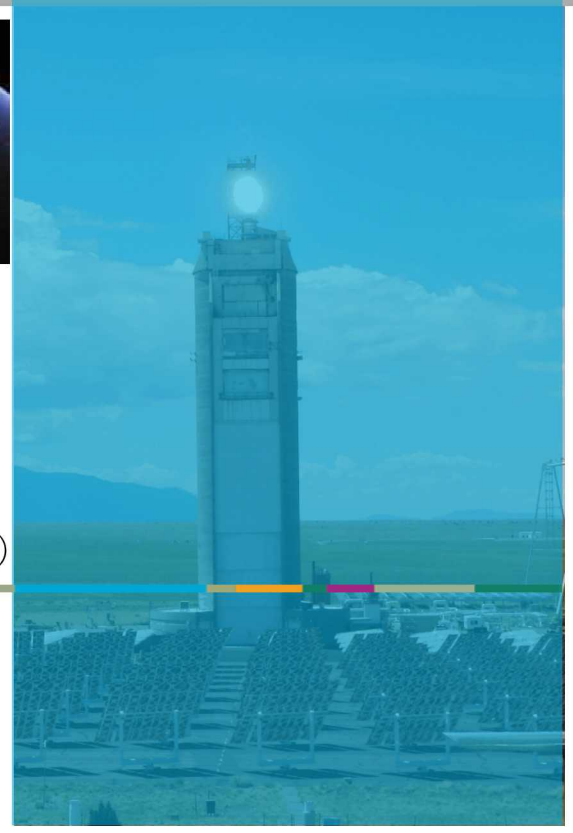
Exceptional service in the national interest

SAND2019-11975PE

Sandia National Laboratories: from atoms to applications



PRESENTED BY

Efraín O'Neill-Carrillo, Ph.D., P.E.
Principal Member of Technical Staff
Renewable & Distributed System Integration (representing
Charles Hanley, Senior Manager, Grid Modernization & Energy Storage)

IEEE Region 4 Student Leadership Conference

October 11-13, 2019
South Dakota State University
Brookings, SD

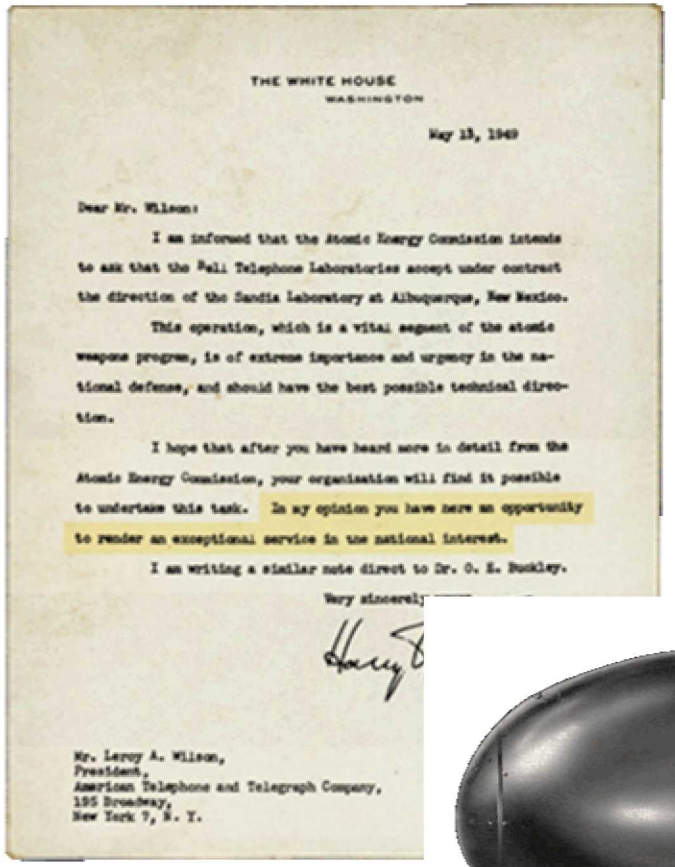
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SAND2019-XXXX P

SANDIA'S HISTORY IS TRACED TO THE MANHATTAN PROJECT

…In my opinion you have here an opportunity to render an exceptional service in the national interest.

- July 1945
  Los Alamos creates Z Division
- Nonnuclear component engineering
- November 1, 1949
  Sandia Laboratory established
- AT&T: 1949–1993
- Martin Marietta: 1993–1995
- Lockheed Martin: 1995–2017
- Honeywell: 2017–present



THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

I am writing a similar note direct to Dr. O. E. Buckley.

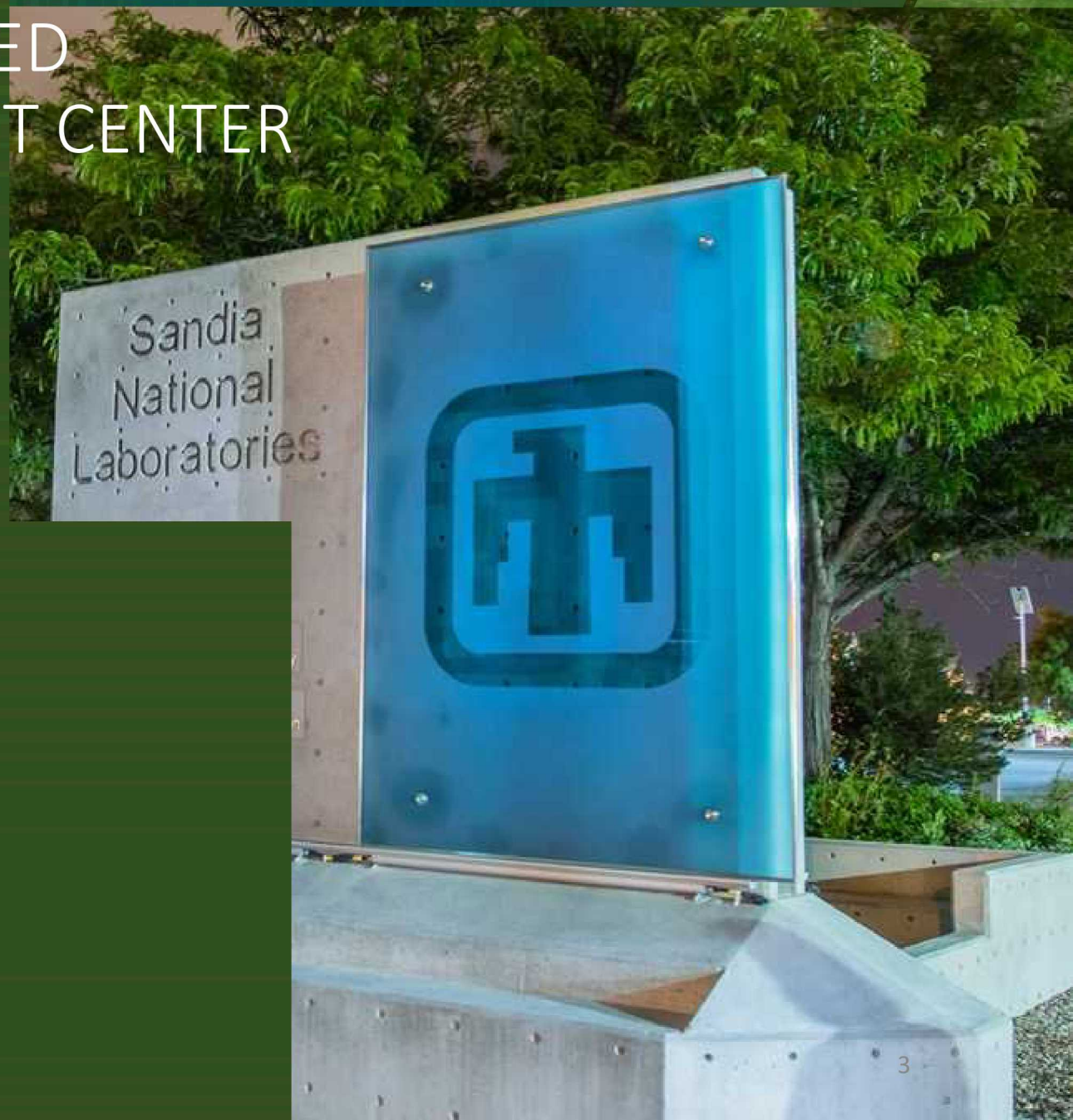
Very sincerely,

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.

