U.S.–INDIA SCCP

U.S.-India Standards and Conformance Cooperation Program (SCCP), Phase II

U.S.-India Virtual Standards Workshop
The Future of Electric Vehicles in India
Session II
Indian EV Power Utilities and Regulatory Issues

February 23, 2021

Opening Remarks

United States Trade and Development Agency

Tanvi Madhusudanan, Country Manager, Indo-Pacific

U.S. Department of Commerce

Geoff Parish, Principal Commercial Officer (PCO) for North India

Confederation of Indian Industry (CII)

Vipin Sahni, Executive Director

Grid Connected Energy Storage System — Safety & Performance Standards and Implementation

Date: February 23, 2021| Indian E.V. Power Utilities and Regulatory Issues

OUR MISSION

Working for A Safer World

Since 1894

Two Distinct Organizations with One Common Mission

Underwriters Laboratories (Nonprofit)

Standards
Research
Education/Outreach

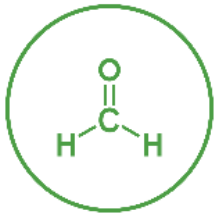
UL (Business Solutions)

Testing, Inspection & Certification
Software as a Service
Advisory Services

Underwriters Laboratories Focus Areas

Battery Safety

Investigating the limits of battery technologies to drive safer innovations and product performance



Chemical Insights

Promoting human health through research and awareness of the potential risks of chemical pollutants

Data Science

Providing analytical, statistical and predictive modeling to enhance strategy and research

Education and Outreach

Developing safety, health and sustainability education interventions to inspire behavior change, awareness and empower positive action

Fire Safety

Leading fire research and developing practical education to help firefighters stay safe and protect people and property

Standards

Delivering standards that guide the safety, performance and sustainability of products and services worldwide

UL Standards by the numbers

OVER

1,600

CURRENT STANDARDS

On safety, security and sustainability

70+

DEDICATED

Standards Professionals

In 8 countries

Over

4,000

VOLUNTEERS

ACTIVELY PARTICIPATING IN STANDARDS DEVELOPMENT

APPROXIMATELY

50,000

REGISTERED CSDS USERS

COLLABORATIVE STANDARDS DEVELOPMENT SYSTEM

35+

COUNTRIES

REPRESENTED ON STPs AND COMMITTEES

450

ACTIVE STPs

AND COMMITTEES

DEVELOPING AND MAINTAINING STANDARDS

Why Energy Storage?

Infrastructure Benefits of Energy Storage

Adding Energy Storage:

- Reduces the need for new grid construction and system upgrades
- Augments the performance of aging transmission and distribution assets:
  - **US DOE Estimates**:
  - 70% of transmission lines are more than 35 years old
  - 70% of transformers are more than 35 yeas old
  - 60% of circuit-breakers are more than 40 years old
- Improves grid security, reliability and resiliency
- Reduces peak demand stress on transmission and distribution lines

IMPORTANCE OF ENERGY STORAGE

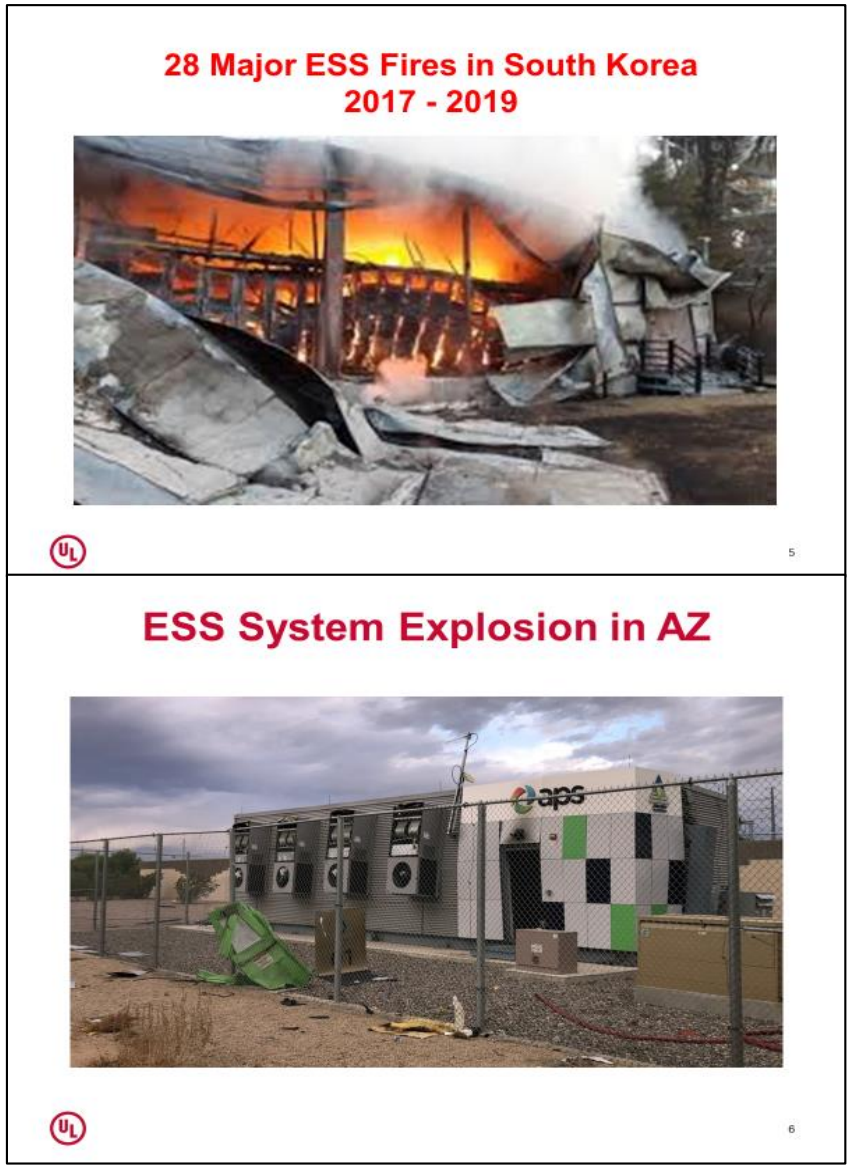
- Enabling the Smart Grid
- Peak Demand & Economics
- Grid Reliability & Resiliency
- Grid Balancing & Load Leveling
- Supporting Renewables by Mitigating Intermittency

What are Implementation Issues to Consider

Issues that may be associated with the Implementation:

Does the BESS provide anticipated performance?

What are the safety concerns?



Potential Hazards

Associated with ESSs

Fire, Explosion, Temperature

Electric Shock, Arc Flash, Burns

Over Pressure, Noise, Moving Parts, Sharp Edges

Exposure to toxic and hazardous substance

2012
Kahuku, Hawaii
Lead Acid Battery

2013
Port Angeles, WA
Li-ion Battery

2017
Brussel, Belgium
Li-ion Battery

2011
Tsukuba, Japan
Sodium Sulfur BAT

International ESS Fire Accidents

Video Source:
http://www.hawaiinewsnow.com/story/19173811/hfd-battling-kahuku-wind-farm-blaze/
https://www.youtube.com/watch?v=IElPzxj37dw

April 2019
Surprise, Arizona
Li-ion Battery

2017~2019
South Korea
Several incidents with
Li-ion Battery

International ESS Fire Accidents

Picture Source:
https://www.greentechmedia.com/articles/read/aps-battery-fire-explosion-safety-lithium-mcmicken-fluencehttps://biz.chosun.com/site/data/html_dir/2020/02/07/2020020700052.html

What are Implementation Issues to Consider

The incidents in South Korea and Arizona USA involved systems that were not certified to a safety standard

There were limited installation code criteria for BESS at the time of installation

It is important to evaluate the BESS as a system to an appropriate level of criteria for safety

- It should be a 3rd party evaluation by an independent certification organization

The installation codes (e.g. fire codes, electrical codes) should adequately address the safety of the installation

- It is important to evaluate for the potential worse case condition (a fire from the BESS) to ensure the infrastructure protections are adequate

What are Implementation Issues to Consider

Policies impacting energy storage systems:

At the Local Level -

- Municipalities, Regional and State Governments rely upon the **model codes** to regulate the installation of electrical equipment
  - Examples:
    - California Fire Code based upon ICC IFC,
    - NYC Dept. of Buildings will be based upon NFPA 855
  - The model codes rely upon consensus standards for product safety
    - Examples are ANSI/CAN UL 9540, ANSI/CAN UL 9540A

At the Federal Level –

- NERC (North American Energy Reliability Corporation) regulations that impact EESS
- EPA (Environmental Protection Agency) regulations - end of life/disposal, GHG emissions (benefit)
- DOT (Department of Transportation) regulations (e.g. UN 38.3)
- OSHA (Occupational Safety and Health Administration) regulations (adoption of UL 9540 and UL 1973)

Safety Approach

In North American

Battery Safety Certification

UL 1642 Lithium Batteries

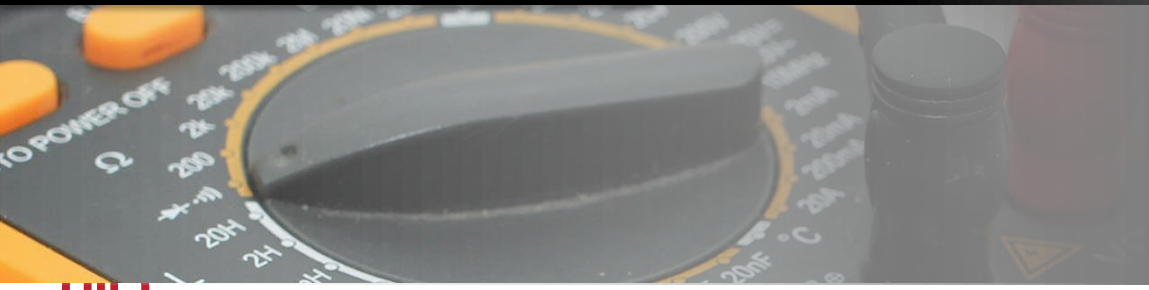
UL 1973 Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications

UL 9540 Energy Storage Systems and Equipment

Installation Codes

NFPA NFPA 1 – Fire Code
NFPA 70 – National Electrical Code (NEC)
NFPA 111 – Stored Electrical Energy Emergency and Standby Power Systems
NFPA 855 – Installation of Stationary Energy Storage Systems

ICC International Fire Code (IFC)
International Residential Code (IRC)
International Building Code (IBC)



