Celebrating 15 Years of State Leadership

Clean Energy States Alliance

Energy Storage Technology Advancement Partnership (ESTAP) Webinar:

Energy Storage Systems for Disaster Recovery and Resilience:

How to get Power Back to the Islands

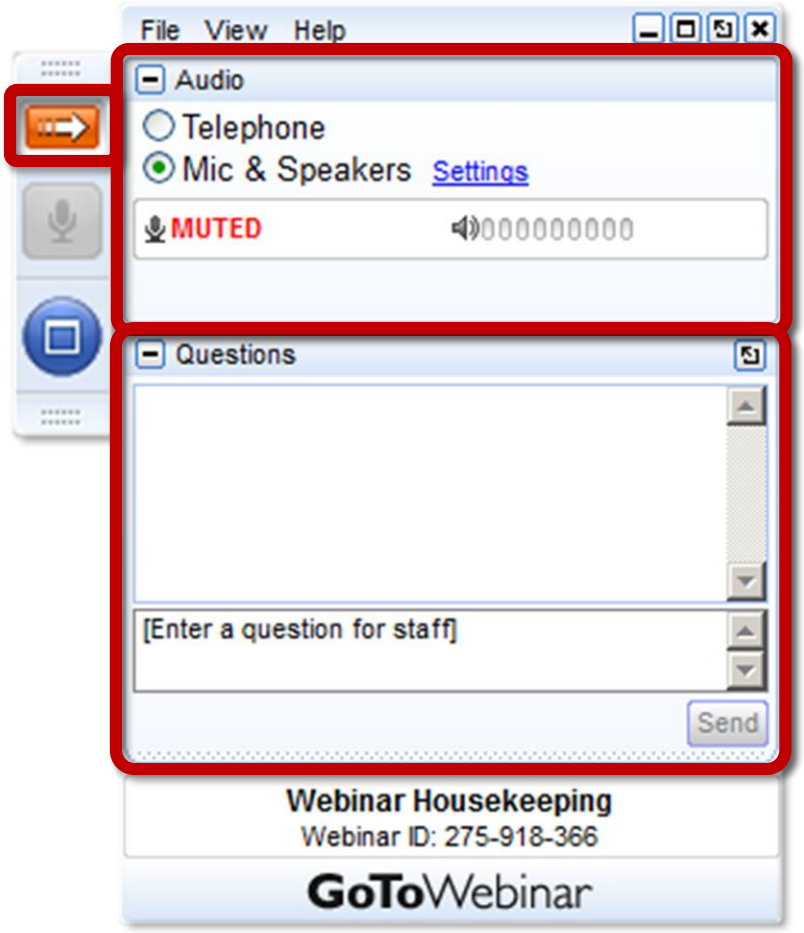
October 24, 2017

Hosted by Todd Olinsky-Paul
ESTAP Project Director
Clean Energy States Alliance

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

Housekeeping



Use the red arrow to open and close your control panel

Join audio:

- Choose Mic & Speakers to use VoIP
- Choose Telephone and dial using the information provided

Submit questions and comments via the Questions panel

This webinar is being recorded. We will email you a webinar recording within 48 hours. CESA's webinars are archived at www.cesa.org/webinars

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STATE OF CALIFORNIA ENERGY COMMISSION

DEPARTMENT OF ENERGY & ENVIRONMENT

EnergyTrust of Oregon

IOWA economic development

Illinois Department of Commerce & Economic Opportunity

NEW YORK STATE OF OPPORTUNITY. NYSERDA

Maryland Energy Administration

New Hampshire Public Utilities Commission

MASSACHUSETTS CLEAN ENERGY CENTER

NEW MEXICO emnrd Energy, Minerals and Natural Resources Department

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VERMONT CLEAN ENERGY DEVELOPMENT FUND PUBLIC SERVICE DEPARTMENT

SMUD™ Powering forward. Together.

Department of Commerce Innovation is in our nature.

DOER Massachusetts Department of Energy Resources

STATE OF RHODE ISLAND OFFICE OF ENERGY RESOURCES

NEW HAMPSHIRE OEP OFFICE OF ENERGY AND PLANNING

OEI Wisconsin Office of Energy Innovation

COMMERCE DEPARTMENT

IPA ILLINOIS POWER AGENCY

PRAIRIE ISLAND INDIAN COMMUNITY

Rhode Island Commerce CORPORATION

ACEP Alaska Center for Energy and Power

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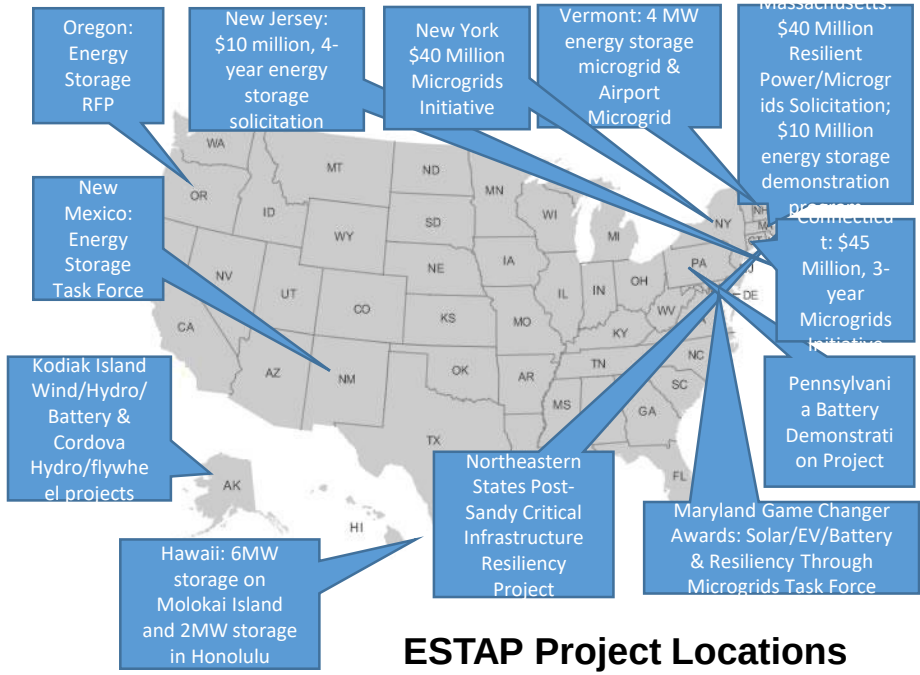
ESTAP is a project of CESA

Clean Energy States Alliance (CESA) is a non-profit organization providing a forum for states to work together to implement effective clean energy policies & programs:

State & Federal Energy Storage Technology Advancement Partnership (ESTAP) is conducted under contract with Sandia National Laboratories, with funding from US DOE.

ESTAP Key Activities:

1. Disseminate information to stakeholders
   - ESTAP listserv >3,000 members
   - Webinars, conferences, information updates, surveys
2. Facilitate public/private partnerships to support joint federal/state energy storage demonstration project deployment
3. Support state energy storage efforts with technical, policy and program assistance



ESTAP Project Locations

Thank You:

Dr. Imre Gyuk
U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability

Dan Borneo
Sandia National Laboratories

Sandia National Laboratories

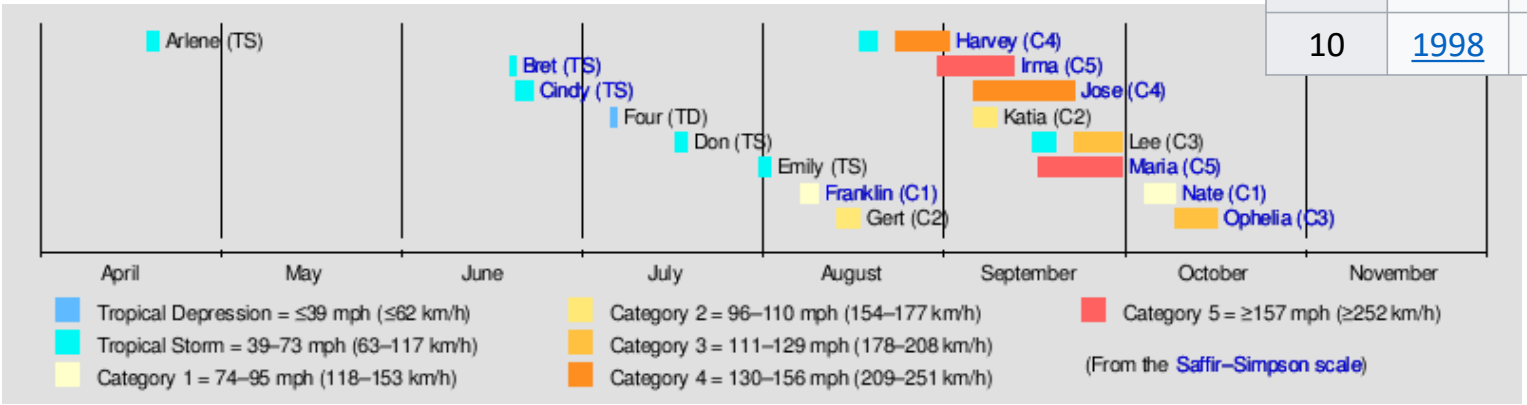
CleanEnergy States Alliance

U.S. DEPARTMENT OF ENERGY

2017 Atlantic hurricane season: part of the "new normal"

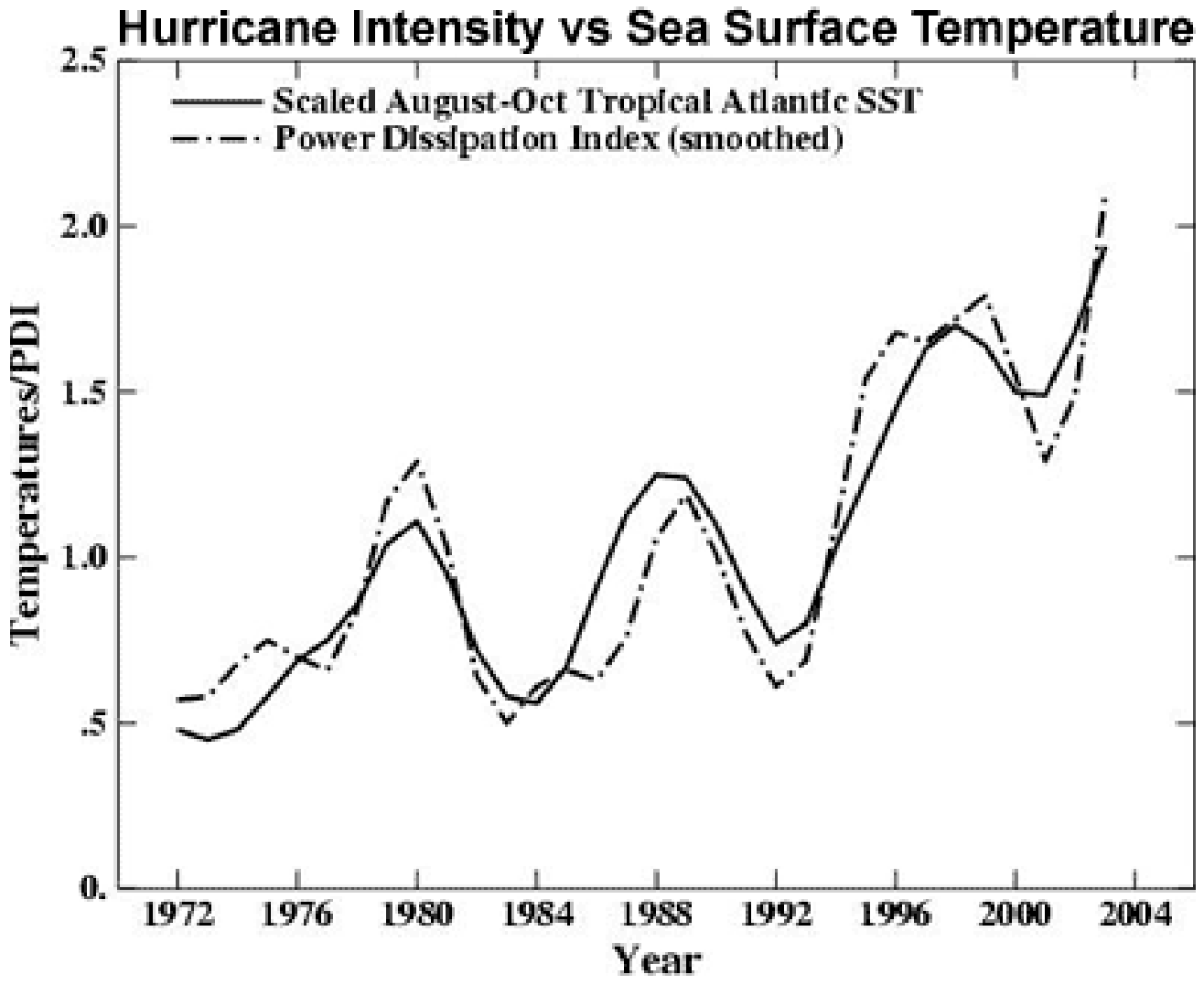
Most intense Atlantic hurricane seasons (since 1850)

Rank	Season	ACE	
1	1933	259	
2	2005	250	←
3	1893	231	
4	1926	230	
5	1995	228	←
6	2004	227	←
7	**2017**	221	←
8	1950	211	
9	1961	205	
10	1998	182	←



ACE = Accumulated Cyclone Energy

Why?


Hurricane Intensity vs Sea Surface Temperature
Scaled August-Oct Tropical Atlantic SST
Power Dissipation Index (smoothed)
Temperatures/PDI
2.5
2.0
1.5
1.0
.5
0.
1972
1976
1980
1984
1988
1992
1996
2000
2004
Year

What to do?

1. Short term solutions
    - Emergency power provision
    - Repairing damaged grids

2. Long term solutions
    - Redesigning grids (hardening, decentralizing, diversifying)
    - More distributed energy resources
    - Resilient power for critical facilities
    - Microgrids

Panelists

- **Imre Gyuk**, Director of Energy Storage Research, U.S. Department of Energy - Office of Electricity Delivery and Energy Reliability
- **William Young**, President and Principle Engineer at SunTree Consulting, formerly of the Florida Solar Energy Center
- **Dana M. Sleeper,** Director of External Affairs, Solar Energy Industries Association
- **Olaf Lohr**, Director of Business Development, Sonnen
- **Dan Borneo**, Program/ Project Lead, Sandia National Laboratories
- **Todd Olinsky-Paul**, Project Director, Clean Energy States Alliance (Moderator)

