



Vehicle to Grid (V2G) and EV Power Export (EVPE): Market Access with Bidirectional EV Chargers

Bidirectional EV Charging Requirements
UL 9741 and UL 1741 Sup SC

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Meet your presenter Timothy Zgonena



Tim has worked for UL Solutions since 1990. His responsibilities include the development, maintenance and application of certification requirements and delivery of conformity assessment services for: utility grid interconnection systems equipment, inverters and converters, EV V2G and V2X, PV BOS equipment, PV rapid shutdown, PV hazard control, wind turbines and wind turbine system components.

Tim serves on multiple Distributed Generation UL, IEEE, IEC and ACP Technical Committees and he is a member of NFPA 70 / NEC Code Making Panel 4, NFLA 37. IEC 1906 Award Recipient.

UL 9741 – Past, present and future

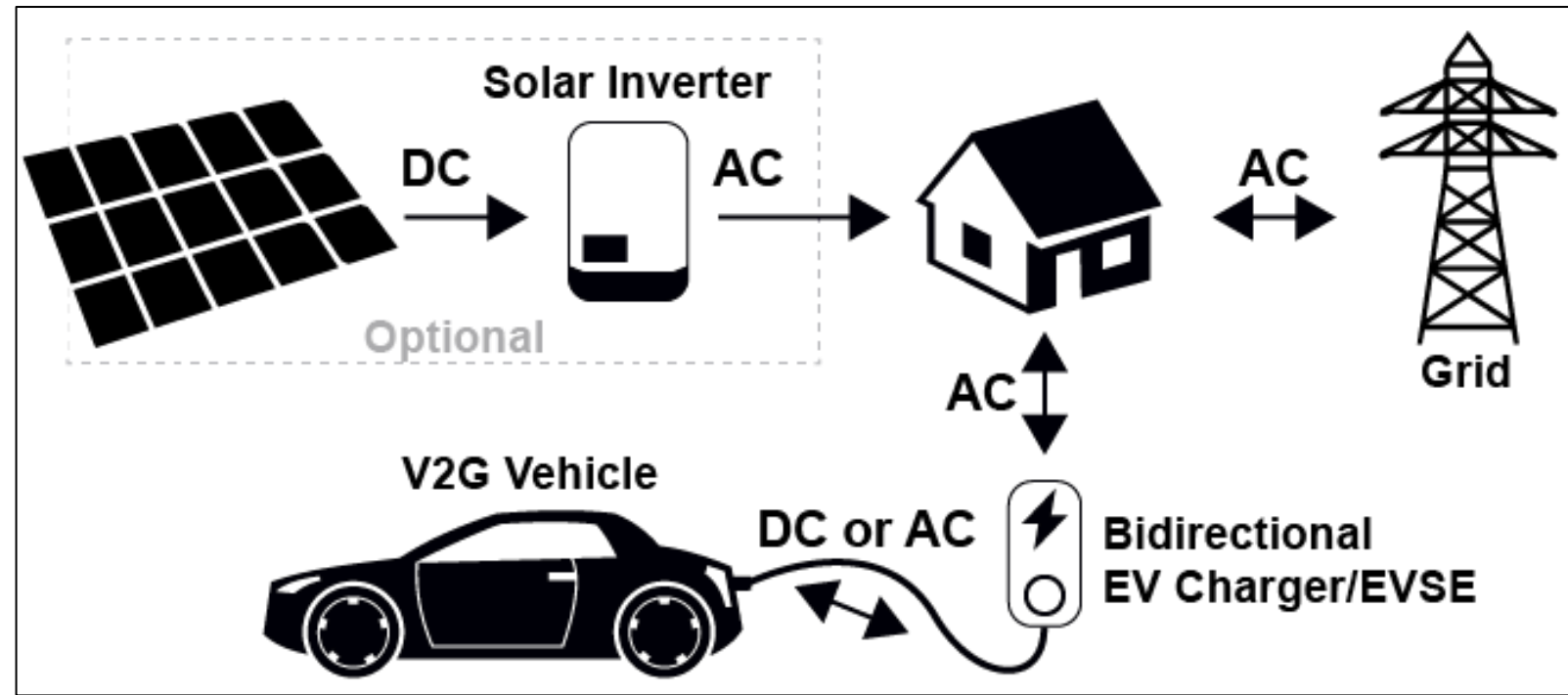
- March 18, 2014: UL 9741, Outline of Investigation for Electric Vehicle Power Export Equipment (EVPE)
 - New Outline of Investigation combined the applicable EV and DER standards.
 - UL 9741 covers bi-directional (V2G) EV charging equipment to evaluate EVPE to the utility grid or other electric power systems.
 - UL 9741 requires UL 1741 for grid interconnection compliance as rated by mfr. (SA, SB, Special purpose and or “old school” 1547.1-2005).
 - Published UL Outline of Investigation (OOI) (Non-consensus document — was ahead of its time)
- Updated UL 9741 second edition in 2021 to address all EV power export V2x apps.
- The UL 9741 OOI has been and is still being used to evaluate/certify these products.
- UL 9741 has entered the consensus process to become a bi-national standard UL 9741/CSA 348 for publication in the U.S. and Canada to accommodate new tech, codes and electric utility requirements.
- The bi-national standard will include a cross reference with UL 1741 Supplement SC.
- Estimated consensus publication is July 2023. Balloting was successful and comments are being addressed before final publication.



