

# WORLD BANK EXPERIENCE ON ENHANCING ENERGY RESILIENCE FOR CLIMATE ADAPTATION



**THE WORLD BANK**

Treasury | IBRD • IDA

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# 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



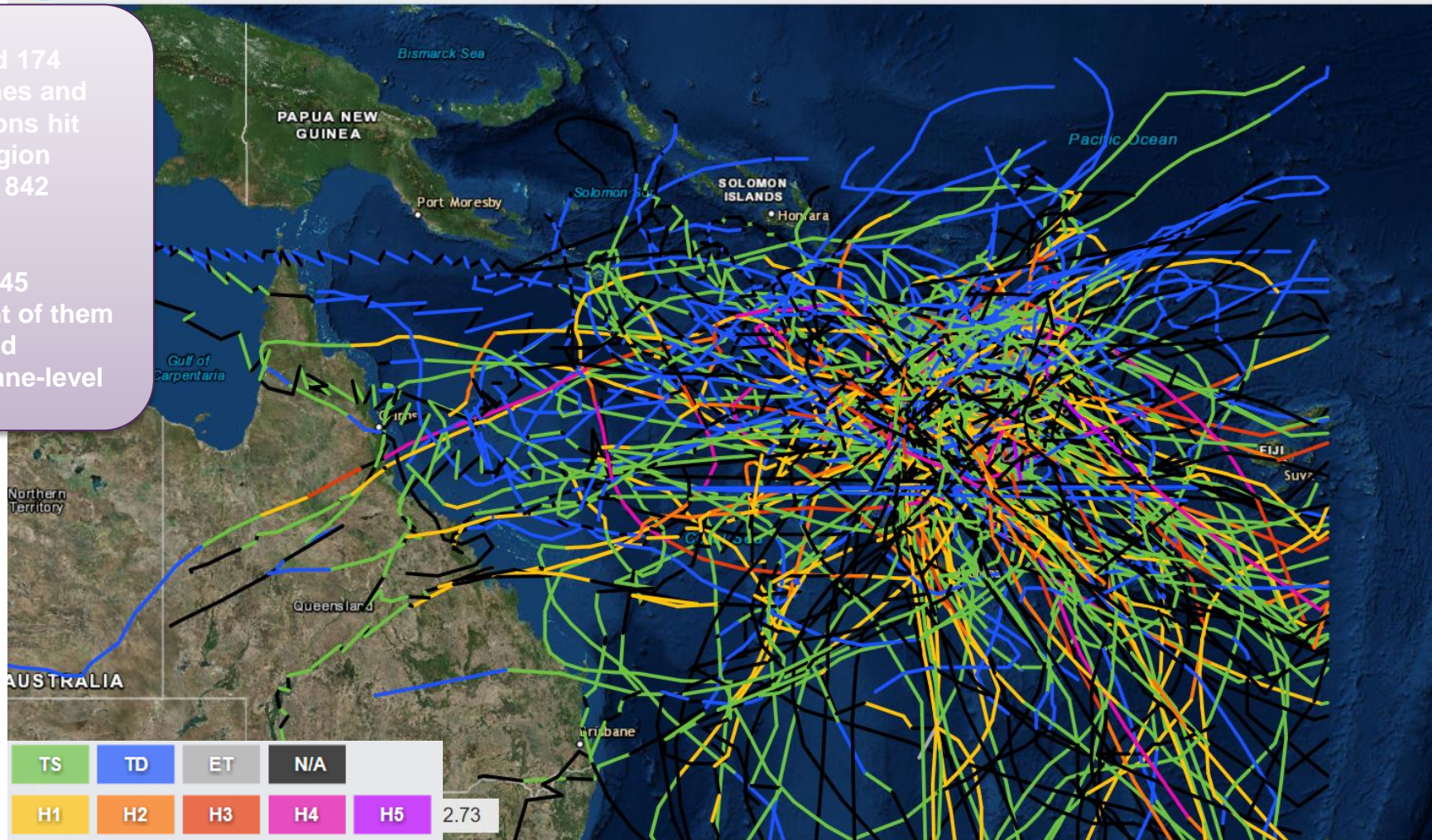
# Western & Central Pacific Region is highly Vulnerable to Extreme Weather and Climate Risks



