Be the Change Our Planet Seeks: How YOU Can Contribute to Running Environment-Friendly Workloads on Kubernetes

Kristina Devochko

whois Kris

- **CNCF Ambassador**
- **Microsoft Azure MVP**
- **Kubernetes Unpacked Podcast Host**
- **…**
- **Preaching about K8s, green tech and cats**

https://kristhecodingunicorn.com

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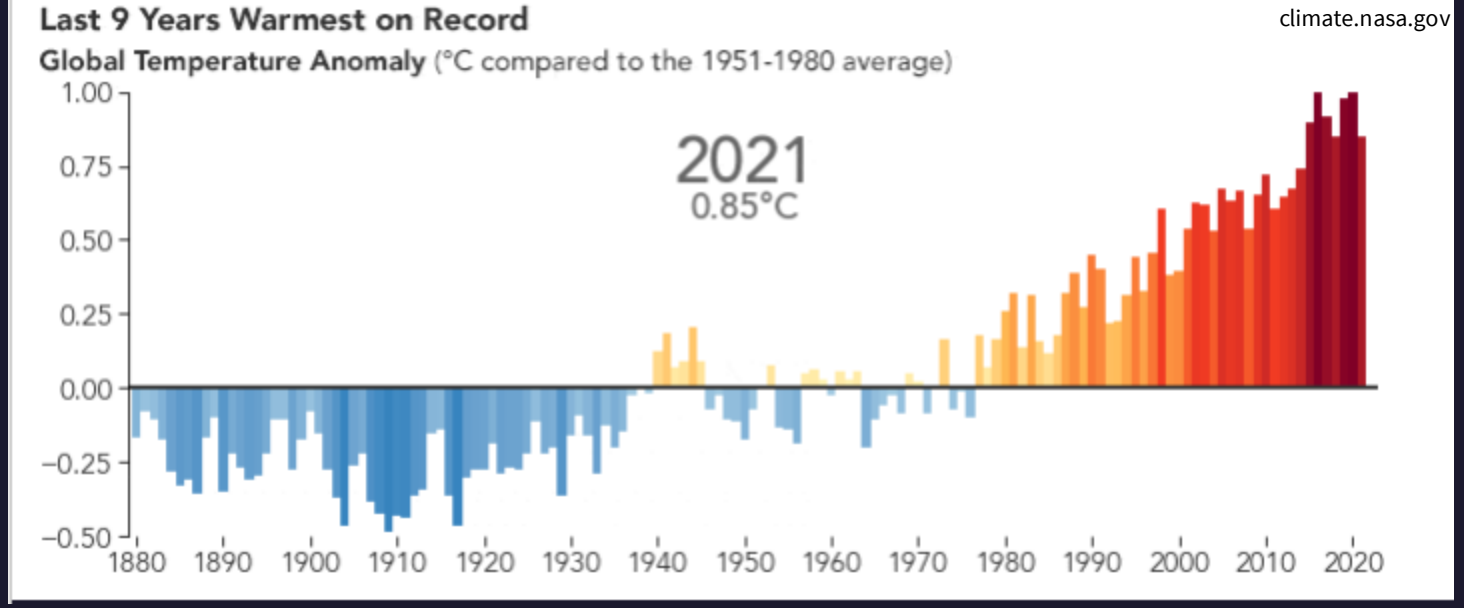
Climate change:

Is it overrated?

Image source: noaa.gov



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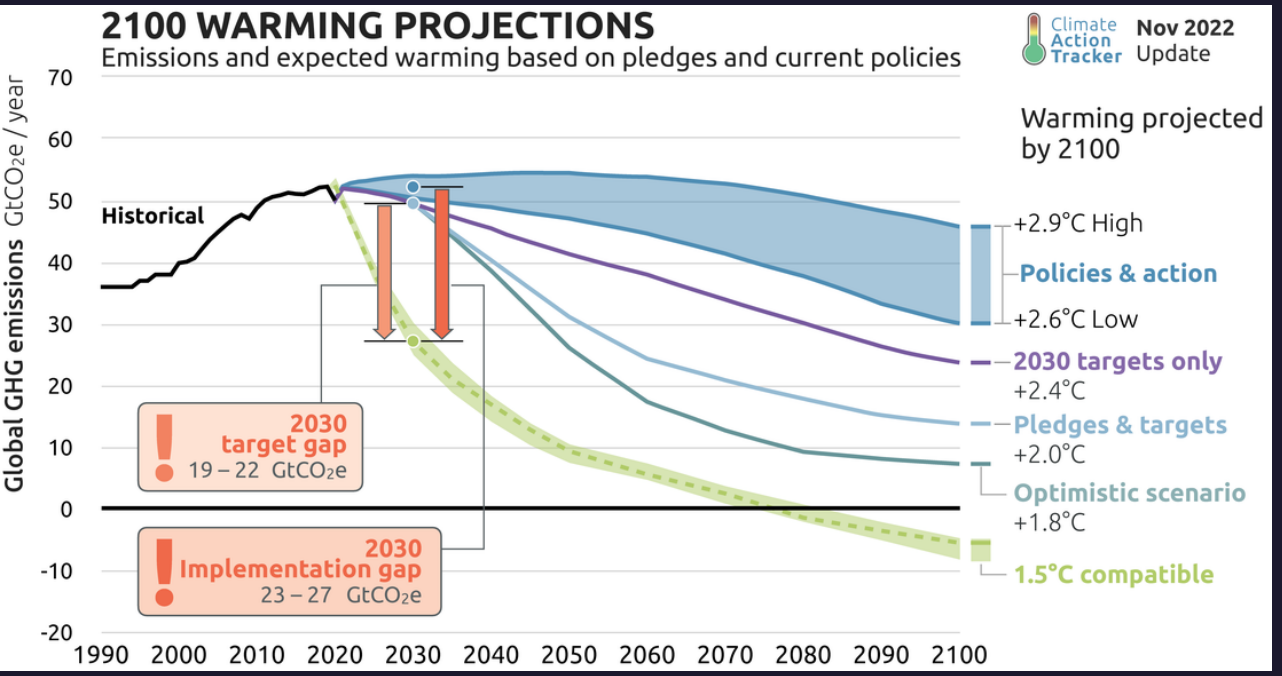

