Princeton Digital Group

Powering a Sustainable Tomorrow:

The Journey to Net Zero for Data Centers in Asia Pacific

At the heart of our digital economy, data centers serve as the critical infrastructure that powers our daily lives and transforms businesses and industries alike.

They provide the massive computing power and storage needed for generative AI and cloud applications, enabling AI to generate human-like text, power intelligent chatbots and deliver transformative applications across industries.

As our reliance on digital services grows, alongside the rapid growth of AI technologies, so do the energy requirements of these technological powerhouses. This underscores the need for clean, sustainable cloud infrastructure, making it a priority in global sustainability efforts.

The Asia Pacific region is experiencing exponential growth in data center infrastructure, driven by increased urbanization, digitization, and a booming digital economy. As countries across the region invest heavily in carbon-free infrastructure to support economic growth and energy security, Asia Pacific has the potential to set new standards in sustainable data centre operations.

Understanding Our Carbon Footprint

As Asia Pacific's leading developer and operator of hyperscale infrastructure, PDG's long-term goal is to reach net zero for Scope 1 and Scope 2 Emissions by 2030.

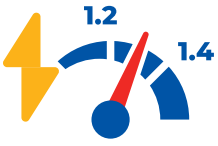
Scope 1 Emissions are direct emissions from sources owned by PDG, including diesel and refrigerants. Scope 2 Emissions are indirect emissions from purchased electricity, steam, heating, and cooling. For PDG, this includes emissions from the electricity used to power customer IT equipment and the electricity used for common areas and cooling data halls.

As a leader in sustainability, PDG is taking steps to reduce its emissions, including:

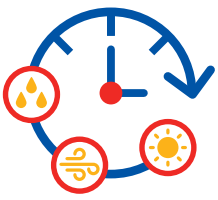
- Procuring solar power from a captive project in India
- Procuring biomass power in Indonesia
- Securing solar and geothermal energy in the form of RECs across markets
- Installing rooftop solar panels
- Transitioning its data centers to renewable or zero-carbon energy options

PDG's Roadmap to 2030

Reach net zero for Scope 1 and Scope 2 Emissions by 2030



Target Power Usage Effectiveness (PUE) between 1.2 and 1.4 for all greenfield data centers



Secure 100% carbon-free energy annually and embark on 24/7 hourly matching

Tackling Scope 1 Emissions

Innovation in Cooling

PDG aims to achieve net zero for all Scope 1 emissions by 2030, including retroactively addressing emissions from 2022 onwards. Scope 1 emissions primarily originate from cooling systems and diesel generators, which typically rely on conventional refrigerants such as hydrofluorocarbons (HFCs) and fossil fuels like diesel.

These conventional refrigerants present a significant environmental challenge due to their exceptionally high Global Warming Potential (GWP)[1]. Some HFCs can have GWP hundreds times higher than that of carbon dioxide (GWP of 1), making their impact on climate change disproportionately severe[2].

HFCs are widely used in refrigeration, air conditioning, and heat pump systems due to their efficiency and chemical stability. However, their environmental footprint is immense. When released into the atmosphere through leaks, improper disposal, or accidental emissions, HFCs contribute significantly to global warming. Unlike carbon dioxide, which can be absorbed by oceans and forests, HFCs are synthetic compounds with no natural sinks. Once released, their long lifespan means that they remain in the atmosphere for decades or even centuries, compounding their environmental impact over time.

Transitioning from HFCs to hydrofluoroolefins (HFOs), with their low global warming potential (GWP) is a key step in reducing data center emissions.

Hydrofluoroolefins (HFOs) offer several advantages over traditional refrigerants:

- **Low Global Warming Potential (GWP):** HFOs, such as HFO-1234ze have a GWP of less than 1[3], compared to HFCs, which can be hundreds of times higher. This helps reduce carbon footprints and meet stringent emissions regulations.
- **Energy efficiency:** Cooling systems account for about 40% of total energy consumption in data centers. HFO systems outperform alternatives like propane (5-21% higher energy use) and CO_2 systems (8-50% higher energy use)[4], delivering cost savings and better performance.

Despite these advantages, adopting HFOs across the hyperscale data center campuses can be challenging due to higher upfront capex. Strategic planning, staff training, modular implementation of cooling solutions, and collaboration with manufacturers are vital for successful deployment. Early results highlight HFOs' strong[5] potential to set new benchmarks for sustainable cooling in data centers.

---

[1] Global Warming Potential (GWP) is a measure of how much heat a greenhouse gas traps in the atmosphere compared to carbon dioxide over a specified time, usually 100 years.

