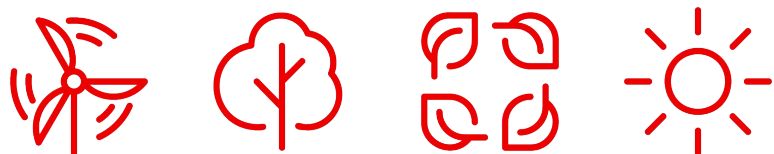
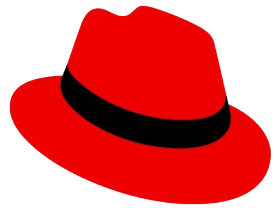


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Level Up dein Sustainability Game: Green Software mit Open Source





Red Hat

Stefan Bergstein

Architect, Field CTO Org
Red Hat

Danijel Soldo

Account Solution Architect
Red Hat

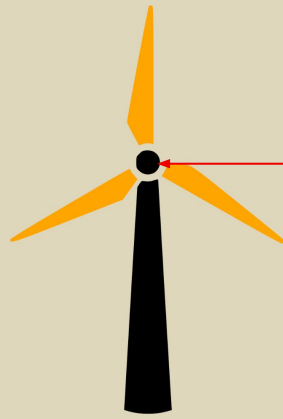
Let's play the **Wind Turbine Race!**



Dashboard: Green Energy

Nickname Team

☰ Arendes Team 2 ⚡



480 W

ENABLE SHAKING

Two teams competing (top 5 players)

Shake to generate energy

„quinoa-wind-turbine-wind-turbine-race.apps.science-cluster.sandbox2009.opentlc.com“ möchte auf „Bewegung“ und „Ausrichtung“ zugreifen

Abbrechen Erlauben

The Race


Team 2 406.79 KW ☰ 250

- 1. Maahs - 1.76 KW
- 2. Latragna - 1.75 KW
- 3. Bayes - 1.74 KW
- 4. Zerwas - 1.73 KW
- 5. Seol - 1.72 KW

Team 1 372.78 KW ☰ 250

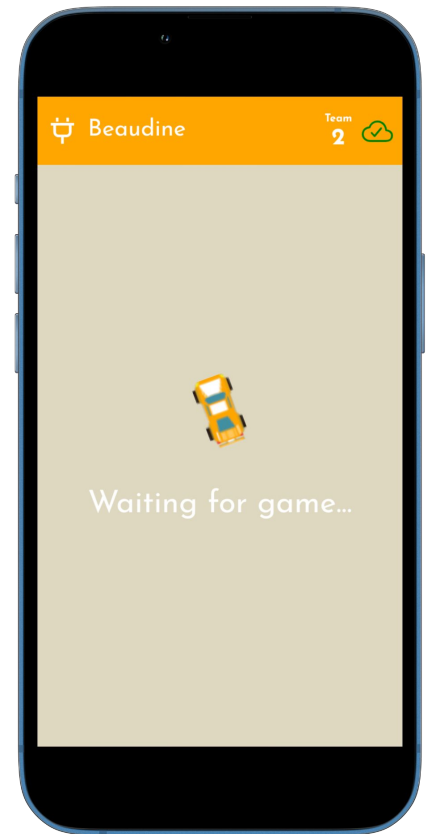
- 1. Londrigan - 1.57 KW
- 2. Rashada - 1.57 KW
- 3. Brunt - 1.56 KW
- 4. Styes - 1.56 KW
- 5. Dauria - 1.56 KW

00:18:16



Cars that need energy

First wins



YOU PLAY!