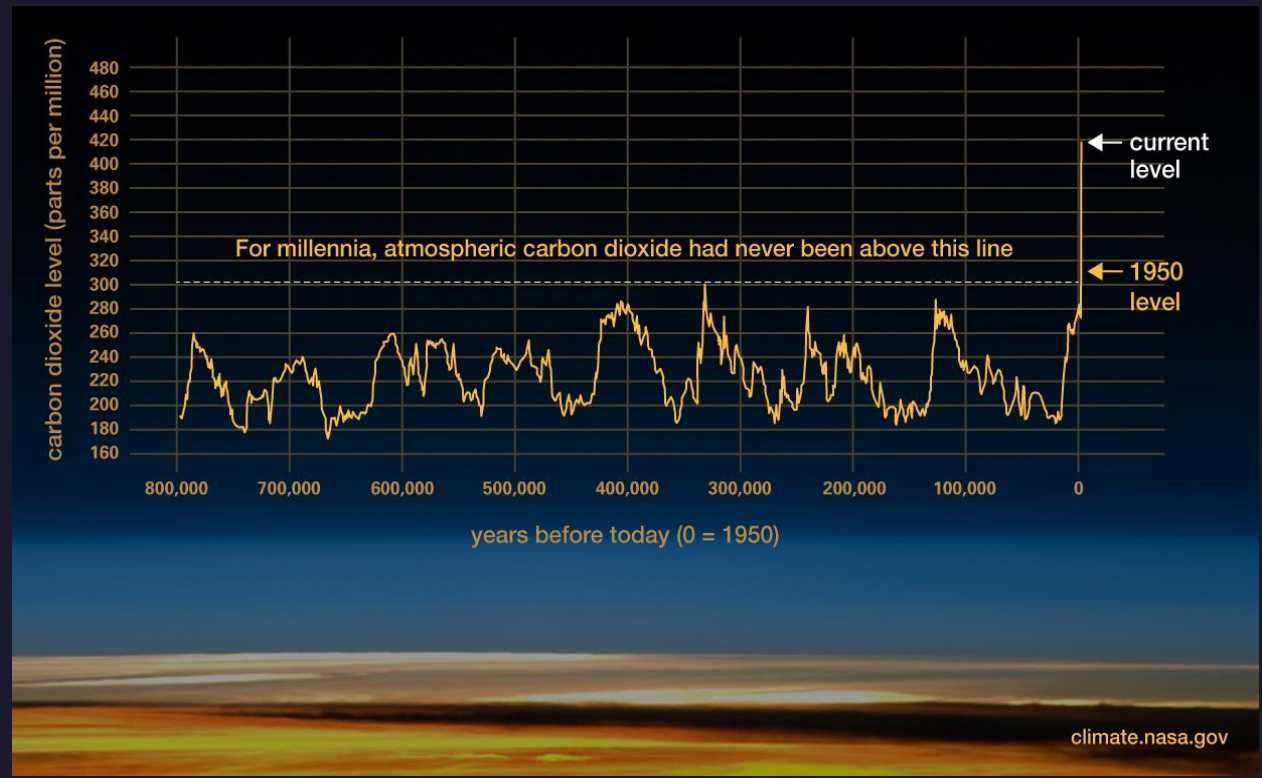

What does it have to do with tech?