V2G functionality: graphical overview

- V2G EVs act as an ESS in discharge mode or as a load in charging mode.
- V2G EVs may export via an onboard converter exporting AC power or bypass the onboard converter and export DC power.
- If the system is equipped only with V2G functionality, the system can only function when the grid is present.

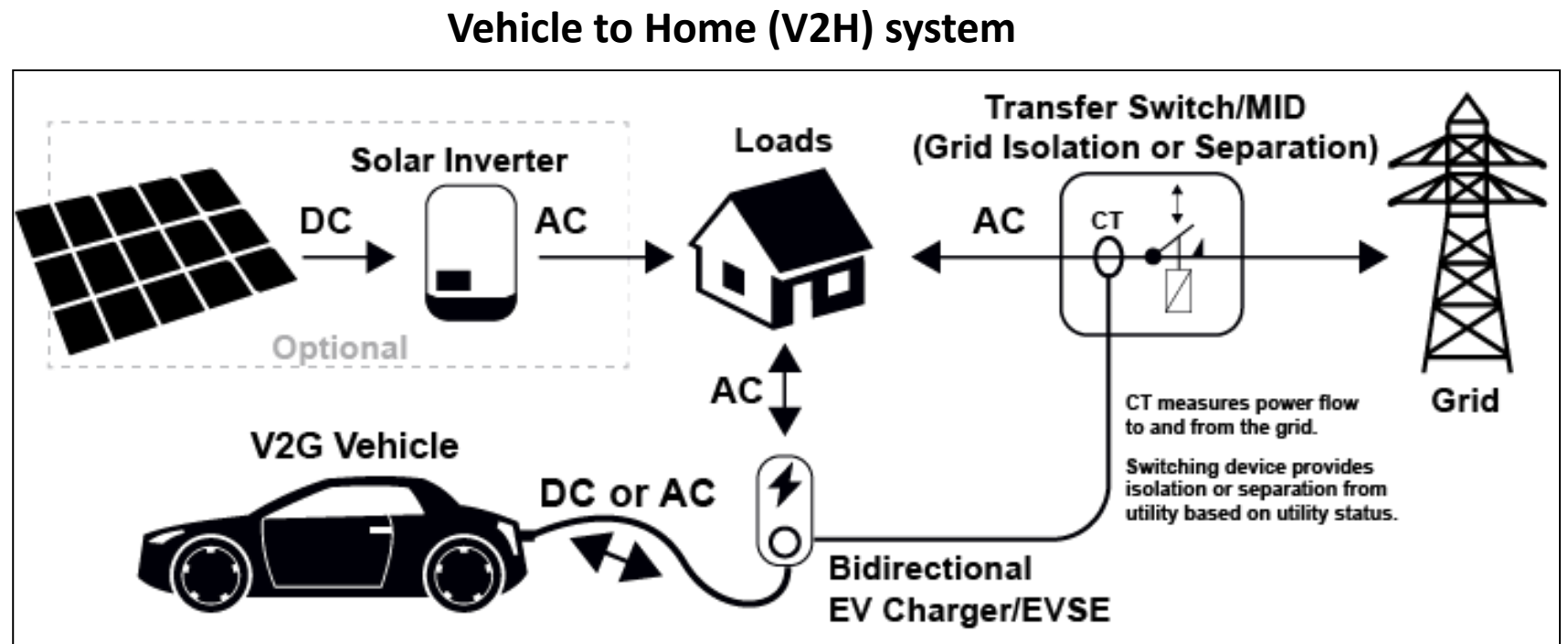
Vehicle to Grid (V2G) system



- EVSE may contain power conversion circuitry (e.g., an inverter with grid interconnection functions) receiving DC power from the V2G EV in discharge mode or the EVSE may have no power conversion circuitry and only act as a pass through/switching/communication device (usually in the case of AC power output from the V2G EV).
- V2G systems may or may not have other power sources (e.g., solar, stationary ESS, etc.) interconnected with the grid at the point of common coupling (PCC) as well as with one another.

V2H functionality: graphical overview

- V2H systems usually contain all the attributes of a V2G system (previous slide) with additional functionality/attributes noted below:

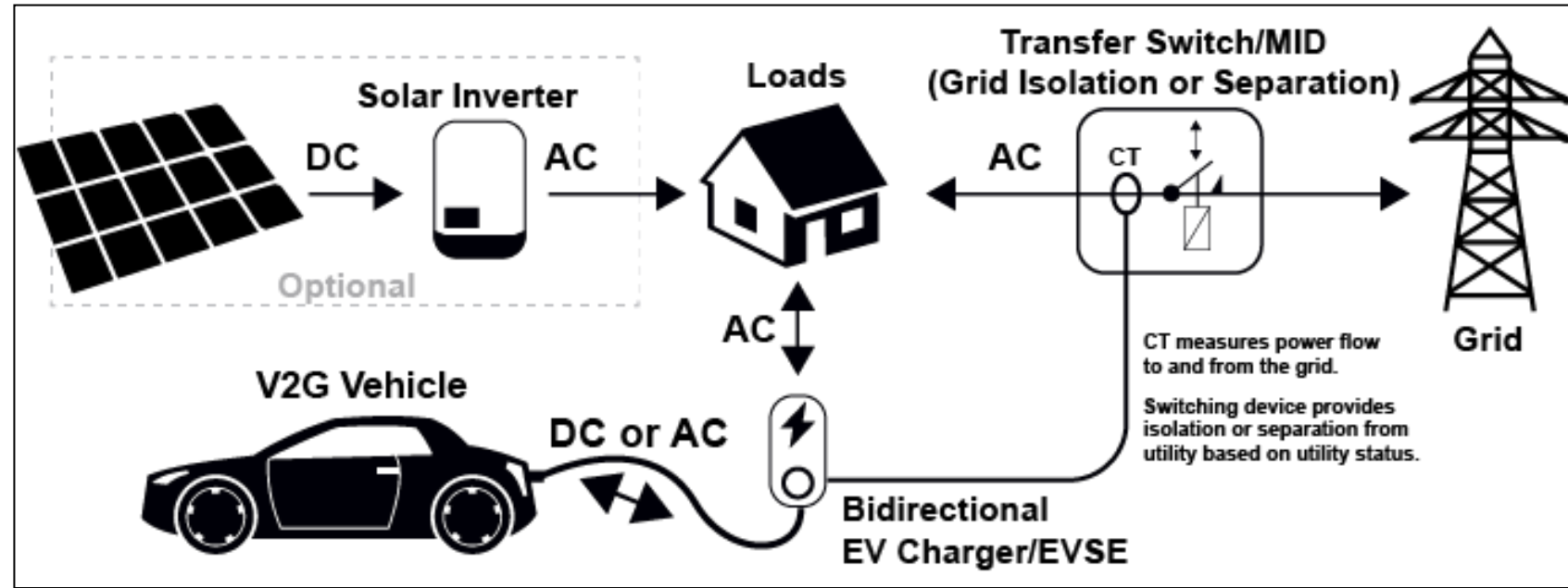


- V2H systems can operate in parallel with the grid (V2G mode) or independent of the grid (V2H mode) via presence of a transfer switch/MID.
- Some V2H systems may only operate when the grid is down (backup power mode)
- When the system is paralleled with the grid, the transfer switch/MID is closed. The system follows the grid voltage and frequency (current source).
- When the system is independent of the grid (islanded), the transfer switch/MID is open. The sources (EV, solar, etc.) regulate/create the voltage and frequency of the system.

V2H functionality (continued)

- When the system is paralleled with the grid, the transfer switch/MID is closed. The system follows the grid voltage and frequency (current source).
- When the system is independent of the grid (islanded), the transfer switch/MID is open. The sources (EV, solar, etc.) regulate/create the voltage and frequency of the system.

Vehicle to Home (V2H) system



- The system may provide open, closed, or delayed transition functionality as defined below:
 - An **open transition** disconnects one live power source before connecting with another. A power loss will result.
 - A **delayed transition** is a form of an open transition that waits for a specified time after disconnecting from one source before connecting the other. A short power loss will result aligning with the delay period.
 - A **closed transition** momentarily parallels distributed generation and utility power when both sources are active. No power loss will result. Close synchronization between the voltage, frequency, and phase angle of the sources is required for this behavior.

DER Safety Standards and Relationship to Utility Interconnection Standards

A variety of DER safety standards reference UL 1741 for utility interactive requirements

DER SAFETY STANDARDS:



V2G EVSE

UL 9741
(V2G Chargers)*



INVERTERS,
CONVERTERS AND MLPE
FOR GRID INTERACTION &
SUPPORT

UL 1741
UL 1741 + UL 62109



WIND CONVERTERS

UL 6142



ENERGY STORAGE
SYSTEMS

UL 9540
UL 9540A
(Battery Fire Safety)
UL 2262
(Fuel Cell Modules)