[2] Source: https://acp.copernicus.org/articles/24/7309/2024/

[3] Source: https://www.climalife.co.uk/docs/Solstice%201234ze%20brochure.pdf

[4] Source: https://www.acrjournal.uk/news/hfos-supporting-the-sustainability-of-data-centres/

[5] HFO technology is recognised by the European Commission as a climate-friendly refrigerant alternative.
Source: https://www.acrjournal.uk/news/hfos-supporting-the-sustainability-of-data-centres/

Sustainable Backup Power: The HVO Revolution

As data centers prioritize greener operations, Hydrotreated Vegetable Oil (HVO) is gaining momentum as a cleaner and more sustainable alternative to traditional diesel fuel for backup power.

HVO addresses Scope 1 emissions by cutting carbon emissions by up to 90% over the fuel's lifecycle when compared with fossil fuels[6]. Produced from renewable sources such as waste vegetable oils and animal fats, HVO not only enables data centers to minimize their carbon footprint but also helps them support a circular economy.

Most importantly, HVO's cleaner combustion process reduces local air pollutants like particulates and nitrogen oxides while matching diesel's performance, ensuring reliable backup power with exceptional cold-start capabilities and long shelf life. With its significant environmental and operational benefits, HVO provides data centers with a sustainable, high-performance alternative to diesel fuel, helping them meet emissions targets without compromising reliability.

Moreover, lower particulate emissions benefit public health by reducing risks like childhood asthma and other respiratory issues.

PDG and Pertamina Patra Niaga have launched a pilot project to accelerate the energy transition through the adoption of Hydrotreated Vegetable Oil (HVO), known as Pertamina Renewable Diesel (Pertamina RD).

As part of our commitment to a cleaner future, PDG and Pertamina have launched this pilot project at the JC2 Cibitung data center. This initiative tested HVO's compatibility with our generators while comparing its performance, fuel consumption, and emissions against conventional diesel. Pertamina partnered with us, providing technical expertise, resources, sampling, and laboratory analysis to ensure robust and credible results.

This collaboration aims to drive meaningful impact, scaling the adoption of cleaner fuels and advancing the global energy transition.

[6] Source: https://watsonfuels.co.uk/for-business/lower-carbon-solutions/hvo-renewable-diesel/

Hydrofluoroolefins (HFOs)

A class of refrigerants consisting of unsaturated organic compounds made up of hydrogen, fluorine, and carbon.

Environmental benefits:

Global Warming Potential (GWP): **Low**
Ozone Depletion Potential (ODP): **Zero**

Performance:

- **Energy efficiency:** Comparable or superior performance in terms of energy efficiency and cooling capacity.
- **Safety:** Low toxicity

Hydrotreated Vegetable Oil (HVO)

Renewable, low-carbon biofuel made by treating vegetable oils or animal fat with hydrogen through hydrocracking or hydrogenation.

Environmental benefits:

- **Reduced emissions:** Up to 90% less carbon than diesel.
- **Lower hydrocarbon (HC) emissions:** Up to 60% for HC when compared to diesel[7].
- **Biodegradability:** Biodegradable, odourless and virtually non-toxic.
- **Particulate emissions:** Low.

Performance:

- **Long shelf-life:** Remains stable for 10 years with proper storage compared to regular diesel, which can start to degrade after one year.

Transforming Scope 2 Emissions

Renewable Energy Strategies

As businesses and industries increasingly adopt AI technologies, the demand for higher compute power will make data center operations even more power intensive. As a result, addressing Scope 2 emissions – those generated from purchased electricity – is a critical focus in the journey to net zero. Transforming Scope 2 Emissions requires country-specific carbon-free energy strategies such as direct Power Purchase Agreements (PPAs) that allow data center operators to secure carbon-free energy at scale while ensuring long-term price stability.

PDG has the following PPA agreements in place:

- **With Tata Power Renewable Energy Limited (TPREL) for solar power in India:** PDG's MU1 data center in Mumbai offsets its carbon footprint through a 25-year solar power contract with TPREL, sourcing renewable energy from a captive solar project in Maharashtra.
- **With PT Cikarang Listrindo Tbk (CL) for biomass power in Indonesia:** PDG's JC Campus in Cibitung, Indonesia, partnered with PT Cikarang Listrindo to source biomass energy from CL's Babelan plant, certified by International Renewable Energy Certificates (I-RECs). It is Indonesia's first data center campus to offer biomass-powered capacity.
- **Installed solar panels on rooftops in China and Malaysia:** PDG has installed 2,000 rooftop solar panels at the SH1 data center in Shanghai, China, which will generate 1,030 MWh annually and reduce GHG emissions by 587 tCO_2e per year. In addition, PDG is embarking on a new project to install solar panels on the rooftop of the JH1 data center in Johor, Malaysia, to generate 1.5 MWp.

[7] Source: https://www.mdpi.com/1996-1073/16/12/4785

In addition to PPAs, Energy Attribute Certificates (EACs), such as Renewable Energy Certificates (RECs)[10], offer a supplementary approach to renewable energy procurement strategy and further offset the carbon footprint. In 2024, PDG procured certified solar, wind and geothermal RECs in India, China, Malaysia and Indonesia to offset ~50% of its total carbon footprint.