Testing for Performance

UL 9540A Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

UL and IEC Standards

UL 9540 Battery Requirements

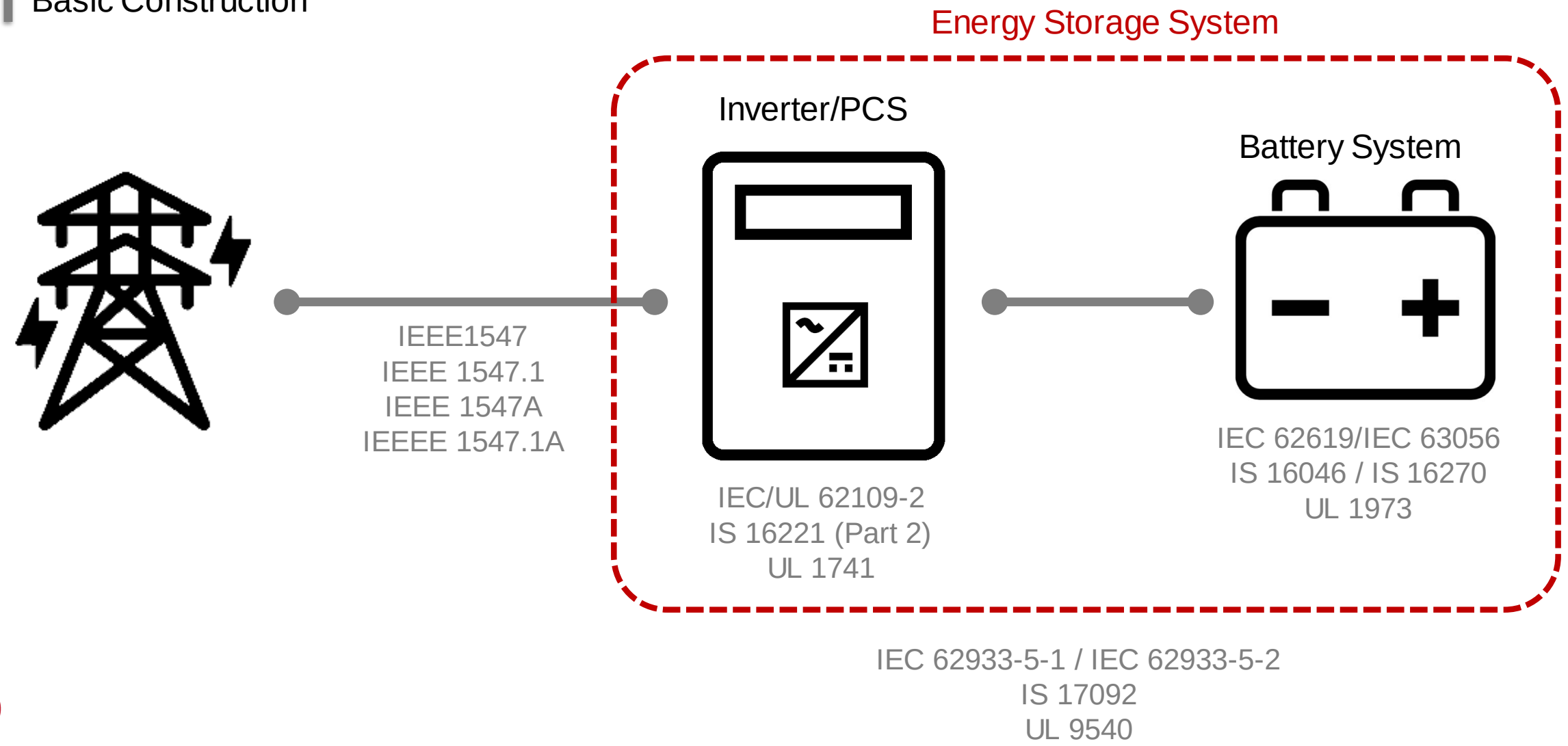
- UL 1973

IEC 62933-5-2 Battery Requirements

- IEC 62619, IEC 63056, IEC 62485-5
- IEC 63115-2
- IEC 62485-2
- IEC 62932-2-2
- IEC 62984-2

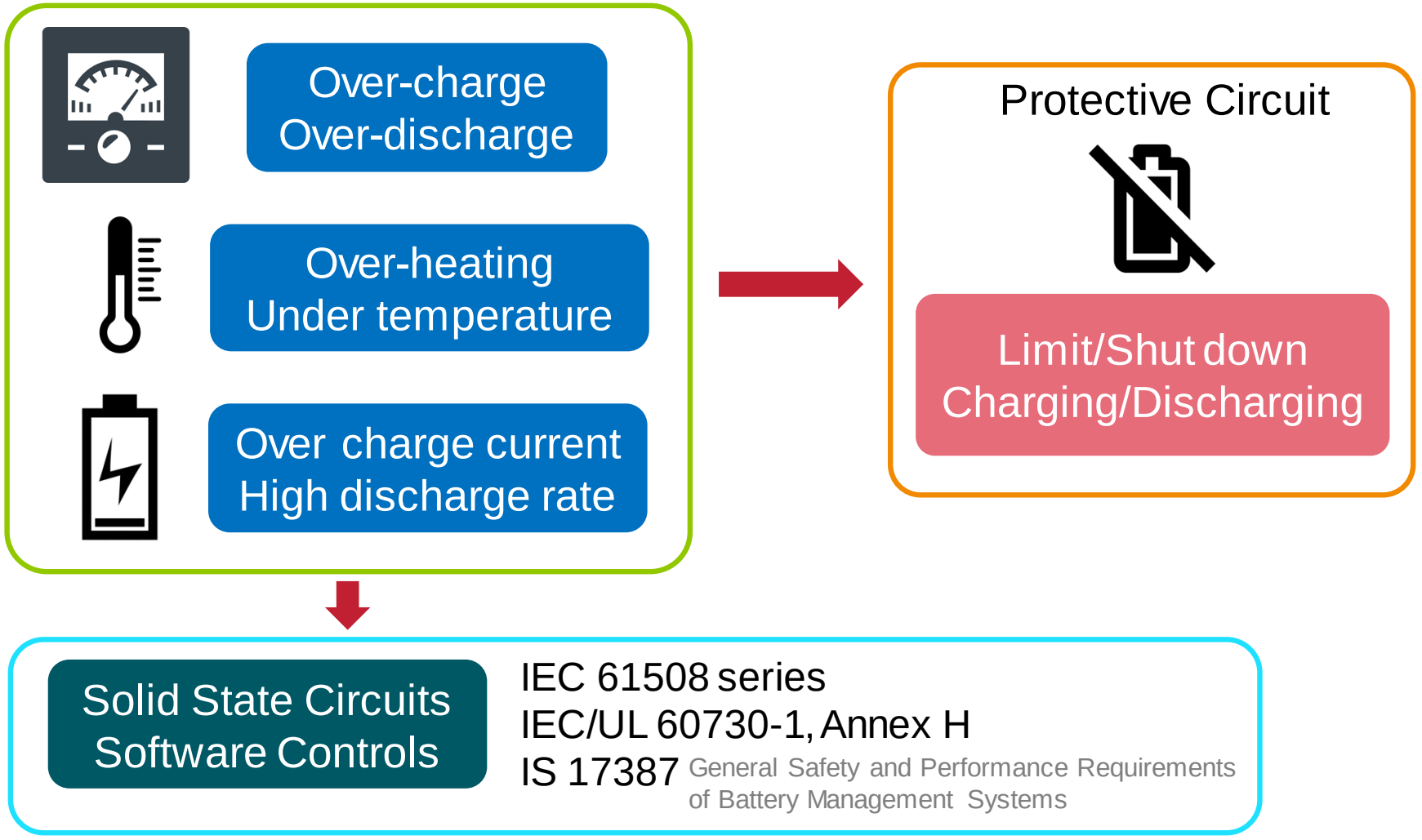
Energy Storage Systems

Basic Construction



Protective Circuit and Controls

Battery management system (BMS) shall maintain cells within the specified operating region.



IEC 62619:2017

Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications

Edition 1.0 Issued 2017-02-13

IEC 63056:2020

Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems

Edition 1.0 Issued 2020-03-27

IS 16046 (Part 2):2018 / IEC 62133-2:2017

Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes — Safety Requirements for Portable Sealed Secondary Cells and for Batteries Made from Them for Use in Portable Applications Part 2 Lithium Systems

ANSI/CAN/UL 1973

Standard For Batteries For Use In Stationary, Vehicle Auxiliary Power And Light Electric Rail (LER) Applications

2nd Edition Issued 2018-02-07

IEC TS 62933-5-1:2017

Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid-integrated EES systems - General specification

Edition 1.0 Issued 2017-07-12

IEC 62933-5-2:2020

Electrical energy storage (EES) systems - Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems

Edition 1.0 Issued 2020-04-06

IS 17092 : 2019

Electrical energy storage systems safety requirements

ANSI/CAN/UL 9540

Energy Storage Systems And Equipment

2nd Edition Issued 2020-02-27

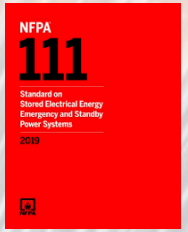
Installation Codes

NEC, IFC, IBC, IRC, NFPA 855

National Fire Protection Association

NFPA 1

Fire Code



NFPA 111

Standard on Stored Electrical Energy Emergency and Standby Power Systems

NFPA 70

National Electrical Code

NFPA 855

Standard for the Installation of Stationary Energy Storage Systems

International Code Council

International Building Code

International Fire Code

International Residential Code

Energy Storage Systems

NFPA 70 - National Electric Code (NEC)

Scope

Section 706.1

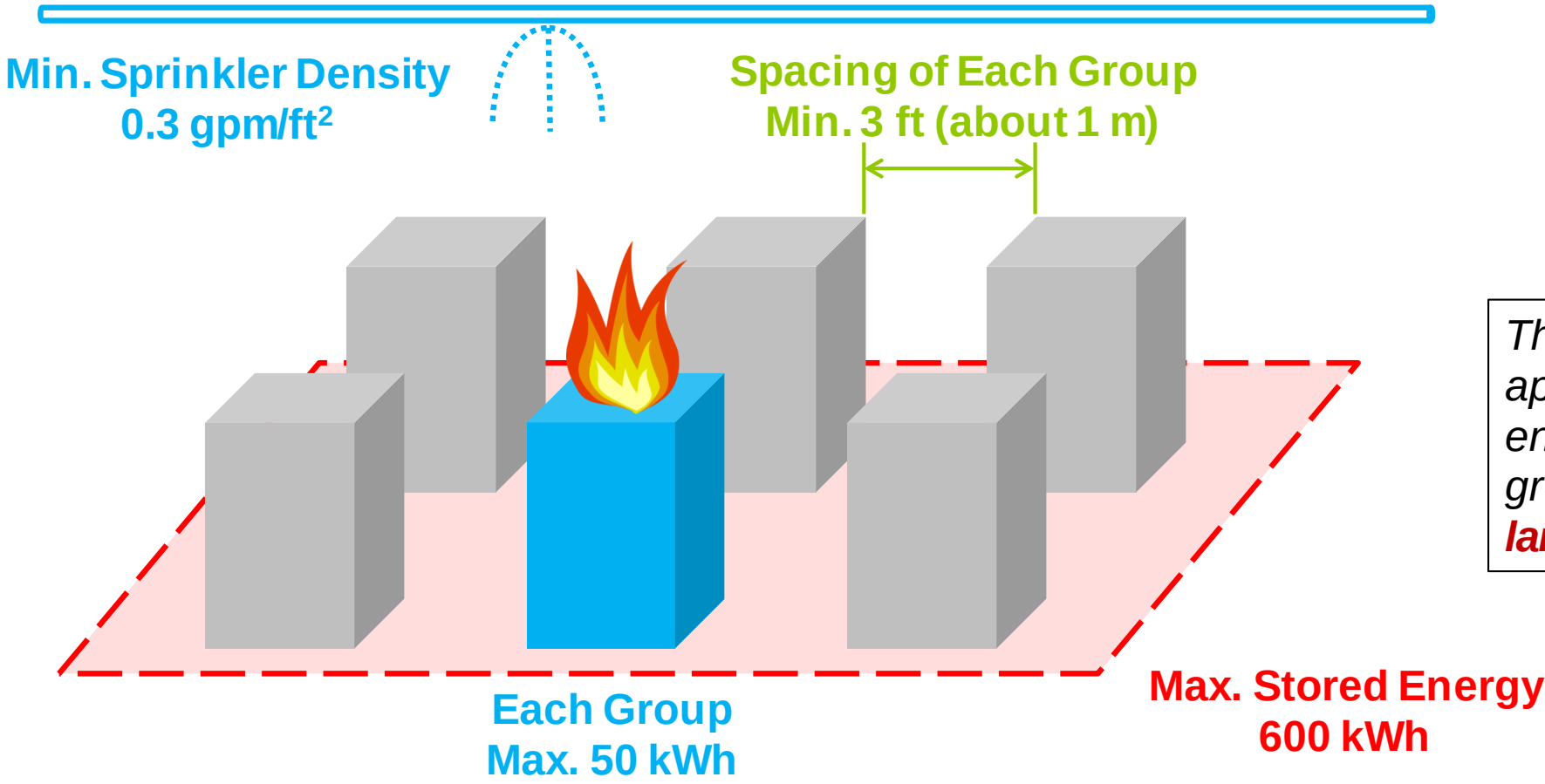
This article applies to all energy storage systems (**ESS**) having a capacity greater than 3.6 MJ (1 kWh) that may be stand-alone or interactive with other electric power production sources.

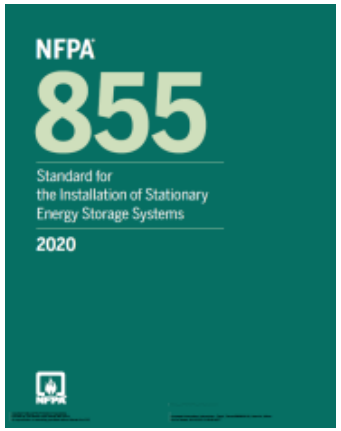
> 3.6 MJ (1 kWH)

Stand-alone **or** Interactive

NFPA 855

Standard for the Installation of Stationary Energy Storage Systems





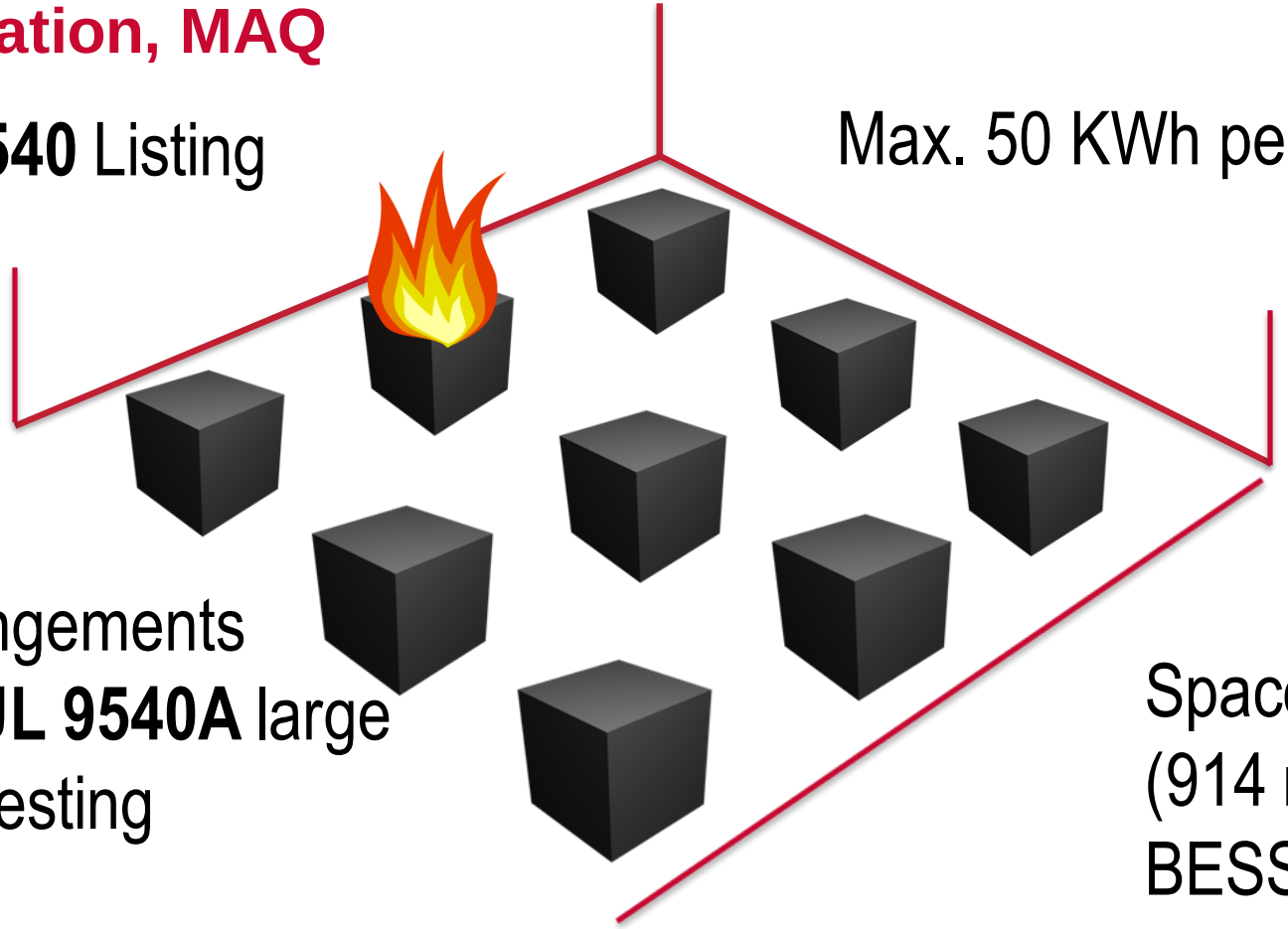
The AHJ shall be permitted to approve groups with larger energy capacities or smaller group spacing based on ***large-scale fire testing****.*

What are Implementation Issues to Consider

ICC IFC 2021 / NFPA 855 Control Measures - Listing, Size, Separation, MAQ

UL 9540 Listing

Max. 50 KWh per unit



Other arrangements based on **UL 9540A** large scale fire testing

Spaced min. 3 ft. (914 mm) from other BESSs and from walls

Max. 600 KWh aggregate/fire area

What are Implementation Issues to Consider

UL 9540A - is a multi-tier test method that determines the capability of a battery technology to undergo thermal runaway (TR) and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems.