Historical Hurricane Tracks

Around 174 Cyclones and Typhoons hit this region since 1842

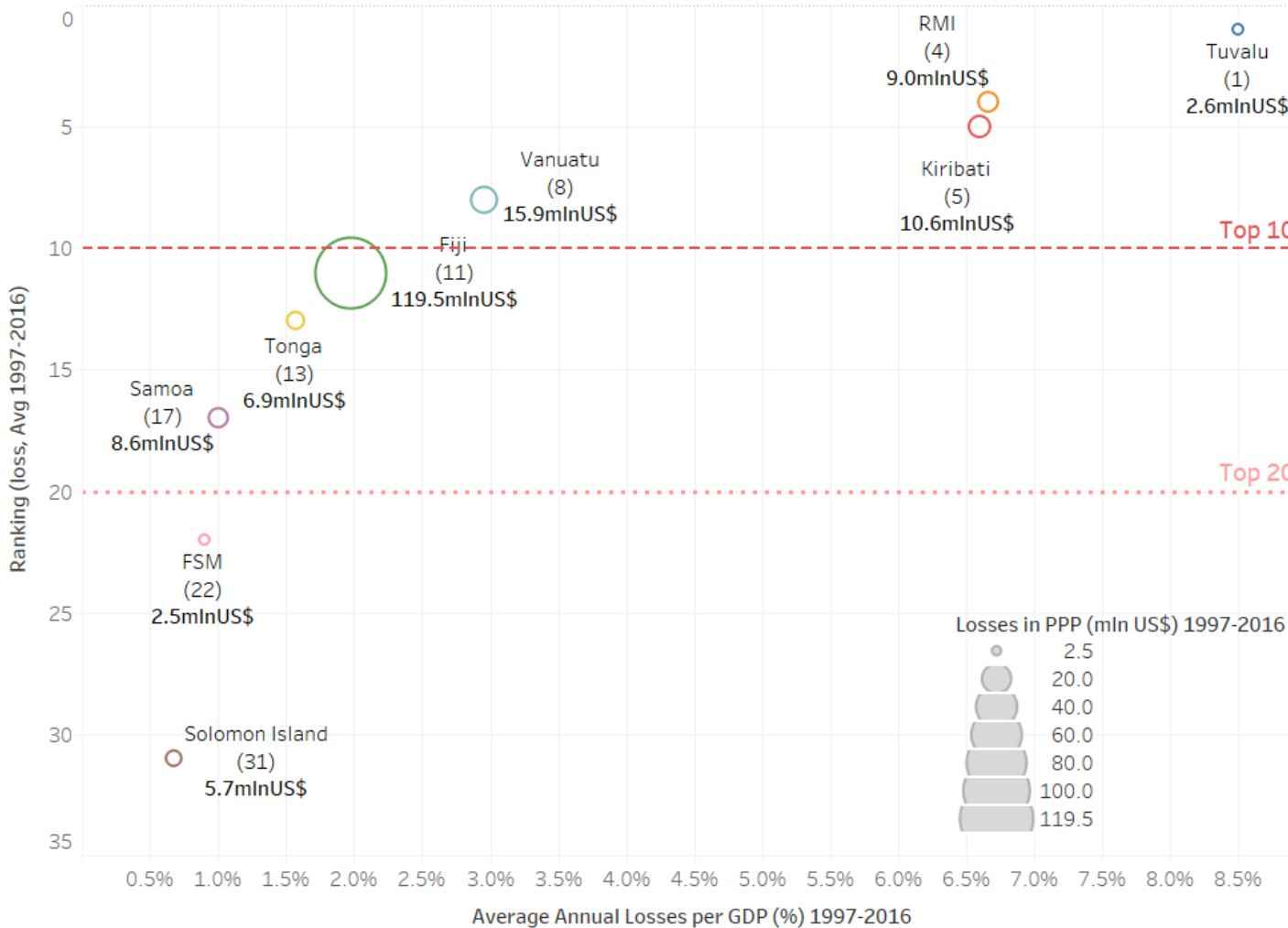
- About 45 percent of them reached hurricane-level



