

**SUSTAINABLE SOFTWARE  
ENGINEERING: BUILDING  
CARBON-EFFICIENT  
APPLICATIONS**



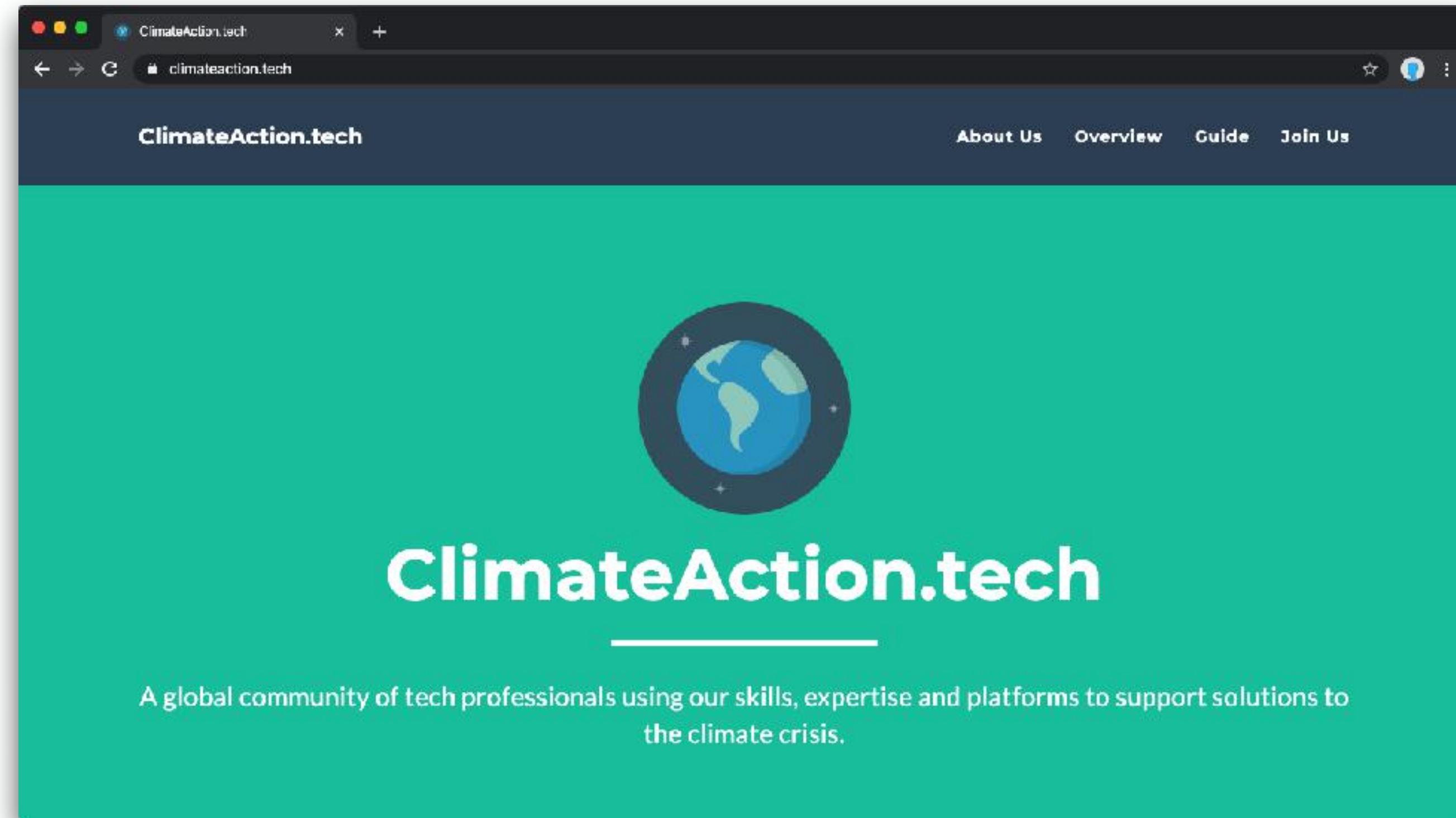
Asim Hussain  
@Jawache  
Asim.Dev  
Microsoft.Com



I LOVE MY  
DADDY

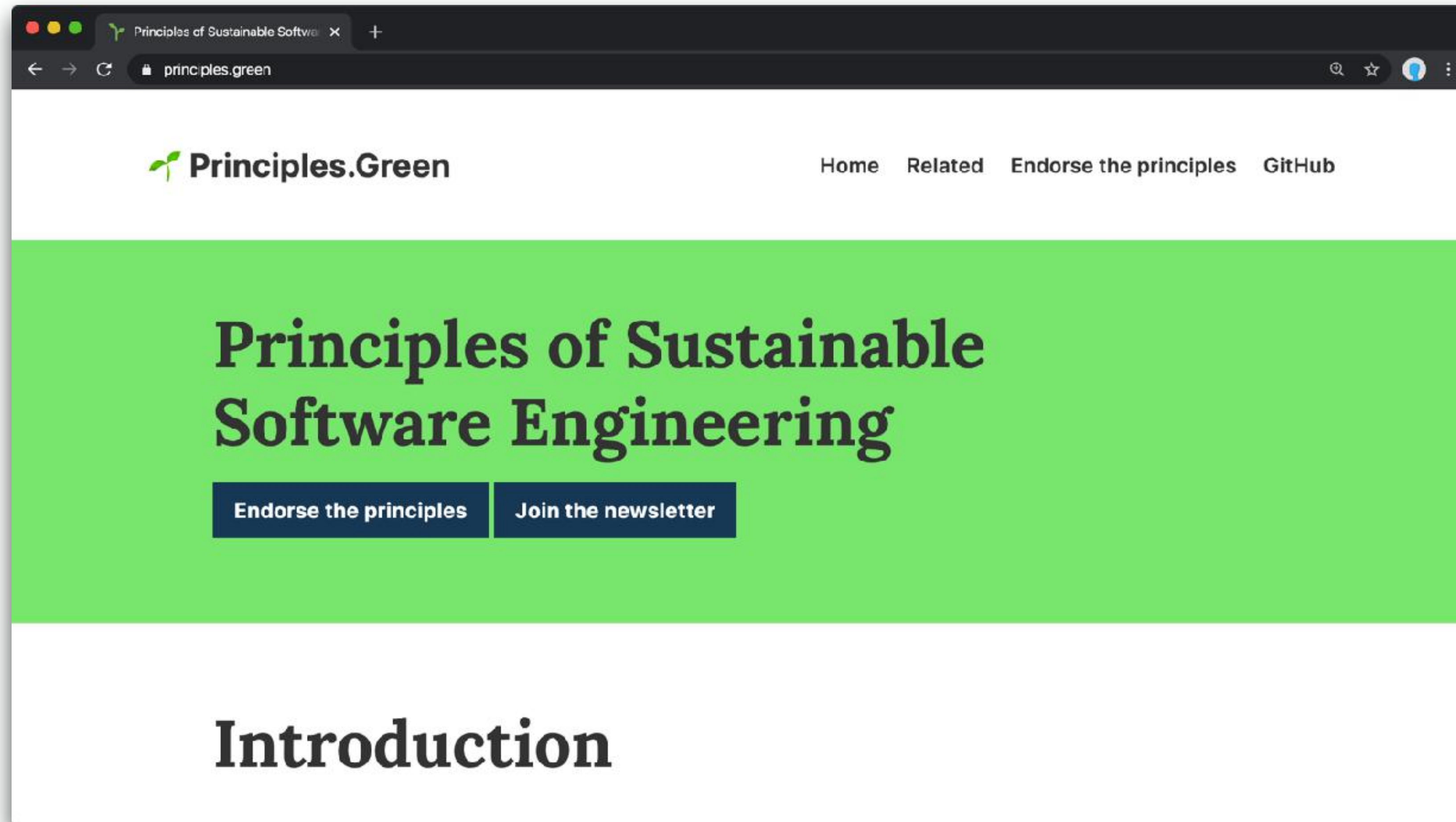


# CLIMATEACTION.TECH



@JAWACHE / PRINCIPLES.GREEN

# PRINCIPLES.GREEN





1/ Carbon

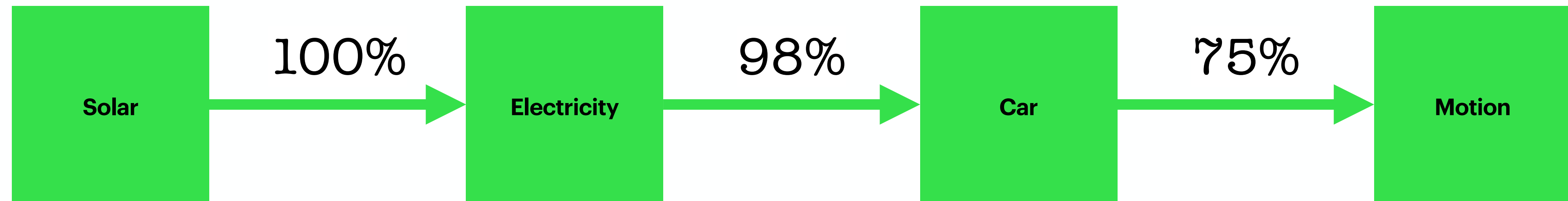
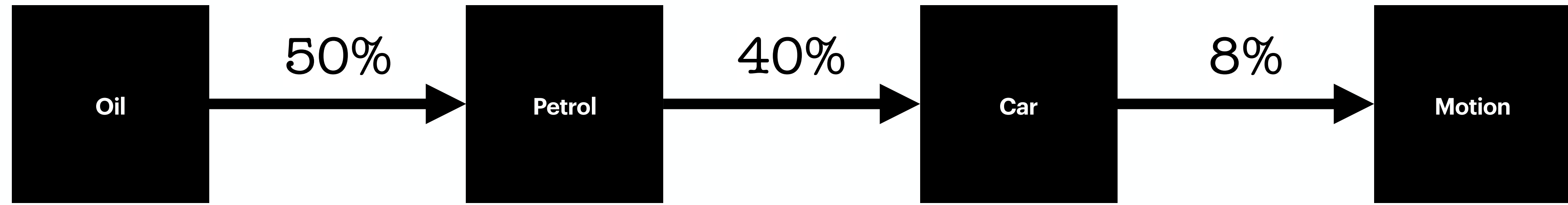


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CO<sub>2</sub>eq  
(carbon dioxide equivalent)



# WASTE



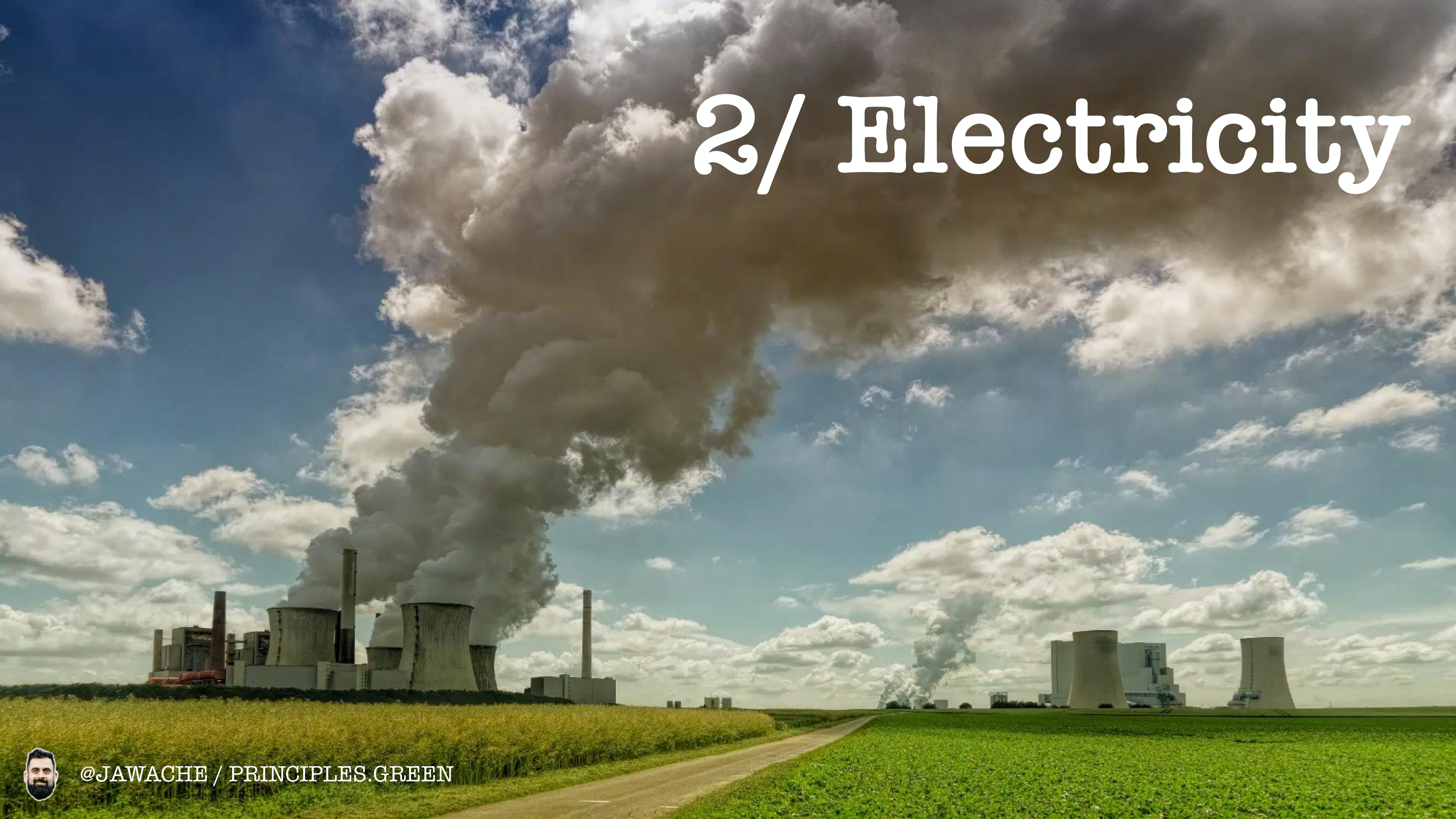


# 1/ Carbon

Build applications that are **carbon  
efficient**



# 2/ Electricity



kWh

(kilo-watt hour)



# Energy

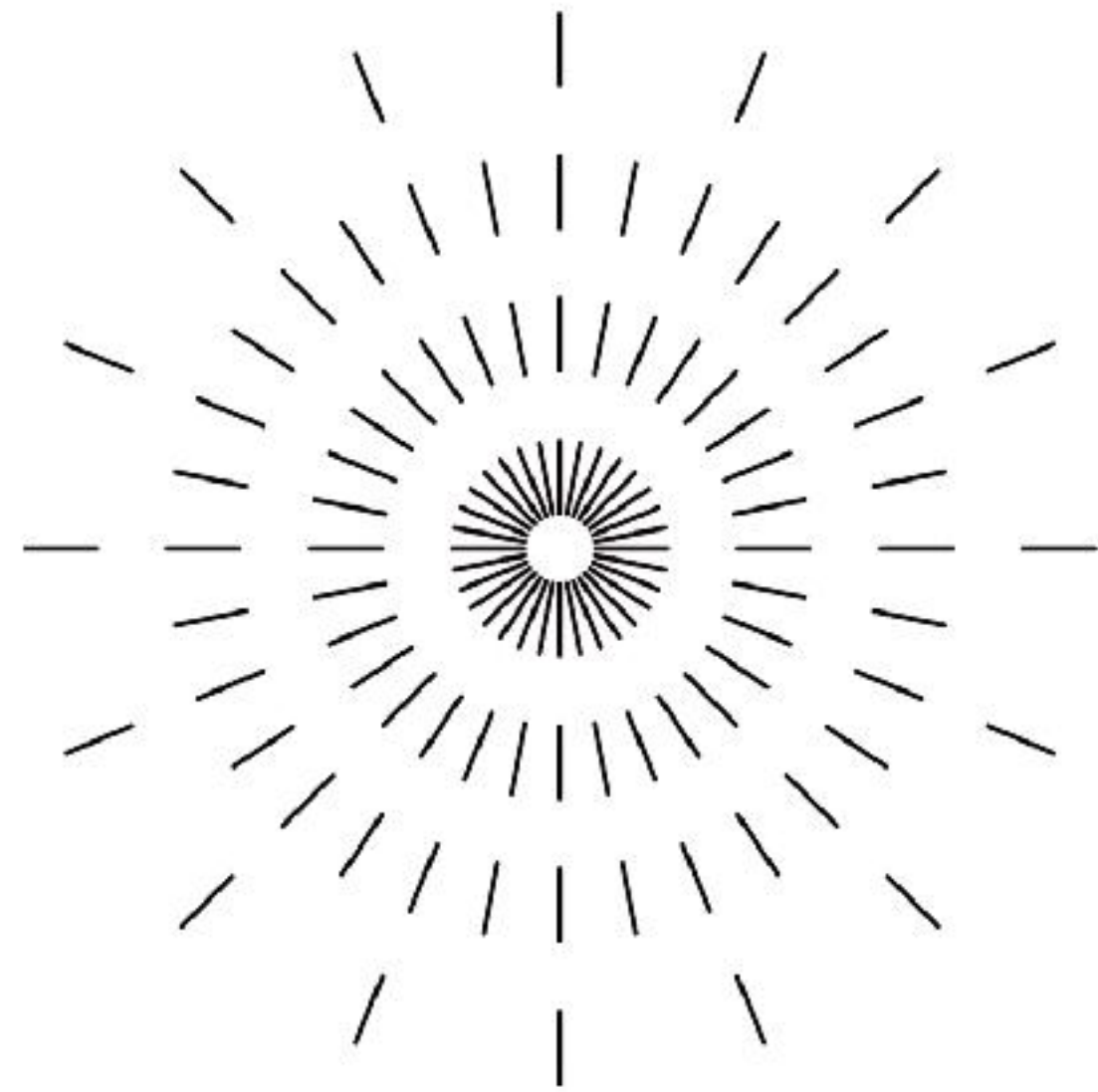
- **18 tW** - World Consumption
- **1,000 tW** - Wind
- **173,000 tW** - Solar



# 2/ Electricity

Build applications that are **energy  
efficient**





*The*  
**ENERGY  
TRANSITION  
SHOW** *with Chris Nelder*

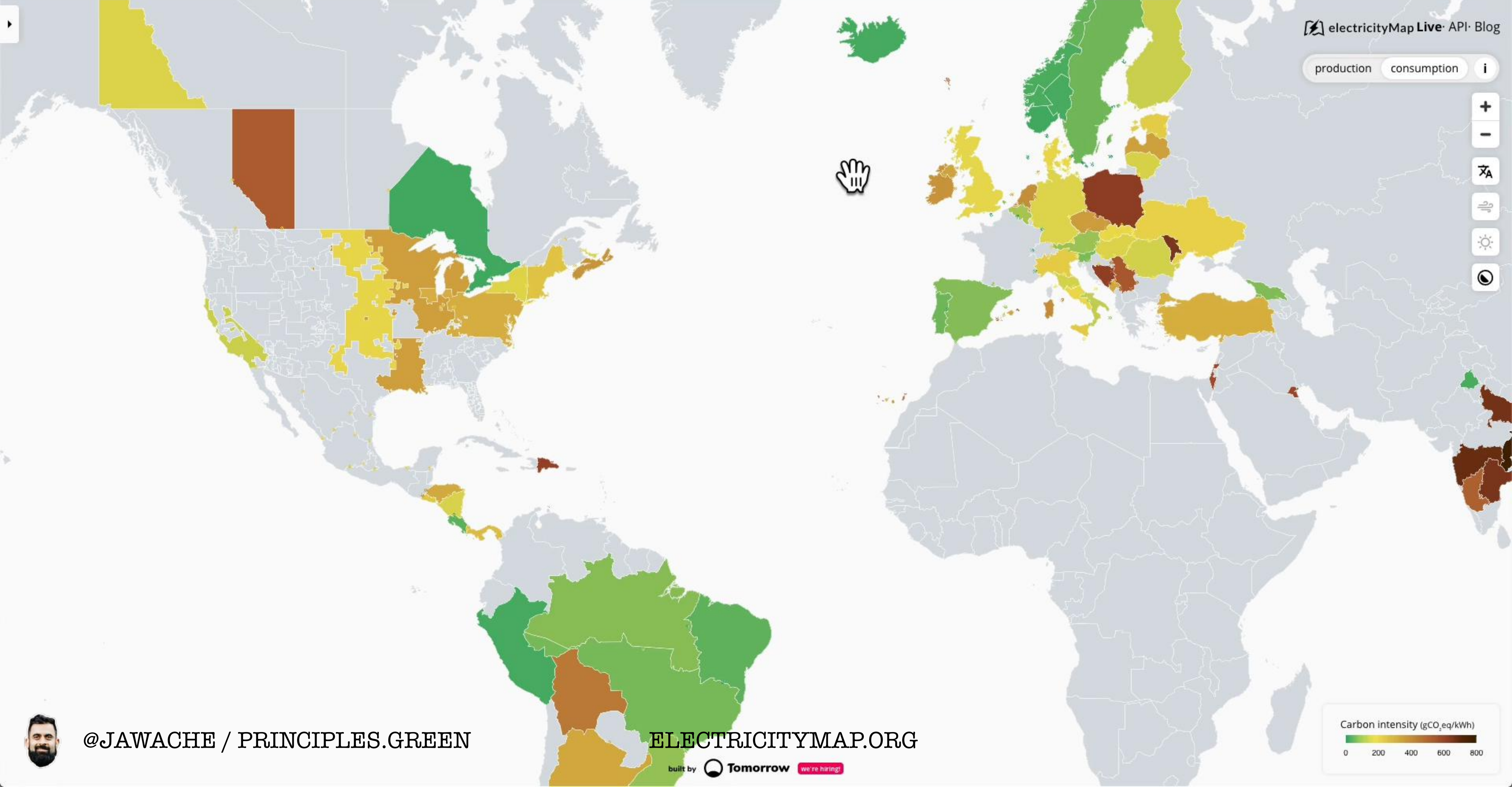
# 3/ Carbon Intensity



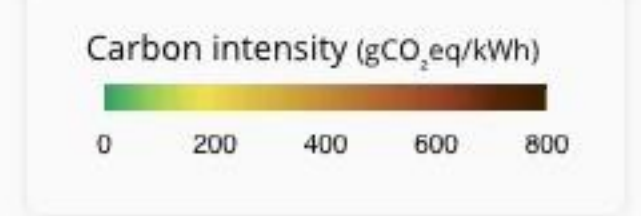
gCO<sub>2</sub>eq/kWh

(grams of carbon dioxide equivalent per kilo-watt hour)





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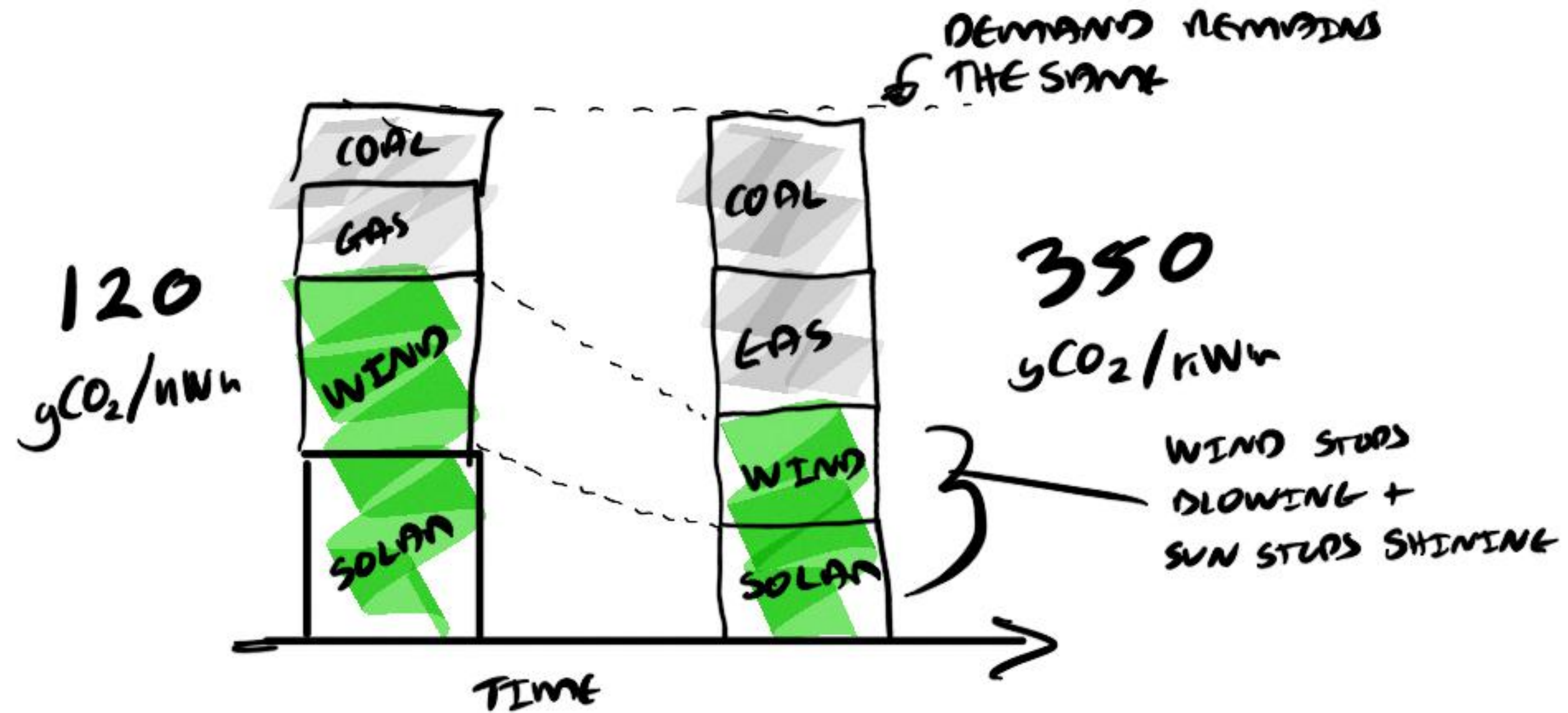
@JAWACHE / PRINCIPLES.GREEN

ELECTRICITYMAP.ORG

built by Tomorrow we're hiring!



# VARIABILITY OF CARBON INTENSITY



# CARBON INTENSITY SOURCES

- [carbonintensity.org.uk](https://carbonintensity.org.uk)
- [watttime.org](https://watttime.org)
- [electricitymap.org](https://electricitymap.org)



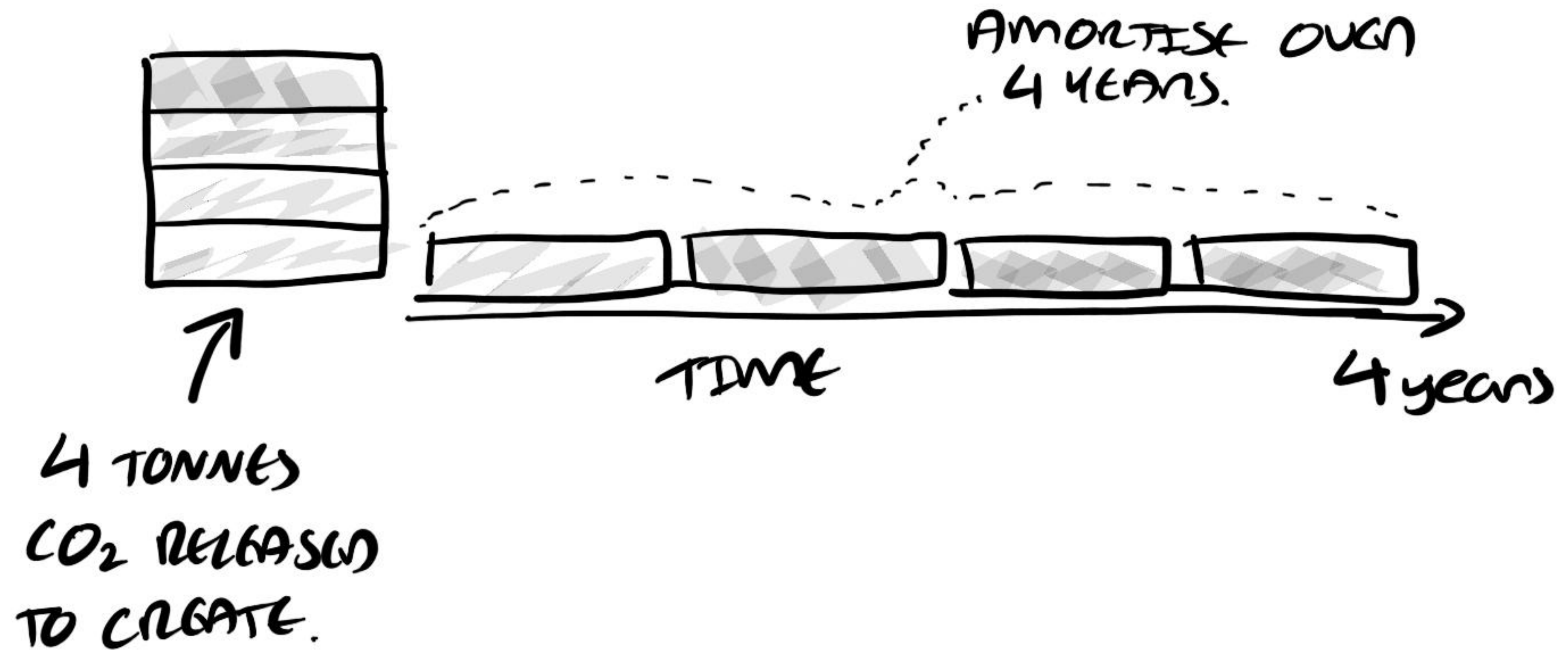
# 3/ Carbon Intensity

Consume electricity with the lowest  
carbon intensity



# 4/ Embodied Carbon





# 2019 R640 Dell Server

**1280** embodied kg

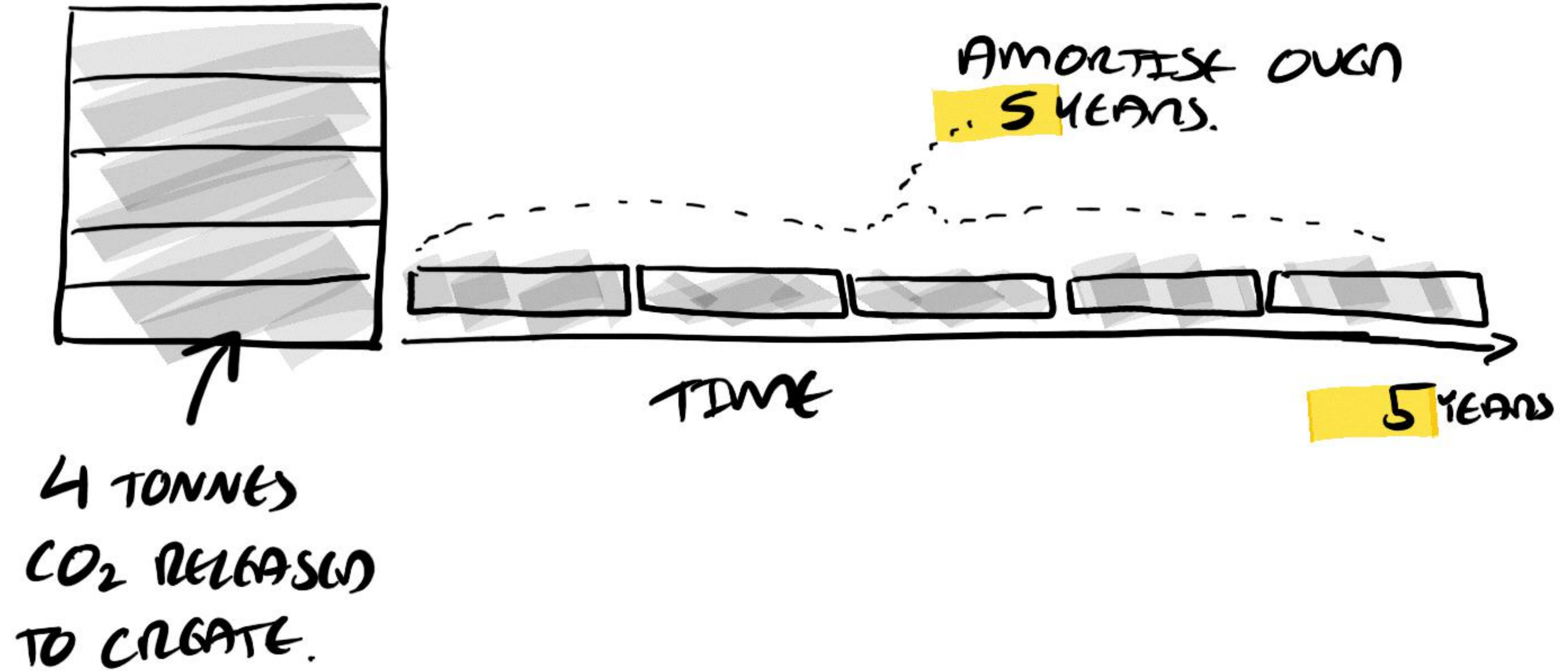
**320** embodied kg/year - assuming **4 year life-span**

**486** kg/year - from the electricity

**806** kg/year - yearly total

**40%** of the yearly total is the embodied carbon.





# 2019 R640 Dell Server

**1280** embodied kg

**256** embodied kg/year - assuming **5 year life-span**

**486** kg/year - from the electricity

**742** kg/year - yearly total

**31%** of the yearly total is the embodied carbon.





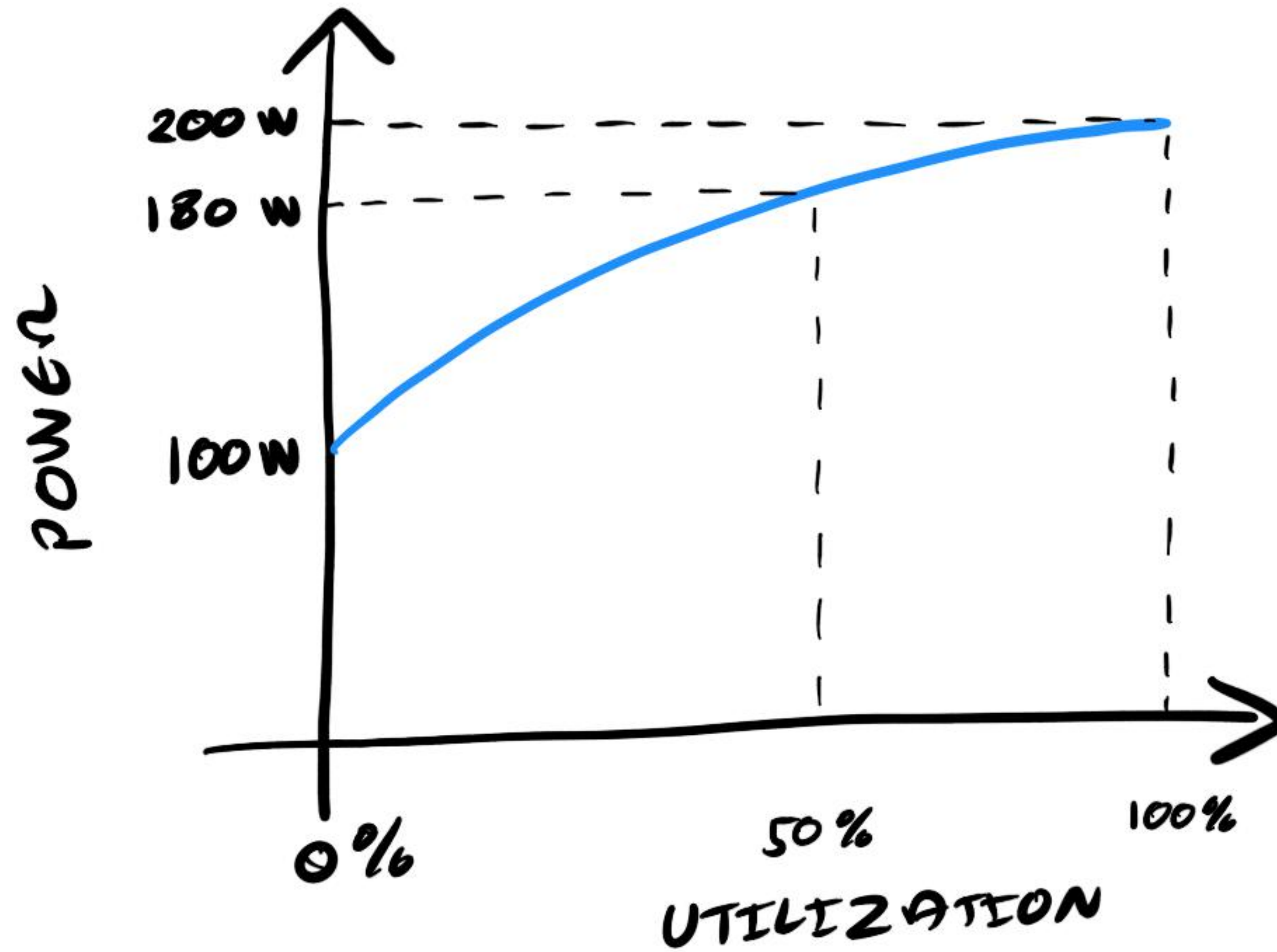
# 4/ Embodied Carbon

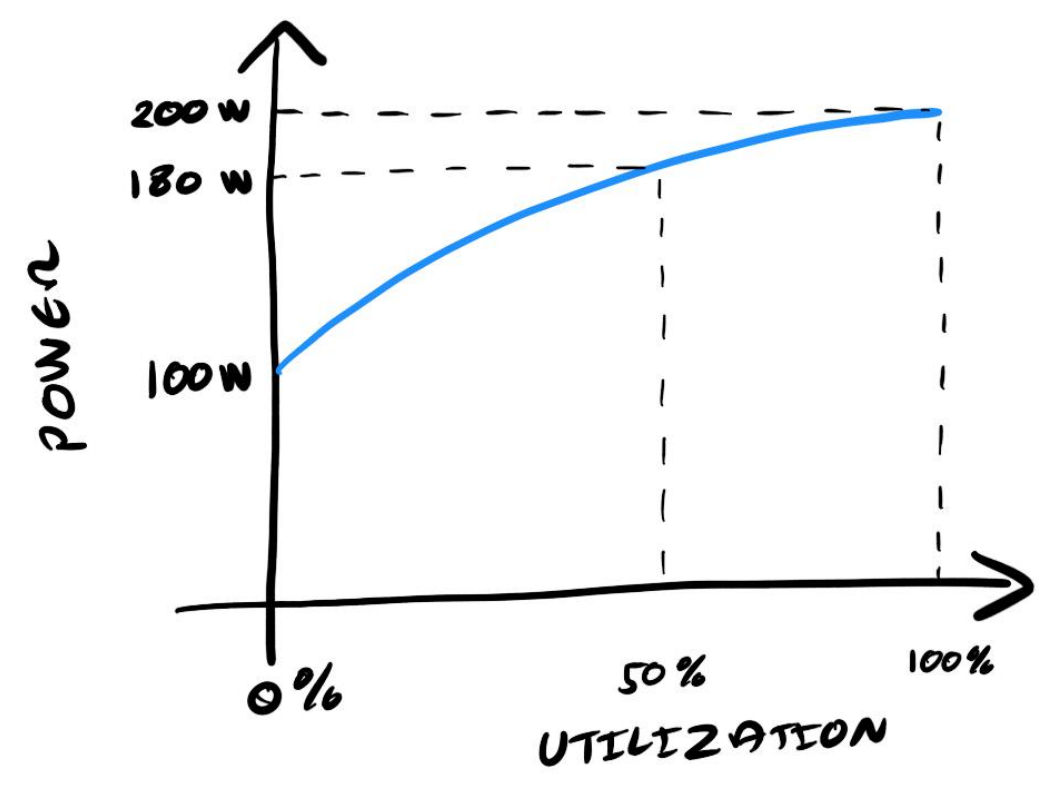
Build applications that are  
hardware efficient



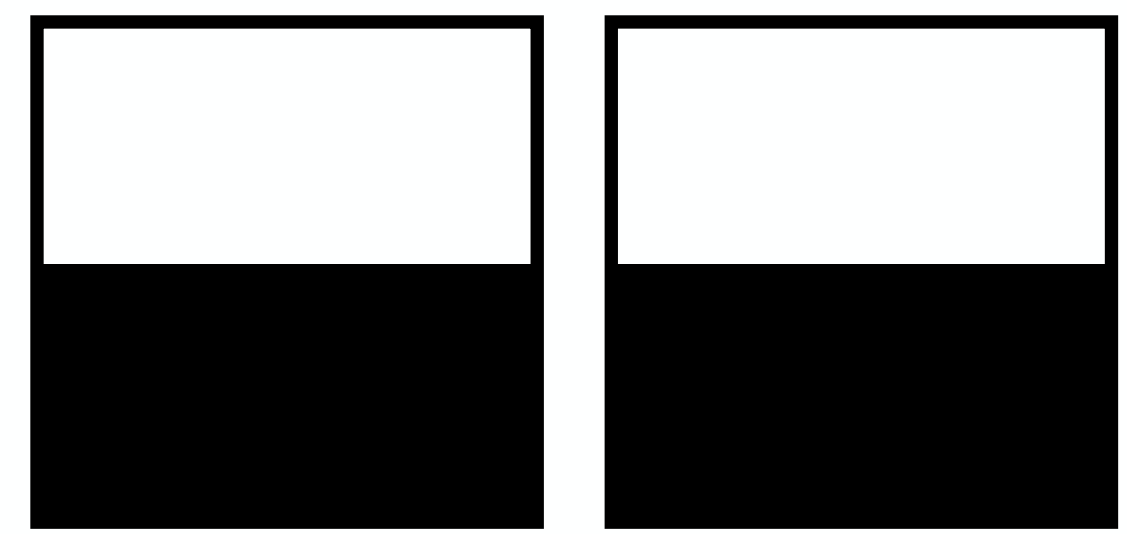
# 5/ Energy Proportionality







360 W



200 W



# 5/ Energy

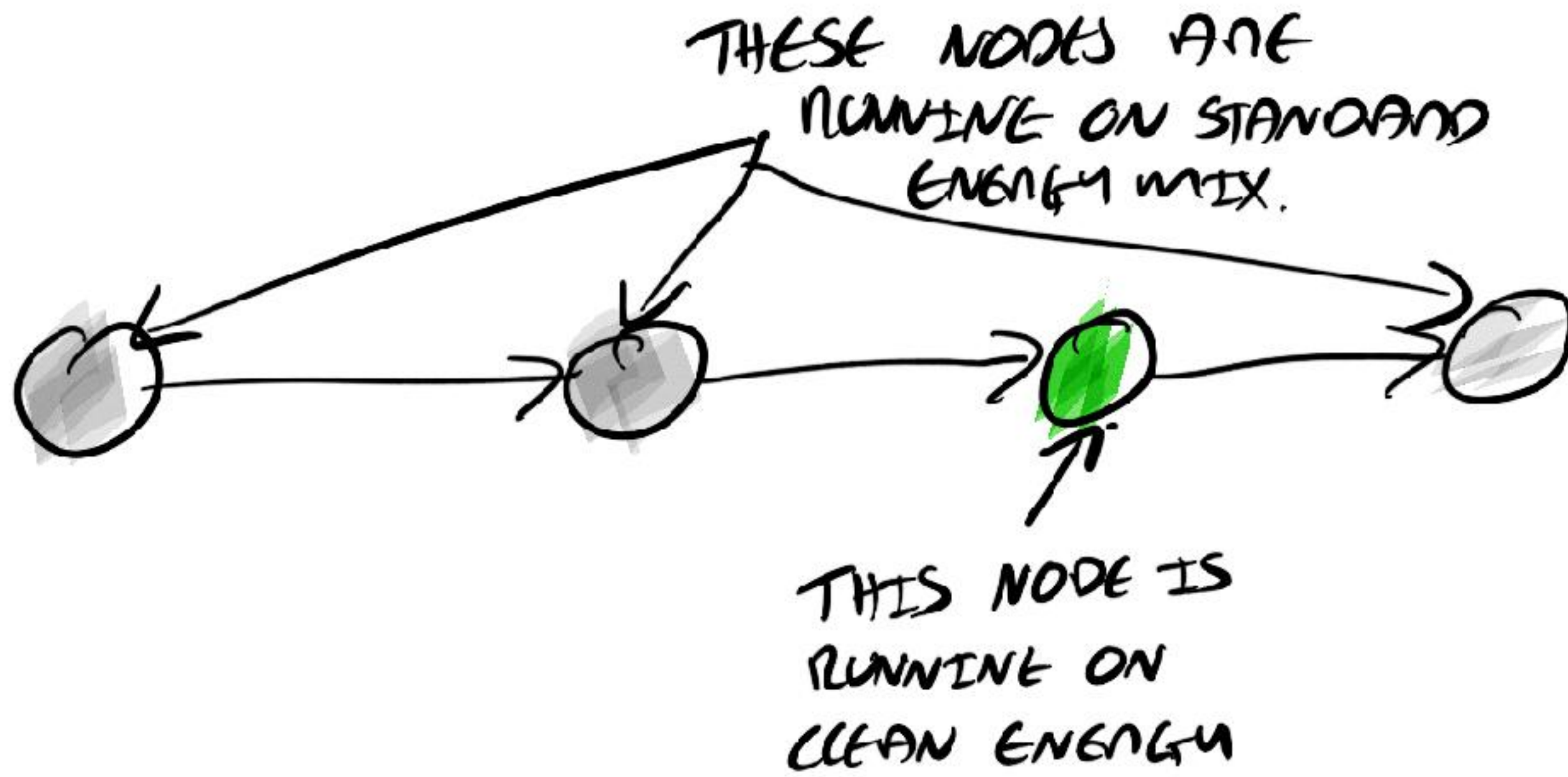
## Proportionality

Maximize the energy efficiency of hardware.



# 6/ NETWORKING





# 6/ Networking

Reduce the amount of data and distance it must travel across the network.





# 7/ Demand Shaping



# Implementation

- Carbon-aware vs. carbon-efficient
- Eco-modes



# 7 / Demand Shaping

Build carbon-aware applications



# 8/ Optimization

**Stars for  
good people**



# 8/ Optimization

- Carbon
- Electricity
- Cost
- Networking
- Performance



# 8/ Optimization

Focus on step-by-step optimizations  
that increase the overall carbon  
efficiency



# Summary [↗](#)

- 1. **Carbon** : Build applications that are carbon efficient.
- 2. **Electricity** : Build applications that are energy efficient.
- 3. **Carbon Intensity** : Consume electricity with the lowest carbon intensity.
- 4. **Embodied Carbon** : Build applications that run on older hardware.
- 5. **Energy Proportionality** : Run servers at a high rate of utilization.
- 6. **Networking** : Reduce the amount of data and distance it must travel across the network.
- 7. **Demand Shaping** : Instead of shaping supply to meet demand, try shaping demand to match supply.
- 8. **Measurement & Optimization** : Focus on end-to-end optimizations that increase the overall carbon efficiency.

# Applying the principals [↗](#)

Here are a few examples of applying the principals of sustainable software engineering to some common application architectures:

- Web-Queue-Worker
- N-tier
- Microservices
- Event-driven architecture
- Big data
- Big Compute

Here are a few examples of applying the principals of sustainable software engineering to some common infrastructure patterns:



# Optimize your network traffic

Reduce the amount of traffic your architecture creates per operation as well as the distance each request and response travels.

- Consider using caching headers, which allows browser caches and proxy caches to have enough information to confidently cache static assets. Caching static assets at the browser or proxy level allows future requests for those assets to be handled by those caches and reduces network traffic to your application.
- Consider using a CDN to distribute your application's static assets closer to the source of a request. This distribution of assets reduces the distance all requests for static assets has to travel over the network.
- Where possible, reduce the size and optimize your bundles and static assets.
  - Consider using compression and decompression for data you transmit over the network. Compression and decompression is usually takes less overall energy than

# AKA.MS/SSE/BLOG

The screenshot shows a web browser window with the URL `devblogs.microsoft.com/sustainable-software/`. The page features a green header with the text "Sustainable Software" and "Learn how to define, build and run sustainable software applications." Below the header is a search bar labeled "Search Sustainable Software". The main content area displays two blog posts. The first post, titled "Balancing the Three Areas of Sustainability Engineering" by Bill Johnson (August 24, 2020), includes an image of stacked stones and a snippet of text: "Sustainability in Software Engineering Software engineering has evolved over the years as new capabilities are discovered and new information introduced. Software developers and operations engineers were typically seen as two very separate roles. Once the cloud began to commoditize hardware these roles began to blend together into a new ...". The second post, titled "Two philosophies of Sustainable Software Engineering" by Asim Hussain (August 17, 2020), includes an image of a library and a snippet of text: "Alongside the 8 principles of Sustainable Software Engineering, there are 2 philosophies. For many of us, sustainability is more than a task. It's a purpose and a movement. Where does Sustainable Software Engineering sit in that broader sustainability movement?". A "Feedback" button is visible on the right side of the page.

Sustainable Software  
Learn how to define, build and run sustainable software applications.

Search Sustainable Software

**Balancing the Three Areas of Sustainability Engineering**  
Bill Johnson August 24, 2020  
Sustainability in Software Engineering Software engineering has evolved over the years as new capabilities are discovered and new information introduced. Software developers and operations engineers were typically seen as two very separate roles. Once the cloud began to commoditize hardware these roles began to blend together into a new ...

**Two philosophies of Sustainable Software Engineering**  
Asim Hussain August 17, 2020  
Alongside the 8 principles of Sustainable Software Engineering, there are 2 philosophies. For many of us, sustainability is more than a task. It's a purpose and a movement. Where does Sustainable Software Engineering sit in that broader sustainability movement?

Feedback

# The Climate Fix



TheClimateFix.com

