Policy Recommendation Report

Watt–Bit Integration: AI-optimized infrastructure for national prosperity

Decarbonization and regional revitalization enabled by geographically distributed data centers



December 2025

Mitsubishi Research Institute

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1. INTRODUCTION: THE NECESSITY AND CURRENT STATUS OF WATT–BIT INTEGRATION

Watt–bit integration is attracting attention due to the rapid increase in demand for generative AI and data centers

Due to the spread of generative AI, demand for data centers (DCs) is rapidly increasing. Cloud service providers, including hyperscalers[1], telecom carriers, and DC operators around the world, are successively announcing large-scale investment plans.

The problem arising from this rapid increase in DC demand is how to respond to growing electricity demand. The issue is particularly apparent in the Tokyo area, where large-scale DCs are concentrated. According to TEPCO Power Grid[2], applications for DC grid connections have surged since 2020, resulting in a substantial wait for connection. If this situation continues, there is a risk that Japan will fall behind in the use of generative AI and its digital transformation. This could even lead to a decline in the competitiveness of Japanese companies.

Watt–bit integration is gaining attention against this backdrop. Here, *watt* refers to power infrastructure, and *bit* refers to information and communications infrastructure, such as data centers and networks. By linking these two, the aim is to simultaneously address the rapidly increasing demand for data centers and the constraints on power supply. To achieve this, the Ministry of Internal Affairs and Communications and the Ministry of Economy, Trade and Industry established the Public–Private Advisory Council on Watt–Bit Collaboration in March 2025. The council involves stakeholders such as power companies, telecommunications operators, and data center operators. It published its first report[3] in June 2025.

Watt–bit integration is not straightforward

Integrating the watt and bit sides is no easy task. In addition to the unique challenges of both, there are also challenges that arise specifically when it comes to integrating the two (Figure 1–1).

The first integration-specific challenge is the "geographical and temporal imbalances of supply and demand". For example, focusing on renewable energy as a decarbonized power source[4], the Hokkaido and Kyushu regions demonstrate high renewable potential, yet most data centers are concentrated near areas of large demand such as Tokyo and Osaka. Also, while the output of renewables fluctuates due to natural conditions such as weather, DCs require a stable supply for their non-stop operation; the result is a temporal mismatch.

The second point is the "differences in investment lead time". For example, offshore wind power generation requires about ten years before operations can begin, and investments in the power

[1] Refers to major cloud service providers such as AWS (Amazon) and Microsoft

[2] Ministry of Internal Affairs and Communications and Ministry of Economy, Trade and Industry, "1st Public–Private Advisory Council on Watt–Bit Collaboration, Document 1–3"

[3] Ministry of Internal Affairs and Communications and Ministry of Economy, Trade and Industry (2025) *Report 1.0 of the Public-Private Advisory Council on Watt-Bit Collaboration*

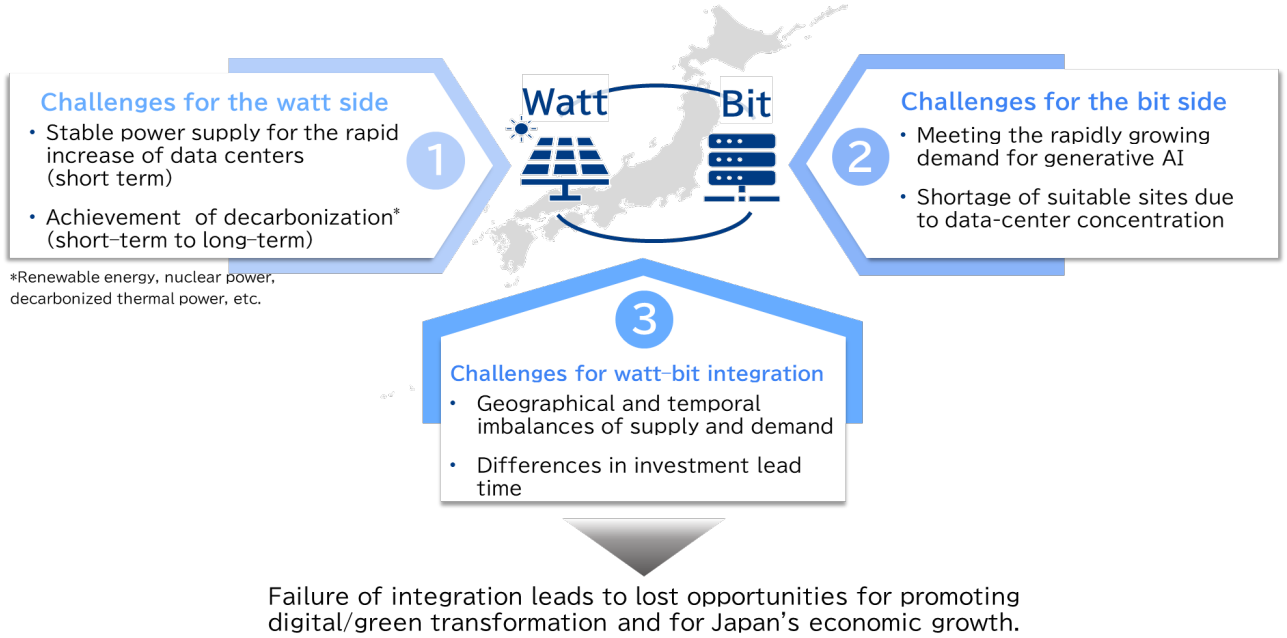
[4] Refers to energy sources such as energy conservation, nuclear power, and decarbonized thermal power. To realize a decarbonized society in Japan, it is important to make the most effective use of each decarbonized power source based on its characteristics

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grid also take time. On the other hand, data centers can become operational in a few years, and some containerized data centers can be up and running in just a few months.

Domestic DC supply could be disrupted if we fumble on the integration of the watt and bit sides. This could not only lead to delays in digital transformation but also result in domestic demand shifting to DCs overseas. Furthermore, it could ignite greater use of thermal power generation to meet the growing electricity demand of DCs, which could lead to increased imports of fossil fuels and delays in green transformation initiatives. In other words, the integration between the watt and bit sides is not merely an infrastructure issue, but one that can affect Japan's competitiveness.

Figure 1–1 Challenges for watt–bit integration



Source: Mitsubishi Research Institute, Inc.

Similar discussions are underway overseas as well

Similar concerns overseas have led to initiatives similar to watt–bit integration. The International Energy Agency (IEA) predicts that the global power demand of data centers will increase to about 945 TWh by 2030, which is roughly equivalent to Japan's current annual electricity consumption[5]. In particular, demand is expected to expand in the United States and China.

In the United States, Electric Power Research Institute (EPRI) launched its DCFlex Initiative in October 2024 and has been conducting studies aligned with watt–bit integration. This initiative involves power utilities and data center operators, including hyperscalers, who are examining data-center operations and power-grid integration, with consideration also being given to collaboration with Europe and other regions.

Similarly, in China, the government-led "Eastern Data, Western Computing" project has been underway since 2022. In the project China promotes a division of roles between its regions: In western China, where renewable energy is abundant, data processing that does not require real-time responsiveness is carried out intensively, while data that requires real-time processing, such as in finance, is handled in eastern China, where demand

[5] IEA (2025) "Energy and AI"

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is high.

Japan needs a watt–bit integration roadmap

Considering these international developments, Japan too must draw up a long-term roadmap for watt–bit integration. We, Mitsubishi Research Institute, Inc. believe that it is necessary to promote *watt–bit 3.0*, which considers ripple effects on the regional economy, from a medium- to long-term perspective (Figure 1–2).

First, in the short- to medium-term, which spans through the early 2030s, securing computing resources should be the top priority to ensure that the country's use of generative AI does not lag. To achieve this, it will be necessary to guide the siting of facilities through the welcome zones[6] published by general power transmission and distribution companies, designate large-scale data center clusters outside of Tokyo and Osaka, and develop the power and communication infrastructure to support them. *Watt–bit 1.0* comprises such optimization of infrastructure placement.

Watt–bit 2.0 represents the stage of optimizing the operation of the developed infrastructure to achieve both efficient utilization of decarbonized power sources, such as renewable energy, and digital transformation (Chapter 2).

For *watt–bit 3.0*, the aim is to make effective use of locally sited data centers, promote local production and consumption of data and energy, and return the added value generated by digitalization and digital technologies to the local community.

The integration of the watt and bit aspects should not be limited to mere infrastructure optimization. The true goal is to utilize it as infrastructure that contributes to resolving the societal issues Japan will face in the future. Japan's population will continue to decline, and the number of elderly people will increase. In such circumstances, the use of digital technologies like AI and robotics will be inevitable to maintain Japan's economy, regional industries, and societal infrastructure. To prepare for a future that will surely come, it is necessary to consider watt–bit integration from a medium- to long-term perspective, or a timespan through 2040.

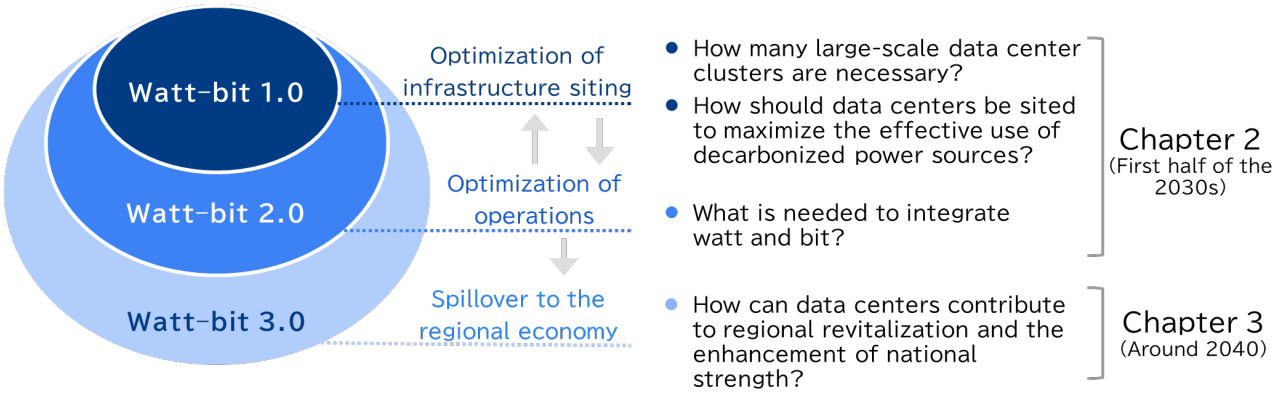
This is how we envision watt–bit 3.0[7]. In a watt–bit 3.0 world, it will be important to make effective use of locally sited data centers (DCs), promote local production and consumption of data and energy, and at the same time, return the value generated from data utilization to the community to foster growth. Whether DCs, which have so far been concentrated in Tokyo and Osaka, can truly be deployed and utilized in local areas, and how this can lead to growth, will be discussed in detail in Chapter 3.

[6] Welcome zones: Areas designated by general power transmission and distribution companies where connection to the power grid is relatively easy and that are intended for supplying large-scale energy demand

[7] Watt–bit 3.0 refers to a series of initiatives including optimization of infrastructure deployment, optimization of operations, and ripple effects on the regional economy (Watt–bit 3.0 in the broad sense). In this article, it refers to initiatives that contribute to regional revitalization and may also be called Watt–bit 3.0 in the narrow sense

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Figure 1–2 Watt–bit 3.0: Concepts and key hurdles for realization

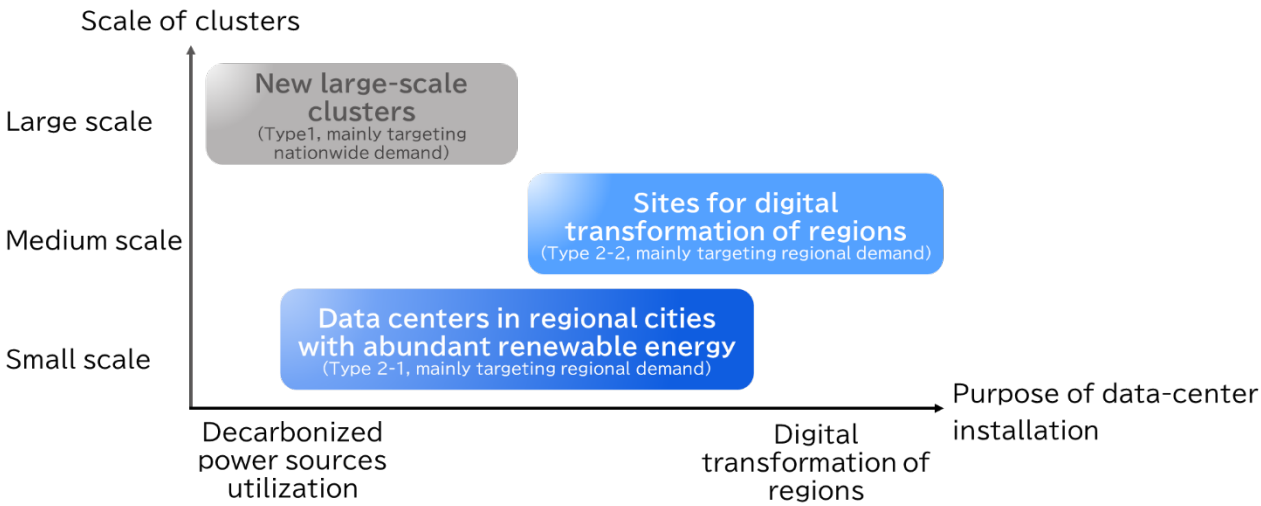


Source: Mitsubishi Research Institute, Inc.

In our proposals on watt–bit integration, we assume two types of data centers: *type 1* data centers are mainly aimed at securing computing demand for Japan as a whole, while *type 2* data centers are mainly aimed at meeting regional demand. In proposing new large-scale clusters of type 1, we aim to both secure computing resources for all of Japan and utilize decarbonized power sources (Figure 1–3).

Type 2 can be further classified into two categories. *Type 2-1* data centers are those located in regional cities with abundant renewable energy. With type 2-1, data centers could be established in cities rich renewables and located near the large-scale clusters of type 1. The complementary roles of type 1 and type 2-1 will help to progress the effective use of decarbonized power sources (Chapter 2). The main purpose of *type 2-2*, or sites for digital transformation of regions, is to stimulate regional demand through the digital transformation of the area (Chapter 3).

Figure 1–3 Classification of data centers envisioned for watt–bit 3.0



Source: Mitsubishi Research Institute, Inc.

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2. ADAPTING TO THE AI ERA THROUGH DISTRIBUTED SITING OF DATA CENTERS

This chapter focuses on the areas of infrastructure optimization (watt–bit 1.0) and operational optimization (watt–bit 2.0) within watt–bit integration. Through various quantitative analyses, we present a concrete picture of watt–bit integration from the perspective of infrastructure optimization. We then propose the technological developments and system design required to optimize the operation of geographically-distributed data centers.

