Powering the Future: How AI Data Centers Are Transforming the Onsite Power Generation Landscape

AI is reshaping industries at an incredible pace, and with it comes a skyrocketing demand for reliable power. Data centers—especially those supporting AI applications—require massive amounts of energy, creating both challenges and opportunities for the on-site power generation sector.

As AI-driven workloads continue to grow, so does the need for innovative power solutions that ensure uptime, efficiency, and sustainability. In this article, we'll explore how the rise of AI data centers is influencing the industry, the latest technologies shaping power generation, and the strategies companies are using to stay ahead in this rapidly evolving landscape.

Rising Demand for Reliable Power

AI's Accelerating Energy Footprint

Compared to conventional IT workloads, AI can be exponentially more power-intensive. AI-focused data centers increasingly require high-density compute resources, often exceeding 30 kW per rack—double or triple that of typical enterprise data centers. As machine learning (ML) models grow larger and more complex, these densified workloads put significant pressure on facility power and cooling systems. This increased power density necessitates more robust and efficient power delivery and cooling infrastructure.

Mission-Critical Uptime

In AI workflows, downtime can be devastating. Interruptions in model training or real-time inference can lead to significant data integrity issues and financial losses. As a result, data centers that support AI workloads aim for near-zero downtime (often 99.999% availability or even higher). This unwavering focus on uptime drives the adoption of robust onsite power generation and storage solutions that seamlessly handle grid disruptions.

Onsite Power Generation for AI Data Centers: A Growing Imperative

The Ongoing Importance of Diesel

Because of this demand for reliable power sources, diesel generators continue to play a vital role as primary power strategies for these types of data centers. Despite increasing interest in alternatives like natural gas and renewables, diesel's reliability, quick-start capability, and familiar technology infrastructure remain compelling. Moreover, innovations in diesel—such as lower sulfur fuels, biodiesel blends, and advanced emissions control systems—are helping reduce emissions and meet evolving environmental standards.

Diversification Beyond Diesel

While diesel has historically been the primary backup source, the drive toward resiliency and sustainability has spurred interest in additional onsite power options:

- Natural gas turbines
- Combined heat and power (CHP) systems
- Fuel cells (hydrogen or natural gas)
- Renewable microgrids paired with battery storage

This diversification offers data center operators greater flexibility in balancing cost, resiliency, and carbon reduction goals.

Microgrids and Distributed Energy Resources

A microgrid is a localized energy network that can function independently or sync with the main grid. Many data centers—especially those running AI workloads—are integrating microgrids for enhanced resilience. By combining distributed energy resources (DERs)—such as solar PV, fuel cells, and battery storage—with intelligent controls, microgrids ensure a stable power supply even amid broader grid disturbances. Diesel generators can (and often do) feature prominently in these configurations as well, acting as a robust anchor alongside cleaner technologies.

Microgrids are a particularly timely topic given that many industry conferences—including those hosted by EGSA—are highlighting them as a key solution. With advanced monitoring and controls, microgrids allow data centers to seamlessly switch between different power sources, improving uptime and operational efficiency. They also enable participation in demand response programs, potentially lowering costs for operators while reducing strain on the broader grid during peak load periods. As AI-driven workloads continue to grow, microgrids provide the flexibility and scalability required to meet ever-rising power and reliability demands.

Fuel Cells and Other Clean Technologies

Data centers, especially those powering AI, are also investing in cleaner onsite generation. Hydrogen fuel cells, for instance, offer reliable, high-quality power with minimal emissions. Ongoing advancements in electrolyzer technologies and the global momentum around hydrogen adoption are making hydrogen-based solutions a more realistic option to support future high-density computing. Other clean technologies, like advanced biofuels and renewable

natural gas (RNG), are also being explored.

Opportunities for the Onsite Power Generation Industry

Design and Consulting Services

AI data centers require specialized power architectures to handle heavy, unpredictable loads—often integrating multiple sources like diesel generators, natural gas turbines, and renewables. These architectures may include:

- Advanced switchgear systems for safe and efficient load sharing across different power sources.
- High-voltage (HV) distribution networks to manage the increased load density without significant line losses.
- Dynamic load balancing and parallel operation setups to optimize generator performance.
- Combined heat and power (CHP) or tri-generation solutions that capture heat for cooling or additional processes, boosting overall efficiency.
- Microgrid controllers capable of orchestrating multiple, diverse energy assets in real time.

Experienced consulting and engineering teams can design these complex power architectures, ensuring compliance with regulatory requirements and alignment with data centers' reliability and sustainability goals.

Equipment and Integration

As demand for onsite power solutions rises, so does the need for scalable, high-reliability equipment. Manufacturers and integrators of diesel generators, turbines, fuel cells, and battery systems can tap into a growing market—particularly where modular, rapid-deployment solutions are critical.

Maintenance, Monitoring, and Analytics

The always-on nature of AI-driven data centers demands proactive maintenance and real-time system visibility. Providers offering predictive analytics and remote diagnostics for onsite power equipment are well-positioned for long-term service contracts that ensure minimal downtime and optimized performance.