# Resulting Economic Impacts are High

## Climate Risks Ranking of Pacific Island Countries (1997-2016)

based on average annual losses per GDP (%) from this time period



**4 PICs are within Global Top 10 most affected countries**

**7 PICs are within Global Top 20**

# An Integrated Disaster Risk Management Approach

## Ocean - Atmospheric Circulation

- Natural Hazards
- *El Nino*
- Climate Change

Pose threats

- Existing Power Infrastructures
- New Infrastructures (from least cost study, IRP)

Hazards Model to Map Out Island wide Risks

Inform

Implement Technical, Institutional Policy and Legal measures

Mitigate the threats

Lead to

Enhanced Energy Resilience for Climate Adaptation

Inform

Exposure Model to Map Out Vulnerabilities of Power System

- Without making Case A, hard to justify “energy resilience for climate adaptation”
- Climate adaptation, not mitigation
- Climate mitigation co-benefit

# Belize: Energy Resilience for Climate Adaptation project

## Enhance System Resilience

### Planning & Operations

**Long-Term Energy Planning for Climate Adaptation \*\***

**Segmentation of Transmission Network\***

- Installation of breakers & insulators

**Collection of meteorological and hydrological data \***

- Installation of MET and HYDRO-MET monitors

**Improved operational and dispatch capabilities\***

- Real time hydro and weather data access for dispatch management
- Back-Up control center

### System strengthening

**Transmission system strengthening\***

- test alternative material for poles to strengthen weakest line sections

**Strengthening select distribution substations \***

- Improvements to control building to better withstand adverse weather
- Relocation of DC battery bank to prevent flood damage

## Rapid Response & Recovery

### Emergency Response

**Improve emergency response plan \*\***

- Develop storm preparedness plan and institutional protocols

**Preventive measures and emergency repair access\*\***

- Vegetation management plan

**Improve awareness and communication during emergencies\***

- Enhance communication system w/ VHF network, installation of relays, and mobile repeaters
- Advanced metering pilot
- Outage management system

