Global Research
& Risk Solutions

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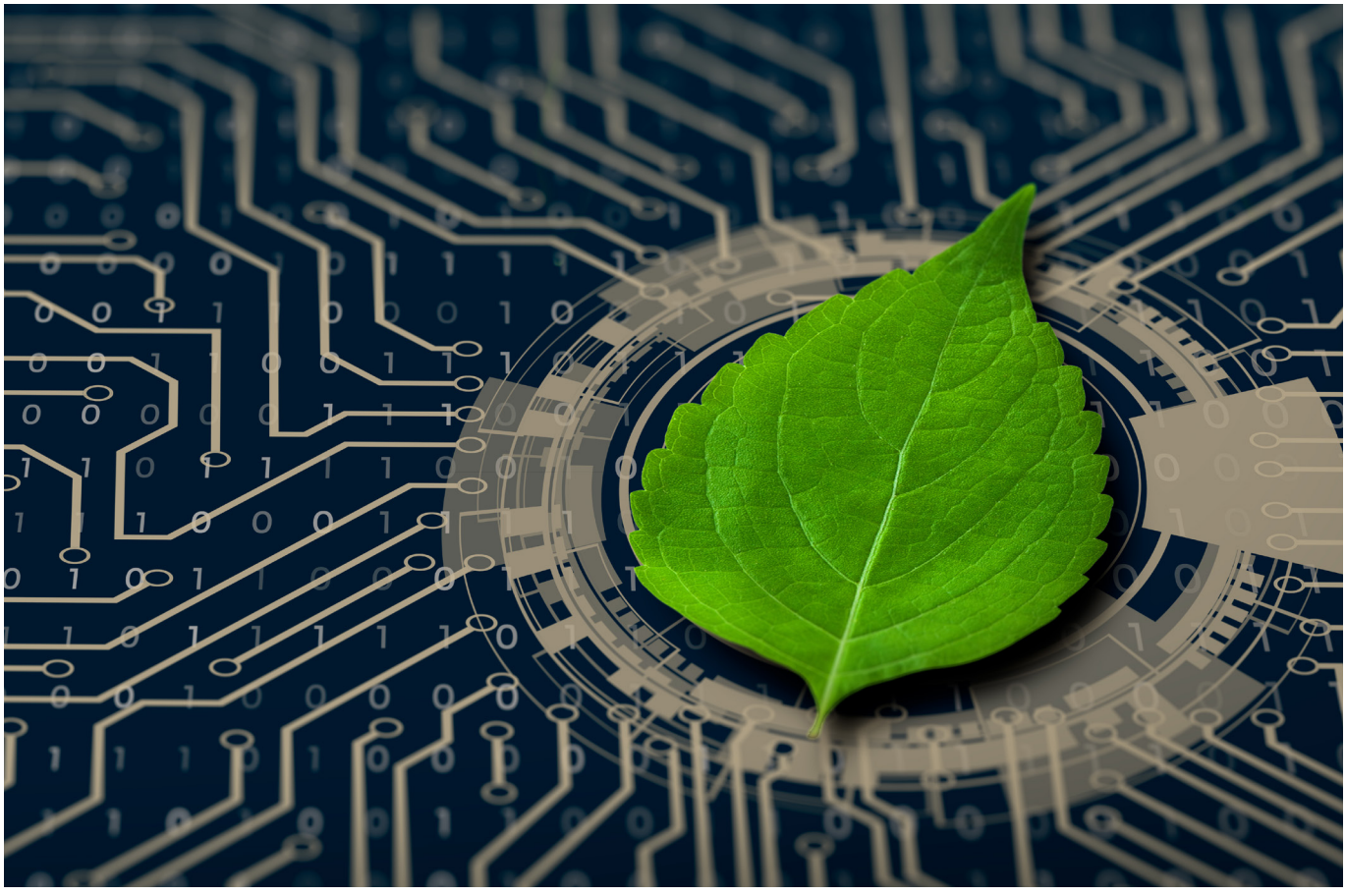
Sustainable IT infrastructure adoption in financial services

The drivers

October 2023



Analytical contacts

Rahul Agarwal
Director
FR ESG
rahul.agarwal@crisil.com

Nikhil Poddar
Associate Director
FR ESG
nikhil.poddar@crisil.com

Maya Mahadevan
Associate Director
FR ESG
maya.mahadevan@crisil.com

Arundhati Kele
Research Analyst
FR ESG
arundhati.kele@crisil.com

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Executive summary

In the pursuit of sustainability, financial institutions (FIs) must recognize the vital role of IT infrastructure. This report highlights the symbiotic relationship between FIs and IT infrastructure providers, emphasizing how FIs' digital transformation and sustainability efforts drive innovation within their supply chains, ultimately benefiting both parties in achieving their sustainability targets.

FIs will need to understand that leveraging 'sustainable' information technology (IT) infrastructure is indispensable to reducing, assessing, and addressing the carbon footprint in their own operations and in their supply chains.

Interestingly, the relationship between FIs and IT infrastructure providers is circular, when seen through the lens of sustainability.

Digital transformation allows for numerous operational benefits alongside reduction in energy consumption and carbon emissions. It leads to greater efficiencies in sourcing raw materials, hardware development, and overall service offerings such as better computation and storage.

As IT infrastructure providers become part of FIs' supply chains, they are bound to incorporate sustainable and innovative technologies in their own operations. The use of renewable energy, artificial intelligence (AI), machine learning (ML), and edge-to-cloud architecture are some examples. This also enables them to achieve their own targets such as Net-Zero carbon emissions.

The report provides a wide range of use cases use cases of where and how select FIs are leveraging IT infrastructure providers in their supply chains in order to achieve sustainable outcomes.

This report, thus, threads the circular linkages between IT infrastructure providers who offer sustainable solutions and FIs, and how they can facilitate meeting their respective sustainability targets.

What is driving adoption of sustainable IT infrastructure

FIs are leaning on technology to stay competitive and increase operational efficiencies

For the financial services business, technology serves as a foundation and a significant contributor to carbon footprint. However, only 23% of banks have a well-defined sustainable technology[1] strategy. Lack of sustainable IT infrastructure and related strategies bear reputational risks for financial services firms.

FIs are increasingly reliant on technology for their day-to-day operations and for providing services globally through digital expansion and transformation. IT infrastructure providers enable FIs to transition into fintech firms from pure-play finance businesses. They also help industry executives achieve ESG-related KPIs.

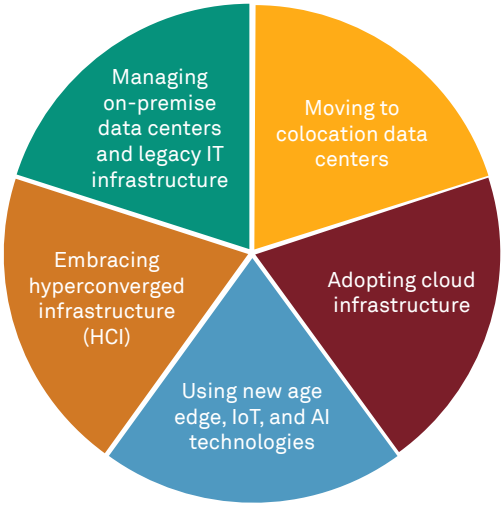
But with technology itself accounting for ~3%[2] of global GHG emissions, its design, implementation, and delivery in a cleaner and greener way is the need of the hour.

