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VGI Roadmap Workshop Panelist Presentation

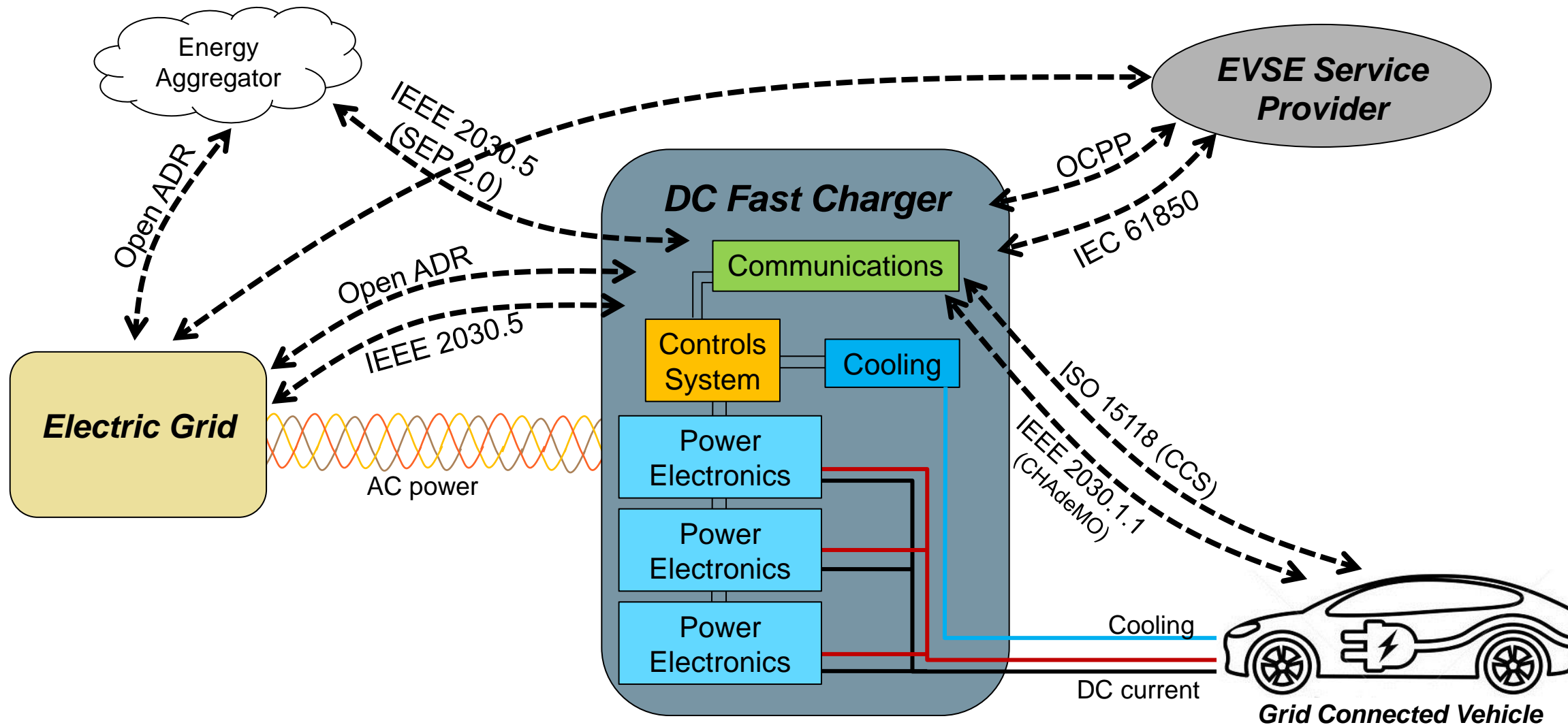
The presentation that I will share during the panelist discussion. This highlights the current efforts of cyber security of Electric Vehicle charging being done at the Idaho National Laboratory (INL).

Additional submitted attachment is included below.

