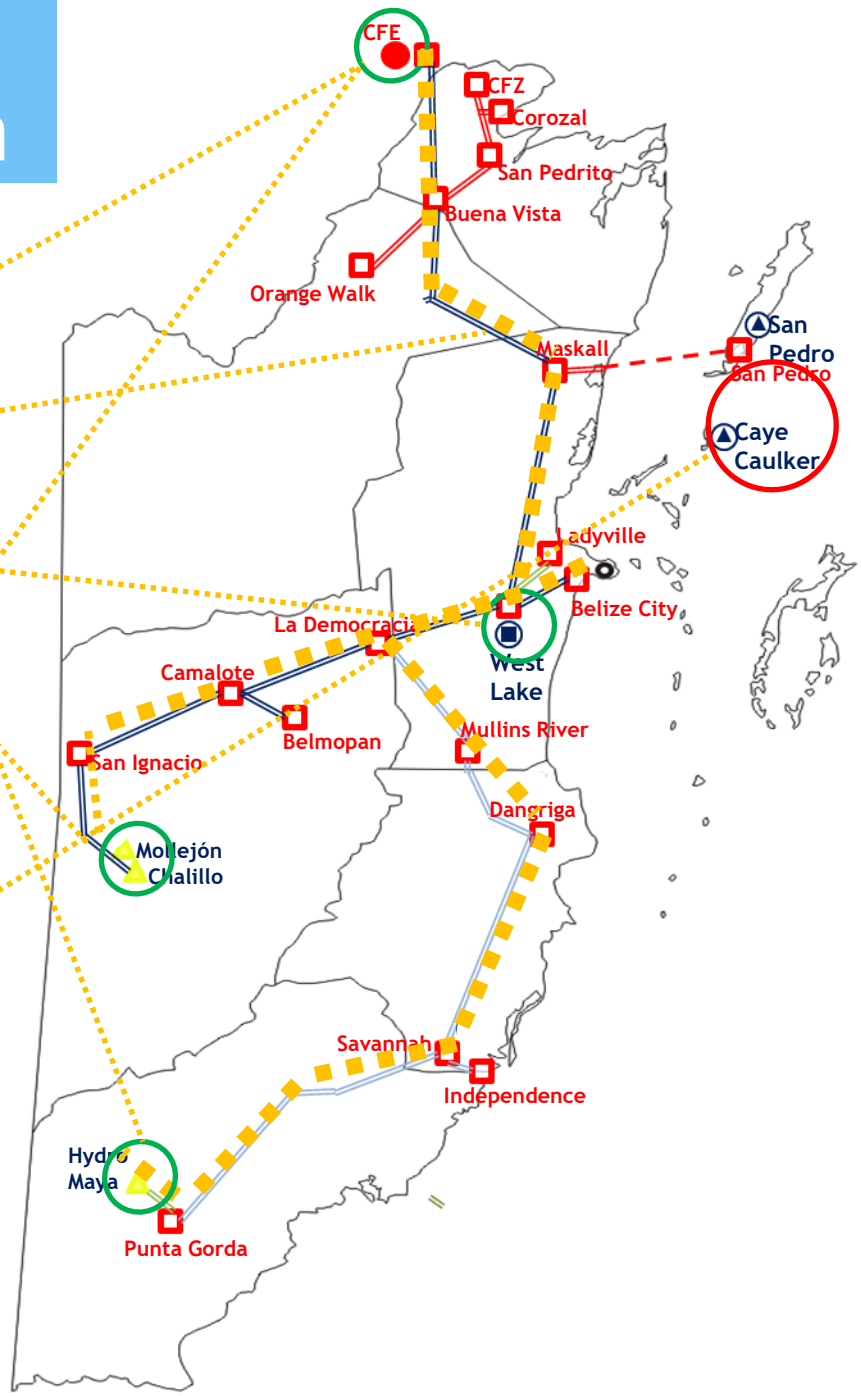
2) Northern transmission lines fail

3) CFE Supply & West Lake PPs unable to fully dispatch

4) Hydro Becol PP dispatch reduced; Hydro Maya PP unable to dispatch

5) Only Caye Caulker isolated system remained fully operational

- Only 1612 kWh/3.5% of normal dispatch* in the grid;
- More than 64,000 customers (88%)** lost power completely



* Compared to the same hour in the previous week;

