Note for readers of this English translation

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Outlook for data center market & IIJ’s initiatives

September 16, 2022

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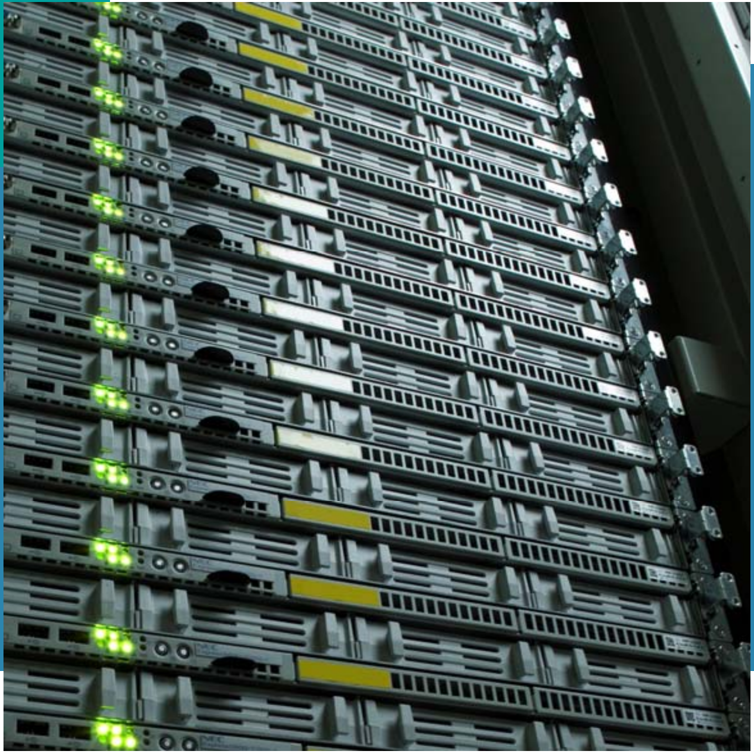
General Manager of Infrastructure Service Division



Outlook for data center market & IIJ's initiatives

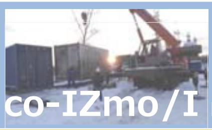
1. History of demonstration & development: Data center market trends
2. Initiatives toward carbon neutral

History of demonstration & development

Market trends of data centers

History of Demonstration & Development（IIJ's initiatives)

Data center construction | **Year** | **Proof of Concept**



Shiroi Data Center Campus
@Shiroi City, Chiba Prefecture: 2019～

- System module
- Outside cooling air
- automation

2009 · 2010 · 2011 · 2012 · 2013 · 2014 · 2015 · 2016 · 2017 · 2018 · 2019 · 2020 · 2021

・**Demonstration experiment of IZmo**
Fabrication & evaluation of a container-type DC demonstration model & a direct outside air-cooling demonstration model

・**Demonstration experiment with respect to the raising of the density of server deployment & operation in a chiller-less facility**
Validation of the cost reduction effects of improved server storage capacity efficiency, evaluation of operation in a chiller-less facility, & calculation of power saving effects

・**Use of the chimney effect for data center operation**
Securing of an amount of air necessary for cooling servers without air conditioning by applying the chimney effect, the application of which facilitates air intake & exhaust with waste heat generated by the servers.

・**Demonstration experiment of co-Izmo/D**
Fabrication & evaluation of a chiller-less & container-type DC demonstration model.

・**IT equipment acceptance test**
To be conducted with server suppliers. Evaluation of the performance of IT equipment used in a chiller-less facility & clarification of concerns

・**Demonstration experiment of co-Izmo/I**
Fabrication & evaluation of a container-type DC demonstration model for sales promotion equipped with in-direct outside air cooling

・**Diagnostic test of server deterioration**
Evaluation of the rate of deterioration of IT equipment used in a chiller-less facility & clarification of concerns

・**PoC of power-related software**
Evaluation of power dem & forecast software & power peak-cut control software

・**Destructive test of a container-type DC**
Inspection of the externally invisible structure of a container-type DC disassembled for the demonstration experiment for the fifth year

・**Demonstration experiment of co-Izmo/I V2**
Fabrication & evaluation of a demonstration model of combined co-Izmo/I. Fabrication & evaluation of a system that features the selective feeding of power generated by fuel cells, PV power generators or DC-UPS

・**PoC of an immersion cooling system**
Verification of installability & operability, comparison with air-conditioning equipment, & consideration of additional applications including cooling servers equipped with GPU for AI/HPC..

・**Demonstration experiment of co-IZmo/Z**
Fabrication & demonstration experiment of a low-cost container-type DC equipped with a refrigeration & air-conditioning unit.

・**Demonstration experiment of automation, lithium-ion batteries, AI-powered control ☆The Shiroi DCC will become a development center of DC technologies☆**
Evaluation of physical robots, RBA/RPA automation platforms, lithium batteries produced by Tesla, & AI-based air conditioning

・**Opening of the Shiroi Wireless Campus**
Features a collection of wireless telecommunication technologies including local 5G & private LTE (sXGP)). To be used as a place that provides customers with experience & a facility for conducting demonstration experiments.

・**PoC for edge micro data centers**
Evaluation of a small-scale data center (one to two meters in height) equipped with equipment & functions required by a data center, for example, an air-cooling system for servers, UPS & physical security, & useable as an edge computing platform.

Trends in data centers (Shift to a hierarchically structured data center system)

- Hyper-scale shift: DC installations are increasing in the Kanto & Kansai areas.
- Shift to edge computing: Due to the broader application of 5G & IoT, demand is growing for on-site computing services that offer cloud-level usability & feature advanced processing.
- Decentralization of data centers: The governmental is supporting decentralization to promote infrastructure adopted in the digital garden city state initiative.

Conceptual image of the hierarchy

Over 5,000 racks

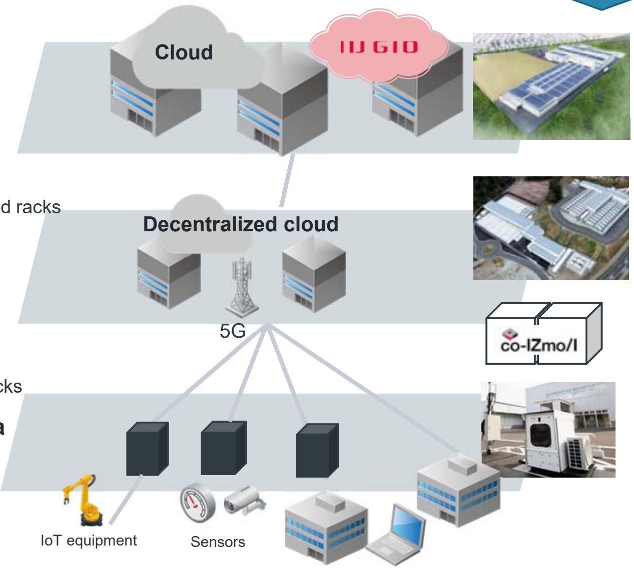
Hyper-scale data center

10 to several hundred racks

Edge/local data center

One to dozens of racks

Edge/on-site data center



Initiatives taken by IIJ

The Shiroi second phase building will commence operation in July 2023. Construction of the Shiroi third phase building is under consideration.

