Investigating the Flexibility of Data Centres for the Research Infrastructures of Tomorrow

(The RF2.0 Project at DESY)

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SC4RC - 05/05/2026

RF2.0 RESEARCH FACILITY
TOWARDS A MORE ENERGY-EFFICIENT AND SUSTAINABLE PATH

DESY

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at DESY.

- EU-funded project tasked with investigating how large research infrastructures can be more sustainable.
- At DESY we focus on what this means for current and future operation (and construction) of green data-centres.

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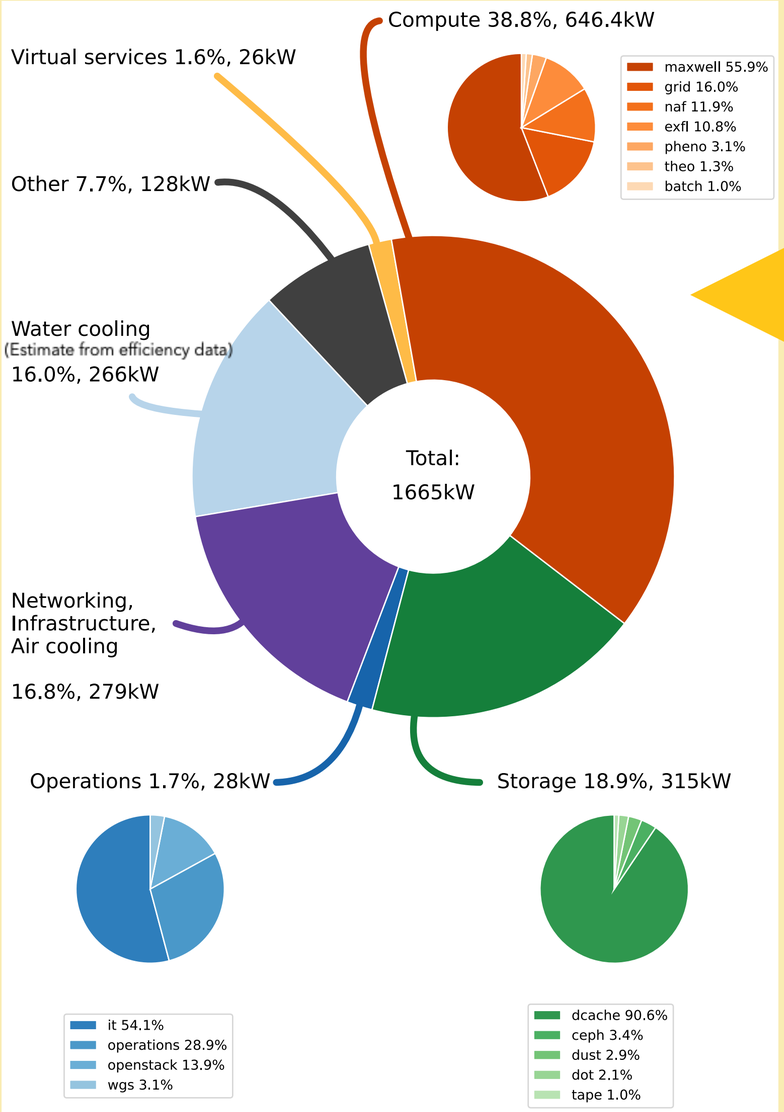

