Users help shaping the path to a **Sustainable Operation of** the **VISPA** computing cluster
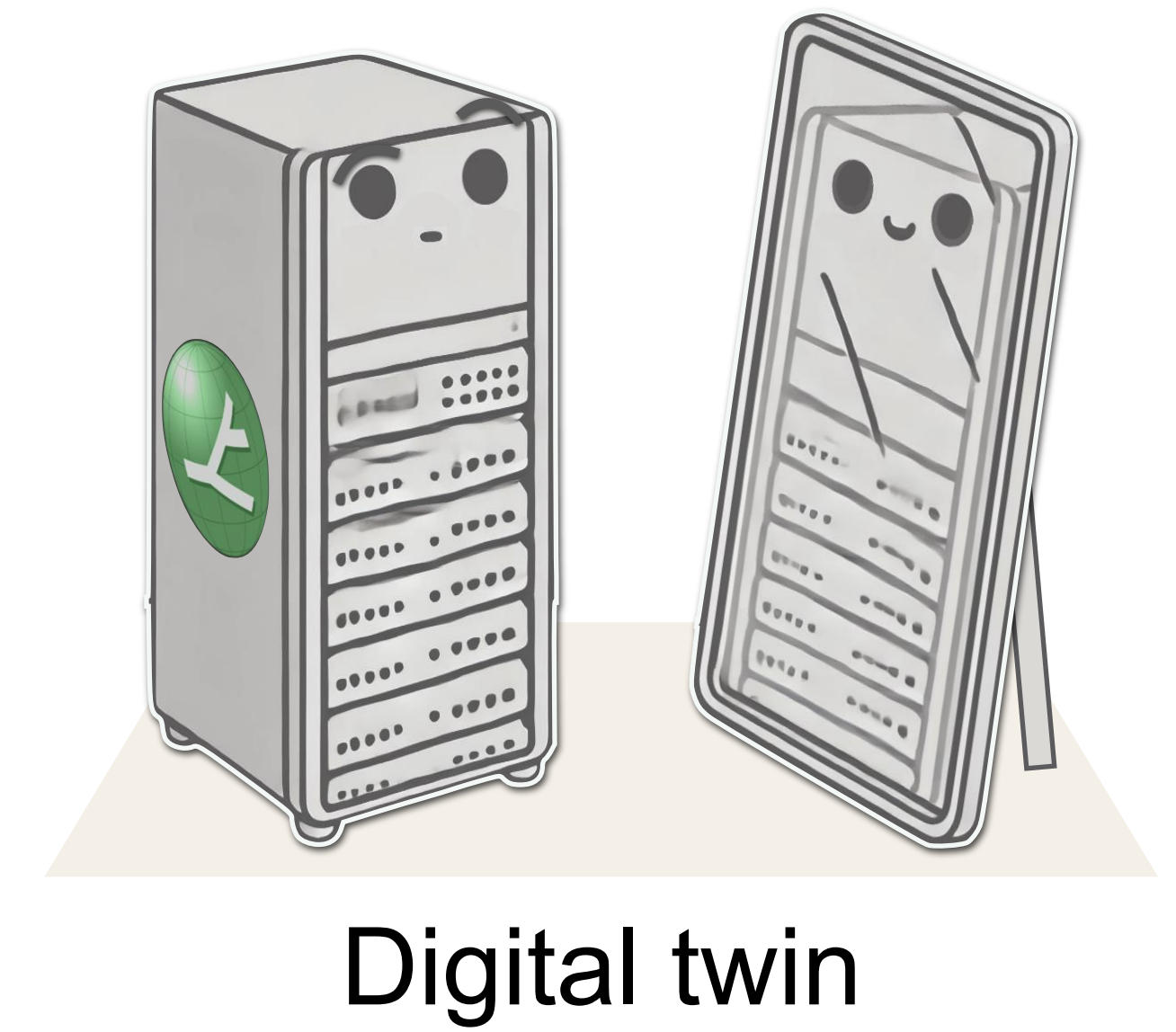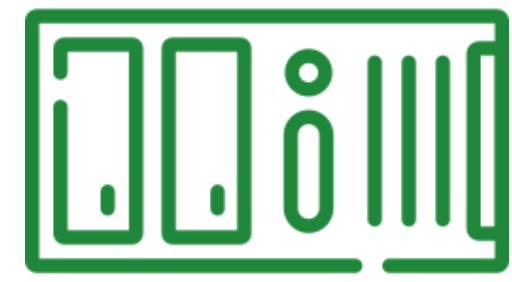

Informing users

Shifting jobs

Digital twin
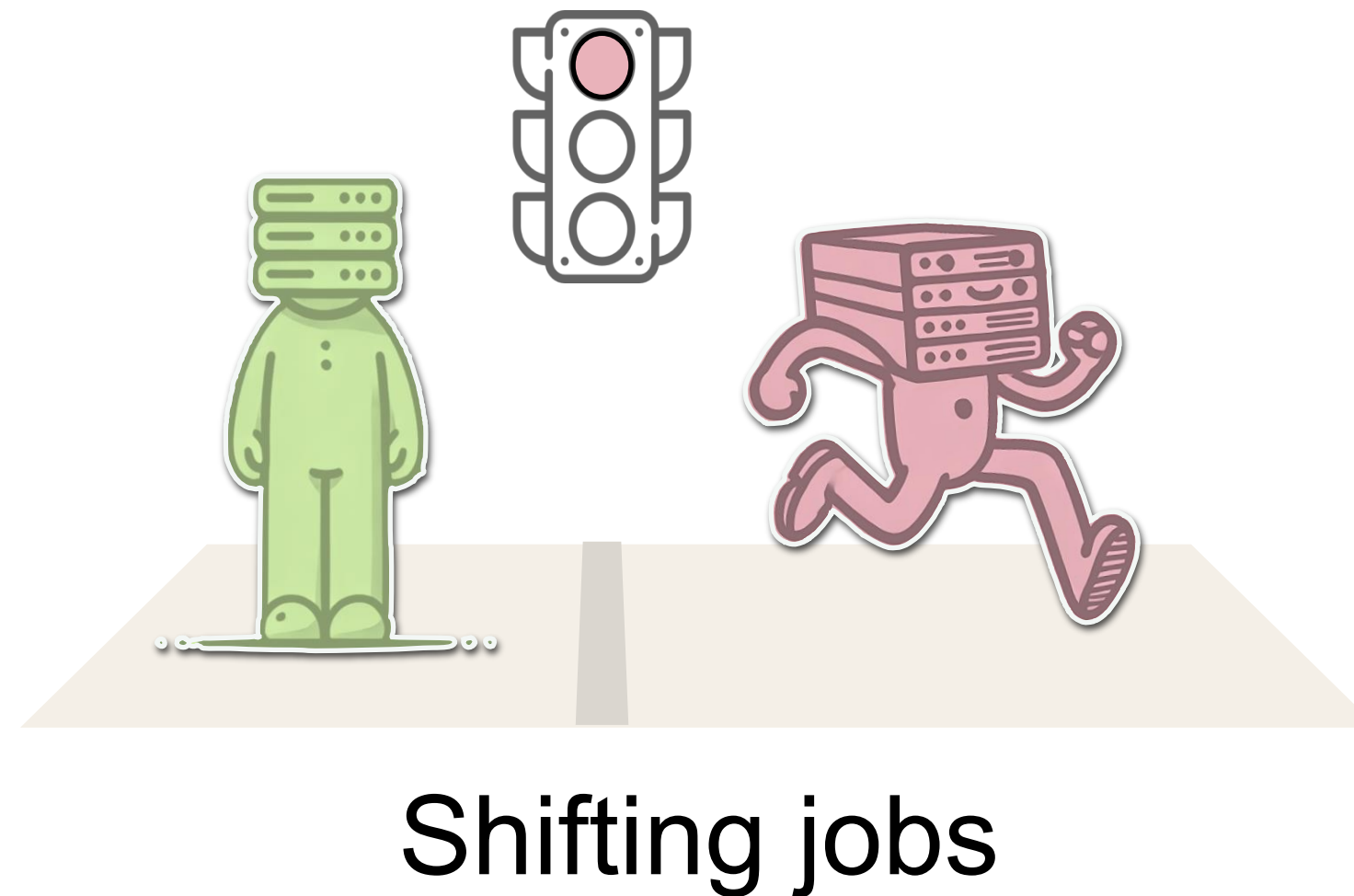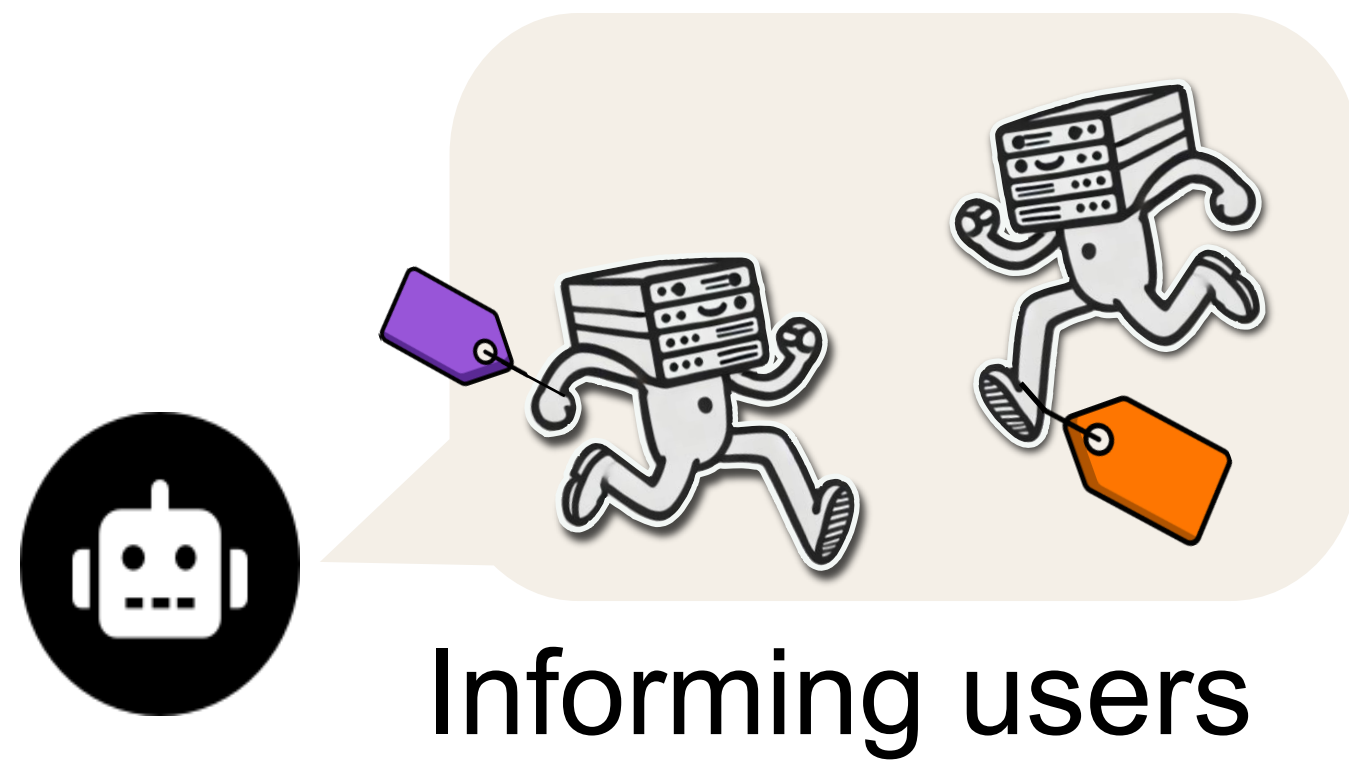
Niclas Eich, Johannes Erdmann, Martin Erdmann, Benjamin Fischer, Paul Gilles, Tim Hauptreif, Jan Kelleter