PDG is committed to sourcing high-quality Energy Attribute Certificates (EACs) from local grids near our data center locations, ensuring alignment with regional energy systems and maximizing environmental impact.

The Quest for 24/7 Carbon-Free Energy

In the journey towards net zero emissions, PDG aims to power their data centers with carbon-free energy (CFE) on a 24/7 basis. This means electricity consumption across data center operations would be matched with carbon-free sources every hour of every day.

Achieving 24/7 CFE in Asia Pacific requires addressing a range of complex challenges, including varied grid maturity levels, developing regulatory frameworks, and geographic constraints that limit renewable energy generation in certain regions.

PDG is proactively addressing these challenges by collaborating with industry-leading consultants and championing innovative solutions. One initiative includes accelerating the adoption of Time-based Energy Attribute Certificates (T-EACs), which enable hourly matching of energy consumption with renewable energy production, paving the way for more precise and impactful sustainability efforts.

Despite these obstacles, the industry is making significant strides. Promising solutions are emerging, such as integrating advanced energy storage systems to ensure renewable energy availability during periods of low generation.

Additionally, adopting multi-technology approaches, including solar, wind, and geothermal, creates a more resilient and balanced energy ecosystem.

Cross-border energy solutions are also gaining momentum, with Southeast Asian nations collaborating to share carbon-free resources across interconnected grids. This cooperation offers a promising path toward a sustainable and carbon-free future for the region. PDG remains committed to partnering with energy providers to further develop 24/7 CFE resources for power operations.

As the world increasingly prioritizes sustainability, this multifaceted carbon-free energy strategy enables PDG to demonstrate its commitment while meeting evolving customer expectations.

[8] RECs are tradable, market-based instruments that certify renewable energy generation, with each REC representing 1 megawatt-hour of clean energy. Companies can purchase these certificates, bundled with electricity or unbundled as standalone attributes, to support renewable energy and offset Scope 2 Emissions, even if they do not directly use it. flexible mechanism enables organizations to demonstrate their commitment to sustainability and renewable energy particularly in regions where direct procurement through PPAs may be limited or challenging.

PDG's Sustainability Journey:
The Progress to Net Zero

2022

- Set a 2030 Net-Zero target for Scope 1 and 2 emissions.
- Assessed Scope 1 and 2 emissions baseline.
- First corporate to procure geothermal RECs from PLN for Indonesian data centers
- Strengthened regional renewable energy partnerships and engagement in Singapore, Japan, and Indonesia.

2023

- Reaffirmed Net-Zero target for Scope 1 and 2 emissions by 2030.
- Secured a 25-year solar contract with Tata Power in India, sourced biomass energy for the JC campus in Jakarta, and obtained certified solar and geothermal RECs across China, Indonesia, and India.
- Improved energy efficiency with PUE <1.3 for NJ1 and SH1
- Began accounting and measuring Scope 3 emissions, engaging partners to reduce supply chain carbon footprints and enabling customers to allocate emissions responsibly.
- Joined iMasons as a foundation partner and joined Climate Accord to champion sustainability

2024

- Integrated ESG criteria into vendor onboarding and enhanced sustainability engagement with suppliers.
- Secured $375M in green loans for JH1 and SG1 projects.
- Installed 2,000 rooftop solar panels at SH1, generating 1,030 MWh annually and remove 587 tCO_2e
- Joined the Asia Clean Energy Coalition to actively drive strategic policy shifts in key national and regional markets across Asia
- Released its first Task Force on Climate-Related Financial Disclosures (TCFD) report

2025 (onwards)

- Reach net zero for Scope 1 and Scope 2 Emissions by 2030
- Target Power Usage Effectiveness (PUE) between 1.2 and 1.4 for all greenfield data centers
- Embark on sourcing 100% carbon-free energy with 24/7 hourly matching
- Plan to install solar panels on JH1, Johor rooftop as well as other data centers in the Indonesia portfolio
- Offsetting historical Scope 1 emissions using high-quality GHG offsets
- Increasing PDG's energy attribute certificate procurement as well as usage of HVO instead of diesel at our data centers

A Call to Action for the Data Center Industry

As we reaffirm our commitment to achieving Scope 1 and 2 net zero emissions by 2030 and advancing toward a 24/7 carbon-free future, we recognize that this journey is not one we can take alone.

We urge our industry peers to join us in pushing the boundaries of innovation and collaboration to drive meaningful progress toward sustainability.

Together, we have the opportunity to set the standard for data centers in Asia Pacific, the largest data center market – facilities that are not only technologically advanced but also environmentally responsible, paving the way for a greener and more resilient future for the region and beyond.