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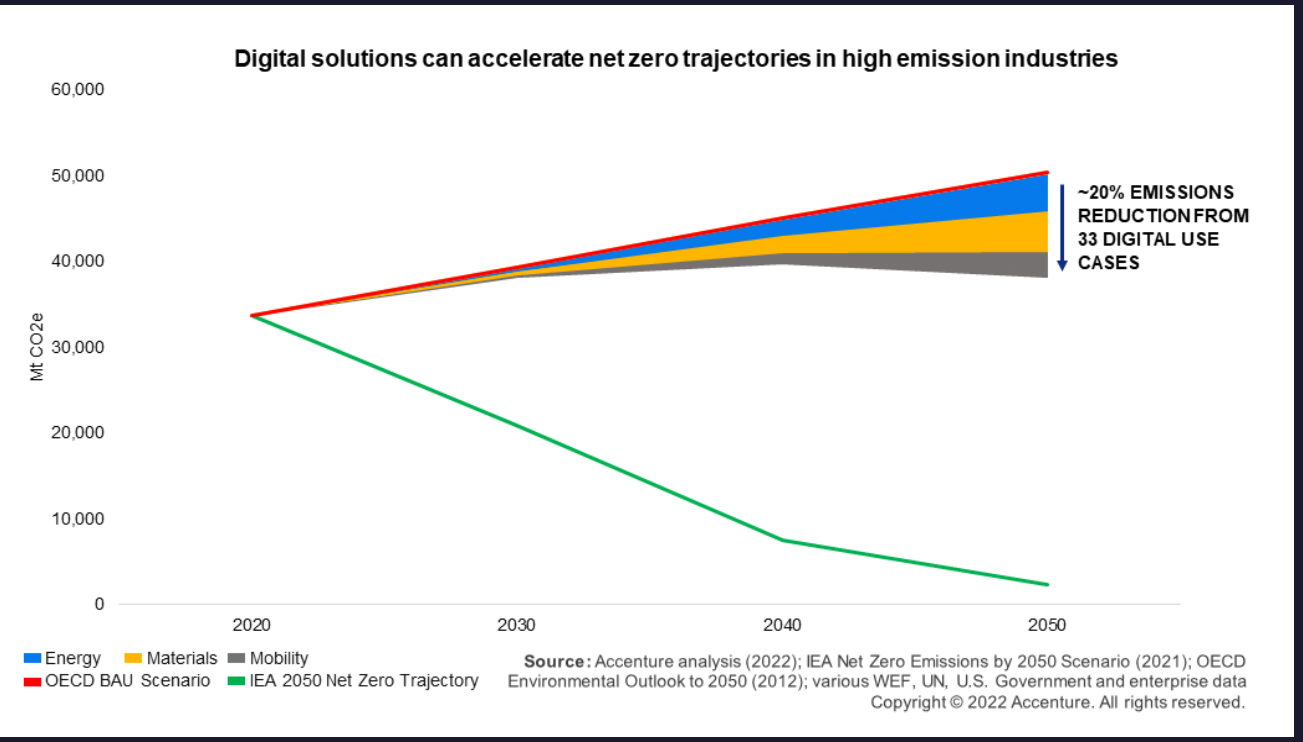
Technology:

Climate friend or Climate foe?

