# THE EMERGING INDONESIAN DATA CENTER MARKET AND ENERGY EFFICIENCY OPPORTUNITIES

ASIAN DEVELOPMENT BANK

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# Executive Summary

Global data center energy use is growing rapidly and so is the case in Indonesia. At the global level, data center energy use was estimated at 1.1% of total energy use in 2012 and by 2020 it is expected to increase to 2.5%. This study estimates that Indonesian data centers used about 1.5% of total electricity-generating capacity in 2014 and will reach between approximately 2.0% and 3.0% by 2017. Between 2016 and 2017, the electricity demand of all data centers over 10 kilowatts is expected to grow by between 236 and 405 megawatts, which will further strain already constrained supply capacities across the country.

In Indonesia, a surge in mobile data and internet users, an ongoing reliance on fossil fuel electricity generation, and rising energy prices due to the removal of widespread energy subsidies contribute to substantial operational costs and increased carbon emissions from energy-intensive data centers. At the same time, Indonesia's Government Regulation No. 82/2012 requiring all Indonesian-related data to be contained in data centers within the country by 2017, will drive information technology industry growth and further increase energy use from the sector.

With this growth is the potential for significant energy savings in Indonesian data centers. Presently, many well-known technologies and practices of varying costs that data center operators can deploy to improve their data center energy efficiency are available. This study has estimated various energy efficiency measures (EEMs) for data centers in Indonesia and found that for no- or low-cost EEMs, there is a significant potential for energy savings across the different types of data centers, as follows: captive–private (8.54%), captive–government (5%), and colocation–private (15.23%). For medium-cost EEMs implemented in the data center sector in Indonesia, a potential 20%–30% cost saving could be achieved if the latest technologies are applied.

However, a key obstacle to realizing the savings from EEMs is that the majority of data center operators in Indonesia are not currently measuring or reporting their center's energy use, nor are they aware of opportunities to improve their center's energy efficiency. A national skills gap and a lack of specialized data center training facilities are additional challenges. Indonesia also lacks existing standards, certification programs, and reporting requirements that can assist data center operators to increase their understanding of energy-efficient practices and reduce energy use and costs.

This study contributes to a growing body of research demonstrating that adoption of internationally available and well-proven energy efficiency measures can improve the effectiveness, sustainability, and global competitiveness of data centers in developing countries, including Indonesia. The sources cited in this report were selected for their recognition as global best practices in data center energy efficiency and their applicability to the Indonesian data center industry. Indonesia can learn from previous studies from other countries that show that the adoption of energy efficiency standards through suitable policy and regulatory mechanisms can support the uptake of energy-efficient technology and practices in data centers.

This report provides an initial assessment of the data center industry in Indonesia in terms of its energy use and energy saving potential as well as market trends, growth opportunities, and major challenges that the industry is facing. The analysis studies relevant EEMs used in other countries, their applicability to various types of data centers in Indonesia, and their energy savings potential.

Given the lack of energy efficiency awareness and energy performance metrics in Indonesia, it is recommended that key stakeholders, such as government ministries and industry organizations, should make all possible efforts to raise awareness about the potential of energy efficiency to lower data center operational costs. Such energy efficiency potential can be achieved without compromising availability (in terms of minimization of downtime) and resilience (in terms of earthquake standards and other security factors) of data centers. Awareness raising can be achieved through benchmarking and reporting of data centers' energy use, technical and policy forums to discuss EEMs and design guidelines, and expanded opportunities for training and development of data center operators.

As private sector data centers are already incentivized to reduce energy use to stay competitive, it is recommended that Indonesia focus its attention first on EEMs in government data centers.

Key study recommendations are as follows:

(i) The Directorate General for New Renewable Energy and Energy Conservation (EBTKE) in the Ministry of Energy and Mineral Resources (ESDM) should support a benchmarking survey of 30–60 data centers and detailed studies of 6–12 data centers in each strategic sector (for example, banking, energy and telecommunications) in Indonesia to establish Indonesia-specific metrics of energy use, energy intensity, and energy efficiency potentials.
(ii) Indonesia should develop national energy efficiency in data center management and energy rating standards based on established and proven standards in other countries, such as those developed in Australia, Singapore, and the United States.
(iii) EBTKE in ESDM should work closely with the Ministry of Communications and Informatics (KOMINFO) to ensure that the upcoming regulation on data center development also addresses energy efficiency and energy reporting issues.
(iv) EBTKE in ESDM should work closely with KOMINFO to focus on improving the energy efficiency of national government-owned data centers, to reduce costs, mainstream EEMs, and provide an example for both regional governments and the private sector to emulate.
(v) The government should facilitate the reporting of energy usage, security, and resilience aspects of data center operations; help raise awareness of the potential of EEMs to lower data center operational costs; and support training to improve knowledge of energy efficiency among data center professionals.

This report is principally based on interviews of key data center owners and operators, consultants, industry organizations, and policy makers to further understand the growth of the data center sector in Indonesia and its potential for improved energy efficiency. The report also draws on available secondary data.

The objective of this report is to bring awareness to a relatively unknown, energy-intensive sector that is expected to grow rapidly with the implementation of Government Regulation No. 82/2012 and an ever-increasing number of mobile data users in Indonesia. Although the total energy consumption of the sector may appear relatively low compared with other high use sectors, there is a great opportunity to promote energy efficiency measures while the industry is still emerging. In line with Government Regulation No. 82/2012, Indonesia is currently developing guidelines and requirements for improving the security and availability of data centers, and this would be a perfect opportunity to also include energy efficiency recommendations and standards.

# Abbreviations

| | |
|---|---|
| ADB | Asian Development Bank |
| CAGR | compound annual growth rate |
| DCIM | data center infrastructure management |
| DRC | disaster recovery center |
| EBTKE | *Direktorat Jenderal Energi Baru Terbarukan dan Konservasi Energi* (Directorate General for New Renewable Energy and Energy Conservation, Indonesia) |
| EEM | energy efficiency measure |
| ESCO | energy services company |
| ESDM | *Kementerian Energi dan Sumber Daya Mineral* (Ministry of Energy and Mineral Resources, Indonesia) |
| ESPC | energy savings performance contract |
| GHG | greenhouse gas |
| GW | gigawatt |
| ICT | information and communication technology |
| ISO | International Organization for Standardization |
| KOMINFO | *Kementerian Komunikasi dan Informatika* (Ministry of Communications and Informatics, Indonesia) |
| NGC | national generation capacity |
| OJK | *Otoritas Jasa Keuangan* (Financial Services Authority, Indonesia) |
| PUE | power usage effectiveness |
| SOE | state-owned enterprise |
| UPS | uninterruptible power supply |
| US | United States |

**Weights and Measures**

"Tons" refers to the metric ton (of 1,000 kg)

# 1 Introduction

A recent report by the Steyer-Taylor Center for Energy Policy and Finance, Stanford University and Anthesis Group reveals that “data centers are among the most sophisticated industrial facilities in modern societies but are rife with inefficiencies.”[1]

Data centers are said to be the “crown jewels of global business” as all international companies and governments must rely on them to deliver business value much greater than their costs.[2] The leading information and communications technology (ICT) companies (such as Amazon, Apple, Facebook, Google, Microsoft, and others) have mastered how to extract that business value, but for companies and governments whose “primary business is not computing, the story is more complicated” as the extent of inefficiency is not only great but mostly unknown.[3] According to one leading expert, Jonathan Koomey of Stanford University, “data centers are often strikingly inefficient. While they may still be profitable, their performance still falls far short of what is possible. And by ‘far short’ I don’t mean by 10% or 20%, I mean by a factor of 10 or more.”[4]

This report provides an overview of data centers and the need for greater adoption of energy-efficient technologies (assisted by appropriate policies such as the adoption of an energy rating standard), and outlines some of the inefficiencies that stem from poor management of existing capital equipment. Hence, the challenges faced by, and energy savings opportunities for, most companies and governments are in both improving technologies used as well as fixing these management failures.

This report describes the following five key characteristics of data centers in most countries, including Indonesia.

