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Update on Energy Storage Safety Working Group

U.S Department of Energy Office of Electricity
(OE) Energy Storage Peer Review

Portland, OR, September, 2015

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Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

The Need for Energy Storage Safety Protocols

As an increasing number of energy storage systems are deployed, the risk of safety incidents increases.

Damage to Facilities



2012 Battery Room Fire at Kahuku Wind-Energy Storage Farm (15 MW, 10 MWh)

- There were two fires in a year at the Kahuku Wind Farm
- There was significant damage to the facility
- Capacitors in the power electronics are reported to be associated with the failure.

Impact to First Responders



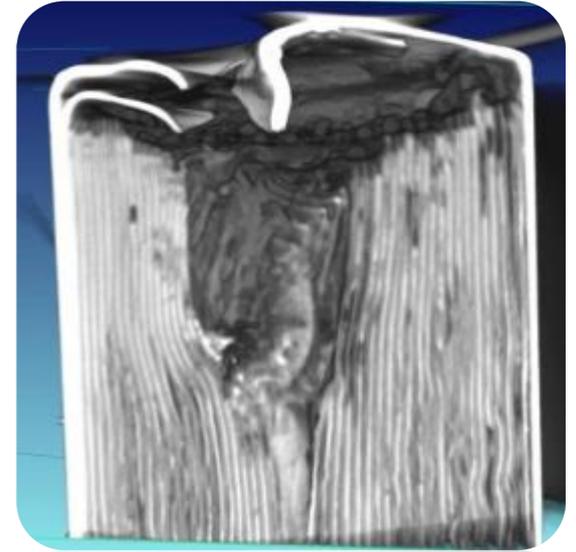
*2013 Storage Battery Fire, The Landing Mall, Port Angeles WA
(75kW, 50kWh)*

- First responders were not aware of the best way to extinguish the fire,
- It reignited a week after it was thought to be extinguished.

Current Approach to Safety

The current approach is to test our way into safety¹

- Extensive destructive tests for safety (crush, burn, etc.)
- Large system (>1MWh) testing is difficult and generically not done.



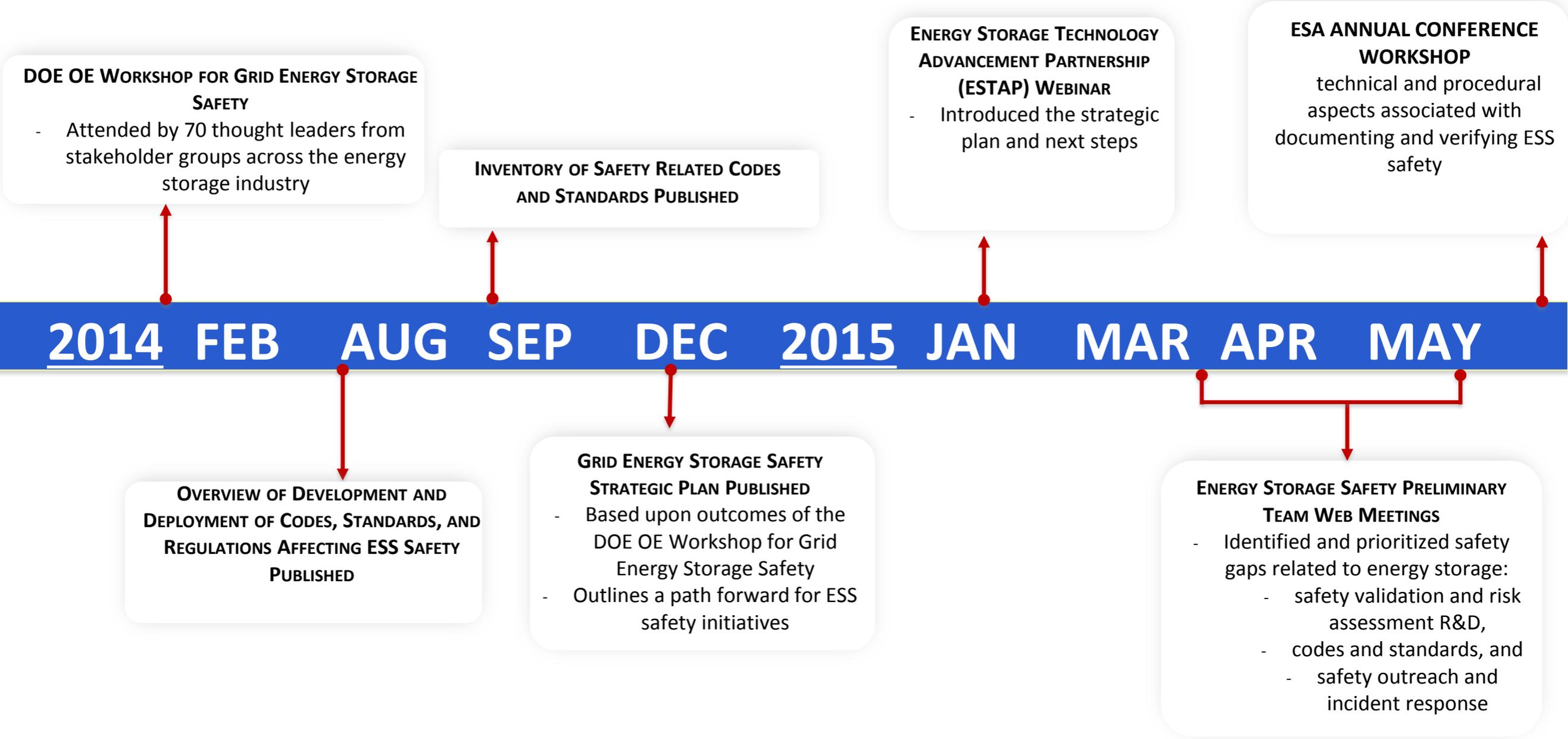
Shortcoming of the current approach:

- Lacks capability to predict untested failure mechanisms with high reliability, i.e. can only design to prevent known failure modes.
- There are few published codes and standard for safety of storage systems.



¹ 'Power Grid Energy Storage Testing Part 1.' Blume, P.; Lindenmuth, K.; Murray, J. EE – Evaluation Engineering. Nov. 2012.

DOE Office of Electricity ESS Safety Activities Timeline



ESSPT Member Organizations and Primary Points of Contact



- **DOE Energy Storage Program (OE)**
 - **Imre Gyuk**, Energy Storage Program Manager
- **Sandia National Laboratories (SNL)**
 - **Stan Atcitty**, Manager, Energy Storage Technology and Systems
- **Pacific Northwest National Laboratory (PNNL)**
 - **Vincent Sprenkle**, Technical Group Manager, Electrochemical Materials and Systems Group
 - **Dave Conover**, Senior Technical Advisor

DNV GL

Rick Fioravanti, Head of Section, Distributed Energy Resources
Alternate contacts: Ben Gully and Davion Hill

Energy Storage Association (ESA)

Matt Roberts, Executive Director

National Fire Protection Association (NFPA)

Kenneth Willette, Division Manager, Public Fire Protection
Alternate contact: Rich Bielen

Underwriters Laboratories (UL)

Laurie Florence, Principal Engineer

Electric Power Research Institute (EPRI)

Steve Willard, Senior Program Manager, Energy Storage
Alternate contacts: Haresh Kamath, Brittany Westlake

