Java sustainability on Microsoft Azure

OpenTour 2023

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Red Hat | Microsoft

Topics

- Why do we need to think of IT sustainability
- Java and Sustainability
- Microsoft Azure Sustainability
- Gains from Java Modernisation
- Customer examples & Economical view
- Where do we go from here?
- Discussion / Questions

What is Azure Red Hat OpenShift?

- Focus on building and scaling applications while we manage the rest.

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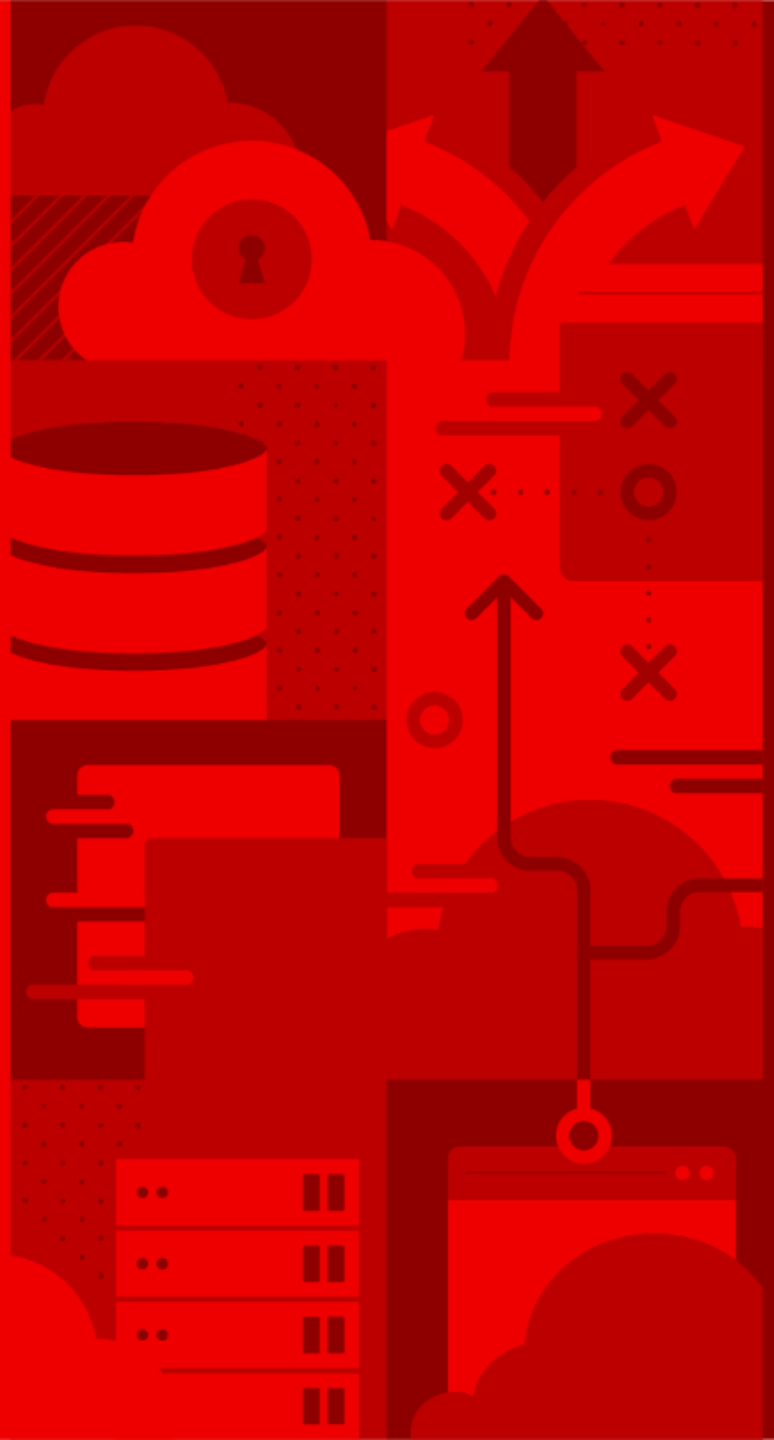
Highly available, fully managed clusters on-demand, built on industry-leading Red Hat OpenShift Container Platform, and managed on a leading public cloud, Microsoft Azure.

Jointly monitored and operated by Microsoft and Red Hat with an integrated support experience.

Turnkey application development platform, with integrations into Azure ecosystem

Enterprise-grade operations, security and compliance

Backed by the experience of global site reliability expert (SRE) teams.



Why do we need to think of IT sustainability?

The Global Climate situation

Climate change – Our most significant challenge ahead

What is the risk?

- ➔ Climate action failure - is the number 1 risk over the next decade*
- ➔ We are on a spiral downwards if we do not do anything now
- ➔ Impossible to sustain life as we know it over time on Earth

How did we get here?

- ➔ 4th Industrial revolution - "The age of Software" (started around 2011)
- ➔ Climate change is caused by human emissions of Co2,
  - ◆ GreenHouse Gasses (GHG),
  - ◆ Overpopulation,
  - ◆ Increased loss of biodiversity,
  - ◆ Exploration of earth metals
  - ◆ Increased waste

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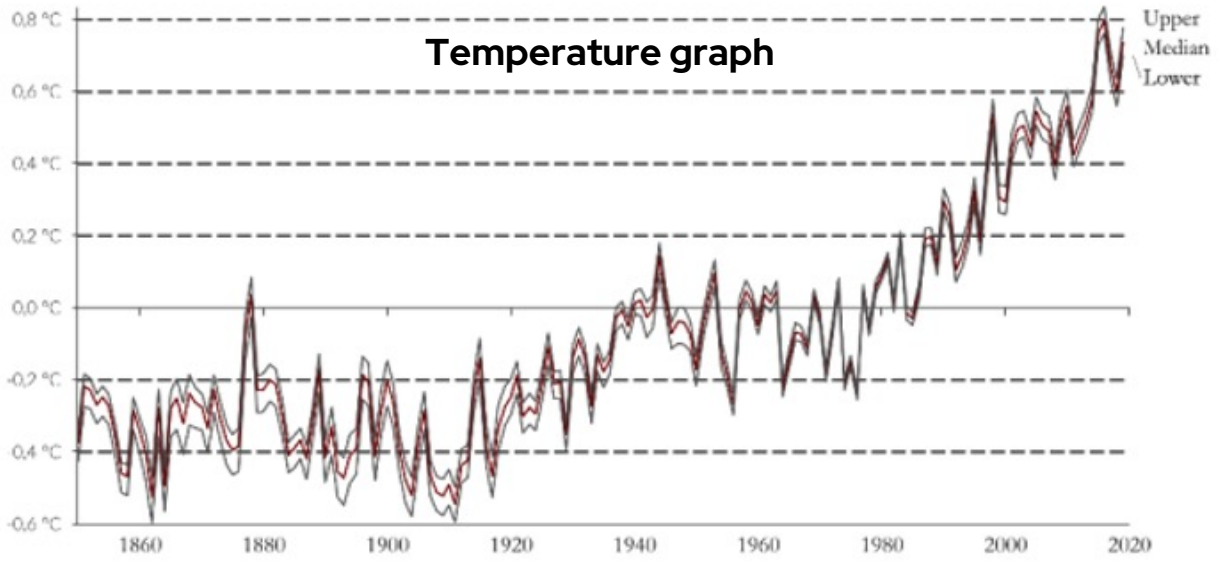
https://www.weforum.org/agenda/2016/01/what-is-the-fourth-industrial-revolution/

How are we impacted globally?

- ➔ Extreme heat / heat trapping
- ➔ Cold where it was not before
- ➔ Massive precipitation (rain)
- ➔ Drought
- ➔ Wildfires



Resulting in devastated lifes, economic downturns regionally and more

Sources: World Economic forum - 2022 Global risk report, IPCC Part 2 report
https://www.weforum.org/agenda/2016/01/what-is-the-fourth-industrial-revolution/

Photograph: Spanish defence ministry/EPA / BBC.com

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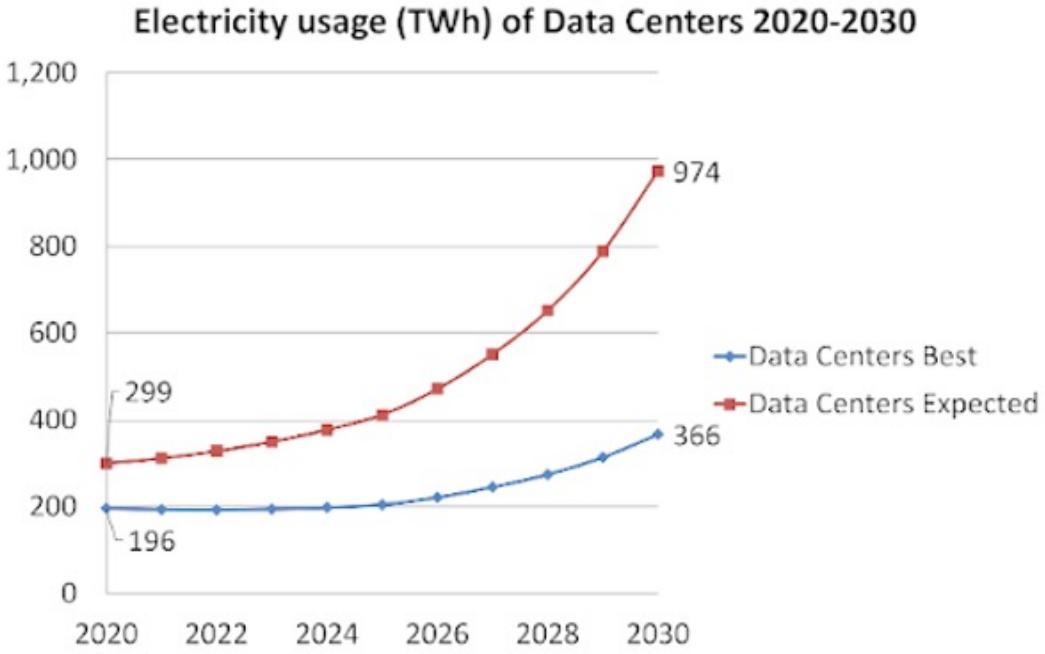
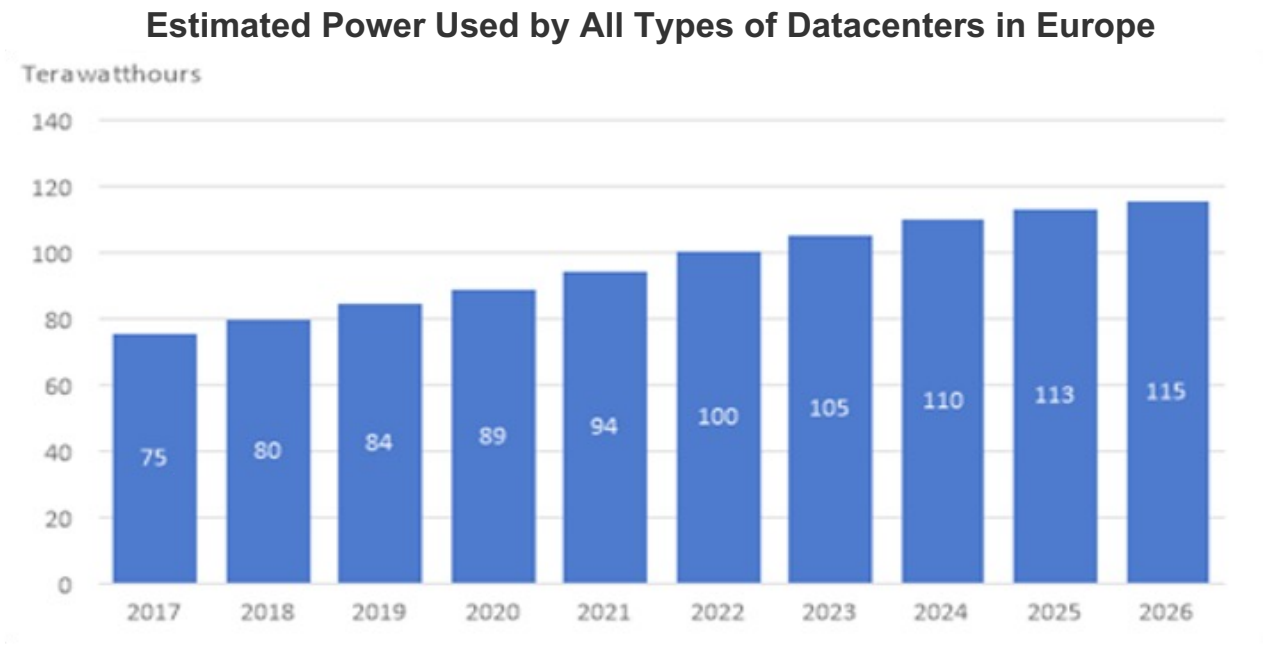
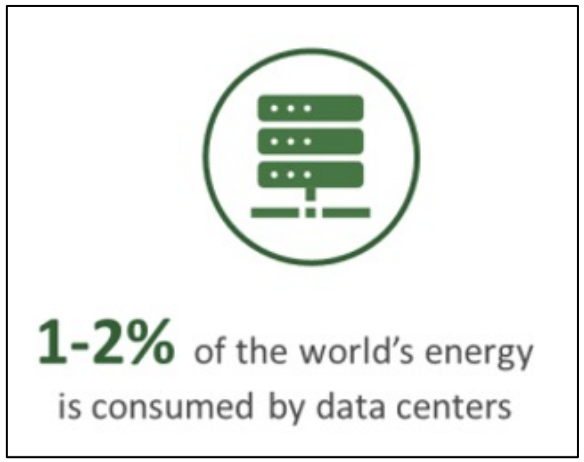
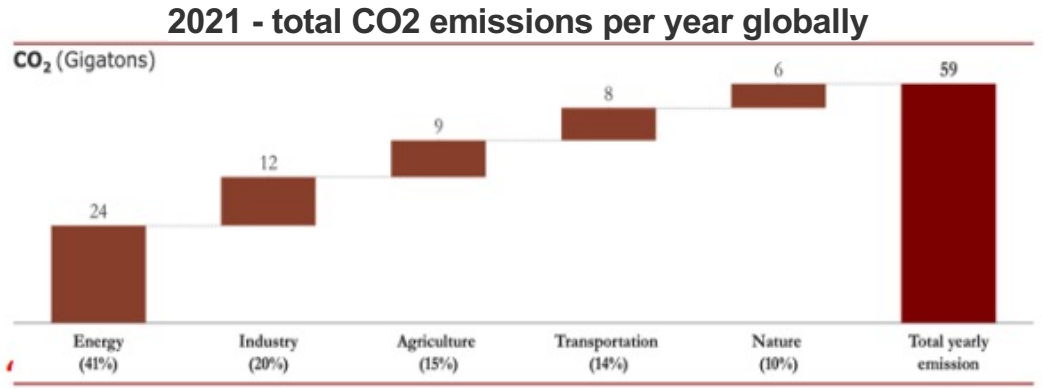
Energy consumption & emissions