SANDIA IS A FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTER MANAGED AND OPERATED BY

National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc.: 2017 – present

Government owned, contractor operated



SANDIA HAS FACILITIES ACROSS THE NATION

Main sites

- Albuquerque, New Mexico
- Livermore, California

Activity locations

- Kauai, Hawaii
- Waste Isolation Pilot Plant, Carlsbad, New Mexico
- Pantex Plant, Amarillo, Texas
- Tonopah, Nevada

SANDIA'S CORE VALUES

- Service
- Respect
- Integrity
- Excellence
- Teamwork

Sandia Key Leadership Competencies

- Communication
- Adaptability
- Relationships
- Task Management
- Production
- Development of Others
- Personal Development

THE LEADERSHIP TEAM BRINGS EXPERIENCE AND EXPERTISE

Board of Managers

Independent Audit

NTESS
NATIONAL TECHNOLOGY & ENGINEERING SOLUTIONS OF SANDIA, LLC

Labs Director's Office

Labs Director
Dr. Stephen Younger

Deputy Labs Director
Dori Ellis

- Counterintelligence
- Environment, Safety, and Health
- Strategic Plans and Policy

Advanced Science & Technology
Dr. Susan Seestrom

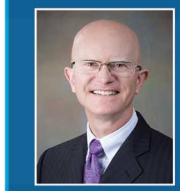
Nuclear Deterrence
Dr. Steve Girrens

HR & Communications
John Myers

Infrastructure Operations
John Clymo

National Security Programs
Mike Burns

Defense Nuclear Nonproliferation
Doug Bruder



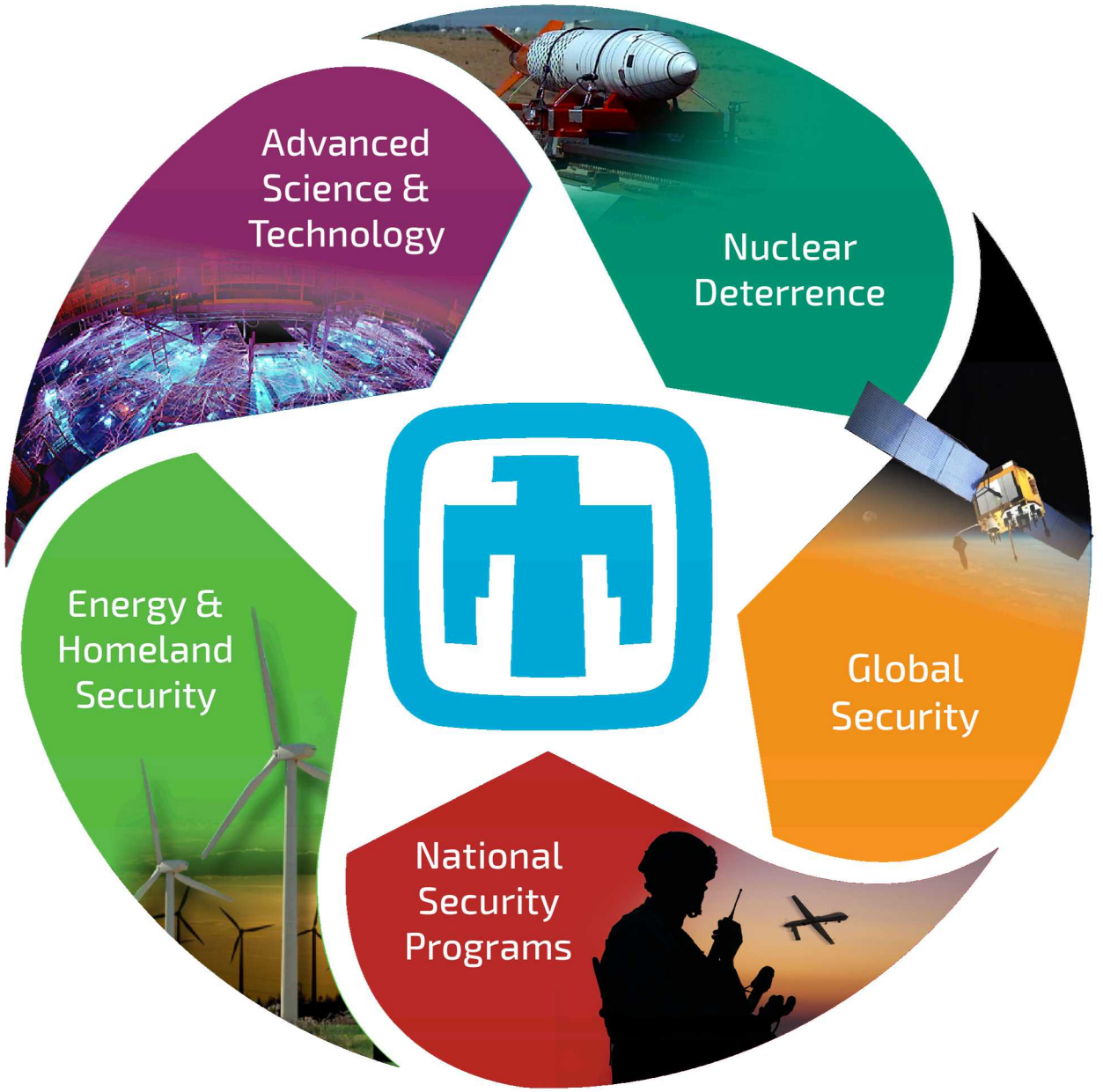
Integrated Security Solutions
Andrew McIlroy