Median Power Consumption of the DESY Data-Centre

1. Learn

Take detailed and fine-grained measurements of data-centre components

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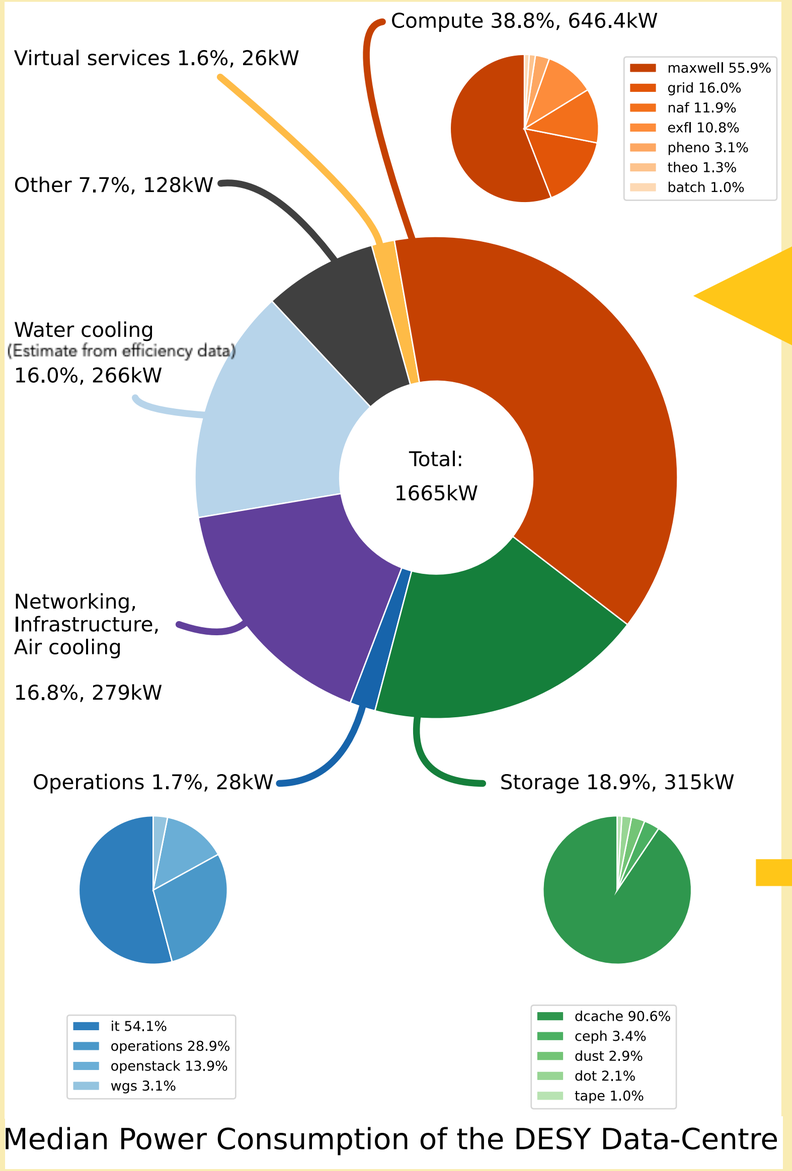

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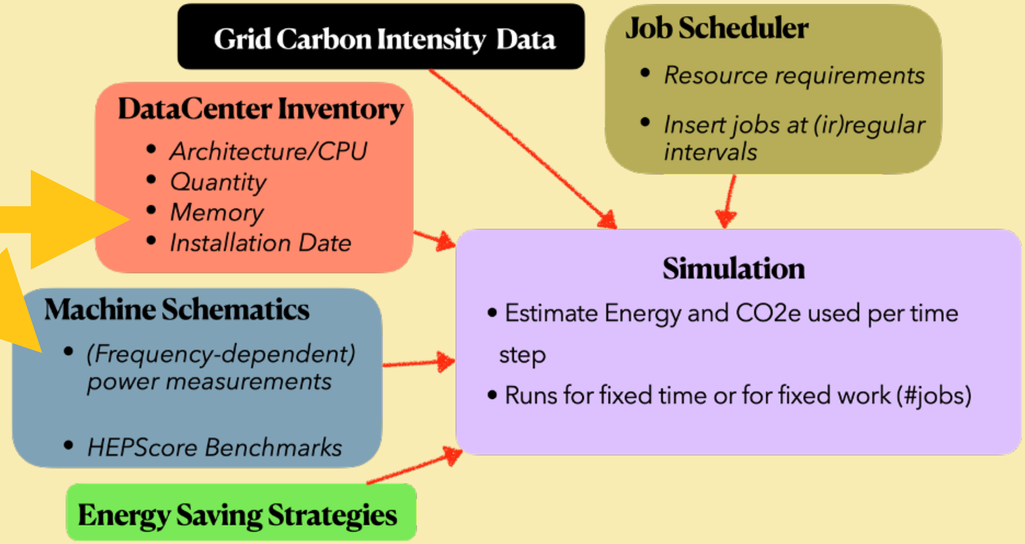
Test different energy-saving strategies/policies in a simulation of the data-centre



