Challenges Experienced Running Distributed Energy Resources

Mark A. Harral, JD

CEO

Group NIRE

GROUP NIRE Renewable Energy Solutions™

Testing & Certification Center

GNIRE exists to enable its partners to perform critical research and development for the commercialization renewable energy projects. The research projects include performing field test of prototypes of electric generation equipment and technologies that expand renewable energy across North America.

GNIRE has expanded its focuses to testing of energy storage and cybersecurity for the electric grid. GNIRE's projects typically have GNIRE performing all permitting with state agencies as well as utilities required to perform a field test.

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1970 Lubbock Tornado Started Initiative

- The 1970 Lubbock F5 tornado occurred in Lubbock, Texas, on May 11, 1970. It was one of the worst tornadoes in Texas history.
- Struck a central business district of a large or mid-sized city:
  - 26 people died during the storm
  - 430 homes were destroyed, 519 sustained major damage, and 7,851 more sustained minor damage
  - 250 businesses were also severely damaged or destroyed
- Initiative Focuses on Field Trials and Test Results


LUBBOCK AVALANCHE-JOURNAL

City Digs Out of Tornado Wreckage

20 ARE KNOWN DEAD

Water Supply Is Critical

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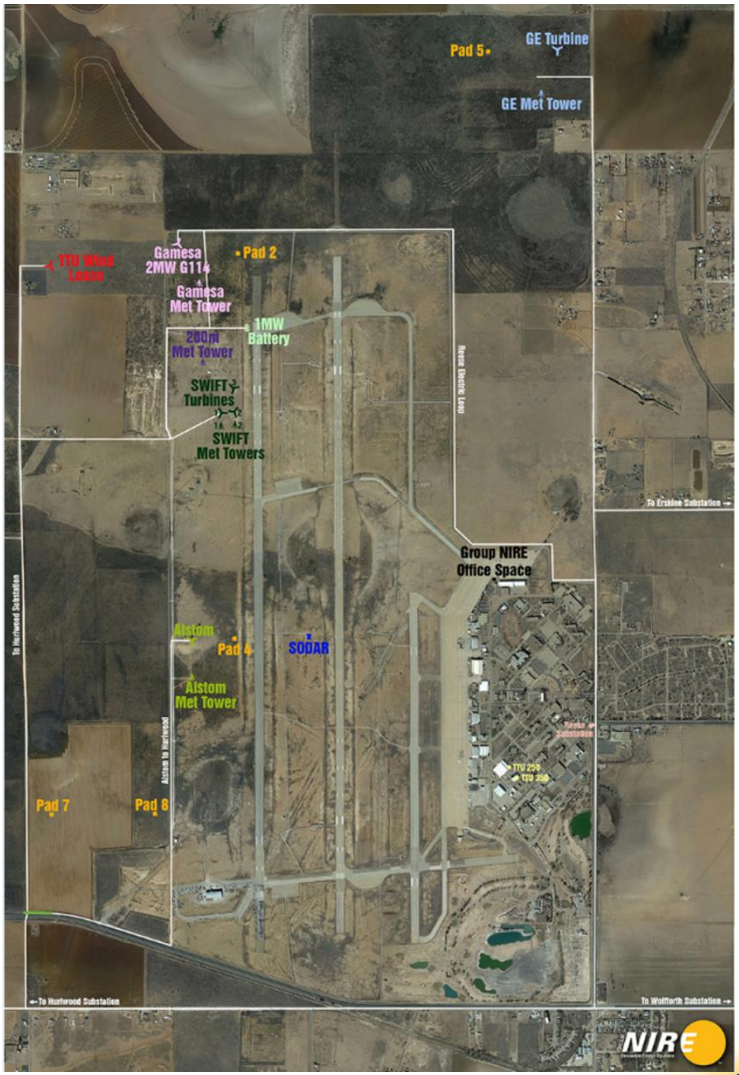
Group NIRE Capabilities

- **Current Generation Assets**
  - $30M installed research projects and equipment with partners like Alstom, GE, Gamesa, Younicos, State of Texas, SPEC;
  - 53% Net Capacity Factors on Recent Wind Turbines, 8.2m/s average wind speed;
- **Distribution System**
  - $1.4M in distribution system upgrades;
  - 30MW Peak Distribution Load Conditions;
  - 10MW Off-Peak Distribution Load Conditions;
  - Access to all Historical load data from local substations
- **Useable Land**
  - 2000 acres of useable land,
  - no environmental issues found through 4 years of studies;