In June 2022, the Matsue DCP was selected as a facility eligible for subsidies aimed to promote decentralization.

The DXEdge was released in November 2021.

Applications

Core cloud platforms used by large-scale cloud service providers & backbone system platforms used by companies

Decentralized cloud as a digital platform, regional colocation operators, 5G & MEC, etc.

Division/complementation of roles

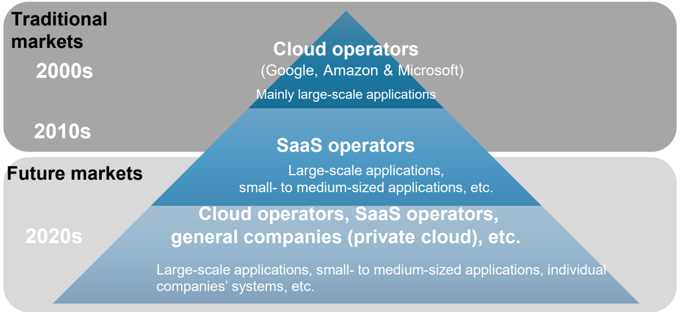
On-premise system platforms (private cloud) & edge computing

*MEC: Short for the Multi-access Edge Computing. One of the edge computing standards that factors in accessibility from local 5G terminals, Wi-Fi devices, IoT devices, etc.

Shiroi Data Center Campus (Shiroi DCC)

Opened a system module-based hyper-scale data center in Shiroi-shi, Chiba Prefecture based on technologies developed through the construction & operation of the Matsue Data Center Park (Matsue DCP)

Conceptual image of target markets



◆ Large scale/large capacity

- ✓ Entire site area: Approximately 40,000m^2
- ✓ Server capacity: 6,000 racks (in case of operation at the effective average output of 6kVA per rack)
- ✓ Maximum power reception capacity: 50MW

◆ Module structure

- ✓ Flexible scalability
- ✓ Quick delivery-oriented construction & low cost
- ✓ High quality (Consistent quality due to the in-plant processing of construction materials)
- ✓ Improvement in use efficiency due to installation in a pillar-less & spacious server room

◆ Energy-saving & use of renewable energy

- ✓ Use of lithium-ion storage batteries
- ✓ Adoption of three-phase, four-wire UPS & a bus duct-based power feeding system
- ✓ Adoption of a direct outside air-cooling system & a blow off-through-the-wall air-conditioning system
- ✓ Installation of solar-power panels

◆ Enhancement, streamlining & automation of DC operation

- ✓ Deployment of four different circuit paths to ensure redundancy
- ✓ Mutual monitoring by the Shiroi DCC & the Matsue DCP (Mutual sharing of engineers & operator-related skills)
- ✓ AI-assisted air-conditioning control & robot operation

Address new demand with an eye toward the fill-scale digital transformation

- ✓ Expand spaces for the deployment of IIJ's own equipment in sync with an increase in demand for various types of network services
- ✓ Respond to an increase in colocation* demand from cloud operators, SaaS operators, general companies (private cloud), etc.

*Colocation: Practice of leasing spaces in a data center, where clients can install their own servers, network equipment, etc.

Construction

◆ Features of system modules

Facilitated the standardization of materials that constitute a building.

Realized reductions in costs & construction periods while simultaneously maintaining consistent quality through fabrication.at a factory.

Succeeded in creating a large pillar-less space (maximum 60 meters) by using steel materials that are used for the construction of high-rise buildings & bridge girders, thereby enabling the efficient use of spaces.

◆ Period required from the start of building construction to the completion thereof

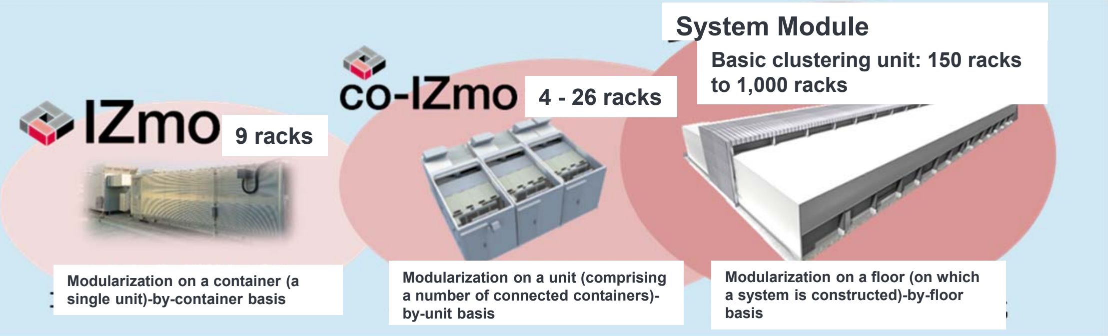
Four months: July 2018 (Start of construction) – November 2018 (Completion of construction)

◆ Earthquake resistance level

Complies with the New Building Standards Act

Due to modularization, the period of construction was shorter than the following records on the construction of the Matsue DCP:

- Approximately six months for the construction of the base portion
- Approximately three months for the installation of additional modules (containers)



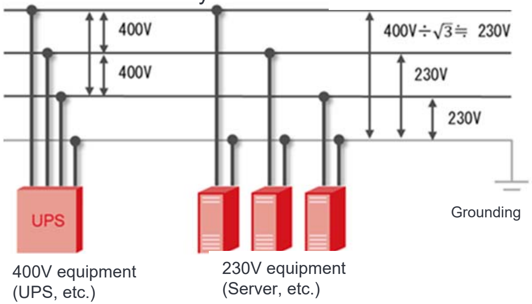
Power supply system: Three-phase, four-wire system & deployment of bus ducts for trunk cables

Reduced electric facility costs by approximately 30%!
Decreased power losses by up to approximately 25%!

*The above percentage-based cost reduction resulting from the introduction of the system reflects a comparison with costs for certain facilities installed in the Matsue DCP.
*The above percentage-based decrease is a theoretical decline under the optimal condition.

