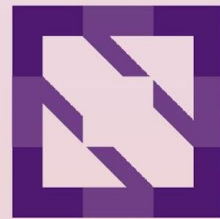




KubeCon



CloudNativeCon

North America 2023





KubeCon



CloudNativeCon

North America 2023

Sustainability and Efficiency: Environmentally-Friendly Software Development with kube-green

Davide Bianchi



I'm **Davide Bianchi**
Senior Technical Leader



@dbianchi92



<https://github.com/davidebianchi/>



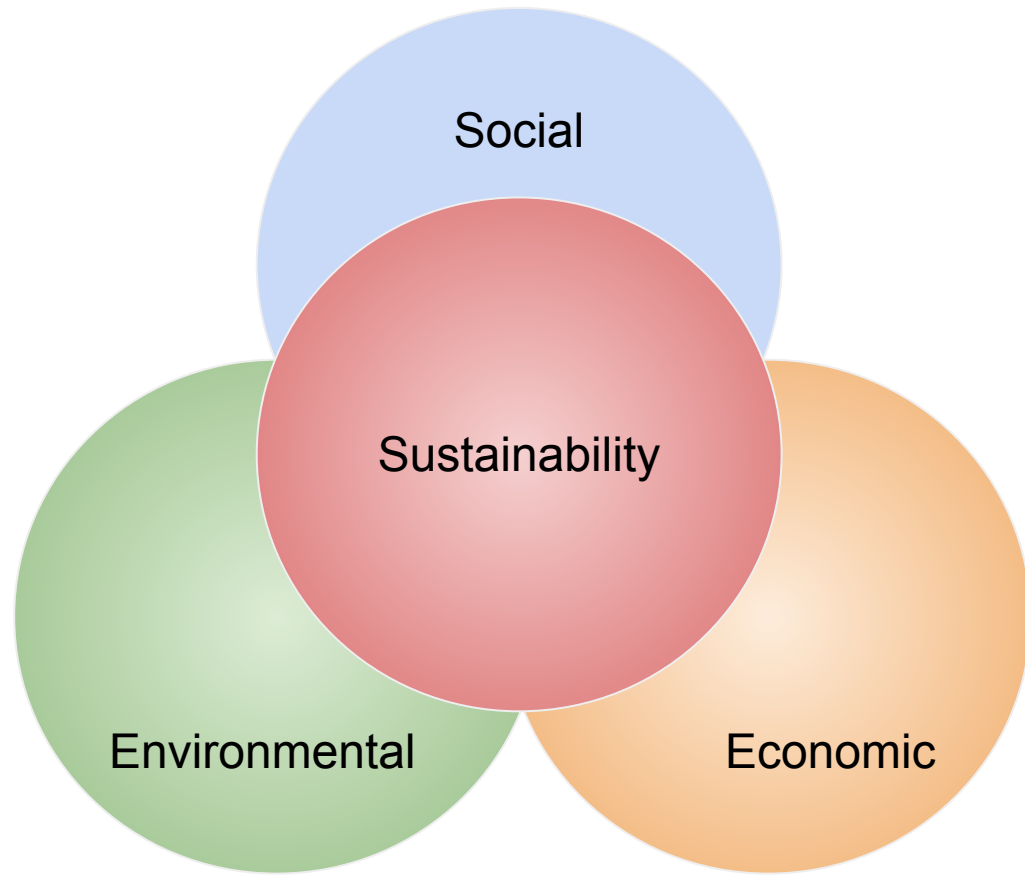
<https://www.linkedin.com/in/davide-bianchi-929a74b9/>

Agenda

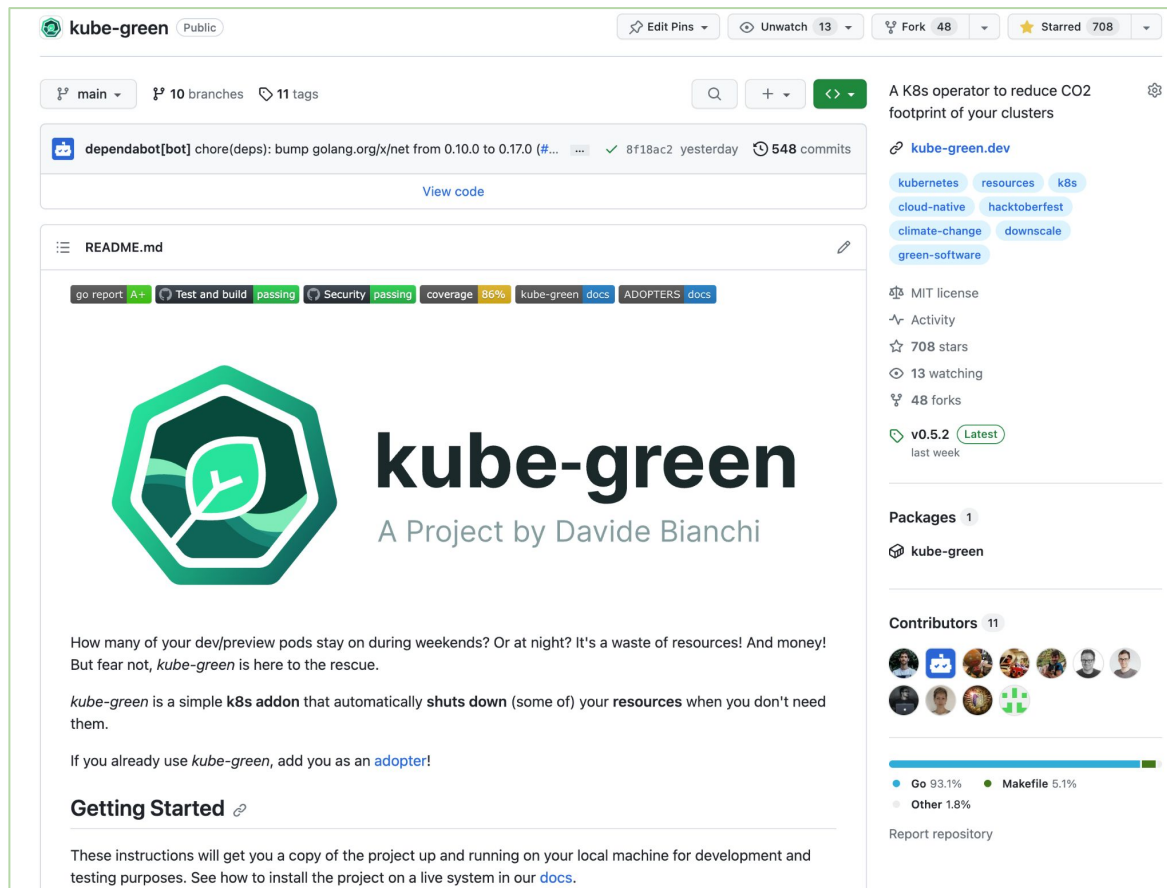
1. Intro to Sustainability
2. Sustainability in IT
3. Green Software
4. kube-green
5. Conclusion

