OPERATIONAL BACKUP IN THE INDUSTRY

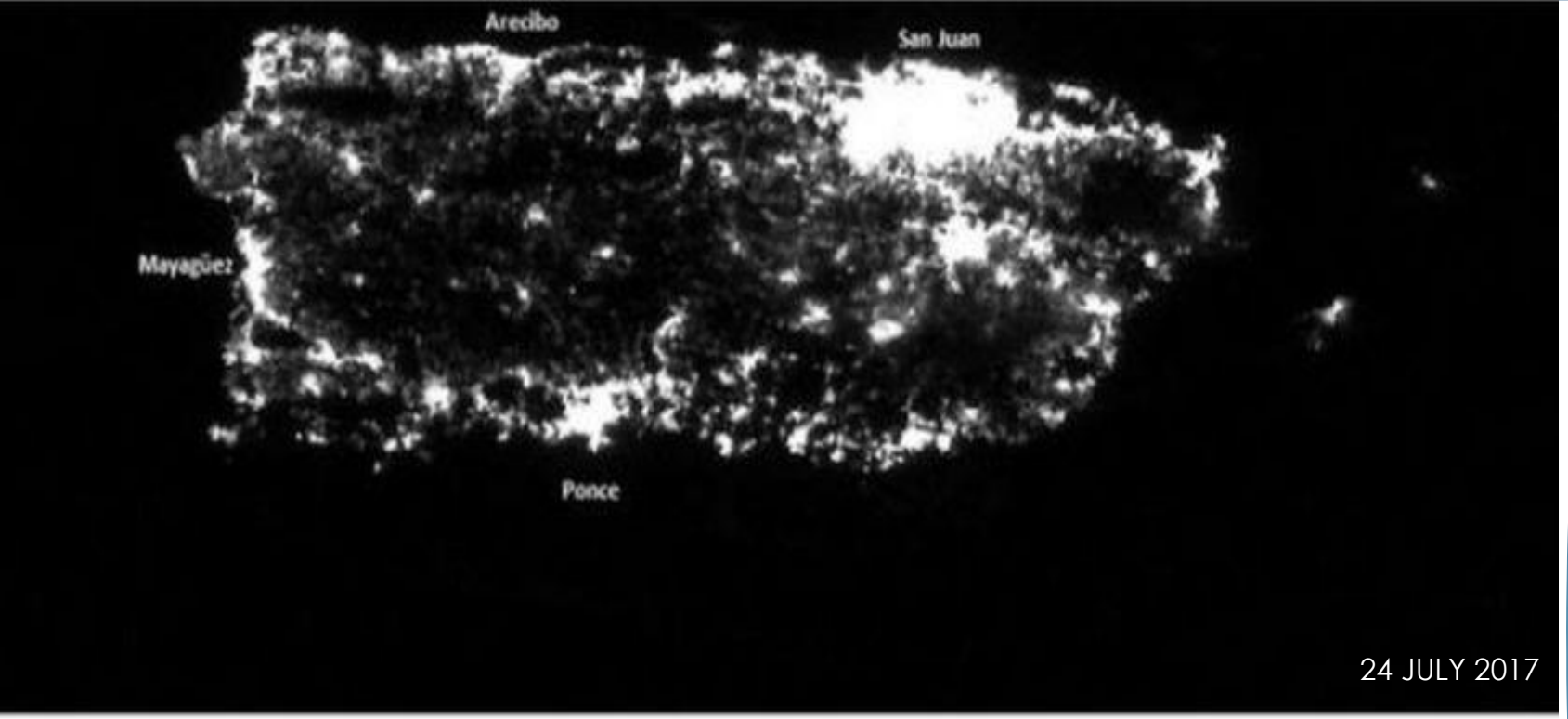
ENG. MARLON CABRERA

AGENDA

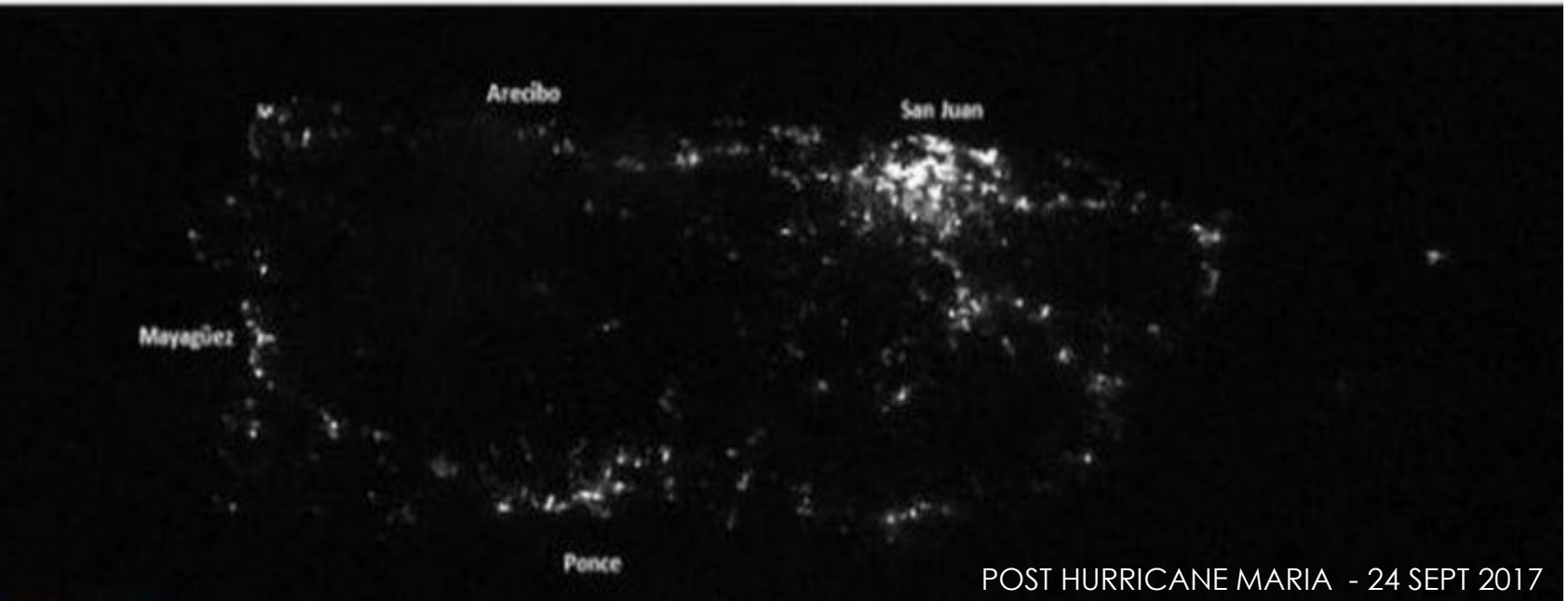
- ¿What is the Operational Resilience or Backup plan
- ¿Why is important?
- Collapse of the Island Systems (electric, water, telecommunications, fuel sypply chain and transportation)
- Estimate Costs of Hurricane Maria
- Energy Resiliency / Energy Management
- Backup Plan
- Reliability Operational
- Combined Heat & Power (CHP)
- Continuos Prime Generation
- Micro Grid
- Renewable Energy
- Real Cases: Empire Gas of Puerto Rico, Hospital la Concepcion, Olein Yabucoa

OPERATIONAL RESILIENCE

Is the ability to prepare, adapt, withstand and recover rapidly from disruptions from unexpected changes and deliberate attacks, like accidents, occurring threats or natural disasters.



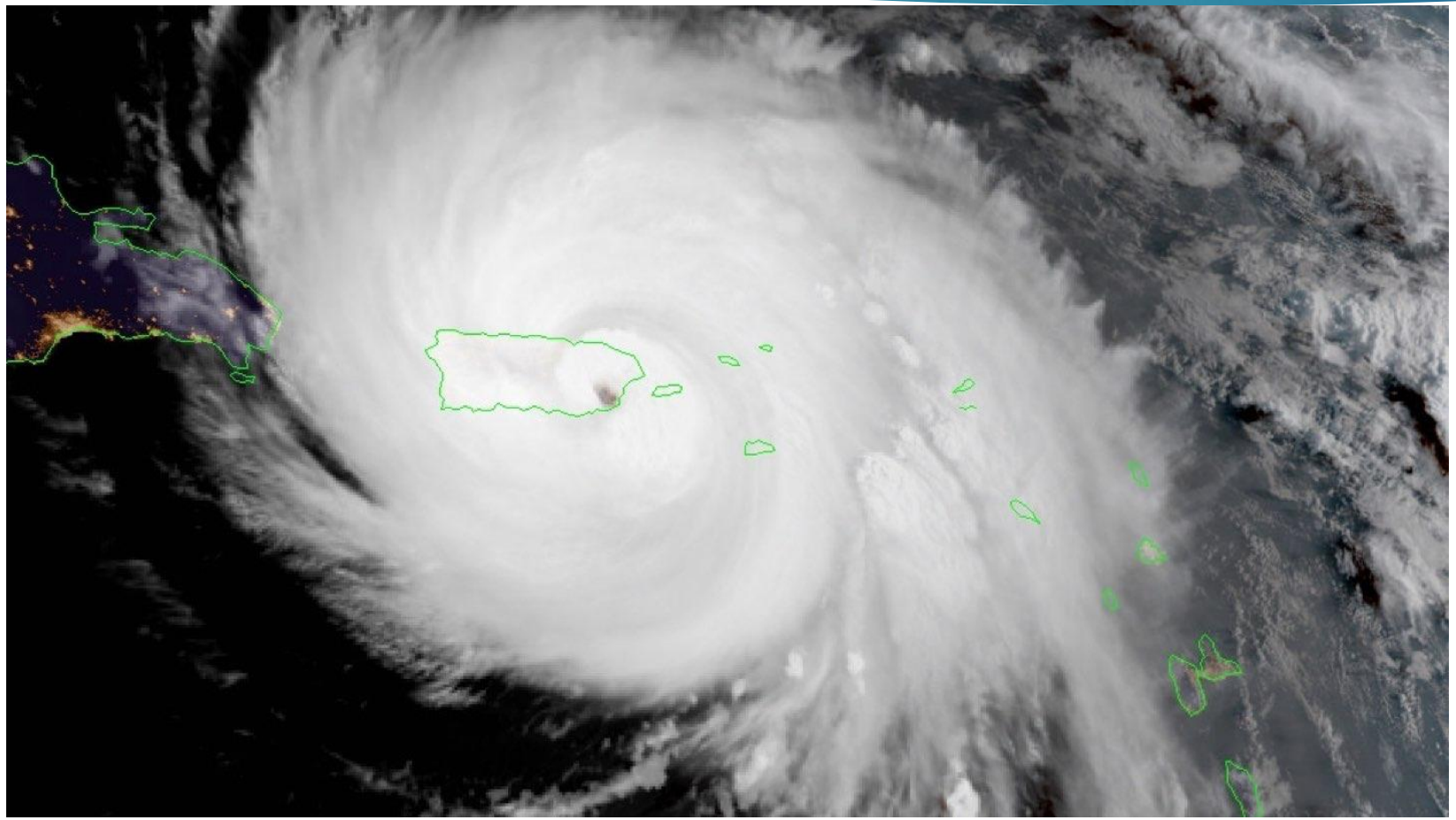
24 JULY 2017



POST HURRICANE MARIA - 24 SEPT 2017

WHY IS IMPORTANT?

HURRICANE MARIA



COLLAPSE OF THE ISLAND

- HURICANE MARIA
  - COLLAPSE OF PREPA
  - COLLAPSE OF THE FUEL SUPLLY CHAIN
  - COLLAPSE OF THE AAA
  - COLLAPSE IN THE TRANSPORTATION

HUMACAO PV PLANT FAILURE

ELECTRIC POWER SYSTEM OF PUERTO RICO

ELECTRICAL SYSTEM

- The Generating Capacity was of 5,839 MW

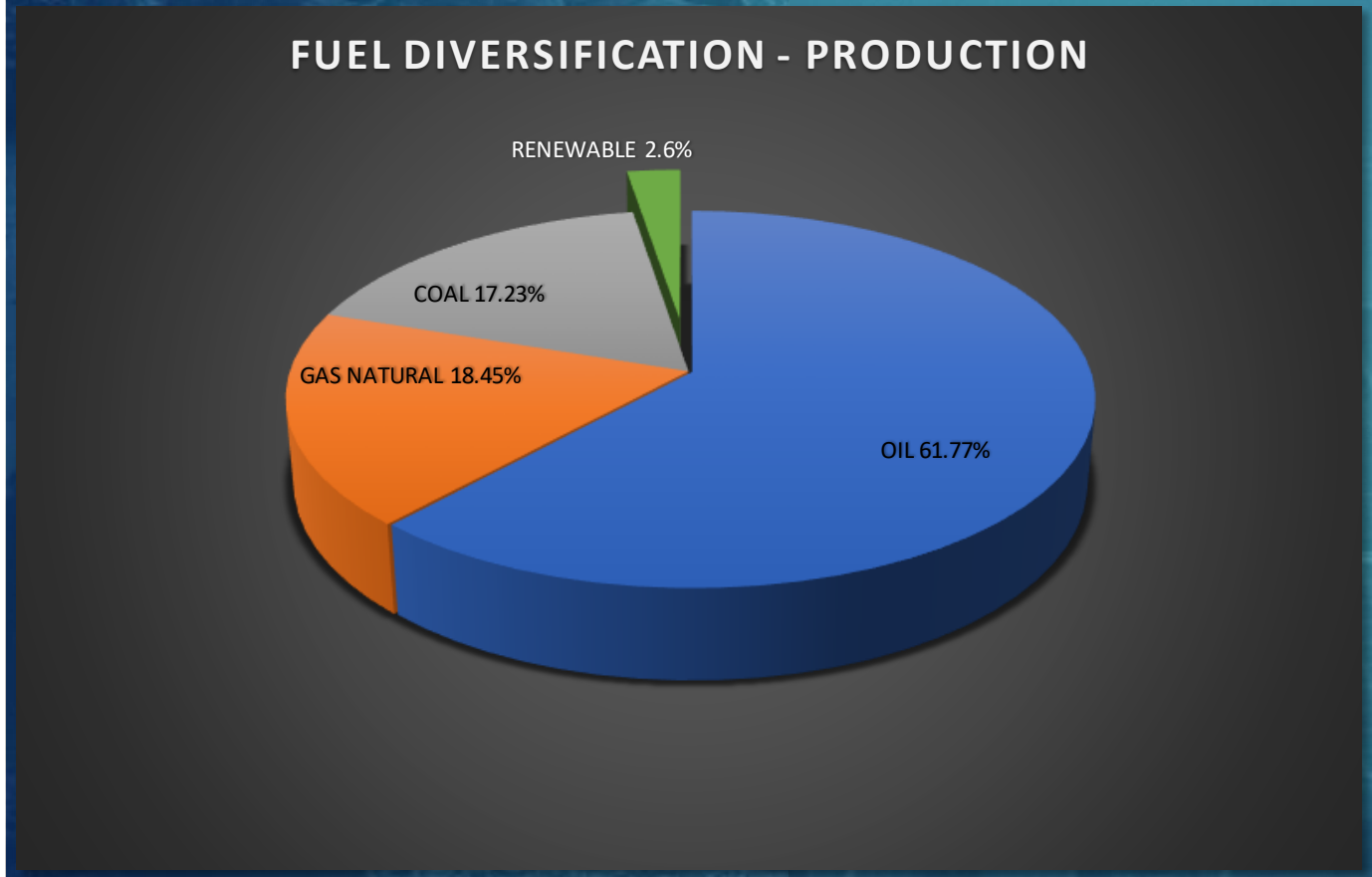
TRANSMISSION SYSTEM

- Transmission Lines: 2,478 miles of 230KV and 115KV

DISTRIBUTION SYSTEM

- The distribution lines add up around 31,446 air miles and 1,723

PERCENT DISTRIBUTION OF THE ELECTRICITY GENERATION



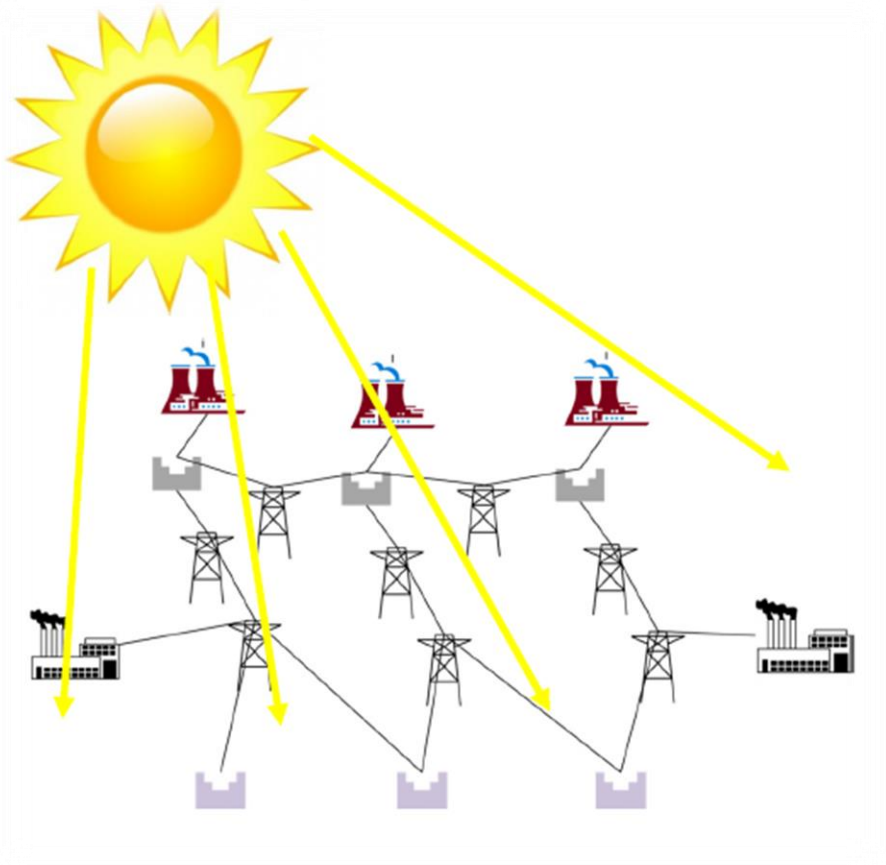
RENEWABLE

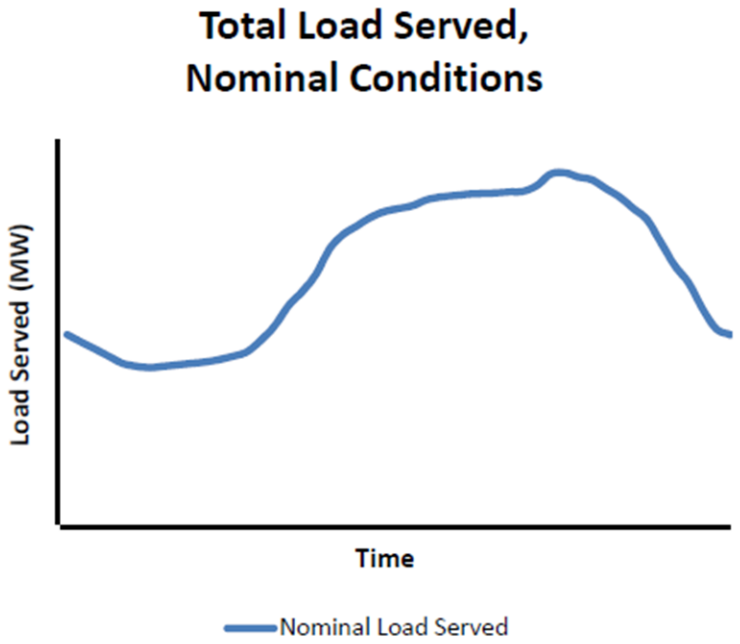
- WIND: 1.30%
- PHOTOVOLTAIC: 0.60%
- HYDROELECTRIC: 0.45%
- DISTRIBUTED GENERATION: 0.20%

