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Intelli-Trailers as Mobile Renewable Backup Generators

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PREFACE

The California Energy Commission's (CEC) Energy Research and Development Division supports energy research and development programs to spur innovation in energy efficiency; renewable energy and advanced clean generation; energy-related environmental protection; transportation; and energy transmission and distribution.

In 2011, the Electric Program Investment Charge (EPIC) was established by the California Public Utilities Commission to fund public investments in research to create and advance new energy solutions, foster regional innovation, and bring ideas from the lab to the marketplace. The EPIC Program is funded by California utility customers under the auspices of the California Public Utilities Commission. The CEC and the state's three largest investor-owned electric utilities — Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Edison Company — were selected to administer the EPIC funds and advance novel technologies, tools, and strategies that provide benefits to their electric ratepayers.

The CEC is committed to ensuring public participation in its research and development programs to promote greater reliability, affordability, and safety for California electric ratepayers. EPIC investments advance these values by:

- Providing societal benefits.
- Reducing greenhouse gas emissions in the electricity sector at the lowest possible cost.
- Supporting California's loading order to meet energy needs, first with energy efficiency and demand response, next with renewable energy (distributed generation and utility-scale projects), and finally with a clean electricity supply.
- Supporting low-emission vehicles and transportation.
- Providing economic development.
- Using ratepayer funds efficiently.

Intelli-Trailers as Mobile Renewable Backup Generators is the final report for the Intelli-Trailers as Mobile Renewable Backup Generators project (EPC-22-008) conducted by the LEAP Institute. The information from this project contributes to the CEC Energy Research and Development Division's EPIC Program.

For more information about the Energy Research and Development Division, please visit the [CEC's research website](http://www.energy.ca.gov/research/) (www.energy.ca.gov/research/) or [contact](mailto:ERDD@energy.ca.gov) the Energy Research and Development Division at ERDD@energy.ca.gov.

ABSTRACT

The California Energy Commission funded the Latino Equity, Advocacy, & Policy Institute (LEAP) to design, develop, field test, and deploy in communities a mobile renewable backup generation system. Branded as the LEAP “Intelli-trailer,” the product is a canopied solar-plus-battery trailer designed to provide shelter and clean, reliable, zero-emission backup power in areas affected by Public Safety Power Shutoffs, wildfires, grid outages, and rural energy insecurity. The project conducted multi-season field testing in three climate zones, assessed operational performance, collected real-world user data, delivered workforce training, and demonstrated tangible energy-equity benefits for disadvantaged communities. Key findings confirm that the Intelli-trailer can replace small diesel generators for a broad range of emergency and non-emergency applications, while reducing operating costs, emissions, noise, and safety risks.

Keywords: mobile renewable generation; trailer-mounted solar generator; MORBUG; Intelli-trailer; clean backup power; Public Safety Power Shutoff (PSPS); disadvantaged communities; lithium-ion battery storage; portable solar canopy; emergency resilience; workforce development; technology transfer; zero-emission power systems

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EXECUTIVE SUMMARY

Background

California's rural and disadvantaged communities are disproportionately affected by grid vulnerability, wildfires, and Public Safety Power Shutoff (PSPS) events. Diesel generators common in emergency and field operations produce emissions, volatile fuel costs, safety hazards, and noise. To address these challenges, the Latino Equity, Advocacy, & Policy Institute (LEAP) developed the Intelli-trailer, a mobile, modular, solar-powered trailer, also known as a Mobile Renewable Backup Generator (MORBUG), that provides electricity, connectivity, shade, environmental monitoring, and communications without using fossil fuels.

The overarching goal of the project was to advance community resilience by providing clean, mobile backup power that reduces dependence on diesel generators during outages and PSPS events, with associated reductions in greenhouse gas emissions and improvements to local air quality. The project aimed to build technical and economic capacity within disadvantaged communities by integrating hands-on workforce development in solar installation, fabrication, and electrical systems, enabling local residents to participate directly in the clean-energy economy. Equally important was the goal of addressing long-standing social and environmental justice inequities by delivering reliable, accessible, and community-driven energy solutions to populations historically most burdened by air pollution, extreme heat, energy insecurity, and climate-related disruptions.

Project Purpose and Approach

The purpose of the project was fourfold:

1. To develop a mobile, zero-emission backup power system capable of replacing small diesel generators during outages.
2. To fabricate and operate four (4) of these systems in a disadvantaged community as defined by CalEnviroScreen (>75%, meaning that the community has a combined level of pollution burden and population vulnerability that is higher than that of at least 75 percent of other census tracts).
3. To demonstrate and validate the performance across three distinct California climate zones (CZ), with multi-season field evaluations spanning winter, spring, summer, and fall.
4. To address environmental justice and social-equity challenges by providing clean power, shade, cooling, Wi-Fi access, environmental monitoring, and safer deployment options in communities disproportionately exposed to the impacts of PSPS events.

LEAP's approach combined engineering design, community-based fabrication, workforce training, and rigorous field measurement. Each Intelli-trailer was equipped with six (6) Mitsubishi PV-MLE275HD2 rigid solar panels (each 1.95 m × 1.0 m / 77 in. × 39 in.) plus supplemental SunPower flexible panels, for a total installed photovoltaic (PV) capacity of 2.4 kilowatts (kW). The base battery configuration used two Bluetti AC500 power stations paired

with two B300S battery modules, providing 6.1 kilowatt-hours (kWh) of lithium-ion (Li-ion) storage and 2.4 kW of continuous alternating current (AC) output with receptacles for 12-volt (V), 110V, and 240V loads, including a 6-kW electric vehicle charging outlet. The system is modular and expandable; adding a second pair of B300S batteries doubles the storage to 12.2 kWh and it can be expanded to 36 kWh. As a practical runtime example, the base 6.1-kWh system can power a 1,000-watt (W) device (such as a space heater or the equivalent combined load) for approximately six hours. In typical field deployment, however, the continuous solar recharge kept pace with daily consumption across all three CZ and all seasons, with batteries generally remaining at near full charge throughout the day.

Design decisions were made following a systematic review of commercially available mobile solar and battery systems, evaluating what was on the market, what it cost, and what potential users in the field actually needed. LEAP assessed competing PV panels, battery platforms, inverters, and structural components against criteria that included unit cost, durability, ease of use, modularity, and supply-chain availability. The Bluetti battery system was selected for its off-the-shelf plug-and-play integration, competitive cost, and scalable architecture. Solar panel selection balanced power output, physical footprint, and affordability. Throughout the process, LEAP incorporated input from its Technical Advisory Committee (TAC) and community stakeholders to ensure that the final configuration aligned with both technical performance requirements and the practical needs of disadvantaged community users.

Intelli-trailer units were assembled in Huron, California, a high-burden disadvantaged community, and deployed in CZ 12, 13, and 16 to test power generation, battery performance, canopy functionality, environmental sensors, Wi-Fi connectivity, ease of setup, transportability, and real-world usability. LEAP used a structured measurement, verification, and optimization plan with 16 technical and community metrics to evaluate the MORBUG Intelli-trailer performance during two-week deployments in each season. This approach enabled LEAP to test the MORBUG Intelli-trailer units under varied solar, temperature, terrain, air-quality, and user-demand conditions while ensuring that the evaluation remained grounded in the needs of disadvantaged communities most affected by PSPS events.

Key Results

From 2023 to 2025, LEAP designed, constructed, and tested four (4) Intelli-trailer units across multiple CZ in three (3) communities (Huron, Angels Camp, Paradise Cove), four (4) seasons (winter, spring, summer, fall), and different use cases, including emergency backup power, agricultural operations, and community events. The results demonstrate that Intelli-trailers can reliably deliver multi-hour renewable energy to charge small devices and tools and to support medical, communication, and lighting needs. Additionally, the Intelli-trailer can provide Wi-Fi, air-quality data, and weather monitoring. Specific results include the following.

- **Reliability Across Three CZ:** The Intelli-trailers operated successfully as designed in Huron (CZ 13), Angels Camp (CZ 12), and Paradise Cove (CZ 16), capturing performance across fog-prone agricultural regions, foothill wildfire-prone terrain, and high-desert mountain environments.

