Embracing Eco-Friendly Testing Practices : Greening the testing Landscape

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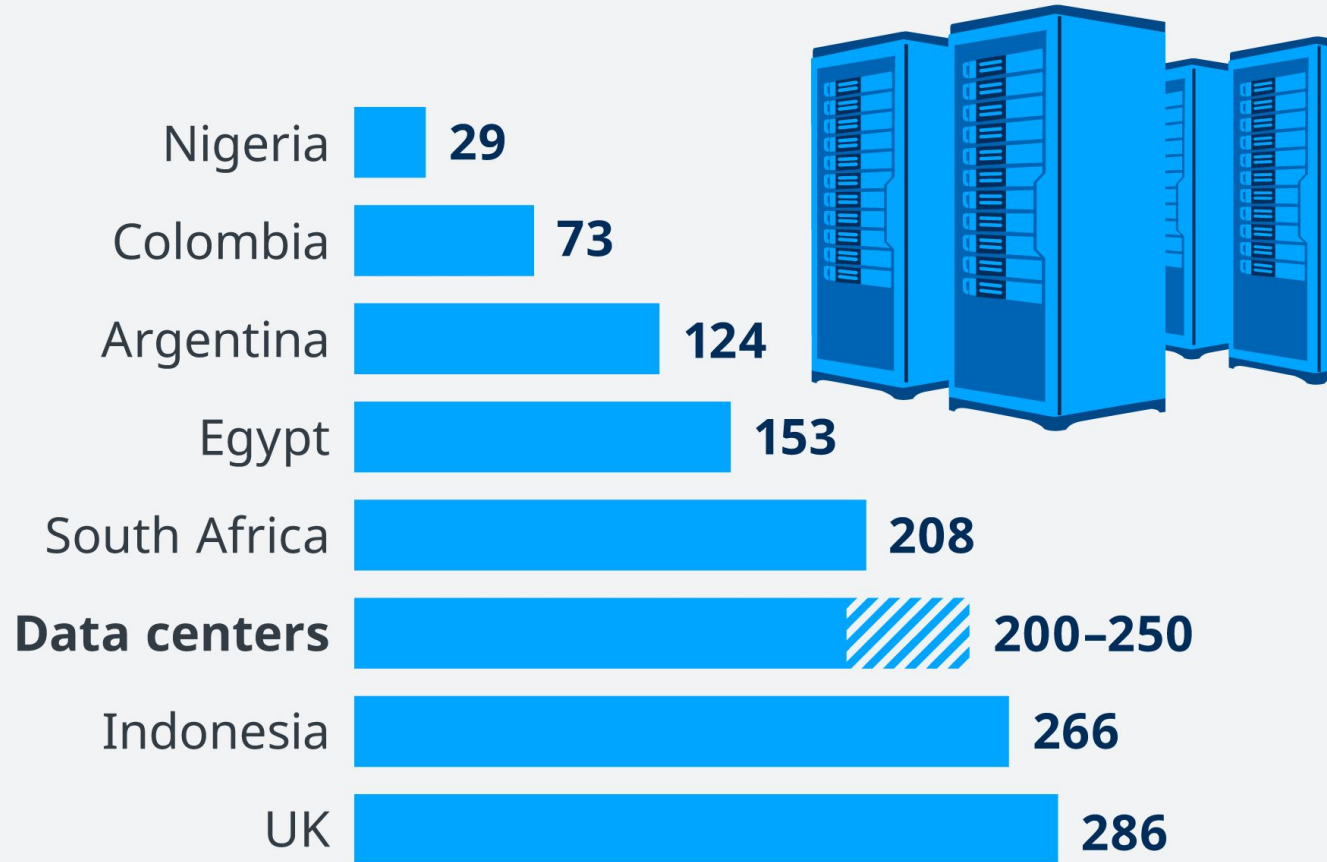
Story of Google

- Hidden environment impact
- Realization : Data Centers uses as much energy as a small city

Data centers use more electricity than entire countries

Domestic electricity consumption of selected countries vs. data centers in 2020 in TWh

| Country	TWh
Nigeria	29
Colombia	73
Argentina	124
Egypt	153
South Africa	208
Data centers	**200–250**
Indonesia	266
UK	286

Source: Enerdata, IEA

The hidden cost of growth

- Software industry's growth
- ICT sector uses 4-10% of the world electricity and generated 1.5-5% of greenhouse gas emissions (European parliament - 2022)
- Data centers: 1% global energy use (International Energy Agency -2023)
- Software testing's energy consumption

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Google's Eco-Friendly Testing Evolution