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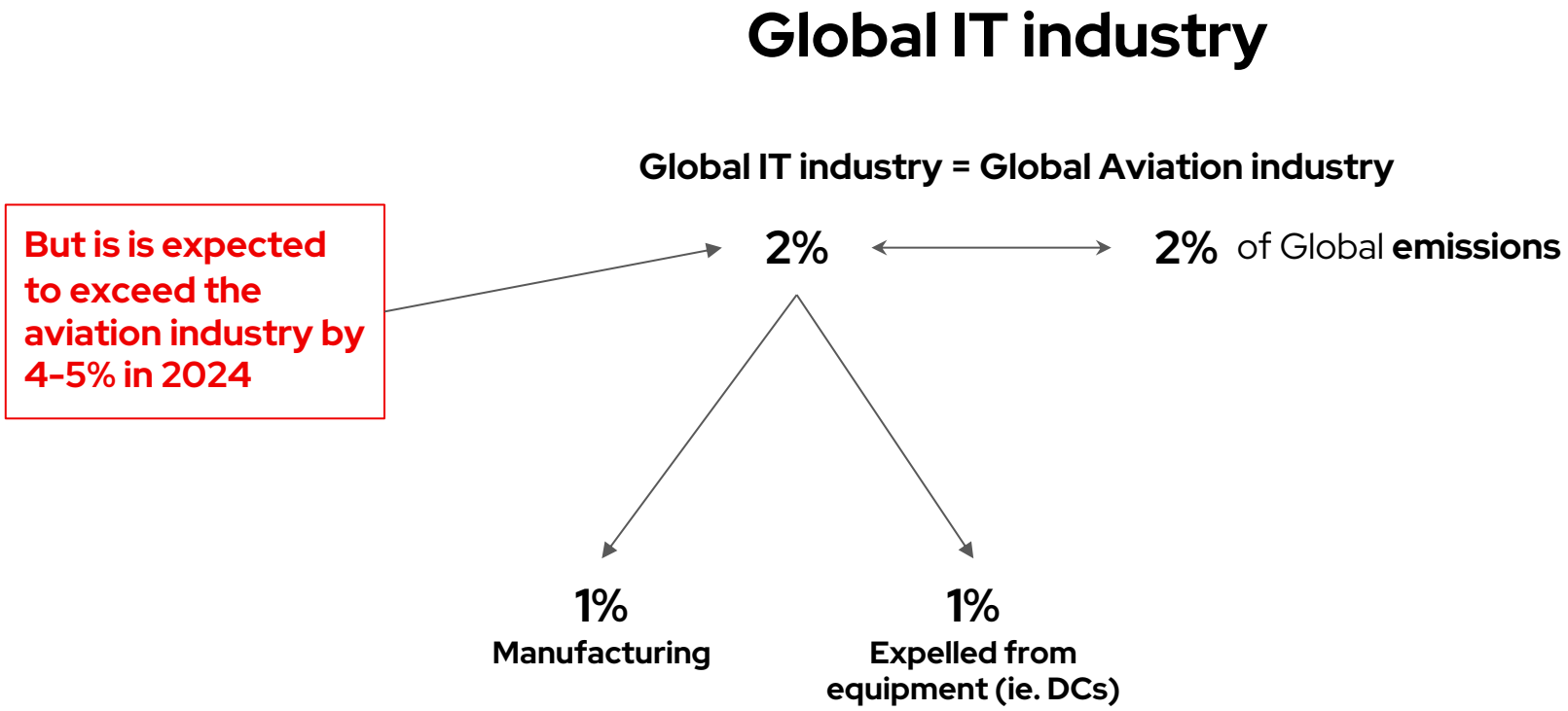
Sources: Source: 451 Research's Datacenter Market Monitor, 2021, Niklas Sundberg, Doerr 2021. 1 Gigaton = 10,000 fully-loaded U.S. aircraft carriers.

Global IT industry emissions



Sources: IEA2019, Niklas Sundberg

Looking ahead

Technologies & Trends predicted to impact our Carbon footprint

- Artificial Intelligence / LLMs (ie Chat4Gpt)
- Online presence / Metaverse
- Robotics / Process automation
- IOT / exponential growth in connected devices
- Hyper connectivity
- Crypto
- ….

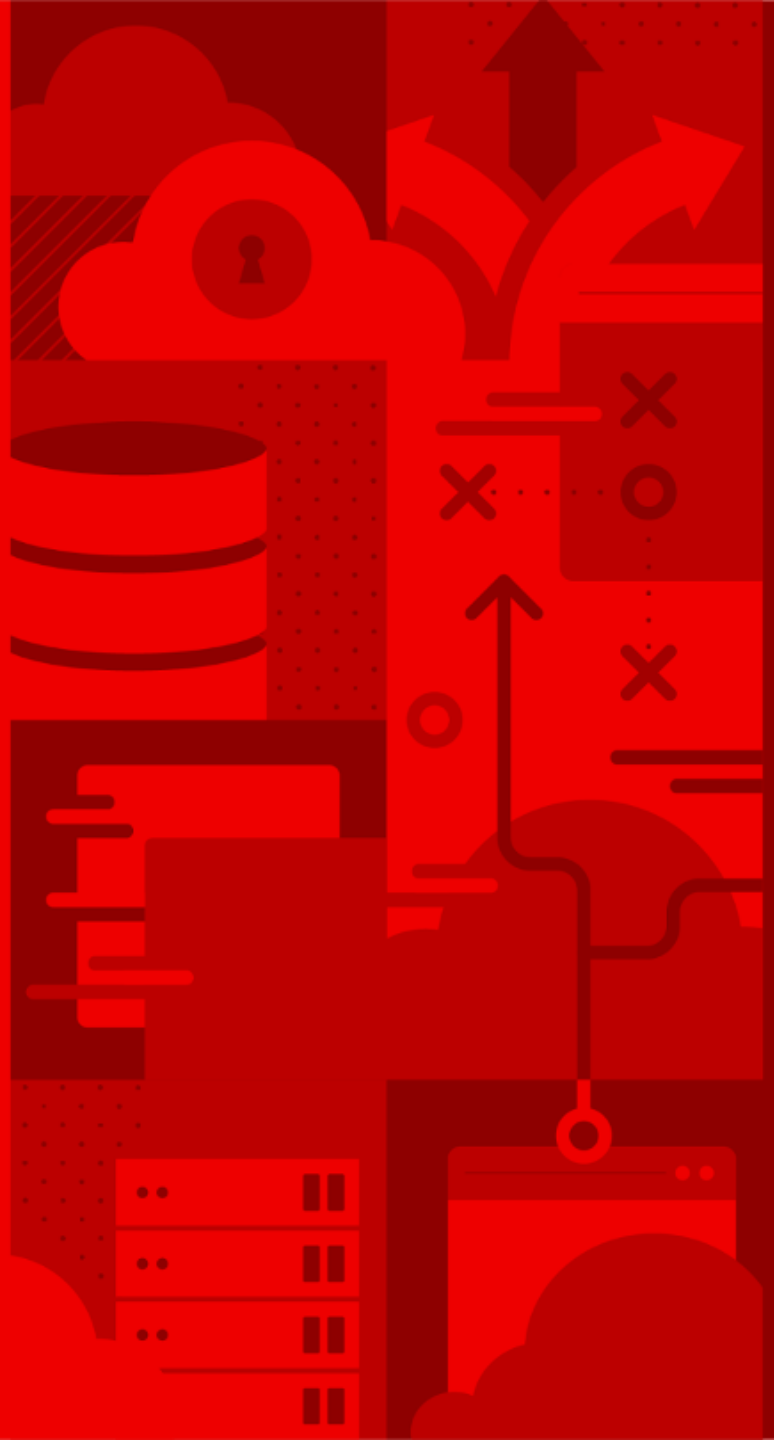
Corporate sustainability

Shift towards a broader spectrum of stakeholders; Employees, Customers, Partners, Ecosystems and communities… in addition to the shareholders

Putting it directly → Companies are faced with the ultimatum; **Innovate or Die**

Four main drivers for Enterprise to invest in Sustainability

Sources: IDC/ServiceNow The C-suite sustainability imperative 2021,



Java and Sustainability

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What is Java / Why Java

80%

of worldwide enterprises run Java on Desktop, Server, Cloud

3 Billion

Active Java Virtual Machines globally

#1

Developer choice for cloud

12 Million

Developers run Java

May 2023	May 2022	Change	Programming Language	Ratings	Change
1	1		Python	13.45%	+0.71%
2	2		C	13.35%	+1.76%
3	3		Java	12.22%	+1.22%
4	4		C++	11.96%	+3.13%
5	5		C#	7.43%	+1.04%

Top 3
programming language

Source: Oracle Java SE subscription infographic https://www.oracle.com/a/ocom/docs/java-se-subscription-infographic.pdf
https://tiobe.com/tiobe-index/

Traditional Java designed for a different time

Traditional

- **Throughput** at the expense of **footprint**
- **Long running** at expense of **startup speed**
- Rich, dynamic behavior for mutable systems

Cloud Native

- **Throughput** solved by horizontal scaling
- Ephemeral, immutable systems
- Footprint and performance matter

What is the consequence?

"**Tumble dryer**"-effect (not fit / too big for purpose)

+

+

"**Light bulb**"-effect (always on)

= unnecessary
economical cost, sustainability cost, people cost

→ **We need to look our own IT set up, have simple mental pictures and start calculating the consequences**

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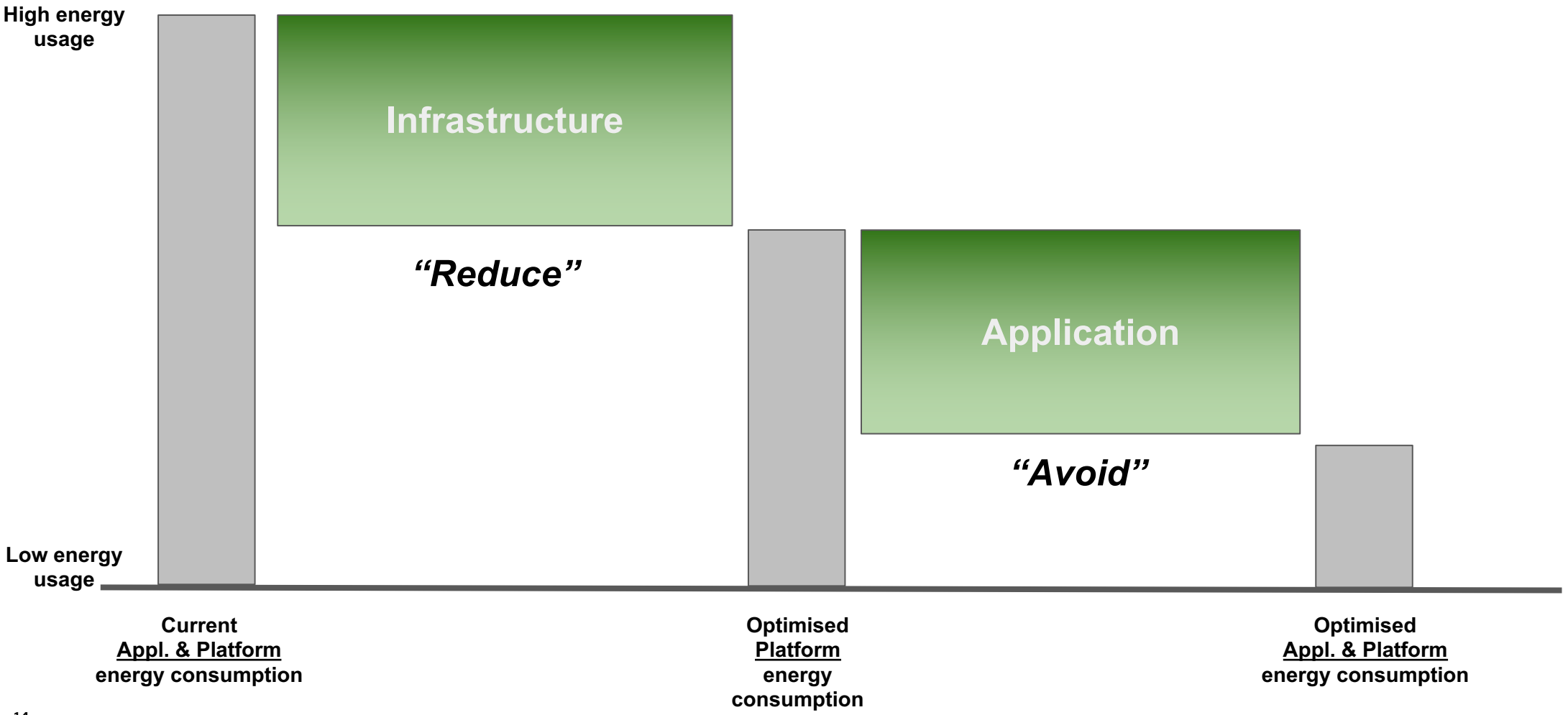
Efficiency Gains from Infrastructure and Application Optimization



Def. Reduce: "make smaller or less in amount, degree, or size"
Def. Avoid: "keep away from or stop oneself from doing (something)"

