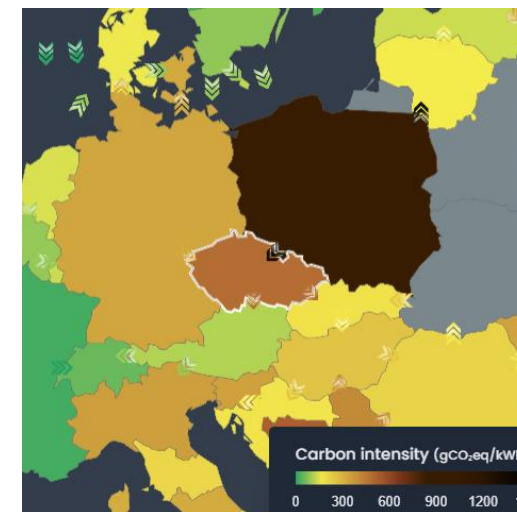
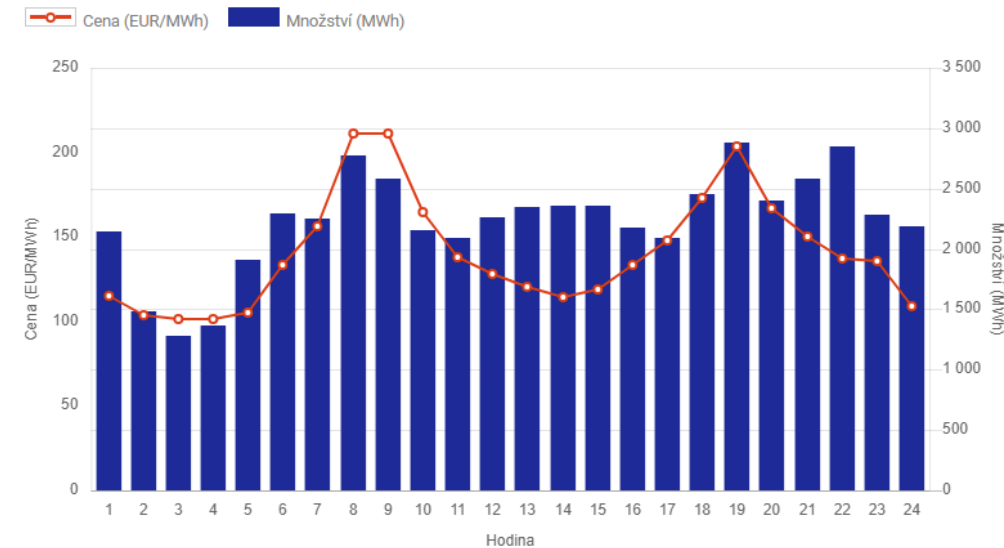


# Power-grid aware computing – motivation

- Flexibility = ability to manage consumption
  - One of the solutions to the energy and climate challenge [\[Teardown\]](#)
  - Smart grid, resilience [\[IEEE SMART GRID\]](#)
  - Flexibility = an asset, value [\[Google\]](#)
- Scheduling and matchmaking
  - Matching workload with resources
  - Adding power „attributes“ to the system
- Control consumption based on
  - Electricity cost, power-grid regulation needs
  - Current carbon intensity of regional electricity
  - Reused heat demand

Výsledky denního trhu ČR - 27.10.2022

Source: [OTE denní trh](#)



[electricitymaps.com](#)

# Power-grid aware computing

- Technical

- New resource attribute green rank available for scheduling
- Reading power/carbon usage, metrics, enhance accounting
- Controlling power consumption
- Handle the lags and other irregularities in batch system, computing workflow, timeouts, etc.