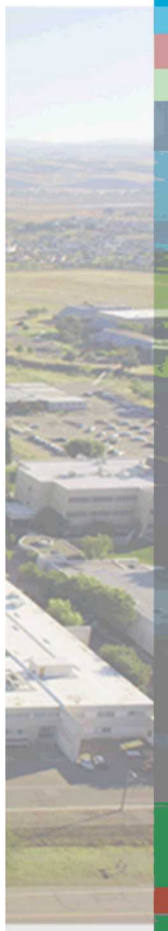
Mission Assurance
Mark Sellers

Mission Services
Scott Aeilts

General Counsel
Will Elias

SANDIA HAS FIVE MAJOR PROGRAM PORTFC

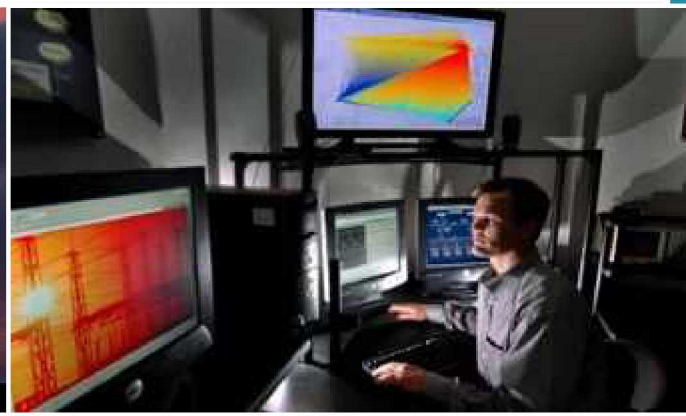




ENERGY & HOMELAND SECURITY

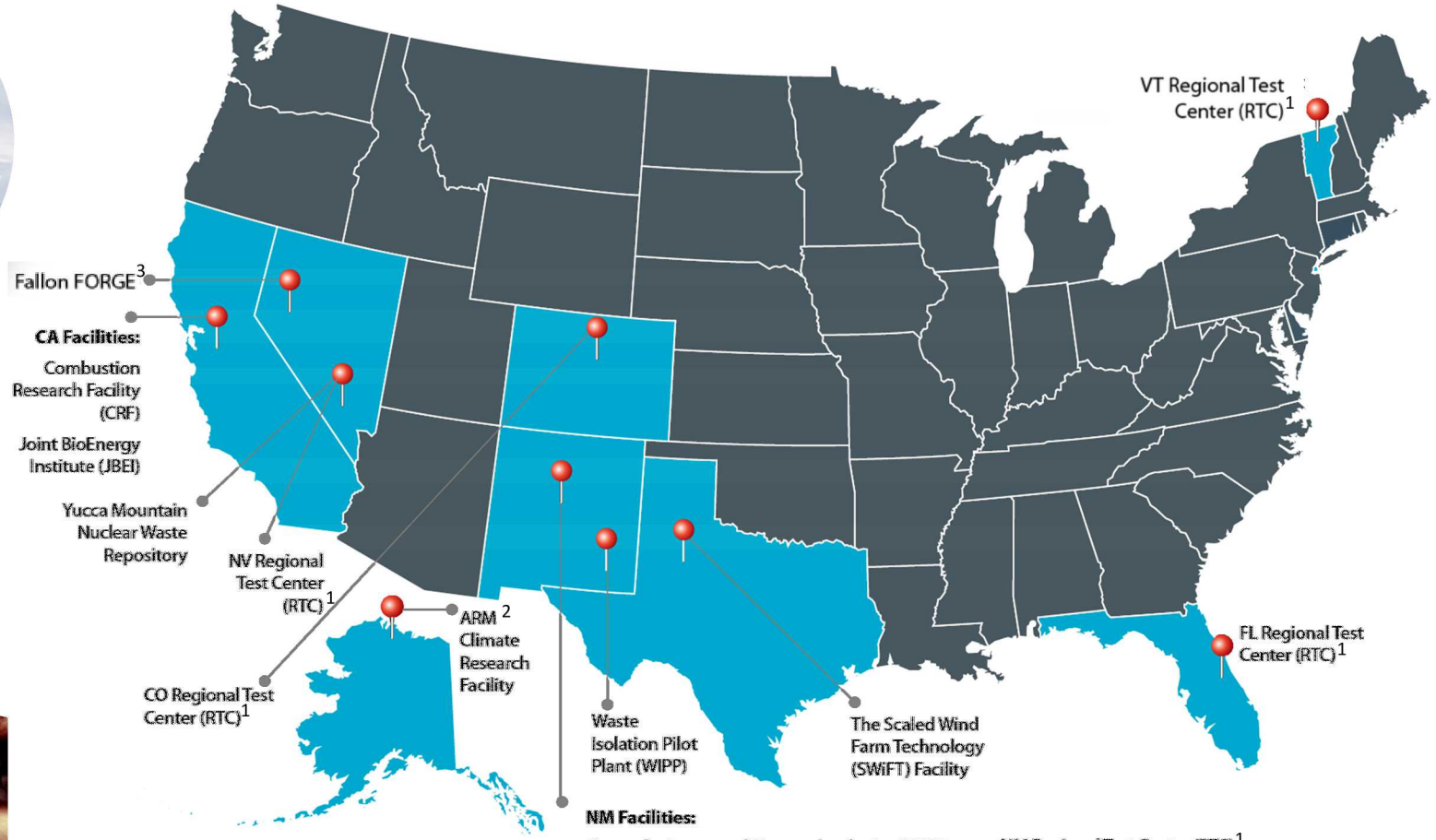
Innovates for a secure future

- Perform fundamental and applied R&D to support the resilience and security of the nation's energy system
- Provide protection for our nation's digital and physical critical infrastructures
- Reduce U.S. vulnerability to chemical, biological, radiological, and nuclear threats
- Accelerate transformative innovations in the transportation sector through foundational physical and computational research



OUR ENERGY FACILITIES

ARM Facility
Utquiagvik, Alaska



National Solar Thermal Test Facility (NSTTF)

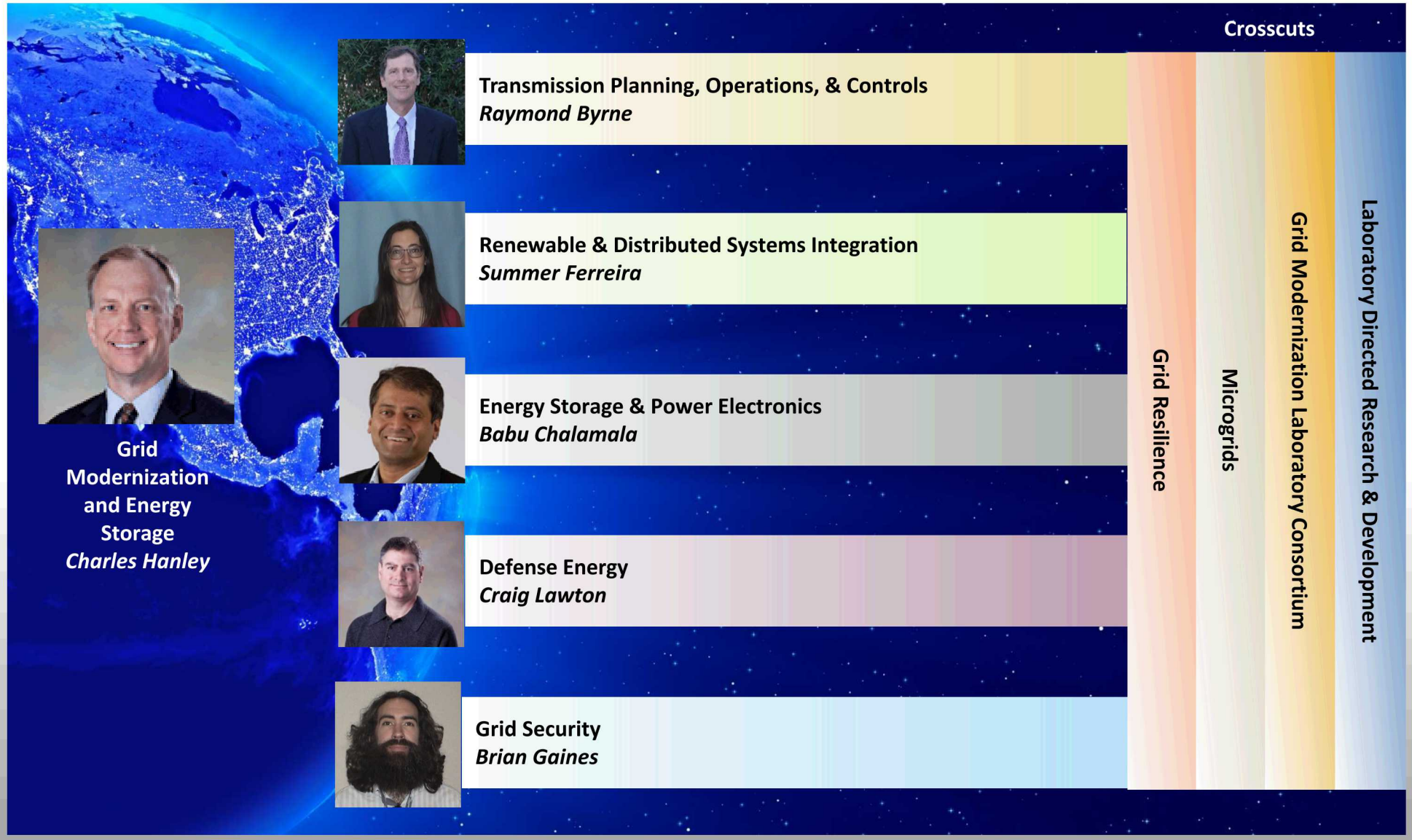
omechanics

Brayton Cycle Lab

The Scaled Wind Farm Technology (SWiFT) Facility

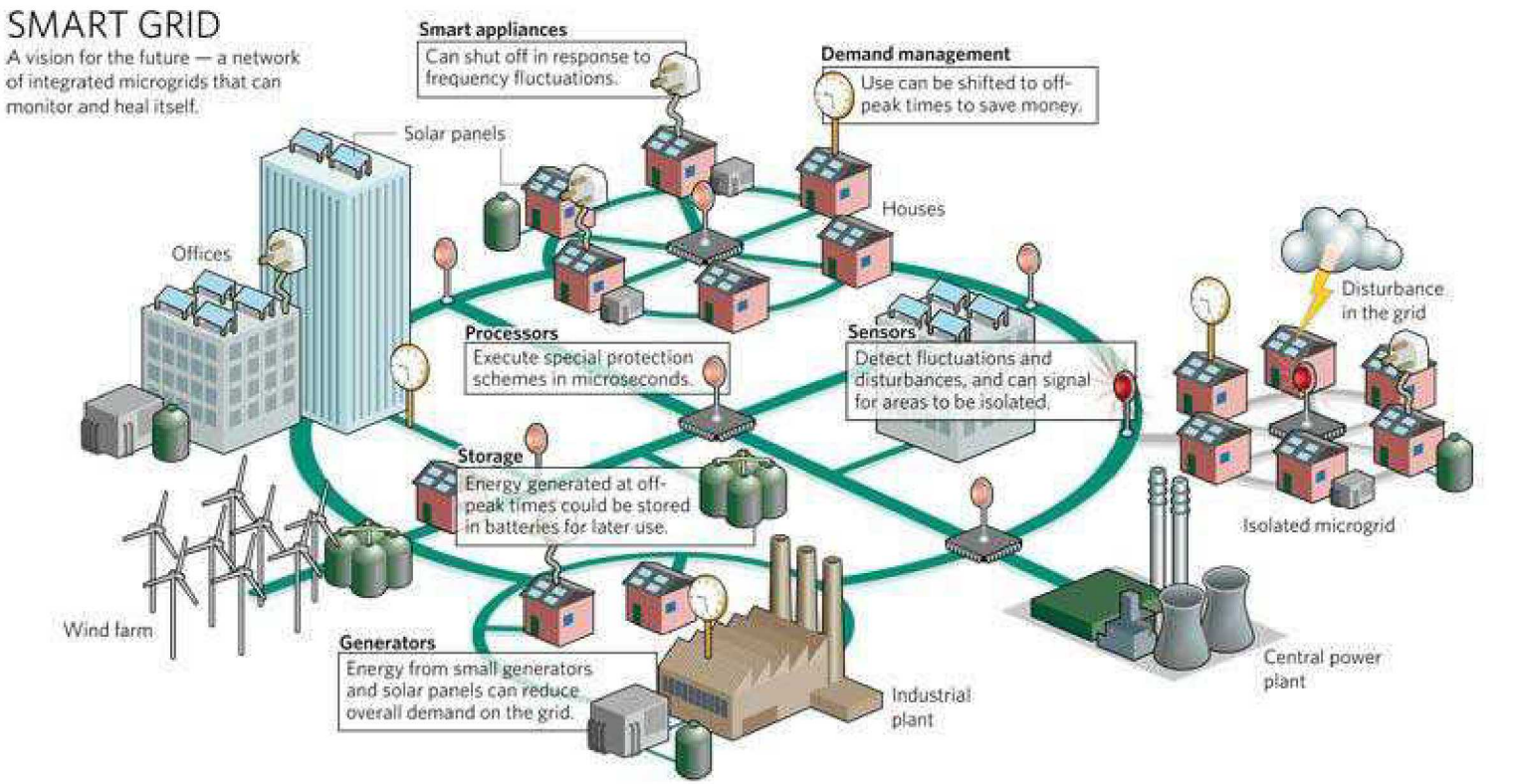
[1] Regional Test Centers (RTCs) provide high fidelity testbeds for US solar companies to evaluate their technologies in varied climates.
[2] The Arctic Radiation Measurement (ARM) Climate Research Facility supports climate modeling, search & rescue operations, and other national security work.
[3] Fallon Frontier Observatory for Research In Geothermal Energy (FORGE) will enable cutting-edge geothermal energy research, and drilling and technology testing.