** Based on the 2014 customer base information

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Segmentation can Isolate Faults

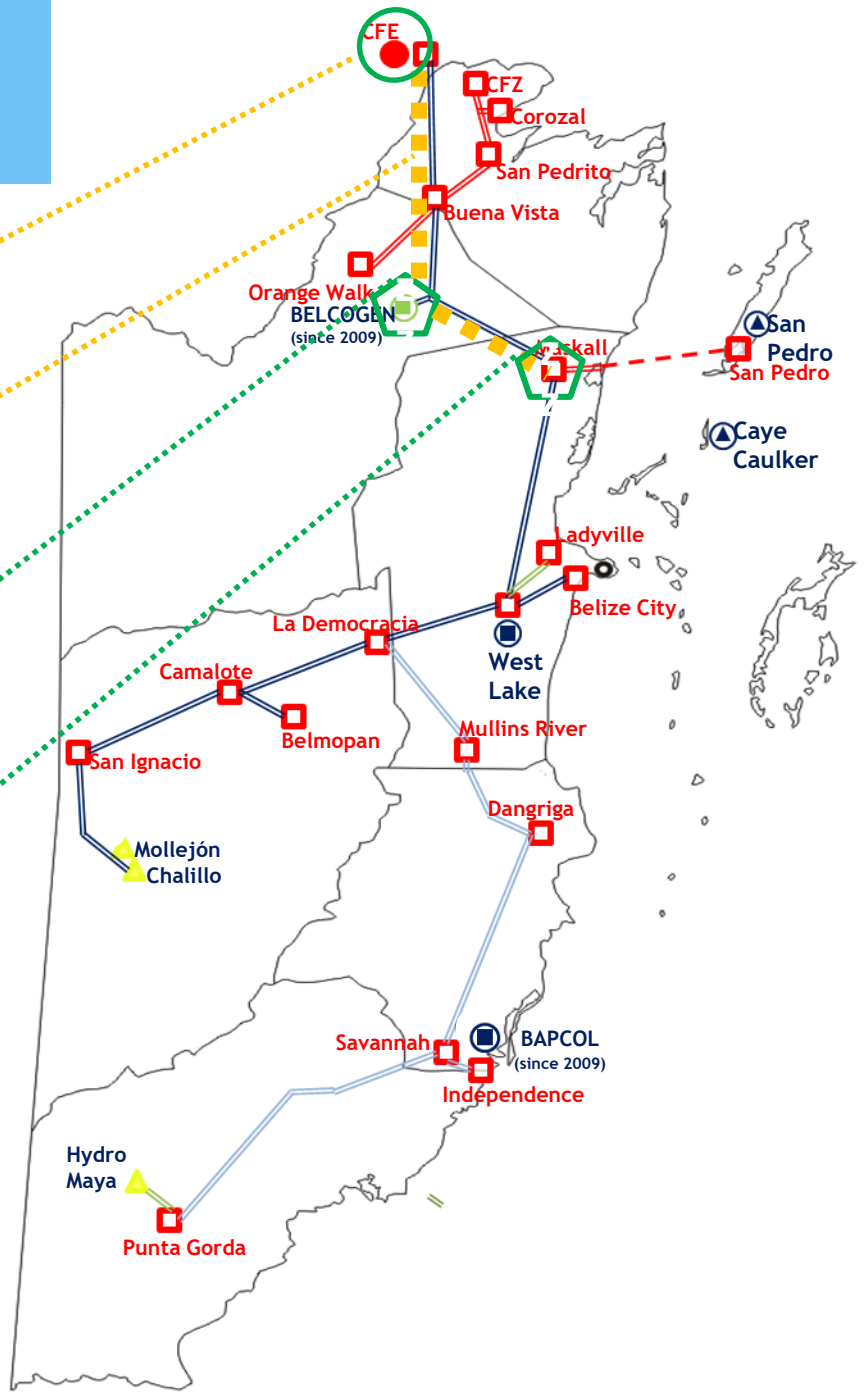
1) Fault in CFE substation in Mexico

2) Northern transmission lines fail

If today, segmentation at Belcogen SS would isolate T-Failure

In 2007, segmentation at Maskall SS would isolate T-Failure

- Most generators able to dispatch
- About 7,000 - 13,000 or 9% - 18% of customers effected (instead of 64,000 or 88%)



