IRISCAST: IRIS Carbon Audit Snapshot

J. Hays – IRIS Science Director
IRISCAST Project PI

IRIS Collaboration Meeting
12th January 2023
IRIS-CAST – The Carbon costing for computing Audit Snapshot

Good robust decisions need good robust information

IRISCAST is a 6 month project funded within the UKRI Net Zero Scoping Project

UKRI Net Zero Digital Research Infrastructure Scoping Project

https://net-zero-dri.ceda.ac.uk/
Martin Juckes, Charlotte Pascoe, Ag Stephens, Poppy Townsend, Katie Cartmell, Jen Bulpett

(Slide extracts from Martin Juckes)
Net-Zero Scoping Project

Project Ambition

- Collect **evidence to inform** UKRI Digital Research Infrastructure (DRI) Investment decisions
- Provide UKRI and their community with an **outline roadmap for achieving** carbon neutrality in their DRI by 2040 or sooner
- Enable UKRI to play a **positive and leading role** in the national and global transition to a sustainable economy

(Slide extracts from Martin Juckes)
Net-Zero Scoping Project

Partners

The core team is supported by partners from 20 institutions, bringing a huge range of experience.

(Slide extracts from Martin Juckes)
Net-Zero Scoping Project

The UKRI Net Zero DRI Scoping project contains 9 consortium projects (right) and has funded 7 additional projects (left) through a sandpit event. These projects will investigate a broad range of technical and social issues related to the Net Zero target.

Machines and Workflows

People and Process

(Slide extracts from Martin Juckes)
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Challenges/questions

- Estimating the carbon costs for scientific computing across a broad heterogeneous landscape
- Identifying the key drivers
- Identifying the hurdles and barriers
- Communicating the costs to drive change
- Working coherently across different communities

Actions and Objectives

- Work together coherently across different facilities with different remits, tooling, and capabilities.
- Learn by doing!
- Document the gaps, the barriers and the issues, drive requirements for future work and decision making
- Communicate across our communities and build a foundation for future action
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Project Team
Alison Packer (STFC)  
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Jon Hays (QMUL)  
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Dan Whitehouse (Imperial)  
Adrian Jackson (Edinburgh)  
Alastair Basden (Durham)  
Nic Walton (Cambridge)  
Alex Ogden (Cambridge)
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Facilities

QMUL GridPP Tier 2  STFC SCARF
Imperial GridPP Tier 2  DiRAC (Durham)
STFC SCD Cloud  Cambridge IRIS HPC/Cloud
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Good robust decisions need good robust information

- Inventory
- Data collection
- Analysis
- Community Engagement
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Good robust decisions need good robust information

Inventory
• Define the scope of the audit
• Build a comprehensive list of all equipment covered by the audit
• Needed to build carbon model including embodied costs
Good robust decisions need good robust information

Data Collection

• Collect data over a 24 hour period covering differing operating conditions
  • Rack, Node, and Job level logging
  • Store data in central repository
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Analysis

• Integrate the different datasets into coherent curated data set
• Refine carbon model
• Extract insights, observations, and conclusions
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Community Engagement
• Talk at CIUK
• Produce draft report
• Publish curated data set and definition of the carbon modelling
• Engage with our communities through an IRIS Workshop – 9th, 10th January in Cambridge
• IRIS Collaboration Meeting 13th January
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Good robust decisions need good robust information

Next steps...

- **Inventory**
  - Done

- **Data collection**
  - Done

- **Analysis**
  - In progress

- **Community Engagement**
  - In progress
Collate hardware information

Collate snapshot data

Data cleaned, harmonised and imported into OpenSearch

Provides visualisations, dashboards and an API

Do this for all sites/facilities/clusters

Anish Mudaraddy, Alison Packer, STFC
Carbon model

Carbon model aims

• Turn gathered energy data in climate impact
  • Carbon (equivalent) emitted

• Evaluate non-active carbon impact
  • Embodied (embedded, sunk cost, etc...)

• Evaluate the order-of-magnitude of different components
  • Facilities, cooling, people, hardware components, etc...

• Evaluate if we need to collect different/more data

Adrian Jackson, Edinburgh
Embodied Carbon

Varies considerably depending on node configuration...