- **Seasonal Performance Findings:** Winter testing validated reliable output under low-irradiance conditions, while spring and summer deployments demonstrated a strong solar harvest, improved battery cycling, and enhanced canopy cooling effectiveness. Fall deployments captured shoulder-season performance under variable sunlight and cooler nights.
- **Ease of Setup and Operation:** Field personnel consistently achieved setup times of under 30 minutes, meeting agreement requirements for rapid deployment. Operators reported that the system could be positioned, leveled, and activated by a single operator with basic training.
- **User-Identified Benefits:** Community members, farmworkers, emergency volunteers, and trainees cited quiet operation, clean energy, Wi-Fi connectivity, shade, lighting, and cooling fans as valuable features, especially in remote or high-heat locations.
- **Cost and Emissions Impacts:** The lifetime cost-of-electricity analysis showed that Intelli-trailer reduced energy costs from approximately \$1.20 per kWh (gasoline generator) to about \$0.20 per kWh. The cost estimate reflected the full capital cost of each unit: approximately \$2,000 for solar panels, \$3,000 for the power station and batteries, and \$3,000 for fabrication and assembly. The field data from seasonal trials estimated annual power generation at approximately 2,000–2,200 kWh per unit, yielding an all-in leveled cost of approximately \$0.20 per kWh when amortized over a 20-year useful life. By comparison, a gasoline generator producing the equivalent output consumes roughly 0.6 gallons per hour, yielding a fuel-only cost of approximately \$1.10–\$1.25 per kWh at current California fuel prices, before maintenance, oil changes, or fuel delivery. The Intelli-trailers also naturally avoid emissions, noise, and wildfire-risk factors associated with diesel generators.
- **Workforce Development:** LEAP provided hands-on training in welding, solar installation, battery wiring, equipment fabrication, environmental sensors, and troubleshooting. This contributed to local skill-building in a disadvantaged community.
- **Social Equity Outcomes:** The MORBUG Intelli-trailers improved access to reliable power, broadband connectivity, environmental data, and shaded working conditions. These represent core social-equity benefits for communities that are disproportionately affected by PSPS and extreme heat.

Collectively, these outcomes demonstrate that the Intelli-trailer offers a scalable and community-aligned solution for clean, mobile emergency power. Community users reported strong satisfaction, citing the Intelli-trailer’s quiet operation, clean energy, shade, and improved working conditions. Workforce trainees gained hands-on skills in solar installation, battery systems, metal fabrication, and electronics. The project met its core objectives by demonstrating reliability, cost-effectiveness, social benefit, and a viable commercialization pathway for clean mobile power systems in California.

Knowledge Transfer and Next Steps

Knowledge transfer was a central component of this project and it included active engagement with local communities, technical advisors, state agencies, educational institutions, and potential industry adopters. Specific technology and knowledge transfer activities conducted include:

- TAC reviews to evaluate design choices, performance metrics, commercialization pathways, and market alignment.
- Public demonstrations and community workshops to gather user feedback and support adoption in disadvantaged communities.
- Website and video documentation to illustrate MORBUG Intelli-trailer functions, assembly, deployment, and field use.
- Participation in clean-energy events, conferences, and regional emergency-response forums to showcase the MORBUG Intelli-trailer's capabilities.

TAC engagement produced several noteworthy design refinements. The original Wi-Fi system, based on Netgear hardware, was replaced with Starlink satellite connectivity after field performance fell short of community expectations — a change directly informed by TAC and user feedback. The overall system design also evolved substantially over the project period, from an initial tent-based shade concept to the final trailer-mounted, dual-inverter configuration with both rigid and flexible solar panels, and TAC members contributed guidance on panel geometry, battery placement, and component modularity at each stage. Among the most visible public demonstrations was LEAP's participation in the October 2024 EPIC Symposium, alongside such community events as Earth Day celebrations, farmworker crew deployments, the 2025/2026 World Ag Expo, and fire-safety days across Huron and the broader Central Valley.

The project generated substantial insight into system design improvements, cost-reduction strategies, and potential manufacturing pathways. For the next steps, the project team intends to implement a number of design refinements, including incorporating hydraulic or gear-assisted canopy lifts, improving the balance and weight distribution, and simplifying the wiring harnesses to reduce assembly hours. The project team will conduct additional field demonstrations during PSPS events, wildfire seasons, and high-heat agricultural periods.

Additionally, the project team is developing a standardized low-cost model suitable for agriculture, emergency services, parks, and community organizations. The team is exploring partnerships with manufacturers or vocational training centers for small-scale production and, at the same time, is looking to scale training in fabrication and assembly into vocational, community college, and pre-apprenticeship programs.

Benefits to California Ratepayers

The Intelli-trailer directly benefits California ratepayers by reducing the economic and social costs of grid instability in communities that are most vulnerable to PSPS events and recurring outages. When the grid goes down, affected households and small businesses typically bear

significant costs: spoiled food, lost wages, hotel stays, and reliance on expensive diesel generators. A deployable, zero-emission backup power system reduces those burdens without placing additional demand on the grid during recovery. More broadly, distributed mobile renewable resources like the Intelli-trailer complement utility-scale investments in grid hardening by providing last-mile resilience in rural and agricultural communities that are often the last to have power restored after outages. Because the system was fabricated locally and designed for community operation without specialized training, it also supports California's broader clean-energy workforce goals, which is a ratepayer-funded priority under the EPIC program.

CHAPTER 1:

Introduction

Problem Statement

California's electricity infrastructure is increasingly threatened by wildfire risk, climate vulnerabilities, extreme heat, and the expanded use of Public Safety Power Shutoff (PSPS) events as preventive measures against catastrophic wildfires. As utilities de-energize circuits to manage wildfire risk during high wind and low humidity events, entire communities can lose electricity for hours or days at a time, particularly in rural regions. While urban areas may possess more robust emergency infrastructure, rural and disadvantaged communities often lack access to clean, reliable backup power alternatives. These communities disproportionately face socioeconomic barriers, limited telecommunications coverage, poor broadband access, and chronic underinvestment in clean energy infrastructure. As a result, PSPS events create significant hardship, including spoiled food, disrupted work, lack of cooling or medical device power, compromised communications, and reduced public safety. The burden frequently falls on households, small businesses, farmworkers, emergency volunteers, and local governments operating in resource-limited rural areas.

Diesel generators remain the dominant form of backup power in these communities, due to their low upfront cost and widespread availability, despite their substantial drawbacks. Diesel and gasoline generators produce localized air pollution and contribute to greenhouse gas (GHG) emissions, unsafe carbon monoxide levels, high noise levels, electrical safety risks, volatile fuel costs, and ongoing maintenance requirements. Moreover, multiple studies have documented significant health hazards associated with generator use, including increased respiratory issues and carbon monoxide poisoning cases during disaster and outage periods. In addition to environmental and health impacts, diesel generators create operational vulnerabilities because they rely on fuel transport during emergencies, which is often disrupted by road closures, wildfire conditions, or supply shortages.

Background on Mobile Renewable Energy Systems and Trailer-Mounted Solar Generators

Over the past two decades, a meaningful body of research has emerged documenting the development, feasibility, and performance of mobile renewable energy systems, particularly trailer-mounted solar generators, as alternatives to diesel generators in off-grid or emergency settings. These systems, often referred to as "solar trailers," "PV-powered gensets," or "mobile renewable power units," integrate photovoltaic (PV) modules, battery storage, and in some cases hybrid backup generators into a transportable structure suitable for rapid deployment.

Early research from the National Renewable Energy Laboratory (NREL) in the late 1990s and early 2000s explored the use of trailer-mounted PV generation systems for disaster relief applications. Early versions of mobile PV generators were used after hurricanes and other natural disasters to support communications, lighting, refrigeration, and essential services. NREL's 1999 bulletin, "Counting on Solar Power for Disaster Relief," (National Renewable

Energy Laboratory 1999) evaluated these early PV-powered mobile systems and documented their capacity to reduce diesel fuel consumption, emissions, and logistical burdens during emergency response operations.