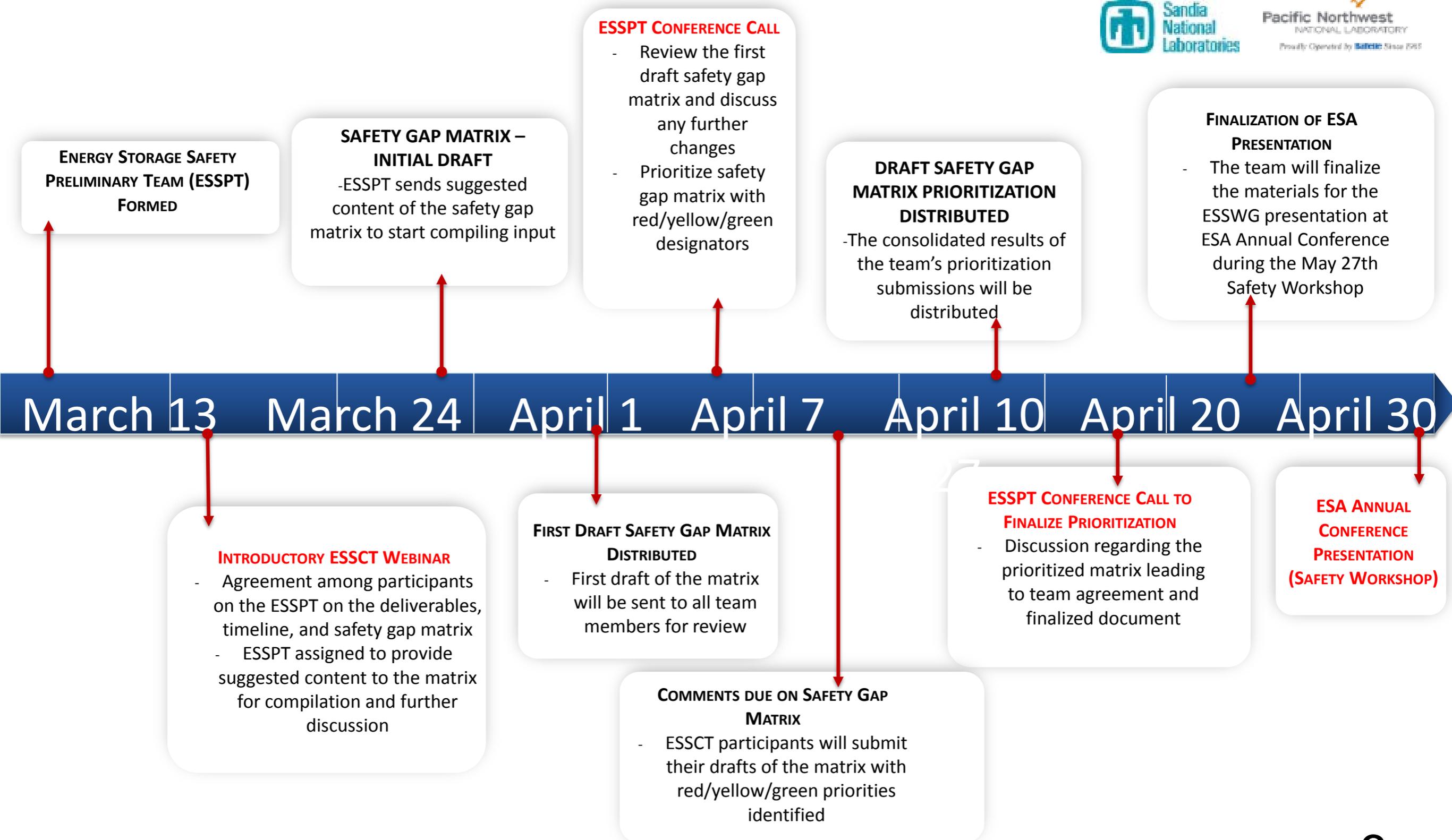
National Electric Manufacturers Association (NEMA)

Ryan Franks, Technical Program Manager

National Institute of Building Sciences (NIBS)

Henry Green, President
Alternate contact: Ryan Colker

ESSPT Milestone Timeline



Energy Storage Safety Working Group (ESSWG) Mission and Vision



Mission

Establish a DOE-facilitated Energy Storage Safety Working Group (ESSWG) involving representatives of the stakeholder community having key competencies and an interest in energy storage system (ESS) development and deployment to plan and execute paths forward to address safety gaps, previously identified and prioritized by the Energy Storage Safety Preliminary Team (ESSPT), needed to support the timely and safe deployment of stationary energy storage systems.

Vision

The ESSWG enables timely deployment of safe energy storage systems consistent with the December 2014 [DOE OE Energy Storage Safety Strategic Plan](#) by following the framework outlined by the ESSPT, which specifically prioritizes the work needed to address gaps in the knowledge associated with energy storage system safety, and carrying out safety related research, education and training, technical support, and codes/standards development activities.

Energy Storage Safety Working Group (ESSWG) Scope of Work



The activity will focus on the safety of all stationary ESSs, and projects to address the gaps will be organized and conducted through coordinated actions focusing on the priority gaps identified by the ESSPT in each of three ESSWG areas:

- *Safety Validation and Risk Assessment*
- *Codes and Standards*
- *Safety Outreach and Incident Response*

To facilitate work on each gap, the ESSWG will leverage past efforts such as those conducted under the DOE Energy Storage Safety Strategic Plan, the Energy Storage Integration Council (ESIC), Energy Storage Association, and other stakeholder organizations.