VISPA is a small computing cluster.

14 nodes

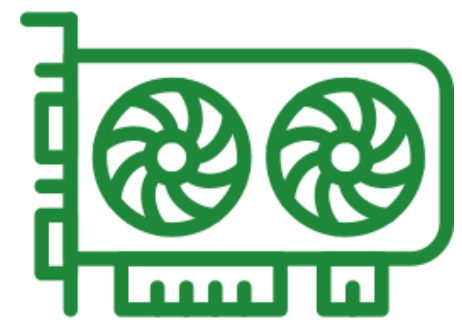**30** GPUs

350 CPU cores

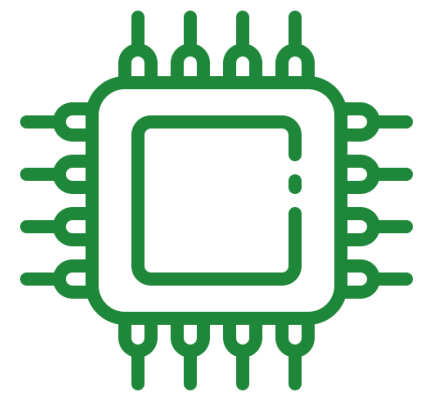**3000** registered users 20 researches, 100 active students / semester
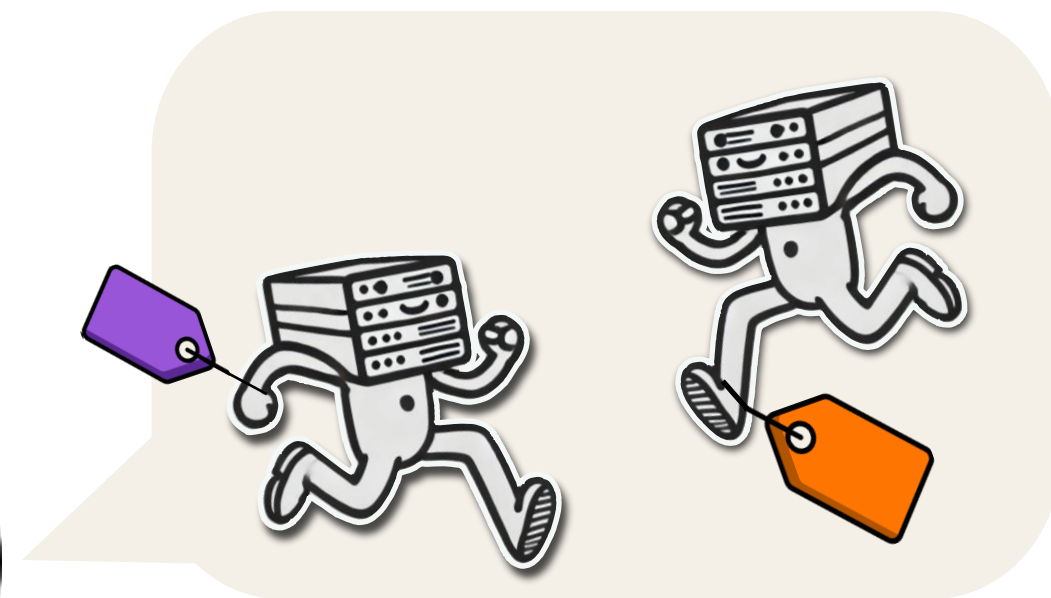
20 single households of energy consumption

400 kg CO_2eq
emitted due to power consumption of VISPA in June 2025

Icons from Flaticon by Freepik, kerismaker, prettycons, Pixel perfect, juicy_fish

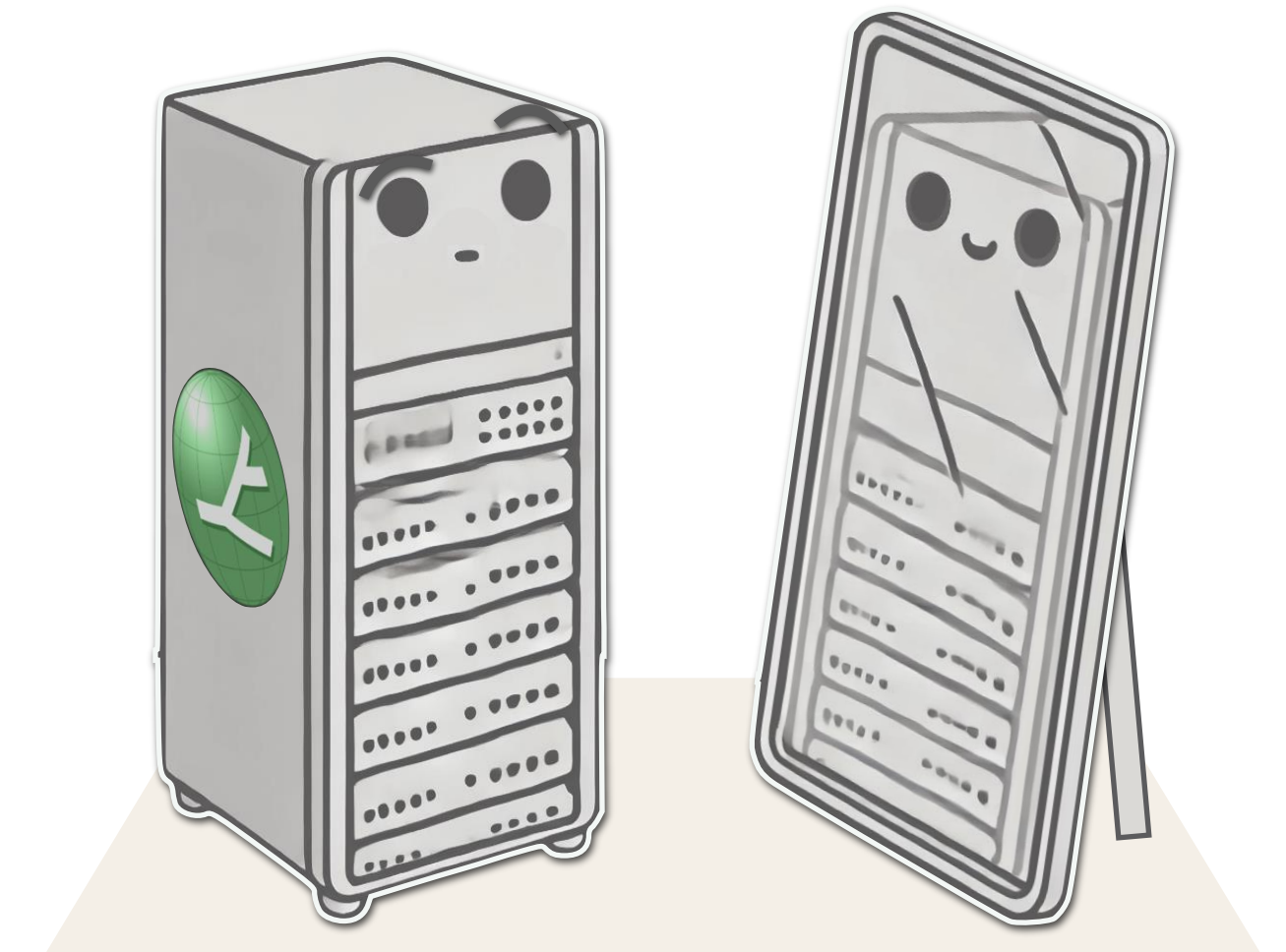RWTH AACHEN UNIVERSITY   VISPA

3 steps towards more sustainabe operations.

