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Panel Presentation

This updated copy is what should be used in the panel.

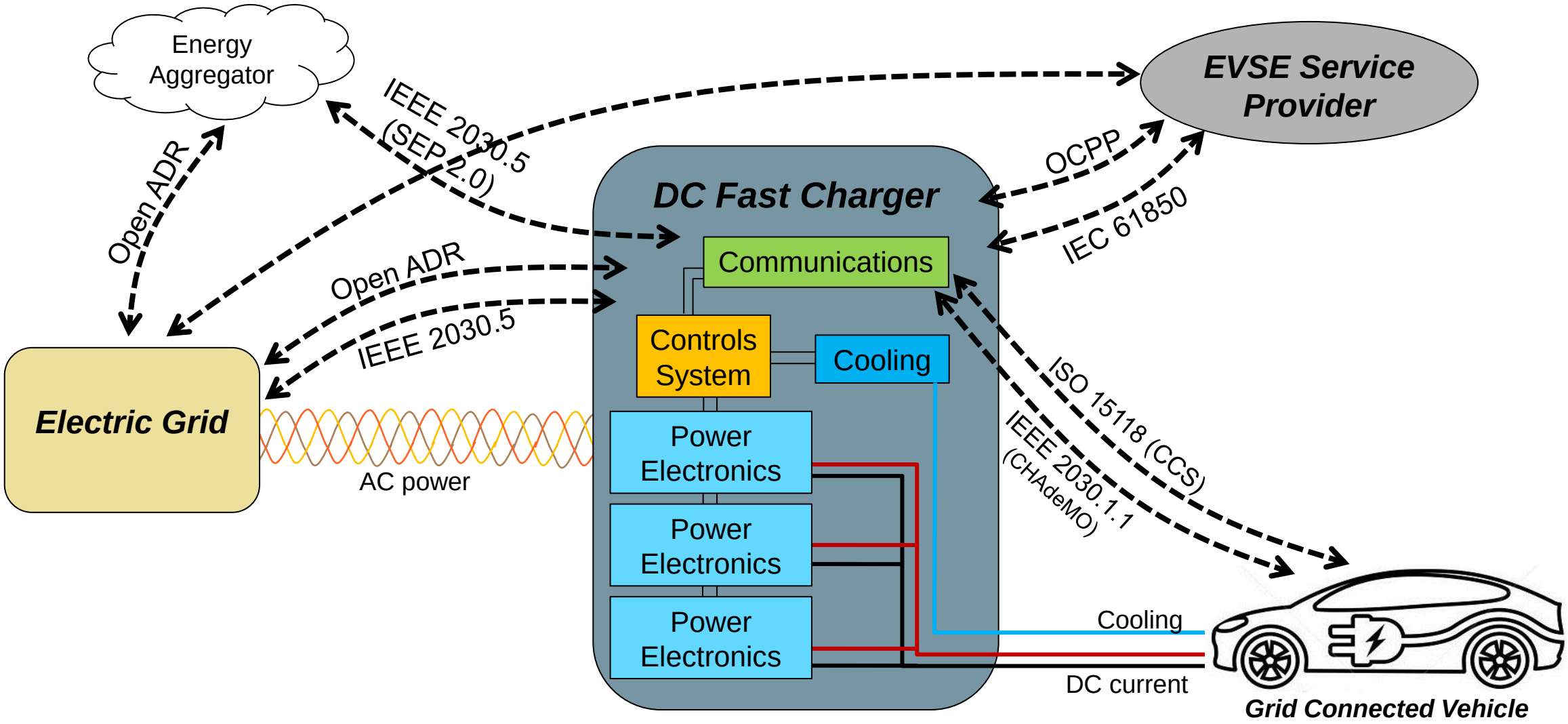
Additional submitted attachment is included below.