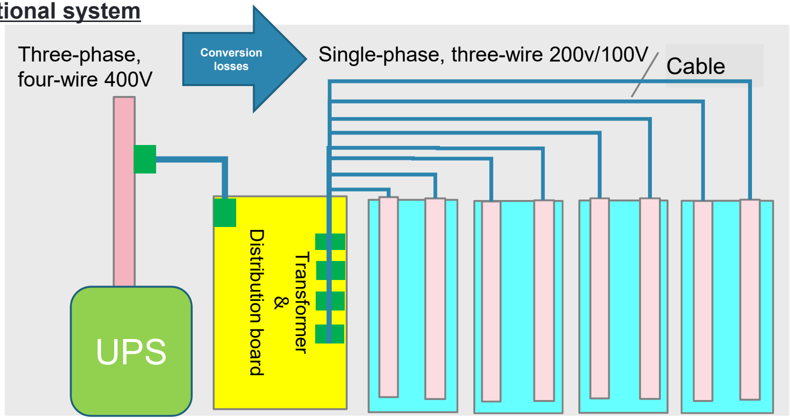
- Effects of the introduction
  - Reductions in cable sizes & power losses due to the transmission of power at high voltages (& at low currents).
  - Replacement of cables required for each container by bus ducts, which enabled the transmission of power centrally from the UPS.
  - Decrease in power losses thanks to transformer-less connection between the UPS outputs & the server inputs.
  - Streamlining of connection work that occurred every time a container was installed.
  - Improvements in the ease of maintenance
  - Space-saving

Principle of a three-phase, four-wire system

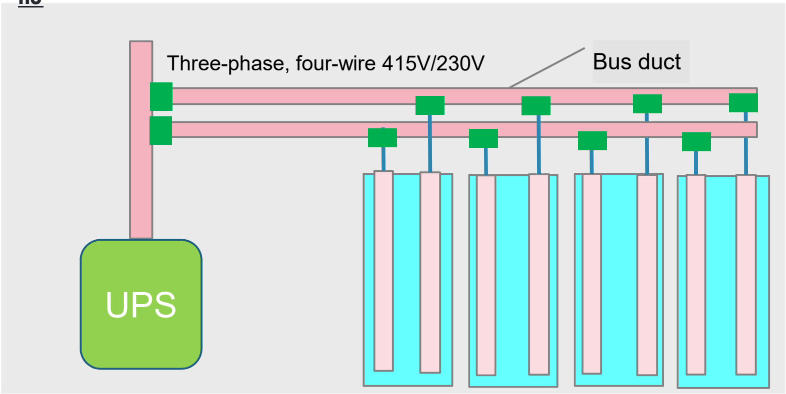


Bus duct

Traditional system



IIJ



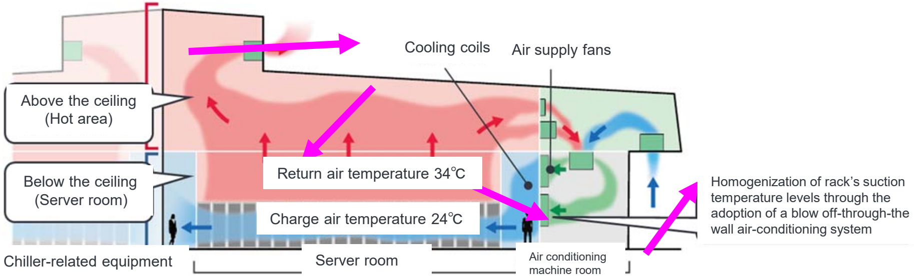
Direct outside air-cooling system

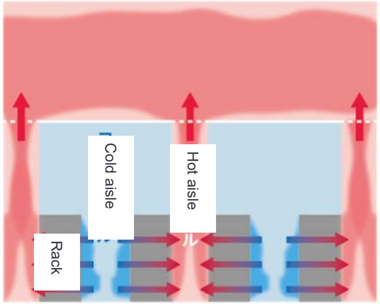
Energy saving

- Responded to the need of cooling the heat generated by the power of up to 20kVA/Rack (6kVA/Rack on average)
- Achieved the design PUE of 1.2 thanks to the adoption of the outside air-cooling system
- Realized highly efficient operation through the AI-assisted control of temperature, humidity & other measured values related to the utilization of equipment
- Reduced the blow off power of air-conditioning units to one third of that of blow off-through-the-floor air conditioning by adopting a rectification system, hot aisle capping & blow off-through-the-wall air-conditioning.

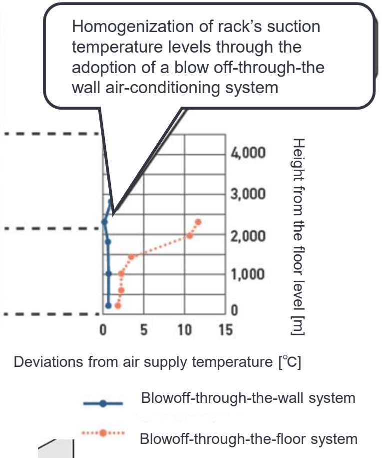
Reliability improvements

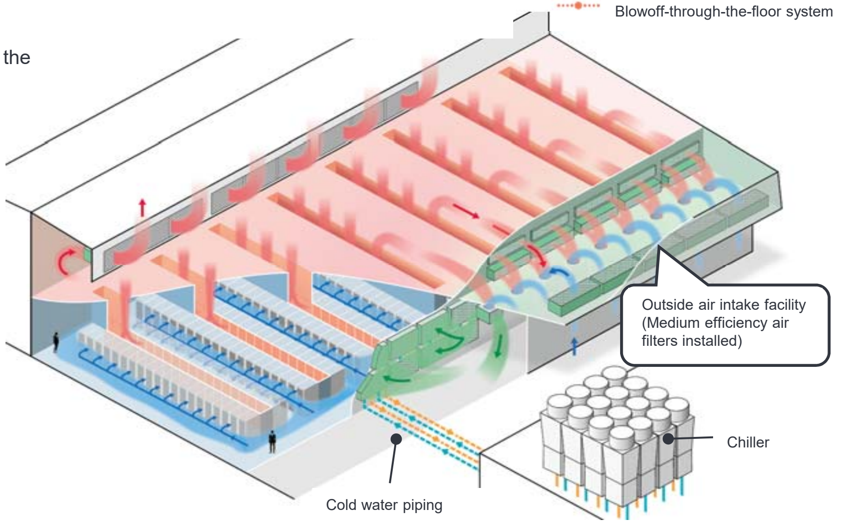
- Redundancy based on the N+1 configuration
- Use of the UPS to protect the pumps for cold water circulation & fans for air blowing. Prevention of the suspension of the server cooling system until the emergency power generator starts to operate, if commercial power supplies are down
- Installation of a buffer tank containing cold water in preparation for the restart of the chiller,