Another foundational example comes from the U.S. Department of Energy's Federal Energy Management Program, which evaluated a mobile PV system deployed at Yellowstone National Park's remote Bechler Ranger Station. The system replaced a propane-fueled generator as the primary power source for the ranger station and delivered significant fuel and cost savings while drastically reducing noise and improving air quality. The case study highlighted multiple benefits, including reduced maintenance requirements and improved environmental conditions in sensitive ecological areas.

A growing number of academic institutions explored solar trailers as engineering design projects. For example, California Polytechnic State University, San Luis Obispo developed a trailer-mounted solar generator as part of a senior engineering project that focused on maximizing PV capacity, optimizing battery configuration, and designing a structurally sound, transportable platform that could be used for remote fieldwork or emergency response. The project emphasized system integration, weight distribution, component selection, and enclosure design, providing a detailed technical analysis of how solar trailers can meet small-scale off-grid energy loads. Similar projects in Europe have produced extensive mechanical drawings, wiring diagrams, and component lists for PV trailers used as nanogrid demonstrators and educational tools.

Recent research explored affordable mobile solar power systems designed for deployment in areas with limited energy access. These systems generally consist of PV modules mounted on a trailer, battery storage, charge controllers, and an inverter sized for small to moderate loads. Their proposed applications include emergency response, agricultural operations, scientific field stations, mobile medical tents, and temporary shelters. Studies emphasize transportability, durability, weather resistance, and ease of deployment, recognizing that these trailers must be operable by individuals without advanced electrical training.

Hybrid systems that combine solar PV, batteries, and small backup generators have been studied extensively. NREL developed a "Hybrid Powered Command Trailers" cost-benefit analysis tool, which models how solar and battery storage can significantly reduce diesel consumption in mobile command trailers that are used for wildfire response, law enforcement operations, and emergency communication centers. NREL's findings demonstrated that adding solar and storage not only reduces annual fuel costs but also extends generator life, reduces air pollution, and improves reliability during prolonged deployments when fuel supply chains may be disrupted. Additional studies of renewable-based emergency backup systems confirm that integrating solar PV and battery storage into generator-based microgrids yields substantial reductions in carbon dioxide and particulate emissions, while maintaining high reliability for powering essential services.

Commercial interest in mobile renewable energy systems has grown, with companies offering trailer-based solar and hybrid units tailored to emergency response, construction sites, agricultural operations, events, and military operations. Sesame Solar markets a line of mobile nanogrids that incorporate solar power, battery storage, and communications systems

designed for disaster zones and remote field operations. These systems emphasize fast deployment, self-sufficiency, and minimal operator expertise. In 2023, CleanTechnica reviewed and chronicled Sesame Solar’s portable solar nanogrids and highlighted their ability to provide several kilowatts of power for critical loads immediately upon arrival in disaster-stricken areas.

Federal agencies also documented the use of mobile solar trailers in incident management contexts. NREL’s Best Practices for Renewable Energy Installations in the Incident Management Enterprise details a 9-kW solar-powered trailer fabricated in 2011 to support wildfire and emergency-response operations. The report discusses how these trailers reduce diesel use, minimize noise exposure, and improve air quality at temporary encampments or field command posts. Additional guidance from emergency management organizations highlights the importance of mobile power units, whether diesel, hybrid, or renewable, for providing safe shelter, lighting, climate control, and communications in wildfire camps or evacuation centers.

Despite these advancements, gaps remain in the market and in research. Most mobile solar trailer systems are designed primarily for commercial, industrial, military, or utility customers and are not tailored specifically to the needs of disadvantaged communities facing PSPS events, agricultural heat exposure, or rural energy insecurity. Few published studies provide detailed analysis of multi-season, multi-climate field deployments using standardized measurements of solar output, battery cycling, communications performance, air-quality data, user experience, or social equity impacts. Similarly, while many commercial products emphasize power output and transportability, they do not integrate shade structures, cooling equipment, weather monitoring, air-quality sensors, or broadband connectivity into a single platform.

The Intelli-trailer project addresses these gaps by developing, field-testing, and refining a trailer-mounted solar-plus-battery energy system designed specifically around the needs of disadvantaged communities affected by PSPS events and recurring grid instability. Unlike typical mobile renewable power products, the Mobile Renewable Backup Generator (MORBUG) Intelli-trailer integrates multiple functionalities — clean backup power, cooling, shade, Wi-Fi communications, weather and air-quality monitoring, night lighting, USB charging, and workforce training — into a single, community-centered mobile resilience platform, as shown in Figure 1. Field testing across multiple climate zones (CZ) and seasons, combined with user surveys, Technical Advisory Committee (TAC) input, and detailed performance metric collection, contributes new data and insights to the evolving literature on renewable mobile backup systems. By aligning technical development with social equity, the Intelli-trailer expands the scope of what mobile renewable energy systems can achieve for frontline communities.

Figure 1: LEAP MORBUG Intelli-Trailer



Source: LEAP

The Intelli-Trailer Concept

The Intelli-trailer system was conceived and developed as a direct response to these challenges. The Intelli-trailer represents a compact, modular renewable power platform integrating solar PV panels, lithium battery storage, high-efficiency inverters, real-time environmental sensors, and communication capabilities. The system is mounted on a towable trailer chassis to maximize mobility, allowing rapid deployment to areas experiencing outages, emergency shelters, agricultural fields, community events, and remote worksites.

The Intelli-trailer's shade canopy comprises solar PV panels, providing both energy generation and physical protection from extreme heat, which is increasingly important for outdoor workers such as farmworkers who often labor in temperatures exceeding 100°F (37.78°C). The system's integration of air-quality monitoring, weather data, cooling fans, lighting, and Wi-Fi expands its use beyond backup power into a multi-functional community resilience asset.

The Intelli-trailer was designed and fabricated in Huron, California, a predominantly Latino, agricultural, and disadvantaged community, leveraging local workforce training, small-scale manufacturing capacity, and community-based innovation. The project aligns with the mission of the Latino Equity, Advocacy, & Policy Institute (LEAP), which focuses on expanding environmental justice, improving clean-energy access, and strengthening resilience in communities that have historically experienced high levels of air pollution, energy insecurity, and socioeconomic marginalization. By grounding the development process in community-led design principles, workforce training, and hands-on fabrication, the project demonstrated that the MORBUG Intelli-trailer represents a model for building local capacity around clean energy technologies.

CHAPTER 2:

Project Approach

Concept Development and Initial Design Process

The Intelli-trailer emerged from LEAP's need to create a fully mobile, zero-emission, multi-functional backup power platform capable of addressing PSPS-driven energy insecurity, extreme heat impacts on farmworkers, and the lack of resilient clean power resources in disadvantaged communities. Beginning in May 2023, LEAP conducted concept development sessions informed by 1) community needs assessments (shade, cooling, charging, lighting, Wi-Fi, air quality data), 2) lessons from wildfire response and mobile disaster power equipment, and 3) available commercial mobile solar trailer designs. The project team then considered cost constraints typical for rural low-income communities as well as workforce capacity within LEAP's fabrication team.

The earliest design phase involved preliminary sketches, conceptual layouts, and component mock-ups that explored different trailer sizes, canopy geometries, PV configurations, and battery system placements. LEAP evaluated trade-offs between weight, aerodynamics, structural rigidity, panel area, panel tilt, shading footprint, deployment time, and a balance between fixed and flexible solar technologies. The specifications ultimately selected aimed to maximize ease of deployment, energy generation, shade production, resilience, and cost-effectiveness, all while ensuring that community members could operate the system without specialized training.

LEAP MORBUG Intelli-Trailer Design

The Intelli-trailer system comprises a towable mild steel trailer frame supporting a solar shade canopy outfitted with six (6) Mitsubishi PV-MLE275HD2 rigid modules (each 1.95 meters by 1.0 meters) and four (4) SunPower flexible solar panels providing 2.4 kW of solar power generation. The system's integrated Bluetti Li-ion battery bank, coupled with Bluetti power stations and inverters, delivers a modular 6- to 12-kWh storage capacity (expandable to 36 kWh) and a 2- to 6-kW continuous output. Additional on-board equipment includes a Starlink cellular router, an Acurite Atlas weather station, an Air Quality Egg multi-sensor package (PM2.5, CO₂, O₃, VOC, NO₂, SO₂¹), and Arlo Pro 3 security cameras. System components are pictured in Figure 2.

