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Behind-the-Meter Renewable Backup Power Technologies â€“ Request For Information

Additional submitted attachment is included below.

SPAN appreciates the opportunity to respond to the CEC's inquiry regarding behind the meter zero emissions backup technologies. Prior to answering specific questions, we would like to provide a general overview of the product and company:

COMPANY AND PRODUCT OVERVIEW

SPAN creates hardware and software products to enable home electrification, load management, and customer engagement. The company was founded by the former head of Tesla's energy storage business, along with executives and engineers from Tesla, Sunrun, Nest and Amazon. SPAN has provided smart panels to homeowners across the USA, with installations in over 35 states. In October 2022 SPAN released a new product, SPAN Drive, to give SPAN Smart Panel owners the simplest path for fast, smart, Level 2 EV charging, continuing our mission of electrifying homes and enabling home loads to be fully flexible.

SPAN is backed by numerous leading investors in clean energy, hardware, and software, including Amazon Alexa Fund, A/O PropTech, ArcTern Ventures, Capricorn Investment Group, Congruent Ventures, Energy Foundry, Hardware Club, Incite Ventures, Munich Re Ventures, TDK Ventures, Ulu Ventures, Wells Fargo Strategic Capital, Wireframe Ventures, and 1/0 Capital. To date, SPAN has received more than $133 million in strategic investments, and has more than 100 employees.

SPAN has received numerous industry awards and recognitions, including several recent announcements:

- Fast Company's 2022 **World's Most Innovative Companies**
- NAHB International Builders' Show: **2022 Best Energy Efficient Product**
- NAHB International Builders' Show: **2022 Best Home Technology Product**
- CES 2022 Innovation Awards (Honoree)

SPAN SMART PANEL - ENABLING ELECTRIFICATION AND RESILIENCY

The SPAN Smart Panel is a one-for-one replacement of the traditional residential electrical breaker box with powerful intelligent technology -- enabling **circuit-level, revenue-grade metering and real-time control** at the whole-home level. The SPAN Smart Panel is purpose-built to facilitate customer engagement, along with simplifying the installation of DERs, and enabling whole-home electrification and resiliency without requiring utility service upgrades. During outages, the SPAN Smart Panel optimizes battery backup protection through customer-driven dynamic load prioritization. Our hardware is intentionally designed to be simple to install, with aesthetics that customers are excited to

have in their home, and there are thousands of panels deployed across the US today, including hundreds in California.

Performance Specifications

AC Voltage (Nominal)	120/240 V
Grid Connection	Split Phase
Grid Frequency	60 Hz
Disconnect Current	200 A
Busbar Rating	225 A
Sub-feed Lug Rating	200A max
Maximum Input Short Circuit Current	22 kA[1]
Main Overcurrent Protection Device	100-200 A Breaker[2]
Controllable Circuits	32 (90 A max per breaker)[3]
Overvoltage Category	Category IV
AC Metering	ANSI revenue accurate (+/- 0.5%)
Primary Connectivity	Ethernet, WiFi (2.5, 5 GHz)
Secondary Connectivity	Cellular (4G/LTE, 3G)
User Interface	Span Home App (iOS, Android)
Warranty	10 years

1 22 kA RMS symmetrical with main breaker installed, otherwise 10 kA
2 Service Entrance Rated when main breaker installed
3 Compatible with tandem/quad style breakers at all positions. Monitoring and control is combined when used.

Environmental Specifications

Operating Temperature	-22 to 122°F (-30 to 50°C)
Operating Humidity (RH)	Up to 100% condensing
Maximum Elevation	2000 m (6562 ft)
Environment	Indoor and Outdoor rated
Enclosure Type	NEMA 3R

Mechanical Specifications

Enclosure Dimensions	39.3 x 14.3 x 6.0 in (998 x 362 x 153 mm)
Flush Trim Kit Dimensions	44.2 x 15.9 in (1123 x 405 mm)
Mounting Options	Wall mounted, flush or surface
Weight	75 lbs (34 kg)

Compliance Information

Certifications	UL 67, UL 916, UL 869A
Emissions	FCC Part 15 Class B
Other	NEC compliant

Additional Features

- Customizable Battery Backup
- Backup Time Remaining Estimates
- Real-time Load Control
- Energy Monitoring & Insights
- Load Management for Upgrade Avoidance

