



ZincFive

IPS

WHITE PAPER

Immediate Power Solutions (IPS): Definition, Benefits, and Impact

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Introduction

The relentless advancement of modern technology is only possible because of the electrical infrastructure that supplies essential power and energy. Driven by macro trends in computing, AI, mobile devices, the electrification of transportation, and power generation and delivery are now at the forefront of public consciousness.

The electrification of everything is spurring innovation across all segments of electrical infrastructure, emphasizing the importance of energy storage, and bringing what was once in the background, to center stage. New requirements and technologies are building upon each other, resulting in an explosion of new products and applications.

Examples abound:

- Rooftop solar installations are now large enough to cause load deflection.
- In the opposing direction, significant increases in electricity demand are jolting the global electric utility industry out of traditional growth rates.
- Energy storage technologies, including mechanical, thermal, electromagnetic (capacitors), or electrochemical (batteries/fuel cells), are rapidly advancing.

Among these energy storage innovations, batteries in particular swiftly transitioned from being overlooked for nearly a century to becoming the focus of major technological advancements, global investments, massive deployments, and even Nobel prizes. Batteries for electric vehicles (EVs), long-duration grid storage, and short-duration applications are now a central concern for technologists, general users, and governments worldwide.

This paper focuses on the expansion in segmentation and applications beyond traditional long-duration energy storage (hours to days) to include short-duration energy storage (minutes to microseconds) utilizing mechanical, thermal, electromagnetic, and electrochemical technologies. Note that all energy storage and short-duration power systems share the characteristics of charging and discharging when desired. This is distinct from power conversion systems which have no storage, such as wind turbines, solar panels, or diesel generators that convert wind, solar, and chemical power into electricity. Long-duration energy storage applications are traditionally labeled Energy Storage Systems (ESS) and long-duration electrochemical (battery) technologies are known as Battery Energy Storage Systems (BESS). In this modern, electrified age, short duration energy storage segments and applications are expanding rapidly due to the surge in use cases and new enabling technologies.

A fundamental difference between long and short-duration energy storage is that storage capacity (i.e., energy density) is the highest value characteristic in long-duration applications and discharge capacity (i.e., C rate or power density) is the highest value characteristic in short-duration applications. Short-duration energy storage examples include mission-critical power backup systems, commercial and military pulse power applications, and short duration industrial and grid power stabilization support. The widening gap between long and short-duration energy storage segments and applications, along with the emergence of new technologies tailored to each, necessitates the creation of a new category aptly named Immediate Power Solutions (IPS).

Under the umbrella of IPS, short-duration energy storage stakeholders can now effectively identify and differentiate their requirements from the long-duration labels used incorrectly due to the lack of alternative. An example of the effect from this overlap is the ever-growing family of lithium-ion rechargeable battery technologies, which are inherently high energy density chemistries. These products work well in long-duration energy storage applications such as renewables, grid storage, and EVs. Due to familiarity, cost, or both, lithium-ion batteries are also applied to short-duration applications where high energy density is a poor fit or even a disadvantage. In this new era, one-size-fits-all applications of battery technologies are now obsolete in favor of optimizing products and technologies for specific applications.

The IPS category helps short duration users, technology providers, and services suppliers self-identify and coalesce to optimize short-duration energy storage implementations.

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Immediate Power Solutions Defined

A requirement of short duration energy storage applications is the availability of instantaneous, high-rate power for a range of minutes to microseconds.

The IPS group of technologies and applications are vital to the growth of all power infrastructure, with many of these applications now categorized as critical, mission critical, or life safety. The presence of instantaneous, high-rate power in a mission-critical application requires the additional characteristic of safety for IPS technology to remain viable. Further, mission critical applications demand high reliability and sustainability, which are now prime factors in all short-duration energy storage use cases.

Given the above characterization, Immediate Power Solutions (IPS) are concisely defined as: safe, reliable, and sustainable, short-duration, high-rate power technologies for critical applications.

