DOCKETED	
Docket Number:	23-ERDD-01
Project Title:	Electric Program Investment Charge (EPIC)
TN #:	250971
Document Title:	Direct Current Power Systems RFI
Description:	N/A
Filer:	Lisa Cortez
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	7/7/2023 2:42:47 PM
Docketed Date:	7/7/2023

STATE OF CALIFORNIA — NATURAL RESOURCES AGENCY Gavin Newsom, *Governor*

CALIFORNIA ENERGY COMMISSION

715 P Street
Sacramento, California 95814

energy.ca.gov

Request for Information
Direct Current Power Systems
Docket # 23-ERDD-01
Due Date: August 7, 2023

Purpose of Request

The California Energy Commission (CEC) is gathering information for a potential future grant funding opportunity (GFO) focused on research needed to enable efficient power delivery for direct current (DC)-based electrical systems. The purpose is to help define critical research needs in this area and identify high-impact use cases that a future research GFO may target.

Background

DC-based power systems can improve system efficiency and achieve energy cost savings by eliminating power conversions. The GFO will aim to 1) develop key power system components such as DC circuit breakers, meters, controls, bidirectional multiport inverters (inverters that can simultaneously manage several inputs and outputs), and other power electronics; 2) enhance the interoperability of the various DC end-use devices; 3) demonstrate DC power systems for electric vehicle charging and bidirectional charging; and 4) demonstrate DC power systems for building applications with high efficiency potential. The DC power systems will reduce or eliminate the number of power conversions, associated equipment and installation, and operations and maintenance costs while enhancing the reliability of the systems because of fewer required power electronics and potential points of failure.

The CEC's Electric Program Investment Charge (EPIC) program invests in scientific and technological research to accelerate the transformation of the electricity sector to meet the state's energy and climate goals. The EPIC 2021-2025 Investment plan identified this research need under Topic 14 "Direct Current Systems for Efficient Power Delivery".

Request for Information

The following questions are designed to elicit information that will help CEC structure solicitations related to this topic. Stakeholders are not required to respond to every question of this Request for Information (RFI). In fact, stakeholders are encouraged to respond specifically to the questions they feel most suit their knowledge and background.

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.
    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.
    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.

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)?
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?
5. What kind of buildings/facilities are the best fit for early DC-based implementation and why?
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?

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?

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?
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?
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 connected DERs?
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?

How to Provide Information
Respondents to this RFI should not include any proprietary or confidential information. Comments may be submitted through 5:00 p.m. on August 7, 2023, using the e-commenting feature at docket 23-ERDD-01, at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=23-ERDD-01.

To use the e-commenting system, respondents will be asked for a full name, email address, comment title, and either a comment or an attached document (.doc, .docx, or .pdf format). After a challenge-response test is used by the system to ensure that responses are generated by a human user and not a computer, click on the "Agree & Submit Your Comment" button to submit the information to the CEC's Docket Unit.

Written comments, attachments, and associated contact information included within the documents and attachments will become part of the viewable public record and searchable on the internet.

Interested stakeholders are encouraged to use the electronic filing system described above to submit information. If you are unable to submit electronically, a paper copy of your information may be sent to:

California Energy Commission
Docket Unit, MS-4
Re: Docket No. 23-ERDD-01
715 P Street
Sacramento, CA 95814-5512

Alternatively, you may email responses to docket@energy.ca.gov with the subject line "23-ERDD-01: RFI DC Power System".

Public Advisor. The CEC's Public Advisor assists the public with participation in CEC proceedings. To request assistance, interpreting services, or reasonable modifications and accommodations, call (916) 957-7910 or email publicadvisor@energy.ca.gov as soon as possible but at least five days in advance of the workshop. The CEC will work diligently to meet all requests based on availability.

Media Inquiries. Email mediaoffice@energy.ca.gov or call (916) 654-4989.

General Inquiries: Email Liet Le at Liet.Le@energy.ca.gov or call (916) 776-0785.

Availability of Documents: Documents and presentations for this meeting will be available at the CEC's docket log for docket number 23-ERDD-01, at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=23-ERDD-01.
When new information is posted, an email will be sent to those subscribed to the EPIC Program and Energy Research and Development. To receive these notices or notices of other email subscription topics, visit Subscriptions, at https://www.energy.ca.gov/subscriptions.

Dated: June 12, 2023 at Sacramento, California.

_____
Angie Gould
Deputy Director
Energy Research and Development Division

Subscriptions:
EPIC Program
Energy Research and Development