Digital Sustainability Game Handbook

The Digital Sustainability Game Handbook

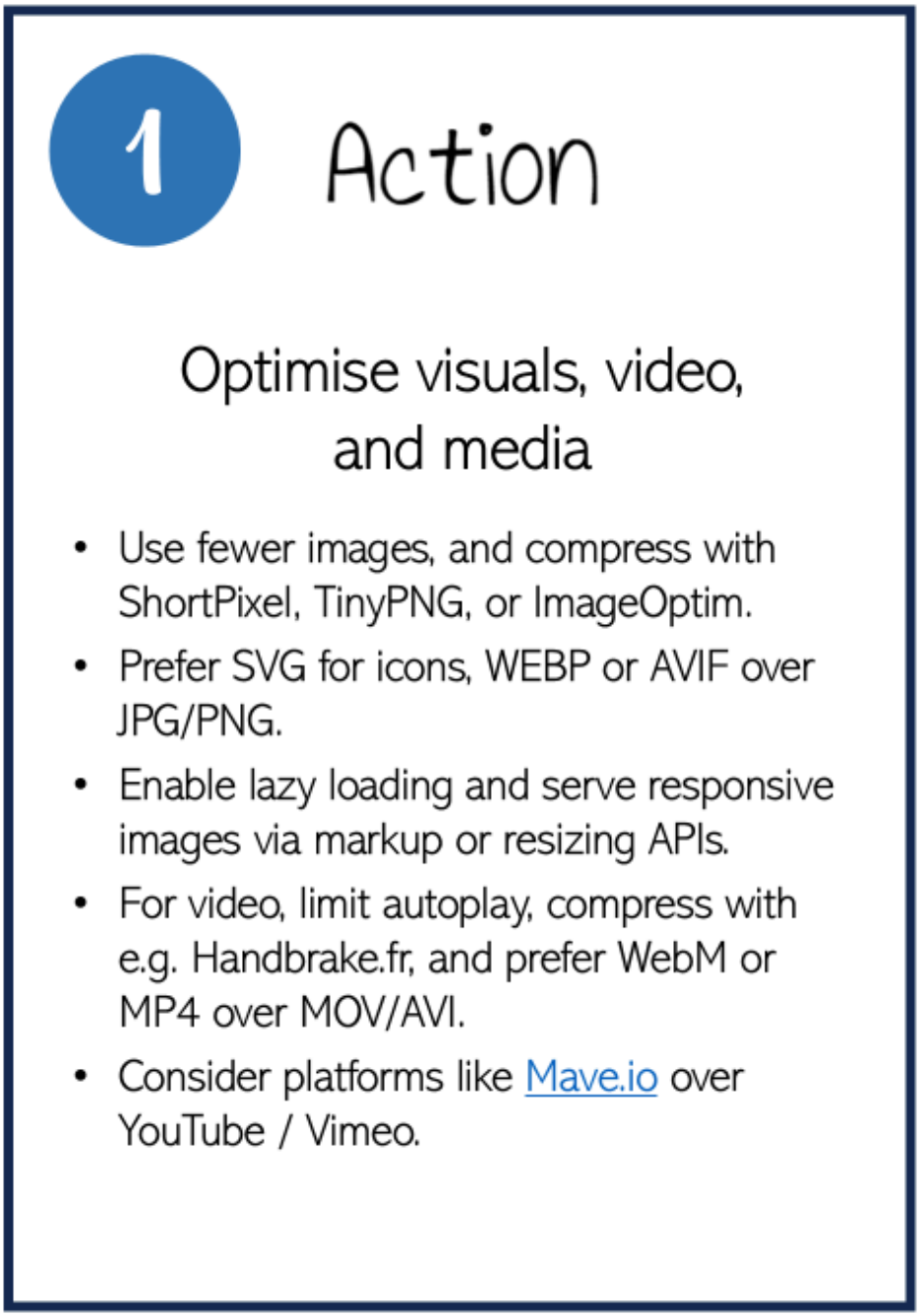
This is a **work in progress.** We very much appreciate your suggestions, especially of tools and case studies, that could help people understand and action the recommendations on the cards (or question them). **Feel free to add things directly into the document.** Some useful sources:

- DHCC Toolkit
- The Green Web Foundation
- The Green Software Foundation
- Web Sustainability Guidelines
- Cambridge / WholeGrain Digital Sustainable Design Guide

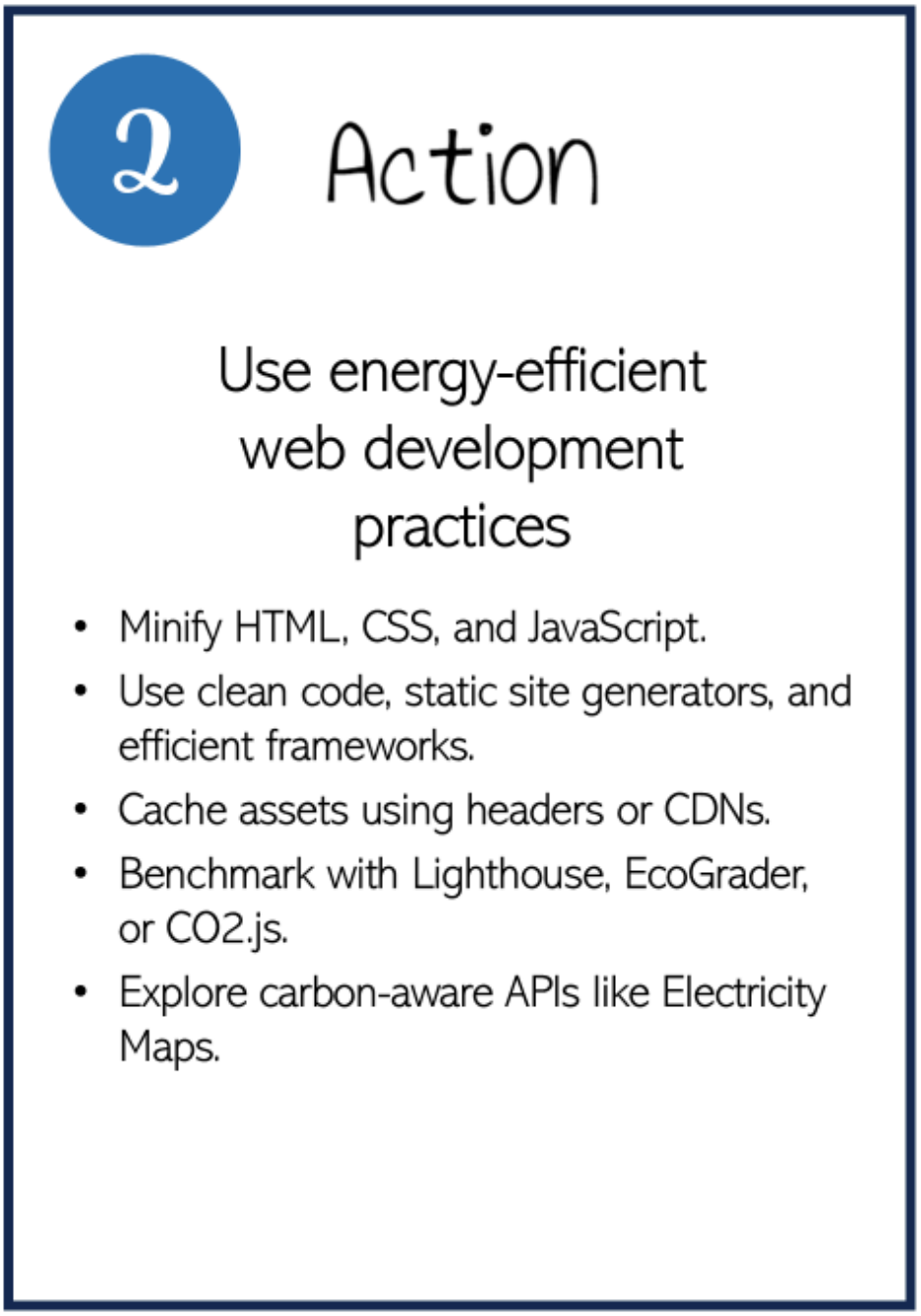
1. General version

30 action cards

{ id: 1, name: "1: Optimise visuals, video, and media" },
{ id: 2, name: "2: Use green web development practices" },
{ id: 3, name: "3: Streamline user journeys" },
{ id: 4, name: "4: Audit your digital dependencies" },
{ id: 5, name: "5: Build sustainability-focused CI/CD pipelines" },
{ id: 6, name: "6: Choose efficient tools, languages, and architectures" },
{ id: 7, name: "7: Use green practices to develop and deploy AI" }
{ id: 8, name: "8: Know which everyday activities are fine" },
{ id: 9, name: "9: Use efficient internet connections + optimise WiFi network" },
{ id: 10, name: "10: Build coalitions, not echo chambers" },
{ id: 11, name: "11: Don't store data we don't need" },
{ id: 12, name: "12: Use near-line and off-line storage" },
{ id: 13, name: "13: Benchmark our digital activities" },
{ id: 14, name: "14: Extend our devices' life spans" },
{ id: 15, name: "15: Use Life Cycle Analysis (LCA)" },
{ id: 16, name: "16: Advocate for right to repair" },
{ id: 17, name: "17: Improve our e-waste recycling" },
{ id: 18, name: "18: Design for humans, not angels" },
{ id: 19, name: "19: Check suppliers for greenwashing" },
{ id: 20, name: "20: Pivot to policy" },
{ id: 21, name: "21: Pivot to protest" },
{ id: 22, name: "22: Understand green energy procurement" },
{ id: 23, name: "23: Measure our carbon for AI and the cloud" },
{ id: 24, name: "24: Use grid-aware demand management" },
{ id: 25, name: "25: Know when not to use AI" },
{ id: 26, name: "26: Understand different kinds of AI" },
{ id: 27, name: "27: Align measurement to maturity" },
{ id: 28, name: "28: Get ready for more carbon tax" },
{ id: 29, name: "29: Understand our place in the energy transition" },
{ id: 30, name: "30: Update our procurement policies" },