Informing users
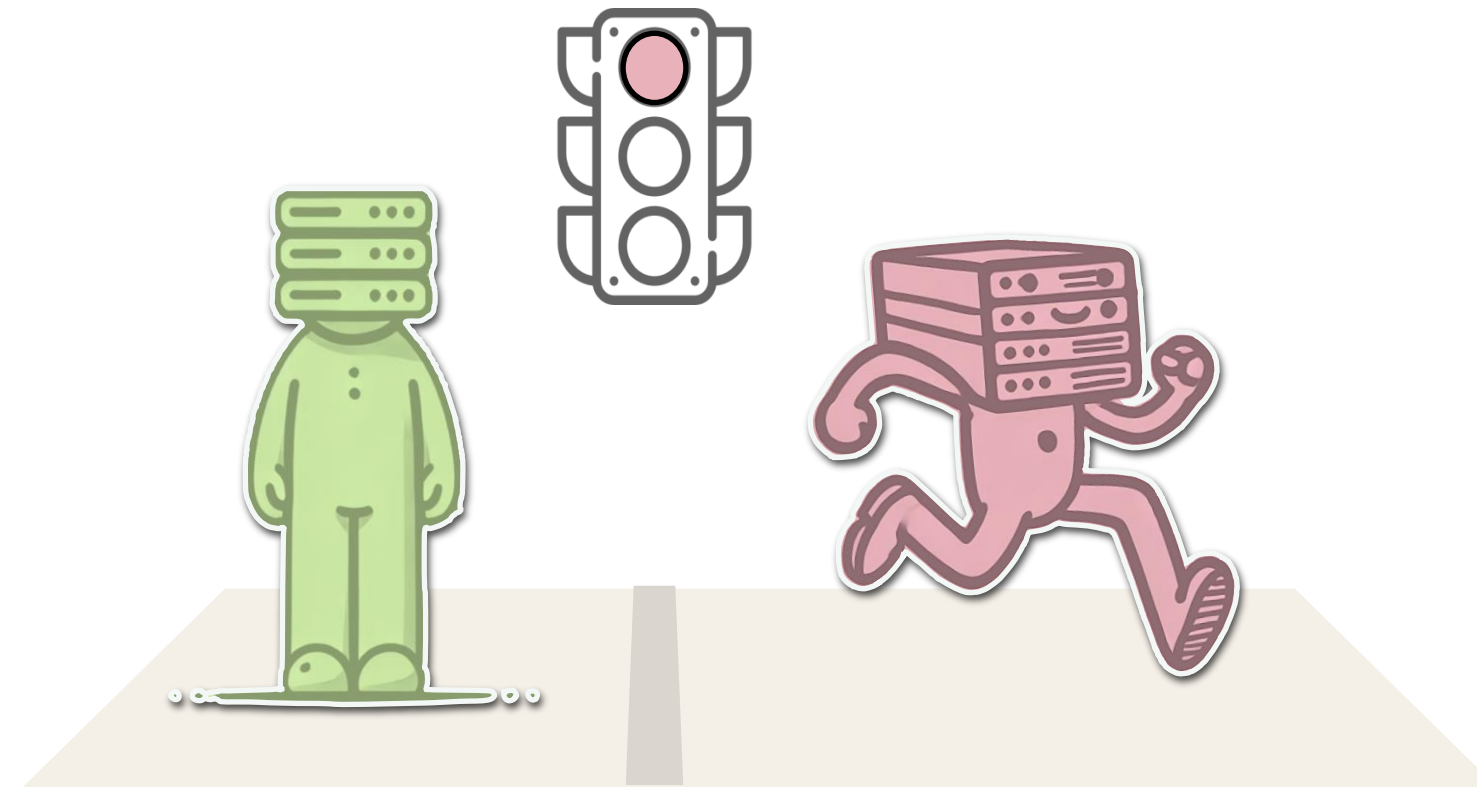
Shifting jobs

Digital twin

Involve the users by informing them.

Personal weekly energy consumption

Icons from Freepik
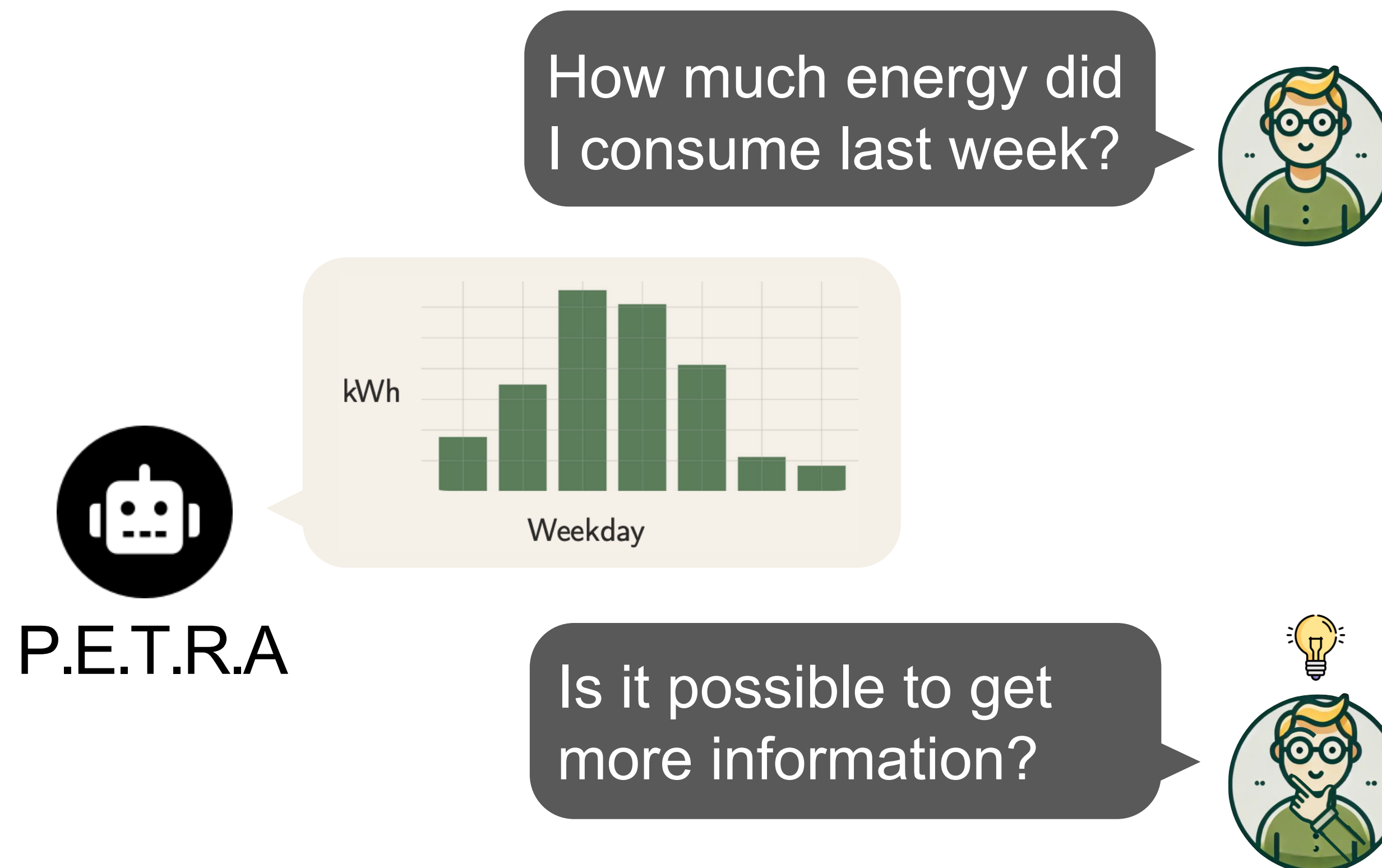
More insights

Job-specific power consumption and Labeling of jobs

12 Wh

14 Wh

8 Wh
failed

30 Wh

18 Wh

March 1st

April 1st
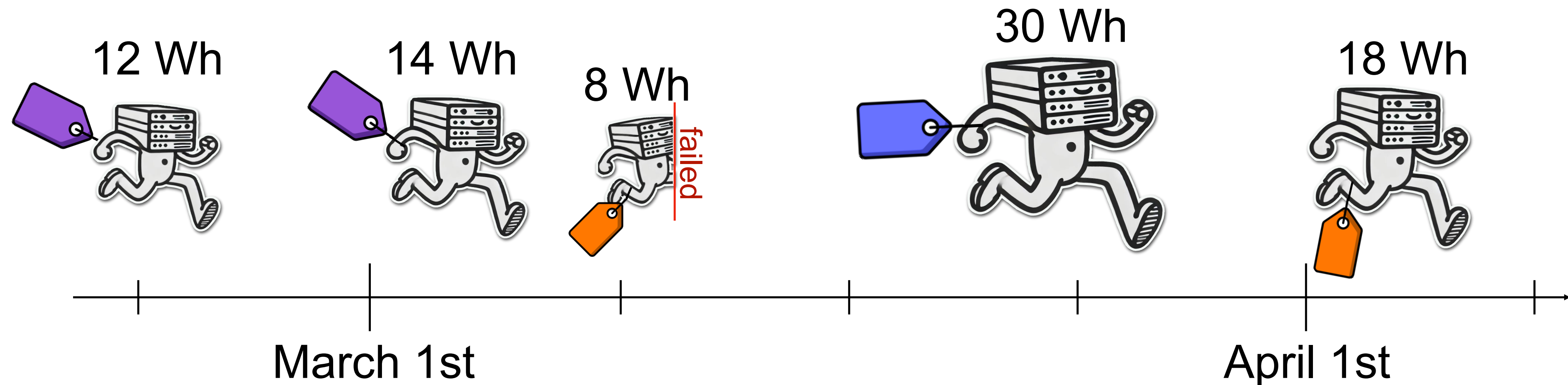
- What were my three biggest jobs?
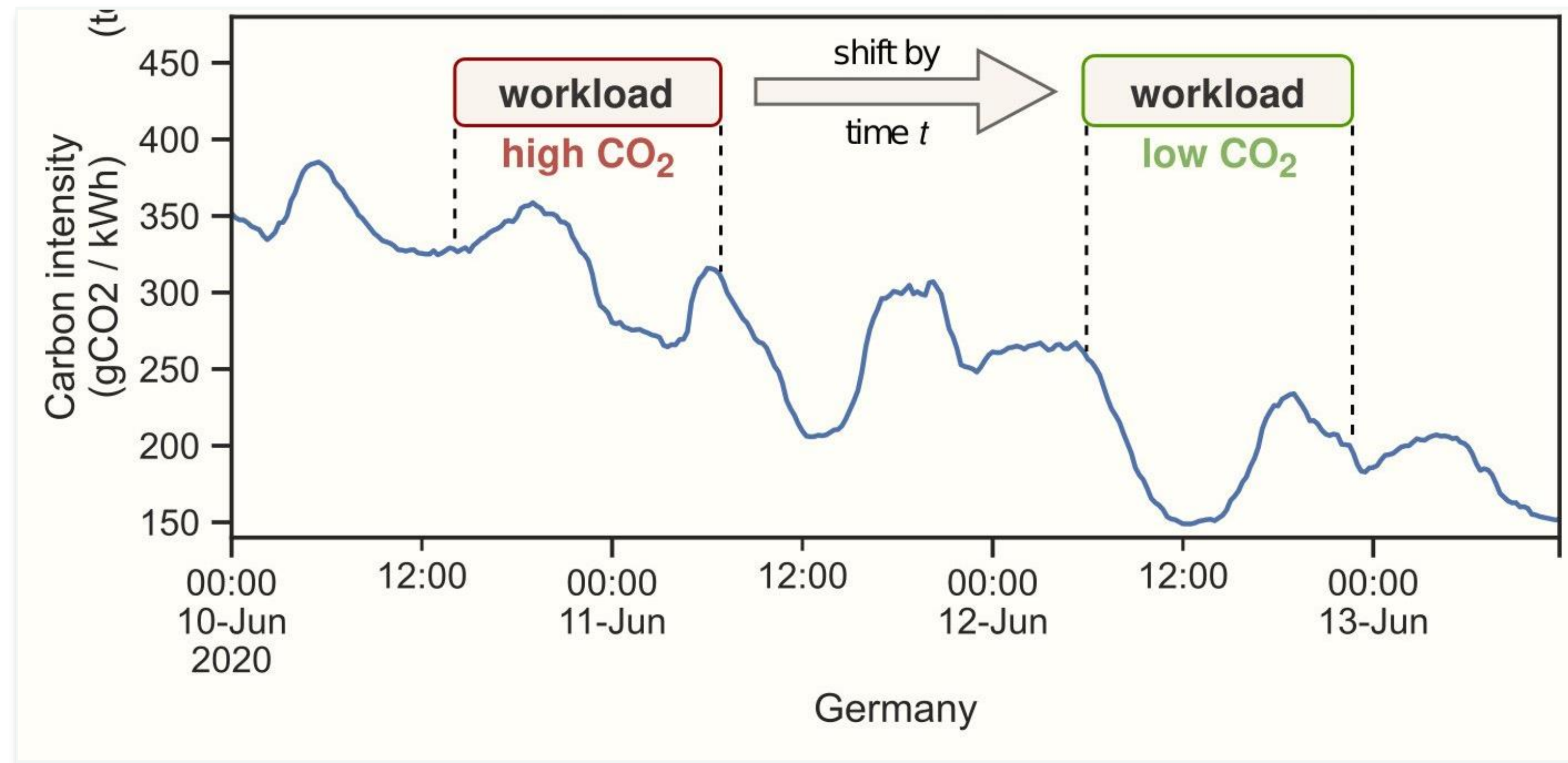- How much did my failed jobs consume?
- ….