2.1. Watt-bit 1.0: Distribution of clusters

Quantitative evaluation from watt and bit perspectives for optimal siting

With the spread of generative AI, the demand for data centers (DCs) are rapidly increasing, making it important to secure stable and sufficient computing resources to meet this demand. To resolve short-term shortages in resources, it is necessary to promote the construction of DCs in areas near Tokyo and Osaka where the power grid has relatively more capacity. For medium-term demand growth, it is necessary to both expand the current DC clusters in the Tokyo and Osaka regions and to consider establishing new large-scale clusters while promoting distributed cluster siting.

In considering the optimal solution for the distribution of clusters, evaluations must examine the situation from both the perspective of power (watt) and ICT infrastructure (bit) (Figure 2–1).

On the watt side, if the increasing demand for DC power remains concentrated in Tokyo and Osaka, it will be difficult to fully harness the potential of renewable energy, and decarbonization investment might stall. Rather, by concentrating on DC facilities near decarbonized power sources, it becomes possible for power utilities to improve the recoverability of their investments.

On the bit side, it is essential to ensure the economic rationality of DCs at a certain level. This is possible through proper siting and the digital transformation of local industries. Through these, DC businesses can be set up in a sustainable manner, even in regional areas. Furthermore, low latency, one of the factors for the concentration of DCs in Tokyo and Osaka, will require collaboration with telecommunications operators and selection of use cases so that regional DCs are not disadvantaged.

The integration of watt and bit aspects affects a wide range of stakeholders: power operators, the telecommunications sector, data-center operators, businesses, individuals, the national government, and local governments. The effects of data center distribution from an economic and social perspective, including these diverse stakeholders, will be examined in detail in Chapter 3.

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Figure 2−1 Perspectives on watt−bit integration evaluation and related stakeholders

Evaluation dimension	Evaluation criteria
Watt side perspective	(a) Decarbonization investment Whether power utilities can ensure profitability, and who will bear the cost of power infrastructure investment
	(b) Fluctuations in the supply and demand of power Whether it can be flexibly adjusted in response to fluctuations in power supply and demand
Bit side perspective	(c) Economic rationality of data centers Whether there is sufficient data demand for data center operators to ensure profitability
	(d) Operational feasibility Whether sufficient power supply, human resources, network connectivity, and resilience (etc.) can be secured
	(e) Low latency Whether it can meet the low latency requirements of applications (such as autonomous driving)
Economic and social perspective	(f) Economic security and industrial competitiveness Whether it can contribute to improving the balance of payments related to energy and digital sector and to strengthen industrial competitiveness
	(g) Regional economy Whether developing a conductive environment for use of digital technologies will lead to revitalization of the regional economy

×

Stakeholder

- Electric power company
- Telecommunications carrier
- Data center operator
- User (corporate/individual)
- National and local government
- ⋮

Source: Mitsubishi Research Institute, Inc.

Geographic distribution of DC cluster scenarios

There are two kinds of distributed DC-cluster siting. The first is the distribution of clusters on the regional level (Figure 2-2, left diagram). In other words, distributing large-scale clusters to areas other than Tokyo and Osaka. Specifically, the current discourse, as indicated in expert meetings[8], looks to Hokkaido and Kyushu for distributing DCs.

The second kind is distribution within clusters (Figure 2−2, right diagram). For example, if a large-scale cluster is formed in Hokkaido, this means siting DCs not only in Central Hokkaido but also in Northern, Eastern, and Southern Hokkaido. This intra-regional distribution is progressing in the Kanto region, which includes Tokyo, as more DCs are being located in Northern Kanto, such as Tochigi Prefecture, where the power grid has relatively high capacity. This contrasts the typical siting of clusters, specifically satellite DCs, in Tokyo, Chiba, and Kanagawa prefectures.

The decision on where to locate DC clusters depends on factors such as effective utilization of decarbonized power sources, securing computing resources, and meeting low-latency communication requirements. We have quantitatively evaluated the optimal distribution of clusters from both the watt and bit perspectives, including how many clusters should be established nationwide and in which regions[9].

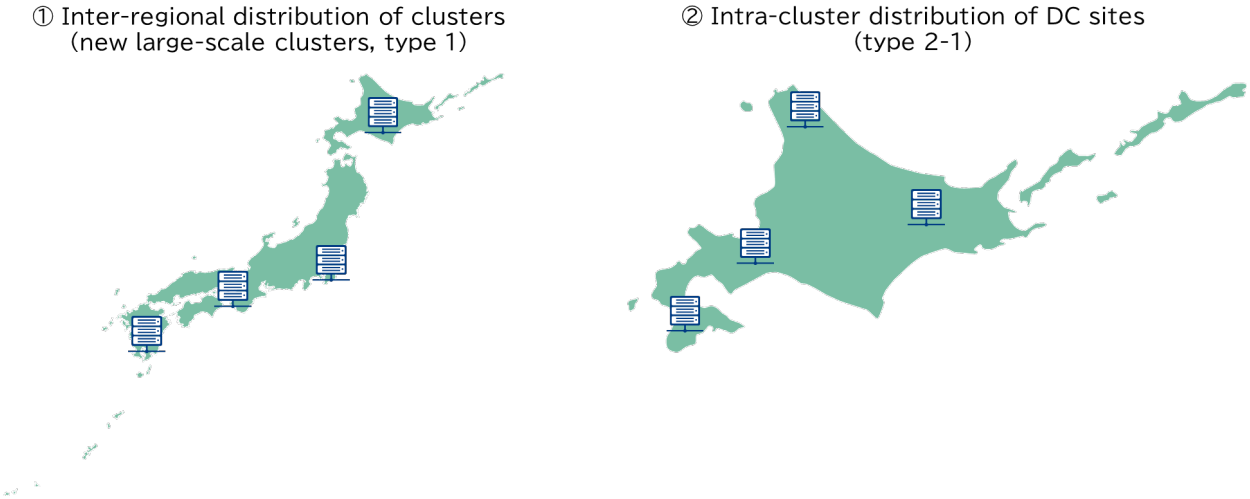
We considered optimization from both perspectives, but it must be noted that we have not taken into consideration the benefits of regional revitalization, such as increased local data demand and progress in industrial digital transformation due to the establishment of data centers. Optimization that also takes into consideration the benefits of regional revitalization is discussed in Chapter 3.

[8] Ministry of Economy, Trade and Industry and Ministry of Internal Affairs and Communications, “Expert Group on the Development of Digital Infrastructures (DCs, etc.): Interim Report 3.0”

[9] In this analysis, due to model constraints, distribution is mainly assumed at the level of electric power company jurisdictions and prefectures

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Figure 2–2　Example of inter-regional distribution of clusters (new large-scale clusters, type 1) and intra-cluster distribution of DC sites (type 2-1)



Note: This figure is for illustrative purposes only and does not indicate the specific data-center locations

Source: Mitsubishi Research Institute, Inc.

2.1.1.Optimal distribution of clusters from the watt perspective

Distributing DC clusters to maximize use of low-carbon power and improve investment certainty

To achieve carbon neutrality by 2050, it is necessary to expand decarbonized power sources. The Seventh Strategic Energy Plan targets a 2040 power-generation mix in which renewables account for about 40–50%. To realize this, it is necessary to enhance the investment predictability for watt-side operators and to promote the effective use of renewables. Watt–bit will be a key factor. Demand for DC is expected to increase in the future, and if the government presents policies for developing DC clusters in regions with high renewable potential, it will improve investment predictability for power-sector operators and contribute to the expansion of decarbonized power sources. In addition, AI training—compared with inference[10]—demonstrates greater flexibility in shifting the location and timing of computational demand. By adjusting where and when training is conducted to match fluctuations in renewable output, it is possible to avoid or mitigate

[10] The training of generative AI refers to creating foundation models or improving models based on foundation models (i.e., fine–tuning). Inference refers to obtaining answers and other outputs from generative AI services such as ChatGPT

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power curtailment[11].

Methods for estimating the effect of cluster distribution

We analyzed the effects of DC distribution from two perspectives: the effective utilization of decarbonized power sources, especially renewable energy, and the impact on interregional interconnection lines (transmission networks between areas) and intra-regional grids (transmission networks within each area)[12]. Figure 2–3 outlines our assumptions results.

Figure 2–3 Assumptions for estimating effects of cluster distribution

Item			Assumptions
Evaluation method for scenario analysis			• Evaluate the effects of relocating data center computing demand to regional areas in terms of the monetized value of fossil-fuel costs and CO_2 mitigation costs
Common assumptions (all scenarios)	Electricity demand	Total	• Total electricity demand: approx 1,010TWh/year (on a transmission-end basis) • Data center electricity demand: as defined below • Other electricity demand: aligned with the "technology development scenario" in the Seventh Strategic Energy Plan
		Data center electricity demand	• About 150TWh/year • Assumed based on our data center power demand estimation model
	Power generation mix	Renewable energy	• Assumed the equivalent of the "technology progress scenario" in the 7th Strategic Energy Plan • Regional deployment volumes are apportioned according to each region's share of FIT-approved but non-operational capacity • Offshore wind power is set based on the status of designated areas and the target values of relevant public-private council
		Nuclear power	• Assumed all existing facilities operate for 60 years
	Inter-regional interconnection lines		• Hokkaido-Tohoku-Tokyo route HVDC+2GW, Kyushu-Chugoku route HVDC+1GW, etc. • Assumed based on the OCCTO master plan and the status of consideration of the planning process
	Shiftability of computing demand		• We classify compute demand into "Shiftable demands" and "Non-shiftable demands" based on low-latency and other requirements arising from the characteristics of generative AI's computational processing (the differences between training and inference) and the use cases • "Non-shiftable demands" refer to cases where most of the computation is performed on the device itself (such as autonomous driving) • We define demand with high flexibility in the choice of computing location as "Shiftable demand". These are estimated as workloads subject to shifting through distribution of clusters
Scenario-specific assumptions	Distribution of data centers	①Distribution of clusters at the area/regional level (Target: All areas)	• Base scenario: Assumed that the current concentration in Tokyo and Osaka areas (two clusters) will continue • 4-area distribution: Hokkaido, Kanto, Kansai, and Kyushu (taking into account the status of consideration of Expert Group on the Development of Digital Infrastructures (DCs, etc.)) • 5-areas distribution: Hokkaido, Tohoku, Kanto, Kansai, and Kyushu • 6-areas distribution: Hokkaido, Tohoku, Kanto, Kansai, Chugoku, and Kyushu • 9-areas distribution: regions within 9 electric power jurisdictions • Assumed that a certain level of data center demand will remain in the Tokyo-Osaka areas, and the rest is evenly distributed across areas outside of Tokyo-Osaka
		②Distribution of data center sites within the cluster/area (Target: Hokkaido)	• Only large-scale clusters: Assumes concentration in Central Hokkaido (Ishikari, Sapporo, Tomakomai) • Large-scale clusters + distribution within the area: Considering the current locations and planned construction of data centers, distribution to Northern Hokkaido (Wakkanai, Asahikawa) and Southern Hokkaido (Hakodate) is assumed

Source: Mitsubishi Research Institute, Inc.

[11] In this analysis, estimates assume a shift in a certain scale of computational demand, including training demand. Details on the dynamic shifting of training demand and other factors are described in section 2.2

[12] Examination targeting the Organization for Cross-regional Coordination of Transmission Operators (OCCTO) "Cross-regional Network Long-term Policy (Master Plan for Wide-Area Interconnected Grid)"

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We conducted simulations by integrating our own original models. We used our Data Explosion Model[13] and our Electricity Demand Projection Model[14] to estimate the extent to which the computational demand of data centers can be distributed and how much this changes power consumption. Subsequently, using a power supply–demand simulation model that considers interregional interconnection constraints in nine power areas, we estimated the impact for each DC cluster–distribution scenario. We also estimated the impact for each scenario of data-center distribution within the Hokkaido area by using a power-system model simulating Hokkaido's main grid. Here, we evaluated the effect of distribution with a focus on curtailed power, since an increase in the amount of curtailed power[15] affects the investment predictability of decarbonized power sources.

Inter-regional distribution of clusters across five areas brings societal benefit of 65 billion yen and minimizes renewable power curtailment

We estimated the amount of curtailed power across Japan under different DC cluster–distribution scenarios (Figure 2–4). Distributing DC sites from the Tokyo–Osaka area to other regions can bring about greater uptake of renewables, and by distributing them across five areas, curtailed-power totals can be decreased to 2,800 GWh/year. However, if the clusters are spread across six or more regions, the amount of curtailed power instead begins to increase. Spreading clusters across so many regions limits the total amount of DC demand brought to areas with high renewable-energy potential (e.g. Hokkaido, Tohoku, and Kyushu). Adding three regions rich with renewable potential to the existing Tokyo and Osaka clusters is optimal for the effective utilization of decarbonized power resources.

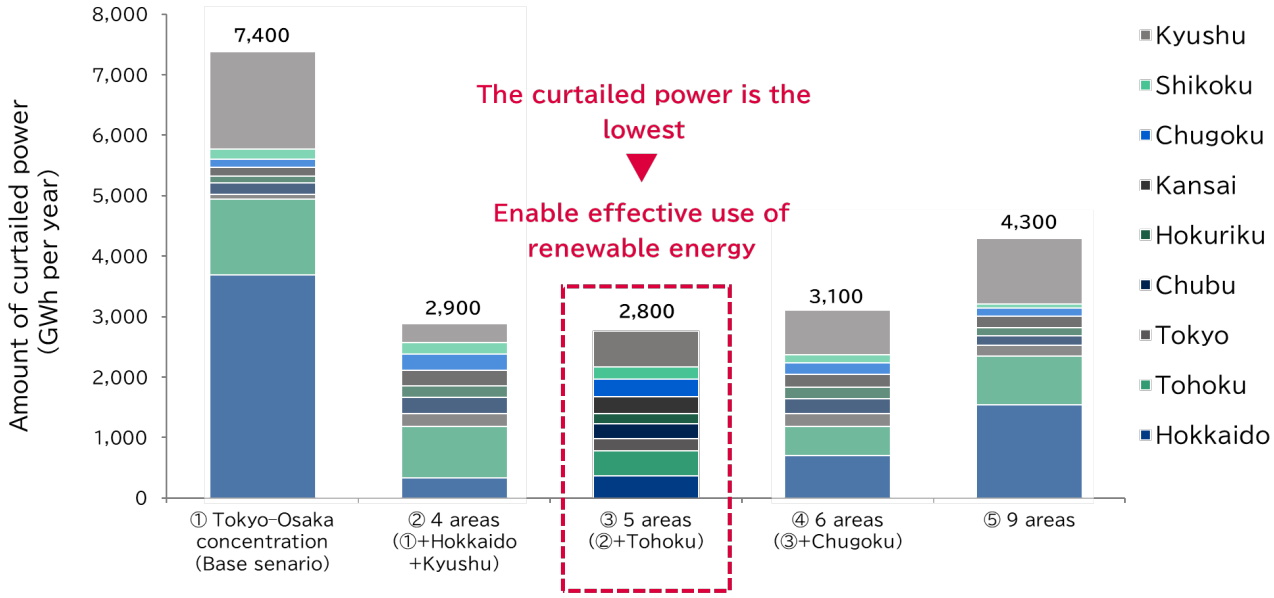
[13] For an overview of the information explosion model, refer to Mitsubishi Research Institute "Beyond 5G 時代の分散型成長を実現する方策を提言—デジタル経済圏の健全な発展に向けて—" (Proposals for Realizing Decentralized Growth in the Beyond 5G Era) Please note that this model has been updated to reflect new technological trends such as generative AI, and traffic assumptions differ between the above proposal and the current estimates
https://www.mri.co.jp/knowledge/insight/policy/20220930.html

[14] For an overview of the Electricity Demand Projection Model, refer to Mitsubishi Research Institute "Impact of Widespread Use of Generative AI on Japan's Electricity Demand"
https://www.mri.co.jp/en/knowledge/insight/20241115.html

[15] Curtailed power: The amount of renewable energy output controlled for power supply–demand adjustment

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Figure 2–4 Amount of curtailed power by distributed-DC siting-scenario



Source: Mitsubishi Research Institute, Inc.