¹ Particulate matter in the air measuring 2.5 micrometers or smaller, carbon dioxide, ozone, volatile organic compounds, nitrogen dioxide, and sulfur dioxide, respectively)

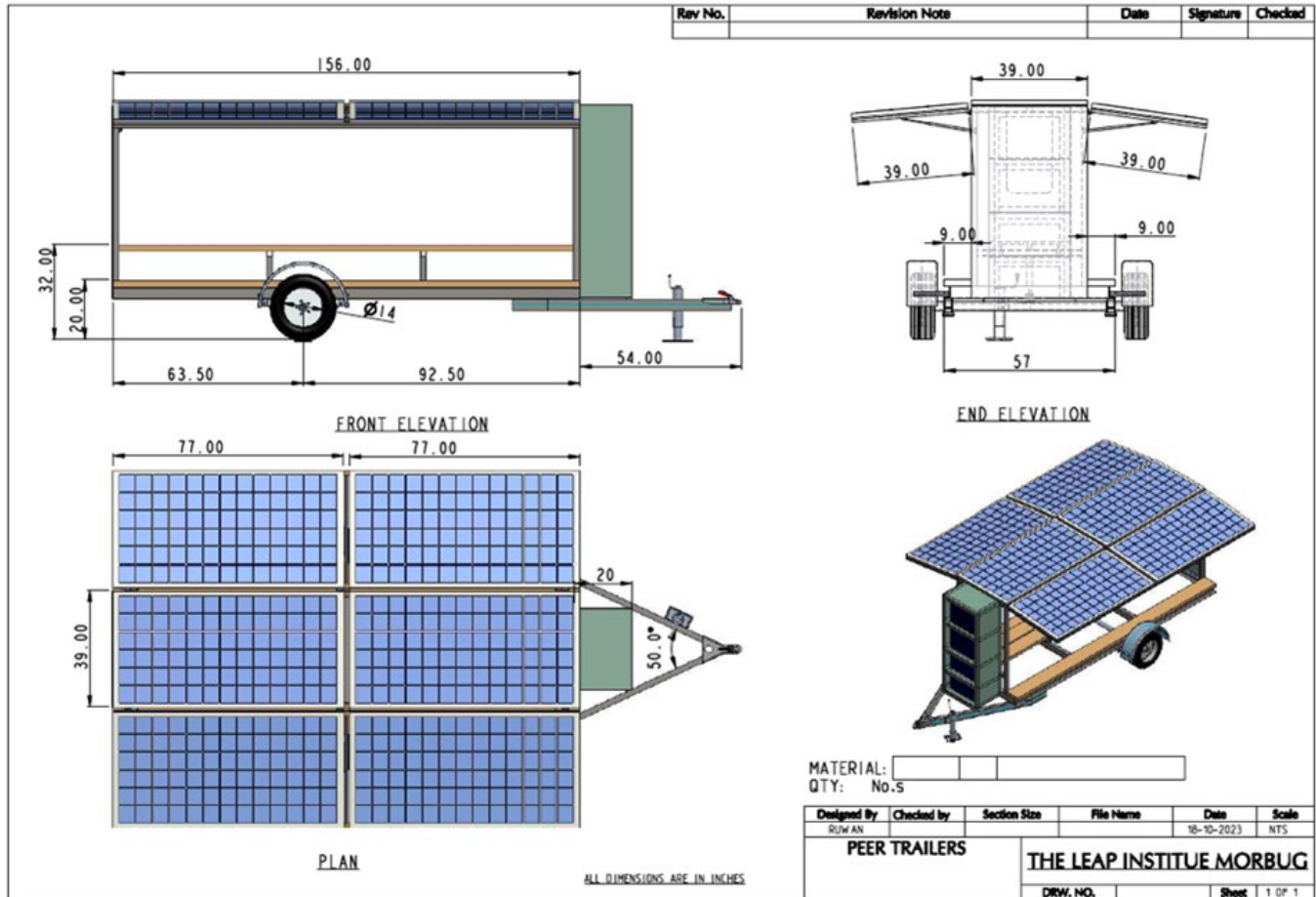
Figure 2: LEAP Intelli-Trailer Components



Source: LEAP

The Intelli-trailer was designed for a maximum 30-minute setup by a one- or two-person crew and provides zero-emission deployment, Wi-Fi connectivity, shade, environmental monitoring, and mobile clean power in one compact trailer platform. After several design iterations, the design was finalized for fabrication as shown in Figure 3.

Figure 3: LEAP Intelli-Trailer Design and Dimensions



Source: LEAP

Fabrication and Assembly

The Intelli-trailers were fabricated by LEAP’s workforce at the Huron campus, integrating workforce training and community participation into the production process. In accordance with project requirements, production included the following steps.

- Trade study and component selection: LEAP evaluated competing inverter, battery, PV, structural, and sensor components based on their price, features, durability, community usability, compatibility, and supply-chain reliability. For select components, LEAP conducted referral checks and market comparisons.
- Component procurement and quality control: LEAP tracked shipments, documented any potential damage, verified component functionality upon receipt, and logged the quality control results into internal tracing and progress reporting.
- Assembly plan development and training: LEAP developed and documented procedures for roof fabrication, PV installation, battery and inverter mounting, sensor and accessory installation, branding, and finishing. Additionally, LEAP trained workforce members on tool use, electrical safety, fabrication sequencing, and quality standards.

- Assembly execution: LEAP implemented assembly plans and documented labor hours, material needs, wiring and component challenges, and fabrication improvements across units. It tracked and leveraged lessons learned in assembly, for example to improve weight balance, solar rack alignment, and canopy fabrication efficiency.
- System testing and validation: LEAP measured and verified that PV output was as expected and tested battery charging and discharging cycles, cooling and lighting functionality, Wi-Fi connectivity, and commissioned air quality sensors.
- Branding and preparation for delivery: LEAP finished Intelli-trailers with LEAP branding, Chicano art panels, the California Energy Commission logo, and documentation packets.

Images of the LEAP team performing fabrication and assembly are shown in Figure 4.

Figure 4: Intelli-Trailer Fabrication and Assembly in Huron, California



Source: LEAP

Intelli-Trailer Demonstration Sites

Demonstration sites were strategically distributed across three geographically distinct regions of California, representing a wide span of the state’s environmental, topographical, and climatic characteristics. Demonstration sites spanned the agricultural lowlands of the San Joaquin Valley, the Sierra Nevada foothills, and the high-elevation desert-mountain region of Kern County. Table 1 summarizes the three field testing sites.

Table 1: Summary of MORBUG Intelli-Trailer Testing Sites

Site Name	Location	CZ	DAC Status	Key Environmental Characteristics
Huron	17010 Apple Ave, Huron, CA 93234	CZ 13	DAC (>75%)	Dense agricultural region; fog, dust, extreme summer heat, low winter irradiance; rural connectivity challenges
Glory Hole Recreation Area (Angels Camp)	6503 Whittle Ranch Rd, Angels Camp, CA 95222	CZ 12	Non-DAC	Sierra foothill environment; higher elevation; wildfire-prone; strong sunlight; moderate temperatures; uneven terrain
Paradise Cove (Lake Isabella)	35°38'58.45"N, 118°25'37.27"W	CZ 16	Non-DAC	Mountain-desert climate; cold nights; high winds; strong UV exposure; dry air; remote connectivity limits

Source: LEAP

The map shown in Figure 5 illustrates the locations of the three testing sites and their associated CZ — Huron in the San Joaquin Valley, the Glory Hole Recreation Area near Angels Camp in the Sierra Foothills, and Paradise Cove at Lake Isabella in the Southern Sierra desert-mountain region. This geographic spread ensured that Intelli-trailer units were evaluated under the diverse environmental conditions that define California’s clean-energy and resiliency challenges.

Figure 5: LEAP Intelli-Trailer Demonstration Sites



Source: LEAP

Taken together on a map, the three test sites span more than 100 miles north to south and an east-to-west gradient from valley floor to mountain plateau. The sites represent realistic deployment locations resembling disaster-response routes, agricultural service areas, and recreational/public-land operations. Brief descriptions of each field-testing site are provided below, and Figure 6 shows images from testing at Huron (left), Angels Camp (center), and Lake Isabella (right).