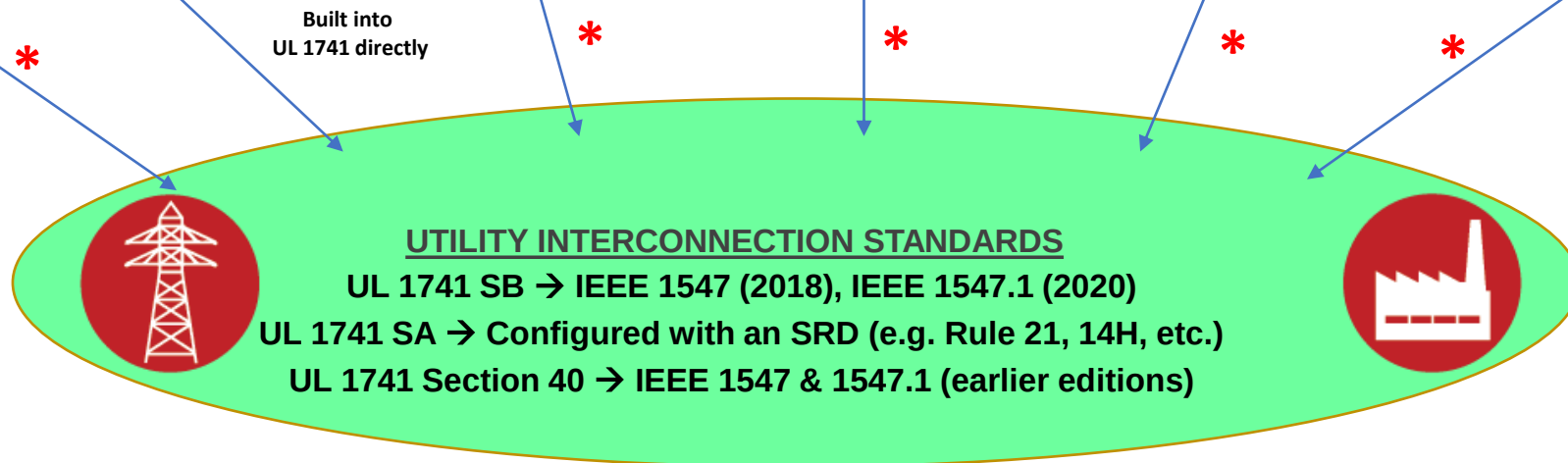
ENGINE
GENERATORS
& CONTROLS

UL 2200
(Generators)
UL 6200
(Controls)



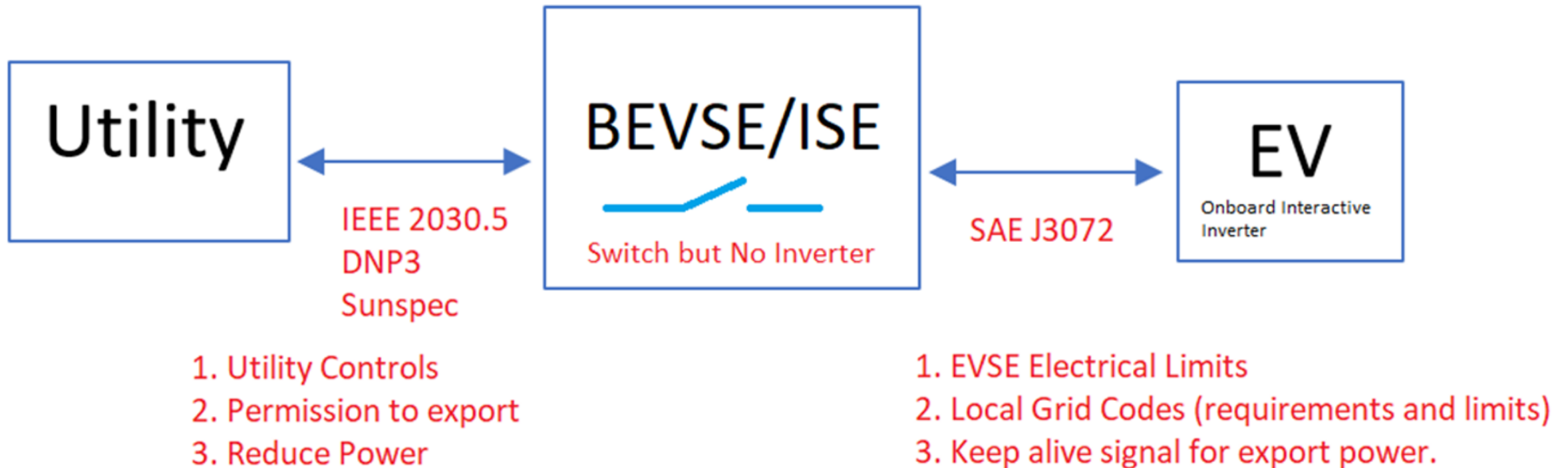
MICROGRIDS &
SINGLE SITE ENERGY SYSTEMS

UL 3001
(Microgrids)
UL 3010
(Single Site Energy Systems)



BEVSE/ISE V2G under development for new UL 1741 Supplement SC

UL1741 Supplement SC Bidirectional EVSE/ISE



Ultimate goals

- Increase EV V2G/EVPE safety and grid interconnection performance with the help of industry, electric utilities, PUCs, building code authorities, and other interested parties.
- Develop and apply appropriate U.S. national codes, standards and certifications for new EVPE products.
- Provide follow-up to verify continued compliance for code authorities and other interested parties.
- **Permit easier entry for manufacturers into their target markets.**
- Facilitate a streamlined national process where EV V2G/EVPE products may be designed, produced, evaluated, certified, sold, installed, and operated in a smooth and agreeable manner for all parties





Thank you

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Distributed Energy Resources

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