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Sandia National Laboratories

Exceptional service in the national interest

Sandia National Labs Scaled Wind Farm Technology (SWiFT) Facility

Navigating Safety into the 2020s

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Wind Energy Technologies Dept.

Climate Change Security Center

8/20/21

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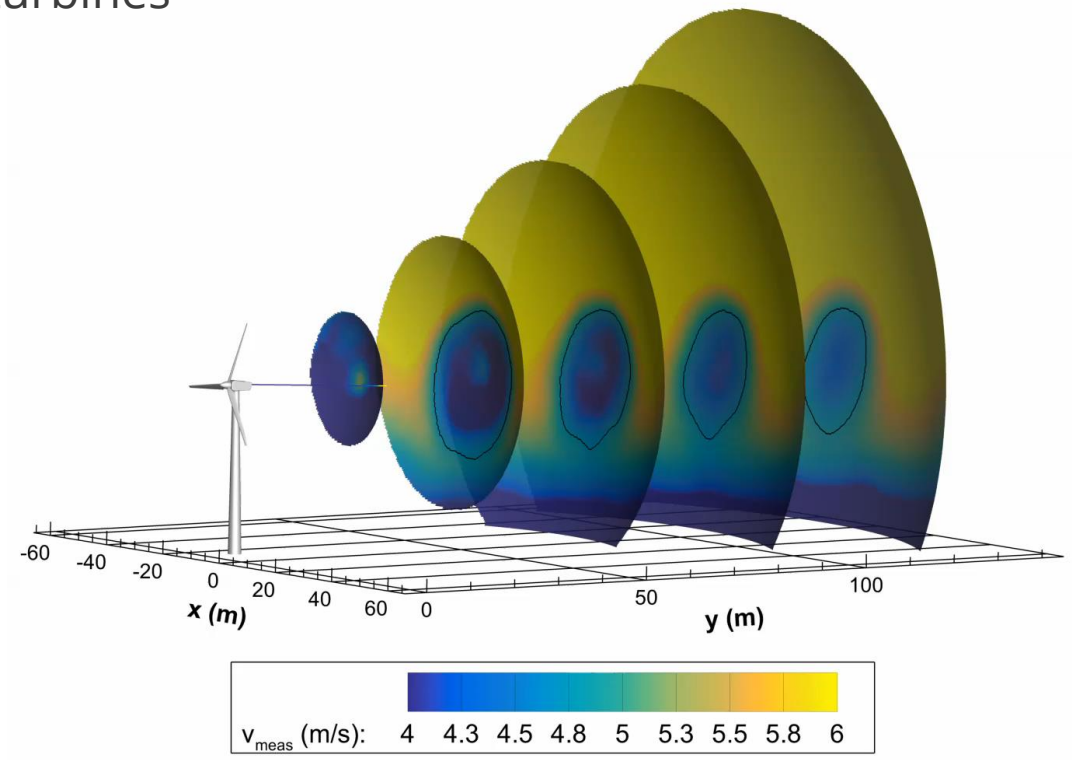
Impact of wind energy research

- Government-sponsored, industry-focused research into wind plant performance
- DOE Wind Energy Technology Office and DOE national laboratories:
  - Increased reliability levels of wind turbines
  - Analytical modeling
  - Engineering databases
  - Test protocols
  - Test facilities



https://energy.sandia.gov/first-wake-data-captured-during-wake-steering-experiment-at-the-swift-facility/

Wind Energy R&D at Sandia

Wind Program Vision:

Our research and innovation in wind energy science enables a future that accelerates the global deployment and adoption of clean, renewable energy systems