Intro to Sustainability

- Economic
- Social
- Environmental



kube-green



The screenshot shows the GitHub repository for **kube-green**, a public project. At the top, it indicates 10 branches and 11 tags. A recent commit by dependabot[bot] is shown, updating golang.org/x/net from 0.10.0 to 0.17.0. The repository description is "A K8s operator to reduce CO2 footprint of your clusters". The README.md file is open, featuring the kube-green logo (a green hexagon with a leaf) and the text "kube-green A Project by Davide Bianchi". The README explains the project's purpose: to reduce resource waste by shutting down dev/preview pods during weekends or at night. It mentions that kube-green is a simple k8s addon and provides instructions on how to get started. The right sidebar shows repository statistics: 708 stars, 13 watchers, 48 forks, and the latest release v0.5.2 from last week. It also lists tags like kubernetes, resources, k8s, cloud-native, hacktoberfest, climate-change, downscale, and green-software.

kube-green (Public)

Edit Pins Unwatch 13 Fork 48 Starred 708


main 10 branches 11 tags

dependabot[bot] chore(deps): bump golang.org/x/net from 0.10.0 to 0.17.0 (#... 8f18ac2 yesterday 548 commits)

View code

README.md

go report A+ Test and build passing Security passing coverage 85% kube-green docs ADOPTERS docs



kube-green

A Project by Davide Bianchi

How many of your dev/preview pods stay on during weekends? Or at night? It's a waste of resources! And money! But fear not, *kube-green* is here to the rescue.

kube-green is a simple **k8s addon** that automatically **shuts down** (some of) your **resources** when you don't need them.

If you already use *kube-green*, add you as an [adopter](#)!

Getting Started

These instructions will get you a copy of the project up and running on your local machine for development and testing purposes. See how to install the project on a live system in our [docs](#).

A K8s operator to reduce CO2 footprint of your clusters

[kube-green.dev](#)

kubernetes resources k8s
cloud-native hacktoberfest
climate-change downscale
green-software

MIT license

Activity

708 stars

13 watching

48 forks

v0.5.2 (Latest) last week

Packages 1

kube-green

Contributors 11

Go 93.1% Makefile 5.1%
Other 1.8%

Report repository

On GitHub at link <https://github.com/kube-green/kube-green>

Environmental Sustainability in IT

The background of the slide is a dark, high-contrast image of a computer circuit board. It features various electronic components such as integrated circuits, capacitors, and resistors, with intricate white circuit traces visible against the dark background. The lighting is dramatic, highlighting the textures and shapes of the hardware.

IT resources consumptions

COMPUTE (CPU & GPU)

STORAGE

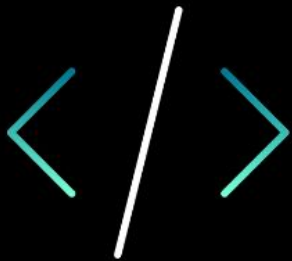
NETWORKING

MANUFACTURING

TRANSPORTING

COOLING EQUIPMENT





All we do online run on a server
somewhere

Also the code we write, once
released on a server, consumes
energy and produces CO₂



Some examples

Global electricity demand

240-340 TWh/year in 2022

<https://www.iea.org/energy-system/buildings/data-centres-and-data-transmission-networks>

1-1.3% global final electricity demand

330 Mt CO₂ eq in 2020

<https://www.iea.org/energy-system/buildings/data-centres-and-data-transmission-networks>



Bitcoin electricity demand

133 TWh/year in 2022

<https://ccaf.io/cbnsi/cbeci>

0.4% global final electricity demand

68 Mt CO₂ eq

<https://ccaf.io/cbnsi/cbeci/ghg>

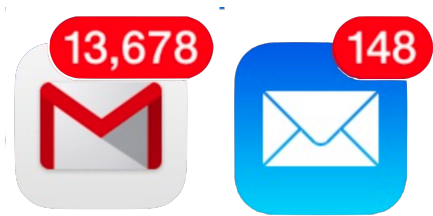
What is the environmental impact of an email?