THE ELECTRIC POWER SYSTEM IN PUERTO RICO

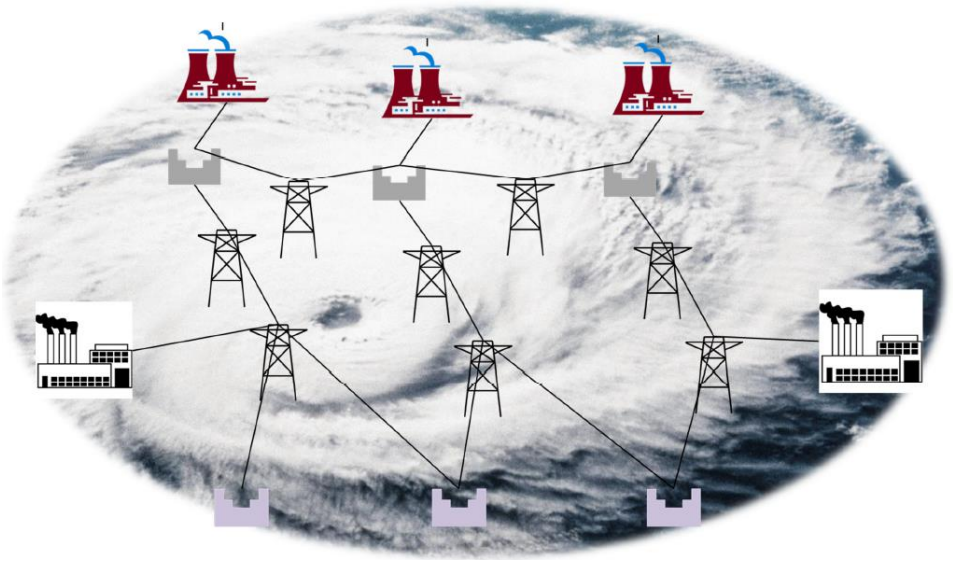
The electric power system in Puerto Rico is **centralized**. That is, the electricity is generated centrally in large quantities and then it is sent by the electric lines to the consumption zones.

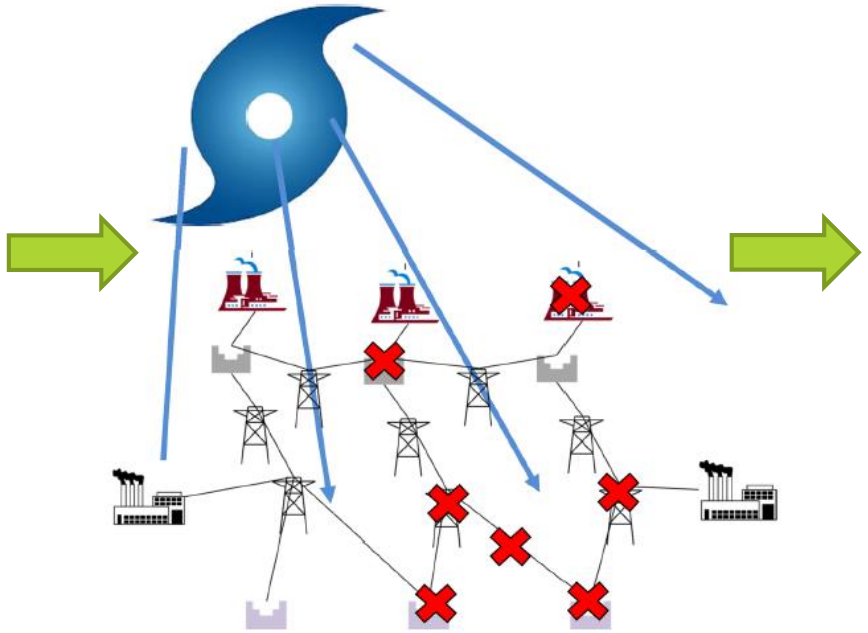
SCENARIO: NORMAL CONDITIONS

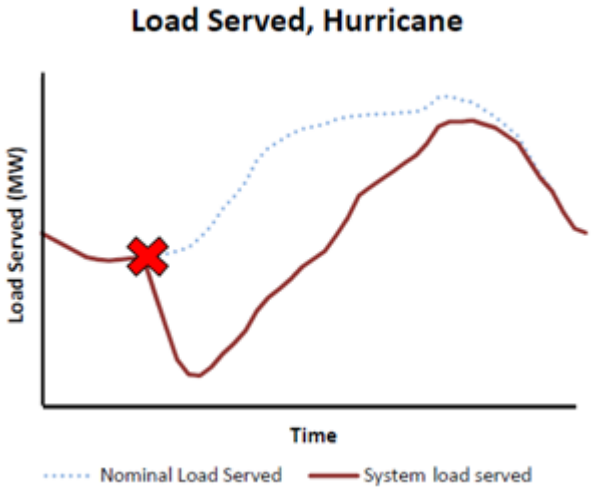




SCENARIO: HURRICANE, IMPACT ON LOAD SERVED







Hurricane affects ability to provide grid services

¿WHY COLLAPSED OF THE ELECTRIC POWER SYSTEM IN PUERTO RICO?

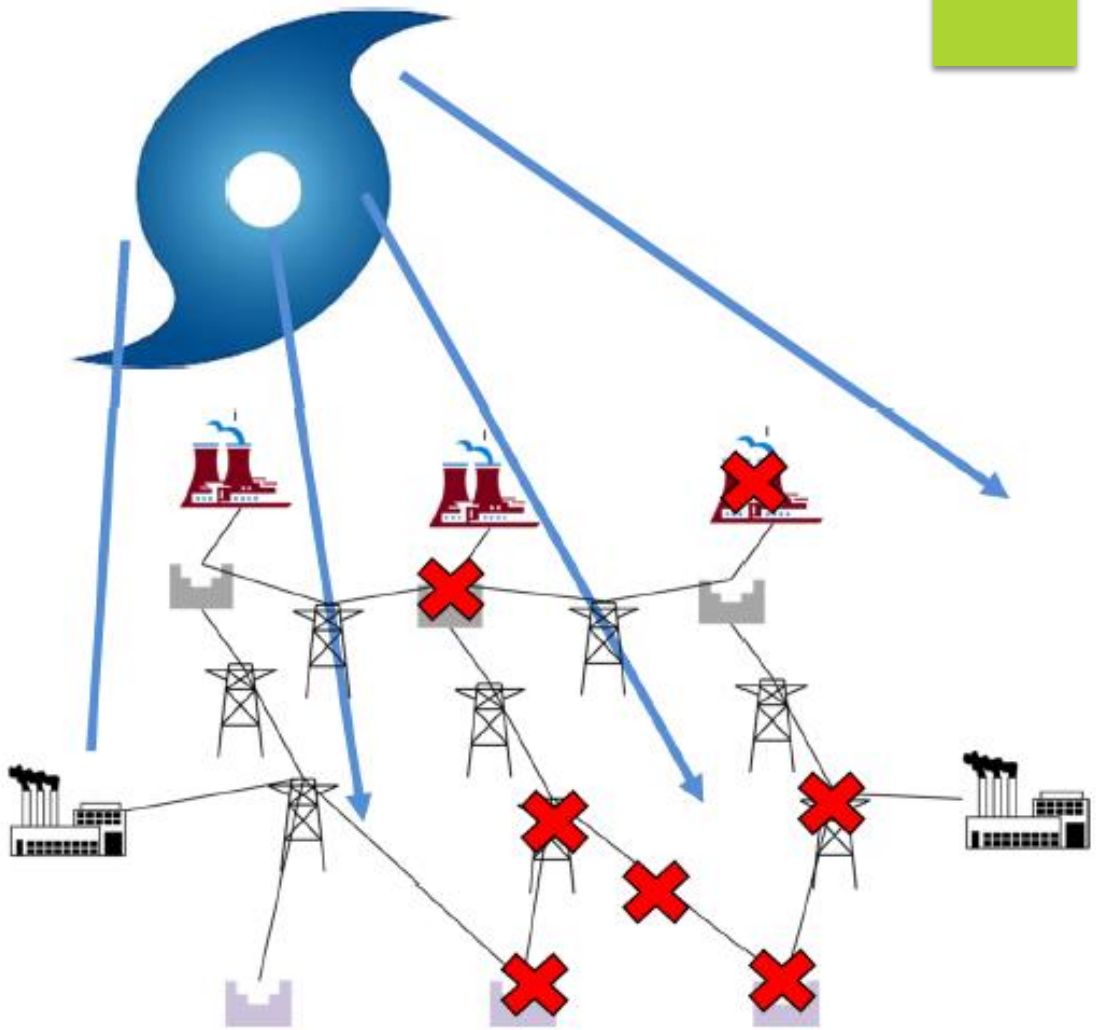
The Generating Plants suffered little damage during the passage of the hurricane

↓

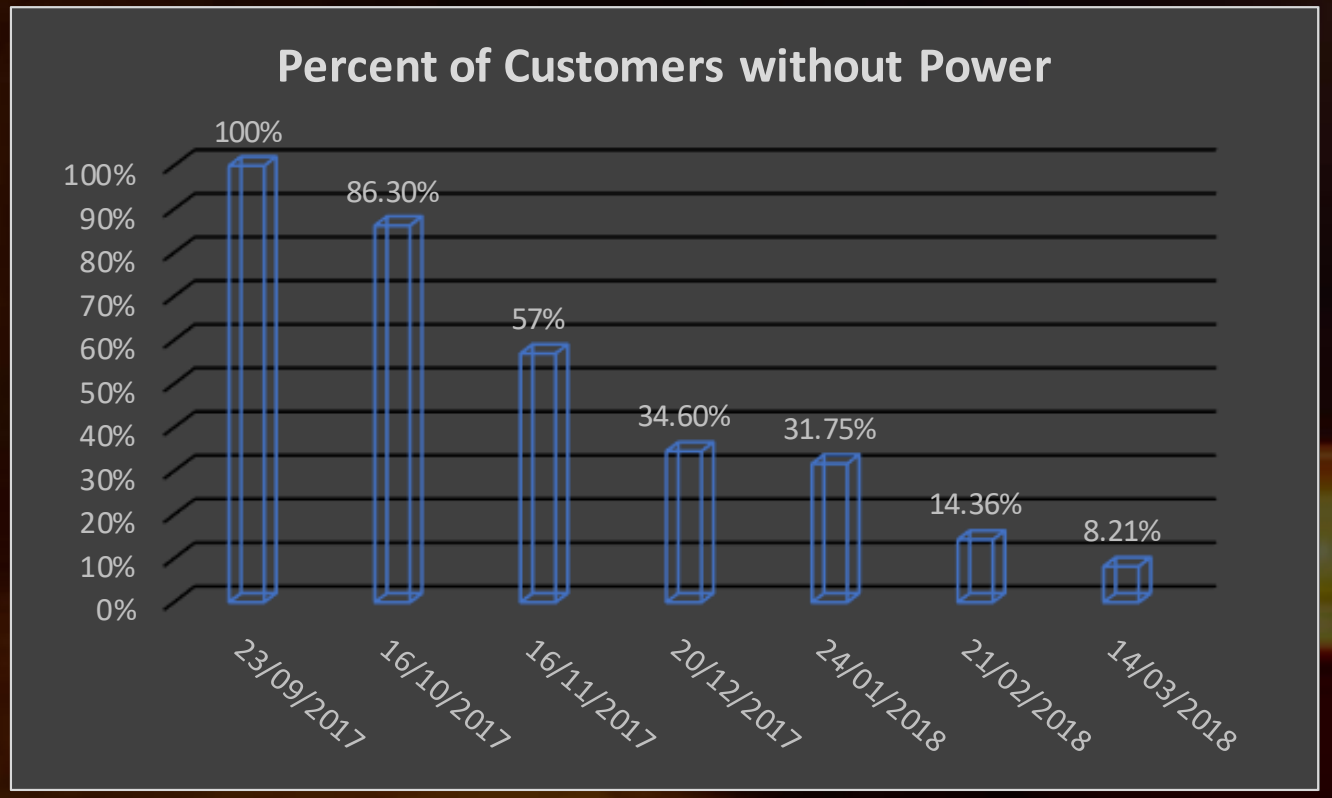
But without:
Transport Network
Distribution Network
Transmission Network

↓

The customers don´t receive electric power service

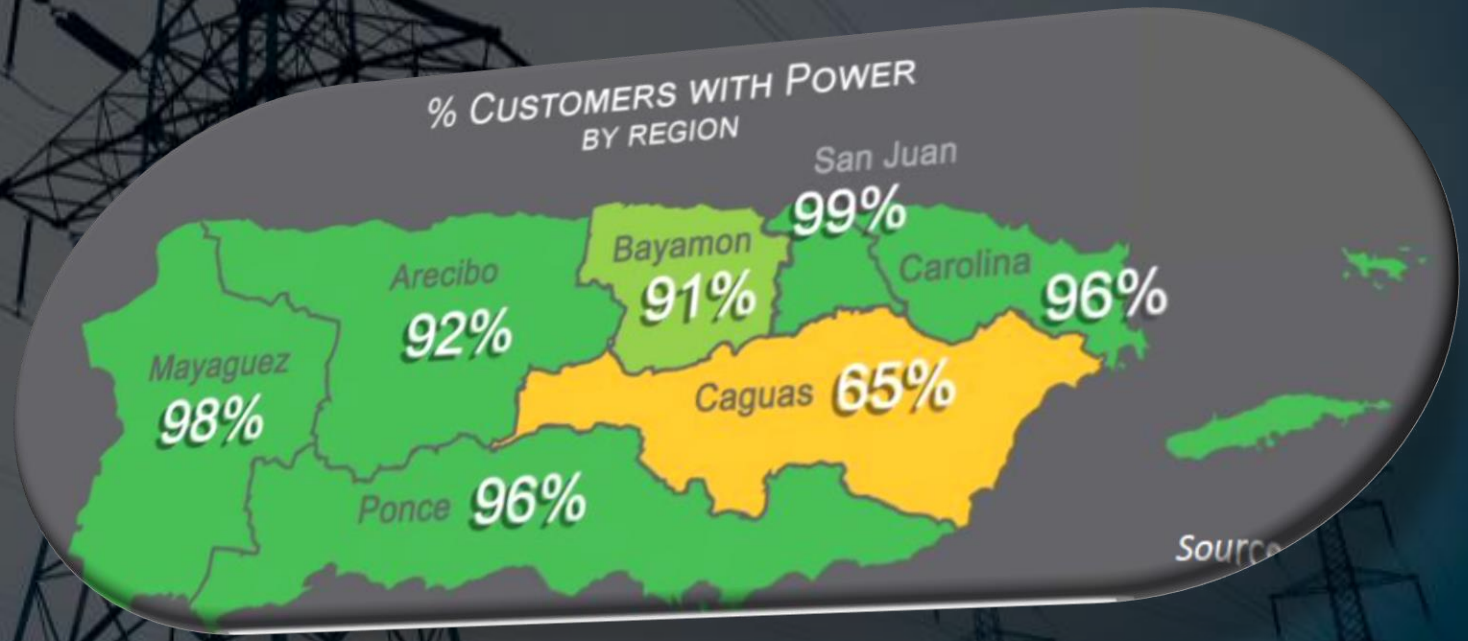


CUSTOMERS WITHOUT POWER



THE ELECTRIC POWER SYSTEM IN PUERTO RICO

Six months later of the hurricane Maria, the service hasn´t been restored in a 100% of the island