Image source: venturebeat.com


Digital solutions can accelerate net zero trajectories in high emission industries
60,000
50,000
40,000
30,000
20,000
10,000
0
Mt CO2e
2020
2030
2040
2050
~20% EMISSIONS REDUCTION FROM 33 DIGITAL USE CASES
Energy
Materials
Mobility
OECD BAU Scenario
IEA 2050 Net Zero Trajectory
Source: Accenture analysis (2022); IEA Net Zero Emissions by 2050 Scenario (2021); OECD Environmental Outlook to 2050 (2012); various WEF, UN, U.S. Government and enterprise data
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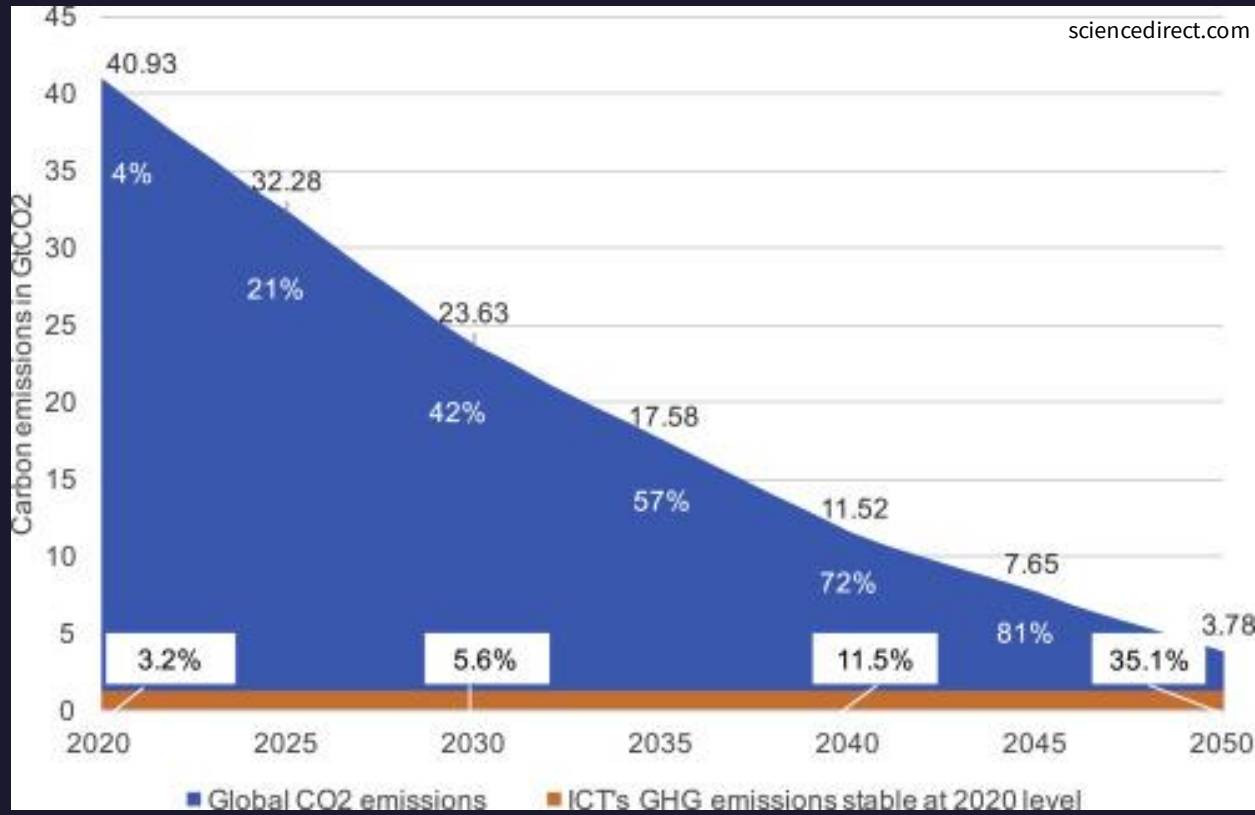
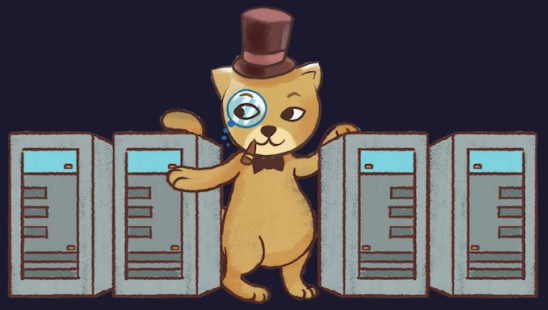

sciencedirect.com
Carbon emissions in GtCO2
45
40
35
30
25
20
15
10
5
0
40.93
32.28
23.63
17.58
11.52
7.65
3.78
4%
21%
42%
57%
72%
81%
3.2%
5.6%
11.5%
35.1%
2020
2025
2030
2035
2040
2045
2050
Global CO2 emissions
ICT's GHG emissions stable at 2020 level



Quiz time!

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Image source: openai.com
Cat image: fatcatapps.com

Quiz time!

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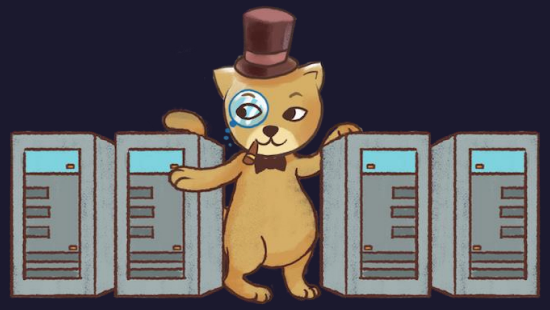
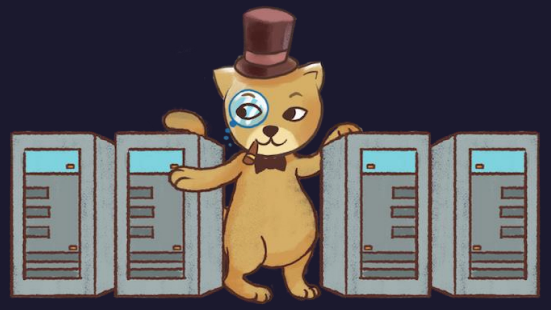
Image source: forbes.com
Cat image: fatcatapps.com



Quiz time!

Image source: blog.economize.cloud
K8s Node icon: kubernetes/community @GitHub



Quiz time!

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Over a third of CPUs for cloud native applications are never used

37% 37% of CPUs for cloud-native applications are never used, on average.