## Data Centers are Energy Intensive

Around the world, data centers have become major electrical power and distribution system users. In the European Union and the United States (US), data centers consume over 2% of all utility-produced electrical power and this energy use increases at a rate of over 15% per annum. In terms of energy intensity, data centers can consume 10–100 times

1 J. Koomey and J. Taylor. 2015. *New Data Supports Finding that 30 Percent of Servers are ‘Comatose’, Indicating that Nearly a Third of Capital in Enterprise Data Centers is Wasted*. http://anthesisgroup.com/wp-content/uploads/2015/06/Case-Study_DataSupports30PercentComatoseEstimate-FINAL_06032015.pdf

2 J. Koomey. 2015. *Modernizing Enterprise Data Centers for Fun and Profit*. DatacenterDynamics. http://www.datacenterdynamics.com/design-strategy/modernizing-enterprise-data-centers-for-fun-and-profit/94711.blog

3 Footnote 2.

4 Footnote 2.

as much electricity per square meter compared to standard office spaces. The largest data centers use as much energy as 10,000 to 100,000 typical households.

Intensive energy use can be costly both in terms of the data center's operating budget and the impact on the environment. Energy costs are the most expensive part of a data center's operating budget, often representing more than 50% of the budget.[5] Data centers also contribute to global greenhouse gas (GHG) emissions: a medium-sized data center's carbon footprint can range from 3 million to over 130 million kilograms of carbon dioxide.[6]

## Data Centers are Inefficient

Researchers estimate that there are about 10 million idle servers worldwide—including standalone servers and host servers in virtual environments—that can be classified as "comatose" servers, meaning they continue to use energy but have not performed any useful function for 6 months or longer. This translates to at least $30 billion in data center capital sitting idle globally.[7]

## Data Center Downtimes are Costly

The true costs of downtime, outages, and failures in data centers are often underestimated and underreported. Despite advances in infrastructure robustness, many information technology (IT) and non-IT organizations still face database, hardware, and software downtime, which can last from short periods of time to shutting down business for days. Both modern private sector and government operations (particularly relating to infrastructure) are critically dependent on data center availability. Data center downtimes are very costly to operators and owners and may include the following:

- Dollar costs range from as low as $90,000 per hour of downtime in the media industry to as high as $6.48 million in financial brokerage or banking services.[8]
- Reputational costs translate to lack of investor and consumer confidence, which may prevent further investment or sales.
- Other costs: for example, when infrastructure fails human lives may be at risk.

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5 I. Sulaiman. 2016. *Scoping Indonesia's Data Center Growth to Meet High Energy Demands and Off-set Emission Growth of New Digital Economy*. Presentation to Energy Efficiency Accelerator Project—Update Meeting. Jakarta. 29 July.

6 Hosting Facts. *How a Green Datacenter Affects Your Website.* https://hostingfacts.com/how-a-green-datacenter-affects-your-website/

7 Footnote 1.

8 T. Plant. 2014. *What Does Network Downtime & Latency Cost Your Business?* http://www.ecessa.com/blog/downtime-costs/

## Data Centers can Decouple the Digital Economy Emissions from Economic Growth

The German digital association BITKOM (covering information technology and telecommunications industries) claims that simple energy saving measures—such as measurement using Simple Network Management Protocol or evaluation of energy consumption using Data Center Infrastructure Management (DCIM) systems—achieved significant results. For example, energy use did not rise in German data centers from 2008 to 2014, despite increasing computational load.[9]

The Global e-Sustainability Initiative (GeSI) reports that while the ICT sector is still a net producer of GHG emissions, the GHG emissions saved by ICT services are approximately 10 times greater than the GHG emissions generated by the sector. In its latest report, GeSI finds that by 2030, the sector can help reduce global GHG emissions by 20% and avoid the production of 12 gigatons of carbon dioxide, while at the same time generating $11 trillion in economic benefits.[10]

## Data Centers are Growing Rapidly in Emerging Economies

About one-third of global data center energy use is in the US, but the fastest growth is occurring in emerging economies.[11] As forecasted, by 2023 annual electricity use by world data centers will reach roughly 1,000 terawatt hours—more than the total electricity use of Japan and Germany combined.[12] The rate of data center construction outside of the US is growing at approximately twice the pace of North America and this growth has major investment implications.

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9 Heise Online. 2015. *Leitfaden soll Energieeffizienz im Rechenzentrum Steigern*. [To Increase Energy Efficiency in the Data Center.] http://www.heise.de/ix/meldung/Leitfaden-soll-Energieeffizienz-im-Rechenzentrum-steigern-2842752.html; and United News Network. 2013. Energieeffizientes IT-Design für eine grüne Cloud. [Energy Efficient IT-Design for a Green Cloud.] http://www.pressebox.de/inaktiv/enlogic-systems-europe-ltd/Energieeffizientes-IT-Design-fuer-eine-gruene-Cloud/boxid/600889

10 UN Climate Change Newsroom. 2016. *ICT Helping Tackle Climate Change: Could Help Cut Global Emissions 20% by 2030*. http://newsroom.unfccc.int/unfccc-newsroom/ict-sector-helping-to-tackle-climate-change/

11 DatacenterDynamics. 2013. *Powering the Datacenter*. London. http://www.datacenterdynamics.com/research/reports/powering-the-data-center/93336.fullarticle#articleContent

12 M. Mills. 2013. *The Cloud Begins with Coal: Big Data, Big Networks, Big Infrastructure, and Big Power.* http://www.tech-pundit.com/wp-content/uploads/2013/07/Cloud_Begins_With_Coal.pdf?c761ac

# 2 Overview of Data Centers

To provide the necessary understanding of data centers, this section will outline the definition of a data center that was adopted in this study.

Palo Alto Networks defines a data center as "a facility that centralizes an organization's IT operations and equipment, and where it stores, manages, and disseminates its data."[13] Data centers may be physical or virtual repositories of a network's most critical systems, ensuring the proper, uninterrupted functioning of the network. Hence, the security and reliability of data centers and their information are of utmost importance to organizations; perhaps even more important than energy considerations, particularly for operators who have not fully metered the different parts of their operations.

In considering their functions, as in most more developed economies, data centers in Indonesia serve a wide range of sectors and industries from the internet, including manufacturing, government, education, traditional media, commerce, energy, transportation and logistics, finance, medical and health services, and others.

Although each data center has a unique design, they can generally be classified based on their location, ownership, energy use, and or availability (percentage of "uptime"), as presented below. Typically, a data center constitutes these elements: facility, support infrastructure, IT equipment, and operations staff.

## Classification by Location and Ownership

Data centers can be classified based on where they are located, either as internet-facing (cloud-based) or captive (in-house) data centers. As explained by Palo Alto Networks, "Internet-facing data centers usually support relatively few applications, are typically browser-based, and have many users, typically unknown."[14] Facebook, eBay, and Google are examples of internet-facing facilities that operate one or more industrial-scale applications for hundreds of millions of users. On the other hand, "enterprise dedicated or captive data centers service fewer users, but host more applications that vary from off-the-shelf to custom."[15] Captive data centers include secure processing facilities for banks and high-performance computing centers for research and development.

13 Palo Alto Networks. 2016. *What is a Data Center?* https://www.paloaltonetworks.com/resources/learning-center/what-is-a-data-center.html

14 Footnote 13.

15 Footnote 13.

In terms of ownership, data centers may be privately managed, government or state-owned enterprise (SOE) managed, or privately rented (also known as colocation). As Ryan Schuchard, Former Associate Director of Climate Change at the global nonprofit, BSR, explains, privately managed cloud and captive data centers:

> *"are managed by one company on behalf of another and range from hands-off, 'wholesale' arrangements, for which the operator rents out secure powered rooms, to more involved 'retail' services, for which the operator provides a suite of equipment, bandwidth, storage, networking, cooling, and staff support."*[16]

Government and SOE data centers are almost always located in-house and are largely self-managed or managed by a contractor company on behalf of the agency.

