Net-zero and DiRAC

DiRAC Science Day 2023

Slot donated by Lenovo

Alastair Basden

Net-zero

- HPC has a problem
  - Significant and growing electricity consumption
  - Associated CO2 emissions
  - Significant embodied (manufacture) CO2
- What are we doing?
- What more can we do?

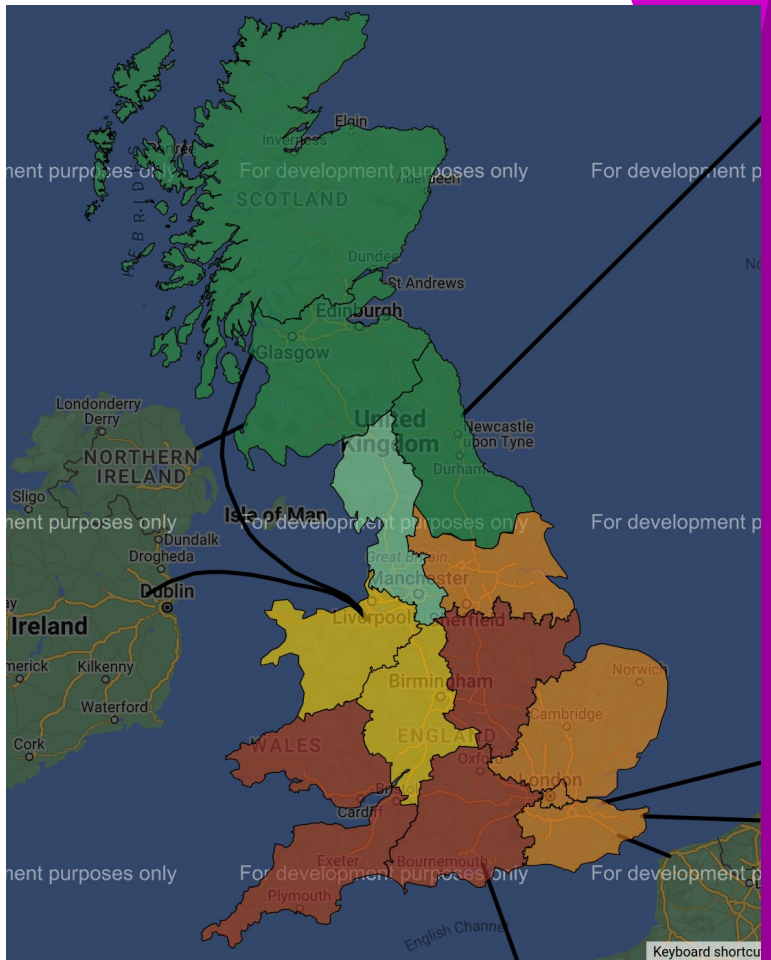
Embodied CO_2

- Accurate numbers are hard
  - Many manufacturers provide data
  - A lot of guess work
    - Changes with time
- Typically 1200-1800kg CO_2 per CPU server

Science production CO2

- Directly related to power consumption
- Depends on Carbon Intensity
  - We should really only consider the national value
  - Now:
    - NE ~30 gCO2/kW·hr
    - GB ~220 gCO2/kW·hr
  - Last year:
    - NE 15 gCO2/kW·hr
    - GB 155 gCO2/kW·hr
- Typical COSMA8 server ~600W
  - 5000kW·hr/year
  - 800kg CO2/year (using national value)
  - 1.5-2 years operation for embodied==production
    - 15-20 years using the NE value!
- As the grid greens, we need to run servers for longer
  - Until manufacturing countries catch up
    - Probably good practice anyway (scarce resources)
- NB: Impact of flights!

carbonintensity.org.uk



Transport and decommissioning

- Ignorable to first order

Awareness

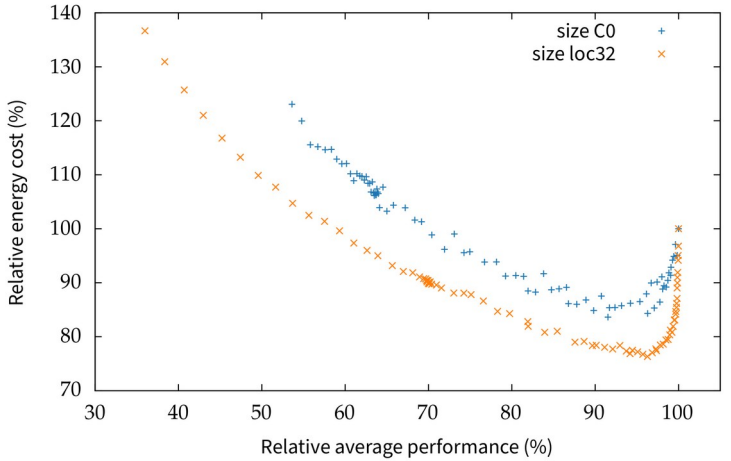
- User awareness can help
  - Brute force vs intelligent parameter searches
  - Selection of code
  - Efficiency of codes
- Within DiRAC, quarterly emails
  - kW·hr, estimated CO2, equivalence
- Admin awareness
  - Monitoring, consolidation

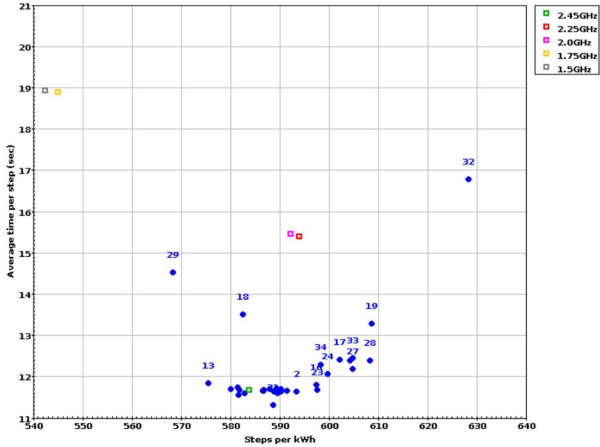
Resource utilisation

- Key to keep this high
  - Idle systems use 25-50% electricity
- DiRAC regularly reviews usage
  - Quarterly emails to underusing PIs
- Study of past usage statistics
  - Reallocation of resources
- Idle power-off? Lifetime considerations

Energy efficient compute

- GPU frequency study
- CPU BIOS settings study
- Bespoke system design
  - Fewer wasted resources
- Green500 systems





Energy efficient cooling

- Early Direct Liquid Cooling adoption
- Investigation into Immersion cooling
- Mandated data centre PUE <1.2
  - Free-air coolers

Waste heat reuse

- In the planning at some sites
  - Primarily for building heating
  - Expensive
  - Time consuming
    - Why did we not start this 10 years ago?
  - Seek to maximise output temperature
- What about the other 6 months?
  - Underground heat storage

Energy efficient storage

- Tape archival
  - Looking to increase this
- Some SSD capacity
  - Future systems will contain more
  - (HDD ~10W, SSD ~6W)

Solar panels

- ~£1m deployment at Durham from DiRAC Federation money
  - To demonstrate feasibility of coupling DRI with net-zero
  - Lessons learned: 6 month timescales are very challenging - longer-term funding required
  - Requires a lot of good will from Estates
  - Good to have a pre-prepared plan

Collaboration

- NERC CEDA Net-Zero DRI project
- Carbon Aware scheduling workshop

Conclusions

- DiRAC have made some steps
  - Hopefully more than lip service!
- There is more to be done
  - Tip of the iceberg
- Key things will be user awareness, code efficiencies, longevity of services