San Joaquin Valley – Huron (CZ 13, CalEnviroScreen 80)

Located in the heart of the Central Valley, Huron lies within one of California's most intensively farmed agricultural regions and is surrounded by vast row-crop fields, orchards, and farmworker communities. Huron is located near the geographic center of California, west of Fresno, within a large, flat basin known for high particulate-matter concentrations and extreme heat. The site's location in a high-burden disadvantaged community makes it central to understanding MORBUG Intelli-trailer's role in mitigating PSPS impacts in vulnerable communities.

Sierra Nevada Foothills – Angels Camp/Glory Hole Recreation Area (CZ 12)

The Angels Camp deployment site is located along the lower slopes of the Sierra Nevada foothills, near New Melones Lake. This region represents a transitional zone between the

Central Valley floor and the higher elevations of the Sierra Nevada. Its terrain is characterized by rolling hills, mixed oak woodlands, and steep ridges — conditions that influence solar exposure, wind patterns, and deployment logistics. The foothill geography corresponds with areas frequently affected by wildfire-related outages and PSPS events.

Southern Sierra/High-Desert Region — Paradise Cove at Lake Isabella (CZ 16)

Further southeast, the Paradise Cove site is located in the rugged mountain basin surrounding Lake Isabella. On the map, this location is found within the southern extent of the Sierra Nevada range, transitioning toward the Mojave Desert. The region features steep canyon roads, high elevation, sparse vegetation, and intense solar exposure. This geography provided an ideal environment for stress-testing MORBUG Intelli-trailer performance under cold nights, dry air, and high-UV daytime conditions typical of California’s interior mountain-desert interface.

Figure 6: Field Testing of the Intelli-Trailer in Diverse California Climates



Source: LEAP

Seasonal Testing Summary

The project also conducted seasonal deployments designed to capture variations in sunlight availability, weather patterns, temperature extremes, and operational conditions across the year. Seasonal testing is important for validating that the Intelli-trailer can perform reliably year-round across California’s seasonal extremes. Seasonal testing timeframes and general characteristics are described below.

- Winter testing (February to March): Field testing in winter months was performed at each demonstration site. Winter testing provided insights into Intelli-trailer performance in conditions with reduced solar irradiance, Tule fog and morning cloud cover, intermittent storms and high wind events, and cold nighttime temperatures affecting battery voltage and depth of discharge. Winter testing also provided insight into assembly and user comfort in cold conditions.
- Spring testing (March to June): Spring conditions provided moderate temperatures with increasing solar availability and significant day-to-day variability in weather patterns. Data collected in this season helped analyze Intelli-trailer performance as affected by: rapid shifts between cloudy and sunny conditions; early-season heat spikes affecting user shade needs; pollen, dust, and airborne particulates impacting sensor performance; and increased agricultural activity.

- Summer testing (June to September): Summer field testing presented the most extreme heat conditions, particularly in the San Joaquin Valley, where temperatures frequently exceeded 100°F (38°C). The summer testing evaluated Intelli-trailer performance in light of: potential thermal derating of solar PV panels; maximum power production in peak solar irradiance; battery thermal performance and potential overheating risks; canopy shade performance for farmworker safety demonstrations; and dust, dryness, and wildfire smoke conditions.
- Fall testing (October to December): Fall field testing evaluated Intelli-trailer performance as California transitioned from wildfire season into winter storm season. The fall season's combination of high particulate matter from fires and reduced sunlight allowed for additional evaluation of air-quality sensors, Wi-Fi performance, and solar efficiency under smoky conditions.

CHAPTER 3:

Results

Measurement and Verification

Testing across three CZ and four seasons provided operational data used for evaluation of the Intelli-tailer's performance in real-world conditions. The project team developed a measurement, verification, and optimization plan that specified 16 key metrics, including energy production, solar PV efficiency, battery capacity and depth-of-discharge, setup time, inverter efficiency, and equipment reliability.

Field teams reported setup times of approximately 30 minutes and verified sustained inverter operation, consistent solar generation across seasons, and reliable communication through Wi-Fi and cellular hotspots. Environmental sensors, including weather stations, air-quality monitors, and particulate sensors, operated continuously during deployments. Energy generation and load-support performance were documented for each season and CZ. Photographic documentation captured the MORBUG Intelli-trailers in field conditions, supporting farmworker crews, recreation areas, and remote emergency-style deployments.

Comparison of field-testing data across seasons and locations provided insights into the performance of the Intelli-trailers and their suitability in different potential applications. Key performance-related observations included the following.

- Solar PV efficiency and energy production varied with weather and season. As expected, production was lower in foggy or dusty conditions (experienced at Huron) and higher in clear weather and high irradiance conditions (Angels Camp and Paradise Cove).
- Field measurements from the March 2024 winter trials at Angels Camp (CZ 12) and Paradise Cove (CZ 16) recorded average daily solar generation of approximately 5.3 kWh per unit, with a peak single-day output of 5.9 kWh recorded at Angels Camp on March 6 under partially cloudy conditions (50 percent cloud cover). Summer output in Huron (CZ 13) was approximately 8.5 kWh per day, roughly 60 percent higher than winter measurements, consistent with the Central Valley's significantly higher summer solar resource. Panel efficiency ranged from approximately 67 percent of nameplate capacity (2.4 kW rated) under optimal clear-sky conditions to near zero during dense fog or heavy overcast conditions.
- Across all deployment conditions and seasons, daily solar generation met or exceeded daily power consumption, with batteries consistently remaining near full charge throughout field operations. This finding held even under winter low-irradiance conditions and partial cloud cover, confirming that the Intelli-trailer reliably met the baseline energy needs of connected loads, including satellite Wi-Fi, air quality monitoring, lighting, cooling fans, and device charging in every tested condition.
- Battery storage capacity and depth of discharge were strongly affected by temperature, with reduced battery voltage and capacity in cold nights (Paradise Cove). Conversely, in

hot conditions (Huron) the battery required evaluation of thermal stability and increased ventilation. A moderate temperature (Angels Camp) reflected near-ideal conditions, which were used as a baseline for comparison.

- Intelli-trailer setup and transport varied across deployment sites due to factors like uneven terrain and slow travel time in remote backroads. There were also differences in the solar orientation and positioning, canopy handling in high-wind areas, cooling fan use in high temperatures, and lighting needs on shorter winter days. These operational differences and lessons learned informed design and operational changes, including where manual lifting mechanisms needed redesign and which features were valued by users, specifically Wi-Fi, shade, cooling, and the unit's quiet operation.
- Specific feedback from disadvantaged communities (Huron) provided information on accessibility, safety, comfort, and perceived benefit, including from farmworkers and in scenarios involving PSPS-vulnerable populations (see Appendix B). This supported the project goals of helping to address longstanding social equity challenges like heat illness in agricultural workers, noise and air pollution, and lack of clean mobile power resources.

Emergency Use Cases

The Intelli-trailer was designed from the outset with emergency response applications in mind. Through stakeholder consultations and TAC input, LEAP identified a broad range of scenarios for which the system is well suited, including: powering critical medical devices such as continuous positive airway pressure (CPAP) machines, used to treat sleep apnea, and oxygen concentrators; refrigerating food and medication during extended outages; supporting air purification during wildfire smoke events; powering communications equipment at fire stations and police departments; providing clean backup power to emergency operations trailers; and delivering limited heating or cooling when grid power is unavailable. While the Intelli-trailer was not deployed in an actual emergency during the project period, its relevance to real-world disaster response was validated when California's Office of Emergency Services (OES) contacted LEAP during the January 2025 Southern California wildfires to inquire about unit availability — an outcome that affirms the system's market readiness as a community-scale emergency power asset and that has since led to discussions with OES about pre-positioning units for future PSPS and wildfire response situations.