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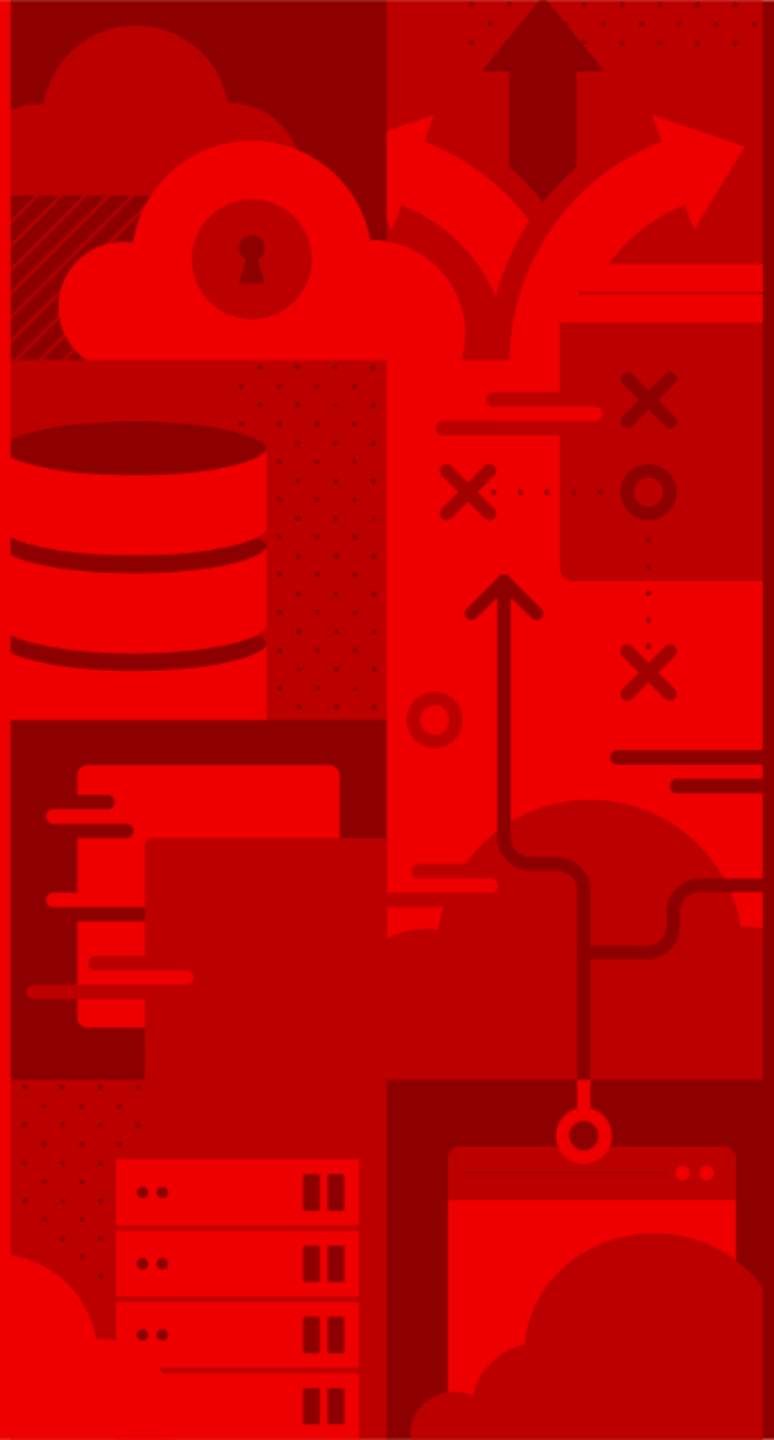

Microsoft Azure sustainability

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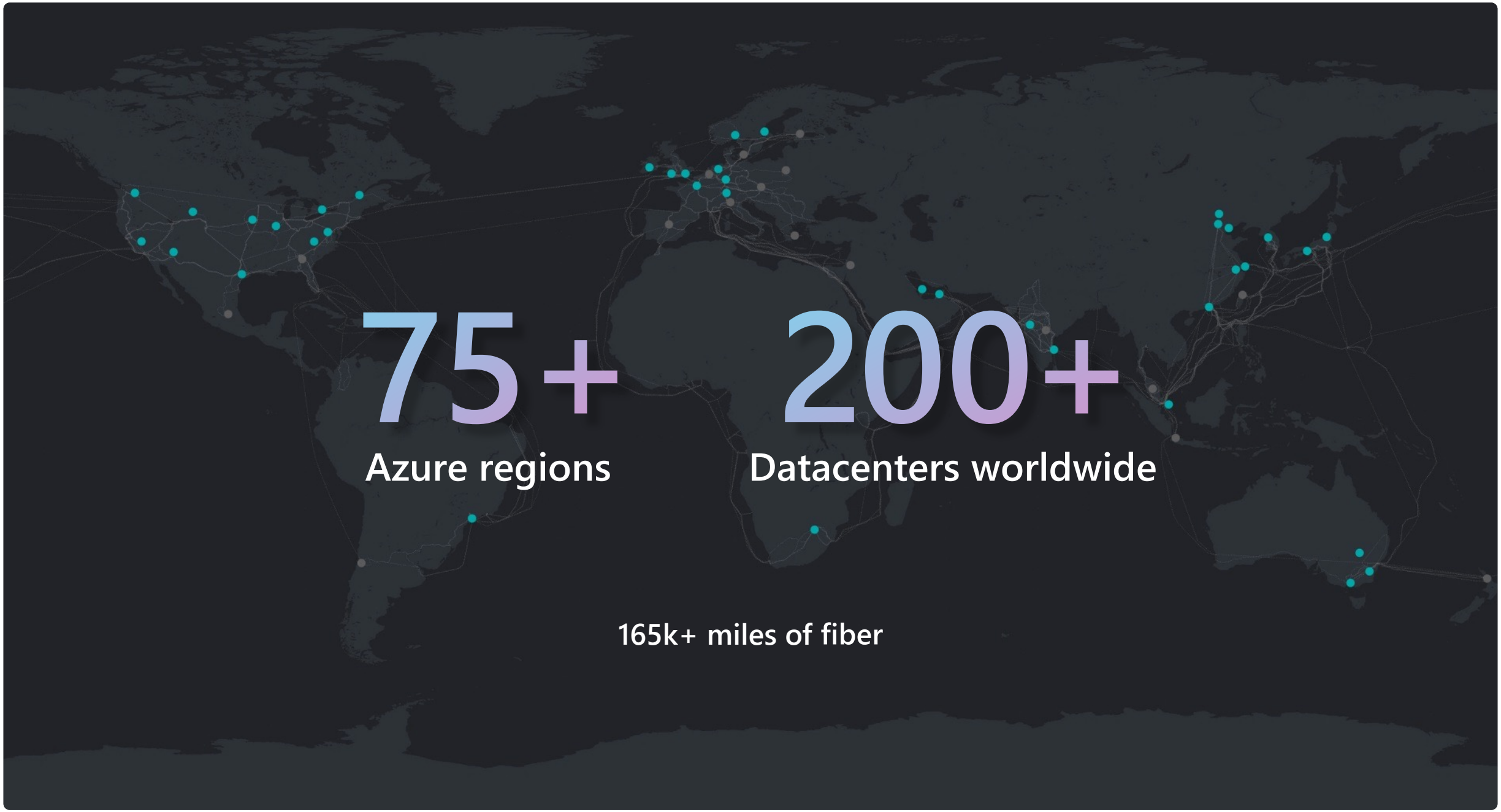
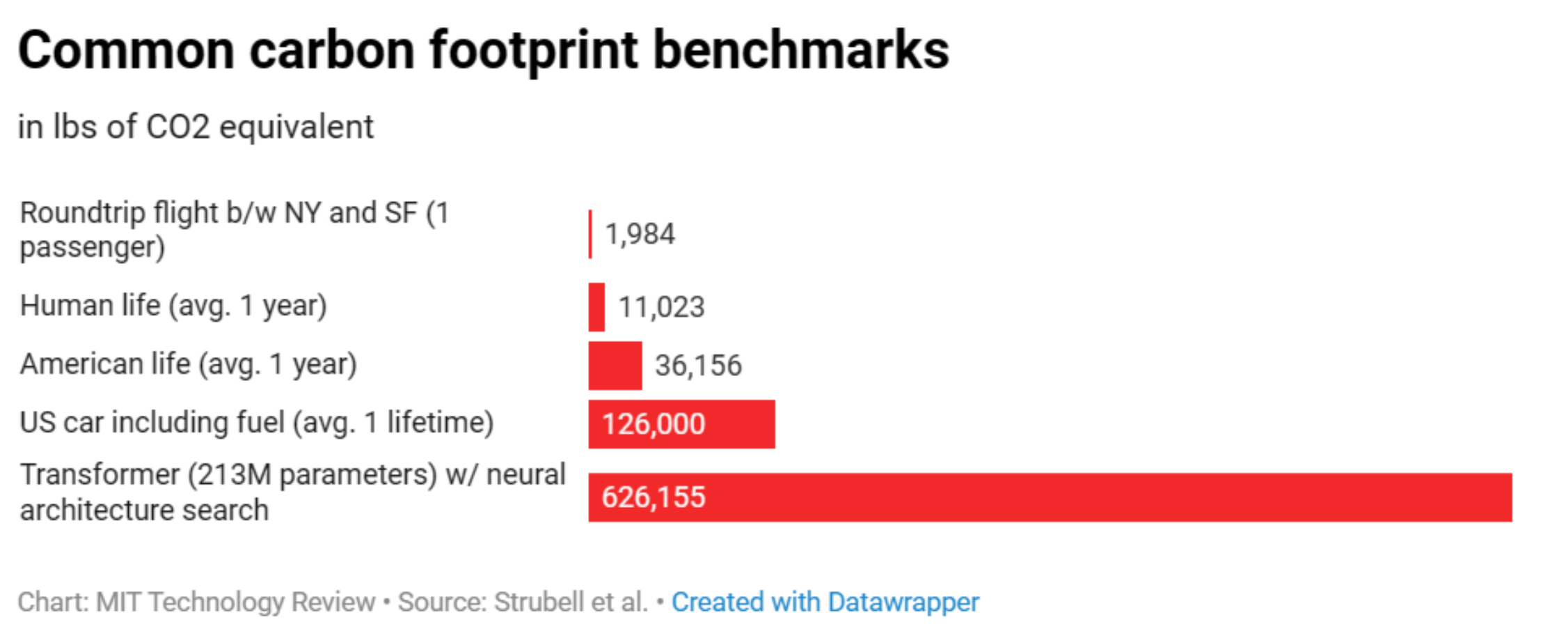

75+
Azure regions
200+
Datacenters worldwide
165k+ miles of fiber

Another paradigm shift is here



Our core environmental sustainability commitments

Carbon negative by 2030

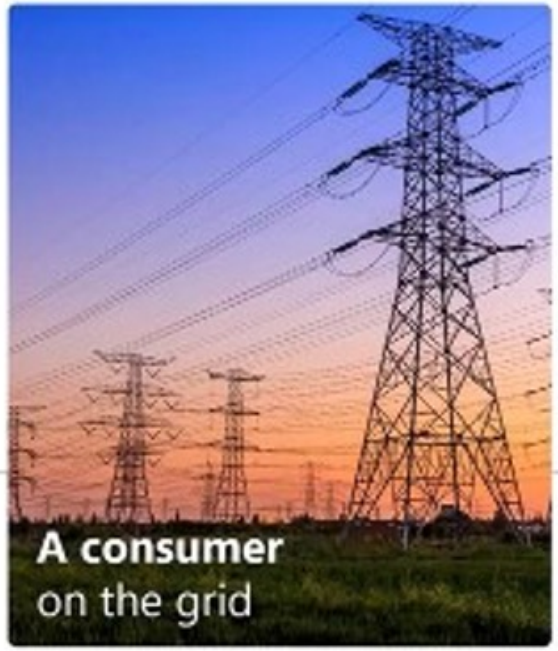
Water positive by 2030

Zero waste by 2030

Build the **Planetary Computer**

Data Centers use 1%
of all energy produced
in the world

Microsoft sees energy from three perspectives



A consumer
on the grid

Large customer with **stable, high-value load** and high average load factor

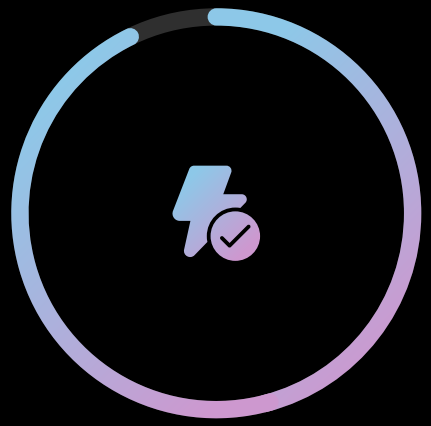
A collaborator
in clean energy & grid

Dedicated to procuring **100% renewable energy,** investing in **grid infrastructure** and being a **backup provider**

