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1. Suggest incorporating large stationary energy storage system (ESS) to reduce size of mains service connection, to better enable V2G testing, and to open up greater opportunities for EMS / DERMS testing. With careful planning and coordination, a large ESS could make the Charge Yard much more versatile and would allow for some level of energy optimization. In this same vein, Charge Yard should consider including a solar power installation. This would further increase Charge Yard's versatility in many ways and would complement the ESS. It could also provide a means of testing control systems for solar-powered EV charging canopies. With such a combination of resources, Charge Yard could double as a DER Yard, EMS Yard, etc.

2. Charge Yard test operations and test scheduling software will be key for efficient lab operation if it's truly expected that this lab will be "busy" / in high demand. Such software should be included or at least considered by applicants.
    a. Additional consideration- If it is expected that a charging event of significant power is likely to occur (i.e., 1MW+ from either a single or multiple charging stations inside Charge Yard), and if the situation is such that this level of power must be sourced from the utility, then should the software notify the DSO in advance of the upcoming charging event?

3. Consider if standard conformance should be evaluated in parallel with interoperability evaluation. This could be a secondary objective, but could be useful in determining if an interoperability failure was a byproduct of a standards test corner case. This could serve as a means to finding ways to improve standards / standards test processes.

4. Charge Yard power infrastructure for testing should be isolated from infrastructure for ancillary loads, and the branch circuit for testing should be able to disconnected from the grid and ran islanded. There should probably be multiple independent mains feeds for test circuits so a test involving intentional island formation does not disable the rest of the Charge Yard. Software to monitor and potentially control the various switches throughout Charge Yard's infrastructure in order to accommodate the test at hand should be considered. This and other information pertaining to infrastructure should also be logged during testing to determine if any electrical issue was a byproduct interoperability failure or affected by infrastructure anomaly.

5. Regarding minimum power levels- high power charging events (let's vaguely define as being on the order of hundreds of kW up to 1MW+) can expose interoperability issues arising from EMC. But determining whether EMC is the possible root cause of an interoperability issue adds complexity; EMC testing and analysis is a whole other animal

6. Depending on existing electrical capacity of target facility, any required electrical capacity expansion, and the equipment/software necessary for testing, $3-4M may be grossly inadequate. Even with ample existing infrastructure, $3-4M still may not be enough and could fall several $ millions short of required CAPEX depending on ratings of target test devices and test objectives. For example, if testing MW-charging systems is a test objective, or if 4x fast DC chargers being tested simultaneously is an objective, and if multiple emulators (i.e., grid emulators) of such size are necessary then $3-4M will go very fast. One could end up spending

$3-4M just on the space alone, before any expansion and/or test equipment/software and/or procurement of EVSE.

7. Test systems (equipment and software) should be highly versatile to extend their use-cases as much as possible.
    a. Consider dual-range AC/grid emulators to eliminate any need for extremely large transformers in the Charge Yard. Transformers will add cost, increase heat, consume footprint, and reduce test system mobility.
    b. Test execution software should be open so Charge Yard customers can write test programs ahead of time

8. Multiport EVSEs have become very popular, particularly for public DC charging stations. Multiport EVSE will present interoperability challenges which can only be tested when multiple EVs are connected to the EVSE at the same time. This should be considered, and at least 1x multiport EVSE should be required for Charge Yard. If connecting multiple EVs to a multiport EVSE at the same time is not feasible, then perhaps there should be emulated EVs available to accommodate such tests.

9. We suggest the CEC does not define a minimum required CharIN CCS certification based on the **naming convention** of CCS implementation (i.e., CCS "Basic" vs "Extended" vs "Advanced") as this may not yield all the capabilities targeted for interoperability testing. Although no decision has finalized yet, there are ongoing discussions about the possibility of CharIN refactoring the naming convention (and associated feature inclusions) for the evolutionary stages of CCS development in order to accelerate the deployment of urgent features, like bidirectional power transfer (BPT). For reference, please see the table below. To prevent any ambiguity about the desired capabilities for Charge Yard devices, it is recommended the CEC defines Charge Yard's minimum CCS implementation requirements based on desired function sets with reference to the ongoing work in CharIN, rather than the name of a specific version of CCS implementation.