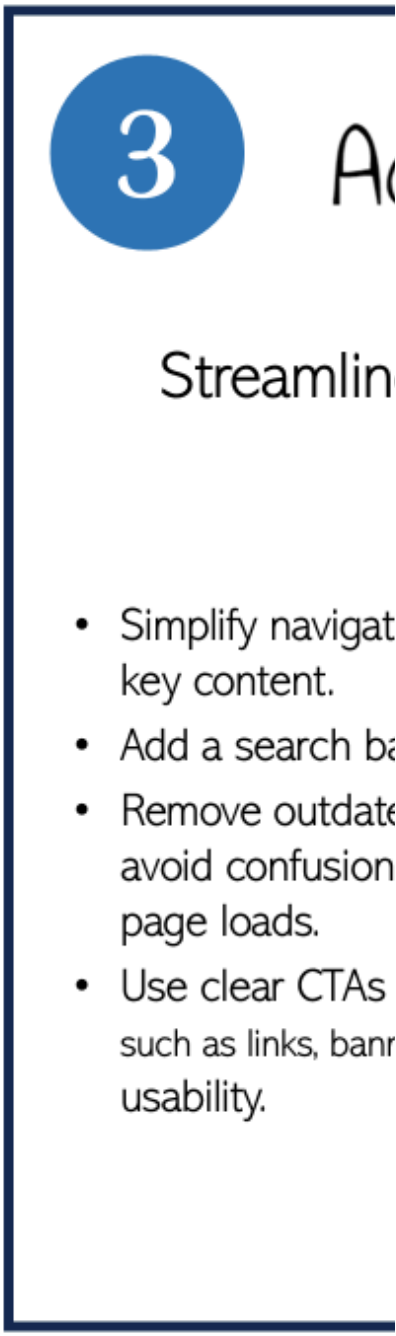
- **Optimising visuals, video** environmental impacts o When a user visits your w (usually "the cloud," in ot onto the user's laptop or that data. It also takes en server, so it's available at generally are much bigge start.
- **Using fewer images** on a that needs to be transfer the energy consumed by
- **Image compression** can c way that can't be perceiv eye. This makes images q bandwidth and storage, b one example of a tool tha download a compressed TinyPNG, ImageOptim or also will let you select the
- **Other tips:** *Responsive in* automatically adjust the screen they're being view screen), limiting data / en *depth of field*, *constraine* and *write good alt text*. C with Handbrake.fr, and av green video platforms—Y explore Mave.io. Prefer W depending on compressio



- Minifying website code files (like HTML, CSS, JavaScrit) means reducing their size which helps the website load faster, use less data and less energy. This is done by removing unnecessary characters ('whitespace' like spaces, tabs or blank lines, and line breaks) that help humans read the code but aren't needed by computers executing the code (so the functionality of the site is not affected). Explore plug-ins for common text editors (like Visual Studio Code, Sublime Text, or Atom) or browser-based tools like minifier.org and also Lighthouse: Minify JavaScript, Mozilla Minification and Minification Benchmarks

* Write efficient, well-structured code—avoid bloat and outdated libraries.
* Use static site generators or server-side rendering where appropriate.
* Optimise font loading, reduce animations, and streamline the DOM.
* Cache files using strong cache-control headers or via a Content Delivery Network.

* Benchmark using tools like Go
CO2.js from the Green * Web Fo
* Use APIs like Electricity Maps



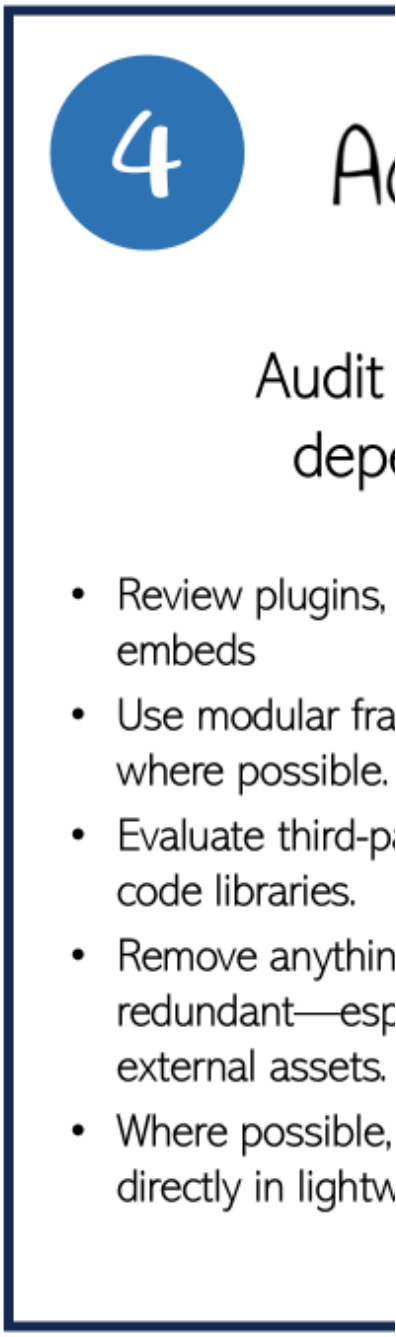
{ id: 3, name: "3: Streamline u

Card text
* Simplify navigation and reduce
* Add a search bar.
* Remove outdated content.
* Use clear CTAs and test usabil

More detail
* Reduce the number of steps users need to take to complete common actions.
* Delete unnecessary or outdated pages to avoid confusion and reduce load.
* Use consistent design conventions and strong visual hierarchy.
* Add a search function to help users skip navigation-heavy browsing.
* Highlight important actions with clear, accessible buttons.
* Run usability tests to identify confusing paths or inefficient layouts.

Clear CTAs - calls-to-action - provide for more streamlined user experiences which not only make websites more engaging, but also more efficient, preventing unnecessary page loads and thus reducing power consumption.

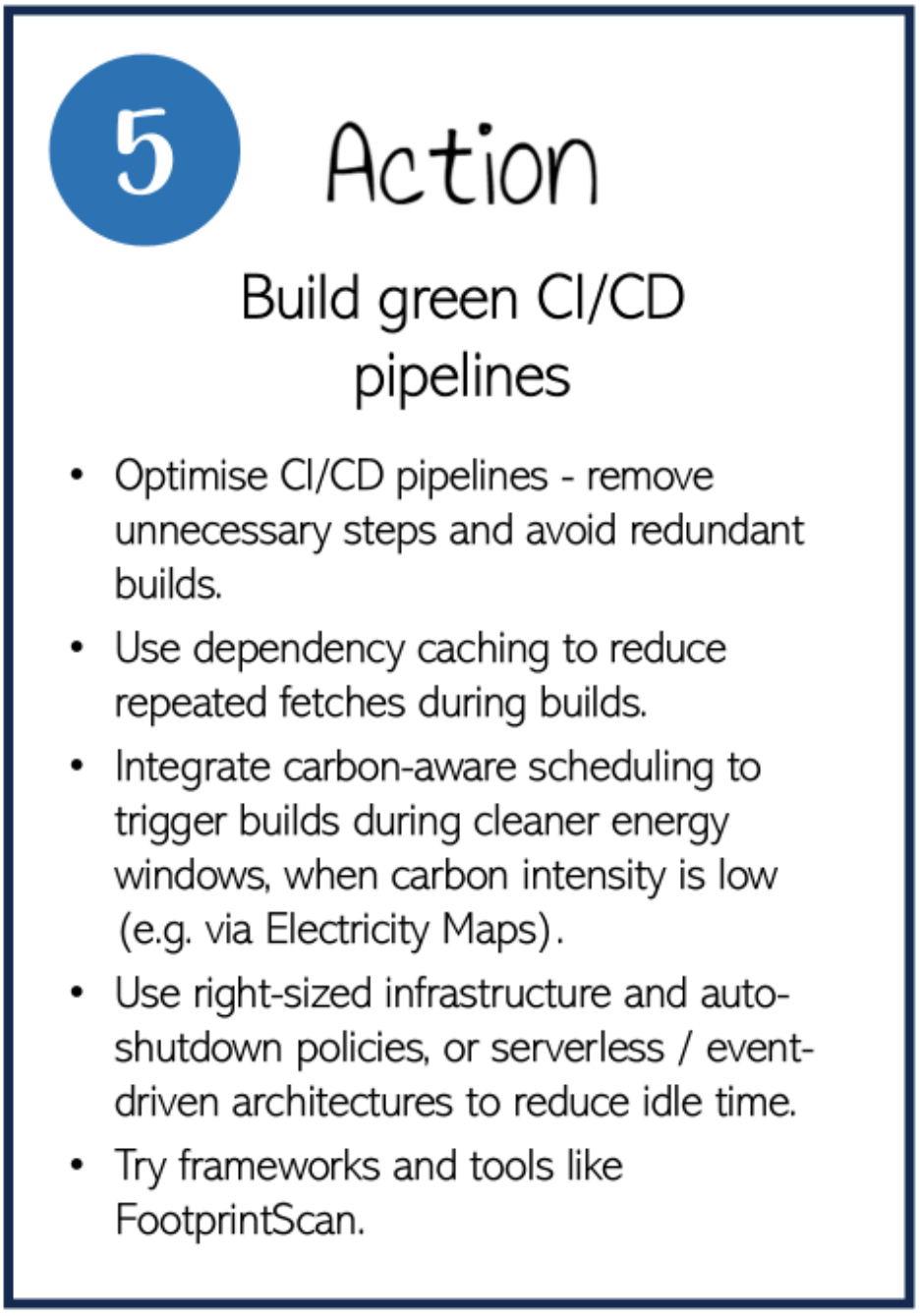
- A lot of advice is available on how to make CTAs engaging and effective, including https://supercooldesign.co.uk/blog/how-to-create-engaging-calls-to-action (e.g. where to place CTAs on a page)
- Reference to CTAs included on sustainable web design guides, e.g. https://www.ronins.co.uk/hub/sustainable-web-design/



{ id: 4, name: "4: Audit your d

Card text
* Review plugins, trackers, libra
* Remove or replace heavy tools
* Use modular frameworks or pl

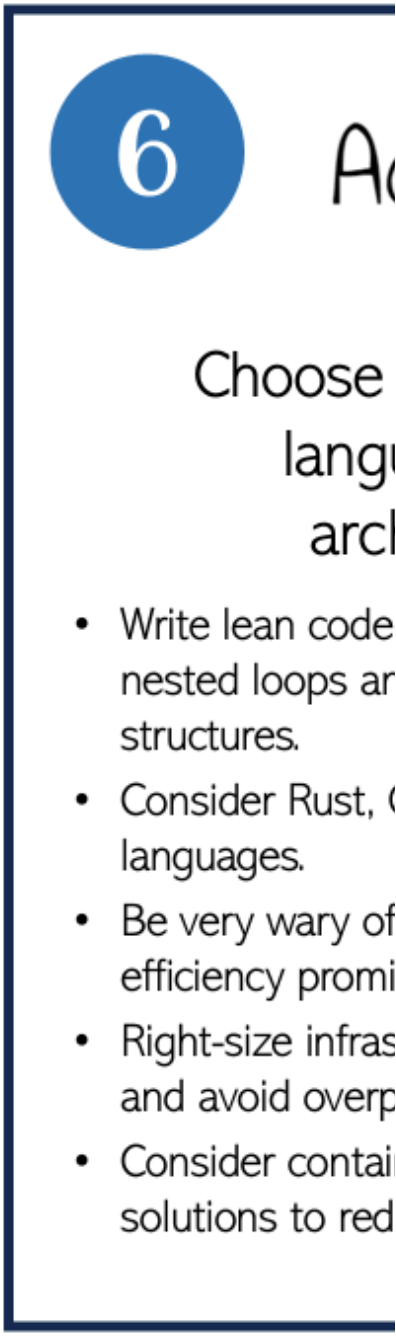
More detail
* Evaluate third-party plug-ins, t
* Remove anything unnecessary
external assets.
* Replace full frameworks (like
CSS utility classes.
* Where possible, implement fun
JavaScript.
* Audit embedded content (maps
remove as needed.