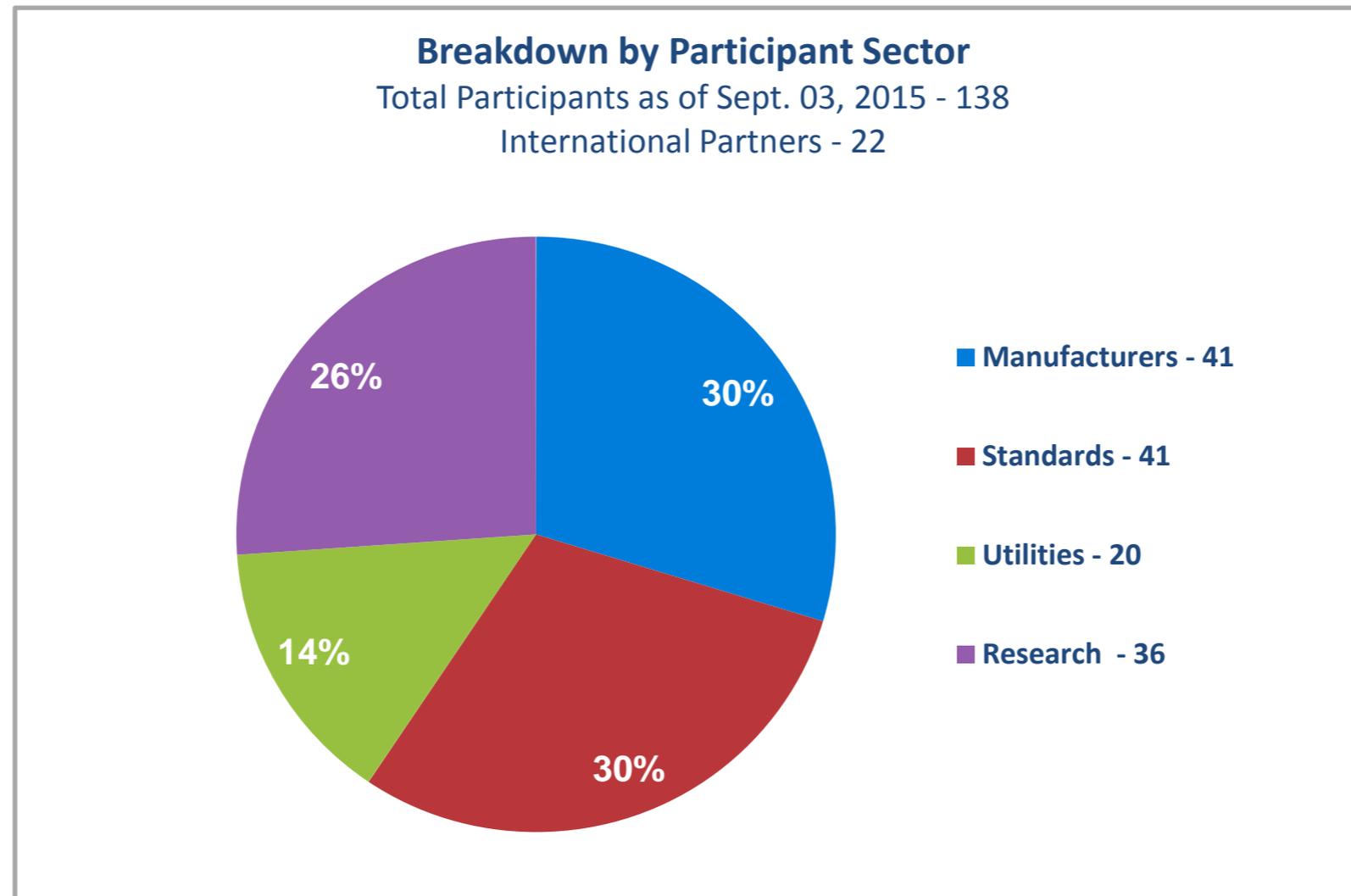
Energy Storage Safety Working Group (ESSWG) Prioritization



