



# February Texas Blackouts and Grid Reliability

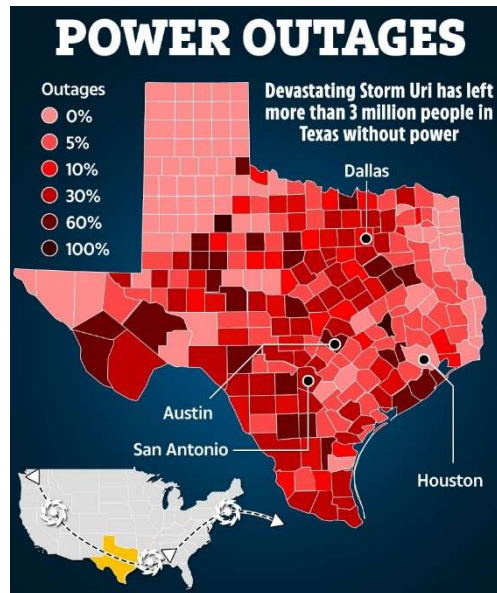
Jessica Bian  
PES President-Elect  
Vice President, Grid-X Partners

# Disclaimer

- **The views expressed herein are the author's, and do not necessarily reflect the views of the PES or any other organizations.**
- **Event datasets and graphs are still in an early stage. This presentation is based on available data at the current time, and may be modified pending further updates.**



# Texas Rolling Blackouts (Feb 15-17, 2021)



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Source: <https://spectrum.ieee.org/>, [www.statesman.com](http://www.statesman.com)

# Superstorm Sandy – October 29, 2012

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## Engineering Storm Hardening

PSE&G: \$1.2 billion

ConEd: \$1.0 billion



9:10 a.m. EDT



# Microgrids ... New York City After Superstorm Sandy

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# What is Grid Reliability?

**Keep Lights On.**

***Does it mean  
grid is not reliable?***



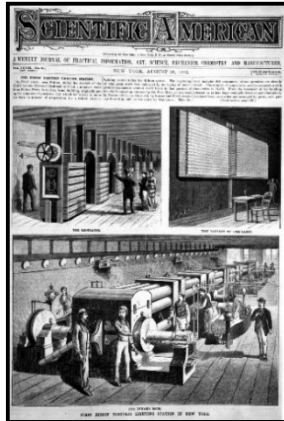




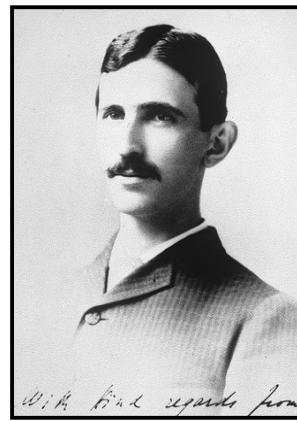
# Industry Started in 1882



Thomas Edison and his 1<sup>st</sup> commercial plant, Pearl St., NY 1882



Westinghouse and his 1<sup>st</sup> multi-volt AC system, Great Barrington, MA in 1886



Nikola Tesla, inventor of the induction motor & polyphase AC power system in 1887



Samuel Insull built the reliable "power pool" by low cost and tiered rates in 1897

- Edison opened his first electric power plant in NY in 1882
  - Microgrid?
- Within a decade, electric power had spread to every corner of the globe, with many new applications!
- Why was grid interconnected throughout the years?

**Cost-effectiveness**

**Reliability**

**Safety**

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# US Reliability History: Key Dates

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## **November 9, 1965 – Northeast Blackout (Cascading Failures)**

**1968:** National Electric Reliability Council (NERC) established by the electric industry

## **July 13-14, 1977 – NYC Blackout (Cascading Failures)**

**2002:** NERC operating policy and planning standards became mandatory and enforceable in Ontario, Canada

## **August 14, 2003 Blackout (Cascading Failures)**

**2005:** U.S. Energy Policy Act of 2005 creates the Electric Reliability Organization (ERO)

**2006:** FERC certified NERC as the ERO; MOUs with some Canadian Provinces

**2007:** North American Electric Reliability Council (NERC) became the North American Electric Reliability Corporation (NERC)

FERC issued Order 693 approving 83; became mandatory and enforceable for the Lower 48 States

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## ALR – Adequate Level of Reliability

Operating the elements of the bulk-power system within equipment and electric system thermal, voltage, and stability limits so that **instability, uncontrolled separation, or cascading failures** of such system will not occur as a result of a sudden disturbance, including a cybersecurity incident, or unanticipated failure of system elements.



# Adequate Level of Reliability (ALR) – Industry Definition

- The BES does not experience instability, uncontrolled separation, cascading, or voltage collapse under normal operating conditions and when subject to predefined disturbances.
- BES **frequency** is maintained within defined parameters under normal operating conditions and when subject to predefined disturbances.
- BES **voltage** is maintained within defined parameters under normal operating conditions and when subject to predefined disturbances.
- **Adverse reliability impacts on the BES following low-probability disturbances (e.g., multiple contingences, unplanned and uncontrolled equipment outages, cybersecurity events, and malicious acts) are **MANAGED**.**
- **Restoration** of the BES after major system disturbances that result in blackouts and widespread outages is performed in a coordinated and controlled manner.
- BES **transmission capability** is assessed to determine the availability to meet anticipated BES demands during normal operating conditions and when subject to predefined disturbances.
- **Resource** capability is assessed to determine the BES's availability to meet anticipated BES demands during normal operating conditions and when subject to predefined disturbances.