Sandia Grid Modernization and Energy Storage Team



Vision

A world of interdependent and variable distributed systems that are optimized at multiple scales – including transmission – to maximize local resources in providing secure, resilient, and clean energy to all users at all times.

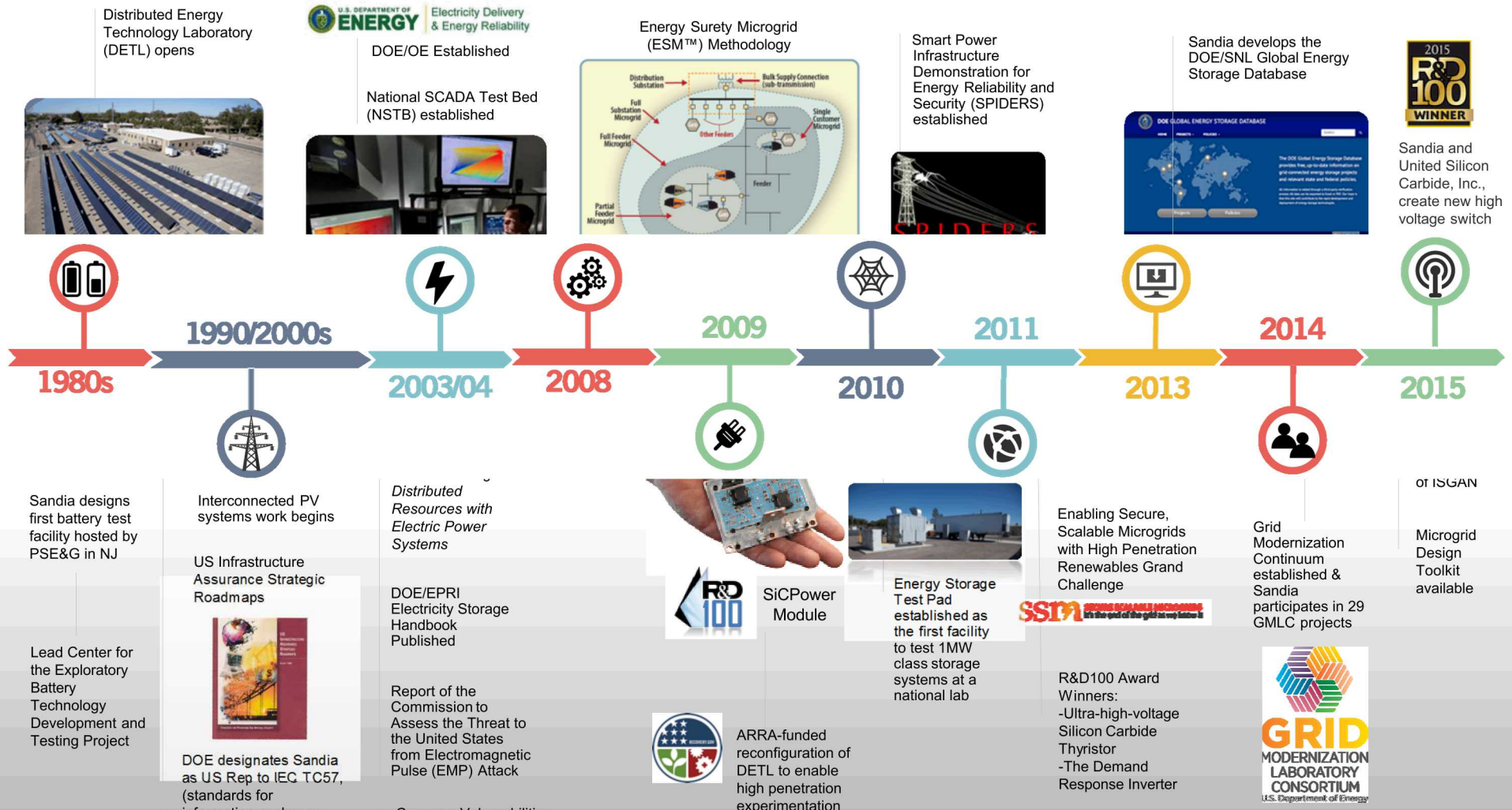


Picture courtesy of: Smart Grid 2030

Our capabilities support this vision:

- DER and renewable energy integration
- Power electronics and controls
- Secure and scalable microgrids
- Advanced grid analytics/complex systems
- Infrastructure interdependencies
- Cyber and physical security
- Embedded sensors, information processing, and secure manufacturing
- Energy storage systems

Timeline: Sandia Grid Modernization



Transmission Planning, Operations, and Controls

Improvements to our nations transmission system and secure operations controls are needed to ensure reliable, cost effective, and flexible transmission network.

Research Areas:

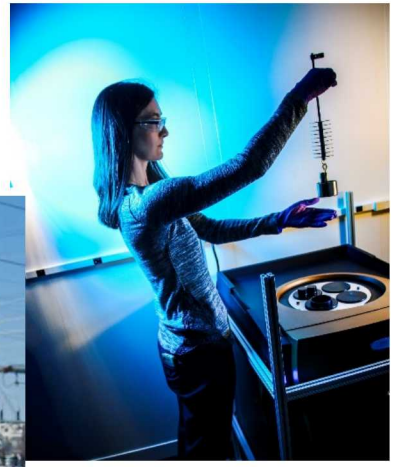
- Production Cost Modeling
- Solar and Wind Integration
- Wide Area Damping Control
- Understanding PMU Latencies in Closed Loop Feedback Controls
- Stochastic commitment and dispatch
- Developing stochastic scenarios from historic forecasts
- Multi-objective multi-resource dispatch
- Decision support for post-contingency grid security
- North American Energy Resilience Model

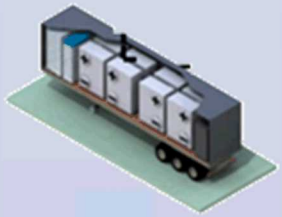
Source: DOE Quadrennial Energy Review, 2017

Energy Storage

Sandia is leading the way in large-scale adaption of energy storage across the electricity infrastructure to increase resiliency during severe disruptions, compensate for renewable generation variability, and improve grid performance.

- Materials and systems development
- Power electronics
- Safety and reliability
- Demonstrations and testing
- Grid analytics and policy
- Outreach



Storage	Integration	Power Conditioning	Energy Management Systems
			

Defense Energy

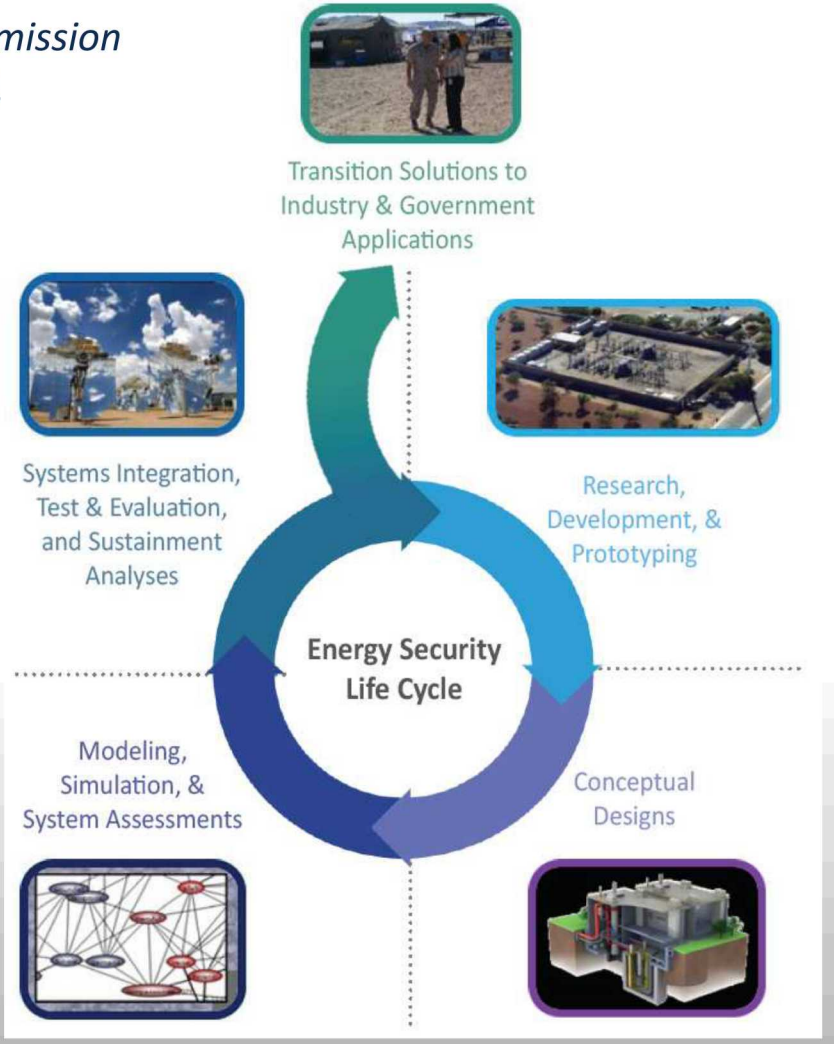
DoD and DOE energy security and resiliency is a critical mission enabler for their operations at home and abroad.