We estimated the fuel and CO_2-reduction costs for each decentralized scenario as compared to a scenario of Tokyo–Osaka concentration (Figure 2–5). Reducing the amount of curtailed power will bring about effective utilization of renewables-derived electricity, which in turn replaces electricity generated by LNG thermal power. This makes it possible to reduce fossil-fuel consumption and CO_2 mitigation costs[16]. Distribution into five areas yields an annual reduction effect of approximately 65 billion yen. Distributing data-center clusters leads to increased revenue for renewable energy–power producers due to reduced renewable energy curtailment, contributing to the promotion of renewable-energy introduction toward achieving carbon neutrality in Japan.

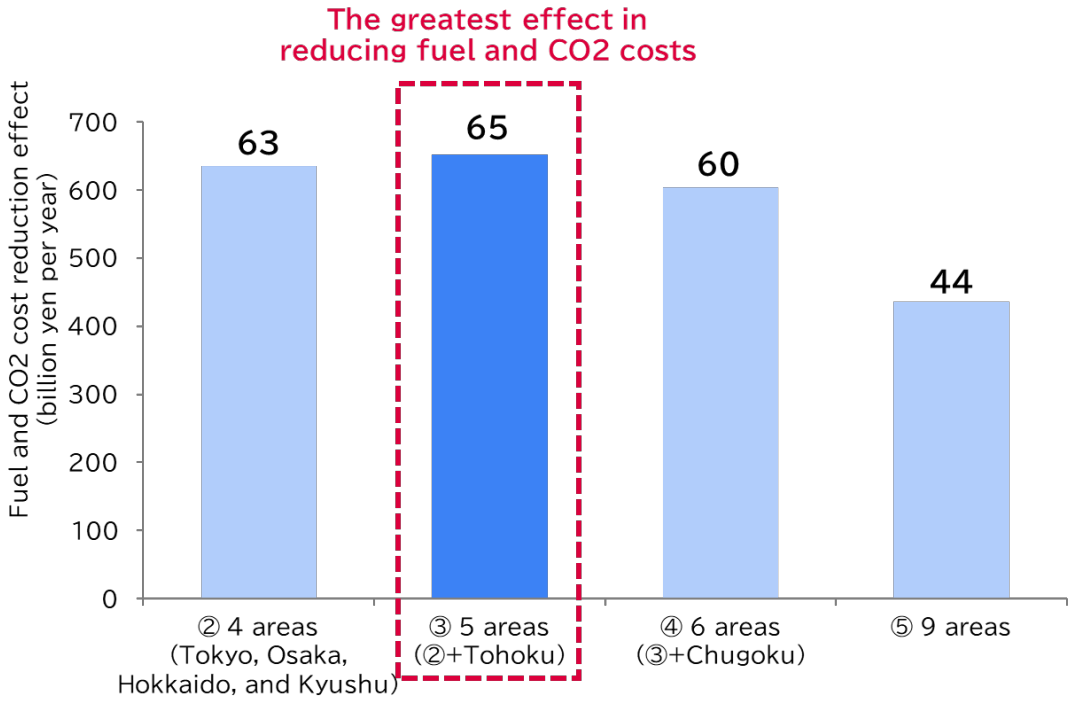
It should be noted that the reduction of renewable-energy curtailment can be achieved through grid reinforcement even if clusters remain concentrated in Tokyo and Osaka, but in that case additional grid reinforcement costs equivalent to the fuel cost and CO_2-reduction effects will be incurred[17]. Therefore, the distribution of clusters can be considered a measure that utilizes local–renewable-energy resources for local consumption and helps to curb grid reinforcement costs.

[16] As the cost of CO_2 countermeasures, 15,000 yen/tCO2 is assumed as the average of the 2040 range in the Power Generation Cost Verification Working Group

[17] As a sensitivity analysis, we assumed an increase in HVDC capacity in the eastern region to the level of the master plan's base scenario (HVDC +6GW between Hokkaido and Tohoku, HVDC +8GW between Tohoku and Tokyo) while maintaining concentration in the Tokyo – Osaka area and analyzed the results. We found that there would be an annual reduction of about 56 billion yen in fuel and CO_2 countermeasure costs, but the annualized cost of HVDC reinforcement based on the master plan's specifications was at the same level as the reduction effect

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Figure 2–5　Effects of reducing fuel and CO_2 costs through distribution of clusters



Note: This is an estimate of the reduction effects on fossil-fuel consumption and CO_2-mitigation costs compared to the case where data centers are concentrated in Tokyo and Osaka

Source: Mitsubishi Research Institute, Inc.

Intra-cluster distribution effects: Enhanced societal benefits

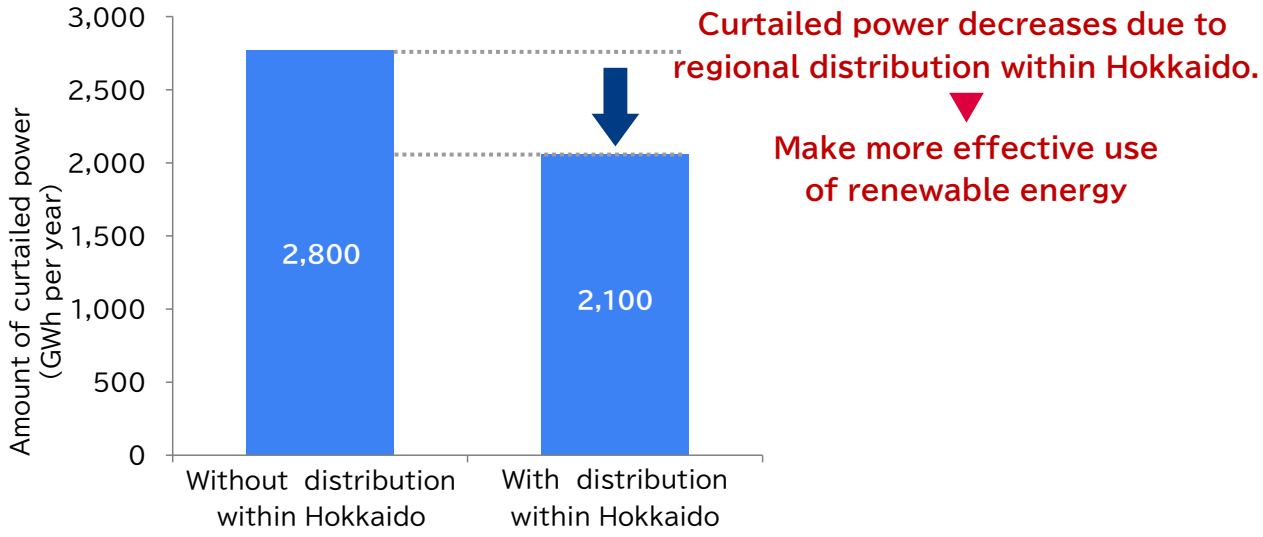
We evaluated the effect of distributing DCs within Hokkaido as an extension of the five-area (i.e. Tokyo, Osaka, Hokkaido, Kyushu, and Tohoku) distribution scenario. We considered grid congestion in the power transmission system and estimated the amount of curtailed power in the Hokkaido area (Figure 2–6). Specifically, we posited cases where DCs are concentrated in central Hokkaido and where they are distributed throughout the region, including in northern and southern Hokkaido.

If DCs are concentrated in central Hokkaido, grid congestion on transmission lines will occur, and renewable energy resources in other parts of Hokkaido will not be fully utilized. On the other hand, if DCs are distributed in areas with a surplus in renewable energy, grid congestion can be avoided, and renewable energy resources can be effectively utilized. As a result, in addition to the reduction effect from distributing the concentration of DCs, a reduction of 700 GWh per year in curtailed power and a reduction of 10 billion yen per year in fuel and CO_2 mitigation costs can be expected.

As the introduction of renewable energy progresses toward achieving carbon neutrality, we will need to strengthen local power grids. However, if DCs are distributed within clusters, the utilization efficiency of renewable energy resources can be improved even with the same grid configuration. Therefore, intra-cluster distribution is paramount as it enables the sustainable expansion of renewables while curbing excessive grid reinforcement.

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Figure 2–6　Effects of distribution of data-center sites within Hokkaido cluster considering grid congestion[18]



Source: Mitsubishi Research Institute, Inc.

[18] In the quantitative evaluation of the distribution of data-center sites, curtailed power due to grid congestion within the site network is not considered, but in the quantitative evaluation of distribution within the cluster, curtailed power due to grid congestion within the site network is considered

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2.1.2.Optimal distribution of clusters from the bit perspective

Explosive growth of data and increasing demand for low latency due to changes in use cases

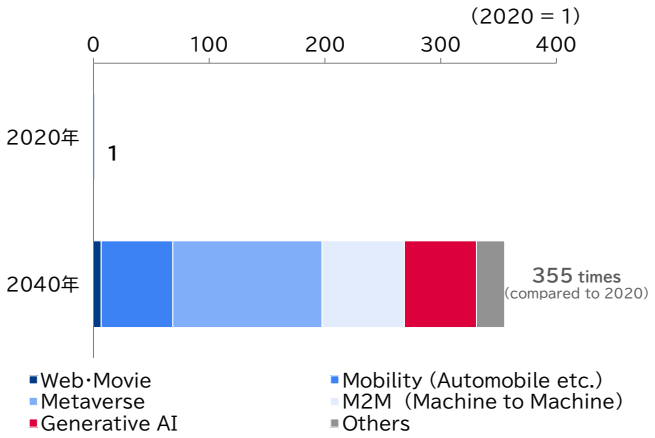
With the widespread adoption of generative AI and robotics in society, it is expected that the volume of data flowing through networks will increase explosively (Figure 2–7). According to estimates using our Data-Explosion Model, communication traffic in 2040 will increase by up to 355-fold compared to 2020. At the same time, the demand for computing in data centers will also surge.

Users will change as well. Currently, much of digital technology is used by people for things like videos, social media, and generative AI, but in the future, data utilization by non-human entities—such as robots and self-driving cars—will increase. This will also include interactions between machines and AI. Furthermore, a larger amount of data will be generated locally as the digital transformation of fields like healthcare, agriculture, and transportation progress.

Along with the explosive increase in data, requirements for communications are also changing. For current mainstream uses such as video streaming, social media, and inference by interactive generative AI, latency of hundreds of milliseconds to a few seconds generally does not cause significant problems. If these use cases remain central, it is reasonable to concentrate processing in data centers in Tokyo and Osaka, considering overseas connectivity. However, ultra-low latency is required for data utilization without human intervention. This might include autonomous vehicles and drones and demand is expected to increase in the future. Even minimal latency could potentially cause accidents in machine-to-machine communications such as between autonomous vehicles. Therefore, we will need ultra-low latency, such as a few milliseconds—a level imperceptible to humans—moving forward.

Such changes in data structures increase the demand for local data processing. The local production and use of data can help regions retain the value of their own locally-generated data. In addition, to achieve ultra-low latency, it is generally preferable to minimize the physical distance between data sources, such as devices, and computing resources, such as GPUs. To meet these needs, the demand for local data centers is expected to increase in the future.

Figure 2–7　Forecast of changes in communication and data traffic



Use of subject	Use of space	Type of data	Latency Requirements
Humans (mainly)	Digital	Public data (video, image, etc.)	Several hundred ms to a few seconds
Diversification (Humans, machines, AI)	Digital and Real	･Internal company data ･Real-time video and images ･Increase in non-public data	･Machines: a few ms ･Humans : less latency means higher experience value

Note: The communication traffic in the left graph is a forecast based on Mitsubishi Research Institute's Information Explosion Model

Source: Mitsubishi Research Institute, Inc.

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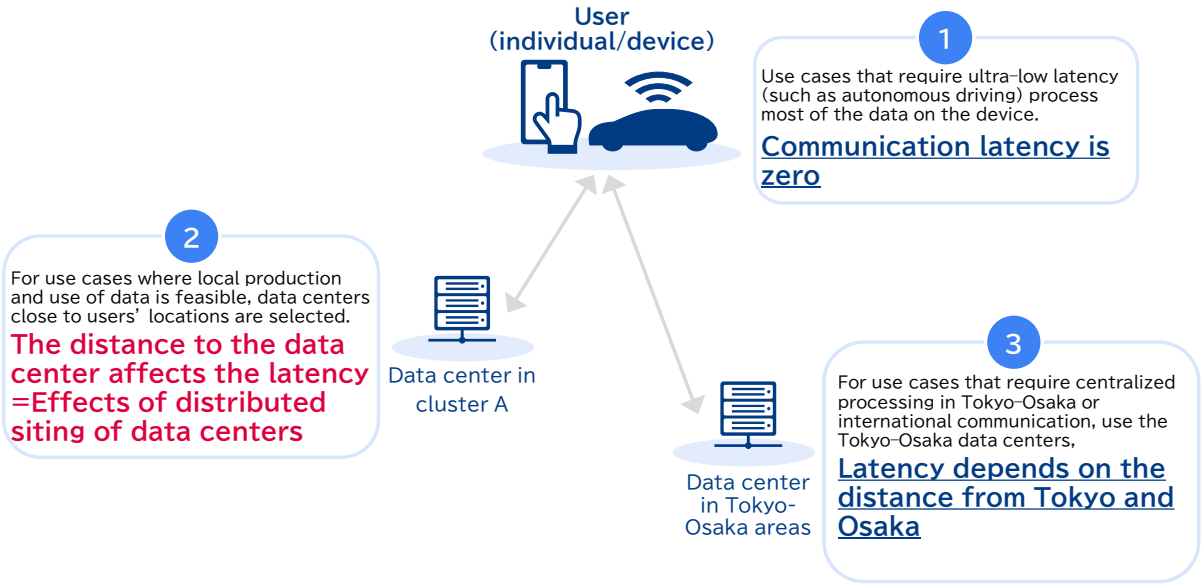
Evaluation of the impact of DC clusters distribution on latency

Based on this background, we evaluated the degree to which the distribution of DC clusters affects communication latency. Just as with the watt side, we took a quantitative approach and used the same cluster-based scenarios.[19] For the watt side, we made assumptions regarding the power companies' nine supply areas, but evaluating latency requirements, we also run analyses on a per-prefecture basis for all 47 prefectures.