46% the total impact of rightsizing and a cost-effective selection of VMs amounts to 46% in dollar terms.

60% the savings reach a substantial 60% in dollar terms by adding spot instances to applicable workloads.

The State of Kubernetes Report: Overprovisioning in Real-Life Containerized Applications

cast.ai/the-state-of-kubernetes-overprovisioning

cast

Image source: cast.ai
Cat image: fatcatapps.com

Oh no...Are my clusters unsustainably lost?..

Image source: lulu007 @tenor.com
K8s icon: kubernetes/community @GitHub
Sustainability icon: Avector @istockphoto.com

Green Kubernetes:

A myth or a reality YOU create?

Image source: kublr.com

It all starts with awareness!

Image source: blogs.iu.edu

Shared Responsibility Model

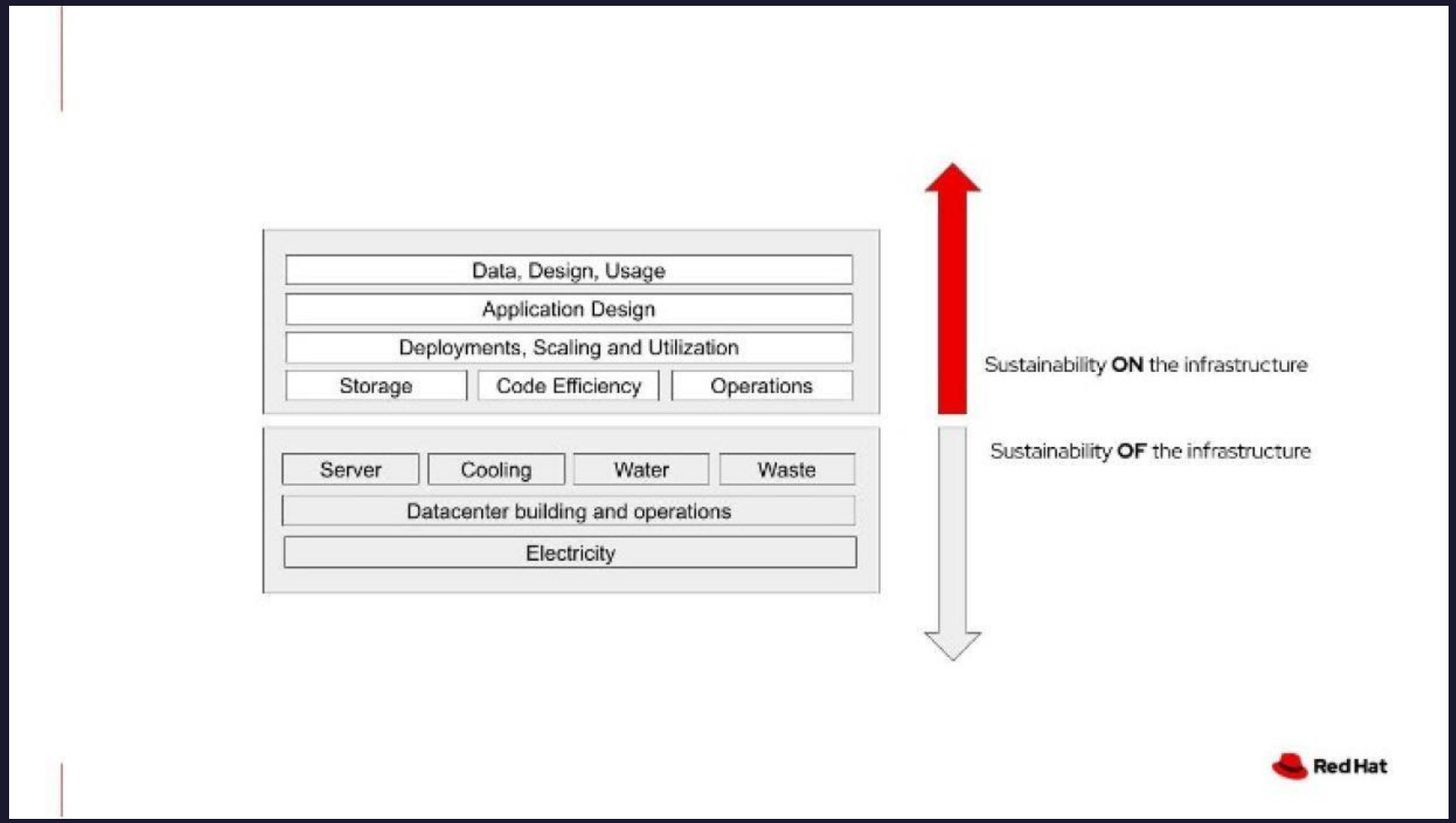

Image source: https://www.redhat.com/architect/sustainable-software-architecture

Supply chain && Location

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- Data center type
- Energy source and efficiency
- Overall strategy and commitments
- Carbon offsetting/Greenwashing
- Region
  - Heat map
  - Consumer proximity