Daily and Non-Emergency Applications

Outside emergency contexts, Intelli-trailer systems demonstrated substantial value as flexible, daily-use, clean-energy assets. Communities identified multiple non-emergency applications, including campground lighting, cultural events, community gatherings, and outdoor recreation activities. Local public works departments found MORBUG Intelli-trailers useful for remote job sites lacking grid access, including water department operations and construction tasks. Agricultural partners used units as farmworker shade trailers with integrated cooling fans, lighting, and charging stations. Intelli-trailers may also be deployed for musical events, garden operations, holiday celebrations, funerals requiring lighting or limited heating, Tribal

reservation entry-gate power, cultural clothing-burning ceremonies, bouncy-house inflatables, outdoor movie nights, refrigeration, ice makers, and general device charging. These uses illustrate the Intelli-trailer's ability to serve as a multifunctional community asset rather than a single-purpose emergency generator.

Improvements From Field Deployment and Iterative Design Development

The range of field-testing activities allowed LEAP to gather real-world data that directly informed the evolution of the Intelli-trailer design. Deployments revealed additional needs concerning stability, usability, power performance, and overall durability that guided refinements across structural, mechanical, electrical, and user-interface components. Overall, each progressive design iteration was built on data and learnings from field testing, resulting in a more reliable, user-friendly, and commercially viable product.

Structural and Mechanical Improvements

Initial deployments revealed that windy conditions, combined with the weight of the roof panel, created challenges for manually raising and lowering the solar canopy. In the next design versions, LEAP incorporated hydraulic supports, reinforced hinge points, improved cross-bracing, and welded steel framing to enhance rigidity of the canopy lift assembly. Wheel chocks and leveling jacks were upgraded to provide a more stable foundation on uneven terrain such as agricultural fields and mountain hillsides. Additional improvements included better weather sealing around equipment compartments, refined caulking and painting procedures, and improved roof-panel fastening that uses higher-strength hardware to withstand vibration during towing.

Electrical and Power-System Improvements

Use of Bluetti power stations and Li-ion batteries proved successful, but field usage revealed opportunities for better cable pathways, improved inverter accessibility, and optimized ventilation to reduce heat accumulation within the electronics compartment. The team reorganized wiring, created dedicated conduits, and added strain relief to protect connectors from movement during transportation. The Mitsubishi PV-MLE275HD2 rigid modules performed reliably in stable sunlight, while SunPower flexible modules offered benefits in weight and mounting versatility. LEAP incorporated mixed panel designs in later builds, allowing for flexible placement and improved access. Component compatibility, grounding practices, and battery management routines were refined based on TAC feedback.

Usability and Operation Enhancements

User feedback from farmworker crews, emergency responders, and community members emphasized the need for brighter nighttime lighting, more intuitive labeling, additional outlets, and simplified setup procedures. Later design iterations included more lighting strips around the canopy, strengthened mounting for cooling fans, additional lockable battery enclosures, and a redesigned equipment layout for easier operator access. LEAP also upgraded the air-quality and weather-station mounting system to withstand high winds. Improved signage and bilingual labels were introduced to better support nontechnical users.

Mobility Improvements

Experience transporting the trailer reinforced the importance of weight distribution to ensure safe towing. LEAP implemented roof redesigns and better placement of batteries, inverters, and communications equipment to improve overall balance. Fenders, tire upgrades, improved rear lighting, and reflective decals were added based on transportation observations. LEAP also enhanced the roll-up tarp system to protect equipment during towing and foul-weather operation.

Lessons Learned

Lessons learned from both technical and community-facing aspects of the project revealed key opportunities for improvement. Beyond the design improvements described above, LEAP identified workforce training and component price sensitivities as critical for future iterations, with users suggesting a demand for lower-cost models. LEAP identified opportunities to reduce labor hours, streamline assembly, improve documentation, and refine system specifications for different market segments. These findings will inform future technology transfer, commercialization strategies, and design improvements.

CHAPTER 4: Technology Transfer and Community Engagement

LEAP’s technology transfer plan encompassed a multipronged strategy for introducing the Intelli-trailers to users, decision-makers, and potential customers through public demonstrations, community events, and presentations at professional and industry event; see Figure 7 and Table 2.

LEAP showcased operational MORBUG Intelli-trailer units at Earth Day celebrations, community gatherings, farmworker events, cultural festivals, Halloween and Trunk-or-Treat events, farmers markets, community PSPS-preparedness workshops, and fire-safety days. Each demonstration allowed residents to interact directly with the system, test the power output, use Wi-Fi, experience the shaded rest area, and provide feedback on potential design improvements.

Figure 7: Intelli-Trailer Community Engagement



Source: LEAP

Additionally, LEAP presented the project and Intelli-trailer prototypes at the EPIC Symposium, the World Farm Expo and agricultural field days, public works and emergency-management trainings, and local government resilience workshops. These sessions generated interest from agencies looking for clean, deployable power solutions.

Table 2: Public Demonstrations and Community Outreach Activities

Date	Event	Number of Attendees	Description of Event
October 30, 2023	Community Showcase, Huron	40	Initial public demonstration of the Intelli-trailer to Huron residents and community stakeholders
October 28, 2024	EPIC Symposium	100+	Showcased the Intelli-trailer to clean-energy researchers, policymakers, and industry stakeholders

Date	Event	Number of Attendees	Description of Event
December 2, 2024	Huron Christmas Parade	400+	Deployed as a functioning power and connectivity hub during a public community celebration
February 11, 2025	World Ag Expo	100,000+	Demonstrated to agricultural producers, farm contractors, and industry professionals
April 17, 2025	Coalinga/Fresno County Fire Emergency Services Demo	10	Hands-on demonstration for frontline emergency response personnel; contributed to ongoing discussions with OES about future deployments
May 2, 2025	Watsonville Community Mobility Options (CMO) Event	100+	Public showcase of green and sustainable transportation and energy products; demonstrated the Intelli-trailer as a zero-emission power solution
September 13, 2025	CA State Parks — San Simeon	34	Demonstration for state parks staff exploring off-grid and recreational applications
October 24, 2025	Pajaro Community Showcase	40	Community outreach and demonstration in a disadvantaged agricultural community
October 31, 2025	Huron Trunk-or-Treat	TBD	Community event deployment providing power, lighting, and connectivity
December 9, 2025	Avenal Community Showcase	20	Public demonstration for residents and local organizations
February 10, 2026	World Ag Expo (2nd appearance)	100,000+	Return appearance, reaching agricultural sector stakeholders worldwide
February 12, 2026	Westlands MLRP Event	30	Demonstration for water district and rural land management professionals
Fridays, ongoing	Huron Farmers Market	200+/week	Weekly deployment providing power, Wi-Fi, shade, and air quality monitoring to market visitors
Weekly, ongoing	Community Learning Gardens — Avenal, Stratford and Five Points	Ongoing	Regular use supporting outdoor education and community programming across three disadvantaged communities

Media, Outreach, and Digital Dissemination

LEAP developed brochures (see Appendix A), fact sheets, a website, and online videos highlighting the capabilities and environmental benefits of the Intelli-trailer. Social-media platforms amplified visibility, while local press coverage introduced the Intelli-trailer to broader audiences across the Central Valley. Future dissemination activities include developing dedicated web-based user manuals, training materials, and an online portal for hosting data visualization and educational content.

Role of the Technical Advisory Committee

The project's TAC played a central role in shaping the Intelli-trailer product, ensuring alignment with technical best practices, emergency-response needs, and community priorities. TAC members included clean-energy engineers, emergency-operations personnel, Tribal leaders, farmworker-advocacy organizations, solar-industry professionals, environmental justice advocates, and telecommunications specialists. Their contributions included:

- Reviewing early design sketches and recommending component substitutions.
- Evaluating candidate solar panels and advising on panel mounting geometry.
- Identifying safety issues such as wind loading and stability.
- Advising on battery placement, grounding requirements, and inverter sizing.
- Recommending weather-station and air-quality sensor placement.
- Reviewing performance data and suggesting improvements in data acquisition.
- Providing insight into PSPS operations, emergency deployment patterns, and real-world communication needs.
- Identifying market barriers and refining the product's value proposition.
- Connecting LEAP with potential manufacturing partners.

The TAC also regularly reviewed community feedback and helped shape training documentation, assembly improvements, and the evolving technology-transfer strategy.