USE OF ELECTRICAL GENERATORS

Collapse of AEE

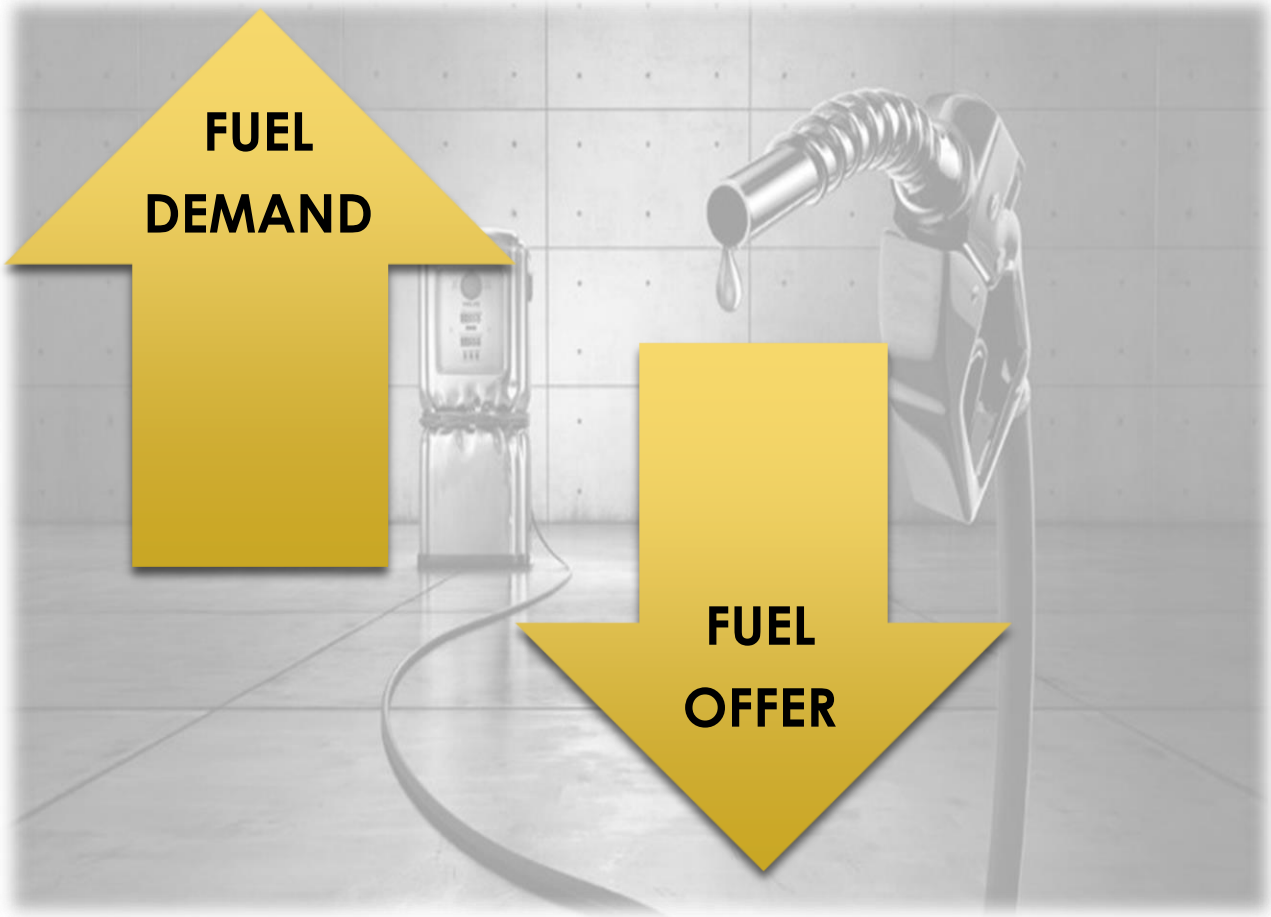
→

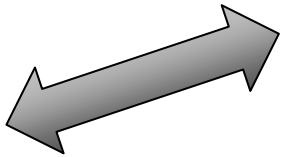
Increase in the use of Electrical Generators

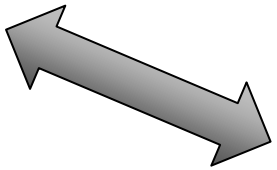
→

Shortage of fuel Offer/ Demand

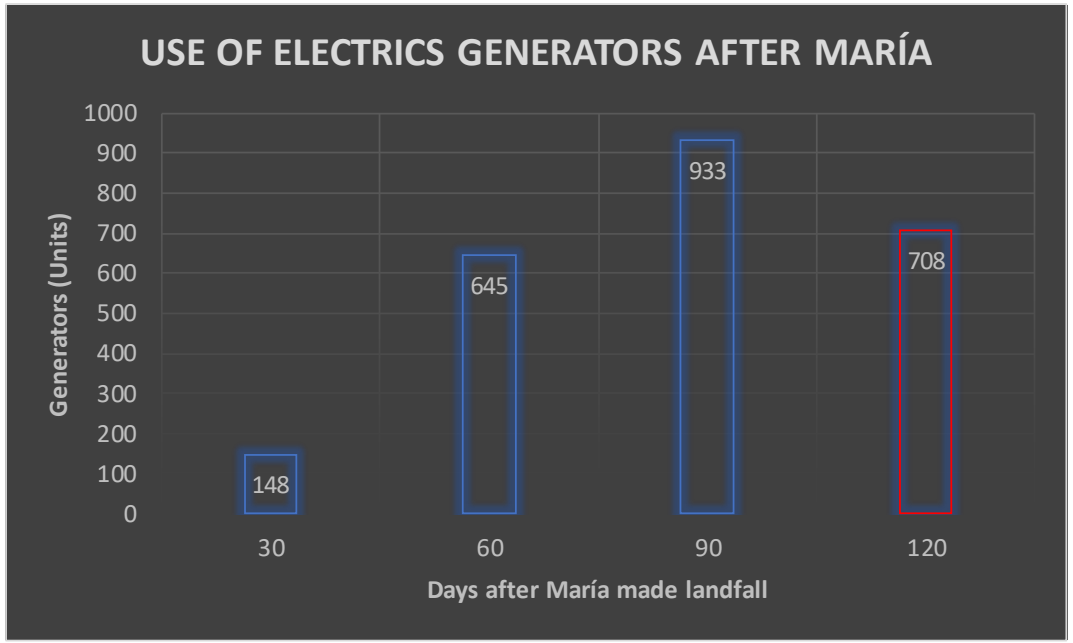
COLLAPSE OF THE LIQUID FUEL SUPLLY CHAIN

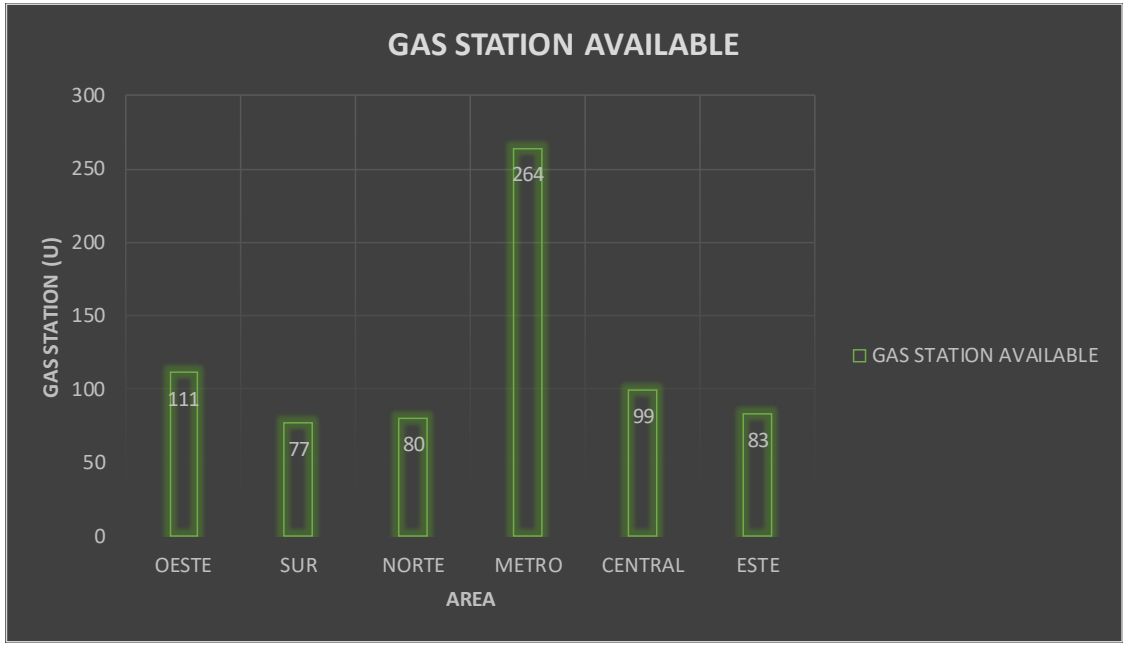






USE OF ELECTRICS GENERATORS AFTER MARIA Vs GAS STATION AVAILABLE





After 120 days of the hurricane, there are 708 electric power generators in use

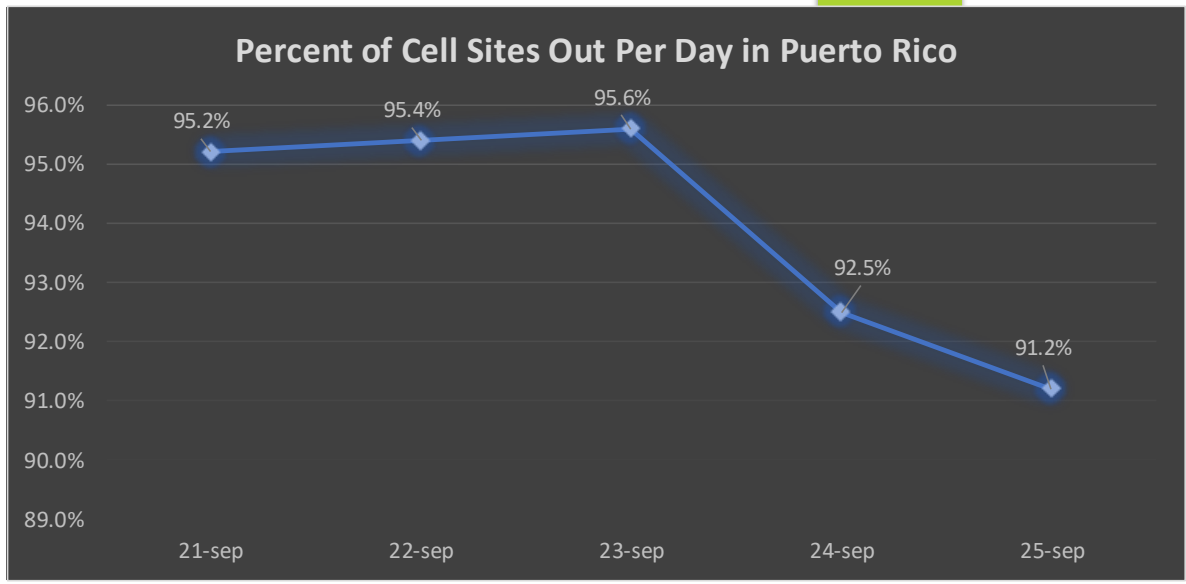
714 Gas station available 30 days after Maria

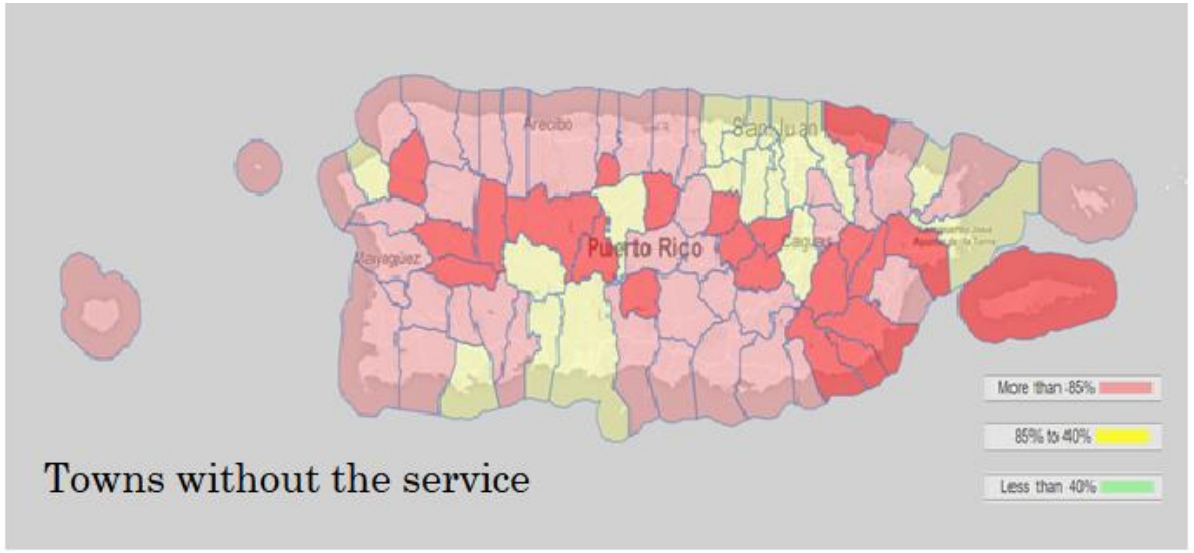
COLLAPSE OF TELECOMMUNICATIONS

34 towns without the services for damages in the system

91.2% of the Island without service

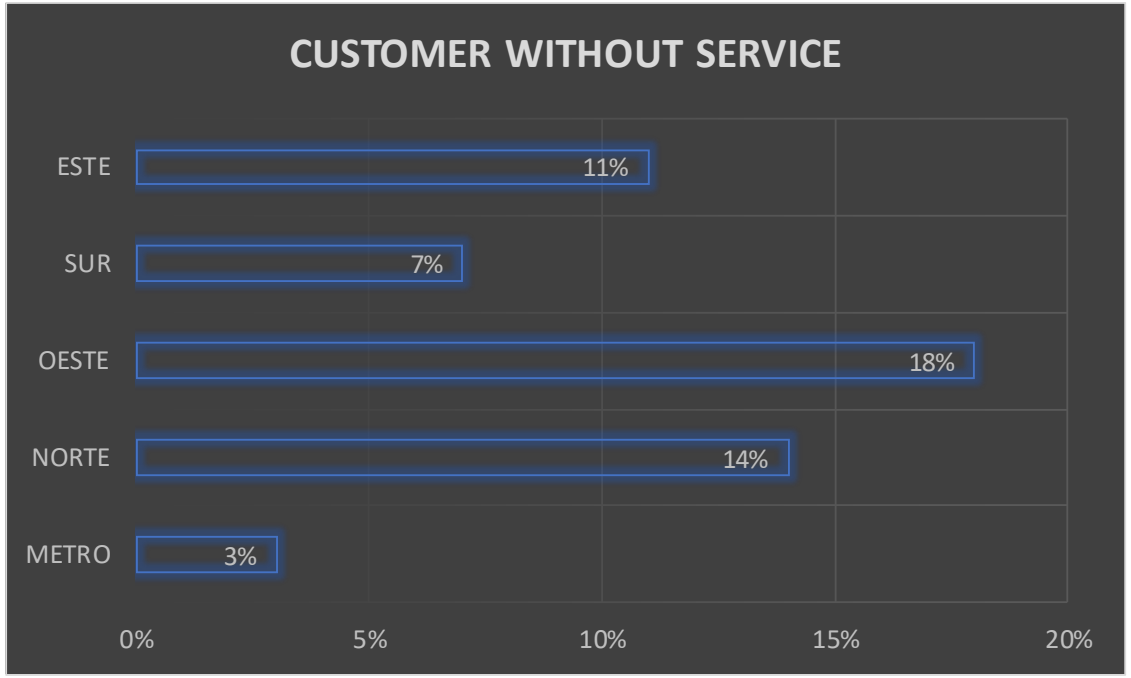
44 towns without service due to lack of electricity



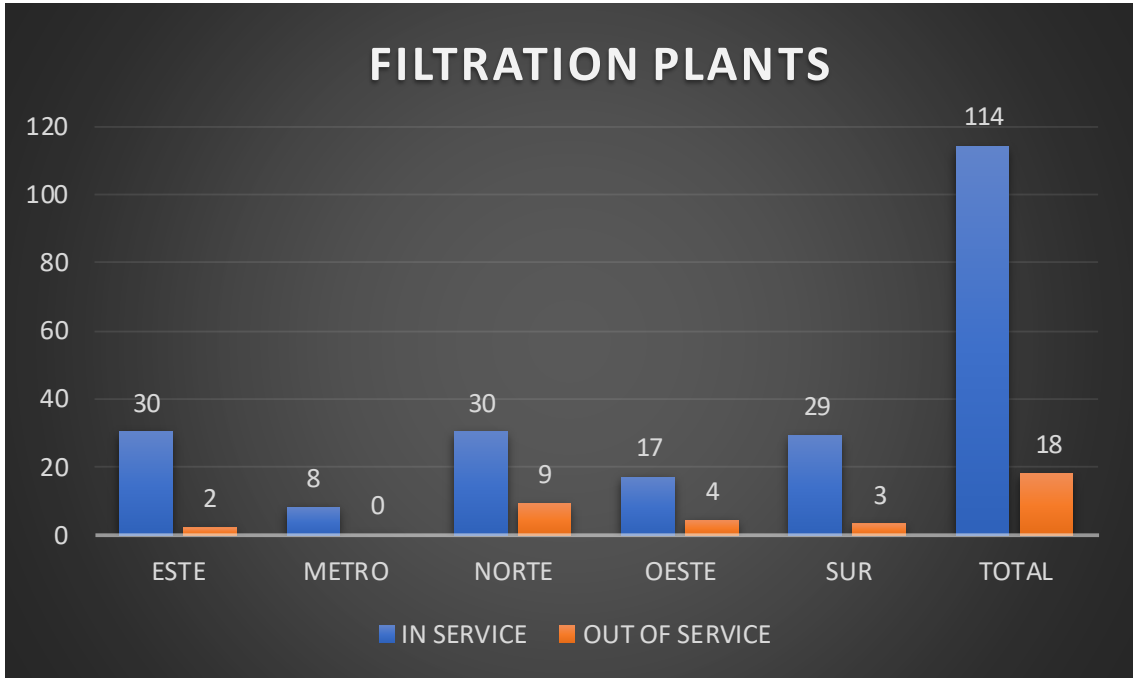


PUERTO RICO AQUEDUCT AND SEWER AUTHORITY(PRASA):