The opposite of managed data centers, privately rented or colocation data centers allow companies to rent data center operations for their cloud-based applications from facilities owned and managed by others. Typically, the colocation provider offers secure space, power for equipment, an internet protocol address, and a connection to the network, which leads to the internet. The company is responsible for providing hardware and software, installation, and upkeep. Colocation data centers can offer flexible solutions as companies grow and adapt to changing needs. By renting its data center, a company may also increase its efficiency.

## Classification by Energy Utilization

Data center energy use varies from a few kilowatts (kW) of power consumption to tens of thousands of kW.[17] Four distinct categories, based on market research from Datacentre Dynamic Intelligence, are presented below. These categories have also been used in various studies in Australia and New Zealand that are relevant to Indonesia:

(a) small data centers ("in-house" server rooms/cupboards) from 10 kW to 150 kW;
(b) medium data centers from 150 kW to 750 kW;
(c) enterprise data centers from 750 kW to 2,500 kW; and
(d) mega data centers from 2,500 kW and larger.

## Classification Based on Availability

The availability classification is based on the Uptime Institute Tier rating, which classifies data centers based on standards for minimum uptime and maximum downtime. For example, Tier IV servers must meet a 99.995% minimum uptime and 26 minutes maximum annual downtime. The annual requirements for all tiers are below:

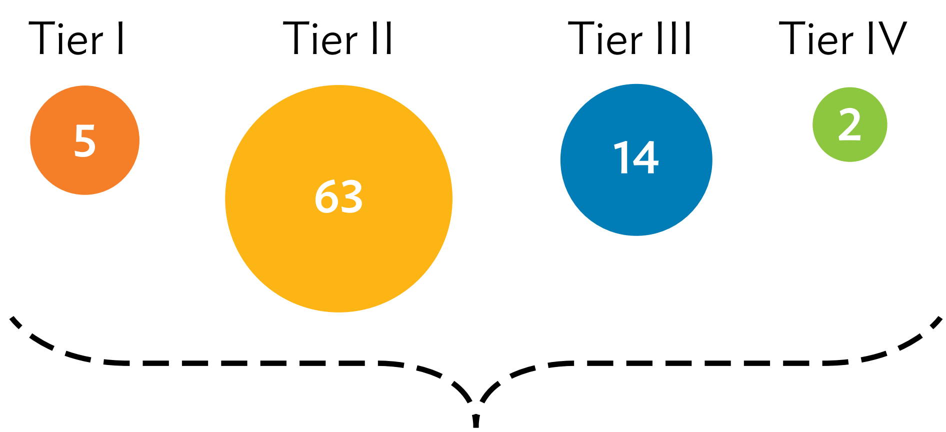
16 R. Schuchard. 2014. *Low-Carbon Power Sourcing for Four Types of Data Centers.* https://www.bsr.org/en/our-insights/blog-view/low-carbon-power-sourcing-for-four-types-of-data-centers

17 Commonwealth of Australia, Department of Industry. 2014. *Energy Efficiency Policy Options for Australian and New Zealand Data Centres.* Canberra. http://www.energyrating.gov.au/document/report-energy-efficiency-policy-options-australian-and-new-zealand-data-centres

(a) Tier I (99.671% minimum uptime and 1,729 minutes maximum downtime)–basic site infrastructure (nonredundant);
(b) Tier II (99.741% minimum uptime and 1,361 minutes maximum annual downtime)–redundant site infrastructure with redundant capacity components;
(c) Tier III (99.982% minimum uptime, 95 minutes maximum annual downtime)–concurrently maintainable site infrastructure; and
(d) Tier IV (99.995% minimum uptime, 26 minutes maximum annual downtime)–fault-tolerant site infrastructure.

A 2015 survey by Sharing Vision has identified 84 data center service types and 39 data center providers in Indonesia: 5 meet Tier I standards, 63 meet Tier II standards, and only 16 data centers meet Tier III and IV standards. However, only 10 data centers were certified by the Uptime Institute in 2015.[18] The estimated distribution of data centers in Indonesia as of 2015 is presented below in Figure 1.

**Figure 1: Estimate of Indonesian Data Centers with Their Uptime Tier Levels**




Source: Sharing Vision. Visiting World Class Data Center in Indonesia. http://sharingvision.com/2015/09/visiting-world-class-data-center-in-indonesia/

In addition, on closer inspection, as Uptime Institute certification refers to either design or constructed facility documents, it turns out that the above categories for Indonesia apply primarily to certification for design.[19] In 2015, there were only two companies that had the "Tier IV–Fault Tolerant" design certification, 10 companies with "Tier III–Concurrently Maintainable" design certification, and one company with "Tier II" design certification. By August 2016, two Indonesian companies received "Tier III–Constructed Facility" design certification. The classification of uptime for data centers is highly relevant to energy use, through the uptime links to energy supply and energy services redundancy.

[18] Sharing Vision. Visiting World Class Data Center in Indonesia. http://sharingvision.com/2015/09/visiting-world-class-data-center-in-indonesia/
[19] Uptime Institute. 2016. Uptime Institute Tier Certifications - All Certifications: Indonesia. https://uptimeinstitute.com/TierCertification/allCertifications.php

# 3 Emergence of Indonesian Data Centers

Since 2000, the Indonesian data center market has experienced significant growth and major changes in its landscape—all of which have a direct bearing on electricity use.

Given recent average economic growth rates of 5%–6% per annum, it is understandable that there has been tremendous growth in data center capacity in terms of expansion of existing facilities as well as the creation of new facilities due to higher transactional volumes and digital data growth.

More specifically, the factors contributing to data center growth in Indonesia are: (i) ongoing increased use of smartphones that coincides with the growth in e-commerce transactions, including mobile phone or computer games; (ii) development of e-government services; (iii) online computer and mobile voice over internet protocol calls and/or social media platforms; (iv) cloud computing and big data analytics; (v) the "Internet of Things"—the increasing connectivity of physical objects that allows them to collect and transmit data; and (vi) Government Regulation No. 82/2012, which states that by October 2017, all organizations, particularly financial institutions, must locate their Indonesian-related data in country (more details below).

The overall growth of the data center market is reflected by Indonesia's ICT indicators as outlined in Figure 2: a large urban population (51%) with a growing proportion of active internet users (26% in 2013, 34.9% in 2014) and social media users on computers (26%) and mobile devices (16%). Recent reports from Indonesian internet service providers (ISPs) have suggested that in 2015, internet users had risen to 93.4 million, with a rapid expansion of e-commerce business reaching an estimated $18 billion, the majority of which (85%) was due to mobile phones accessing the internet (see Figure 2).[20]

## Estimates of Energy Use of Data Centers

In 2012, the Indonesian government announced Government Regulation No. 82/2012 on electronic systems, administered by the Ministry of Communications and Informatics (KOMINFO). This regulation requires all companies to locate their data centers in Indonesia and the regulation is to be fully implemented by October 2017.

The total number of data centers in Indonesia and initial estimates of energy use vary according to the definition used (see previous discussion on definitions). While there is

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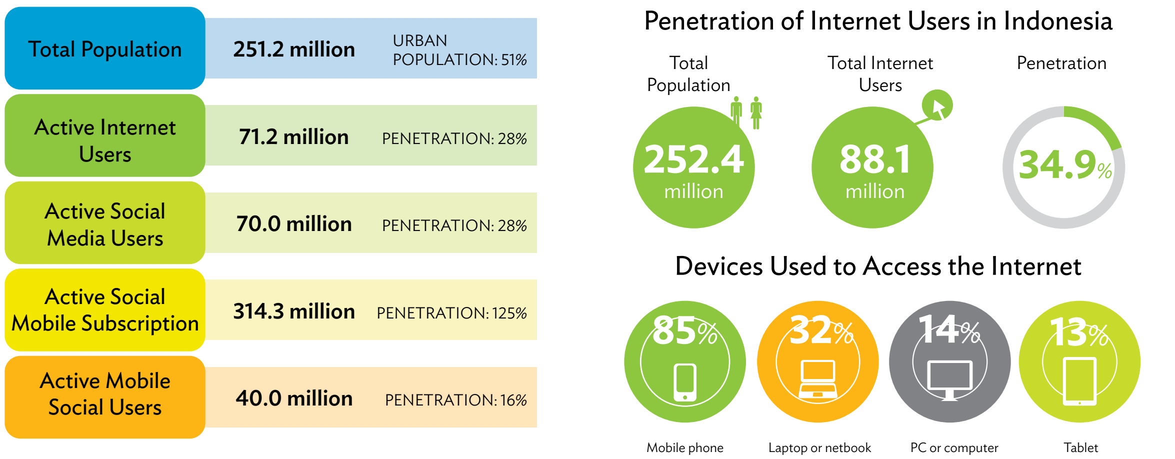
20 *Bisnis Indonesia*. 2015. KPPU Diminta Masuk Atur E-Commerce. 5 November.