- Cell Level
  - Establishes TR capability, vent temperature, collects & analyzes cell off gassing (lower flammability limit (LFL), burning velocity (S_u), max deflagration pressure (P_{max}))
- Module Level
  - Determine propagation, measures temperatures, HRR (heat release rate), SRR (smoke release rate) and off gassing data
- Unit Level
  - Evaluates BESS installation (*without fire or deflagration protection*) response to TR within the BESS and measures off gassing (H_2, CO, CO_2, THCs) and measuring HRR, SRR, heat flux, and temperatures
- Installation Level
  - Evaluate effectiveness of BESS installation fire protection and deflagration protection during a BESS fire event

What are Implementation Issues to Consider

UL 9540A Evaluates BESS Installation Parameters
- Separation distances between units
- Separation distances between units and walls
- Potential of fire spread to overhead cabling

UL 9540A Evaluates Fire Protection (Integral or External)
- Evaluates fire protection strategies

UL 9540A Determines Installation Deflagration Requirements
- Quantifies deflagration potential
- Quantifies heat generation

UL 9540A Aids Fire Service Strategy and Tactics
- Characterizes magnitude of potential fire event
- Documents re-ignitions within a BESS unit under test
- Documents gases generated

UL 9540A Test Levels

Cell Level

- Thermal runaway methodology
- Cell surface temperature at gas venting
- Cell surface temperature at thermal runaway
- Gas composition and LFL (lower flammability limit)

Module Level

- Heat release rate
- Gas generation and composition
- External flaming and flying debris hazards
- Locations of flame venting

Unit Level

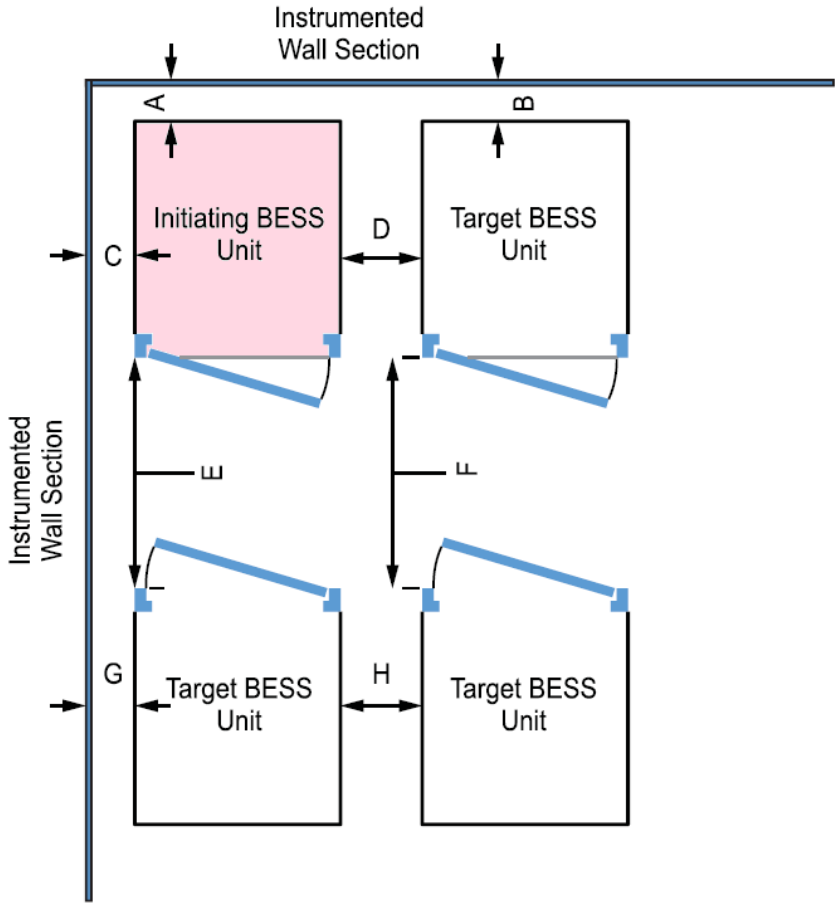
- Heat release rate
- Gas generation and composition
- Deflagration and flying debris hazards
- Target BESS and wall surface temperature
- Heat flux at target walls

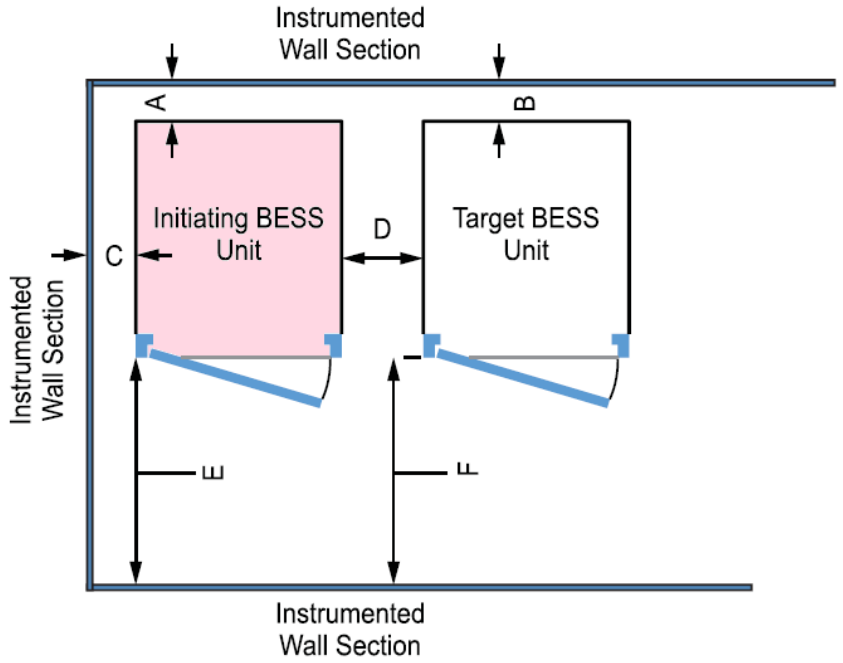
Installation Level

- Fire mitigation (methods)
- Target BESS and wall surface temperature
- Gas generation and composition
- Deflagration and flying debris hazards
- Heat flux at target walls

UL 9540A – Unit Level Tests

Examples of test arrangements

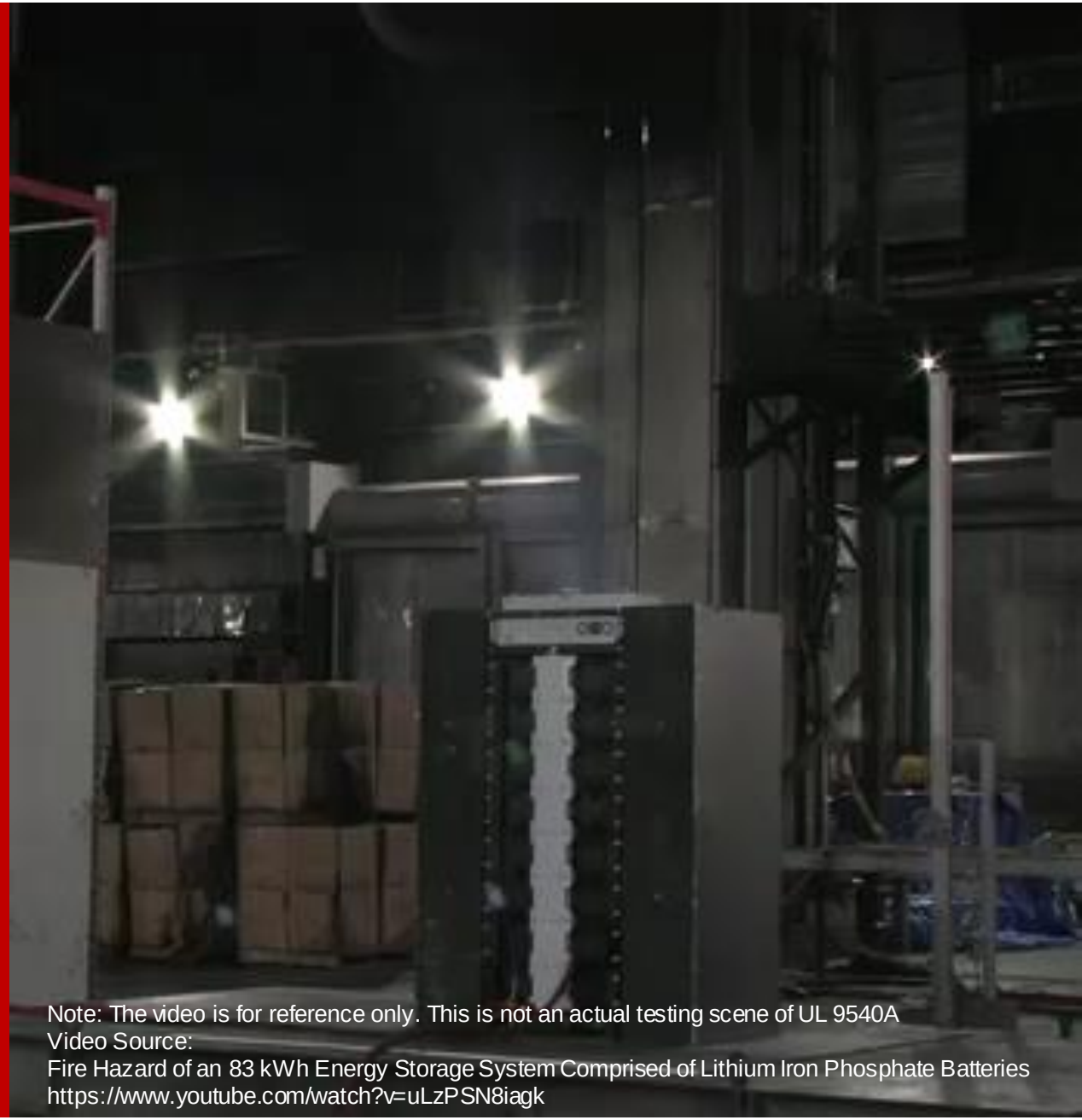




ANSI/CAN/UL 9540A

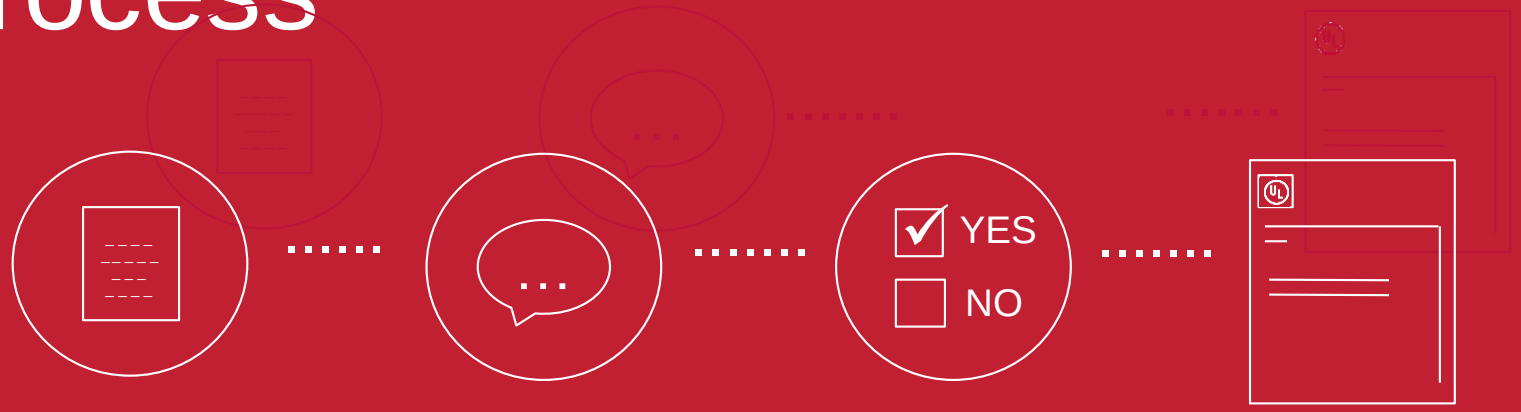
Test Method For Evaluating Thermal Runaway Fire Propagation In Battery Energy Storage Systems

4th Edition Last Revision 2019-11-12



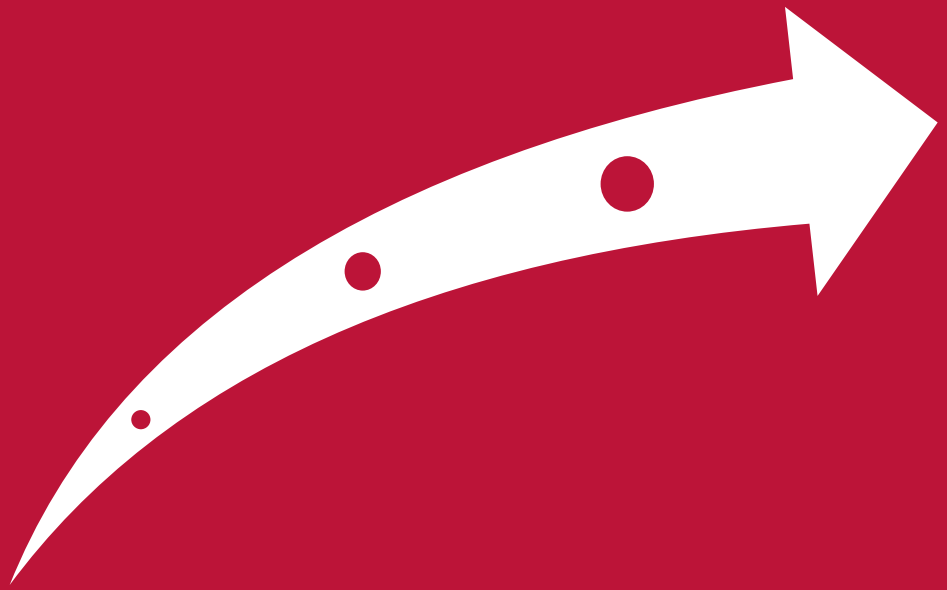
Note: The video is for reference only. This is not an actual testing scene of UL 9540A
Video Source:
Fire Hazard of an 83 kWh Energy Storage System Comprised of Lithium Iron Phosphate Batteries
https://www.youtube.com/watch?v=uLzPSN8iagk