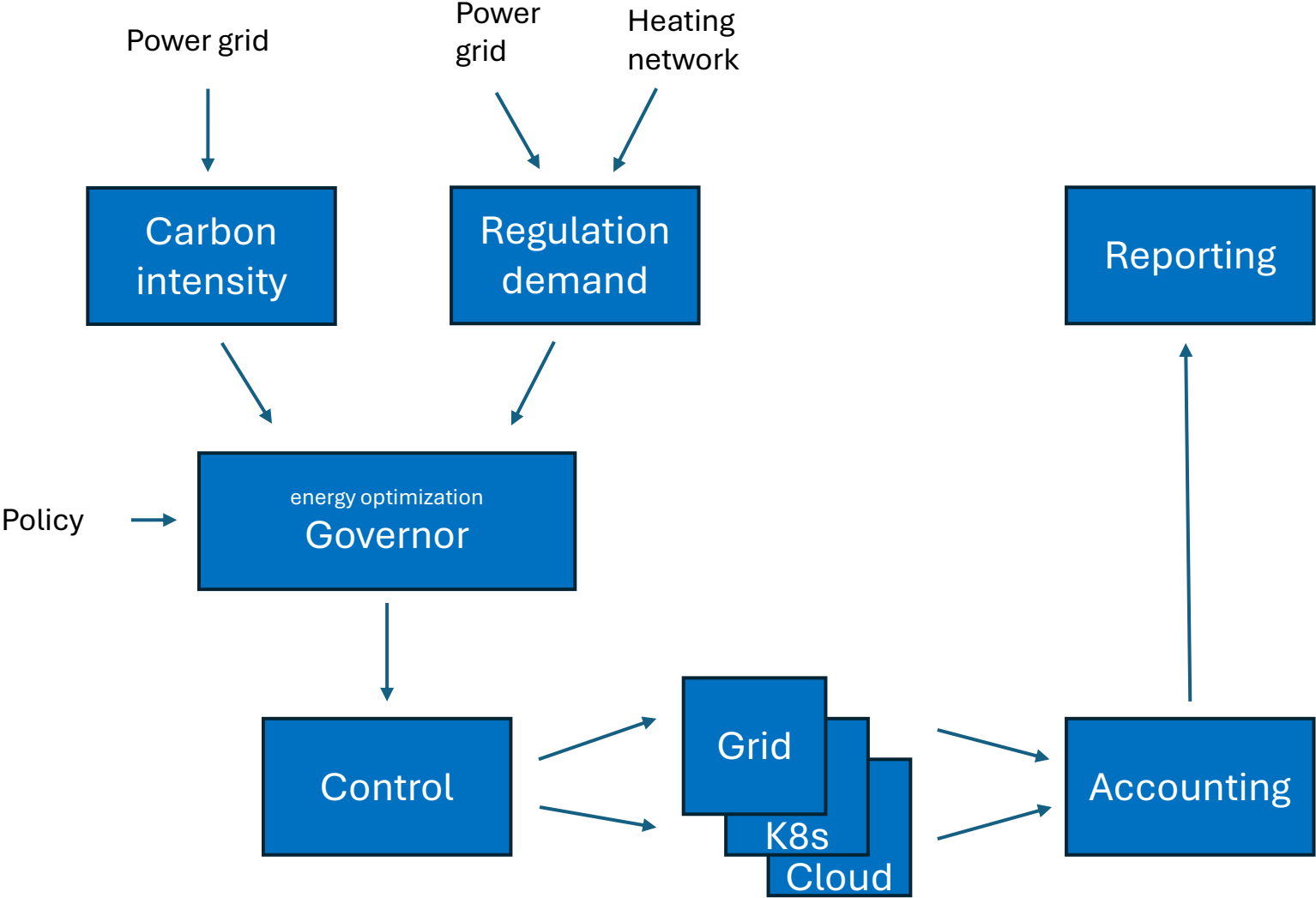
- Non-technical

- Handle user's perspective – worse service, longer wait – shared responsibility model
- Power regulation works well on fully loaded machines (batch workloads, interactive and cloud workloads can be tricky)
- Policy definition as input – priorities consistent with energy and sustainability policy – example: balance lowering carbon impact vs efficient HW usage