Cyber Security of DC Fast Charging: Potential Impacts to the Electric Grid

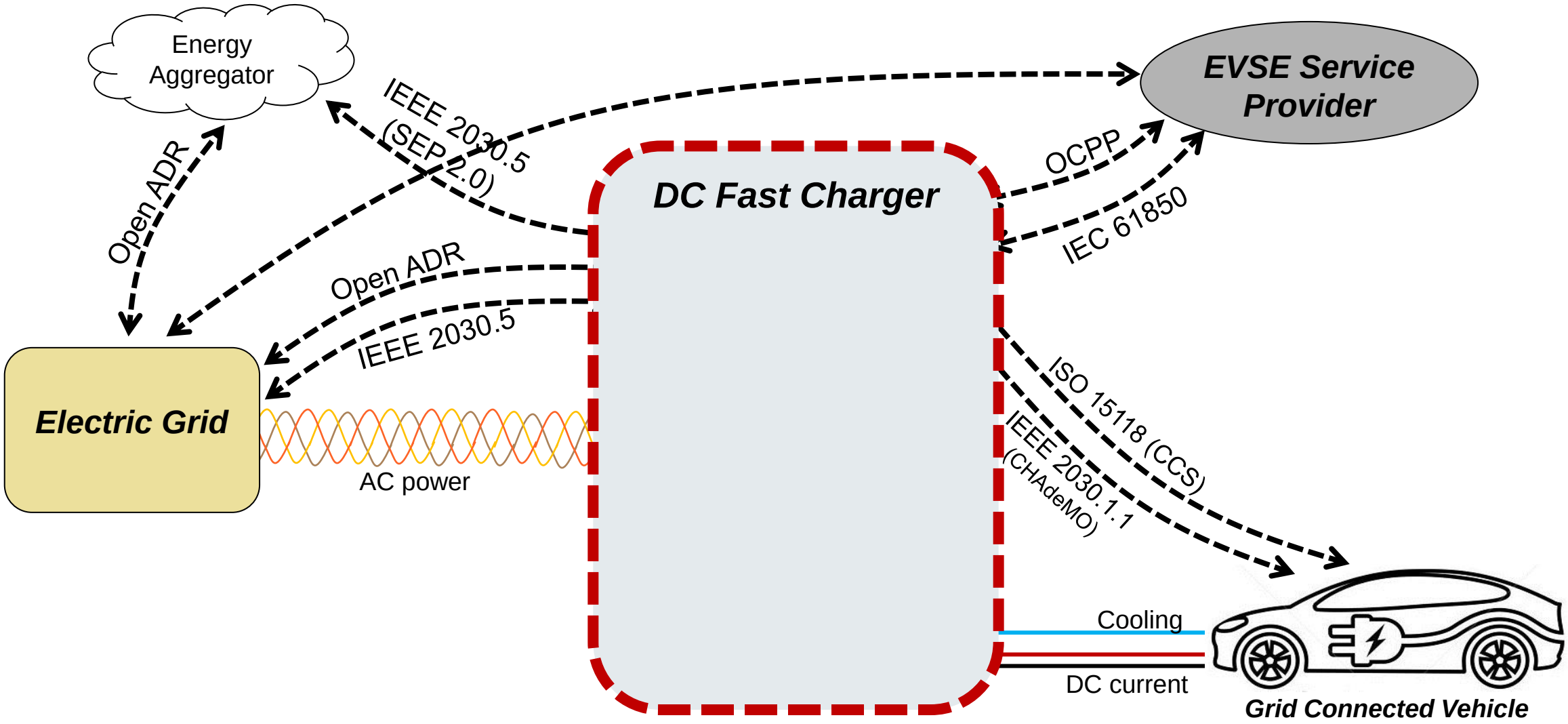
Barney Carlson – Advanced Vehicles group
Ken Rohde – Cyber Security R&D group