UL Standards Development Process

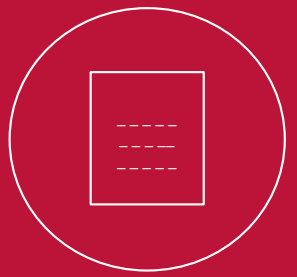


UL Standards development process

Phases of the process



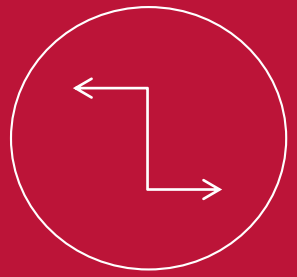
Each phase is processed in UL's standards development system, CSDS



Proposal Submission

Preliminary Review

Proposal Review

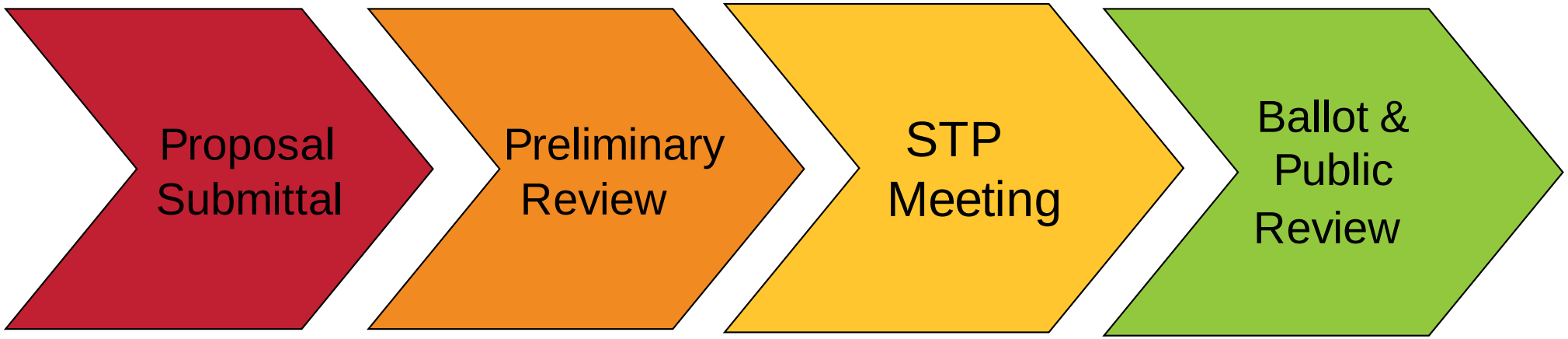


Recirculation

STP Process Overview

- The Standards Technical Panel (STP) process is used for all consensus standards development which will be pursued for ANSI and/or SCC approval.
- An STP is a group of individuals, representing a variety of interests and representing a balanced matrix connected to the UL Standard, formed to review and vote (or ballot) on proposals for new Standards or revisions to existing Standards.
- Our procedures were approved by the Standards Council of Canada (SCC) in Canada and the American National Standards Institute (ANSI) in the US.
- Our procedures are audited by ANSI and SCC.

What are the steps in the STP process?



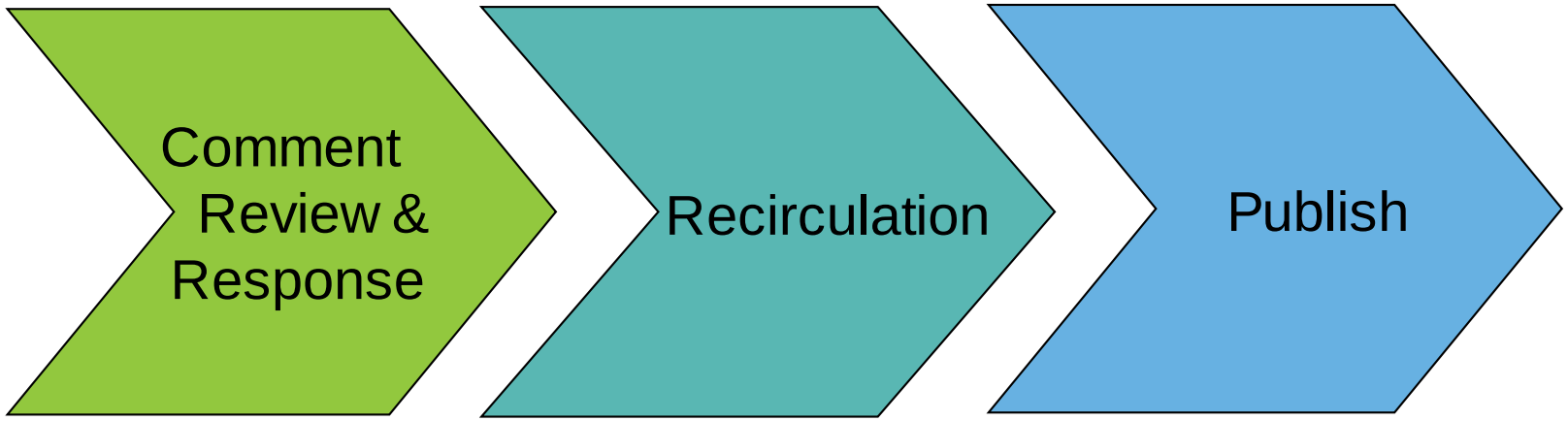
- May be submitted by UL or others

- Typically 14-30 days.
- Can be shortened or waived (as appropriate)

- As needed.
- Anyone can attend and participate in STP meetings

- 30-60 days
- Ballot by STP member
- Anyone can sign up as non-voting member to provide comment
- All commenting and balloting done via UL's on-line Collaborative Standards Development System (CSDS)

What are the steps in the STP process?



- Timing depends on number and complexity of comments received.
- Responses drafted by proposal submitter

- 30 or 45 days
- (timeframe set by ANSI)
- 2 weeks for comment and responses (comment matrix) only

- If consensus reached.
- If not, proposal fails

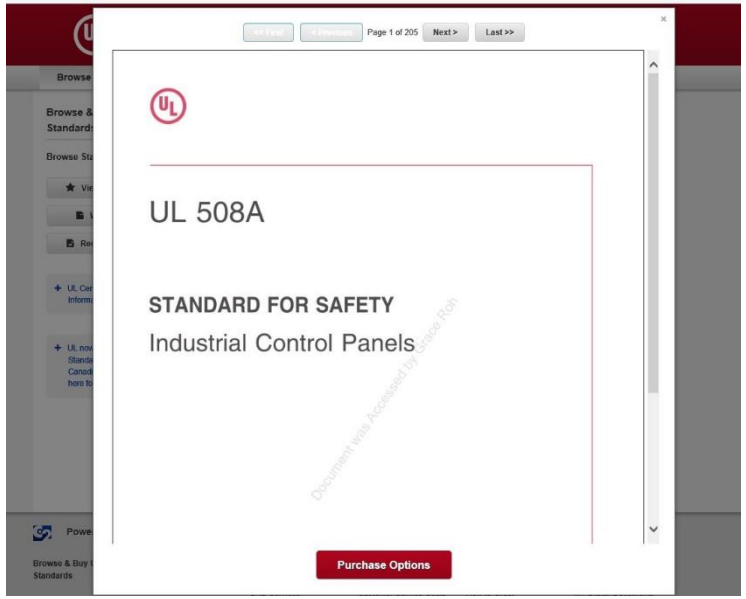
Free Digital View of UL Standards

View all current editions and revisions of UL and ULC Standards for Safety free of charge.
Includes national differences to IEC/ISO based standards.

Register and access the standards at
www.shopulstandards.com

- Allows standards to be viewed before purchase
- Raises the awareness of what is required in the standard
- Can be accessed by anyone around the world
- Enables a variety of individuals and organizations to preview, including international stakeholders
- Benefits a wider group of stakeholders such as regulators, academia, product designers, and innovators who will look for safety certification at a future date.
- Promotes collaboration

Furthers UL's mission and commitment to public safety.



Thank you

Empowering Trust™

Contact details:
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E-mail: Manjunath.V@ul.org
Phone: +91 9902088120

Accelerating eMobility

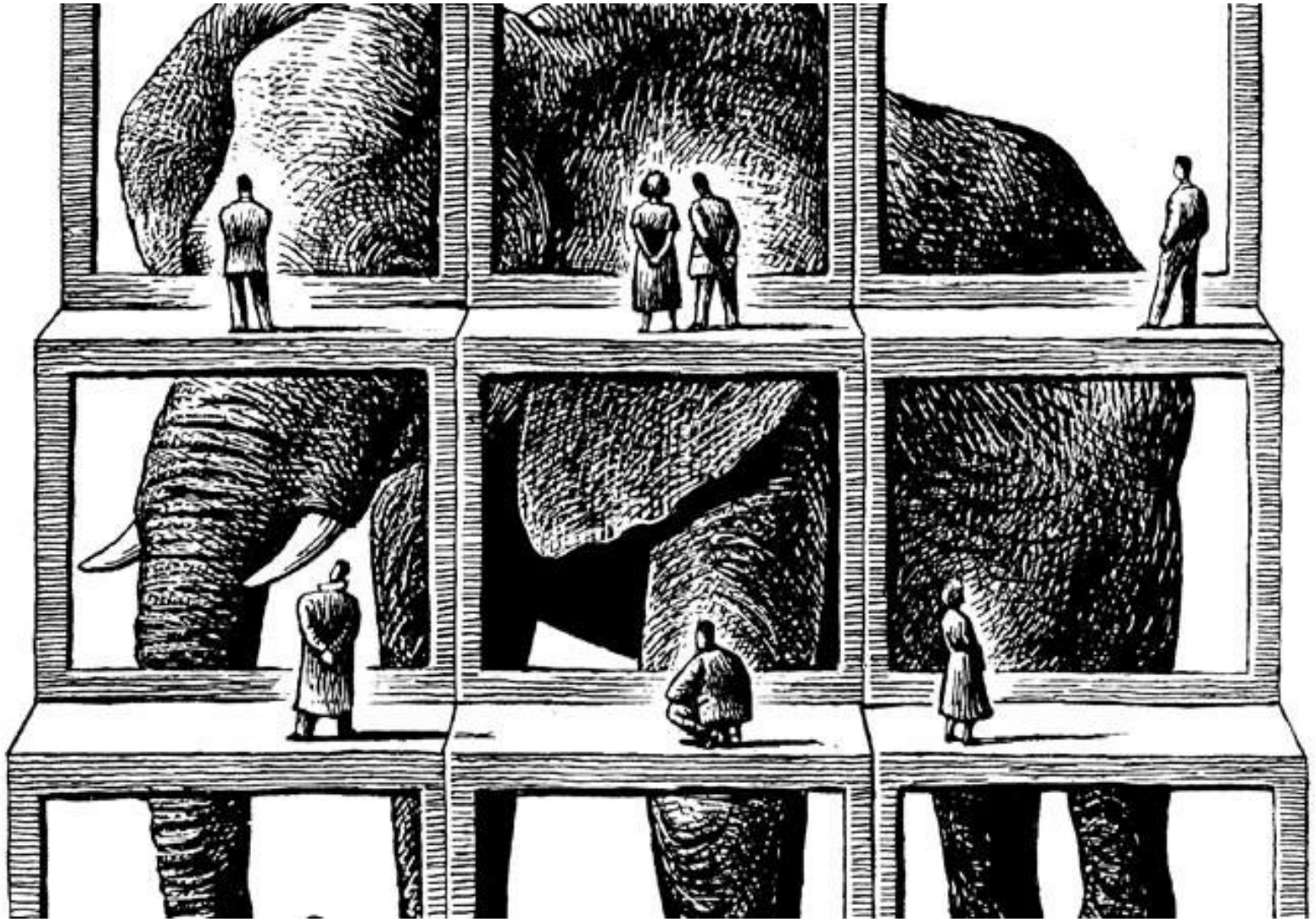
EV Technology Roadmap for emerging markets

Ravikiran Annaswamy,
CEO, Numocity Technologies

Tuesday, 23 February 2021

IEEE SA STANDARDS ASSOCIATION

Numocity

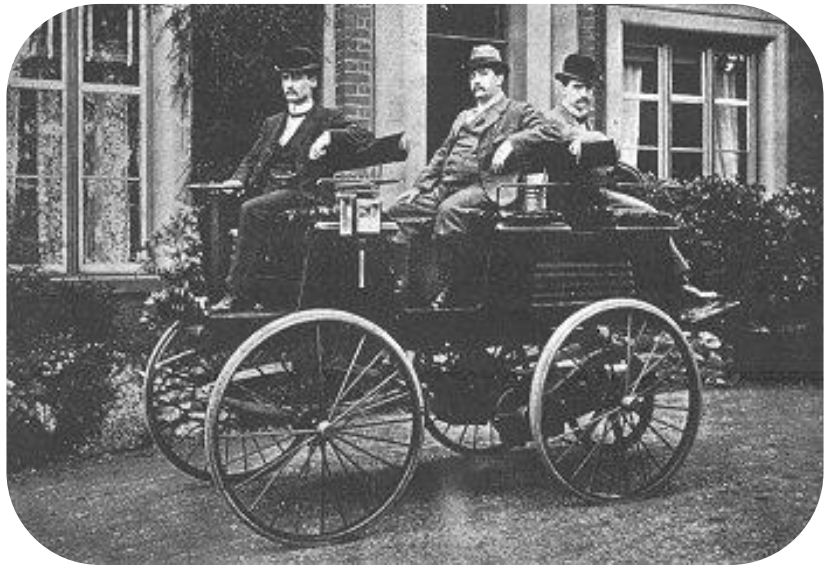


Perspectives on EV

When we say Electric vehicle ....