Source: Capgemini Report (2021) [3] *, CRISIL GR&RS*

The figure above showcases the tremendous opportunity for FIs to bridge the gap as they will be required to accelerate their sustainable IT initiatives to remain competitive, meet stakeholder demands (including regulatory mandates), and minimize operational and reputational risks.

1 Capgemini 23% banks sustainable IT strategy
2 IT sector's contribution to GHG emissions
3 Capgemini Report (2021)

Transformation to sustainable IT infrastructure



Managing on-premise data centers and legacy IT infrastructure

On-premise data centers refer to the servers and IT infrastructure that the FIs privately own and control.

The benefit of this is that FIs have complete visibility and make all decisions relating to cooling, power, redundancy, bandwidth, and security measures. Any issues that arise can be addressed instantly. On-premise data centers are useful workloads that may be required to be so for regulatory reasons; FIs also handle sensitive data and may be comfortable to keep it within their purview/control. This also includes stored data with respect to data residency norms.

- Data residency refers to the geographical location of data and is often an aspect of FIs' regulatory requirements. For example, certain regulations may require that data is only stored in a specific jurisdiction to ensure that FIs retain such data in their on-premise data centers.

  According to a 2021 survey, data residency (56%) is the top ranked reason why organizations maintain infrastructure outside of the public cloud, far outpacing this number for 2019 (39%)[4].

- Digital infrastructure can be vulnerable to cyberattacks, which can result in significant data breaches and financial losses. In 2019, Capital One experienced a major data breach that affected more than 100 million customers, resulting in a $80 million fine[5].

- A data center in South UK experienced an extended outage due to an incident when several chilled water pumps shut down. The internal temperature for some parts in the data center began to rise above the operational thresholds and automation began shutting down the network, compute, and storage resources to protect data durability. Resultantly, the data

4 IBM-importance of on-premises IT infrastructure
5 Capitol One to Pay $80 Million Fine After 2019 Data Breach (bitdefender.com)
6 Microsoft Azure data center outage in South UK

center was unavailable for critical business services for several hours[6].

As such, FIs will continue to keep a portion of their on-premise IT infrastructure and can incorporate the following sustainable strategies:

- **Power and cooling efficiency:** Effective management of power consumption and cooling is integral for maintaining optimal performance and availability. Power efficiency involves managing the electrical power consumption of a data center's IT equipment, including servers, storage devices and network components. Cooling efficiency involves managing the temperature and humidity levels within a data center to ensure that IT equipment remains within safe operating parameters. To improve power and cooling efficiency in data centers, various technologies and strategies can be employed, including virtualization, liquid cooling, power management, hot and cold aisle containment, etc.
  - JP Morgan Chase[7] uses efficient cooling and ventilation at its data centers, driving overall greater efficiencies. In 2021, the bank joined the Low Carbon Patent Pledge to share the related key patents that enable transition to low-carbon technology.
- **Carbon-free energy and circular economy:** FIs can use renewable energy sources such as solar, wind, and geothermal energy to power their IT

7 JPMC data center cooling efficiency example

infrastructure and invest in energy-efficient systems. They can promote a circular economy by using recycled and refurbished IT equipment, reducing the amount of electronic waste generated. This could help reduce the carbon emissions associated with the production and disposal of electronic equipment. FIs can also promote sustainable practices such as turning off unused IT equipment and implementing power management settings.

  - Goldman Sachs has implemented a new data center that uses outside air for cooling, which contributed to 23% reduced energy consumption in 2020 from 2013 baseline[8].

  - Morgan Stanley committed to carbon neutrality by 2022, and hence, has been sourcing its entire global energy needs from renewable sources since last year. As a part of this commitment, it reduced its data center energy consumption by 20% from the 2012 baseline[9].

- **Energy monitoring and management:** FIs can implement energy monitoring and management systems to track energy consumption and identify areas for improvement. By monitoring energy usage, FIs can optimize their infrastructure for energy efficiency and sustainability.

  - Advanced management solutions, like a leading platform, enable efficient control over conventional IT operations, accelerating the deployment of novel applications and services. This platform effectively handles various server, storage and networking solutions, ensuring streamlined and automated administration of hybrid infrastructure, both currently and in the foreseeable future. Furthermore, its collaboration with external cloud management tools empowers enterprises to enhance the supervision of their diverse workloads spanning from core systems to cloud environments.

Implementing sustainability strategies within FIs' data centers might require dedicated investments. While retaining extensive on-premise systems exposes FIs to increased climate risks and maintenance costs, the rapidly advancing technology and growing demand for high-density computing loads necessitate continuous capital investment in infrastructure. This poses a considerable challenge for privately-owned data centers.

To address the risks associated with physical infrastructure, FIs can consider transitioning to co-location facilities that embrace sustainability strategies, offering opportunities to capitalize on these initiatives without incurring substantial costs. By strategically retaining suitable workloads in-house and migrating others to co-location facilities, FIs can reduce their physical footprint, mitigate climate risks, and lower maintenance expenses. Embracing more advanced and sustainable IT infrastructure also leads to enhanced operational efficiencies, resulting in reduced energy consumption and carbon emissions.

Minimizing the physical footprint emerges as a paramount strategy in curtailing embedded emissions. Opting for intentional consumption and resource-efficient practices not only lessens environmental strain, but also paves the way for a more sustainable future.

To mitigate the risks posed by physical infrastructure, FIs can look at moving to co-location facilities that employ sustainability strategies, which can be leveraged by FIs without incurring related costs. FIs can retain unsuitable workloads with in-house data centers, but move these to co-location facilities to reduce their physical footprint and associated climate risks and maintenance costs, while increasing operational efficiencies from adopting more advanced and sustainable IT infrastructure, resulting in lower energy consumption and carbon emissions.

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8 Goldman Sachs | Our Operational Impact - Carbon, Energy and Business Travel
9 Carbon Neutral by 2022: Renewable Energy | Morgan Stanley

Embracing co-location data centers

FIs can mitigate physical asset risk by moving to co-location facilities where they can rent space for their servers and other computing hardware at a third-party provider's data center facility. Typically, a co-location facility includes the building, cooling, power, bandwidth, and physical security.