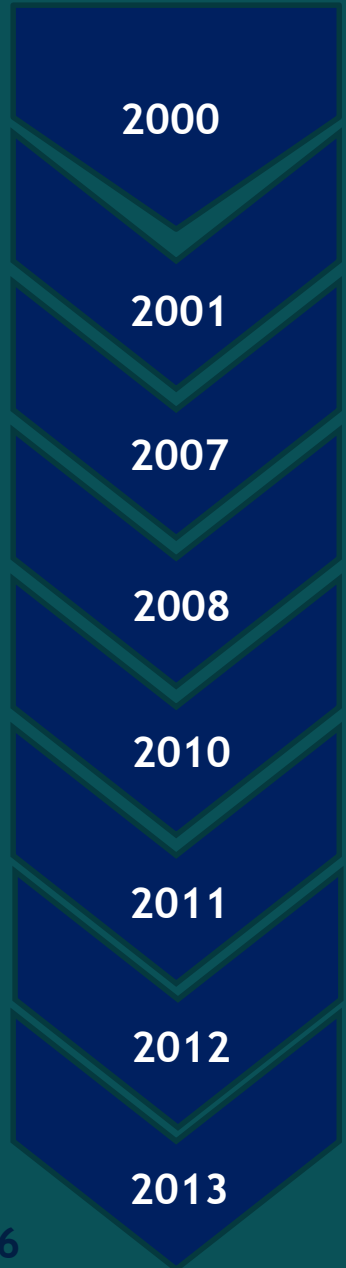
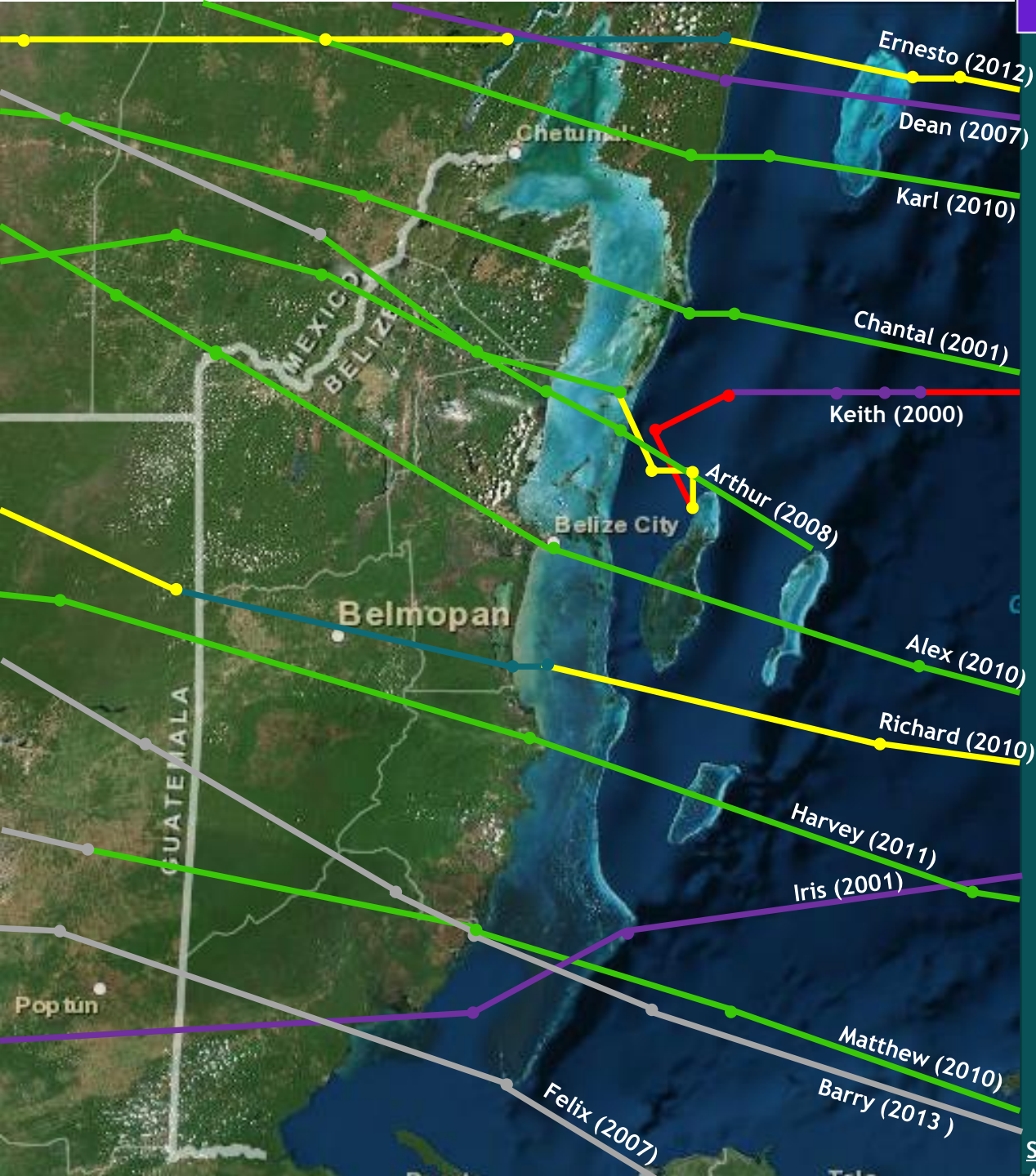
### Recovery & Reconstruction

