ANSI Electric Vehicles Standards Panel

Roadmap of Standards and Codes for Electric Vehicles at Scale (EVs@Scale)

Christine D. Bernat
Associate Director, Standards Facilitation
ANSI

American National Standards Institute

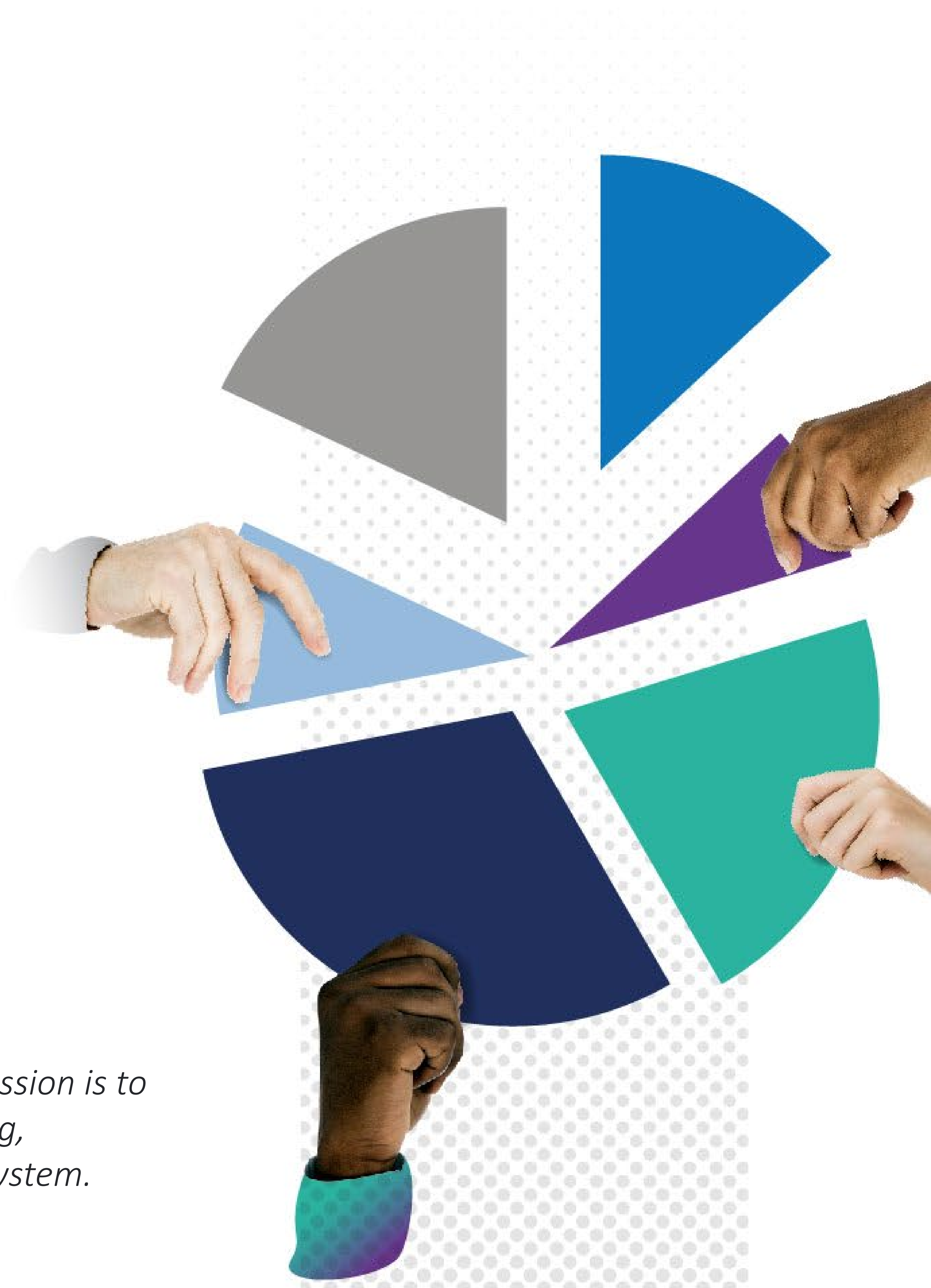
Standardization Collaboration

One way ANSI coordinates and supports the standardization system is through **standards collaboratives and workshops**, which:

- Bring together the public and private sector in a **neutral forum**
- Identify current and in-development standards, where gaps exists, and recommend solutions
- Identify organizations that can perform the needed work

ANSI does **NOT** write standards

Founded in 1918, ANSI is a private non-profit membership organization whose mission is to enhance U.S. global competitiveness and the American quality of life by promoting, facilitating, and safeguarding the integrity of the U.S. voluntary standardization system.