We used a specific framework for latency requirements. Here, we assumed client-side processing for most data in our use cases, such as autonomous driving and drones that require ultra-low latency (Figure 2–8, ①). On the other hand, for use cases that do not require ultra-low latency and are suitable for local processing, we assumed that data processing would be carried out at data centers in close proximity to user locations (Figure 2–8, ②)[20]. For example, in cases where data center clusters are formed in Tokyo, Osaka, Hokkaido, and Kyushu, users in Aomori Prefecture would use a Hokkaido data center, and users in Miyagi Prefecture would use a Tokyo data center. In addition, we assumed that processing would be done at centralized facilities in Tokyo and Osaka for the handful of cases that this would be more efficient, such as video streaming (Figure 2–8, ③). Furthermore, we assumed the uptake of new network technologies such as all-photonics networks[21].

Under these assumptions, we evaluated the achievement rate of latency requirements for each use case by prefecture in each cluster-distribution scenario.

Figure 2–8 Conceptual framework for evaluating latency requirements



Source: Mitsubishi Research Institute, Inc.

[19] See Figure 2–3 for an overview of the scenarios

[20] In the local production for local consumption use case, it was assumed that the user and the data center would be connected via the same regional IP network

[21] Technology for processing communications on a network as optical signals. Current optical fibers convert signals into electrical signals partway along the communication path. By processing signals as optical signals, ultra–low latency, large capacity, and low power-consumption communications can be achieved. A representative implementation of all-photonics networks is NTT's IWON (Innovative Optical and Wireless Network)

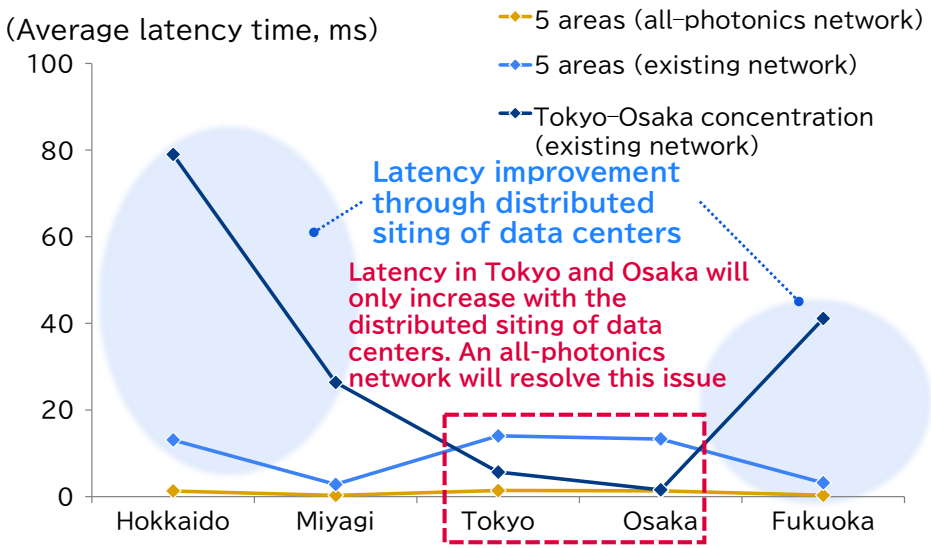
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Evaluation result: Distributing clusters improves latency and inter-regional differences diminish with an all-photonics network

We calculated the average latency times for each distribution scenario (Figure 2–9). Assuming today's networks, increasing the number of clusters leads to improved average latency in areas where data centers are located near demand sites. On the other hand, distribution results increased average latency times for Tokyo and Osaka. For example, if the clusters are distributed across five areas (i.e. Tokyo, Osaka, Hokkaido, Kyushu, and Tohoku), which was found optimal in the watt-side analysis, the latency in prefectures near the newly established clusters is expected to improve by several tens of milliseconds.

However, changes in network technology greatly alter the assumptions regarding latency. If all-photonics networks become the norm nationwide[22], the differences in latency between prefectures would almost disappear (Figure 2–9, yellow line). One of the reasons why DCs have been concentrated in Tokyo and Osaka is the low latency achieved by proximity to internet exchange points (IXs)[23] and network connectivity. This is a valid choice if we only consider the distribution of clusters, but all-photonics networks nationwide would render the point moot—latency would cease to be a significant issue for most data-processing–demand and siting concerns.[24]

Figure 2–9 Average latency by scenario (2040)



Note: This is an estimate based on the assumption that an all-photonics network has been deployed nationwide. "5 Areas" refers to a scenario in which data centers are distributed across clusters in the Tokyo, Osaka, Hokkaido, Kyushu, and Tohoku regions. Here, the average latency time in the representative prefectures of each area is shown as an example

Source: Mitsubishi Research Institute, Inc.

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[22] In Document 7-3 of the Ministry of Internal Affairs and Communications "Information and Communications Council, Information and Communications Technology Subcommittee, Technical Strategy Committee, All – Photonics Network Common Infrastructure Technology Working Group (7th Meeting)", the nationwide spread of all-photonics networks is assumed to be around 2040

[23] Abbreviation for Internet Exchange. It refers to facilities that allow Internet service providers (ISPs) and data center operators to interconnect with each other

[24] For applications that require real-time control, such as autonomous driving and drones, processing mainly needs to be performed on the device. In addition, for operators who already have large-scale computing resources in Tokyo and Osaka, we considered that there remains a certain advantage in continuing to concentrate computing resources in these areas, as it allows server-to-server communication to be completed within the same area

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2.1.3.Optimal distribution of clusters based on both watt and bit perspectives

Five-area distribution optimal for effective use of decarbonized power sources

Assuming the widespread adoption of all-photonics networks, the selection of clusters needs to prioritize the requirements on the watt side. Specifically, while utilizing existing data centers in Tokyo and Osaka, it is optimal to establish large-scale clusters in Hokkaido, Tohoku, and Kyushu, where there is high potential for decarbonized power sources.

It should be noted that this analysis does not consider natural disaster risks, which are important for DC location, or the benefits of regional revitalization, which span from increased local data demand to the advancement of industrial digital transformation. Optimization can be designed to tap into the benefits of regional revitalization (Chapter 3).

Ultimately, we recommend a holistic approach to DC siting.

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2.2. Watt-bit 2.0: Operational optimization as a source of competitiveness

Watt–bit 2.0: Optimizing infrastructure operations

Watt–bit 2.0 serves to improve operational efficiency by linking power supply and demand with digital processing. The main goal is to optimize the coordination between the watt and bit sides to enhance operational efficiency. Here, the key lies in *workload shifting* (WLS). WLS involves flexibly moves the timing and location of computational loads for the dynamic and efficient optimization of temporal and spatial information processing—particularly important for the bit side.

WLS brings several benefits. First, by shifting computational processing from data centers with high operating rates to those with lower rates, it is possible to improve overall computational-resource efficiency while suppressing excessive investment at each site. Second, by distributing processing across multiple sites, redundancy can be ensured and high availability maintained for the entire system, even if each site has only minimal equipment.[25] Third, if processing can be flexibly shifted in response to fluctuations in renewables' output, it will lead to effective utilization of surplus electricity and help to avoid curtailment. Fourth, by adjusting the load as a power consumer, it is expected that new value can be created for demand response (DR).

Generally, the power load of AI-oriented–data centers (DCs) is recognized as being fixed. This is due to the current tendency for operators to place top priority on utilizing extremely expensive computing resources, such as GPUs, at high operating rates. On the other hand, even in existing DCs, fluctuations in power consumption due to computational task execution at colocation facilities[26] have been reported[27]. Such daily DC loads vary depending on the type of computational tasks being executed, and in the case of AI-oriented DCs, on the size of the foundation models, as well as individual or corporate usage and use cases. Until now, data on the fluctuation characteristics of DC power demand has been limited, so studies on how to extract flexibility from these loads have also been limited. However, with the expansion of DCs for AI training, discussions have begun on the role, definition, and forms of flexibility value (Figure 2–10).

[25] There is a concern that the entire synchronized cluster may stop due to the nature of large-scale AI training, and risk mitigation by WLS is expected

[26] Colocation is one of the usage forms of a data center (DC). It refers to DC user companies renting space within the DC to install their own servers and operate their infrastructure

[27] Sonja Klingert et al., "Sim2Win: How simulation can help data centers to benefit from controlling their power profile" https://link.springer.com/article/10.1007/s12053–020–09873–5

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Figure 2–10　Main topics in the consideration of watt–bit 2.0

Classification	Key consideration
Policy & planning considerations	• IEA estimates that if European data centers can provide 30 hours of flexibility per year, the available grid capacity will more than double.[25] • In Belgium's long–term electricity plan, data center flexibility at high levels ranging from 0–50%, and up to a maximum of 75% depending on the scenario, is being considered. • There are emerging initiatives to build new transaction models, such as the standardization of computing power transactions promoted by the Compute Standards Council.
Technical demonstration between specific companies	• Verrus (a spin-off company of Alphabet (Google's holding company)) plans to operate a demonstration data center utilizing dynamic workload shifting and storage batteries by 2027. Currently, the data center can achieve up to 100% load reduction within one minute of receiving a signal from the power company. • Tokyo Electric Power Grid and Hitachi are conducting demonstration tests to provide upward and downward demand response by implementing distributed control of computational loads between multiple data centers based on supply and demand conditions (inter data center spatial shift) and adjusting computational loads based on the output status of variable renewable energy (inter data center temporal shift).
Technical demonstration among diverse companies	• EPRI has launched an initiative called DCFlex in collaboration with data center investors and system operators. By 2027, it plans to deploy 5 to 10 large-scale flexibility hubs and begin demonstrations from the perspective of how data centers can provide demand flexibility and grid services.

Source: Mitsubishi Research Institute, Inc. from IEA "Energy and AI"[28]

[28] Visit https://www.iea.org/reports/energy–and–ai for more information. Of the times when grid load reaches 80%, more than half of the power supplied to regular DCs is available. In 50% of these times, about three–quarters of grid capacity is available.

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Current issues and their solution

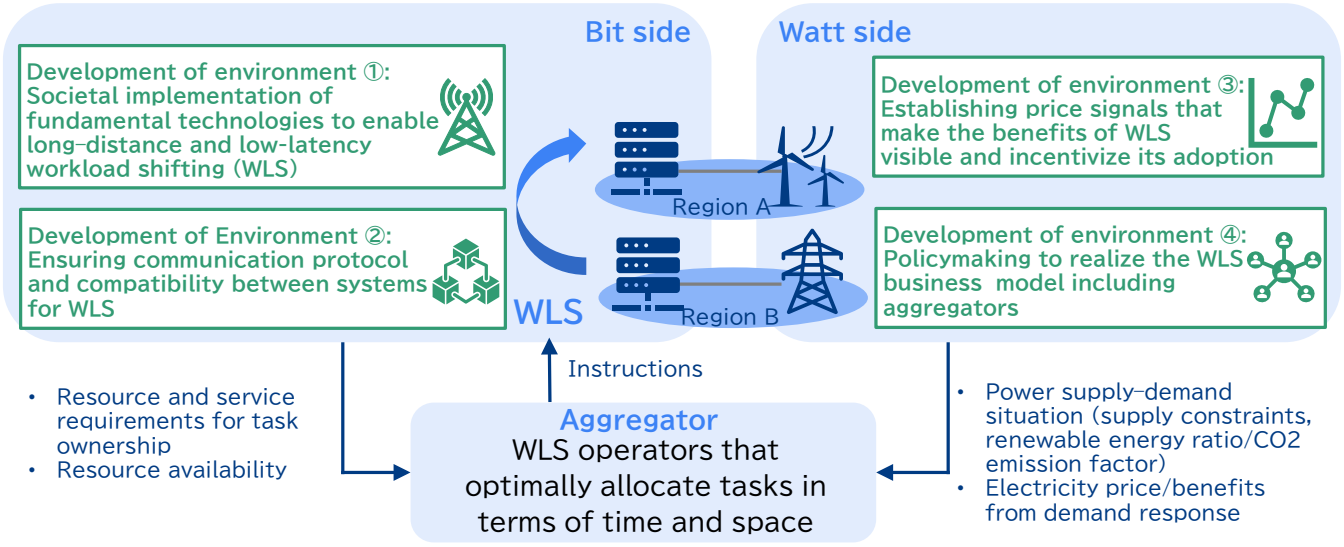
Additional investment is required for WLS. Specifically, on top of developing the necessary communication infrastructure, WLS needs redundant computing resources (e.g., GPUs) for flexible operations. Whether the resulting cost savings or benefits justify these additional investments will serve as the criterion for determining whether or not to implement WLS.

Dynamic WLS is still nascent technology, and a conducive environment has yet to be developed. Several conditions can be considered for its implementation. The bit side will require ① the societal implementation of fundamental technologies for long-distance, low-latency WLS and ② compatibility between communication protocols and systems. The watt side will require ③ the development of price signals that can provide a visualization of and guide WLS benefits and ④ policy that supports WLS-conducive business models including aggregators for overall WLS optimization (Figure 2–11).

Regarding these environmental improvements, it is first necessary to take measures so that WLS between specific companies can be realized at an early stage. Meanwhile, a handful of all-photonics networks are already being set up, and their development should be integrated with 2030 DC-cluster plans. Furthermore, when promoting WLS between specific companies, it is also important to ensure compatibility (②) between communication protocols and systems, with an eye toward future expansion and development. In order for WLS incentives (③) and business models (④) to function appropriately within the electricity system framework by around 2035, it is necessary to start detailed design discussions early and to proceed with environmental improvements to achieve WLS among many businesses and sites.