A **standard email**, one without an attachment, has a carbon footprint of **4gm of CO₂e**.

Adding **just a small attachment** can **dramatically increase the carbon footprint** of your emails – **19gm CO₂e**

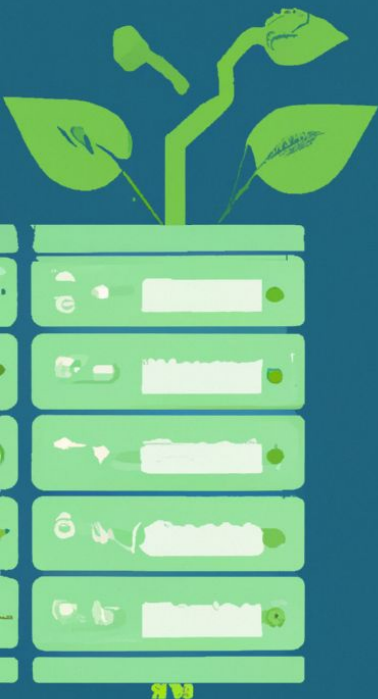
With **100 email/day** received in average, we have an average emissions per person **in a year of 150 Kg/CO₂eq**

~1000 km driving a mid-sized car



<https://www.eco2greetings.com/News/The-Carbon-Footprint-of-Email-vs-Postal-Mail.html>

How to avoid to consume energy?



We could not use software, but it's our work and especially it is more and more important in all working environments.

How can we create more sustainable software?

(image from DALL-E)

Green software

Green Software groups



The Green Software Foundation Mark is a trademark of The Linux Foundation in the US and other countries."

<https://greensoftware.foundation/>

The mission is to build a trusted ecosystem of people, standards, tooling and best practices for creating and building green software.



<https://tag-env-sustainability.cncf.io/>

The TAG goal is to advocate for, develop, support, and help evaluate environmental sustainability initiatives in cloud native technologies.

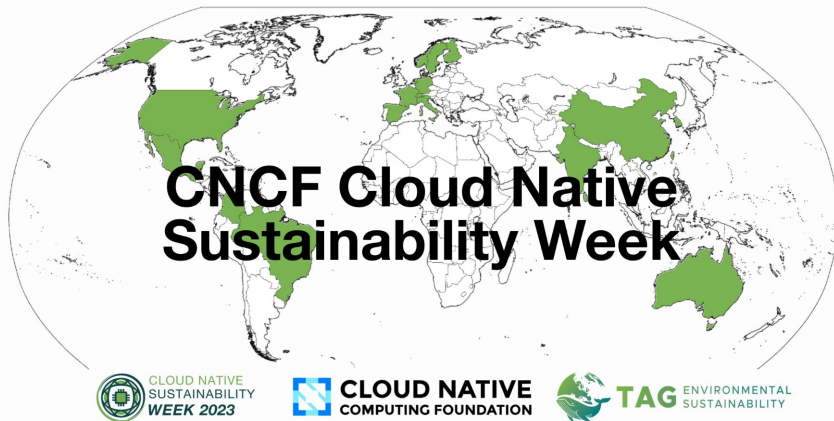
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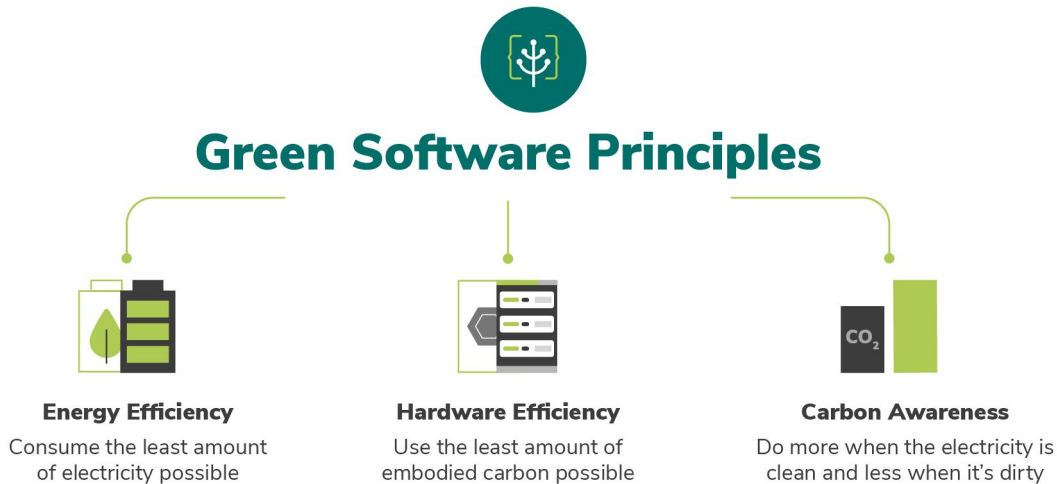