Community Engagement and Knowledge Transfer

Extensive community engagement, public outreach, and workforce development activities were conducted throughout the project. Engagement was essential to align Intelli-trailer design and capabilities with the needs, priorities, and lived experiences of disadvantaged communities. The LEAP team conducted broad and inclusive outreach with community stakeholders, residents, emergency personnel, trainees, and critical service providers in Huron and partnering regions. These activities extended across the project lifecycle, from initial design development through field demonstrations, surveys, and hands-on training.

Stakeholders and Community Partners

The project was supported by a diverse set of community stakeholders whose participation shaped design decisions, use-case priorities, and deployment strategies. Engagement included: community leadership; emergency response teams; residents, including vulnerable populations; emergency coordinators; critical-facility operators; and farmworker crews. These groups provided continuous input on use cases, system design needs, emergency-priority functions, and desired community benefits. Their involvement supported cultural relevance, trust-building, and alignment with community resilience goals. Through open communication channels, surveys, and repeated in-person engagement, LEAP strengthened community buy-in and created a feedback loop that informed both technical refinements and deployment priorities.

Engagement Activities and Outreach

Throughout the project, LEAP implemented an extensive and iterative series of engagement activities designed to maximize access, transparency, and participation. These activities took place in Huron and other communities that hosted field testing and included:

- Kick-off briefings and training introducing MORBUG Intelli-trailer system capabilities and the project goals.
- Distribution of bilingual brochures, flyers, and instructional guides at community centers, schools, clinics, and housing complexes.
- In-person MORBUG Intelli-trailer demonstrations at community events, cultural celebrations, Earth Day gatherings, public safety fairs, and farmworker outreach events.
- Hands-on operation sessions that allowed residents and first responders to practice deploying solar panels, connecting loads, and accessing Wi-Fi.
- Surveys and idea-collection sessions where residents provided feedback on preferred use cases and emergency needs.
- Mobile demonstrations conducted directly in neighborhoods, agricultural fields, and remote sites.
- Integration into existing community events, such as Halloween and Trunk-or-Treat celebrations, cultural burns, and school outreach days.
- Ongoing communication through printed materials, social media, on-site signage, and direct bilingual-engagement teams.

These activities ensured that the MORBUG Intelli-trailers were visible, accessible, and familiar to a wide cross-section of residents. They also helped overcome barriers to trust and adoption that often impact clean-energy deployment in low-income rural communities and Tribal communities.

Community Feedback and Interest in Adoption

Throughout demonstrations and field trials, LEAP collected both formal and informal feedback from residents, farmworkers, emergency responders, youth, elders, and partner agencies.

Input was gathered through surveys, interviews, public-meeting discussions, and community-engagement events.

Community feedback consistently emphasized high-interest features such as: Wi-Fi and communications availability; quiet, zero-emission operation; the shade canopy for heat protection; air-quality monitoring during wildfires; cooling fans and lighting; device charging for phones, laptops, and tablets; and refrigeration for medications and perishables. Community members suggested improvements, including additional lighting for nighttime agricultural crews, easier panel-lifting mechanisms (for example, hydraulic or electric systems), higher-capacity solar arrays, greater battery storage for extended outages, and more ruggedized trailer components for off-road deployment.

Knowledge Transfer and Engagement With Key Potential Users

LEAP formally engaged firehouses, clinics, community emergency coordinators, Red Cross teams, and local utility liaisons to explore operational integration of the Intelli-trailer and similar products into emergency plans. These demonstrations and engagements have generated strong interest in incorporating the Intelli-trailer into facility-level emergency planning and PSPS support strategies and have led to ongoing discussions with several agencies about future deployment.

- Local fire stations, police agencies, and volunteer emergency teams expressed interest in using the Intelli-trailer for powering mobile command centers, lighting staging areas, powering communications repeaters, powering medical triage zones, and deploying Wi-Fi during outages. Agencies also noted the benefit of reduced emissions compared to diesel generators.
- Public works and telecom providers noted that MORBUG Intelli-trailers could support temporary tower sites, water-department operations, drought monitoring stations, remote cameras, or environmental sensor arrays.
- Campgrounds, recreational vehicle resorts, Tribal recreation centers, and state parks expressed interest in portable renewable energy units to replace generator rentals.
- Farmworker crews reported the highest practical benefit, using MORBUG Intelli-trailers for mobile shade, cooling, lighting, device charging, and irrigation-pump support. Agricultural employers expressed interest in expanded versions of MORBUG Intelli-trailers for nighttime harvesting, pesticide mixing areas, field offices, and remote communications.

Through these discussions and engagements, LEAP identified three potential future product classes for development: 1) a residential/small-load model (1 to 1.5 kW); 2) a mid-range field unit (2 to 3 kW, 12 kWh storage), which is the size of the current Intelli-trailer design; and 3) a heavy-duty facility version (5 to 8 kW). The ability to scale the Intelli-trailer for different users and contexts illustrates the replicability and commercialization potential of the product.

Training and Workforce Development

Workforce development was a central goal of this project. LEAP integrated hands-on training in fabrication, solar installation, electrical systems, data logging, and general clean-energy operations. LEAP fabricated the Intelli-trailers in-house, which allowed trainees to learn real manufacturing processes, enabling LEAP to explore an apprenticeship model with regional community colleges, workforce-development boards, and other educational partners.

Participants, many from Huron and surrounding rural towns, received hands-on training that aligned with emerging clean-energy job pathways, helping prepare them for employment in solar, electrical and construction, public works, and other fields. Specific training components included:

- Apprentice-style hands-on instruction in metal fabrication, welding, trailer preparation, electrical wiring, and solar-panel mounting.
- Commercial sewing and fabrication training for production of tarp walls and canopy materials.
- Solar installation and portable power system integration, including the Bluetti inverter and battery configuration.
- Sensor installation and calibration (weather stations, air-quality monitors, particulate sensors).
- Communications installation, including Wi-Fi hotspot and router integration.
- Operations and maintenance training for community stewards, facility managers, and residents.
- Train-the-trainer modules, enabling local technicians to become future operations and maintenance leads.
- Field deployment training for LEAP's Green Raiteros electric vehicle drivers and community volunteers.

These activities created a skilled pool of community-based technicians who can assemble, deploy, maintain, and troubleshoot Intelli-trailer units over their lifecycle. They also advanced LEAP's broader workforce mission, providing participants with exposure to solar technologies, battery systems, clean-mobility tools, and emergency-response equipment.

Challenges and Next Steps

While the Intelli-trailer units performed effectively across field demonstrations, several structural and market challenges remain. Fabrication costs are currently higher than mass-produced commercial alternatives, largely due to labor-intensive assembly and limited economies of scale. Competing trailer-mounted solar generator products are entering the market with lightweight frames, simplified lifting mechanisms, and integrated electronics, illustrating the growing competitive landscape for mobile renewable power systems.

Long-term reliability testing revealed opportunities to improve component durability and weather protection, particularly in extreme heat, fog, dust, and high-wind conditions. Theft and vandalism also emerged as concerns, especially when units are deployed in isolated agricultural or rural areas without overnight security. Additionally, market adoption will require ongoing efforts to educate potential customers, including utilities, construction firms, Tribal governments, farms, and emergency-response agencies, about the system's capabilities, limitations, and best-fit use cases. The variability of solar resource availability continues to pose operational challenges, requiring clear end-user guidance on expected charging rates and load management.

Next Steps

Building on the lessons learned, LEAP will refine the Intelli-trailer design to reduce costs, streamline assembly time, integrate hydraulic or electric lifting systems, and increase battery and solar capacity. Plans include exploring modular "stackable" battery expansions, alternate PV configurations, and improved system enclosures. LEAP will strengthen market outreach through targeted demonstrations, industry expos, EPIC Symposium presentations, and media campaigns.

Commercial production pathways will include the development of manufacturing partnerships, licensing opportunities, and collaborations with community colleges and workforce-development programs to support larger-scale fabrication. LEAP will also investigate financing models, such as lease-to-own systems, public-private partnerships, and municipal procurement pathways, to improve affordability for rural communities and critical facilities.