Co-location facilities are better suited to manage data centers and employ sustainability strategies. as compared with on-premise IT infrastructure, given their core business is managing and hosting data centers. FIs that move their IT infrastructure to co-location facilities can choose to have their own servers and a private cloud. The co-location facility can benefit FIs by:

- **Server virtualization and consolidation:** Virtualization technology enables FIs to consolidate multiple physical servers onto a single server, reducing the overall number of servers and associated energy consumption. This is done using virtualization software that enables a single physical server to run multiple operating systems and applications in separate virtual environments. Virtualization can also improve server utilization rates, reducing the need for additional hardware and storage consolidation. Here are a few examples of server virtualization:

  - AHV, a server virtualization technology, serves as an integral component of a HCI platform, enabling the generation and administration of virtual machines on dedicated servers[10]. Its prominence stems from its smooth assimilation within the corresponding ecosystem and its effectiveness in optimizing resource allocation.
  - vSphere is a server virtualization software that facilitates the creation of multiple virtual servers on a single physical server. This approach enables IT infrastructure consolidation and minimizes hardware expenses[11].

- **Hardware efficiency:** This refers to how effectively and efficiently hardware devices (such as computers, servers, or data center equipment) use energy and resources to perform their intended tasks. It includes factors such as energy consumption of the device, the amount of heat generated, and the device's ability to perform tasks quickly and accurately. Efficient hardware can help reduce energy consumption costs and minimize waste, which can have both environmental and financial benefits. Hardware efficiency can be measured and evaluated through various metrics, such as power usage effectiveness (PUE) for data centers or energy star ratings for consumer electronics. Manufacturers can also design hardware with efficiency in mind, using energy-efficient components, optimizing cooling systems, and employing other strategies to minimize energy consumption cost and waste.
  - Data center operators emphasize hardware efficiency through virtualization, advanced power management, and water-cooled servers, achieving a notable PUE score under 1.3. This underscores their commitment to lower energy consumption and promote environmentally-friendly practices within their hyperconverged solutions[12].

- **Energy-efficient buildings:** Co-location facilities and other digital infrastructure providers are helping improve energy efficiency in buildings by developing innovative solutions that use smart automation, predictive analytics, energy-efficient hardware, and renewable energy integration. By optimizing energy usage, buildings can reduce their environmental impact, save money, and improve occupant comfort and productivity.
  - A co-location and sustainable data center provider is recognized as a leader in data center sustainability, having developed 34+ data centers with LEED Silver certification and other accolades from certifications such as Energy Star and BREEAM[13].

10 Nutanix AHV
11 Digitization and virtualization - Circular Economy Guide (ceguide.org)
12 NextDC White Paper
13 Digital Realty - Green Data Centers

Challenges faced by co-location facilities

- **Security measures:** FIs prioritize security to protect their critical assets. Co-location facilities offer cost savings and operational efficiency, but raise concerns about shared space compromising security. However, responsible co-location providers implement robust physical and digital security measures to prevent theft and cyberattacks.

  In selecting a co-location solution, caution is advised when entrusting third-party facilities. FIs should conduct thorough assessments of potential partners' security measures to ensure they meet specific requirements and standards.

  – A specialized cloud solution addresses risk and speeds up cloud adoption for sensitive workloads. The platform includes integrated security and controls for automated compliance, and simplified risk management for financial institutions[14].

- **Connectivity:** FIs would have to rely on the bandwidth provided by the co-location facility, which must provide reliable connectivity to the internet and other networks. This requires high-bandwidth connections, redundancy, and diverse routing options to ensure that customers can always access their network.

- However, co-location facilities often offer network back-up solutions, minimizing the loss of connectivity and further enhancing network reliability.

Co-location facilities offer a viable solution for reducing climate risk linked to physical assets and minimizing maintenance expenses, while maintaining robust security measures. Yet, concerns have emerged due to the shared infrastructure, limiting control and visibility for FIs. However, it is crucial to recognize that contemporary co-location facilities have made substantial progress in overcoming these security and operational challenges. Renowned providers now furnish cutting-edge features such as rack-level smart PDUs (power distribution units) and comprehensive online portals, greatly enhancing data oversight, monitoring, and security management for each tenant.

With the implementation of these technologies, FIs can gain a higher level of visibility of their infrastructure's performance, energy consumption, and security measures. These smart PDUs enable granular power monitoring at the rack level, allowing FIs to optimize energy usage and identify potential areas for security and efficiency improvements.

14 *IBM Cloud for Financial Services*

Adopting cloud infrastructure

Cloud infrastructure refers to a comprehensive set of computing resources, including servers, storage, databases, networking, and software applications, that are delivered over the internet on a pay-as-you-go basis. Instead of owning and managing physical hardware and software, FIs can access and utilize these resources from cloud service providers. The cloud offers a range of deployment options that cater to different business needs and objectives. Whether it is enhancing security, scalability, cost-efficiency, or operational agility, FIs can leverage cloud technologies to stay competitive in the rapidly evolving financial industry.

Cloud infrastructure offers the following benefits:

- **Scaling:** Cloud infrastructure offers greater scalability, which refers to the system's ability to scale (allocate/deallocate) resources, allowing FIs to quickly add or remove resources as needed compared with in-house systems that are constrained by the resources available either on-premise or in co-location facilities. This is especially important for FIs that experience spikes in demand or need to rapidly deploy new applications or services.
- **Cost-effectiveness:** The total cost of ownership (TCO) across a five-year period indicates that hybrid cloud and private cloud along with HCI deployment models tend to exhibit a comparatively lower TCO in contrast to the on-prem and public cloud. Hybrid and private cloud solutions along with HCI offer cost advantages due to efficient resource utilization, operational simplicity through unified services and automation, hypervisor, and flexible hardware options. HCI helps in optimizing performance and resource allocation, resulting in lower TCO compared with traditional infrastructure and native public cloud solutions.
- **Agility:** Cloud offers greater agility than on-premise or co-location facilities, which means greater ability to quickly respond to market changes, customer needs, and regulatory requirements. This is because cloud providers can offer new features and services more quickly, owing to the depth resources available at their disposal - both monetary as well as technological.
- **Vendor resilience:** Cloud infrastructure is still evolving and improving, with technology that rapidly fluctuates. Hence, any significant changes in technology would result in re-evaluation of cloud service providers. FIs that rely on just one infrastructure for their entire database could find it difficult to adapt to the changing technology. Hence, FIs should consider using a hybrid and multi-cloud infrastructure to provider resilience against any single cloud service provider. Furthermore, FIs should avoid long vendor lock-in periods and build their own proprietary formats for data storage with portable applications where the core features do not depend on the services of a particular cloud provider.
- **Network redundancy:** This refers to having an alternative network with a different service provider available in case one network fails. FIs that have greater resiliency requirements can employ such strategies using a multi-cloud infrastructure.
- **Decentralization:** When building IT infrastructure, FIs can decentralize or reduce vendor concentration by using hybrid and multi-cloud to integrate multiple service providers/ vendors. Concentration refers to the event wherein one service provider might be hosting several banks in a specific region. resulting in business disruption for not just one but several banks in case of an outage. Hence, FIs can review their concentration across regions and integrate varied service providers to mitigate such a risk.