Prioritization Process

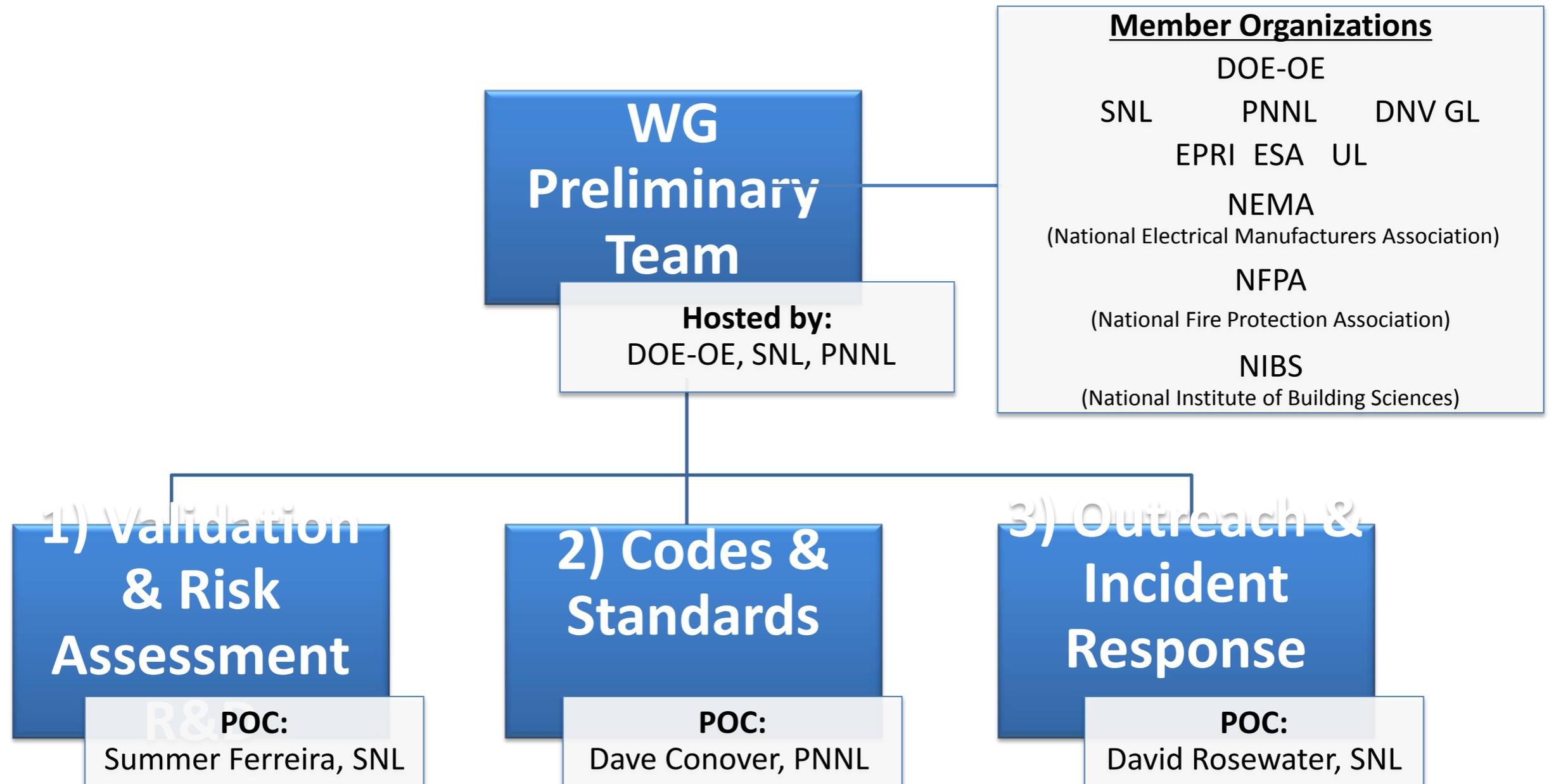
- A survey of the safety challenges was conducted by the ESSPT to collect a list of the **issues and issue categories**.
- The issues were then sorted into the strategic objective areas Safety Validation and Risk Assessment Issues, Codes and Standards issues, and Safety Outreach and incident Response issues
- A second survey was then performed which asked the ESSPT to provide **Ease** and **Impact** rankings for each issue
- The responses were then collected and reviewed as a group to **identify the top issues in each strategic objective area**

Energy Storage Safety Working Group (ESSWG) Participation



International partners represent the following countries: Australia, China, France, Japan, South Korea, and the United Kingdom.

Energy Storage Safety Working Group (ESSWG) Organizational Structure



Identified three immediate subject areas and a short list of top priorities in each area.

Energy Storage Safety Working Group (ESSWG) Strategic Objectives



Working groups will be guided by volunteers with expertise in the topical areas and conducted through a coordinated effort. WG's will address highest priorities as identified by the ESSPT.

Safety Validation and Risk Assessment R&D

Coordinate with other WG's to **maintain prioritized list of research and development** focuses critical to the industry.

Codes, Standards and Regulations (CSR)

Using the queue of gaps in existing codes and standards generated by the ESSPT, **revise existing CSR** and **develop new CSR** to effectively guide energy storage system safety and do not act as barriers to system deployment.

Safety Outreach and Incident Response

Outline and implement a plan to educate, engage, and train stakeholder communities on applying criteria and practices to ensure that systems are safe when placed into service and the first-responder community is equipped to respond, if there is an incident.

Energy Storage Safety Validation & Risk Assessment R&D Working Group



WG's intent is to address highest priorities as identified by the ESSPT.

- Coordinate with other WG's to **maintain prioritized list of research and development** focuses critical to the industry.
 - Suppression testing and analysis
 - Thermal runaway research
 - System scale burn test
 - Commodity classification
 - Fire and vent gas modeling and analysis
- Kickoff meeting held September 10th, 2015.
- Share knowledge of R&D efforts and funding opportunities in the key initiatives
- Hold a quarterly call to review status, and share information of relevant feedback from the CSR and outreach groups and their impact on R&D, and identify any appropriate feedback out to these groups.
- Identify upcoming deadlines for conferences, and events relevant to ESS safety R&D.

Safety Validation and Risk Assessment R&D Prioritization



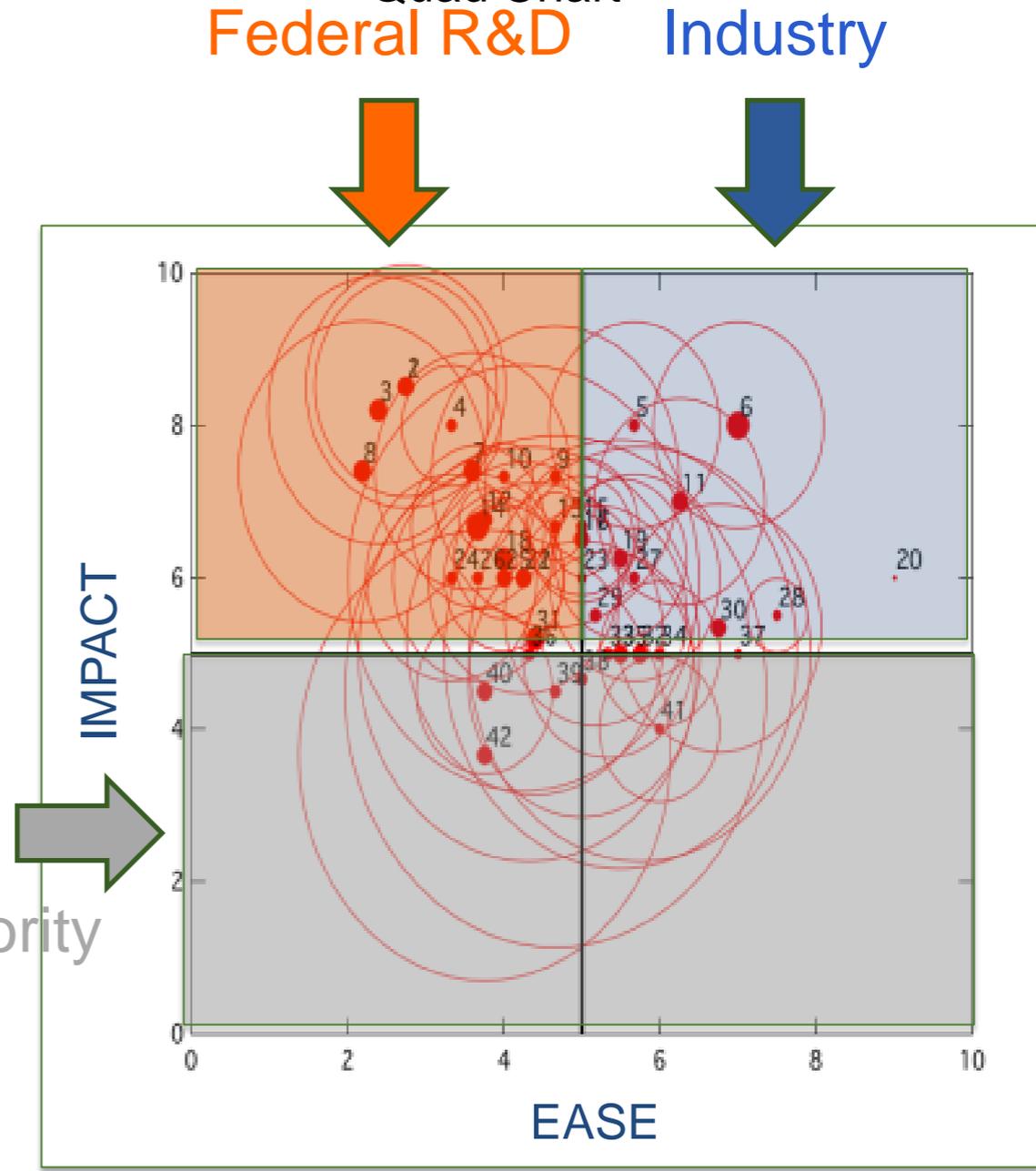
Key need – Identify R&D efforts that will have the largest impact on the safety of the industry.