U.S. DEPARTMENT OF ENERGY

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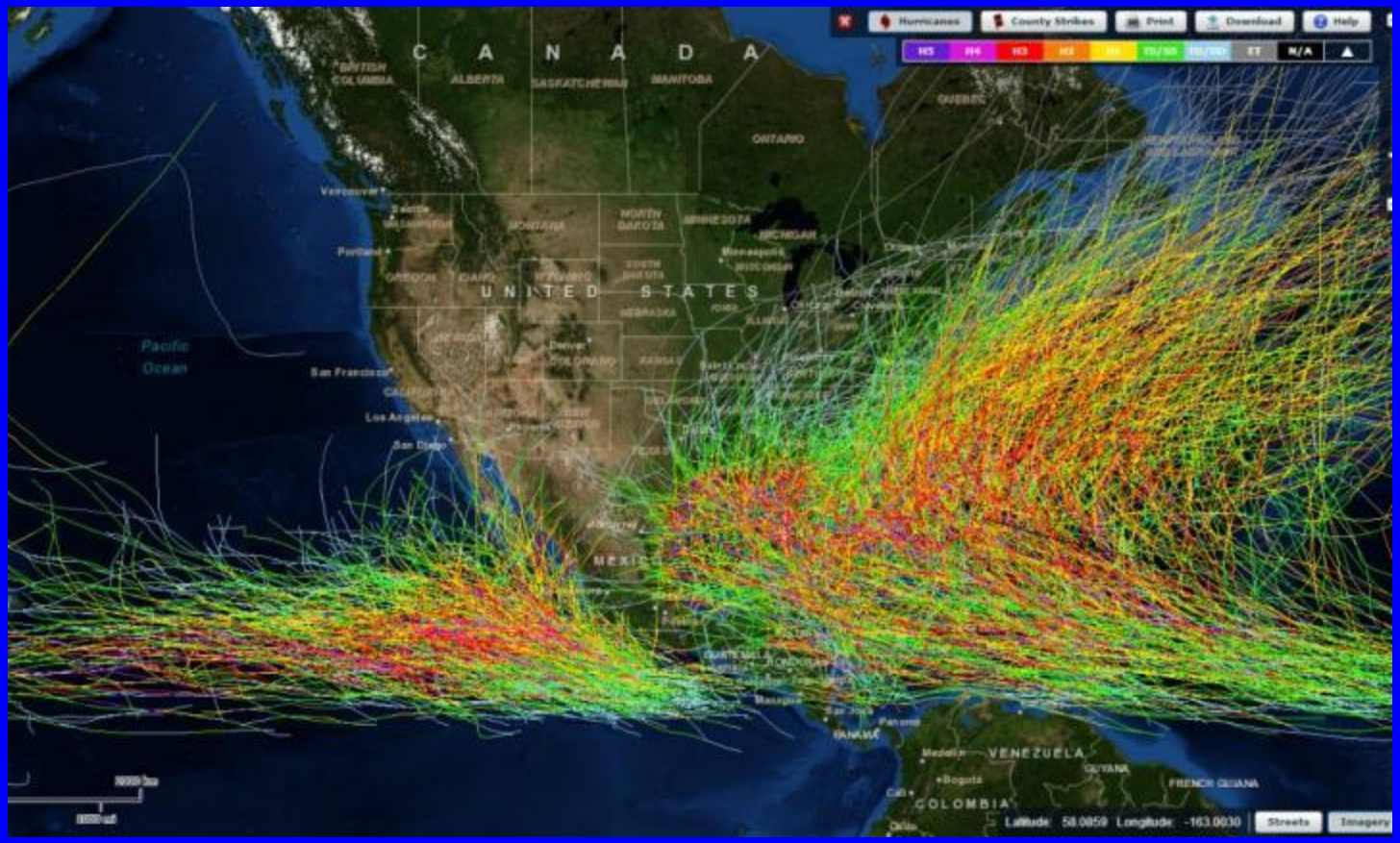
Disaster Recovery, Preparedness, and Resilience: Building Microgrids with Storage and Renewables

IMRE GYUK, DIRECTOR,
ENERGY STORAGE RESEARCH, DOE-OE

Harvey
Irma,
Jose,
Katia,
Maria

$188 billion
in damages!

170 years of Tropical Storms and Hurricanes



In the Eastern United States, Mexico and the Caribbean no place is safe!

Leaving behind Wreckage and Misery

Electrical Infrastructure
is particularly vulnerable!

- Emergency Measures
- Service Restitution
- Planned Resilience

A Rule of Thumb:

Every $1 spent on protection measurements can prevent $4 in repairs after a storm!

A more Resilient Grid can be developed
by the introduction of Microgrids,
which can be Islanded during Emergencies
but are connected to the Main Grid during
Ordinary Operation.

During Emergency Operation,
Microgrids (Buildings, Campuses, Villages etc.)
need to have sufficient Energy Storage
as well as Distributed Renewable Generation
to maintain Mission Critical Functions.

During Ordinary Operations, Multiple Benefit Streams
should allow the Installation to pay for itself,
provided the Regulatory Structure allows it.

Vermont Public Service Dept. – DOE - Green Mountain Power

Joint Solicitation issued by VPS/OE
Rutland, VT

4MW / 3.4MWh of storage
Integrated with 2MW PV
Integrator: Dynapower

Groundbreaking: Aug. 12, 2014
Commissioning: Sep. 15, 2015

System can be islanded to provide emergency power for a resilient microgrid serving a highschool / emergency center.

Storage: Monetization through frequency regulation, arbitrage, yearly and monthly demand charge reduction

PV: Green power for the grid. Situated on Brown Field area

Sterling, MA: Microgrid/Storage Project

Sterling, MA, October 2016

Sterling, MA, December 2016

Sterling Municipal Light Department.

$1.5M Grant from MA Community Clean Energy Resiliency Initiative (MA Dept. of Energy Resources). DOE/Sandia. Clean Energy Group.

2MW/2hr storage with existing 3.4 MW PV to provide resiliency for Police HQ and Dispatch Center. Li-ion batteries provided by NEC.

Storage Economics in Action!

Description (1MW/1hr)	$
Arbitrage (buy low,sell high)	13,321
Reduced Monthly Peak	98,707
Reduced Yearly Peak	115,572
Frequency Regulation	60,476
Total	288,076

Capital cost: $1.7M/MW

simple payback: 6.7 years

R. Byrne, Sandia

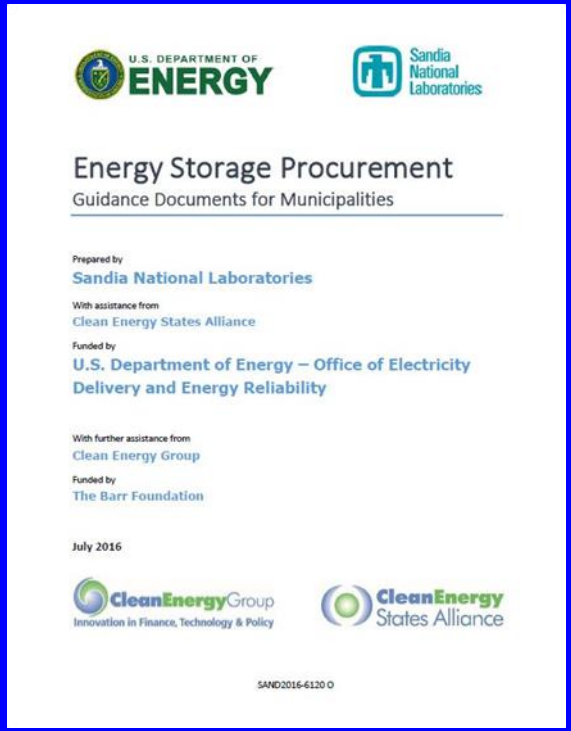
- ✓ **2016** December
- ✓ **2017** Feb, March
- ✓ **2017** Apr, May
- ✓ **2017** June (annual) !!
- ✓ **2017** July ……

S. Hamilton, Sterling

Energy Storage Procurement, Guidance Document for Municipalities

Dan Borneo (Sandia)

Specific examples of the elements that should be included in a solicitation for the procurement and installation of a battery energy storage project designed to provide backup power during outages and facilitate timely cost recovery.



www.sandia.gov/ess

SAND 2016-8544

2017 GTM Grid Edge Award !

Washington State Clean Energy Fund:

Solicitation for $15M for Utility Energy Storage Projects

Selected projects with UET vanadium flow battery:

- Avista (1MW / 4MWh) -- PNNL -- WA State U
- Snohomish (2MW / 8MWh) – PNNL -- 1Energy -- U of WA

Under a DOE / WA MOU, PNNL participates in both projects, providing use case assessment and performance analysis.

Vanadium technology with 1.7x Energy density developed at PNNL for DOE

Ribbon Cutting
Avista, April 2015

Other Projects in Chattanooga, Hawaii, Alaska, and Decatur Island

As we rebuild the Grid in the Coastal Regions of the U.S., in Puerto Rico, and the Islands, we should avail ourselves of new Technology that is being developed: Microgrids, Energy Storage, Distributed Renewable Energy, for a greener, more Resilient, and more effective Grid!