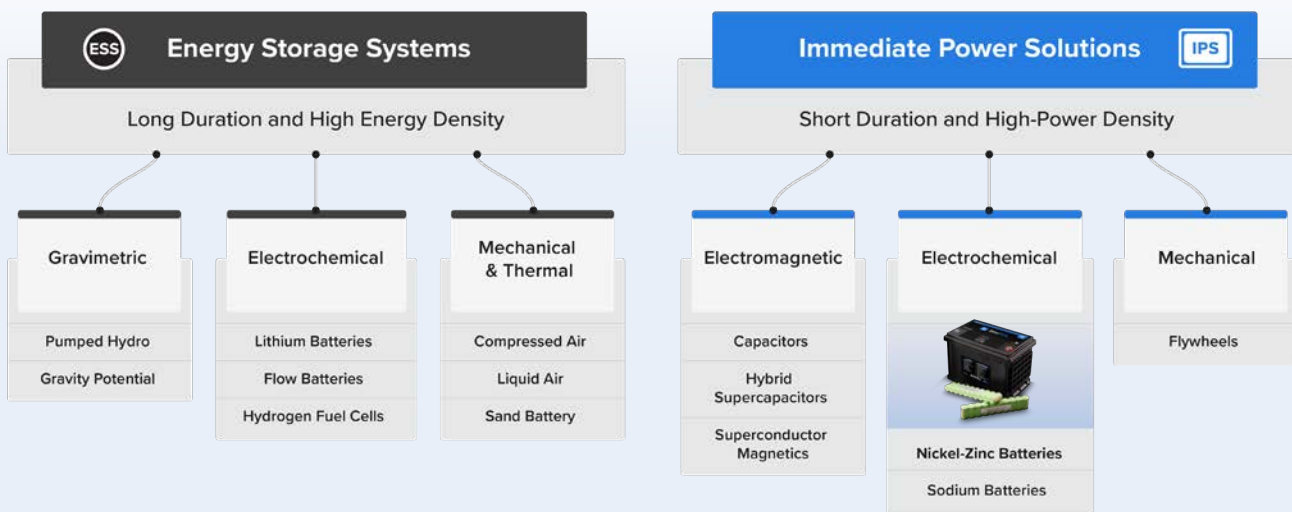
Immediate Power Solutions (IPS) address the needs of electrical applications that are defined by their power levels and typically require short-duration response time to maintain desired system operation. For example, a 480 VAC three phase UPS system in a data center that must provide 1 Megawatt of power within 10 milliseconds and for up to 2 minutes to assure the successful start and synchronization of backup generators. This is an Immediate Power Solution that requires AC and DC power, real and reactive power considerations, and energy typically discharged by mechanical, electromagnetic, or electrochemical means.

IPS is not a new idea, but the frequency and severity of problems caused by power outages in computer systems, medical monitoring equipment, and other mission-critical environments demonstrated the importance of the category. As is often the case, new IPS challenges spur the development of new, innovative IPS solutions. Moreover, each new IPS solution will both address its target application and apply to a range of similar challenges and applications.



Immediate Power Solutions (IPS)

Safe, reliable and sustainable, short duration, high-rate power technologies for critical applications.



Immediate Power Solutions (IPS): Applications and a Look Ahead

With Immediate Power Solutions (IPS) clearly defined, the remainder of this paper explores their current state and future directions. As illustrated in the previous section, there are multiple technological approaches to IPS, each with its own set of performance characteristics. This allows users to identify applications that fall into the IPS category and compare their requirements to the available technologies.

Understanding the IPS distinction is critical for matching the right technology to the use case. While the world demands more power and energy, not every application requires a long-duration Energy Storage System. Using ESS technology where it is not the best fit is inefficient. Conversely, employing an IPS product for a 4-hour grid support application is impractical and costly.

Applications for this short-duration power delivery span multiple verticals including industrial manufacturing, data centers, electric vehicle charging infrastructure, artificial intelligence (AI)/machine learning (ML) power influxes, and even support for long-duration energy storage and generation products during the ramp up to peak power. These use cases are inadequately served by ESS products, as there are IPS products tailored to each of these needs. For instance, ZincFive nickel-zinc (NiZn) batteries can bridge short duration power gaps (1 minute to 5 minutes) in multi-megawatt data center installations with a small footprint, and super-capacitors can fill millisecond voids for electronics to ensure proper function. (See the below section, Immediate Power Solutions in the Data Center Industry, for more information)

The examples referenced thus far involve existing systems now facing new challenges driven by the immediacy, magnitude, and duration of AI workloads and accelerated processing. Although individual servers incorporate onboard capacitance to absorb very short-duration power spikes, those local buffers are designed for micro-scale events and cannot support the larger, repeated surges seen at the rack or facility level.

Particularly during training and inferencing bursts, AI dynamic loads generate rapid, frequent, and high-magnitude changes in power demand that traditional power supplies struggle to consistently mitigate over extended periods. As these rapidly cycling loads become more common, meeting reliability and safety requirements increasingly requires power systems that can respond immediately at scale. This creates an opportunity for IPS technology, which can deliver the fast, repeatable power response needed at the system level, far beyond what individual server capacitors can provide.