No under-floor space required for air conditioning



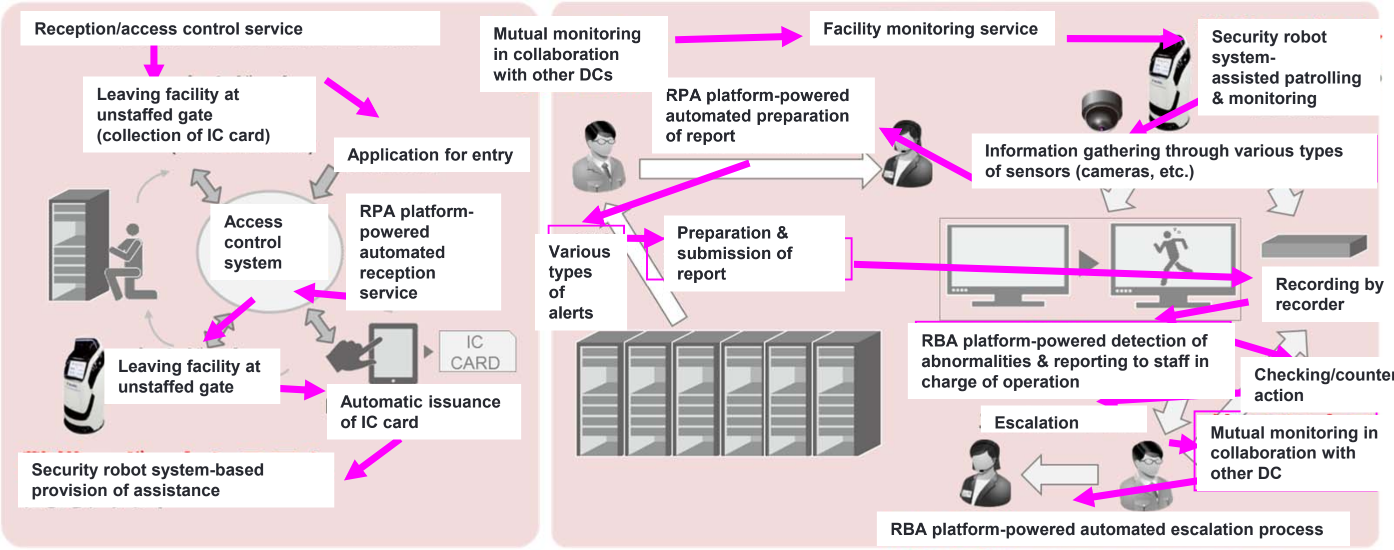


*For other initiatives on energy-saving, please refer to "The Shiroi DCC (i) Creation of a chimney effect-applied data center"

Facilitation of automation & unstaffed operation (labor-saving) through the introduction of robots

<u>Shift to the unstaffed operation with respect to manually-operated tasks, mainly routine services, that can be carried out by robots</u>

1. Demonstration of the unstaffed operation of services such as providing assistance to guests & conducting patrols inside & outside facilities by using a physical robot (REBOR-Z. a security robot of ALSOK).
2. Demonstration of the automation of IT-based operations carried out in the filing of applications for entry into facilities, implementation of recovery measures in case of emergencies, & other activities by using soft robots.



This page has been prepared in cooperation with IIJ Engineering Inc. & Sohogo Security Services Co., Ltd. (ALSOK)

*For other initiatives on the streamlining & automation of DC operation , please refer to reference information entitled “The Shiroi DCC (ii) AI-assisted control of air conditioning”

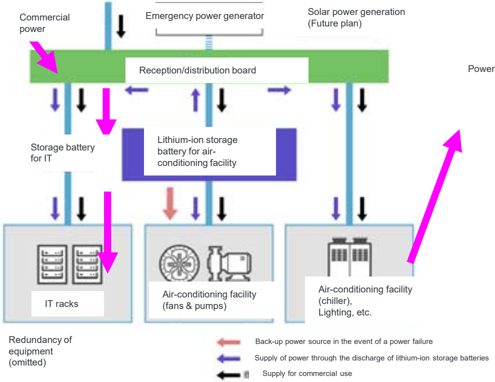
Initiatives advanced at the Shiroi DCC to improve energy use efficiency through the utilization of storage batteries.

- Implemented the receiving power peak-cut control of UPS for air conditioning by incorporating large capacity storage batteries, as well as the backup function in the event of a power failure
- Realized the reduction of peak power during the summer time, a challenge in outside air-cooling air conditioning
  - ✓ Achieved a 10.8% peak cut of DC's overall power demand on an actual measurement basis during days on which power demand peaked in summer 2020.
- Responded to a request for power-saving, which was made due to tight power supply in the service area of Tokyo Electric Power Company, by way of discharging power for approximately six hours.
  - ✓ March 2022: Tight power supply due to the suspension of thermal power stations caused by an earthquake & a rise in demand for heaters following a decline in temperature
  - ✓ June 2022: Rise in demand for coolers

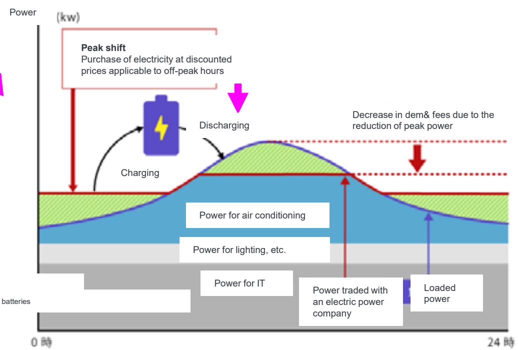
Storage battery power pack made by Tesla

Category	Adopted specs
AC power	Three-phase 400V
Output/ Capacity	436kW/696kWh (Initially)

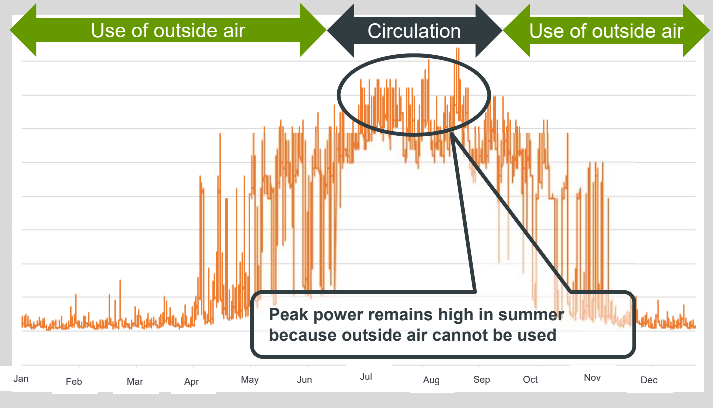
Conceptual image of system configuration