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PN 1-00800-XX | REV. 2021-11-29

The SPAN Smart Panel is the only smart panel that offers *all* of the following capabilities:

- Is certified to **all relevant UL safety standards** related to smart panels:
    - UL 67 (Panelboards)
    - UL 916 (Energy Management Equipment)
    - UL 869A (Service Equipment)

- Provides real-time monitoring, control, and energy insights for **every branch circuit in the panel** (vs. being limited to a small number of circuits) -- with the ability to remotely turn circuits both on *and* off. This unique capability is essential for customers, who we have found want to understand their entire home's energy usage rather than just a part of it. We have observed high and persistent customer engagement with the SPAN mobile app due to this capability, and we can make this data available to utility customer apps or other 3rd party sites via API.

- Directly integrates with solar PV, EV charging, and leading battery energy storage systems, providing **real-time insights on all distributed energy resources** available at the customer site.

- Acts as a **one-for-one replacement** for a traditional load center, to ensure ease of installation without needing to add unnecessary boxes to a customer's wall.

- Is fully self-contained as a **complete electrical panel**, certified for installation indoors or outdoors (NEMA 3R rated), without requiring the installation of CTs, etc.

- Uses **standard, off-the-shelf circuit breakers** -- including AFCI/GFCI and tandem/quadplex (vs. requiring expensive, custom, or proprietary breakers with limited functionality and form factors)

- Supports **up to 90A breakers** in each of its 32 breaker slots (vs. being limited to 60A or lower) -- enabling faster EV charging, as well as simple control and monitoring of 75A+ sub-panels that are common in many homes.

- Has **robust, persistent internet connectivity** for high-fidelity monitoring via ethernet, wi-fi, and cellular connections

In addition, the SPAN Smart Panel provides key functionality that enhances the value proposition:

- SPAN panels are specifically designed to be able to be installed in any home, without limitations on location, configuration, or the need to be compatible with an existing

panel in the home. The SPAN Panel (or panels) can be installed either as a direct replacement for a standard panel, or in the case of meter/load center configurations, as a subpanel adjacent to the meter. And when configured with subpanels larger than 90A, the SPAN panel includes subfeed lugs rated for 200A.

- SPAN panels can enable whole-home electrification without costly electrical service upgrades and/or utility distribution system investments. We can support much higher levels of electrification than would otherwise be possible by intelligently limiting the home's demand to prevent simultaneous operation of multiple large electric loads -- for example, the EV charger can be temporarily "paused" when an induction cooktop is turned on.
- The SPAN panel provides a comprehensive view of all electrical end-uses in the home, providing utilities with data to target customers for specific DSM programs. For example, if a customer doesn't have an active EVSE circuit, then that customer may be a potential opportunity for an electrification program -- or if a customer has an electric resistance water heater, they may be a candidate for a heat pump water heater program. (This capability is impossible without a full view of all circuits in the home.)
- The SPAN panel integrates with on-site batteries to make intelligent decisions based on the battery state of charge. For example, in an outage the SPAN panel can shed certain unnecessary loads when the battery is in a low state of charge to save power for refrigerators and other critical loads, then automatically turn those loads back on when the battery recharges. This capability is unique to SPAN due to the integrations SPAN has developed with leading battery providers.