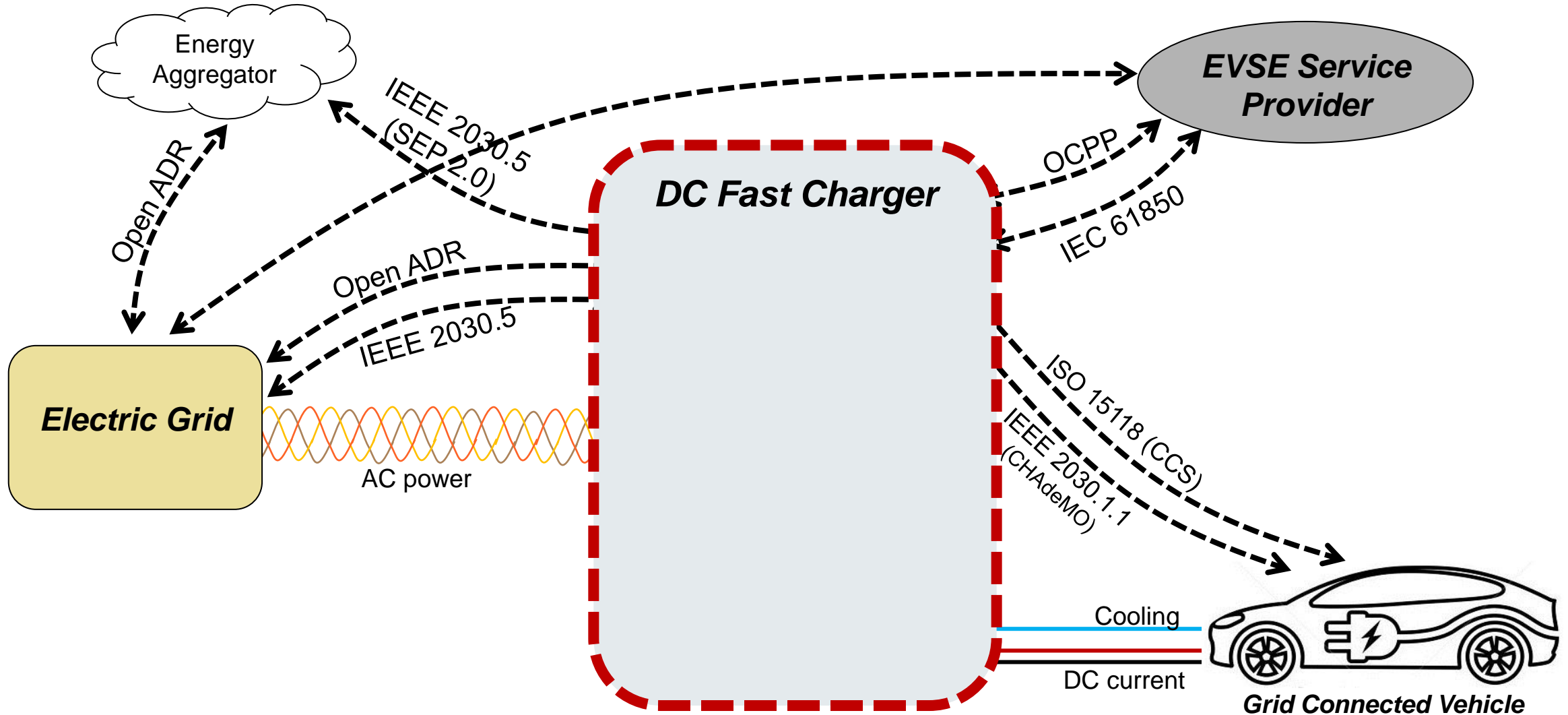
Cyber Security of DC Fast Charging: Potential Impacts to the Electric Grid