<https://quinoa-wind-turbine-gitops-demo-prod.apps.rosa-demo15.oiw8.p1.openshiftapps.com/>

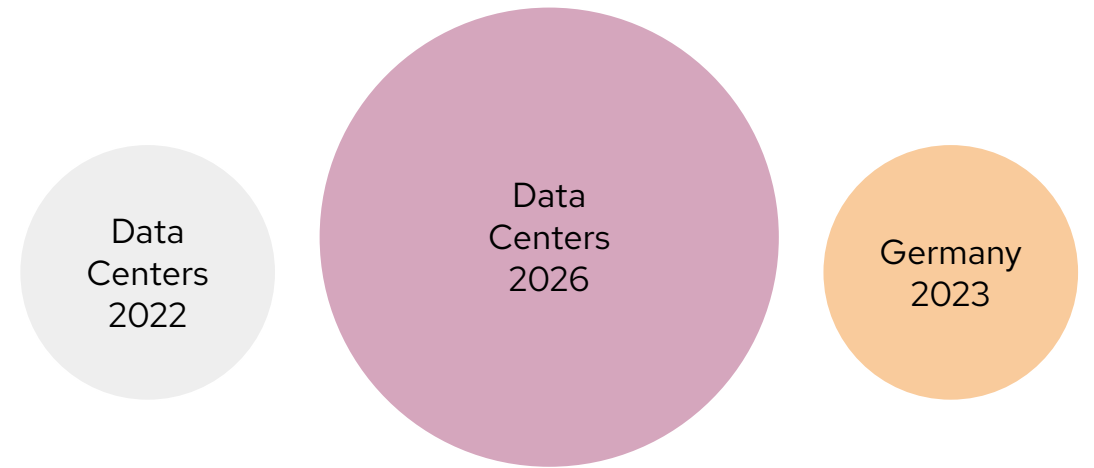
We just produced *fake* electricity in the game...

But are we aware of the *real* impact on the environment our game just had?



Why does it all matter?

After globally consuming an estimated **460** terawatt-hours (**TWh**) in 2022, data centres' total electricity consumption could reach more than **1 000 TWh in 2026**.



Source: <https://www.iea.org/reports/electricity-2024/executive-summary>

What are the most popular jokes about software development nerds and IT sustainability?




Perplexity

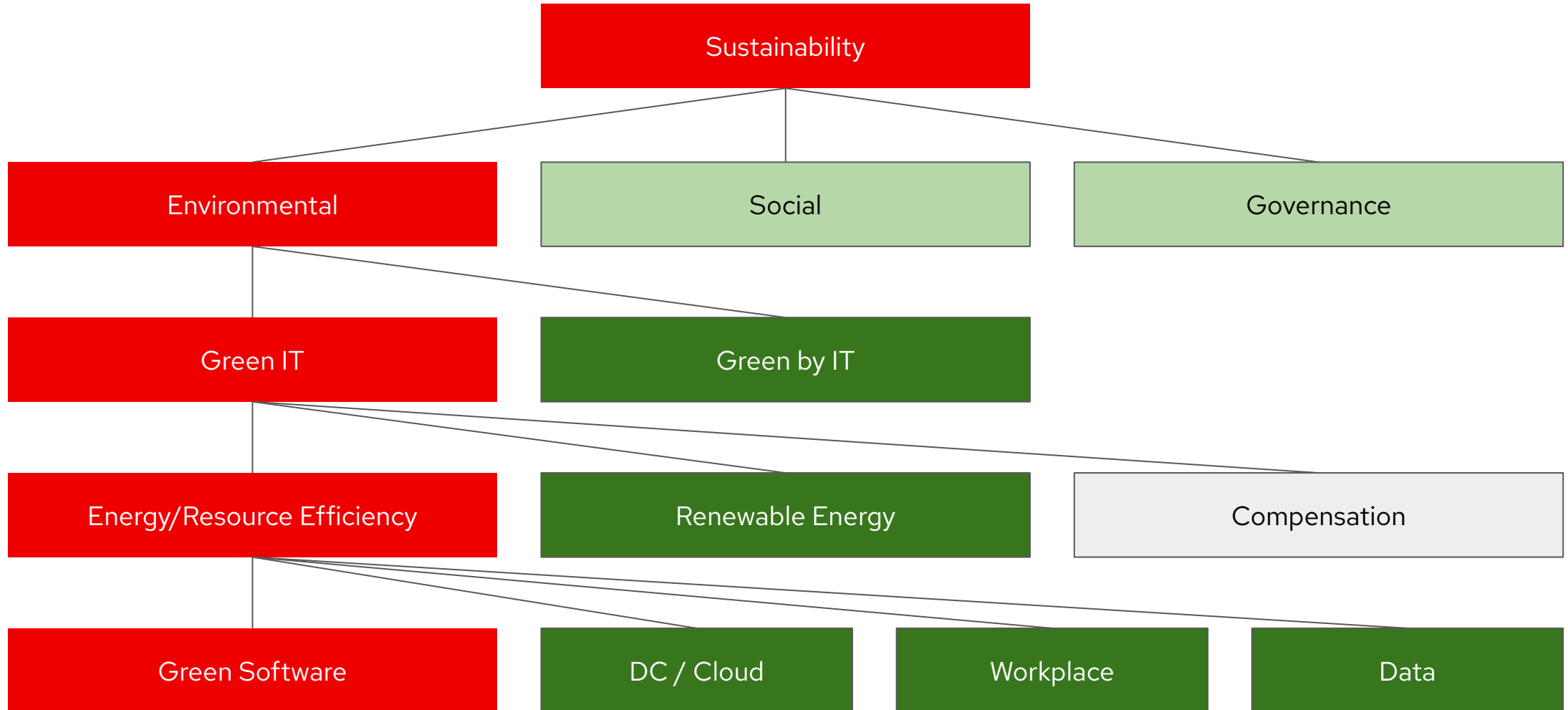
Here are some popular jokes about software development and IT sustainability:

Software Development Jokes:

- "Why do programmers prefer dark mode? Because light attracts bugs!"
- "How many programmers does it take to change a light bulb? None, that's a hardware problem!"

IT Sustainability Jokes:

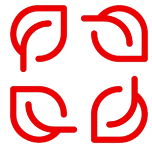
- "Why don't environmentalists play hide and seek? Because good luck hiding when they're always saving the trees!" 
- "If trees sent Wi-Fi signals, people would plant more of them. Too bad they only produce this oxygen stuff!"  



IT Sustainability



- ▶ Improve IT systems energy efficiency
- ▶ Prevent hardware renewals, extend life-time



- ▶ Promote recycling and reuse of devices
- ▶ Use less negative-impacting materials



- ▶ Sustainable software development
- ▶ Use renewable energy



Green Software Principles



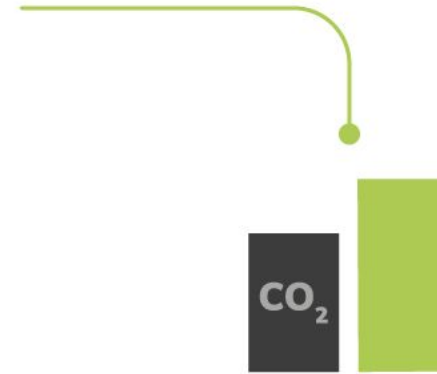
Energy Efficiency

Consume the least amount of electricity possible



Hardware Efficiency

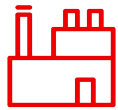
Use the least amount of embodied carbon possible



Carbon Awareness

Do more when the electricity is clean and less when it's dirty

Carbon Awareness



Demand Shifting: Avoid time when carbon intensity is high



Spatial Shifting: Move workload to low carbon intensity location



Temporal Shifting: If moving workload to new location is not possible move to a time with lower carbon intensity location



Demand Shaping: Do more when carbon intensity is low and less when its high

Open Source technologies support your IT Sustainability goals

▶ Shrink you app

- Tailors your app for HotSpot & GraalVM
- Fast boot time and low RSS memory
- Serverless fit