# History Helps Us Understand Why We Are Here Today

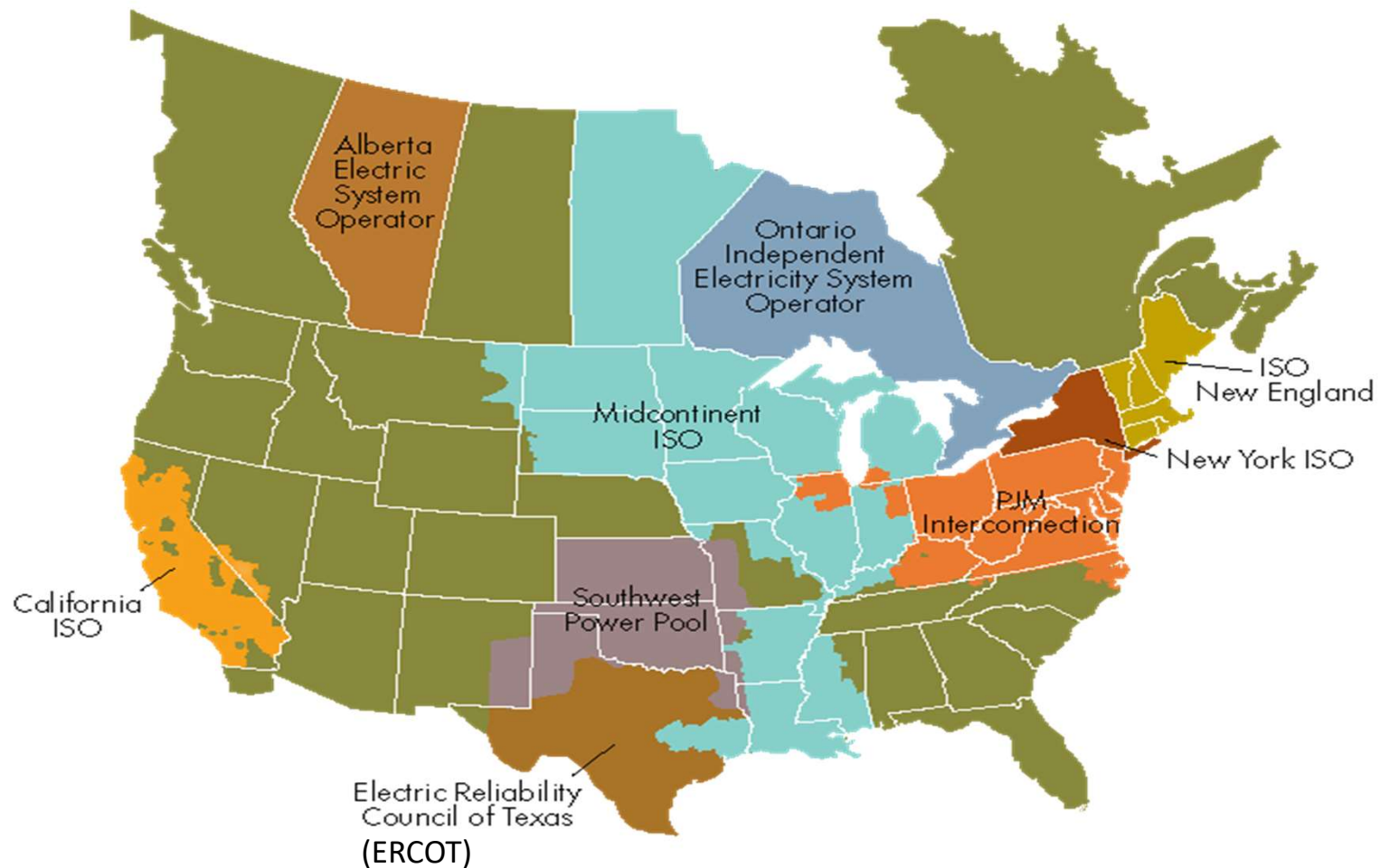
- Look across time
  - Decades are not detached
  - Lives across time – Growing up from birth to now
- Look across all the factors that drive change
  - Science and technology
  - Business strategy
  - Law and the courts
  - Regulatory policy
  - Politics (and geopolitics)
  - Culture