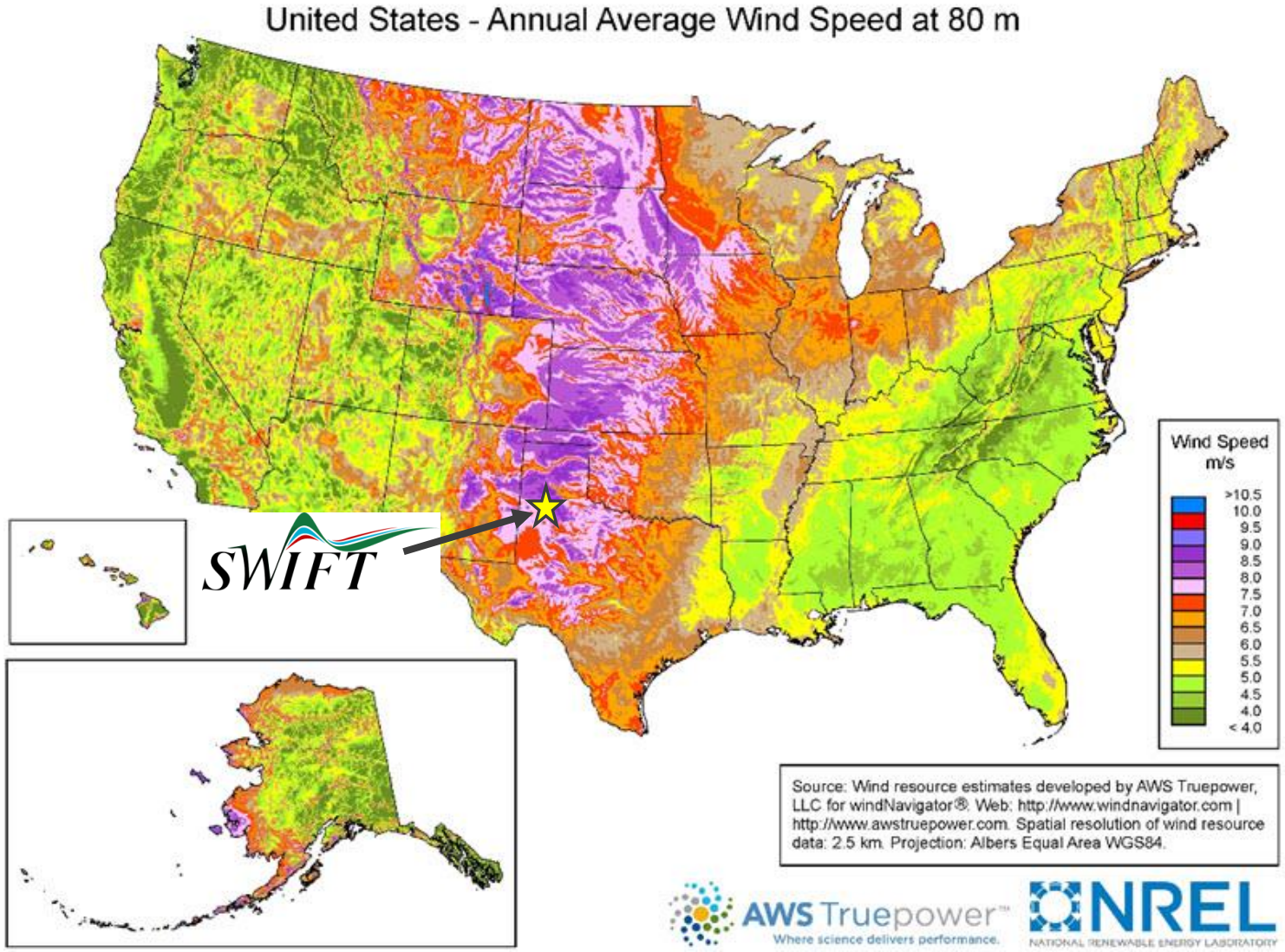
Early Sandia National Labs wind energy research

Sandia National Laboratories NM

USDA Site Bushland, Texas

Berg, D. (2016). *The Sandia legacy VAWT Research Program: Scientific and technological challenges in offshore VAWTs*. Albuquerque, NM: Sandia National Labs.

Move to Lubbock



- Consistent wind direction
- Highly characterized site with adjacent 200m TTU met tower
- Most similar to off-shore wind conditions
- BBQ…

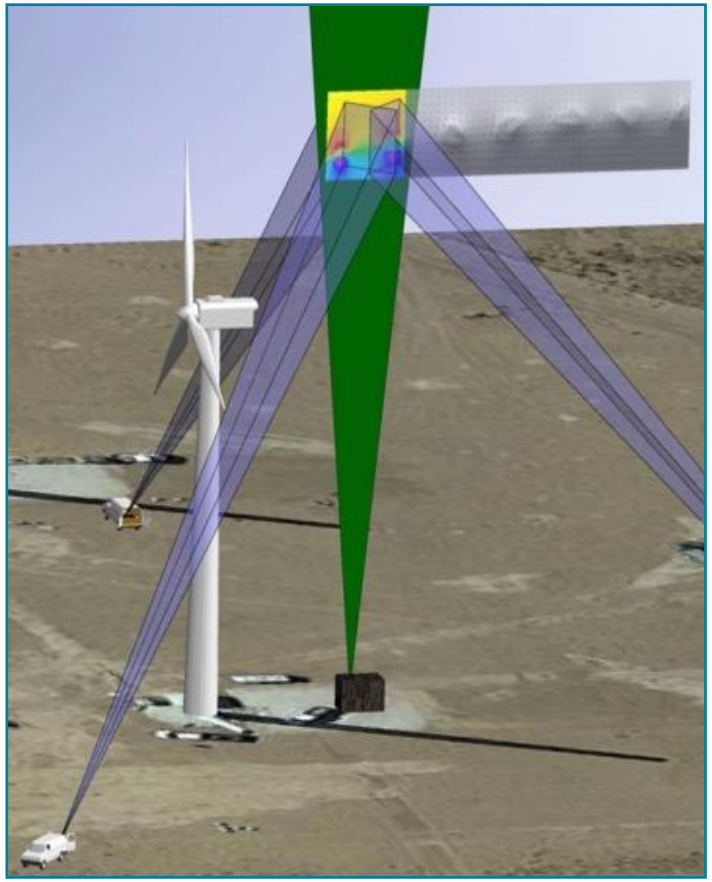
Source: National Renewable Energy Laboratory, U.S. Department of Energy (public domain) – Retrieved from https://www.eia.gov/energyexplained/wind/where-wind-power-is-harnessed.php