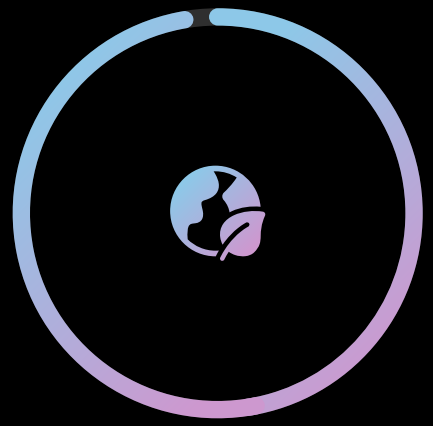
An innovator
of energy technology

Improving **grid reliability** and enabling **environmental efficiencies**

Microsoft Azure is more energy efficient



Up to 93%
more energy efficient

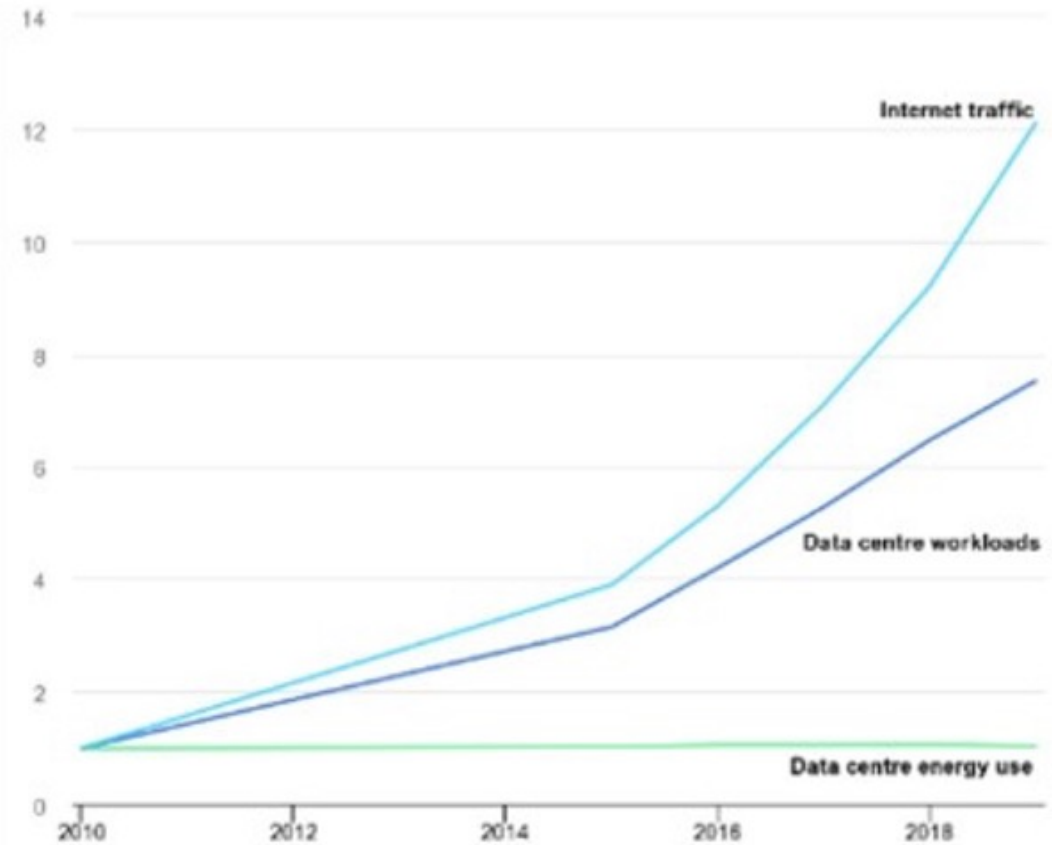


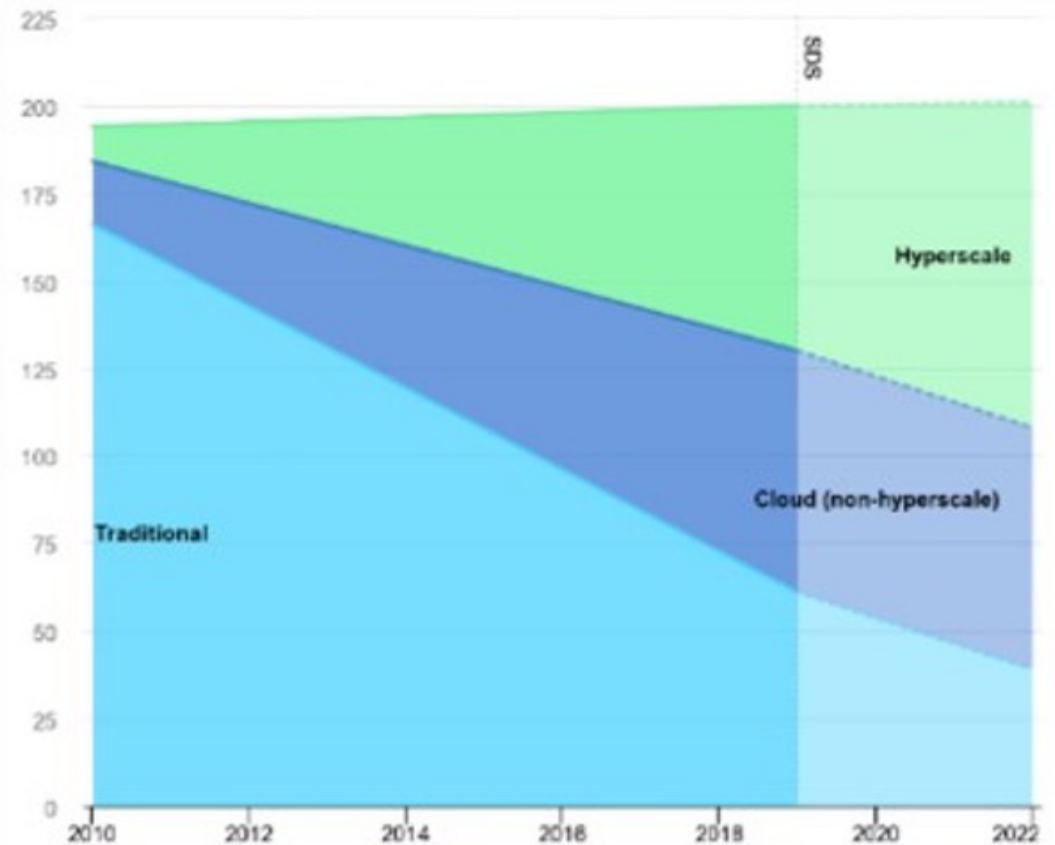
Up to 98%
more carbon efficient

Source: The Carbon Benefits of Cloud Computing: A study of the Microsoft Cloud in partnership with WSP, 2018

Consumer: Cloud Efficiency Over Last Decade

Workloads increased 8x and traffic 12x ...yet datacenter energy use remained constant





IEA, *Data Centres and Data Transmission Networks*, June 2020

Techniques

Common Green Cloud Computing practices:

Virtualization	• Improves machine management and energy efficiency through sharing a single physical instance of a resource/application with multiple customers or organizations at the same time. • It not only allows for better monitoring and resource allocation but also protects the environment by maximizing the number of accessible resources in an environmentally responsible manner. • Deployment of virtual technologies is a key Green Cloud Computing approach.
Dynamic Voltage Frequency Scaling (DVFS)	• A strategy for lowering processor power and energy usage that's combined with frequency scaling, a technique where dynamic control of the voltage and frequency is adopted. • DVFS minimizes data center energy usage and maximizes resource use.
Nano Data Centers (NaDa)	• A computing platform that uses internet service providers (ISP)-controlled home gateways to offer computing and storage services. • More energy-efficient than conventional data centers, NaDas help reduce the cost of heat dissipation, have high service proximity, and the capacity for self-adaptation or self-scalability.

Techniques

Other sustainable options include:

Alternative cooling methods/ recycling heat

- The servers inside of data centers generate a lot of heat and that heat is typically not recycled. Solutions to improve power consumption include:
  - Locating data centers in places with free cooling (cold air, sea water, etc.).
  - Reusing the heat in areas with heating needs, such as nearby offices or residences.
  - Supplementing the center's power with solar panels, to reduce grid demand.

Carbon-aware job/workload scheduling

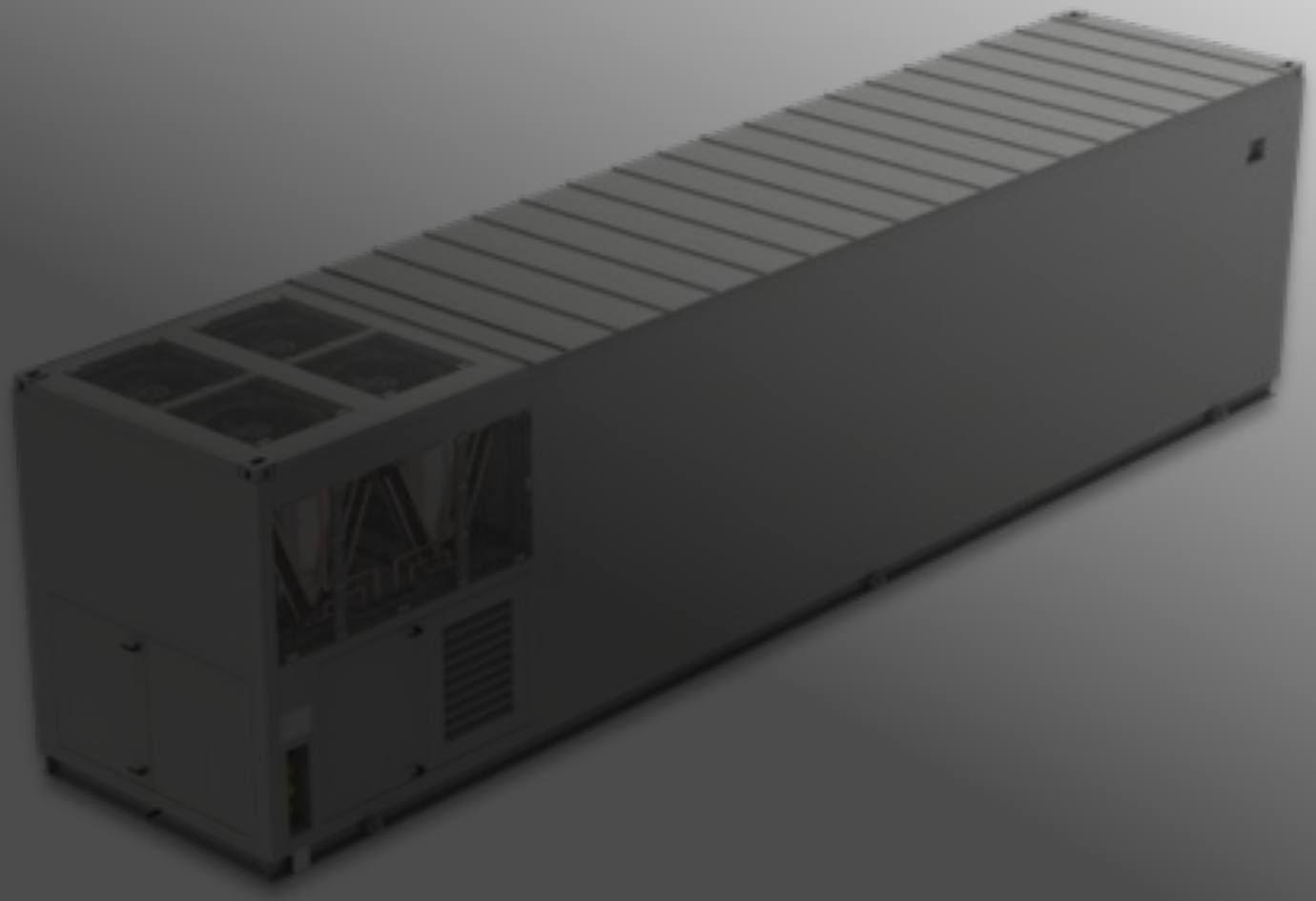
- The amount of carbon dioxide (CO_2) emitted by electricity grids varies by time of day and location.
- Job scheduling during less carbon-intensive times is a key way to lower grid emissions.

Reducing CPU Power Dissipation

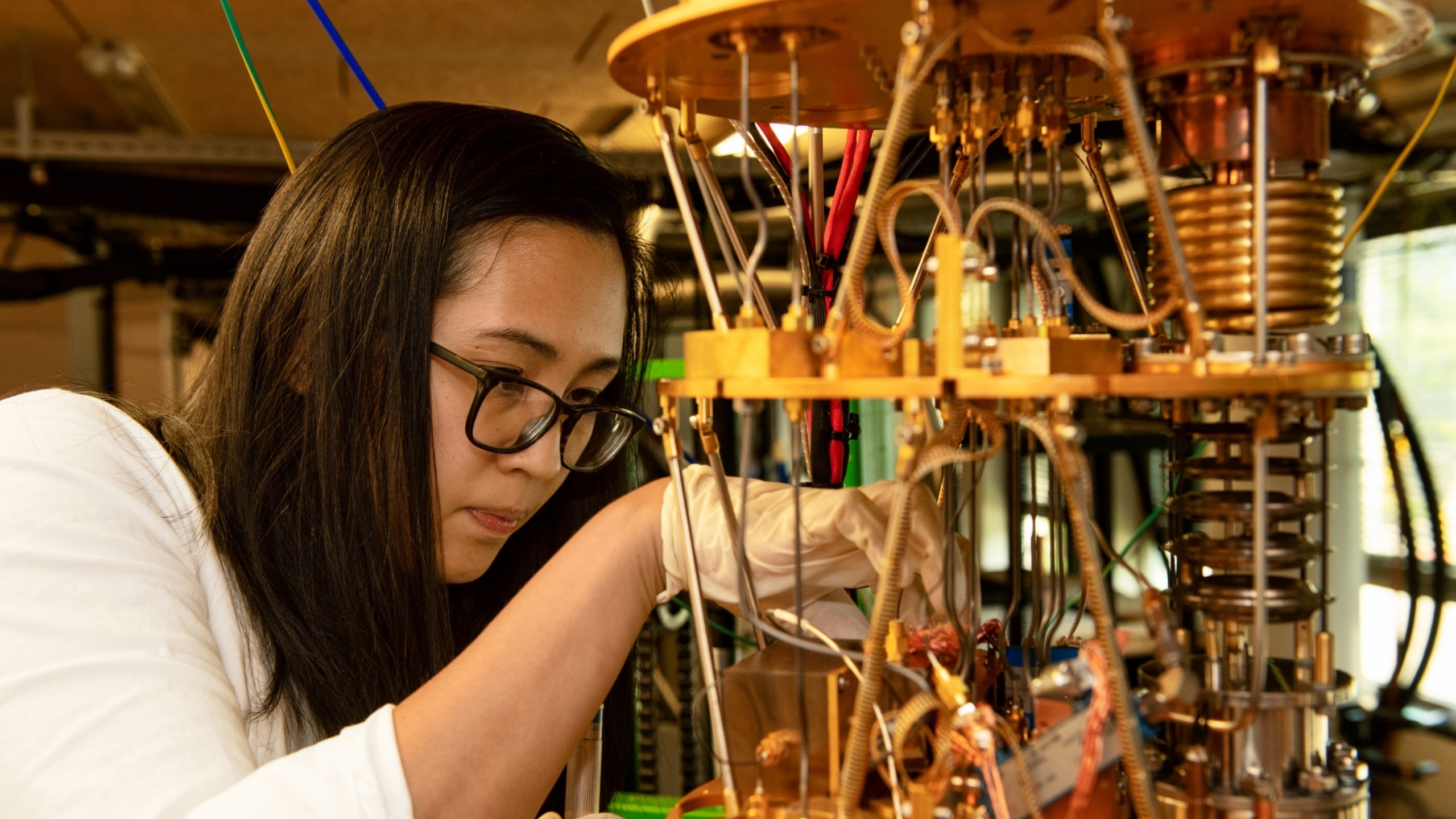
- Multi-core technology enables the processing of higher loads using less power.
- Most CPUs have power-management features that optimize power consumption by dynamically switching among multiple performance states based on utilization.