# Four Asynchronous Interconnections in North America

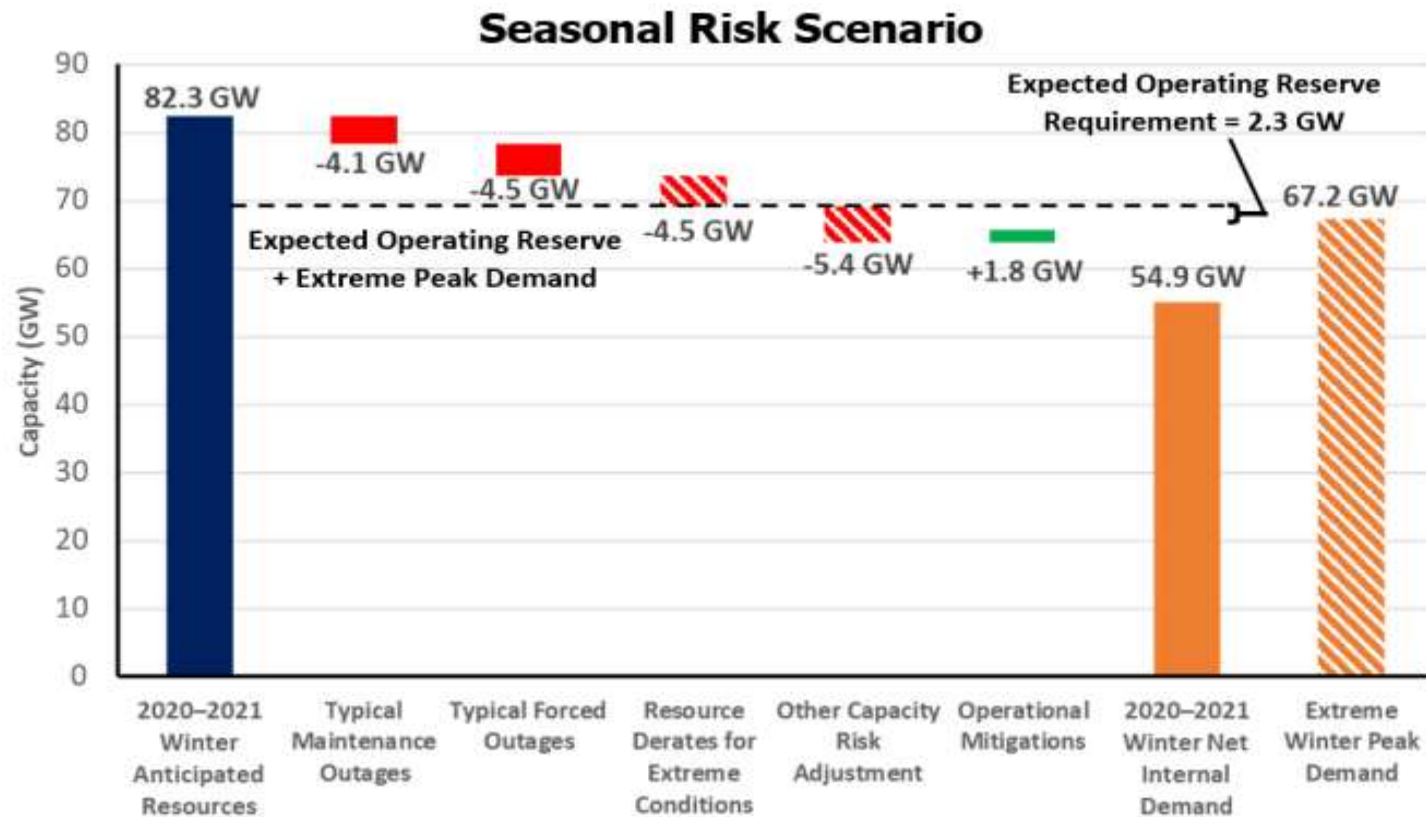




# Competition - Wholesale Electricity Markets in North America



# ERCOT 2021 Winter Planning Capacity



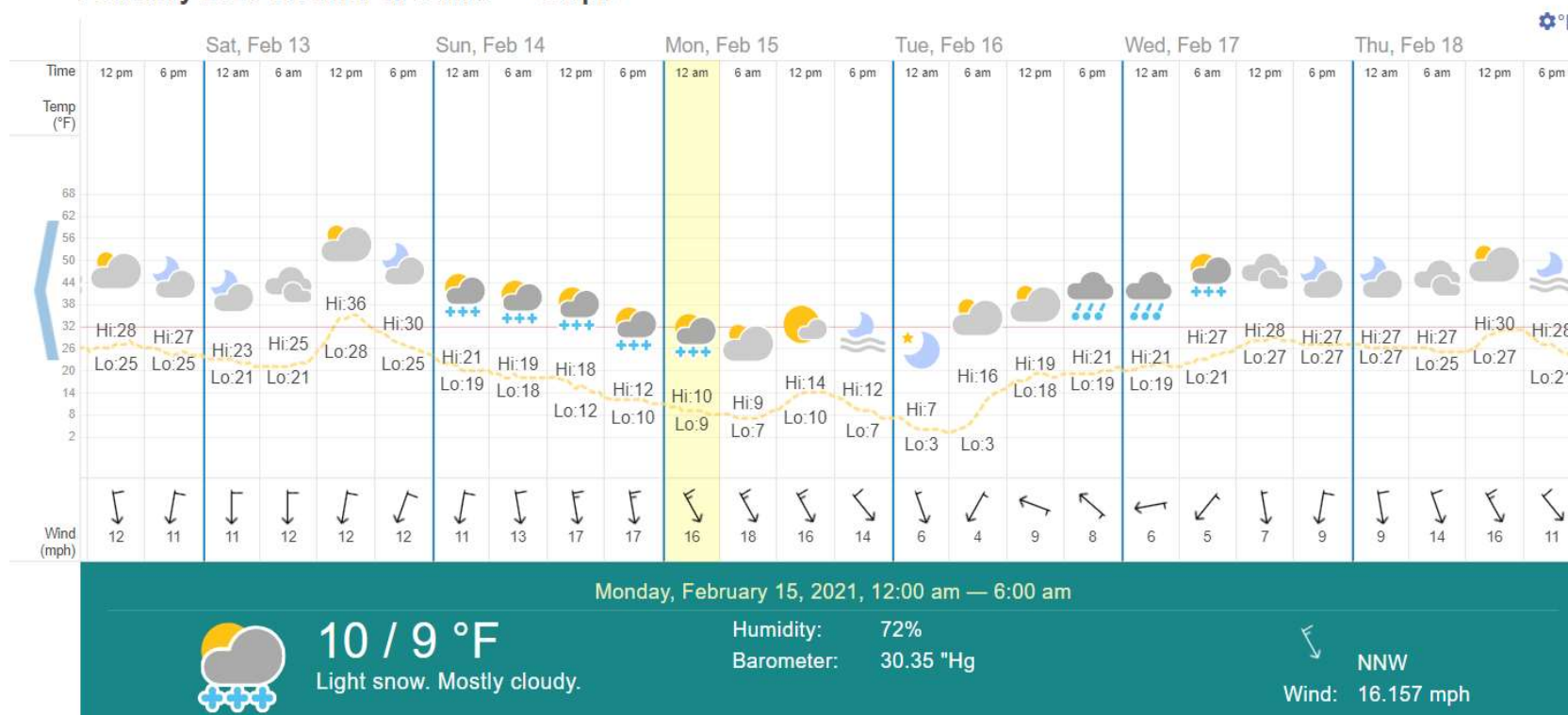
**Risk Scenario Summary** - Operating mitigations and EEAs may be needed under extreme demand and extreme resource derated conditions studied.