Hyperscale data centres are significantly more efficient than internal data centres

Category	Energy use	Computing workloads	Water intensity	Carbon intensity	Water intensity	Carbon intensity
	Million MWh	million	M_3 MWh_{-1}	ton CO_2-eq MWh_{-1}	m_3/workload	Ton CO_2-eq /workload
Internal	26.90	16	7.20	0.45	12.15	0.75
Colocation	22.4	41	7.00	0.42	3.85	0.25
Hyperscale	22.85	76	7.00	0.44	2.10	0.15

Source: Siddik & Sehab 2021

climatiq

Supply chain && Location

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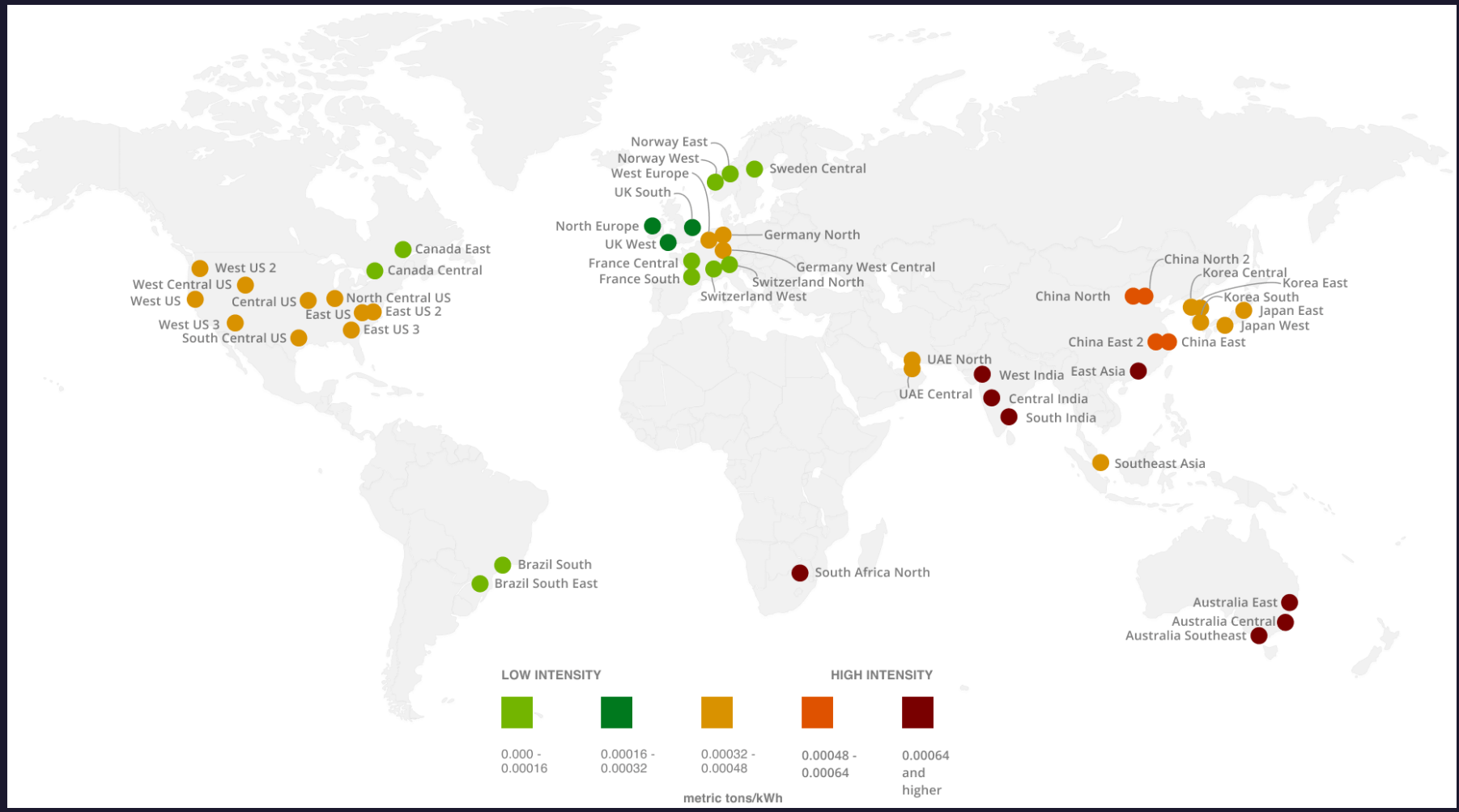

[Interactive View]

Node type && size

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- VM type and size
  - VM series
  - Power-efficient processors (Ampere Altra Arm-based)
  - Oversizing ⚠️
- Spot instances
- Proximity placement group

Fewer compute resources + highest utilization = 

Hearts image source: Mariia Shapilova @Dreamstime.com

Scaling

- Conscious scaling
- Sudden bursts vs. constant load
- Automatic vs. manual scaling
- Event-driven scaling

Emerging: Carbon-aware scaling

Eliminate zombies!

