DOCKETED	
Docket Number:	23-ERDD-01
Project Title:	Electric Program Investment Charge (EPIC)
TN #:	251507
Document Title:	Nextracker Comments - RFI for EPIC Initiative 14 Direct Current Systems for Efficient Power Delivery
Description:	N/A
Filer:	System
Organization:	Nextracker
Submitter Role:	Public
Submission Date:	8/4/2023 3:37:53 PM
Docketed Date:	8/4/2023

Comment Received From: Nextracker
Submitted On: 8/4/2023
Docket Number: 23-ERDD-01

RFI for EPIC Initiative 14 Direct Current Systems for Efficient Power Delivery

Additional submitted attachment is included below.

August 4, 2023

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

From: Alex Au, CTO and Founder, Nextracker; Jacob Morin, SVP Product Management; Jason Henry, VP Power Systems Engineering; Ramon Yll Prous, Sr Mgr. NXPP Systems Engineering

Thank you for the opportunity to respond to your Request for Information regarding DC powered buildings.

About Nextracker:

Nextracker is the leading provider of intelligent, integrated solar tracker and software solutions used in utility-scale and ground-mounted distributed generation solar projects around the world.

Nextracker pioneered smart solar tracking technology and continues to lead the industry with our design, engineering and software innovation. Our robust portfolio of intellectual property protects both our hardware and software products, and includes hundreds of granted patents and pending or published patent applications covering Nextracker's mechanical inventions, electronics & controls innovations, and software-driven, yield-improvement technologies.

Not only is Nextracker a technology and market leader, but we are actively engaged in public policy, workforce development and related issues. In an effort to improve our own supply chain as well as strengthen the U.S. solar manufacturing base, Nextracker has partnered across the U.S. to install fabrication lines dedicated to producing solar steel for our trackers.

We are a diverse group of technology innovators and clean energy activators. We are collaborative team players. We do the right thing. We are accountable and deliver results. We believe in equity and inclusion. We are committed to sustainability, decarbonization and a better tomorrow. We are Nextracker, on a mission to be one of the world's leading energy solutions companies delivering the most intelligent, reliable, and productive solar technology for future generations.

We've reviewed the entire RFI and answered where we feel qualified to provide information. Please let us know if we can provide additional information and clarification where necessary.

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)?*

NX Response:

- More DC metering options for both small & large currents and voltages. Specifically needed for 1500V and up to ~5000A (currently there are only a few companies supporting). This needs to go hand in hand with ISOs regulation. Currently it is unclear how metering will work in DC-coupled hybrid plants.
- BESS or storage resources capable to DC-couple, through non-isolated DCDC converters, to negatively-grounded DC busses.

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.*

NX Response: This technology is pretty well developed though is missing more galvanically-isolated options

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

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

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

NX Response: This is not developed enough and could use some more research and development.

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.*

NX Response: It would potentially be good to have UPS/servers capable of DC-coupling versus AC-coupling.

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.*

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

<u>*DC Adoption Pathways and Use Cases*</u>

3. *What are the most likely commercial applications for DC-based power systems in the short (3-5 years) and long terms (5+ years)?*

NX Response: Storage (e.g., batteries) in renewable energy applications.

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?*

NX Response: Utility (>50MW), Distributed (>3MW), Commercial (>15kW), and residential PV + BESS projects.

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

NX Response: In terms of utility (>50MW) it does not matter but for distributed, commercial and residential; places with a constant load or with a big load during night hours (to exercise storage discharge) would be best.

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?*

NX Response:

- Standardize components, for example EV chargers, so that multiple manufacturer components can be used interchangeably.
- Enforce utilization of Sunspec for comms/controls.

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?

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

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?*

NX Response: The opportunities are substantial, especially when resources that are currently subject to clipping losses (i.e., PV) exist or when interconnection at POI is limited.

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?*

NX Response:

- Interconnection rules, which drive decisions on EPCs, which currently are very unclear on how to deploy PV+S dc-coupled projects.
- Safety for PV+BESS in DC-coupled applications.

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?*

NX Response: Publish e-studies to prove efficiency gains for storing in DC-coupled hybrid plants (round-trip efficiencies) vs. ac-coupled. Include battery degradation to see whether there are any effects on it.

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?*

NX Response: Research into controls. Who controls the DC bus, DCDC converters, inverters, etc.?

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?

NX Response: Research into controls. Who controls the DC bus, DCDC converters, inverters, etc.?

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

NX Response: Hybrid inverters at utility scale, as most hybrid inverters are in residential applications today.

13. *What are the enabling or emerging technologies that can:*
    a. *Advance adoption pathways for DC power in buildings?*

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

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

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

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

NX Response: • NX does not have the necessary information or knowledge to provide a response to this question at this time.

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?*

NX Response: • NX does not have the necessary information or knowledge to provide a response to this question at this time.

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?*

NX Response: The opportunities are substantial, as studies should be done to see whether voltages can be pushed >1500V for PV + DC-coupled, EV-charging projects. Also, it is recommended to include this study to PV projects only.

16. *What areas of research are required to potentially accelerate adoption of DC buildings and related technologies by residential and commercial developers and customers?*

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

17. *What pertinent data (e.g., performance and cost) are required to accelerate large-scale commercialization and deployment of DC-based end-use equipment?*

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

18. *What current or upcoming communication standards or protocols should be demonstrated and/or developed to ensure successful DC-DC integration and interoperability?*

NX Response: Sunspec is very basic. Models 701-715 should be extended to include multiple types of alarms. Currently, we do not use it due to how general some of the alarm/fault categories are.

19. *What specific codes and standards will the deployment of a DC-based power system help inform?*

NX Response: IEEE1547 and UL1741 are possible codes/standards that could be "informed."

Safety and Protection

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

NX Response: See response above on grounding.

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?*

NX Response: Automatically controlled breakers/reclosers would be appropriate. SEL has some good products already in the market.

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?*

NX Response: Standardize controls of safety equipment and publish guidelines for EPCs to follow.

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?*

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

24. *What emerging technologies can be demonstrated to reduce the safety and electric shock risks associated with higher DC voltage operations?*

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

25. *What further research and/or analyses are required to ensure DC components/equipment protection is developed and proper guidelines are established?*

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.

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?*

NX Response: Standardization on controls for DC-coupled PV+BESS is key, and also, in safety, DC metering, and clarifications on grounding.

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?*

NX Response: NX does not have the necessary information or knowledge to provide a response to this question at this time.