Whole System Trade Analysis Tool – System level trade analysis between design decisions

Systems of Systems Analysis Toolset – SoS level impacts to changes to the systems, the SoS formations, or SoS operations

Capability Portfolio Analysis Tool – Portfolio fleet-level investment decisions ensuring strategic investments that balance performance, cost, and schedule across the fleet

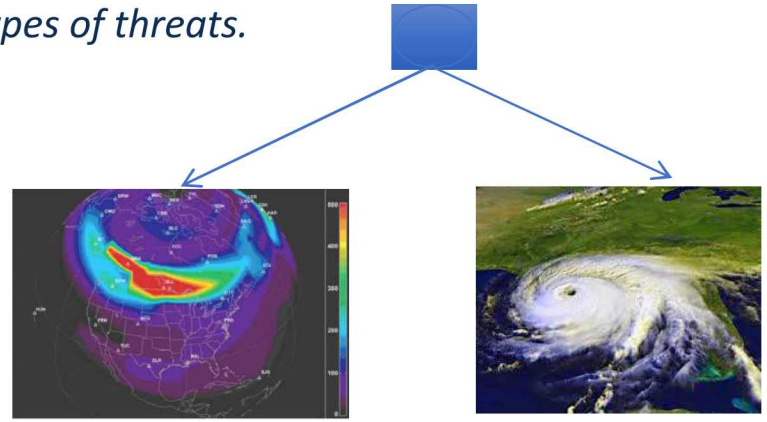
Microgrid Design Toolkit – Provides optimal microgrid energy solutions for given scenarios to guide requirements definition and acquisition investments

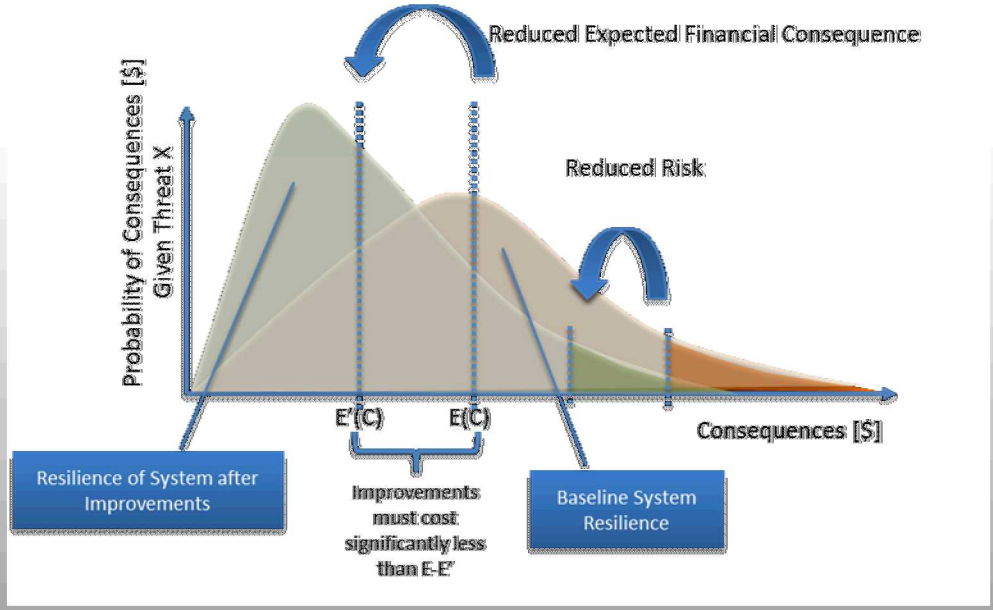


Grid Resilience

Resilience of the U.S. electric grid is a key part of the nation's defense against severe weather and other types of threats.

- Resilience Analysis Framework:
  - Can handle different types of threats
  - Provides information for different types of decision makers
- Geomagnetic Disturbances (GMDs)
- Weather and Physical Security
- Nuclear Driven Radiation Environments & EMP





Microgrids

Microgrids integrate distributed generation with power controls and optimized resource allocation for islanded and grid-tied systems

Research spans advanced concepts through applications:

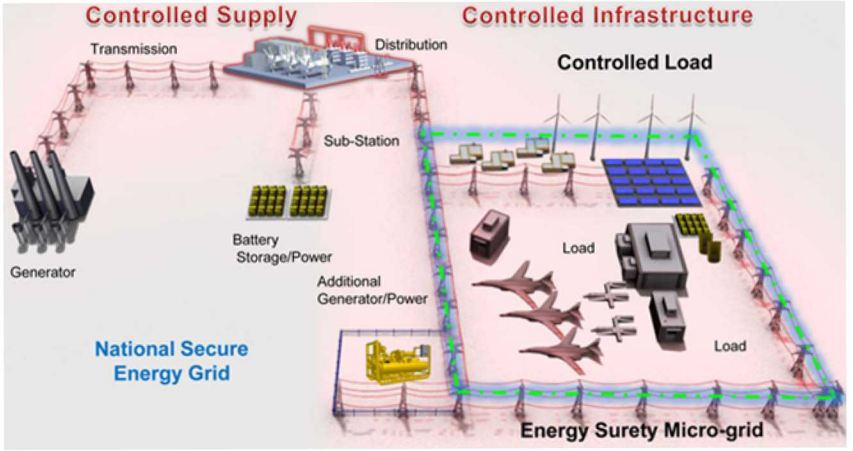
- Controls and optimization theory
- Resilience theory
- Cyber security
- Mission Assurance

Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS)

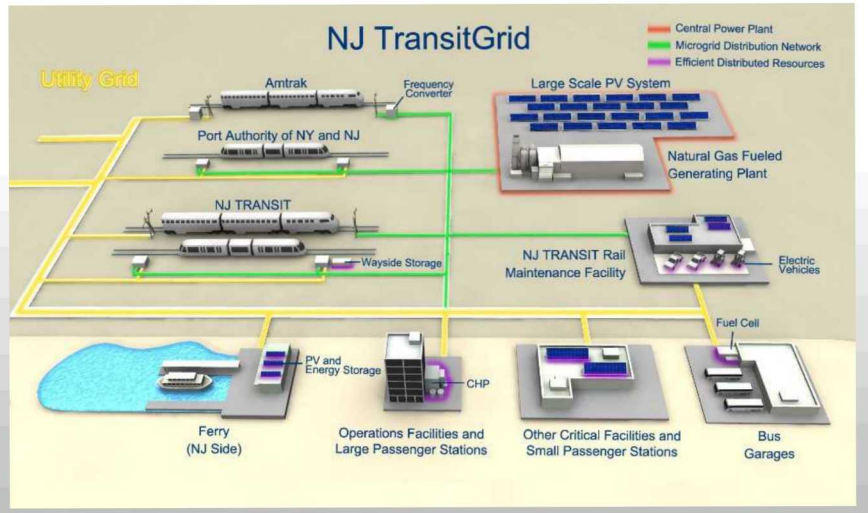
Hoboken and NJ Transit

Remote sites: Alaska, Caribbean, Forward Operating Bases

Additional DOD and international microgrid work.



Design lead on 3 SPIDERS microgrids for DOD



In the wake of Hurricane Sandy, led the design of resilient microgrids for NJ Transit and City of Hoboken

MICROGRID DESIGN TOOLKIT

2017 R&D 100 WINNER

18

Renewable Energy & Distributed Systems Integration

Our 35 years of work in renewable energy includes a growing focus on cost competitiveness and higher deployment of distributed energy resources while enhancing overall grid resilience and reliability.

