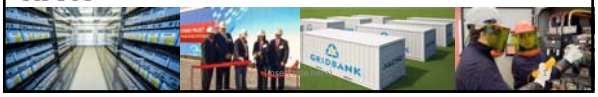
Energy Storage and Microgrid

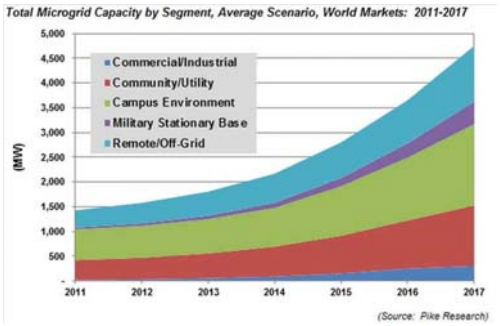
ESAM-TAC

Training and Certification

Why, What, Where, When?



Energy Storage and Microgrid Market is ***rapidly expanding***



https://www.youtube.com/watch?v=osXwnyDiLLo

U.S. Market: April, 2018: **686** energy storage projects
Majority, 449, are electro chemical

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Example: Goldsmith, Texas

Notrees Battery Storage Project - Duke Energy - 36 Megawatts

Notrees updated with Samsung lithium Ion batteries in 2016. Duke Energy deployed a wind energy storage demonstration system at the 153 MW Notrees Wind power project in western Texas. Project demonstrates how energy storage and power storage technologies can help wind power systems address intermittency issues by building a 36 megawatt (MW) turnkey energy storage and power management system capable of optimizing the delivery of energy, in addition to providing regulation service in the ERCOT market.

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Example: Phoenix, Arizona

STMicroelectronics UPS System - S&C Electric - 12,500-kilvolt-ampere (kVA)

August 2000 installation of a 12,500-kilvolt-ampere (kVA) uninterruptible power supply (UPS) system operating at 12,470 volts (V), located in the utility substation. The UPS system at STMicroelectronics in Phoenix utilizes five 2500-kVA energy storage units operating at the utility system voltage of 12,470 V. High-speed power-electronic components create modular energy storage units. Combined, they produce a large-scale (>1,000 kilowatts) offline UPS system which operates only upon the occurrence of a utility system disturbance.

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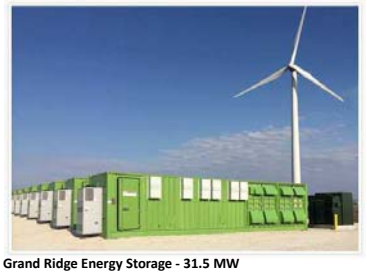
Example: Marseilles, Illinois



Grand Ridge Energy Storage - 31.5 MW

Grand Ridge Energy Storage project is located approximately 80 mi southwest of Chicago, IL. It has a power rating of 31.5 MW and an energy rating of 12.2 MWh. The project is projected to operate sometime in 2015 with the purpose of fast response regulation. Technology Type: Lithium Iron Phosphate Battery

Example: Elkins, West Virginia

AES Laurel Mountain - 32 KW

AES installed a wind generation plant comprised of 98 MW of wind generation and 32 MW of integrated battery-based energy storage. The project is supplying emissions-free renewable energy and clean, flexible, operating reserve capacity to the PJM Interconnection, the largest power market in the world.

Indianapolis, Indiana

IPL Advancion Energy - 20 MW

Indianapolis Power & Light Company, a subsidiary of AES Corporation, developed a grid-scale, battery-based energy storage system to improve reliability and lower costs for its customers. The battery storage system will provide 20 MW / 20 MWh of interconnected advanced, battery-based energy storage. The battery storage facility will **deliver enhanced grid reliability and ancillary services, focused on primary frequency response.**

Example: Montauk, NY

Deepwater Wind - 15 MW

Deepwater Wind is planning to build a 90-MW offshore wind farm combined with 15 MW of storage capacity by General Electric to serve the South Fork peninsula in New York state. They will use lithium-ion battery technology designed and installed by GE and will together store 15 MW of energy.

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Dayton, Ohio

AES Tait Battery Array - 40 MW

AES has installed an additional 40 MW (+20/-20) of advanced energy storage resources to PJM Interconnection, which controls the power grid for 60 million people in the Northeast and Midwest. Dayton Power and Light's (DP&L) Tait generating station, south of Dayton, battery array will provide frequency regulation service to the PJM market and bring new energy technology to Ohio that is safe, reliable, and does not bear direct emission.