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- Regular "Dugnad" :)
- Scale to zero
- Turn off policy
- On-demand usage
- Scheduling time frame
- Detect and alert upon "zombie" workloads

Image source: blog.cat-gifs.com
And my animation designer skills :)

Applications

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Lift and shift ≠ sustainable (by default)

- Application architecture
- CI/CD
- Deployment model
- Observability
- Best practices
  - Containerized applications
  - Green coding/Green Software Engineering
  - Lean coding

Image source: digitalsme.eu

Define – Measure - Optimize

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- Sustainability pillar of Well-Architected Framework
- Carbon emissions calculator && dashboards
- Cost management tools

cloud-carbon-footprint/
cloud-carbon-footprint

Cloud Carbon Footprint is a tool to estimate energy use (kilowatt-hours) and carbon emissions (metric tons CO2e) from public cloud...

69 Contributors · 5 Used by · 16 Discussions · 639 Stars · 197 Forks

Sustainable Computing

79 followers · United States of America · http://www.sustainable-computing.io · info@sustainable-computing.io

Overview · Repositories 22 · Projects 2 · Packages · People

Green Software Foundation

The Green Software Foundation is a non-profit with the mission to create a trusted ecosystem of people, standards, tooling and best practices for green software

316 followers · https://greensoftware.foundation

Overview · Repositories 33 · Discussions · Projects 2 · Packages · People 3

Principles of Sustainable Software Engineering

Principles.Green

OpenGitOps

TAG ENVIRONMENTAL SUSTAINABILITY

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Cloud Carbon Footprint

RECOMMENDATIONS

Cloud Providers: 1 of 3 | Accounts: 1 of 3 | Services: 26 of 26 | Start Date → End Date | 1M | 3M | 6M | 12M | ALL

Your cumulative emissions are

5.9 metric tons CO2e

that is equivalent to

CO2e emissions from

7

direct one way flights from NYC to London

FLIGHTS | PHONES | TREES

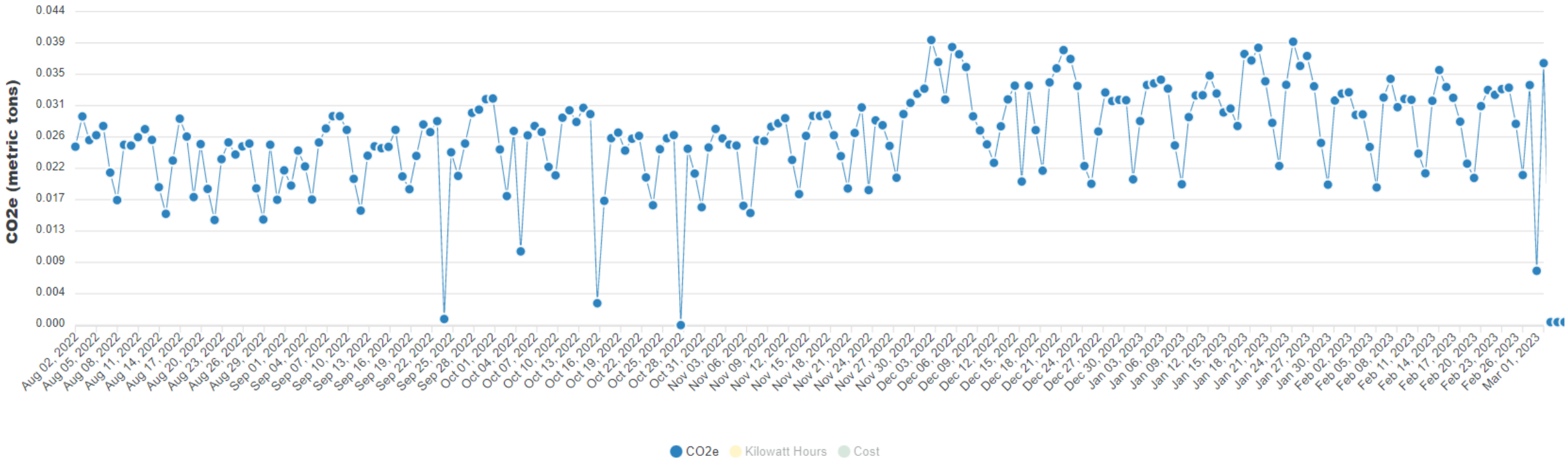
Source: Flight Carbon Footprint Calculator