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

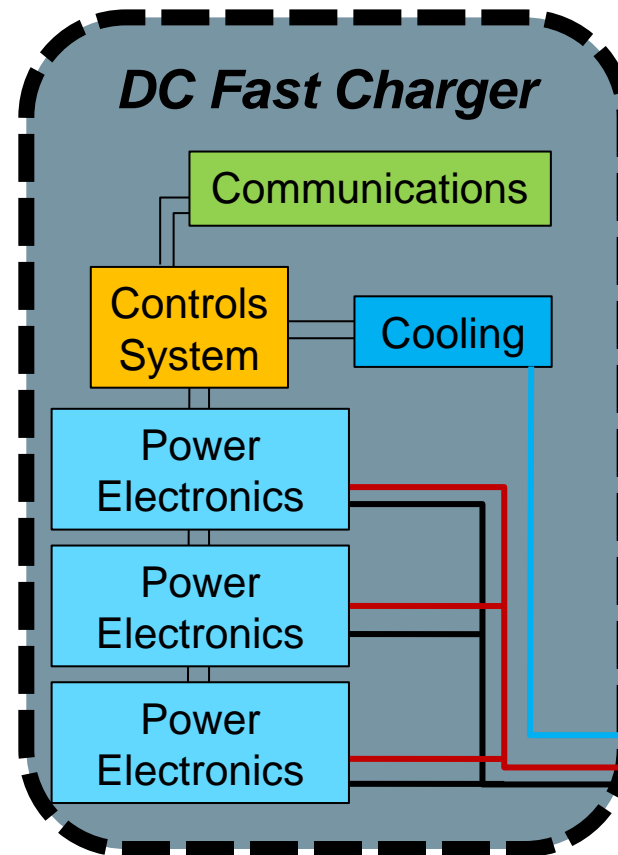
EV Charging Communications and Controls



External Attack Surfaces and Vectors