**Figure 2: Main Trends of Information and Communication Technology in Penetration of Internet Users and Devices that Access the Internet**




Source: Ministry of Communications and Informatics, Republic of Indonesia (KOMINFO), 2013.

Note: In the survey, respondents can give more than one response. The majority of internet users in Indonesia access the internet using a mobile phone.
Source: Indonesia Internet Service Provider Association (APJII) – Profile Report, 2014.

currently a mandatory reporting program on energy consumption for large energy consumers with over 6,000 tons of oil equivalent (or about 70 gigawatt hours) per year of energy demand (Government Regulation No. 70/2009), there are no data centers that meet this requirement. As such, there is little self-reporting and limited knowledge of the full scope of energy use in the data center industry. However, with the introduction of Regulation No. 82/2012, it is expected that energy use from data centers will grow significantly.

In this report, to calculate estimated energy use, average power levels were used for four categories of data centers: small (average 20 kW), medium (average 200 kW), enterprise (average 1,500 kW), and mega (average 3,500 kW). These averages (based on interviews of Indonesian data center professionals) are combined with the estimation techniques used in the Australia and New Zealand market to derive the estimates of energy use seen in Table 1 and Table 2.[21]

Under a low-growth scenario of 18% per annum, in 2017, Indonesian data centers will consume about as much generating capacity as Jambi, Riau, and West Sumatra combined, or 1,309 megawatts (MW), and experience a growth of 236 MW in just 1 year from 2016 to 2017. Assuming national generation capacity (NGC) was around 53.585 gigawatt (GW) in 2014, data centers accounted for 1.5% of NGC in 2014. This percentage will increase to approximately 2% in 2017 if the NGC increases to around 70 GW.

[21] Footnote 17.

### Table 1: Estimates of Energy Use above 10 kW by Data Centers in Indonesia under Low-Growth Scenario, 2014–2017

| Year | Small (10–150 kW) | Medium (150–750 kW) | Enterprise (750–2,000 kW) | Mega (2,000 kW and larger) | Low-Growth Rates | Total Energy Use (kW) |
|---|---|---|---|---|---|---|
| 2014 | 352,800 | 133,000 | 238,500 | 73,500 | | 797,800 |
| 2015 | 402,192 | 151,620 | 271,890 | 83,790 | 14% | 909,492 |
| 2016 | 474,587 | 178,912 | 320,830 | 98,872 | 18% | 1,073,201 |
| 2017 | 578,996 | 218,272 | 391,413 | 120,624 | 22% | 1,309,305 |

Note: Calculations for low growth rate are based on 18% compound annual growth rate.

Source: Author's calculations.

### Table 2: Estimates of Energy Use above 10 kW by Data Centers in Indonesia under High-Growth Scenario, 2014–2017

| Year | Small (10–150 kW) | Medium (150–750 kW) | Enterprise (750–2,000 kW) | Mega (2,000 kW and larger) | High-Growth Rates | Total Energy Use (kW) |
|---|---|---|---|---|---|---|
| 2014 | 352,800 | 133,000 | 238,500 | 73,500 | | 797,800 |
| 2015 | 441,000 | 166,250 | 298,125 | 91,875 | 25% | 997,250 |
| 2016 | 560,070 | 211,137.5 | 378,618.75 | 116,681.25 | 27% | 1,266,508 |
| 2017 | 739,292 | 278,702 | 499,777 | 154,019 | 32% | 1,671,790 |

Note: Calculations for high growth rate are based on 25% compound annual growth rate.

Source: Author's calculations.

This is equivalent to adding 400 MW of baseload power demand from the data center sector in just 2 years (2015–2017), which is more than the full capacity of the 330 MW Sarulla Power Plant (the largest geothermal plant in the world), which is to be completed in 2018 in Sumatra.

Under a high-growth scenario of 25% per annum, in 2017, Indonesian data centers will consume about as much generating capacity as North–South Sumatra and Bengkulu combined, or 1,672 MW. In this scenario, data centers will represent approximately 3% NGC in 2017 if the NGC increases to around 70 GW. This is equivalent to adding 405 MW of baseload power demand—more than the capacity of the Sarulla Power Plant (330 MW)—in just 1 year from 2016 to 2017.

## Estimates of Additional Small Captive Data Centers

A BroadGroup study estimates that on average, 85%–90% of companies in Asian countries have their data center located in-house. Their estimate for each country varies from 75% in Singapore to 95% in Indonesia.[22]

Based on the definitions of energy use categories of small, medium, enterprise, and mega data centers, it is estimated that there are over 48,000 data centers in Australia and New Zealand combined. When ranked by total energy consumed in 2013, the small data centers represented 39%; medium data centers, 21%; enterprise data centers, 32%; and mega data centers, 8%.[23]

Although the data center population in Australia and New Zealand may be greater than in Indonesia, and the per capita purchasing power between Indonesia and Australia and New Zealand varies greatly, the distribution of data centers across different energy categories in Australia and New Zealand may be used as a first approximation for Indonesia's situation. Hence, it is assumed that small and medium-sized data centers constitute 50%–60% of the total data centers' energy use in Indonesia. Thus, the small data center energy usage would be approximately 133 MW, assuming that the enterprise and mega data center load in Indonesia was about 200 MW in 2015. However, since the small data center operators are hard to mobilize, they are not considered further in this study's analysis of energy saving potentials.

The hard to mobilize nature of small and medium data centers could change if the Government of Indonesia decides to adopt a certification for enterprise computer servers such as the ENERGY STAR server certification system in the United States.[24]

## Estimates of Additional Captive Government Data Centers

A government data center can be defined as one that is used by any of the levels of government in Indonesia including central, provincial, and district agencies, as well as those used by SOEs— accompanied by their associated disaster recovery center (DRC), a second data center that allows an organization to recover data and resume operations following a disaster. A conservative estimate (excluding data centers of less than 150 kW) suggests that there are around 120 data center facilities in central government agencies, each with their own DRC, thus at least 240 data centers. (There is more on this in the Potential Energy Savings section).[25]

As for data centers in SOEs, since there are 155 SOEs and if each has a data center and a DRC, then there are 310 data centers belonging to the SOEs.[26] Hence the total number of data centers belonging to government agencies and SOEs would be 550, which could be higher than those in the private sector.

[22] BroadGroup. 2013. *Data Centers South East Asia.* 4th Ed.
[23] Footnote 17.
[24] ENERGY STAR. Enterprise Servers. https://www.energystar.gov/products/office_equipment/enterprise_servers.
[25] Based on recent data (dated 15 December 2015) from the Ministry of Administrative Reform (MenPAN): http://www.menpan.go.id/berita-terkini/120-info-terkini/4173-rapor-perkembangan-nilai-akuntabilitas-kinerja-k-l-provinsi.
[26] Government of Indonesia, Ministry of State Owned Enterprises. 2016. *Daftar BUMN [List of State Owned Enterprises].* Jakarta. http://bumn.go.id/halaman/situs

In many cases, power usage is unknown and total costs are high. Backup and disaster recovery systems are often poorly designed and managed, and sometimes are nonexistent. Demand on these government data center systems is growing at an unprecedented rate as governments and SOEs are required to store more data. Key IT managers or department heads are entering into contracts that include unused capacity to ensure continuity of expansion. Contractual conditions are problematic and risk allocation poorly managed, resulting in hidden costs and significant risks for the Government of Indonesia.