{ id: 5, name: "5: Build green CI/CD pipelines" }

Card text
* Eliminate redundant builds.
* Use dependency caching.
* Schedule builds when carbon intensity is low (e.g. via Electricity Maps).
* Use right-sized infrastructure and auto-shutdown policies.

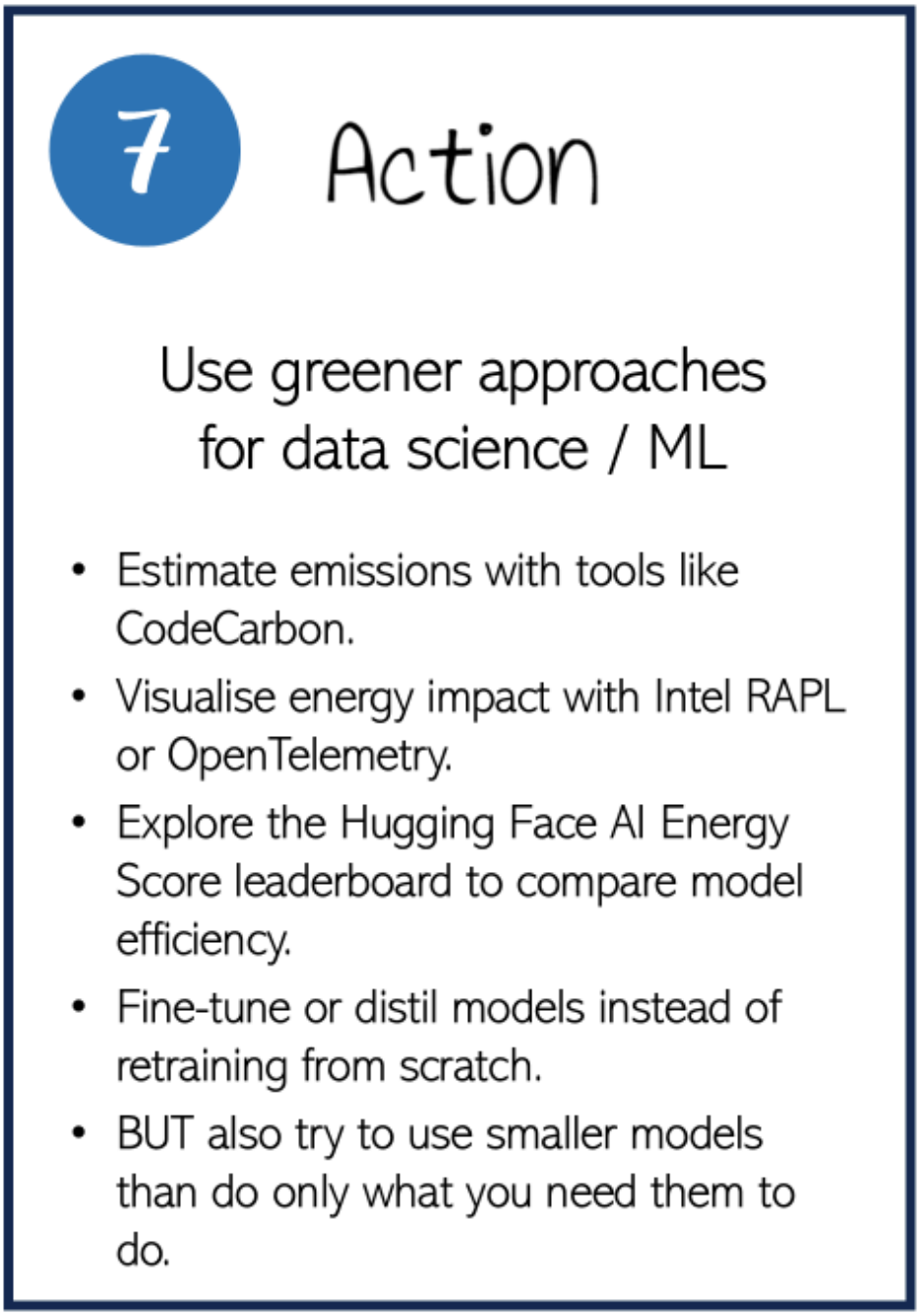
More detail
* Optimise CI/CD pipelines by removing unnecessary steps and avoiding redundant builds.
* Use dependency caching to reduce repeated fetches during builds.
* Integrate carbon-aware scheduling to trigger builds during cleaner energy windows.
* Apply GreenOps / SusDevOps principles / tools.
* Use green Infrastructure-as-Code to right-size compute resources and set auto-shutdown or scaling policies.
* Consider serverless or event-driven architectures to reduce idle time.
* Try frameworks and tools like



Card text
* Write lean code and avoid bloa
* Consider Rust, Go, or other gr
* Be very wary of AI-generated
* Avoid overprovisioning and us

More detail
* Use efficient algorithms and da
overhead.
* Avoid nested loops or bloated
* Choose energy-efficient langua
performance-critical tasks.
* Treat AI-generated code with c
default.

* Right-size infrastructure and avoid provisioning more resources than needed.
* Use containerisation, autoscaling, or serverless solutions to reduce idle resource use.

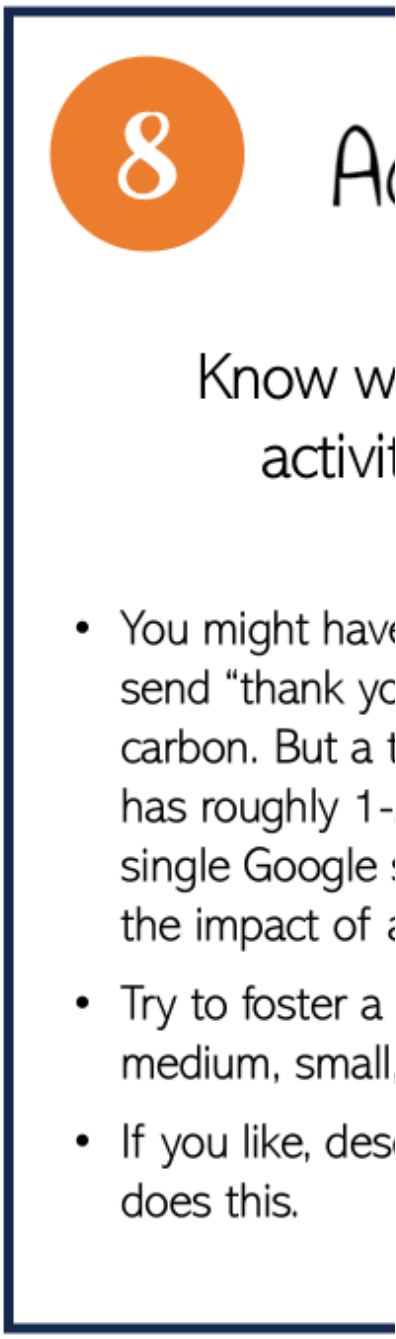


{ id: 7, name: "7: Use greener approaches for data science / ML" }

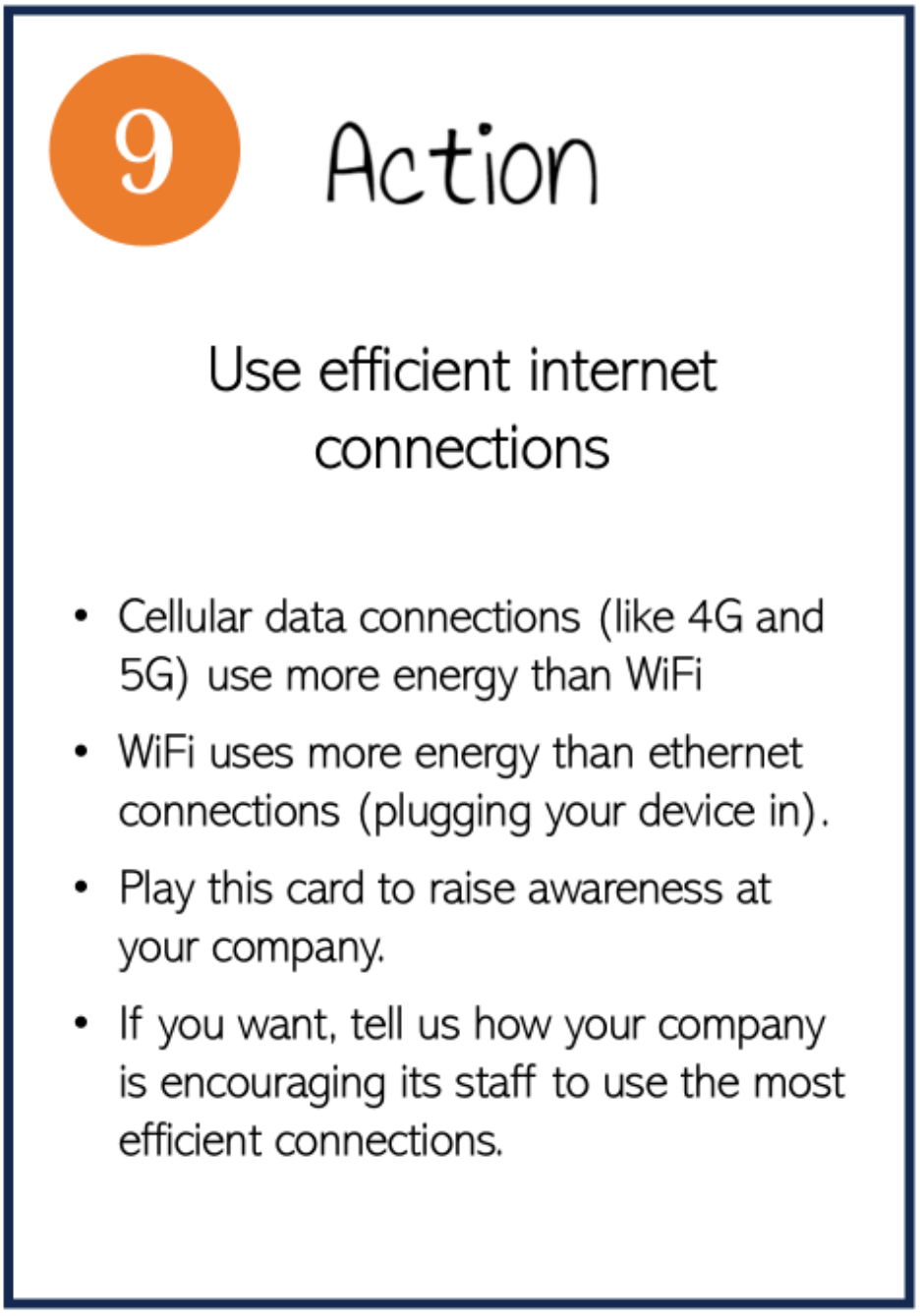
Card text
* Estimate emissions with CodeCarbon.
* Visualise impact with Intel RAPL or OpenTelemetry.
* Use AI Energy Score leaderboard.
* Fine-tune or distil models instead of retraining from scratch.
* BUT also try to use smaller models than do only what you need them to do.

More detail
* Use tools like CodeCarbon to track emissions from model training and inference.

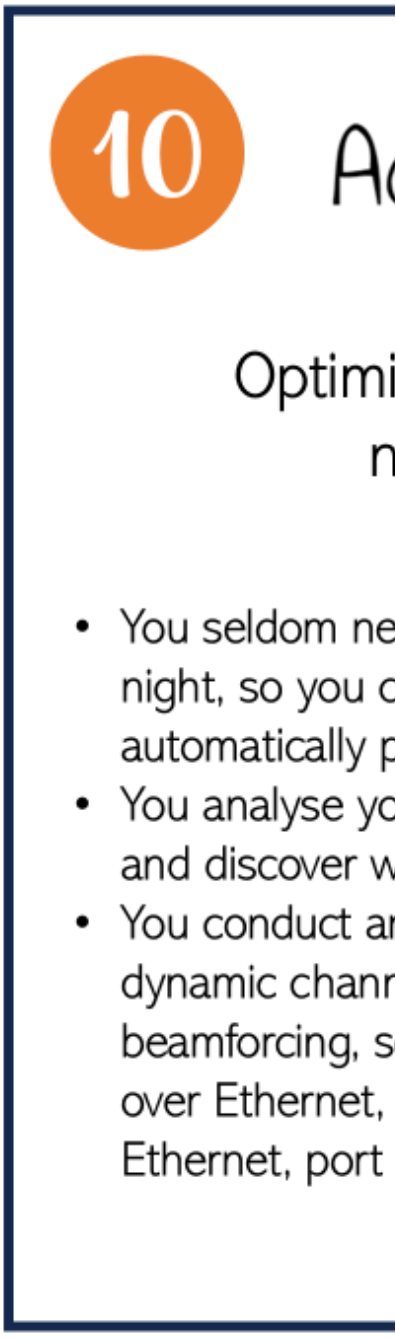
* Visualise service-level energy
RAPL.
* Explore the Hugging Face AI
model efficiency.
* Avoid unnecessary retraining—
* But there can be a trade-off he
more sustainable in the longer te
* Use model distillation to comp
efficient versions.
* Optimise training loops, limit
movement in ETL pipelines.



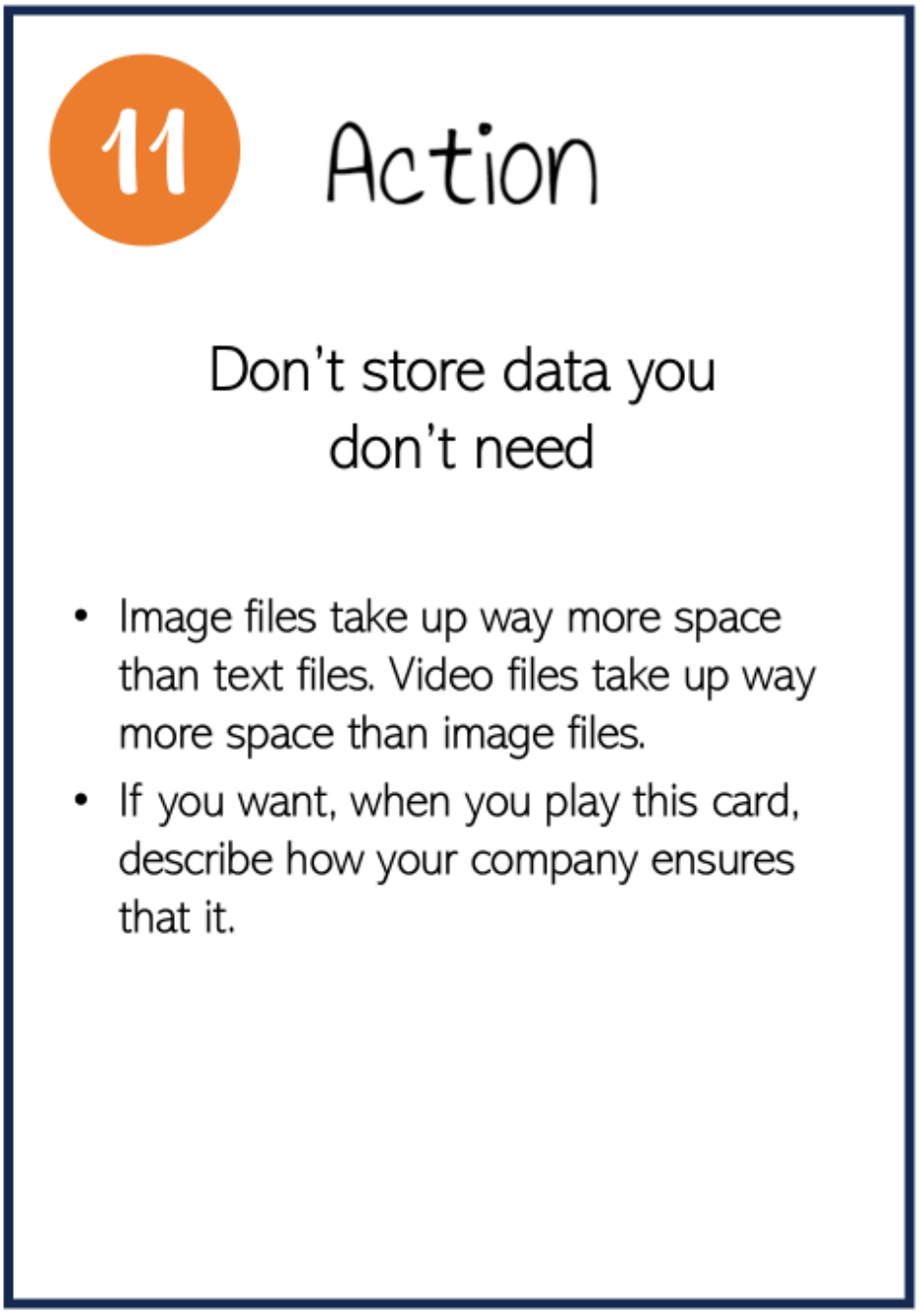
{ id: 8, name: "8: Know which e



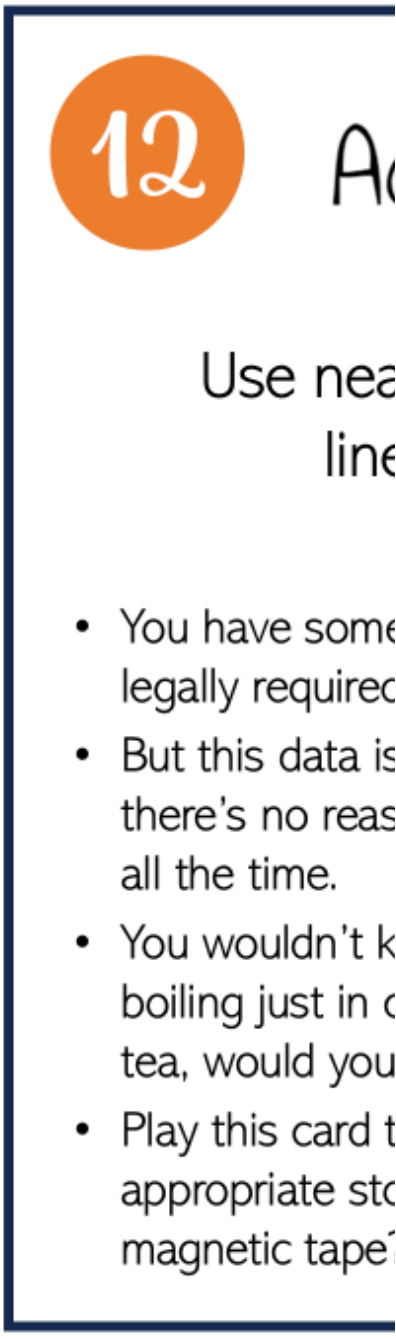
{ id: 9, name: "9: Use efficient internet connections + optimise WiFi network" },