New IPS technologies, like batteries that exhibit superior power and energy density compared to capacitors, similar cycle life, and simple battery management characteristics, are gaining traction in applications like power supply surge capacity.

Another potential IPS application example is microgrid power stabilization when exposed to unpredictable loads and availability of power sources. Microgrids exist on a small enough scale that the introduction of a single stabilizing component can make a significant overall performance difference.

IPS technology also enables easy management of hybridized fuel cells, diesel, and gas turbine generators by allowing any type of generator to provide immediate power at “time zero.”

A final, unique use case for IPS involves resolving unrecognized problems associated with the status quo. Consider a factory that sequentially starts all its process motors to avoid power surges that exceed utility-supplied power limits. An IPS solution can help this factory achieve the operational efficiency benefits of simultaneous motor starting. This type of IPS application example highlights the direct benefits of an IPS solution to both known problems and yet-to-be discovered future IPS application opportunities.

Immediate Power Solutions in the Data Center Industry

As data centers undergo exponential growth in power demand over the next decade, operators are tasked with ensuring safety and meeting sustainability requirements, while reducing costs wherever possible.

An ideal IPS use case is supporting uninterruptible power supply (UPS) systems in data centers and addressing the unique demands of GPU and AI-driven dynamic loads. Compared to conventional ESS systems, IPS systems feature a higher charge and discharge rate, or slew rate which enables them to deliver near-instantaneous power. In a mission-critical data center environment, a delay could mean introducing catastrophic financial and operational outcomes via total harmonic distortion outside acceptable ranges for data center power infrastructure. Now, with rapid AI power spikes numbering millions monthly, at various loads, several times a second, there is a greater immediate need for operators to choose the best IPS solution.

One prominent chemistry for IPS applications is nickel-zinc (NiZn), which features high-power density in a compact footprint, making this technology ideal where speed, space, and power are key considerations. Compared to lithium-ion and lead-acid, nickel-zinc occupies one-half and one-third of the footprint, respectively, optimizing space for revenue-generating equipment. While traditional solutions struggle to perform under high-cycle environments, nickel-zinc's ability to rapidly discharge and recharge high rates of power, position this chemistry as the ideal choice for managing AI-driven power spikes without compromising performance.

Nickel-zinc IPS solutions also deliver reliable performance without compromising safety. Unlike lithium-based chemistries – which may require system shutdowns via battery management systems (BMS) to prevent thermal events – NiZn systems remain operational even when individual cells become weak or depleted, ensuring uninterrupted performance and minimal downtime. Additionally, NiZn chemistry offers exceptional operational flexibility, withstanding a broader temperature range than lead-acid or lithium-ion – without the risk of thermal runaway at the cell level. As customers and legislators emphasize the call for greater environmental responsibility, data center operators are increasingly choosing solutions that prioritize sustainability criteria. With an operational lifespan up to three times longer than lead-acid batteries, nickel-zinc (NiZn) battery technology provides a sustainable, recyclable Immediate Power Solution. The lifetime greenhouse gas emissions from NiZn solutions are 25–50% lower than lead-acid and lithium-ion alternatives, and utilize conflict-free, widely-available materials. From cradle-to-grave, nickel-zinc solutions are the more sustainable and environmentally responsible choice for immediate power in modern data centers.



Conclusion

Immediate Power Solution technologies and applications are essential in the sustainable expansion of power infrastructure. Especially in mission critical environments, where even brief power disruptions can result in major financial and operational impacts, IPS plays a critical role.

Clearly differentiating between ESS and IPS, and knowing when each technology is best applied, plays a significant role in addressing power infrastructure challenges effectively. Consequently, this significance necessitates a distinct IPS category in the market, focused on meeting today's unique power demands and ensuring robust solutions for these vital applications.

In the age of AI, cloud services, and expanding electrical infrastructure, selecting the right IPS solution for each application is essential, as we continue to face and solve the power issues by developing IPS infrastructure.

About ZincFive, Inc.

ZincFive is the world leader in innovation and delivery of nickel-zinc batteries and immediate power solutions. Supported by an impressive portfolio of international patents, ZincFive technology harnesses The Power of Good Chemistry™ to propel the world forward. ZincFive technology leverages the safety and sustainability of nickel-zinc chemistry to provide unparalleled high power density and performance for mission critical applications. ZincFive is a privately held company based in Tualatin, Oregon.

For more information, visit www.zincfive.com

Contact ZincFive

Contact ZincFive today to learn more about its innovative NiZn technology and IPS solutions.

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