Emissions Breakdown

Region

1 - 8 of 8

Cloud Usage


CO2e (metric tons)
0.044
0.039
0.035
0.031
0.026
0.022
0.017
0.013
0.009
0.004
0.000
Aug 02, 2022
Aug 05, 2022
Aug 08, 2022
Aug 11, 2022
Aug 14, 2022
Aug 17, 2022
Aug 20, 2022
Aug 23, 2022
Aug 26, 2022
Aug 29, 2022
Sep 01, 2022
Sep 04, 2022
Sep 07, 2022
Sep 10, 2022
Sep 13, 2022
Sep 16, 2022
Sep 19, 2022
Sep 22, 2022
Sep 25, 2022
Sep 28, 2022
Oct 01, 2022
Oct 04, 2022
Oct 07, 2022
Oct 10, 2022
Oct 13, 2022
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Jan 03, 2023
Jan 06, 2023
Jan 09, 2023
Jan 12, 2023
Jan 15, 2023
Jan 18, 2023
Jan 21, 2023
Jan 24, 2023
Jan 27, 2023
Jan 30, 2023
Feb 02, 2023
Feb 05, 2023
Feb 08, 2023
Feb 11, 2023
Feb 14, 2023
Feb 17, 2023
Feb 20, 2023
Feb 23, 2023
Feb 26, 2023
Mar 01, 2023
CO2e
Kilowatt Hours
Cost

Custom

Nodes	10
Namespaces	23
Pods	1302
Controllers	74

Total Cost	US$623.40
Estimated Savings	US$2,930.49
Efficiency	7%
Spending Trend	N/A

Efficiency

NAME	REQUESTED / USAGE
CPU	3% Efficiency
RAM	11% Efficiency

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Savings

Estimated monthly savings available

US$2,336.45

Right-size your cluster nodes

Adjust the number and size of your cluster's nodes to stop over-spending on unused capacity.

Kubernetes Insight

Save up to US$2,452.21 /mo

Remedy abandoned workloads

Scale down, delete or resize pods that don't send or receive a meaningful rate of network traffic.

Kubernetes Insight

Save up to US$182.95 /mo

Manage unclaimed volumes

Delete volumes that are unused by any pods or move them to a cheaper storage tier.

Kubernetes Insight

Explore savings

Manage underutilized nodes

Turn down or resize nodes with low memory and CPU utilization.

Kubernetes Insight

Save up to US$934.67 /mo

	CURRENT	RECOMMENDATION: COMPLEX	RECOMMENDATION: SIMPLE
Total cost	US$2,850.79/mo	**US$421.50/mo**	**US$398.58/mo**
Savings		US$2,429.29 (85.2%)	US$2,452.21 (86%)
Node count	9	4	3
CPU	64 VCPUs	14 VCPUs	12 VCPUs
CPU utilization	25.5% utilized	70.6% utilized	71.7% utilized
RAM	424 GB	33 GB	48 GB
RAM utilization	5.9% utilized	44.8% utilized	26.6% utilized
Instance breakdown	7 DS13 v2 x86 **VCPUs** 8 VCPUs ea. **RAM** 56 RAM (GB) ea. **Cost** n/a 2 D4s v3 x86 **VCPUs** 4 VCPUs ea. **RAM** 16 RAM (GB) ea. **Cost** n/a	2 B1ls x86 **VCPUs** 1 VCPUs ea. **RAM** 0.5 RAM (GB) ea. **Cost** US$4.16/mo ea. 1 F8s v2 x86 **VCPUs** 8 VCPUs ea. **RAM** 16 RAM (GB) ea. **Cost** US$280.32/mo ea. 1 B4ms x86	3 B4ms x86 **VCPUs** 4 VCPUs ea. **RAM** 16 RAM (GB) ea. **Cost** US$132.86/mo ea.

Nodes with underutilized CPU & memory

Nodes with low memory and CPU utilization are candidates for being turned down or resized. The following nodes have sustained usage below 25% in both categories. Your cluster has enough resource availability to support turning these nodes down.

Maximum CPU/RAM Request Utilization (60%)

Node	Node Checks	Pod Checks	Recommendation
akswinpol00003o	Passed	Passed	Safe to drain. Save $246.87 / mo.
akswinpol00003i	Passed	Passed	Safe to drain. Save $246.87 / mo.
akswinpol00003s	Passed	Passed	Safe to drain. Save $246.87 / mo.
akswinpol00003n	Passed	Passed	Safe to drain. Save $246.87 / mo.
aks-nodepool1-16599594-vmss000000	Failed	Failed	Do not drain
akswinpol00003p	Failed	Passed	Do not drain
akswinpol00003r	Failed	Passed	Do not drain

It's all about balance!

GIF source: lundstigarne @tenor.com

YOU can make a bigger impact than you think!

Image source: imgflip.com

Thank You!

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SCAN ME

@kristhecodingu1

krisde

kristhecodingunicorn.com

Icons source: icons8.com
GIF source: tenor.com

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I appreciate YOUR feedback 😻