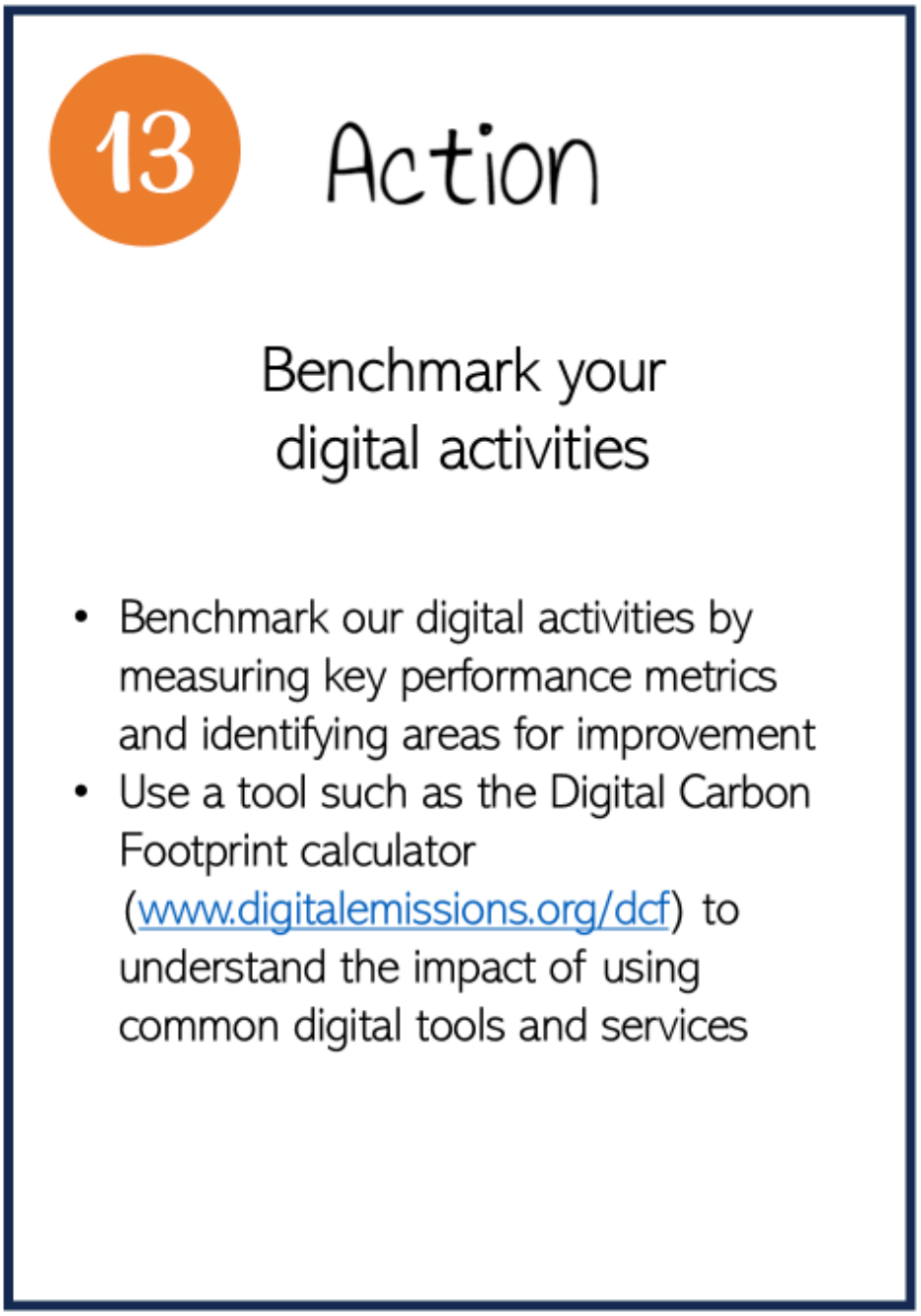
{ id: 10, name: "10: Build coaliti



{ id: 11, name: "11: Don't store data we don't need" },



{ id: 12, name: "12: Use near-lin



{ id: 13, name: "13: Benchmark our digital activities" },

{ id: 14, name: "14: Extend our devices' life spans" },
{ id: 15, name: "15: Use Life Cycle Analysis (LCA)" },
{ id: 16, name: "16: Advocate for right to repair" },
{ id: 17, name: "17: Improve our e-waste recycling" },
{ id: 18, name: "18: Design for humans, not angels" },
{ id: 19, name: "19: Check suppliers for greenwashing" },
{ id: 20, name: "20: Pivot to policy" },
{ id: 21, name: "21: Pivot to protest" },
{ id: 22, name: "22: Understand green energy procurement" },
{ id: 23, name: "23: Measure our carbon for AI and the cloud" },
{ id: 24, name: "24: Use grid-aware demand management" },
{ id: 25, name: "25: Know when not to use AI" },

{ id: 26, name: "26: Understand
{ id: 27, name: "27: Align measu
{ id: 28, name: "28: Get ready fo
{ id: 29, name: "29: Understand
{ id: 30, name: "30: Update our p

Superseded: Old version
The Digital Sustainability Game Handbook

Introduction
This is a card-based game, based on the contents of the DHCC Toolkit. The cards can be viewed here, and the rules here. Players take the roles of organisations competing (and perhaps collaborating) to become more digitally sustainable. Two hours, and 3-10 participants, is about right, although it is flexible: we've played it with groups of 15-20 too.

The Rules
https://docs.google.com/document/d/1Wc1cLBB-Pwl8qLGnZ9X0qvcul0hCGmWxQf0iQAtJqCs/edit?usp=sharing

The Deck
https://drive.google.com/file/d/1VFoeZn7GrryuSp2gGgEWF4S6ALlhueNu/view?usp=drive_link

Interview Results
TBC

https://climateacuity.org

Making your website more green can be a nice place to start. There are often a lot of easy wins. It can send a good message, and you can track progress with free, accessible carbon website calculator tools. Try the Web Sustainability Guidelines.

Optimise website visuals. What happens when a user visits your website? Data is moved from somewhere (usually "the cloud," in other words a big data center somewhere) onto the user's laptop or phone. It takes a bit of energy to move that data. It also takes energy to store that data on a switched-on server, so it's available at any time. Pictures, audio, and videos generally are much bigger files than text. They're a good place to start.

Reducing the number of images on a website can decrease the amount of data that needs to be transferred to a user's device, thereby reducing the energy consumed by servers and networks.

Then there is **image compression.** It's often possible to reduce the file size of an image, in a way that can't be perceived (or barely perceived) by the human eye. This makes images quicker to load and less demanding on bandwidth and storage, both of which can save energy. ShortPixel is one example of a tool that can do this: upload your image, and download a compressed version of it. Most imaging editing software also will let you select the level of compression you want.

Images can also be saved in lots of different **file formats**. SVG (Scalable Vector Graphics) and GIFs are often smaller in file size compared to other formats and are ideal for simple or animated images like logos and icons. SVGs are efficient for graphics that need to scale well on different screen sizes without losing quality.

WEBP and AVIF are modern image formats that provide superior compression and quality characteristics compared to older formats like JPG and PNG. This means they can deliver the same quality as JPG or PNG but at a smaller file size.

Enable lazy loading: Lazy loading is a technique where images only load when they enter the browser's viewport (i.e., when they become visible to the user). If a user doesn't scroll down to the image, then it won't load. This saves energy and data by only loading images that are actually going to be seen. You can use a JavaScript library such as LazySizes. There are lots of approaches: laziness is an art!

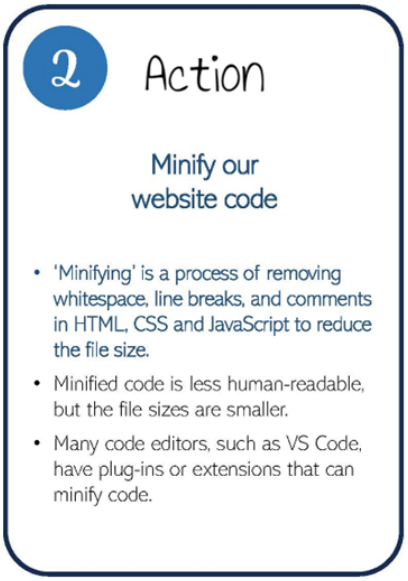
Responsive image markup: This is a technique where you set up a website's code to automatically adjust the size of the images based on the size of the screen they're being viewed on. For example, someone looking at a website on their phone will see smaller images than someone looking at the same site on a larger computer screen. This means the website doesn't use more data than necessary, which can save energy.

Image resizing API: An API (Application Programming Interface) is a tool that helps different software systems communicate with each other. An image resizing API automatically changes the size of an image to fit the screen it's being viewed on. This is done before the image reaches the user, so only the perfectly sized image is sent over the internet. This reduces the amount of data sent and can help save energy.

Experiment with shallow depth colours: Shallow depth of field i sharp focus – the background is l can reduce the file size of the im number of colors) can make imag especially on OLED screens, can

Perfect your image alt text: Alt HTML code to describe the appe mainly for accessibility purposes if the user decides not to display Branch Magazine) also adjust dy grid. When there is clean energy When there isn't, they display th want to see the image.

```
<img src="beautiful-sunset.
the ocean with vivid orange
```

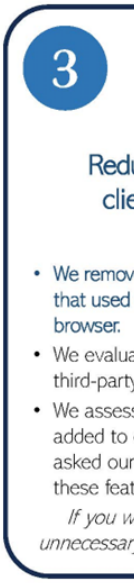


Minifying is a technique used to reduce the size of code files (like HTML, CSS, and JavaScript) that make up a website. This process involves removing all unnecessary characters from the code without changing its functionality. Here's what this involves:

1. **Removing unnecessary whitespace**: Whitespace includes spaces, tabs, and blank lines used to make the code easier to read for humans but is not needed for computers to execute the code.
2. **Eliminating line breaks**: Line breaks are used to separate lines of code to make them more readable for developers. Removing these doesn't affect how the code runs but does make the files smaller.

By reducing the file size, minifying helps the website to load faster because there's less data for a user's browser to download. Faster load times mean less energy is used, which can help in reducing the website's environmental impact.

Tools & Resources
Text editors and their plug-ins: Most modern text editors (like Visual Studio Code, Sublime Text, or Atom) support plug-ins or packages that can automatically minify code. There are also browser-based tools like www.minifier.org/.
Lighthouse: Minify JavaScript
Mozilla Minification
Minification Benchmarks



A **plugin** is a small piece of softw
giving it additional features or fu
from scratch.

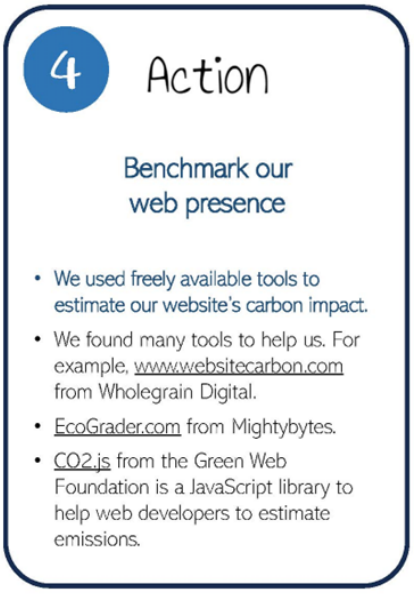
For example, in a Content Manag
WordPress Plugin Directory. It's

The first thing to remove might b
Do you really need that chatbot?
sharing buttons? Does that image
thought?