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Figure 2–11　Development of an environment conducive to workload shifting



Development of environment ①: Societal implementation of fundamental technologies to enable long-distance and low-latency workload shifting (WLS)	• As a key transmission technology for WLS, it is essential to accelerate social implementation by developing and demonstrating next-generation technologies such as all-photonics networks. • In addition to the above transmission technologies, the enabling technology set for WLS includes: (i) virtualization and containerization[26] to ensure data portability; (ii) orchestrator technologies for dynamic, optimal placement of workloads/data; and (iii) load-balancing and distributed-storage technologies to guarantee performance and availability and enable seamless operations. • Based on these technologies, it will be necessary to design and implement a system architecture that enables agile, autonomous, and zero-downtime movement of data processing (workloads).
Development of environment ②: Ensuring communication protocol and compatibility between systems for WLS	• To satisfy the performance levels required by each use case and enable secure, seamless communications, interoperability of communication protocols and compatibility between systems must be ensured. • Realizing WLS requires an integrated system composed of the technology sets described above; ensuring protocol- and system-level interoperability is indispensable. • WLS is the focus of active competition among Big Tech and Japanese telecom operators. It is important to closely monitor moves toward de facto standards by Big Tech and, in implementing WLS in the Japanese market, avoid Japan-specific divergence (“Galapagos” outcomes) and ensure interoperability.
Development of environment ③: Establishing price signals that make the benefits of WLS visible and incentivize its adoption	• WLS requires not only operational improvements on the “bit” side but also incentive design on the “watt” side to quantify and make visible the resulting benefits and to steer behavior through price signals. • The benefits can be broadly grouped into two categories: (i) the value of effectively utilizing variable renewable generation, and (ii) the value of contributing to system supply-demand balancing/control. • By modulating demand via WLS, data centers can avoid curtailed renewable energy and support grid balancing. Many data centers already have on-site generation for resilience, and co-location of battery energy storage is expected to expand, opening access to multiple value streams across power markets. • Price signals in power markets should be designed using a combination of: (i) demand-response compensation that incentivizes shifting load to times/locations with congestion relief or renewable surpluses; (ii) renewable certificates with locational and temporal attributes; (iii) carbon pricing; and, where appropriate, (iv) negative prices.
Development of environment ④: Policymaking to realize the WLS business model including aggregators	• To implement WLS smoothly, real-time resource orchestration and demand forecasting are required; it is also necessary to mitigate information asymmetries between the watt and bit sides and to ensure market-wide transparency. • To that end, a third-party aggregator is needed that, using information from both the watt and bit sides, allocates workloads across time and space. While WLS will likely remain limited to operations among specific data centers in the short term, in the medium to long term institutional/market design is needed to enable a business model in which the aggregator serves as the central coordinator, with a view to deployment over public/shared networks.

Source: Mitsubishi Research Institute, Inc.

[29] A technology that facilitates data migration and enables faster processing by packaging the elements necessary to run an application into a container

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Competitive advantage of Japanese companies: Growth opportunities brought by dynamic WLS and three key points

In the conventional digital-infrastructure market, global hyperscalers, leveraging massive investments and economies of scale, hold an overwhelming advantage. On the other hand, in the watt–bit integration market, local factors such as the supply and demand of electricity play a significant role, creating the possibility for local players in each country to gain a relative advantage. Both the watt and bit sides possess networks, such as grids and base stations, and maintenance systems across the nation. Japan needs a strategy that utilizes these existing assets. Such a strategy must prioritize three things.

① Leveraging strengths in control system technology in the fields of electric power and telecommunications

In disaster-prone Japan, a design culture that emphasizes high reliability and resilience has taken root. Against this backdrop, comprehensive electrical equipment and electronics manufacturers have put to use their prowess for technological development through vertical integration and fine-tuning. They integrate the control of power aspects and communication aspects to achieve advanced optimization of control and operations for systems. These include HEMS, BEMS, and smart grids. Furthermore, concrete services and use cases are being developed for all-photonics networks, a core technology for realizing WLS. This is in parallel to progress on components and materials combining photonics and electronics. We expect further technological advancements moving forward. Beyond saving energy in data centers, the field of optimal energy control—including private power-generation facilities and battery storage—is an important area that contributes to the increase in available computing resources, and Japanese companies are well poised to maintain their competitive advantage in all these areas.

② Technological standardization through open strategies

Japan lacks big tech capable of providing all services as a single company. By turning this situation into an advantage, Japan could be quick to establish an open, cross-operator WLS model and market at an early stage. As mentioned above, in watt–bit integration, specific factors affecting a region's electricity play a significant role, and a model that involves diverse stakeholders—for example, general transmission and distribution operators in each region—is more desirable than a closed model for WLS centered on a single company—often seen with big tech. Furthermore, since region-specific factors in electricity are not unique to Japan and apply to other countries, we foresee the formation of markets through the export of business models to regions such as Southeast Asia and Eastern Europe. This will help promote international standardization.

③ Further strengthening of policy support for watt–bit integration

There are concerns that delays in responding to increased power demand accompanying the expansion of data centers could result in missed opportunities for the development and societal implementation of digital technologies. But watt–bit integration offers a viable way forward and thus is included in various strategic documents from the Japanese government: *Basic Policy on Economic and Fiscal Management and Reform 2025*, *Grand Design and Action Plan for a New Form of Capitalism 2025 Revised Version*, *Basic Concept for Regional Revitalization 2.0*, *Report 1.0 of the Public–Private Advisory Council on Watt–Bit Collaboration*, and *GX2040 Vision*. The current policy support for watt–bit integration is focused on watt–bit 1.0, or the development of DC clusters, but we expect to see parallel progress on concrete policy support for WLS, and thus watt–bit 2.0.

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3. REGIONAL DISTRIBUTION FOR A STRONGER JAPAN (WATT–BIT 3.0)

3.1. Digital and green transformations to energize Japan from its local communities

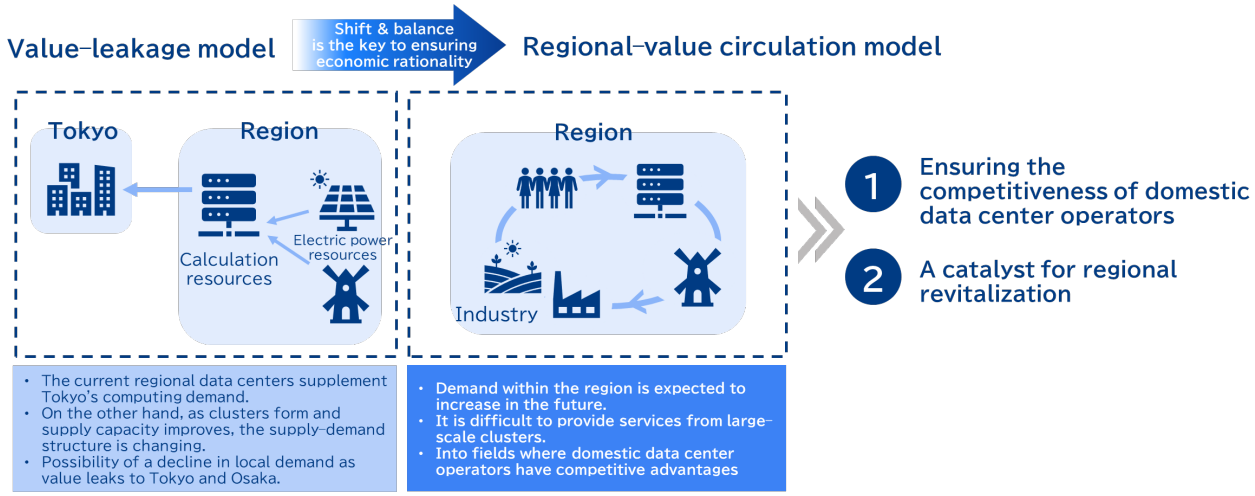
Watt–bit 3.0: Competitive domestic data centers and regional revitalization

Watt–bit 3.0 centers on the utilization of regional data centers (DCs), and there are two main points precluding this.

The first point is the structural change in the future supply and demand for data computation. Currently, regional data centers—those located outside of Tokyo and Osaka—are handling computation demand from areas such as Tokyo in response to the growing use of AI. In other words, the current model is premised on value leakage, and computational and power resources are provided externally (Figure 3–1). However, as the development of data centers and local demand for data processing ramp up moving forward, it will become important for domestic data-center operators to shift to and find a balance in a business model that circulates regional value. Domestic operators will be able to demonstrate their advantages if computational and power resources within regions can be utilized and the value generated can circulate within those regions.

Second, regional revitalization is a key national issue for Japan. For sustainable economic growth, Japan must both strengthen concentrated investment in urban areas and implement a geographically distributed industrial and infrastructure strategy that leverages the resources and characteristics of the country's various regions. The distribution of data centers through watt–bit integration is one of the keys to supporting this foundation. Harnessing inertia in the digital and green realms, the establishment of data centers in regional areas bridge watt–bit integration to regional revitalization. The key issues can be organized from the perspectives of domestic operators and the government—both national and regional.

Figure 3–1 Two types of business model for regional data centers



Source: Mitsubishi Research Institute, Inc.

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Domestic DC operators: Proactively addressing future increases in regional demand

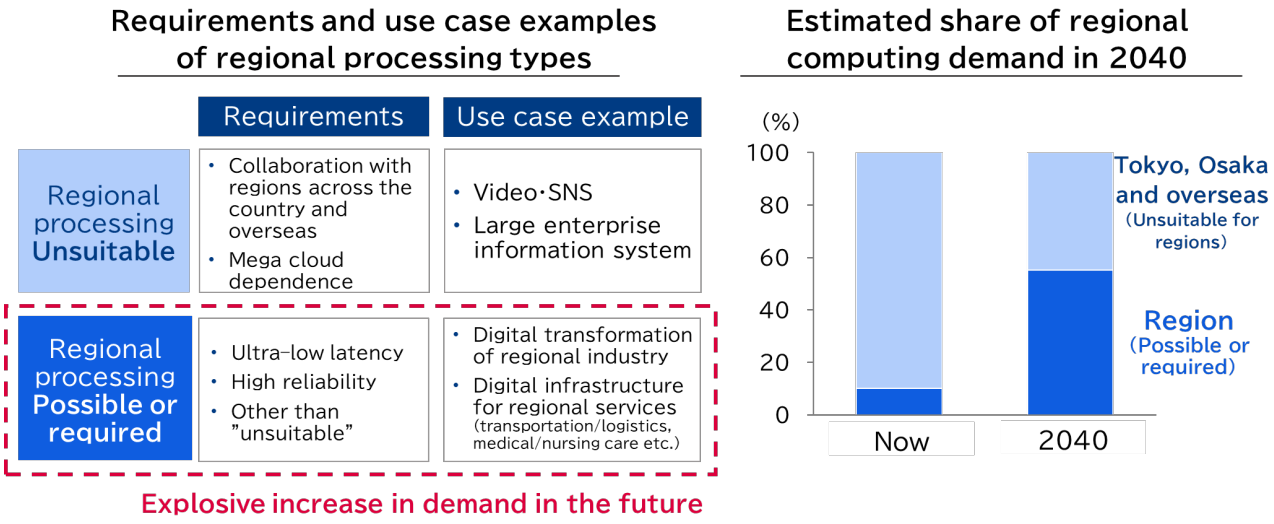
Currently, regional data centers mainly play a complementary role in meeting AI-related demand: They support demand from areas like Tokyo in a value-leakage business model. However, they will need to shift to a regional-value circulation model moving forward. There are two main reasons for this.

First, Japan must improve the supply capacity of its large-scale clusters. On their own, data centers currently struggle to keep up with the strong growth in demand. However, the supply–demand situation could be ameliorated with government lead development of additional large-scale DC clusters. This would wane regional cities off of value-leakage models, and effect a business environment difficult for such models to be viable.

Second, local demand is growing too. Current discourse tends to focus on demand, and use cases that crop up are not suitable for local processing. However, we expect to see an increase in demand that can or must be handled locally in the future. We estimate a potential rise in the share of computing demand handled locally from the current 10% to levels over 50% by 2040 (Figure 3–2).

In this context, it is particularly important for service providers that cater to regional demand, such as domestic data center operators, to focus on a type of business model conducive to regional value circulation. Even if the overall supply–demand balance moves toward equilibrium with the development of large-scale clusters, large-scale data centers, such as hyperscalers, may not be able to meet the detailed and localized needs that arise in each region. In order for domestic operators to enhance their competitiveness with a business model different from that of hyperscalers, it is essential to proactively develop strategies for and prepare to address the anticipated increase in regional demand.

Figure 3–2　Data suitable for regional processing and forecast of regional computing demand in 2040



Source: Mitsubishi Research Institute, Inc.

National and local governments: An opportunity for regional revitalization

For the government, national and local, watt–bit 3.0 can become a powerful driving force for regional revitalization. Three points underpin this.

First is the potential of DC as an investment field. For many of the country's regions, sectors with promising prospects for new investment are limited, so there are high hopes for digital transformation as a growth industry. However, there are also

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challenges, such as the difficulty of creating local employment through DC siting alone.

Second is the point of young talent. Digital-transformation–related jobs are relatively more attractive to younger generations[30], and the creation of such industries in regions outside the Tokyo–Osaka area can serve as an incentive for young talent to find employment locally.

Third is the reduction of disparities between Tokyo and the country's other regions. Currently, the country's digital infrastructure is concentrated in Tokyo and Osaka, and the country's other regions depend on the human resources and infrastructure of these cities. If things continue as is, value and high-level talent will continue to concentrate in Tokyo–Osaka, flowing out of the other regions and preventing them from becoming more prosperous.

However, the inertia of the digital- and green-transformation era can be leveraged to benefit local communities. The key lies in creating and sharing external benefits through watt–bit integration and the digital transformation of local industries. The next section will discuss the structure of these external benefits and the requirements for target regions to autonomously achieve watt–bit 3.0.

3.2. Creating a conducive environment: Objective analysis to prioritize and focus efforts

Creation and sharing of external benefits for regional value circulation

Japan's regions must create and share external benefits if they are to build an environment conducive regional value-circulation business models. Internal and external benefits take a multi-layered structure (Figure 3–3). Internal benefits include advantages to the data center itself, from its installation and operation to the employment created by the data center. However, the internal benefits for data centers are relatively small compared to those of manufacturing industries, such as semiconductor factories. In contrast, external benefits refer to advantages that spread beyond the data center. Here, external benefits are organized into two types: intra-regional benefits and inbound benefits.