In addition, building on the workforce development and fabrication expertise established under this agreement, LEAP intends to launch LEAP Industries, a community-based manufacturing enterprise that will produce and commercialize the Intelli-trailer at scale. A key priority is transitioning from prototype-quality fabrication to a professionally finished, factory-grade product with refined structural design, consistent paint and surface finishes, and a market-ready appearance appropriate for commercial sales. An enhanced next-generation version, the Mega Intelli-Trailer, will add area lighting, refrigeration, and expanded air quality monitoring to the proven platform and will target agriculture, emergency services, and municipalities across California's disadvantaged communities. LEAP Industries will also develop the PUEBLOS Lux Smart Light, a solar-powered off-grid LED streetlight created in partnership with Pacific Gas & Electric Company. Both products will be fabricated in Huron by personnel trained under this program and future workforce development programs, with the initial market focus on California's highest-burden disadvantaged census tracts and a phased scale-up to statewide deployment by 2030.

CHAPTER 5:

Summary and Conclusions

Project Achievements

Through this project, LEAP successfully designed, fabricated, and field-tested four mobile renewable backup generation Intelli-trailers units that provided zero-emission, trailer-mounted solar power to support communities facing PSPS events, wildfires, energy insecurity, and extreme heat. Across three CZ and four seasons, the MORBUG Intelli-trailer units demonstrated consistent operational performance, reliable solar generation, multi-hour battery support, and the ability to power critical loads in both emergency and non-emergency situations. Communities benefited from shaded rest areas, cooling fans, internet connectivity, lighting, environmental monitoring, and portable renewable energy — features that addressed both immediate resilience needs and chronic environmental justice challenges.

The project directly engaged disadvantaged communities, including Huron, Tribal communities, farmworker crews, and rural households with medically vulnerable residents. LEAP integrated community outreach, bilingual engagement, surveys, stakeholder consultations, and tailored user training to ensure that the systems reflected actual community priorities. The demonstration events, emergency-preparedness workshops, in-home visits, and youth science, technology, engineering, and mathematics activities expanded understanding of renewable backup systems and strengthened trust between clean-energy technology developers and historically marginalized communities.

The project validated the feasibility of LEAP’s design approach and resulted in a lightweight, towable, modular solar-plus-battery unit fabricated entirely in-house using workforce trainees and off-the-shelf components. The project established a replicable model for clean, mobile resilience solutions, one that can be deployed rapidly by municipalities, Tribal governments, agricultural employers, emergency responders, and community-based organizations. The results can inform utilities, public agencies, and others seeking scalable alternatives to fossil-fuel generators in emergency response, outdoor work sites, public events, and remote operations. In addition, positive user feedback confirmed that the integration of shade, Wi-Fi, lighting, cooling, and environmental sensors increased the value of the system well beyond energy production alone. As climate impacts intensify, the Intelli-trailer stands as an adaptable, zero-emission, community-centered resilience tool capable of supporting California’s clean-energy transition while strengthening safety, equity, and environmental justice across the state.

Benefits to California Ratepayers

The project generated significant benefits for California’s ratepayers by demonstrating a clean, reliable alternative to fossil-fuel generators, which are widely used during PSPS events and grid outages. While providing critical electricity access, the Intelli-trailer also eliminated the need for gasoline and diesel generators, helping to reduce local air pollution, GHG emissions,

and health risks. These benefits are particularly important in disadvantaged and low-income communities that experience disproportionate pollution burdens.

The Intelli-trailer's use of 100-percent renewable energy also eliminates fuel purchase costs and reduces long-term operating and maintenance expenses, providing meaningful economic savings to households, small businesses, and local governments. The project demonstrated technology solutions to increase community resilience and safety in the face of wildfire-related outages. Furthermore, the project's workforce-training component builds long-term capacity for California's clean-energy labor market, supporting the state's transition to a more resilient, sustainable, and equitable energy future.

List of Terms/Glossary

Term	Definition
CARB	California Air Resources Board
CEC	California Energy Commission — California’s primary energy policy and planning agency
CZ	Climate zone(s) — region(s) with similar temperatures, humidity, and wind for building codes (16 zones in California)
EPIC	Electric Program Investment Charge
GHG	greenhouse gas
kWh	kilowatt-hour
LEAP	Latino Equity, Advocacy, & Policy Institute
Li-ion	lithium-ion
M	meter
MORBUG	Mobile Renewable Backup Generator
NREL	National Renewable Energy Laboratory
OES	California Office of Emergency Services
PM2.5	Air quality measurement of Particulate Matter 2.5 micrometers or smaller in the air
PSPS	Public Safety Power Shutoff
PV	photovoltaic
TAC	Technical Advisory Committee
V	volt

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Project Deliverables

The following is a list of all of the products produced under this agreement.

- Project Performance Metrics Questionnaire
- TAC Performance Metrics Summary
- Project Performance Metrics Results
- Measurement, Verification, and Optimization Plan
- Assembly Plan
- Schedule of Sites
- Lessons Learned on MORBUGs
- Project Benefits Questionnaire
- Annual Survey(s)
- Documentation of Organization/Project Profile on EnergizeInnovation.fund
- Summary of TAC Comments
- Technology Transfer Report
- High Quality Digital Photographs
- Critical Project Review Report
- Quarterly Progress Reports

Project deliverables, including the Critical Project Review and Quarterly Progress Report reports, are available upon request by submitting an email to pubs@energy.ca.gov.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX A: Intelli-Trailer Brochures

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Appendix A: Intelli-Trailer Brochures



MOBILE RENEWABLE BACKUP GENERATION (MORBUG) UNIT

The LEAP INTELLI-TRAILER

Features

- ◊ 2.5 kW of Solar Power Generation
- ◊ 6 to 12 kWh of lithium-ion battery storage
- ◊ 12v, 110v & 240v power availability
- ◊ 6kW EV charging receptacle
- ◊ Starlink 120 Mbps Satellite Internet Connectivity
- ◊ Cool Chest & Cooling Fan
- ◊ Multi-function Weather Station
- ◊ PM2.5 Air-Quality Monitor
- ◊ Shade and Protection from the elements





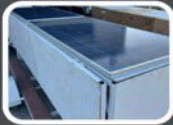
MORBUG



The Mobile Renewable Backup Generator (MORBUG) is easily transportable and adaptable to various areas. Its compact trailer-mounted design allows for quick towing and simple setup, making it ideal for remote or disaster-affected locations. With the ability to operate in diverse climates and terrains, it offers a versatile solution for construction sites, rural areas, and outdoor events.

Components Included

1



2.5 kW Solar Panels

2



Bluetti Battery Systems

3



Starlink Satellite Internet

4



WiFi Weather Station

5



EV Charging



The project is funded under agreement EPC-22-008, with the support of the California Energy Commission, and focuses on developing and demonstrating the use of four MORBUG units in different climate zones of California.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX B: Social Equity Survey & Operating Log Sheet

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Appendix B: Social Equity Survey & Operating Log Sheet

Date: _____ MORBUG #: _____

Location: _____ Operator: _____

1. First / Last Name: _____

2. City / Town: _____

3. Preferred Language: _____

4. Race / Ethnicity: _____

5. Age: _____

6. Gender: _____

7. Employment Status: _____

8. Educational Attainment: _____

9. Household Income (% of Median Family Income or Poverty Level):

10. Do you have access to reliable electricity at home? Yes No

11. Have you experienced power shutoffs or outages? Yes No

12. Did MORBUG services improve your access to power or information? Yes No

13. How often did you use MORBUG services?

14. Overall satisfaction with MORBUG: 1 (not satisfied) – 5 (very satisfied):

15. Additional comments or feedback:

Intelli-Trailer Operating Log Sheet

Date: _____ MORBUG #: _____

Location: _____ Operator: _____

Climate Zone: _____ Season: _____

#	Metric	Benchmark	Log / Observations
1	Dispatch & Travel	N/A	Mileage: Time:
2	Setup Time	30 min	Setup Time:
3	Cellular Service	N/A	Signal: Bandwidth:
4	Electric Generation	100% non-renewable	kW / 24 hrs:
5	Solar Efficiency	20%	Avail: Output:
6	Battery Storage	>12 kWh	Sunset: Sunrise:
7	Depth of Discharge	80%	Sunset %: Sunrise %:
8	Charger/Inverter	Auto 220/110v	Input: Output:
9	Weather Data	N/A	24-hr Data: Yes / No
10	Air Quality	N/A	24-hr Data: Yes / No
11	Social Equity	N/A	Surveys #: