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From: Bob Kroon
CEO and Founder, August Berres Corporation

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

About Us

August Berres manufactures cordless solutions for many applications in commercial workplaces, utilizing DC power provided by lithium-ion batteries. Our products operate at the user end point of any energy resource to power typical workplace devices such as laptop computers, monitors, induction phone chargers, sit/stand motors, printers, and other devices.

We exist largely because we believe that DC-powered buildings are an effective, sensible, and practical approach for the future.

We started our business during the outbreak of the COVID-19 pandemic when we realized that workplaces would never be the same. From customer interactions, we learned that hybrid co-working facilities would require flexibility, cleanliness, and sustainability.

During the discovery phase of our project, we realized we could power most typical offices with battery power at the point of use. Our solution eliminates cords, cables, power strips, and extension cords on the floor—a chronic pain point for most facilities for the last 40 years.

Since individual workstations are battery powered, the need for 120V AC wiring to individual workstations Is eliminated. This reduces or eliminates the need for breaker boxes, conduit, wiring and power drops, under-carpet wiring, and carpet tiles.

From a life cycle perspective, there are also benefits. When an organization invests in an AC solution, their investment stays behind if they move. It often requires expensive reconfiguration whenever they do a facility re-layout. Sometimes, the cost becomes an avoidance factor that prevents organizational change.

With a battery solution, there is no cost to change. Organizations can change or move and keep their investment.

Customers react positively. Our DC-powered solutions offer several other benefits. Historical or older buildings can be technologically upgraded without structural changes. Since there is a correlation between underserved communities and older buildings, DC power is a way to make older commercial real estate more useful.

DC-powered workstations also enable tenants and landlords to negotiate shorter lease terms as tenant improvement costs are reduced. Move-ins can be quicker. And technical businesses can locate in otherwise less-desirable buildings.

We are excited to be a part of the rapidly growing movement towards DC-powered buildings, and we believe that our products can assist greater adoption.

We answered the questions in the RFI where we felt qualified to contribute. Please reach out if you would like any more information or clarification.

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)?*

Technological Readiness

August Berres uses configurable DC power components from OE Electrics to cordlessly power commercial computerized workplaces such as office workstations, laboratories, factories, and schools. The system is modular, and components can be directly connected to each other.

Technological readiness? These products are commercially available and operate with little or no issues.

The components include a 200Wh (net) lithium-ion battery, a 120V AC to 30V DC power supply, USB-A and USB-C outlets, induction phone charger (wireless), a constant 19.2V DC power supply compatible with Samsung and LG monitors, connections to sit/stand mechanisms, and a DC to 120V AC inverter with a 3-receptacle outlet.

All these components are available for deployment except the inverter. The inverter is expected to be available in Q42023.

With these components, using a single 21-cell battery pack, the system can simultaneously power an office workstation with a laptop, 27” monitor, phone charger, and sit-stand desk for 6 hours (calculated using manufacturer power consumption specifications). We believe the published specs to be overstated as our users report as much as 8 hours of constant usage on a single charge. Some users are also using dual monitors with no issue.

For users with greater power needs, discharged batteries can be swapped with charged batteries without the use of tools. Alternatively, systems can be configured with more than one battery as they can be daisy-chained to provide more Watt-hours of use.

The system Is safe. When fully charged, the batteries operate at 29V. When discharged, 21V. Short circuit and heat detection are included to prevent abuse that could cause injury or property damage.

The system components have also been designed, tested, and manufactured in accordance with every known certifying agency in the world. Go here for more details.

Suggestions for Advancing Technological Readiness

- When portable batteries are used to power workstations and other devices in buildings, the rules should mandate charging up to 90% of gross battery capacity and discharging to 10%. This practice extends the life of lithium-ion batteries. Most users will retain 80% of the battery capacity after ten years of use if this logic is incorporated into the design. There are products marketed that are irresponsibly designed and do not incorporate this control logic. Some have a life span as short as 18-24 months. Banning these from use in buildings would make sense from a circular economy perspective.
- For safety reasons, heat and overcurrent protection should be a requirement as part of any battery power system.
- Certain components, particularly USB-A and USB-C receptacles, should be replaceable without impacting other system components as these have a history of frequent failure. Some existing products in the market do not have this feature and a receptacle failure renders the entire battery power system to fail.
- All further research and demonstration should build upon work previously completed by the Emerg Alliance, the PoE Consortium, IEEE, and Underwriters Laboratories.
- Monitors and Displays are the typical office workplace devices that consume the most power. Some display products use external power supplies and others internal power supplies. The designs using external supplies can be directly connected to a DC system. Monitors that use an internal power supply require 120V connections. To use these, a DC building would needlessly require inverters to convert DC power to AC power just for interconnection. DC-powered buildings should use DC-powered workplace devices.