At present, the Government of Indonesia has yet to produce a government wide plan to anticipate future demand increase for these data center facilities. However, if a strategic plan is developed to meet the likely increase in government demand for data storage over the next 5–15 years, there is potential for substantial savings that can be gained by consolidating older, smaller, and less efficient data centers. For example, the US government expects to save $3 billion in the next few years from the Federal Data Center Consolidation Initiative.[27] Criteria should be developed through benchmarking surveys to enable the Government of Indonesia to objectively determine which data centers are deemed inefficient, and rethink the ongoing use of its aging data centers.

As in other countries with emerging data center industries, decision makers in Indonesia managing government data centers often may not have the latest knowledge of available technologies, time, or funds to appropriately choose between constructing an energy-efficient data center or purchasing government-approved cloud services. They may not sufficiently prioritize IT energy efficiency due to other pressures, such as ensuring security and reliability.

Improving energy efficiency in data centers as a whole should be a critical objective to improve power supply for other priority sectors, including agriculture, industry, domestic, and residential sectors. However, colocation data centers have the greatest interest to improve energy efficiency. As Greenpeace stated:

> *"While the data centers of the major internet and cloud companies generally get the greatest attention from the public, a major chunk of the internet is hosted by 'colocation' data center operators, which serve as the digital landlords of our online world."*[28]

While the extent of energy monitoring and energy certification across different functional categories still remains to be seen, there is little doubt that most operators of colocation data centers are increasingly more concerned with energy efficiency of their facilities than solely with the cost of maintaining a high level of availability and security. The viability of energy efficiency measures in Indonesia has been assisted by the gradual removal of electricity and fuel subsidies in the last 2 years with the advent of the President Joko "Jokowi" Widodo Administration as of October 2014.

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27 M. Biddick. 2013. Three Lessons from 5 Years of Federal Data Center Consolidation Delays. *Information Week*. 3 June. http://www.informationweek.com/3-lessons-from-5-years-of-federal-data-center-consolidation-delays/d/d-id/1110222

28 G. Cook. 2015. *Clicking Clean: A Guide to Building the Green Internet*. Washington, DC: Greenpeace.

# 4 Energy Savings Potential in Indonesian Data Centers

The benefits of developing a more energy-efficient data center sector in Indonesia have much to do with lowering current costs of IT management, and accessing vast amounts of internet data (both consumer and industrial) at local data center speeds and bandwidth.

This section looks at some of the global trends to improve the energy efficiency of data centers and the potential energy efficiency measures (EEMs) that could be deployed in Indonesia.

## Potential Energy Saving Technologies

At present, there are many references for various EEMs that can be considered by data center operators and owners.[29] For example, the ENERGY STAR program provides a list of 12 of the most commonly used energy efficiency strategies in data centers and server rooms.[30] For each of the opportunities identified, the ENERGY STAR program provides sufficient information on how to implement the measures, anticipated costs and savings, and additional resources. The 12 areas within three subgroups are as follows:

Opportunities in IT

- Server virtualization
- Decommissioning of unused servers
- Consolidation of lightly utilized servers
- Better management of data storage
- Purchasing more energy-efficient servers, uninterruptible power supply (UPS), and power distribution units

Airflow Management Strategies

- Alternating hot aisle/cold aisle layout
- Containment and/or enclosures
- Variable speed fan drives
- Properly deployed airflow management devices

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29 The *Data Center—Master List of Energy Efficiency Measures* by Lawrence Berkeley Laboratory in the US also provides a high-level and detailed list of measures that covers energy management, IT equipment, environmental conditions, cooling air and air management, and cooling plant.

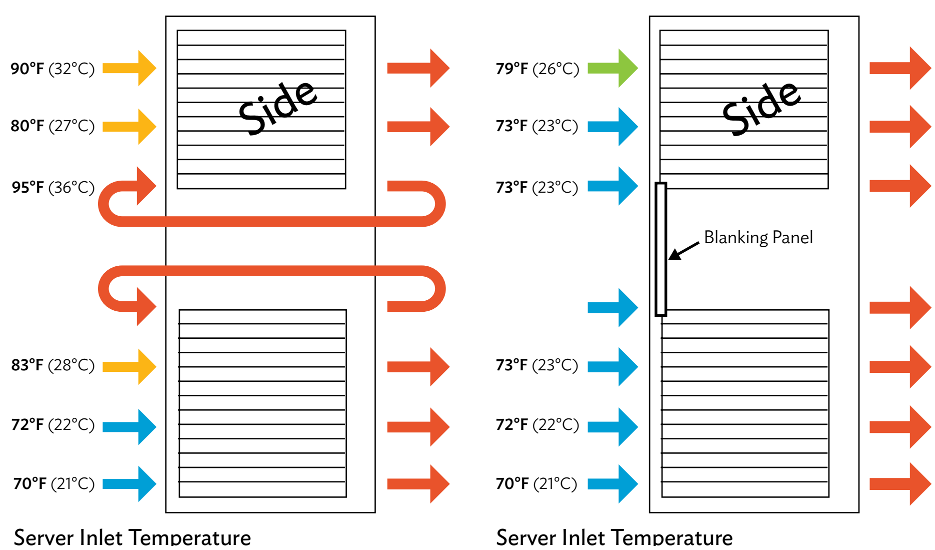
30 ENERGY STAR. 12 Ways to Save Energy in Data Centers and Server Rooms. http://www.energystar.gov/products/low_carbon_it_campaign/12_ways_save_energy_data_center

Heating, Ventilation and Air Conditioning Adjustments

- Server inlet temperature and humidity adjustments
- Air-side economizer
- Water-side economizer

Some of the strategies named can achieve significant savings with low-cost improvements, such as increasing server inlet temperature or employing airflow management devices. For instance, for every 0.56 degree Celsius increase in server inlet temperature, ENERGY STAR reports that data centers can save 4%–5% in energy costs.[31] The proper use of airflow management devices, such as blanking panels, floor grommets, diffusers, optimized air vent tiles, and structured cabling systems, can maximize cooling of servers and prevent recirculation of hot exhaust air, lowering cooling costs. See examples in Figure 3 and Figure 4. Payback on these types of improvements can be as little as 1 year and can represent approximately 20% of a data center's energy efficiency savings.[32]

**Figure 3: Installation of Blanking Panels can Improve Cooling**

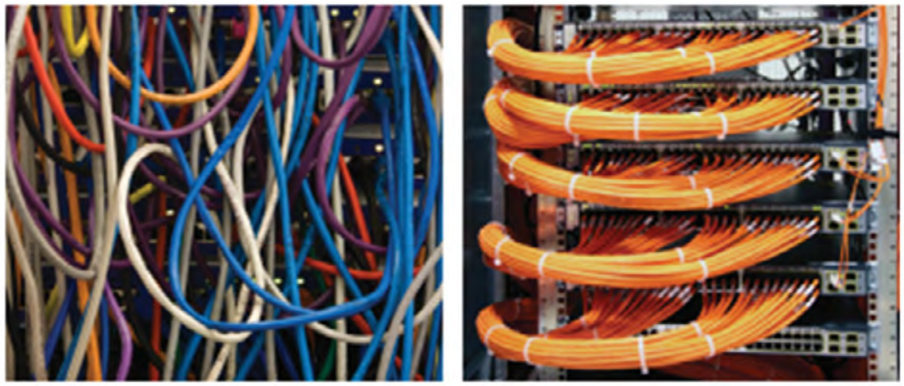



Source: ENERGY STAR. *Top 12 Ways to Decrease the Energy Consumption of Your Data Center*. https://www.energystar.gov/sites/default/files/asset/document/DataCenter-Top12-Brochure-Final.pdf

31 ENERGY STAR. Server Inlet Temperature and Humidity Adjustments. https://www.energystar.gov/products/low_carbon_it_campaign/12_ways_save_energy_data_center/server_inlet_temperature_humidity_adjustments

32 ENERGY STAR. Deployed Airflow Management Devices. https://www.energystar.gov/products/low_carbon_it_campaign/12_ways_save_energy_data_center/properly_deployed_airflow_management_devices