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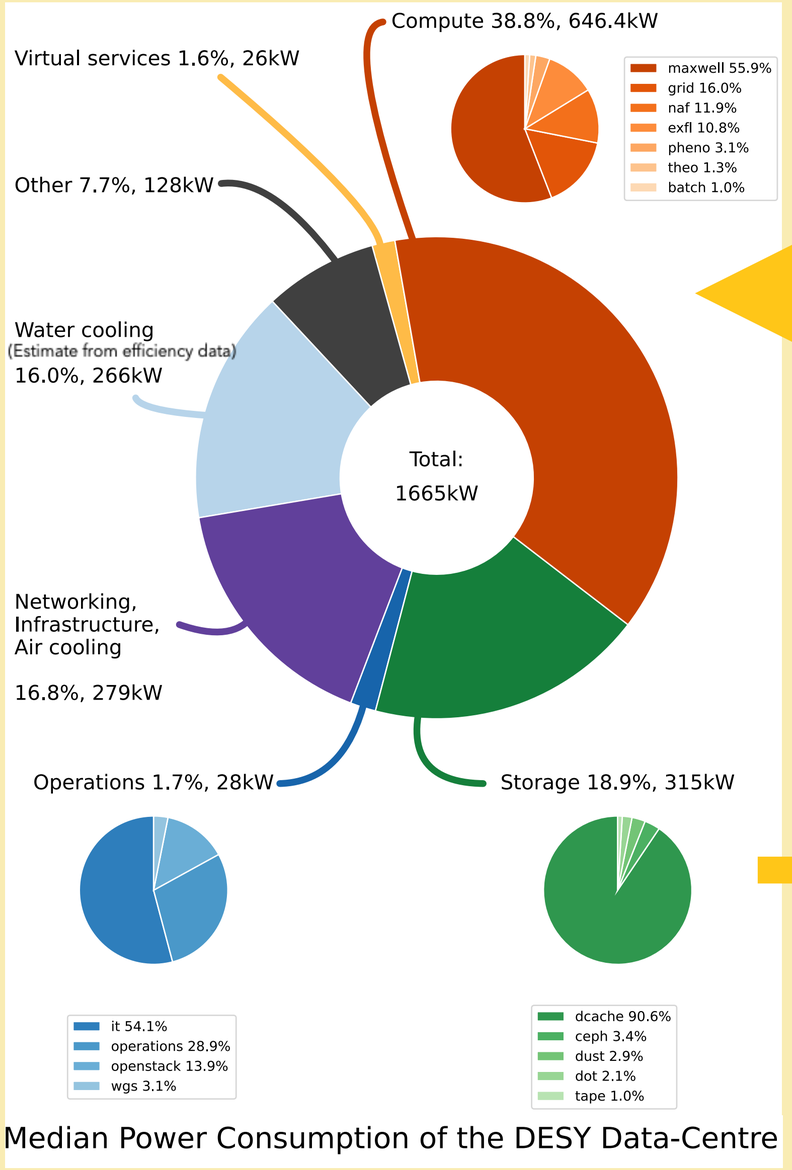

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Take detailed and fine-grained measurements of data-centre components

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Take simulation findings and dynamically implement them at the datacenter

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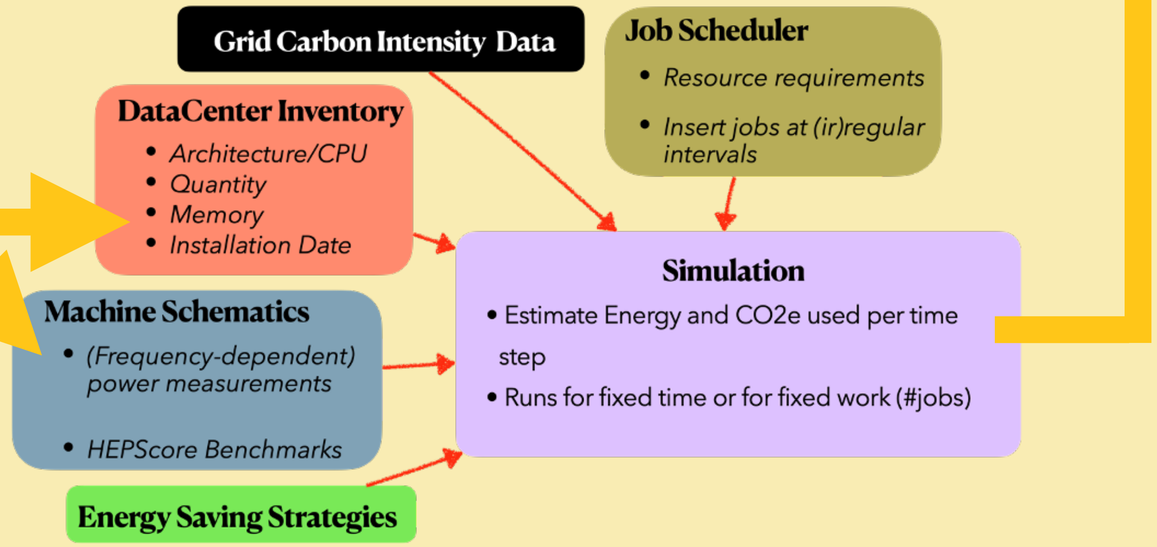

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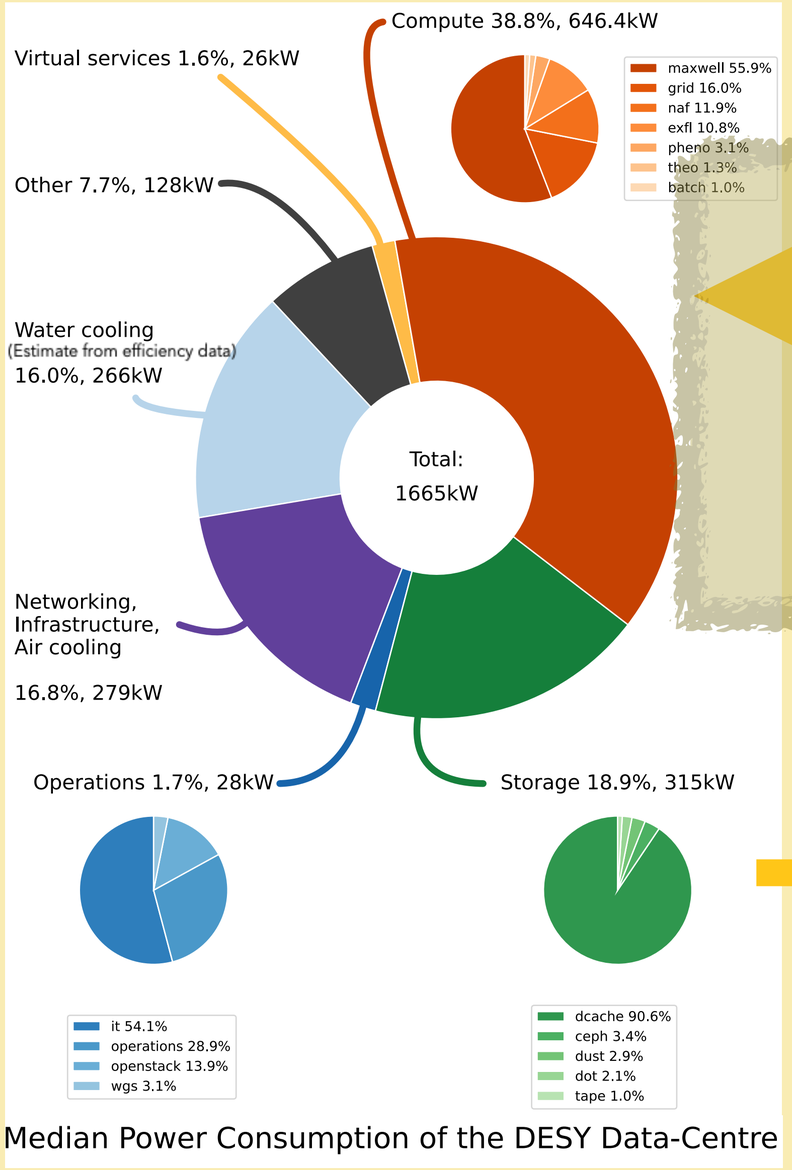