In addition, AI data centers will increasingly require a robust field service force—competent, comprehensive, and reliable technicians, along with management solutions that can handle fast response times and complex troubleshooting. Specialized training programs and advanced management tools become critical to retaining skilled labor, keeping pace with evolving technologies, and maintaining safe, efficient operations.

Innovative Financing Models

Large capital expenditures can challenge data centers looking to upgrade their power infrastructure. Financing models like energy-as-a-service (EaaS) or power purchase agreements (PPAs) help spread costs over time, fueling adoption of both advanced diesel solutions (e.g., with emissions aftertreatment) and newer technologies (e.g., hydrogen fuel cells).

Overcoming Challenges

Increased demand brings new challenges that the industry is beginning to recognize. New solutions are required on top of traditional problems of scale, logistics, and regulation that still apply.

Fuel Accessibility and Infrastructure

Deploying alternative fuels, like natural gas or hydrogen, requires a reliable supply chain and support infrastructure. Even diesel, while widely available, can face logistical challenges in certain regions or during extended grid outages. Onsite power providers must coordinate closely with fuel distributors and local officials to ensure consistent access in all scenarios.

Regulatory and Environmental Hurdles

Many jurisdictions have introduced stricter emissions controls on diesel-based backup power, prompting operators to adopt lower-emission engines, alternative fuels, or aftertreatment systems. Although evolving diesel technologies offer reduced emissions, compliance with regulations—and navigating community perceptions—remains paramount.

Integration and Interoperability

Implementing microgrids or hybrid energy solutions that combine diesel, fuel cells, solar, and energy storage requires sophisticated controls. Ensuring seamless interoperability among these assets—and with the data center infrastructure—minimizes complexity. Advanced monitoring and analytics are essential for optimization and avoiding single points of failure.

Minimizing AI's Power Needs: A New Frontier

Beyond optimizing power generation, minimizing the power consumption of AI itself is a critical area of focus. Companies like DeepSeek are developing more efficient AI algorithms and hardware architectures that require less energy for training and inference. This "green AI" approach not only reduces operational costs but also lessens the environmental impact of AI technologies, making them more sustainable in the long term.

However, it's important to acknowledge that the pursuit of efficiency in AI can sometimes raise concerns. For example, some companies might prioritize energy reduction at the expense of robust security measures or data privacy protocols. There may also be a temptation to underreport the true costs associated with AI development and deployment, particularly regarding the environmental impact of training large language models. Careful consideration must be given to the full lifecycle impact of AI and the trade-offs involved in pursuing greater efficiency.

Looking Ahead

As AI accelerates demand for high-density compute, data centers will turn to onsite power generation to deliver reliability, scalability, and sustainability. Diesel is expected to remain a cornerstone for many, given its established track record and reliability, while alternative solutions continue to evolve to meet emerging needs and environmental mandates. Whether it's advanced diesel engines, new microgrid configurations, or cutting-edge hydrogen technologies, the onsite power generation industry stands at the intersection of critical infrastructure and digital transformation. By innovating in technology, business models, and fuel supply chains, providers can deliver the resilient, low-carbon solutions needed to power the data-driven world of tomorrow.

References

Uptime Institute, "2024 Global Data Center Survey"
https://uptimeinstitute.com/resources/research-and-reports/uptime-institute-global-data-center-survey-results-2024

Data Center Frontier, "Microsoft Knows Future of Data Center Power Will Be 'Everything Everywhere All at Once" (2024)
https://www.datacenterfrontier.com/energy/article/33019254/microsoft-knows-future-of-data-center-power-will-be-everything-everywhere-all-at-once

Data Center Frontier, "Can We Solve the AI Data Center Power Crisis with Microgrids?" (2025)
https://www.datacenterfrontier.com/energy/article/55268513/perspective-can-we-solve-the-ai-data-center-power-crisis-with-microgrids

Microgrid Knowledge, "The Compelling Case for Data Center Microgrids" (2023)
https://www.microgridknowledge.com/data-center-microgrids/article/33000470/the-compelling-case-for-data-center-microgrids

McKinsey & Company, "How Data Centers and the Energy Sector Can Sate AI's Hunger for Power" (2024)
https://www.mckinsey.com/industries/private-capital/our-insights/how-data-centers-and-the-energy-sector-can-sate-ais-hunger-for-power

International Energy Agency (IEA), "Global Hydrogen Review 2022"
https://www.iea.org/reports/global-hydrogen-review-2022

Ever wonder how AI can help write about… well, AI?

Jake Stratton
EGSA, Director of Technology and AI

In this behind-the-scenes look, I'll show you how I used ChatGPT (Model 4o) and Gemini to craft an article on how AI data centers are impacting the onsite power generation industry. Think of this as a "meta-article" - I'll walk you through my prompts, what I was trying to achieve, and how I fine-tuned everything for extra polish.