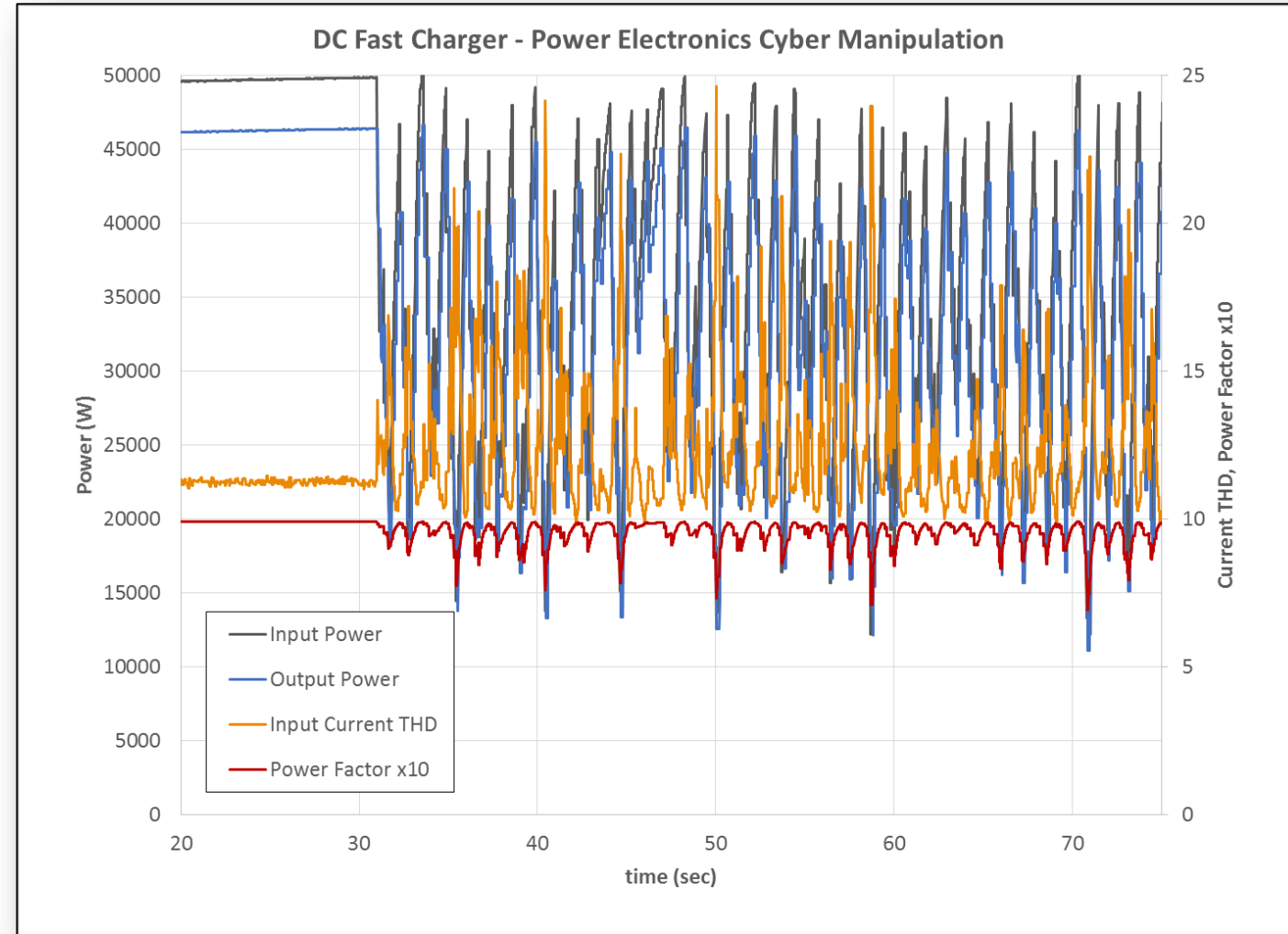


Internal Attack Surfaces and Vectors



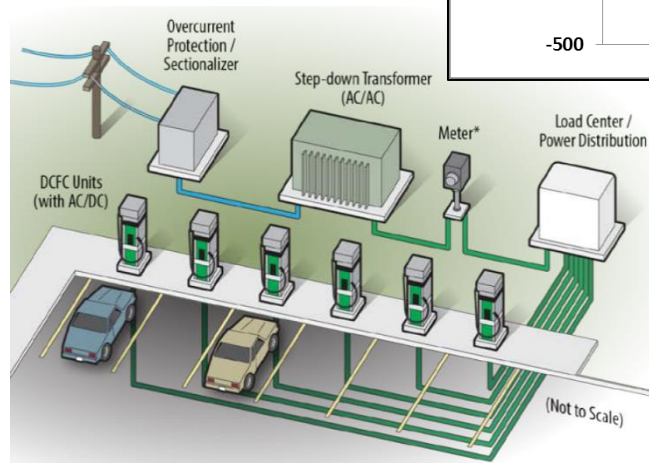
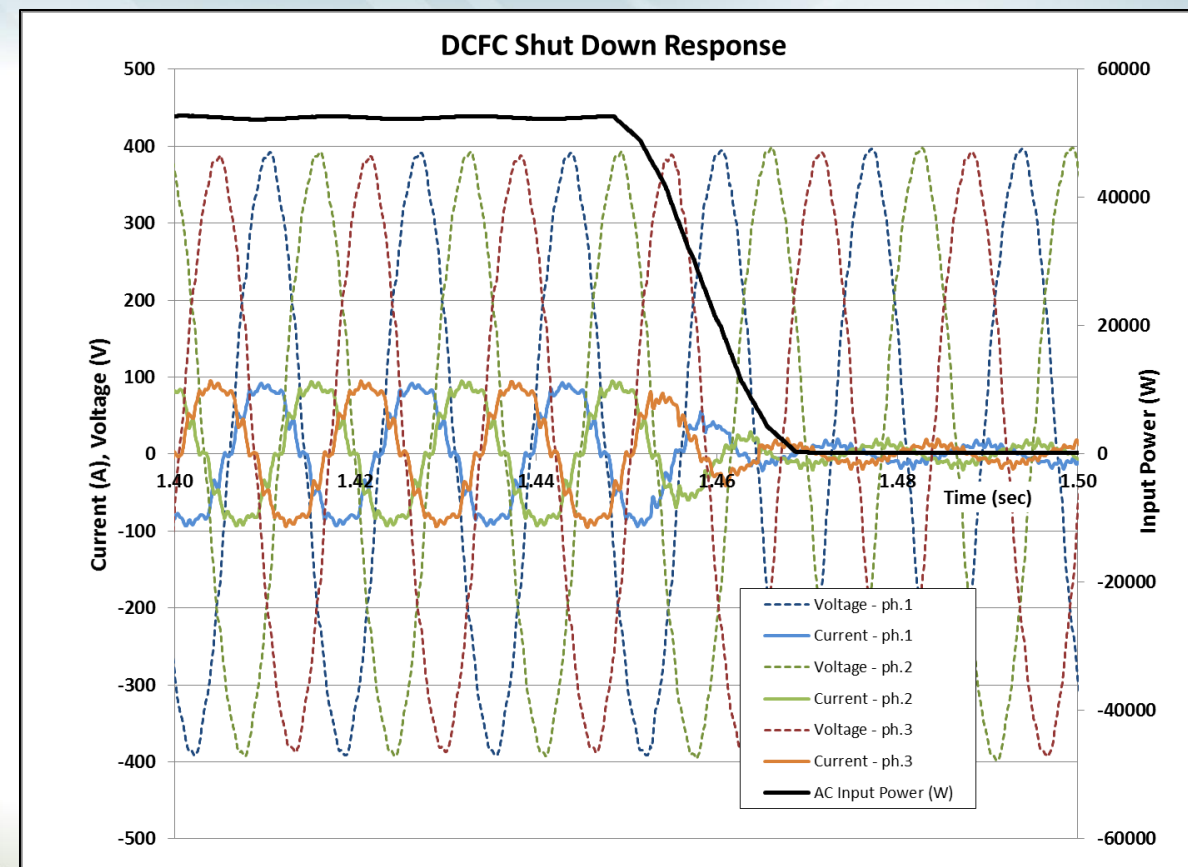
Recent Results and Findings