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Warrior Run Facility, Maryland

Warrior Run Advancion Energy Storage - 10 MW

10 MW Lithium Ion storge facility at Maryland's Warrior Run. The system will utilize the Advancion 4, AES's newest iteration of its battery storage system.

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Anchorage, Alaska

Golden Valley Electric Association Energy Storage System - 27 MW

Completed in 2003, one of GVEA's initiatives to improve the reliability of service to GVEA members. In the event of a generation or transmission related outage, it can provide 27 megawatts of power for 15 minutes. That's enough time for the co-op to start up local generation when there are problems with the Intertie or power plants in Anchorage.

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Long Beach, California.

Alamitos Energy Storage Array – 400 MW

A 20-year Power Purchase Agreement (PPA) by Southern California Edison (SCE), to provide 100 MW of interconnected battery-based energy storage, a 200 MW flexible power resource. This new capacity can deliver 400 MWh of energy and will be built south of Los Angeles at the Alamitos Power Center.

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Kahuku Wind Farm, Hawaii

15 MW

Younicos installed a 15 MW fully integrated energy storage and power management system designed to provide load firming for a 30 MW wind farm in Hawaii, as well as provide critical grid integration services. The project was supported by a U.S. DOE Office of Electricity loan guarantee.

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Meyersdale, Pennsylvania

Meyersdale Energy Storage – NextEra – 18 MW

In 2015, NextEra Energy Resources commissioned the Meyersdale Battery Energy Storage System, an 18 MW facility located in Pennsylvania operating in the PJM frequency regulation market.

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ESM Market Opportunities

- Peaker Plants: ES is less expensive and much faster – as little as 6 months!
- ES + RE can function like base load generation
- Peak shaving & load shifting
- Energy arbitrage
- Grid resilience
- Emergency response systems
- Etc.

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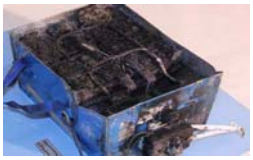
Safety Risks

- Strong industry growth, but
- Electro chemical batteries have had problems
- Mostly consumer battery issues
- Some commercial situations

Galaxy Note 7



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Government & Industry Safety Concerns

Battery energy storage systems (BESS) are a serious safety risk if not correctly installed, potentially leading to:

- Electric shock
- Fires
- Arc Flash
- Flash burns
- Explosions
- Exposure to hazardous chemicals

Key: ***"if not correctly installed"***

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In response to the energy storage boom and safety concerns, ESAM-TAC development led by Penn State, Incorporating **national industry standards**

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ESAMTAC

- Strong IBEW-NECA support from all around the nation
- National Science Foundation – Advanced Technician Training (NSF-ATE) program funding
- Collaborative, industry-wide process is foundation for
  - High quality training
  - Optimum system performance
  - Safety, safety, safety
  - Acceptance and recognition of training and certification by industry, utilities, government agencies, etc.

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Goals

- Develop training program and certification (EPRI Approved) for energy storage installation
- Serve Manufacturers, Contractors, Electrical Workers, Investors, IEEE, Utility Professionals, Government Agencies, Insurers, and more
- Develop and test blended-learning modules
- Continue train-the-trainer courses, and expand class instruction

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Why Develop a Credential?

- ***Formalizes and standardizes*** training program
- Elevates specialty skills and knowledge ***needed to work safely*** on energy storage and microgrid projects, produce optimum performance, and longevity
- Enables credential to be specified by manufacturers
- ***Most projects are financed*** – quality assurance can lead to reduced insurance rates / improved viability
- Allows market to identify and utilize skilled providers

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Why Develop / Require Training and a Credential?