**Improve emergency recovery and reconstruction plan \*\***

- Systematic and rapid recovery
- Damage assessments and evaluation

\* indicates investment

\*\* indicates technical assistance



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

## HURRICANE DEAN



**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

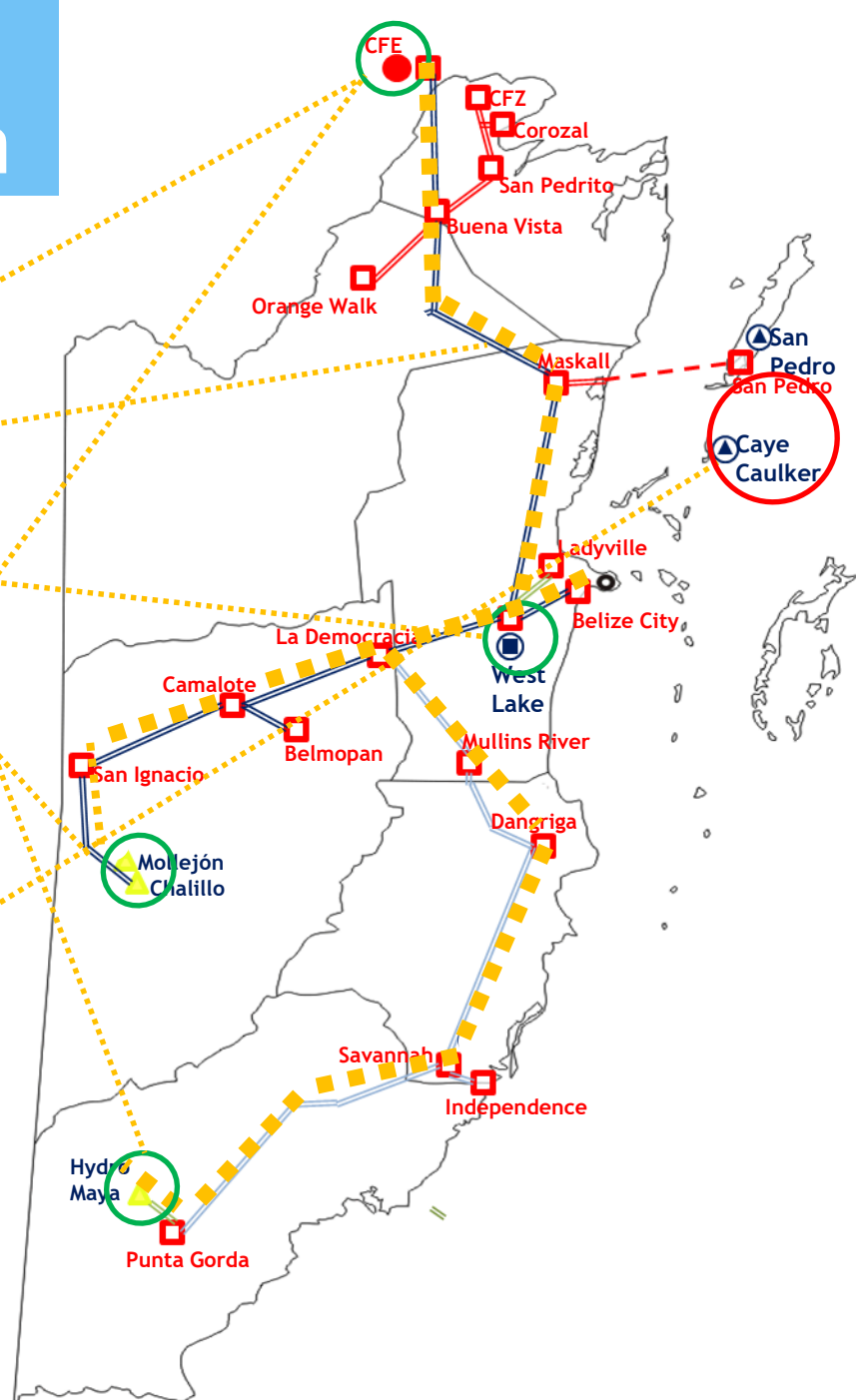
- Only 1612 kWh/3.5% of normal dispatch\* in the grid;
- More than 64,000 customers (88)\*\* lost power completely

\* Compared to the same hour in the previous week;

\*\* Based on the 2011 customer base information



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# Segmentation can Isolate Faults