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Grid Carbon Intensity Data

DataCenter Inventory
- *Architecture/CPU*
- *Quantity*
- *Memory*
- *Installation Date*

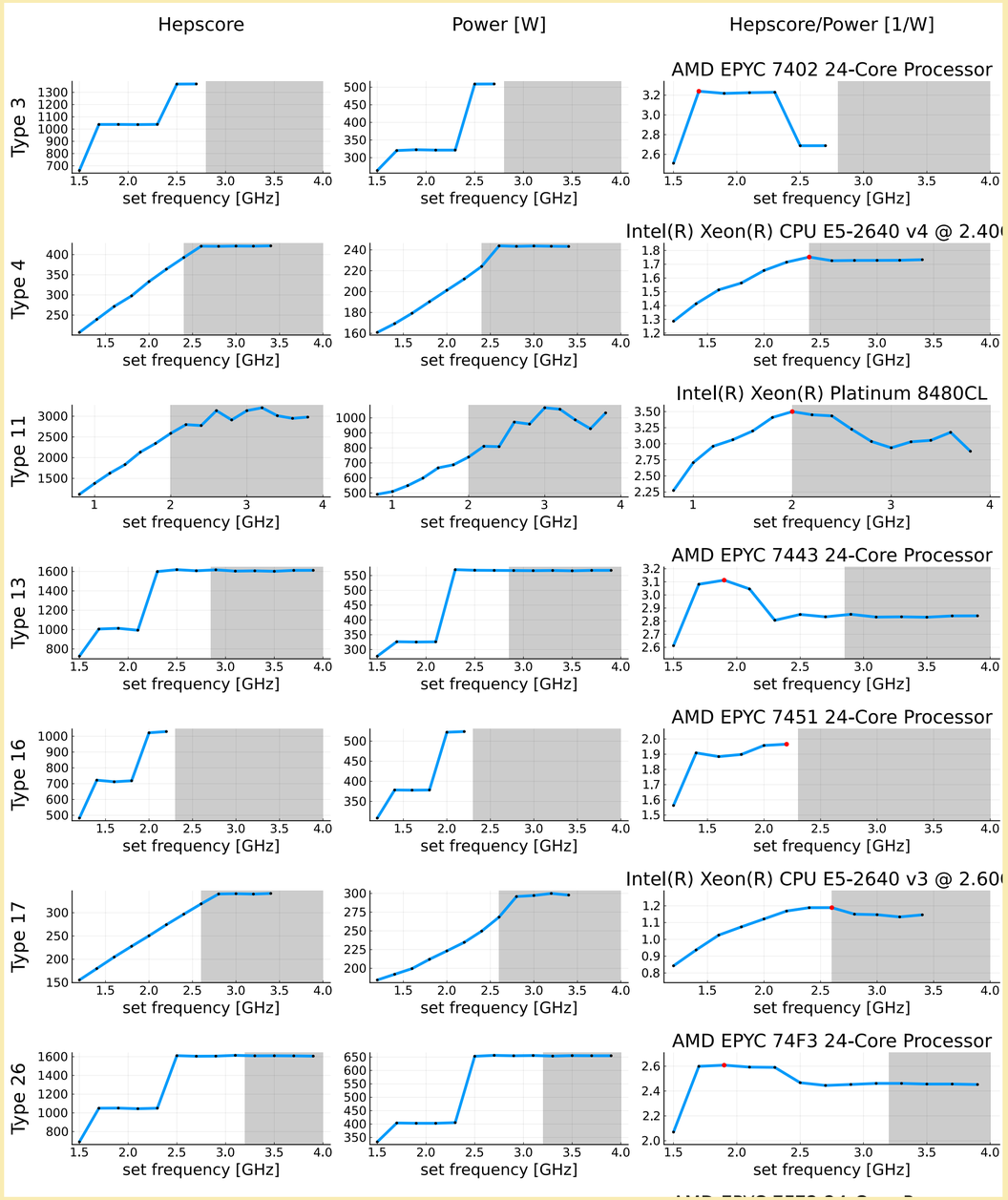
Job Scheduler
- *Resource requirements*
- *Insert jobs at (ir)regular intervals*