### Figure 4: Structured Cabling Improves Air Circulation to Servers



Unstructured Structured

Source: ENERGY STAR. Top 12 Ways to Decrease the Energy Consumption of your Data Center. https://www.energystar.gov/sites/default/files/asset/document/DataCenter-Top12-Brochure-Final.pdf

The *Energy Efficiency Guidelines and Best Practices in Indian Datacenters*, published by the Indian Bureau of Energy Efficiency, states that the minimum energy saving potential by adoption of the latest technologies is between 25% and 30%. Furthermore, this publication stated its estimates of various energy saving technologies on the overall energy saving potential in a data center (see Table 3):[33]

### Table 3: Estimates of Various Energy Saving Technologies on the Overall Energy Saving Potential in a Data Center

| Energy Saving Technology | Impact in Overall Saving Potential (%) |
|---|---|
| Server virtualization | 40 |
| More power efficient servers | 20 |
| More efficient facilities infrastructure (e.g., CRACs, PDUs, etc.) | 7 |
| More power-efficient storage system | 6 |
| More power-efficient network equipment | 5 |
| Data storage management technologies | 5 |
| Server or PC power management software | 4 |
| Use of alternative or renewable energy | 4 |
| Tiered storage | 4 |
| Other | 5 |

CRAC = computer room air conditioner, PC = personal computer, PDU = power distribution unit.
Source: Government of India, Bureau of Energy Efficiency, Ministry of Power. 2010. *Energy Efficiency Guidelines and Best Practices in Indian Datacenters*. New Delhi.

33 Government of India, Bureau of Energy Efficiency, Ministry of Power. 2010. *Energy Efficiency Guidelines and Best Practices in Indian Datacenters*. New Delhi.

## Efforts to Improve Energy Efficiency and Reduce Emissions in Indonesia

While the full extent of measures taken up in Indonesia can only be determined by a more detailed survey, there are indications from interviews that most of the EEMs have been implemented by colocation data centers. It is important to determine which EEMs are likely to be adopted in Indonesia so that the authorities can determine which technologies are eligible for incentives. Some incentives have already been identified in the Sustainable Financing Roadmap by the Financial Services Authority (OJK).

There are various measures for improvement that have been identified by large data center operators, particularly those from managed services and colocation data centers and by professional consultants working in Indonesia.[34] These measures are as follows:

### *More Energy-Efficient Non-IT Components*

Power management

- Higher transformer efficiency
- Higher UPS efficiency
- Higher generator set efficiency
- Efficient power supplies
- "Platinum" power supplies
- Hardware upgrades
- Diesel rotary UPS systems
- Isolated-parallel switchboards[35]

Cooling management

- Higher room temperature = higher energy saving
- Never cooling "empty space"
- Better cooling zoning
- Higher efficiency cooling equipment
- Scrolling compressor
- Variable speed fans and/or drives and variable refrigerant flow
- Electrically commutated plug fans
- Improved air ways or airflow (i.e., remove obstructions under the floor, ensure unobstructed airflow through equipment, clean air conditioner filters, use appropriate levels of perforated and/or grilled tiles)
- Co- or tri-generation
- Alternating hot and cold aisle principle
- Use "free" cooling where feasible
- Use blind plates and/or blanking panels
- Well-designed and sealed raised floor setup

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[34] The list of EEMs is based on the activities that Telkomsigma has announced and the items were confirmed through interviews.

[35] Isolated-parallel topology combines the advantages of many proven UPS topologies without limitations. It provides a highly reliable, flexible electrical system where central capacity and redundancy are shared.

- Proper maintenance of air conditioners, condensers, and chillers
- Appropriate set points (too low uses excessive energy)
- Closed coupled air cooling principles

### *More Energy-Efficient Lighting*

- Use power saving lights (replace incandescent lights with power saving compact fluorescent light bulbs or light-emitting diode lights with motion sensors in data hall)
- Light-emitting diode fixtures, new or retrofit kits, longer lifespans
- Solar-powered perimeter lights
- Automated on–off lights based on movement in data center and access control measurement for ultimate savings (but at all times the light levels should allow security cameras to function properly)

### *Greener Fire Suppression Agent*

- Zero ozone depletion potential
- An atmospheric lifetime of 5 days, compared to 65 years for halons[36]
- A global warming potential of less than 1—about the same as naturally occurring carbon dioxide

### *Improvement on Data Center IT Equipment*

- Server virtualization
- Environment "tolerant" IT equipment
- Central processing unit power throttling
- Power management software to monitor power use patterns or data center infrastructure management (DCIM) to provide the holistic monitoring needed to ensure effectiveness and safety

A common solution among the examples cited is to consider the DCIM as a "baseline" category of solutions for energy efficiency adoption in Indonesian data centers. DCIM tools provide monitoring, measuring, management, and intelligent capacity planning of a data center's critical systems, including IT equipment and physical infrastructure components.

The thinking on DCIM at the global level is best summarized by an executive at Gartner: "By 2014, DCIM tools and processes will become mainstream in data centers, growing from 1% penetration (in 2010) to 60%."[37] While these numbers may not necessarily reflect the realities in Indonesia, there is little doubt that dynamic optimization DCIM software is perceived to bridge the critical gap between IT equipment and data center physical infrastructure and has many benefits, particularly in terms of increased energy efficiency and availability.

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36 Halons are an effective fire-extinguishing agent but in 1989 the Montreal Protocol agreement determined that halons deplete the ozone layer.

37 D. Cappuccio. 2010. *DCIM: Going Beyond IT Problems.* Stamford, CT: Gartner.

The list of various technologies mentioned has been included in the Master List of EEMs compiled by the Ministry of Energy and Mineral Resources (ESDM). This list is to be submitted to OJK so that banks can provide incentives in these areas. Some of these incentives may be channelled through energy services companies (ESCOs).[38]

# Energy Efficiency Potentials at Firm Level

There are many available well-known energy efficiency technologies that data center operators and owners in Indonesia can utilize, which are expected to be similar to the range of data center energy efficiency technologies used in the People's Republic of China (PRC) and India. Estimates of energy savings potential at the firm level were developed based on case studies using measurements from DCIM estimates from the PRC and India, which were used as proxies for measuring various EEMs for Indonesia. Below are summaries of the results.

## No-Cost and Low-Cost Potential for Energy Saving

The study found that with the implementation of no- or low-cost EEMs, there is significant potential for energy savings across various data centers, as follows: captive–private (8.54%), captive–government (5%), and colocation–private (15.23%).

## Medium-Cost Potential for Energy Saving

From the analysis of energy savings potential in the PRC and India, it can be inferred that with the implementation of medium-cost EEMs, the data center sector in Indonesia could have 20%–30% potential energy cost savings if the latest technologies are applied.

# Energy Efficiency Potential at Industry Level

Using comparative analysis, the study explored potential industry wide energy savings that have been obtained in the PRC, India, and other comparable countries. Based on the data available and assuming similar technology applications, the data center sector in Indonesia could see energy savings of at least 5%–15% with the implementation of no- or low-cost EEMs. Furthermore, assuming that there is rapid building of new data center facilities in the rush to meet Government Regulation No. 82/2012 (the "onshoring" of data centers by October 2017), these savings could reach 25%–40% per annum with the adoption of the latest energy efficiency-related technologies.

[38] The recent publication of ESDM Regulation 14/2016 concerning the implementation of ESCOs and the availability of incentives offered by the OJK to banks for funding energy efficiency projects may help encourage energy efficiency improvements in data centers.

# Power Usage Effectiveness as an Energy Efficiency Measurement Tool

Power usage effectiveness (PUE) is a widely accepted formula for measuring energy efficiency in a data center, defined as the ratio of the total amount of power entering a data center to the power consumed by the IT equipment.

While the ideal state for this ratio is 1.0, it is also well accepted that the most efficient data centers in the world have achieved PUEs of between 1.15 and 1.20. According to interviewed data center professionals, the majority of data centers in Asia and the Pacific region have PUEs exceeding 2.0, which is true for Indonesian data centers as well.

