

# Sustainable Software Engineering

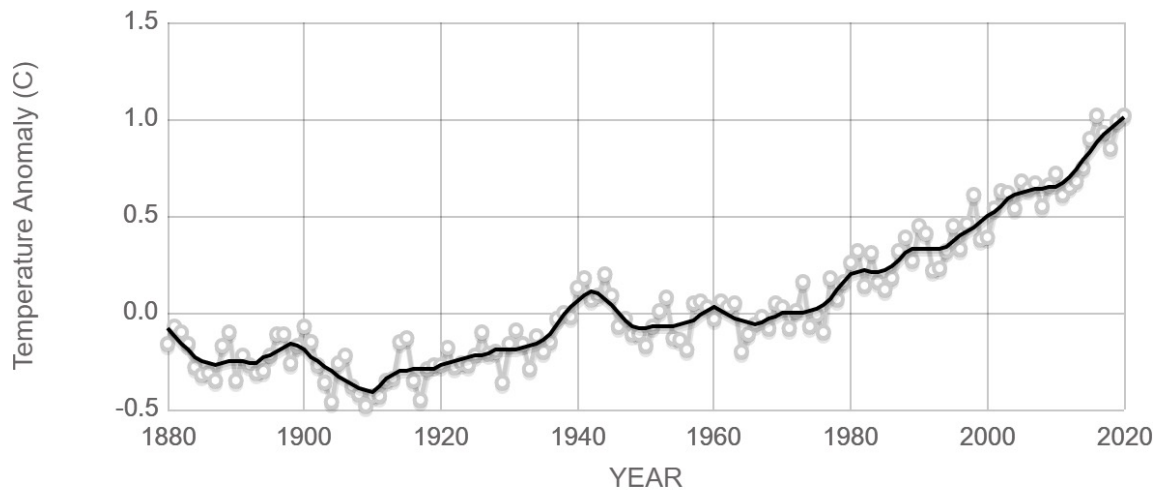
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Bill Johnson - Azure SRE



# SLO: 1.5°C average global temperature

30 year rolling average compared against 20<sup>th</sup> century average



Source: climate.nasa.gov

2020 Value: 1.02°C

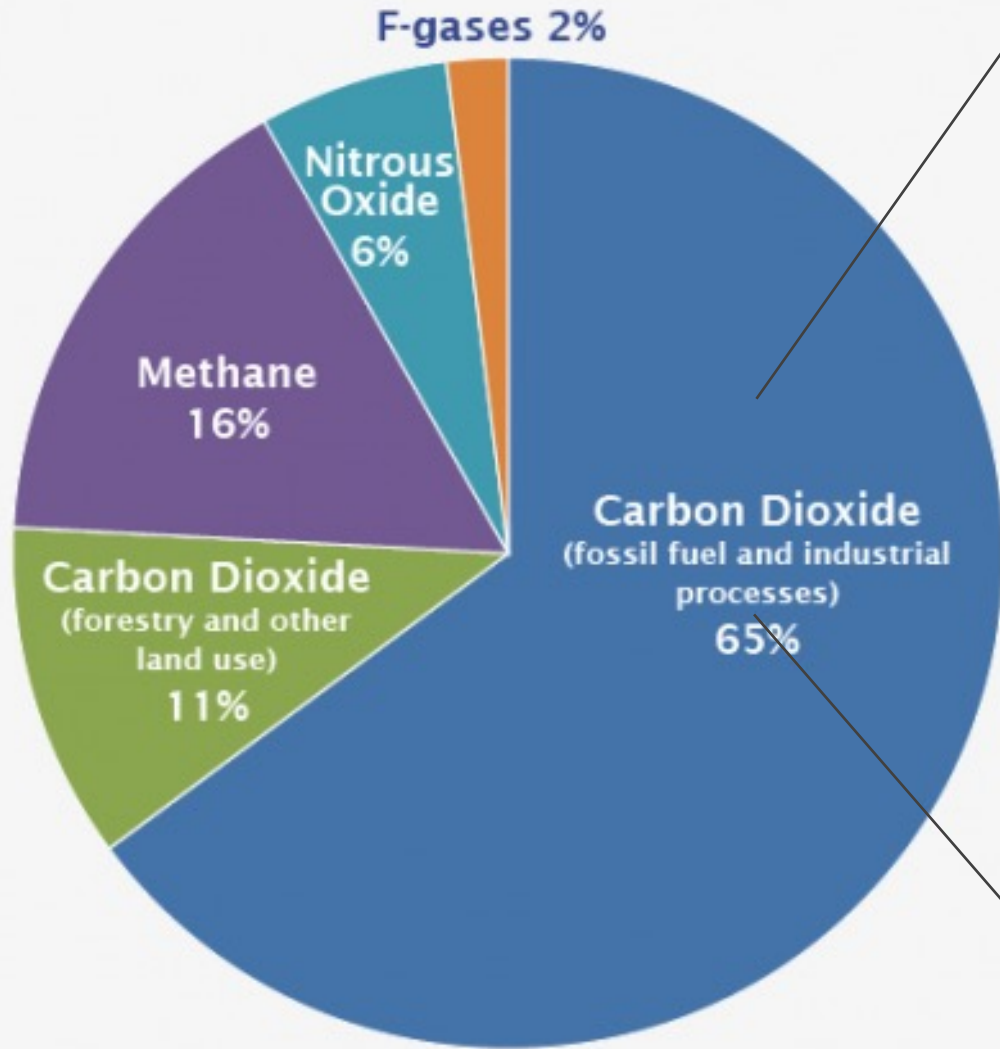
Projected breach: 4-7 years

<https://climate.nasa.gov/vital-signs/global-temperature/>

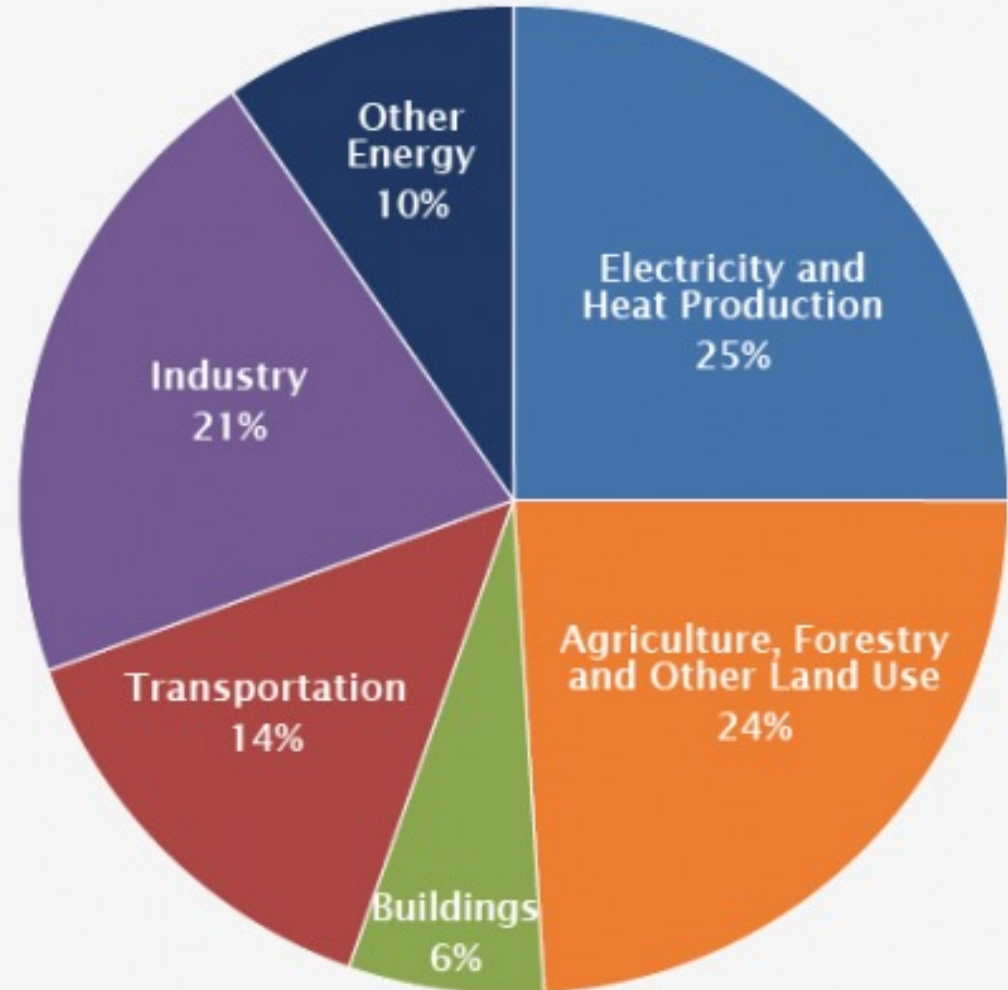
<https://www.noaa.gov/news/2020-was-earth-s-2nd-hottest-year-just-behind-2016>



## Global Greenhouse Gas Emissions by Gas



## Global Greenhouse Gas Emissions by Economic Sector



Electricity is 20% of GHG emissions

8.275<sub>gt</sub>





# Carbon

Photo by [Rene Bieder](#) on [Unsplash](#)



# Water

Photo by [David Billings](#) on [Unsplash](#)



# Waste

Photo by [John Cameron](#) on [Unsplash](#)



# Why Should SREs Care?



**Jez Humble**   
@jezhumble

“One of the most important things that distinguishes software engineering from programming is considering the wider impact of your work, and applying systems thinking.”

<https://twitter.com/jezhumble/status/1386758745342971904>

## Carbon-Efficient Systems

- ✓ **Faster**
- ✓ **Cheaper**
- ✓ **Resilient**



# Moore's Law

Number of transistors doubles every 2 years  
Starting to slow down

# Dennard Scaling

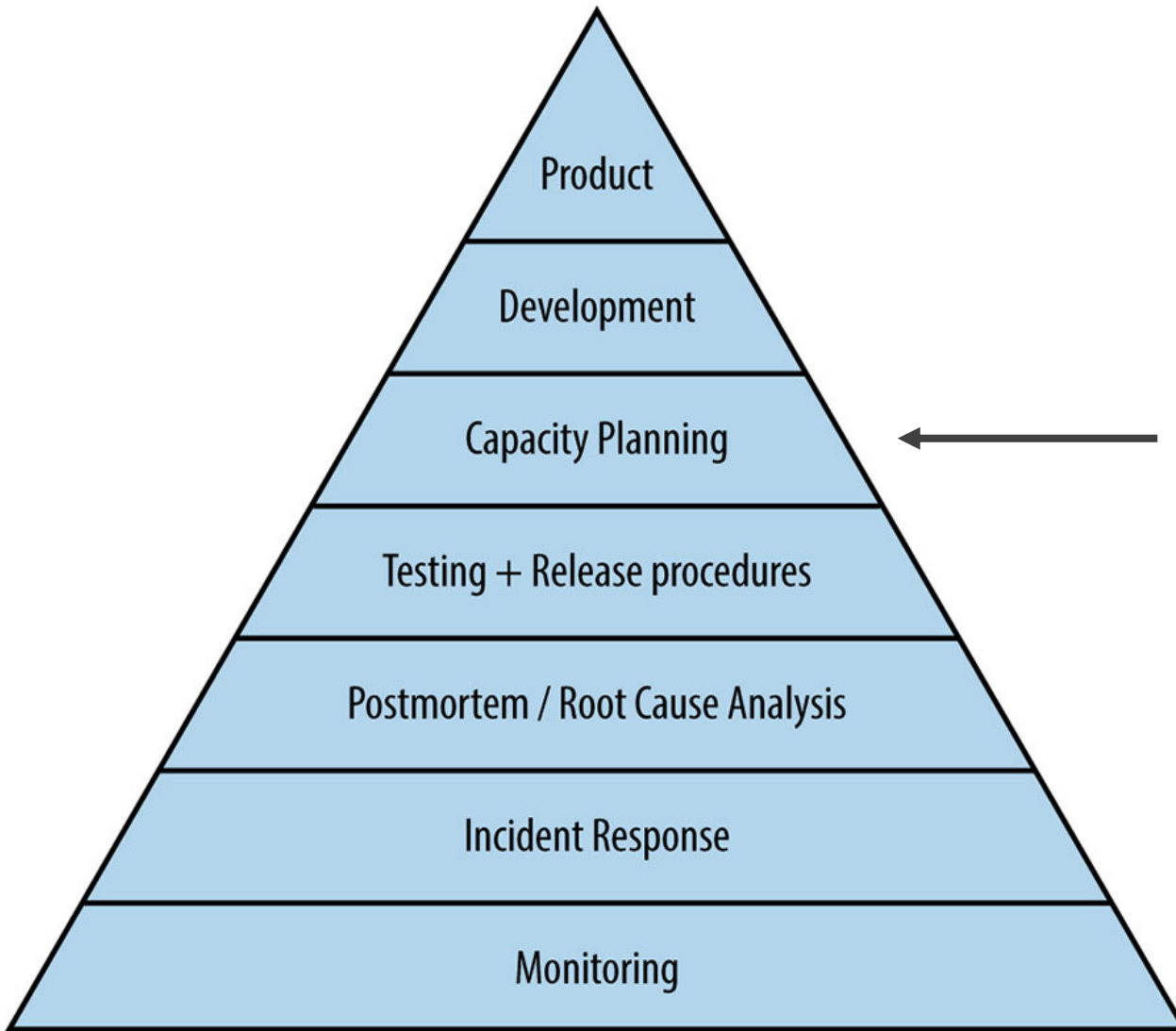
Performance per watt doubles every 2 years  
Haven't met since 2012

# Natural Resources

Don't have enough material in the world to meet  
projected growth rates

# Power & Cooling Demands

More expensive to power and cool



<https://sre.google/sre-book/part-III-practices/>

# Technical

**Hardware & software**  
functionality of the system

# Operational

**Human toil** needed to  
maintain a technical system



SLO

```
dubrie:/team/capabilities$ apt-get install SRE
Reading package lists... Done
Building dependency tree
Reading state information... Done
E: Unable to locate package SRE
```



**Sustainability = Reliability over time**



An aerial photograph of a dense evergreen forest, showing a vast expanse of green trees from above. The lighting is soft, creating a rich, textured canopy.

# Environmental Sustainability

The impact on the planet of our Technical  
and Operational choices

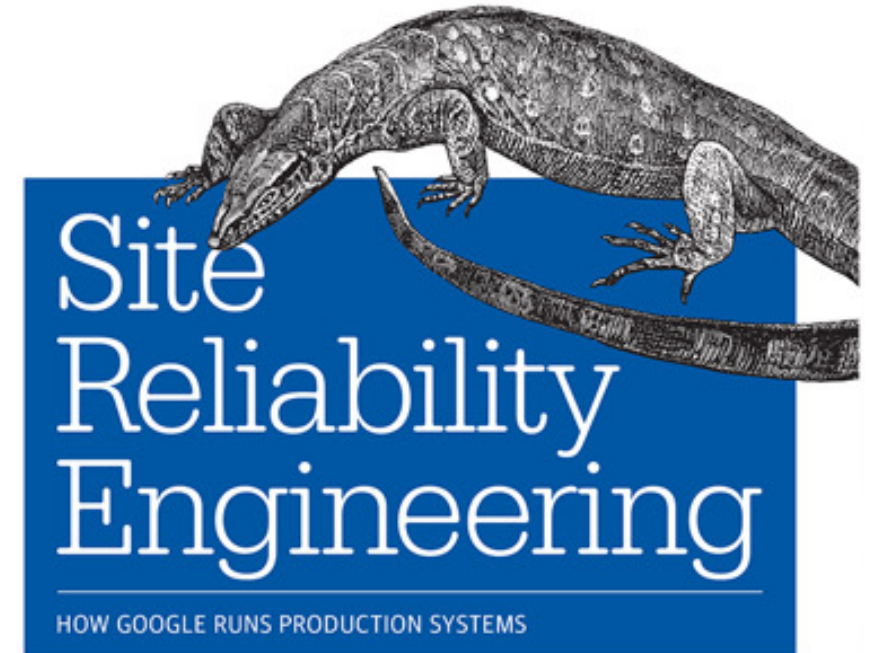


“

In general, an SRE team is responsible for the **availability, latency, performance, efficiency**, change management, **monitoring**, emergency response, and **capacity planning** of their service(s). ”

-- *Introduction in SRE Book*

O'REILLY®



Edited by Betsy Beyer, Chris Jones,  
Jennifer Petoff & Niall Murphy

L

Latency

E

Errors

T

Traffic

S

Saturation

SRE  
Golden  
Signals



L

Latency

E

Errors

T

Traffic

S

Saturation

## Low Latency

- Less bottlenecks
- Reduced wait times on client/server
- 50% of power is used just to have a machine on





L

Latency

E

Errors

T

Traffic

S

Saturation

## Low Error Rates

- Reduced overall traffic
- Reduced processing
- Require less resources

L

Latency

E

Errors

T

Traffic

S

Saturation

## High Traffic Support

- Maximize utilization
- Maximize code efficiency
- Maximize scale up/down efficiency



L

Latency

E

Errors

T

Traffic

S

Saturation

## “Right-sized” Saturation

- Maximize utilization
- Maintain buffers
- Faster requests
- CPUs balance out at ~70%

## Clockspeed versus Power-Consumption

*i7-2600K versus i7-3770K*



Idontcare

Frequency

3.5GHz ---- 40% ----- 5GHz

Power

50W ----- 250% ----- 175W



# Why Should SREs Care?



Holistic systems thinking is  
already part of the job



Reducing carbon benefits  
your system (save \$\$\$!)



Planet is running out of  
materials and resources



Aligns to SRE Golden Signals



Aligns to good engineering  
practices and hygiene

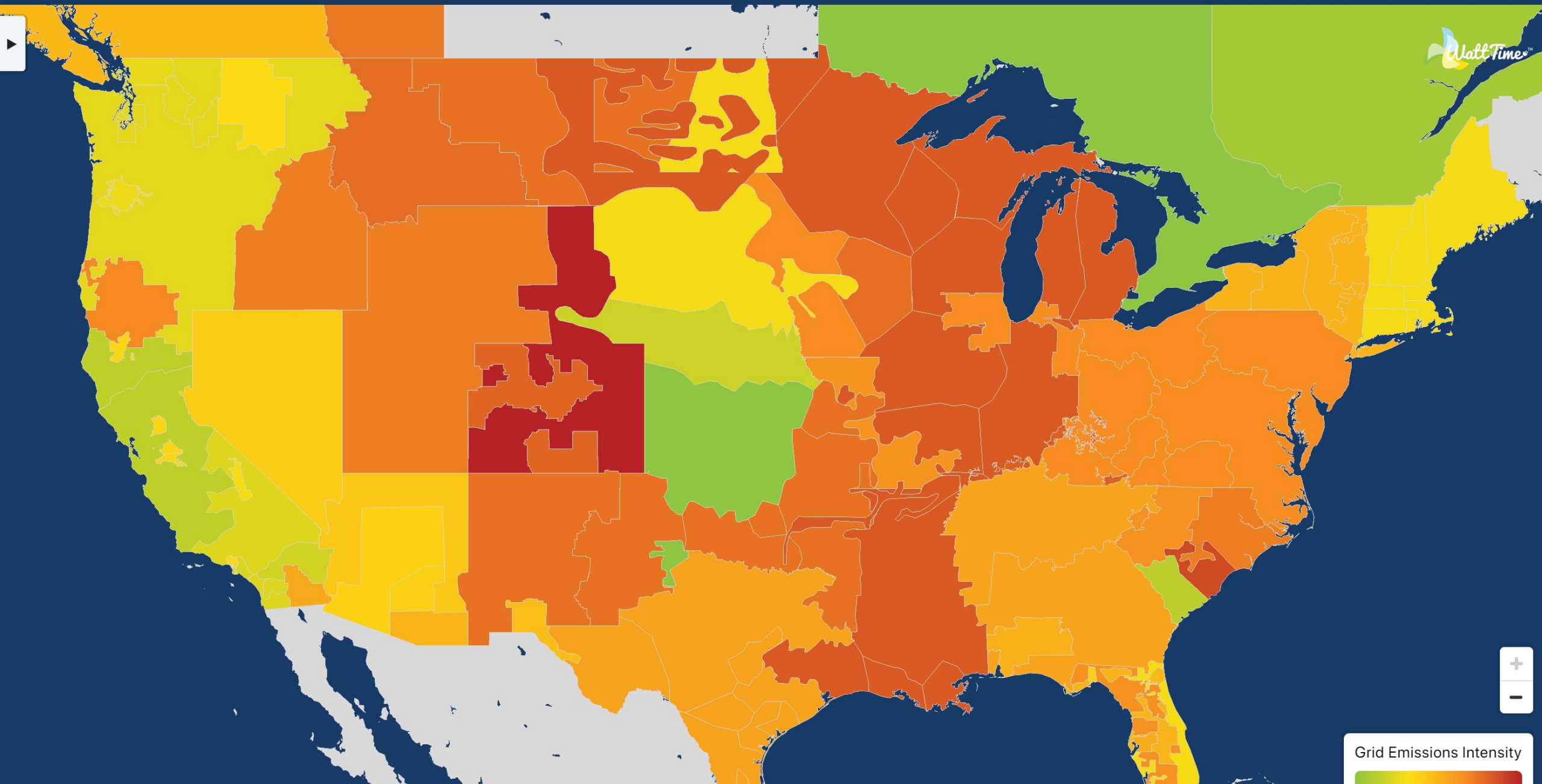


Reliability over time is  
Sustainability

# Sustainable Software Engineering

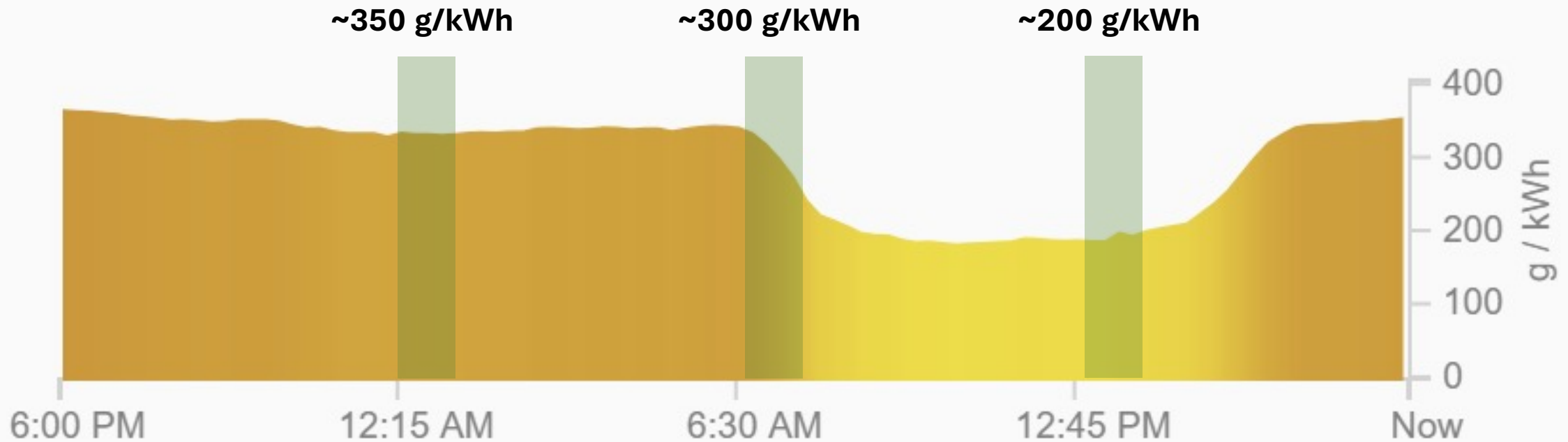
<https://principles.green>

- 
1. Build Carbon-Efficient Applications
  2. Build Energy-Efficient Applications
  3. Maximize Utilization
  4. Minimize Carbon Intensity
  5. Minimize Embodied Carbon
  6. Minimize Data Amount & Travel Distance
  7. Shape Demand To Supply
  8. End-to-End Optimization Of Carbon Efficiency





# Carbon Intensity over 24 hours



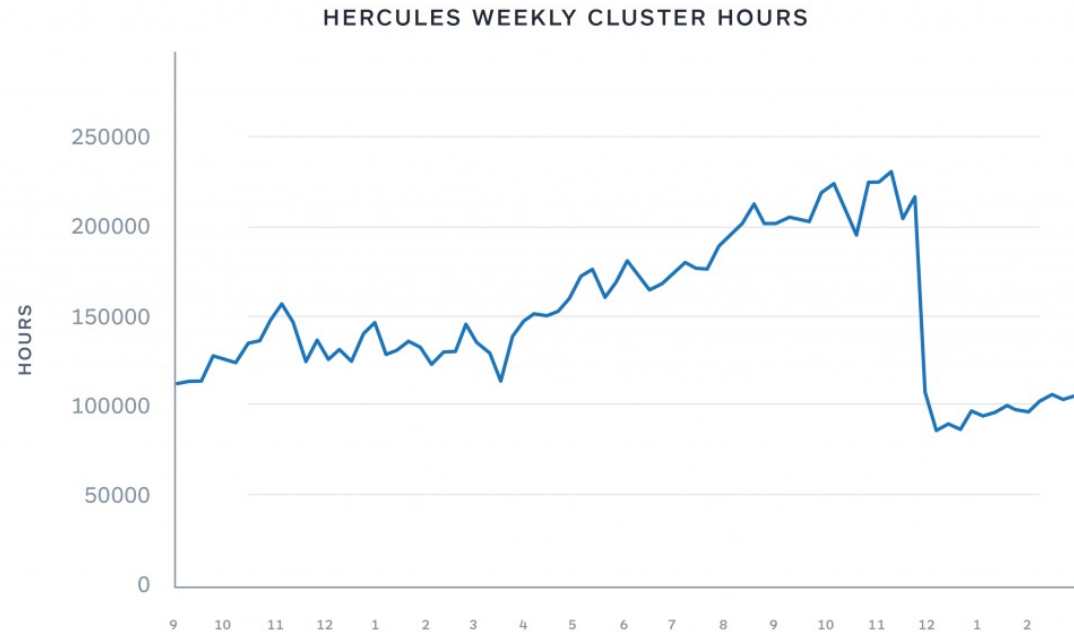
# Quantcast

## Saving Millions by Dumping Java Serialization

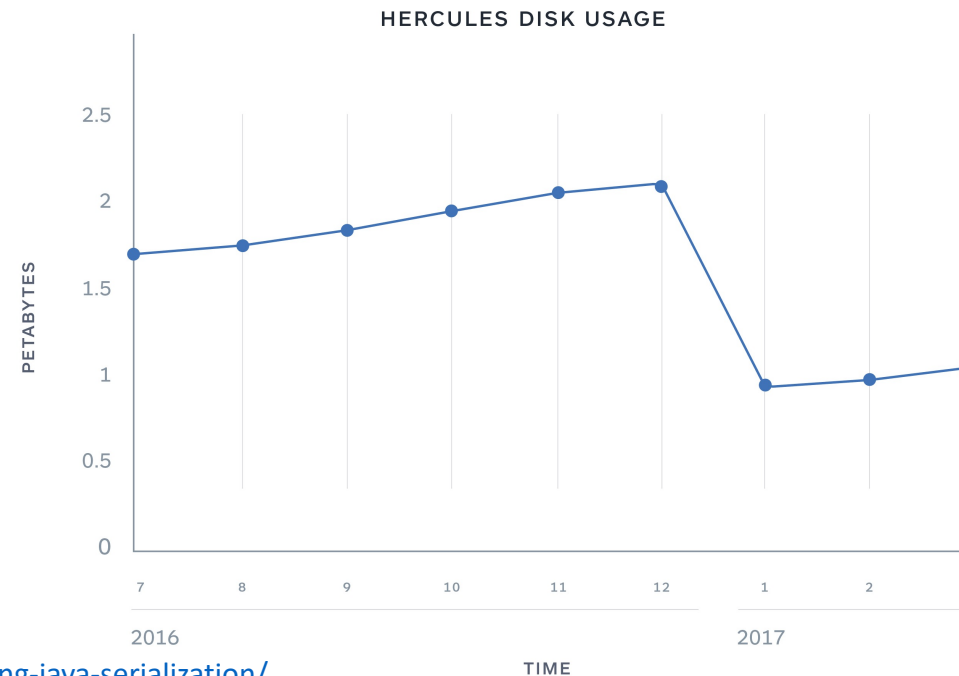
JACKSON NEWHOUSE



Switched java serializer  
from proprietary to  
Rowfiles



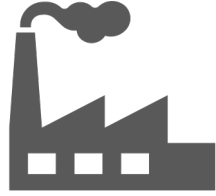
30% reduction  
\$1M



50% reduction  
\$2M



**Resource**



**Refine**



**\$\$\$**

**=**

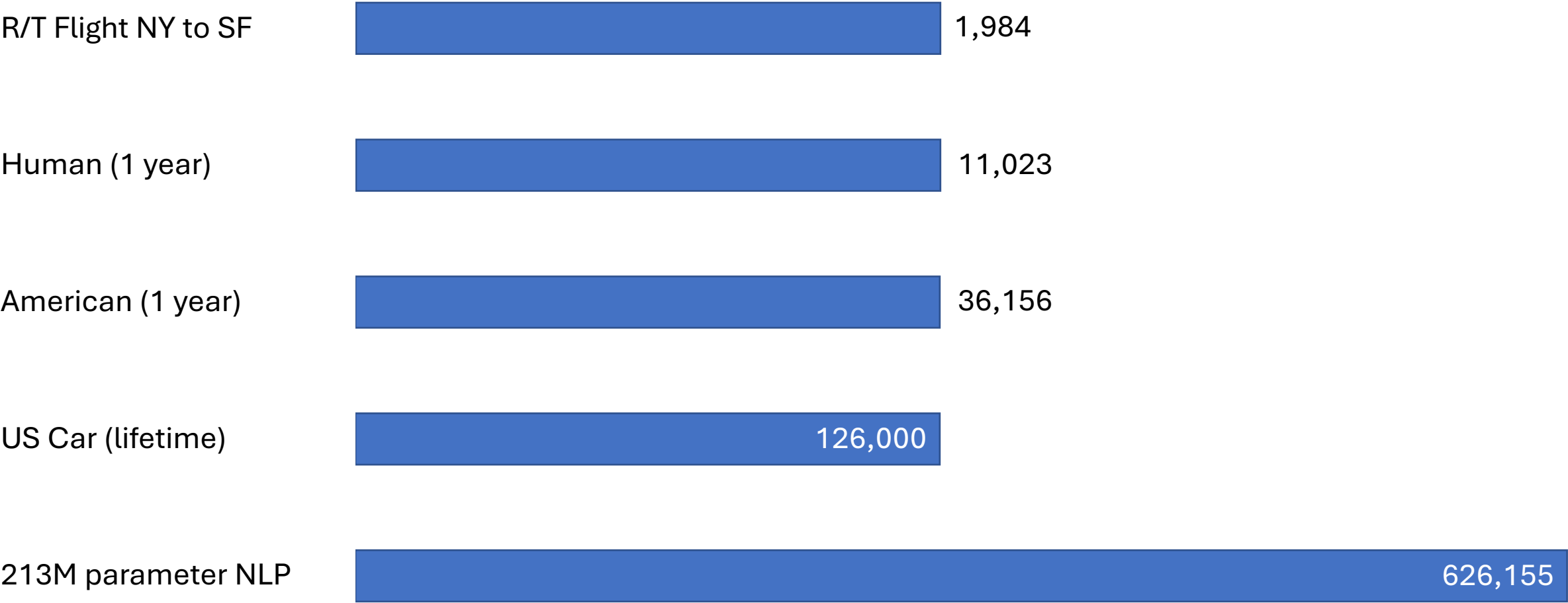


AI computation costs have increased **300,000x** over 6 years

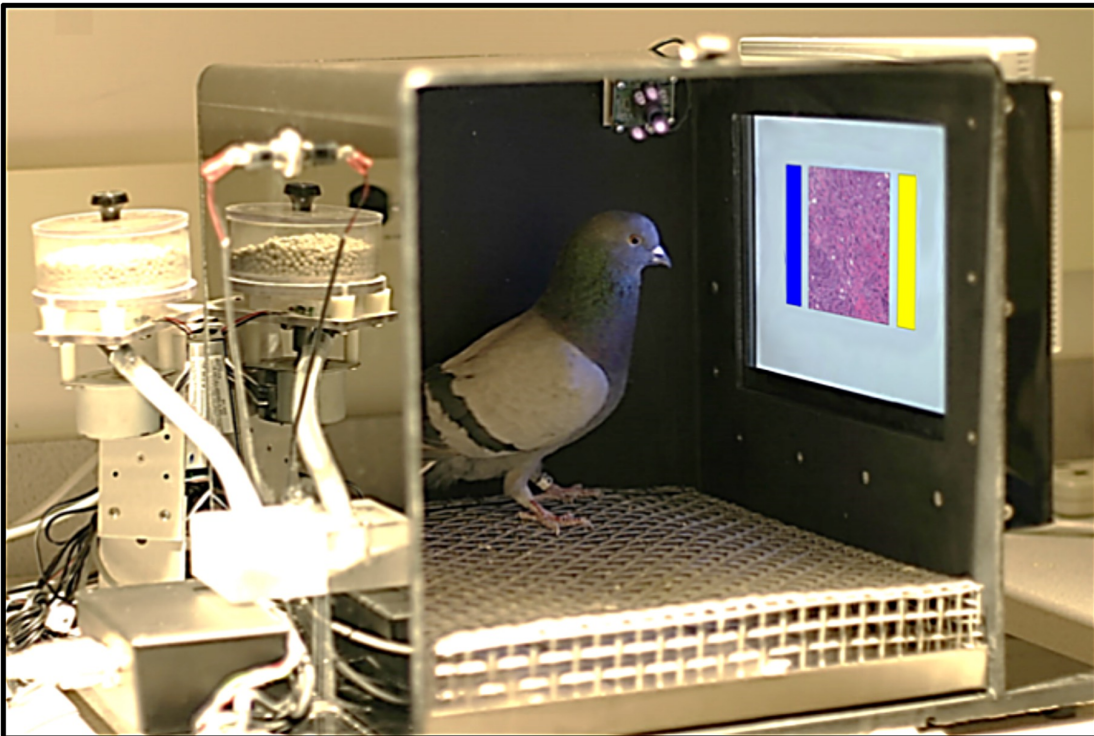


# Carbon Footprint Benchmarks

*in lbs of CO<sub>2</sub> equivalent*



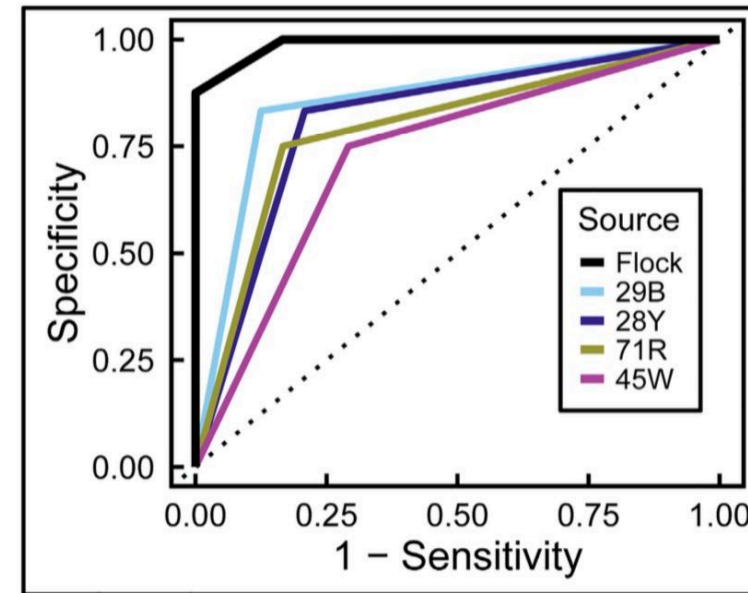
# Pigeons!



Detecting cancer in medical imaging

AI Algorithms: ~90% accuracy

Flock of Pigeons: ~99% accuracy



**Fig 9. Flock sourcing.** A “flock-sourcing” score was calculated by summing the responses of individual birds as described in the text. Pooling the birds’ decisions led to significantly better discrimination than that achieved by individual pigeons. The dotted line represents no discrimination between benign and malignant exemplars.

doi:10.1371/journal.pone.0141357.g009



# SRE Responsibilities

# Sustainable Software Principles

Availability

Latency

Performance

Efficiency

Monitoring

Capacity Planning

Carbon-Efficiency

Energy-Efficiency

Utilization

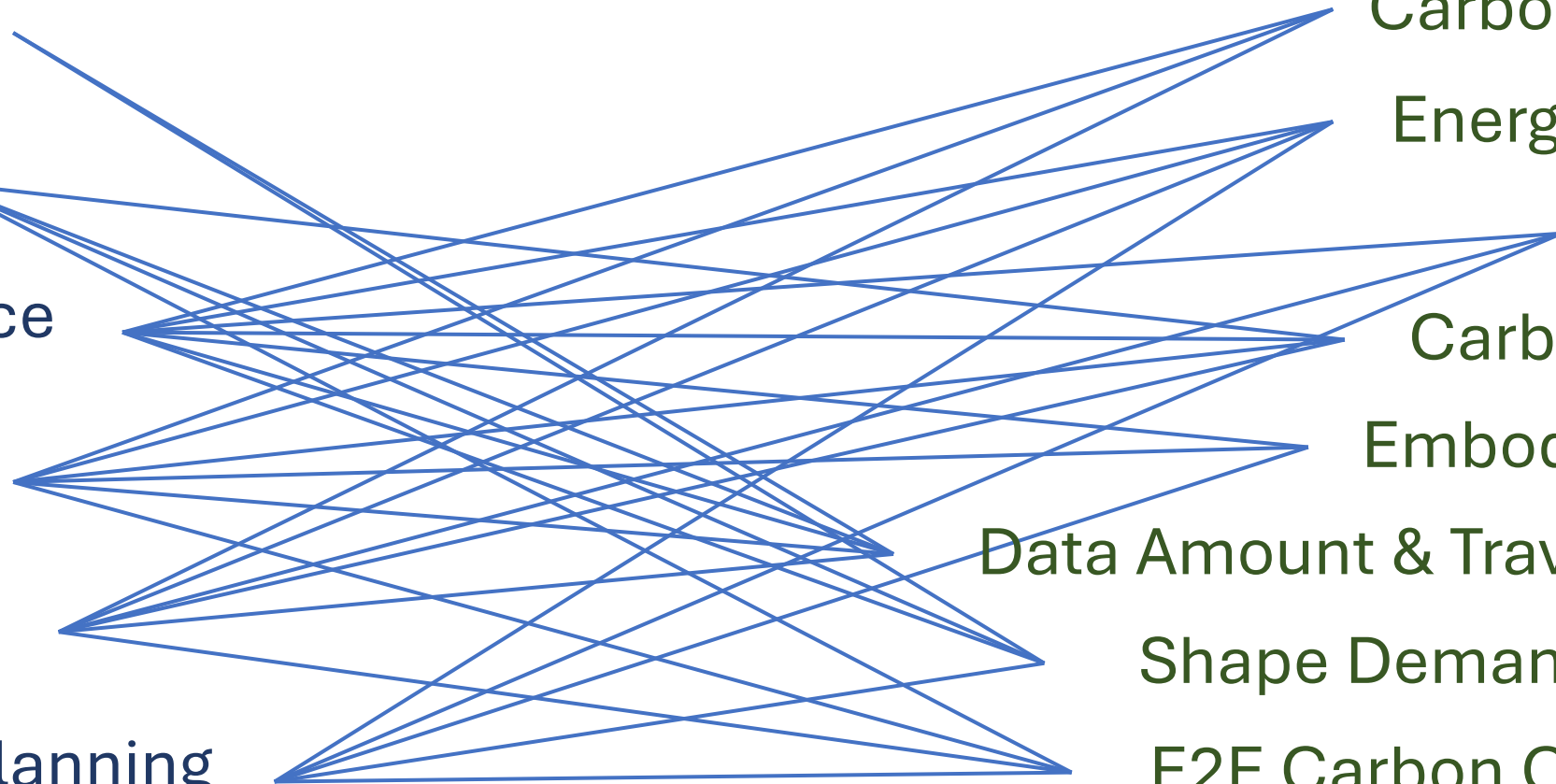
Carbon Intensity

Embodied Carbon

Data Amount & Travel Distance

Shape Demand To Supply

E2E Carbon Optimization





# Carbon Efficiency

Saves \$\$\$

=



Reduces complexity

=

**Reliability!**

Reduces Resource Requirements

=

**Reliability!**

Increases Resiliency

=

**Reliability!**

Increases Performance

=

**Reliability!**

# Takeaways

- 1 Everyone has a part to play, especially SREs
- 2 Set Sustainability SLOs (Power, Utilization, Carbon Intensity)
- 3 SRE Principles align with “Green” Principles
- 4 Share your stories, projects, tools, failures!

“A habitable planet is the ultimate in reliability”

## Read



[aka.ms/sse/blog](https://aka.ms/sse/blog)



[branch.climateaction.tech](https://branch.climateaction.tech)



[heated.world](https://heated.world)

## Join



[principles.green](https://principles.green)



[ClimateAction.tech](https://ClimateAction.tech)



[GreenConf.io](https://GreenConf.io)





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