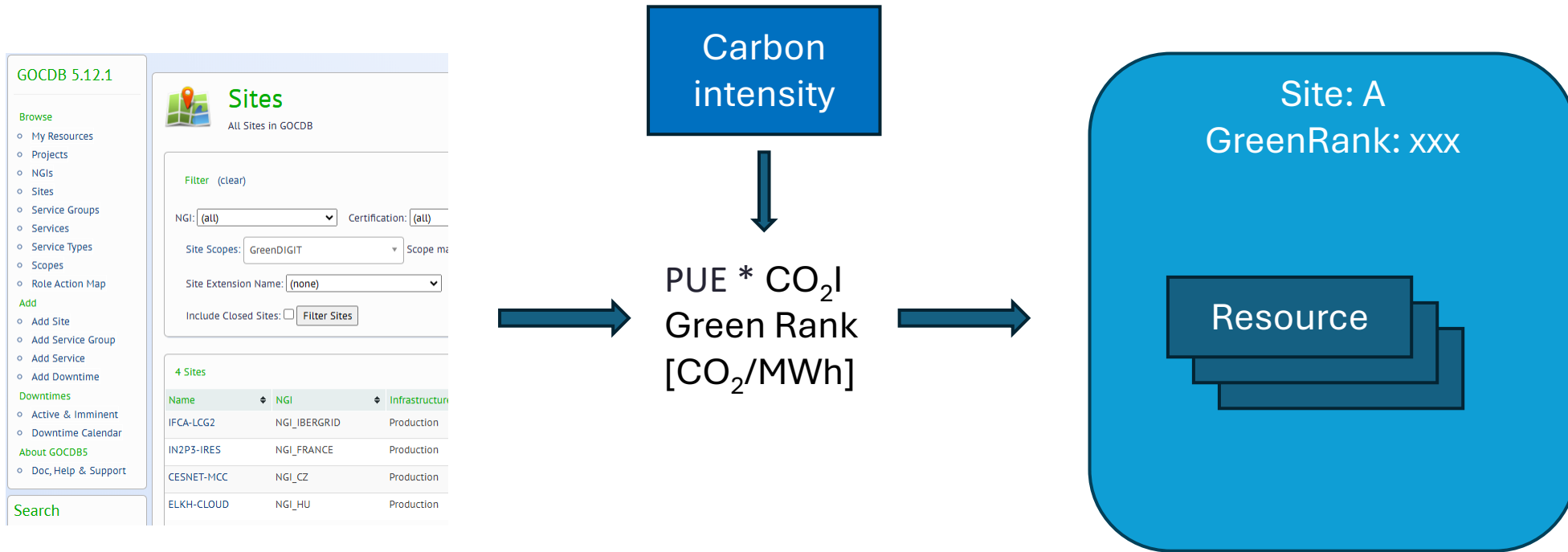
# Power-grid aware computing – advanced

- Resuffle jobs based on its type (CPU bound or I/O bound)
  - The scheduler can plan different job types to control the consumption
  - No job wall time extension seen, no lower efficiency of HW usage
- How to identify type of jobs
  - User will describe the job, annotated workflows
  - Simple heuristic based on executable name
  - Train AI/ML – collect accounting data containing the power measurements and job description as the annotated learning set

# Draft of generic architecture



# Green rank attribute in EGI



- GreenRank for each site
  - How frequently updated? From once a year to each minute.
  - Which technology to use in case of frequent updates?
- Specific green attribute for individual resources?
  - SPECpower [SPECpower committee]

# Summary of challenges

Challenge	Solution
Heterogeneity – RI are distributed with many owners, policies, goals, power sources, advancements	Federations (EGI), working with reference scenarios, site policy definition as input
Real flexibility monetization can be far away (electricity contracts)	Provide carbon footprint reporting to address the corporate sustainability goals. Provide roadmap of possible outcomes (resilience, flexibility, efficiency)
User's perspective – worse service, longer wait	Shared responsibility model, job resuffling

# References

- Reading power/carbon usage, metrics
  - AI4EOSC – make users aware of AI carbon/environment impact
    - Power reading for Open Stack (Scaphandre), metrics [presentation](#)
  - IT4I power metrics system meric <https://code.it4i.cz/vys0053/meric>
- Controlling power consumption
  - IT4I CPU frequency cap [presentation](#)
  - Feasibility study controlling power consumption
    - CERIT-SC FR-CESNET Green computing in Academic Datacenter technical report

# Related work

- Powering down nodes
  - [Slurm power saving guide, scripts and experiences by dtu.dk](#)
- Dynamic power management
  - SLURM (power capping parameters, freq control?)
  - [EAR](#) Energy Aware Runtime (freq control)