1) Fault in CFE substation in Mexico



2) Northern transmission lines fail

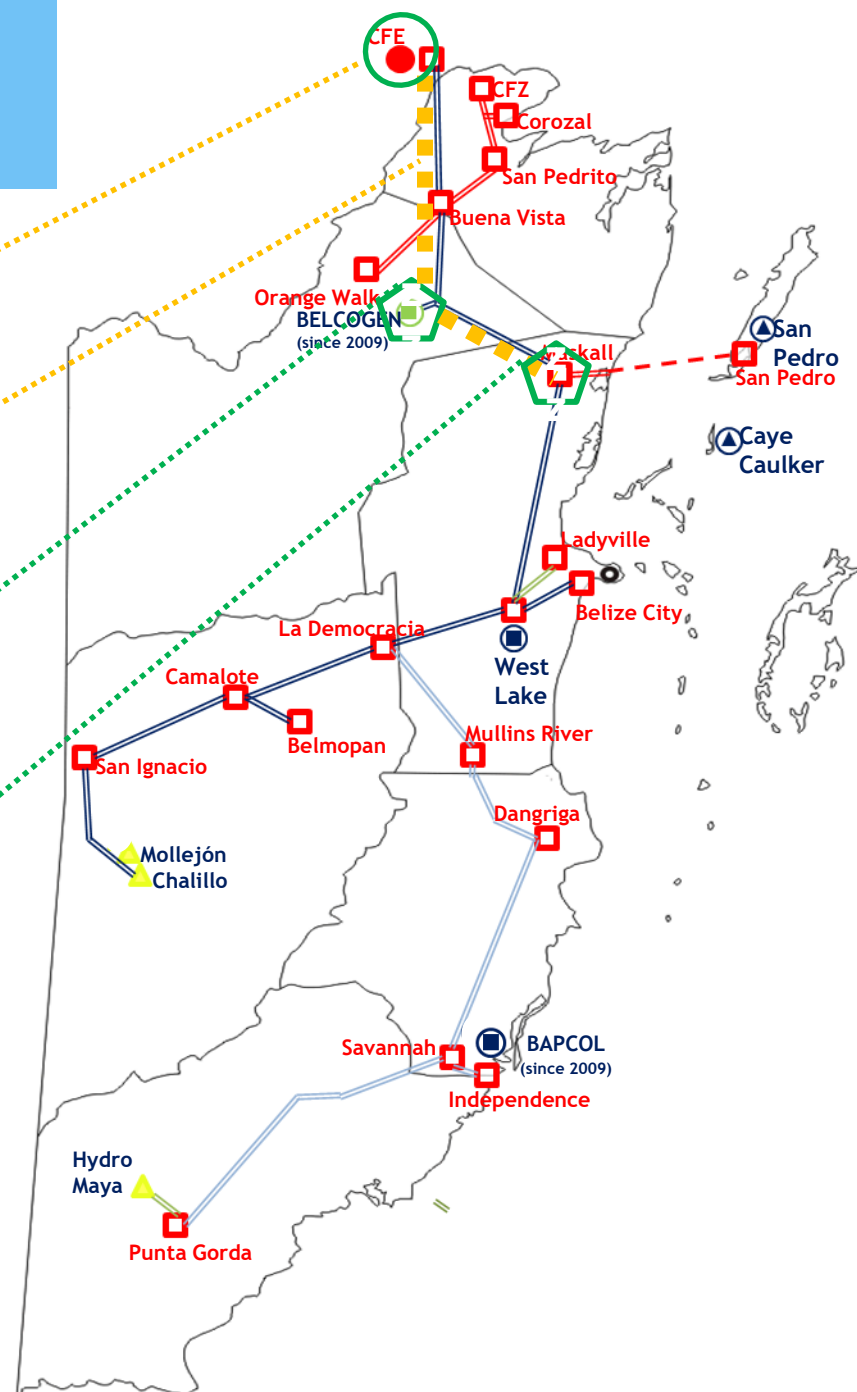


If today, segmentation at Belcogen SS would isolate T-Failure



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%)



## 2. Strengthening of Transmission Network Structures

# If Maskall-West Lake Line Were to Fail

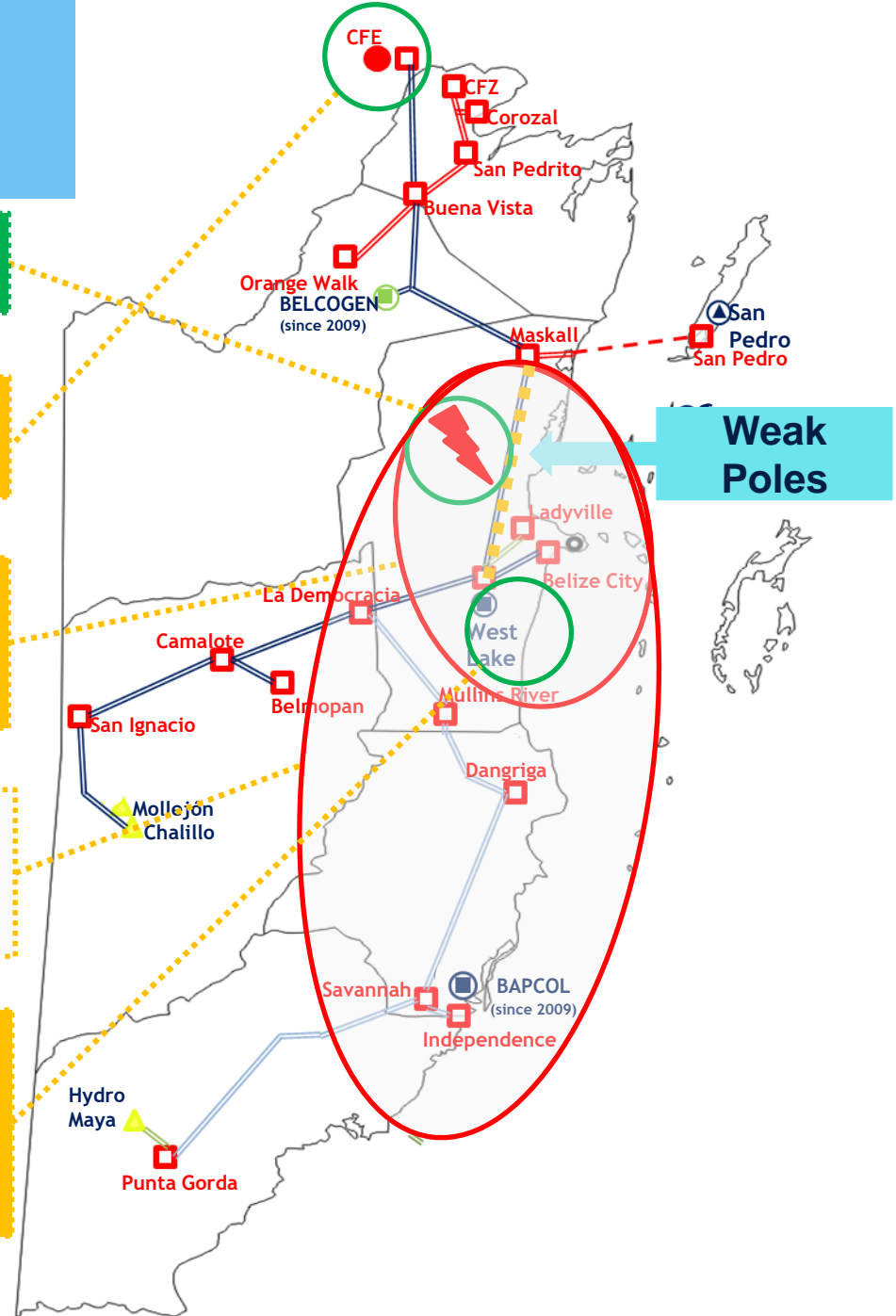
A fault in Maskall-West Lake Line would lead to

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)