COLLAPSE OF THE AQUEDUCT SYSTEM IN PUERTO RICO



15/11/2017



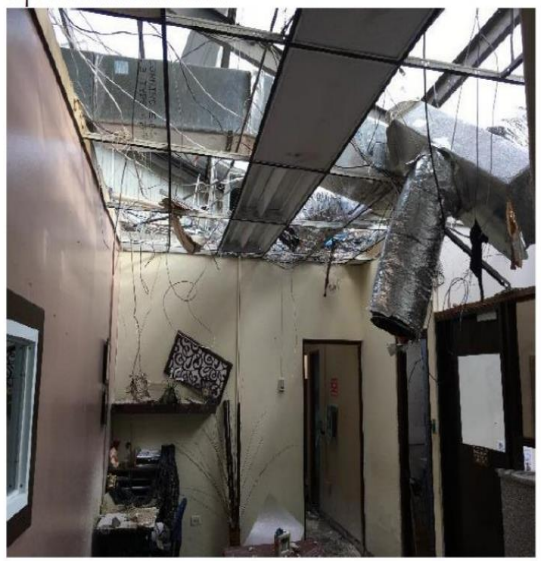
07/11/2017

"PRASA WATER IS NOT GOING TO DROWN THE PEOPLE"

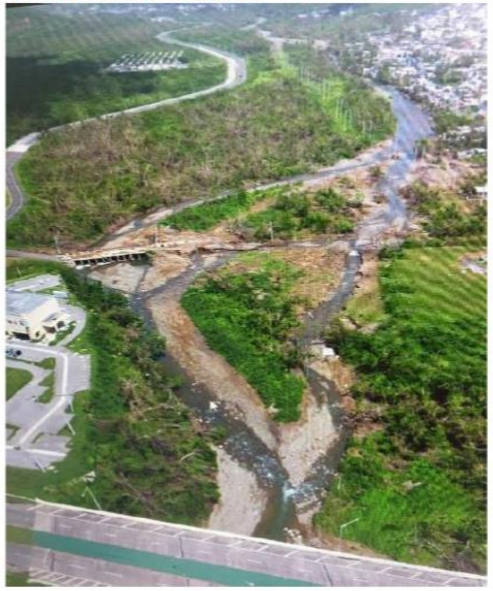
- Without electric power they can´t operate at 100% capacity
- Continuity in the operation with the use of electrical generators
- Suspension of operations for damage to the generators. Absence of a maintenance program.
- Three months after the hurricane PRASA operated with 1050 electrical generators

Tanque Buena Vista, Humacao

Operaciones Humacao



Troncal Río Gumaní



Troncal Comerío

US DROUGHT MONITOR PUERTO RICO

March 8, 2016

(Released Thursday, Mar. 10, 2016)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	57.00	43.00	18.83	4.97	0.00	0.00
Last Week 3/1/2016	57.00	43.00	18.83	4.97	0.00	0.00
3 Months Ago 12/8/2015	41.00	59.00	39.12	14.29	4.92	0.00
Start of Calendar Year 12/29/2015	41.00	59.00	41.71	14.29	4.92	0.00
Start of Water Year 9/29/2015	29.55	70.45	45.15	38.44	14.74	0.00
One Year Ago 3/10/2015	83.41	16.59	0.00	0.00	0.00	0.00

Intensity

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

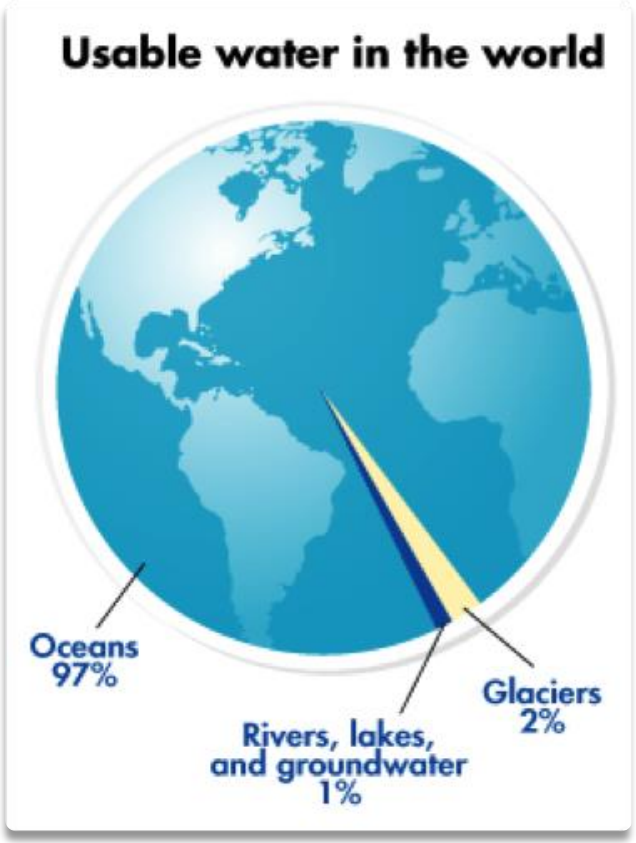
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
David Miskus
NOAA/NWS/NCEP/CPC

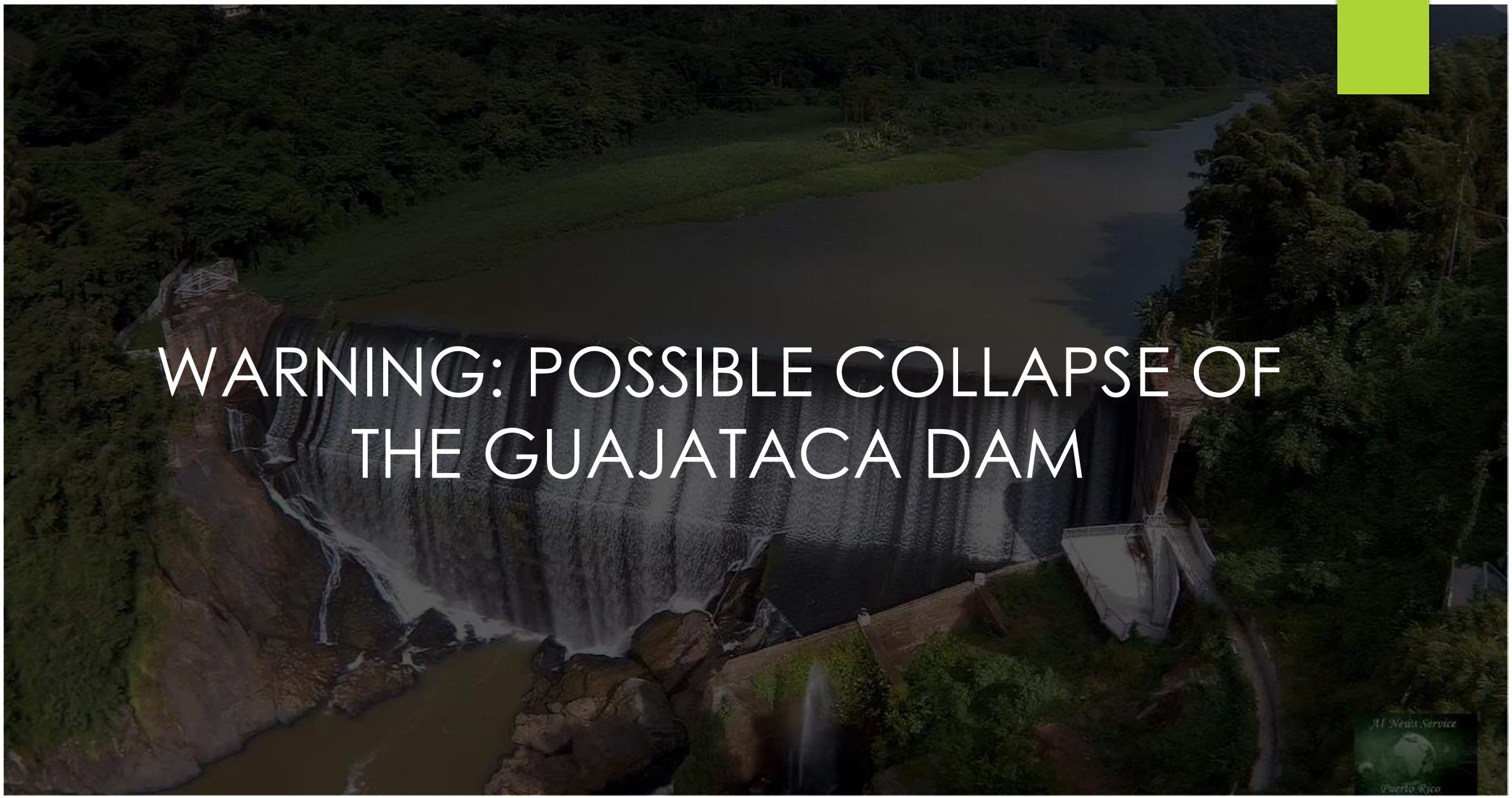
http://droughtmonitor.unl.edu/

INDUSTRIAL SECTOR RISKS- DROUGHT

- Growing scarcity of freshwater is increasingly seen as a major risk for the global economy.
- Physical risk: water shortage and pollution can affect operations and supply chains.
- Financial risk: stricter regulatory uncertainty could pose financial risk, such as higher water process, reduced rations, stricter emission permits or obligatory water saving technology
- Reputational risk: negative public attention if company is seen as contributing to unsustainable water use.

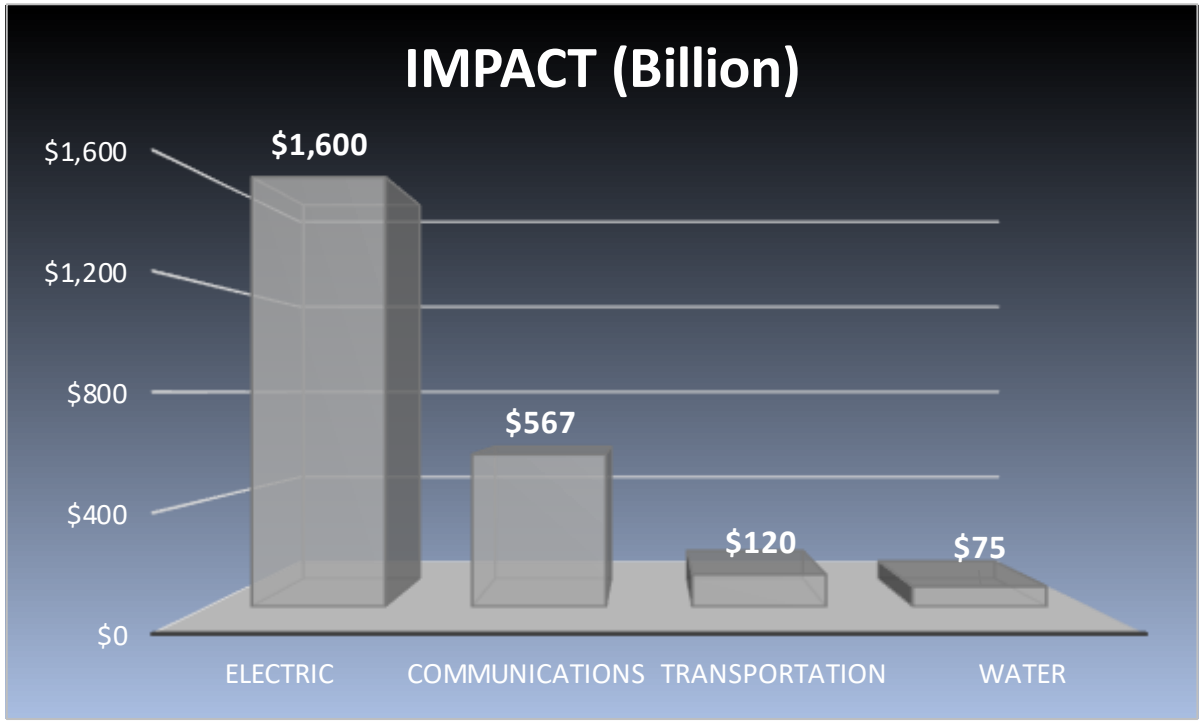


WARNING: POSSIBLE COLLAPSE OF THE GUAJATACA DAM



ESTIMATE COSTS OF HURRICANE MARIA

- Two key companies in the economy of Puerto Rico had great lost: PREPA and PRASA
- The infrastructure damages costs it´s around $50 billions
- **The hurricane has made clear the need not just to return the system to its pre-hurricane status, but to transform it into a modern, resilient, and efficient electric power system.**



Confirmed data in oct. 2017

HOW MUCH DID THE HURRICANE COST YOU?

INDUSTRY FAILURES

1

Inadequate infrastructure

Little Resilient

(Dependence of PREPA)

2

Weak Supply Chain

3

Inefficient maintenance programs in electric power generators

4

Outdated contingency plans

NEED FOR INDUSTRY FOR CONTINUITY IN OPERATION

In the face of disruptive events such as natural disasters, the industry depends and needs:


ELECTRIC POWER


WATER


FUEL


RAW MATERIAL


MANPOWER

CHANGES IN THE INDUSTRY TO BE RESILIENT

- Increase the resilience of Puerto Rico's electrical system
- increase the reliability (Capacity and safety) of the industry's electrical system:
  - **Capacity:** Existence of sufficient facilities to meet the demand and operational restrictions of the system
  - **Safety:** ability to respond to disturbances caused by the electrical system
- Consider disruptive events (natural disasters) as a risk of occurrence and high impact on the electrical system

RESILIENT INFRASTRUCTURE

ENERGY EFFICIENCY MASTER PLANING (EEMP)

You can not manage, control and improve something that you do not really measure or understand

ISO 50001 Energy Management Systems:

Establishes the requirements to become a system of energy management in an organization to help:

Improving energy efficiency

Increase energy efficiency

Reduce the environmental impacts

Increase their competitive advantage in the markets in which they participate

WHY IMPLEMENTING EEMP: SOLUTIONS

The Energy efficiency (Energy Management) known as “The Fifth Fuel” this can help to meet the growing demand for energy as surely as coal, gas, oil or uranium. But in these times of increasing environmental awareness has been moved up a category.

WHY ENERGY EFFICIENCY (EE) ?

