



Envoltz Mobile Microgrid Ecosystem

Modular Power Generation, Storage, and Distribution

Pick-and-Choose Architecture | Gensets | BESS | Supercapacitors | Power Distribution
Mobile Reliable Power

Technical White Paper

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Executive Summary

Envoltz delivers a comprehensive power ecosystem tailored for demanding applications requiring high mobility, logistical simplicity, rugged durability, and seamless integration. This pick-and-choose modular suite allows customers to select and scale components precisely to their needs, ensuring optimal performance without unnecessary complexity. Whether deploying a single genset for remote power or combining supercapacitor banks with battery energy storage for fluctuating loads, Envoltz systems adapt effortlessly, supporting capacities from hundreds of kilowatts to multi-megawatt configurations.

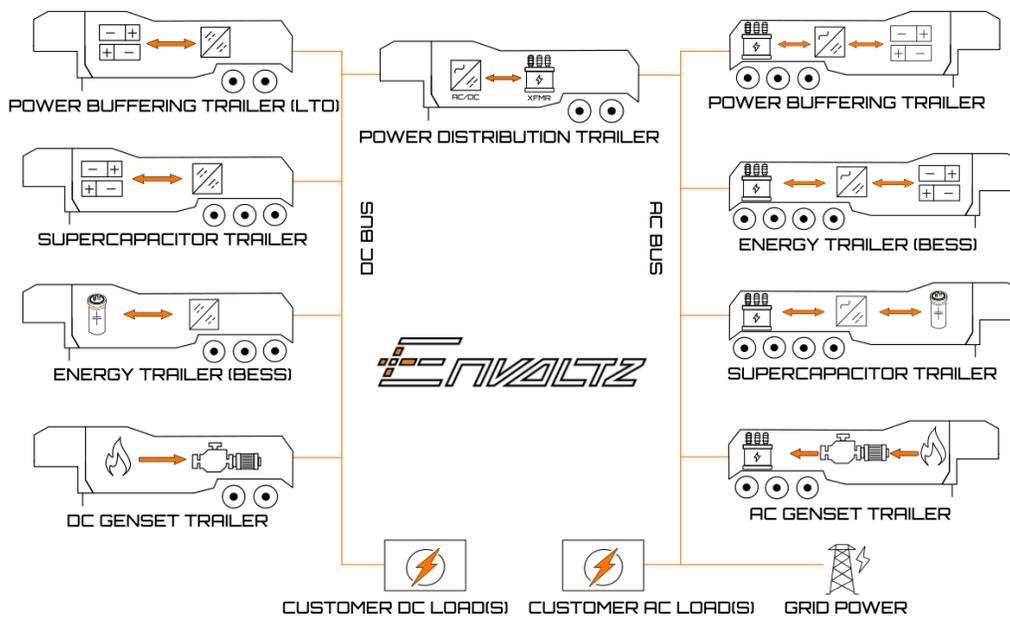


Figure: Envoltz's Modular Customizable Microgrid Environment

Sectors like oil and gas, EV charging, and AI datacenters drive growth in mobile energy products by demanding more resilient power solutions. The global microgrid controller market is projected to grow from USD 6.8 billion in 2024 to USD 18.7 billion by 2029, at a CAGR of 22.6%, fueled by increasing energy demands and renewable integration [1]. Modular power systems provide strategic value through enhanced flexibility, enabling cost-effective responses to regulatory shifts and energy volatility [2]. Envoltz empowers executives to achieve operational resilience and sustainability goals confidently.