- How much did **Lecture preparation** **Workshop** **Newest paper** consume?

Icons from bqlqn

Studies show: Shifting jobs saves CO_2.

Simulation →

Let's Wait Awhile: How Temporal Workload Shifting Can
Reduce Carbon Emissions in the Cloud

arXiv:2110.13234

Philipp Wiesner,
Ilja Behnke,
Dominik Scheinert,
Kordian Gontarska,
Lauritz Thamsen

**Realize
this idea** →

RWTH AACHEN UNIVERSITY VISPA

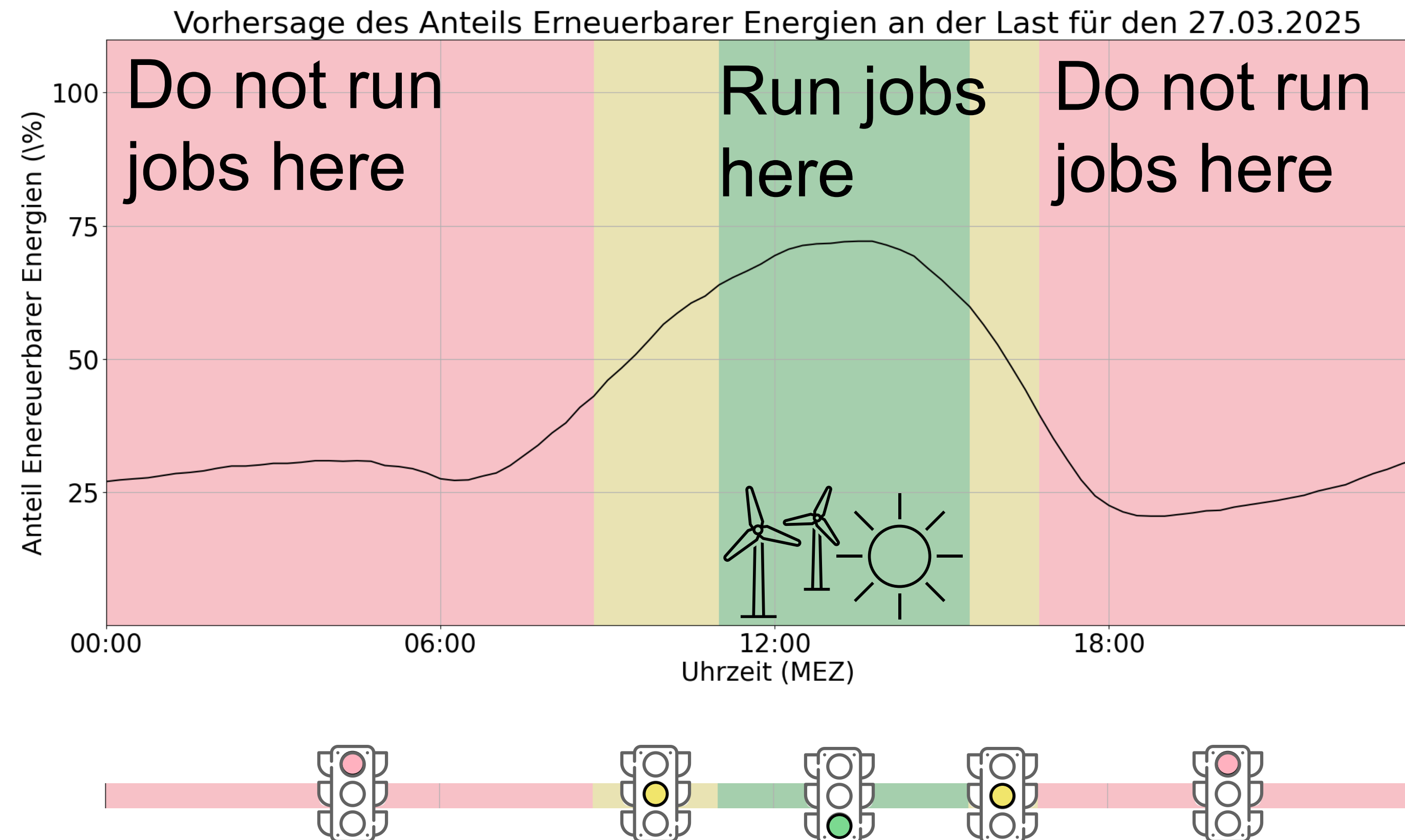# Shift jobs to less CO_2 intensive hours.

Percentage of renewable energy

- Available as forecast
- Intuitive

Vorhersage des Anteils Erneuerbarer Energien an der Last für den 27.03.2025
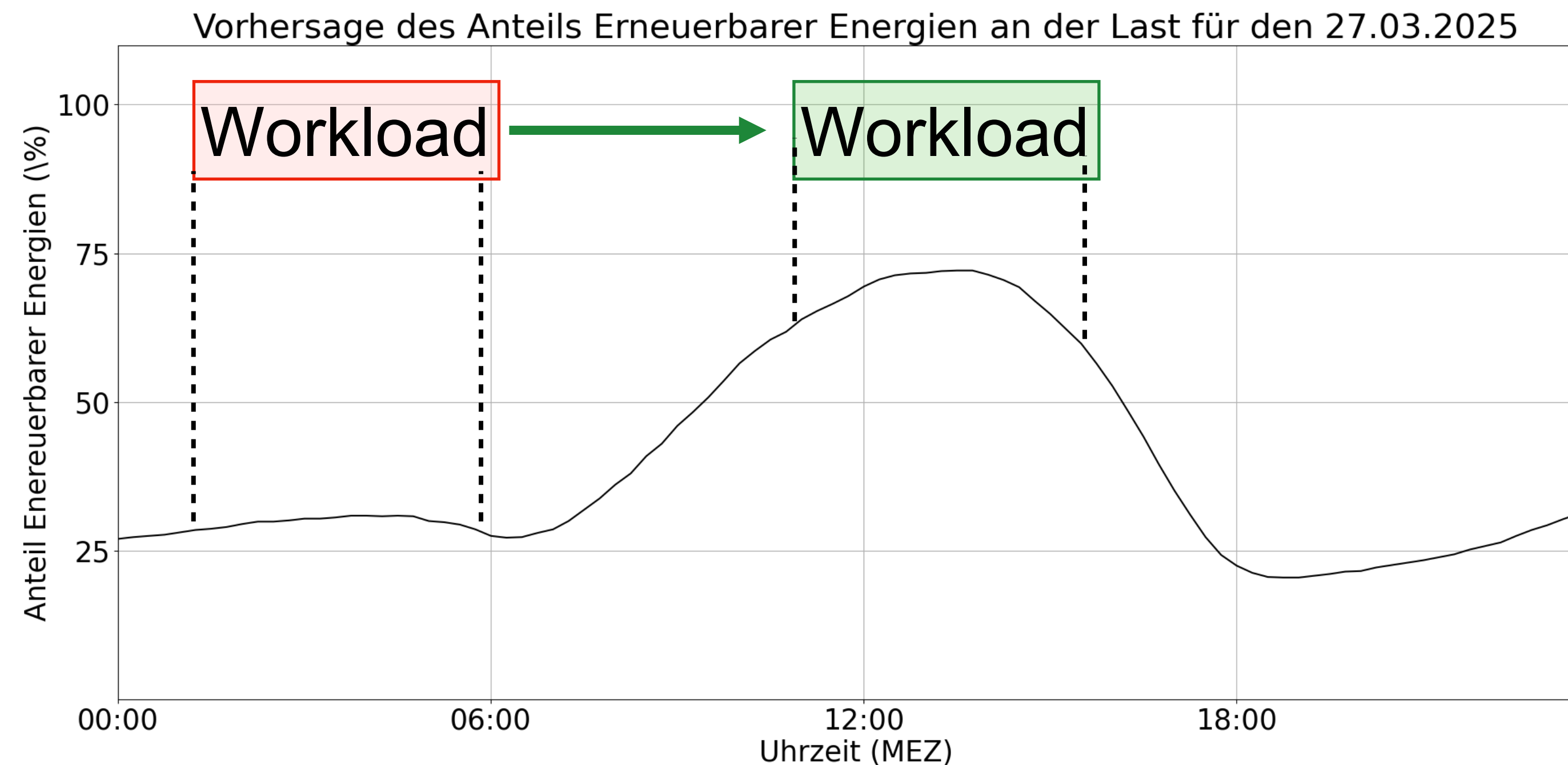
Shift Jobs to green hours.