RISK REDUCTION

- Financial Institutions
- Insurance underwriters
- Manufacturers

MAINTAIN A HIGH DEGREE OF PUBLIC AND MARKET CONFIDENCE IN BATTERY SYSTEM SAFETY

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EPRI | ELECTRIC POWER RESEARCH INSTITUTE

- Certification will be monitored and classified by EPRI
- 3rd party validation of credential
- Will help spread awareness across extensive network of EPRI members
- EPRI is known and respected by utilities, governments, universities, and private organizations nationwide

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EPRI's Standardized Task Evaluation

- Proven knowledge and skills evaluation process that ensures the competency of the industry's craft and technician workforce
- ***Ensure that the workforce is competent to reliably perform the many tasks*** associated with operating and maintaining industry facilities

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EPRI's Standardized Task Evaluation

STE Evaluation

- Collaboratively developed evaluation tests that support high-priority industry needs.
- Each covers a specific task area
  - PPE Selection
  - Battery Assembly
  - Battery Maintenance
- The EPRI STE process provides a method to accomplish objective validation.

National Registry

- Documented registry of personnel who have demonstrated competency in specific task areas.

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Example, Lesson Learned:

Data-Center battery assembly and maintenance requires specialty skills not formally covered in training programs.

ESM systems will require ***even more knowledge and skills*** to build and maintain active energy storage systems.

- Battery systems have very different characteristics
- Extensive monitoring
- Multiple operating modes
- Planned replacement

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Example, Lesson Learned:

On-site racking and stacking of battery cell vs. off site prefabrication

On site assembly:

- Simplifies shipping of cells
- Enables more control of integration process
- Move work from remote factories to on-site
- Provides site-specific experience in case of need to swap/replace cells
- Rack design more conducive to safe work
- Larger rack enables critical ventilation and cooling of battery
- Favored by battery manufacturer (Example: Samsung)

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Example, Lesson Learned:

On-site racking and stacking of battery cell vs. Off site prefabrication (Continued)

Modular systems

- Smaller units / racks
- Containerized systems create confined space / hard to meet code

So-called “plug and play, modular” ESM systems are not reducing the need for trained, expert electricians!

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Safety is Critical!

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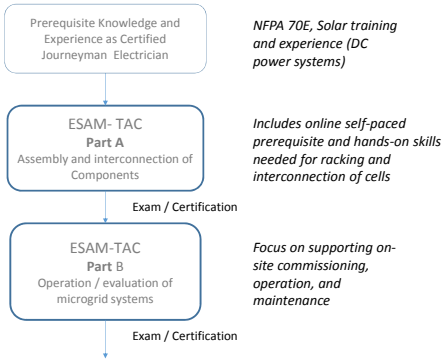
Credential Design



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Level One Course Modules

0: Introduction to ESAMTAC
1: Business Drivers
2: Microgrid systems and Components
3: ESM Storage Systems
4: Battery Safety
5: DC Theory, Devices, and Meters
6: ESM Control and Communication Systems

(Insert title here) 32

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(Continued)

7: ESM Assembly Methods and Safety
8: Enclosures and Racks for Batteries
9: Installation of Batteries in Racks
10: Connections Between Batteries
11: DC Power Conductors and Connections
12: Grounding and Bonding of ESM systems

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Level One Course Hands-on Labs

1.1 Microgrid Applications
1.2 Energy Storage Application
2.1 Inverter Properties
2.2 Micro-turbine Interconnection
3.1 En. Storage Chemistry and Application
4.1 PPE selection
4.2 Emergency Action Plan for Lead Acid Battery Installation
5.1 Wet cell battery maintenance
6.1 Method of Procedure

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(Continued)

7.1 Hazard & Arc Fault Risk Assessment
8.1 Battery Systems Case Study
9.1 Moving Batteries into Racks
10.1 Making Connection Cables
10.2 Connecting Batteries in a Row
11.1 Make up Fine Twisted Strand Cable
11.2 DC Cable Connections
11.3 ESM Project Planning Analysis

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Strategy: Curriculum built around actual energy storage and microgrid systems

GridSTAR Center Micro Grid Systems

Building Integrated Hybrid CHP-Solar-Battery

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Strategy: Curriculum built around actual energy storage and microgrid systems

1200 acre unregulated Navy Yard Grid

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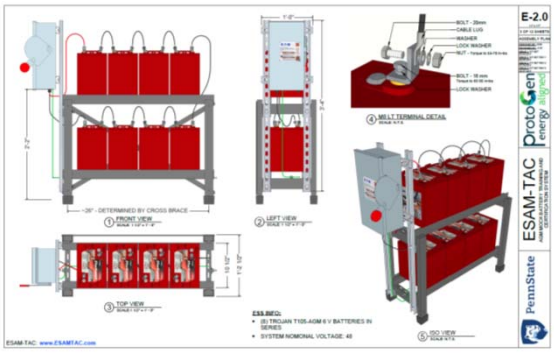
Labs: Custom Drawing and Specifications of GridSTAR Systems