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2. Strengthening of Transmission Network Structures

If Maskall-West Lake Line Were to Fail

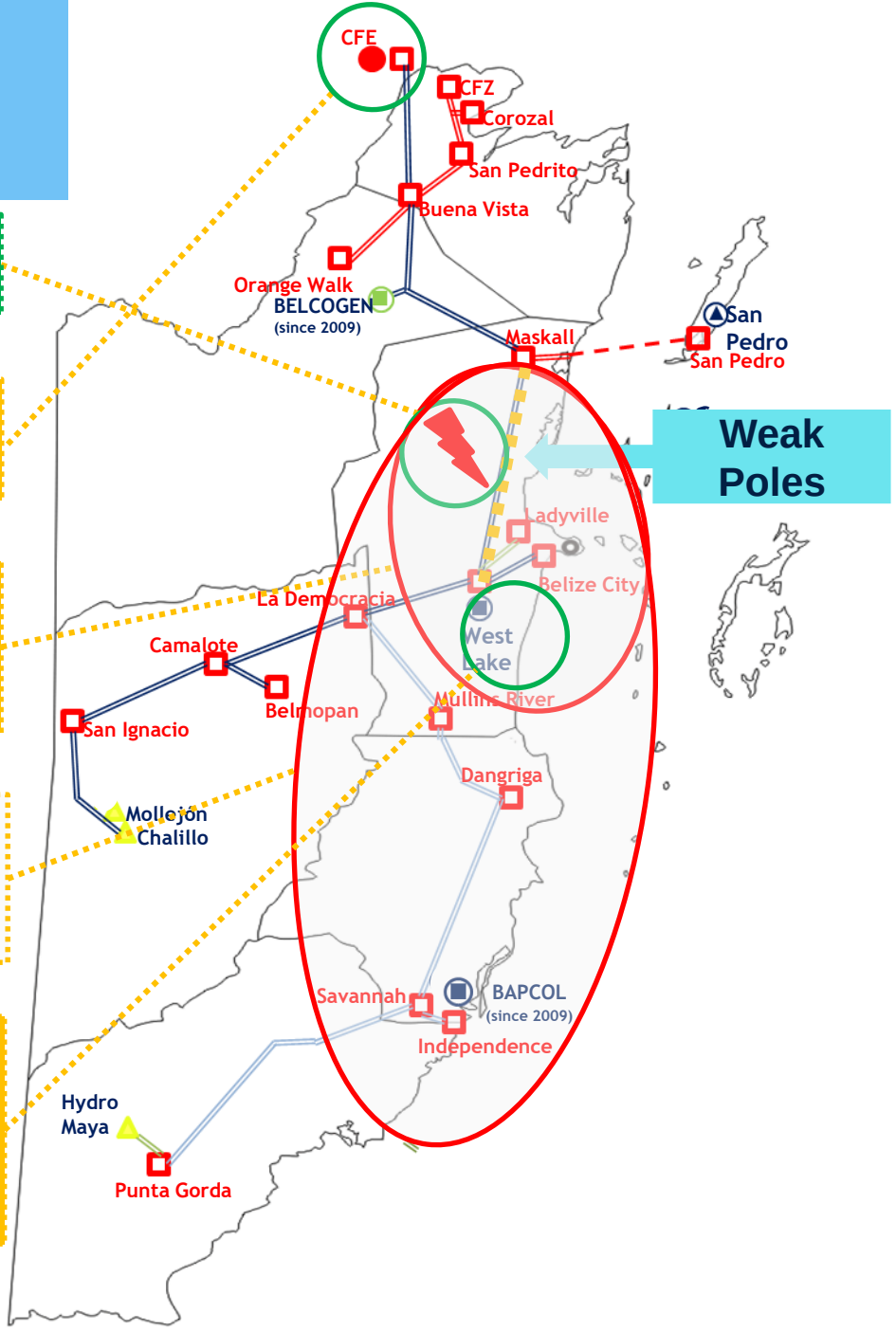
A fault in Maskall-Wesk Lake Line would lead to

1. CFE supply (up to 50 MW; 42% of dispatch capacity) disrupted;

2. At least 24,500 customers in Central would experience outages or shortages (25% of customer base)

3. Affected areas can be extended to the South (at least 11,000 more customers)

4. Cost of generation temporarily higher due to use of diesel generation at Westlake GT PP (2.5 times more costly than CFE)