Cloud forms

Different forms of cloud infrastructure that FIs can consider and the advantages they offer are detailed below:

1. **Private cloud:** This entails an exclusive cloud infrastructure used by a single organization, providing heightened control and security for sensitive data. For FIs, data security and compliance are of paramount importance, making private clouds an attractive option. By leveraging a private cloud, FIs can:

    1. Ensure that critical financial data and applications remain within their controlled environment, reducing the risk of unauthorized access and data breaches.

    2. Optimize performance and meet the unique demands of their financial operations through the ability to customize the infrastructure and allocate internal resources efficiently

2. **Public cloud:** This is a type of cloud computing deployment where third-party cloud service providers own and operate hardware, software, and infrastructure, delivering resources on the internet.

1. Public cloud offers FIs the opportunity to benefit from the provider's economies of scale, resulting in cost savings and enhanced scalability.

2. It enables FIs to access a wide array of services and applications, such as web-based email, office tools and development environments, fostering collaboration and driving innovation.

    While security and compliance remain key considerations, reputable public cloud providers implement robust security measures and certifications to address these concerns effectively.

3. **Hybrid cloud:** This environment combines private and public cloud offerings, presents a compelling option for FIs seeking flexibility and a balanced approach to their cloud strategy. The hybrid cloud allows FIs to keep sensitive financial data on a private cloud while leveraging the cost-effectiveness of the public cloud for non-sensitive workloads. However, integrating and managing both environments can be challenging, particularly when it comes to ensuring seamless API integration, consistent data security measures, and compliance with regulations. FIs must approach the hybrid cloud with careful planning and rigorous security measures to mitigate potential risks.

4. **Multi-cloud:** This approach involves leveraging cloud services from multiple cloud providers, offering FIs the freedom to choose the best features and capabilities from each provider. By adopting a multi-cloud strategy, FIs can:

    1. Avoid vendor lock-in

    2. Enhance resilience

    3. Tailor their infrastructure to meet specific business needs effectively.

However, managing multiple cloud platforms requires careful coordination and integration to ensure seamless data transfer, consistent security measures, and cost optimization. FIs must invest in comprehensive management and monitoring tools to effectively govern their multi-cloud environments.

5. **Hyperconverged infrastructure:** HCI represents a streamlined IT framework that combines compute, storage, networking, and virtualization resources within one cohesive system. It can be deployed on both on-prem and cloud infrastructure. For FIs, HCI offers substantial benefits by: simplifying data center management, enhancing operational efficiency, and facilitating the development of hybrid cloud setups that connect in-house infrastructure with public cloud services.

    This approach enables FIs to retain essential data on-site while expanding their capabilities to the cloud for particular workloads, striking a harmonious equilibrium between security and operational flexibility.

Steps to consider

Moving forward, FIs could use a combination of IT infrastructure where they retain critical and unsuitable workloads in their on-premise data centers and move dynamic and suitable workloads to the cloud, which could be a combination of their own private, public, hybrid or multi-clouds. Moreover, this would align with FIs' sustainability strategy as cloud infrastructure is perceived as inherently sustainable as it operates on the principles of aggregated and shared resources. This leads to better utilization and optimization of available computing resources and energy, driving greater efficiencies.

- **Cloud-native application architecture:** This can help FIs reduce carbon emissions by enabling remote work, optimizing resources, server consolidation, green computing and using energy-efficient data centers, among others.
- **Green cloud optimization:** This refers to the process of optimizing cloud computing resources and operations to reduce energy consumption, carbon emissions, and overall environmental impact. The goal of green cloud optimization is to ensure cloud computing is as sustainable and environmentally friendly as possible.
  - Capital One reported expected savings of 10 megawatt of power per year by migrating to a cloud-native architecture and exiting its data centers[15].
  - Santander has reported a 70% reduction in IT infrastructure energy consumption through the implementation of cloud native architecture[16].
- **Compute utilization:** This refers to the amount of computing resources that are being used in each period such as CPU cycles, memory, storage, and network bandwidth. In the context of sustainable IT infrastructure, compute utilization is an important factor to consider because it directly impacts energy consumption and carbon emissions. High compute utilization means the IT infrastructure is being used efficiently and effectively, maximizing the use of available resources while minimizing waste. This can help reduce energy consumption of data centers and other IT infrastructure, leading to a corresponding reduction in carbon emissions.
  - A collaboration led to a significant computing transformation for RBL Bank, resulting in remarkable improvement in the performance of call-center apps and databases, leading to quicker login times and a 35% increase in staff efficiency. This enhanced customer interactions and cross-selling capabilities, freeing up 160 hours daily for customer engagement. This agility facilitated rapid adaptation, doubling transactions overnight and effectively managing a 75% call volume surge during the Covid-19 pandemic. This shift made computing a central component of RBL Bank's evolution, leveraging utilization to excel in service and operations[17].
- **Sustainable software engineering:** This is the practice of developing software applications and systems that are environmentally and socially sustainable throughout their entire lifecycle, right from design to disposal. It involves considering the impact of software development and usage on the environment, as well as the social and ethical implications of the software. Energy-efficient coding, digital transformation from legacy/paper-based work, remote work, and cloud computing are ways to implement this.
- **Flexibility to deal with unpredictable workloads:** Digital infrastructure providers are adopting a more agile and flexible approach to managing unpredictable workloads, leveraging the latest technologies and best practices to ensure their systems can adapt to changing demands quickly and efficiently.