What if you're not sure what a pl
staging environments where you
deactivate or remove plug-ins in
live site. In most Content Manag
deactivate plug-ins without fully

Deleting a plugin may still leave
should have an option to uninstal

Tools & Resources
Google PageSpeed Insights
GTMetrix
Lighthouse



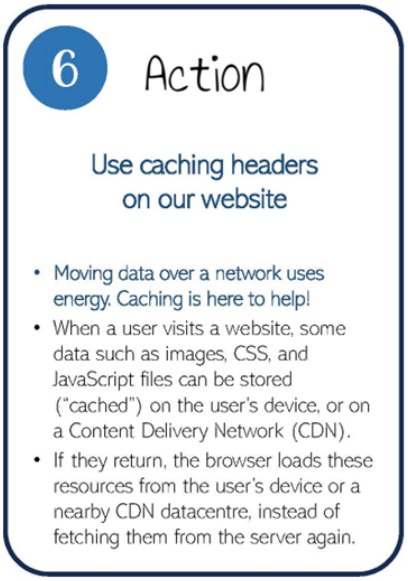
Tools & Resources
WebPageTest has a **Carbon Control Option.** Under the hood, WebPageTest uses CO2.js, an open source JavaScript library that enables developers to estimate the emissions of websites and software.
The Website Carbon Calculator estimates the carbon footprint of a webpage. It looks at the amount of data transferred during a visit, the energy required to transfer and process that data, and the type of energy source used by the data centre, whether renewable or non-renewable (although data centre energy procurement is a very complex and controversial topic). It also considers the carbon intensity of the electricity used in the region where the data centre operates. Website traffic is factored in, as the number of visitors influences the total energy consumption and emissions.
Ecograder is designed to assess the environmental impact of websites, combining Google Lighthouse's open-source page metrics with the **CO2.js** module from The Green Web Foundation. CO2.js helps estimate a website's carbon emissions by analyzing factors such as consumer device usage, network data, data center energy consumption, hardware production, and regional carbon intensity. Ecograder also considers whether a website uses green hosting, offering more accurate emission estimates. By using CO2.js, Ecograder produces emissions estimates.
DIMPACT estimates digital content carbon emissions using user-provided data such as data center processes and device type. It focuses on aggregated data (monthly or yearly).
GreenFrame: Measures carbon emissions by running web interactions in a Dockerized environment, using real-time data from server and client containers. It integrates with CI/CD pipelines for continuous measurement.
Sustainable Web Design (SWD): Uses data transferred as the main input for calculating the carbon emissions of a website, covering hosting, networks, devices, and manufacturing, although data transfer alone is a weak emissions proxy. Variables include grid intensity, % of new visitors

to page, % of returning visitors returning visitors. Can be tested
Firefox Profiler: Captures the providing a CO2e estimate base
Ecoping: Based on calculations tweaks: getting grid intensity fr the website hosting is.
Once you've benchmarked, in Web Alliance's accreditation thr for your website. Keep pages av view, with a home page below
Sustainable web design guidelin sustainablewebdesign.org/, Bra

5 Action

Optimise our website dependencies

- Now our website only loads the code it actually needs!
- Code libraries (like jQuery) and frameworks (like Bootstrap) are collections of pre-written code that developers use to save time.
- We now use modular libraries that let us import only the parts we need.
- Some functionalities that once needed external libraries can now be done with plain vanilla CSS and JavaScript.



Moving data over a network uses energy. HOWEVER, there is evidence that this is fairly 'inelastic,' in other words, a section of network has a fairly stable energy draw regardless of whether traffic is high or low.

[Explanation of caching]

[More explanation of CDN]

7

Action

Block the bots

- Our website was growing pretty popular with the bots. We deployed a script to block the unwanted ones.
- This reduced the network activity associated with our website.

If you want, describe why all these bots were visiting your website in the first place.

8 Action

Mobile-first design for our website

- Our websites and applications are now optimised for mobile devices (but also work on larger screens).
- We designed them with touch interactions in mind.
- Responsive web design fluidly changes layout based on the browser size, while adaptive web design uses static layouts that change at specific breakpoints. For our website, we went for responsive design.

9 Action

Apply Minimal Computing principles

- Minimal Computing is one approach to digital sustainability.
- It considers constraints such as hardware, software, network capacity, but also education, wealth, access, health and wellbeing, and more.
- Minimal Computing invites us to recognise real trade-offs that we can't just optimise our way out of.

If you like, explain how your company approaches these trade-offs.

Tools & Resources
WebPageTest has a Carbon Control Option. Under the hood, WebPageTest uses CO2.js, an open source JavaScript library that enables developers to estimate the emissions of websites and software.
An article from the BBC R&D team, "Does what you scroll burn coal? Mythbusting energy consumption on the web," looks at the effect of dark mode on device electricity usage and user behaviour, and the correlation between performance metrics, data transfer, and energy usage. Here's a response from WholeGrain Digital.
Sustainable web design guidelines: W3C web sustainability guidelines, sustainablewebdesign.org/, Branch magazine's original design principles.

10 Action

Shift workloads off the front-end

- Mobile devices are much more powerful than they were a few years ago. So it's possible to do more computation in the "front end" (the user's device) than the "back end" (a remote server).
- Often it's good to keep the heavy work for the back end, where there are more opportunities for efficiencies.
- However, there are exceptions and debates about this!

11 Action

Compress our images and video

- To minimise our image file sizes, we use tools like Shortpixel, TinyPNG, ImageOptim, and ImageAlpha.
- We use video sparingly. We compress video with tools like Handbrake.fr.
- YouTube or Vimeo embeds might not be optimal. We're interested in alternative platforms like Mave.io.
- WebM and MP4 formats sometimes have the edge on MOV and AVI. But it really all depends on resolution and compression.

12 Action

Simplify user journeys on our website

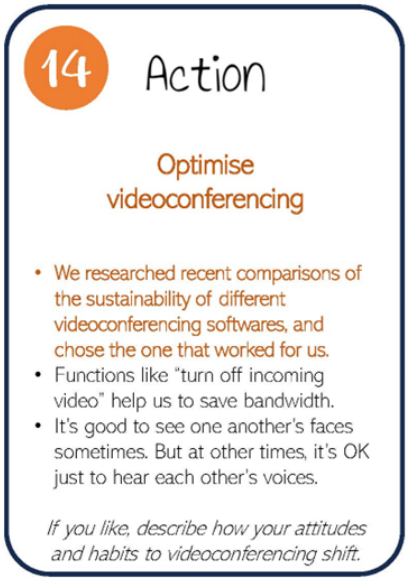
- We use consistent visual conventions and a clear visual hierarchy. We include prominent call-to-action buttons.
- We've included a search function.
- We delete old content regularly.
- We test our website with end-users. There are usually a few surprises.

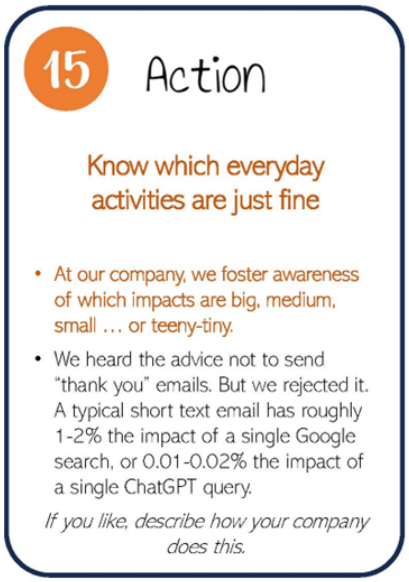
If you like, describe how terrible it was before, and how amazing it is now.

13 Action

Switch to green website analytics

- We've switched to a cookie-free, eco-conscious analytics tool, for example Cabin (withcabin.com).
- "Cookies" are small text files that websites leave on users' devices. They are used to "save" user preferences.
- They're also used by web analytics to track user behaviours.
- "Third-party cookies" are accessed by advertising networks to display targeted ads.





Since we created this card, Google has started including LLM results in its search queries — we'll need to update it!

There are a lot of different estimates out there, and they vary considerably. Why do they vary? One good answer is, "We don't have good data." The developers of major AI platforms like ChatGPT, and the operators of the data centres where they run, have been criticised for a lack of transparency. So behind these statistics, there are assumptions and even guesswork.

An even better answer might be, "It depends how you look at it." Even if all the data were available, there are many reasonable methodologies for making such a calculation. Do we include the energy of the user device, the network, and the data centre? Do we include an amortised slice of the embodied carbon of the user device, the network, and the data centre? If the data centre operator is offsetting the carbon emitted by its energy use via green energy procurement (instruments like Renewable Energy Certificates), do we include that in our calculation ('market-based' carbon accounting) or do we instead use where the data centre is located (

If you explore these questions fu ethical dimensions. What do we leading investment in green ener resources?

Estimate 1 - 0.7%

Short text email: 0.3g CO2e	Source: Mike Berners-Lee, *How Bad are Bananas?: The Carbon Footprint of Everything* (2020/2021)
ChatGPT query: 4.3g CO2e	Source: Vinnie Wong / Piktochart (2024)'s estimate
Comparison: A short text email may have 7% of the impact of a ChatGPT query	

Estimate 2 - 0.1%

Short text email: 0.03g CO2e	If we're talking about a brief "thank you" email, it may be closer to Berners-Lee's calculation for a spam email.
ChatGPT query: 41g CO2e	Selvan has a much higher estimate, as d'Aramon et al. (2024) describe
Comparison: A short text email may have less than 0.1% of the impact of a ChatGPT query	

Then again, thinking "Oh, I just emitted about 4g / about 40g of carbon with that prompt!" every time you query ChatGPT is probably misleading.

Piktochart's methodology for the ChatGPT query is based on the total number of GPUs running ChatGPT per day, and the total number of queries ChatGPT gets per day. These are estimates (even rumours). We also don't really know how efficiently the system scales in relation to demand. Idle GPUs are still consuming resources.

In the long term, of course, if demand for ChatGPT went down considerably, fewer processors would be devoted to it.

16 Action

Use efficient internet connections

- Plugging your device into an ethernet connection is better than using WiFi.
- And using WiFi is better than using a cellular data connection (like 4G/5G).

If you want, tell us how your company is helping staff to always use the most efficient connections.

17 Action

Optimise our WiFi network

- We seldom need our WiFi network at night, so we scheduled it to to sleep.
- We analysed our cable management and discovered ways to improve.
- We also researched features like dynamic channel assignment, beamforming, seamless roaming, Power over Ethernet, Energy Efficient Ethernet, and port trunking, to see how else we could optimise our WiFi networks.

18 Action

Don't store data we don't need

- We created processes to reduce unnecessary data storage.
- We regularly clean up junk data and 'dark data.'
- Image files take up way more space than text files. Video files take up way more space than image files. We prioritised the heavy file types.

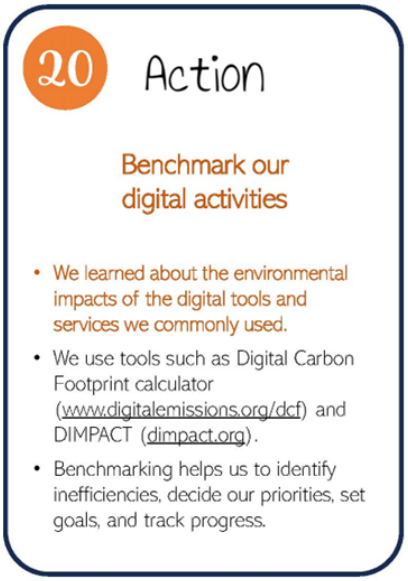
If you want, when you play this card, describe how your company reduces the storage of unnecessary data.