- Renewable energy powered data centers
- Adopting test impact analysis

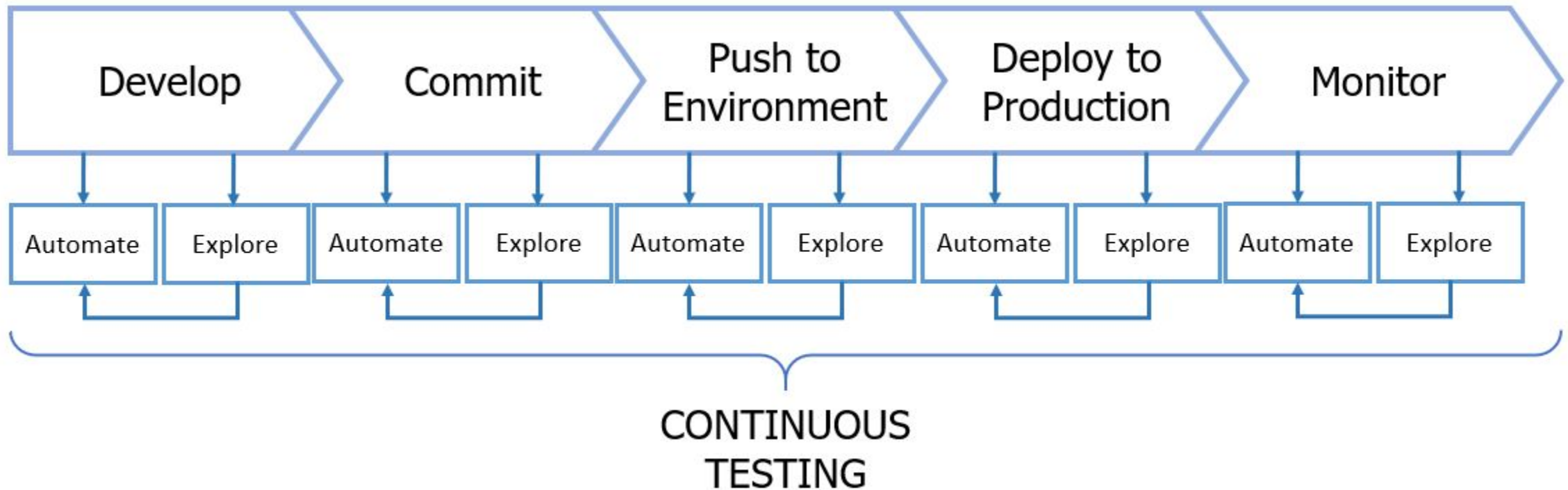Have you thought about the environmental impact of running tests?
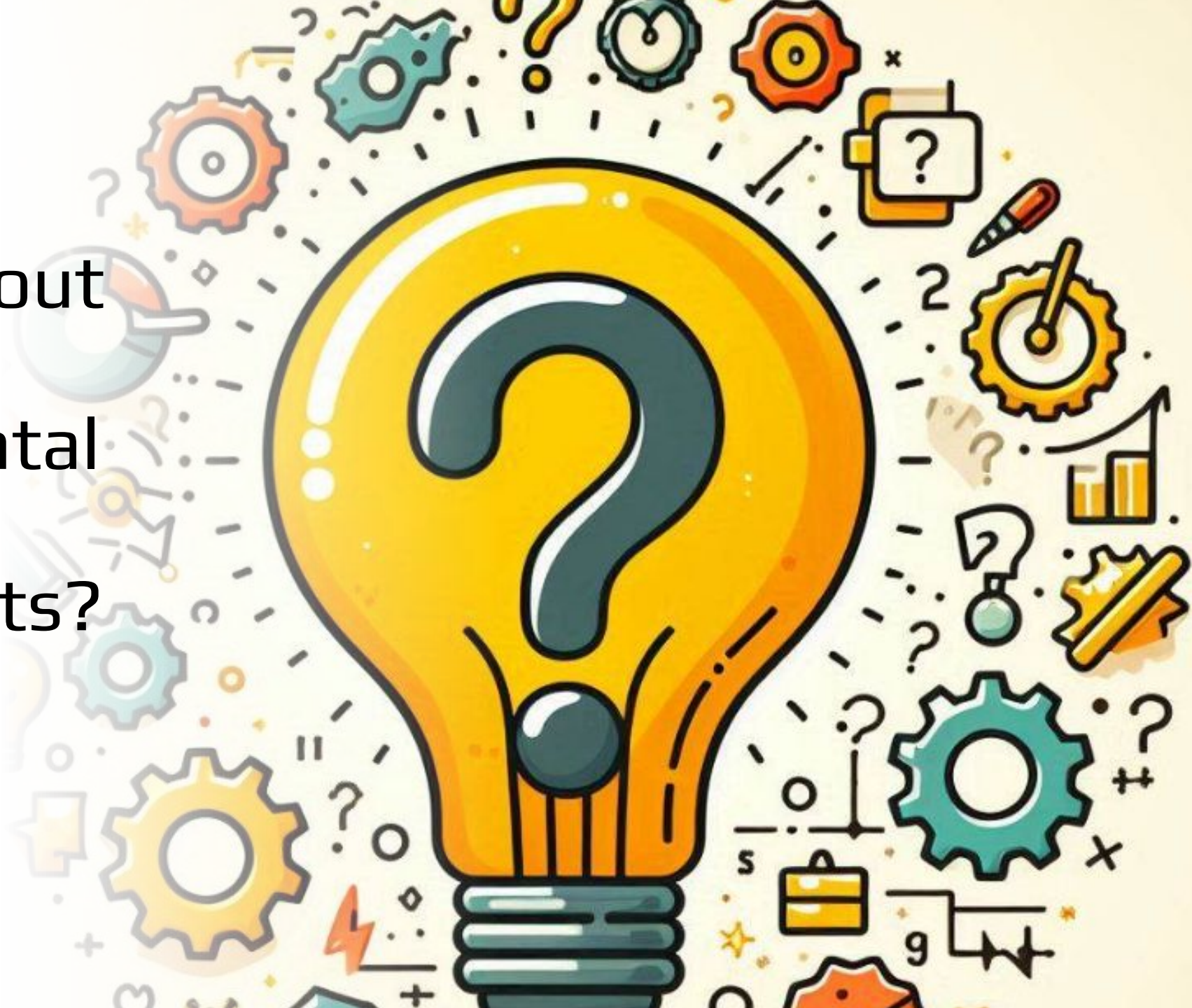
Greening your Testing