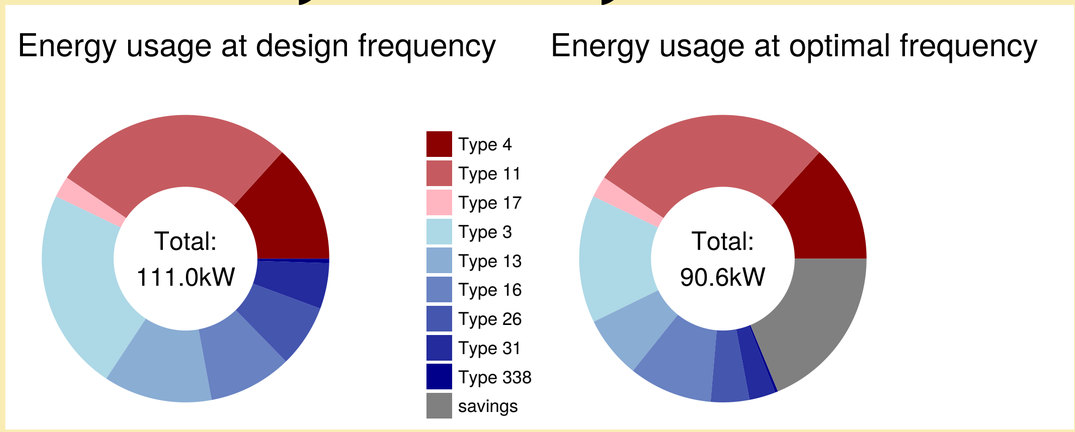
Machine Schematics
- *(Frequency-dependent) power measurements*
- *HEPScore Benchmarks*