Liquid Cooling

Azure Modular Data Center



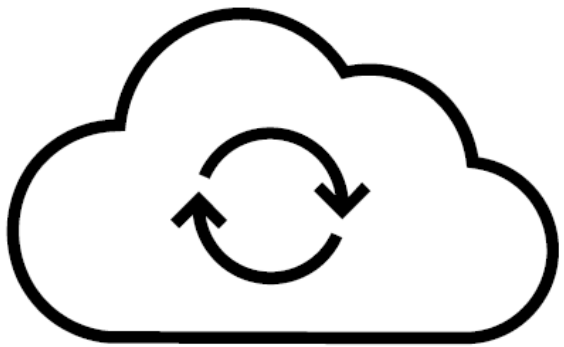
Project Natick



Sustainability is a Shared Responsibility

- Operate sustainably
- Deliver products and services that help customers operate sustainably

Vendor is responsible for offering sustainable products and services

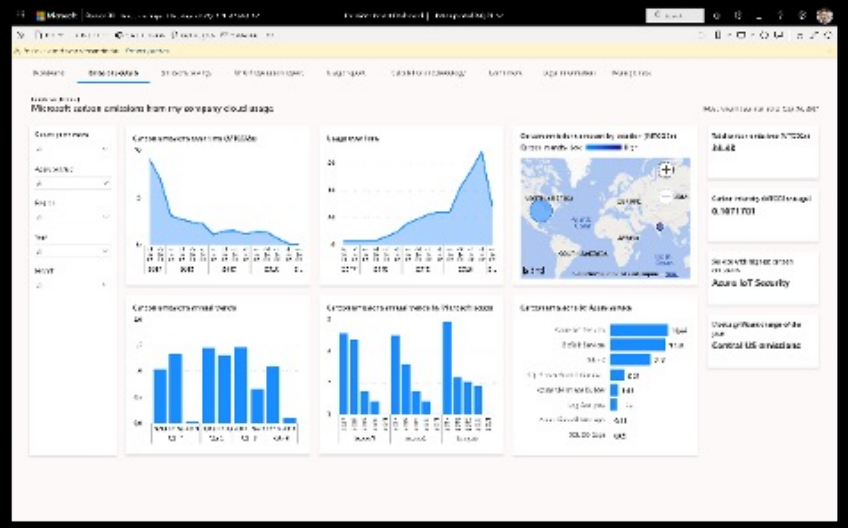


Consumer is responsible for using technologies sustainably

- Select sustainable vendors
- Use products and services to achieve their own sustainability outcomes

Gartner

Emissions Impact Dashboard



The **Emissions Impact Dashboard** provides Microsoft customers with transparency into the emissions produced from their use of Azure services.

Emissions Impact Dashboard for Microsoft 365 tracks emissions related to using Microsoft 365 core cloud services including Exchange Online, SharePoint Online, OneDrive for Business, and Microsoft Teams.

Simplify carbon reporting with easy access to report on Scope 3 emissions from your cloud infrastructure

Validated methodology for carbon calculation is based on standard protocols, has been verified by a 3rd party

Decide with data reviewing reduction trends for cloud usage over time through Microsoft Cloud use

Sustainability guidance

Plan your path forward, improve your sustainability posture, and create new business value while reducing your operational footprint.

Azure Well-Architected Framework sustainability guidance

Azure Well-Architected Framework sustainability self-assessment

Azure Kubernetes sustainability guidance

Skilling initiatives

Build cloud skills and cultivate a culture of learning to help your teams navigate evolving sustainability requirements.

Cloud Skills Challenge for Azure sustainability topics

Microsoft Learn Collection for Azure sustainability topics

Principles of Sustainable Software Engineering course

SUPPORTING OUR CUSTOMERS ON THE PATH TO NET ZERO

Datacenters are the compute engine of the cloud

Microsoft

7.8 gigawatt renewable energy procured globally to date

renewable energy around the globe

remove CO_2

reduce CO_2

100/100/0 commitment

Emissions Impact Dashboard

We are building strategies, solutions, and partnerships that put the power of our technology to work on the planet

Microsoft Cloud for Sustainability

"We can truly make an outsized impact on climate change leveraging the power of technology"

RECORD

REPORT

REDUCE

↳ carbon emissions

Protect more land then then we use

renew

resources

restore

revitalize

Circular Centers

carbon negative

incredibly Herculean task

Become

zero waste

achieve and renew Zero Waste certifications

water positive

We will reduce water use in our evaporative cooled datacenters globally by 95% by 2024

Innovate how we build and operate datacenters

two-phase liquid immersion cooling

Advance waterless cooling technologies

Will help us extend the lifecycle of our servers

83% reuse and 17% recycle of critical parts while reducing carbon emissions by 145,000 metric tons CO2 equivalent

Reduce reliance on diesel backup power

hydrogen fuel cell backup power

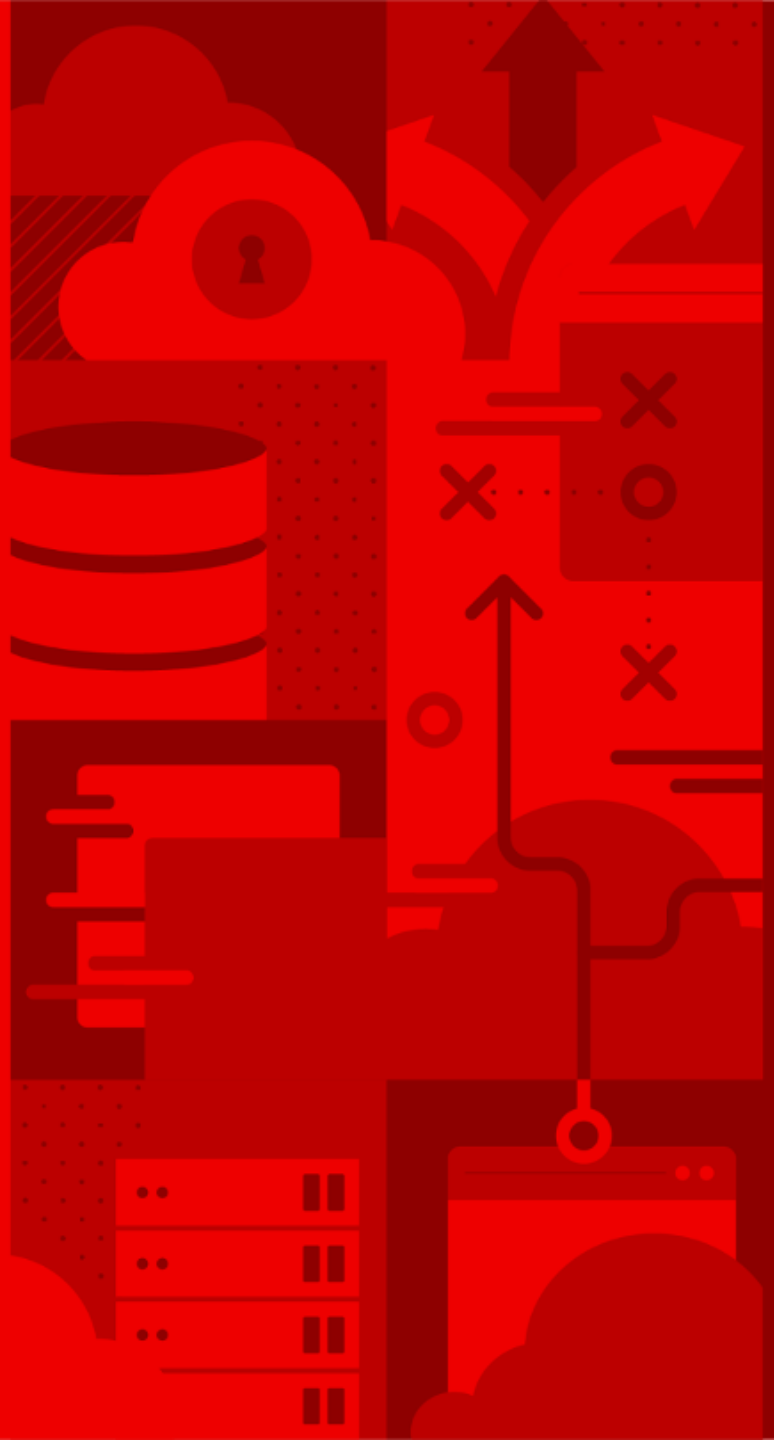
Provide more renewable, reliable energy to the grid

grid-interactive uninterruptible power supply

Reduce embodied carbon in construction

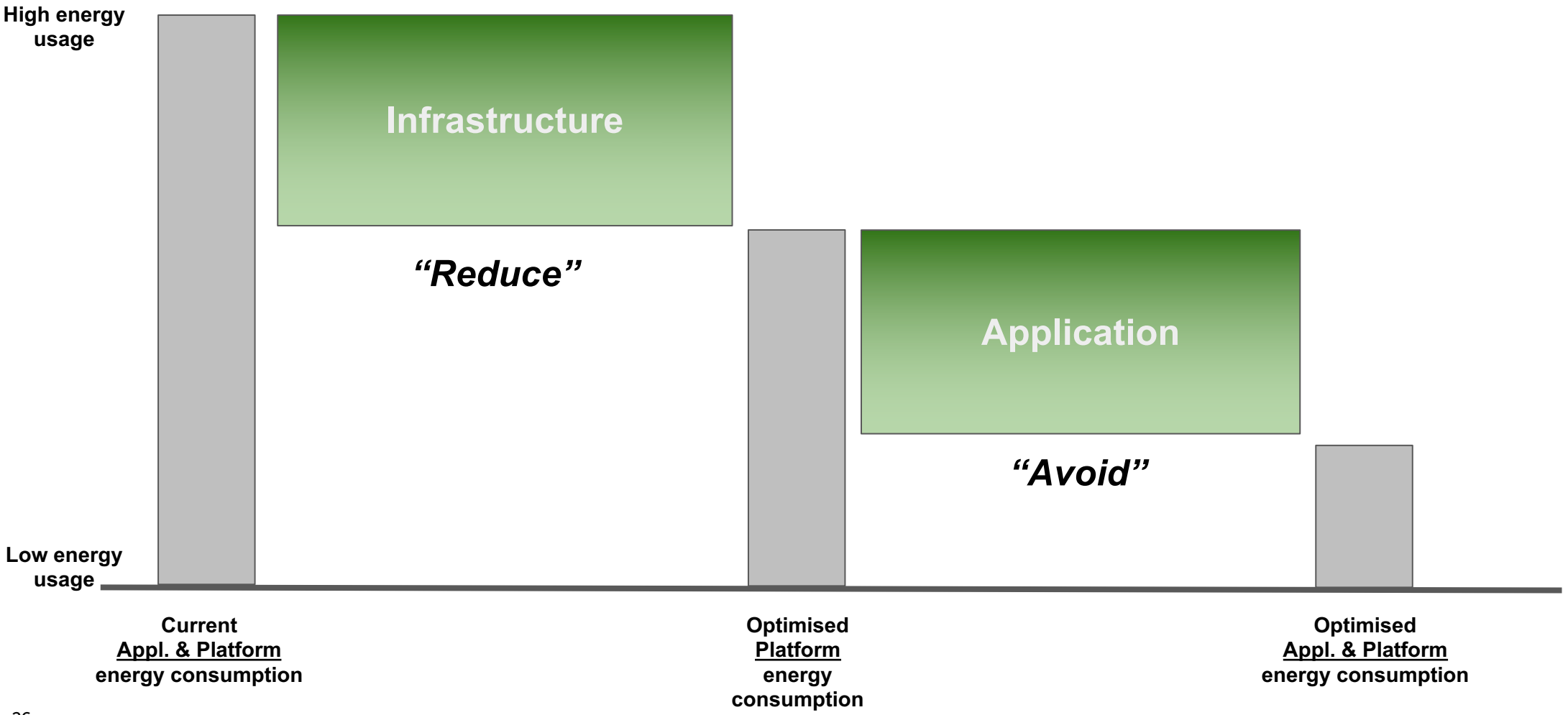
explore carbon-storing materials such as algae and mycelium (mushroom)

Empower every person and every organization on the planet to achieve more



Gains from Java Modernization

Efficiency Gains from Infrastructure and Application Optimization



Def. Reduce: "make smaller or less in amount, degree, or size"
Def. Avoid: "keep away from or stop oneself from doing (something)"

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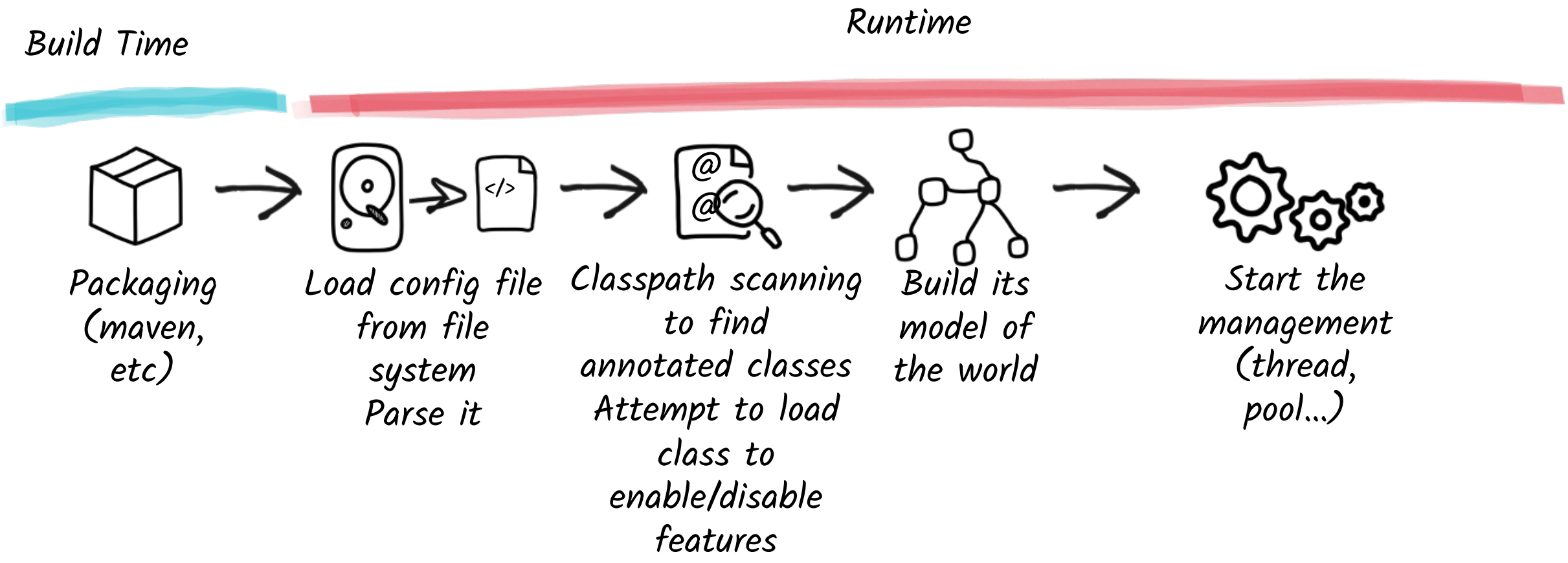
How do we solve it and get the benefits of modernisation?