<https://tag-env-sustainability.cncf.io/>

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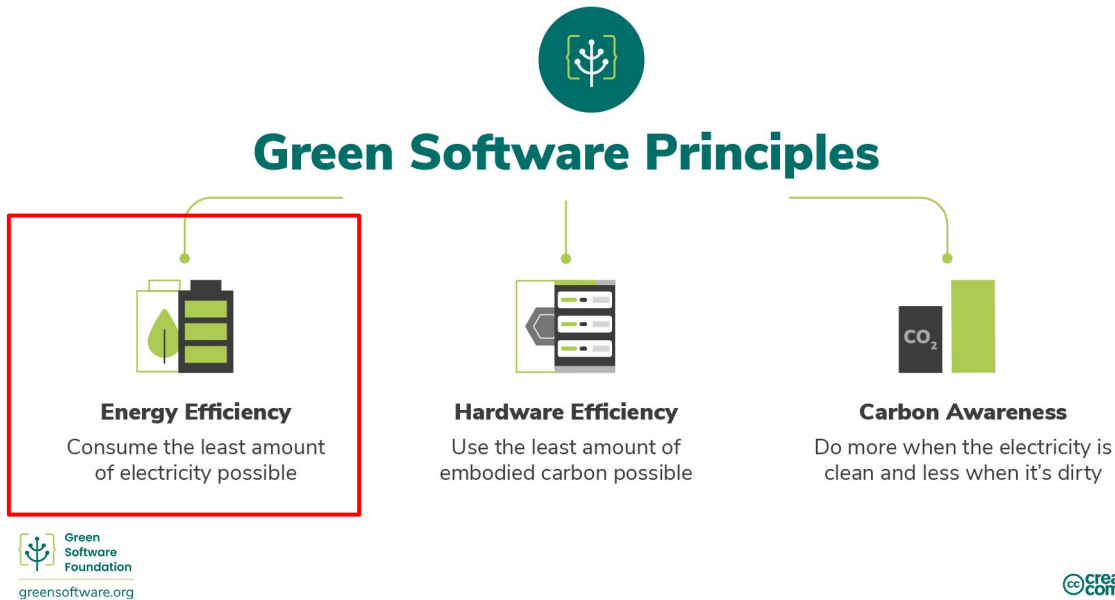
What is green software?

Green software is carbon-efficient software, meaning it emits the least carbon possible.



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<https://learn.greensoftware.foundation/introduction/>

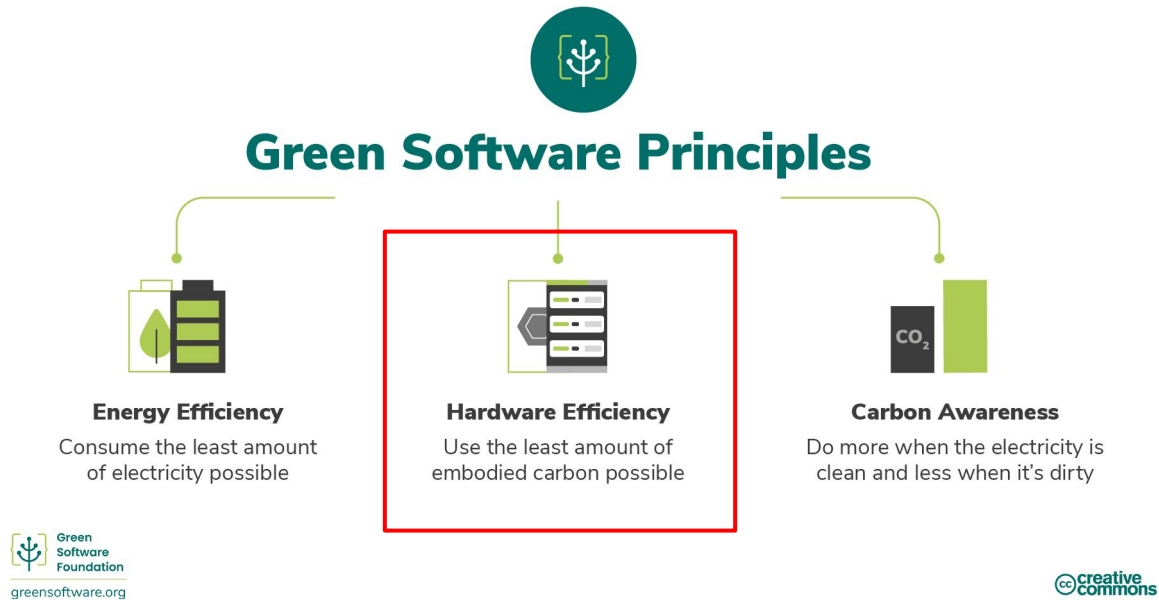
Energy Efficiency

How can we create efficient software:

- Create the correct number of microservices for an application
- Write efficient code
- Optimize data handling
- Use of new and more performant hardware (e.g. ARM architecture)

What is green software?

Green software is carbon-efficient software, meaning it emits the least carbon possible.



<https://learn.greensoftware.foundation/introduction/>

Hardware Efficiency

Embedded carbon: the amount of carbon pollution emitted during the creation and disposal of a device.

How to improve hardware efficiency?

- **Extend lifetime** of the hardware

Hardware Efficiency

Extend lifetime of the hardware (amortization)

If I need **4000 Kg CO₂e** to create and disposal a server, if we use the server:

- for **4 years**, the amortized carbon is of **1000 Kg CO₂e/y**
- for **5 years**, the amortized carbon is of **800 Kg CO₂e/y**

Hardware Efficiency

Embedded carbon: the amount of carbon pollution emitted during the creation and disposal of a device.

How to improve hardware efficiency?