19 Action

Use near-line and off-line storage

- We use this for long-term data we need to store, but seldom access.
- There's no reason to have it online and available all the time.
- You wouldn't keep a kettle constantly boiling just in case you need a cup of tea, would you?
- We began by exploring options like magnetic tape and holographic storage.

If you like, describe the details.



Tools & Resources
Digital Carbon Footprint Calculator
DIMPACT
GSF's **Impact Framework** aims to mainstream software sustainability measurement, formalising it into a discipline with standards and tools to help decarbonise software, with an open source ethos. The framework is built around the **SCI Specification as the standard** and the **Impact Framework as the tooling**. A key component is the **manifest file**, which serves as a shareable, portable, and human-readable audit. It defines an application's architecture, holds input data, and contains all configurations necessary for impact calculations. The manifest file acts as an executable audit that can be re-executed by anyone to verify environmental impact calculations. Data for the manifest can come from external files, APIs, or manual inputs, with existing plugins for various data sources like Azure, Prometheus, and CSVs. The vision is to create an open communication standard, with the manifest file becoming the primary way to share environmental impacts of systems. The core functionality currently focuses on calculating software carbon intensity for cloud applications, but it is flexible enough to be used for on-premi systems, supply chain modeling, and other use cases. The framework allows users to transform metrics like CPU utilisation and page views into environmental impacts such as carbon emissions and energy consumption. It also supports exploring "what-if" scenarios to assess how software changes affect environmental performance. There is a strong "open" energy here: the decentralised and democratised nature of the framework can enable others to verify, validate, and even challenge the findings by rerunning or adjusting the manifest file. **The Software Carbon Intensity (SCI) Specification** provides a standardised methodology for calculating the carbon emissions rate of

software systems. It helps users
decisions to reduce emissions b
hardware usage, and the carbon

"Software practitioners have a s
reducing the SCI score during th
software applications." For exar

- Software Programmers:
- AI/ML Developers: Opt
optimised hardware for
- Database Engineers: Sch
optimisations.
- DevOps Practitioners: D
builds strategically, leve
- QA Engineers: Create en
performance testing scri
- Architects: Design serve
optimise infrastructure,

In April 2024, the SCI Specifica
international standard (ISO/IEC
though!)

21

Action

Reduce demand for devices

- We created policies to buy fewer devices overall, and make better use of them.
- We can support employees to use their own devices for work purposes.
- We've partnered with a Repair Café.
- We never use "dark patterns" that drive user engagement, without real benefits. We don't want our customers addicted.

If you like, describe the challenges (and eventual success) of getting your employees to use fewer devices.

22

Action

Care for our devices

- We buy extended warranties, and make it easy for staff to get devices repaired.
- We guard against smashes with phone cases, screen protectors, and so on.
- We use and store devices within recommended temperature range.
- We avoid overcharging devices.

If you like, describe your company's strategy, and challenges you overcome.

23

Action

Extend laptop battery lifespan

- We use our laptops' built-in power-saving features such as Smart Charging.
- We avoid extreme temperatures.
- We aim to keep the battery between 20% and 80%.
- We reduce the number of programs running simultaneously.
- We avoid storing a fully charged or fully drained battery for a long period.
- With most modern devices, leaving it plugged in at 100% isn't as bad as it used to be, but it's still not ideal.

24

Action

Use Life Cycle Analysis (LCA)

- A LCA evaluates the impact of a product or service on the environment, from creating it to disposing of it.
- Databases such as ecoinvent.org, and the European Life Cycle Database, provide life cycle inventory data for conducting LCA studies.
- openLCA offers free software for LCA.

If you like, tell us how conducting an LCA reveals interesting things about one of your company's products.

24

Action

Use Life Cycle Analysis (LCA)

- A LCA evaluates the impact of a product or service on the environment, from creating it to disposing of it.
- Databases such as ecoinvent.org, and the European Life Cycle Database, provide life cycle inventory data for conducting LCA studies.
- openLCA offers free software for LCA.

If you like, tell us how conducting an LCA reveals interesting things about one of your company's products.

26

Action

Improve hardware efficiency

- We regularly review our hardware to see if efficiency can be improved and life-span extended.
- We found eco-labels like ENERGY STAR, EPEAT, and TCO Certified useful.
- We also found SustainableIT.org's environmental ESG standards useful.
- But we do our own analysis and research.

27

Action

Advocate for right to repair policies

- We're pushing policymakers to subsidise repairs, through repair voucher schemes or other systems.
- We're pushing for laws against planned obsolescence: for example, banning practices that make independent repairs difficult or impossible.

If you want, describe how your company makes this happen.

28

Action

Adopt sustainable design principles

- We avoid planned obsolescence.
- We demand the same from our suppliers.
- We design products that can be adaptable to different scenarios.
- We design products that use fewer materials.
- We design products that are easy to upgrade and repair.

If you want, describe how your company makes this happen.

29

Action

Design with the future in mind

- Technical debt refers to the future costs that arise from choosing an easy or quick solution now, over a better approach that would take longer.
- In terms of sustainability, technical debt can come from prioritising requirements like cost, functionality, or time-to-market.

If you want, describe how your company ensures sustainability is a priority when it designs its products.

30

Action

Become regenerative by design

- Sustainability isn't just about "reducing our impact." Of course that's a huge part of it! But we also try to have positive impacts on natural capital.
- For example, we've increased local biodiversity a lot.
- Our company is net zero already, and soon we'll be net negative.

If you want, describe how your company makes this happen.

31

Action

Improve our e-waste recycling

- A huge proportion of e-waste is still managed through illegal channels, recovering a few valuable components and dumping toxic remains.
- Much e-waste cannot be recycled and has to be downcycled.
- Many livelihoods in the Global South rely on informal e-waste management.

If you want, describe what actions your company takes.

32

Action

Design for humans, not angels

- We promote cultural shifts and behaviour change, but we don't count on these initiatives working.
- Our employees encounter obstacles in trying to work sustainably. We create credible mechanisms for these experiences to be captured, not lost.
- We re-design our systems to better support our people. We try to make the green path the path of least resistance.

If you want, describe how you do this.

33

Action

Check suppliers for greenwashing

- Our IT suppliers claim to be green!
- We do our own detectivework. We also like to use resources like Corporate Responsibility Monitor and Zero Carbon Analytics.
- There are so many ways to be sneaky: omitting parts of Scope 3; reporting carbon but not methane; choosing a dodgy baseline year; using misleading terms like "carbon neutral"; misusing carbon offsetting; etc.

34

Action

Pivot to policy

- When we encounter problems that seem insoluble at the company level, we don't just leave it there. We use our experience to advocate for policy changes.
- We're a company, but we're also made up of human beings who care about the future of this planet.

If you want, give an example, and/or explain how you cultivate this practice in your company / sector.

35

Action

Pivot to protest

- We foster meaningful dialogue and collaboration with climate activists.
- We are genuinely concerned for the future of the planet.
- Grassroots environmentalists have always played a key role in fighting greenwashing and getting climate science adopted by policymakers.

If you want, give an example, and/or explain how you cultivate this practice in your company / sector.

36

Action

Check cloud providers' sustainability claims

- Carbon intensity varies by location, and over time (when the wind blows, when the sun shines).
- We don't just rely on a data center's Power Usage Effectiveness (PUE). We also use magic acronyms like CUE (Carbon Usege Effectiveness), WUE, GEC, DPPE, and LEED.
- We know why 24/7 hourly matching and Power Purchase Agreements are usually better than unbundled RECs/REGOs.

37 Action

Measure our carbon for AI and the cloud

- The major cloud providers all offer monitoring tools. We use them, but push the providers to improve them.
- We don't rely on market-based carbon reporting exclusively, which could be misleading. Location-based plus market-based is better.
- There are useful open source tools such as www.cloudcarbonfootprint.org.
- We rely on Carbon Market Watch for more information on carbon credits.

38

Action

Carbon-aware computing: demand shifting

- We move our energy consumption to locations or times of days with lower carbon intensity (see app.electricitymaps.com).
- We are also exploring changing the clock speed for big jobs, depending on carbon intensity.
- This is carbon aware computing. We're now moving to an even *more* holistic approach, grid-aware computing.

39 Action

Carbon-aware computing: demand shaping

- Demand shaping means adapting our energy consumption around carbon intensity variability.
- A simple example: if carbon intensity is low, the full version of our website is shown. If carbon intensity is high, the user needs to click to reveal images.
- This is part of carbon aware computing. Grid-aware computing is an even more holistic approach.

https://www.thegreenwebfoundation.org/publications/report-ai-environmental-impact/

41

Action

Understand different kinds of Machine Learning (ML)

- AI companies kept telling us, "AI has a climate cost, but AI is also vital for fighting climate change."
- We have done our research, and we know how to evaluate these claims.
- A lot of the climate-harming AI is Generative ML. A lot of the climate-helping AI is Discriminative ML.
- Non-ML approaches like active inference can be less energy-hungry.

42

Action

Get ready to change our core business

- We've begun to ask a hard question: is our core business part of global overconsumption?
- Climate change is a distributional problem. E.g., millionaire carbon emissions alone will deplete 2/3s of our carbon budget by 2050 (Stefan Gössling and Humpe 2023).

If you want, describe how your company pivots to operating in a way consistent with a rapid, just transition to net zero.

43 Action

Get ready for more carbon tax

- To future-proof, we have voluntarily adopted an internal carbon price.
- Carbon taxes increase costs for carbon-intensive businesses. These taxes can incentivise emissions reductions, generate revenue to help tackle climate change, and encourage low-carbon innovation.
- A Carbon Border Adjustment Mechanism tax prevents "carbon leakage," but there are concerns about impacts on Global South exporters.

https://www.green-coding.io/projects/green-metrics-tool/ The Green Metrics Toolkit t can support developers best to measure the energy / CO2 consumption of software architectures..

45 Action

Optimise resource use with digital tech

- Use smart systems to allocate resources efficiently in real time. But we don't let obsession with measurement eclipse common sense.
- Digital platforms can help to pool and share resources in new ways. But when they are profit-driven and poorly regulated, platforms can lead to monopoly, exploitation, precarity and idle resources, and limit users' capacity to modify or repair resources.

