# The L in LEED Stands for Lao PDR Energy Efficiency Modular Data Center Project

The "LEED: Lao PDR Energy Efficient Datacenter Project" that IIJ is involved in was approved as the first JCM project in the Lao People's Democratic Republic (Lao PDR) on July 31, 2017. We have published information about this project in press releases*1 and other formats in the past, but here we will provide a comprehensive overview of JCM, providing an outline of the project and its history to date, and examining IIJ's role within the project, as well as the characteristics of the technology we are providing.

## 3.1 The Lao PDR Environment

Some readers may be unfamiliar with the Lao PDR, so here is some background information. The Lao PDR is a country located to the north of Thailand, with a population of just under seven million (about the same as Saitama Prefecture in Japan). Its GDP of 15.9 billion US dollars in 2016 was less then that of Tottori Prefecture, which has the lowest population in Japan. That said, their economy is expanding, with a GDP growth rate of 8%. It is visited by many tourists from Europe and America, and the tourism industry is the second largest revenue source of foreign currency after mining. It appears that another factor driving economic growth is using its abundant water resources to export hydroelectric power to Thailand. Meanwhile, looking at the IT industry, there are four mobile carriers, and smartphone penetration is on the rise. However, in most cases IT equipment is simply installed in a corner of the office even within government agencies and companies, so there is still a lot of room for growth in the data center market and other areas related to corporate IT.

Japan has provided support to Lao PDR by improving various public facilities. Some examples include the international airport, Pakse Bridge (also featured on a banknote) that connects Thailand and Lao PDR over the Mekong River, and public transportation (buses with the national flag of Japan on them are frequently seen in the city). The relationship between Japan and Lao PDR is good, although there are also many businesses supported by South Korea, and signs for Chinese construction firms can be seen on tall buildings under construction, so Japan is not the only country with a high presence there.

The citizens are very friendly, neighborhoods are safe enough to the point that one does not sense any danger even when walking the downtown area at night, and you rarely hear car horns, so it feels different from other Southeast Asian countries. Also, because it is a Buddhist country, there are many temples in the city, and even in the capital of Vientiane, you can see monks in red robes collecting offerings early in the morning.

The cuisine consists of many rustic dishes that use meat, fish, and vegetables, along with sticky rice as the staple food, and you never get tired of it even when you eat it every day (although those who dislike herbs such as coriander may find it not to their taste). Although it is not well known, the cultivation of high-grade coffee in high altitude mountainous regions has also become popular, and the export volume is increasing. Perhaps because it was once a French territory, many restaurants serve delicious baguettes as well.

The capital of Vientiane is located along the Mekong River which also borders with Thailand, and around April when the dry season is almost at its end, the water level drops low enough that it seems you could walk to Thailand on the opposite shore. However, the water level rises during the rainy season in May, reaching its peak between August and September. The sight of the setting sun reflected in the slow flowing river surface rivals the beauty of Lake Shinji, a famous spot for viewing the sunset in Japan.

## 3.2 About JCM

Let us get back to the subject at hand. JCM is the abbreviation for Joint Crediting Mechanism, which is a mechanism for facilitating the diffusion of low-carbon technologies, products, systems, services, and infrastructure, as well as implementing actions to mitigate, and contribute to the sustainable development of developing countries. It is also intended to appropriately evaluate contributions from Japan to greenhouse gas emission reductions or removals in a quantitative manner, and use these to achieve Japan's emission reduction target, while contributing to the objectives of the United Nations Framework Convention on Climate Change (UNFCCC) on a global scale. In more simple terms, this can be thought of as a system where Japan's low-carbon technologies are being introduced to developing countries, contributing to the industrial development of these countries, while generating credits based on the amount of greenhouse gas reduced. Credits allocated to Japan are then utilized to meet Japan's reduction goals.

*1 IIJ press release (https://www.iij.ad.jp/en/news/pressrelease/2016/0126-2.html).

