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Method to Actively Drain EV Battery Due to Impending Flood Condition

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Many automotive OEMs are committing to a highly electrified vehicle lines in the future. Many future cars will be all electric. Flooding is destructive to both ICE engines and EVs but more so for EVs. During recent hurricane in Florida, some EV vehicles were challenged days after the hurricane as water seeped into the battery enclosure and shorted out the HV battery. Saltwater can be more destructive than freshwater as salt can eat away at metal enclosures that house/protect the battery cells that contain electrical charge. Once water enters the enclosures, short circuiting can cause thermal events. While some EV may be able to get out of harm's way by driving to safe areas (by itself if AV or by users if manned vehicle), other vehicles may not be able to move or discharge its battery, such as commercial fleets, rental units, or dealer lots. As EV fleet vehicles are projected to become more prevalent in future years, a method to mitigate the effect of flooding is necessary to protect the fleet vehicles from causing collateral damages from thermal events.

Method

A X2V messages/alerts are sent to the vehicles/owners that flooding is about to occur. Flash floods and storm surge may be modelled to predict the path the water will flow, or the local water level is rising. Vehicle owners that are parked in the flood zone are advised to leave immediately. The cloud management system can provide routes that owners can take where flood waters are not predicted or where there is expected low water level. Plan routing is especially useful for autonomous vehicles as they can receive the route data and depart immediately. The advised routes may include high ground areas such as hills, parking structures, etc. Some vehicles, such as fleets, may be stuck in the flood zone as they lack autonomous driving and/or it is not feasible to be driven away. In this case, the focus is to mitigate the potential damage of the battery by actively depleting the EV battery from charge. Upon receiving X2V message of impending floods, the process is to ensure each stationary vehicle is/will not be in use during the alert conditions in the zone, and then activate one or more electrical loads inside the vehicle to rapidly deplete the HV battery as follow:

A multi-tiered, hierarchical battery discharge method is as such:

1. If EV is plugged into a smart home, V2H message to home controller initiates the home to disconnect itself from grid (or home may have already lost power from the storm) and powers itself from the vehicle HV battery. The discharged power from EV is not lost but sent back to the grid.

2. If EV is plugged into the grid and V2H is not feasible, upon receiving the message, the EV switches its charge mode to dump its HV battery charge back onto the grid using V2G. Some vehicles maybe equipped with bi-directional charging capability. The discharged power from EV battery is not lost but sent back to the grid. Grid may also be a battery bank(V2B).

3. If EV is not plugged in and is unable to move V2V discharge is also possible. If another EV is seeking a volunteer vehicle to charge it so that it can drive away from flood zone, it can mate with the static vehicle via jumper cable. V2V discharge of static vehicle battery allows it to transfer its energy to another vehicle which may drive away or seek shelter.

4. If EV is not plugged in and able to move autonomously if safe to do so, EV may perform "discharging laps" around a block to discharge its battery while turning on all electrical

loads. During, the laps, regenerative braking is turned OFF as to not recharge the EV battery.

5. If EV is not able to perform V2G, V2H, V2V energy transfer at this point, active onboard electrical energy depletion is commenced.

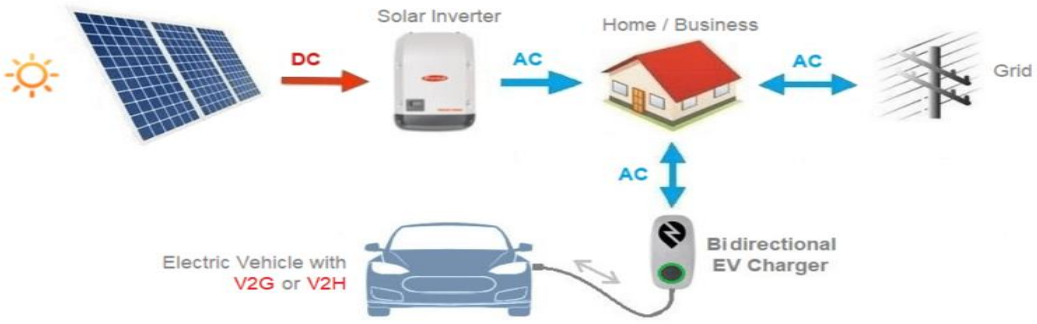
6. If vehicle isn't equipped with depletion system, then some of the electrical loads will be activated, such as, exterior and interior lights, HMIs, stereo, cameras, modules, defrosters, cabin heater, seat heaters, steering wheel heating, all onboard motors such as electrical fans, seat movement, windows, etc. (excluding propulsion motors), coolant pumps, are all turned on to drain the HV battery. The discharged power is lost but is offset in the interest of reducing potential damage to the battery.

7. The customer using an APP may also perform the above actions manually by turning on V2G, V2H or all onboard electrical loads.

8. It may take few hours to deplete the HV battery depending on its initial SOC in the meantime the method monitors the street/parking area water level using onboard cameras and when water level is observed to be greater than a threshold, the electrical loads are all turned off.

HEV Solution –

HEVs have both an electric motor as well as an ICE engine. The tiered method of draining the HV battery can occur as explained above. But with a HEV, draining the battery using onboard electrical load actuation methods is much more rapid in a pure EV platform. If V2G and V2H are not available but have been exhausted, the electric motor is used to spin the ICE engine unfueled. This essentially uses HV battery power to rotate the engine without fueling or sparking it. It takes a lot of battery energy to spin an engine and this method drains the HV battery more rapidly. Cranking current can easily be greater than 100A. In addition to spinning the engine unfueled to deplete the HV battery, all electrical loads are turned on. At some point, the HV battery may lack juice to spin the electric motor. If that occurs, the method terminates the unfueled engine spin and only performs the onboard electrical loads drains.



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