Conceptual image of a peak cut

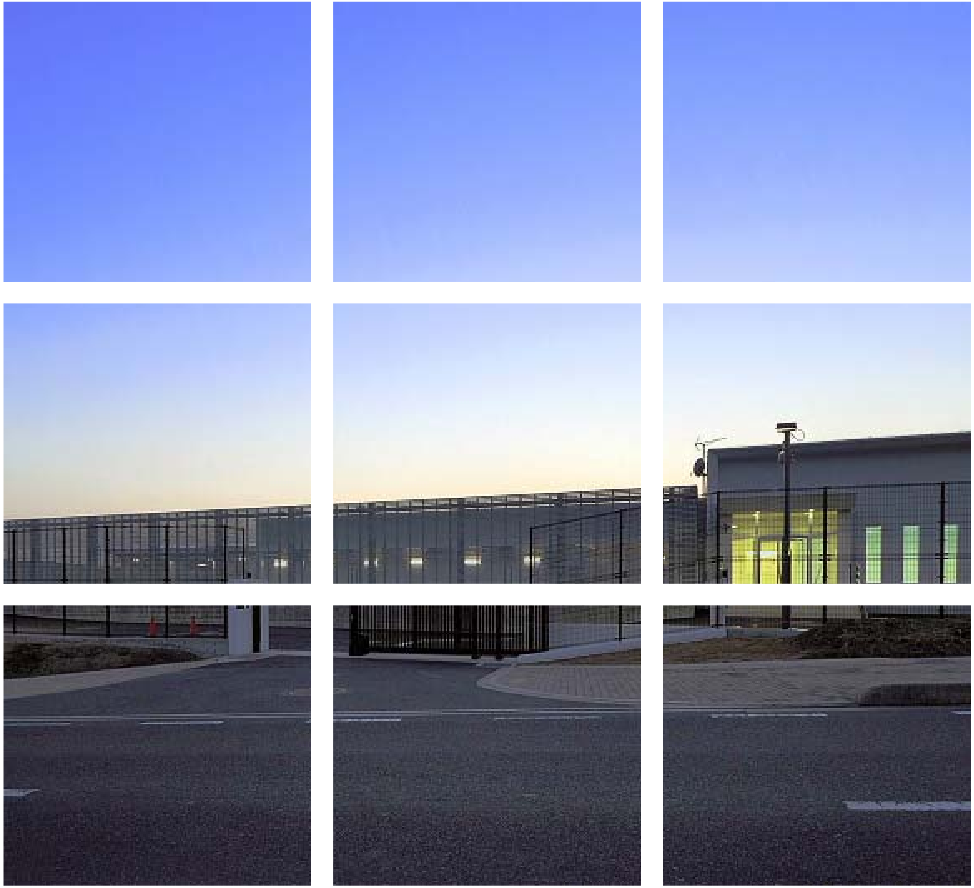


Changes in the power consumption of air-conditioning facilities over one-year period at the Shiroi DCC



Reference: The result of validation of power energy control conducted at the Shiroi Data Center (December 17, 2020)
https://www.iij.ad.jp/news/pressrelease/2020/1217.html

Initiatives toward Carbon neutral



IIJ’s initiatives toward carbon neutral: Information Disclosure based on the TCFD (※1) Recommendation

Policy for Greenhouse Gas Reduction Initiatives at IIJ's Own Data Centers

IIJ Group contributes to the reduction of greenhouse gas emissions in society as a whole by improving the efficiency of social activities through the provision of network related services and by sharing computer resources through the provision of cloud services. However, the use of electricity is essential for delivering these services.

IIJ recognizes the importance of reducing greenhouse gas emissions at its own data centers, which account for more than 70% of greenhouse gas emissions (Scope 1 and 2 (*2)), by "usage of renewable energy (*3)" and "improvement of energy conservation". IIJ has set targets for each of these initiatives.

Measures	Targets
Usage of renewable energy	The target is to increase the renewable energy usage rate of data centers (Scope 1 and 2) to 85% in FY2030.
Improvement of energy conservation	The target is to keep the PUE(*4) of the data center at or below the industry's highest level(*5) until FY2030 through continuous technological innovation.

(*1) TCFD：Task Force on Climate-related Financial Disclosures

(*2) Scope 1 and 2 (Greenhouse gas emissions by a company): Direct emissions from the use of fuels and industrial processes at the company and indirect emissions from the use of electricity and heat purchased by the company (as defined by the GHG Protocol)

(*3) Renewable energy: Including substantial renewable energy through the use of non-fossil fuel certificates

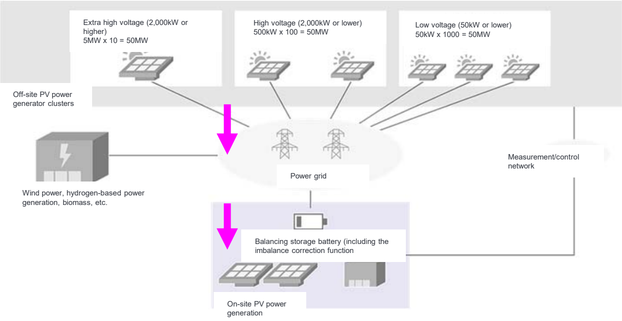
(*4) PUE（Power Usage Effectiveness）：Total data center facility energy usage divided by IT equipment energy usage

(*5) Industry's Highest Level PUE : PUE 1.4 or lower (As of April 2022, the Agency for Natural Resources and Energy has set a benchmark index and target level of PUE as 1.4 or lower in the data center sector, and operators that achieve this are considered excellent energy conservation operators.)

https://www.iij.ad.jp/en/ir/integrated-report/tcfd/

IIJ’s view of carbon neutral data centers

IIJ will create a carbon neutral data center reference model & implement it in its own data centers.