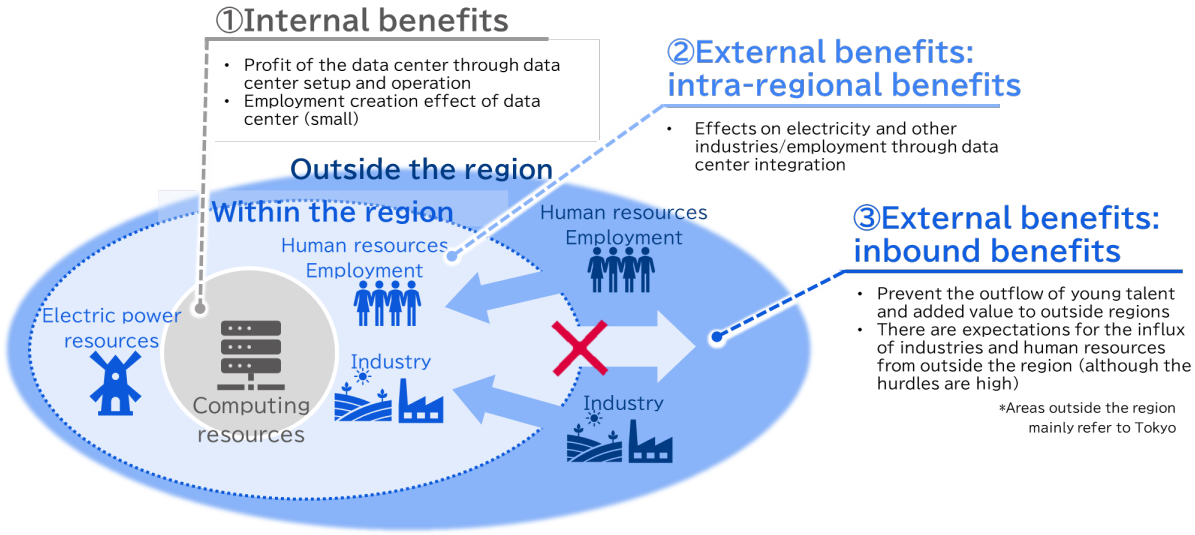
Intra-regional benefits include advantages for the electricity sector within the region through watt–bit integration, as well as effects on other industries and employment. The latter might include the digital transformation and productivity improvement of existing industries through digitalization. Inbound benefits refer to effects such as preventing the outflow of young talent and value from the region as it becomes revitalized, and further, attracting industries and human resources from outside the region. While the hurdles for achieving the latter are particularly high, it is important to consider strategies that aim for such effects when promoting regional revitalization.

To create external benefits, it is necessary for DC operators to act as clusters, proactively promoting the digital transformation of local industries and increasing the benefits that spread throughout the region. After generating these external benefits, it is important to share them, for example by internalizing the external benefits for DC operators.

[30] According to the "Mynavi 2025 University Student Employment Awareness Survey" (https://career–research.mynavi.jp/reserch/20240416_74092/), "Software, Information Processing, and Internet–related" is the second most desired industry (8.1%)

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Figure 3–3　Internal and external benefits of watt–bit 3.0



Source: Mitsubishi Research Institute, Inc.

Watt–bit city: Decarbonized power and digital transformation

We created the term *watt–bit city* (WBC) to refer to regional cities that aim to revitalize their communities by creating external benefits through watt–bit integration.

We broadly classify WBCs into two types. This depends on the kinds of external benefits emphasized in each region (Figure 3–4). The first is *decarbonized-power WBCs*. These are centered on renewable energy (type 2–1), and, like watt–bit 1.0, utilize the potential of renewable energy to help avoid curtailment and grid reinforcement, among other things. The second is *digital-transformation WBCs* (type 2–2).[31] These are mainly aimed at contributing to the digital transformation of regions, disaster response, and business continuity planning.

Figure 3–4　Types of watt–bit city

Category	Feature
Type 2-1: **Decarbonized-power watt–bit cities**	• Within power grid areas abundant in renewable energy (assuming Hokkaido, Tohoku, and Kyushu) • **Although there is substantial renewable energy potential nearby**, grid connections to the data center clusters insufficient. • It can also be viable even in relatively small-scale cities.
Type2-2: **Digital-transformation watt–bit cities**	• Other areas within the above jurisdiction (without renewable energy advantage) • **Possessing an industrial base and population that will generate significant future data demand** (regional core city) • New investments in the power system are relatively minor. • High resilience to natural disasters

Source: Mitsubishi Research Institute, Inc.

[31] In this paper, DCs primarily aimed at securing computational demand for all of Japan are defined as *Type 1*, and DCs primarily aimed at meeting regional demand are defined as *Type 2*. For details, see 1. Introduction

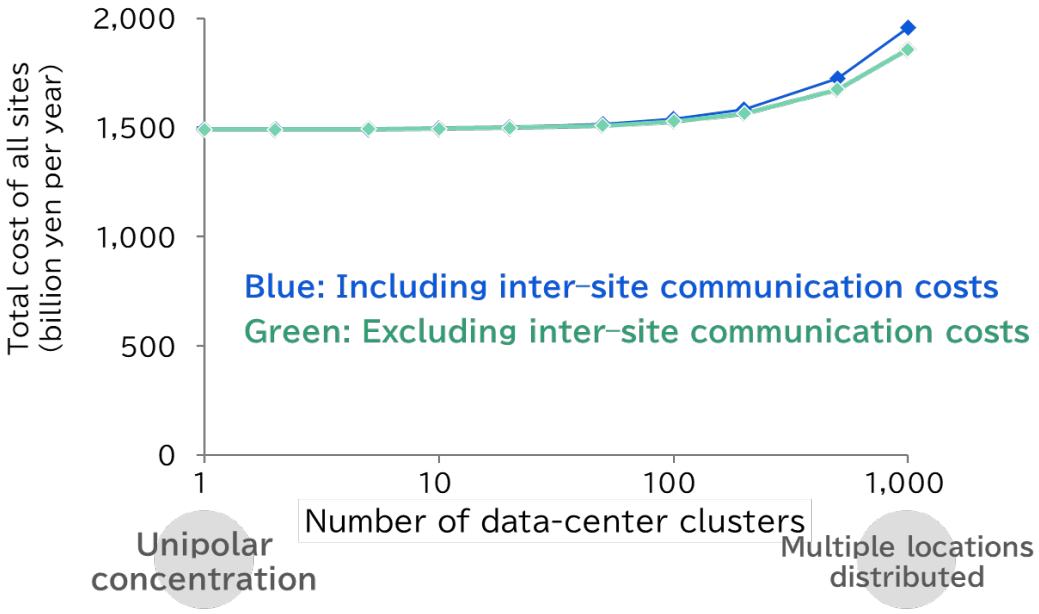
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Defining requirements: Identifying advantages and disadvantages

Watt–bit 3.0 cannot be established in every region. Since the external benefits that can be generated and the costs of realizing them differ by region, it is important to identify the requirements for becoming a watt–bit city and promoting initiatives accordingly.

First, from the perspective of DC installation, it is a general concern that economic efficiency will decline due to the regional distribution of infrastructure. However, in AI-oriented DCs, which are expected to expand in the future, most costs are accounted for by GPUs, so the diseconomies of scale from splitting DC sites are limited (Figure 3–5). For the large-scale hyperscalers that operate by integrating multitudes of server racks, there are significant advantages to concentrating sites in terms of reducing inter-rack communication latency and costs. But for regional DC operators that do not require so many racks, the disadvantages of establishing small-scale regional sites are minor. The recent increase in operators establishing small-scale regional DCs, such as modular DCs, is also evidence that the economic efficiency of small-scale DCs is not necessarily inferior to that of large-scale sites[32].

Figure 3–5　Changes in data center costs due to multi-site distribution



Note 1: The total cost includes initial costs (land acquisition costs, construction costs, electricity and air conditioning installation costs, GPU acquisition costs) and operating costs (electricity charges, personnel costs, inter–site communication costs). Initial costs are accounted for by dividing each item by its useful life.

Note 2: It is assumed that a total of 1 GW of data centers will be developed in the same area, and the value obtained by dividing this 1 GW by the number of sites (for example, 10 MW per site if there are 100 sites) is set as the receiving capacity for each data center site, and the initial and operating costs are estimated accordingly.

Source: Mitsubishi Research Institute, Inc.

[32] In small–scale data centers, such as container types, there are cases where cost advantages are prioritized and sufficient redundancy for power and communications is not ensured. Although simple comparisons are difficult due to differences in data center usage, it should be noted that in terms of redundancy and other factors, they may be inferior to large-scale sites

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Next, from the watt perspective, the regional distribution of DCs can be both an advantage and a disadvantage.

Decarbonized-power WBCs should see effects similar to that of watt–bit 1.0, or the distribution of DC clusters. By distributing DCs near renewable energy, it becomes possible to reduce curtailed power and suppress costs such as grid reinforcement.

For digital-transformation WBCs, the distribution of DCs may require new grid enhancements, in which case distribution becomes a disadvantage. However, if DC scale is around 100MW, there are often cases where available grid capacity can be secured, making it possible to curb new investments.

Furthermore, in the regional context, there is also the possibility of creating synergy by integrating the initiatives of local communities with power sources such as agrivoltaics[33] and nuclear. Also, greater uptake of battery storage can serve to add value to DCs by ensuring redundancy and providing functionality in the case of disaster. This is in addition to their existing multifaceted value.

In this way, distribution may entail disadvantages on both the bit and watt sides. It is desirable from the perspective of overall optimization to calmly assess these disadvantages and foster WBCs in regions where the expected benefits outweigh them.

[33] This refers to the initiative of installing solar power generation equipment above farmland, aiming to achieve both farming and power generation

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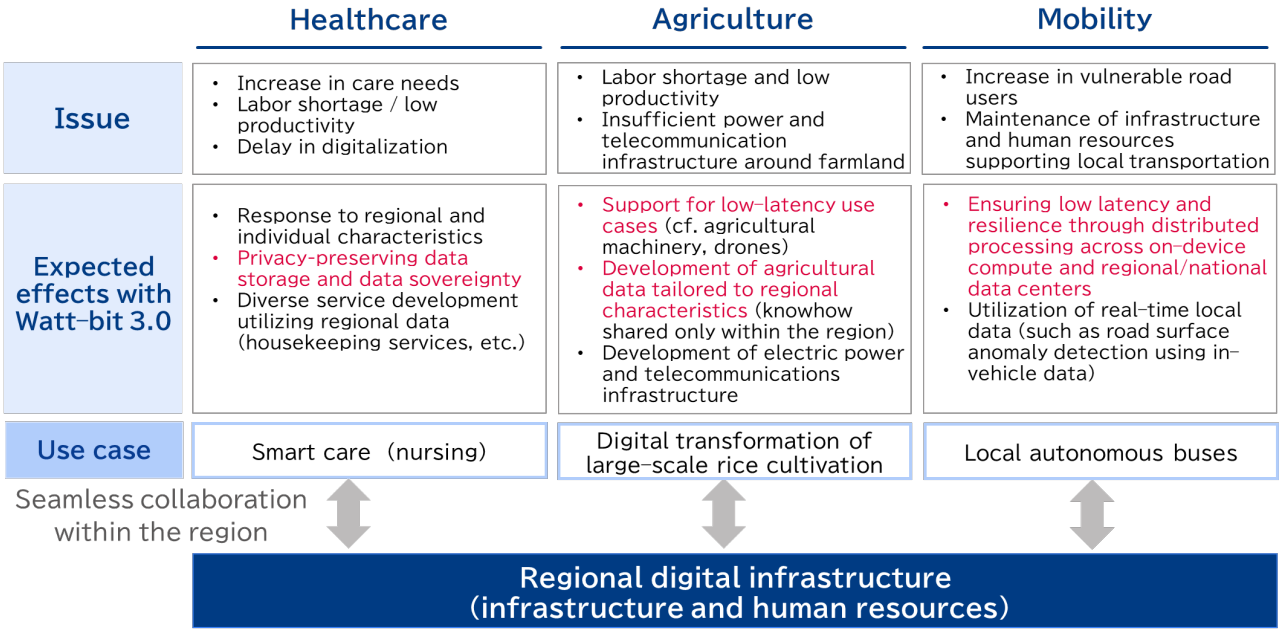
3.3. Use Cases by Sector and Economic Impact

Watt-bit cities bring regional digital transformation

To foster watt–bit cities (WBCs), it is important to generate external benefits through not only the integration of the watt and bit aspects, but also regional digital transformation. We analyzed the effects of regional data-center siting for three sectors: healthcare, agriculture, and mobility. This is in light of wider regional perspectives such as falling, ageing populations and the maintenance of local societal infrastructure (Figure 3–6).

All three sectors face workforce shortage. Digital technologies, such as AI and robotics, will be necessary to resolve these issues. While digital solutions can be achieved by utilizing large-scale integrated data centers (DCs), it is expected that the digital transformation of local areas will progress further through the added value provided by local DCs, such as low latency, data sovereignty, and close ties to the community.

Figure 3–6 Digital-transformation effects of regional data-center siting by field



Source: Mitsubishi Research Institute, Inc.

Setting up regional data centers will make it possible to tailor healthcare to regional and individual needs. Data management and data sovereignty for the region should benefit too, as would digital transformation in long-term care. Each region features a different degree of population decline and long-term care demand. Regional digital infrastructure will be ever more important when it comes to resolving these region-specific issues under local leadership. The local healthcare market can grow even more if locally-generated data can be linked with private services outside the umbrella of national health insurance, such as household support services and preventive-care services. Furthermore, regional data centers offer advantages in terms of privacy. For example, monitoring services and sensor technologies handle sensitive data such as users' images and voice audio, and the protection of privacy and personal data is essential. Keeping information within regional digital infrastructure, close to users, may lead to a greater sense of security.

For agriculture, watt–bit 3.0 would bring a host of benefits—for example, the advancement of smart rice-paddy cultivation. The digital transformation of

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agriculture is well underway, including demonstrations of new technology such as the remote control and autonomous operation of agricultural machinery and the spraying of pesticides by drones. Yet the development of infrastructure will have to be ramped up to meet this progress, including the expansion of power supply and communication networks to farmlands like rice paddies. Paddies are typically found in rural areas, especially in hilly and mountainous regions, and these places often lack sufficient power lines and power capacity. In addition, wireless communication networks are often fragile. As a benefit of establishing regional data centers (DCs), data accumulation within the region is also possible. The government is building WAGRI, a system for centralized management of agricultural data, but weather conditions, soil quality, and cultivation methods can differ according to regional characteristics even for the same agricultural products. This has left many farmers hesitant toward centralized management. In addition to management at the national level, if regional DCs can handle highly regional and confidential information, they could further accelerate the digital transformation of the agricultural sector.

The field of mobility shows promise for the autonomous operation of public transportation, such as buses. Level 4 autonomous driving involves information processing by onboard devices, but numerical data necessary for wide-area control—such as the position and speed of each bus, driving operations, and road surface conditions—needs to be centrally managed at a data center (DC). In addition, onboard devices have trouble processing various types of image data, and these too need to be processed at DCs. Processing this data at regional DCs has advantages especially when it comes to low latency requirements[34]. Furthermore, keeping data within the regional DC can reduce the risk of data leakage, and it is also possible to avoid the risk of failures occurring in the region affecting a wider area. By aggregating data at the regional DC, flexible data processing tailored to local circumstances becomes possible, enabling various secondary applications such as road-surface monitoring and peripheral surveillance while driving.