- **Extend lifetime** of the hardware
- **Increase device utilization**

Hardware Efficiency

Increasing device utilization

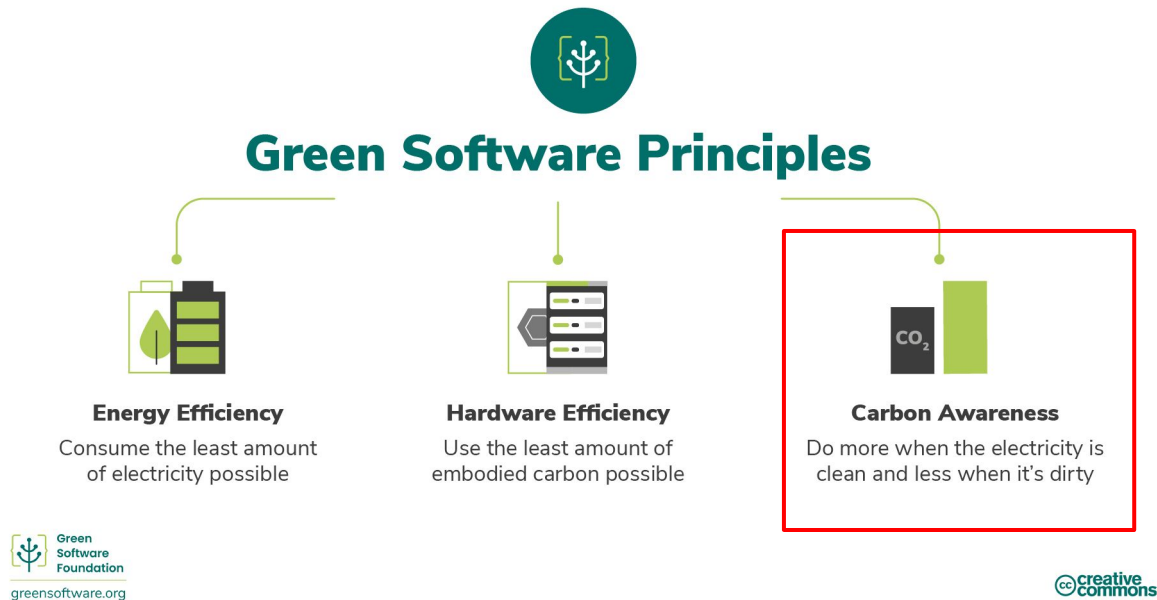
It's better to **use one server at 100% utilization than 5 servers at 20% utilization** because of the cost of embodied carbon

The most common reason to do it is to account the peak capacity. So, **if you use the servers at 20%** means that **you can responds to the traffic peaks**.

One of the main advantages of the **public cloud**: you know that **if you need to scale, the space will be there**

What is green software?

Green software is carbon-efficient software, meaning it emits the least carbon possible.



Carbon Awareness

Use more electricity when it's coming from lower-carbon sources like renewables.

How to do it in real life use cases?

- Demand Shifting
- Demand Shaping

Carbon Awareness

Demand Shifting

Spatial shifting

Move your computation to another physical location with lower carbon intensity

Temporal shifting

If it is not possible to shift spatially, shift to another time during day or night when the carbon intensity is lower

<https://learn.greensoftware.foundation/carbon-awareness>

Carbon Awareness

Demand shaping

Instead of moving the demand, **change the demand based on the carbon intensity**.

- if the **carbon intensity is low**, **do more** in applications
- if the **carbon intensity is high**, **do less** in applications

Carbon Awareness

Demand shaping

Real life demand shaping examples:

- **eco mode of our appliances** like cars, televisions...
- video conferencing software adjust **streaming quality** automatically, based on the bandwidth
- **reduce performance** of our application

Demand shaping is related to reduce the consumption.

The background of the image features a dark teal color with a large, curved, lighter teal shape on the right side, creating a modern, abstract design.

Kubernetes

Application example

E-Commerce website on Kubernetes

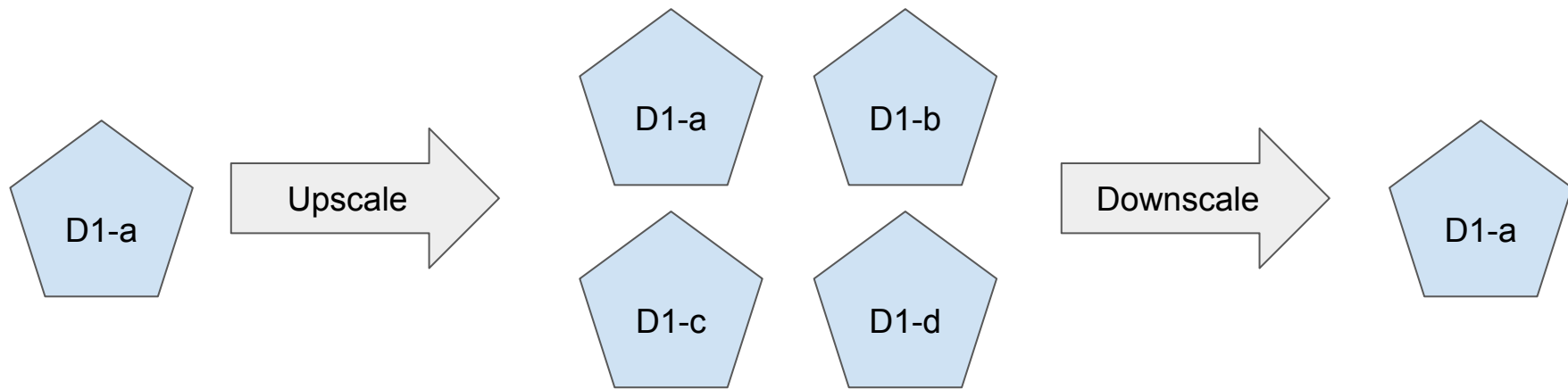
- Traffic Surges during product launches or sales events, traffic can surge significantly

- Resource Demands Vary demands fluctuate throughout the day, requiring more resources during peak hours and fewer during low-traffic periods