**Scenario Assumptions** - **Extreme Peak Load:** Based on 2011 historic winter peak load; **Typical Outages:** A capacity derate for thermal resources based on historical averages (Wind, solar, and hydro outages are accounted for in capacity contribution percentages.); **Derates for Extreme Conditions:** The expected amount of natural-gas-fired generator derates/outages due to natural gas curtailment at the time of an extreme peak load; **Other Capacity Risk Adjustment:** Low wind output based on the fifth percentile of hourly wind capacity factors (hourly MW output as a percentage of installed capacity) associated with the 100 highest net load hours (load minus wind output) for the 2015/2016–2019/2020 winter peak load seasons; **Operational Mitigations:** Additional resources (e.g., switchable generation resources, additional imports, voltage reduction, and mothballed capacity) to support maintaining operating reserves that are not already counted in WRA reserve margins. See more detailed [here](#)

# Feb 11-20, 2021 Historic Winter Outbreak in Texas

## - “Stress Test” on Resilience

February 2021 Weather in Dallas — Graph



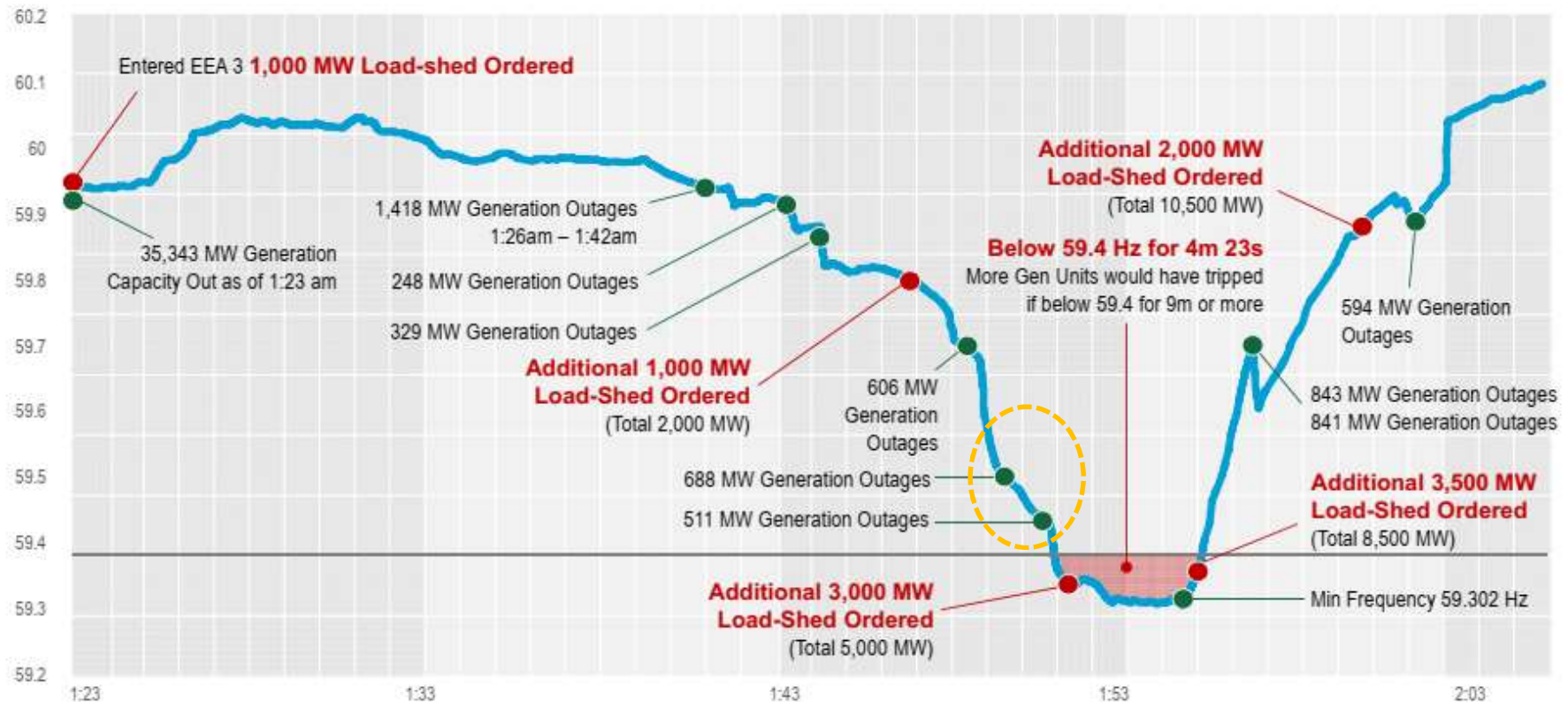
- Third worst winter storm in 130 years - Geographic, Severity, Duration
- Coldest winter, February 1899, second coldest, December 1989
- Dallas Feb Avg High/Low (°F): 61/41, YES – snow, while rare, is still possible.