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3. Vegetation Management

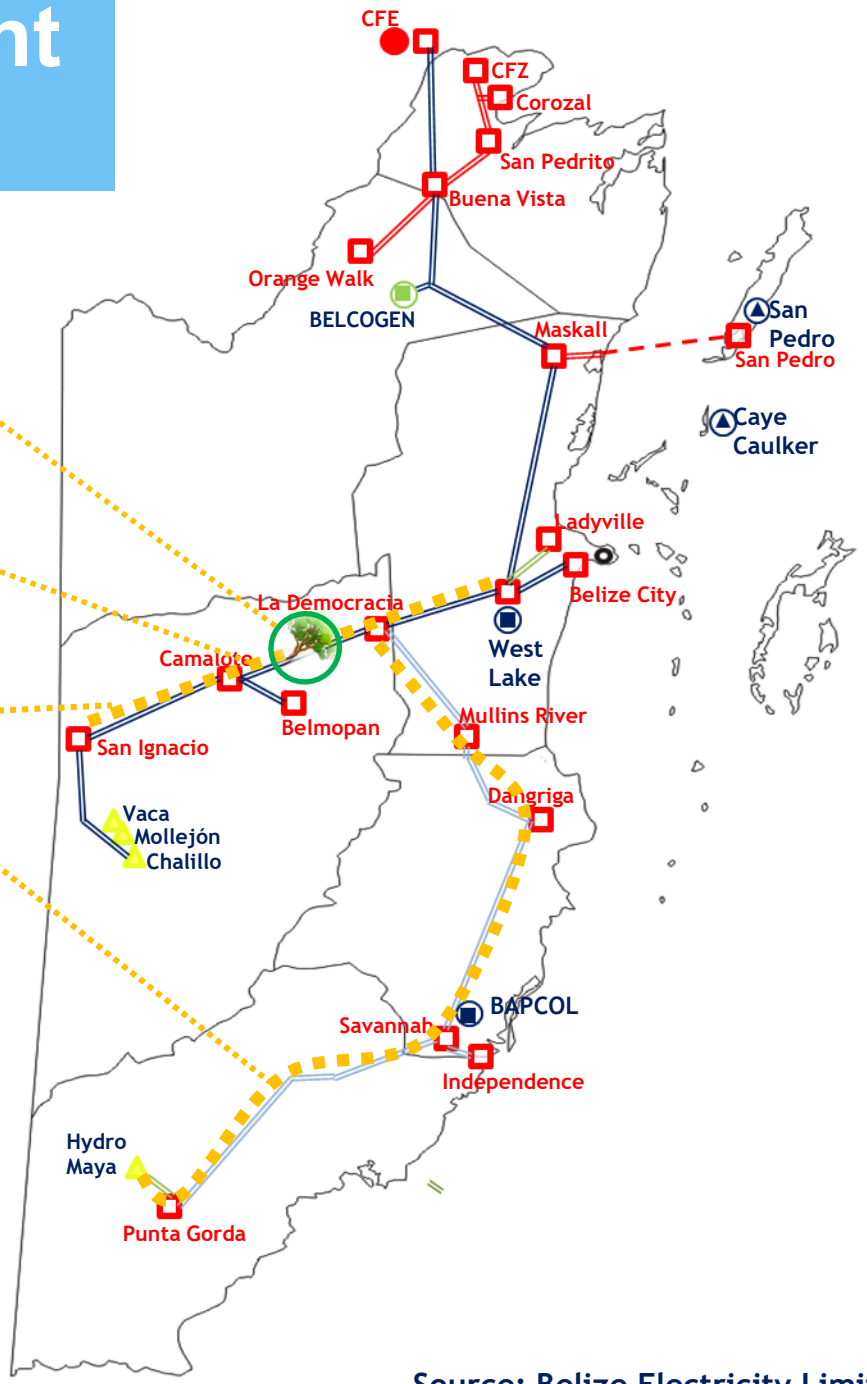
Vegetation management matters….

1) Tree fell on western transmission line between Democracia and Camalote

2) Failure of transmission lines in the West & South

3) Western lines recovered quickly; southern lines disabled for 21 hours

- 7,552 customers in the South lost electricity (9% of customer base)



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Source: Belize Electricity Limited

Proposed Pacific Regional Energy Resilience For Climate Adaptation Program