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Four Main Challenges to Address

- Interconnection Studies
- Weather and Nature
- Communication and Control Systems
- Cyber Security

Always focused on field testing or gathering field data

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Interconnection Studies

- GNIRE's history includes
  - 4 Utility Scale (>1.5MW) WTG deployed with different interconnection points;
  - OEMs include Alstom, Gamesa, and GE. We previously were the contractor used by Vestas for DOE/SNL SWiFT Site.
  - 1MW/1MWh Lithium Ion Battery
- Interconnection Studies for Distributed Energy Resources
  - Initial utility application to connect at distribution level is nearly as complicated as interconnection at transmission level.
  - Most Potentially Affected System Operators do not have another study path and require PSSE Models regardless of generation size. Assume the following:
    - $20-40K to submit and apply for a distribution interconnection study;
    - Make sure generator has PSSE models necessary to submit applications;
    - Study process can take 6-12 months;

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Weather and Nature

- GNIRE's history includes building and operating DERs in the following:
  - Worst blizzard in 50 years
  - 95mph winds
  - Dust storms and Raining Mud
  - Extreme Heats and Cold
- Design and Installation of DER devices is SITE SPECIFIC
  - DER systems may not be designed or installed adequately;
  - Mice eat through communication cable; Prairie dogs eat through electrical and fiber lines; wasps and moths establish nest inside of containers;

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Communication and Control System

- GNIRE's history includes building and operating DERs in the following:
  - Building fiber optic lines between buildings and DER devices;
  - Utilizing radio network between substations and point of interconnects for SCADA DMP3 and PMU data;
  - DER Devices have faults that trip adjacent DER Devices;
  - Curtailment of DER devices by 50% Nameplate for potential over production of generation vs. load demand.
- Recommended Practices
  - Install SEL 734 revenue meters with DMP3 and PMU data functions;
  - Fiber optic lines can and will fail. Should always utilize encrypted radio networks;
  - Existing control systems do not provide adequate Forward Operating Profiles
  - Gather PMU Data to determine when DER devices trip other DER devices

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Curtailment of DER Devices

- May 2015-Utility Requires Curtailment of 2 DER devices
  - Concern was that consumer load was dropping and DER production was higher than usually;
  - Utility believed that the situation would persist for a month without a way to actively regulate the DER production not exceeding consumer load;
  - The weather, consumer load data, and availability of wind assets showed that wind production would have only exceeded consumer load
    - 6 instances of 15 minute periods identified;
    - Month Long Curtailment resulted in $10,000 in lost revenue;