"**Tumble dryer**"

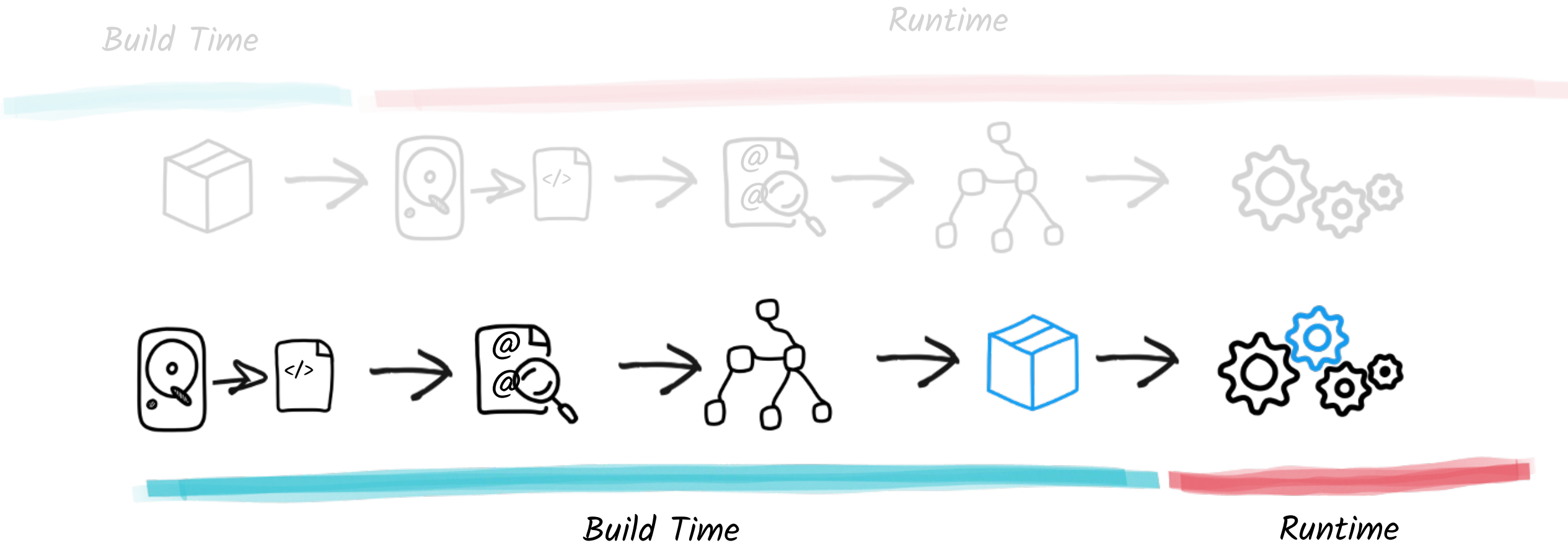
"**Light bulb**"

Let’s focus on Java….

How does a traditional Java framework start?



How a Quarkus framework starts



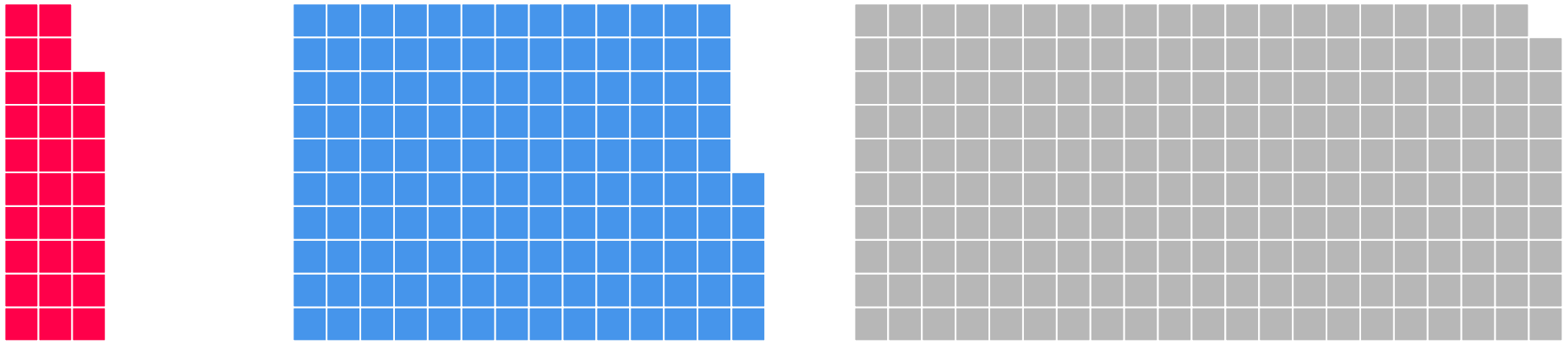
What is Quarkus - A Java framework tailored for Kubernetes deploym.

Supersonic, Subatomic **Java**

Fast.
Blazing fast to start.
Millisecond fast!
Improve memory consumption.
Increase deployment density.

What is the difference → smaller footprint to do the same or more

In Operation → when running REST (Integrations / APIs) + CRUD (Create, Read, Update and Delete) *



Quarkus + Native
(via GraalVM)
28 MB

Quarkus + JVM
(via OpenJDK)
145 MB

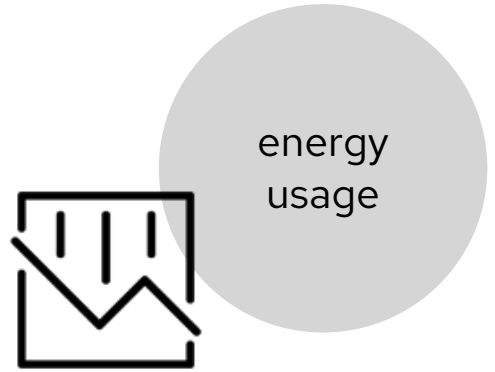
Traditional Java
Stack
209 MB

*Memory (RSS) in Megabytes, tested on a single-core machine

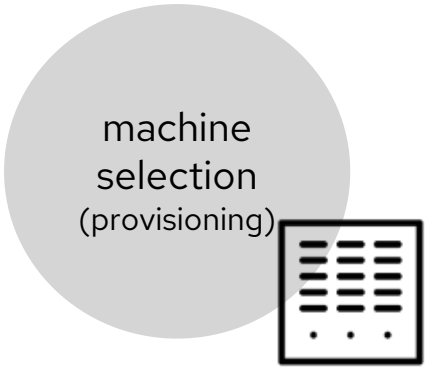
How does Quarkus help reduce carbon?

‘free’
direct
passive
easy to measure

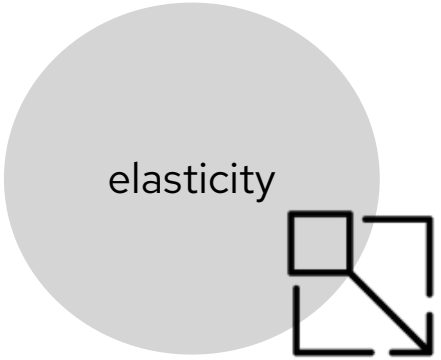
lower memory usage
higher throughput for same resources



‘enabled behaviours’
harder to measure real world impact
depends on people taking advantage

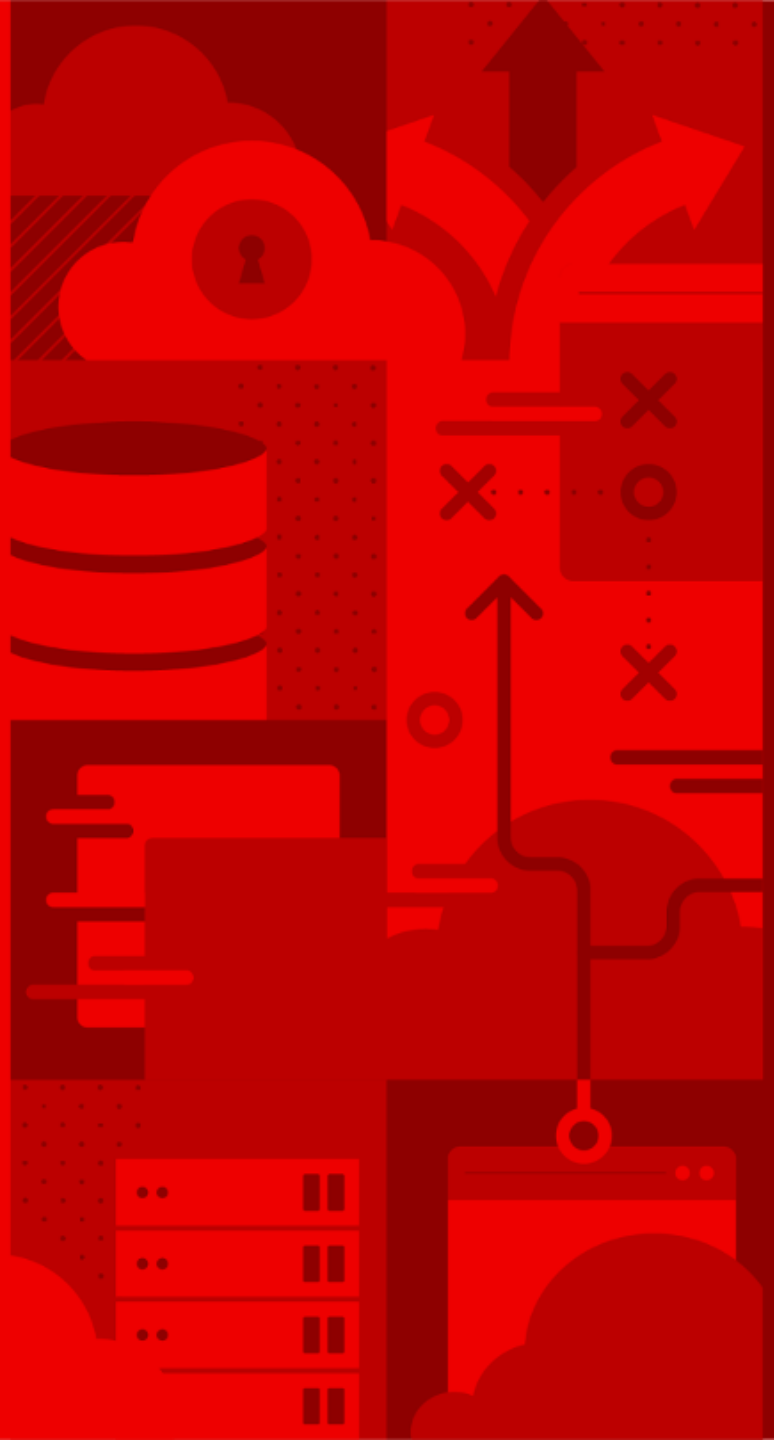


running the same workload on a smaller machine
saves energy
saves embodied carbon



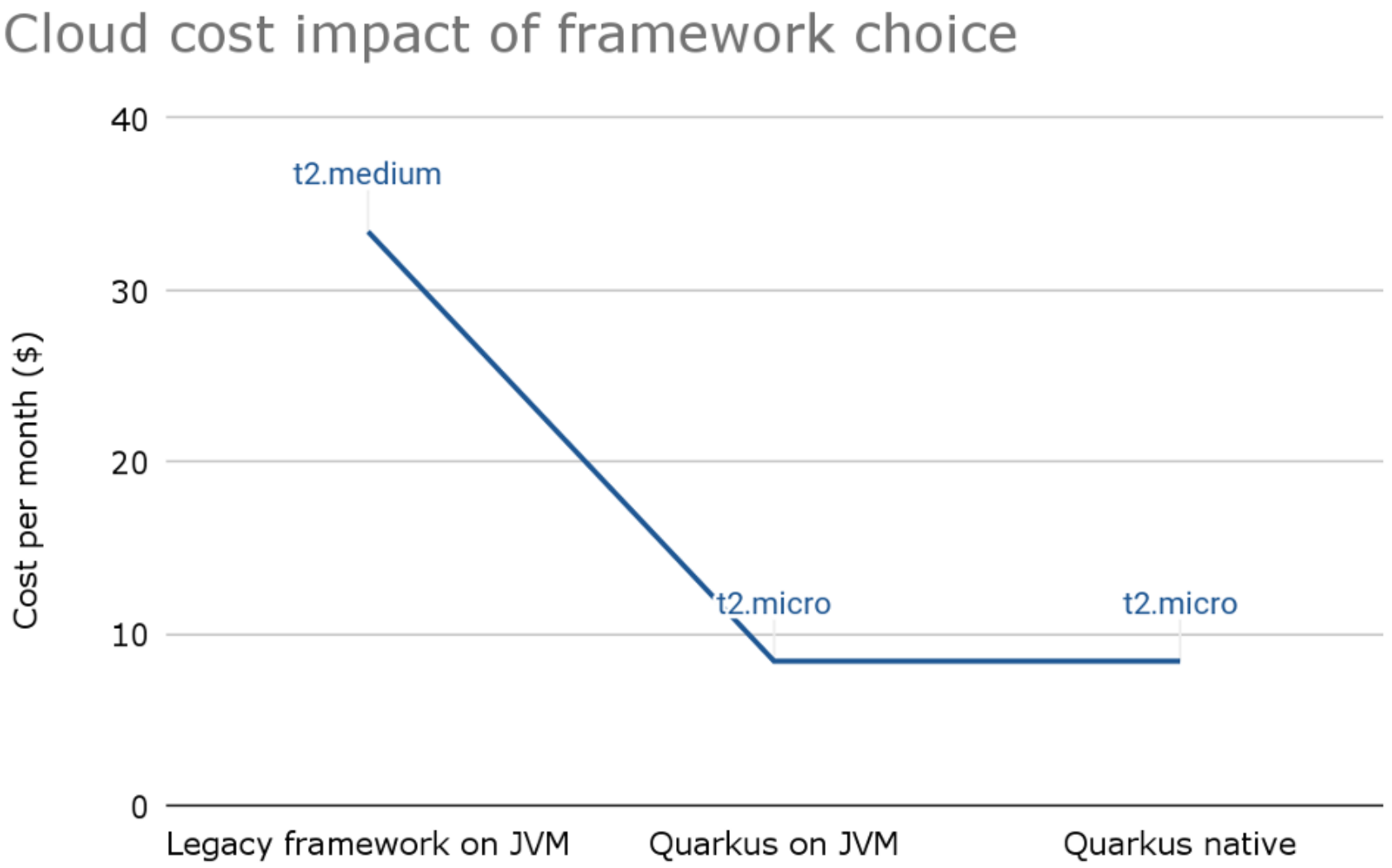
scaling workloads down (ideally to 0)
serverless a good example (but not the only one)