Source: <https://www.timeanddate.com/weather/usa/dallas/historic>



# Independent System Operator (ERCOT)

- Transmission and wholesale electricity market operator
- Monday morning, February 15, 2021

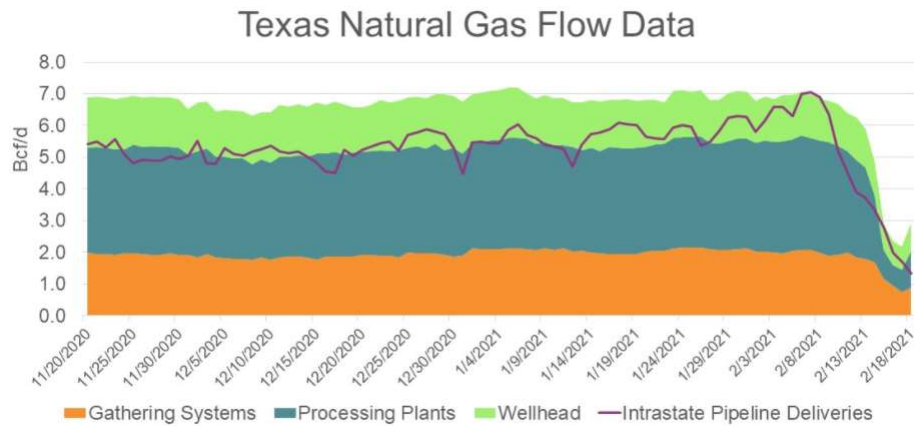


- ERCOT Underfrequency Load Shedding (UFLS) setting: 59.3 Hz
- [2008 Florida UFLS event](http://www.ercot.com/content/wcm/key_documents_lists/225373/Urgent_Board_of_Directors_Meeting_2-24-2021.pdf) with large freq/volt swings

Source: [http://www.ercot.com/content/wcm/key\\_documents\\_lists/225373/Urgent Board of Directors Meeting 2-24-2021.pdf](http://www.ercot.com/content/wcm/key_documents_lists/225373/Urgent_Board_of_Directors_Meeting_2-24-2021.pdf)

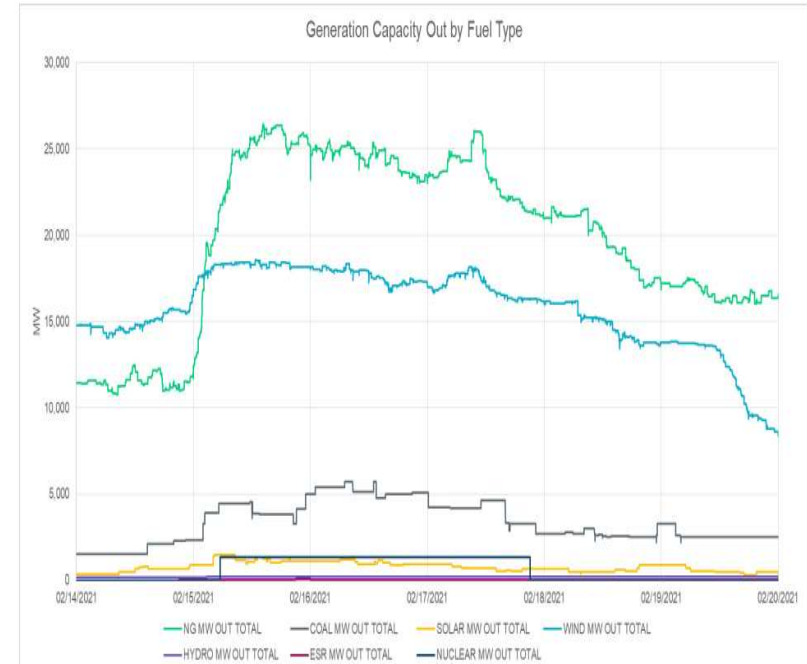
# Fuel and 48.6% Peak Generation Out

- Natural gas pipeline flow dropped more than half
  - High residential demand; pipeline low pressure -> derating generator output
  - Equipment freeze-offs, compressors/pump stations stop working w/o power



Source: <https://www.enverus.com/blog/trading-and-risk/ercot-power-grid-outage-what-went-wrong/>

Generation Capacity Out by Fuel Type



# Transmission and Distribution Utilities (TDU)

- Load shedding up to 72 hours
  - Many feeders not rotating
    - 25% UFLS feeders
    - ~25% feeders with a few critical loads
  - No other feeders left for rolling outages after shedding 20,000 MW
- Shed many water treatment plants and natural gas compressor/pump stations
  - Not on the “critical load” list
- Smart meters – Not “SMART” to identify and rotate non-critical load

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# Austin Downtown & East (Feb 15, 8:35pm)



**Terri Gruca** ✓  
@TerriG\_KVUE



A tale of two cities - on the right is downtown Austin - to the left East Austin. Look who has power. @KVUE



10:40 AM · Feb 16, 2021





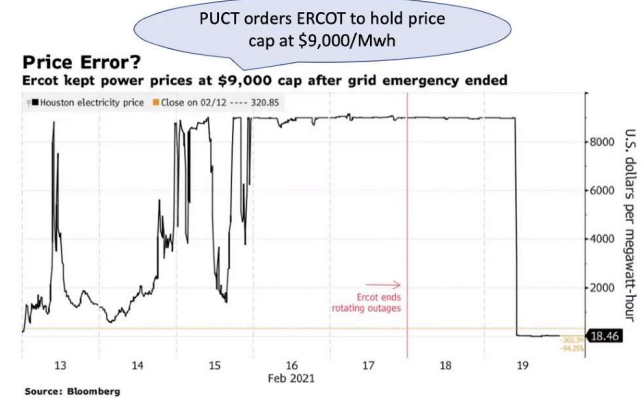
# Demand Side

- Emergency Response Service (ERS)
  - \$50 million cap, commercial/aggregated large load bids
- TDUs asked large industrial load to come offline one by one
- Many commercial buildings were lit at night during load shedding periods
- Not designated as critical load
  - Some senior centers
  - Many water treatment plants
  - Many natural gas compressor/pump stations
- Variable rate (~40,000 retail customers out of 7 million)
  - PUCT issued an [emergency order](#) on 2/21 for an immediate suspension of disconnections for non-payment

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# Market

- Optimization algorithm
  - Energy prices were low for many hours during first-day rolling outages, as low as \$1,200/MWh
  - Less than its system-wide offer cap of \$9,000/MWh
- PUCT issued an emergency order Monday evening, February 15 - set energy clearing at \$9,000/MWh
- Real-time \$9,000/MWh for four days - ~\$45 Billion