Japan has established a JCM with 17 countries; Mongolia, Bangladesh, Ethiopia, Kenya, Maldives, Vietnam, Lao PDR, Indonesia, Costa Rica, Palau, Cambodia, Mexico, Saudi Arabia, Chile, Myanmar, Thailand and the Philippines (as of January 2017). Credits are issued through a process that includes approval of MRV methodologies by a joint committee consisting of representatives from both governments, validation by third party entities, an approval of the project registration by a joint committee, and verification of reduction amounts by third party entities. MRV is an acronym for Measurement, Reporting, and Verification, and these methodologies define how reductions should be measured, reported, and verified. As described later, this is closely related to the technology/business that we introduced in Lao PDR.

## 3.3 Project History

The LEED project is a demonstration undertaking aimed at verifying the effectiveness of reducing greenhouse gas emissions by constructing and operating a highly energy-efficient modular data center in Vientiane, the capital of Lao PDR. In July 2015, three companies including IIJ were entrusted with the following roles by NEDO (New Energy and Industrial Technology Development Organization).

- Toyota Tsusho Corporation: Overall project supervision, equipment transport, and advice and guidance for test run based on primary design documents.
- IIJ: Advice and guidance for basic design of verification equipment, equipment construction and building work.
- Mitsubishi UFJ Morgan Stanley Securities: Development of MRV methodologies and greenhouse gas-reduction effects measurement.

A JCM must also contribute to the sustainable development and industrial promotion of the partner countries. For this project, we aim to improve the IT infrastructure of the Lao PDR government by building and operating a data center that incorporates a cloud infrastructure providing resources such as servers, networks, and storage, along with security solutions. Beginning with enabling the secure and stable use of basic applications such as e-mail and file sharing programs, it is hoped that these will be put to use in establishing government applications such as e-Government solutions. It will also be applied to a variety of other areas, such as the development of future IT personnel, and industry.

After being entrusted with the project, we conducted a pre-demonstration study, and the three companies drew up a project proposal covering aspects such as the scale and functions of the data center, how it should be used, and greenhouse gas reduction amounts. Then, along with NEDO, we worked with the Lao PDR side towards a consensus on how the project would be implemented. In January 2016, we were able to simultaneously make cooperation agreements at the government and implementation levels, including the time frame, between NEDO, the other three parties, and the IT Department of the Lao PDR Ministry of Science and Technology. Based on these agreements, it was determined that a demonstration project including equipment installation and monitoring would be conducted over a two year period until February 2018.

Following consultation with the Lao PDR government, a power company, and telecommunications carriers, and also the preparing of detailed design plans, work began at a site in the capital of Vientiane in May 2016. Seven months later, in November 2016, construction of Lao PDR's first environmentally-friendly government-run data center was completed. An opening ceremony was held, and many stakeholders including members of the Lao PDR Ministry of Science and Technology, the Lao PDR Embassy of Japan, and NEDO attended.

When construction began in May 2016, it was the start of the rainy season, and there were concerns that this may affect the strength of the concrete foundations. Fortunately, there was not that much rain, and construction proceeded according to schedule (Figure 1). Also, while power outages are a daily occurrence in the neighboring country of Myanmar, the power in Vientiane is relatively stable (except for voltage drops due to lightning strikes, which are more common than in Japan), and there were no major problems that impeded the progress of construction. Local communication lines are provided by multiple carriers, and continuous progress is also being made with the development of fiber optic networks. This situation may be different in rural areas, but in Vientiane at least, infrastructure such as the communications and power needed for data centers are in place.