Global Microgrid Controller Market Growth

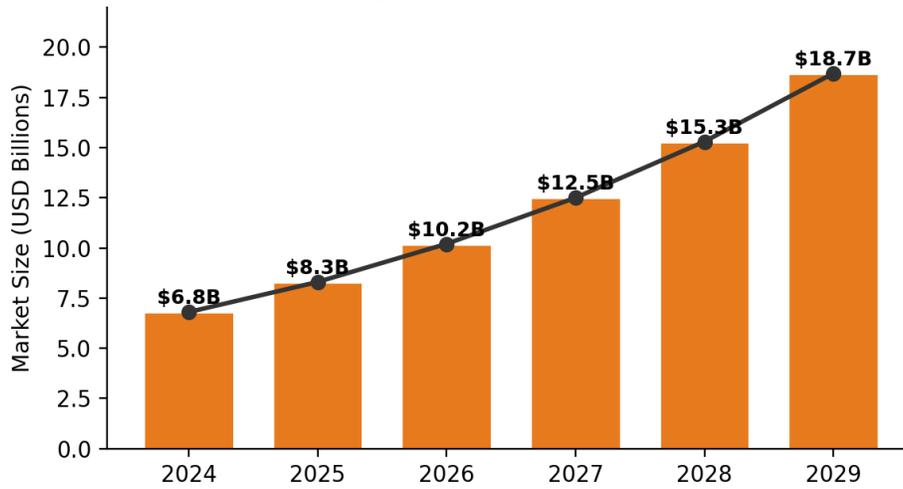


Figure: Global Microgrid Controller Market Projection (22.6% CAGR) [1]

System Overview

Envoltz provides a suite of trailer-mounted power products designed for mobility and modularity: gensets, supercapacitor banks, power buffering using lithium titanate oxide (LTO) batteries, and battery energy storage systems (BESS). Each product offers AC or DC interfaces; DC versions include integrated DC/DC converters, while AC versions pair AC/DC converters with transformers. Additionally, Envoltz supplies a power distribution trailer equipped with AC/DC converters and transformers to bridge AC and DC buses seamlessly.

These solutions operate in island mode or grid-connected configurations, addressing diverse use cases. In oil and gas operations, they recover waste flare gas for on-site generation, reducing emissions by up to 73% [3]. For EV charging stations, they enable remote or temporary setups with stable power delivery. In datacenters, curtailing peak loads for just 0.25% of the time has been shown to reduce peak power demand by up to 25%, demonstrating the efficiency gains possible through targeted power buffering strategies [4]. Renewable energy management benefits from scalable storage, smoothing intermittency for reliable output.

Overview — GENSET

The Envoltz GENSET is a trailer-mounted natural gas generator providing reliable prime or standby power. It functions as a core energy source in microgrids, converting fuel to electricity for continuous or backup needs. Overall system rating reaches up to 2.5 MW.

Overview — Supercapacitor Bank

The Envoltz Supercapacitor Bank stores and releases energy rapidly, ideal for applications requiring high-power bursts. It supports voltage stabilization and transient handling with a high cycle count exceeding 1,000,000 cycles. Overall system rating is up to 2.5 MW.

Overview — Power Buffer (LTO)

The Envoltz Power Buffer employs LTO batteries for high-power density buffering. It absorbs and delivers power during short-term fluctuations, bridging gaps in generation and demand. As high-power units, they excel in cyclic operations. Overall system rating is up to 2.5 MW.

Overview — Power Distribution

The Envoltz Power Distribution Trailer facilitates interconnection between AC and DC components. It converts and transforms power for efficient distribution, ensuring compatibility across the ecosystem. Overall system rating aligns with multi-MW scales.

Engineer's Notes — AC/DC Availability

Each Envoltz product is configurable with AC or DC interfaces. DC setups integrate efficient DC/DC converters for minimal losses, while AC includes bidirectional AC/DC converters and transformers rated for high-voltage compatibility, with interconnection features aligned to IEEE 1547 standards for grid-tied DER compliance [5]. This simplifies hybrid system design.