[https://www.bloomberg.com/news/articles/2021-03-04/texas-watchdog-says-power-grid-operator-made-16-billion-error?mkc\\_tok=DDUwLVRBQSO1MTEAAAF7rQjvL7a-5X78FWYiz\\_q1XGRYro5xi-YNY67dpjQCMKaf2CaQ8PDRsveHaoloi\\_9q\\_XJOAegk2d4b4zpa-SY-q14yntzqUzLOPA7m64UqLU](https://www.bloomberg.com/news/articles/2021-03-04/texas-watchdog-says-power-grid-operator-made-16-billion-error?mkc_tok=DDUwLVRBQSO1MTEAAAF7rQjvL7a-5X78FWYiz_q1XGRYro5xi-YNY67dpjQCMKaf2CaQ8PDRsveHaoloi_9q_XJOAegk2d4b4zpa-SY-q14yntzqUzLOPA7m64UqLU)

- Brazos Electric coop (Texas's largest and oldest electric power cooperative) filed for bankruptcy on March 1
  - \$1.8B bill from ERCOT
- City of Denton (muni) sued ERCOT – Prevent ERCOT from charging it for fees unpaid by other users
- Other lawsuits filed by individuals and other entities

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# Regulators

- Public Utility Commission of Texas (PUCT) for ERCOT, TDUs, retail, etc.
  - Lack of enforcement authority
- Texas Railroad Commission
  - Natural gas pipelines
- [SB1133](#) – Introduced after [Feb 1-5, 2011 ERCOT winter rolling blackout](#)
  - Passed by the Texas Senate in April 2011, House in May 2011
  - Allow PUCT to require entities to submit/update emergency operations plans
  - But no mandate on generator winterization

	2011	2021
Maximum generation capacity forced out at any given time (MW)	14,702	52,277
Generation forced out one hour before start of EEA3 (MW)	1,182	2,489
Cumulative generation capacity forced out throughout the event (MW)	29,729	46,249*
Cumulative number of generators outaged throughout the event	193	356
Cumulative gas generation de-rated due to supply issues	1,282	9,323
Lowest frequency	59.58	59.30
Maximum load shed requested (MW)	4,000	20,000
Duration load shed request (hours)	7.5	70.5
Estimated peak load (without load shed)	59,000	76,819

\*Note: "Cumulative" values for 2021 were calculated using NERC 2011 report methodology  
Cumulative amount for 2021 starts at 00:01 on February 14, 2021

## Bright Spots - Home Solar + Batteries Performed

- Hundreds of homes powered thru the event
- Extended outages mitigated with storage
- 50+ hours of backup solar energy reported
- 350% traffic jump at all rooftop solar company websites right after the event



Houston, Feb 16, 6am



## Bright Spots (cont'd) - Microgrid Performed

- Users with energy storage systems
- Demo Microgrid
  - Two 1.3 MW Gas generators
  - 1MW / 1MWh battery energy storage system
  - Total 60 MWh over 3.5 days



Microgrid in Austin

# 2014 Polar Vortex and 2018 Cold Snap Events

- 2014 event - PJM unit forced outage rate: [22%](#)
- April 2015 - [FERC Order 809](#)
  - Improve the coordination of the scheduling processes of interstate natural gas pipelines and public utilities
- 2016 - PJM implemented new capacity performance rules
  - Credit for good performance when called upon
  - Penalty for poor/bad performance when called upon
- 2018 event - PJM unit forced outage rate: 12%
  - Typical forced outage rate: 7%
- ISO-NE - [Interim winter reliability program](#) after the 2014 event
  - Pay for Performance solution became effective in 2018.
- NERC has been developing a [new cold weather emergency preparedness standard](#) in the wake of the 2018 South Central (SPP, MISO, TVA, etc.) cold weather event.

# Many Solutions Discussed

- Energy efficiency in old buildings and houses to reduce peak load
- Customers have backup power for 2-days at critical load sites
- Make distribution systems more granular, smarter
  - Add more sectionalizers, particularly on old feeders
- More Energy Storage
- Transmission Tie with Eastern Interconnection
  - 1GW line, saving \$1 billion, and keeping heat on for 200,000 homes in Texas
  - More at [https://acore.org/wp-content/uploads/2021/07/GS\\_Resilient-Transmission\\_proof.pdf](https://acore.org/wp-content/uploads/2021/07/GS_Resilient-Transmission_proof.pdf)

# New Bills – Signed into Law June 2021

- Texas Senate Bill 3
  - Oversight and accountability
  - Communication failures - Create a power outage alert system with the cooperation of the Texas Department of Transportation, the Texas Division of Emergency Management, the Office of the Governor, and the Public Utility Commission of Texas. The system would let Texans know earlier if there would be a possible power outage in their area.
  - Weatherization
- Public Utilities Commission of Texas (PUCT) - Set weather emergency reliability standards for a municipally owned utility, electric cooperative, wholesale power generation company
- Create an independent organization to do compliance inspections and issue penalties for non-compliance up to \$1,000,000