Traffic Light by Fraunhofer ISE
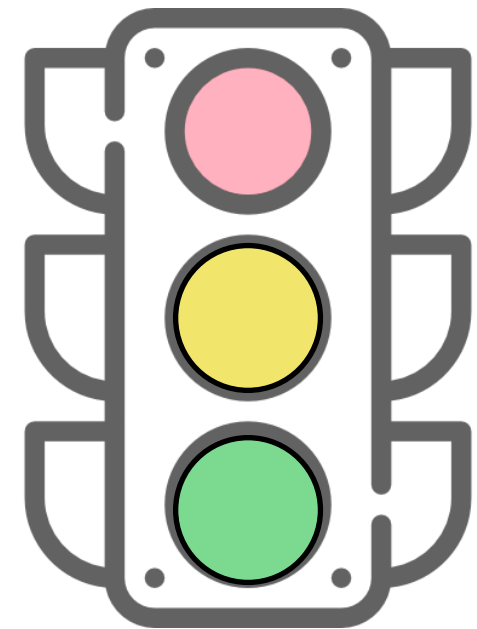
Wake up. Look at forecast. Work. Repeat.

- Posted every morning

- Users can plan their day
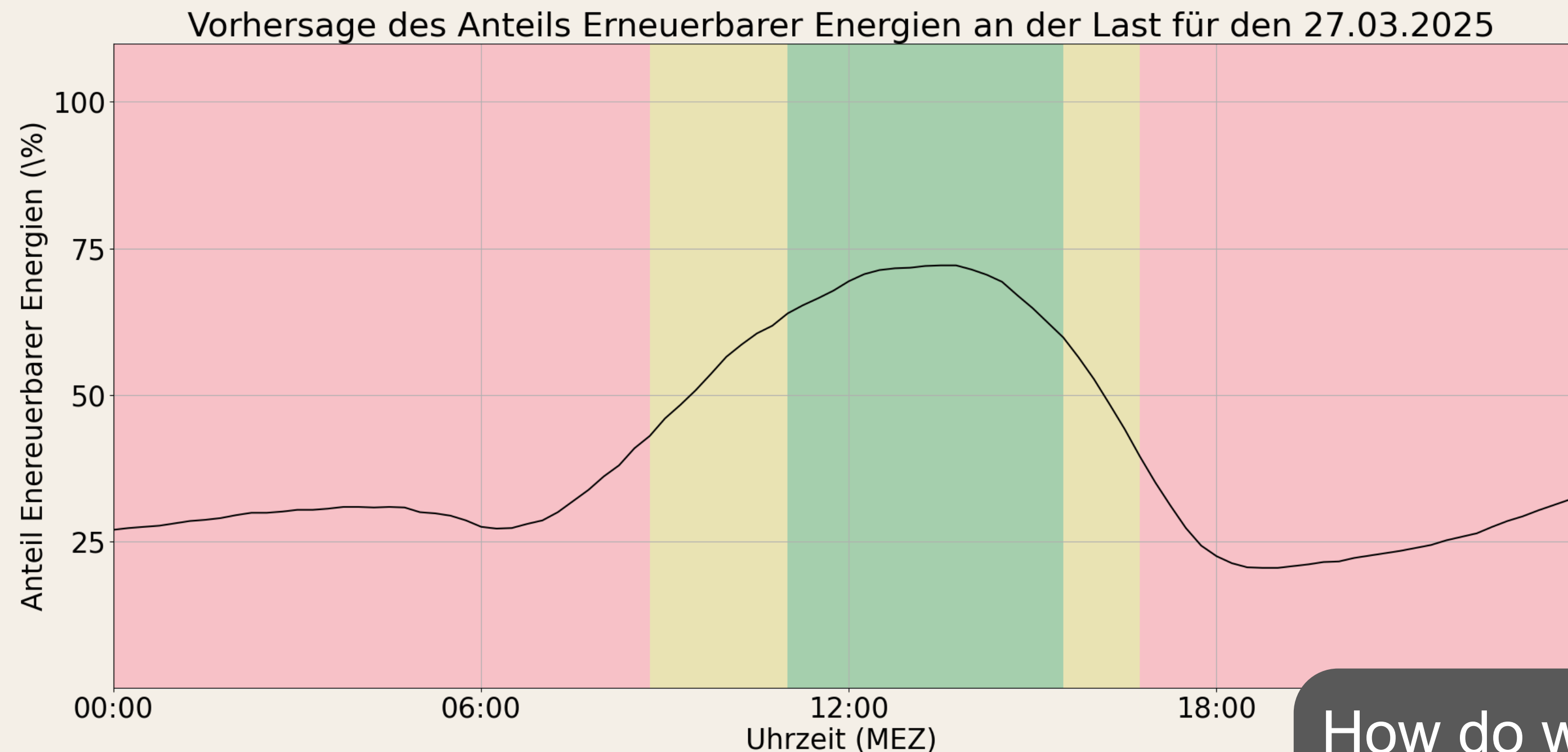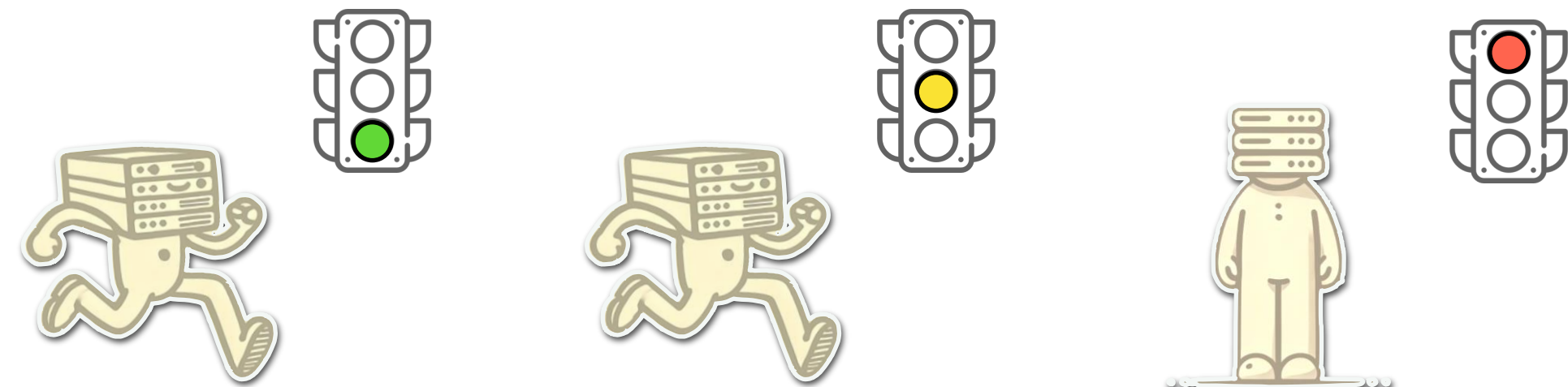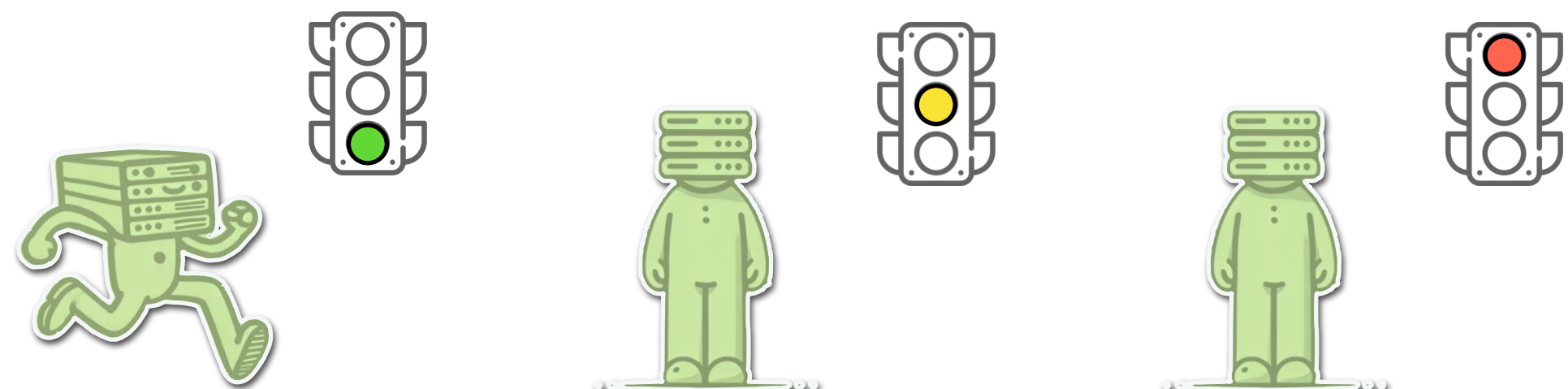
Enable users to **easily** shift jobs.