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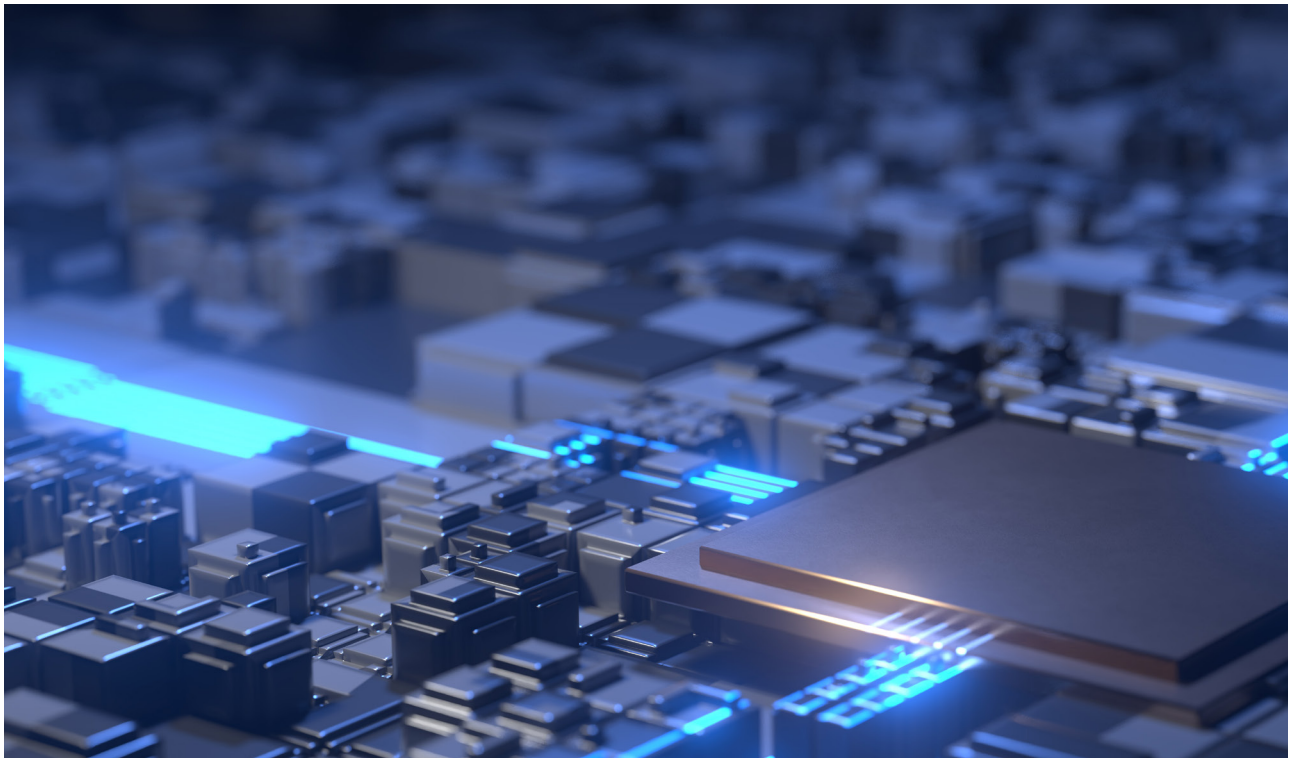
15 Capital One Brings Sustainability to Its Cloud Migration/AWS for Industries (amazon.com)
16 Santander energy consumption reduction
17 Nutanix and RBL Bank



- **Scalability:** FIs are using cloud-based infrastructure that can be scaled up or down depending on workload demand. This means they can quickly allocate more resources when the workload is high and vice versa.
    - A well-recognized provider of cloud services offers a range of scalable solutions such as Cloud Virtual Servers, Kubernetes Service, and Cloud Functions. These services can be readily adjusted to scale according to requirements[18].
- **Automation:** FIs are leveraging automation tools and technologies to automate routine tasks, such as scaling up and down resources, balancing load, and provisioning new instances. This helps them respond quickly and efficiently to changes in workload demand.
    - A comprehensive set of tools is available for automated workload management, including Autoscaler that dynamically adjusts instance numbers as demand changes, and Stackdriver, which offers real-time monitoring and insights into workload performance[19].
- **Analytics:** FIs are using data analytics to predict and forecast workload demand based on historical data, user behavior, and other factors. This helps them plan and allocate resources in advance, minimizing the risk of unexpected spikes in workload demand.

18 IBM Cloud Free Tier | IBM
19 Migration to Google Cloud: Deploying your workloads

    - An advanced feature is available for predictive scaling, utilizing machine learning (ML) algorithms to predict future workload demand. This is complemented by auto-scaling capabilities that dynamically adjust instance numbers based on changes in demand[20].

  - **Resource pooling:** FIs are pooling their resources and distributing them across multiple data centers and regions. This ensures the workload is distributed evenly and can be handled by different parts of the infrastructure, reducing the risk of overload or downtime.

    - Enterprises can harness cloud computing offerings from various providers to access on-demand computing resources such as storage, processing capabilities, and network bandwidth. These providers employ resource pooling strategies to enhance resource usage efficiency and minimize inefficiencies.

- **Dynamic voltage and frequency scaling (DVFS) and energy optimization:** This technique is used to reduce the energy consumption of computing devices by adjusting the operating voltage and frequency of the processor based on workload. Cloud providers use this technique to improve the energy efficiency of their data centers and reduce their carbon footprint. Some options for DVFS to help achieve sustainable outcomes are as follows:

  - **Energy savings:** DVFS allows cloud providers to reduce energy consumption by dynamically adjusting the voltage and frequency of processors based on workload. This helps reduce the overall energy consumption of data centers, leading to lower energy bills and carbon emissions.

    - DVFS has been integrated into the Elastic Compute Cloud (EC2) instances to enhance energy efficiency and performance. By dynamically adapting the voltage and frequency of processors according to the workload, this optimization technique effectively minimizes energy consumption and resource wastage[21].

  - **Improved performance:** DVFS can also help cloud providers optimize the performance of their computing infrastructure. By dynamically adjusting the voltage and frequency of processors, cloud providers can ensure the processors are running at the most efficient level for the workload, which can improve overall performance.

    - DVFS is employed by a certain cloud provider to lower energy consumption and carbon emissions within its data centers. The provider continually monitors server performance and dynamically tunes the voltage and frequency of processors to maintain optimal efficiency levels[22].

  - **Resource allocation:** Cloud providers can use DVFS to allocate computing resources more efficiently. By dynamically adjusting the voltage and frequency of processors, cloud providers can better match the computing capacity to the workload, reducing the number of idle resources and increasing overall efficiency.

    - DVFS has been integrated into the cloud infrastructure of a certain provider to enhance performance and lower energy consumption. Through dynamic adjustments of processor voltage and frequency in response to varying workloads, the provider effectively optimizes computing resources and mitigates energy wastage.

  - **Flexibility:** DVFS allows cloud providers to adjust the voltage and frequency of processors on demand, providing greater

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20 Predictive scaling for Amazon EC2 Auto Scaling - Amazon EC2 Auto Scaling
21 Secure and resizable cloud compute – Amazon EC2 – Amazon Web Services
22 Predict; Do not React for Enabling Efficient Fine Grain DVFS in GPUs - Microsoft Research

flexibility and responsiveness to changing workloads.

- DVFS has been incorporated into a cloud infrastructure to enhance performance and decrease energy consumption. Through dynamic voltage and frequency adjustments of processors, the cloud infrastructure effectively optimizes computing resources and curbs energy wastage[23].

- **Significant investment in renewable energy to power operations:** Digital infrastructure providers such as cloud providers and co-location facilities can invest in large-scale renewable energy projects (such as solar, wind, hydroelectric, and geothermal) to power their operations, thereby reducing carbon footprint and promoting sustainability. FIs can benefit from this trend as selecting a carbon-neutral service provider would help them meet their sustainability goals.

Solar power: A technology company has installed over 1.6 million solar panels across its data centers and offices, generating the same amount of renewable energy as 65,000 home rooftop solar systems[24].

Wind power: A technology company has entered into long-term power purchase agreements (PPAs) with wind farms in Texas to increase the amount of renewable energy on the grid and reduce its carbon footprint[25].