When measured accurately and reported, PUE can be used to rank data centers with industry benchmarks and provide an energy efficiency scorecard for a particular data center. For example:

- PUE=1; all power used to power IT equipment (theoretical)
- PUE=1.2–1.6; optimized, feasible with appropriate measures
- PUE=2; efficient, should be the first target
- PUE=2.4; average, more improvement needed
- PUE >3; inefficient, a lot of room for improvement

Energy savings can be achieved when the PUE is reduced through the implementation of EEMs. Generally, the least-efficient data centers (with the highest PUEs) have the greatest energy savings potential. For example, in the Indian guidelines for data center energy efficiency, it states that: "Typically, for conventional data centers with operating PUE of 2.0, the minimum energy saving potential by adoption of latest technologies is between 25% to 30%."[39]

However, Indonesian data centers are not currently self-reporting nor are they required to measure or to report their PUE, and many operators remain unfamiliar with the PUE metric. In addition, there appears to be no register where Indonesian data center companies are listing their PUE metrics, nor is there any third-party validation of data.

[39] Government of India, Bureau of Energy Efficiency, Ministry of Power. 2010. *Energy Efficiency Guidelines and Best Practices in Indian Datacenters*. New Delhi.

# 5 Barriers and Recommendations to Improve Data Center Energy Efficiency

Several barriers at the enterprise, industry, and national level are preventing data center operators in Indonesia from improving the energy efficiency of their centers. These barriers result in less-efficient data center designs and lower capacity utilization of data centers once they are built. Major barriers identified during field interviews and addressed in this report include[40]

- the absence of relevant guidelines for data center energy efficiency;
- a skills shortage leading to a limited pool of qualified operational and maintenance staff;
- organizational resistance to implementing EEMs; and
- lack of national reporting requirements, an energy rating standard, or a certification process.

These barriers and recommendations to overcome these barriers are discussed as follows:

## Lack of Industry Guidelines on Energy-Efficient Design and Performance

A guideline, manual, or code of conduct on data center energy efficiency and sustainability would be useful to raise awareness among data center designers and operators. In Indonesia, as in many emerging economies, it is difficult to define design requirements early on in the project, such as projecting growth estimates of the ultimate load. Such uncertainty often results in over-provisioning of IT; heating, ventilation, and air conditioning systems; power supplies; and other equipment.

In some countries, authoritative manuals on design requirements and standards have been compiled.[41] For example, they suggest preinstalling fixed elements such as ducts and pipes and designing for modular growth of the mechanical equipment, such as variable speed fans, pumps, and compressors. Their key message is to be mindful of properly sizing all plant equipment because overbuilding in anticipation of future needs leads to inefficient operations with current loads. Analytical tools can provide early stage diagnostics of the data center design for owners and operators. Examples are the Data Center Profiler

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40 This section in based on interviews of selected data center industry professionals based in Indonesia and abroad.

41 Government of India, Bureau of Energy Efficiency, Ministry of Power. 2010. *Energy Efficiency Guidelines and Best Practices in Indian Datacenters*. New Delhi. Similar manuals have been produced in Australia, Germany, the United Kingdom, the US, and others.

(DC Pro) Flagship Tool, the DC Pro Lite Tool, and the PUE Estimator, which all provide an estimated PUE metric to assist with data center energy efficiency benchmarking.[42]

There are several international guidelines that could be relevant for Indonesia. Some examples are provided as follows:

- In the US, the Lawrence Berkeley National Laboratory runs the Department of Energy's Center of Expertise (COE) for Energy Efficiency in Data Centers. The COE offers tools, guides, training, and analyses to assist with implementing policies and developing energy-efficient data centers.[43]
- The European Commission has produced a comprehensive guideline that covers a wide range of topics to improve resource usage, and environmental sustainability of data centers, entitled *The European Code of Conduct for Energy Efficiency in Data Centre*.[44] It provides a useful framework of best practices for operators to review the performance of existing data centers and to apply changes that will improve energy efficiency.
- The German digital association BITKOM has produced a guideline for its data center industry that is reported to be one of the most efficient in the European Union. The BITKOM guideline shows that energy saving tools such as Simple Network Management Protocol or DCIM systems achieved significant results.[45]
- India's *Energy Efficiency Guidelines and Best Practices in Indian Datacenters* identifies the best practices on EEMs adopted in data centers and outlines various tips and process descriptions in four major areas: (i) electrical system and power management, (ii) cooling systems and techniques, (iii) IT solutions, and (iv) operation and maintenance.[46]

In addition to developing guidelines, a forum for technical and policy discussions could raise the importance and level of awareness of energy efficiency among policy makers and industry professionals. Such a forum could address the development and use of an appropriate national energy rating standard, as well as contribute toward best practice outreach activities, education, and industry leadership. A separate government data center forum would also be useful to address unique public sector issues.

## Skills Shortage

Professionals have cited a shortage of skilled professionals and a lack of specialized data center training facilities as a major market gap. To some extent, these problems have been exacerbated by the introduction of Government Regulation No. 82/2012, regarding "onshoring" all data storage in Indonesia, which has led to significant competition for skilled professionals. The ongoing Association of Southeast Asian Nations economic integration approach will bring similar challenges.

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42 These tools are provided by the Center of Expertise for Energy Efficiency in Data Centers of the US Department of Energy, and managed by the Lawrence Berkeley National Laboratory. https://datacenters.lbl.gov/tools

43 Footnote 42.

44 European Commission Joint Research Centre. 2008. *The European Code of Conduct for Energy Efficiency in Data Centre.* http://iet.jrc.ec.europa.eu/energyefficiency/ict-codes-conduct/data-centres-energy-efficiency

45 Footnote 9.

46 Footnote 39.

There is a need for specially tailored professional training programs to produce the necessary data center experts and consultants, as well as to qualify and upgrade the skills of existing experts. Suggested solutions identified include creating training institutes—in partnership with corporations and universities—and undertaking efforts to better align university courses with the needs of the data center sector. Furthermore, it will be critical to include energy efficiency components into any data center practitioner certification process to accelerate energy savings in the dynamic and energy-intense marketplace of data centers.

As an example, the US Data Center Energy Practitioner certificate training program aims to produce qualified data center professionals who can[47]

- identify and evaluate energy efficiency opportunities in data centers;
- demonstrate proficiency in the use of the Data Center Profiler (Data Center Pro) and select assessment tools;
- address energy opportunities in electrical systems, air management, heating, ventilation, and air conditioning, and IT equipment;
- meet academic or work experience requirements (prequalifications);
- receive training on conducting data center assessments; and
- pass one or two exams.

## Organizational Resistance

For many data center operators and owners, energy efficiency is not a high priority—unlike availability. Given the perception that downtime is much more costly, it is difficult to get managers to buy in to a balanced approach for availability and energy efficiency, and to undertake EEMs, even with short payback periods. Also, as there is no regulatory or management-reporting requirement on energy, many companies do not have energy efficiency-related performance metrics. The issuance of effective guidance, regulation, and/or incentives for implementing EEMs can increase awareness, acceptance, and uptake of EEMs.

## Lack of National Reporting Requirements, Energy Rating Standards, or Certification Process

Indonesia has yet to implement national reporting requirements, energy rating standards, or a certification process for data centers. There is some limited self-reporting in the following aspects of data center operations: availability (as defined by the Uptime Institute's Tier rating[48]); resilience (as defined by earthquake standards); management certification (as defined by International Organization for Standardization [ISO] 9001,

[47] Government of the United States, Department of Energy, Center of Expertise for Energy Efficiency in Data Centers. 2017. Data Center Energy Practitioner (DCEP) Training. https://datacenters.lbl.gov/dcep

[48] See section 3 on overview of data centers, classification based on availability, for details of the Uptime Institute Tier rating system.

ISO 20000, and ISO 27001); occupational health and safety (as defined by Occupational Health and Safety Assessment Series 18001); Central Bank Compliance; and GREENSHIP Certification of green buildings.[49] However, there are no data centers that have self-declared or certified energy efficiency credentials in terms of PUE or other relevant energy rating or certification systems.