SWIFT

Reese Technology Center

SWiFT's uniqueness

- Designed up front to be open-source to maximize the value and access to the data and knowledge generated at the site
- Scale relevant to modern utility systems, most cost effective to conduct field research with sufficient precision



Scaled Wind Farm Technology (SWiFT) Facility

Partnering and outreach

- Reduce turbine-to-turbine interaction and wind plant underperformance
- Develop advanced wind turbine rotors
- Improve the validity of advanced simulation models

DTU

tpi COMPOSITES

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

Vestas

TU Delft

Operated in partnership with:

Sandia National Laboratories

TEXAS TECH UNIVERSITY

NREL NATIONAL LABORATORY

SWiFT

GROUP NIR Renewable Energy Solutions

UW

Standing Up a New Research Facility and the Learning Organization

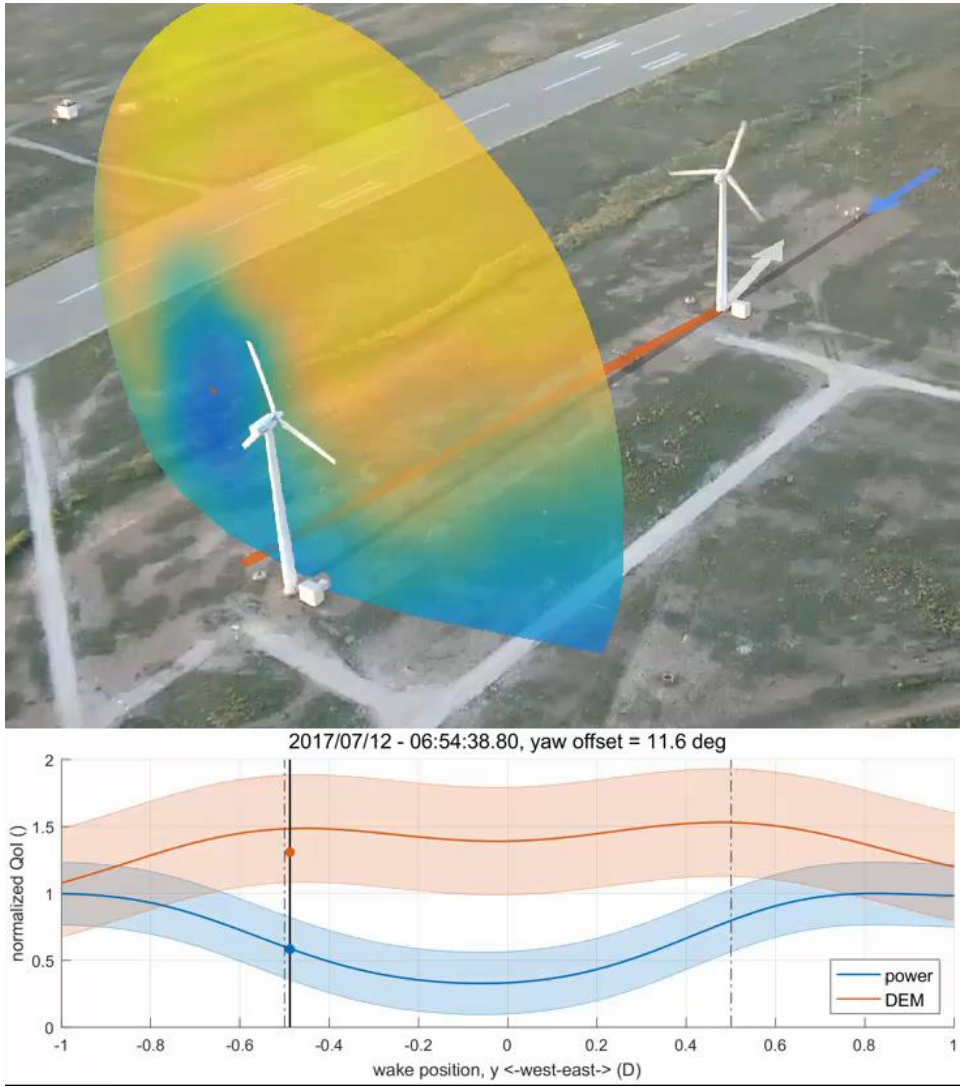
A new research facility

2014 event

- Rotor overspeed
- Numerous corrective actions following a root cause analysis
- Led to moderate-hazard facility designation

Corrective actions & restart

- Management self-assessment (MSA)
  - corrective actions meet the intent of the causal analysis
- Independent Readiness Review (IRR)
  - validate the effectiveness of corrective actions implemented
  - develop a report of readiness
- Granted approval to resume normal operations in 2017