There is a Blue Angel certification for software:
https://www.blauer-engel.de/en/productworld/software

47

Action

Holistic sustainable procurement

- We've set targets for purchasing sustainable technology (e.g. 80% of spend by 2030).
- We're building sustainability in all stages of procurement. E.g. definition of need, procurement method selection, requests for proposals, evaluation and selection, contract negotiation and administration.
- We're joining up procurement decisions to enable sharing.

48

Action

Footprint our digital carbon

- We had to be careful not to be dazzled by the data. They say, "What gets measured gets managed." But measuring digital carbon is complex, and we shouldn't let it delay other actions.
- We started with free tools like ICTFOOTPRINT.eu's SAT-O.
- Standards have been gradually emerging across bodies like ISO/IEC, GHG Protocol, GeSI.

49 Action

Use GreenOps to manage AI and the cloud

- We use GreenOps to optimise our company's cloud usage from a sustainability perspective.
- GreenOps can draw on a variety of data sources and metrics (such as the Carbon Useage Efficiency of a data center).
- Also known as DevSusOps or DevGreenOps. GreenOps emerged from FinOps, which was all about monitoring and optimising cloud costs.

50 Action

Make a Net Zero Action Plan (NZAP)

- We made a Net Zero Action Plan for all our digital technologies.
- We used the "5Ws" approach: What? Who? When? Where? Why?
- Our NZAP did involve carbon credits, but we opted for a Beyond Value Chain Mitigation approach. We report our carbon footprint and our carbon credit portfolio separately, side by side, not as one consolidated figure. (You can't subtract apples from oranges).

51

Action

Make a Plan B

- Some actions might not work without the support of key decision-makers.
- For example, your company's senior management might change, or the existing management might change their minds.
- Maybe make a Plan C too!

If you like, describe the details. Who are you worried might withdraw their support? What can you do to mitigate?

52

Action

Elevate work that's already being done

- We found out which teams or individuals were championing sustainability, and we gave them support and resources.
- Some initiatives didn't have sustainability as their primary goal, but still delivered sustainability benefits. We made sure we shone a light on these too.

If you like, give an example.

ewaste:

https://betanews.com/2024/06/25/land-of-hope-glory-and-e-waste-brits-are-set-to-become-the-biggest-contributors-to-electronic-waste-this-year-but-why/

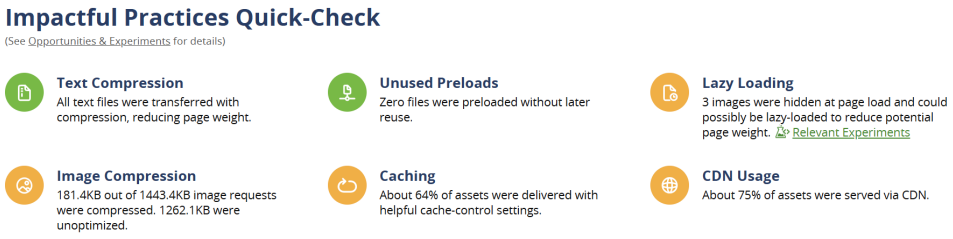
AI

ChatUI-energy, the first interface where you see in real-time what energy your AI conversations consume.

~$ pip install carbontracker

https://github.com/lfwa/carbontracker

https://kombit.dk/Media/638632730886209868/raghav_kombit.pdf



Projects we contribute to, or that use CO2.js

Web page	**Website Carbon** Javascript, proprietary.	**WebpageTest** php + js, open source, available as hosted service	**Sitespeed.io** Javascript, used by Wikipedia. Open source
AI training	**Code Carbon:** Used in many AI papers. Open source.		
A part of a system	**Firefox profiler:** Javascript, browser focussed. Open source.	**Scaphandre:** Rust, server-side focussed. Open source.	**Datavizta:** Python. Embodied carbon focus. Open source
Whole system	**Green Metrics Tool:** Python, simulates usage scenarios. Open source.	**KEPLER** Open source, runs in production, kubernetes focussed. Open source.	
Cloud bill	**Native calculators** Offered by Microsoft, Google, AWS, etc	**Cloud Carbon Footprint** Scopes 1,2 3 - first "significant" open source project	**Green Pixie** 3rd party. Independent. Now offers richer data than just carbon.

NOTES ON SECOND EDITION

We made sure our AI was contestable.

the key to AI accountability is algorithmic transparency. I have specifically emphasized the need to use the term "contestability" and not "explainability" to understand a rights-based approach to AI governance.

We inventoried our AI.

Defining an AI Use Case

Traditional IT inventories track software, hardware, and applications, but AI inventories require a different approach due to AI's adaptability. AI models can be repurposed for different tasks—an AI trained for geospatial analysis, for example, might later be applied to patent research. This flexibility makes simple cataloging insufficient for effective risk management.

To address this, AI use cases should be documented with three key factors:

- **Purpose of Use:** The specific problem the AI system is designed to solve.
- **Model Type:** The nature of the AI system (e.g., machine learning, natural language processing).
- **Scope of Data:** The datasets used to train and validate the model, which have implications for security, compliance, and ethical considerations.

A well-structured AI use case inventory provides organizations with greater visibility into AI applications, enabling better risk management and compliance with emerging regulations.

2.2 Challenges of Comprehensive AI Inventories

As AI adoption expands across organizations, maintaining a comprehensive and accurate inventory becomes increasingly difficult. The rise of **generative AI tools**—such as ChatGPT, Copilot, Llama 3.1, and Gemini—has democratized AI use, allowing non-technical employees to deploy AI without centralized oversight. This creates several risks:

- Employees may use AI tools on sensitive data without understanding governance policies.
- AI-generated outputs could contain restricted or proprietary information.
- Organizations may struggle to track AI use across different teams, leading to gaps in oversight.

The widespread availability of AI blurs the lines between **formal AI deployments and ad-hoc, user-driven AI interactions**, making traditional inventory methods ineffective. Without strict policies and tracking mechanisms, organizations risk data exposure, compliance violations, and unintended AI-driven decisions.

AI-Integrated Applications & Third-Party Challenges

There may be **hidden AI integrations** from third-party vendors. Many companies unknowingly rely on AI features embedded within external tools and services.

1. **Opaque AI operations** – E.g. a financial institution using an AI-based fraud detection tool may not realise that parts of the analysis are outsourced to an undisclosed third party. Organisations may unintentionally expose sensitive data when subcontractors use AI to generate voice recordings, assist with coding, or process proprietary materials.
2. **Non-AI vendors using AI** – Companies might integrate AI-generated content without explicitly disclosing it. An educational platform, for example, may use an AI image-generation tool without including it in their AI inventory.

Organisations are likely to try to **prioritise high-impact AI use cases** instead of attempting to inventory every AI tool. This would mean focusing on AI systems that:

- Directly impact critical business functions.
- Involve sensitive or regulated data.
- Are integrated into decision-making processes.

But the integrations are important, and where exactly are they being handled? At a more sectoral level? By policy? Not at all?

Companies can advocate for **transparency from third-party vendors**. Monitoring high-risk AI applications and establishing internal policies for AI governance will help organizations manage AI risks more effectively.

AI Risk Management & Mitigation

Identifying AI Risks

A primary goal of AI inventories is to manage risk, but the types of risks vary by industry. In energy, risks may include **safety failures and infrastructure vulnerabilities**, while in finance, risks might involve **bias in decision-making** (e.g., AI-driven loan denials).

AI risks can be categorized into:

- **Human safety risks** – AI errors in critical sectors like energy and healthcare can lead to physical harm.
- **Data security risks** – AI models trained on sensitive data may inadvertently expose confidential information.
- **Bias and fairness issues** – Poorly designed AI systems can reinforce discrimination in hiring, lending, or law enforcement.
- **Regulatory non-compliance** – Failure to meet legal requirements can result in fines or reputational damage.
- **Operational risks** – Unreliable AI decisions can disrupt essential functions, leading to cascading failures.

Organizations should **prioritize risk assessment** within their AI inventories, identifying high-risk use cases that require closer monitoring and compliance with industry regulations.

Risk Mitigation Strategies

Managing AI risks requires a proactive approach:

- **User training:** Employees need to understand AI capabilities, limitations, and ethical considerations.
- **Transparency:** Organizations should clearly document when and how AI is used to improve accountability.
- **Human-in-the-loop oversight:** AI-generated outputs should be subject to human review before critical decisions are made.
- **Vendor agreements:** Contracts with third-party AI providers should require transparency about how AI models operate, what data they use, and whether they involve subcontractors.

A structured risk mitigation framework ensures that AI systems remain **secure, fair, and aligned with business objectives** while minimizing unintended consequences.

Strategic AI Investments & Inventory Prioritization

Decision-Making in AI Investment

AI initiatives should be **use case-driven**, not just technology-driven. When assessing AI projects, organizations must determine:

- Whether the AI system solves a **critical business problem**.
- If the **expected value outweighs risks and costs**.
- Whether similar AI solutions **already exist within the company**, avoiding redundancy.

A **World Economic Forum report on Generative AI** recommends aligning AI investments with strategic objectives rather than chasing trends. Companies should focus on **measurable business value** when expanding their AI capabilities.

Special Considerations in AI Investment

Before launching an AI project, organizations must anticipate potential challenges:

- **Risk Assessment:** Each project should undergo **data security, operational, and ethical risk evaluations** before approval.
- **Regulatory Compliance:** With global AI regulations evolving, organizations should **future-proof** their AI investments by considering **upcoming laws on transparency, bias, and privacy**.
- **Avoiding Duplication:** Many AI projects are redundant—data scientists should evaluate whether similar AI tools already exist internally before investing in new solutions.

By addressing these considerations, companies can **ensure AI investments are sustainable and legally compliant** while avoiding wasted resources.

A **well-structured AI inventory is critical** for managing risk, ensuring compliance, and maximizing AI's business value. However, given AI's rapid adoption, maintaining a **complete inventory of all AI use cases may become impractical**. Organizations should focus on:

1. **Use Case-Driven Inventories** – Track AI use cases, not just models or applications, prioritizing **high-impact and high-risk areas**.
2. **Risk-Based Prioritization** – Instead of tracking every AI instance, focus on **data-sensitive and financially significant AI systems**.
3. **Regulatory Alignment** – Adopt international standards like **ISO 42001, the NIST AI Risk Management Framework, and the EU AI Act** to stay compliant.

4. **Strategic AI Investment** – AI decisions should be **goal-oriented**, avoiding unnecessary duplication and aligning with business objectives.

With a **targeted AI inventory approach**, companies can balance **innovation and risk management**, ensuring AI is used **effectively, ethically, and securely**.

Article links

https://www.sustainability-times.com/research/living-mushrooms-could-power-your-phone-this-stunning-breakthrough-might-replace-plastic-and-rechargeable-batteries-forever/