▶ K8S - Cloud native designs

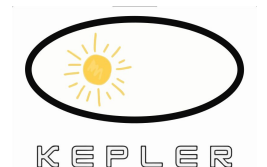
- 12-factor apps
- Event-driven
- Elastic design

▶ Scaling up/down with purpose

- Respond to your user and service demand
- Fine-grained autoscaling (including to/from zero) for event driven Kubernetes workloads
- Sleep your pods

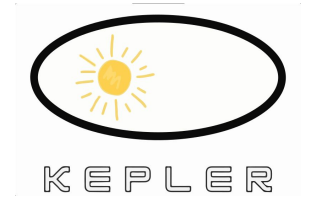
▶ Monitor and expose resources and energy consumption

- Determine top consumers
- Energy trends by applications



Power Monitoring with KEPLER

Kubernetes-based Efficient Power Level Exporter

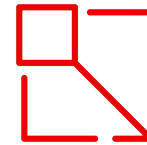


Multi Architecture, Any footprint Support

Process, Container, or Pod level energy consumption monitoring, including **CPU/GPU, RAM**

Support K8S/Linux on **bare metal** as well as **VM**

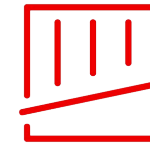
Runs on **x86, ARM, S390x**



Lightweight Collection

Low computational resource usage by the probe

Using **eBPF** to reduce overhead



Linear Regression

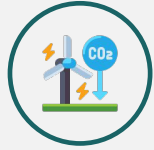
Scientific research based **ML** models

Science based approach

How much CO₂ did my cluster produce?



SCI - Software Carbon Intensity Index



Carbon emitted per kWh of energy, gCO2/kWh



Carbon emitted through the hardware that the software is running on

$$SCI = ((E \cdot I) + M) \text{ per } R$$

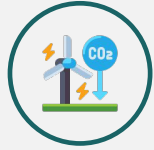


Energy consumed by software in kWh



Functional Unit; this is how software scales, for example per user or per device

SCI - Software Carbon Intensity Index **Simplified**



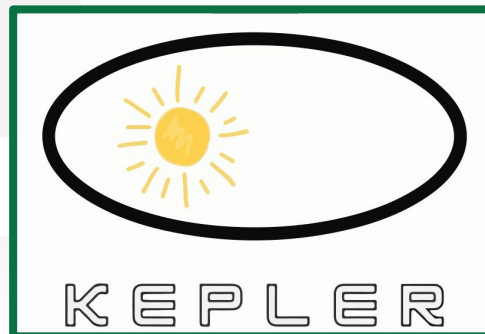
Carbon emitted per kWh of energy, gCO₂/kWh

 **ELECTRICITY MAPS**

$$\text{SCI} = (E \cdot I)$$



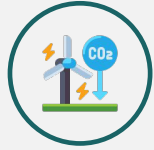
Energy consumed by software in kWh



Demo: Kepler / Electricity Maps



SCI - Software Carbon Intensity Index **Simplified**



Carbon emitted per kWh of energy, gCO₂/kWh

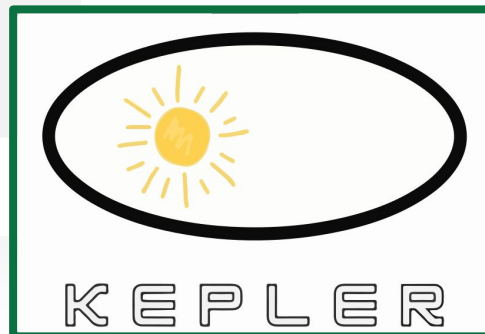
 **ELECTRICITY MAPS**

$$\text{SCI} = (E \cdot I)$$

$$= \$\text{kepler} * \$\text{EM}$$
$$= ?? \text{ gCO}_2$$



Energy consumed by software in kWh



It just takes **67g**
of **CO2** emitted
to cost **1 kg** of
glacier ice.

That's about 15
ChatGPT
queries.



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Thank you



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