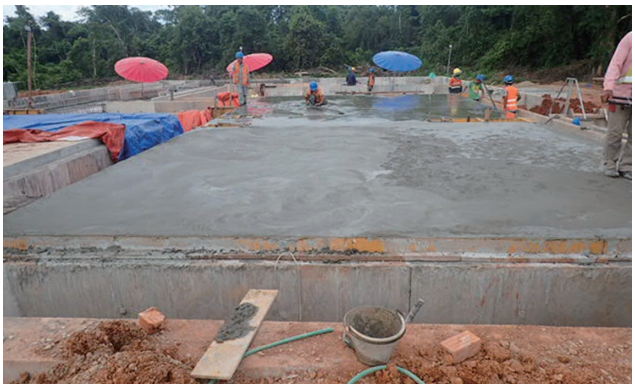

**Figure 1: Construction of Concrete Foundations**
**Creating shade with large sun umbrellas while working**

Development of the MRV methodologies necessary for registering the JCM project proceeded in conjunction with the construction of the facility, and these methodologies were approved at the JCM Joint Committee held in October 2016. In typical methodologies, the calculation of reduction amounts often involves comparison with existing equivalent facilities, but in Lao PDR there was no data available on the power consumption or greenhouse gas emissions of comparable data centers. Taking this into consideration, we decided to calculate the reduction amount through comparison with a PUE=2 data center. PUE is an ISO-standardized indicator of efficiency calculated by dividing the power consumption of an entire data center by the power consumption of its IT equipment, so the closer the result is to 1, the more efficient the data center is. For comparison, we decided to use the PUE measurement data for multiple data centers in Singapore, since the climate conditions were fairly similar. However, the average monthly temperature in Singapore is 30 degrees Celsius, and remains about the same throughout the year, whereas in Lao PDR there are days in December and January where the temperature drops to about 15 degrees Celsius, so we believe that less power will be consumed for air cooling than in Singapore during the four months from November to February. Accordingly, we adjusted the PUE for Lao PDR to be lower than that of Singapore, arriving at a PUE of 2 for comparison.

In this way, based on the methodologies drawn up and approved, we prepared a plan for implementation as a JCM project, and submitted it to the JCM Joint Committee. After a public comment period and validation by a third-party entity registered with the committee, it was approved and registered as a JCM project by the joint committee. Now, we will continue to monitor the reduction amounts, and we plan to apply for the issuance of emission reduction credits after the demonstration period ends in February 2018. The data center is currently running smoothly, and Web services, file sharing services, and email services are being used within the Lao PDR government.

## 3.4 Three Features of the Modular Data Center Implemented in This Project

The data center built and operated for the LEED project has three main features. First, to achieve the project's objective of reducing greenhouse gas emissions, the technology and equipment implemented must have a high level of energy efficiency. In data centers, cooling equipment consumes the second highest amount of power after IT equipment such as servers. Consequently, if you can drastically reduce the power consumption of cooling equipment, it becomes possible to raise the energy efficiency of the entire data center. You can generally lower the power consumption of cooling equipment by using outside air. For example, when the temperature of outside air is low, you can apply outside air directly to servers and cool the IT equipment using only fans, which consumes less power than an air conditioner would. However, when using outside air directly, there are drawbacks such as it being difficult to control because adjustments may be necessary, with you having to warm the air to an appropriate temperature when it is too cold, and frequently humidify or dehumidify the air as necessary. Also, in environments where outside air is low in quality, such as when the air contains a lot of dust or waste gas, there is a risk that the internal IT equipment may be adversely affected. To resolve this problem using technology, IIJ developed the "co-IZmo/I" container module that cools by dissipating heat using a heat exchanger that utilizes outside air, instead of taking in the outside air directly. By introducing this technology to the project, we were able to implement a highly energy-efficient data center with a PUE of 1.28 (designed value).

The second feature is that we can shorten the construction period at the site by building modular cooling and electrical equipment at the factory in advance. This time, by installing cloud computing infrastructure such as servers and storage at the factory in Japan, it was possible to drastically shorten the construction period for both the data center facility and the IT systems, resulting in data center construction and IT hardware installation being completed in just seven months.