Electric Vehicles Standards Panel

Formed: March 2011

Purpose: Develop a roadmap of standards and conformance programs needed to facilitate the safe, mass deployment of EVs and charging infrastructure in the U.S., with international coordination, adaptability and engagement.

Background:

- Support Biden Administration's goal for a clean energy future
- Initiated by Department of Energy (DOE), Office of Energy Efficiency & Renewable Energy (EERE), Vehicle Technologies Office (VTO) and Argonne National Laboratory (ANL)

Strictly a coordinating group; it does <u>not</u> develop standards

ANSI EVSP Timeline

March 2011
ANSI Electric Vehicles Standards Panel (EVSP) formed

April 2011
ANSI workshop on Standards and Codes for EVs held w/support from DOE/INL

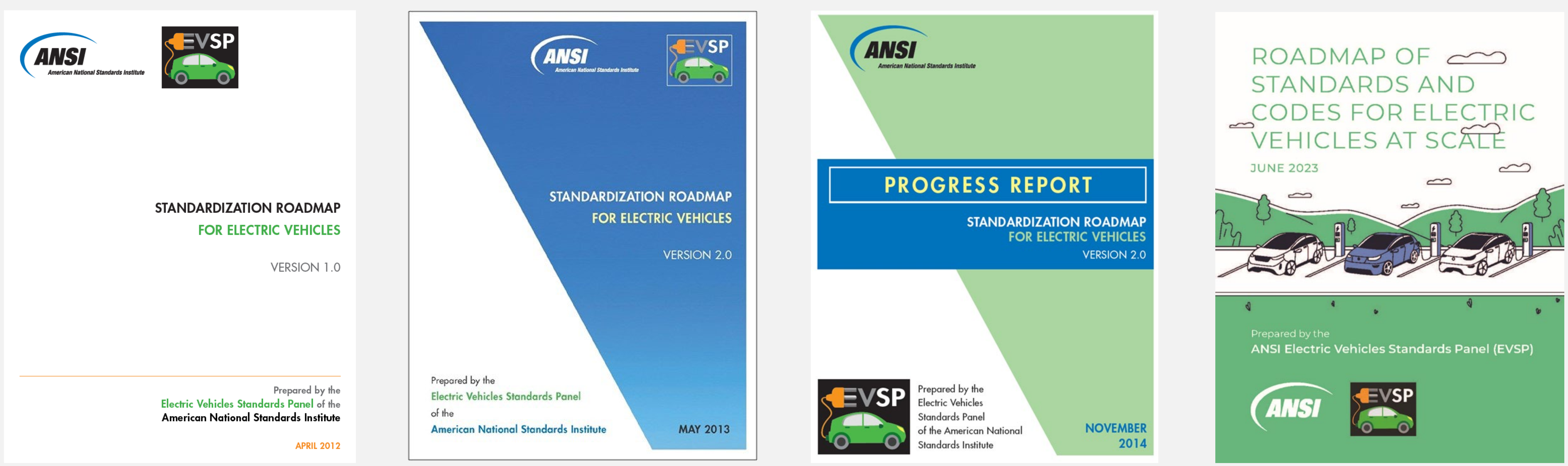
April 2012
Roadmap V1 Published

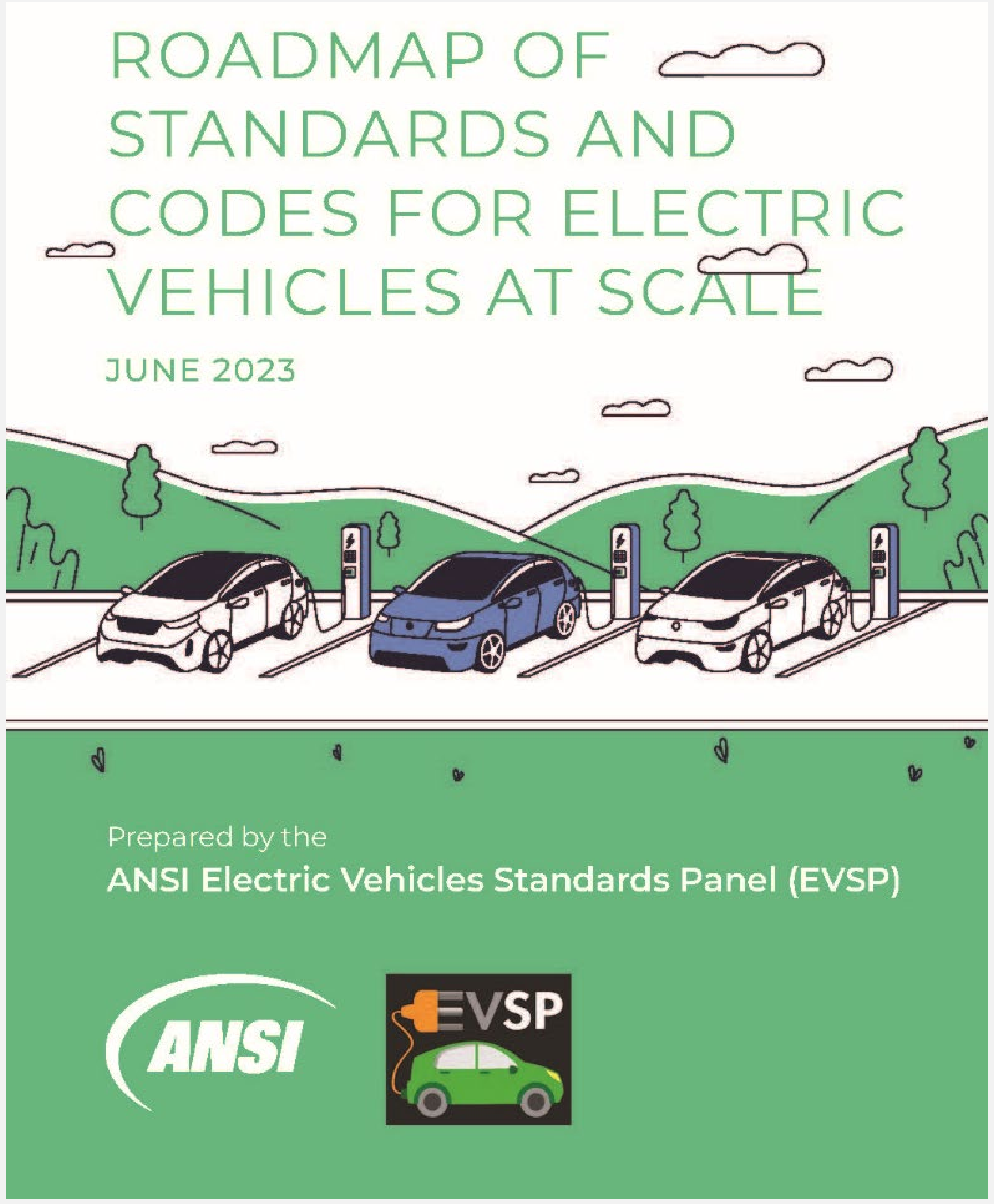
May 2013
Roadmap V2 Published

Nov. 2014
Progress Report Published

June 2022
Relaunched per EVs@Scale initiative

June 2023
Publication of updated Roadmap





2023 Roadmap for EVs@Scale

- **Identifies** EV issues, standards, codes, guides, and related policies (e.g., NEVI Final Rule) that exist or that are in development
    - Focus on U.S. market with international harmonization issues noted
- **Technical Areas:**
    - **Section 2:** Vehicle Systems (WG1)
    - **Section 3**: Charging Infrastructure (WG2)
    - **Section 4**: Grid Integration (WG3)
    - **Section 5**: Cybersecurity (WG3)
- **Total Gaps**: 37
    - Gap means no published standard, code, regulation exists
    - 14 high priority, 20 medium priority, 3 low priority
    - 24 require R&D
- **Participation**: Approximately 130 individuals from 80 organizations

Gap Contents

- **Background Information**: Leading text provides context on the subject area and identifies existing related policies, codes and standards
- **Short Title & Description*:** Brief background specific to the gap.
- **R&D Needs**: Describes R&D *(if any)* to complete to advance knowledge to aid in closing gap.
- **Recommendation** for new or revised standards, codes, guides, priorities, and organizations which could offers solutions
- **Priority Level**: H,M,L with consideration of Criticality, Achievability, Scope (e.g. resources) and Effect (e.g. ROI)
  - High Priority** (a score of 10-12) / 0-2 years
  - Medium Priority** (a score of 7-9) / 2-5 years
  - Low Priority (a score of 4-6) / 5+ years
- **Organization(s)** who could aid in closing the gap

Gap V1: Battery Safety. There is an ongoing need to address safety issues related to battery thermal runaway, potential immersion scenarios, and vibration resistance.