- Optimize testing pipelines
- Leverage cloud environments
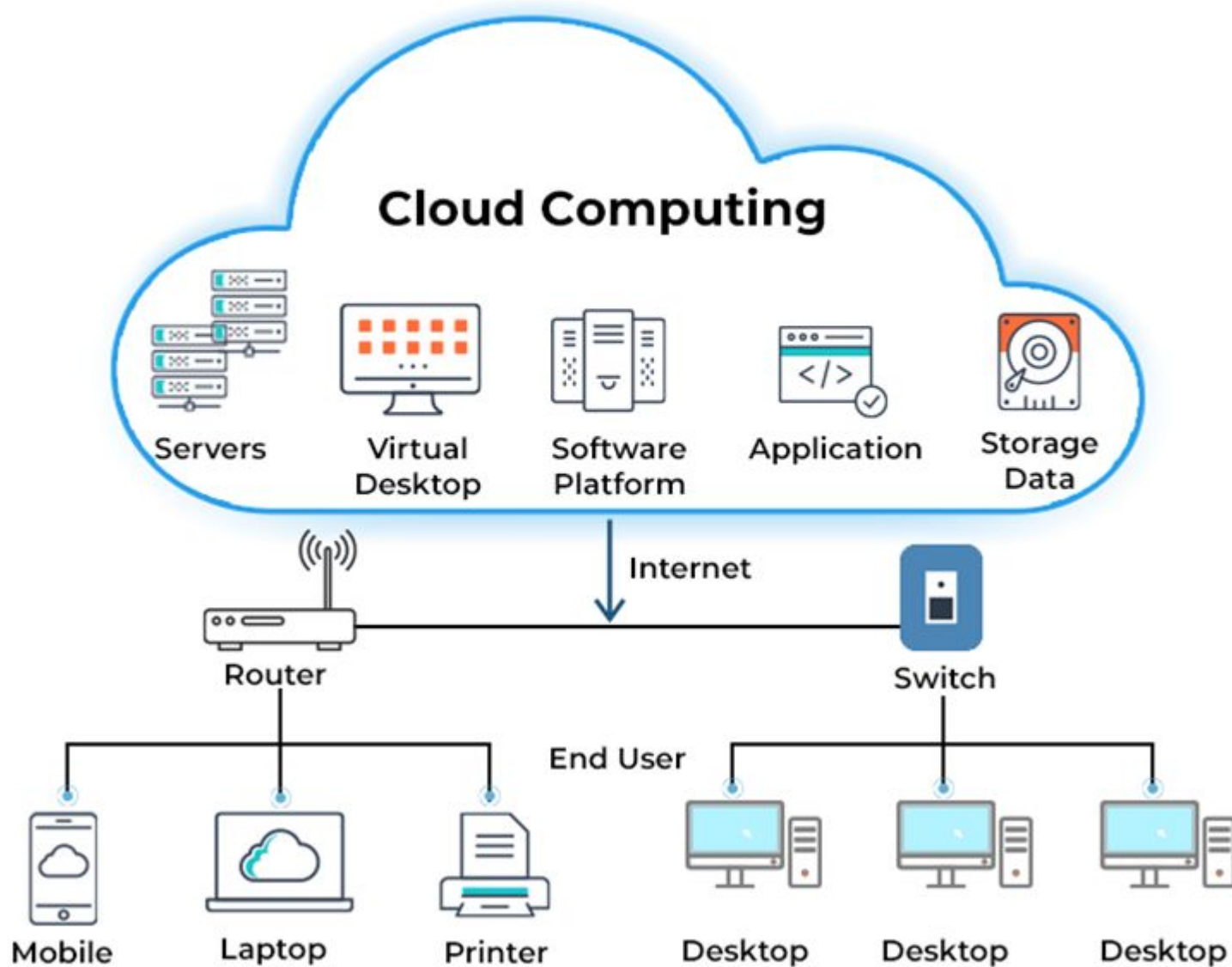- Write efficient test code

