DOCKETED

Docket Number:	23-ERDD-01
Project Title:	Electric Program Investment Charge (EPIC)
TN #:	251519
Document Title:	Intertie Inc Comments_- CEC RFI_DC Power Systems
Description:	N/A
Filer:	System
Organization:	Intertie Incorporated
Submitter Role:	Applicant
Submission Date:	8/7/2023 2:34:38 PM
Docketed Date:	8/7/2023

Comment Received From: Intertie Incorporated
Submitted On: 8/7/2023
Docket Number: 23-ERDD-01

Intertie Inc Comments_CEC RFI_DC Power Systems

Additional submitted attachment is included below.

Docket #: 23-ERDD-01
RE: Request for Information - Direct Current Power Systems
Submitting Party: Intertie Inc.

DC Components, Equipment, End-Use Devices, and Technologies

1. What DC components and equipment are needed to enable more efficient integration of DC devices with other DC devices? What is the current technology readiness level (TRL) of these devices? What specific research is needed to advance the TRL (e.g., design work, laboratory testing, pilot and/or commercial demonstration)?
2. What are the TRL, cost effectiveness, efficiency, and availability of the following technologies?

    a. DC-DC converters that provide high voltage and high current to enable high power transfer or bi-directional transfer between various DC equipment.
    - DC-DC converters are commercially available (TRL 9) but lack voltage matching, certification (required for California-based projects), combiner, and protection.

    b. Solid-state transformers for integration of renewables, electric vehicles (EV), and energy storage.

    c. DC revenue-grade meters to measure, collect, and store real-time data for DC power systems.

    d. DC power systems for buildings that can be directly coupled with distributed energy resources (DERs) to reduce energy losses with fewer redundant stages of power conversions.
    - DC-coupled solar is commercially available (TRL 9) but lacks integrated module-level rapid shutdown, arc fault current interruption, and ease of wire management.
    - Fully DC-coupled Level 2 EV charging has achieved TRL 3.
    - Fully DC-coupled Level 3 EV charging (fast charging) has achieved TRL 7.

    e. DC-based end-use equipment (e.g., refrigeration, cooktops, lighting, motor-driven loads) that can be integrated into an efficient DC-based power system.
    - Most motors are controlled by VFDs, which convert AC to DC and then use pulse width modulation to convert DC. One can remove the rectifier stage in VFD and connect to a DC bus.

DC Adoption Pathways and Use Cases

3. What are the most likely commercial applications for DC-based power systems in the short (3-5 years) and long terms (5+ years)?
    - Short-term (3-5 years): DC-coupled solar, DC-coupled Level 2 and Level 3 EV charging.
    - Long-term (5+ years): DC lighting, DC motors
4. What are the recommended ideal locations (e.g., where on the distribution grid, geographically, or at particular facility types like electric vehicle supply equipment stations) to deploy DC-based power related demonstrations and what technology(ies) would ideally be demonstrated?
    - Currently, behind-the-meter locations would be ideal to demonstrate a DC-based power system to minimize its impact on the existing electric distribution panel and utility service. It would also increase the utilization of existing grid resources.
5. What kind of buildings/facilities are the best fit for early DC-based implementation and why?
    - Locations where EV charging and solar can be simultaneously installed.
6. What are potential DC adoption pathways for residential and commercial buildings, and how could we structure a solicitation to best inform that transition to greater adoption?
7. What research is required to directly connect an EV via a DC bus to a residential/commercial building allowing for a more flexible and efficient bi-directional power flow? What components/equipment and research are required to accelerate the adoption of DC bi-directional power flow equipment in residential/commercial buildings and improve the overall system efficiency?
    - Requires advanced firmware in DC/DC converters that enables an EV to connect to variable DC bus voltages.
8. What are the research opportunities to demonstrate DC building blocks for a local DC microgrid that increase the overall system efficiency and reliability when compared to a similar alternating current (AC) system?
9. What are potential DC adoption pathways for residential and commercial buildings, and how could we structure a solicitation to best inform that transition to greater adoption?
    - Provide a standardized specification in terms of EV charging (Level 2 and Level 3) and solar PV connected to a building and compare system efficiencies of DC versus AC.

Near-Term (3-5 Years) Opportunities

9. What are the high priority DC-related technologies and/or research needs to successfully integrate or transition to DC-based power distribution networks?
   - Development of DC-coupled Level 2 EV charging station.

10. What specific DC equipment (e.g., DC-DC converters) and components are required to serve as an enabling device for the integration of DERs with a microgrid or DC-related infrastructure?

    a. What are the research opportunities to advance the TRL to simplify the interconnection of microgrids to the grid in one package using only DC-DC related components and equipment and eliminating DC-to-AC followed by AC-to-DC conversion?

    b. What additional research is required to maintain the quality and reliability of DC-DC converters while minimizing unnecessary costs and improving the efficiency of the converters?

11. What advancements are required in power electronics to enable DC and mixed DC/AC microgrid topologies that can reduce power conversion, increase efficiency, and improve reliability?

12. What power electronics need to be advanced and demonstrated to provide reliability and stability to DC systems?

13. What are the enabling or emerging technologies that can:

    a. Advance adoption pathways for DC power in buildings?

    b. Accelerate DC-based power distribution networks for efficient DC-DC integration of DERs?

    c. Enable residential/commercial buildings to better serve as DC building blocks for local DC microgrids?

14. What are the opportunities for EVs to directly support a residential/commercial building directly via a DC bus that eliminates the requirement of an inverter and increases system efficiency and reliability?

Longer-Term (5+ Years) Opportunities

15. What are the opportunities for standardizing DC voltages and system design across various DERs, end uses, and DC plug-in electric vehicle chargers? How can research help to accelerate this process?

16. What areas of research are required to potentially accelerate adoption of DC buildings and related technologies by residential and commercial developers and customers?
17. What pertinent data (e.g., performance and cost) are required to accelerate large-scale commercialization and deployment of DC-based end-use equipment?
18. What current or upcoming communication standards or protocols should be demonstrated and/or developed to ensure successful DC-DC integration and interoperability?
19. What specific codes and standards will the deployment of a DC-based power system help inform?

Safety and Protection

20. What power electronic solutions are needed and required to enhance the safety of a DC microgrid?

    - Development of high voltage, high amperage DC overcurrent protection devices.

21. What protection equipment is needed to interface with a DC/AC microgrid that will enable the reliable operation of the microgrid during disaster events?
22. What are the opportunities to advance DC components/equipment to improve the protection and coordination and increase the resiliency and interoperability of multiple con

    - Development of DC distribution panels for 1000V and 1500V.

23. For DC-DC converters, what are the safety mechanisms (e.g., NFPA 79) that are required in manufacturing, and how can research help address issues related to fire protection and health and safety?
24. What emerging technologies can be demonstrated to reduce the safety and electric shock risks associated with higher DC voltage operations?
25. What further research and/or analyses are required to ensure DC components/equipment protection is developed and proper guidelines are established?

EPIC Program Area and Funding

26. For each suggested area of research above, what are the initial and concluding TRLs of the technologies being recommended? What is required to advance each technology's market readiness?
27. For each suggested area of research above, what is the recommended CEC funding amount? What percentage of the funds should be provided by the recipient in terms of match?