Tesla Model 3

Best selling EV with over 500k sales in 2020



Electric Car from 1884 by Thomas Parker

Lead Acid Batteries

These are also Electric vehicles

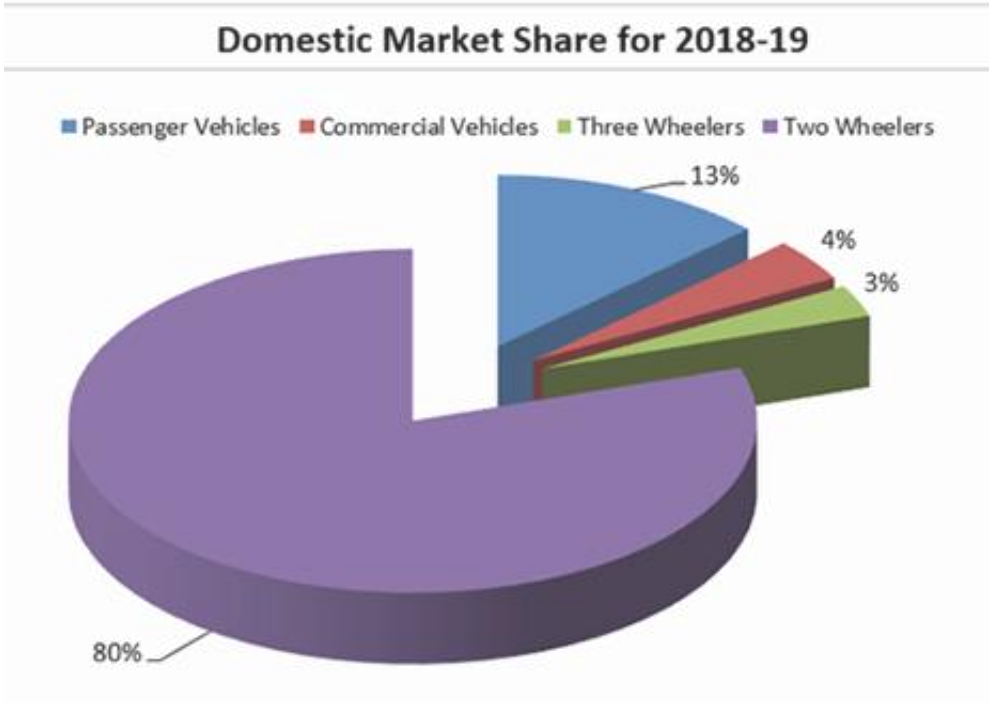
As of 2018 India has about 1.5 million lead acid battery-powered, three wheeled rickshaws on its roads with speed less than 30 km/hr

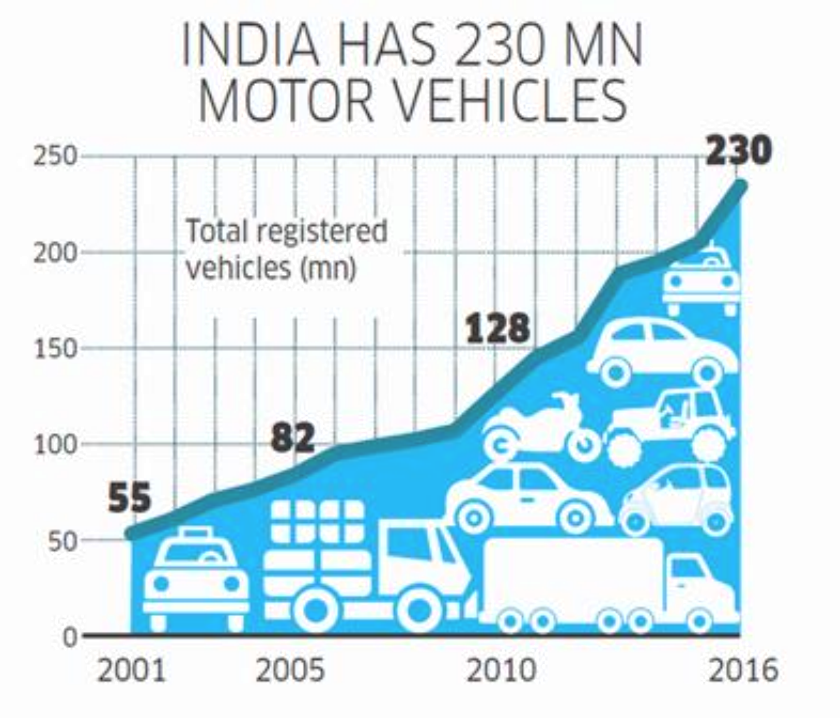
Image : Yulu Bikes
Shared Mobility
Over 10,000 on road in India

Image : Ather 450
Premium Connected Scooter, designed for Indian Roads

India : Unique market segment

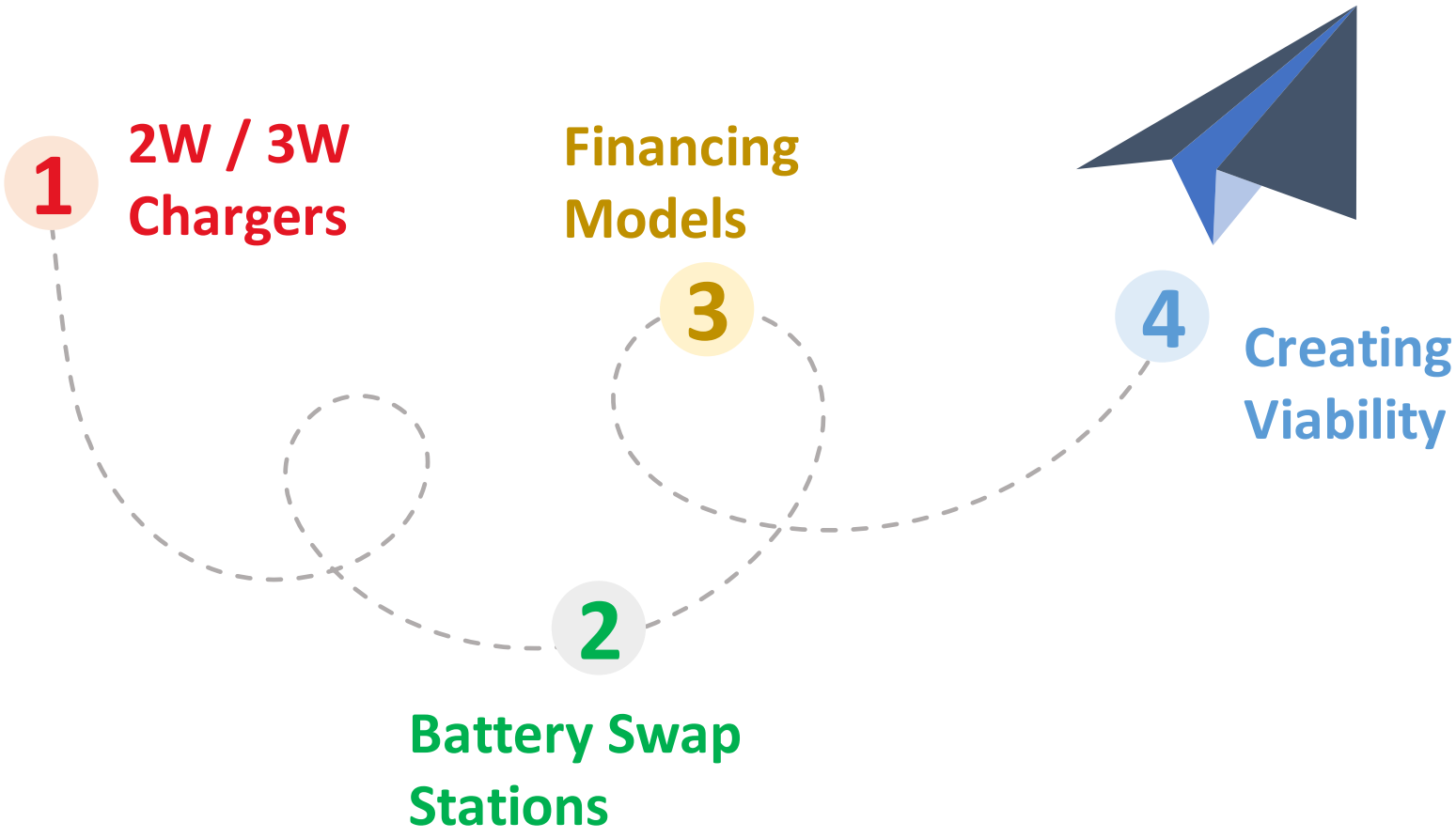
dominated by 2 wheelers & 3 Wheelers





Innovations to Accelerate eMobility

Technology Demands

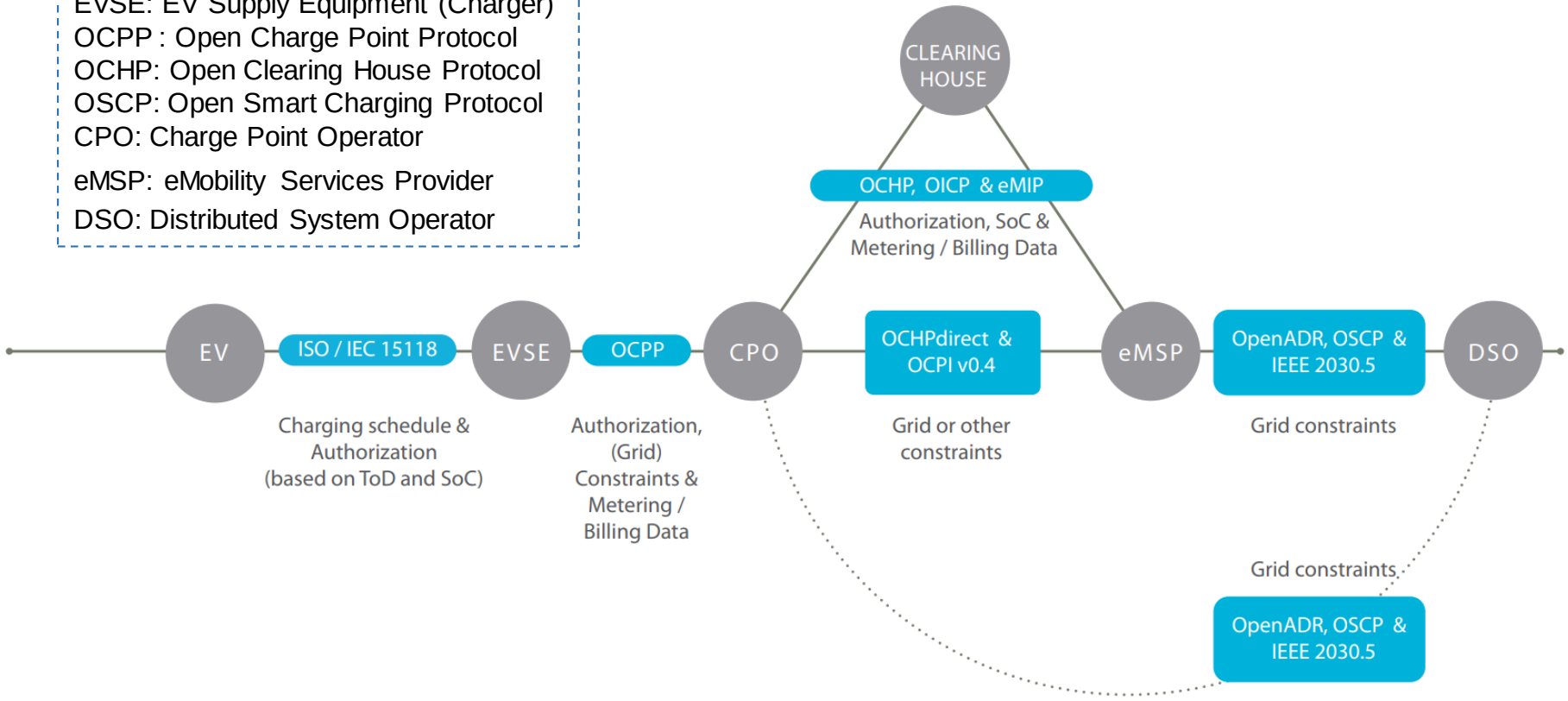


1. 2W/3W Chargers Making Charging Ubiquitous

- Communication module to connect charger to cloud systems
- Sensors to monitor voltage, current and other operating parameters of the charger
- Controller/Relay to enable remote control of charger operation
- RFID reader to enable card-based access
- Power backup for monitoring and control module

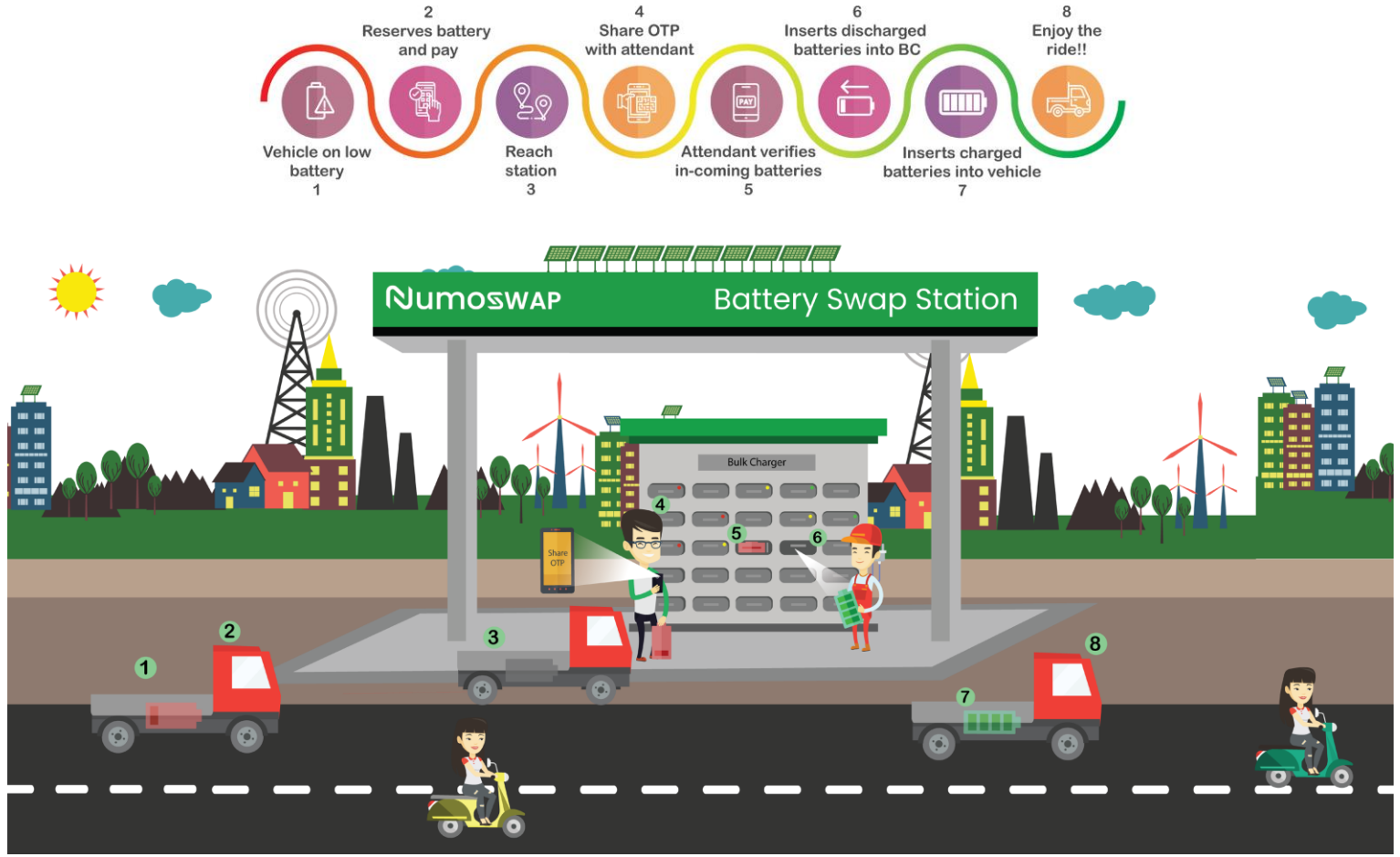
1. AC/DC Chargers controlled by Software

EV: Electric Vehicle
EVSE: EV Supply Equipment (Charger)
OCPP : Open Charge Point Protocol
OCHP: Open Clearing House Protocol
OSCP: Open Smart Charging Protocol
CPO: Charge Point Operator
eMSP: eMobility Services Provider
DSO: Distributed System Operator



2. Battery swap operations

Complicated Orchestration



2. Optimized energy usage

Using swap stations for energy storage

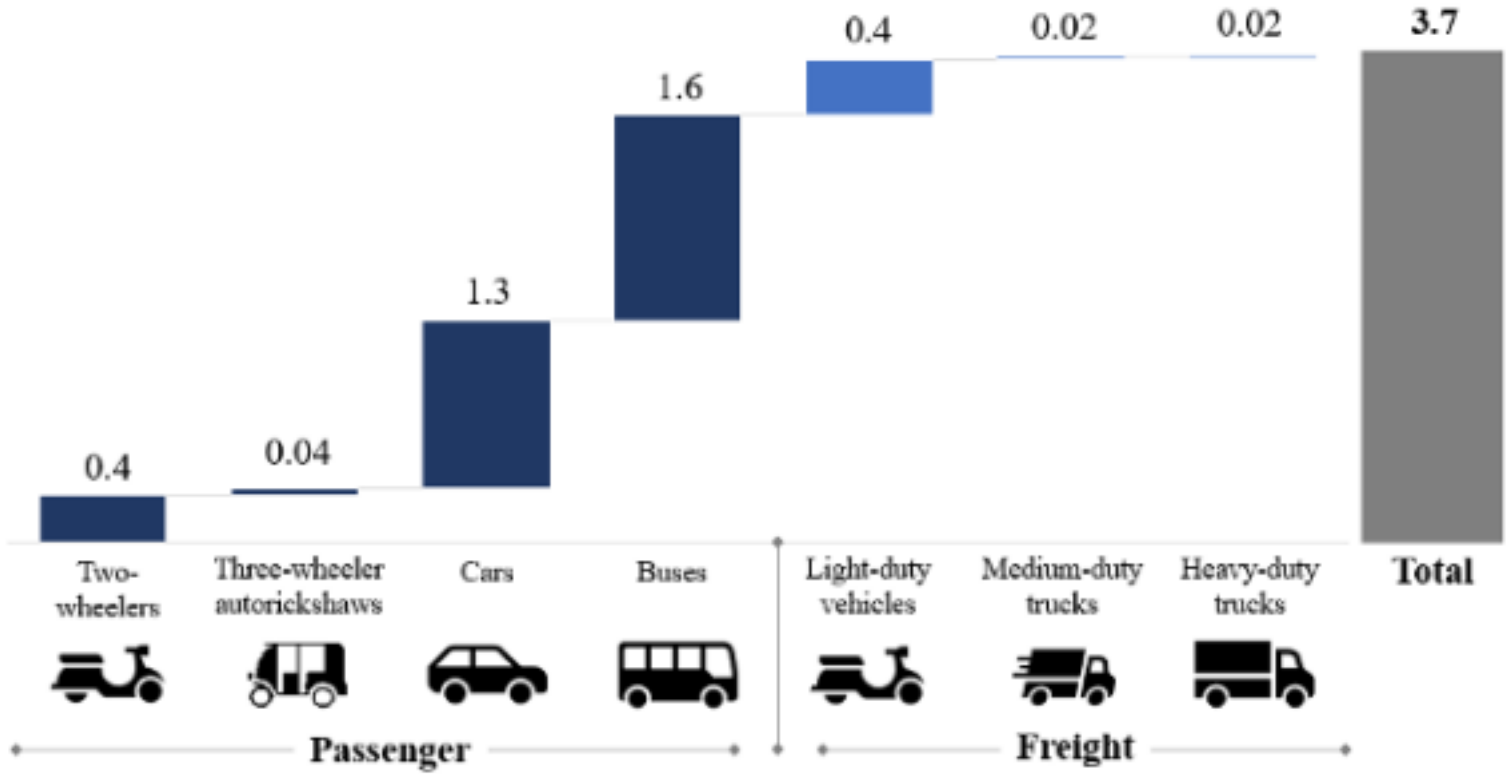
Solar renewables used for charging batteries

Source : https://revolution-green.com/wp-content/uploads/2017/07/GoStaton_Solar_Energy20170728_093857-1024x576.jpg

3. Making EVs affordable

CAPEX to OPEX business model for Drivers

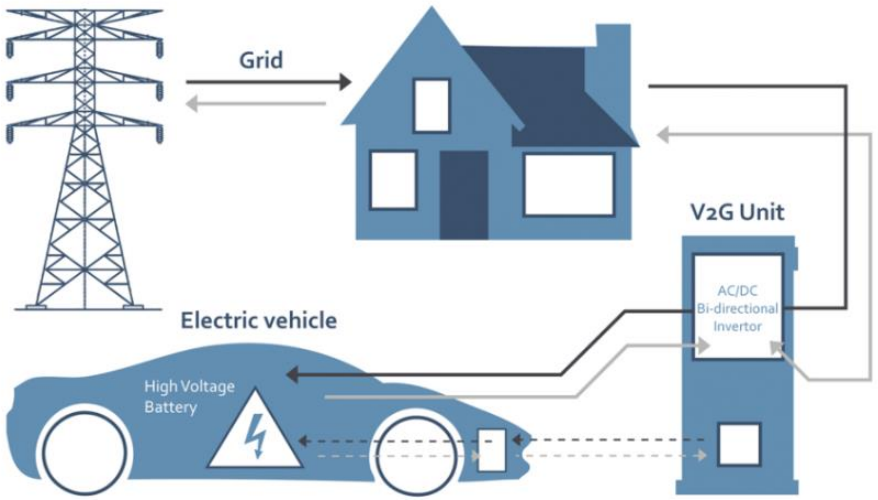
Size of India's EV financing market in 2030:
INR 3.7 lakh crore (USD 50 billion)



http://www.cleanfuture.co.in/2021/02/15/financing-electric-vehicles-risky/

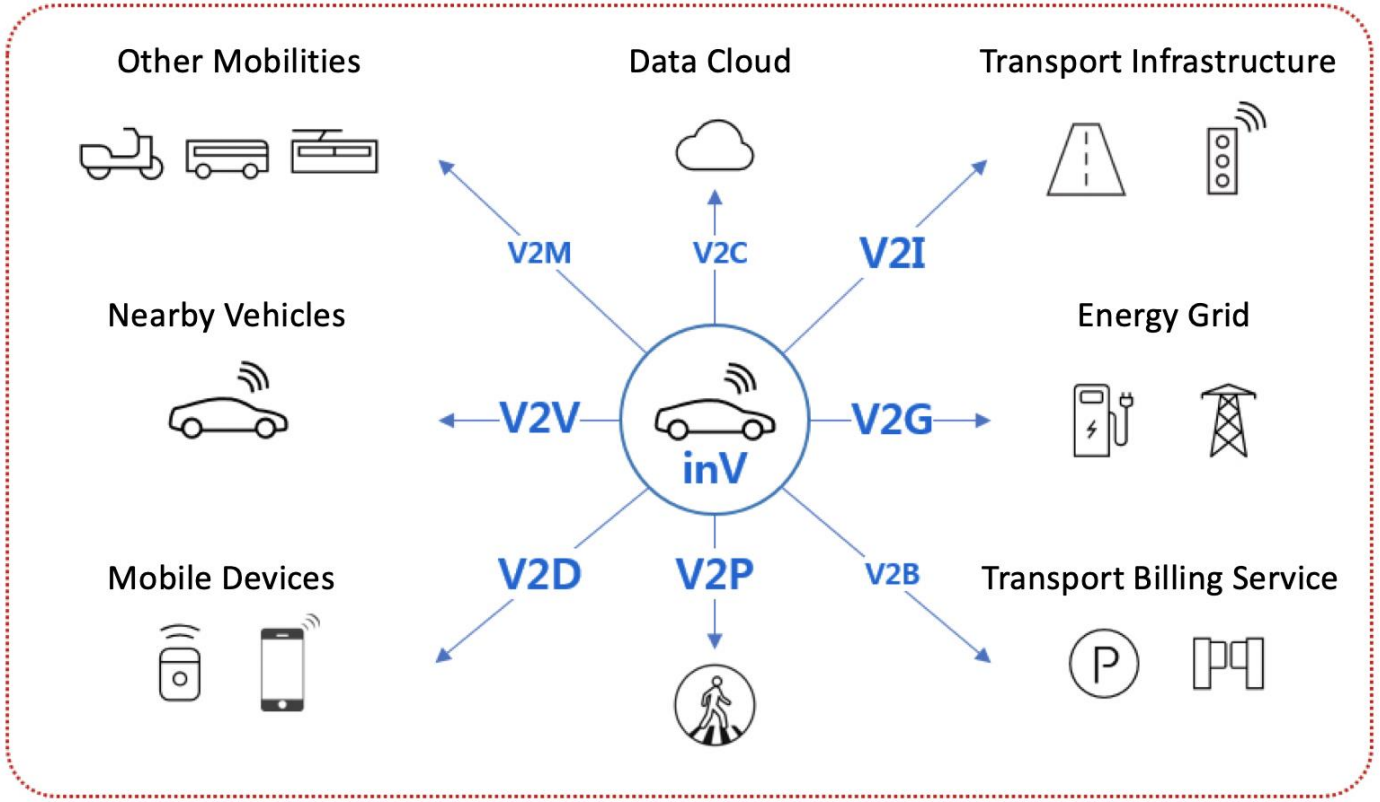
4. Interface to Smart Grids

- Provide Power to Household – lighting
- Support to stabilize grid voltage and harmonics



V2H – Vehicle to Home
V2G – Vehicle to Grid
VPP – Virtual Power Plants

4. Connected ecosystem



https://www.pentasecurity.com/blog/iot-connected-car-transport-security/

IEEE SA STANDARDS ASSOCIATION

Implementation Roadmap for systemic EV Adoption in India and Asia

Industry Connections Activity Initiation Document (ICAID)

IEEE SA STANDARDS ASSOCIATION

Industry Connections Activity Initiation Document (ICAID)

Implementation Roadmap for systemic EV Adoption in India and Asia

Chair : Ravikiran Annaswamy, Numocity Technologies

Overview :

Electric Vehicles (EV) are emerging as the option for clean mobility across the world. The EV ecosystem brings together three industry verticals who traditionally have not worked together. EVs need Automobile industry to modify the vehicles to use Batteries and new connected vehicle technologies. Power industry needs to gear up

to fueling these EVs with electricity and they need to build Charging infrastructure across the highways, malls and workplaces. All these equipment are IOT enabled and connected so both telecom connectivity (4G/5G) along with Digital tech like Cloud, Data and analytics become essential for accelerating EV adoption.

The goal of the IC activity is to bring all together the stakeholders (policy, business and tech) across Auto, Power and Digital technologies and create a viable, systemic and meaningful roadmap for Indian market. India is different from other world markets in mobility with over 85% being 2 and 3-wheeler vehicles. The technology and business models are frugal and designed for Indian market

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Expected Activities :

- EV Industry Advisory body will be created with all involved stakeholders in Indian market by January 2021.
  - In 2022, there will be additional advisory boards created in other markets of Asia, Africa and LATAM
- Create a series of workshops also under the banner of the IC program - focused on the 3 pillars and one workshop bringing together all the elements (some teaser webinars planned for Dec 2020)
  - Three workshops one every month by May 2021.
- The IC program will identify specific deliverables - workshops, white papers and discussion papers, identification of reference use case on the grid side, all of them towards development of the final roadmap document. IC program can also include standards gap analysis for developing future standards
- Monthly meetings of the advisory board and there will be an activity (webinar or workshop) every quarter during the duration of the program

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Implementation Roadmap for systemic EV Adoption in India and Asia

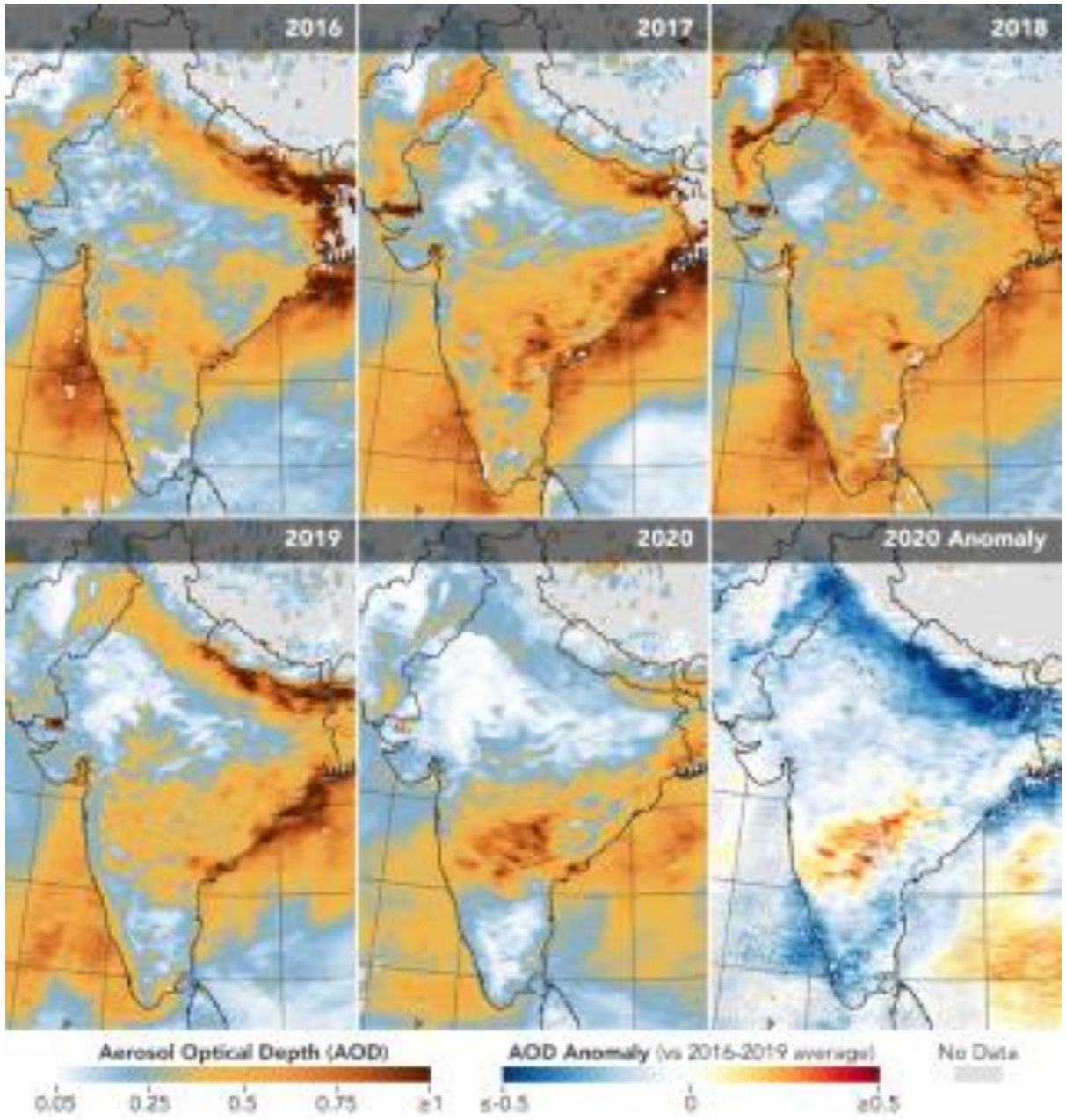
Chair : Ravikiran Annaswamy, Numocity Technologies

Launch :

- 25th February 2021
- 10:00 AM to 11:30 AM
- Online (WebEx) and in person at IEEE Bangalore office

Interested to contribute

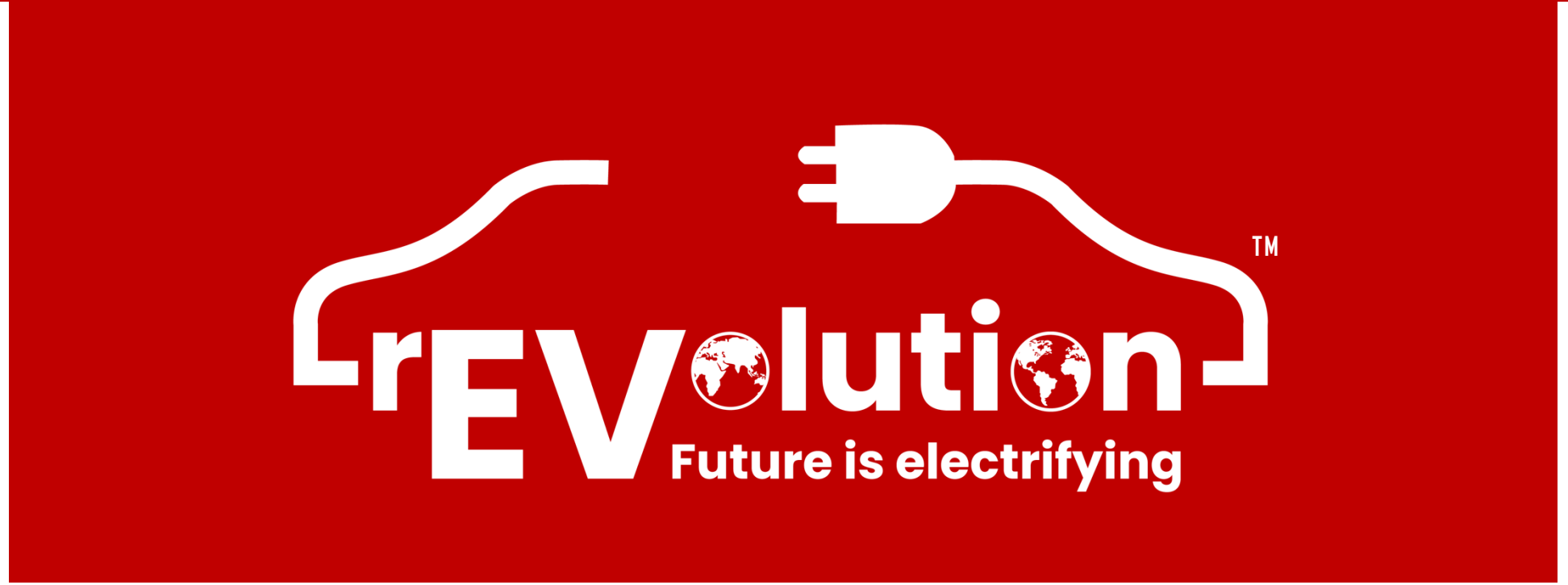
Contact : ravikiran.a@numocity.com or sri.chandra@ieee.org , ravindra.desai@ieee.org



Source : https://www.space.com/india-air-pollution-drops-coronavirus-lockdowns.html

Positive side of Pandemic,
During Lockdown NASA satellites have detected the lowest aerosol levels in 20 years over northern India.

Electric vehicle adoption will have a positive impact on the reduction of urban pollution



YOURSTORY TECHSPARKS 10TH EDITION 2019

Techsparks 2019 Edition
Tech 30 company

TiE

Selected as Top Emerging IoT Startup of 2019 at TiEShortlisted as the finalist of Startup awards 2018
IoT Day

ELECRAMA
we are all about electricity

Thanks

Ravikiran.A@numocity.com

Numocity

Electric Vehicle Charging

Fee Collection

John Halliwell
Senior Technical Executive
jhalliwell@epri.com

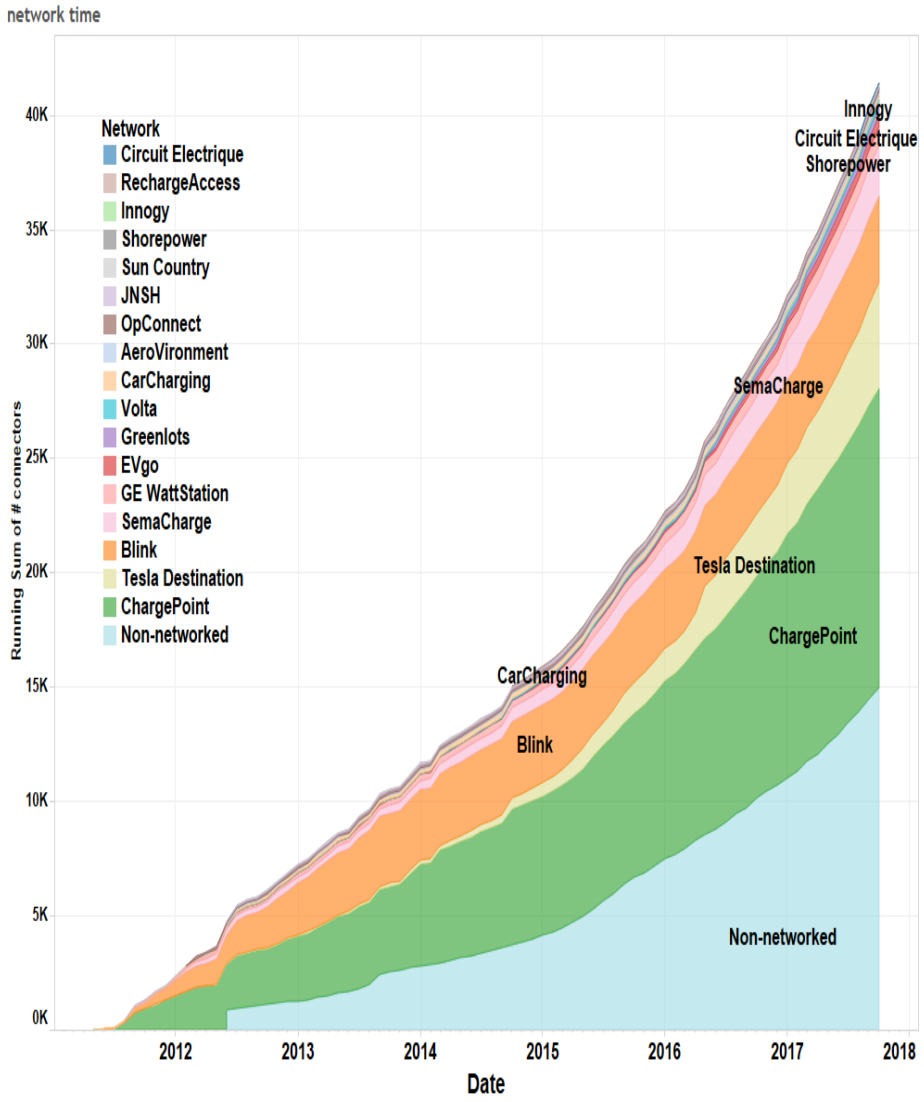
February 23, 2021
U.S. – India Standards and Conformance Cooperation Program

Charging ($ or ₹) for Charging (⚡)

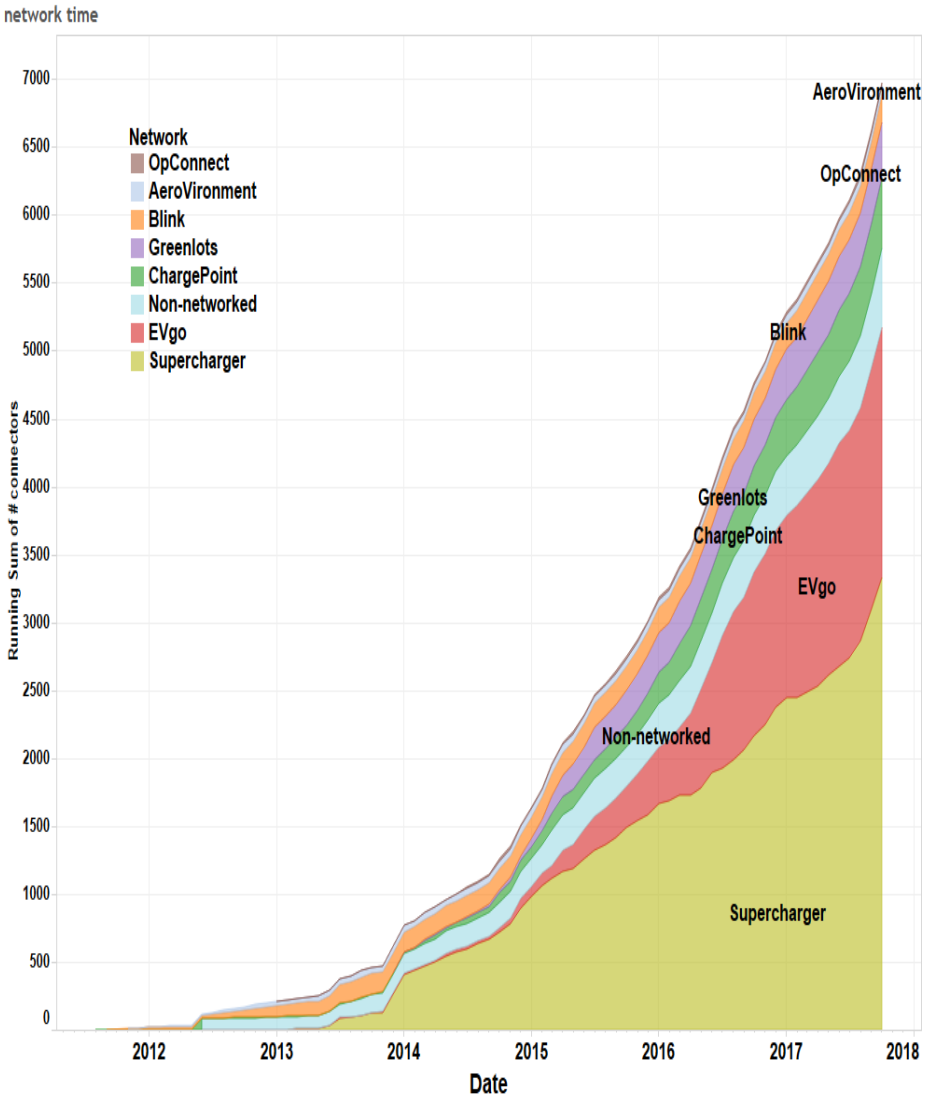
- Free
  - Mostly AC chargers
- Fee
  - Some AC and Most DC
    - Parking fee
    - Session fee
    - Time fee ($/second; $/minute; $/hour)
    - Energy fee ($/kWh)
    - Combination
- How do you pay?
  - Credit card (contactless or magnetic stripe)
  - RFID card (issued by network provider)
  - Call phone number
  - Smart phone app
  - Plug-and-Charge (currently for DC only in U.S.)