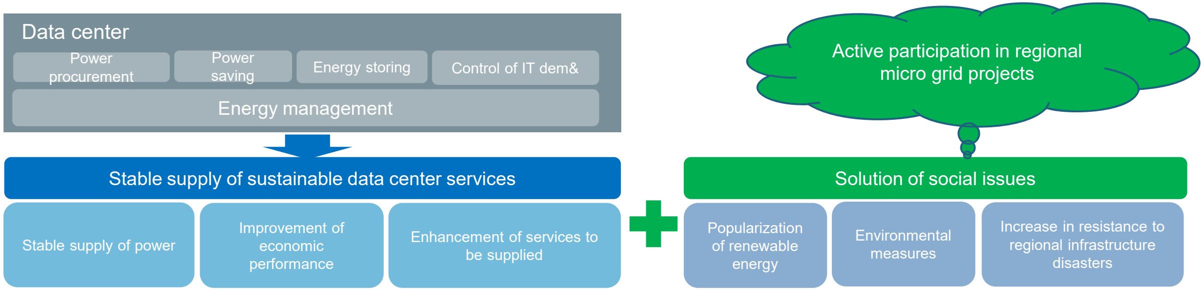


Initiative	No.	Outline
Improvement of energy efficiency (Promotion of energy-saving)	1	Reduce the absolute amount of power consumption chiefly through the adoption of outside air-cooling systems & three-phase, four-wire UPS systems, thereby reducing power consumption in air conditioning by a wide margin & facilitating the improvement of energy efficiency, respectively.
Use of renewable energy	2	Rework building rooftop structures to make sure that large spaces are secured for the installation of on-site PV power generation systems without installing any facilities on the building rooftops.
	3	Procure a package of power comprising specially high voltage, high voltage & low voltage generated by off-site PV power generation systems on a short-term basis, while also considering the procurement of power generated with the use of other types of energy such as wind & hydrogen on a medium- to long-term basis.
	4	Store power for use during the night-time, for example, if power supplied during the day-time exceeds power consumed.
	5	Put the amount of power generated on par & in sync with the amount of power consumed by leveraging power generation facilities, measurement/control networks covering data centers, & EMS
	6	Shifting power load to hours during which surplus power is generated by controlling IT loads, thereby saving storage battery capacity.

IIJ will convert a “static” power supply system in which power is unintelligently consumed except in case of emergency into a “dynamic” power supply system in which power is consumed efficiently at all times in daily operations, & by implementing such a system, will seek to create a new data center reference model.

Main features of a dynamic power supply system model

- Being VPP/DR ready
- Power storage center that collaborates interactively with electric power systems
- Operation at optimal rates through the composite use of power generated by different types of energy including renewable energy
- Interchange of power between users
- Automatic transactions through the application of the Blockchain technology



Indicators of energy-saving initiatives at data centers

Indicator of the effectiveness of power used at data centers = PUE (Power Usage Effectiveness)

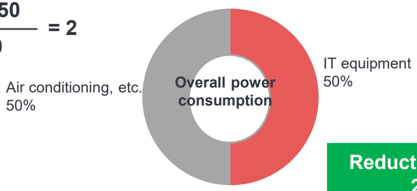
$$PUE = \frac{\text{Amount of power consumed due to air conditioning} + \text{Power consumption of IT equipment}}{\text{Amount of power consumed by IT equipment}}$$

Energy-saving not only contributes to the creation of a low-carbon society but directly leads to in running cost reductions

*Base on the assumption of a DC with 500 racks (4kW per rack), or the same sale of operation as the Matsue DCP.
The unit price of electricity was preliminarily calculated at the rate of 15 yen/kwh. (The unit price of electricity is based on the TEPCO's tariff for specially high voltages.)

Traditional-type DC*

$$PUE = \frac{50+50}{50} = 2$$

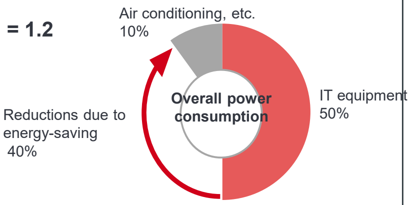


Estimated electricity for one year: 525,600,000 yen

Reduction by approximately 200 million yen

Energy saving-type DC*

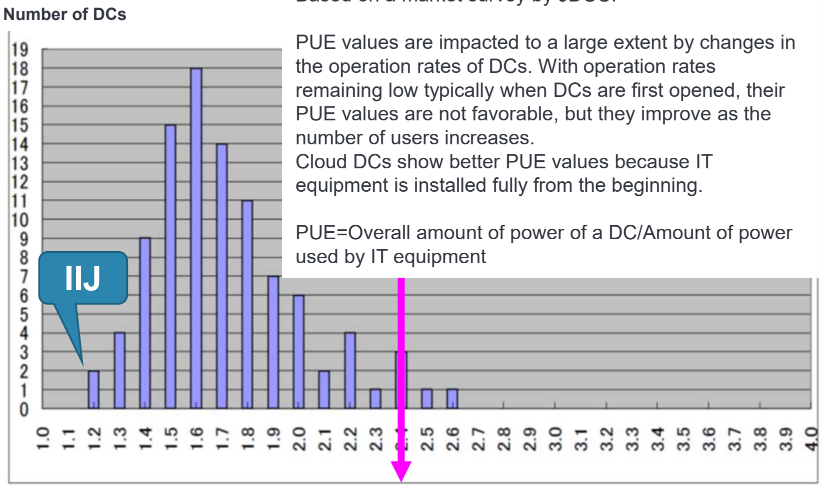
$$PUE = \frac{10+50}{50} = 1.2$$



Estimated electricity for one year:315,360,000 yen

Actual PUE values recorded by the Shiroi DCC & the Matsue DCP

- The average PUE is approximately 1.7 in Japan.
- The Matsue DCP has been operated stably since FY2017 with the PUE standing at around 1.2, or the most favorable level in Japan.
- The PUE of the Shiroi DCC is expected to improve to a 1.3 level in FY2022 due to a higher operating rate.