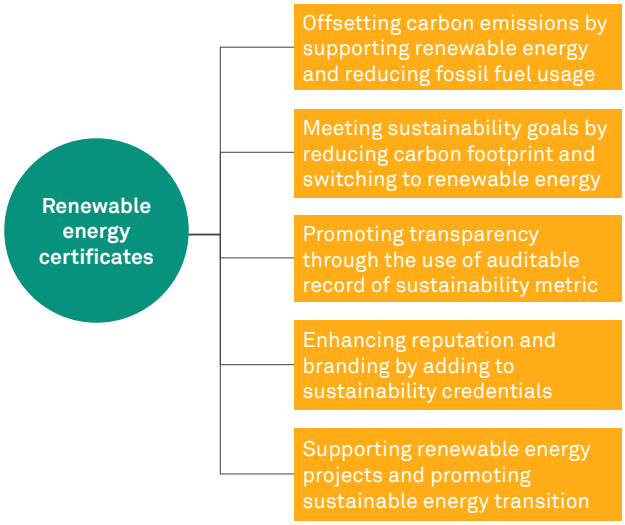
Hydroelectric power: A designer and builder of innovative co-location data centers in Norway, uses 100% renewable hydropower for all its data centers' daily operations[26].

Geothermal power: A technology company operates a data center in Nevada that is expected to be powered by geothermal energy[27].

23 Nutanix AHV
24 Google: 1.6 million solar panels will power these new data centers | ZDNET
25 Microsoft and ENGIE announce innovative renewable initiatives - Stories
26 Green Mountain Hydropower example
27 Google geothermal power

Another way to promote renewable energy usage has been the purchase and sale of RECs. An REC is a tradeable commodity that represents the rights to sustainable electricity generation. RECs may be issued by those with the authority to do so and require one megawatt-hour (MWh) of electricity to be generated from a renewable energy source and delivered to the electricity grid. RECs are used where installation of renewable energy systems is not feasible for companies.

– RECs are employed to counterbalance carbon emissions stemming from non-renewable sources. In 2021, a significant quantity of renewable energy, totaling 12,969,246 MWh, was procured through RECs and long-term power purchase agreements (PPAs) at predetermined rates by a cloud service provider[28].



Source: CRISIL GR&RS

However, it is worth noting that offsetting of carbon emissions by purchasing RECs may not be accepted as a suitable Net-Zero transition plan by organizations such as the Science Based Targets initiative (SBTi). IT providers offering sustainable computing solutions should, therefore, focus on implementing energy-efficient practices and directly sourcing renewable energy to reduce their carbon footprint.

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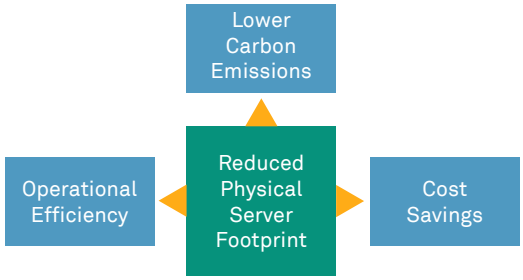
28 Amazon uses RECs

Integrating HCI with IT infrastructure

FIs today navigate a complex and interdependent landscape of cloud strategies, with options such as public cloud offering scalability and agility for innovation, yet raising security concerns for sensitive data. Private cloud, while ensuring control and security, may lack scalability, especially for a single organization that needs significant investment for expansion. Hybrid cloud strikes a balance, enabling FIs to secure critical data while harnessing public cloud scalability. Multi-cloud takes flexibility a step further, reducing vendor lock-in and bolstering resilience, yet demanding meticulous management. FIs, in practice, often rely on a mix of these strategies to effectively meet their diverse needs, achieving a delicate equilibrium between control, scalability, cost-efficiency, and innovation in their operations.

HCI and sustainability: HCI is a robust component for on-premises infrastructure. While it can also be utilized effectively in cloud environments, its primary strength lies in enhancing on-premises infrastructure and driving improved sustainability outcomes in this context.



1. Reduced physical server footprint: HCI simplifies data center management by integrating compute, storage, networking, and virtualization into a single system. This consolidation reduces the number of physical servers needed, decreasing power consumption and physical space requirements.

2. Lower carbon emissions: As a result of reduced physical server deployment, FIs can significantly reduce their carbon footprint. According to IDC, organizations adopting HCI can achieve an average reduction of 57,500 kg of carbon dioxide (CO2) per year. This aligns with the growing importance

of sustainability efforts in today's business landscape.

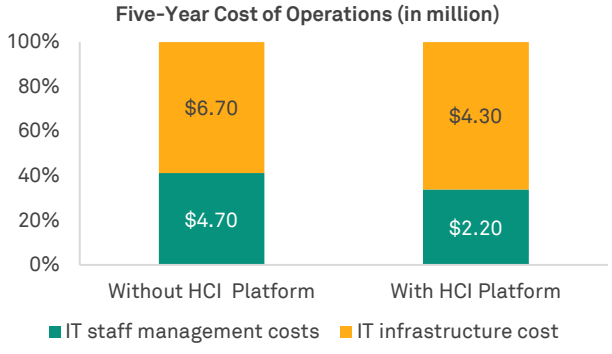
3. Cost savings: HCI not only reduces infrastructure costs by optimizing resource utilization, but also lowers operational costs due to improved management capabilities. Over five years, organizations can achieve a 43% reduction in their cost of operations for infrastructure.

IT Infrastructure Management Staff Impact

	Before HCI Platform	With HCI Platform	Difference (FTEs)	Benefit
IT infrastructure management - FTE equivalent per organization	9.4	4.5	5	53%
Equivalent value of staff time per year	$943,800	$447,100	$497,700	53%

4. Operational efficiency: The streamlined management of HCI simplifies IT operations, reducing the need for extensive physical infrastructure and associated maintenance. This efficiency not only saves costs, but also reduces the environmental impact of IT operations.

In summary, HCI offers FIs an environmentally conscious approach to manage their on-premises infrastructure. By consolidating resources and improving efficiency, it contributes to reduced carbon emissions and overall sustainability, making it a valuable addition to their IT infrastructure toolkit. When combined with cloud strategies, FIs can achieve a holistic IT environment that balances control, scalability, and sustainability.



Examples of integrating HCI:

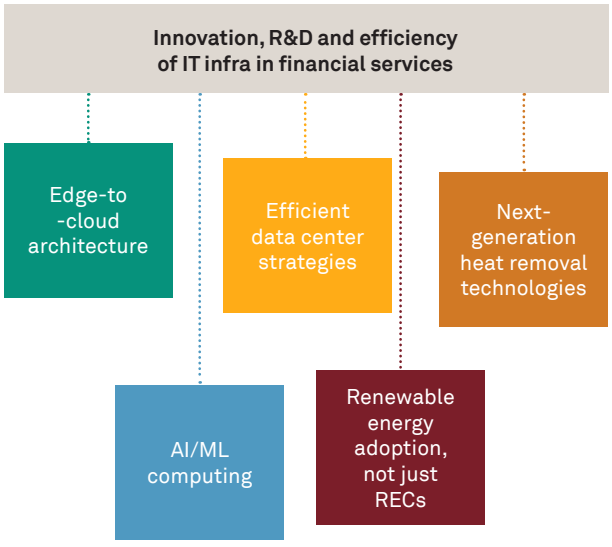
- Laxmi Bank successfully underwent a digital transformation that yielded impressive outcomes, including a 50% reduction in IT administration, a shift from days to hours in software deployment time, seamless one-click upgrades, a swift system reboot process, an 87% processing performance boost, a 50% decrease in hardware usage, and a 30% reduction in power consumption. The bank also fortified its disaster recovery capabilities and established a foundation for a private cloud strategy. These achievements translated to streamlined operations, enhanced IT efficiency, improved application performance, reduced costs, and reliable disaster recovery, positioning Laxmi Bank competitively to meet evolving customer expectations and provide top-notch digital banking services[29].
- Penn National Insurance transitioned to a hybrid cloud infrastructure to simplify its VDI deployment and rapidly deploy new virtual desktops for disaster recovery (DR) purposes. It utilized a management interface to monitor and manage the cloud clusters seamlessly, whether on-premises or in the cloud. This hybrid multi-cloud solution effectively reduced both operational and capital expenses. As a result, the time required for system upgrades was shortened from several months to just a few hours, DR processes were expedited from several days to under two hours, and database configuration tasks were reduced from over a week to just 45 minutes[30].

29 Nutanix-On-premise solution with hyperconverged infrastructure
30 Nutanix-Multi and Hybrid Cloud for Penn-national-insurance

Using new-age technologies such as Edge, internet of things (IoT), and artificial intelligence (AI)/machine learning (ML)

IT infrastructure providers play a critical role in supporting sustainable infrastructure within the financial services industry. Through innovation, these providers can enhance operational efficiency while simultaneously reducing opportunity costs associated with transformation, transition, or adoption processes.

In the financial services sector, technology plays a pivotal role in delivering seamless and secure services to customers. The industry deals with vast volumes of data, demands real-time processing capabilities, and must adhere to stringent security and compliance regulations. Consequently, IT infrastructure providers are essential in ensuring that the financial services industry effectively leverages cutting-edge technologies to remain competitive and meet its unique requirements.



Source: CRISIL GR&RS

1. **Implementing edge-to-cloud architecture:** Implementing edge-to-cloud architecture: This approach to computing involves integrating edge devices and cloud computing resources to provide a seamless computing experience.

1. By processing data at the edge, close to the user, it minimizes the need for extensive data movement, thereby reducing network latency and energy consumption associated with transmitting large amounts of data to distant data centers.

2. In this architecture, data is collected and processed locally at the edge by devices such as sensors, cameras, and other IoT devices. Local processing reduces the reliance on central data centers, which can lead to a potential net benefit for sustainability due to lower energy consumption and reduced carbon footprint.

3. The edge-to-cloud architecture retains the pay-per-use model and computing resources of the cloud, while bringing in the ability to process real-time, critical user data at maximum speed.

   For the financial services industry, this means improved operational efficiency, better customer experiences, and enhanced security. The relevance of edge technology for the financial services industry is evident in various applications.

   1: For instance, edge computing can be applied to ATM/kiosk operations, where local processing of transaction data can reduce the response time and improve overall user experience.

   2: Moreover, portfolio companies can leverage thin-edge capabilities to process data locally, enabling real-time analysis of financial trends and risk assessment.

By incorporating edge technology into their enterprise solutions, FIs would not only enhance their service delivery, but also align with sustainability goals through reduced data movement, lower energy consumption, and improved overall efficiency.

Fraud detection

- Collect data from ATMs, point-of-sale systems, and other devices
- Analyze data from multiple sources in real time
- Transmit to the cloud for analysis, enabling faster response to fraudulent activity

Risk management

- Collect and analyze market, customer, and transaction data
- Enable FIs to make better decisions and reduce risk

Customer experience

- Collect and analyze market, customer, and transaction data
- Enable FIs to make better decisions and reduce risk

Physical asset management

- Collect and analyze data from sensors and other devices in real time
- Monitor and manage assets more efficiently and proactively
- Reduce maintenance costs and improve asset performance

Source: CRISIL GR&RS

Some examples of edge-to-cloud implementation in FIs are as follows:

- Capital One is using edge computing and cloud technologies to improve its fraud detection capabilities. The company has developed a platform that uses ML and advanced analytics to detect and prevent fraud in real time[31].
- Citigroup is using edge computing and cloud technologies to improve its customer experience. The company has developed a platform CitiConnect, which uses ML and advanced analytics to provide personalized services and more relevant products to customers[32].

2. **AI/ML computing:** AI and ML technologies play a crucial role in improving the sustainability of data centers by optimizing energy usage, enhancing maintenance strategies, efficiently managing workloads, and reducing downtime through predictive maintenance.

   Energy optimization: AI and ML analyze real-time data to minimize energy use by controlling hardware and cooling systems efficiently.

   Maintenance efficiency: Predictive maintenance models prevent unplanned downtime by forecasting equipment needs based on historical and real-time data.

   Workload automation: AI allocates resources smartly, reducing energy waste during low-demand periods, ensuring optimal resource use.

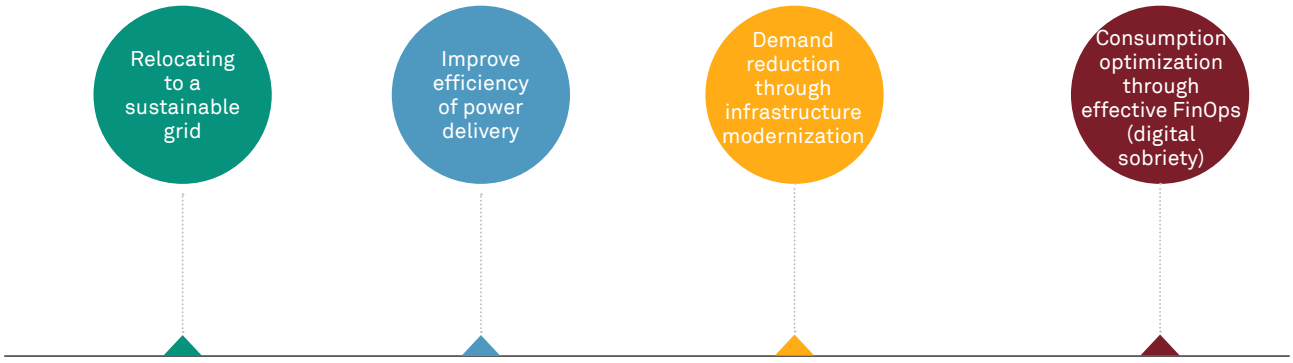
   Monitoring and reporting: Continuous tracking using measurable indicators helps identify areas for improvement in energy efficiency.

- Charles Schwab[33], a financial services company, uses robo-advisors for automating investment portfolios. The platform provides automated investment advice to customers and uses AI/ML algorithms to analyze customer data and provide personalized investment recommendations based on individual investor goals and risk tolerance.
- AI-powered chatbots[34] are being used across the financial services industry to enable faster and round-the-clock customer service. Banks and insurance firms, among others, have adopted chatbots to help retrieve balance, report stolen or lost cards, track historical spending, pay bills/premiums, and receive timely alerts.
- BPM[35], the business process management division of a notable technology corporation, offers analytics powered by ML to aid FIs in identifying credit card fraud or irregular usage. Utilizing predictive analytics, models are trained to evaluate the likelihood of fraud and monitor atypical transactions.