R&D Needed: Yes. Further investigation regarding safety issues (e.g., hazmat) for water and sand immersion should be conducted prior to addressing in standards.

Recommendation: Continue to advance battery safety through NHTSA's participation in the development of Phase 2 of Global Technical Regulation No. 20 for Electric Vehicle Safety and the SAE Battery Field Discharge Committee.

Priority: High

Organization(s): NHTSA, WP.29, SAE

**Gap "Descriptions" provided on the following slides do not include the full text from the roadmap.*

***High/Medium Priority Gaps are indicated with red/green text on the following slides.*

Section 2. Vehicle Systems

2.1. Power Rating Methods

2.2. Battery Safety

2.2.1. Functional Safety in the Charging System

2.2.2. Delayed Battery Thermal Events

2.2.3. Electric Vehicle Emergency Response

2.2.4. Micromobility and Light Electric Vehicles (LEV)

2.2.5. Electric Mopeds and Motorcycles

2.3. Battery Testing – Performance and Durability

2.4. Battery Storage

2.5. Battery Packaging, Transport, and Handling

2.6. Battery Recycling/Materials Reclamation

2.7. Battery Secondary Uses

2.8. Crash Tests/Safety

2.9. EV Maintenance

Section 2. Vehicle Systems Gaps

- Gap V1: **Battery Safety.** Address safety issues related to battery thermal runaway, potential immersion scenarios, and vibration resistance.
- Gap V2: **Delayed Battery Thermal Events.** Delayed battery thermal events needs to be addressed.
- Gap V3: **Safe Storage of Damaged Lithium-ion Batteries.** Safe storage of damaged (i.e., unknown condition) lithium-ion batteries, whether at warehouses, repair garages, recovered vehicle storage lots, or auto salvage yards.
- Gap V4: **Packaging and Transport of Lithium-ion Batteries.** Battery package testing and performance-based packaging for lithium batteries as cargo on aircraft.
- Gap V5: **Design for Battery Recyclability/Materials Reclamation.** Battery construction design with the intention of recycling/materials reclamation are needed. The ability to disassemble batteries after use in order for parts and materials to be reclaimed or recycled to manufacture new batteries should be considered during the design phase.
- Gap V6: **Battery Secondary Uses.** Methods to capture and track battery health for second life applications for grid storage and other uses. The principal objective is to decide whether a battery should be reused, repurposed, or recycled.

Section 3. Charging Infrastructure

3.1. Charging Systems

3.1.1. DC Fast Charging and AC Level 2 for Light, Medium, and Heavy-Duty EVs

- 3.1.1.1. Power Quality
- 3.1.1.2. EV Charging Levels
- 3.1.1.3. EV Supply Equipment and Charging Systems
- 3.1.1.4. EV Couplers
- 3.1.1.5. Electromagnetic Compatibility (EMC)

3.1.2. Megawatt Charging Systems for Medium and Heavy-Duty EVs

3.1.3. Wireless Power Transfer (WPT)

- 3.1.3.1. Static Wireless Power Transfer
- 3.1.3.2. Dynamic Wireless Power Transfer
- 3.1.3.3. Communications in Support of Wireless Power Transfer

3.1.4. Automated Power Transfer

3.2. Station / Site Architecture

3.2.1. General Infrastructure Installation Considerations

- 3.2.1.1. Site Assessment / Power Capacity Assessment
- 3.2.1.2. Charging Station Permitting
- 3.2.1.3. Personnel Involved in Installing, Maintaining, and Operating EV Charging Infrastructure
- 3.2.1.4. Impact of Environmental and Use Conditions on EVSE
- 3.2.1.5. Ventilation – Multiple Charging Vehicles
- 3.2.1.6. Cable Management
- 3.2.1.7. Labeling of EVSE and Load Management Disconnects for Emergency Situations
- 3.2.1.8. EV Charging – Signage and Parking
- 3.2.1.9. Physical Security of EVSE
- 3.2.1.10. Accessibility for Persons with Disabilities to EVSE

3.2.2. Specific Installation Considerations for Different Charging Scenarios

- 3.2.2.1. Residential Charging
- 3.2.2.2. Commercial / Workplace Charging
- 3.2.2.3. Highway / Corridor Charging