SPAN SMART PANEL: SPECIFICATIONS

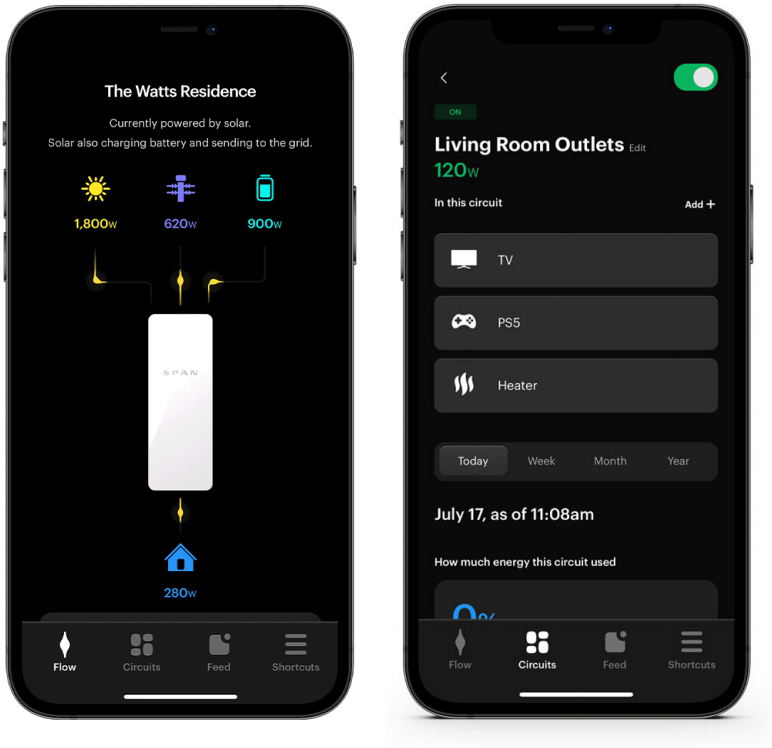
Please reference the sheet on the following page for detailed specifications related to the SPAN Smart Panel.

Currently, SPAN Smart Panels can be controlled via the customer app, or through our secure fleet management platform (SPAN PowerAssist). Connectivity between SPAN's cloud server and SPAN Smart Panels is provided through the customer's internet gateway (through either the customer's Wi-Fi or hardwired ethernet connection) -- if customer internet is unavailable, the SPAN Smart Panel can communicate through an integrated 4G cellular connection. By Q4 of 2022, we expect to release functionality for local control of SPAN panels using the customer mobile app connected via bluetooth.

Note that the SPAN Smart Panel uses standard circuit breakers; **these breakers are not included with the panel** -- for installations where the SPAN panel is being installed as a replacement for an existing panel, circuit breakers can often be reused; alternatively, the installer can specify and purchase breakers appropriate for the specific home's requirements.

SPAN CUSTOMER APP

To support customer interaction with the SPAN Smart Panel, we have developed a robust mobile application (available on the Apple App Store here, or the Google Play store here).



Screen views of SPAN customer app

The SPAN customer app includes features designed to maximize user value and engagement such as:

- Remote control of the home's circuits
- Monitoring of solar generation in real time
- Ability to manage battery backup during an outage
- Enhanced control over backup battery storage and usage
- Understanding home energy usage with insights, anomalies, and trends

More information on the SPAN customer app is available at this link.

SPAN has a number of certified installers available in California already, and also has a dedicated installer support team that can provide comprehensive training and support of the installation for future installers.

1. *What are key barriers to behind the meter (BTM) zero-emission renewable backup for critical loads? Is the lack of standardized solutions a primary barrier for permitting and interconnection?*

Key barriers to BTM zero-emission renewable backup include:

1. Permitting timelines and complexity for zero-emission systems
2. Initial customer expectations that they will have access to backup power for all loads in their home
3. Home layouts and difficulty relocating loads
4. Space taken up in a customer's garage or other part of the home due to the complexity of installing a utility meter, site meter, main panel, backup loads panel, battery, inverter, and transfer switch on the wall

To date, there has not been technology available that seamlessly enabled consumers and small businesses to identify and manage critical loads within their homes/businesses during outages. SPAN is a relatively new market entrant, producing smart panels that enable consumers to choose which loads to back up in an outage, and change those loads. This means that customers can choose to back up different loads during the day (e.g. HVAC) and night (e.g. lights), and enables them to access all loads in their home. In addition, the SPAN Panel includes a Microgrid Interconnection Device (MID) which can perform the same function as a transfer switch - being the grid disconnect - without requiring additional hardware. SPAN can also enhance the duration of their battery backup by over 40% by identifying the crucial loads to keep running during an outage. Please view this article and associated video for a case study from New Orleans.

Overall, Smart Panels such as SPAN can create a standardized main panel / backup panel that obviates the need for individual review of which loads are backed up and which are not, while also creating a single standardized grid disconnect.

2. *What are the current opportunities for standardizing design of how BTM backup systems interconnect with the distribution grid while enhancing safety and managing operational constraints?*

Currently, each BTM backup system is bespoke because customers must choose specific loads to be backed up and not backed up, then hard wire those loads. This creates a need to review individual plan sets, each with a different set of loads in the “backup loads panel”. Smart Panel technology such as SPAN can standardize the interconnection by creating a virtual “backup loads panel” - the hardware approved in permitting and interconnection remains the same, while software enables the customer to choose which loads are backed up.