- Autoscaling solution adjusts resources ensuring performance during traffic surges and cost-efficiency during quieter times

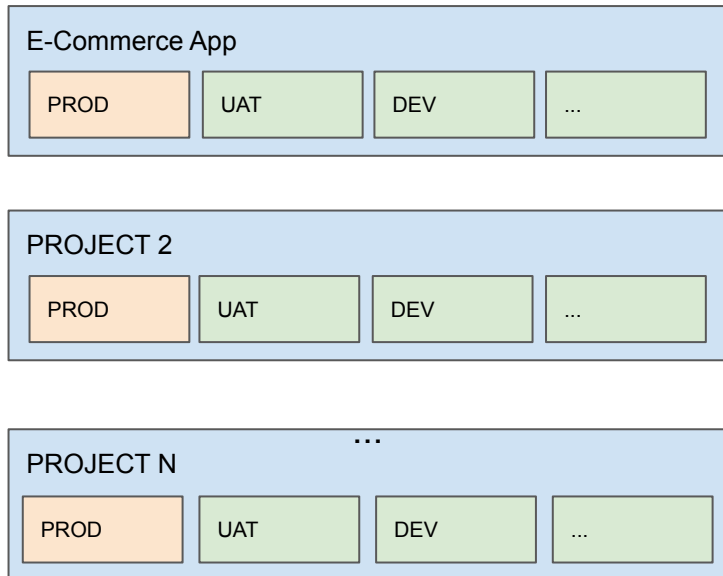
Autoscaling

With **autoscaling**, the application **scale accordingly to some metrics** (such as CPU, memory or other custom metrics)

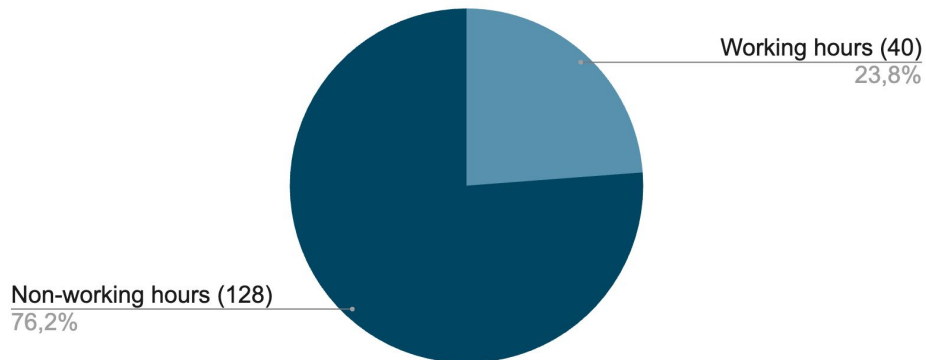


And above all, it's important to also **downscale to consume only what is necessary**. This has repercussions both on cost and on the environment.

Development project lifecycle



Week hours



kube-green

Is an **open source operator** which runs inside our cluster

It is **configurable via a CRD: *SleepInfo***

It is possible to **set up the resources to “sleep”**, and it works at scheduled time

```
apiVersion: kube-green.com/v1alpha1
kind: SleepInfo
metadata:
  name: working-hours
spec:
  weekdays: "1-5"
  sleepAt: "19:00"
  wakeUpAt: "07:00"
  timeZone: "Europe/Rome"
  suspendCronJobs: true
  excludeRef:
    - apiVersion: "apps/v1"
      kind: Deployment
      name: api-gateway
```

How can I use it?

It is really simple to use:

1. **Install kube-green** in your cluster
2. Configure the **SleepInfo CRD** inside the desired namespaces
3. See the **kube-green in action at scheduled time** (both pods sleep and wake up)

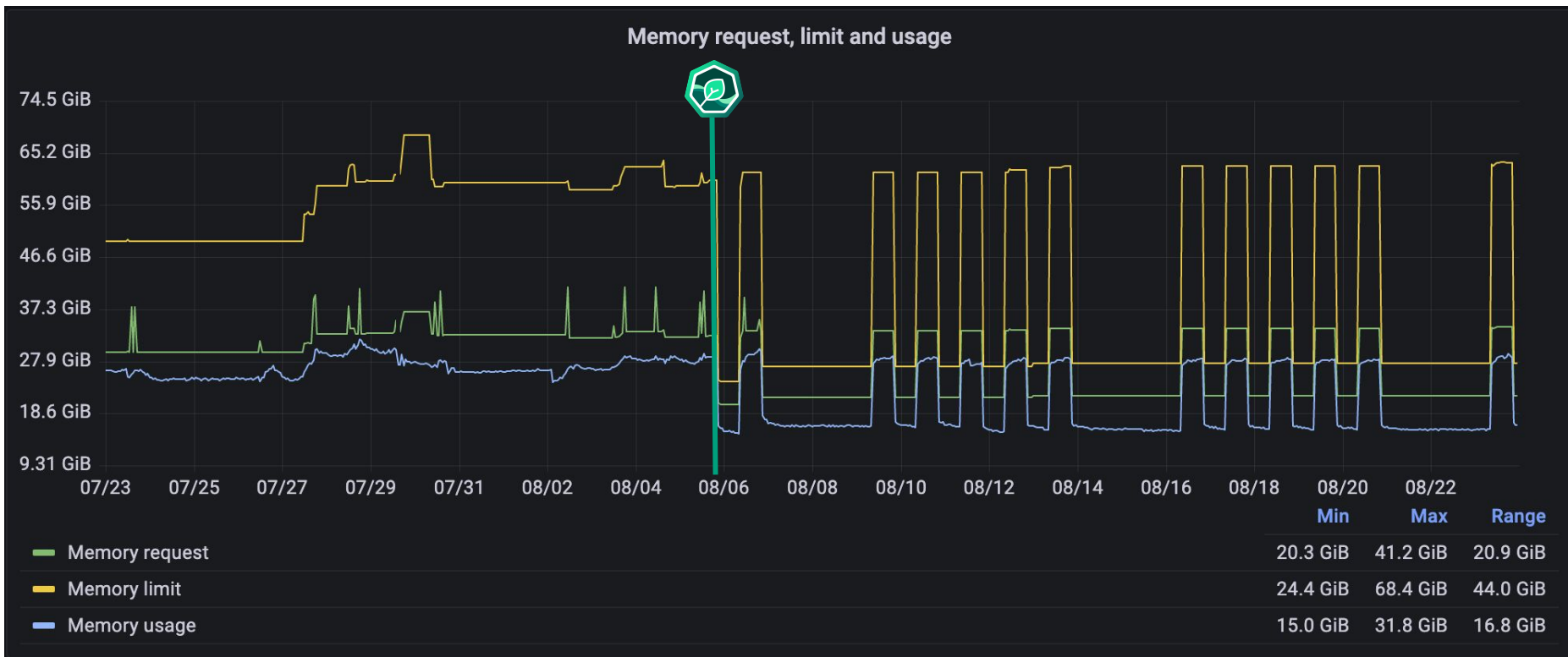
Really basic tutorial available on kube-green site:

<https://kube-green.dev/docs/tutorials/kind/>

Real Life Usage

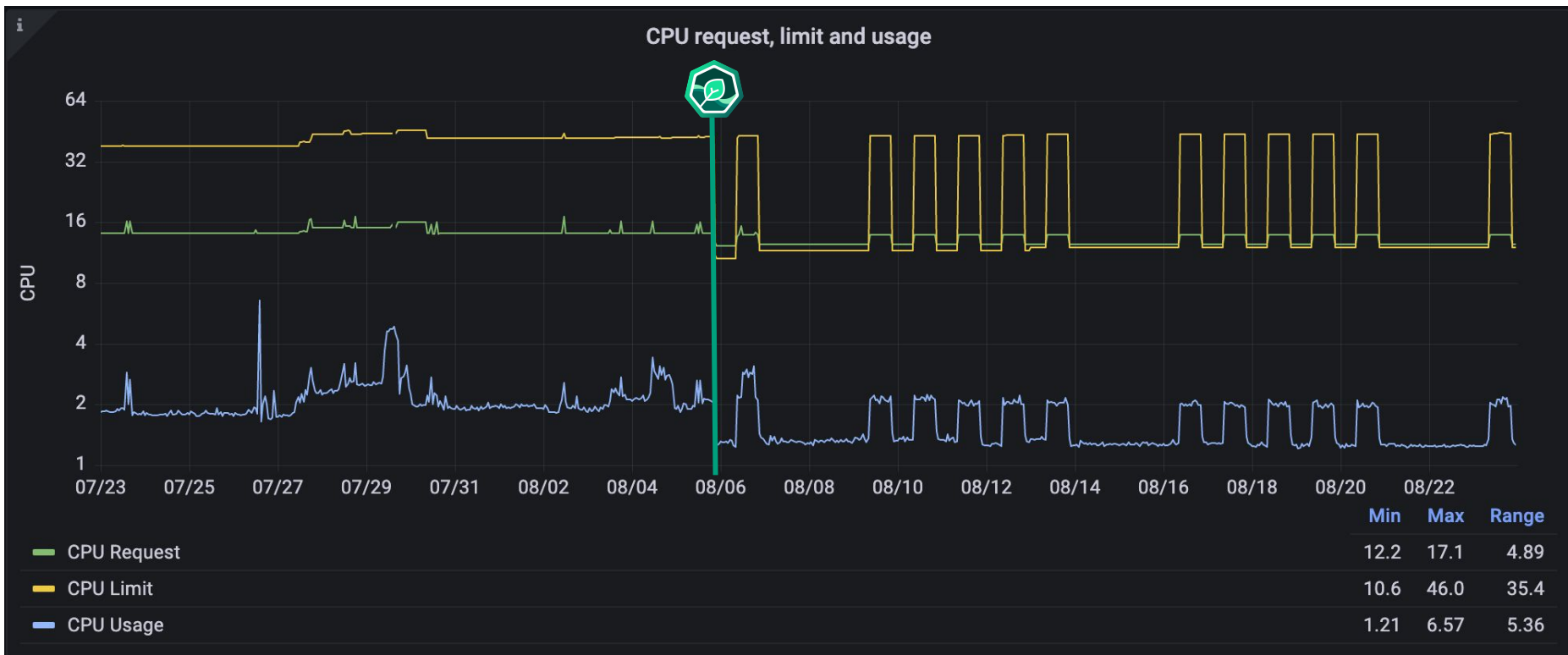
Some charts - Memory

3/15 namespaces of the cluster with kube-green enabled



Some charts - CPU

3/15 namespaces of the cluster with kube-green enabled

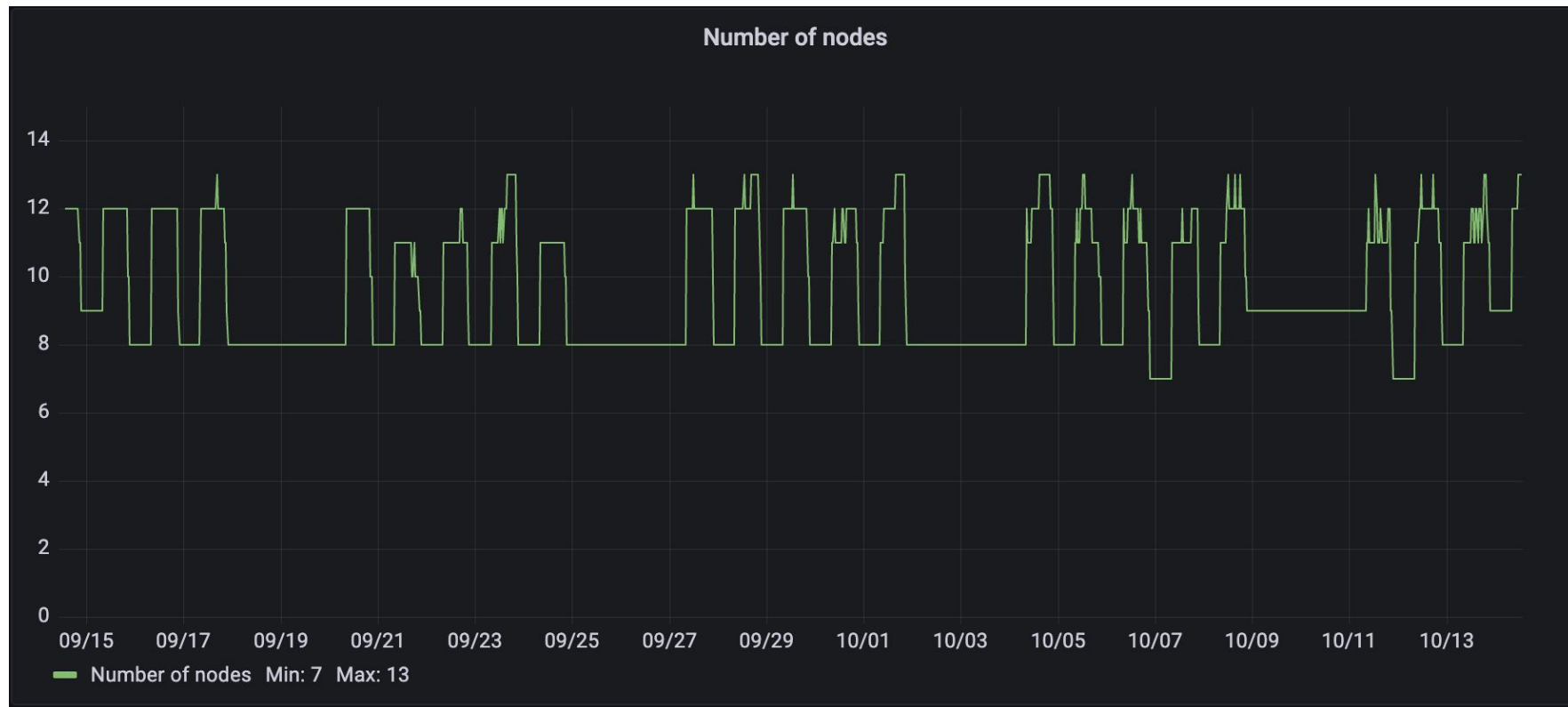


Numbers

48/75 namespaces with kube-green enabled

	Total	with kube-green	Difference
# of pods	1050	450	-600
Memory usage [Gb]	54	21	-33
CPU usage [core]	4.5	1	-3.5
Memory requested [Gb]	75	30	-45
CPU requested [core]	40	15	-25

Some charts - Nodes



kube-green

- an interesting **number of adopters already using kube-green** (list on <https://kube-green.dev>)
- **more than 200k downloads**