Section 3. Charging Infrastructure Gaps

- Gap C1: **Megawatt Charging Systems (MCS).** MCS to support for heavy-duty EVs such as aircraft, trucks and buses.
- Gap C2: **Static Wireless Charging.** Heavy-duty/high power static wireless charging are still in development.
- **Gap C3: Dynamic Wireless Charging Interoperability.** Dynamic wireless charging interoperability are still needed. Both light-duty and heavy-duty EVs should be able to use the same ground-based transmitter system.
- Gap C4: **EMC and EMF Measurements of Dynamic Wireless Power Transfer (WPT).** Methods and procedures for conductive charging are needed for dynamic WPT.
- **Gap C5: Communications in Support of Wireless Power Transfer.** Address conflicting requirements and harmonization (ISO 15118-series / SAE J2847/6)
- Gap C6: **Power Export.** While permitting for EVSE installation is covered by codes, permitting for the actual delivery of power from the vehicle (i.e., power export) is not specified in codes. Conformance with stationary energy storage systems and V2G standards, such as NFPA 855, may be required.
- Gap C7: **Cable Management.** Functional management of EV cables in public parking spaces is not specifically addressed by codes or standards.
- Gap C8: **Fire protection in relation to EV parking/charging in/near older buildings**. Fire propagation of electric vehicles differs from conventional vehicles.

Section 4. Grid Integration

4.1. Communications/Controls

4.1.1. Communications Architecture for EV Charging
4.1.2. Communications Requirements for Various EV Charging and Grid Support Scenarios
4.1.3. Communication and Measurement of EV Energy Consumption
4.1.4. Telematics Smart Grid Communications

4.2. Power Distribution / DER Integration and Fast Charging Stations / Microgrids

4.2.1. Power (Electrical) Systems and Safety
4.2.2. Communications / Controls

4.3. Vehicle to Grid (V2G)

4.3.1. V2G Interconnection, EVSE Safety and Functionality
4.3.2. V2G and Vehicle Functionality
4.3.3. V2G Communication Protocols

Section 4. Grid Integration Gaps

- Gap G1: **Standardization of Error Codes and Reporting.** Diagnostics including standardized error codes across the EV charging ecosystem, such as for no charge events. Considerations include what should be reported, specific formats, associated language, and appearance (e.g., symbols, color) for display.
- Gap G2: **Locating and reserving a public charging station, Obtaining Pricing and Availability Information.** Guides to permit EV drivers to locate a public charging spot, reserve its use in advance, and obtain pricing information and near real-time availability.
- Gap G3: **Communication of standardized EV sub-metering data.** Communication of EV sub-metering data between third parties and service providers.
- Gap G4: **Metrological Traceability for Quantitative Measurement of DC Power Delivery.** At present, the U.S. does not maintain System Internationale (SI) traceability for DC measurement in ensuring metrological soundness of DC EVSEs. Further, there is no current specification for transfer standards or processes for establishing traceability of EVSE measurement of DC power by testing authorities.
- Gap G5: **Standardization of EV sub-meters.** Including embedded sub-meters, are needed to address performance, security/privacy, access, and data aspects. Policy development is needed to assist utilities in applying EV charging tariffs to the facility, and not the customer charging their vehicle.
- Gap G6: **Dynamic Capacity Management (DCM).** Questions remain though as to clarification of further grid coordination mechanisms to be supported, as well as consumer information to enhance understanding of standards.
- Gap G7: **Safety and Protection of DC architectures are not standardized.** How to do a thorough DC protection system design (especially with regard to islanding). Short circuit protection for complex energy sources (e.g., multiple energy sources and bidirectional power flow) is the primary gap.
- Gap G8: **Fault Current Signatures for AC and DC Architectures under Islanding Conditions.** Coordination in front of and behind the meter is needed when systems are islanding, especially within the context of hybrid (AC/DC intertwined) and DC architectures, and non-linear loads.