INL/MIS-18-51289

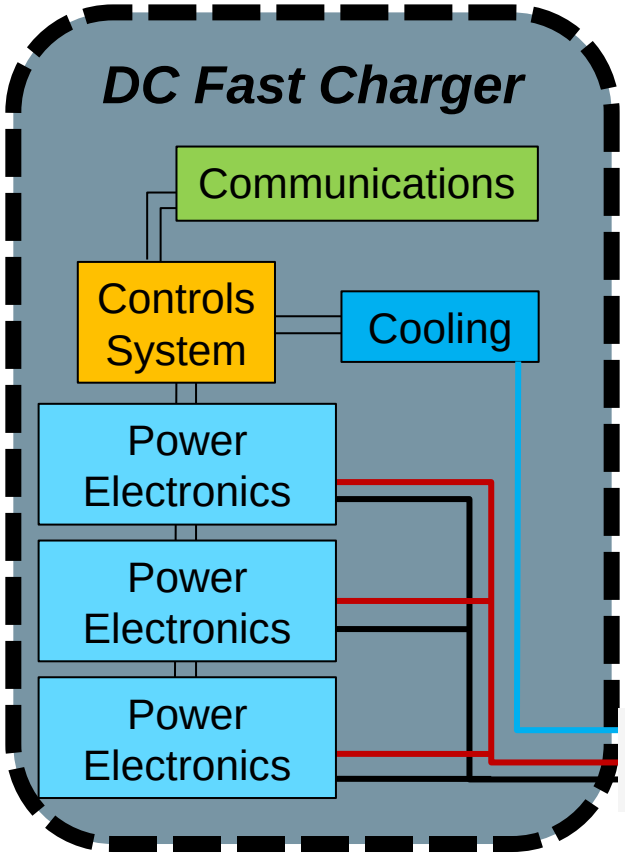
EV Charging Communications and Controls



External Attack Surfaces and Vectors

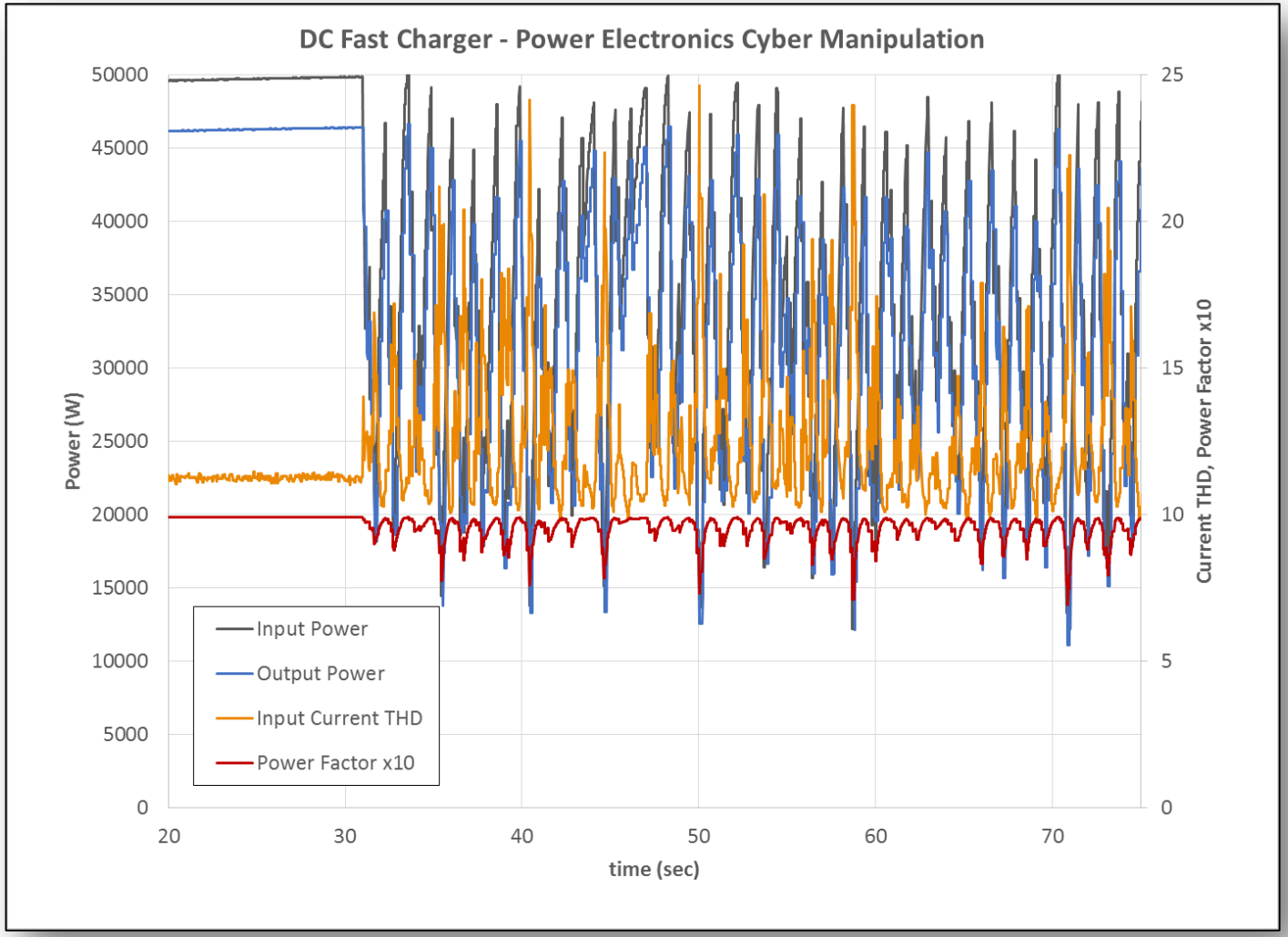


Internal Attack Surfaces and Vectors



Recent Results and Findings

- Disrupt controls coordination between power electronics modules
- Response of the DCFC:
  - Fluctuation of:
    - Input power from grid
    - Input power quality
      - Power Factor
      - Current THD
    - Output power to EV
  - Results in power quality outside of industry limits
    - Power Factor: <0.8
    - Current THD: > 20%