Negawatts win over Megawatts

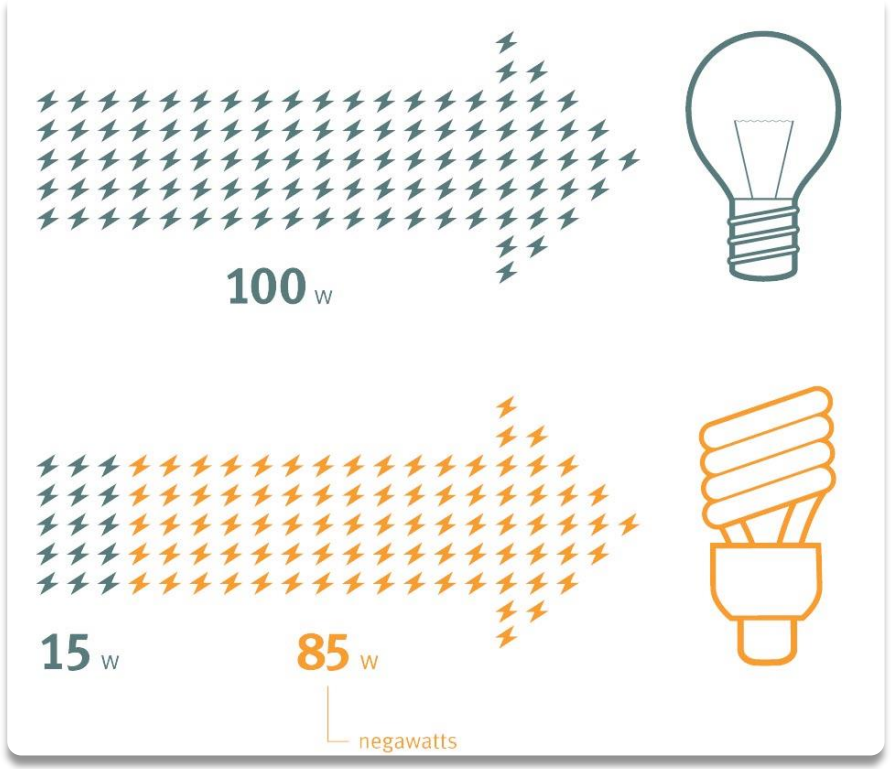
Economic perspective (National and/or Supplier) :

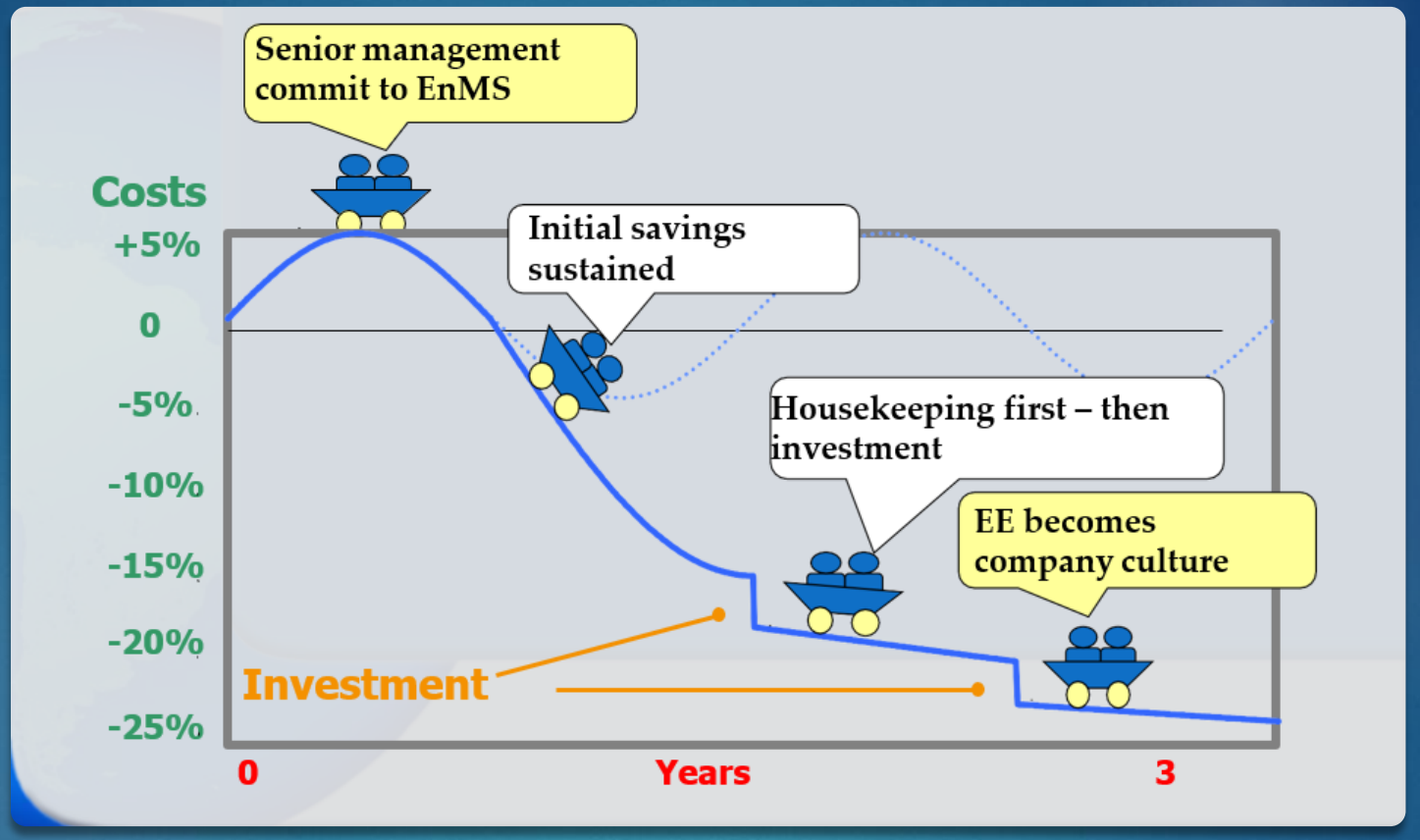
EE (or Negawatts) are cheaper than Megawatts

EE provides maximum system wide benefits

EE reduces need for imports & scare resources

EE mitigates risk from supply vulnerabilities





SYSTEMATIC APPROACH


Do you have a backup
plan?
Yes
No

DO YOU KNOW WHEN THERE WILL BE A SUSPENSION OF THE ELECTRIC POWER SERVICE?

What is your position in this situation?

No Backup

Lock up, go home and wait for power to return. There are no customers and there is no revenue until power is restored.

Orderly Shutdown

Safely shut down computers and registers. Key customer/business data is protected, but customers will have to go elsewhere until utility power returns.

Limited Operation

With backup power for essential circuits, you can stay open for business, but not at full productivity. Losses are reduced and you can continue to provide some level of service to your customers.

Full Operation

Operations continue as if there were no outage. Revenues increase and new customers are gained while competitors are closed or operate at reduced capacity.

SOME CONSEQUENCES

Lost revenue is only part of the story. When you consider some of the other direct costs and intangible losses, it's easy to see why an extended outage can be devastating.

- Data can be lost
- Customers are inconvenienced and buy from your competitors
- Employees are idled
- Manufacturing processes are disrupted
- Refrigerated goods spoil
- Security systems may be disabled

BACKUP POWER PLAN

The company must garantee businees continuity in the event of any disruptive event. It is responsible for minimizing the impact of a disruption to our customers, employees, infrastructure, and business operations.

Develop Business Continuity and Disaster Recovery plans

Identify critical functions, infrastructure and risks

Implement strategies to minimize the risk of a disruption

Develop Business Continuity and Disaster Recovery plans

Critical infrastructure refers to the assets, systems, and networks, whether physical or virtual, so vitals that their incapacitation or destruction would have a negative and debilitating effect for the company , in competitive and economics terms

STRATEGIES TO MINIMIZE THE RISK OF A DISRUPTION

REDUNDANCY

The inclusion of extra components that are not strictly necessary to functioning, in case of failure in other components.

EQUIPMENT REDUNDANCY

Equipment redundancy in heating/cooling systems is built as a safeguard in case of equipment failure to ensure operation at all times. Often referred to as N+1, firm capacity, etc.

POWER REDUNDANCY

What powers your campus, plant or facility?

Electricity Supply Grid

- Generating reserves
- Substation equipment
- Feeders

Onsite Generation

- Emergency generators
- Combustion Turbines
- Solar panels

Microgrids

- Operate independently from the rest of the grid
- Localized grids that are normally connected to traditional electric grids but can be disconnected in times of emergency

FUEL REDUNDANCY

Back-up fuel sources are as important to emergency power generation as the power source

Fuel types dictate the selection of emergency generation because of availability, storage, and power range

- Delivery
- Storage
- Environment
- Security
- Cost
- Technology

NATURAL GAS

BIO FUEL

PROPANE (LPG)

RELIABILITY

The ability of a system or component to perform its required functions under stated conditions for a specified period of time.

Fuel Supply

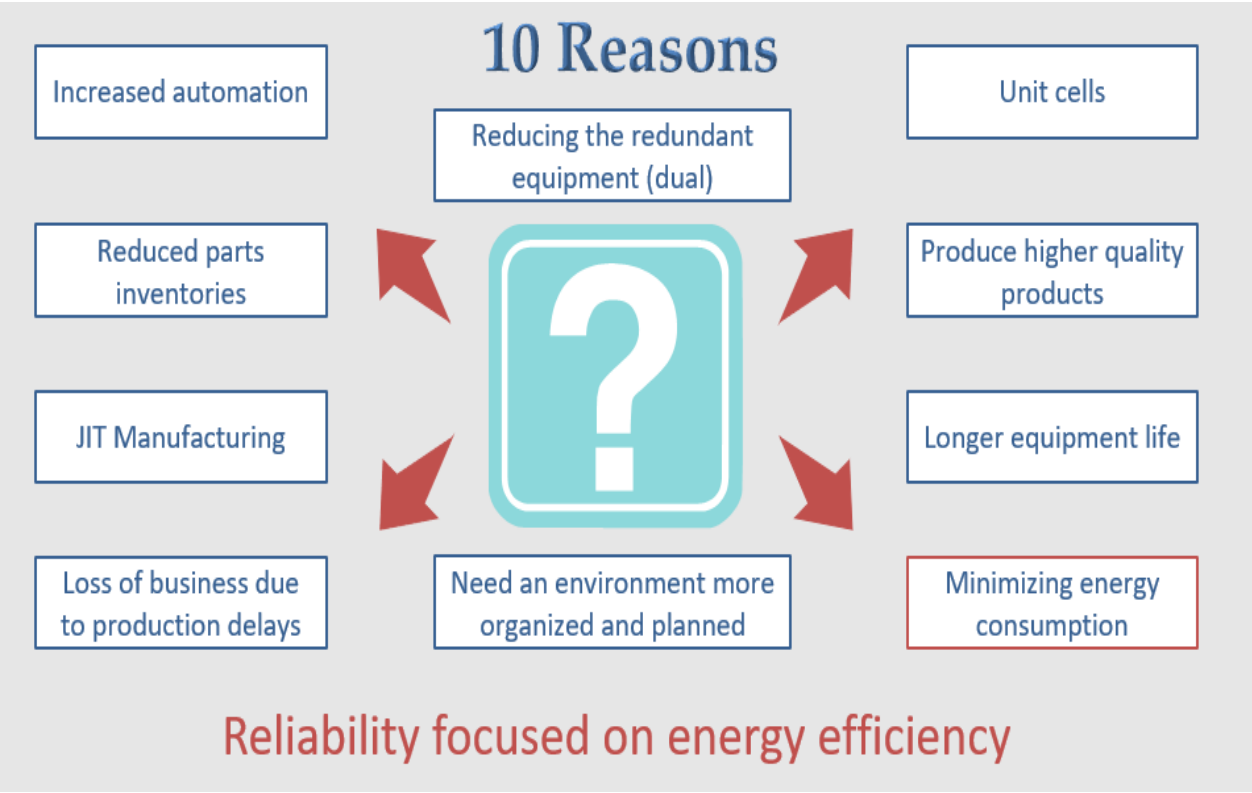
- Gas Pressure
- Frequency of Curtailment
- Delivery routes
- Contracts

Equipment Reliability - >95%

- Combustion Turbines
- Electrical Centrifugal Chillers
- Boilers
- Reciprocating Engines

RELIABILITY OPERATIONAL

WHY REIABILITY IS IMPORTANT?



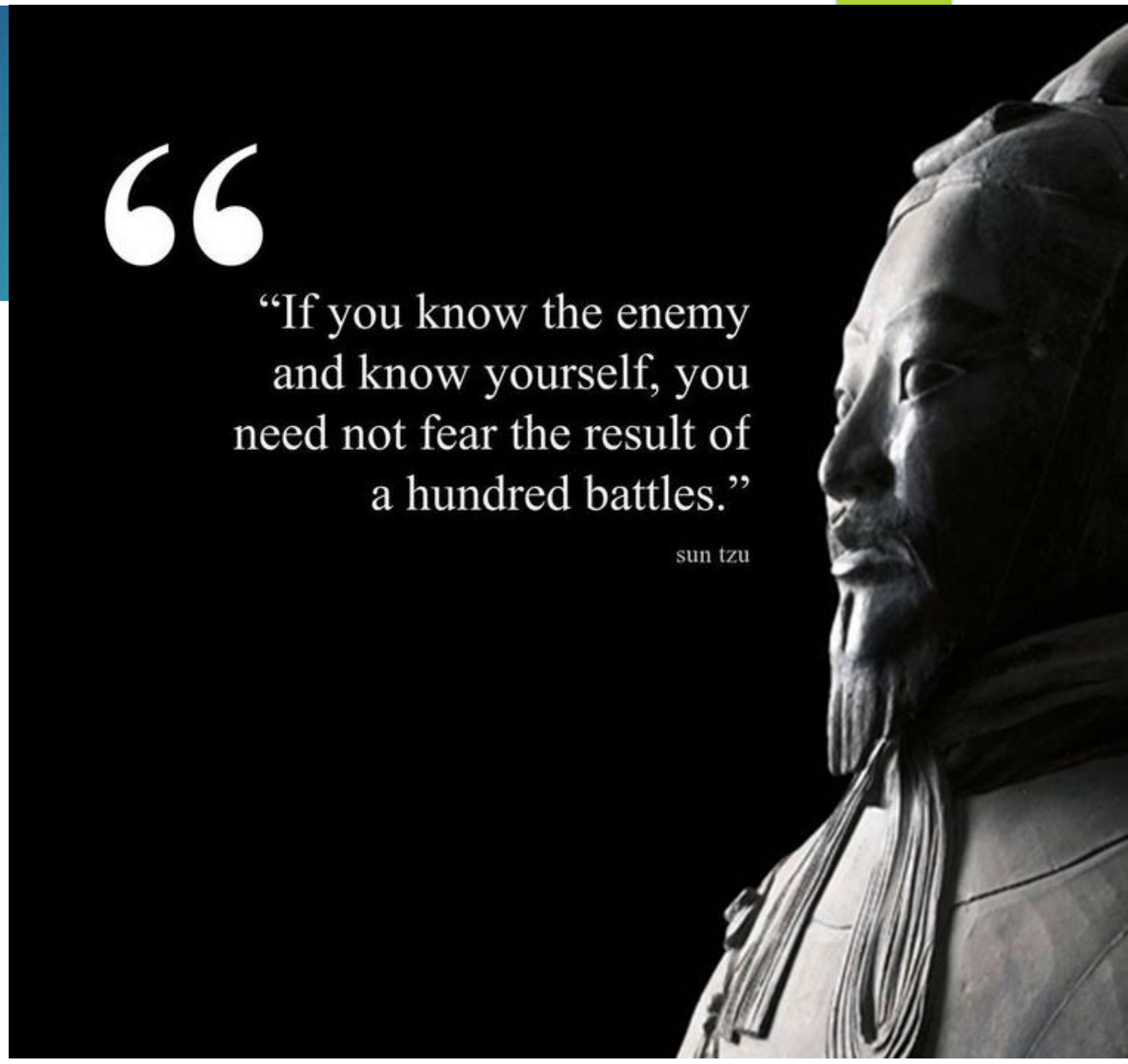
BENEFITS OF RELIABILITY IMPLEMENTATION

STRATEGY

- Who is our enemy?
  - **Failure**: the inability of an asset to perform its designed function.

Reliabilityweb.com

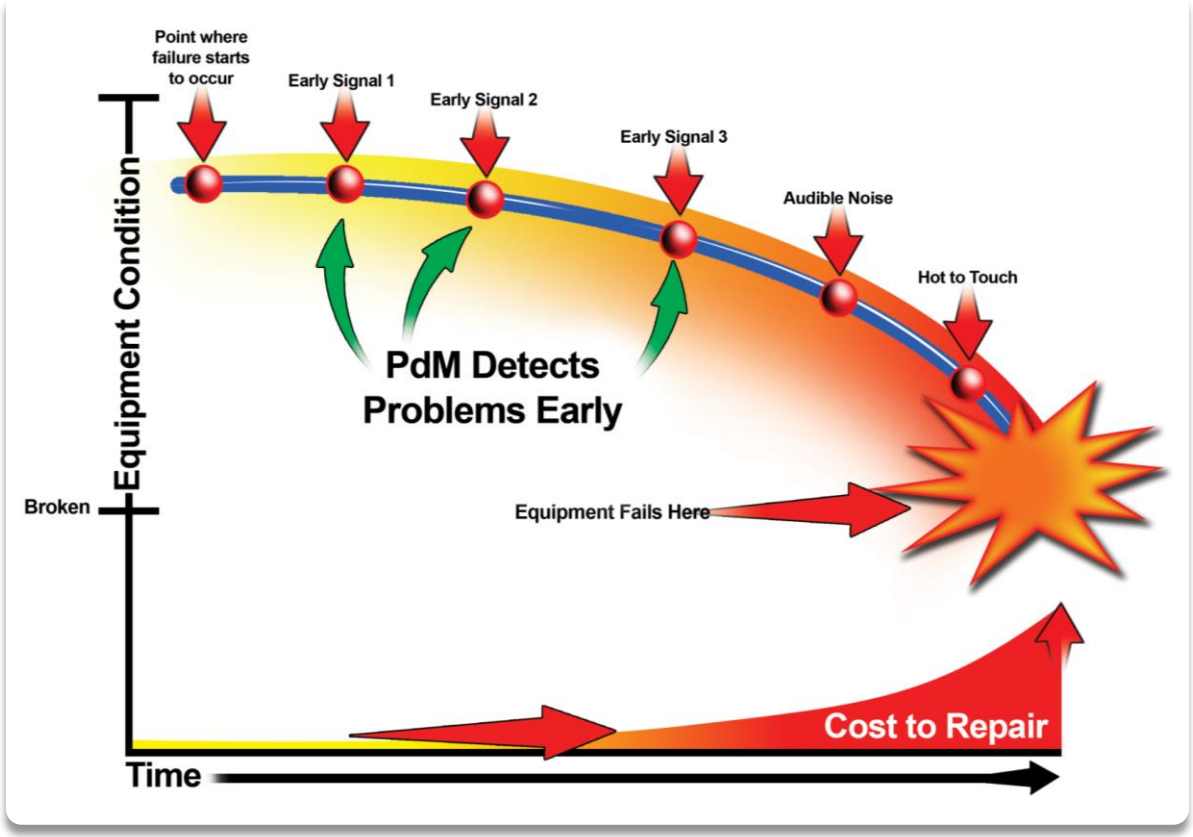
  - How is failure expressed on our Assets?
  - Functional Failure vs Operational Failure



STRATEGY ASSET CONDITION MANAGEMENT

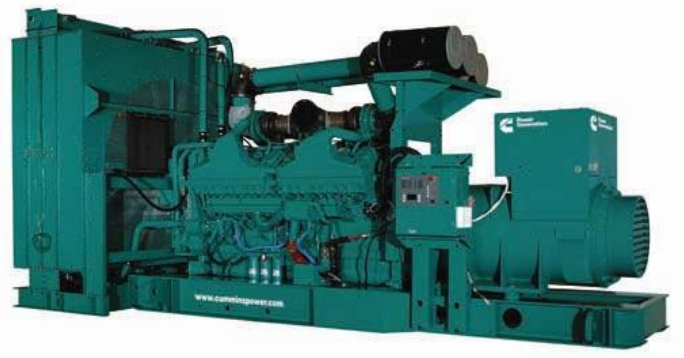
Condition Based Maintenance: "an equipment maintenance strategy based on measuring the condition of equipment to assess whether it will fail during some future period and taking appropriate action to avoid the consequences of that failure."