Embodied carbon estimates

Adrian Jackson, Edinburgh
Embodied Carbon

- Estimate based on single node made up value:
  - 350 kgCO$_2$
  - 4 year life span
  - 0.24 kgCO$_2$ per day

- Estimate for a the snapshot resources
  - 2398 nodes
  - 575.25 kgCO$_2$

- Need a lot more work to make this accurate and trustwort
Active carbon (scope 2)

WARNING – initial back-of-envelope calculations – not yet properly verified!

Consider three energy supply carbon intensity scenarios: low, medium, high

<table>
<thead>
<tr>
<th>System</th>
<th>Cumulative energy used (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QMUL</td>
<td>1299.7 (118 compute nodes)</td>
</tr>
<tr>
<td>CAM</td>
<td>261.5 (59 compute nodes)</td>
</tr>
<tr>
<td>DUR</td>
<td>8699.9 (Cosma8 360 nodes (4175.3), Cosma7 452 nodes (3979.1), Storage (345.4))</td>
</tr>
<tr>
<td>STFC CLOUD</td>
<td>3903.2 (597 compute nodes (2624.3) + 103 storage nodes (1743.9) + 21 control nodes (62.2))</td>
</tr>
<tr>
<td>STFC SCARF</td>
<td>4271.3 (571 compute nodes (3288.6))</td>
</tr>
<tr>
<td>IMP</td>
<td>943.9 (117 compute nodes)</td>
</tr>
<tr>
<td>Total</td>
<td>19379.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System</th>
<th>Active Energy Carbon ($C_{AE}^p$) (kgCO2)</th>
<th>Mean Node Active Energy Carbon ($C_{AE}^n$) (kgCO2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QMUL</td>
<td>Low: 65 Medium: 227 High: 390</td>
<td>Low: 0.55 Medium: 1.92 High: 3.31</td>
</tr>
<tr>
<td>CAM</td>
<td>Low: 13 Medium: 46 High: 78</td>
<td>Low: 0.22 Medium: 0.78 High: 1.32</td>
</tr>
<tr>
<td>DUR</td>
<td>Low: 435 Medium: 1522 High: 2610</td>
<td>Low: 0.54 Medium: 1.87 High: 3.21</td>
</tr>
<tr>
<td>STFC CLOUD</td>
<td>Low: 195 Medium: 683 High: 1171</td>
<td>Low: 0.27 Medium: 0.95 High: 1.62</td>
</tr>
<tr>
<td>STFC SCARF</td>
<td>Low: 214 Medium: 747 High: 1281</td>
<td>Low: 0.37 Medium: 1.31 High: 2.24</td>
</tr>
<tr>
<td>IMP</td>
<td>Low: 47 Medium: 165 High: 283</td>
<td>Low: 0.4 Medium: 1.41 High: 2.42</td>
</tr>
</tbody>
</table>

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Active carbon (scope 2)

WARNING – initial back-of-envelope calculations – not yet properly verified!
Three PUE scenarios...

Active carbon estimate

<table>
<thead>
<tr>
<th>Metric</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Energy Carbon (kgCO2)</td>
<td>969</td>
<td>3391.4</td>
<td>5813.8</td>
</tr>
<tr>
<td>PUE Estimate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active Energy Carbon including Facilities (kgCO2)</td>
<td>1066</td>
<td>1260</td>
<td>1550</td>
</tr>
</tbody>
</table>

- Lowest low: 1066 kgCO2
- Highest high: 9302 kgCO2

Adrian Jackson, Edinburgh
Summary

- 24 hour period
  - Embodied carbon estimate:
    - 575 kgCO₂
  - Active carbon range:
    - 1066 – 9302 kgCO₂
- Active looks bigger, 2-10x bigger depending on the assumptions we make
- However, active will reduce as the energy mix gets cleaner
- Embodied has very wide error margins at the moment
- Other things look much lower impact (i.e. buildings)
- Comparator:
  - https://www.carbonindependent.org/22.html
  - Typical flight CO₂ emissions: 92 kgCO₂ per passenger per hour
  - Imaginary 24 hour flight for one person 2208 kgCO₂

Adrian Jackson, Edinburgh
Next steps

Complete the carbon analysis
Write the final report
Contribute to the NetZero Scoping Project Report

Carbon monitoring for IRIS?
IRIS Net-Zero policy development
Future collaboration with UKRI NetZero activities