## New Bills (Cont'd)

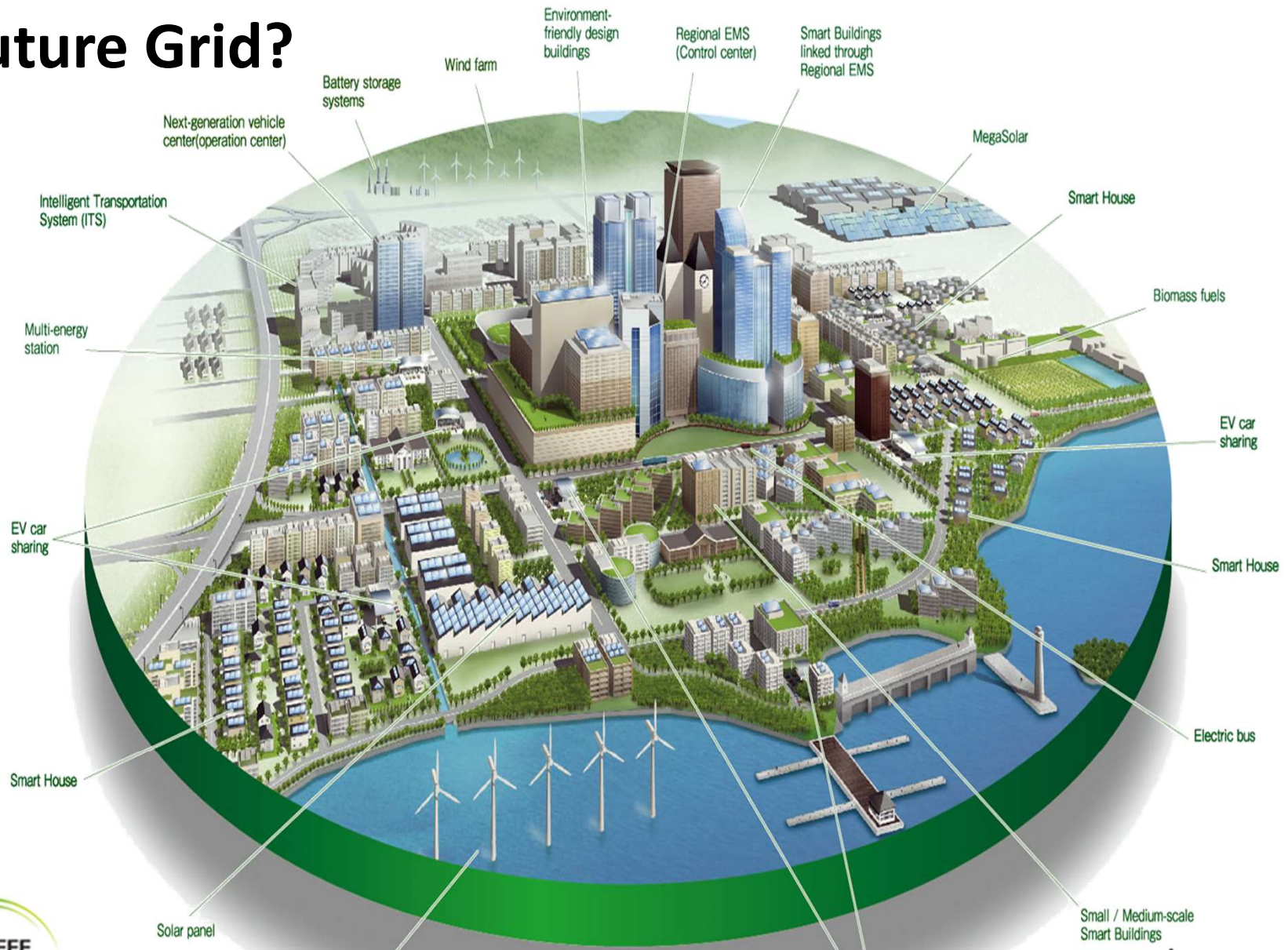
- The Railroad Commission - Require facility operators in the natural gas supply chain to implement measures to prepare to operate during a weather emergency. The Railroad Commission has the authority to do inspections for compliance in these cases.
- Create the Texas Energy Reliability Council to ensure that the energy and electric industries meet high priority human needs and address critical infrastructure concerns; and enhance coordination and communication in the energy and electric industries
  - Include the presiding officer of the PUCT as well as representatives from the Office of Public Utility Counsel and the Texas Commission on Environmental Quality, as well as industry representatives
  - Must bring recommendations to the legislature on how to strengthen the electricity supply chain

# New Bills (Cont'd)

- Create the Texas Electricity Supply Chain Security and Mapping Committee
  - Make sure critical infrastructure in the natural gas industry is not accidentally turned off as it was in the winter storm
  - Create a map of Texas's electricity supply chain
  - Establish best practices for facilities that provide electric service/natural gas service in the electricity supply chain to maintain service in an extreme weather event
  - Include representatives from PUCT, the Railroad Commission, ERCOT, and the Texas Division of Emergency Management
- Texas Senate Bill 2 – Requires PUCT to approve new policy changes from the new 11-member ERCOT Board
  - Number of seats reduced from 16 to 11
  - The governor, lieutenant governor and speaker of the House would play key roles in appointing board members. Each official will appoint a member of a newly formed selection committee, responsible for appointing eight of the 11 ERCOT board members.
  - Require all members reside in Texas

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# Future Grid?