With a Smart Panel certified to UL 67, UL 867A, and UL 916, safety can be maintained by ensuring that individual loads retain the hardware-based breakers used across the country today. Safety can be enhanced through software that tracks total load on the system and pauses or disconnects loads before electrical current trips the traditional hardware-based breaker safety system, adding an additional layer of protection.

3. *If the CEC issues a solicitation in this research space, should there be carve outs for specific technologies or technology bundles targeting specific performance metrics (e.g., separate groups each targeting a technology such as critical load panels, switchgears, and multi-mode inverters)? How should technologies be bundled, and what metrics should be targeted?*
4. *If the solicitation included multiple groups, how should those groups be structured? Some examples below:*
    1. *Multiple-group solicitation:*
        1. *One group for Applied Research and Development (ARD) projects that would pilot emerging technology in a controlled environment and engage with stakeholders, including CBOs and municipalities.*
        2. *Another group for Technology Deployment and Demonstration (TDD) projects that would roll-out and implement technology mature enough to seek rapid-deployment for near-term benefits.*
    2. *Multiple-group solicitation in which each group is defined by a particular site characteristic or use case. Examples could include: urban and rural, residential and commercial, various climate zones.*

The technology needed to achieve the CEC goals of carbon-free backup power to critical loads for consumers and small businesses is already available and in market today. SPAN recommends deployment of packages including solar, inverters, batteries and smart panels across consumer groups (single family residential and small commercial) in all different climate zones to prove out the resiliency use case.

The following will help target specific technology advancement research:

5. *EPIC 4 Initiative 15 mentions specific potential research areas for BTM backup technologies, listed below. What is the current state of the each technology, and what research and design considerations are required to advance the technology and market readiness of each?*

1. *Customary electrical equipment, such as critical load panels and meters, that are integrated with multi-mode inverters with enhanced islanding functions.*

The SPAN Smart Panel is currently compatible with all solar inverters. In order to give end customers and utilities visibility into on-site resource capacity, SPAN has chosen to tightly integrate with leading batteries, rather than just be "compatible," meaning that the SPAN panel and the battery can actively communicate with each other regarding state of charge, grid status, and other essentials of home energy management. This capability uniquely enables SPAN partners to have a single view of all DERs on site. SPAN currently has active integrations with batteries covering an estimated 90% of the market: Tesla, LG, and SolarEdge. We anticipate soon having an integration with the next largest company, Enphase, and during 2022, we expect to announce compatibility with several additional leading inverter and storage systems on the market.

2. *Standardized switchgears and/or integrated power centers that can be rapidly deployed at several locations with minimal alterations.*

Standardized grid disconnects integrated into load centers are available in market today. Smart Panels such as SPAN can be deployed in residential and some small commercial applications today. This technology integrates the Microgrid Interconnection Device / grid disconnect into the main panel, which uses the individual monitoring and control capabilities to also be the backup load panel and site meter.

3. *Multi-mode or hybrid inverters with built-in battery storage backup system capabilities.*

6. *What is the current Technology Readiness Level (TRL), or state of technology, for meter collars (i.e., electrical equipment that plug-in directly between a meter and its meter socket) that streamline the integration of solar PV, battery energy storage, electric vehicle charging, and other DERs?*
    1. *What research is needed to advance the TRL of this technology towards commercialization?*
    2. *How broad is the market – are multiple technology vendors developing this technology?*
    3. *What design considerations and advanced functionality may be useful enhancements to this technology going forward?*
    4. *What would be the highest-impact demonstration use cases for which advanced meter collar functionality could be validated in the field?*

Meter collars are an acceptable solution to add an individual load to a home. However, these solutions are suboptimal if targeting either:

- Customizable backup, where they do not enable the customer to choose what they back up
- Adding additional electrification over time. For example, a meter collar could be used to add an EVSE, but if the desired outcome is to then fuel switch to an

induction cooktop, water heater, heat pump HVAC, and / or electric dryer, then an individual meter collar will only be a temporary solution