Sustainability Flag

`$ submit --sustainability red    …`
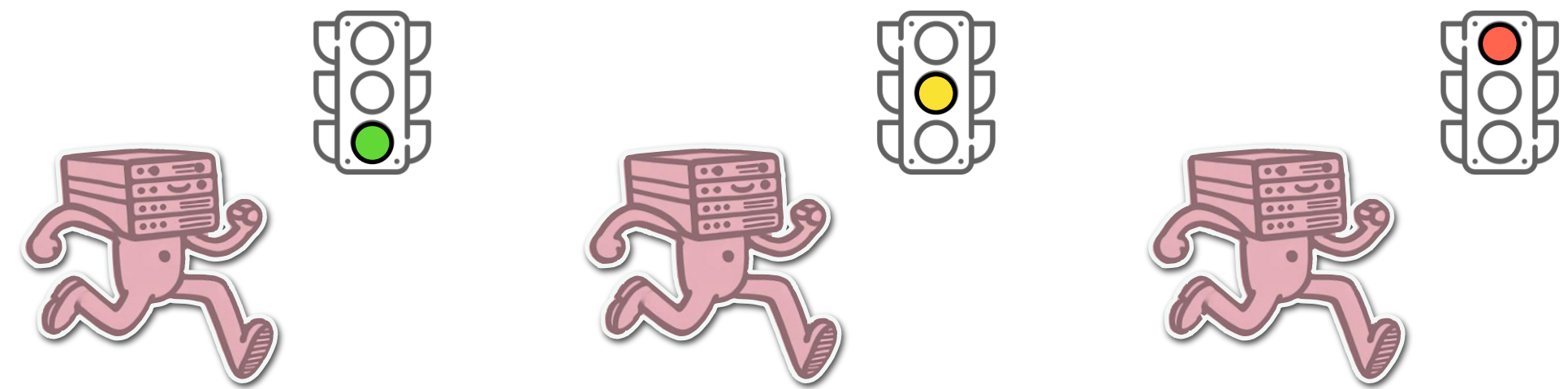
`$ submit --sustainability yellow …`

`$ submit --sustainability green  …`

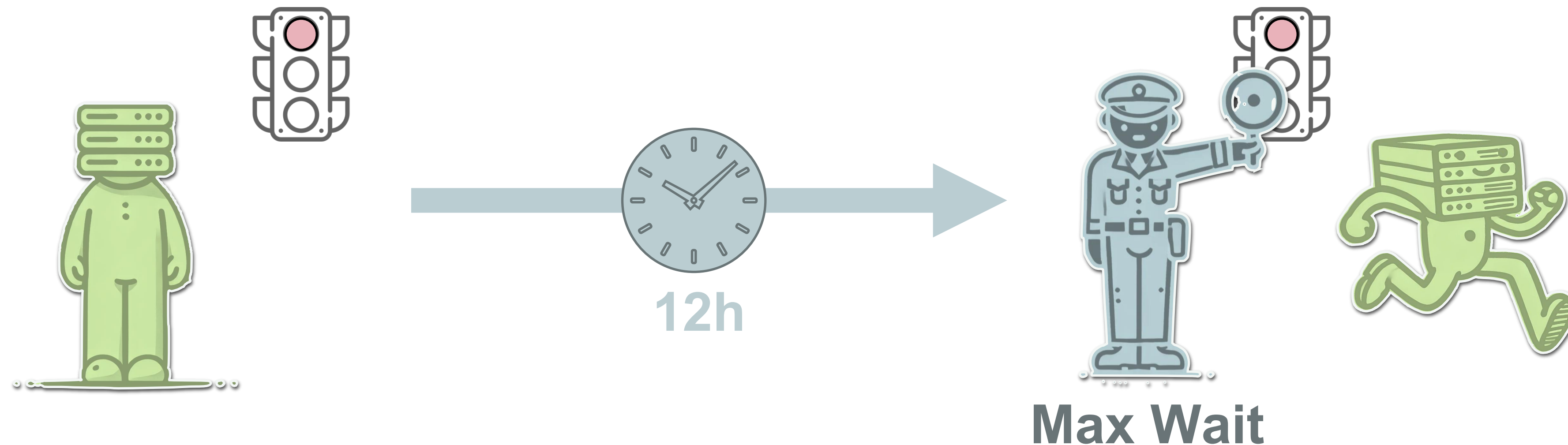# Rules exists to be broken.

Example: 1h would
not be wise

```
$ submit --sustainability green  --maxwait 12 …
```


12h

Max Wait

➜ As green as possible while
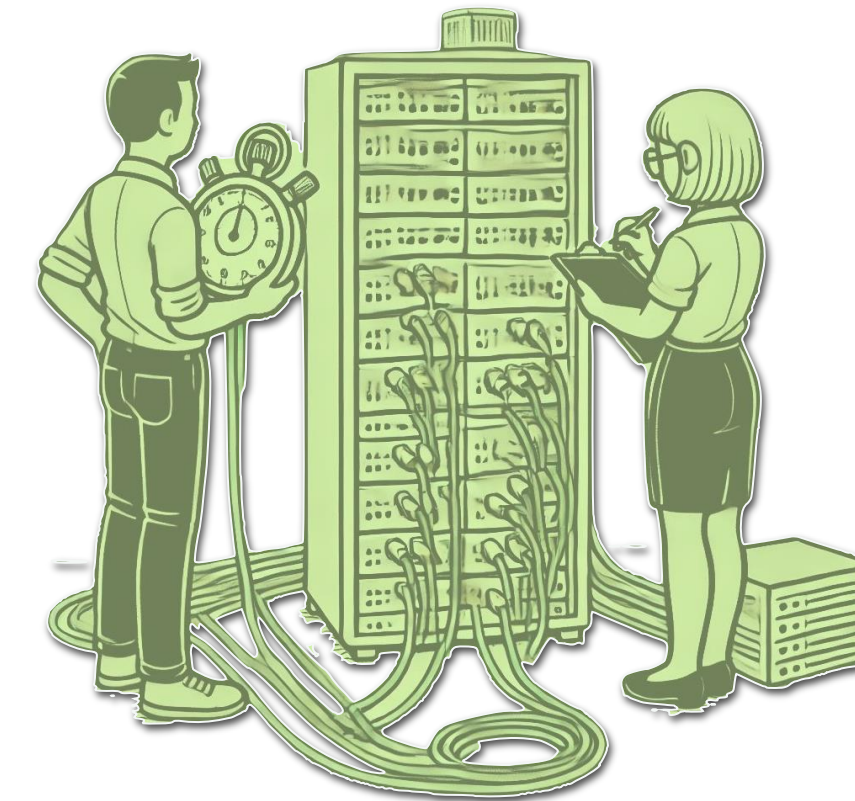meeting the deadline

comfortable
enough….

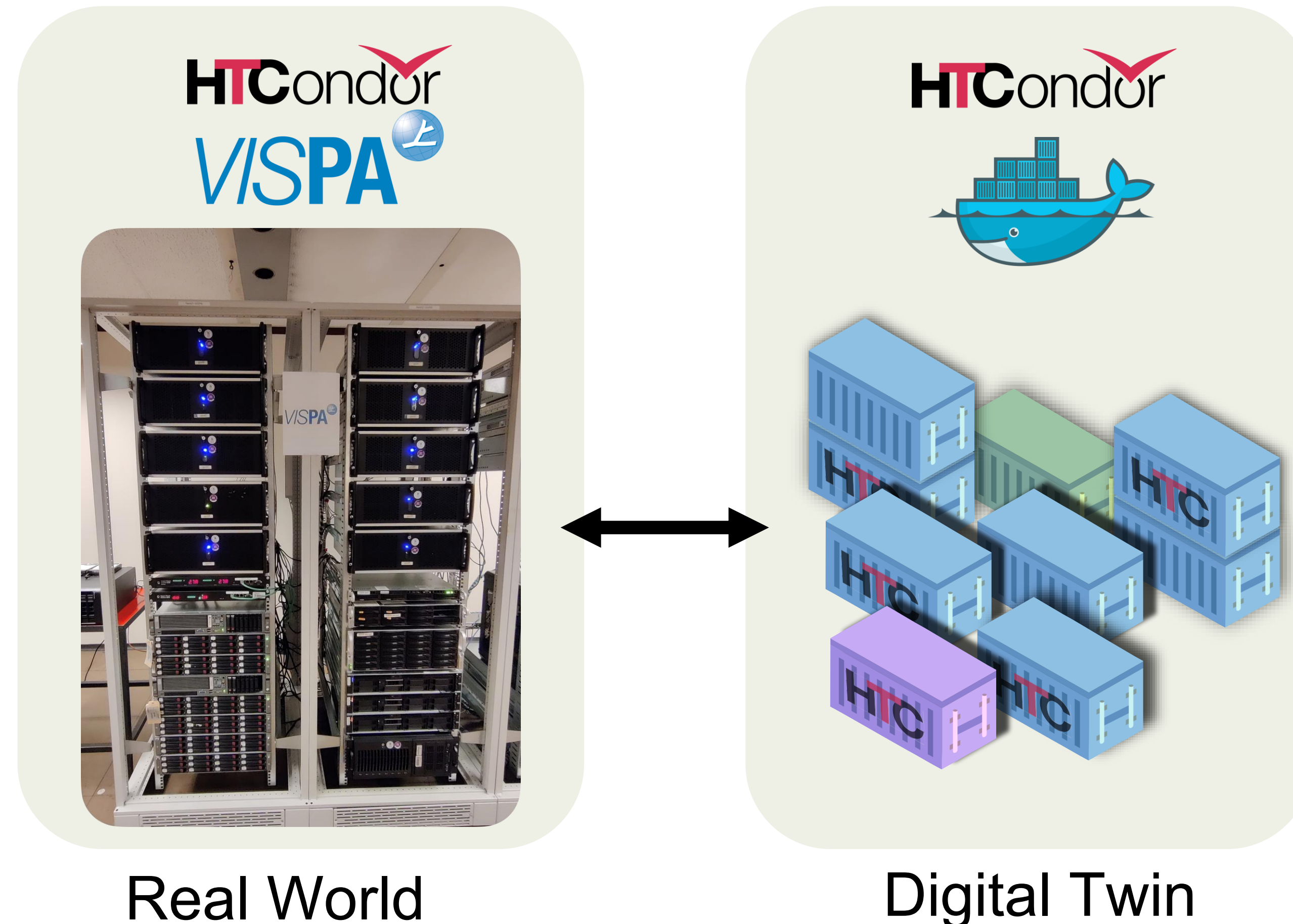# Testing & Simulation on a Digital Twin.

What do we want?

- Develop and test new functions
- Downtime is not an issue

- Estimate the effects of changes
- Find optimal configurations
  (e.g. default value of maxwait flag)

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Ready, steady, containerize!