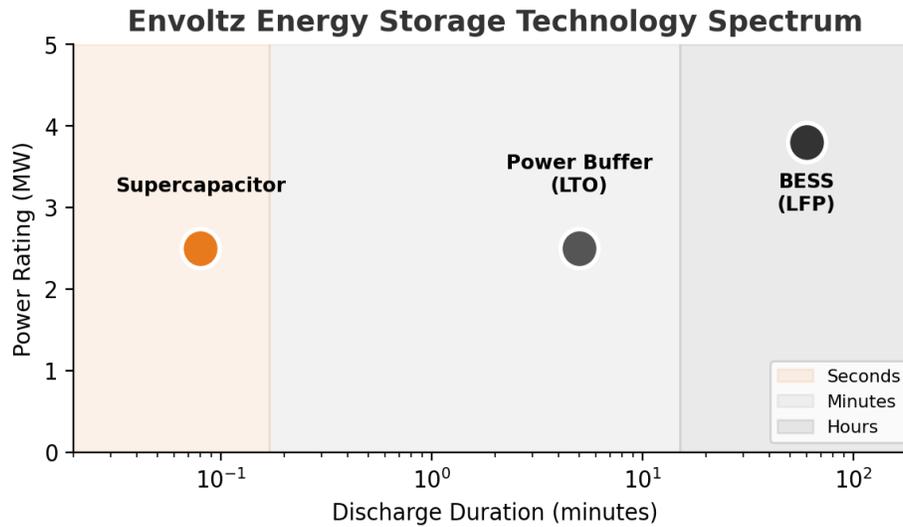


Figure: Envoltz Energy Storage Technology Spectrum: Power vs. Duration

Operational Benefits

Envoltz modular microgrids enhance operations across key dimensions, delivering measurable improvements that appeal to executive buyers in high-stakes industries.

Improvement of Logistics

Mobile microgrid fleets offer significant logistical advantages over traditional site-built microgrids. Their modular, standardized design allows them to be transported using standard vehicles, eliminating the need for specialized logistics planning. Unlike site-built systems, which often require extensive civil works, trenching, and utility coordination, mobile systems arrive pre-integrated and ready for setup with minimal site preparation. This streamlined approach reduces the burden on engineering, permitting, and construction teams, which are typically major cost and time drivers in fixed installations. Additionally, mobile microgrids can be relocated and redeployed as operational needs evolve, offering a level of flexibility and asset reusability that fixed systems cannot match [6].

Site-Built vs. Mobile Microgrid Timelines

Typical timelines for site-built microgrids range from 24–36 months including feasibility and planning, design and engineering, permitting and procurement, and construction and commissioning phases.

Phase	Typical Duration
Feasibility and planning	6 months
Design and engineering	6–9 months
Permitting and procurement	6 months
Construction and commissioning	12 months

In contrast, a mobile microgrid trailer fleet (pre-engineered and containerized) can be deployed and operational in 24–72 hours, depending on site access and interconnection requirements. This stark contrast in deployment timelines highlights the strategic advantage of mobile microgrids for time-sensitive applications [7].

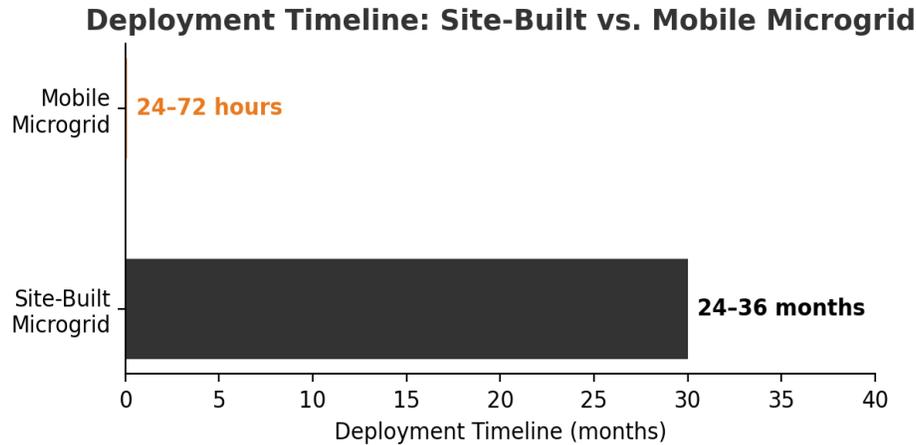


Figure: Deployment Timeline: Site-Built vs. Mobile Microgrid

Maintenance

Systems incorporating IP-rated enclosures and remote diagnostics benefit from reduced manual inspection requirements and enhanced problem detection capabilities. IP66-rated BESS housing prevents ingress of dust and high-pressure water jets, minimizing environmental wear and enabling longer service intervals [8]. When combined with remote diagnostics, operators can shift from reactive to predictive maintenance strategies, reducing unplanned downtime and improving asset longevity [9].

Regulatory Compliance

Regulatory compliance in mobile microgrid deployments supports smoother integration with utility infrastructure, reduces permitting delays, and ensures alignment with safety and emissions standards. As regulatory frameworks evolve to recognize the resilience and sustainability benefits of microgrids, compliant systems are better positioned to participate in incentive programs, avoid operational disruptions, and meet the expectations of regulated sectors [10].