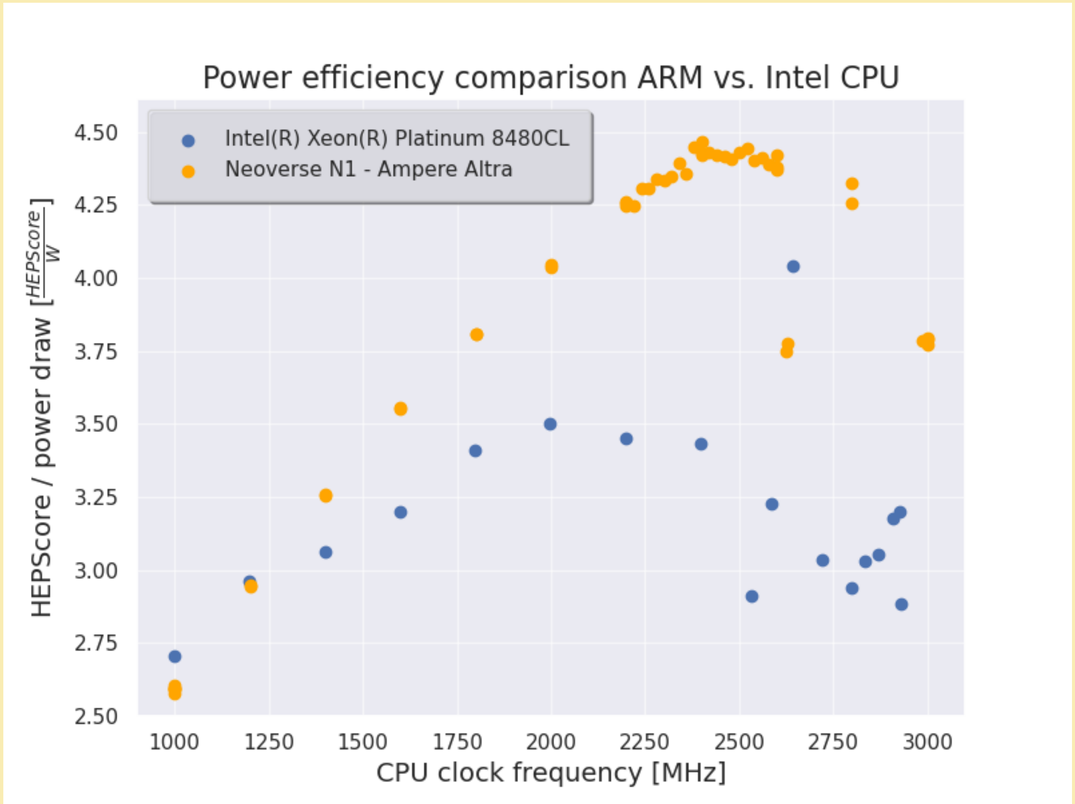
Simulation
- Estimate Energy and CO2e used per time step
- Runs for fixed time or for fixed work (#jobs)

Energy Saving Strategies

Data-Centre Data Summary Analysis







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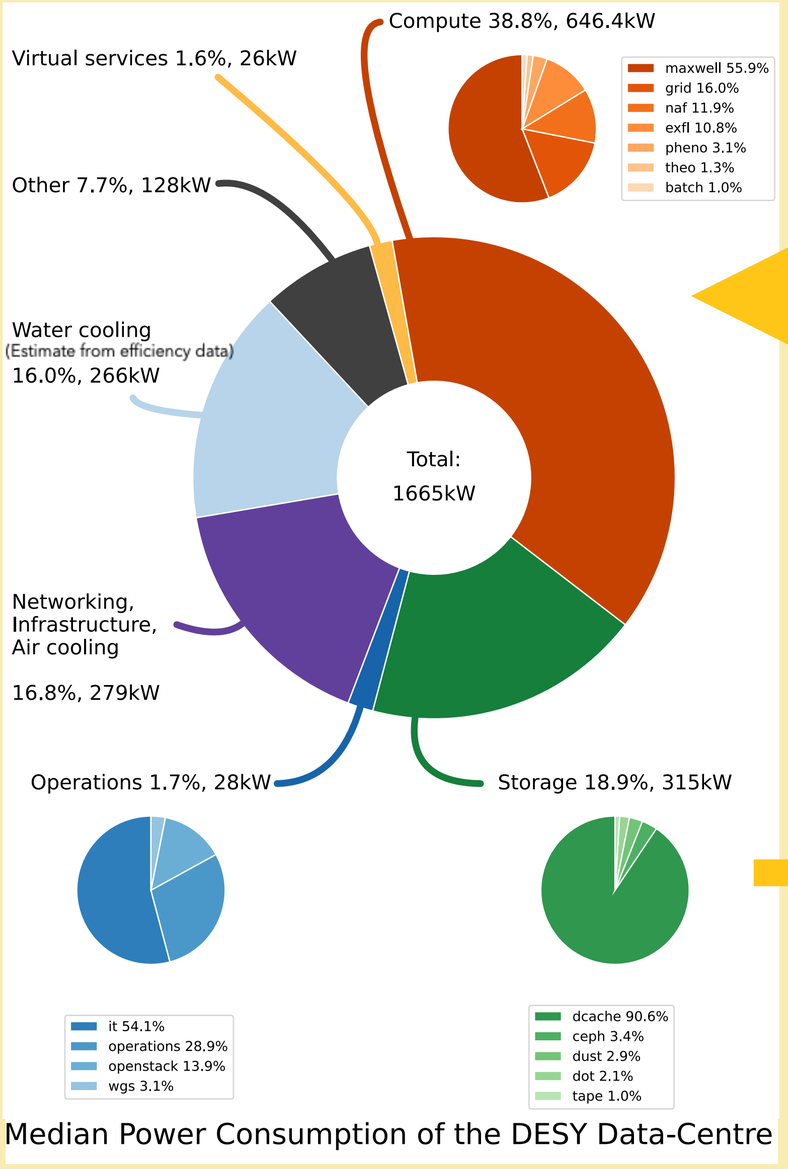