7. *Would integrating multi-mode inverters and islanding functions into critical load panels increase system reliability and ease installation while reducing overall system costs and complexity? What design considerations, technology development, and performance metrics are necessary to achieve this?*
8. *What would be the most strategic form of implementation for the next generation of critical/smart load panels?*
    1. *Specifically designed to power essential loads and/or small devices during a grid outage?*
    2. *Built-in switchgear to facilitate islanding of a mini-microgrid?*
    3. *Facilitate ease of retrofitting existing, older buildings that have outdated/legacy electrical panels?*
    4. *Other potential areas not covered above?*

SPAN agrees that use cases 1, 2 and 3 are essential and not mutually exclusive. SPAN is a simple swap of the existing electrical panel in single family homes and small commercial establishments and can meet the requirements of 1, 2, and 3 above today. The technology is capable of powering essential loads in a dynamic fashion. For example, during a short-duration outage, customers may elect to have their whole house powered, whereas during a PSPS event, consumers could elect to only power the most essential equipment; medical equipment, HVAC, etc.

Today in California, hundreds of thousands of traditional electrical panels are installed or replaced each year. In the majority of those cases, instead of being replaced by a panel that enables backup, they are replaced by another traditional electrical panel. This is a major missed opportunity, as each of those replacements is now a household that must make further changes to be backup-ready and electrification-ready in the future.

Overall, the most strategic form of implementation of the next generation of smart panels would be to build a Technology Demonstration and Deployment program that targeted all panel swaps and new builds happening in the state. This program could incorporate contractor education, incentives, fast-tracked interconnection, or other policy measures to ensure that traditional panels are replaced with technology that will enable backup and electrification in the future - smart panels.

9. *What is the current state of technology for portable battery storage systems that can serve as a direct replacement for portable diesel generators?*
    1. *What design considerations or modifications are necessary to allow the portable battery storage system to charge directly from the rooftop solar PV during a local grid outage with plug-and-play functionality?*

10. *What are some examples of emerging technology solutions not previously mentioned in this RFI that could streamline interconnection and permitting for BTM solar-paired energy storage or other zero-emission backup power? To what extent have these technologies been validated in the field?*
11. *What BTM renewable backup power technology is mature enough to move forward from pilot-scale (ARD) to technology demonstration-scale (TDD)?*

The following will help identify high-impact use cases for this research to target:

12. *What applications or use cases might be the best fit or highest priority for achieving easily replicable solutions with maximum impact? For example:*
    1. *Multifamily housing and community centers.*
    2. *Emergency facilities in wildfire-prone areas.*
    3. *Manufactured homes.*
    4. *Critical loads in common areas affected by Public Safety Power Shutoffs.*
    5. *Homes in under-resourced communities with outages higher than the utility average and/or that are subject to extreme heat conditions.*
13. *What are the most significant barriers (technical, cost, design, permitting, etc.) to integrating BTM backup power in the various sectors (e.g., residential, rural) and use cases mentioned above? What unknowns can be illuminated through research? Please be as specific and concise as possible in your response.*
14. *What factors need to be considered when deploying BTM generation at different climate zones and environments? How might technology solutions vary depending on the climate zones in which they are sited? What research is needed for modular, standardized BTM generation equipment to address the unique needs of California's various climate zones?*
15. *What are the most significant barriers to integrating BTM zero-emission backup power in under-resourced communities (low-income, disadvantaged, tribal)? What technology solutions or research areas could overcome these barriers?*

As noted above, these BTM/distributed energy technologies are all available and in market today, but deployment has often been difficult because of the need to ensure consumer/community awareness, coordination with electricians etc. With the implementation of IRA funds, in combination with other state and federal funding targeted towards environmental justice and carbon-reduction, there is now an opportunity to deploy packages of these technologies at scale; however it will require a concerted effort at the local level to raise awareness that these technologies are available, develop interest and secure a fleet of electricians and installers to deploy quickly.

16. *How can BTM generation (with optionally paired storage and additional DERs) be designed and streamlined to be more effectively deployed at multitenant rental properties?*
    1. *What ownership structure mechanisms would need to be put in place and how would this ensure that tenants receive benefits?*
    2. *Please list any examples of real-world implementations, including both good examples worth replicating and cautionary tales worth learning from.*