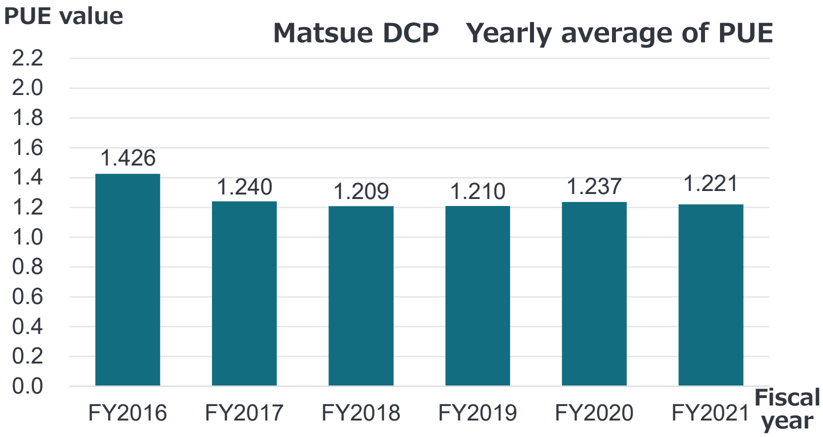


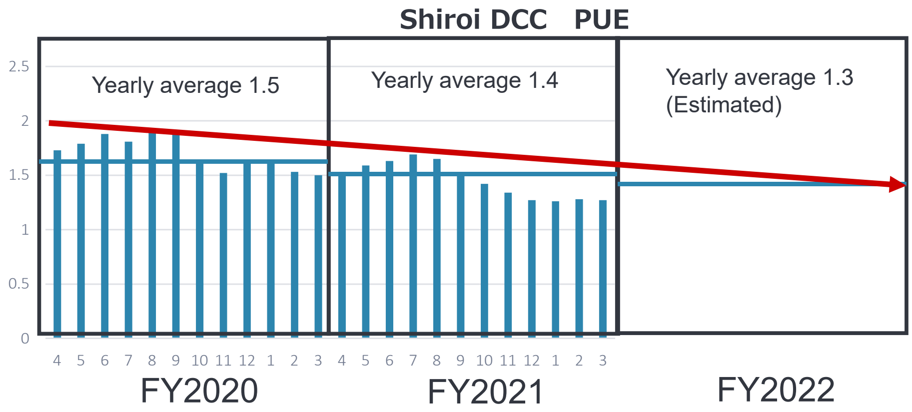
Based on a market survey by JDCC.

PUE values are impacted to a large extent by changes in the operation rates of DCs. With operation rates remaining low typically when DCs are first opened, their PUE values are not favorable, but they improve as the number of users increases.
Cloud DCs show better PUE values because IT equipment is installed fully from the beginning.

PUE=Overall amount of power of a DC/Amount of power used by IT equipment

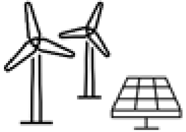
N vale: 98, Max: 2.6, Min: 1.2, Mean: 1.7

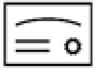




Roadmap for carbon neutrality

Step 1. Raise the ratio of renewable energy as soon as possible by purchasing renewable energy-based power & green power certificates.





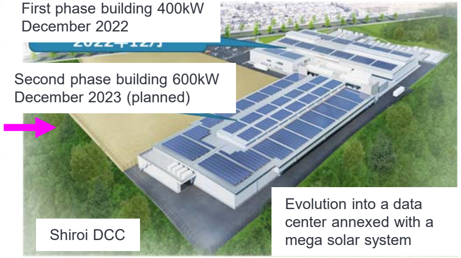
Contracts on tariffs for renewable energy-based electricity

Matsue
Achieved 100% in the ratio of renewable energy in April 2022

Shiroi
Working on necessary measures

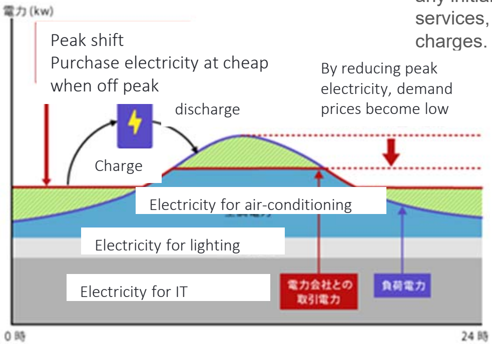
Step 2. Increase the ratio of renewable energy-based power to take advantage of its high-level additionality.

Step 2-a. Install highly cost-effective on-site private power generation systems in the Shiroi DCC & the Matsue DCP



Use of lithium-ion storage batteries

Istalled at the first phase building. IIJ will increase the capacities of batteries installed in the second phase building for inclusion in VPP with an eye on entering the capacity market.



Step 2-b. Facilitation of procurement through off-site PPA*2 (including self-consignment) (Efforts are being made at the Matsue DCP & the Shiroi DCC for early implementation.)

***1. Green Power Certificate**
A certificate used in the system/market in which the non-fossil value of electricity generated by non-fossil fuels (non-fossil power sources) is traded in the form of a certificate. The certificate may be used for environmental reports to RE100 & other organizations related to global warming.

***2. PPA (Power Purchase Agreement)**
A power trading agreement concluded between a power user (consumer) & a power operator that sells electricity to the customer (PPA operator). The customer provides the PPA operator with a space such as a site &/or a rooftop, while the PPA operator installs solar panels &/or other equipment at no charge & undertakes the operation & maintenance thereof. The PPA operator inspects a meter with respect to the amount of power generated from such sources & privately consumed, while the customer pays electricity fees thereof. The system provides a number of advantages such as the customer not required to pay any initial expenses, provide maintenance services, or pay renewable energy-related charges.

Roadmap for the utilization of storage batteries: Use in micro grids after going through the process of carbon neutrality

-2023

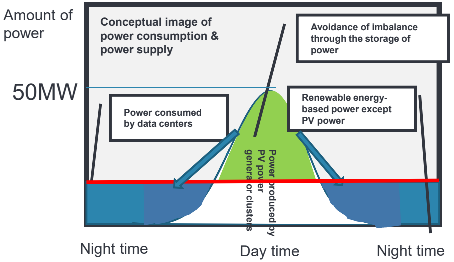
Peak cut
Peak shift

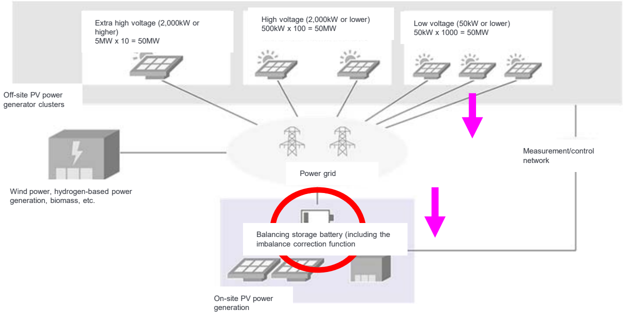
Balancing supply & demand when a request for power saving is issued

Participation in the capacity market

2023-

Carbon neutrality
Storing power produced at off-site renewable energy-based power generation facilities





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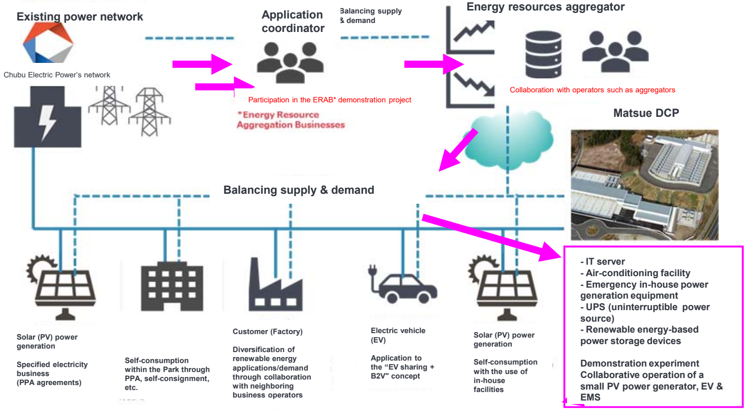
Data centers & micro grids as digital infrastructure



What is a micro grid?