- 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: $> 20\%$

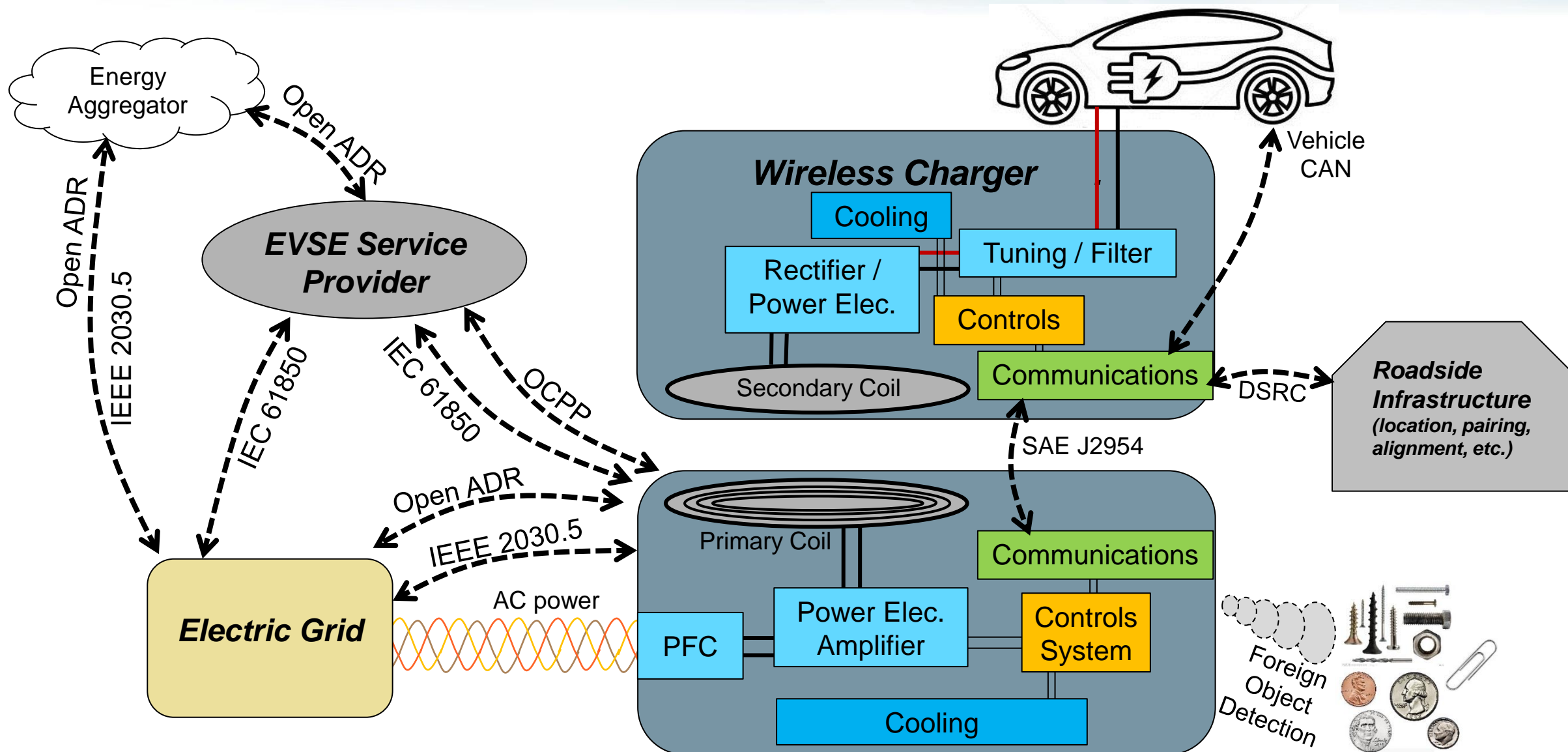


Recent Results and Findings

- 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



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