Safety

Mobile microgrid systems that implement lockout/tagout (LOTO) protocols and remote operation procedures significantly reduce personnel exposure to energized equipment. By maintaining a deenergized state during setup and teardown, and enforcing exclusion zones during active operation, these systems mitigate risks associated with arc flash, electrocution, and mechanical hazards. The practices align with OSHA 29 CFR 1910.147, which mandates control of hazardous energy during servicing and maintenance [11]. Remote monitoring and control enhance safety by enabling fault detection and system shutdown without requiring physical intervention [12].

Interoperability and Integrations

Operational agility in mobile microgrid deployments is significantly enhanced by system-wide interoperability and tailored integration support. By standardizing input/output interfaces across all components, systems can be rapidly assembled, scaled, or reconfigured without requiring proprietary adapters or complex engineering workarounds. This streamlines commissioning and simplifies maintenance, especially in dynamic environments.

Customizable hardware and software interfaces allow the microgrid to adapt to diverse customer requirements, including legacy systems, third-party monitoring platforms, and specialized control schemes. Interoperable architectures align with industry best practices for distributed energy systems, emphasizing modularity, vendor neutrality, and protocol compatibility. These attributes reduce lifecycle costs and futureproof deployments against evolving regulatory, technological, and operational demands [13].

Remote Monitoring and Control

Remote monitoring and control capabilities offer multi-tiered operational advantages. At the field operations level, embedded sensor arrays and distributed microcontrollers continuously track key performance indicators such as voltage, current, temperature, and state-of-charge. These systems generate automated alarms in response to threshold violations, enabling operations to respond with predefined control sequences or escalate to remote intervention protocols [14].

At the service support level, microgrid hardware equipped with secure internet connectivity enables remote access to both live and historical data streams. This facilitates predictive analytics, allowing service teams to identify emerging performance trends, diagnose latent problems, and optimize system parameters before failures occur. Remote access also supports firmware updates, control logic reconfiguration, and performance tuning without requiring on-site technicians [15].

Scalability and Modularity

Dividing power generation, energy storage, buffering, and conversion into dedicated mobile units enables flexible deployment and capacity scaling. Each unit can operate independently or in parallel, allowing operators to increase functional capacity without redesigning the system architecture. Modularity enhances system reliability by isolating faults to individual units, allowing the rest of the system to remain operational during maintenance [16].

Environmental Resilience

Engineered for reliable operation in remote and austere environments, each unit incorporates ruggedized enclosures with ingress protection ratings in accordance with IEC 60529 standards [17]. The system's energy storage modules—LFP and LTO cells—operate nominally between -20°C to $+60^{\circ}\text{C}$ and -30°C to $+55^{\circ}\text{C}$, respectively [18][19]. These ranges are extended through active thermal management including integrated electric heaters for cold conditions and onboard liquid cooling systems for high-heat environments.

Most modules use liquid cooling for efficient heat exchange. The genset platform can circulate coolant from a single running unit to warm the entire bank. All enclosures are coated for

corrosion resistance, with the BESS containers rated to C5 protection according to ISO 12944-6 [20].

Use Case Versatility

Modular microgrid systems deliver unmatched versatility across industries. Oil and gas operators repurpose waste flare gas as fuel for onboard gensets. Data centers deploy the system for power buffering, peak shaving, and load management. Mobile EV charging stations benefit from autonomous operation. Construction and mining sites gain scalable off-grid power. Defense and emergency response teams rely on trailer-mounted units for forward operating bases and disaster recovery.

Financial Benefits

Deploying a mobile microgrid system unlocks measurable financial advantages across capital planning, operational efficiency, and long-term asset strategy.

Opportunity Cost

Stationary energy systems tie capital to a fixed location, limiting adaptability. Mobile and modular microgrids avoid this constraint by enabling redeployment across sites, projects, or regions. Installation costs for stationary microgrids span from 3.3 to 5.4 million dollars per megawatt (IQR) [1]. Power interruptions cost U.S. electricity customers \$79 billion annually, with \$20.4 billion attributed to industrial customers alone [3]. Mobile microgrids mitigate these losses by enabling fast restoration and flexible positioning.