Article Creation

ChatGPT to Create Rough Draft

I needed a concise, targeted piece for POWERLINE magazine readers, focusing specifically on how AI data centers are influencing onsite power systems rather than large-scale power plants. Specifically mentioning EGSA's POWERLINE magazine should give it the context it needs to know the audience and content since, presumably, the model knows about EGSA and its publications.

"Write an article for EGSA's Powerline magazine about the effect AI data centers are having on the onsite power generation industry."

The result was very good and telling the model this explicitly ensures that it will continue to respond in the same manner. But I wanted to ensure the article had credible references to support the claims, so I asked ChatGPT to incorporate relevant citations and direct links.

"That's great. Include references with URLs"

The article was regenerated in its entirety – complete with references and associated links. However, after seeing some older citations, I needed fresh data and recent stories to keep the article current and more compelling for the readers.

"Rewrite it with only the most up-to-date information. 2016 references are too old."

The result was a well-written, concise, and factually accurate article, complete with references to current information.

As I read through the latest version of the article, I noticed that it leaned heavily towards renewable energy sources, yet there's significance in diesel-based power solutions in the onsite generation space. This could potentially be an example of bias, a large concern among many regarding LLMs. So, I asked ChatGPT to incorporate content addressing diesel generators and their role.

"That is exactly what I am looking for. Now remember that we have diesel members also, so don't leave that out."

The result was a very good article, but it still needed work. Some of the referenced links were broken, and some users find Gemini better for these types of content creations. So, after I had the final version from ChatGPT, I brought the draft into Gemini. I was hoping this would potentially balance any biases and fact-check.

Gemini to Fact Check and Fix References

"I am writing this article for EGSA's POWERLINE magazine. Please check it for errors and verify the references. Make corrections as needed. I also would like to include something about how minimizing the power needs of AI technology is another hot topic (i.e. DeepSeek)." (I cut and pasted the full text of the article created by ChatGPT and sent it as a single prompt to Gemini.)

The result was a slightly updated version of the article, with a new section on the issue of minimizing the power demands of AI technologies, working reference links, and suggestions on how the article could be improved.

In less than an hour, I had a concise,

informative article tailored to our members. However, I still needed an introduction and a clear overview of the creation process. To accomplish this, I returned to the same ChatGPT session where the majority of prompts and text generation had occurred.

ChatGPT to Detail Creation Process

"I am writing an article about how I created this article using ChatGPT and Gemini. I started with ChatGPT using all the prompts in this chat. Then I took the draft version of the article to Gemini and asked it to check all the references and add a section about minimizing the power demands of AI (ie DeepSeek). Write me an intro to my article and an explanation of the prompts, including why I made the adjustment (infer the reasoning)."

From that single prompt, ChatGPT produced a succinct introduction outlining how the article was created through the combined use of ChatGPT and Gemini. It followed up with a clear, prompt-by-prompt explanation, naturally inferring the rationale behind each adjustment without any further nudging.

The next step was to put it all together. I cut and pasted the introduction, the prompts and reasoning, and the final article output into ChatGPT and gave the following prompt:

"Correct any typo and grammar mistakes in this article."

The article had only one error, and, not surprisingly, it was a user error. There was a double space between two words at the end of a line – something I would never have noticed on my own.

Final Edits

It was now time to share this draft with the AIOPTF for review and edits (using ChatGPT or Gemini). They asked ChatGPT to replace the original introduction with a fresher, more engaging one by pasting the intro and giving the following prompt:

"Write an article introduction. Remove everything that mentions the publication and make the introduction friendly and easy to read."

Also, the article, in some places, jumped too abruptly from one section to the next, a common issue in AI-generated text. The following prompts were given, and the model returned bridging sentences that significantly improved the flow. The following prompt was used to improve the transition:

"The transition from the section titled 'Rising Demand for Reliable Power' to 'Onsite Power Generation: A Growing Imperative' doesn't flow well. Improve that."

Additionally, there were a few areas we felt needed more depth. To address these gaps, I consolidated the feedback from a task force member into a single prompt for ChatGPT:

"I like the serendipitous mention of Microgrids since that aligns well with conference topics for this year. Makes it very relevant. Expand on this aspect.

- In the "Opportunities for Onsite Power Generation Industry" section, the 'Design and Consulting Services' bullet talks about specialized power architectures but doesn't specifically say what those architectures are. Because we have an industry-educated audience for this article, perhaps we should get more detailed about those architectures to lend credibility...

- Same idea (enhanced detail) for the section on Maintenance, Monitoring, and Analytics – We could mention the subsequent and inevitable need for competent, comprehensive, and reliable field service technicians and management solutions."

The model easily incorporated these points into the article, adding the details we sought without requiring additional prompts. It was fully aware of the existing text, so this single, consolidated prompt was all that was necessary to guide the expansion.

Results

After these collaborative steps—spanning multiple prompts in ChatGPT and Gemini—the final article emerged as both factual and engaging. It offered well-researched insights on how AI data centers are transforming onsite power generation. Notably, a title was automatically generated by the model, even though we never explicitly requested one—a handy reminder that today's AI tools can sometimes anticipate our needs before we even articulate them. ●