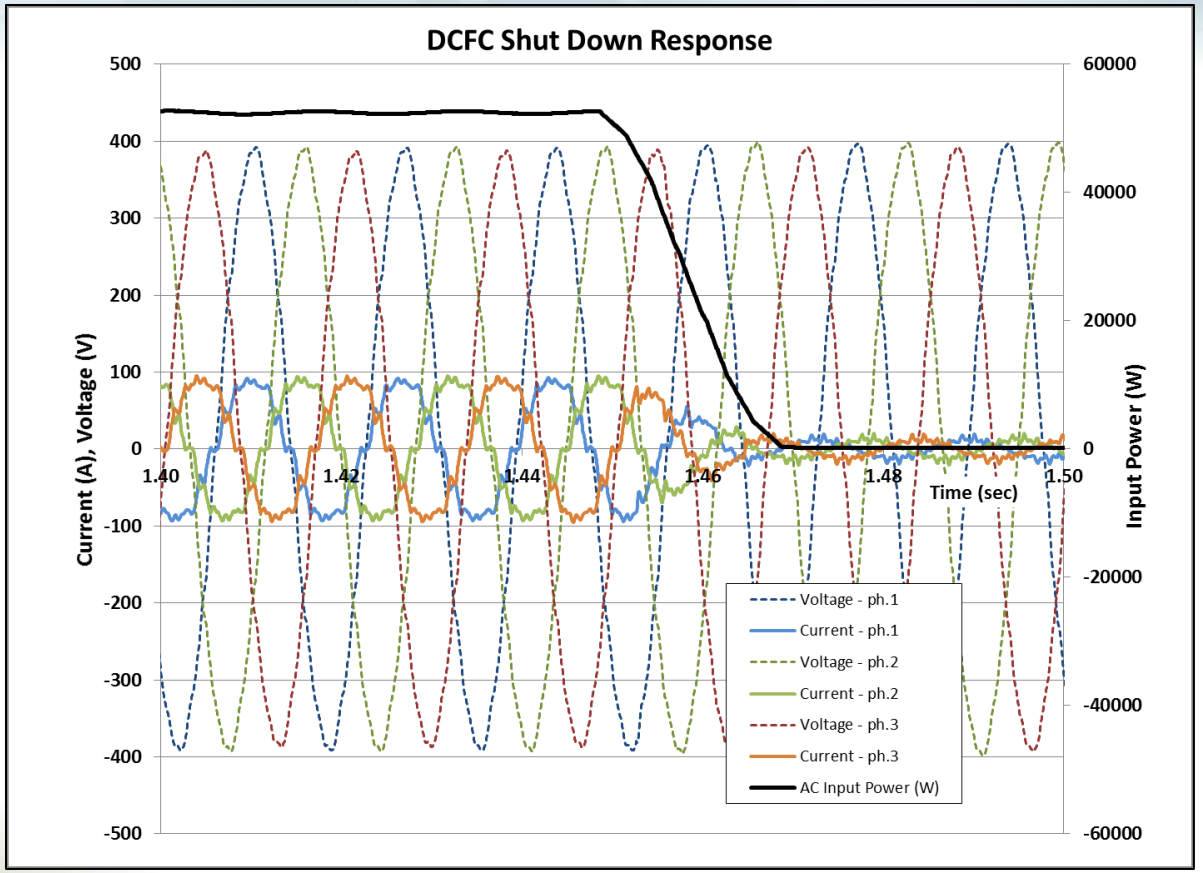


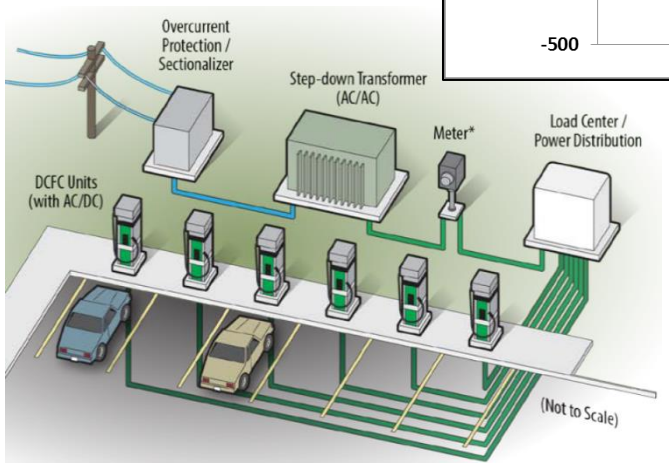
Recent Results and Findings

- Simultaneously turn off all power electronics modules

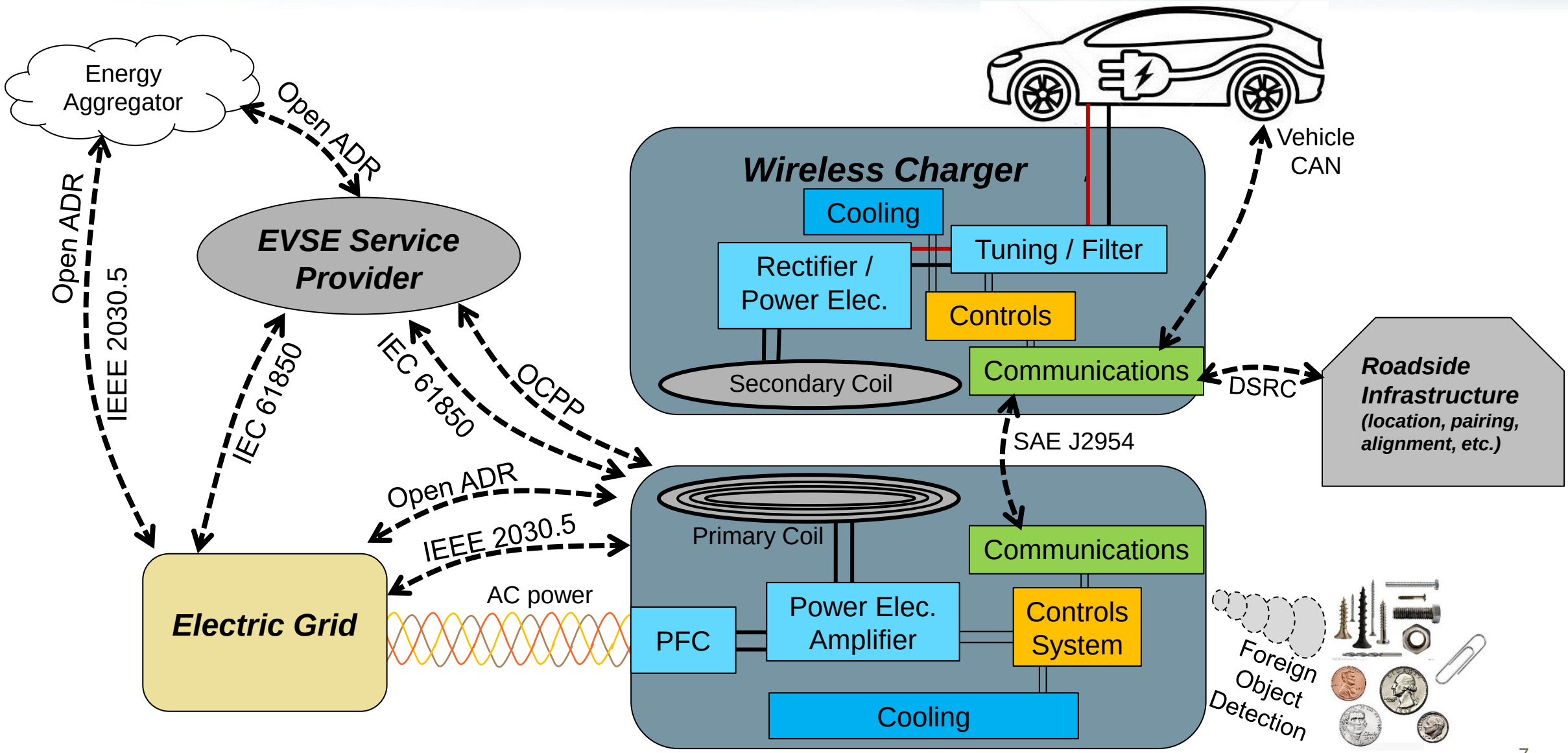
- Response of the DCFC:
  - Full power (50 kW) to standby power (~300W)
    - 0.020 seconds (-2.6 MW/sec)

- No impact to grid from a single DCFC shut down
- Potential impact to grid if simultaneously shut down of 100's of DCFC
  - ? What about 350 kW XFC