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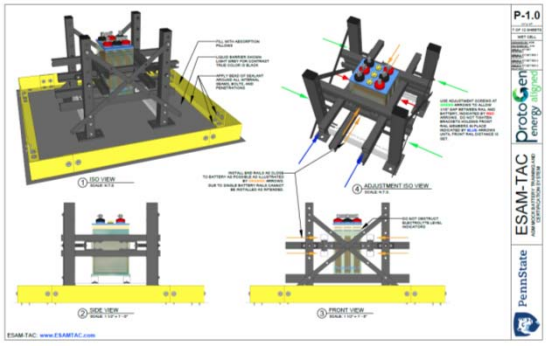
Labs: Custom Drawing and Specifications of GridSTAR Systems



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Level Two Course Topics (Only After Level 1)

- Situation Assessment of Microgrid Systems
- Power systems communication infrastructure
- Component parts & protocols of ESM systems
- SCADA / interface systems
- Operations and reset procedures
- Cyber security networking/ Network segmentation
- Design & code compliance / certification
- Site controller interface and programming
- Evaluation of monitoring data
- Sensors and monitoring systems
- Commissioning and testing standards
- Advanced troubleshooting methods for BESS systems
- O&M processes & Retrofit procedure
- Decommissioning and recycling of ESM systems

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Challenges (ESAMTAC is Great, But …)

- Instructors are being trained, but not enough
- Not all trained instructors are teaching classes
- Not all JATCs - with trained instructors - are scheduling classes
- Very few apprentices and journey-level electricians are improving their ESM skills and safety
- The market keeps growing and we are losing our advantage
- Why is this happening?

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We Must Move Forward Now

- *"ESAMTAC is still making changes"*
- *"The course is not done"*

Must not allow the perfect to be the Enemy of the good!

- *"EPRI certification process is not yet complete."*
- *"We're not teaching/scheduling/taking ESAMTAC because the certification is not available."*

JATC certification is the answer through the transition.

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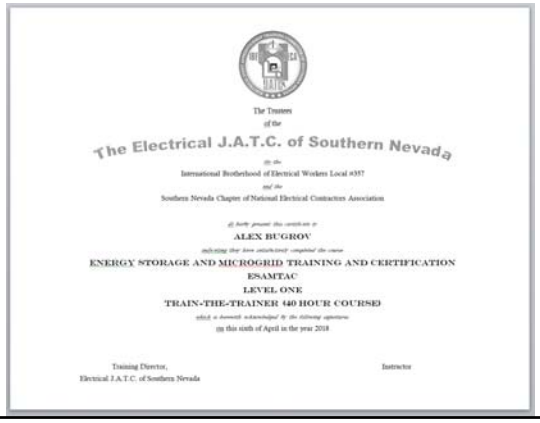

The Trustees
of the
The Electrical J.A.T.C. of Southern Nevada
of the
International Brotherhood of Electrical Workers Local #357
and the
Southern Nevada Chapter of National Electrical Contractors Association

do hereby present this certificate to

ALEX BUGROV

indicating that he has satisfactorily completed the course

ENERGY STORAGE AND MICROGRID TRAINING AND CERTIFICATION
ESAMTAC
LEVEL ONE
TRAIN-THE-TRAINER 440 HOUR COURSE

which is hereunto acknowledged by the following signatures

on this sixth of April in the year 2018

Training Director,
Electrical J.A.T.C. of Southern Nevada

Instructor

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NOW IS THE TIME FOR ESAMTAC

- DELAYING ESAMTAC REDUCES SAFETY
- WAITING HARMS OUR ABILTY TO COMPETE AND SUCCEED
- HE OR SHE WHO HESITATES, LOSES
- TTT NOW
- SCHEDULE CLASSES NOW
- PROMOTE ESAMTAC NOW
- GET THE NUMBERS – CRITICAL MASS IS CRITICAL

Energy Storage and Microgrid

ESAM-TAC

Training and Certification

Thank you

PennState

NFPA

ANSI

EPRI ELECTRIC POWER RESEARCH INSTITUTE

National Electrical Code

nec