A micro grid, which was put forward by the Consortium of Electric Reliability Solutions (CERTS) of the United States in 1999, is defined as follows.

① An aggregation of more than one decentralized small power sources, power storage devices & power loads that collectively work as a network.
② The aggregation may be not only operated independently of the system but also linked to the system or other micro grids appropriately
③ It is designed, installed & controlled according to customer needs.

In Japan, it is generally defined as a system in which power is generated by renewable energy-based power generation facilities & consumed in a controlled manner with the use of storage batteries, among other devices, in a limited area, namely, a system that realizes the local production & consumption of power.

Conceptual image of future data centers

Evolution from the concept of individually established facilities to the concept of a virtuality-oriented system connected through the internet.

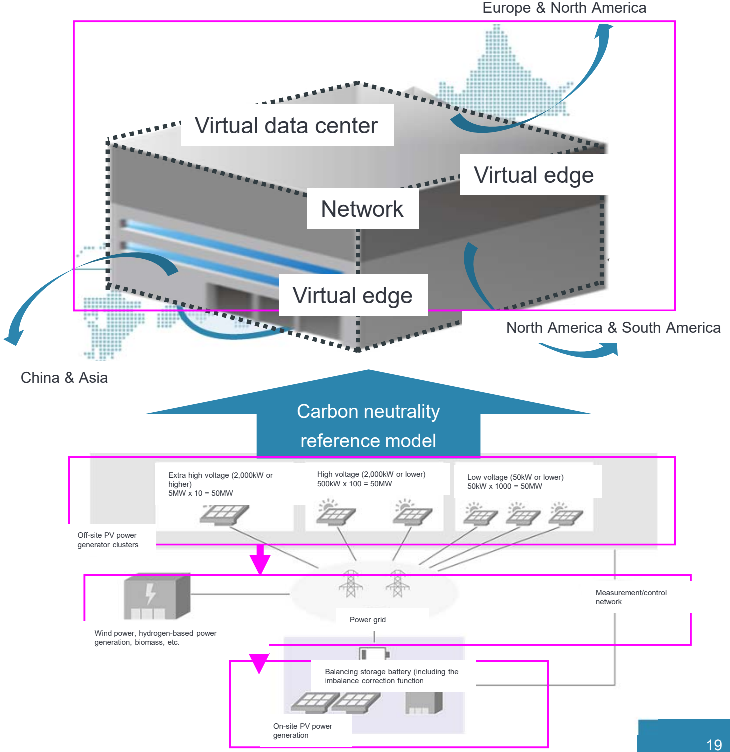
While keeping an eye on a rapid progress in energy saving/green-oriented efforts for the carbon neutralization of data centers, IIJ will also strive to promote relevant engineering businesses (supply of infrastructure technologies on an OEM basis, namely, becoming an enabler) by leveraging knowledge that it has accumulated so far. By doing so, it will simultaneously work on the development of technologies to ensure that it continues to take the lead in new areas.

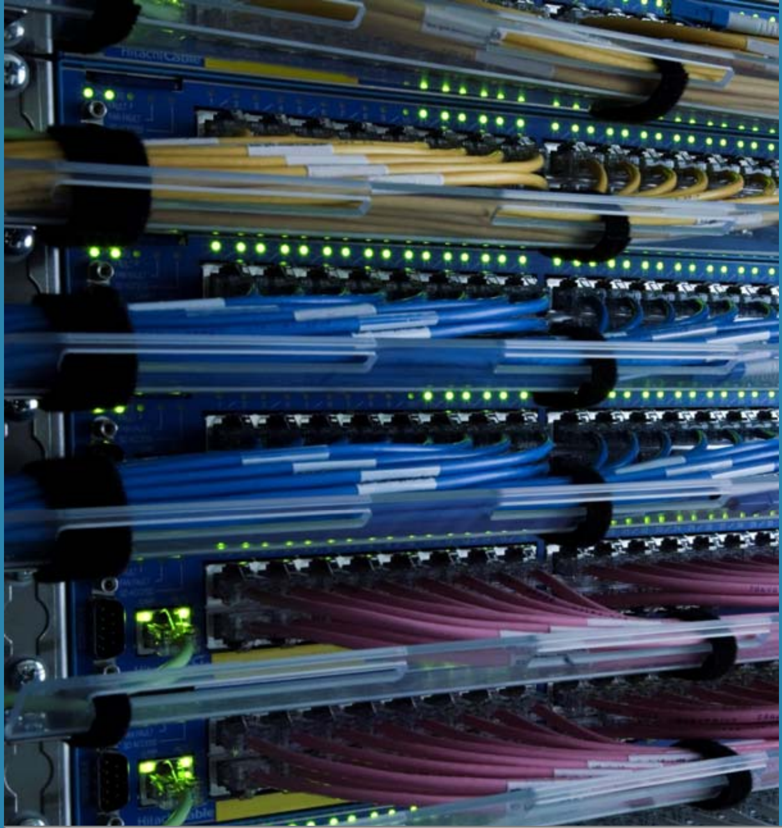
- Infrastructure in which IIJ's infrastructure technologies can be provided to other operators on an OEM basis
  → As an enabler that supports service providers behind the scenes
- Active participation in projects related to micro grids & digital grids
  → Another advanced utilization of DC facilities from the perspective of DER
- Transactions of power with the use of digital currency platforms
  → Pursuit for first-mover advantages by setting a precedent
- Measures to deal with the dem& response concept through a tie-up with VPP aggregators
  → Efforts for reductions in electricity rates (cost)

IIJ has decided that it should set a concreate example in terms of the implementation of physical infrastructure that underpins the non-continuous expansion of businesses by starting to enhance IT-related equipment such as servers & storage devices, as well as facilities.

To develop a conceptual image of such infrastructure, IIJ has visualized a **Hyper Scale Digital Complex as indicated on the right**, which will be incorporated in its business strategies going forward.

"Hyper Scale Digital Complex platform initiative"





Thank you for listening!

Disclaimer

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