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Curtailment of DER Devices

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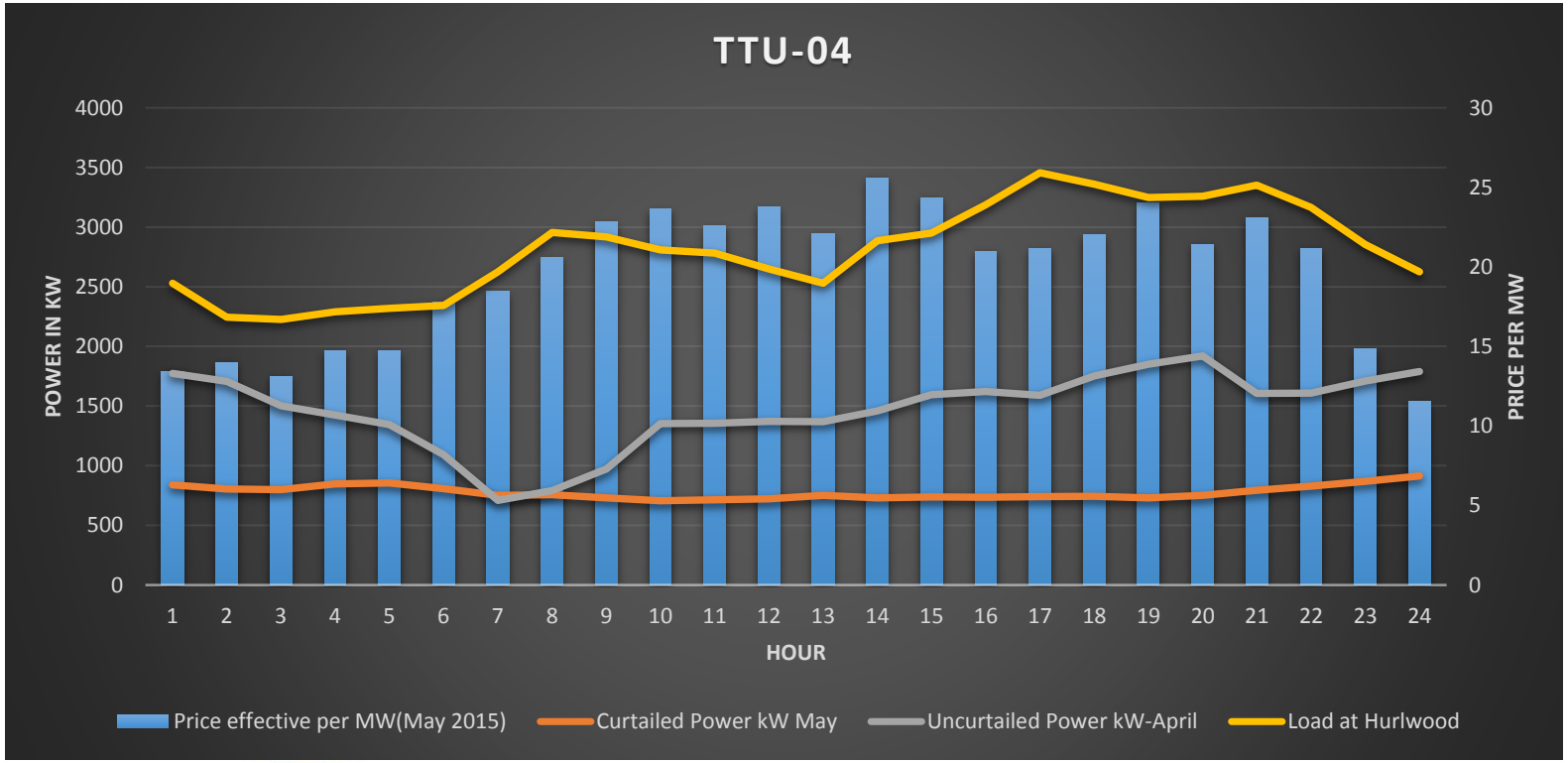

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Cyber Security

- GNIRE's history includes deploying and testing Intel/McAfees Security Fabric Software:
  - Deployed it on a PMU network utilizing SEL734 revenue meters, PDC, and RTDMS;
  - Created a "Honey-Pot";
- Recommended Practices-Assume Hackers can:
  - Identify and target DER devices;
  - Penetrate the communication equipment from the internet converter;
  - Can change user names and passwords.

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Forensics Reporting Q1 2013

IP Address	Type of Network	Failure Attempts	Successful Attempts	Number of Attempts	Region	Type of Attempt
113.240.248.18	External	7824	0	7824	China Telecom	Brute Force
121.96.56.11	External	1425	0	1425	Bayan Telecom	Brute Force
222.186.15.153	External	1825	0	1825	China Telecom	Brute Force
222.211.85.150	External	436	0	436	China Telecom	Brute Force
58.215.173.114	External	410	0	410	China Telecom	Brute Force
61.147.113.93	External	768	0	768	China Telecom	Brute Force
114.80.202.30	External	275	0	275	China Telecom	Brute Force
114.80.226.94	External	408	0	408	China Telecom	Brute Force
61.147.116.20	External	400	0	400	China Telecom	Brute Force
61.147.116.24	External	276	0	276	China Telecom	Brute Force
61.147.119.106	External	264	0	264	China Telecom	Brute Force
60.191.45.248	External	228	0	228	China	Brute Force
112.91.240.230	External	109	0	109	China Unicom Jieyang Branch	Brute Force
195.93.180.125	External	105	0	105	Russia	Brute Force
112.216.82.130	External	99	0	99	Korea	Brute Force
222.88.154.79	External	87	0	87	Russia	Brute Force
92.63.96.106	External	86	0	86	Russia	Brute Force
85.232.244.50	External	84	0	84	Poland	Brute Force

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Thank You

- GNIRE would like to thank DOE-AMO for the opportunity to present at the this workshop;
- GNIRE recognizes the DOE-ARPA E CHARGES and NODES programs and State of Texas GLEAMM award which are leading to solutions to these issues;
- GNIRE recognizes the contributions of Golden Spread Electric Cooperative and South Plains Electric Cooperative
- For more information, please contact:

Mark A. Harral

Mark.Harral@groupnire.com

806-771-7722

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