Real World

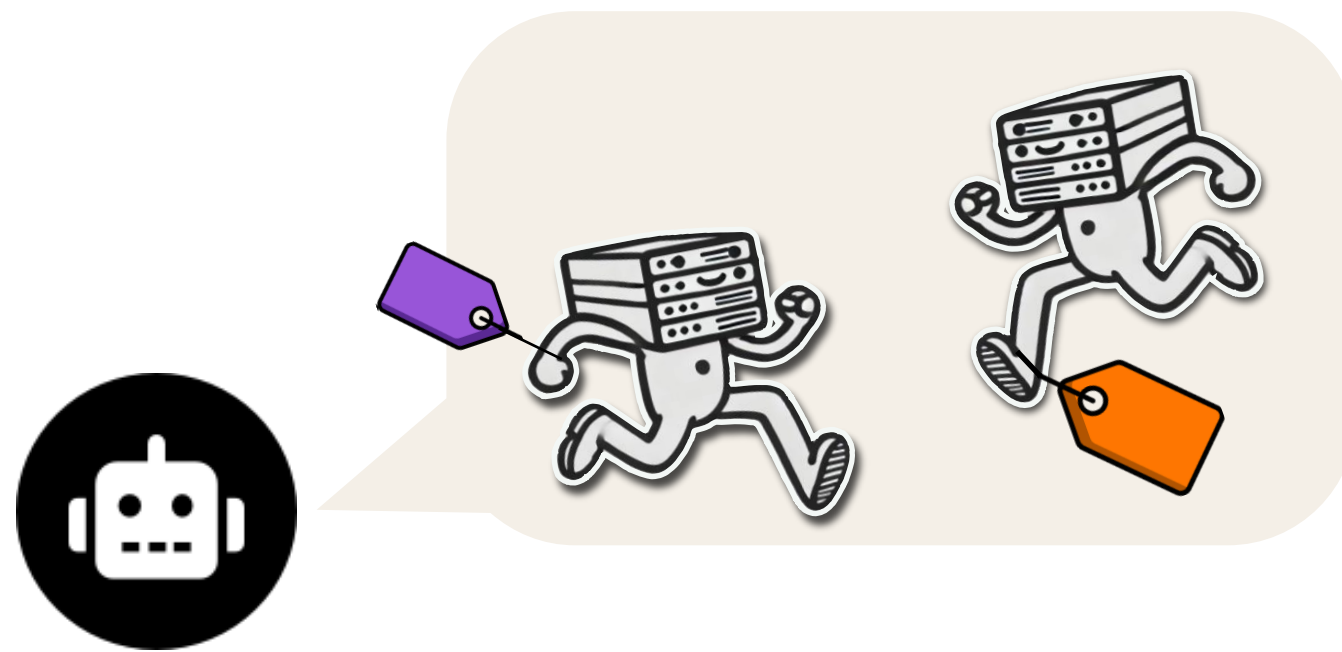Digital Twin

- Each node is now a container

- Virtual ressources

- No load from jobs

- Complete HT Condor installation

- Use same configuration files

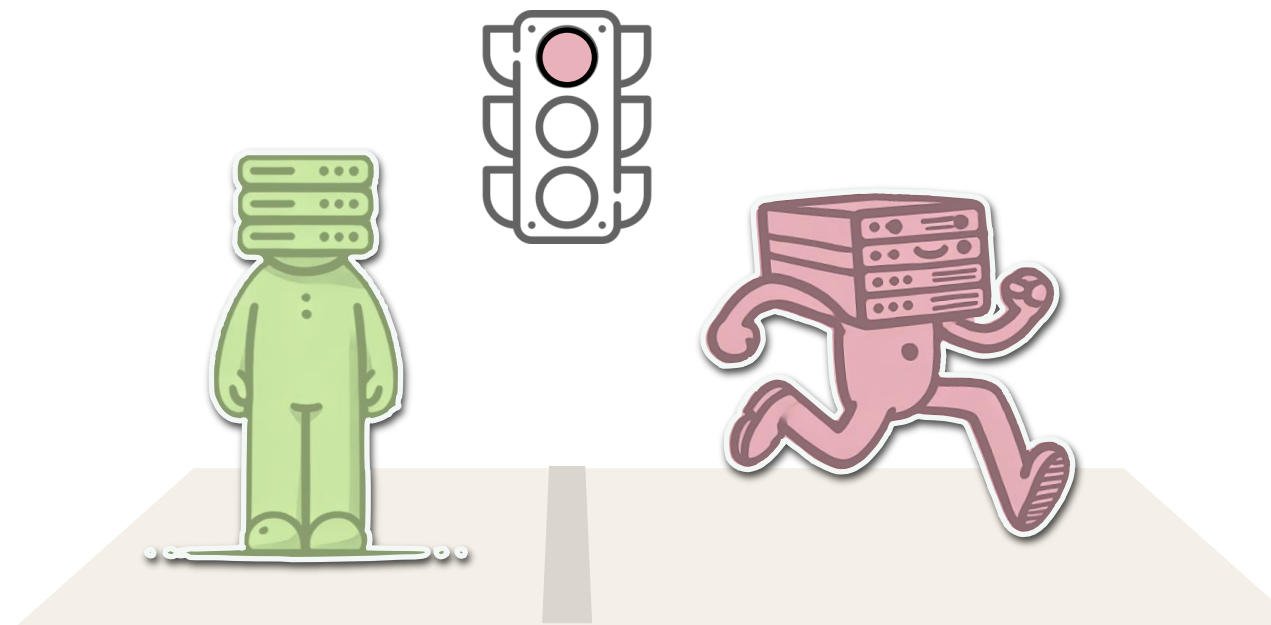Icon from Flaticon by smashingstocks

Use Digital Twin to measure effects of sustainability flag.

All green history → Digital Twin → CO_2, walltime

Real job history

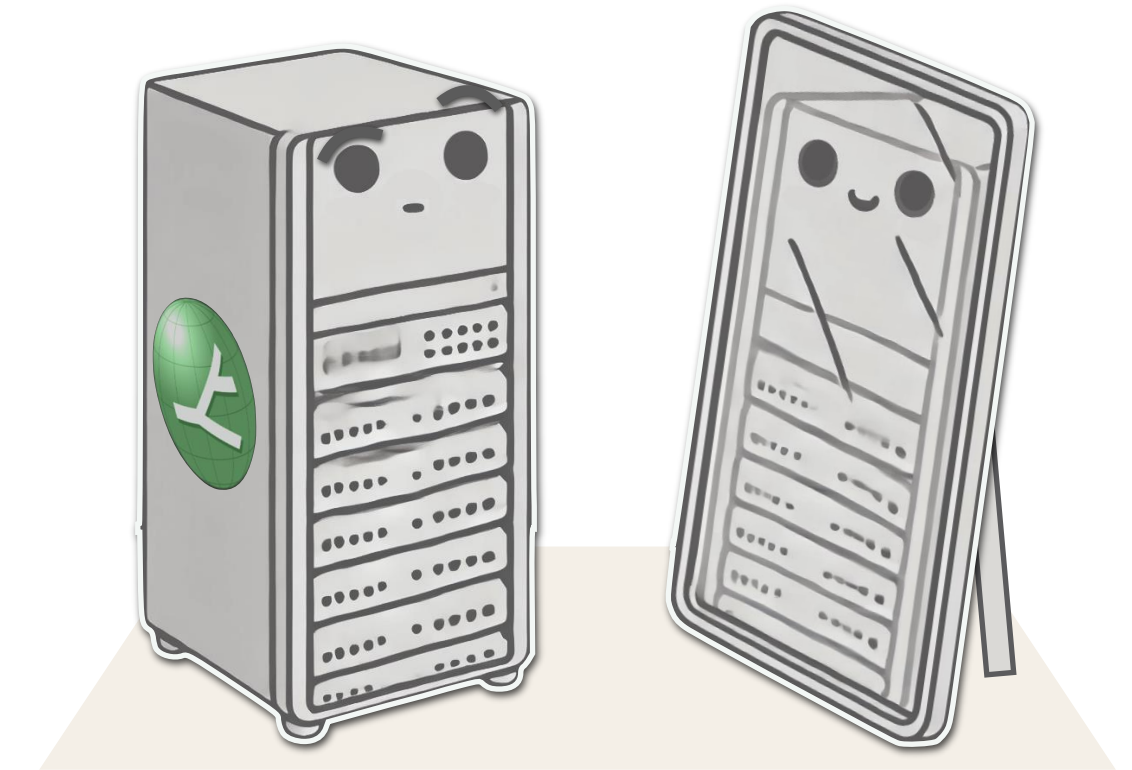All red history → Digital Twin

CO_2, walltime
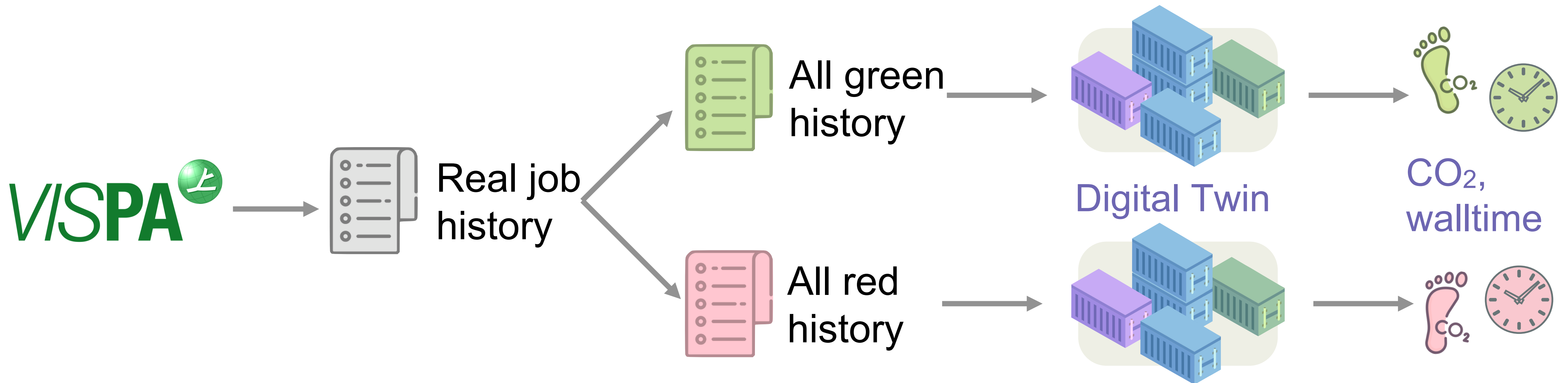
Informing Users

- Approximate energy consumption per job

- Added labeling of jobs

Shifting Jobs

- Use traffic light forecast

- Automatically shift jobs (if wanted by user)