- Advanced Modeling and Simulation
- Power Electronics and Controls
- Distributed Energy Technology Validation and Demonstration
- Integrated energy systems optimization, distributed controls, communications, interoperability, and cybersecurity
- Standardization
- Distributed Energy Technologies Laboratory

Example: My Work at Sandia

- PV Hosting Capacity Analysis
- Designing Resilient Communities
- DG challenges in remote/islanded systems (e.g., EVs)
- Transmission & Distribution system interaction with increased number of DERs

Examples of career possibilities at Sandia

- Aerospace Engineering
- Bioscience
- Business Support & Operations
- Chemistry & Chemical Engineering
- Computer Science
- Cybersecurity
- Electrical Engineering
- Geoscience
- Materials Science
- Mechanical Engineering
- Nuclear Engineering
- Physics
- Systems Engineering

FROM PUBLIC WEBSITE
https://www.sandia.gov/careers/

Sandia: **World-changing technologies. Life-changing careers.**
https://www.youtube.com/watch?v=-LKXkLVJq-0

R&D, Electrical Engineer - SPICE/PSpice Modeling and Simulation (Entry/Mid-Career) Albuquerque, NM. Job ID 669282, Full-Time, Regular

- Develop device and circuit models, conduct simulations on Sandia's high performance computing clusters, validate results against specifications and test results, and report to customers. Will work on several projects simultaneously while in a teaming environment.
- Opportunities exist to work with either electromagnetic effects analysts, in-house code developers, or to pursue development/application of innovative modeling and analysis techniques.
- You may also work on projects that consist of the following: Conducting simulations on large multi-node, UNIX based computational platforms for the characterization of circuit performance and the determination of circuit sensitivities and uncertainty quantifications. Developing and simulating analog, or digital, or mixed mode circuit models. Developing a detailed understanding of customer requirements and verifying electrical devices, subsystems, and systems performance to those requirements
- Qualifications
  - Master's degree in Electrical Engineering or equivalent years of experience and/or education
  - Analog circuit design and modeling experience

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http://www.sandia.gov/careers/ps-forward.html

R&D Electrical Engineer (Early/Mid-Career) Albuquerque, NM. Job ID 669303, Full-Time, Regular

- Develop, exercise and analyze high-fidelity electrical devices, circuits and system models in extreme environments. Develop device and circuit models, conduct simulations on Sandia's high performance computing clusters, work with code developers to improve the in-house circuit and device simulation capabilities, validate results against specifications and test results, and reporting to customers.
- Opportunities exist to work with either circuit and device effects analysts, in-house code developers, or to pursue research/development/application of innovative modeling and analysis techniques such as machine learning.
- You may also work on projects that consist of the following: Conducting simulations on large multi-node, UNIX based computational platforms for the characterization of circuit performance and the determination of circuit sensitivities and uncertainty quantifications. Developing and simulating analog, digital, or mixed mode circuit models. Developing and validating high fidelity environmentally aware device models.
- Qualifications
  - A minimum of a master's degree in Electrical Engineering or relevant discipline
  - Knowledge, by way of training and/or experience, of analog circuit simulation and/or design, of the physics and construction of semiconductor devices
  - Qualifications We Desire: A minimum of a master's degree in Electrical Engineering or relevant discipline plus five years of related experience; or PhD in Electrical Engineering or relevant discipline

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http://www.sandia.gov/careers/ps-forward.html

Electrical Engineer (Early/Mid-Career) Livermore, CA. Job ID 669328, Full-Time, Regular

- Design of electronic Printed Wiring Boards and Printed Wiring Assemblies (PWA) including analog and digital circuit design and FPGA firmware development and implementation.
- Lab testing of electrical components, devices, subsystems and systems. Develop the architecture of higher level electronic subsystems and systems; integrations and testing of multiple PWAs into a subassembly. Prepare and implementing test planning, test execution, requirements derivation. Conduct environmental testing, qualification of development and production hardware.
- Qualifications
  - Bachelor's degree in Electrical Engineering or in a related discipline plus 2 years of related experience or Master's degree in Electrical Engineering or in a related discipline, or equivalent.
  - Demonstrated experience in design and test to include one or more of the following: analog and/or digital circuit design, RF system design, embedded system design, and electromagnetic radiation (EMR) effects on electronics.

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http://www.sandia.gov/careers/ps-forward.html

Mechanical Engineer (Early/Mid-Career) Livermore, CA. Job ID 669324, Full-Time, Regular

- Designing for components and manufacturability. Conducting environmental testing, qualification of development and production hardware. Implementing instrumentation and data acquisition systems. FEA mechanical modeling.
- Rapid prototyping of development hardware. Providing technical consultancy on critical design elements. Presenting at technical design reviews.
- Qualifications
  - Bachelor's degree in Mechanical Engineering or related discipline plus 2 years of related experience, or Master’s degree in Mechanical Engineering or related discipline; or equivalent related experience and/or achievements that demonstrate the knowledge, skills and ability to perform independent research and development.
  - Academic or job experiences in areas such as: engineering design, qualification, production, or related modeling/simulation projects.

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http://www.sandia.gov/careers/ps-forward.html

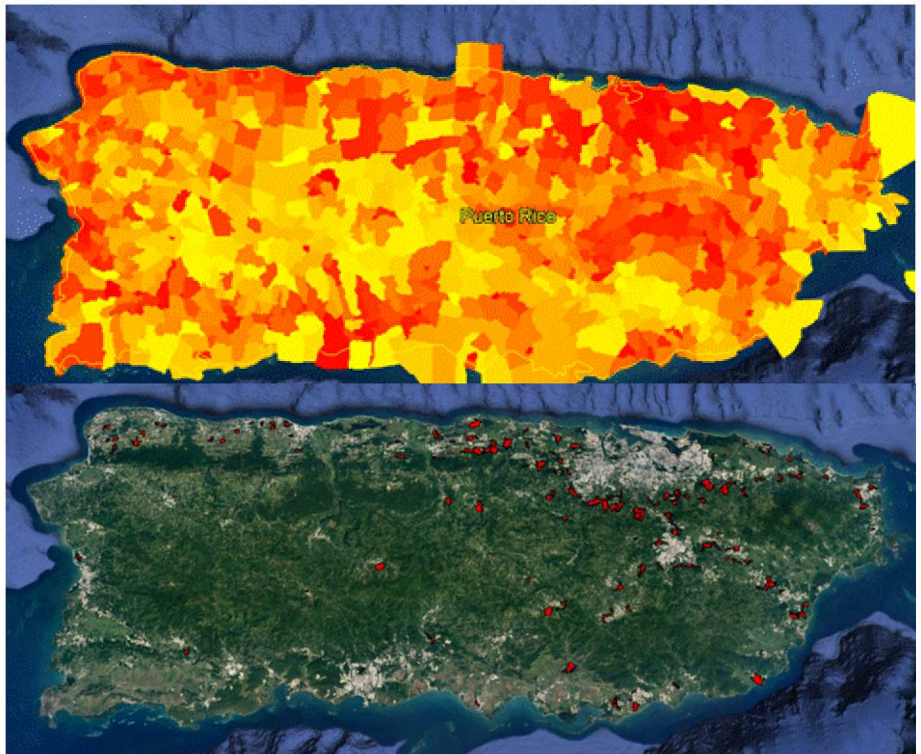
Life at Sandia

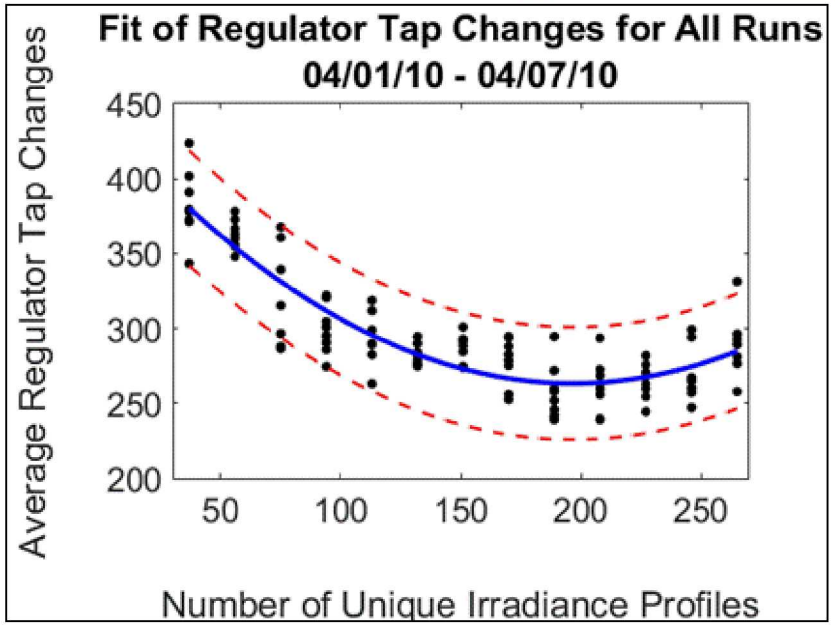
- Sandia gives opportunities to perform challenging and meaningful work without sacrificing your personal life.
- People & Culture: Sandia fosters a diverse and inclusive environment. We value talented individuals from all backgrounds and promote multidisciplinary collaborative teamwork. Our work environment is dynamic, friendly, and inspiring.
- Work-life balance is integral in the Sandia community. We offer flexible work arrangements, telecommuting, and compressed workweek options so that our employees can choose the schedules that fit their lives.
- From health and compensation to diversity programs, flexible career tracks, community outreach, and more, Sandians receive great rewards for their great work.

FROM PUBLIC WEBSITES
https://www.sandia.gov/careers/life_at_sandia/index.html
https://www.sandia.gov/careers/benefits_perks/index.html

Intern experiences: Melvin Lugo

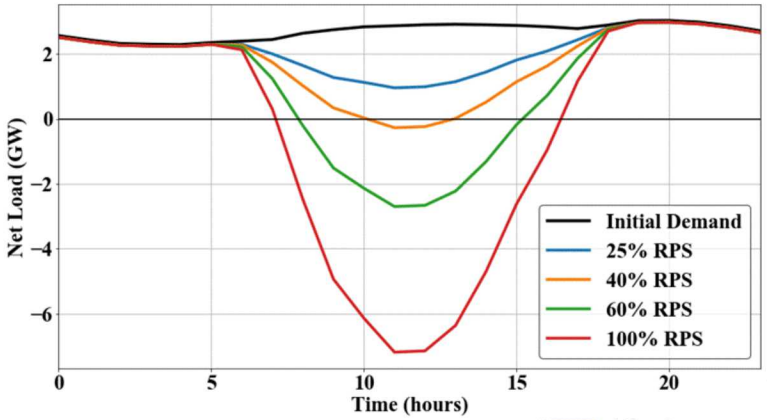
- MSEE student, University of Puerto Rico-Mayaguez (UPRM)
- Internship at Sandia: Summer 2018 (10 weeks) and June to October 2019
- Research topics: irradiance profile variability from clouds, microgrid and load selection based on severe blackouts
- MS thesis based on Sandia work

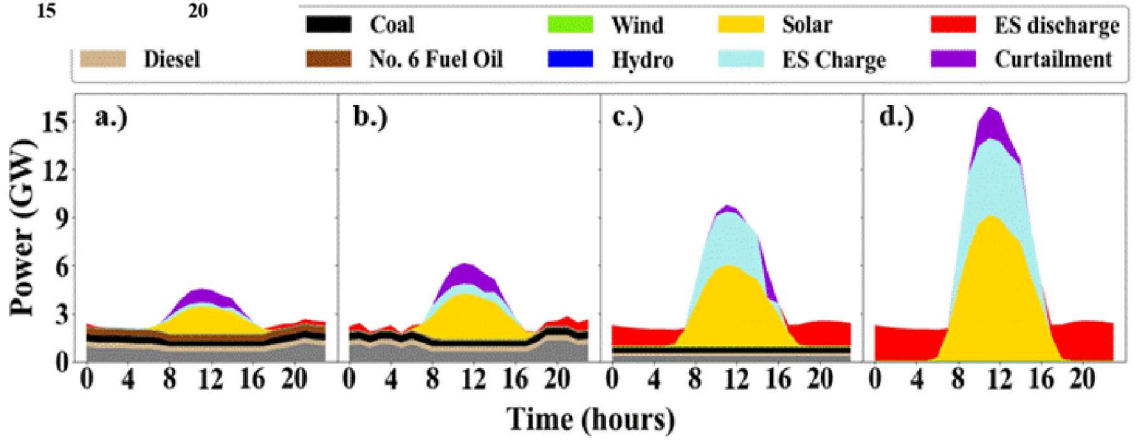


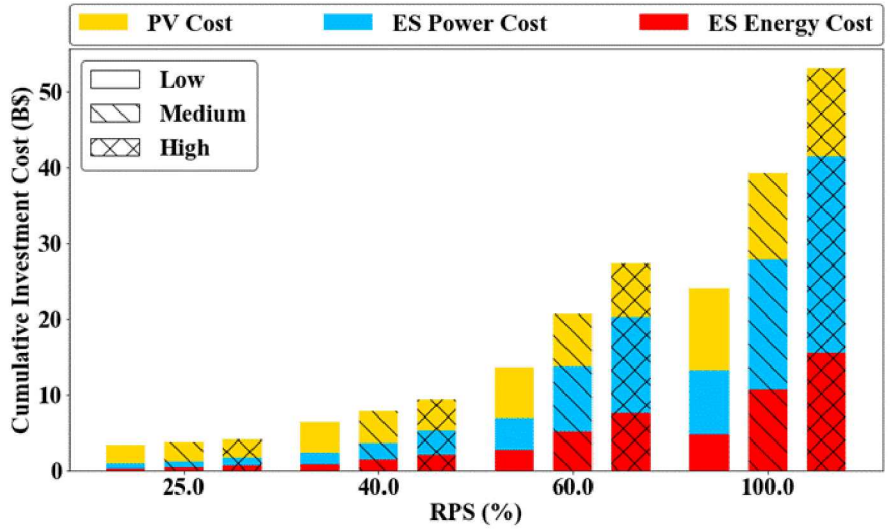


Intern experiences: Cody J. Newlun

- PhD student, EE, Iowa State University
- Internship at Sandia: May to August 2019
- Research topic: Resource planning and battery storage for 100% renewable energy (case study: PR)
- Paper submitted to the 2020 IEEE T&D Conference

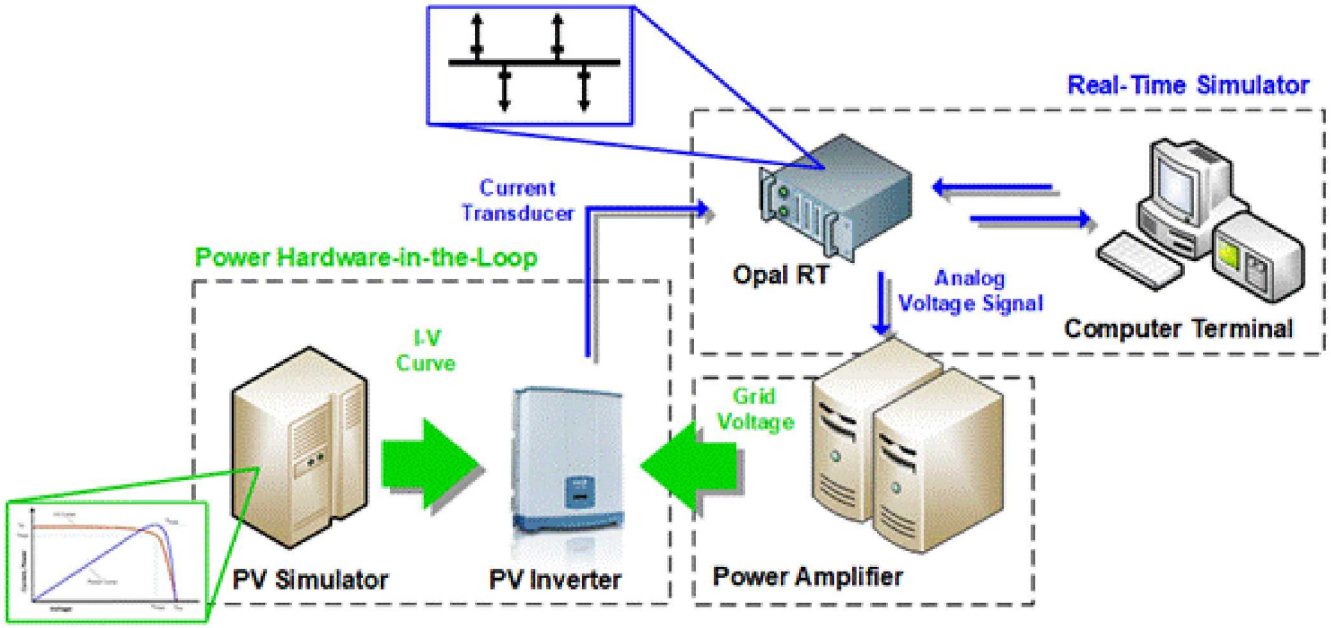


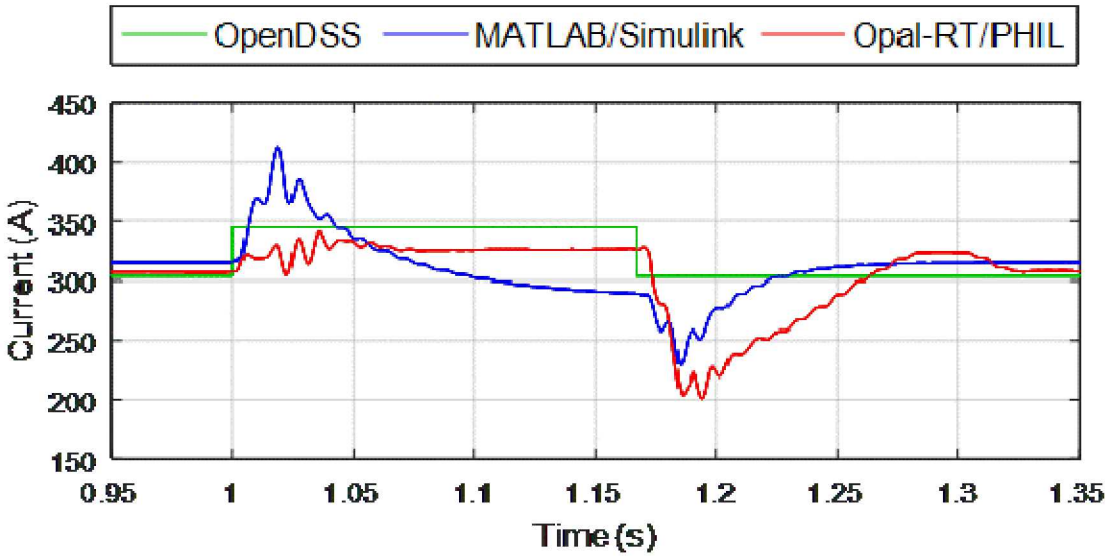




Intern experiences: Rachid Darbali

- PhD student, EE, University of Puerto Rico-Mayaguez (UPRM)
- Internships at Sandia: Summer 2017 & 2018, Year Round 2019 *(new MOW)*
- Research topics: Power Hardware-in-the-Loop, cybersecurity, power electronics, protection systems, resilience
- Papers in IEEE Journal of Photovoltaics, IEEE World Conference on Photovoltaic Energy Conversion, IEEE Photovoltaic Specialists Conference & IEEE Andean Council International Conference



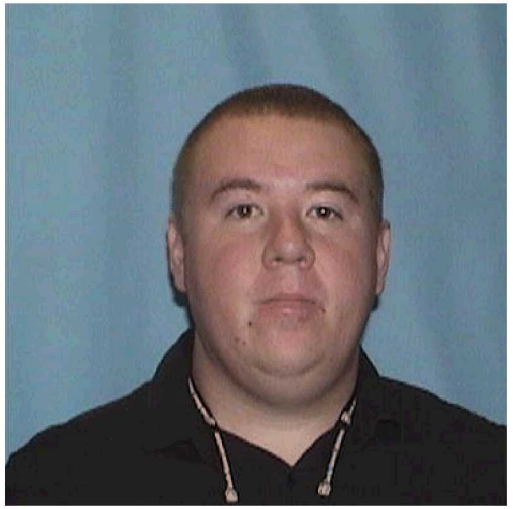


Comments from student interns

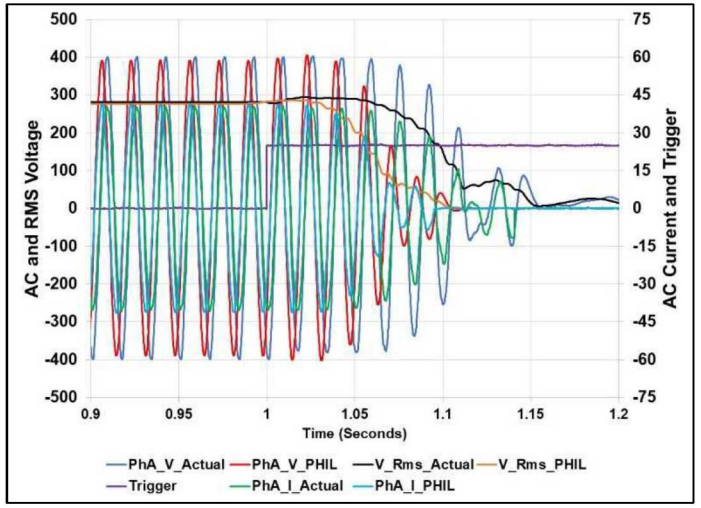
- Sandia tours of research facilities
  - “These tours allowed me to see the different research areas that Sandia is involved with.”
- Technical presentations from visiting researchers
- Collaboration with technical experts across Power Systems (8813), Energy Storage (8811), Distributed Technologies (8812), cyber-security and applied mathematics departments, among others.
- Opportunity to present at Sandia-wide research symposium and intern poster sessions
- Depending on specific project, opportunity to collaborate on conference/journal papers and attend conferences.

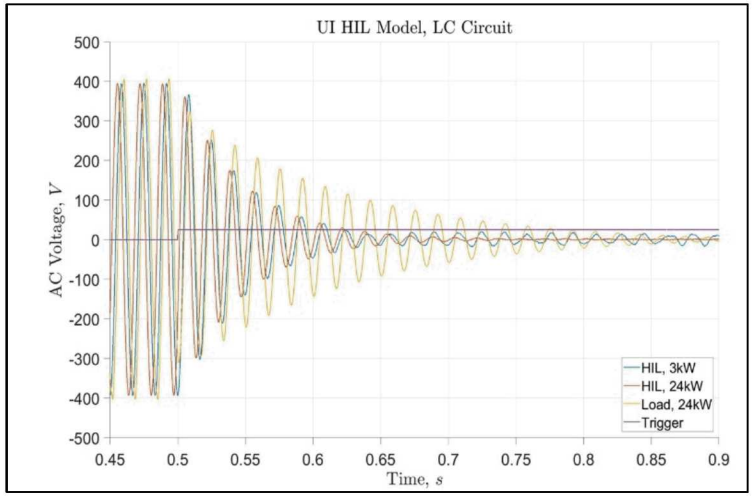
From intern to member of the workforce:

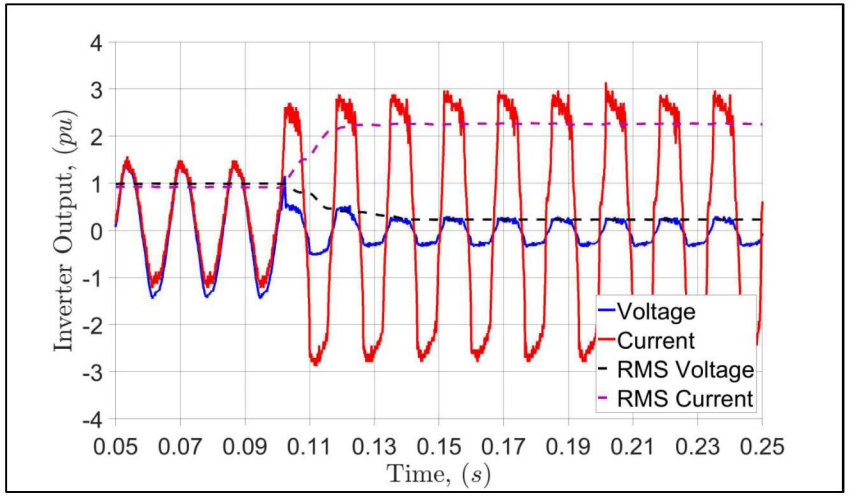
Nicholas S. Gurule



- BSME and MSME from the University of New Mexico
- Internships at Sandia: year-round undergrad/grad from June 2016 to July 2019, member of staff after completing MS degree
- Research topics: high impedance faults of grid-forming inverters, microgrid protection, grid interconnection requirements, unintentional islanding, advanced sensors
- 5 conference papers for IEEE Photovoltaic Specialists Conference as lead and/or coauthor







An internship with real-world application (Internships & Co-ops)

- Students from around the country—from those in their final years of high school to researchers obtaining PhDs— work in a variety of technical and business positions. Interns work on real-world, challenging projects to contribute to critical national goals.
- A range of disciplines, including cyber security, energy surety, engineering design, and software development.
- Our internships provide students:
  - Opportunities to work on challenging projects at competitive pay
  - Academic credits for some co-op and other internships
  - Research mentoring from top scientists and engineers
  - Training and practical work experience using state-of-the-art equipment and instruments
- *In some cases, internships can also lead to an offer of full-time employment*.

FROM PUBLIC WEBSITE
https://www.sandia.gov/careers/students_postdocs/internships/index.html

Internship Types

- Summer Internships are available to students at all education levels from all over the country, typically run 10-12 weeks. Summer interns may work up to 40 hours per week.
- Co-Op Internship conducted in partnership with individual schools, allow students to take time off during the academic year to gain work experience at Sandia, working up to 40 hours a week. These internships typically run 3–8 months during the academic term and may include an adjacent summer term.
- Year-Round Internships allow students who attend local schools to work part-time at a Sandia site.
- Academic Internship is a non-traditional internship is available to R&D or technical pipeline students who are attending a school with a track system or who have an alternative status that allows deferral of a term. Typically runs 3–5 months and may include an adjacent summer. Academic interns may work up to 40 hours per week.

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Internship Requirements

- Full-time enrollment status (typically 12 units for undergraduates and 9 units for graduate students) at an accredited college, university, or high school
  - Year-round/co-op intern – Full-time student during the academic school year (spring, fall, and winter)
  - Summer intern – Full-time student during the spring term immediately preceding the internship
  - Academic intern – Full-time student during the term (spring, fall, or winter) immediately preceding the internship
- Minimum cumulative grade point average
  - 3.0/4.0 for graduate students, 3.0/4.0 for undergraduate and high school students applying for Research and Development (R&D), Technical, or Business positions, 2.5/4.0 for undergraduate and high school students applying for clerical or laborer positions (Laborer positions are available only at the Sandia/New Mexico site)
- U.S. citizenship for positions that require security clearance or as stated in the job posting
- At least 16 years of age

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Q & A