- an **average of the 30% of reduction in cloud costs**, with the consequent **reduction in emissions**

Conclusion

Key Takeaways

1. **Sustainability** is important also **in IT**, and it's important to think about it in the software lifecycle
2. The **environmental sustainable** transition could start thinking about the **cost savings**
3. There are some groups which can help you to create **green software**
4. In K8s environment, it is possible to improve the energetic efficiency using **kube-green**



kube-green

A Project by Davide Bianchi

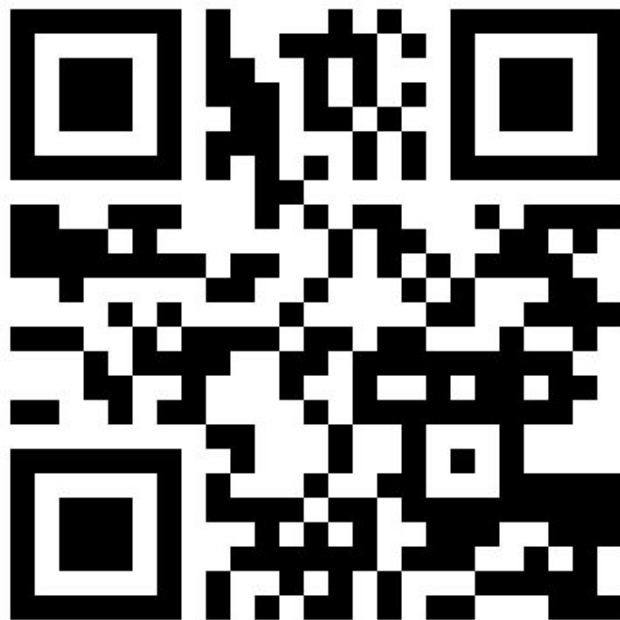
Thank you

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**Please scan the QR Code above
to leave feedback on this session**