- Work to date
 - Ongoing work in labs, industry and academia address safety in an ad hoc manner.
 - Focused largely on performance of single cells

- Short term priorities identified:
 - **Fire Suppression testing** and analysis
 - **Thermal runaway** research
 - **System scale burn test**
 - **Commodity classification** development
 - **Fire and vent gas modeling** and analysis

- Longer term priorities: as resources allow.
 - DC fusing recommendations
 - How to handle stranded energy
 - Access control guidance
 - Guide to ESS safety analysis
 - R&D to address gaps found in standards

Safety Validation and Risk Assessment
Quad Chart



Codes and Standards Working Group Activity Update



- Meetings held July 28th and August 25th and are scheduled for once a month
- About 40 participants at each meeting, with agenda and relevant materials to update activities and drive discussion sent out in advance of each meeting
- Working in 3 core CSR related areas and coordinating with the other 2 ESS Safety WGs as warranted
 1. Compliance Guide to Codes and Standards for Stationary Energy Storage Systems
 - Responding to a need to foster more timely consideration and approval of ESS under current CSR
 - First draft posted and being developed via web based process
 - Publication targeted for year end
 2. Update existing CSR
 - Responding to need to foster updating to facilitate deployment of safe ESS recognizing technology evolves in advance of CSR development and deployment
 - Have identified numerous CSR updating opportunities and are connecting CSR WG members participants with them and where indicated fostering stakeholder collaboration on input to CSR revisions processes
 3. Development of new CSR
 - Responding to the need to fill gaps where standards do not exist
 - Have identified 3 possible new standards that would initially be developed as protocols for transfer to an SDO
 - Safety classification of flow battery electrolytes, safety of mechanical ESS and ESS installation

“Facilitating the timely development and deployment of safe ESS by implementing the DOE ESS Safety Plan through collaboration of all interested parties and key stakeholders on needed CSR”

Safety Outreach and Incident Response Working Group



- Kickoff Meeting August 10th and will be scheduled for once every 2 months, or as needed
- About 20 participants at the meeting, with agenda and relevant materials to update activities and drive discussion sent out in advance of each meeting
 - Divided work into 7 task groups:

Top Issues in Safety Outreach and Incident Response

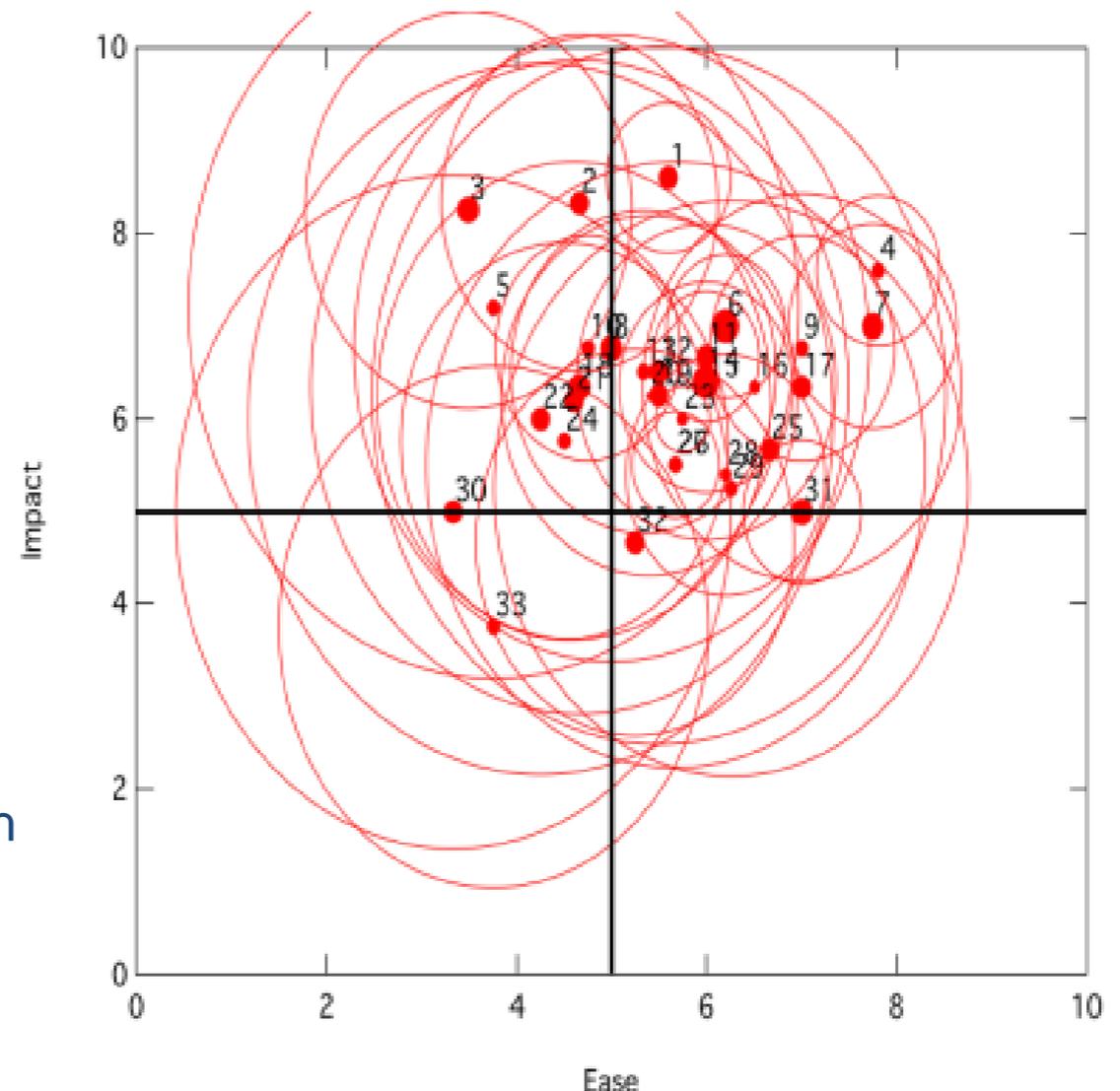
- A. Provide guidance and information on ESS installation and protection design
- B. Provide guidance and information operational safety including thermal management
- C. Develop first responder training material for responding to an ESS fire
- D. Develop guidance and information on ESS safety analysis through energy storage websites, the ESS Handbook, and by offering safety analysis courses to developers and startups
- E. Promote first responder knowledge and confidence by developing a template for providing information to and working with local fire departments and by make safe methods available to first responder groups through demonstration (practice system fire), videos, guides, and courses.
- F. Provide links to educational material on cyber security on energy storage websites
- G. Provide guidance and information on the safe transportation/delivery of energy storage systems

Safety Outreach and Incident Response Prioritization



- Key need – the ability to make safety critical information accessible to all stakeholders including first responders, inspectors, and regulators
- Work to date
 - Energy Storage Safety Meeting
 - Energy Storage Safety Strategic Plan
 - Ad-hoc engagement and collaboration between national labs, and industry on safety
- Short term activities
 - Guidance and information on ESS installation and protection design
 - Guidance and information operational safety
 - Develop first responder training material
- Longer term activities
 - First responder knowledge and confidence through demonstrations, videos, guides, and courses
 - Guidance and information on safe transportation

Safety Outreach and Incident Response
Quad Chart



Energy Storage Safety Working Group (ESSWG) Open Invitation



- All ESS stakeholders are invited to participate in any or all of these three working groups or task groups that may be established under them.
- Each WG will establish a path forward and work towards relevant goals as outlined in the slides on R&D, CSR and Outreach.
- Work will start immediately so please get involved.
- Look for a communication from the POC of the area(s) where you have expressed an interest in participating within the next week.
- **Send an e-mail to energystorage@sandia.gov to indicate which working group(s) you want to participate in so the support staff for each group can send you the information needed to get you involved.**

www.sandia.gov/ess/safety

Acknowledgement



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