DESIGNING MORE SUSTAINABLE BACKUP POWER GENERATION FOR SOUTHEAST ASIA'S DATA CENTERS OF TOMORROW

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INTRODUCTION – DATA CENTER MARKET PROVING RESILIENT

The data center market in Southeast Asia is poised for rapid expansion as increasing capacity constraints and rising competition from regional neighbours drive substantial investment in edge, colocation and hyperscale facilities.

According to the latest research, the market will grow by $12.6 billion between 2020 and 2025 as internet consumption habits in the region continue to evolve. While pandemic restrictions have been eased in many countries, most companies have continued to encourage hybrid working. This trend has supported the continued adoption of cloud solutions, with new data centers located close to users to deliver better performance.

But the overall growth in the data center market belies regional fragmentation. Government regulation differs from country to country, while population density variances significantly impact land availability and, consequently, planning controls. As a result, some countries in Southeast Asia are recording surging levels of data center investment, while in others, it remains modest.

Sustainability is also becoming a critical factor in the data center market. All countries are looking to reduce the environmental impact of data centers by reducing harmful emissions. These ambitions are powering the uptake of innovative technologies, particularly around mission-critical power. Again, some countries are at the forefront of the sustainability agenda, while in others, more prosaic factors such as cost remain the most important consideration.

These are undoutedly exciting times for the data center market in Southeast Asia. This e-book looks at some of the region's leading regulatory and technology trends in the sector before exploring the sustainability issue in greater depth.

HEADLINE TRENDS ACROSS SOUTHEAST ASIA

So, what are some of the regional variances coming into play? Firstly, government regulation is a critical factor in a tier 1 country like Singapore, which represents 35% of the overall market for data centers in Southeast Asia. A moratorium on new data center projects initially put in place in 2020 over concerns about rising energy consumption has now been lifted. But there are conditions attached.

A briefing document for new data centers launched by Singapore's Infocomm Media Development Authority and Economic Development Board shows that Singaporean authorities will be more selective regarding new data center criteria. Milestones around sustainability and energy efficiency will need to be achieved as part of the planning approvals process. In decarbonization, for example, applicants must provide proposals on how to best achieve sustainability goals through renewable energy and plan to invest in innovative energy pathways such as 'Hydrogen, Building Applied Photovoltaics /Building Integrated Photovoltaics' to offset their carbon emissions footprint. New infrastructure might be restricted to lower capacities and sizes, reflecting continued pressures on land availability. Also, new build facilities could be required to have stringent power usage effectiveness (PUE), delivered by adopting more innovative technologies.

Whatever the specifics of the criteria, Singapore's reputation as the digital powerhouse of South-East Asia is likely to remain intact, resulting in high levels of data center investment and reigniting new construction in the city-state.

Other tier 1 nations are showing strong market growth, too. Data center investment in Japan, South Korea, Hong Kong and Taiwan have remained remarkably resilient since the start of the pandemic, and many global GAFAM companies are considering building new facilities in these places. This impetus reflects a desire to establish a more distributed footprint in the region, reducing the risk of disruption to services because of political instability in any one country.

Meanwhile, many tier 2 countries are also seeing buoyant demand. Indonesia, Malaysia, Thailand and the Philippines are all geographically well-positioned as landing stations from Western countries to Southeast Asia. Each country has its own regulatory framework and government support, but they all hold strong potential for higher levels of data center investment over the medium term.

Finally, more specifically related to mission-critical equipment used for backup power in modern data centers, fuel availability in Southeast Asia remains a significant factor influencing market trends. In Japan, there has been a notable shift from gas turbines to diesel gensets. Gas is seen as susceptible to supply risks during political or economic uncertainties – with concerns exacerbated by the conflict in Ukraine. Also, the shift from gas to diesel in Japan and other countries, reflects the globalization of the data center market. GAFAMs and large colocation providers want to realize economies of scale by replicating data center designs worldwide, and diesel remains the fuel of choice for mission-critical backup power.

SUSTAINABILITY IN GREATER DETAIL

Those are headline trends in the data center market in Southeast Asia. And with sustainability becoming a more critical issue, it is worth delving deeper into some of the environmental advances that have taken with the design of next-generation generators for data center applications. This shift involves notable innovation in engine architectures, maintenance and fuel supply

Data centers use redundant electrical infrastructures with uninterruptible power supplies and emergency backup generators to ensure that services never go offline. Diesel generators provide a highly reliable response when the local electricity grid fails. The fuel is readily available in most Southeast Asian countries and is safe and easy to store on site. In addition, high power 4MW units for data centers deliver excellent performance levels in a small footprint, a critical attribute in places like Singapore, where population density puts pressure on land availability.

The nature of backup power means diesel generators are used infrequently, limiting emissions of carbon dioxide and other harmful particulates into the atmosphere. However, with data center operaters looking to decarbonize their infrastructure, the diesel generator is coming under pressure to become more environmentally friendly, especially with other innovative technologies such as batteries, fuel cells and hydrogen being considered as replacements.

THE DEVELOPMENT OF CLEANER DIESEL GENERATORS

Meeting the expectations for greener generators has therefore been a priority for Kohler. As such, intense research and development efforts with key industry partners have led to the development of in-cylinder and after-treatment technologies which reduce the pollutants emitted at the point of use.

IN-CYLINDER ADVANCEMENTS

Digital tools like computer-aided engineering and computational fluid dynamics provide engineers with an opportunity to refine engine behaviour modelling, optimizing the entire system for better performance. Adjustments to piston and ring assembly tolerances can reduce the amount of fuel escaping the combustion chamber, and that can increase engine burn efficiency, significantly mitigating the conditions that lead to wet stacking. Common rail fuel injection and engine monitoring systems ensure better fuel atomization and enable “fuel mapping,” so that the combustion process is better tailored to emissions and the temperature in the cylinder.

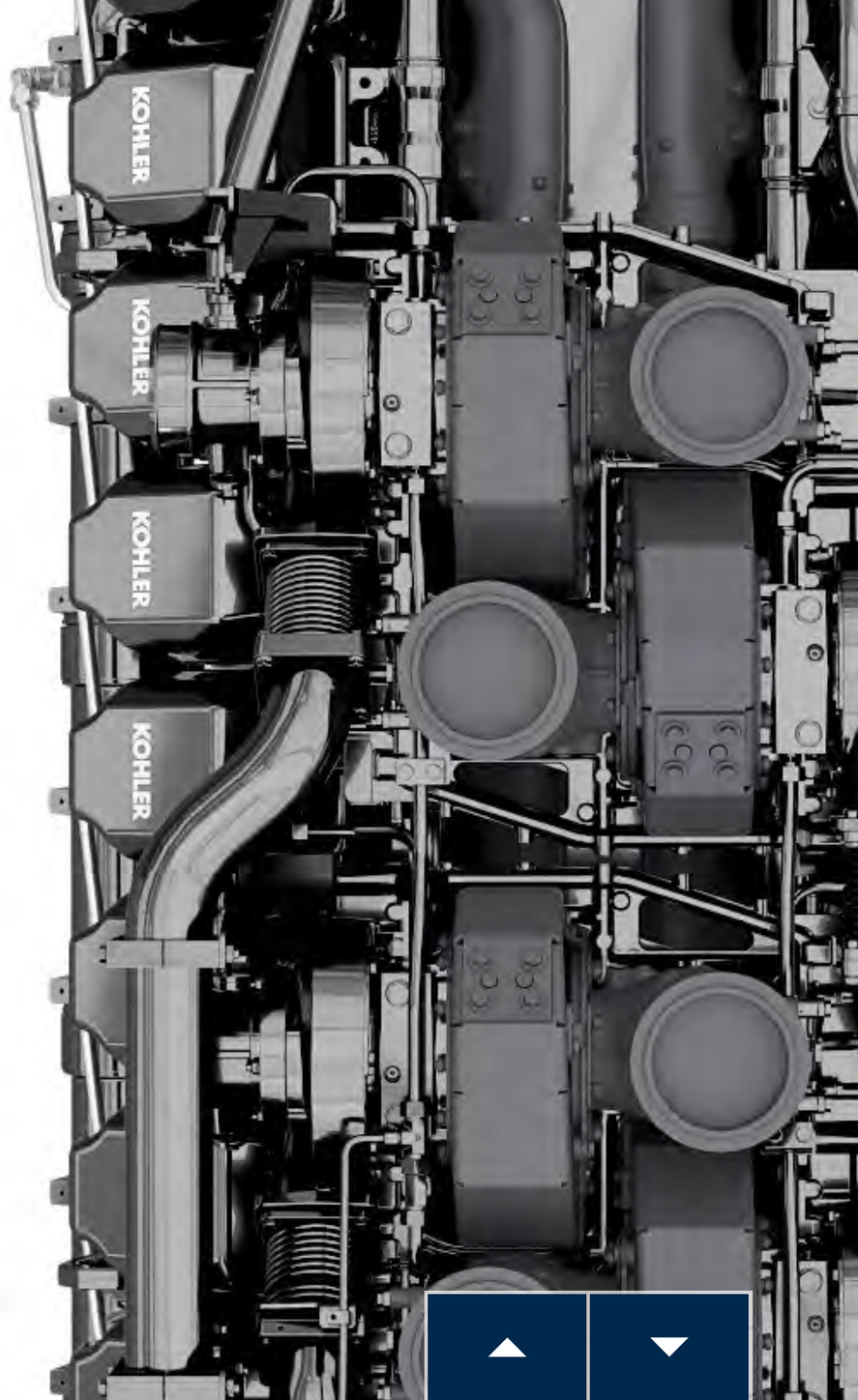
AFTER TREATMENT

Advancements in in-cylinder control technologies can only reduce pollutant formation to a certain extent, given the inverse relationship between nitrogen oxide emissions (NOx) and particulate matter (PM). NOx is created with high cylinder temperatures while PM forms with low cylinder temperatures; therefore, one, or occasionally both, must be treated within the exhaust stream to meet some local regulations in Southeast Asia. After-treatment systems take the form of add-ons to the diesel engine, although, some regulations certify the pollutant emission levels consider the after-treatment device an integral part of the engine, and the engine cannot be allowed to operate without it. There are several after-treatment devices include Diesel Oxidation Catalysts (DOC), Diesel Particulate Filters (PDF), and Selective Catalytic Reduction (SCR).

DOC reduces CO, HC, and the soluble organic fraction (SOF), of diesel particulates. The DOC deploys heat and catalyst materials to create oxidizing chemical reactions which in turn produce carbon dioxide (CO2) and water (H2O). DOCs are easy to apply to engines within data center generators, are relatively low cost and need little maintenance. However, they do not effectively reduce levels of PM or NOx, and therefore often need to be used with another after-treatment device, such as a PDF or SCR.

DPFs filter the PM emitted by the engine, usually seen as soot and black smoke. Tiny pores in the ceramic substrate of the filter trap the PM as exhaust gases pass through. DPFs must be regularly regenerated to burn off the layer of trapped soot, which clings to the filter, increasing back pressure on the engine. Regeneration systems need minimum exhaust temperatures, often requiring the addition of fuel or some other heat additive, which may mean adding a load bank to the system.

SCR is currently the best commercially available technology for reducing NOx emissions. SCR injects diesel exhaust fluid (DEF), a mixture substance comprising urea-derived ammonia and water, into the exhaust stream. The NOx in the exhaust stream is converted to nitrogen (N2) and water (H2O) by reacting with ammonia in the presence of a metal-based catalyst, increasing the reaction rate. SCRs must be carefully designed and deployed, considering operating temperatures, DEF storage conditions and load profile factors. DEF fluid maintenance is crucial to an SCR system as it is very corrosive and has a freezing point of 12°F (-11°C).



HVO AS A RENEWABLE FUEL

Decarbonization initiatives are causing a resurgence in the use of renewable fuels or biofuels. First-generation biofuels were often derived from food sources or took up land space that could be used for the growing of food. However, hydrotreated Vegetable Oil (HVO), or renewable diesel as it is also known, is a second-generation biofuel that is manufactured from waste and residual fat fractions leftover from food production, as well as being derived non-food grade vegetable oils.

HVO is a “slot-in” replacement for regular diesel, providing up to 90% reductions in carbon emissions without needing engine modifications or additional fuel tanks. The fuel can be blended with diesel in any proportion without affecting engine performance and, unlike previous biofuel generations, can be stored for several years without degrading.

HVO manufacturing is already taking place worldwide as a commercial-scale process but is currently concentrated in localized markets where its use is mandated. In Southeast Asia it is being produced in Indonesia and Malaysia, and other refineries are being planned across the region. Global production capacity will continue to grow as demand evolves, ensuring supply chains local to key data center markets.

HVO offers data center operators an immediate opportunity to further reduce diesel engine emissions. Kohler’s KD Series engines have now been tested and certified to operate with HVO100 biofuel. The company is also continuing to analyze and assess other new types of cleaner fuels.

APPROVED FOR HVO RENEWABLE FUEL

FUTURE TECHNOLOGIES TO ENTER THE MIX

The above sections provide a snapshot of the evolutionary developments in diesel generator technologies that have been driving down emissions in data center applications. In the long term, however, commitments to eradicate hydrocarbons in the data center will likely result in the adoption of commercial scale solutions based on innovative technologies like batteries and fuel cells.

Lithium-ion battery prices have fallen by about 80 per cent over the last five years, prompting Hyperscale operators like Google to research megawatt-scale battery systems. Google is assessing the viability of replacing generators in one of its data centers with large batteries as backup systems become critical components in carbon-free energy systems. Batteries would appear to offer a sensible solution in Southeast Asia, as the region benefits from a vibrant automotive sector which has resulted in the development of a mature supply chain. The challenge, of course, is scaling such technology to the unique requirements of the data center applications.

Hydrogen fuel cells also present exciting opportunities for environmentally friendly mission-critical backup power solutions. Microsoft has already run a trial powering a row of ten racks of Azure cloud servers for a total of 48 hours using a 250-kilowatt hydrogen-powered fuel cell system. With most power outages lasting less than 48 hours, the Microsoft trial proved the viability of fuel cells as a potential longer-term replacement for diesel generators during a utility outage.

Alternative technologies such as battery and fuel-cell solutions face significant scalability and cost challenges. However, although neither technology can, at the current time, match the availability and energy density characteristics of the diesel generator, numerous ongoing research and development initiatives aim to overcome these limitations.

In truth, Southeast Asia's future data centres will most likely deploy a mix of backup power generation, decided on a case-dependent basis, ensuring that performance, reliability and sustainability always go together.

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