- Wake Steering Campaign, jointly executed with NREL



2018 event

- While troubleshooting a turbine system, an employee experienced a mild electrical shock
- RCA revealed several areas associated with the turbine safety systems, along with implementation of work planning and controls
  - the process of identifying, planning, approving, controlling and executing work at a DOE facility
- RCA recommendations:
  - strengthening training
  - additional rigor on work documentation
  - continuing efforts to improve software parameter changes
  - intrateam communications
  - turbine electrical system design for operability (user-centered design)

Leadership & Team Strategies

Integrated Safety Management (ISM)

- Site-specific factors, conditions, analyses, and processes:
  - Potentially hazardous work
  - Results of design studies, safety analyses, hazard reduction analyses, and risk analyses
  - Types of hazards

https://www.energy.gov/sites/default/files/2014/04/f14/9612-ISM_Brochure.pdf

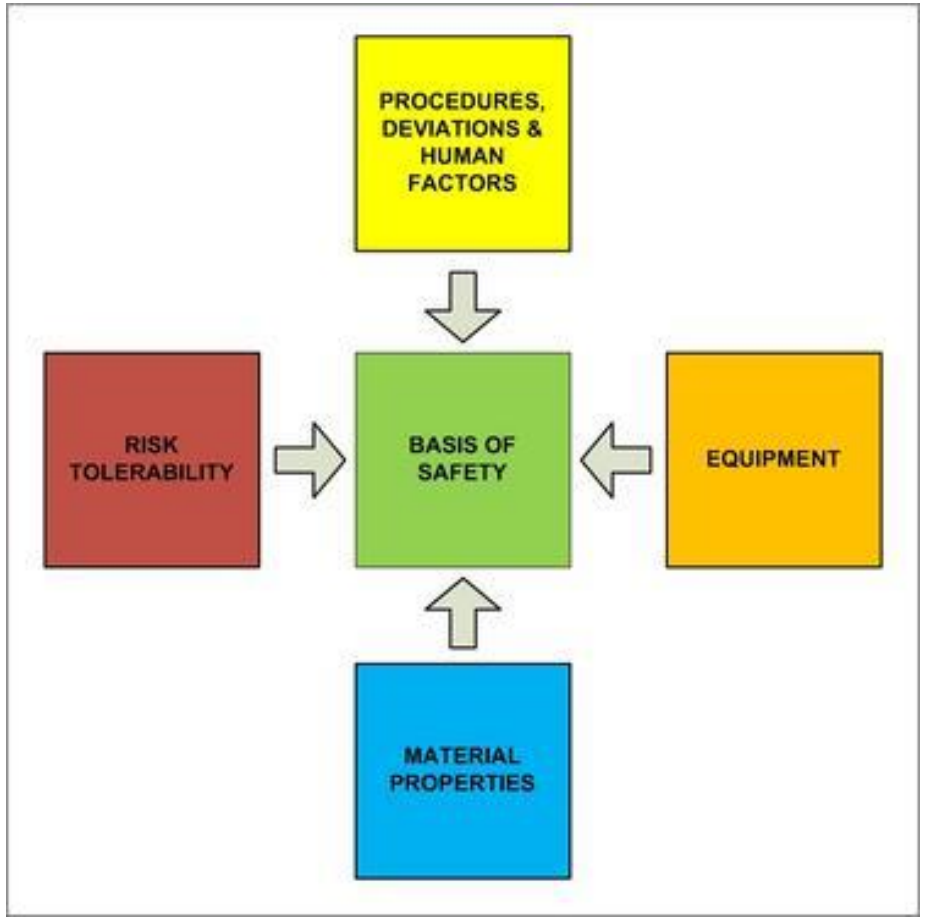
Safety basis process

- Systematic identification of both natural and man-made hazards
- Evaluate normal, abnormal, and accident conditions
- Enabled team to derive and update the hazard controls
  - protection of workers
  - protection of the public
  - protection of the environment
  - demonstrate adequacy of controls
- Ensure the safe operation of the facility

The safety basis describes the facility hazards and the risks to the workers, the public, and the environment and defines the safety-related equipment, procedures, and practices relied on to adequately control those hazards.

Safety basis in action

- Identify possible hazards of a new system
- Identify states that can lead to an accident or incident
- Qualified experts - relevant to the new facility
- Safety case provides assurance



http://www.hazardous-area-consultants.com/basis-of-safety.html

Engagement and improvement

- Multidisciplinary team of ES&H professionals and systems safety SMEs
  - Emergency management, facilities electrical safety, LOTO, industrial hygiene, and fall prevention and protection disciplines
  - Confined space, dedicated circuits and suggested modifications to better implement LOTO, tower rescue (incapacitated worker/climber – need for emergency response drills)
- Procedures, policies, and technical work documents
- Dedicated hardware-in-the-loop (HIL) system
- Configuration management procedure with an engineering change notice (ECN) process
- New procedures are reviewed holistically

Control framework

Foundational path to successful customer integration

Performance improvement (customer confidence)

Structured reviews & approvals

Data integrity

Configuration management (documents & physical assets)

Compliant and usable procedures

Succinct and relevant project and site ops documents

Clearly defined and appropriate training

Engagement with SMEs

Sustainability in our processes, procedures, and culture

Ability to plan

Predictable maintenance

Capacity to conduct world-class research

Ownership

SWIFT

Drive out risks

- Latency
- Risk ID & management
- Continuous improvement
- Measure performance
- Analyze processes
- Safety as an integral part of a facility's operational management and site culture

https://www.forbes.com/sites/steveculp/2020/06/29/covid-19-highlights-need-for-new-approaches-to-risk-management/#5440a48766b8

Sustainable safety

- Start every meeting with safety
- Wind industry expertise
- Collaborative engagement with safety engineering and safety basis organizations
- Strong configuration management and engineering change control process

https://nawindpower.com/wp-content/uploads/2017/05/turbine-technician.jpg

Continuous improvement in our processes

- Training – emergency response, self-rescue, etc.
- Collaborate and engage
  - Both internal and external
- Use available tools to plan the work, work the plan
- Staffing
  - Diversity in skills and in perspectives

Continuous improvement in our infrastructure

- Continue to modernize and improve our assets and infrastructure
  - Attract research
  - Be ready for new research opportunities
  - User-operator interfaces & data management/quality
  - Outreach with partners
- Spares program

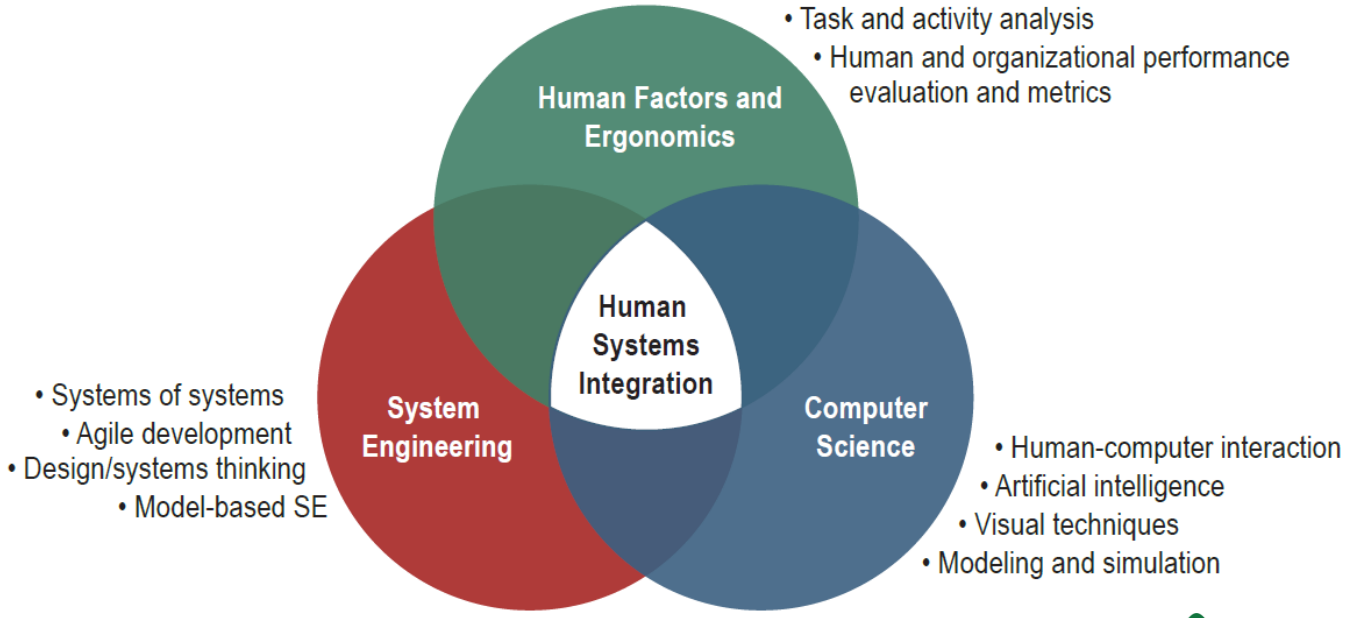
Continuous improvement in our people

- Continue to collaborate with our SMEs
- Look for better and safer ways of doing our tasks
- Get outside [contract] help when it makes sense
- Provide opportunities to learn new skills & engage with industry
- Showcase SWiFT and its capabilities

Conclusion

Early project development

- Comprehensive SMS throughout the system life cycle
- Implement robust and deliberate system safety early on in a project
- Conduct initial hazard analysis in the early conceptual stage of a new research facility
- Knowledge and safety expertise
- Manage stakeholder and customer expectations.

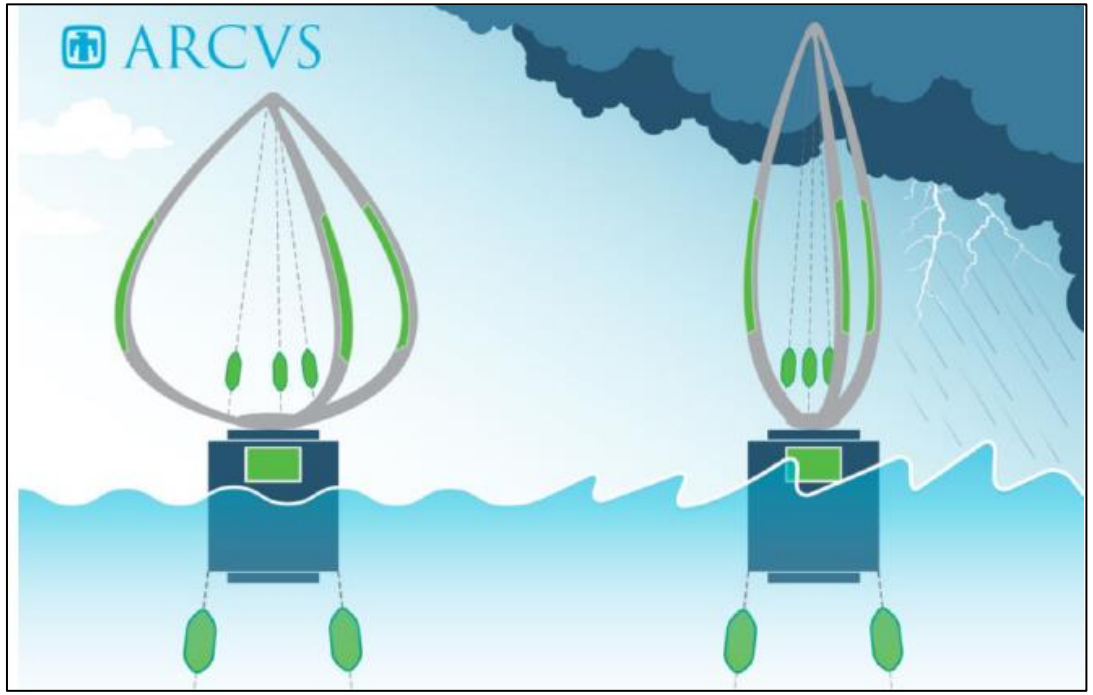


Boy, G. (2019). Human systems integration. Presentation given at the 2019 Annual INCOSE International Workshop. Torrance, CA: International Council on Systems Engineering (INCOSE).

Cross-cutting approach to safety

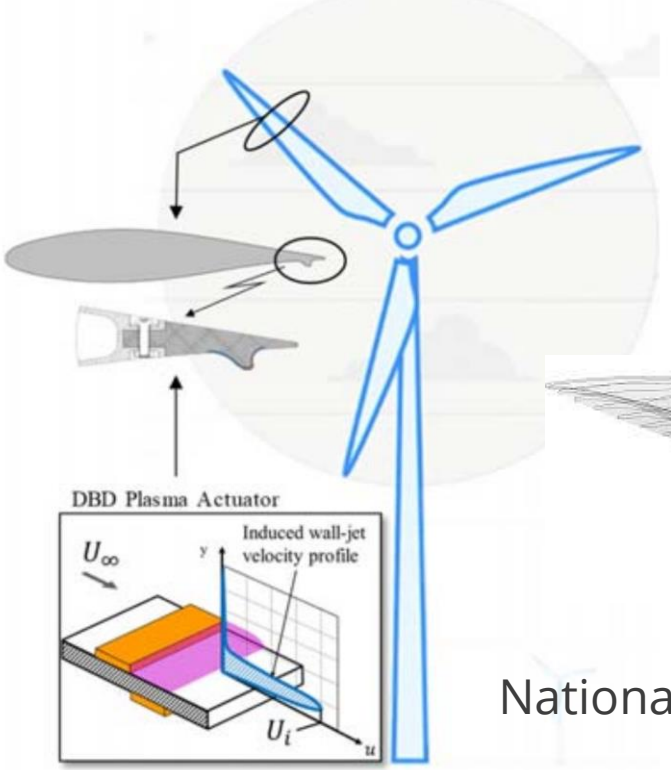
https://medium.com/@solar.dao/risk-management-in-renewable-energy-projects-129eb976fde5

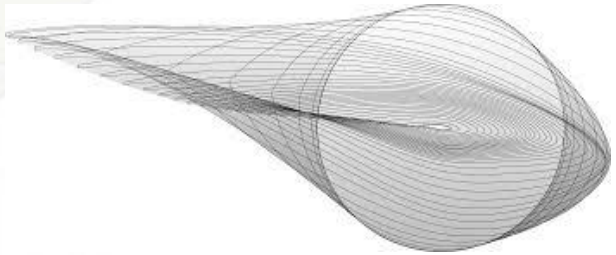
Where we're at now



https://www.osti.gov/servlets/purl/1771266

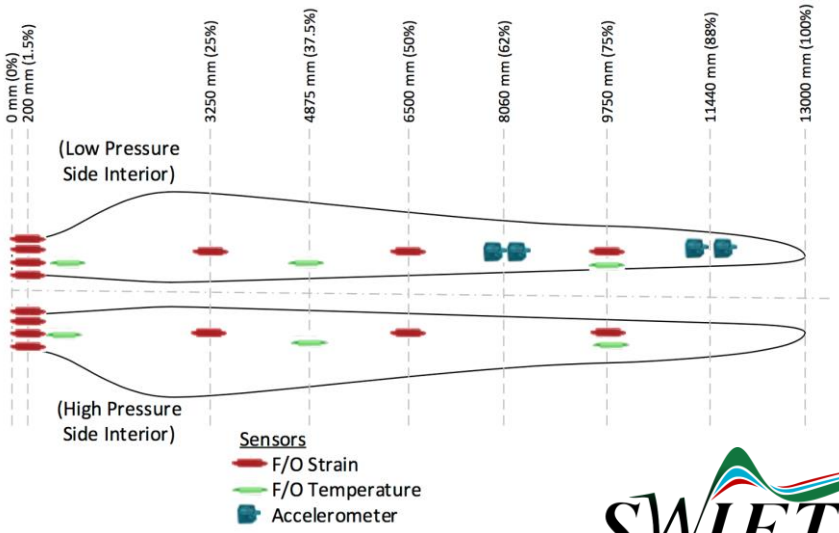
ARCUS Vertical-Axis Wind Turbine





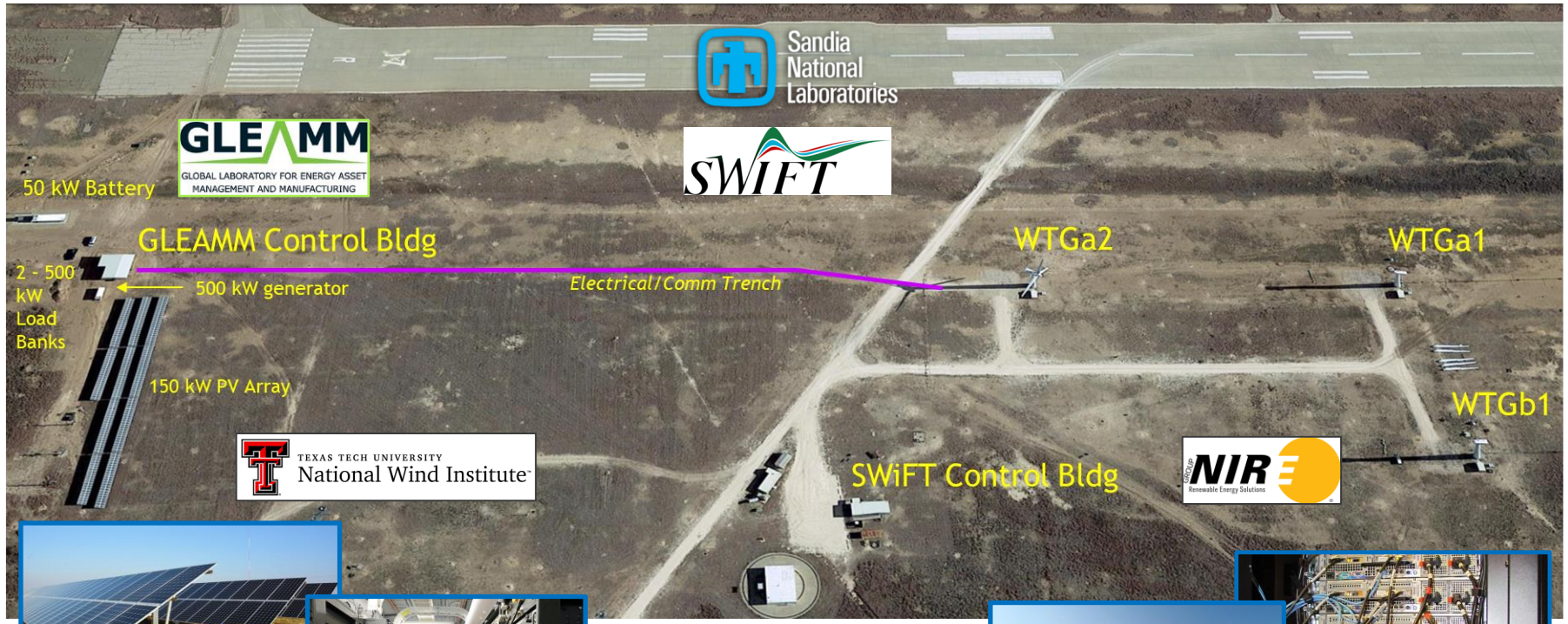
https://www.osti.gov/servlets/purl/1431697

National Rotor Testbed (NRT)

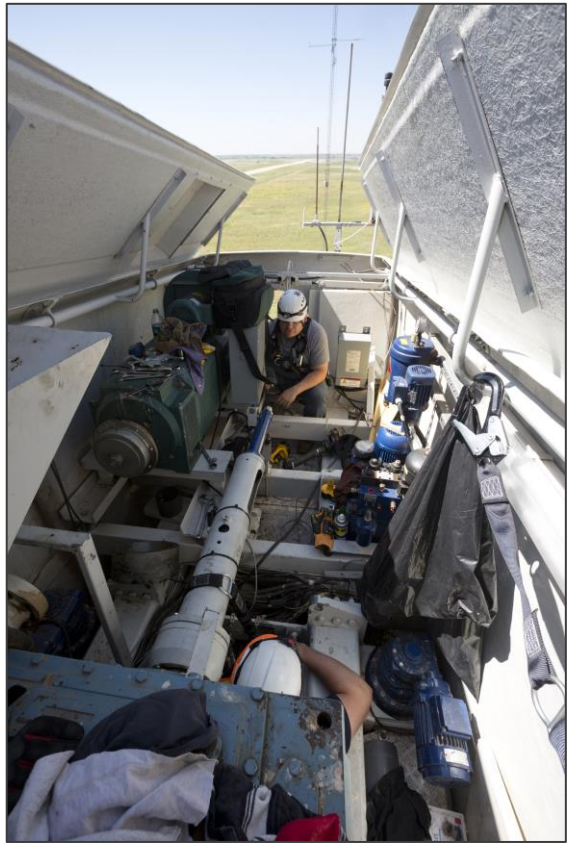


Grid Integration & Power Systems

- New connection to adjacent TTU microgrid
  - Will support new research opportunities for islanded and distribution grid-connected microgrid configurations



Resiliency & sustainability



Research center-of-excellence

Thank you!