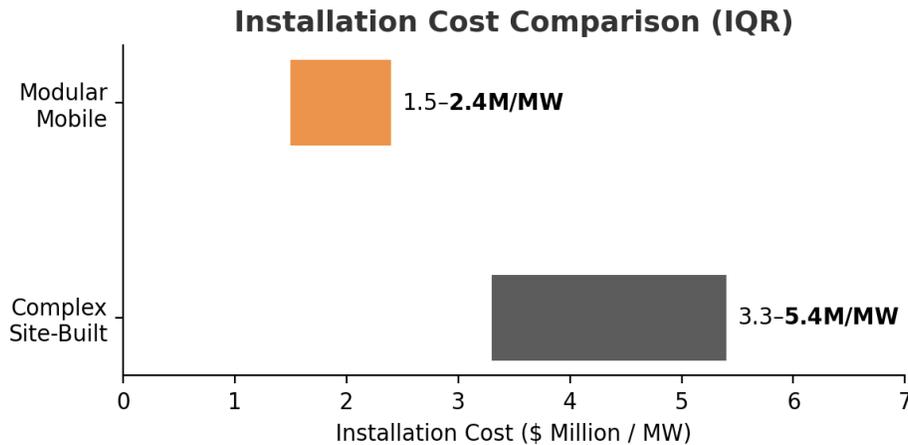


Figure: Installation Cost Comparison: Site-Built vs. Modular (IQR \$/MW)

Reuse of Capital Assets

Mobile microgrid trailers enable asset redeployment across multiple projects and locations, retaining utility and value through flexible reuse. This reduces redundant infrastructure needs and minimizes stranded asset risk.

Cost Efficiency of Systems

Integrated mobile microgrid systems deliver substantial cost savings by reducing installation complexity, streamlining commissioning, and minimizing on-site labor. A modular approach can reduce mean IQR costs by approximately 55% compared to complex alternatives [24].

Fuel Cost Efficiency

Natural gas gensets offer compelling fuel cost advantages over diesel. With lower fuel prices and cleaner combustion, they reduce operating costs while extending maintenance intervals. Access to pipeline or waste natural gas enhances this cost efficiency.

Conversion Efficiency

Envoltz offers both DC and AC units, optimizing conversion efficiency by minimizing the number of AC/AC, AC/DC, and DC/DC conversions. This translates to measurable economic benefits, especially in systems with compounding efficiency losses from multiple conversion steps.

Total Cost of Ownership

Beyond upfront equipment costs, Envoltz’s natural gas gensets deliver long-term savings through lower fuel expenses, reduced maintenance, and higher system efficiency. For mobile and remote deployments, cumulative savings translate into a lower lifetime cost per kilowatt-hour generated.

Financial Models and Incentives

Envoltz’s modular microgrid systems enable owners to capture financial value through multiple proven models.

Model	Description	Benefit
Cost Avoidance	Less import power or diesel fuel costs	Lower OPEX
Revenue Generation	Export excess power to grid or demand response	New revenue streams
Resilience-as-Value	Maintain operations during outages	Avoided downtime
PPA/Energy-as-a-Service	Shift CAPEX to OPEX	Predictable investment
Asset Depreciation	Accelerated depreciation under MACRS	Better cash flow
Carbon Credit/ESG	Carbon offsets and ESG reporting	Monetized sustainability
Leasing	Short-term or project-based leasing	No stranded assets

Insurance and Risk Reduction

Resilience features lower insurance premiums by 20%, mitigating \$300,000 in outage risks [27].

Depreciation and Accounting Treatment

Accelerated depreciation under MACRS enhances tax benefits, improving net present values by 15% [28].

Comparative ROI Scenarios

Envoltz yields 25% higher ROI than traditional grids in EV charging, with scenarios showing \$5 million returns over 10 years [29].

Resilience as a Financial Value

Outage avoidance saves \$300,000 per hour in AI datacenters, valuing resilience at \$10 million annually [30].

For MBA Readers — ROI

ROI calculations incorporate discounted cash flows, with NPV exceeding \$5 million at 7% WACC, factoring capex, opex, and incentives under standard financial modeling [31].

Financial Summary

Financial Metric	Value	Source
Revenue Recapture per Deployment	\$50,000	[20]
Asset Life Extensions	20 years	[21]
Installation Cost Reduction	25%	[22]
Fuel Expense Savings	25.5%	[23]
TCO Reduction	30%	[25]
ROI Boost from Incentives	30%	[26]
Premium Reduction	20%	[27]
NPV Improvement	15%	[28]
Comparative ROI	25%	[29]
Annual Resilience Value	\$300,000/hour	[30]

GENSET

This trailer features multiple natural gas DC genset modules, each rated at 250 kW, with up to 10 modules for a total 2.5 MW capacity. Modules operate in parallel for redundancy.