Section 4. Grid Integration Gaps (*cont.*)

- Gap G9: **"Ride Through" Requirements for EVSE under Grid Service Conditions.** When EVSE are supplying power to the grid, "Ride Through" requirements need to be defined under specific conditions. "Ride Through" is not applicable in this context for DC systems.
- Gap G10: **DC-as-a-Service (DCaaS).** A thorough review of standards is needed for applicability. This includes electrical power standards and any other standards for DC distribution, as well as for fast charging stations and DC microgrids. DCaaS is a business proposition and involves standards, codes, policy development, and coordination to ultimately be successful.
- Gap G11: **Structured information and energy services exchange with utilities.** Structured information and energy services exchange to enable utilities to balance utility-side availability of renewables with site requirements, including EVs, stationary storage, and/or any flexible load to provide grid services.
- Gap G12: **Assess UL 1741 V2G Integration Requirements**. Assess and potentially revise UL 1741 and Supplements to ensure it properly accounts for V2G integration. Currently, most requirements cannot be used for automotive electronics and an automotive version would be needed (SAE J3072 was created for this purpose).
- Gap G13: **Maintain alignment between UL 9741 and UL 1741**. With regard to V2G, these two standards complement each other and it is important to maintain alignment as they are revised.
- Gap G14: **Revise SAE J3072 to harmonize with UL 1741 SB.** SAE J3072 currently references IEEE 1547 (2018) and IEEE 1547.1 (2020); however, it does not currently reference UL 1741 Supplement SB. UL 1741 Supplement SB contains approximately 30 pages of additions and corrections that need to be used in conjunction with the IEEE 1547 standard suite. IEEE 1547 is the test standard where UL 1741 is the certification standard. They need to be used together.
- **Gap G15: Assess Interoperability Between Communication Protocols and Standards.** The ability to assess interoperability between the utility and the downstream DER via allowed protocols per IEEE 1547 (IEEE 2030.5, SunSpec Modbus, and DNP3) is required to ensure utility / DER compatibility.

Section 5. Cybersecurity Gaps

- Gap S1: **Comprehensive review of cybersecurity codes and standards for applicability to the EV charging ecosystem.** Gaps should be identified and prioritized.
- Gap S2: **The lack of an end-to-end secure trust chain and encryption system for the EV charging ecosystem.** This results from the use of different protocols and data transfer mechanisms between EV charging related systems. An entity trust chain is needed across all elements of the EV charging ecosystem incorporating a comprehensive public key infrastructure (PKI).
- Gap S3: **Cybersecurity and Data Privacy.** Due to the nature of cybersecurity, the interactions of systems, and the emerging threats environment, there is an ongoing need for guidelines and standards to address cybersecurity and data privacy concerns specific to EVs and smart grid communications. Architectures should be designed with cybersecurity in mind.
- Gap S4: **Robust "Security-by-Design."** Security-by-Design is needed for equipment and systems throughout the EV charging ecosystem.
- Gap S5: **Digital Cybersecurity as Part of Interconnection Standards.** Cybersecurity threats exist at the power system point of interconnection. The digital interconnection could be compromised which may affect the electrical interconnection. Presently, there appears to be no standards requirements nor other guidance for utilities to address digital cybersecurity challenges.
- Gap S6: **Cybersecurity of Power Management under DER Aggregation Scenarios.** Cybersecurity gaps exist with regard to aggregation of DERs for Grid Services and subsequent power management.
- Gap S7: **Cybersecure Firmware and Software Updates.** Although some OEMs also have developed their own algorithms to protect firmware/software updates, open-sourced the algorithms, and shown they are compatible with the majority of automotive processors on the market today, the approaches are fragmented and may need standardization.
- Gap S8: **EVSE Cyber-physical Vulnerabilities.** EVSE have physical vulnerabilities that can serve as threat vectors and cascade to cybersecurity high consequence events.

Breakdown of Gaps

Section # & Title	High Priority (0-2 years)	Medium Priority (2-5 years)	Low Priority (5+ years)	Total
2. Vehicle Systems	5	1	0	6
3. Charging Infrastructure	2	4	2	8
4. Grid Integration	3	11	1	15
5. Cybersecurity	4	4	0	8
Total	14	20	3	37

23 gaps require pre-standardization R&D

Next Steps

- Increase awareness about roadmap availability and recommendations, especially to recommended organizations listed in the gaps
  - Add to agendas to Standards/Codes developing organizations technical committee meetings
  - Brief research organizations during project development phases
  - Outreach to EV OEMs & suppliers/providers
  - Related local, state and federal government bodies
  - Social media and other communication channels
    - Press Release
    - Roadmap (direct link)
- Collaborate to close gaps!

Staff Contact

Christine D. Bernat
Associate Director, Standards Facilitation
1-212-642-8919 (o)
1-202-236-7580 (m)
cbernat@ansi.org

More Info:

evsp@ansi.org
www.ansi.org/evsp
www.ansi.org

ANSI
American National Standards Institute