FLORIDA SOLAR ENERGY CENTER®

Creating Energy Independence

SunSmart Emergency Shelter (E-Shelter) Program

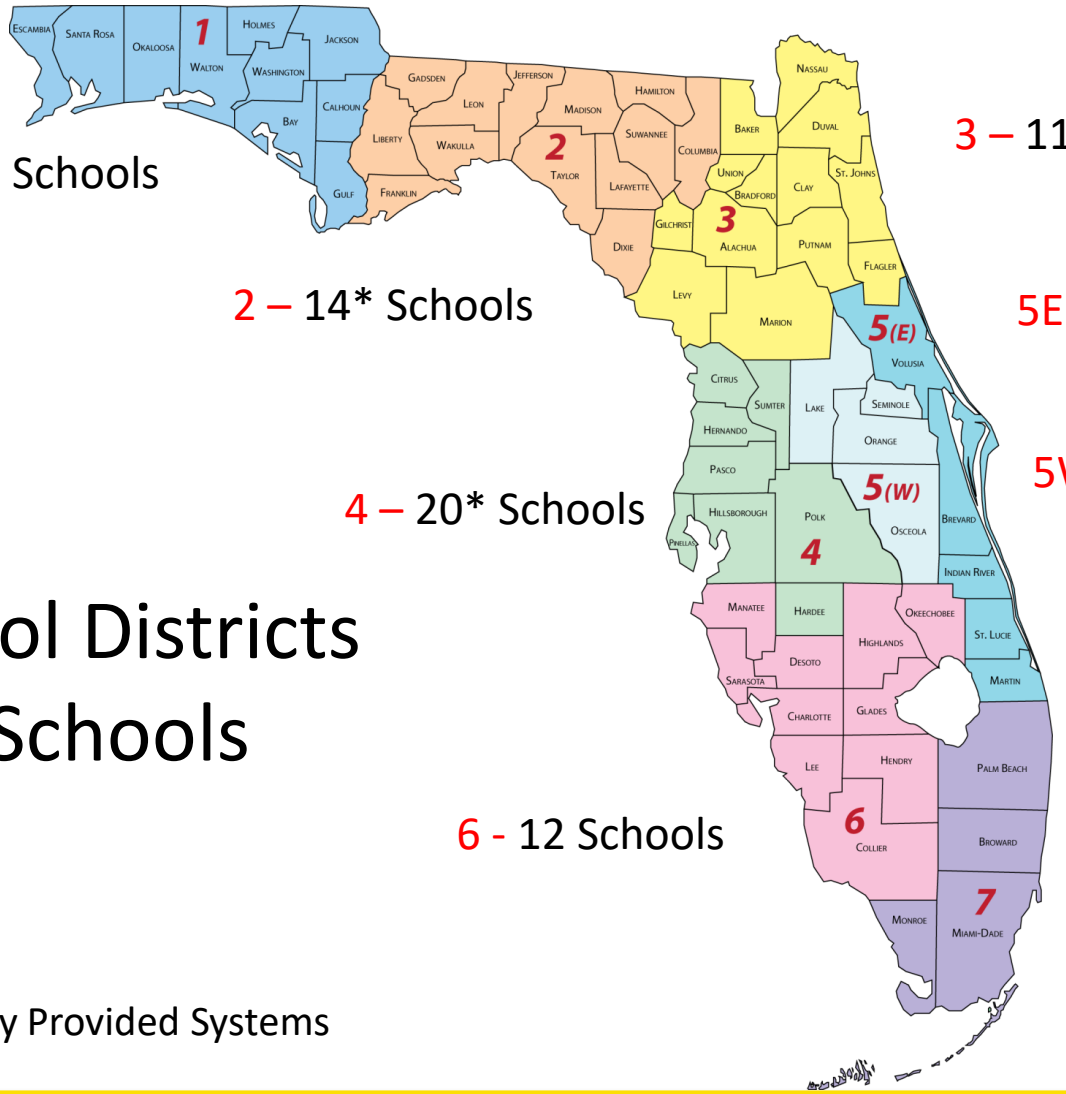
www.energywhiz.com or 321-638-1000 or SunSmart@fsec.ucf.edu

A Research Institute of the University of Central Florida

SunSmart E-Shelter Program Goals

- Generate Clean Electricity from the Sun with storage
- Provide Power to Critical needs to Emergency Shelters
- Educate students and teachers about Clean Energy Technologies and Careers
- Creates jobs in Florida
- Reduces Green House Gas Emissions

Emergency Management Regions



1 - 13 Schools

2 – 14* Schools

3 – 11 Schools

5E - 14 Schools

5W – 12* Schools

4 – 20* Schools

7 - 14 Schools

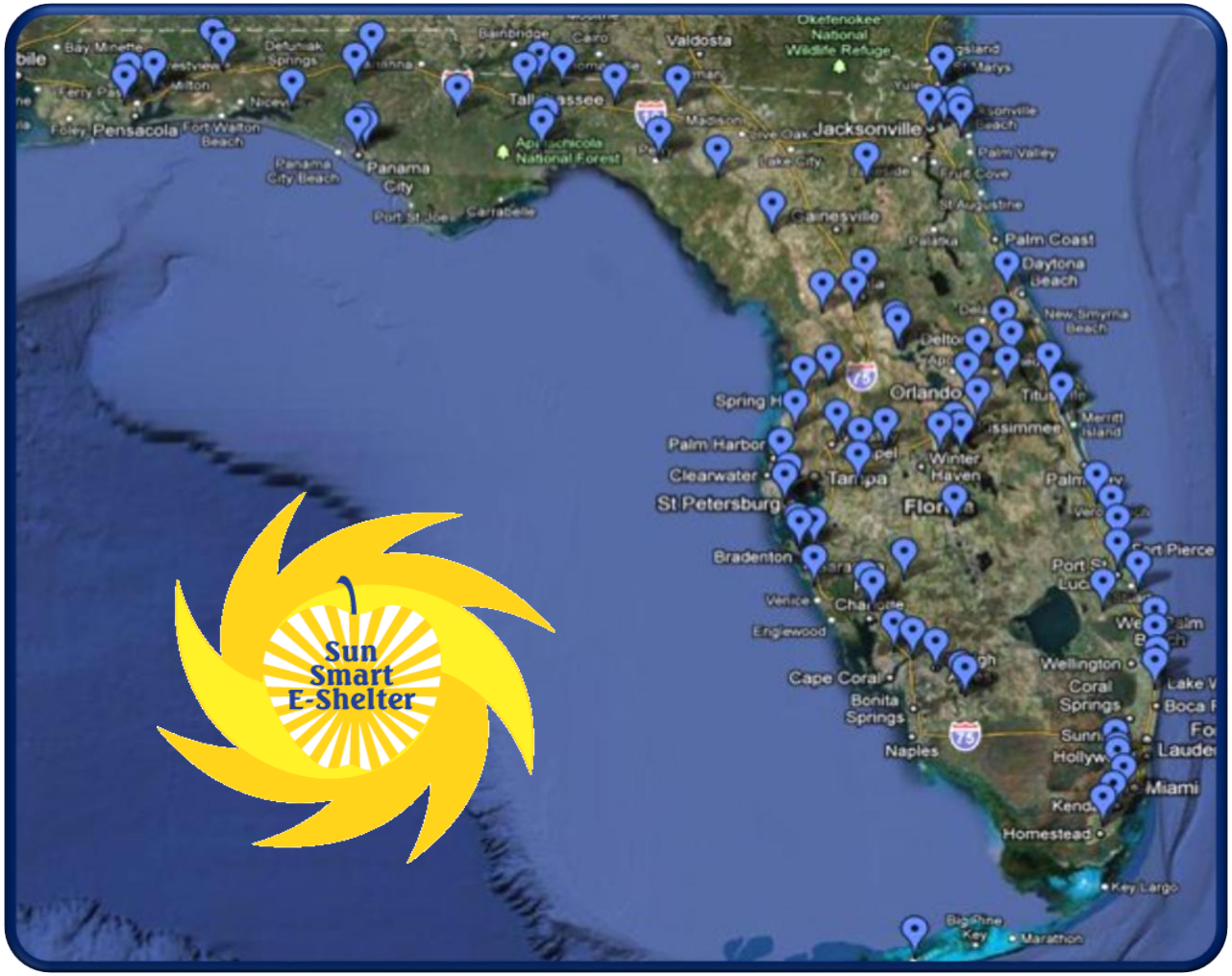
6 - 12 Schools

45 School Districts

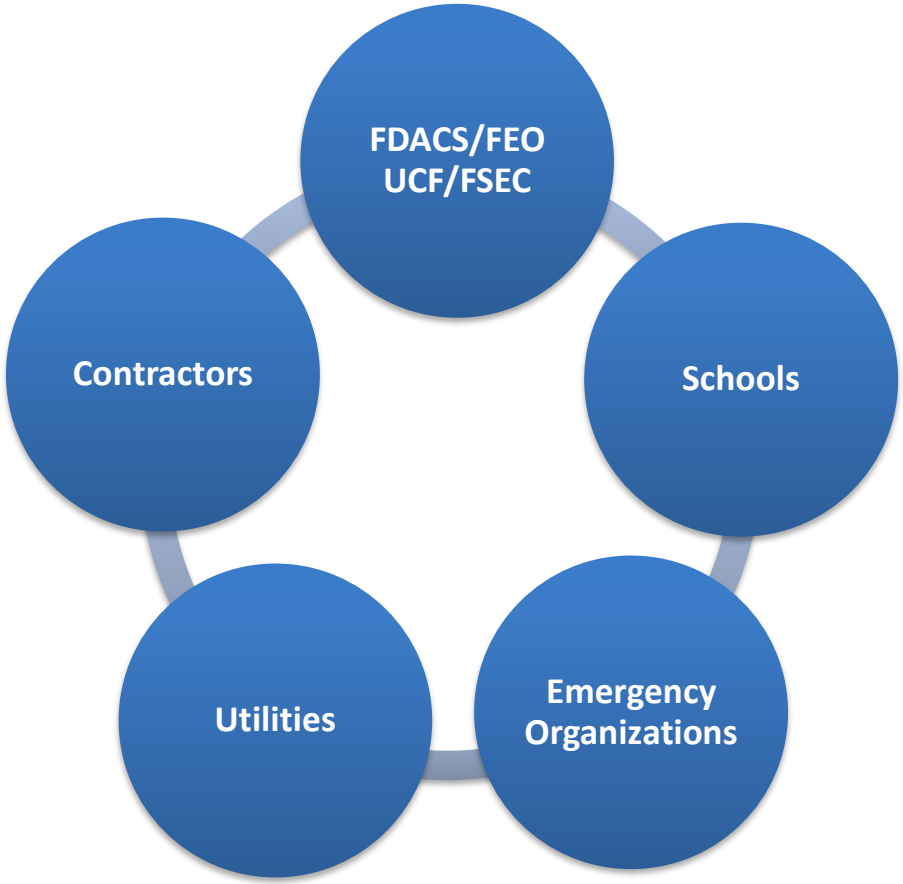
112 Schools

*Includes Utility Provided Systems

SunSmart E-Shelter School Locations



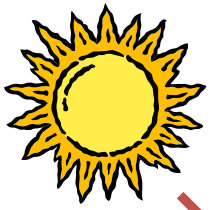
Program: Team Members



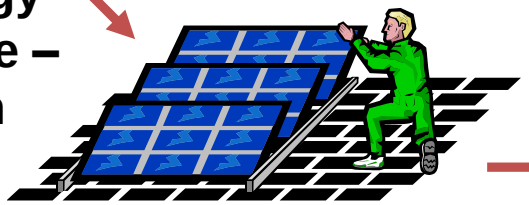
Program – Solar + Storage for Shelters

- 10 kW Photovoltaic System
- 48 kWh Battery Back-Up Energy storage
- 3 Phase Building Electricity
- Utility Grid-Connected
- Net Metering Power
- Data Monitoring
- Ground Mounted Array
- ~1000 Square feet area

Basic Components of a PV + Storage System

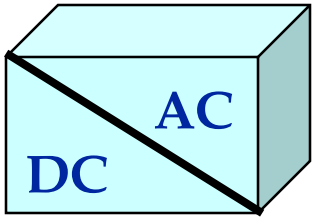


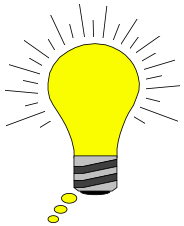
Energy source – Sun



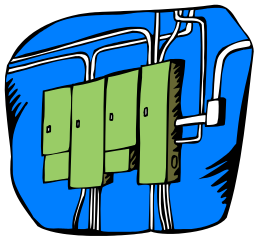
Energy conversion - Photovoltaics

Power conditioning - Inverter and controllers





Energy use - critical loads

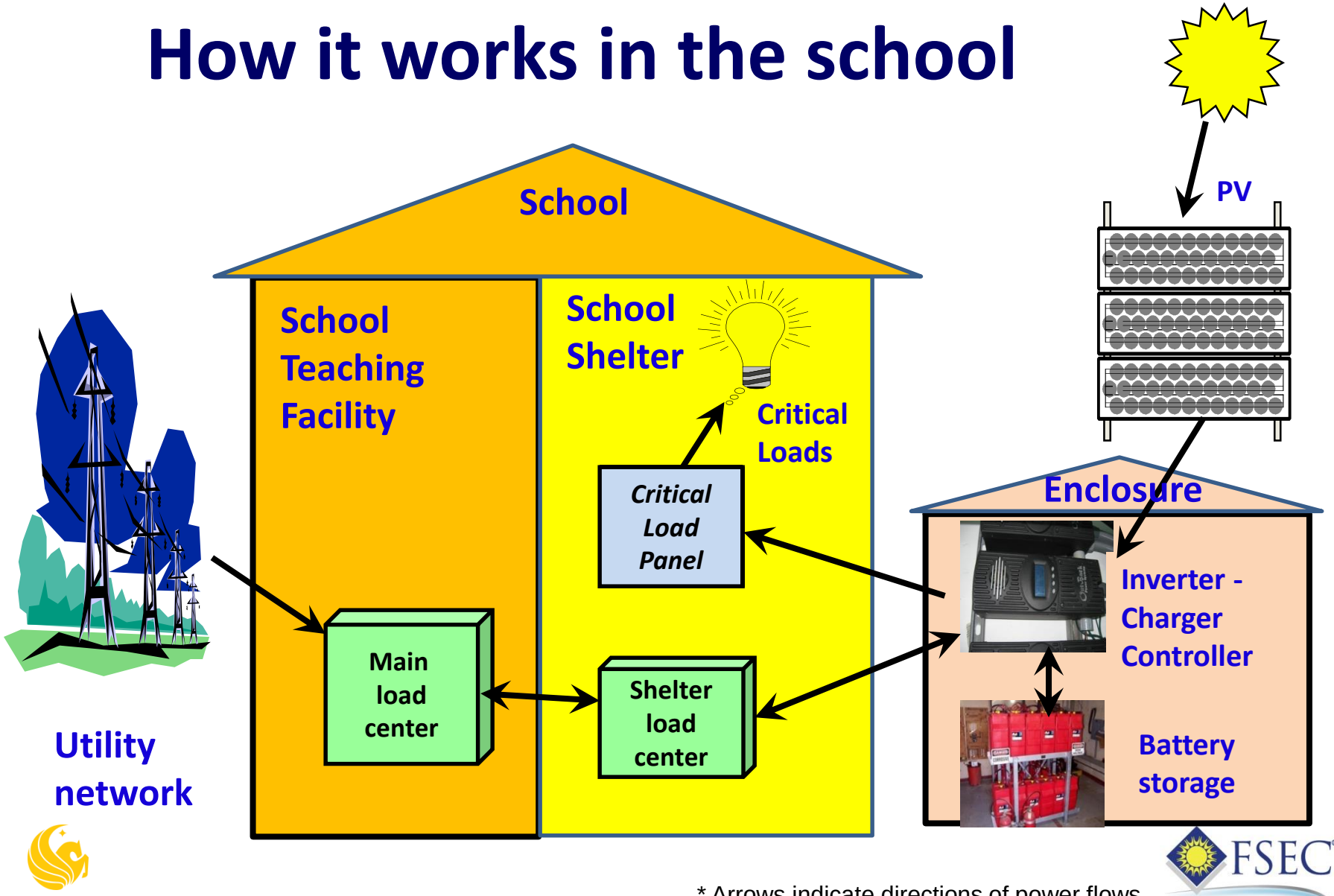


Connecting to the Grid – Critical Load Panel

Energy storage - Battery

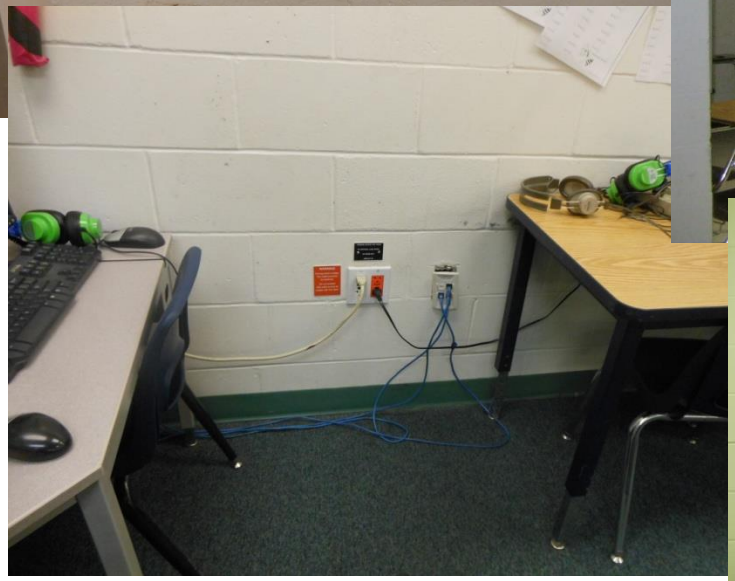
Electric grid - Utility network

How it works in the school



* Arrows indicate directions of power flows

Shelter Critical Loads



PV + Storage System Details

SunSmart E-Shelter Program
October 24 Irma Hurricane Status

- 112 PV + Storage Systems Installed as of 2014
- 35 Schools did not open
- 41 Schools did open as shelters
- 13 Schools did not lose utility power
-

Apollo Elem,
Brevard County

Apollo Elem,
Brevard County

Fairmount Park Elem,
Pinellas County

Fairmount Park Elem,
Pinellas County

Douglas L. Jamerson, Jr. Elem,
Pinellas County

Sun Smart E-Shelter

Douglas L. Jamerson, Jr. Elem,
Pinellas County

Durant High,
Hillsborough County

Durant High,
Hillsborough County

SunSmart E-Shelter Program Progress

Questions?

- Bill Young
- Retired FSEC, project engineer
- President, Florida Renewable Energy Association
- SunTree Consulting
- fl_byoung@hotmail.com

sonnen

The Leader in Grid Tied Residential Energy Storage

sonnen

sonnen Inc. Pledges to Build and Donate Microgrids to Help Bring Emergency Power to the People of Puerto Rico

English

sonnen, the global leader in residential energy storage, launches "Puerto Rico Energy Security Initiative" (PRESI), including the deployment of Microgrids throughout the island

Olaf Lohr
Director or Business Development, sonnen Inc.
olaf.l@sonnen-batterie.com

Energy Storage Applications

#1. Situation in Puerto Rico

No power

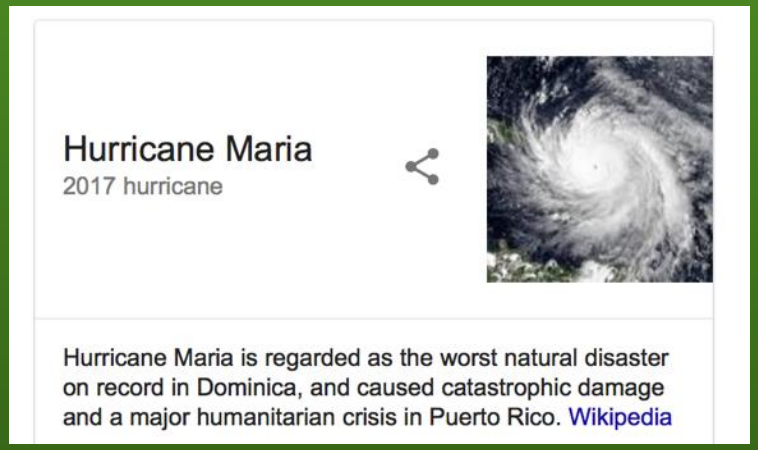
No water

No fuel

Darkness: life in Puerto Rico without electricity

Puerto Rico's misery won't end without power. The problem is that it isn't getting any.

No gas. No food. No power. Puerto Ricans fear their future



Energy Storage Applications

#2. Sonnen is dedicated to help with short term disaster relief!

- *Keep shipping product*
- *Donation of 15 microgrids*
- *"boots on the ground"*
- *Formation of 501c3 "*Sonnen Foundation for Energy Security"

Bloomberg

Puerto Rico to Get Power Relief From German Microgrid Supplier

MICROGRIDS

Extreme Storms Spur Interest in the Developing Battery Microgrids Market

Tesla, Sonnen and others see a market for battery-backed, storm-resilient microgrids. The market could draw $22.3 billion in global investment over the next 10 years.

by Katie Fehrenbacher
October 06, 2017

sonnen

smart energy storage system,
unlocking a clean energy future

Solar Optimized Backup Power

- *Long history of installing sonnen*
- *Partner Pura Energia*
- *Energy Security*
- *Off grid power*
- *Energy bill savings*
- *Energy independence*