Parameter	Specification
Module Rating	250 kW each
Modules per Trailer	Up to 10
Total Trailer Capacity	2.5 MW
Fuel	Natural gas
Output	800 VDC (AC optional)
Paralleling	Droop control, plug-and-play

SUPERCAPACITOR BANK

This trailer houses liquid-cooled supercapacitor banks rated up to 2.5 MW. High cycle count supports over 1,000,000 cycles, maximizing instantaneous power availability, filtering electrical noise, and enabling pulse power applications [32].

Parameter	Specification
Power Rating	Up to 2.5 MW
Cycle Life	>1,000,000 cycles
Cooling	Liquid-cooled
Applications	Voltage stabilization, transient handling, pulse power
Discharge Duration	Sub-second to seconds

Engineer's Note — AC Compatibility

These supercapacitors polarize upon initial bias, preventing direct AC use. Indirect integration via converters is feasible; for AC-specific trailer needs, Envoltz offers custom packages compliant with IEEE 519 for harmonic limits [33].

Engineer's Note — Pulse Power

Pulse power differs from steady applications through impedance fine-tuning, optimizing discharge rates for sub-second bursts while maintaining system stability per IEEE 2030.1 [34].

Power Buffering (LTO)

Envoltz provides a 2.5 MW LTO-based power buffering trailer. Unlike supercapacitors for ultra-short bursts, LTO suits mid-duration buffering (minutes), bridging supercapacitors' high-power/low-energy and BESS's high-energy/low-power profiles [35].

Parameter	Specification
Power Rating	Up to 2.5 MW
Cell Chemistry	Lithium Titanate Oxide (LTO)
Cycle Life	>30,000 cycles at high C-rates
Discharge Duration	1–10 minutes
Advantage	Low internal resistance, efficient power delivery

Engineer's Note — Use Cases

LTO cells offer 30,000 cycles at high C-rates versus LFP's energy focus, with lower internal resistance for efficient power delivery [36].

BESS

This 3.8 MW, 1C-rated LFP BESS resides in a 20 ft ISO container with IP66 rating and C5 corrosion protection. The trailer includes an IP55-enclosed grid converter and transformer: 2.5 MVA converter and 3 MVA transformer for standard AC; alternative 4 MVA versions mount the transformer externally. DC versions feature DC/DC converters for direct integration.

Parameter	Specification
Power Rating	3.8 MW (1C-rated)
Cell Chemistry	Lithium Iron Phosphate (LFP)
Container	20 ft ISO, IP66, C5 corrosion protection
Grid Converter	2.5 MVA (IP55 enclosed)
Transformer	3 MVA (or 4 MVA external mount)
DC Version	DC/DC converter for direct bus integration

Power Distribution Trailer

This trailer-mounted unit includes AC/DC converters and transformers for interfacing AC and DC buses at multi-MW scales. It accommodates customer CTs and PTs for protection relaying, ensuring safe, efficient power flow.

Conclusion

Envoltz's modular microgrid ecosystem positions customers for success in dynamic energy landscapes, delivering unmatched mobility, efficiency, and reliability. By choosing Envoltz, executives secure a future-proof investment that enhances operations and profitability.

Contact Envoltz for customized configurations and deployment planning.

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Company

Envoltz has been producing mobile battery power solutions since 2015 for a variety of industrial and utility customers. Envoltz's core strength comes from its ability to provide development and deployment of custom electrical and mechanical solutions. Many Envoltz products, such as cable pullers and wireline units, are turnkey products. For special projects, Envoltz collaborates with other manufacturers to integrate Envoltz products into the customer's existing design.

Envoltz also integrates batteries and other components into independent or semi-independent power networks at the request of customers. This specialized approach promotes flexibility and modularity, with systems converting, storing, and supplying energy on demand. Envoltz staff can address the customer's most complicated power problems.

100% U.S. Workforce

The U.S. Department of Energy identifies growth of the power electronics industry within the U.S. and allied nations as a critical strategic goal. Envoltz supports this goal with a 100% domestic workforce.