Reliabilityweb.com



RESILIENCY

The power or ability to return to the original operating condition after loss of power, natural disaster, etc.



Black Start

The capability to Black Start, a procedure to recover from a total or partial grid shutdown, prevents prolonged power outages in the event of a natural or man-made disaster

RESILIENT ENERGY SYSTEM

"RESILIENCE is the ability of an energy system to tolerate external disturbances and continue to supply energy to consumers.

A RESILIENT ENERGY SYSTEM is one that can quickly recover from large shocks providing VARIOUS means to supply energy whenever there are changes in external circumstances" (UK Energy Research Center, 2011)

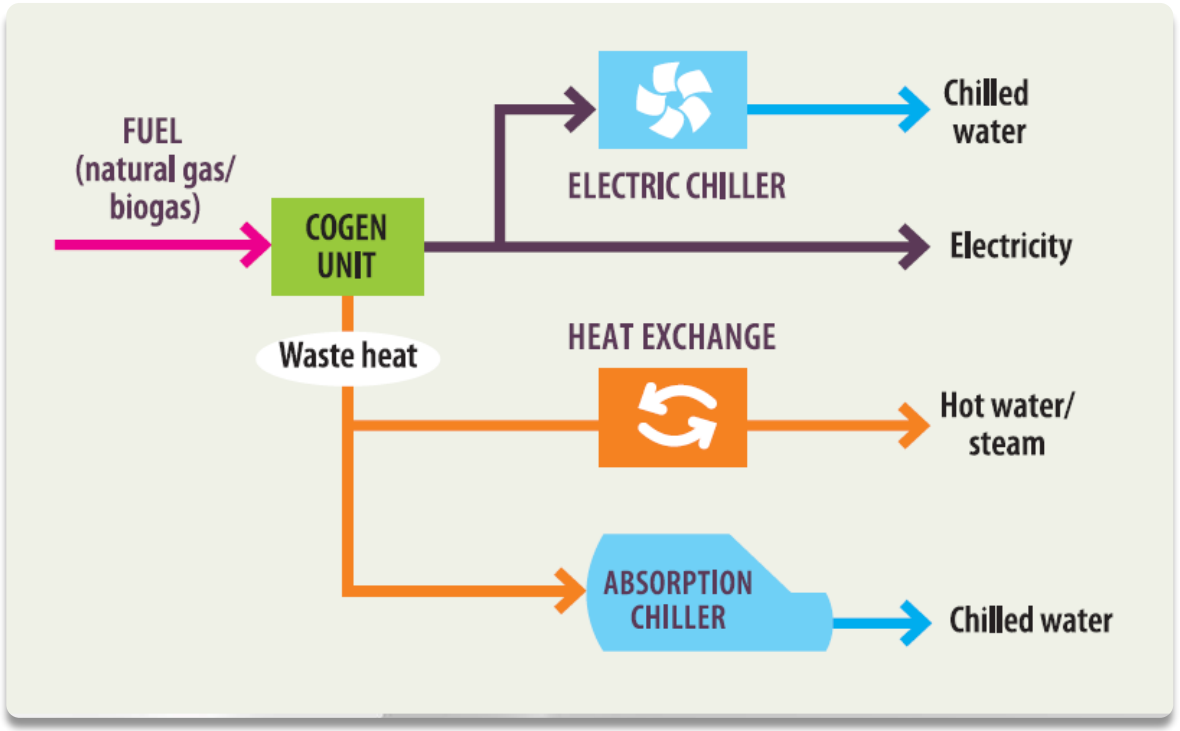
COMBINED HEAT & POWER (CHP)

Combined Heat & Power (CHP) is the simultaneous generation of electricity and useful heat from a single fuel source.

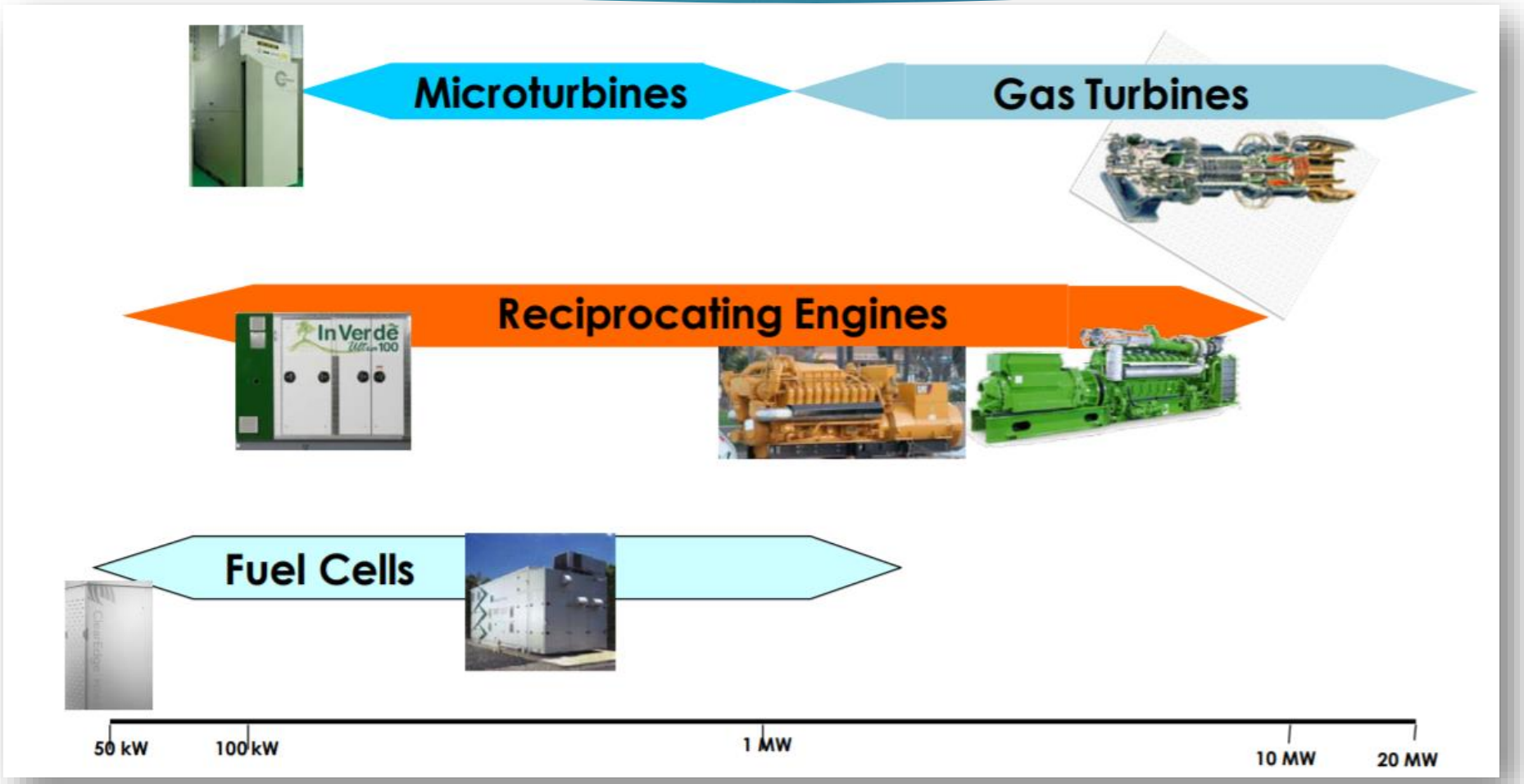
CHP, is also known like:

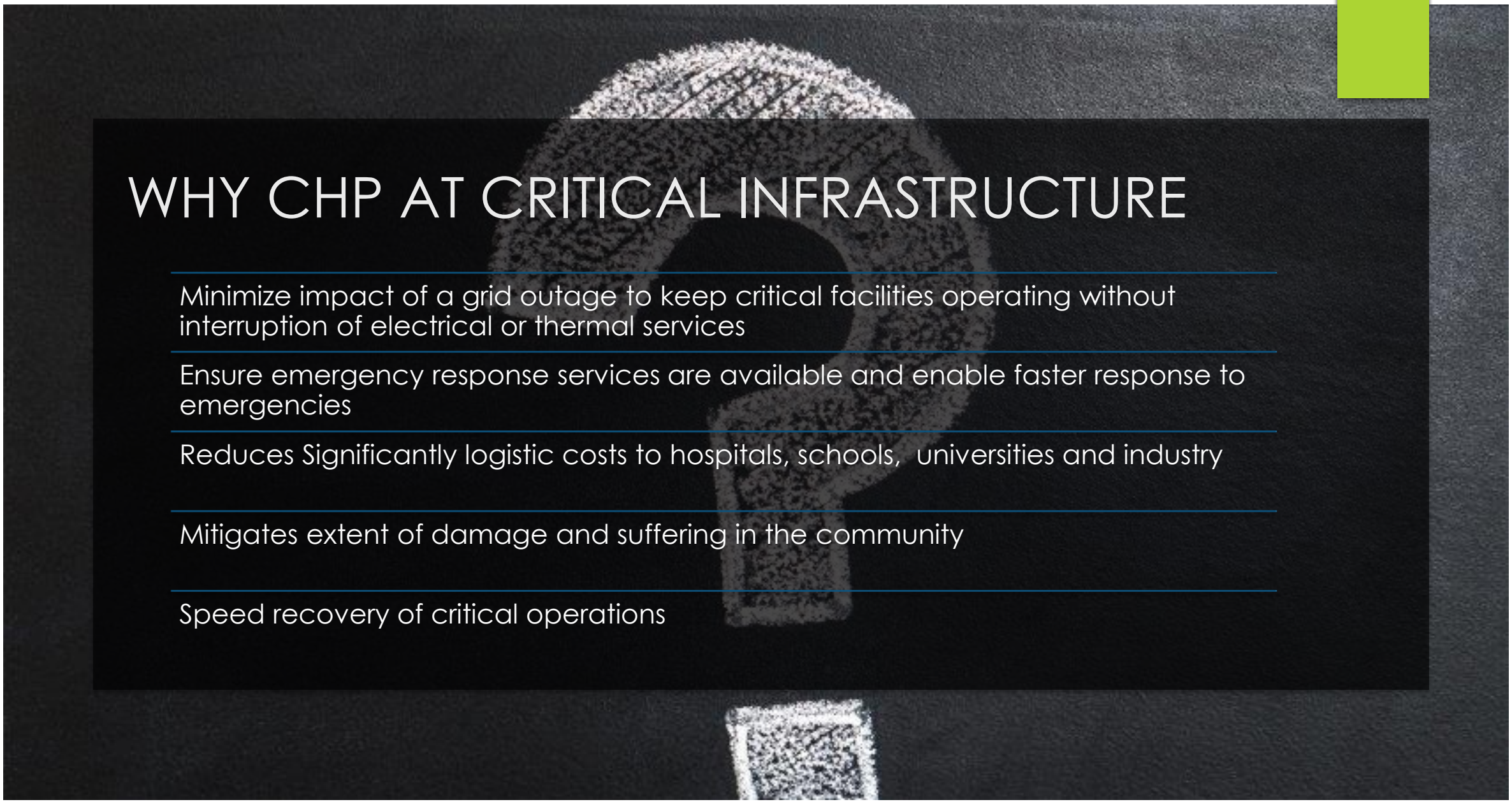
- Cogeneration
- Tri-Generation
- Combined Cooling, Heating, and Power (CCHP)

Unlike conventional plants that release heat without taking advantage of it and send it to the environment, CHP plants can simultaneously use the generated energies



COMMON CHP TECHNOLOGIES





WHY CHP AT CRITICAL INFRASTRUCTURE

- Minimize impact of a grid outage to keep critical facilities operating without interruption of electrical or thermal services
- Ensure emergency response services are available and enable faster response to emergencies
- Reduces Significantly logistic costs to hospitals, schools, universities and industry
- Mitigates extent of damage and suffering in the community
- Speed recovery of critical operations

BENEFITS OF CHP

SAVE MONEY: That mean you can cut your energy cost by 40% and focus on what´s really important

INCREASE RELIABILITY: CHP systems provide reliable power independent of weather and time

BE INDEPENDENT: Be your own energy supplier and take back control over your energy cost

BE SUSTAINABLE: Meet the highest environmental standards. lower Co2 emissions by 60%

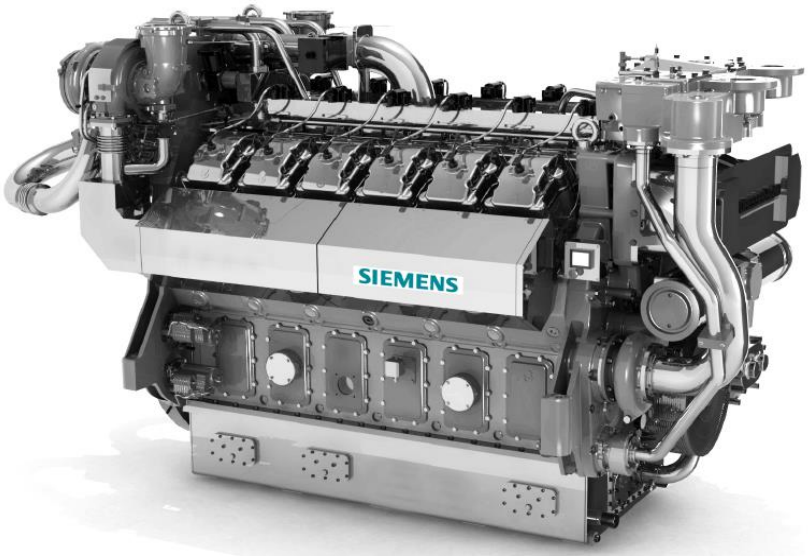
CHP vs BACKUP GENERATION

	CHP	BACKUP GENERATION
System Performance	Designed and maintained to run continously Improved performance reliability	Only used during emergencies
Fuel Supply	Propane gas infrastructure typically not impacted by severe weather	Liquid fuel limited by on-site storage.
Transition from Grid Power	May be configured for "flicker-free" transfer from grid connection to "island mode"	Lag time may impact critical system performance
Energy Supply	Electricity Thermal (heating, cooling, hot/chilled water)	Electricity
Emissions	Typically natural gas fueled Achieve greater system efficiencies (80%) Lower emissions	Commonly burn diesel fuel

CONTINUOUS/PRIME GENERATION

- Continuous Generators
  - To be used as Main Source of Power
  - Designed to operate Continuously with **Consistent** Load

- Prime Generators
  - To be used as Main Source of Power
  - Designed to operate Continuously with **Variable** Load



CONTINUOUS / PRIME Vs STANDBY GENERATORS

Feature	Continuous/Prime	Standby
Cooling System	Large cooling system to prevent inevitable build up of temperature. Includes cooling for lubricating oil.	Small Cooling System sufficient enough to cool down the engine to the max allowed temperature.
Alternator	Heavy-Duty Winding to withstand temperature rise due to continuous flow of current.	Regular Winding not designed for extended period of use.
Air Cleaner Assemblies	Continuous power generators require heavy-duty air cleaners, air filters, and air cleaner assemblies.	Require to to clean its internal parts and components intermittently.
Timing	Gear	Belt or Chain
Preventive Maintenance	Every 1,300 Hours or Higher	Every 250 to 500 Hours

RENEWABLE ENERGY

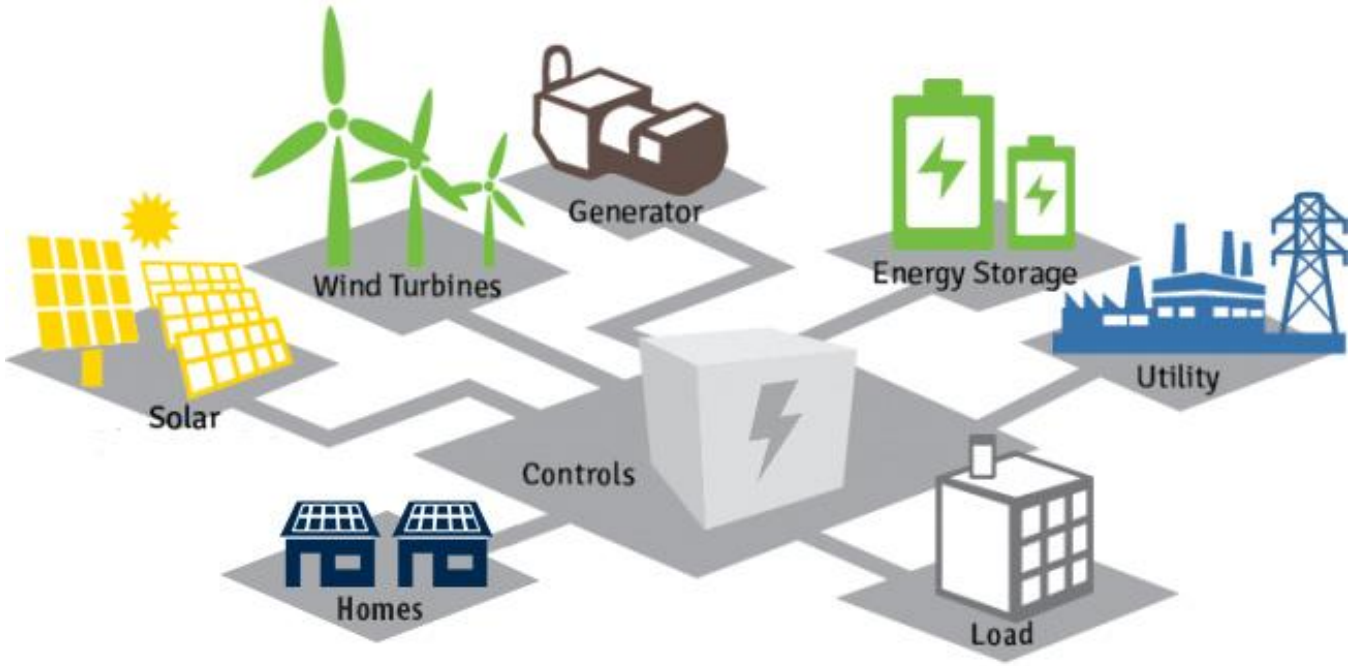
Energy derived from natural processes that are replenished at a faster rate than they are consumed.

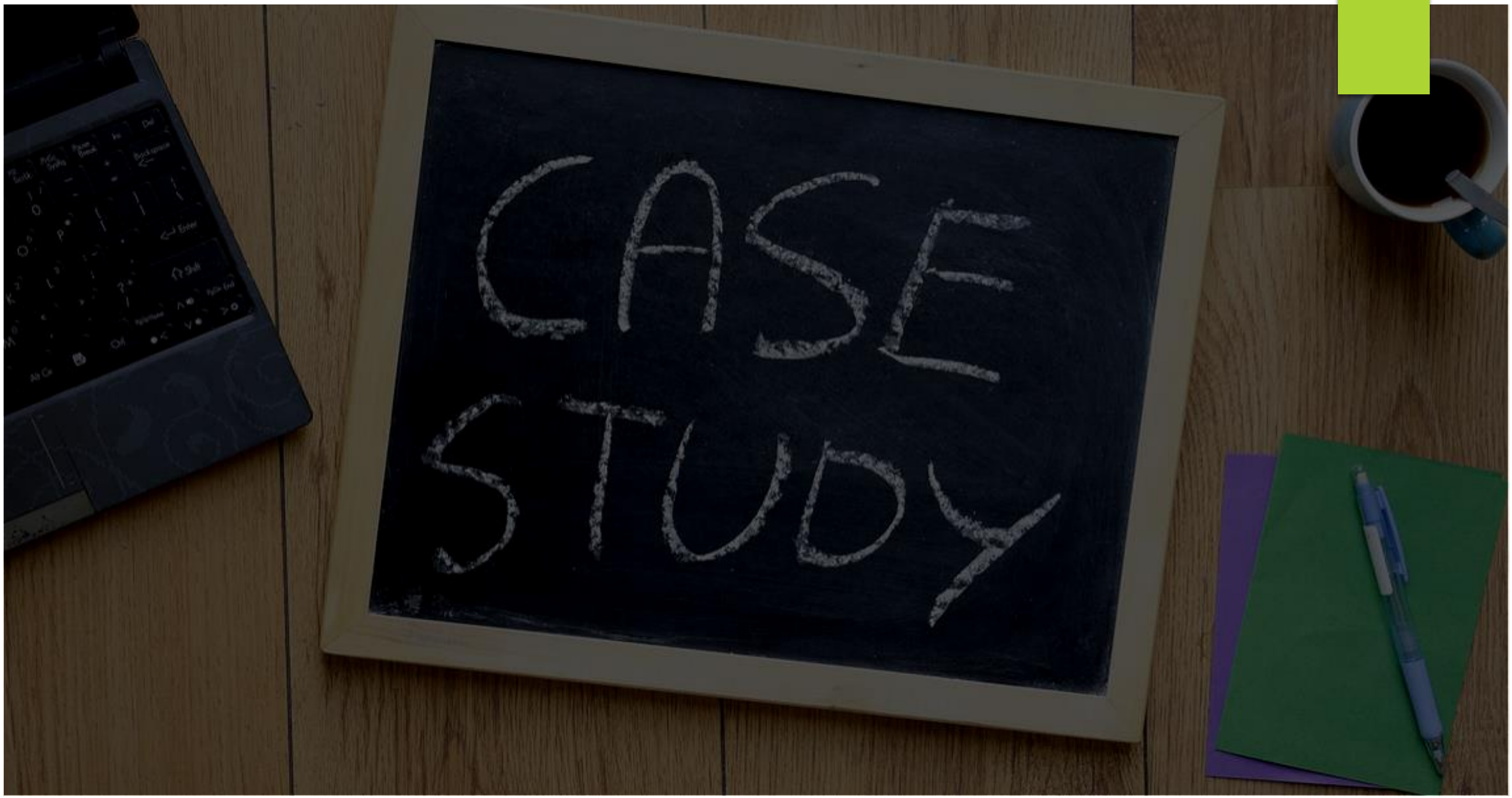
- Solar
- Wind
- Hydro

And some forms of biomass are common sources of renewable energy.

MICROGRID

"Bidirectional power generation system that allows the distribution of electricity from suppliers to consumers, using digital technology and favoring the integration of sources of renewable generation, with the aim of saving energy, reducing costs and increasing reliability"




CASE
STUDY

EMPIRE GAS COMPANY - PROCARIBE

Natural Propane Gas: Simply Secure, Always Available and Economic

EMPIRE GAS COMPANY

- Puerto Rican LPG Distributor
- Founded by Ramón González Cordero in 1967. ¡51 years!
- Starting annual sales volume: 500,000 gallons
- Current annual sales: 72+ million gallons
- Markets: Puerto Rico, Vieques, Culebra , St. Maarten & U.S.VI.
- Have more than 75% of the LPG market, annual sales of $100MM+
- Most of the Liquefied Petroleum Gas – HD-5 Propane field grade, is imported from U.S., Africa, Northern Europe , Brazil, and occasionally Trinidad.

EMPIRE GAS

WHAT IS PROPANE GAS?

Propane is a flammable hydrocarbon gas liquefied through pressurisation.

It is classified as LPG, along with butane and mixtures of these gases.

Propane comes from natural gas processing and oil refining. It is used as heating, cooking and auto fuel.

WHY PROPANE FUEL IN PUERTO RICO?

Propane price in Puerto Rico it is cheaper per MMBTU than other fuels

Propane is delivered odorized at the end user facility.

Propane infrastructure is less expensive and simpler

Better combustion than liquid fuel

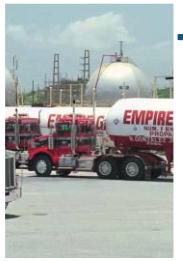
Better waste heat recovery in stack economizers due to "No Sulfur Content"

Less carbon Content per MMBTU means less CO_2 emissions (15%<) than liquid fuels

HURRICANE MARIA → EMPIRE GAS → PROCARIBE

PROCARIBE
DISASTER RECOVERY PLANS

Receiving ships in three different locations in PR, Peñuelas , Guayanilla , Ponce



Our truck fleet has four locations of distribution

Ours Terminals are vital equipment fully backup

Procaribe has a capacity storage to 12,000,000 gallons that ensure a Propane supply to Puerto Rico

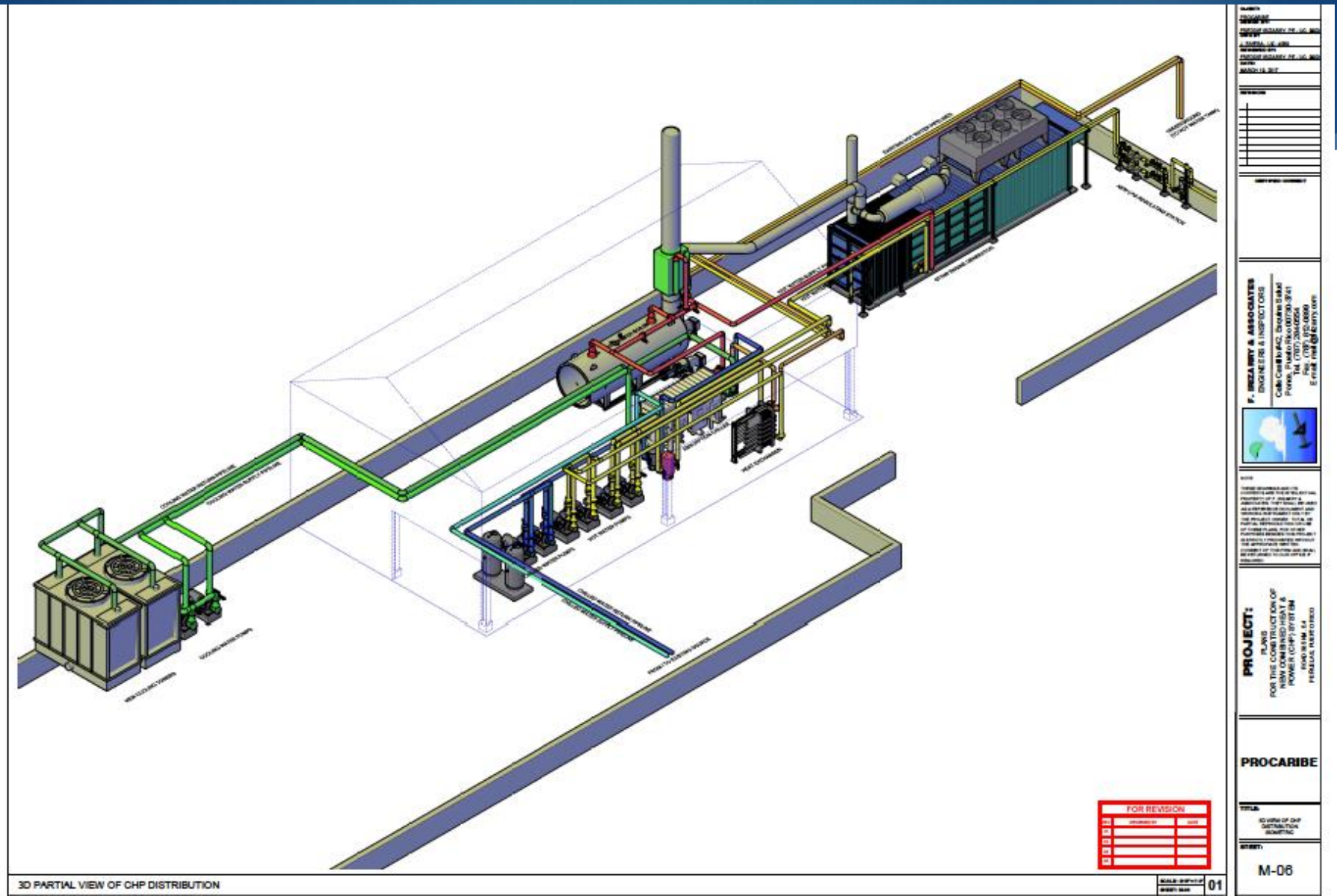
Our facilities are operated by our highly trained personnel twenty four hours a day, every day of the year

Emergency response 24 hour ,7 days a week

PROCARIBE restarted operations the day after the hurricane

EMPIRE GAS REGRIGERATED TERMINAL

PROCARIBE TRIGENERATION



HOSPITAL CONCEPTION

In spite of the serious breakdowns in the water and energy distribution systems of the country, the medical institution - contrary to others - continued to treat patients from the municipality of San Germán, where they are located, as well as from neighboring towns. "He was the only one from the area and, probably, from Puerto Rico who worked uninterrupted before, during and after the hurricane. The hospital did not need a generator "

SITUATION OF HOSPITALS IN PUERTO RICO

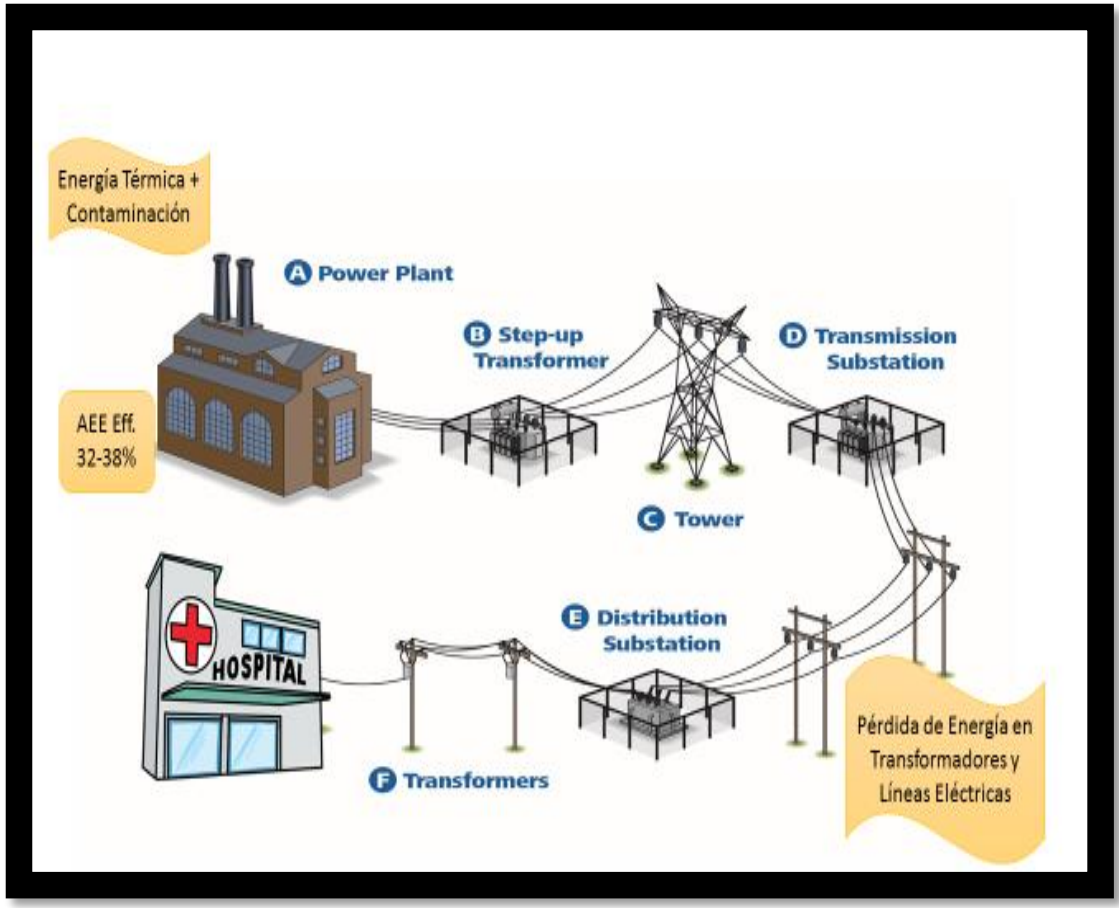
PREPA

- High energy costs
- High dependence on oil
- Obsolete equipment
- Environmental non-compliance
- Centralized generation
- Bond debt situation

Instability Electrical system

- Blackouts increase by 449% since 2013
- It affects critical services such as Operations Rooms and Intensive Units

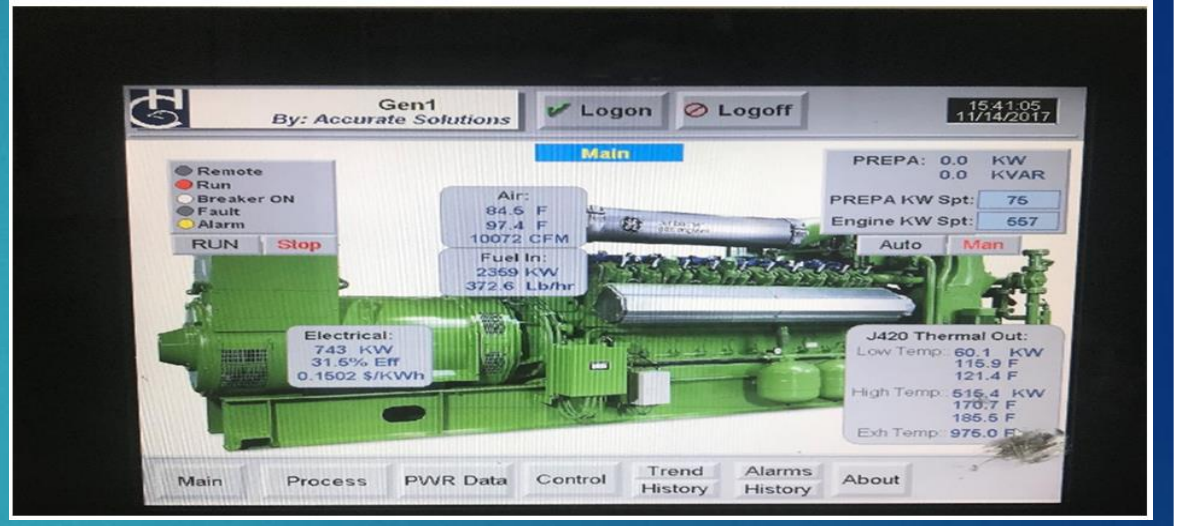
Little resilience due to dependence on diesel emergency generators.