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3. Refine

Take what we learn and apply it

- Ultimate goal is to have the data centre be more flexible on demand.
    - Consume electricity when green energy is available, do not consume electricity when green energy is sparse
    - Try to run on the most effective frequencies

- Different clusters serve different communities, and each have their own needs, and therefore their own demands - no one size fits all solution.

POCCET - Proof of Concept Cluster for Emissions Tracking

We installed:
- 17 Dell PowerEdge R430 Machines in two racks
- 2 Ampere Altra (ARM based machines)
- 2 Power metering capable smart PDUs installed, reporting to Graphite, visualized in Grafana

- These PDU's have the ability to switch each port individually, and allow for more accurate energy/power draw measurements

- The hosts have been configured to be part of a separate VLAN, to not interfere with the rest of the data centre

- A basic HTCondor setup is provisioned via puppet, consisting of central manager, access point and execution points

A mini data centre to test the future of flexible computing

RF2.0

KIT Karlsruhe Institute of Technology

ALBA

CERN

DESY.

HZB Helmholtz Zentrum Berlin

MAX IV

COMMTIA

Zaphiro

Cryoelectra

ELYTT ENERGY

For further information and to follow our project progress visit www.rf20.eu

and our Social Media accounts: RF2.0 Project @rf20_project

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101131850 and from the Swiss State Secretariat for Education, Research and Innovation (SERI).

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Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
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Dynamic control of POCCET

External inputs

- **Simulation Feedback**
- Power Grid Info (price, RE availability, demand curves)
- Manual Inputs/ Strategies (“save x%, cancel shortest job runtime first”)
- Time based-rules (Save x% between 11:00-15:00)

Decision Tool - “Comptroller”

Internal Input (States)

- Machine Inventory + HEPScore/ Watt(Frequency)
- Energy Use
- Machine States
  - Host is up/down
  - Host is running at x Frequency
- Job States
  - Jobs Running since ...
  - Jobs Running until ...

Decision Tool

➡ **Power available to consume?**

- boot instances
- set more aggressive cpu governor

➡ **Do we need to scale down?**

- shutdown lowest HS/W first
- try not to lose running compute jobs

Actions

- /instances/batchYYYY
  - Set governor “powersave”
- /instances/batchZZZZ
  - shutdown
- /instances/controller
  - Boot “batchWWWW”

Monitoring

Post state and resource consumption of servers

Instances/controller-agents

batchXXXX-agent

Send Actions to be performed on servers

Run actions on servers and update machine states

How to build and test this Comptroller?

Work “Backwards”

- Create scripts that can automatically change the states of machines.
- Test various capabilities individually
- Evaluate effectiveness using monitoring