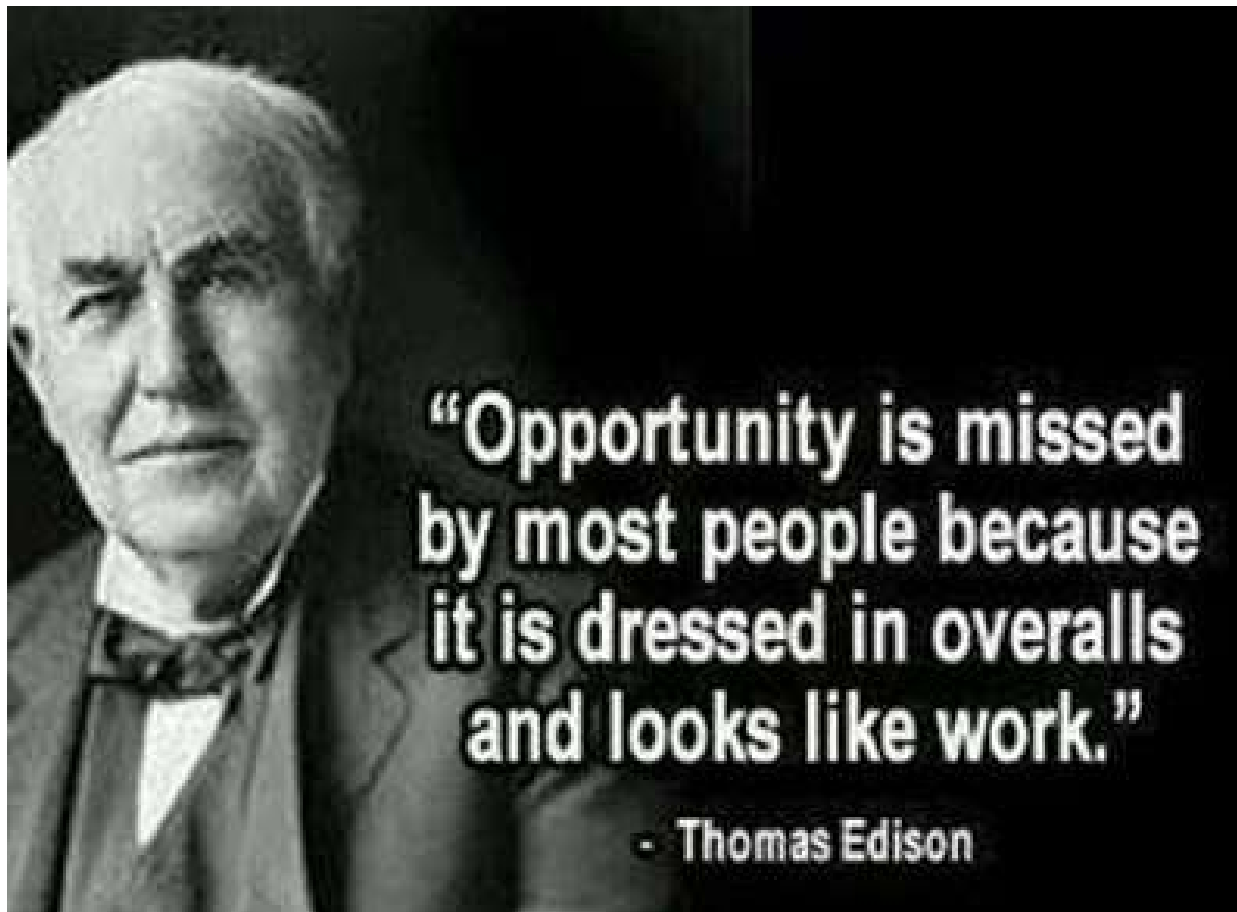


# Dream Grid

- Reliable and Affordable - Done
- Resilient?
- Flexible?
- Friendly and Nice Looking?
- Other Cool Features?
- Complete Makeover?



# What It Means – Opportunities!!!



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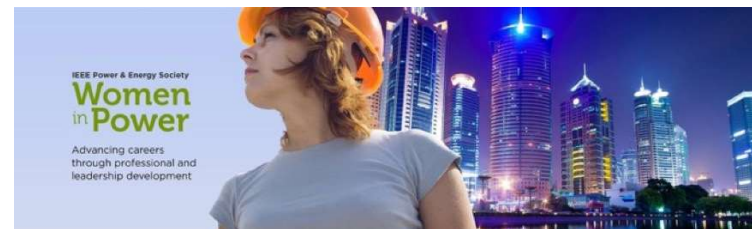
# #MorePowertotheFuture

- “Be the change that you wish to see in the world.” - Gandhi
- Join our month-long PES events - PES DAY in April 2021, more at <https://site.ieee.org/pes-day/>

## You Can Win The IEEE PES Young Professionals "Milestelfies" Photo Contest!

- 1 Choose from the 177 milestone landmarks on the list!
- 2 Go There! Grab a Selfie!
- 3 Post it with the hashtag #Milestelfie and tag @IEEEPESYP

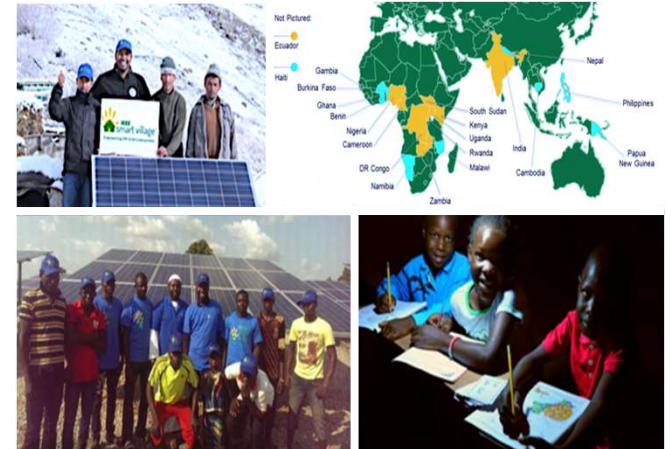
[CLICK FOR MORE INFORMATION](#)



# Keeping Lights On

- Academia (learn, teach, invent/research)
- Manufacturers (invent, apply)
- Generator owners and operators (all resource types)
- Electric utilities (T&D planning, operations, asset management)
- Transmission and market operators (ERCOT, PJM, etc.)
- Standards organizations (NIST, NERC, IEEE, IEC, etc.)
- Regulatory agencies (Federal, State and local regulators, etc.)
- End-users (demand response, energy efficiency, etc.)
- Associations (EEI, APPA, NRECA, PES, CIGRE, etc.)
- Investors, startups, entrepreneurs, high tech firms,...
- ... ..

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