The Ministry of Communications and Informatics (KOMINFO) is currently working on a data center Ministerial Decree that will outline some key reporting requirements by data center operators under Government Regulation No. 82/2012 regarding System and Electronic Transactions Providers. Regarding energy use reporting, ESDM has started discussions with KOMINFO on a joint reporting mechanism on energy use as well as the development of a related joint program to improve EEMs, which are also in line with data security and resilience requirements.

While the scope of the above reporting is still in development, ESDM should be able to make some recommendations on the energy reporting framework (or data points or fields required) specifically designed for data centers to enable an ongoing energy analysis of the data center sector. Furthermore, ESDM has indicated that government data centers need to be prioritized, and that improved performance in energy efficiency should be implemented together with improvements in other areas such as availability, security, and resilience.

Hence, there is an urgent need for ESDM and KOMINFO, as well as other ministries such as finance and bureaucracy reform, to work together with representatives from the data center sector to develop an Indonesia data center operators' guidelines where energy reporting (for example on PUE measures) can become part of broader reporting requirements on cyber security or data protection, physical security (including meeting earthquake-proof standards), and resilience (availability or least downtime).

To develop an Indonesian data center energy standard and rating tool, it is recommended to review existing and well-known energy management standards and rating tools based on current certifications. These standards and certifications may be adapted to meet Indonesia's specific conditions.

There are many energy standards from various countries, which can be categorized as follows:

Energy management standards:

- International Organization for Standardization standard for Energy Management Systems (ISO 50001)
- Standard for Green Data Centers–Energy and Environmental Management System (SS 564–Singapore)

[49] Green Building Council Indonesia. 2017. GREENSHIP Rating Tools. http://gbcindonesia.org/greenship

Performance-based rating tools:

- The National Australian Built Environment Rating Scheme (NABERS–Australia)
- GREENMARK (Singapore)
- Environmental Protection Agency ENERGY STAR program (United States)

Design-based assessments:

- Leadership in Energy and Environmental Design (LEED–United States)
- Building Research Establishment Environmental Assessment Method (BREEAM–United Kingdom)

It is important to work on developing an Indonesian data center energy management standard, which addresses the issue of "how to go green" by providing specific measures to increase efficiency (see *Potential Energy Savings Technologies* above). Equally important is the simultaneous development of an Indonesian data center energy rating tool, which addresses the issue of "how green the data center is" by providing an assessment of energy performance based on actual measurements that allows for comparison among peers.

# 6 Focus on Improving Energy Performance of Government Data Centers

The Government of Indonesia can focus on its own government data centers to conduct energy efficiency benchmarking for the development of an Indonesian standard and rating tool, as well as to promote energy performance reporting and energy savings through the implementation of EEMs, and to provide a testing ground for ESCO services.

## Benchmarking and Consolidating Government Data Centers

The focus on government data centers is based on the concerns of many consulting engineers working to maintain or do emergency repair work in these government data centers. According to these engineers, with some internationally certified exceptions, many government data centers are drastically underperforming on most metrics around energy, security, and resilience, and are thus less reliable and generally slower than international IT companies and email providers. This is evident in the fact that, with the exception of a few ministries, most government officials seldom use their own ministries' e-mail accounts and instead use those provided by leading technology providers.

As a first step, ESDM can provide some objective energy efficiency benchmark guidelines (such as PUE) for all government agencies to form data center clusters or start migrating to future government-owned or nominated data centers. A data center consolidation program, which might be difficult to implement due to institutional resistance, could rapidly accelerate data center energy efficiency and further support the "shared infrastructure and services" vision supported by KOMINFO. For example, in implementing "infrastructure sharing" in the cellular telecom towers (by at least three cell network operators), the government claims that operators will save Rp5.2 trillion (slightly less than $500 million). Hence, the government could also contemplate infrastructure sharing or consolidation of data centers.

In order to support such data center consolidation, a ministerial decree by KOMINFO on reporting requirements for both government and private data centers is under development. This is an opportunity for ESDM to come to an arrangement with KOMINFO to include a joint reporting mechanism on use of EEMs, and to identify less energy-efficient data centers.

## ESCO Activities for Government Data Centers

The recent publication of ESDM Regulation No. 14 of 2016 provides definitions and guidelines for ESCO services. However, further regulation is required to allow governments to access ESCO services on a paid-from-savings basis and enter into multiyear energy savings performance contracts (ESPCs). Once these regulations are in place, the government can promote ESCO services and the ESPC model by employing this model for its own government data centers.

## National Whole-of-Government Road Map to Support the Data Center Industry

The Government of Indonesia may consider developing a whole-of-government data center technology road map (including an emphasis on energy efficiency and sustainability) with input from the research community, industry, and government agencies. The road map can provide insights on methods and systems to reduce energy consumption in data centers without compromising system performance or security requirements. It can also identify key areas of research where both academic and professional institutions can take lead roles in developing energy reporting strategies and emerging technologies.

# 7 Summary and Conclusion

The growth of ICT can facilitate a net reduction in energy consumption for the economy at large as a result of decreased transportation, better e-commerce services and manufacturing techniques, and other energy saving impacts. However, there is an associated rise in the localized energy consumption at data centers as well as an increase in energy costs and related greenhouse gas (GHG) emissions.

In recent years, Indonesia has experienced an unprecedented rise in the use of computers, mobile phones, and other mobile-based devices. This increased use of ICT devices required tremendous growth of "back-office" support in the form of data centers, leading to a direct and unchecked surge in electricity use. In 2014, the electricity use of the data center sector was estimated at about 1.5% of Indonesia's national generation capacity.[50] By 2017, data center electricity consumption is estimated to increase to about 2.0% to 3.0% of total generation capacity.

It remains to be seen if the country will be able to provide the data center infrastructure required to meet its soaring demand. Managing this growth depends on the commitment and effort of both the government and private sector to modernize the data center industry by adopting best practices and implementing energy efficiency standards, as well as addressing availability, safety, and other operational procedures.

Based on the results of this study, the following measures are recommended to the Government of Indonesia to ensure the transformation to an energy-efficient data center industry:

(i) The Directorate General for New Renewable Energy and Energy Conservation (EBTKE) in ESDM should support a benchmarking survey of 30–60 data centers and detailed studies of 6–12 data centers in each strategic sector (for example, banking, energy, and telecommunications) in Indonesia to establish Indonesia-specific metrics of energy use, energy intensity, and energy efficiency potentials.

(ii) Indonesia should develop national energy efficiency in data center management and energy rating standards based on established and proven standards in other countries, such as those developed in Australia, Singapore, and the United States.

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50 In 2014, the national generating capacity of all electric power plant in Indonesia was around 53.5 GW and this amount is expected to grow to about 70 GW (Government of Indonesia, Ministry of Energy and Mineral Resources. 2015. Current National Electricity Condition. 16 March. http://www3.esdm.go.id/news-archives/electricity/46-electricity/7174-current-national-electricity-condition.html).

(iii) EBTKE in ESDM should work closely with KOMINFO to ensure that the upcoming regulation on data center development also addresses energy efficiency and energy reporting issues.
(iv) EBTKE in ESDM should work closely with KOMINFO to focus on improving the energy efficiency of national government owned data centers, reduce costs, mainstream EEMs, and provide an example for both regional governments and the private sector to emulate.
(v) The government should (a) facilitate the reporting of energy usage, security, and resilience aspects of data center operations; (b) help raise awareness of the potential of EEMs to lower data center operational costs; and (c) support training to improve knowledge of energy efficiency among data center professionals.

**The Emerging Indonesian Data Center Market and Energy Efficiency Opportunities**

Global data center energy use was estimated at 1.1% of total energy use in 2012 and is expected to increase to 2.5% by 2020. Indonesian data centers used an estimated 1.5% of total electricity generating capacity in 2014 and are expected to use between 2.0% and 3.0% by 2017. This report assesses the Indonesian data center industry in terms of energy use, energy saving potential, market trends, growth opportunities, and major challenges. This report shows how Indonesia and other developing countries can attain up to 30% energy savings and improve the effectiveness, sustainability, and global competitiveness of data centers by adopting internationally proven energy efficiency measures.

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ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to a large share of the world's poor. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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