Optimize Testing Pipelines

- Only run necessary tests after code changes
- Run larger number of tests on less traffic times – off peak testing

Develop		Commit		Push to Environment		Deploy to Production		Monitor	
Automate	Explore	Automate	Explore	Automate	Explore	Automate	Explore	Automate	Explore

CONTINUOUS TESTING

Leverage Cloud Environments

- Use cloud environment that scales resources dynamically

(Cloud is not infinitely scalable)

- Cloud based testing

- If using cloud is not possible, use virtual machines (VMs)

- Choose provider using renewable energy

Cloud Computing

Servers · Virtual Desktop · Software Platform · Application · Storage Data

Router · Internet · Switch

End User

Mobile · Laptop · Printer · Desktop · Desktop · Desktop

Write efficient test code

- Poorly written tests waste resources and energy
- Parallel test runs
- Reduce the complexity of loops and functions
- Minimize use of polling
- Optimise memory management

Manage Test Data

- Only collect and retain test data that is necessary

- Generate data on demand

- Focus more on data sub-set testing
  - Instead of full data set, use subset that are representative of entire data set

- Virtual test data generation

- Data masking and anonymization
  - Reduce the need of multiple data sets

What's your hardware footprint?

Track Green Metrics

Measure energy impact of your tests

Tools and technologies

- Industry standards
  - **ISO/IEC 30134-1:2016** provides guidelines for the energy efficiency of data centers
  - **ISO/IEC 25010:2011** defines a model for software quality, including efficiency as a key characteristic. It helps in evaluating the energy efficiency of software products
  - **IEEE 1680.1-2018** focuses on environmental performance criteria for electronic products, including energy efficiency
  - **Green Software Foundation**: While not a formal standard, this foundation provides best practices and guidelines for developing sustainable software. It includes principles for reducing the carbon footprint of software applications
  - **Energy Star for Data Centers**: This program, managed by the U.S. Environmental Protection Agency (EPA), includes criteria for energy-efficient software and hardware used in data center
- Frameworks
  - **µDroid**: This is an energy-aware mutation testing framework specifically for Android applications
  - **EnerJ** is a framework developed by Google to monitor and optimize energy usage during software testing. It focuses on energy-aware programming by allowing developers to specify energy usage policies and constraints within their code.
  - **Energy-aware Mutation Testing for EAST-ADL**: This framework focuses on creating energy-related mutants for EAST-ADL architectural models. It uses statistical model checking and mutation analysis to generate and select test cases that can identify energy inefficiencies

- Visualisation Technologies
  - Red hat's **Kepler project** for resource management in Kubernetes environments
  - **Green-coding.io**
  - **Grafana**
  - AWS **customer carbon footprint tool**
  - Azure **Emissions impact dashboard**
  - Google cloud **Carbon footprint tool**

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What can you do?

- Revisit your automation test suit

- Schedule test run on non-busy times of the day

- Efficient test data management

- Make it a habit to scale down unused environments and scale up what is needed

- Try to reuse and repurpose hardware

- Continues improvement and monitoring

In Summary

- Small changes lead to big impacts
- Eco friendly testing not only good for the planet but boosts efficiency
- Challenge : How will you contribute to greener testing

The greatest threat to our plant is the belief that someone else will save it.

Thank you!