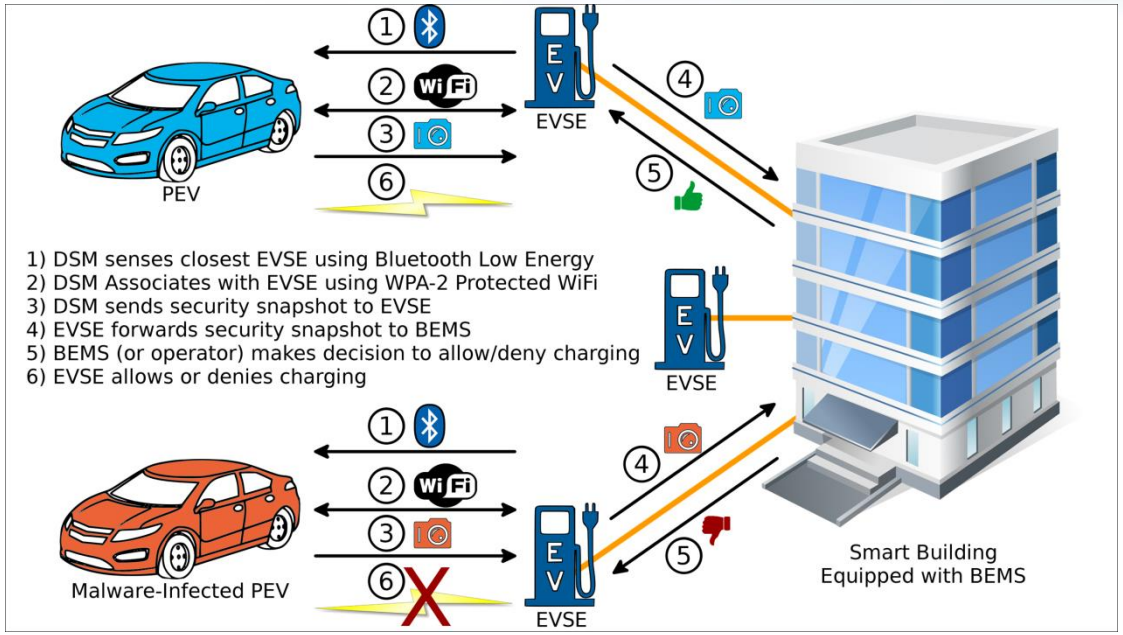


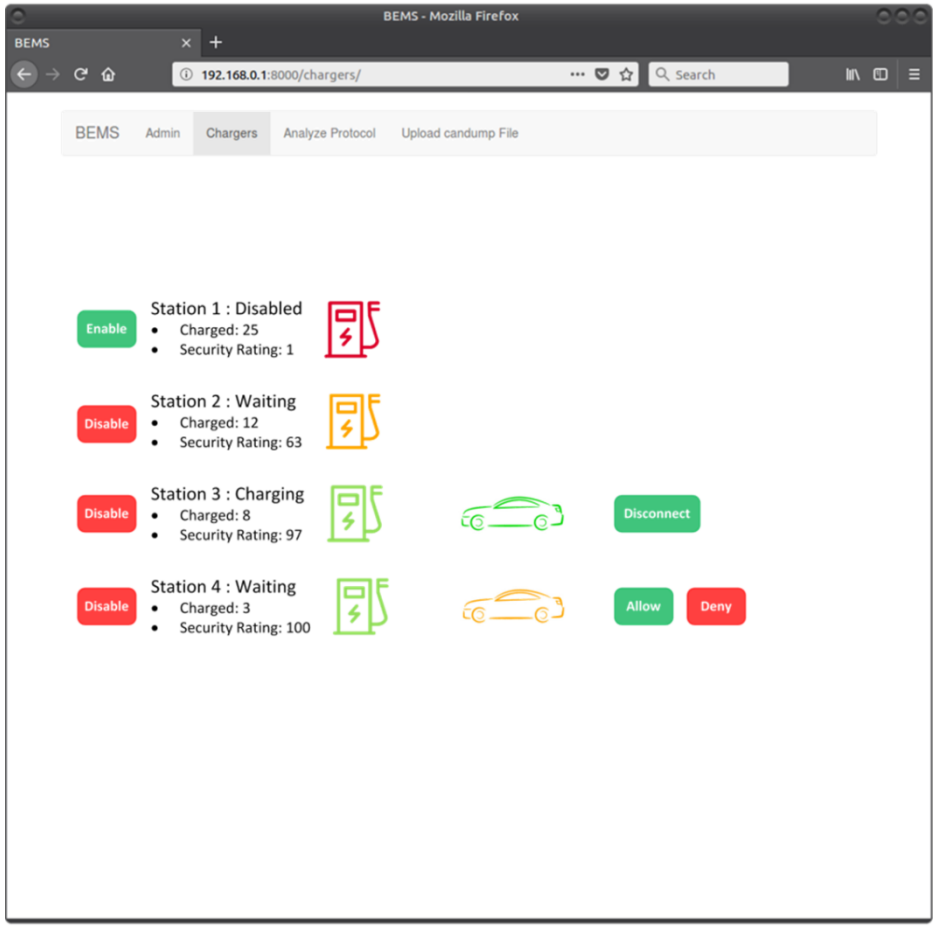


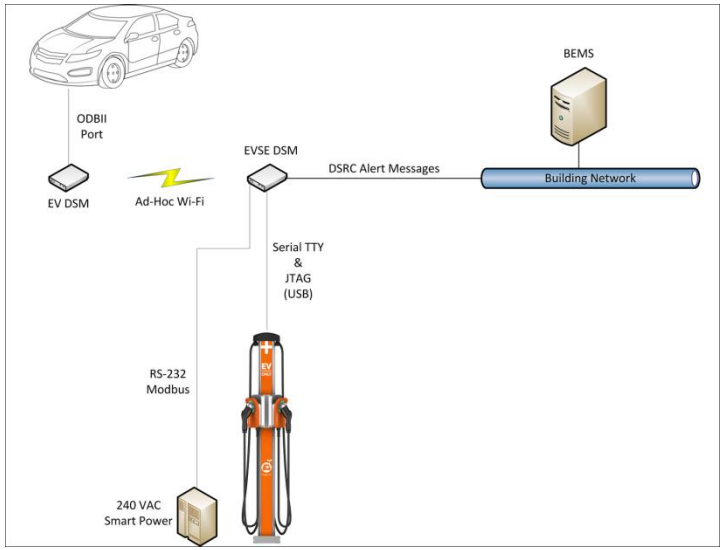
Wireless Power Transfer



Diagnostic Security Modules (DSM)







INL's Focus: Wireless Charging (WPT) & Xtreme Fast Charging (XFC)

1. **XFC**: Higher power
   - 350 kW (500A / 1000VDC) or higher
   - Liquid cooled cable & connector
   - Multiple standards still required (CCS, CHAdeMO, GB/T, overhead charging, etc.)