Economic impacts for regions from digital infrastructure and external industries

The realization of watt–bit 3.0, including the implementation of these use cases, has the potential to bring positive effects to regional economies. It is becoming harder and harder for communities to maintain local industries and public services due to labor shortages and an ageing populations. The active introduction of digital technologies such as AI and robotics in various fields can help improve productivity and serve to counter these negative trends. The use cases explained in the previous sections are examples of this. To implement digital technologies, it is also essential to secure human resources and funding, as well as to develop infrastructure such as electricity and IT.

Here, as an example, we estimated the economic impact of achieving watt–bit 3.0 by 2040 on regional industry as a whole. We included the use cases and assumed a prefecture with a population of 1.2 million and a gross prefectural product of 4.5 trillion yen.

[34] There are types of data, such as those needed for wide-area collaboration in regional transportation, that are more efficiently consolidated at large-scale DC clusters, like those in Tokyo and Osaka. This makes it is essential to coordinate the division of roles with regional DCs

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Without resolving labor shortage induced by declining birthrate and population ageing, the economic scale of the prefecture in 2040 will decrease by 18% compared to 2022 levels[35]. In contrast, if digitalization progresses, it is assumed that sufficient investment[36] necessary for digitalization will be made in the prefecture, productivity will improve, and the economic scale will be maintained. In this analysis, two scenarios regarding digital investment were set to analyze the economic effects[37].

The first scenario involves utilizing data centers outside the region. In this scenario, no regional data center is established, and data centers located at large-scale clusters are used. While investments in equipment such as AI and robotics progress to advance digitalization within the region, it is assumed that data-center usage fees and similar costs will flow out of the prefecture—in reality, the absence of a regional data center may also suppress digitalization. In this scenario, the economic scale increases by +0.2% compared to 2022 levels due to the advancement of digitalization in the region, allowing a certain level of economic scale to be maintained even amid population decline.

The second scenario postulates the cultivation of a watt–bit city, which would house a regional data center, in the prefecture. In this case, by attracting digital infrastructure and processing local data demand within the region, it would be possible to prevent the outflow of added value to other prefectures. As a result, the economic scale will expand by +6% compared to 2022 levels. Furthermore, additional economic effects could be reaped by attracting industries and human resources through the establishment of a regional DC. Local digital infrastructure would attract new industries and people, potentially leading to research and development and the stimulation of innovation within the region (Figure 3–7).

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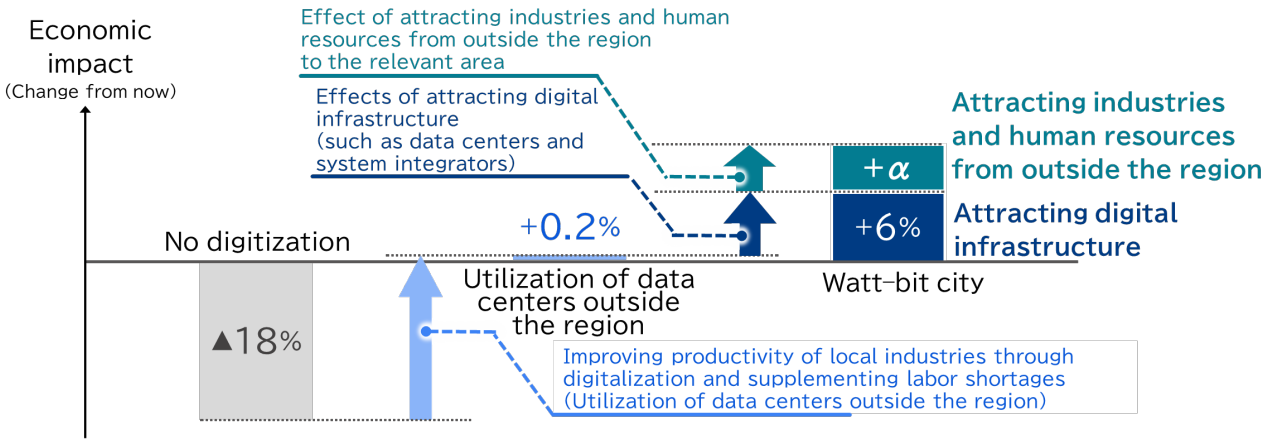
[35] We estimated the decrease in the prefecture's gross product by industry, assuming it would decline in proportion to the decrease in the number of workers by industry through 2040. The number of workers by industry in 2040 was calculated using the baseline and gradual labor force participation scenario (by prefecture) from the "Estimation of Labor Supply and Demand—National Estimates (FY2018 Edition) and Prefectural Estimates Based on Them—" (2020) by the Japan Institute for Labor Policy and Training

[36] With digitalization investment, labor productivity improves, compensating for the shortage of workers, and the gross prefectural product of traditional industries is maintained, as assumed. The coefficient by which digital investment induces other industries was set with reference to previous studies (Ayako Onozaki, "International Input–Output Analysis of the Information and Communication Industry: Focusing on Japan, the US, China, and India," Input–Output Analysis, Vol. 31, No. 1 (2024); Ministry of Economy, Trade and Industry and Japan Robot Association, "Basic Knowledge of Robot Utilization" (2017))

[37] Currently, workers in the information and communications industry are concentrated in Tokyo and other major areas. In the scenario where data centers outside the region are used, it is assumed that much of the digital investment will flow out of the prefecture, based on the proportion of the information and communications industry within all industries in the prefecture projected for 2040 in the baseline. On the other hand, in the WBC scenario where a data center is located within the region, it is assumed that the information and communications industry will be attracted to the prefecture and 70% of digital investment will be received within the prefecture

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Figure 3–7　Economic impact of digital transformation on regions



Source: Mitsubishi Research Institute, Inc.

3.4. Realizing Watt–Bit 3.0: Starting from emerging cases

A model case for attracting data centers to a region

There are still few cases of watt–bit 3.0 that start with attracting data centers to local regions. As analyzed in the previous section, the benefits and economic effects of establishing regional data centers are clear, but the use of AI in these areas has not yet progressed sufficiently. This pushes the full-scale introduction of robotics into various industries to the latter half of the 2030s. Nevertheless, infrastructure development takes time. With an eye on the coming era of full-scale AI and robotics utilization, some cases have begun to strategically start developing data centers in parallel with fostering data demand.

For example, Kagawa Prefecture published its Setouchi Corporate Attraction 100 Plan (せとうち企業誘致 100 プラン) in March 2023. Here, the prefecture declares that it will actively work to attract data centers in light of the recent and rapid increase in data traffic due to the promotion of digitalization. It is also based on the national government's efforts to optimally locate large-scale data centers in regional areas. For Kagawa Prefecture, DCs have been positioned as a key industry for attraction. Responding to this proactive stance by the prefecture, HIGHRESO Inc. (headquartered in Tokyo), which provides GPU cloud services, established a special-purpose company called HIGHRESO Kagawa and opened a DC in Takamatsu City, Kagawa Prefecture, in 2024.

In Kagawa Prefecture, efforts are being made not only to attract supply-side data centers but also to promote the digital transformation of government and industry as a means of fostering demand. For example, the Kagawa DX Lab, established and operated by the prefecture, involves participation from the prefectural government, all municipalities within the prefecture, and 49 private companies (as of the end of August 2025). Through public–private collaboration, they are working to put digital transformation to work in resolving regional issues in various fields.

According to HIGHRESO, the majority of its GPU-service client base is situated in Tokyo and other major cities[38], but in the future, they expect to meet regional computing demand. They expect such initiatives to contribute to the development of regional demand.

National and financial institutions also play an

[38] Based on an interview with HIGHRESO (August 2025)

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important role in Kagawa Prefecture's initiatives. The Ministry of Economy, Trade and Industry designated HIGHRESO's data center–installation project as a plan for ensuring supply of specified critical products and decided to provide 7.7 billion yen in subsidies. In addition, the Development Bank of Japan made a direct investment in HIGHRESO Kagawa and, in cooperation with several local financial institutions, formed a syndicated loan.

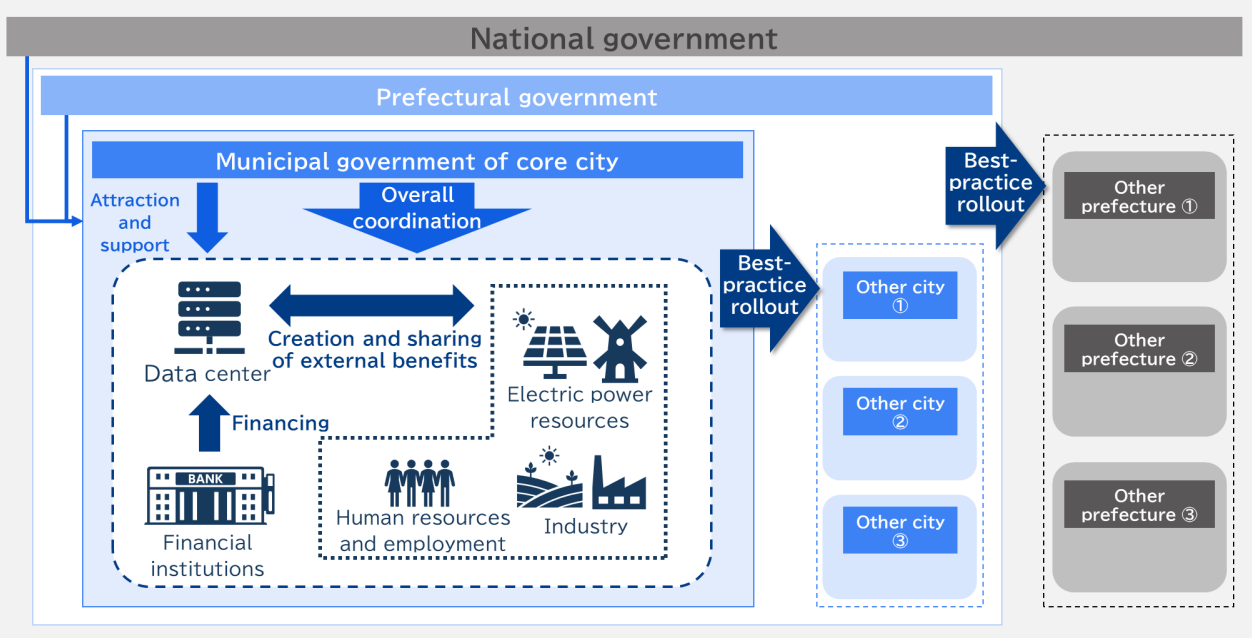
Local government frameworks conducive to external benefits and regional circulation model

Many of the regional data centers for AI that have been increasing in recent years are mainly focused on internal benefits and are largely based on a value-leakage model. Going forward, it is important to further develop such cases and shift toward a regional circulation model, while effectively generating external benefits. As shown in Section 3.3, digitalization and attracting foundational infrastructure are expected to produce significant economic effects. It is important to use watt–bit 3.0 as an opportunity to transform the economic structure of regions, which would otherwise shrink due to factors such as population decline.

For example, STNet, a major ICT company in Shikoku, has its main data center in Takamatsu City, Kagawa Prefecture, and many businesses within Shikoku use it[39]. The use of regional data centers by local companies is already underway, and it is expected that as this expands into the field of AI utilization, regionally circulating business models will also grow.

To achieve this, it is necessary to take a broad perspective and promote progress while coordinating with various players. In addition, since some external benefits include value that will be created in the future, it is also important to reflect future benefits in current mechanisms in advance. An entity that can fulfill a coordination role is integral to promoting watt–bit cities (WBCs). Prefectures are also paramount due to their roles and driving force (Figure 3–8). It is important to build schemes and mechanisms led by local governments while keeping in mind the requirements for establishing WBCs.

Figure 3–8　Local government–led frameworks for watt–bit cities



Source: Mitsubishi Research Institute, Inc.

[39] Based on an interview with STNet (July 2025)

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4. CONCLUSION AND RECOMMENDATIONS

4.1. Achieving optimal watt–bit integration

Optimal form of watt–bit integration in 2040

In Chapter 2, we analyzed the establishment of additional large-scale clusters (watt–bit 1.0), and in Chapter 3, we analyzed establishing DCs in regional cities (watt–bit 3.0). Based on these, we have defined the optimal form of watt–bit integration in Japan in 2040 (Figure 4–1).

Large-scale clusters (type 1) and regional-city DCs (type 2-1: regional cities with abundant renewable energy and type 2-2: sites for regional digital transformation) each have different purposes and are expected to play complementary roles. National demand will mainly be met by large-scale clusters. We recommend establishing about five, including the existing Tokyo and Osaka clusters. This would contribute to Japan's resilience.

Meanwhile, type 2-2 regional city DCs will be responsible for uncovering regional demand through regional digital transformation. We envision expanding Japan's set of large-scale clusters to the Hokkaido, Tohoku, and Kyushu regions, which are rich in decarbonized power sources. But to make even more effective use of decarbonized power within these three regions, type 2-1 regional-city DCs located close to power sources will be essential. We envision the development of DCs with a total grid receiving capacity of about 25 GW across all clusters, equivalent to an annual power consumption of about 150 TWh[40]. We expect large-scale clusters to account for about 80% of this.

Figure 4–1 Overview of watt–bit integration in 2040

		Type 1: Additional establishment of large-scale clusters (Including satellite data centers in Tokyo and Osaka)	Type 2: Regional city data centers (Watt-bit city)	
			Type 2-1: Decarbonized-power watt–bit cities	Type 2-2: Digital-transformation watt–bit cities
Target demand		Mainly nationwide demand	Mainly regional demand	
Cluster size		Extra-large (up to 10GW)	Small (several tens to 100MW)	Medium (100 to several hundred MW)
Number of clusters		About 3 (Tokyo, Osaka, +α)	About 10–20	About 5–15
Total utility power capacity (Nationwide)		Around 20GW (including Tokyo-Osaka)	Several GW	Several GW
Purpose of establishment	【Watt】 Utilization of decarbonized power sources	◎ (3 regions with abundant decarbonized power sources) ◎ (Further power source proximity)		△ (limited)
	【Bit】 Increase in computing power supply, BCP	◎ (Main purpose of deployment)	—	○ (Secondary purpose of deployment)
	【Bit】 Contributing to digital transformation of region	—	○ (Secondary purpose of deployment)	◎ (Main purpose of deployment)

Source: Mitsubishi Research Institute, Inc.