3. **Efficient data center strategies:** Such strategies are essential for FIs to responsibly manage and store their data. While multiple options are

31 AI & ML in Banking with Humans at the Center | Capital One
32 CitiConnect® | Channel Services | Treasury and Trade Solutions (citibank.com)
33 Charles Schwab case study
34 Banking chatbots
35 Infosys BPM ML

available, HCI emerges as a valuable choice due to its capacity to optimize server utilization, decrease energy consumption using low-power components and innovative cooling technologies, and seamlessly integrate workload management for sustainable grids. HCI's adaptability, scalability, and seamless integration with hybrid multi-cloud and edge-to-cloud computing paradigms make it a compelling choice, ensuring cost-effective operations while aligning with the organization's goals of transforming data centers for maximum efficiency and reduced environmental impact. FIs can prioritize vendors who have access to lower carbon emitting regions, such as Sweden, France, Brazil, or environmentally responsible data centers in the US, to reduce their carbon footprint[36].



Sustainable and efficient data center strategies

Source: CRISIL GR&RS

There are various data center efficiency strategies that can be implemented, and sustainability tools and calculators can help with suggestions and monitoring of these strategies.

- Flowe, an Italian bank, uses cloud and banking sustainability tool to measure and reduce its carbon footprint. The tool provides a detailed analysis of the bank's energy consumption and carbon emissions, breaking down the data by location, data center, and individual server. Based on the insights provided by the sustainability calculator, Flowe has been able to reduce its carbon footprint and become carbon neutral[37].

4. **Next-generation heat removal technologies:** IT infrastructure providers are investing in new technologies that can improve efficiency of heat removal and reduce energy consumption of data centers, ultimately reducing costs and improving sustainability. In recent years, focus on developing more advanced heat removal and cooling technologies for data centers has intensified. These technologies include direct liquid cooling, immersion cooling, and liquid immersion cooling.

- A technology company has introduced StatePoint Liquid Cooling, an innovative data center cooling solution that employs water rather than air to dissipate heat from servers. This system has the potential to lower water usage by as much as 20% in comparison to conventional air-cooled systems[38].
- The ThinkSystem SR650 server incorporates a rear-door heat exchanger that employs water

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36 Climatiq.io
37 Temenos Launches Carbon Emissions Calculator on Temenos Banking Cloud - Temenos
38 StatePoint Liquid Cooling system for data centers - Engineering at Meta (fb.com)

for heat removal from the server's components, resulting in energy efficiency gains of up to 40% compared with standard air-cooled systems[39,40].

5. **Circularity and waste management:** Digital infrastructure providers are focused on developing innovative solutions that focus on the treatment of used water, reduction of waste, and recycling and reuse practices. By promoting circularity, they are helping businesses reduce their environmental impact, save money, and create more sustainable products and services.

- A cloud service provider utilizes sensors and IoT devices to actively monitor water usage, pinpoint inefficiencies, and instantly detect leaks. This empowers users to curtail water consumption and avert wastage effectively[41].
- A technology company has pioneered circular supply-chain management solutions, enabling enterprises to oversee their product life cycles comprehensively. Another organization has adopted this system to trace the origin of raw materials and assess supplier sustainability, fostering recycling and reuse initiatives while minimizing waste[42,43].

It is, however, important to note that these new-age technologies may help FIs achieve their sustainability goals, they are at a nascent stage in terms of evolution and are as yet unproven at scale.

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39 Lenovo ThinkSystem SR650 | Rack Servers
40 Lenovo ThinkSystem SR650 Server (Xeon SP Gen 1 / Gen 2) Product Guide > Lenovo Press
41 Microsoft Azure - IoT for water management
42 Circular Economy Solutions & Software | Zero Waste | SAP
43 Circular Economy - SGEF (societegenerale.com)

Unlocking the potential to drive sustainability via partnership with IT

The sustainability strategies outlined above, such as increasing renewable energy use, implementation of energy-efficiency and green computing through use of cloud-based infrastructure, adoption of a circular economy, and investing in carbon offsets, can help infrastructure providers reduce their carbon footprint. Meanwhile, active, consistent efforts and investments are required to achieve a carbon negative status.

- JPMorgan Chase has committed to financing and facilitating $200 billion in clean energy and sustainable development projects by 2025. To achieve this, the bank has invested in several CCS projects, including a partnership with ExxonMobil to develop new CCS technologies and a project with Carbon Clean Solutions to capture carbon emissions from a steel plant in India.

Overall, some FIs might find that the initial cost of digitalizing infrastructure is significantly high and legacy systems are not always compatible with digital infrastructure, which can result in additional costs and delays.

- JPMorgan Chase reportedly invested over $12 billion in technology in 2019, with a significant portion going towards digitalizing its infrastructure.
- HSBC reported challenges in integrating its legacy systems with new digital infrastructure, resulting in additional costs and delays .

However, there are several benefits that outweigh the cost of incorporating digital infrastructure, such as:

- **Increased efficiency:** Digital infrastructure can automate processes and streamline operations, resulting in increased efficiency and reduced costs.
  - Bank of America reported a 23% increase in efficiency following the implementation of digital infrastructure, resulting in cost savings of $2.1 billion in 2019.
- **Improved customer experience:** Digital infrastructure can provide customers with faster and more convenient access to financial services, improving overall customer satisfaction.
  - Ally Financial has implemented a digital platform for its auto lending business, resulting in faster loan processing and improved customer satisfaction.
- **Better data management:** Digital infrastructure can provide real-time data insights, helping FIs make informed decisions and improve risk management.
  - Mastercard has implemented a data analytics platform that provides real-time insights into payment transactions, enabling better fraud detection and risk management.
- **Enhanced sustainability:** Digital infrastructure can enable FIs to reduce their carbon footprint and contribute to broader sustainability goals by implementing sustainable strategies, such as energy-efficient data centers.
  - Wells Fargo has implemented sustainable strategies for its IT infrastructure, including use of energy-efficient data centers and renewable energy sources, resulting in a 100% renewable energy target for its global operations.

These are just a few examples of how FIs' adoption of digital infrastructure has been both challenging and beneficial. The specific experiences can vary depending on the institution's size, industry, and geographic location.

In conclusion, financial services companies are at a vantage point where they can use their resources to define a sustainable IT infrastructure policy and implement it efficiently with select partners to achieve positive outcomes.

The IT services sector has grown by leaps and bounds in providing efficient IT infrastructure possibilities. However, given the evolving nature of IT infrastructure technologies, FIs and IT service providers need to come together to develop and scale these offerings to achieve common sustainability goals. Though this may seem like a tall order, it is certainly achievable.

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