+

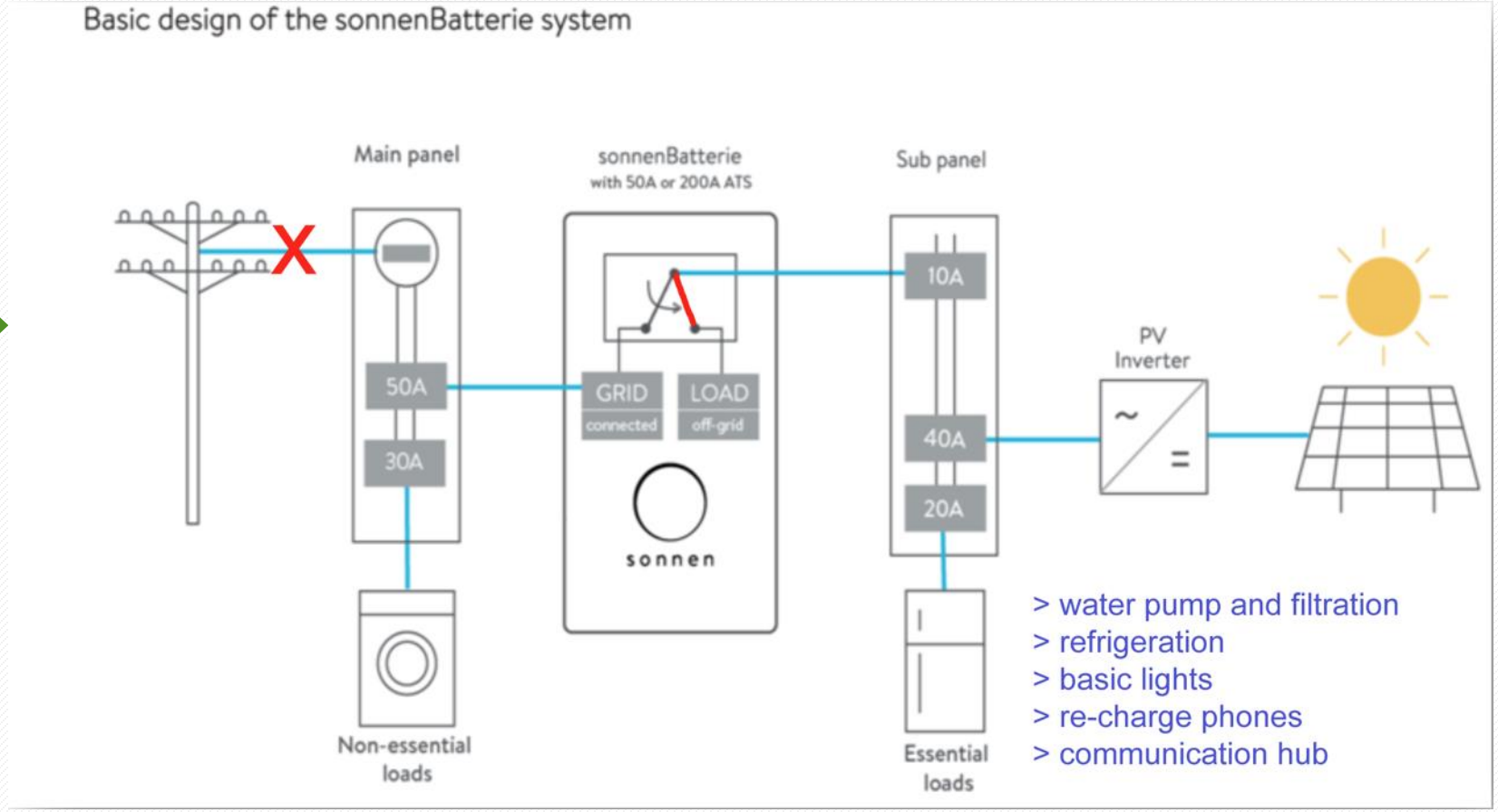
=

"The Electricity Grid of the Future"

Function of the sonnen microgrid

- **Immediate disaster relief**
- **Serve "the last mile"**
- **Implement a lasting solution**

Microgrid System Design Overview



Rebuild PR with renewables

Why Energy Storage?

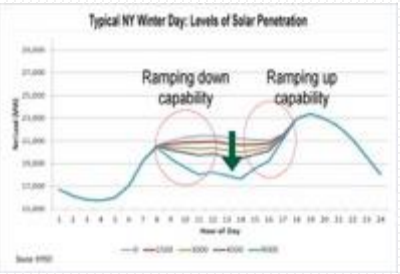
#2. sonnen provides mid to long term solution:

- Provide energy security
- Provide a renewable energy source
- Create energy and bill savings
- Key stone technology to build a smart grid
- Help rebuild Puerto Rico with renewable energy requires storage

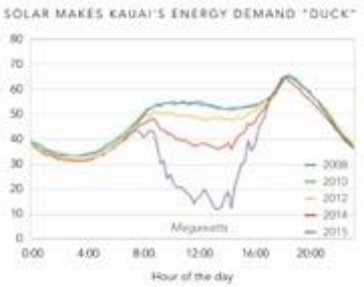
1. *Results of an intermittent generation source*
   - I. *Oversupply from renewable production: mid day from PV, night from wind and hydro*
   - II. *rapid ramping requirements: afternoon from PV, intermittency from clouds*
   - III. *Non coincidental peaks –morning peak, evenings, day peak from heavy A/C needs*

Result: Electricity Grid requires a resource mix that can react quickly to rapid changes

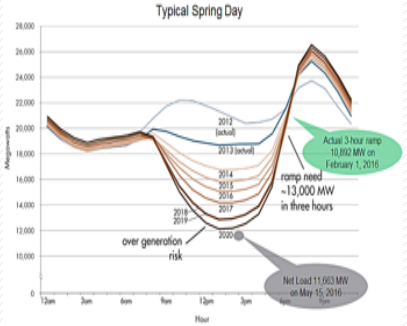
New York



Kauai, HI



California “Duck”



The sonnenCommunity Story

#3 sonnen Community

- Over 8,000 Members in Germany
- World's largest Peer-to-Peer Clean Energy Trading Platform

- Planned sonnenCommunity in Arizona
- *2,900 homes equipped with sonnen*
- *Largest concentarted residential VPP in the world*

ENERGY STORAGE

Sonnen Brings Its Virtual Power Plant to the US With a 2,900-Home Project

residential energy storage

Chief *Emotional* Value Points:

1. Independence
2. Carbon Neutral
3. Resilience

1. Independence from fossil fuel
2. Generating and locally consuming your own clean energy
3. Energy Security
4. Optimized Solar
5. Energy Management without sacrifice
4. Carbon Neutral Living
5. Doing something substantial to “combat” climate change
6. Being a part of the “*Energy Transition*”

"The Electricity Grid of the Future"

Sonnen cooperation partners:

- **WaterMission.org**
- **Pura Energia PR**

watermission.org

puraenergiapr.com

- **To get involved: email Olaf.L@sonnen-batterie.com**
- Sonnen Foundation for Energy Security

Exceptional service in the national interest

Sandia National Laboratories




Microgrid Resiliency

Dan Borneo

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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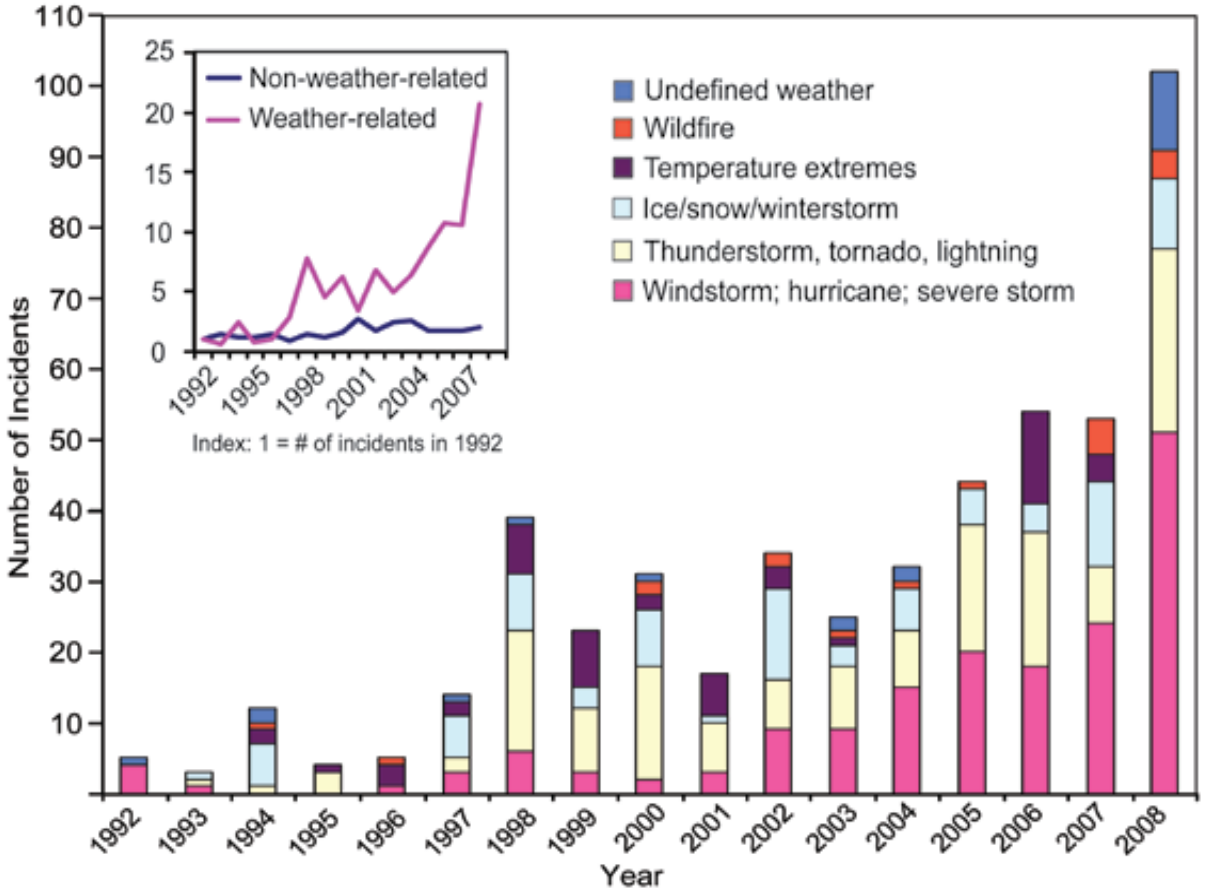
Emerging Energy Assurance Concerns