Commercial Demonstrations

In its efforts to market cordless power solutions to customers, August Berres is learning that its workstation DC power solutions are technologically ready, but customer lack of knowledge and reluctance persists. While there are many meaningful benefits to DC power, AC power is the incumbent technology, used for over 100 years.

Demonstration installations, case studies, and public relations campaigns are the only way to overcome the resistance to change. Financial incentives for DC powered buildings should allocate at least 80% towards demonstration projects, and not more than 20% towards further research.

There are five existing technologies that are important to a DC Building Demonstration.

1) Building Microgrids (solar and/or wind plus battery storage) for onsite generation of power,
2) PoE (power over ethernet) for power distribution (current standard is 90W, 120W pending but expected in 2024),
3) IoT (internet of things) sensor devices that detect such things as occupancy, air quality, and safety, for example. Sensor information is passed to software in the cloud that decides to actuate devices power by PoE,
4) Fault Managed Power Systems a.k.a. Class 4 Power that enables devices that use more than 90 (or 120) Watts to be powered with PoE cabling, and
5) Cordless-Powered Workplaces using batteries at the point of use, the market segment targeted by August Berres. For a more detailed explanation of these, go HERE.

Separately, each of these technologies has merit, but there would be far greater value to demonstrations where all of them are combined into one building. We recommend a holistic approach to the topic of DC-powered buildings.

Commercial demonstration projects could be in new or retrofitted into existing buildings. Demonstration projects in older buildings should be given priority as older real estate tends to correlate with underserved or rural communities.

There are also more opportunities with older buildings. Most construction that occurred before the mid-1990's did not consider the impact of the internet and the widespread use of computers and other devices in every workplace.

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.*

   No comments.

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

   No comments.

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

No comments.

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.

This would be imperative. There is no reason to waste power converting from DC to AC to DC power.

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 end-use equipment is particularly important to a DC powered building. The alternative is to use inverters to change from DC to AC power. “DC Building Compliant” could be a labeling and/or specification requirement for end-use equipment. There could be multiple classes of compliance.

- Devices that can directly connect to PoE,
- Devices that can connect to Fault Managed Power Systems (Class 4), and
- Devices that require 120V power.

A classification system would assist buyers to select devices appropriate for DC buildings.

Device specifications should also clearly state the Maximum Wattage and Typical Operating Wattage of the device to make it easier to match the appropriate DC power delivery technology with the device. If a device consumes power on an intermittent basis (refrigeration, for example), the daily Watt-hour requirements should be clearly indicated.

Some DC devices can be powered with a range of voltages. Others require a specific voltage. Device specifications should clearly state the input voltage requirements of the device.

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)?*

3-5 Years (should be 0-5 years):

1. Vehicle Charging
2. Commercial Offices and Co-working Facilities
3. Certain laboratories and R&D facilities
4. Certain retail stores
5. Digital advertising
6. Audio-visual displays
7. Trade shows, convention centers, event venues
8. Process command and control centers
9. Security systems
10. Street and Parking Lot lighting, Traffic Control Devices
11. Light Manufacturing
12. Hotels
13. Irrigation
14. Rooftop Agriculture, Urban Agriculture
15. Tiny House communities

5+ Years

1. Restaurants
2. Heavy Manufacturing
3. Heavy Transportation
4. Data Centers

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?*

See answer to question 5.

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

- Any building undergoing a clean energy retrofit such as a school. Since DC power is more efficient in the way power is consumed, the amount of generation can be reduced and funds for retrofits can extend to more buildings.
- College and university buildings, particularly historical buildings. Some studies conclude that over 50% of existing buildings need upgrading. DC power technologies can provide upgrades and reduce the need for structural changes. Decisions to build new buildings might be avoided if the cost and feasibility of retrofitting an older building is reduced.
- Buildings that exceed 30,000 square feet. A certain amount of any installation is a fixed cost so the cost per square foot of installing DC technology in a larger building will be less than in a smaller building.
- Buildings that are structurally sound and capable of a longer life.
- State, County, and Local Government buildings, particularly high profile facilities or highly trafficked facilities such as DMV buildings to maximize the impact of the DC power demonstration on public opinion and acceptance.
- Facilities designated for disaster shelters to provide resilience.
- Older commercial buildings, especially in downtown urban areas. Vacancy rates are higher on older buildings that need technology upgrades.

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?*

- Large commercial real estate owners. This is a small fraction of the public that can generate a substantial impact. Solicit owners to submit buildings for demonstration projects. Create a weighted scoring system to identify the best candidate buildings and provide owner-matched grants for DC conversions. Consider building age (older is better), building size (bigger is better), technologies to be included (more is better, extra consideration for using five technologies)), community impact (underserved is better), and importantly, annual reduction in power sourced from the grid (greater reduction is better).
- Enable and incent California's Community Choice Aggregators (CCAs) and Investor Owned Utilities (IOUs) to own and operate DC building/community microgrids and sell power to building owners with a power purchase agreement. Reduce and associate the grid interconnection charges for actual usage for facilities designed to mostly "island" from the grid. Allow the CCAs and IOUs to operate DC microgrids outside their service areas. Eliminate interconnection charges for DC powered buildings designed to completely "island" from the grid.
- Allow other qualified entities, in addition to CCAs and IOUs, to own and operate DC building/community microgrids that serve multi-customer buildings.

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?*

No comment.

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?*

    - Create a software simulation tool that allows an electrical contractor estimator to compare the cost of a DC-powered building to an AC-powered building. Include operating impacts such as reducing peak loads and purchasing power during peak time periods.
    - Create a software simulation tool that enables a building designer to determine the amount of battery storage necessary to "island" a building for ~99% of expected weather patterns incorporating generation capabilities and consumption patterns. This would enable a building to be completely off the grid (no interconnection required). Designing for 100% uptime would require extra costs for the infrequent instances where inadequate generation and extra-high consumption patterns are coincident.

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?*

- Building Microgrids (solar and/or wind plus battery storage) for onsite generation of power. This is a high priority because approximately 30% of the energy generated by distant sources is lost to the inefficiencies of the grid.

- PoE (power over ethernet) for power distribution (current standard is 90W, 120W pending but expected in 2024). This is a high priority because PoE power can power many devices and is a particularly good fit for lighting. Since lighting is present in every room in a building, this means PoE cabling can also be present. If this was the existing distribution in a building, there would be little incremental value for adding expensive AC wiring.

- IoT (internet of things) sensor devices that detect such things as occupancy, air quality, and safety, for example. Sensor information is passed to software in the cloud that decides to actuate devices power by PoE. These devices are a priority because they can detect the need for power and trigger system actions when power is needed/not needed in a section of a building. They eliminate much of the need for human intervention.

- Fault Managed Power Systems a.k.a. Class 4 Power that enables devices that use more than 90 (or 120) Watts to be powered with PoE cabling. This is a high priority because PoE power sufficient to many devices but not all devices. Class 4 power expands the range of devices that can be powered.
- Cordless-Powered Workplaces using batteries at the point of use. This is a high priority because it eliminates most, if not all, of the remaining need for AC power in a building. A single pair of wires from Class 4 power is sufficient infrastructure to charge a quantity of 24 200Wh (net) batteries in eight hours (overnight).

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?*

There should be a "power routing" device, controlled by a cloud-based algorithm that directs the DC system to power the building directly from the DER, from the building's "master" battery system, or from a grid interconnection.

The algorithm should take into account the state of the master battery charge, the season of the year, the time of day, the weather forecast, and the planned occupancy for the near future.

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?*

No comment.

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?*

No comment.

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?*

We do not see a reason for mixed DC/AC topologies except for unusual circumstances. As noted previously, every typical device can be powered with DC power.

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

We believe DC systems are stable and there are no technological advancements necessary.

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

    See the answers to question #1 and question #9.

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

    No comment.

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

    The interconnection of a building microgrid with a community microgrid is a concept that adds complexity. We suggest this notion be considered in 3-5 years.

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?*

A well-designed DC building that includes DERs, batteries, and the five important DC technologies should not require EVs for supplemental power. The concept does not save energy as the EV itself must eventually be recharged.

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?*

If standard voltages are established, standards for connectors should also be established. Note the success of the USB-C for widespread adoption. It has become a world-wide standard, not just North America, Europe, or Asia. Any standards should harmonize with other standards around the world. California should support, encourage, and demand development of standards as they are in the best interests of consumers.

The goal of researching and establishing standards should be to *eliminate* the integration risks in combining the five important technologies. All the components for a DC building should fit into a “plug and play” methodology. If a building owner sees integration risk in adopting DC power, they will be hesitant to commit.

We believe there is enough progress in the DC building industry to act on this sooner than later. Five years seems too long. DC buildings can have an enormous impact and an accelerated effort would be appropriate.

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

Case studies, supported by data show the savings of DC buildings in operating expenses, build-out costs, and life-cycle costs.

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

See the answer to #16.

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

- DER to EV connections.
- DER to PoE connections.

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

No comment.

Safety and Protection

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

No comment.

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?*

No comment.

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?*

No comment.

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?*

No comment.

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

No comment.

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

No comment.

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?*

No comment.

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?*

No comment.