| 02/2023 | **CCS Ladefunktions-Mengengerüst 1.0**<br>*CCS charging-function quantity structure 1.0* | | | | | |
|---|---|---|---|---|---|---|
| | **Charging functions for customers in CCS** | Level 0 Grid-compliant Charging | Level 1 V1G Controlled Charging | Level 2 V1G/H Cooperative Charging | Level 3 V2H Bidirectional Charging | Level 4 V2G Aggregated (bidirectional) Charging |
| CCS Basic | **Basic Functions** | | | | | |
| | AC Charging | x | x | | | |
| | DC Charging (incl. HPC = High Power Charging >> CharIN Powerclass) | x | x | | | |
| CCS Extended | **Smart Charging** | | | | | |
| | Local Load Balancing | x | x | x | | |
| | Local Load Balancing w Data connection | x | x | x | | |
| | Online Load Balancing | x | x | x | | |
| | **Automatic Paying** | | | | | |
| | Plug and Charge (ISO 15118) | x | x | x | | |
| | Auto Charge (proprietär ohne Schnittstellenfestlegungen) | x | x | x | | |
| | **Smart Paying** | | | | | |
| | Payment app (MSP = Mobility Service Provider) | x | x | x | | |
| | Payment app (ad hoc) | x | x | x | | |
| | Credit Card (EIM = External Identification Means) | x | x | x | | |
| | RFID (EIM = External Identification Means) | x | x | x | | |
| | **Vehicle-to-Vehicle Charging** | | | | | |
| CCS Extended Plus | **Grid Integration Level V2X** | | | | | |
| | Bidirectional Charging | x | x | x | x | |
| | Aggregated Bidirectional Charging | x | x | x | x | x |
| CCS Advanced | **Automated Connection Device (ACD)** | | | | | |
| | ACD-S (Automated Conductive Device - Sidecoupler) | x | x | x | x | x |
| | ACD-U (Automated Conductive Device - Underbodycoupler) | x | x | x | x | x |
| | Pantograph | x | x | x | x | x |
| | WPT (Wireless Power Transfer) | x | x | x | x | x |

10. Suggest considering Charge Yard to also be used for certification testing services. This would add cash flow opportunity for Charge Yard operator. However, there may be additional hoops to jump through in addition to added cost and due diligence factors. It should at least be a consideration and shouldn't be prohibited.

11. Charge Yard should be interconnected with the Area EPS and operated as a Local EPS with aggregate capacity comprised of multiple DERs. However, obtaining permission to interconnect should not be a barrier to opening Charge Yard for testing.

12. Test equipment and test tools for consideration (details to be determined):
    a. Hardware
        i. Grid emulator(s)
        ii. Utility / DERMS server comms emulation (capability vs hardware)
        iii. EV emulator(s)
        iv. EVSE emulator(s)
        v. DC battery emulator(s)?
        vi. DC PV emulator(s)?
        vii. Sniffers
        viii. Scopes/power analyzers?
        ix. HiL simulator(s)? (seems like this should be avoided if possible)
        x. Passive load banks? (seems like this should be avoided if possible)
        xi. Various types of gateways?
    b. Software
        i. Lab operations software?
        ii. Test execution and instrument control / emulation software?
        iii. Data analysis / analytics software?
        iv. Conformance test software?
        v. Cybersecurity test software?

13. Charge Yard could be monetized in numerous ways:
    a. "Pay as you use" where payment structure is defined based on time and equipment usage, tests ran, technician time, etc.
    b. "Subscription users" where customers users pay a flat fee for term-based (3mo, 6mo, or 12mo) priority access to Charge Yard services (NOT including certification)
    c. "Data access fees," paid on an annual basis (optional) to access anonymized test data produced through Charge Yard testing (if you pay for Charge Yard testing services, you get permanent access to the data produced, but if you want access to other data produced by Charge Yard – i.e., the "data dashboard" – you must pay an annual membership access fee)
    d. Standard certification test services
    e. Conference and plug fest attendance fees

14. Bidirectional charging (both islanded / V2L/H/B and grid-tied utility-interactive / V2G) should absolutely be a required capability of Charge Yard

15. Regarding how certification procedures for -20 should be developed to support future interconnection requirements…harmonization process between traditional DERs and V2G capable EVs and EVSEs needs to be defined and established based on consensus agreement among utility operators with inputs from industry (EV/EVSE OEMs, national labs, industry-leading entities such as CharIN, OCA, etc.)… not a requirement of Charge Yard, and maybe out of scope, but a consideration industry needs to make in general.

16. Consider if "Charge Yard-Tested for Interoperability" should be an additional datapoint included on the CEC V2G inverter list as an added vote of confidence for interoperability and to help further accelerate interconnection applications

17. A Charge Yard leadership committee should be formed to steer future use-cases of Charge Yard and to lead industry convening processes as a result of findings during Charge Yard testing. This may include an annual or bi-annual report to utilities, OEMs, standards associations, national labs, etc. to summarize key findings and suggested considerations for inclusion in new standards development. Decisions to adopt new or adjusted requirements in ongoing standards development, processes for certifications, etc. should be ratified and aligned on through this process. Similarly, standards writing groups should be able to leverage Charge Yard's capabilities to test and investigate the feasibility, appropriateness, and necessity of new or proposed standard test procedures.

18. Data collected through Charge Yard testing should be passed through an AI/analytics engine to identify common errors, predict potential interoperability issues, provide recommendations for improvements, etc. This will be an extremely rare opportunity to have enormous data sets from various manufacturers, which can be mined for valuable insights to improve test processes and overall interoperability. Such insights can be summarized for qualified stakeholders in an online dashboard and detailed further in bi-annual reports to industry as described in 17. above.