Want more information? - then see this Redmonk interview:
https://redmonk.com/videos/sustainable-software-and-systems-lightswitch-ops-for-the-triple-win-a-redmonk-conversation/



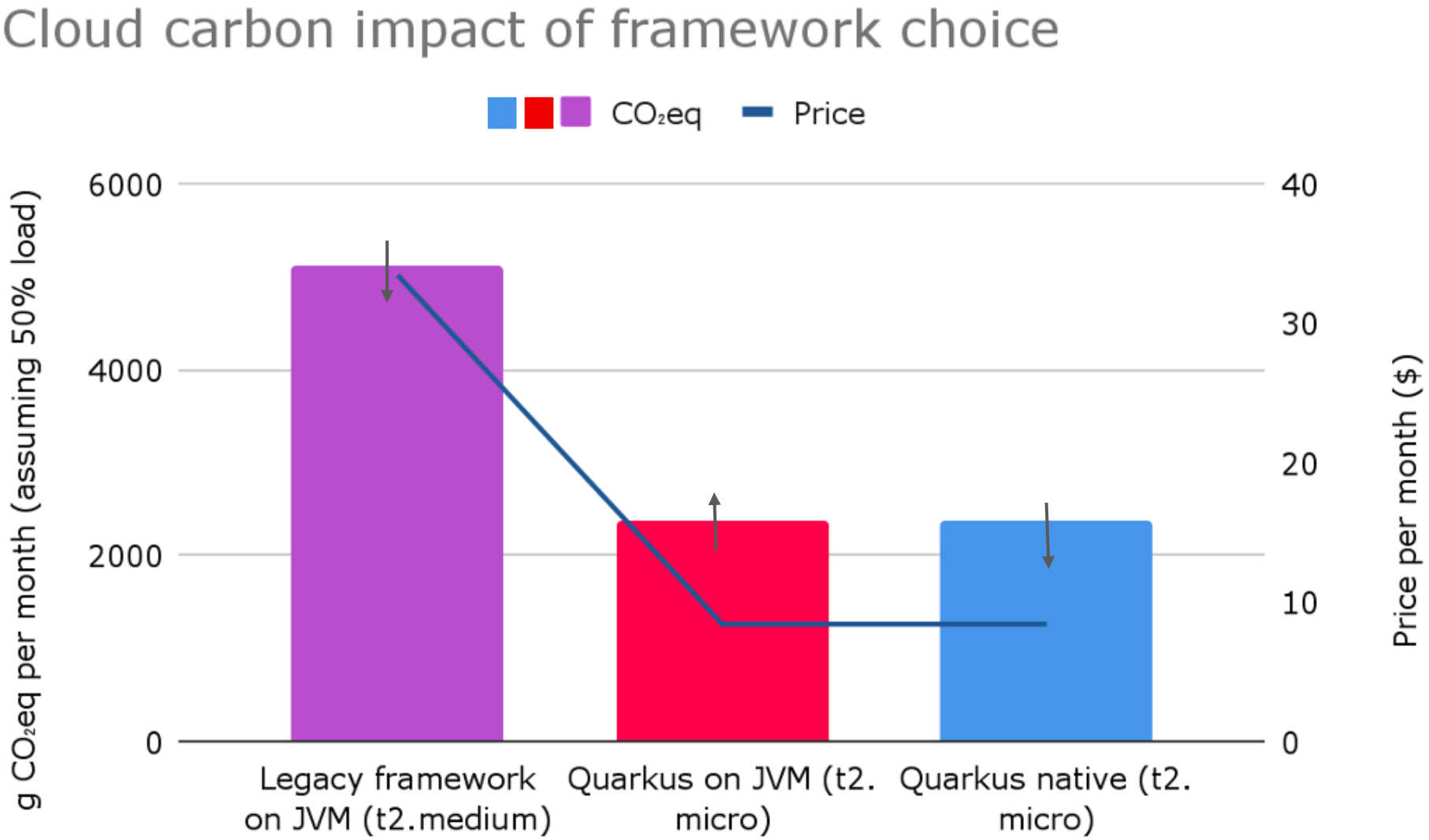
Customer Examples & Economical view

Calculation example based on real applications using Quarkus



What's being measured? An application handled 800 requests/second, over 20 days. The application was run on the smallest EC2 instance that did not result in errors. Costs are for us-east-1.

Calculation example - translated to Co2 footprint



What's being measured? An application handled 800 requests/second, over 20 days. The application was run on the smallest EC2 instance that did not result in errors. Costs are for us-east-1, and carbon is estimated using the Teads dataset. Because of limitations of the datasets, load was assumed to br 50%. The arrows show a guess at actual load.

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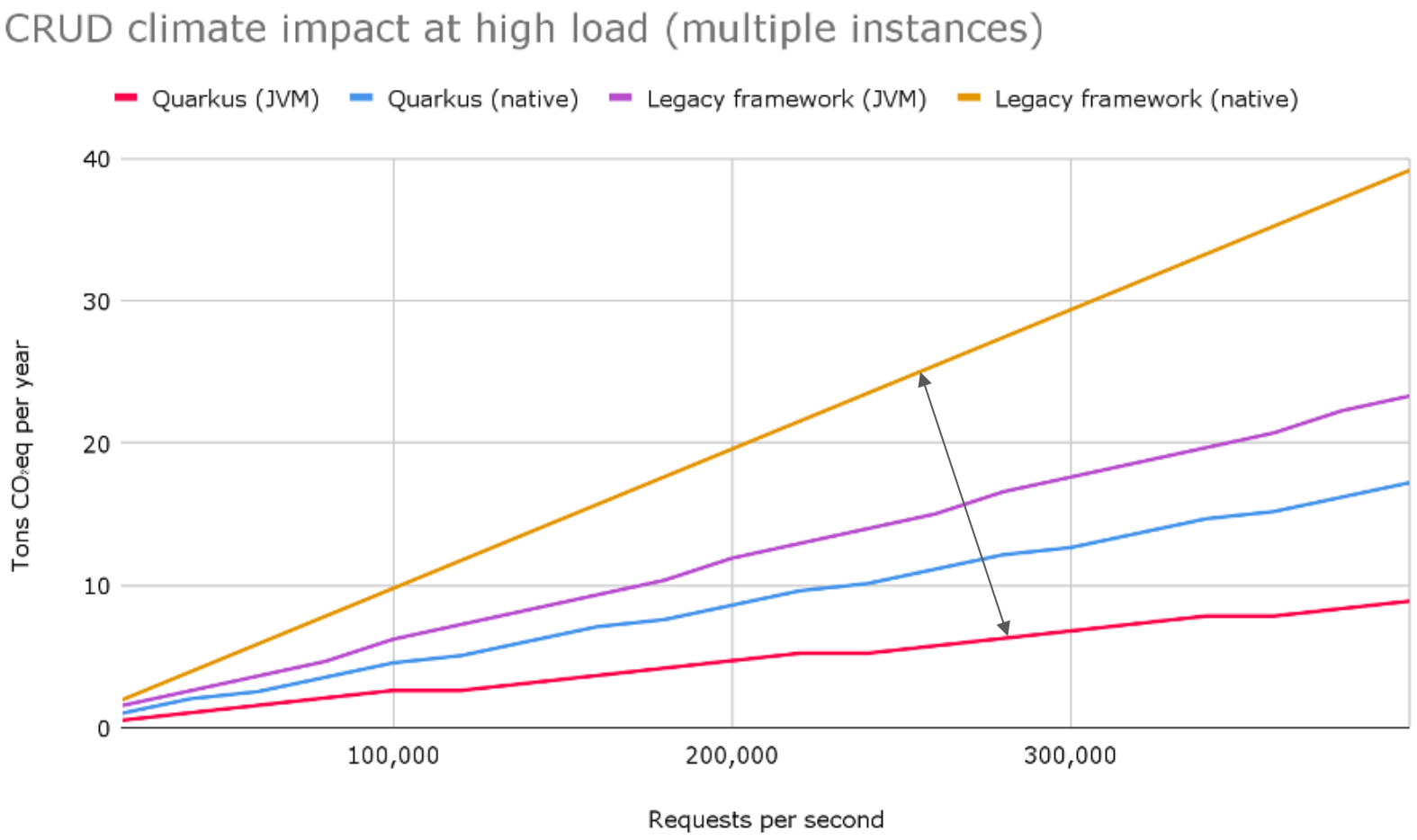
Calculation example - translated to Co2 footprint - at Scale



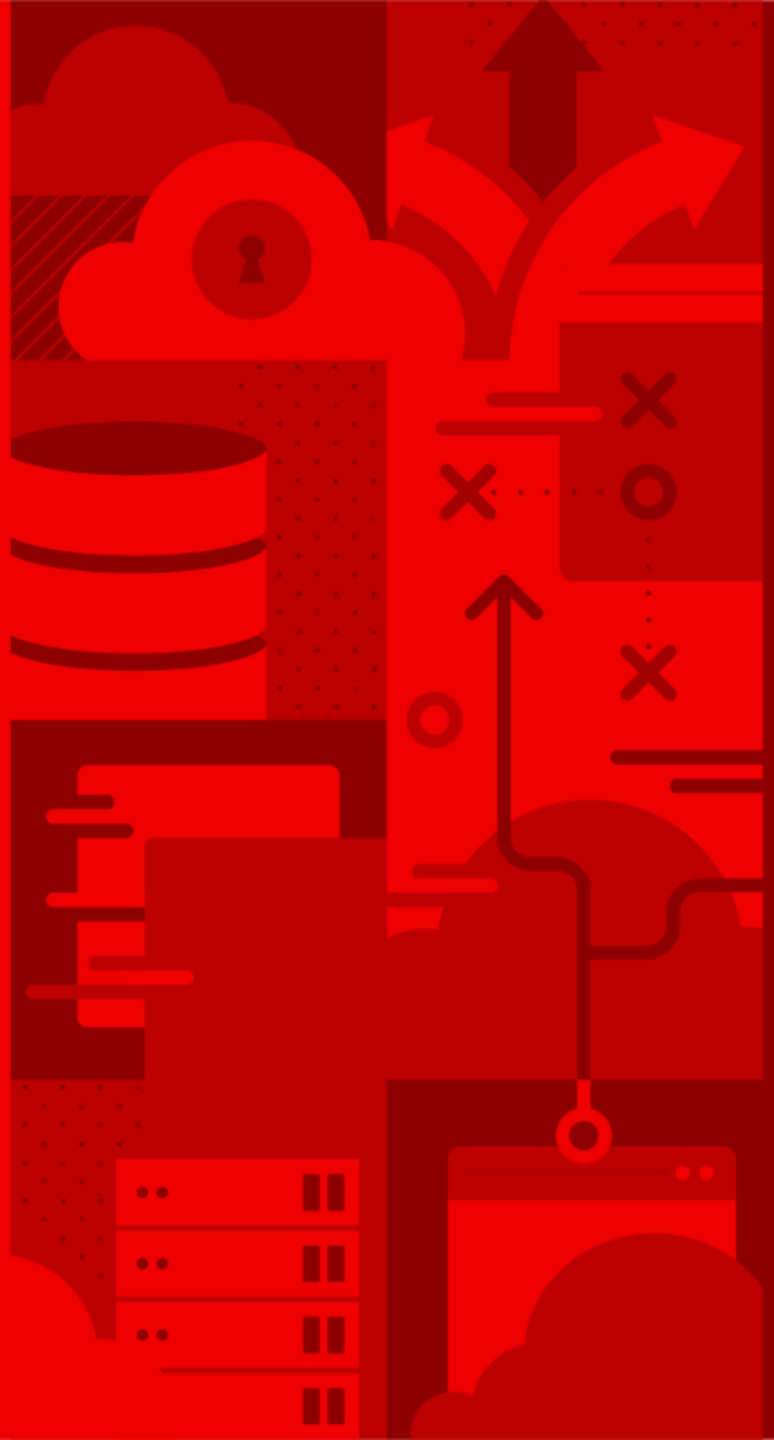
What's being measured? Power consumption of a REST + CRUD application. To support the higher load, multiple instances are needed; Quarkus needed fewer extra instances, which is why its power consumption is so much lower. The CO_2-eq figures are based on the US energy mix.

That is all good, but….