# 3. Vegetation Management

# Vegetation management matters....

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

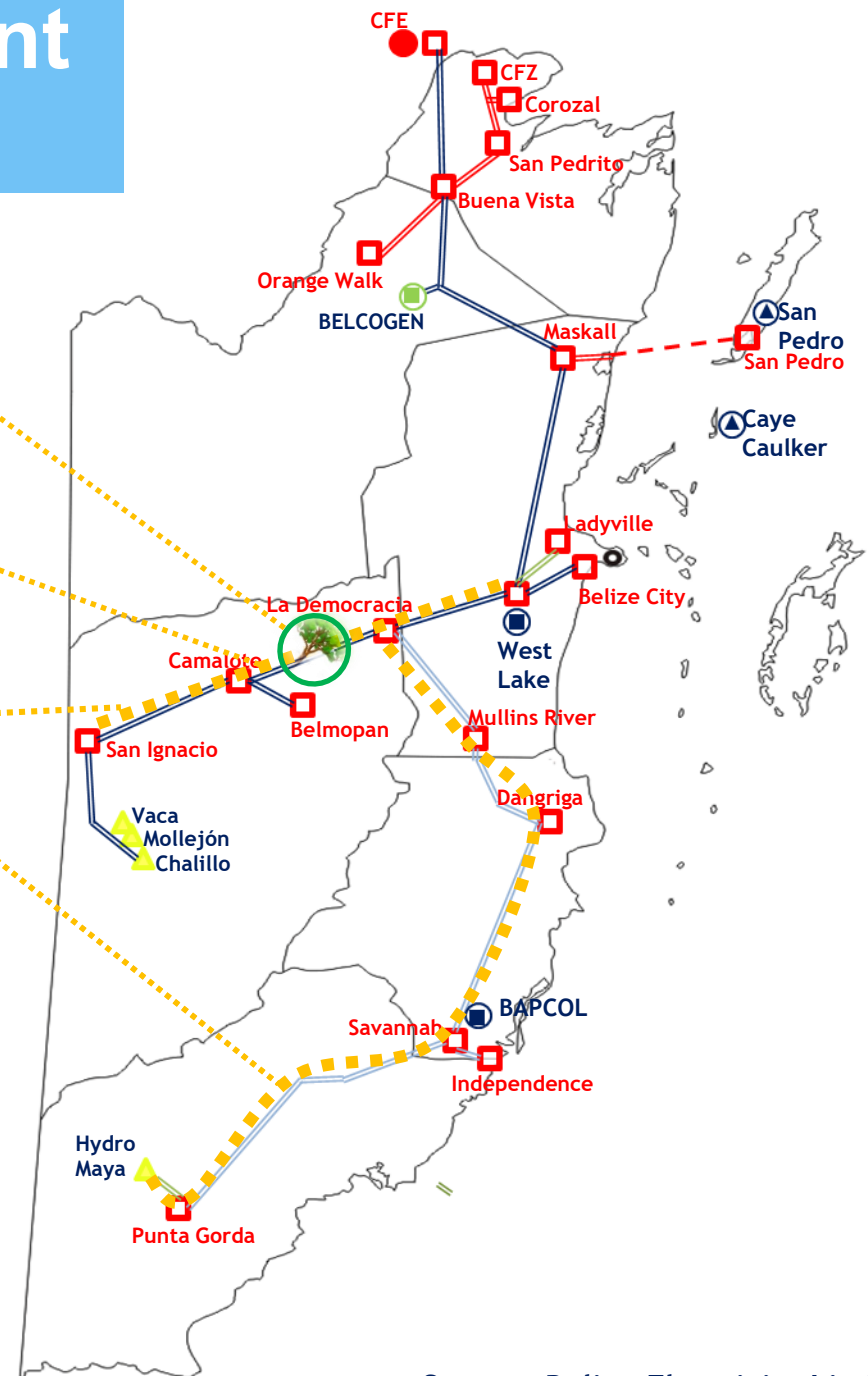


2) Failure of transmission lines in the West & South



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

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



# Proposed Pacific Regional Energy Resilience For Climate Adaptation Program

*Noted: Countries listed below is for Illustration Purpose Only*

## Phase I: Pilot Phase

Federated States of Micronesia  
GDP = 322 (US\$mIn)  
Population = 104,937

Papua New Guinea  
GDP = 16,930 (US\$mIn)  
Population = 8,085,000

Marshall Islands  
GDP = 183 (US\$mIn)  
Population = 53,066

## Phase II: Scale-up Phase

Kiribati  
GDP = 166 (US\$mIn)  
Population = 114,395

Tuvalu  
GDP = 34 (US\$mIn)  
Population = 11,097

Vanuatu  
GDP = 774 (US\$mIn)  
Population = 270,402

Australia

New Zealand