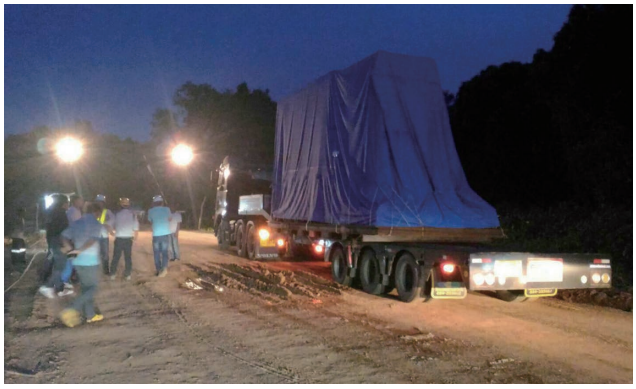

**Figure 2: Arrival of Module No. 1**
**Transporting at night to secure work hours during the day**

Meanwhile, the transportation of equipment from Japan to enable us to shorten the construction period at the site required extreme care. Although the container module we implemented is a standard 20-foot container (6m by 2.5m) that is easy to transport, we took elaborate measures to ensure its safety, such as measuring vibrations during transportation, and checking the state of roads in advance, partly because IT equipment was installed inside. The transport ship from Japan arrived in Thailand, and from there the modules were transported across Thailand to Lao PDR (Figure 2), which reminded us that Lao PDR is the only landlocked country among ASEAN nations. We also overcame incidents (Figure 3) that we would never have experienced within IIJ's main business, IT system construction

work. These incidents included having to revise the transportation schedule because of road traffic restrictions put in place due to the ASEAN summit held in September 2016, which happened to coincide with the peak of construction. In addition, we had to consider widening the entryway at the data center site at short notice because the trailers for transportation were larger than we had confirmed in advance (at the end of the day, they fit just fine without widening the entryway).

The third feature is high quality services assured through commercial service operation experience. IIJ has been operating modular data centers as part of commercial infrastructure for cloud services ahead of other companies, and we have applied the operational experience and knowledge we gained through use of this to the design and development of the internal structure and cooling controls for co-IZmo/I. Our self-developed system for monitoring aspects such as the status of equipment, temperature and humidity, and power consumption is also included in the package, making it possible to remotely monitor the data center. The data center we constructed for this project is currently being operated by the Lao PDR government, but this monitoring system enables us to provide operational support from IIJ sites in Japan upon request.

## 3.5 The Need for Energy Efficient Data Centers and Future Initiatives

President Trump has announced that the United States will pull out of the Paris Agreement, a global framework aimed at reducing greenhouse gas emissions. However, many companies in the United States have voiced opposition to this, and we believe there will be more and more calls for initiatives to combat global warming going forward, including improvements to energy efficiency. The overall demand for electricity at data centers is expected to grow worldwide, with an expected average annual growth rate of 4.2% in Europe, 5.8% in North America, 6.8% in APAC, 10.6% in the Middle East and Africa, and 11.2% in Central and South America. It could be said this is an industry that will require energy efficiency initiatives on a global scale. Although data centers enable IT equipment to be operated in an efficient manner, because they consolidate a large quantity of IT equipment, the power consumption relative to size of the floor area can sometimes be tens of times higher than commercial facilities such as office buildings and department stores (about 50 to 100 W/m2). The total amount of power consumed is also greater, so individual facilities, not just the entire data center industry, have an increasingly important social responsibility to implement energy-efficient solutions.

IIJ currently operates 21 data centers in Japan. Since 2009, we began initiatives toward energy efficiency with proof-of-concept tests for modular data centers. In 2011, we constructed and began operating our Data Center Park in Matsue, Shimane Prefecture (where Lake Shinji, a famous spot for viewing the sunset in Japan is located), and this was the first in Japan to utilize container modules with an outside-air cooling system. At the Matsue Data Center Park, we have continued to conduct proof-of-concept tests to efficiently use energy while integrating facilities and IT, and the co-IZmo/I module we installed in Lao PDR for this project is one of the products included as part of these tests.

IIJ will continue to aim to popularize energy efficient modular data centers both in Japan and overseas, taking advantage of their high energy efficiency and the ability to build high quality solutions in a short period of time. In addition to IT infrastructure for governments like in this project, we would like to also continue developing technologies that broaden the scope of application, including distributed processing platforms for IoT, and utilization as a cache for video distribution networks. By putting our various experiences in Lao PDR to use, we will promote activities that can contribute to the reduction of greenhouse gas emissions, while breaking new ground in the ever-changing domestic and overseas IT markets.

**Figure 3: Installation of a Module by Crane**
**Installation is completed in a few days, significantly reducing the construction period**

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Mr. Kubo joined IIJ in 2008. Currently he supervises IIJ Group data centers both in Japan and overseas, while also pursuing the development of technology such as modular data centers with the aim of integrating IT and facilities.