Digital Twin

- Rebuild cluster in container

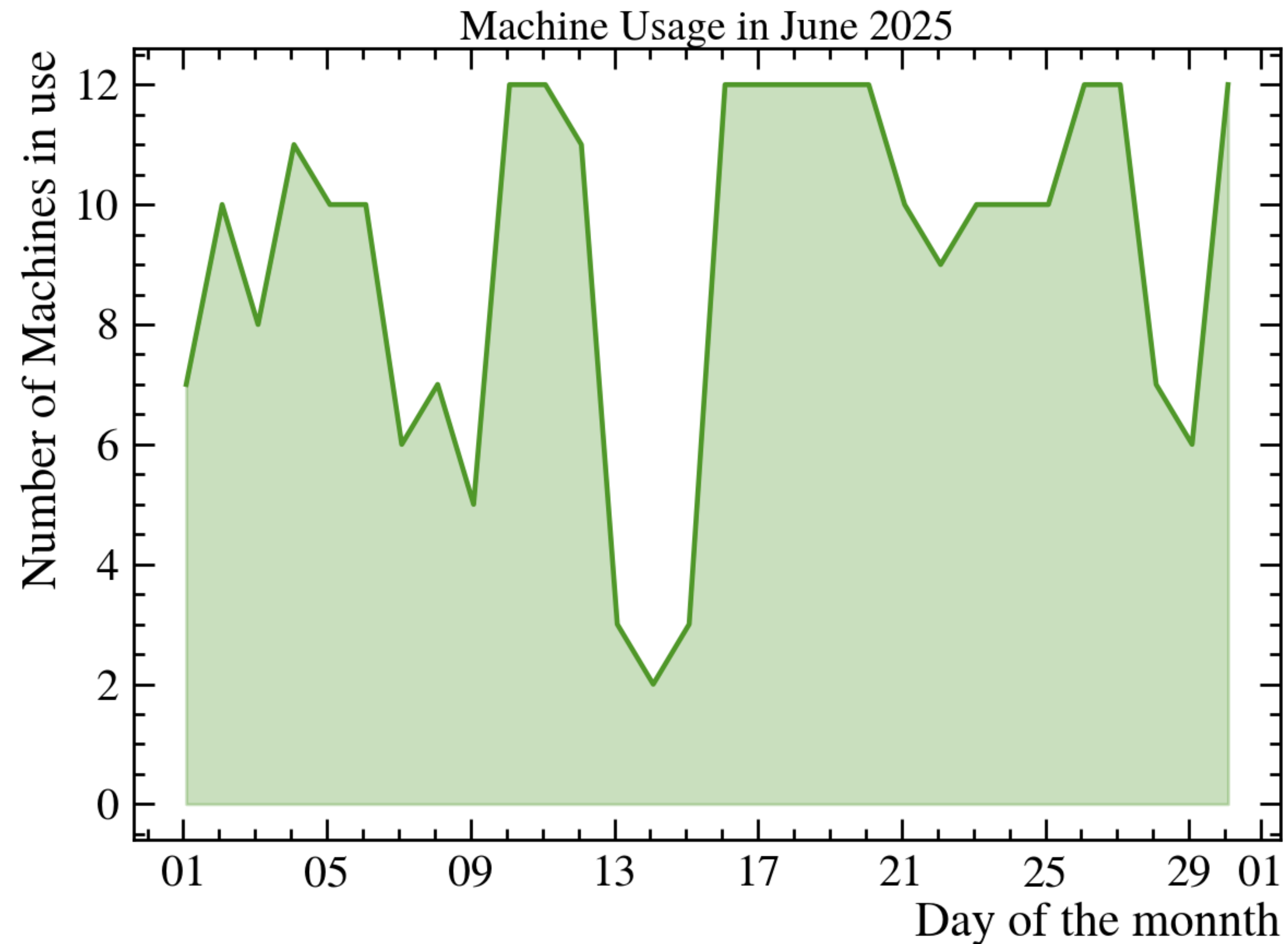- Can be used for developing and simulating

https://git.rwth-aachen.de/3pia/vispa/sustainability

VISPA

Physics Institute III A

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Backup

Usage of the VISPA Cluster

Machine Usage in June 2025

Advantages of our Digital Twin

Testing

✓ Development environment

✓ Breaking is allowed

✓ Seamless deployment from twin to VISPA

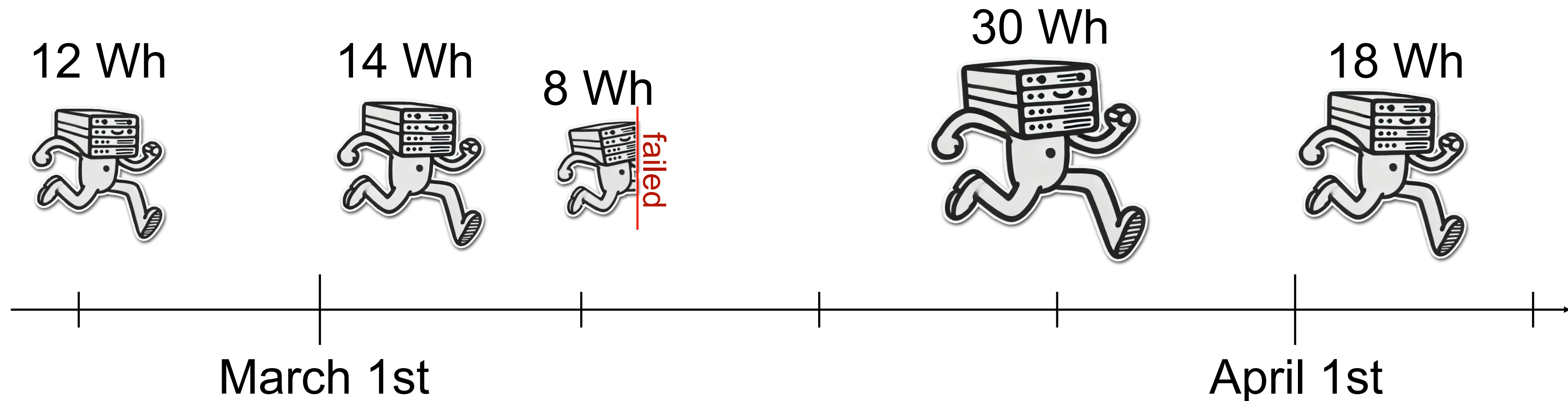## Simulation

✓ Can run real jobs = Can be used as simulation

✓ no need to simulate HTCondor logic

✓ Still, simulation faster than real-time is possible

✓ Highly adjustable for other clusters

More insights
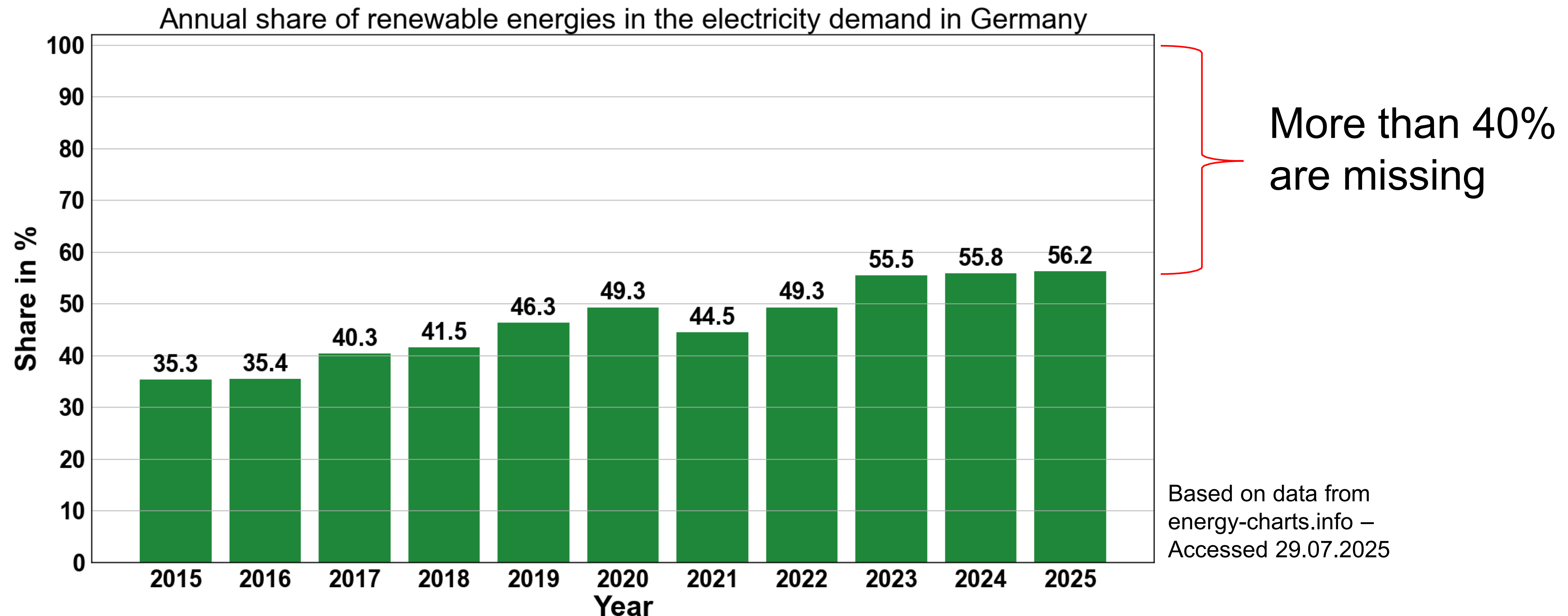
Job specific energy consumption

Power consumption leads to CO$_2$eq emissions.

Annual share of renewable energies in the electricity demand in Germany

More than 40% are missing

Based on data from energy-charts.info – Accessed 29.07.2025

Power consumption of VISPA in June 2025:   ~ 1 800 kWh   →   ~ 400kg of emitted CO$_2$eq

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Calculation of CO_2eq

Energy Source	Biopower	Solar Energy	Geothermal Energy	Hydropower	Wind Energy	Nuclear Energy	Natural Gas	Oil	Coal
gCO$_2$/kWh	18	46	45	4	12	16	469	840	1001

Koeffizienten aus IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation

Calculation of CO$_2$eq