COGENERATION IS THE SOLUTION

PHASE 1: LPG STATION

PHASE 2: OFF GRID GENERATION



Description of Hospital de la Concepción

- The hospital Total Square Feet: 220,000
- Energy consumption: 10.8 MWh / Year

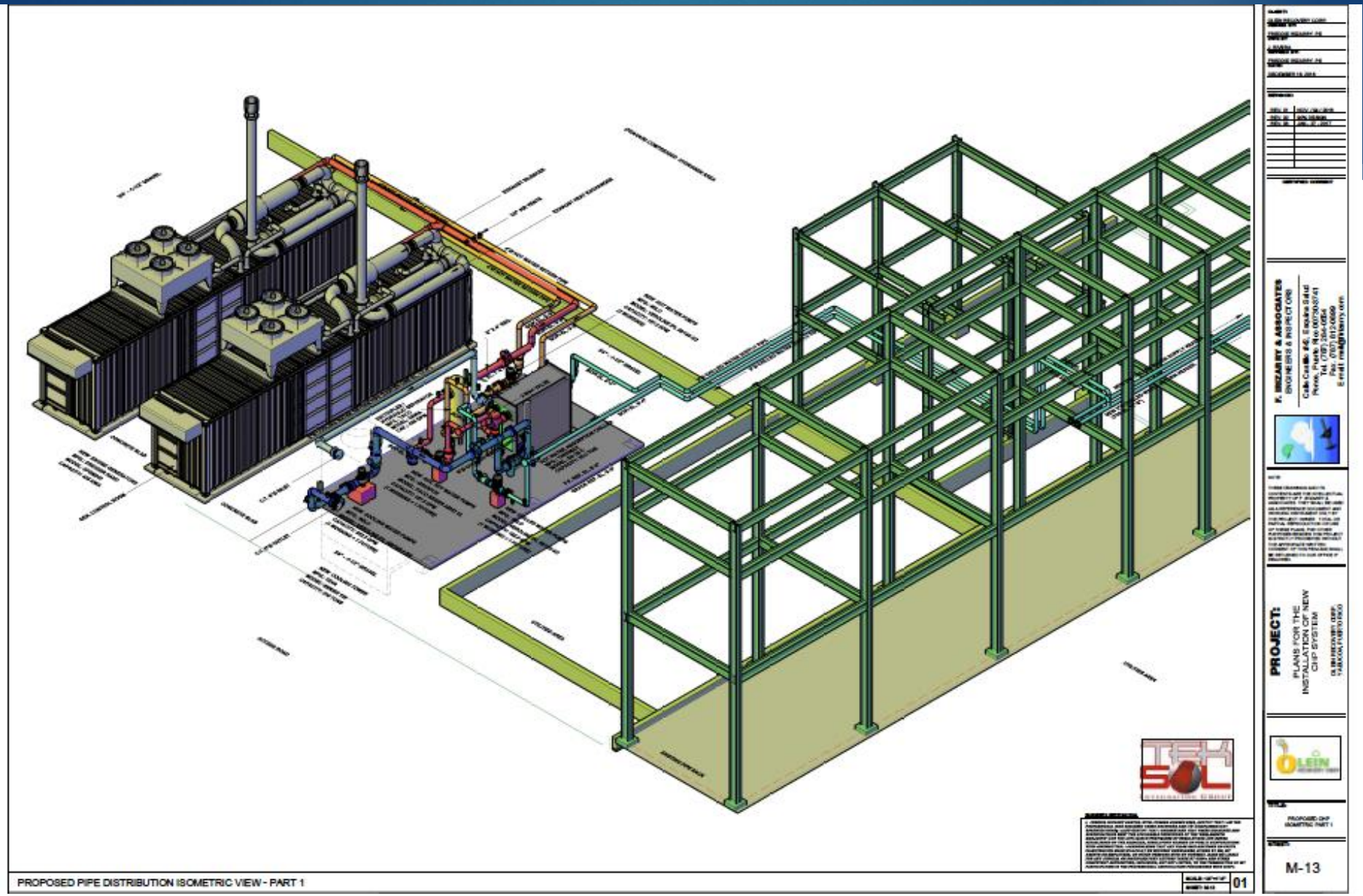
CHP Experience (January-November)

- During hurricanes Irma and María:
  - 21 days (504 hours) without power from the AEE
- HDLC continued uninterrupted services at 100% capacity
  - Emergency room
  - Operations Rooms
  - Ancillary Services
- Diesel fuel savings plus maintenance: $ 215,000

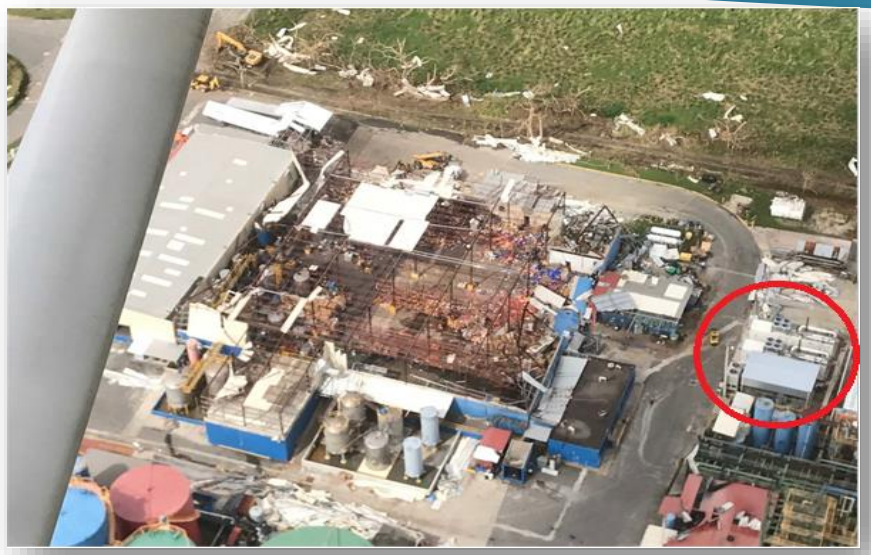
OLEIN
Recovery Corp.

Olein Refinery & Lubricants is an American company established in Yabucoa, Puerto Rico that recovers and re-refines used oil and manufactures motor oil, synthetic oil, transmission fluid, and other automotive fluids.

OLEIN TRIGENERATION



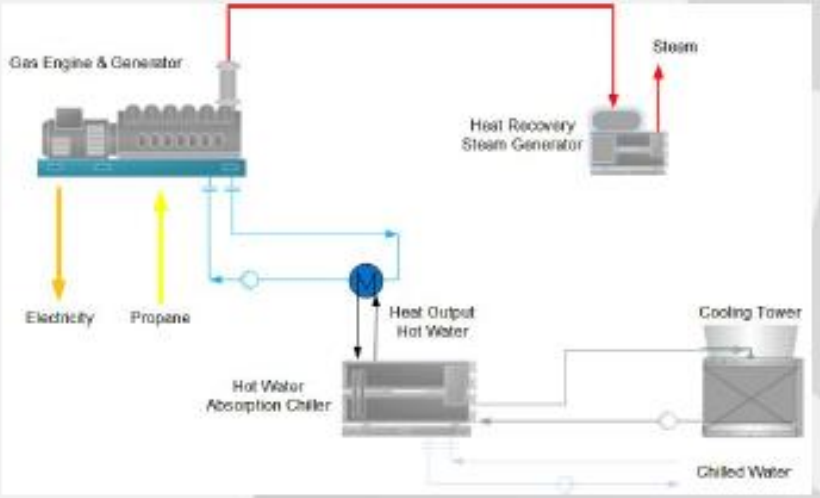
CHP SYSTEM: RELIABILITY, RESILIENCE AND BUSINESS CONTINUITY

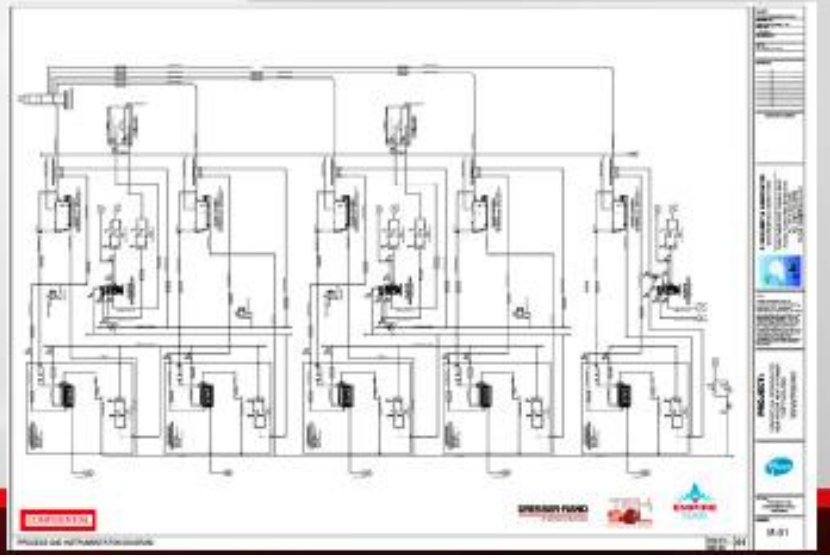


- Located in Yabucoa where Hurricane Maria Wind
- Speed reached 150 miles/hr
- Significant Impact to Facilty
- No Impact to CHP
- CHP (Power) available immediately after
- Hurricane
- Plant resumed operation 4 days after Hurricane
- Plant was fully operational 11 days after Hurricane
- Olein had Record Sales in October due to Oil for Stby Generators demand.

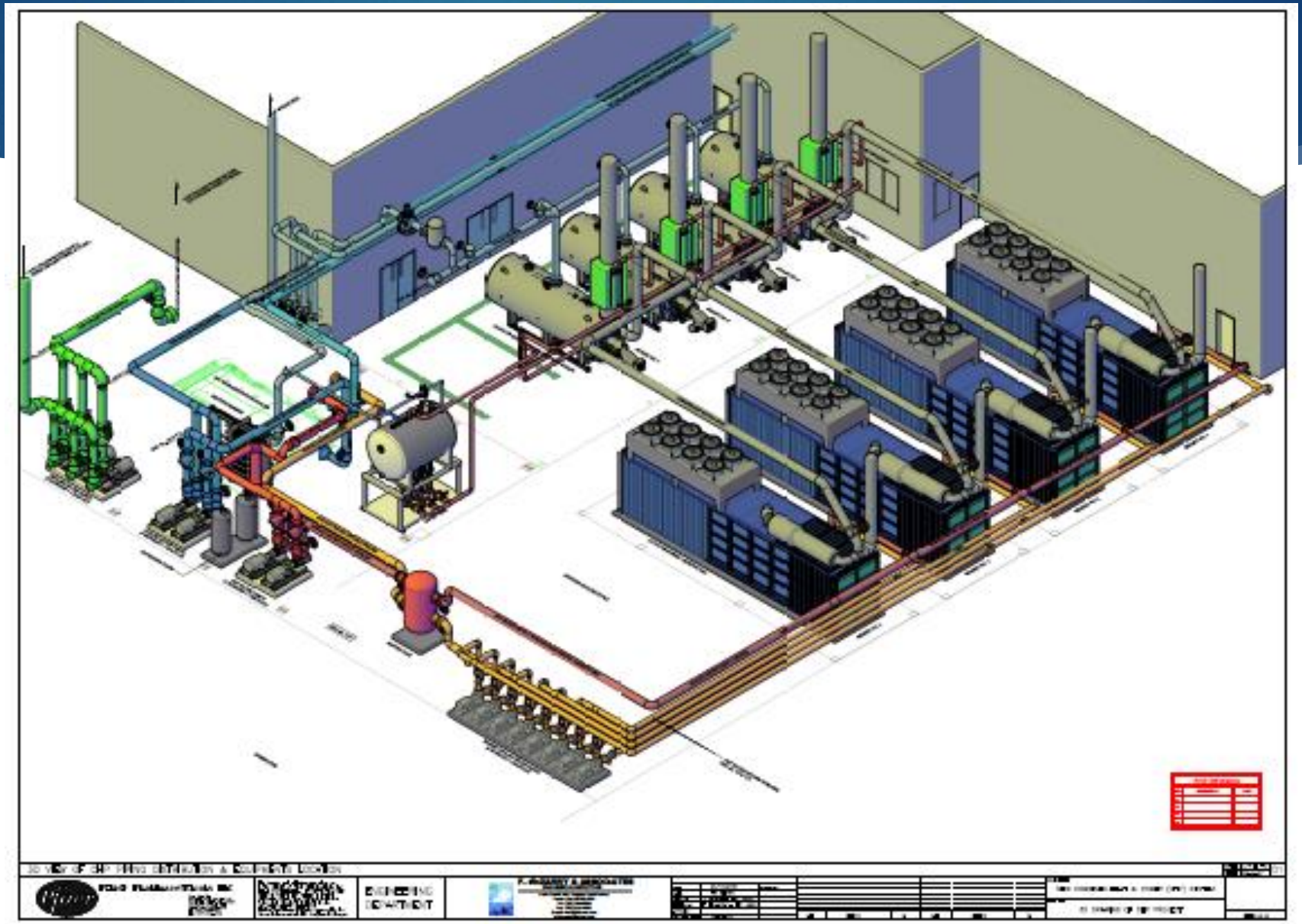
Local PPA Case Study: Pfizer Vega Baja

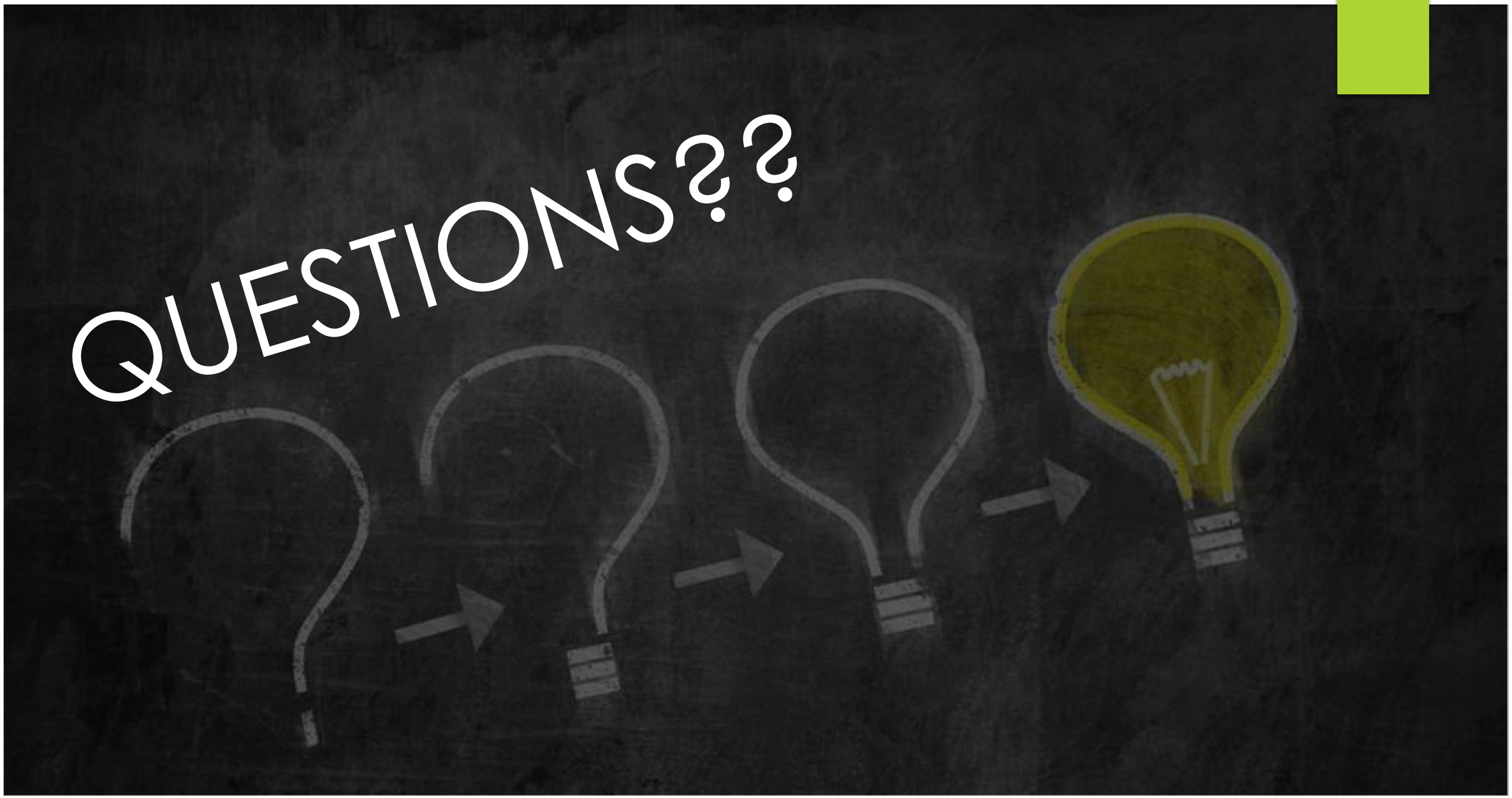
- PPA Contract Awarded after bid with 16 candidates from USA and PR.
- CHP Capacity
  - Power: 3,492 KW
  - Steam: 4,888 lb/hr
    - Post Burner Included to supply 16,000 lb/hr (100%) site steam demand
  - Chilled Water: 460 RTON
  - Hot Water: 400 KW
- Empire Gas 100% Funds & Owns CHP
- Empire Gas & TEKSOL provide Operation, Maintenance and Warranty Support
- Pfizer pays for PPA and Fuel





QUADGENERATION PFIZER VEGA BAJA




QUESTIONS??


THANK
YOU
GRACIAS
ARIGATO
SHUKURIA
BOLZÏN
MERCI
BÏYAN
DANKSCHEEN
TASHAKKUR ATU
YAQHANYELAY
SUKSAMA
EKHMET
GRAZIE
MEHRBANI
JUSPAXAR
GOZAIMASHITA
EFCHARISTO
KOMAPSUMNIDA
MAAKE
PALDIES
SHUKRIA
TINGKI
SPASSIBO
SNACHALJHUYA
NUHUN
CHALTU
WABEEJA
MAITEKA
YUSPAGABÀTAM
HUI
GUI
HÄTÄR
SPASIBO
DENKAUJA
HENACHALJHYA
UNALCHÉESH
EKOJU
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BAIKA