   - Likely co-located with several XFC at charge depot (>1 MW demand on grid)

2. **WPT**: Higher system complexity & controls
   - Controls communication is wireless
     - from ground assembly to vehicle assembly
   - Foreign object detection system
   - Vehicle approach, pairing, and alignment system

- INL is developing cyber consequence engineering methodology guideline for advanced charging systems

Photo source: Electrify America

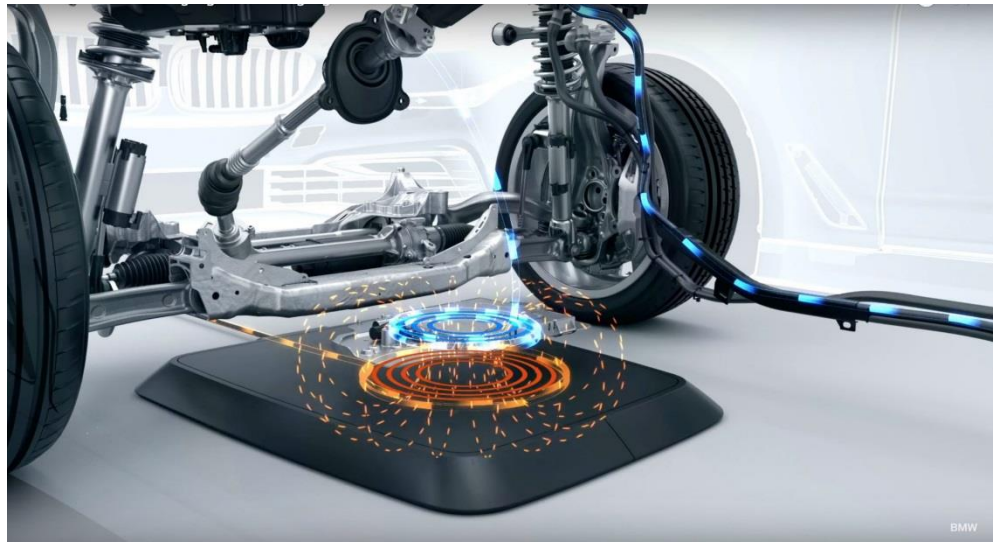


Photo source: companycartoday.co.uk