SLO’s SRE’s GHG’s
Hello, I’m Bill!

Principal Engineering Manager

Chair, Patterns Working Group
How much energy does your system consume?

Per User?
Per Request?
Per GB?
Energy Is Not Created Equally

**Carbon Intensity**
How much CO2 it takes to create one kilowatt hour of electricity

**CO2 Equivalent (CO2eq)**
Normalization of Greenhouse Gases (GHGs) into equivalent CO2 impact
Software Carbon Intensity

$$\text{SCI} = \left( (E \times I) + M \right) \text{ per R}$$

- **SCI** = Software Carbon Intensity
- **E** = Energy consumed by the software in kWh
- **I** = Carbon emitted per kWh of energy, gCO2/kWh
- **M** = Embodied carbon of hardware running the software
- **R** = Functional Unit; how software scales, for example per user or per device

https://grnsft.org/sci
Energy Calculation (kWh): 50% load for 24h

\[
kWh = \text{Num CPUs} \times \text{CPU Power Consumption} + \text{Memory Power Consumption} + \text{Num GPUs} \times \text{GPU Power Consumption}
\]

Azure D8as v4 VM → AMD EPYC 7452 processor → 155W TDP

\[
kWh = 8 \times 1.86 \text{ kWh} + \sim 0 + 0 \times 0 = 14.88 \text{ kWh}
\]
Carbon Intensity: Azure West Europe (24h avg)

Carbon intensity in the last 24 hours

Get hourly historical, live, and forecast data with Electricity Maps API

265 gCO2/kWh
SCI = \(((E \times I) + M)\) per R

Embodied Carbon: D8as v4 VM over 24h

https://github.com/cloud-carbon-footprint → 1560.4 kg

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<th>Series</th>
<th>Instance Virtual Machine</th>
<th>vCPUs</th>
<th>Instance Memory</th>
<th>Total Platform Scope 3 Emissions (kgCO₂-eq)</th>
<th>Total Platform Scope 3 Emissions (mtCO₂-eq)</th>
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855 gCO₂
Software Carbon Intensity

Functional Unit: Requests

Requests per second: 10

\[ SCI = \left( \left( E \times I \right) + M \right) \text{ per } R \]

864,000
\[ \text{SCI} = \left( \left( E \times I \right) + M \right) \text{ per R} \]

\[
\text{SCI} = \left( \left( 14.88 \times 265 \right) + 855 \right) \div 864,000
\]

0.005553 carbon emission rate per request

5.553 carbon emissions rate per 1,000 requests
How to reduce software carbon emissions

- Use Less Hardware
- Use Less Energy
- Use Energy More Intelligently
Sustainability = Reliability over time
A habitable planet is the ultimate reliability

Thank you!