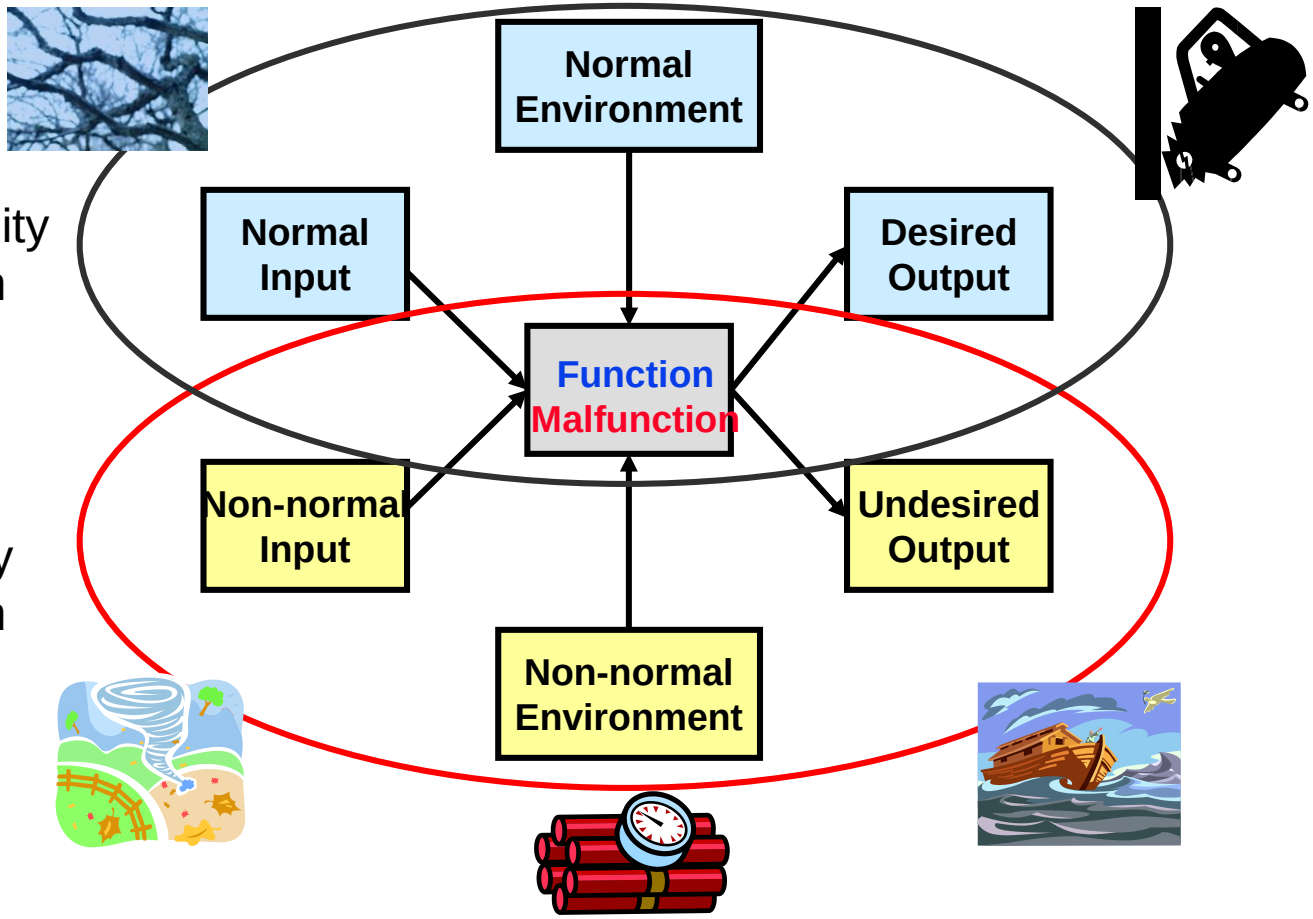


Electric Power Outage Intensity in the U.S.

for trending example only, Courtesy of EIA

New Energy System Performance Requirements

Sandia National Laboratories



"Have assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet critical operational needs under normal and extreme events"

Electric Grid Assurance Strategies

Sandia National Laboratories

Component Hardening (Protection)	Increase Component Redundancy (Mitigation)	Accelerate Outage Response (Response & Recovery)	Distributed Resources (Mitigation, Recovery)
Harden substations	Redundant transmission lines	Real-time monitoring of substations and transmission lines	Distribution switch gear improvements to make smarter and controllable
Harden substation equipment	Redundant substations	Fast response, fast reconstruction, maintain spares	Local energy generation including PV and generators
Harden transmission and distribution lines	Increase connectivity	Extra equipment, pre-planned work around	Renewables and/or alternative fuels
High costs, events beyond design basis	High costs, regional outage issues	High costs, regional outage issues	Medium costs, outage duration issues

Critical Municipal Services to be Considered

Sandia National Laboratories

Municipal Controlled Services	Community Controlled Services
Communications (Radio and Phone)	Telecommunications (cell towers)
Data Service / Internet	Community media (radio)
Local Emergency Response Coordination	Existing shelters - heat/cold
Regional E/R Coordination	Hospitals
Civil order	Assisted living services
Road Clearing / Management	Pharmacies/Medication supply
Equipment maintenance	Fuel (Natural Gas / propane / Gasoline / Diesel)
Emergency Services	Food / provisions
Potable Water	
Waste Water	
Flood Control	
Temporary Housing / Shelters	
Safety systems (lighting etc.)	

Resiliency

- While PV/Wind/ESS can contribute to resiliency, they shouldn't be the only form
  - Renewables are intermittent
  - ESS is limited by its capacity
  - Generators should be considered
- Microgrid should be small and close to load
  - Multiple microgrids provide redundancy
  - Reduce problems
  - Multiple locations

Sandia Advanced Microgrid Analysis, Modeling, and Testing Capabilities

Sandia National Laboratories

- Energy Surety Design Methodology
  - initiated in 2001 to provide performance-based, risk informed designs for energy infrastructures
  - Applied to electric power, energy pipeline, marine and railroad energy transport, and energy refineries
  - Used since 2006 for microgrid designs
- Distributed Energy Technology Laboratory
  - Operational 500 kW microgrid test facility with diesel, PV, microturbine, and energy storage resources to test power and load management and control approaches for single and multiple microgrids
  - Agent-based and Hamiltonian DC and AC control research and cyber security protection
- Microgrid Design Toolkit
  - Series of user friendly energy reliability, consequence, risk, cost, and optimization models developed for DOE to support universal microgrid analysis and design
- Performance Based Resiliency Metrics
  - System Level- Ex. Customer minutes interrupted
  - Consequence Level
    - Human- Ex. Number of people without services x time without services
    - Economic-Ex. Dollars lost due to outage
- Project Development
  - Application and economic analysis (open sources optimization tools)
  - Construction planning and document development
  - Commissioning planning
  - Operational data collection and analysis

Contact Info

CESA Project Director:

Todd Olinsky-Paul

(Todd@cleanegroup.org)

Sandia Project Director:

Dan Borneo

(drborne@sandia.gov)

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