"I've never met a customer who wanted to buy software or hardware.
I've only met customers who wanted the value they provide"

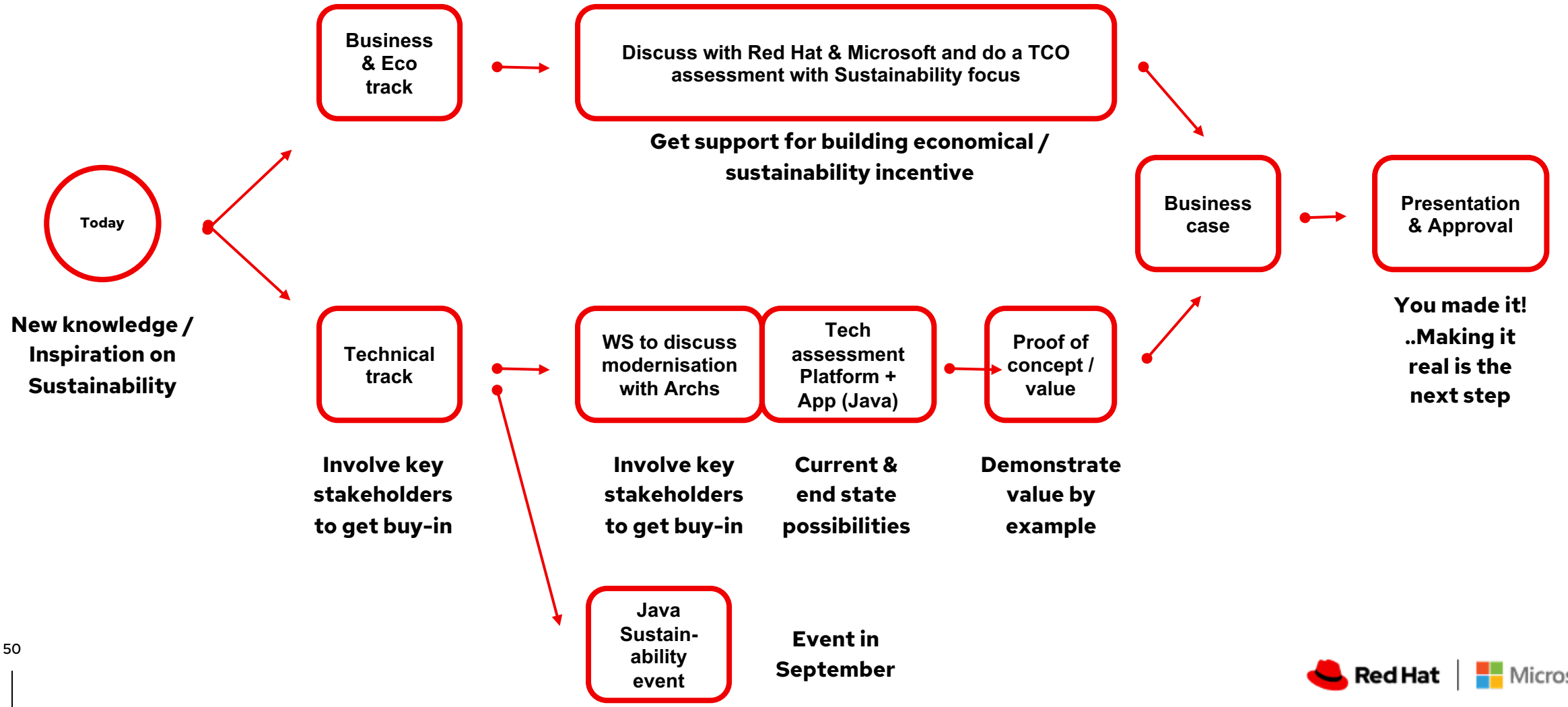
- ➔ Companies are understandably cautious about the current and future state of the economy.
- ➔ Red Hat recognizes the need to prioritize projects based on the highest and fastest returns.
- ➔ Red Hat offers no-charge Business Value Assessments to pro-actively help you compare cost & business value

Qoute by Steve Mills



Where do we go from here?

Your situation… What are the next steps?



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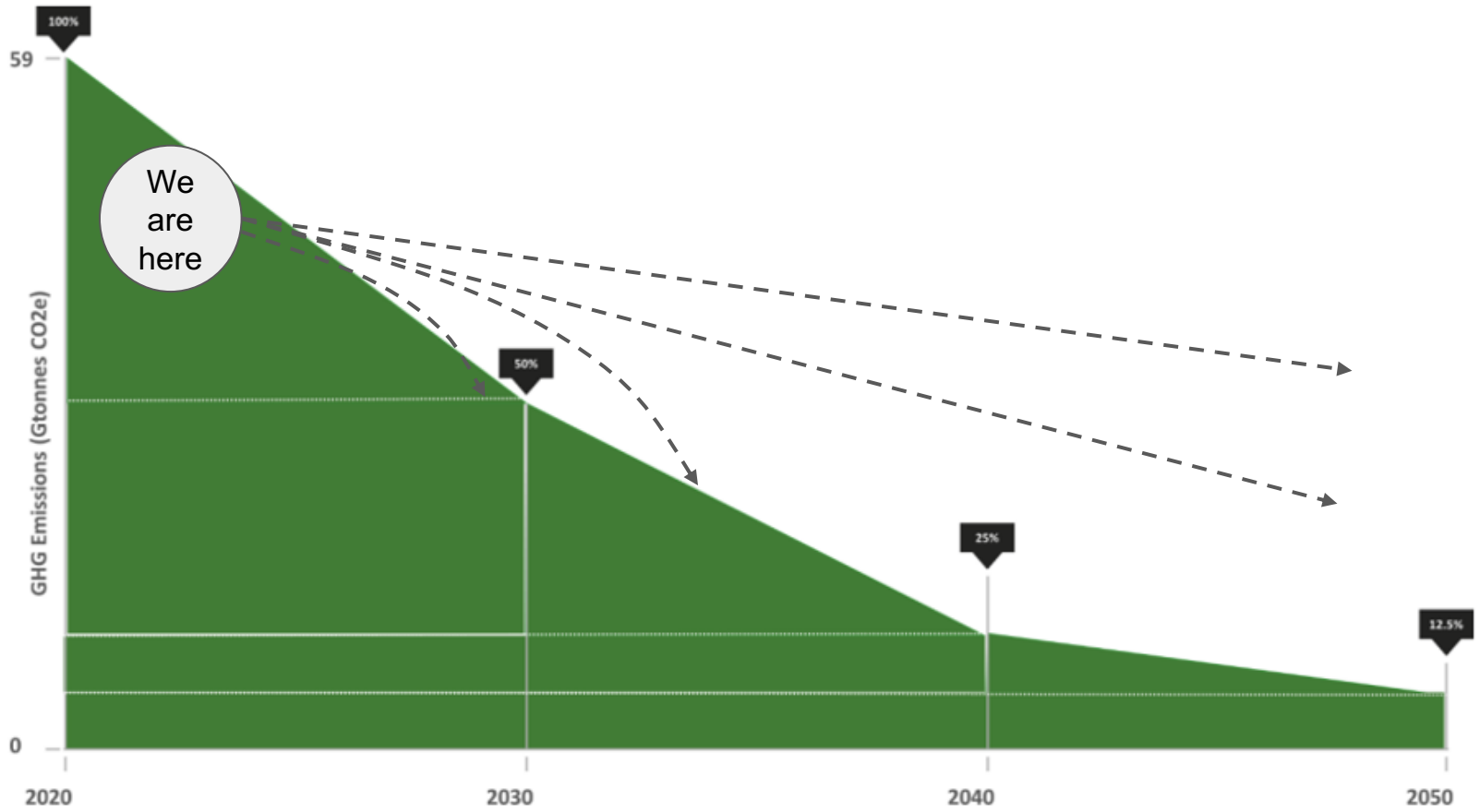
Zooming out

Rebalance / Stabilize -> Bend the curve



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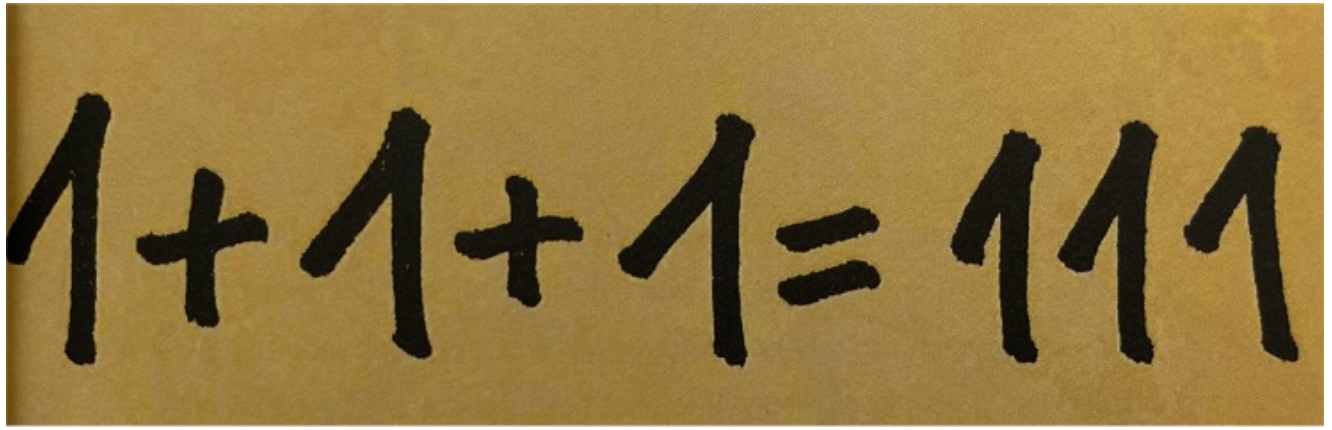
Sources: Niklas Sundberg

How much will it help?



New sustainable Java frameworks

Efficient Cloud solutions

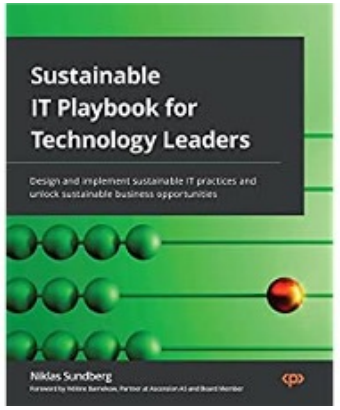
Viable economic of initiatives

⇨

Compounded reduction in footprint
“Go to Green”

Build your awareness

- Recommended / Useful books



https://www.amazon.de/-/en/dp/1803230347?psc=1&ref=ppx_yo2ov_dt_b_product_details

https://quarkus.io/blog/quarkus-for-spring-developers/

- Red Hat technology
  - Whitepaper around Quarkus for sustainability - https://www.redhat.com/en/resources/greener-java-applications-detail
  - Redmonk interview - https://redmonk.com/videos/sustainable-software-and-systems-lightswitch-ops-for-the-triple-win-a-redmonk-conversation/

Summary, where do we go from here?

Your own decision, but….

The future depends on what you do today.

Recap on why companies invest in sustainability

Come over & discuss with our Azure and Red Hat colleagues today!
We are here during today's event

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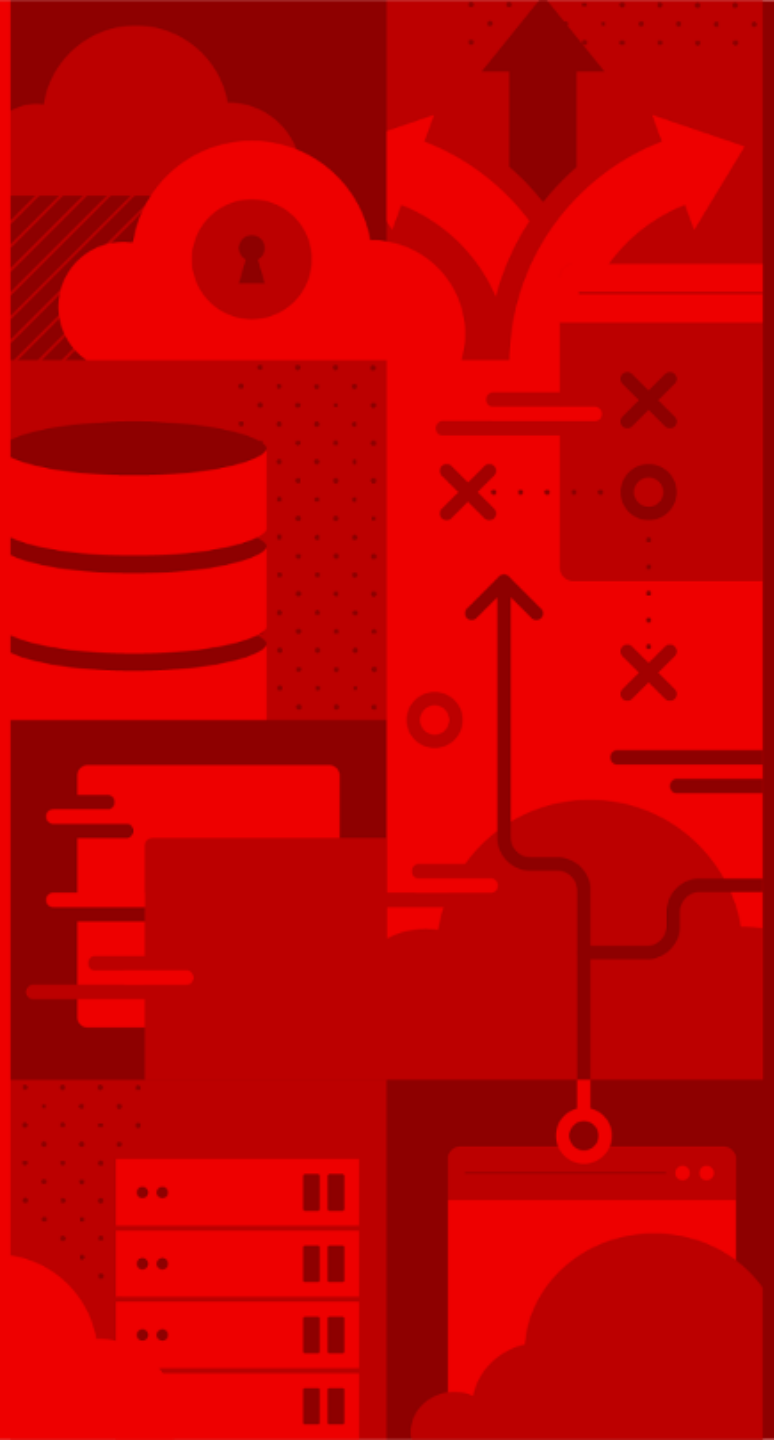
Quote by Mahatma Gandhi.



Discussion / Questions