[40] The method for forecasting DC power consumption refers to Mitsubishi Research Institute's "Impact of Widespread Use of Generative AI on Japan's Electricity Demand" (https://www.mri.co.jp/en/knowledge/insight/20241115.html). When converting to receiving capacity, an average operating rate of 70% was assumed

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To advance DC development from the perspective of overall-, rather than partial-, optimization, it is necessary to make selective, focused decisions so each site yields net national benefits (Figure 4–2).

The development of large-scale–integrated clusters will bring significant benefits. On the watt side, we foresee reduction in the curtailment of renewable energy and savings on inter-regional grid investment. On the bit side, it will ameliorate insufficient DC supply and prevent opportunity loss, such as the outflow of DCs overseas and limits on the use of generative AI.

For regional-city DCs of type 2-1 as well, similar benefits on the watt side are expected, such as further reduction of curtailed renewable energy and savings in local interconnection-line investments. From the bit perspective, these benefits are expected to outweigh the additional costs of ICT infrastructure associated with distributing DCs, such as the losses from splitting the DC itself and the costs of developing communication infrastructure.

Planners will need to carefully evaluate the situation before establishing type 2-2 regional city DCs. While the advantages, such as regional digital transformation and the discovery of data demand on the digital side, are quite apparent, there is also the possibility for disadvantages, such as additional costs from decentralized development of power and communication infrastructure and losses from splitting DCs. It is important to select regions where the total benefits, after evaluating both sides, are positive. In our analyses, we generally assumed about one type 2-2 regional DC per prefectural area (or an area covering several prefectures, depending on the region). Although many local governments are interested in attracting DCs, when considering support measures such as subsidies, it is necessary to determine whether they contribute not only to regional benefits but also to nationwide benefits.

Figure 4–2　Benefits of developing data-center sites for watt–bit integration

	Type of benefit		Type 1: Additional establishment of large-scale clusters (Including satellite data centers in Tokyo and Osaka)	Type 2: Regional city data centers (Watt-bit city)	
				Type 2-1: Decarbonized-power watt–bit cities	Type 2-2: Digital-transformation watt–bit cities
National level benefits	Watt	Curtailed power reduction	+++ (Up to 65 billion yen per year nationwide)	++ (Incremental effect with closer proximity to power sources, for example, 10 billion yen/year in Hokkaido)	△ (limited)
		System investment savings			– (Possibility of increased new investment in the system)
	Bit	Digital transformation of region	Nothing in particular.	+	++ (Digital transformation of region, data demand discovery)
		Improving ICT quality (such as low latency)	+ (Currently, in the existing network, latency is improved in the establishment area; however, after the widespread adoption of all-photonics networks, the effect will be minimal.)		
		ICT infrastructure Investment savings	+ (Economies of scale)	– (There is a split loss, but the impact is minimal.)	
Benefits of the relevant region	Increment of total benefit		◎ (Significant benefits are expected)	○ (Selectable regions available)	○ (Selectable regions available)

+Regional revitalizing in DC-siting regions

Source: Mitsubishi Research Institute, Inc.

Timeline for the development of clusters toward 2040

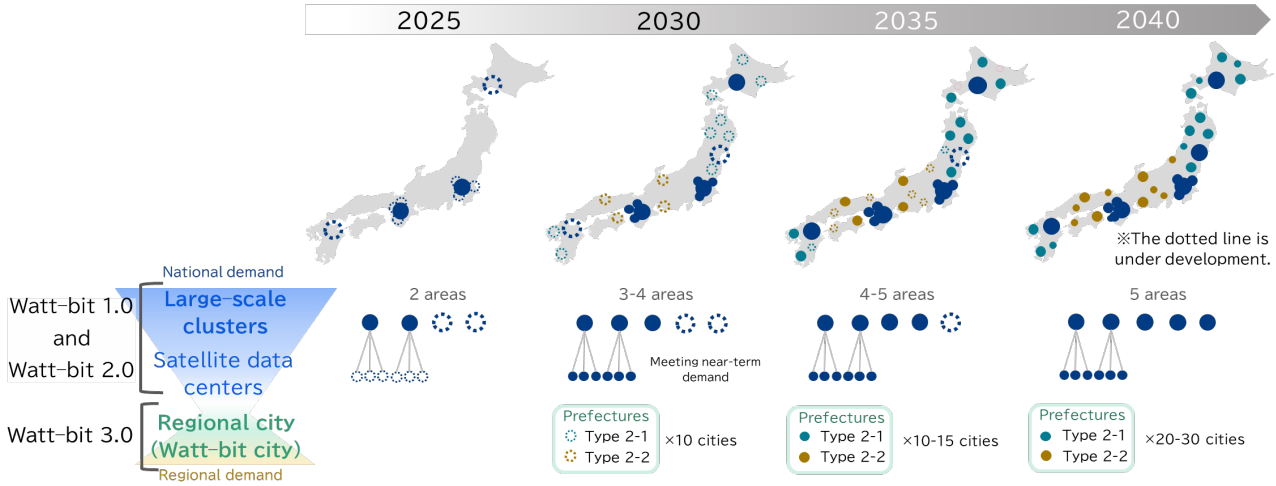
DC sites will take several years to develop if the power grid is already in place, and about seven to ten years if new power grid infrastructure needs to be built. In the short term, it will be necessary to promote the establishment of DCs in areas near Tokyo and Osaka—*satellite DCs*—with surplus grid capacity, such as in northern Kanto, while also urgently starting the development of large-scale

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clusters in other regions. In the 2030s, as new large-scale clusters begin operation, the expansion of regional data demand and the development of all-photonics networks will further drive the establishment of type 2-1 (regional cities with abundant renewable energy) and type 2-2 (sites for digital transformation of regions) DCs in regional cities.

We recommend ultimately, by 2040, establishing a core of around five large-scale clusters (type 1) nationwide, while also developing satellite DCs in the Tokyo and Osaka regions, and type 2 DCs in regional cities (about 20 to 30 cities). The ideal is to simultaneously realize the three values of watt, bit, and regional revitalization. This is possible by efficiently utilizing decarbonized power sources distributed across the country, providing sufficient computing power in an economically efficient and resilient manner to meet strong AI demand, and responding to the needs for revitalization in the regions where data centers are located (Figure 4–3).

Figure 4–3　Timeline for the development of data-center clusters under the watt–bit integration paradigm



Note: This figure illustrates the concept of data-center–site deployment and does not specify the exact locations of data-center–site development.

Source: Mitsubishi Research Institute, Inc.

Then, by connecting the DCs developed in various locations across the country with an all-photonics network, it will become possible to provide low-latency services regardless of the distance from internet exchanges.[41] In addition, by establishing a market for workload shifting (WLS) that spans multiple operators and regions, it will be possible to dynamically move data processing to sites in regions where renewable energy output is expected to be excessive due to weather conditions, or to have nearby sites take over computation when data processing is likely to exceed the capacity of a specific DC site during large-scale events. Domestic operators must take the initiative in developing all-photonics networks and WLS markets, and they should utilize technologies in which Japan has strengths, such as photoelectric fusion and power supply–demand control.

[41] For services that require ultra-low latency, it is assumed that this will be achieved by connecting users and regional data centers within each region via the regional IP network without going through internet exchanges

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4.2. Recommendations for solutions to bottlenecks in watt–bit integration

There are multiple bottlenecks toward the real-world application of watt–bit integration and maximizing economic value. These span technology, systems, and business operations, and they cannot be addressed individually. They are interrelated and require a comprehensive approach.

Bottlenecks hindering the realization of watt–bit integration

The need for regional distribution of data centers (DCs) has long been discussed, even before the spread of generative AI and the emergence of terms like *watt–bit integration*. However, efforts toward regional distribution still remain limited, often only sporadic examples supported by subsidies. The main reason for this is the lack of incentives for DC operators, who are the primary investors, to invest in regional DCs. For them, there is a highly degree of uncertainty, with the potential returns outweighed by the potential risks. This is particularly pronounced in regional DCs for watt–bit 3.0 (Figure 4–4).

Figure 4–4 Stance on investment in regional data centers by major private-sector stakeholder

Stakeholder	Intentions regarding new data center sites	Stance on Regional data-center investment
Data center operators	• Prefer siting data centers in major cities (esp. Tokyo/Osaka) due to concentrated networks and compute demand.	**It depends on infrastructure development in regional areas and on compute demand(currently in a wait–and–see situation).** • In rural areas, there are concerns about procuring large–scale and stable electricity and communication infrastructure. • It is difficult to expect large–scale customer migration from the Tokyo–Osaka data centers, and the demand for locally produced and consumed computing is highly uncertain.
Electric power utility	• Short term: We want to attract data centers to regions with available capacity on the existing power grid. • Medium to long term: We recognize the need to develop power supply and grid facilities for data center use in regions with strong potential for decarbonized generation.	**Recognizing it as a business opportunity, but taking a cautious stance due to the need for long–term and large additional investments.** • Regional data centers are promising consumers, but long–term and large–scale additional investments are required for power supply. • Data center power demand is highly uncertain, and the risk of upfront investment is also high.
Telecom carriers	• If demand for network infrastructure serving regional data centers materializes, new investment opportunities will emerge. • There are also investment opportunities in the collaboration between regional communication networks and edge data centers.	**Exploring medium- to long-term profitable business models.** • Local production and consumption–type data demand in the region is promising but still limited. • Exploring competitive business models such as collaboration between communication networks and edge data centers。.

Source: Mitsubishi Research Institute, Inc. from discussions with various businesses

On the other hand, as summarized in the previous section, the total benefits of watt–bit integration are positive. Not only the establishment of large-scale clusters, but also the installation of regional data centers of type 2-1 (regional cities with abundant renewable energy) and type 2-2 (sites for digital transformation of regions) offer opportunities for securing profits in the long term and from a comprehensive perspective. However, much of the benefit arises as external benefits on the watt side, or for local industries, and does not directly accrue to the data center operators—the main investors. This is the fundamental structure behind the lack of investment by operators in regional data centers.

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Three initiatives for achieving watt–bit integration

To ensure the watt–bit integration does not remain aspirational, it is necessary to structurally resolve the lack of investment incentives for data center operators.

Here, we propose watt–bit 3.0, which, despite still being quite conceptual, is strategically important. We have put together three specific points for making it possible (Figure 4–5).

The first point is **the creation of a watt–bit city model led by prefectural governments.** In order to get regional watt–bit integration on track, it is essential to involve not only the electricity and ICT sectors, but also a wide range of stakeholders including applied industries and government. Municipal governments play a pivotal role in facilitating this collaboration, and prefectural governments bring the planning and leadership abilities crucial for coordinating interests over a wide area and the long-term. Active involvement by prefectural governments will also be a major tailwind for DC operators in terms of ensuring the predictability of investment returns. The initiatives introduced in Kagawa Prefecture in Chapter 3 may serve as a useful reference.

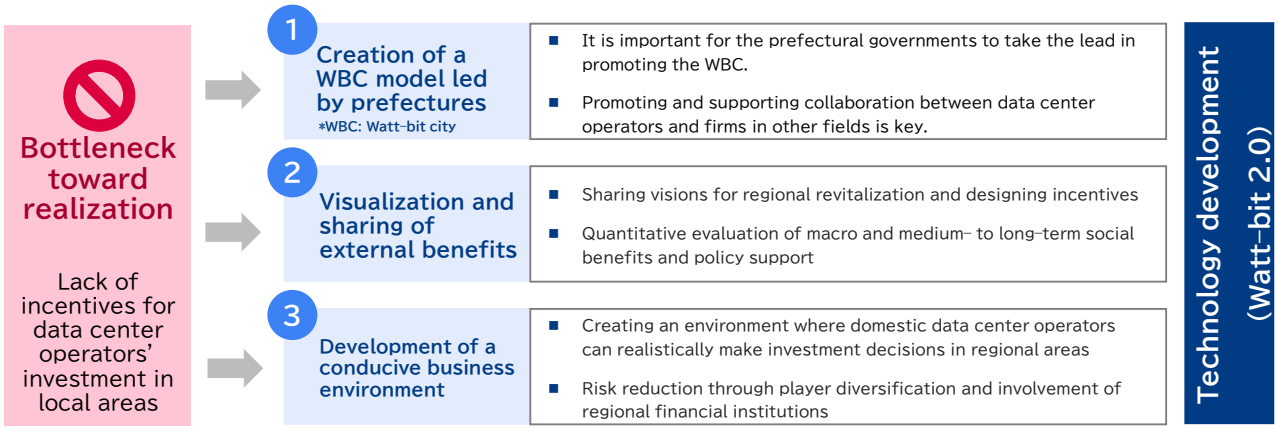
The second point is **the visualization and sharing of external benefits**. As mentioned above, investment in regional DCs is characterized by significant external benefits. It is effective to quantitatively evaluate and provide visualizations of these external benefits from a top-level perspective. It will also be effective to build a mechanism for sharing findings among stakeholders. For example, if renewable-energy power producers and local industries greatly benefit from regional DCs, creating a system to share a portion of those benefits with DC operators could make it possible to attract DC operators with a willingness to contribute to the community ahead of other regions. Sharing of benefits could, for example, be implemented in the form of electricity-rate reductions.[42].

The third point is **the development of a conducive business environment.** Even if long-term profitability can be expected, it does not change the fact that building a DC requires a huge upfront investment. To encourage active investment by domestic DC operators and startups, it is also necessary to diversify risks. For example, it would be effective to form funds mainly through government-affiliated financial institutions or regional financial institutions, and to utilize securitization schemes, such as J-REITs, so that investment risks can be shared among many investors. In addition, the use of subsidies from the national and local governments can also be considered, but it is important to conduct impact evaluations. When evaluating, it is necessary to take a perspective that includes not only the simple development of DCs using subsidies, but also the ripple effects such as whether they lead to regional revitalization.

[42] In South Korea, there is a case where, in 2023, a system was introduced to reduce or exempt electricity-facility usage fees (a three-year temporary measure) when establishing new DCs in regions other than Seoul, Gyeonggi–do, and Incheon. In China's "Eastern Data, Western Computing" project, electricity fees for western DCs are also often significantly reduced or exempted through subsidies

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Figure 4–5　Bottlenecks in watt–bit integration and three measures for solutions



Source: Mitsubishi Research Institute, Inc.

Japan can take the lead in building a unique watt–bit integration model by adding the development of operational technology, or watt–bit 2.0, to integrated execution of these three measures. This would increase benefits and resolve the drawbacks of DC distribution. Japan's cutting-edge ecosystem could also be deployed in other countries, such as those in East Asia, Southeast Asia, and Eastern Europe, which face similar challenges regarding the power consumption of generative AI. For Japan, which faces massive energy and digital-trade deficits, promoting watt–bit integration has the potential to not only curb fossil-fuel imports and payments to overseas cloud services, but also contribute to building a new revenue model in which the country earns foreign currency through the export of schemes that resolve societal issues.

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