Charge Station Populations by Network

AC Charging



DC Charging



Key Regulatory Question – Is Fueling an Electric Vehicle an Electric Utility Function?

- In the U.S., this decision is made at the State Level
- About 1/2 of the 50 U.S. States (25) have decided that fueling an electric vehicle is not a utility function

If it is a Utility Function: State Utility Regulatory Commission

- Usually means that third parties can't sell kWh
- Charge for Charging by TIME

If it is not a Utility Function: State "Weights and Measures" Regulatory Body

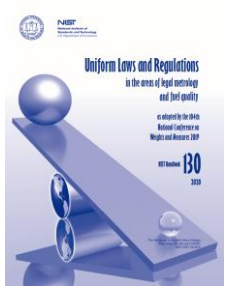
- Usually, part of state's Department of Commerce or Agriculture
- Regulated as a vehicle fuel (see next slide)
- Can sell by energy units (kWh)
- Only California has started to regulate electricity as a fuel

While U.S. States Regulate Commerce – Federal Government Provides Model Language through NIST Handbooks

Handbook 44

- Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices
- See - Section 3.40 - Electric Vehicle Fueling Systems
- Focuses on technical requirements for metering of time and energy
- Still "Tentative Code"

Handbook 130



- Uniform Laws and Regulations in the Areas of Legal Metrology and Fuel Quality
- See Section 2.34 - Retail Sales of Electricity Sold as a Vehicle Fuel
- Focuses on unit of sale and labeling of stations

NIST = National Institute of Standards and Technology

HB 44: https://www.nist.gov/pml/weights-and-measures/publications/nist-handbooks/other-nist-handbooks/other-nist-handbooks-2-2

HB 130: https://www.nist.gov/pml/weights-and-measures/publications/nist-handbooks/other-nist-handbooks/other-nist-handbooks-2-1

A high-level look at the global EV world: 2021

John Voelcker

Auto-industry reporter + analyst

www.linkedin.com/in/jvoelcker

THEN: 2009

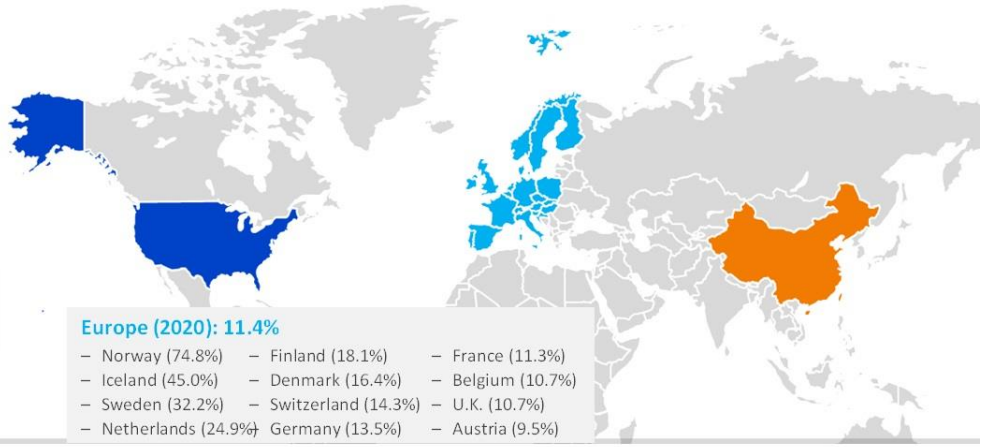
NOW: 2021

USA: All about trucks (and Tesla)

GLOBAL SALES: China, EU, USA

Electric transportation is a global market

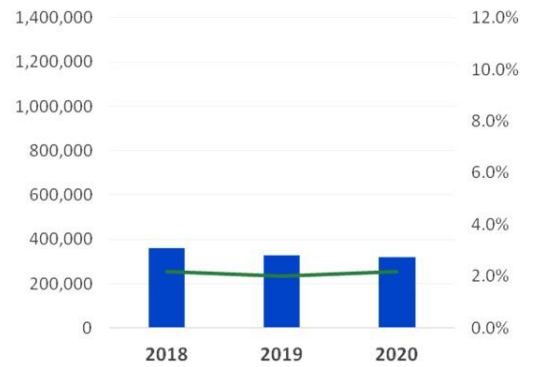
Despite global pandemic, EV sales grew especially where supported by strong policy and EV supply



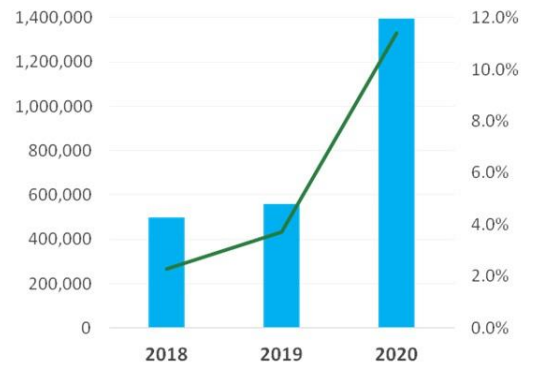
Europe (2020): 11.4%

- Norway (74.8%)
- Iceland (45.0%)
- Sweden (32.2%)
- Netherlands (24.9%)
- Finland (18.1%)
- Denmark (16.4%)
- Switzerland (14.3%)
- Germany (13.5%)
- France (11.3%)
- Belgium (10.7%)
- U.K. (10.7%)
- Austria (9.5%)

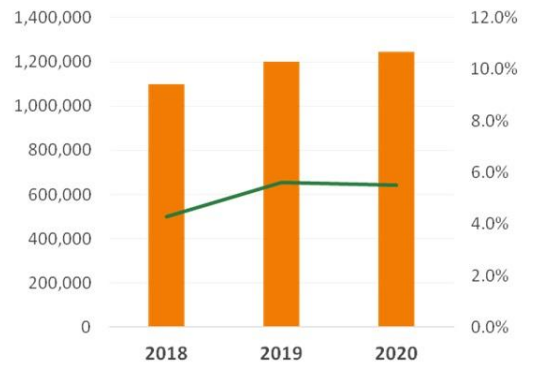
US EV Sales 2018–2020



Europe EV Sales 2018–2020



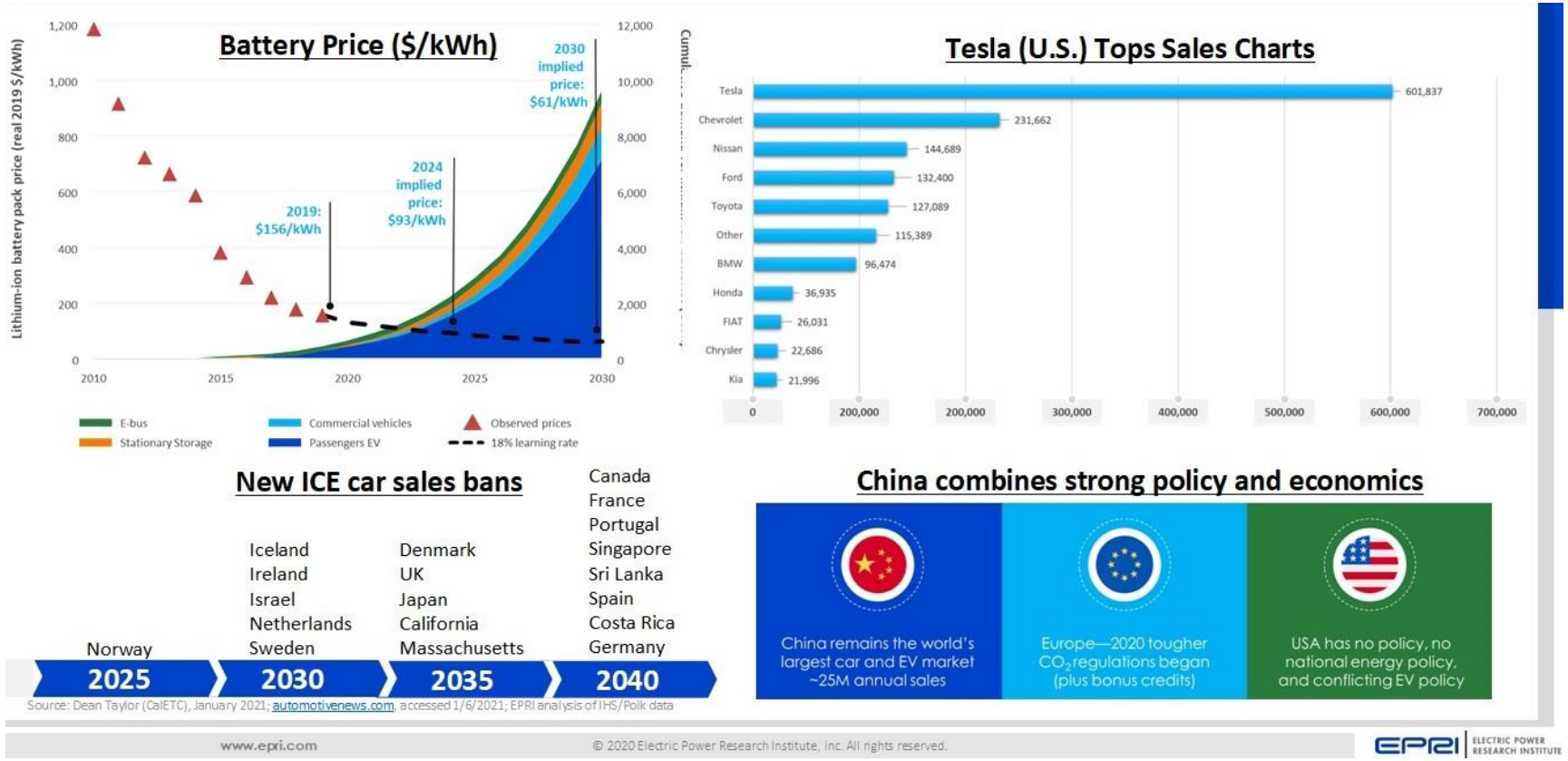
China EV Sales 2018–2020



Source: EPRI analysis, February 2021; https://cleantechnica.com/2021/02/08/global-plugin-vehicle-sales-up-43-in-2020-european-sales-up-137/; https://insideevs.com/news/489169/european-countries-plugin-market-share-q1q4-2020/; https://www.spglobal.com/platts/en/market-insights/latest-news/metals/121720-chinas-ev-sales-to-reach-more-than-13-mil-units-in-2020-caam; http://www.ev-volumes.com/

2010s: POLICY MATTERS!

2020s: Demand pull adds to regulatory push?



DC CHARGING: LEVELS RISE

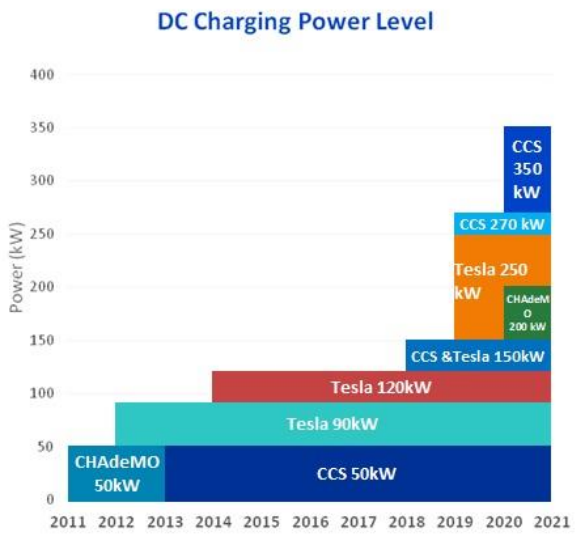
But most EV charging is at 120V or 240V

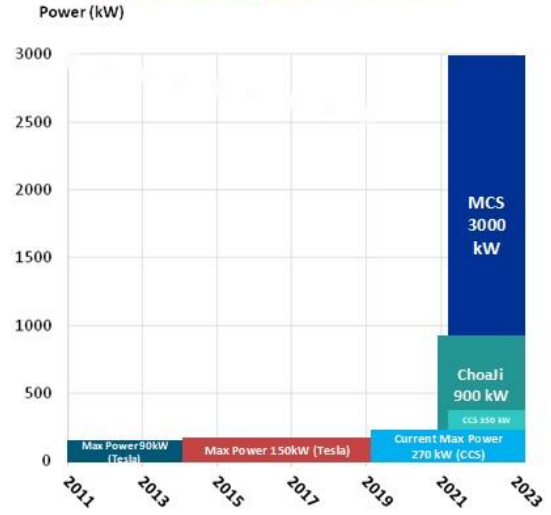
Key market drivers:

DC charging power levels increase

Battery prices decrease

This enables larger EVs as well as lower volume market segments





U.S.–INDIA SCCP

USTDA U.S. TRADE AND DEVELOPMENT AGENCY

CII

मानक: पथप्रदर्शक: Bureau of Indian Standards

ANSI

U.S.-India Standards and Conformance Cooperation Program (SCCP), Phase II

Question & Answers

Submit questions in the chat box. If they are not answered then we can connect with you after the session.

U.S.–INDIA SCCP

U.S.-India Standards and Conformance Cooperation Program (SCCP), Phase II

Thank you!

Remember to register for our final EV webinar sessions on February 25th

Reach out to us-indiasccp2@ansi.org with any questions