



## RESEARCH PROPOSAL

<b>Faculty</b>	
<b>Research Title</b>	<i>Optimizing Website Design for Sustainability: A Standardized Template and Practical Guidelines</i>
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## **Research Proposal Format**

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## Introduction

In recent decades, the internet has evolved into an essential utility, underpinning a wide spectrum of global economic, social, and political activities. The exponential growth in online content, website usage, and data transmission has brought with it substantial energy consumption demands. Servers, data centers, content distribution networks, and end-user devices all contribute to a significant carbon footprint, which compounds as digital adoption accelerates. While people typically view the internet as a “clean” technology, the energy required for web hosting, data processing, and network operations is far from negligible.

The ongoing climate crisis puts immense pressure on all sectors including the Information and Communication Technology (ICT) field to rethink energy usage and implement more sustainable practices. Websites once considered mere “online brochures,” are now multimedia experiences, often featuring extensive high-definition images, video content, interactive plugins, and dynamic elements that enhance user engagement. Such features, however, demand more bandwidth and CPU resources, potentially increasing the overall carbon emissions per page load. At scale, even small inefficiencies can cascade into substantial environmental consequences.

This research proposal highlights the importance of **optimizing web design for sustainability** and outlines a plan to develop and validate new design frameworks, code optimization techniques, and hosting strategies aimed at significantly reducing the energy consumption of websites. The sections that follow provide an in-depth exploration of the problem, the research objectives, the proposed methodology, and the expected outcomes.

## Executive Summary

Digital services, including websites, have grown exponentially in complexity and global reach. While this growth fuels innovation and connectivity, it also results in higher carbon emissions. Current estimates suggest that websites produce an average of 1.76 grams of CO<sub>2</sub> per page view, and with massive daily traffic across billions of sites, the aggregate environmental impact becomes substantial. Some studies posit that the ICT sector contributes as much as 1.5–4% of global greenhouse gas emissions a figure poised to rise as our reliance on digital solutions expands.

Despite the availability of energy-efficient web frameworks, such as Qwik, Astro, and Svelte, many developers still rely on traditional platforms like PHP, WordPress, and Wix. These mature platforms, while user-friendly and widely documented, frequently lack default configurations that prioritize low energy usage or minimal carbon impact. Consequently, developers are left to figure out custom optimizations on their own, often resulting in uneven adoption of green practices.

The goal of this research is threefold. First, it aims to benchmark current website emissions to clearly understand baseline footprints. Second, it proposes to develop a standardized sustainable website template that leverages best practices from green web frameworks, as well as provide practical optimization guidelines for dominant platforms such as WordPress. Finally, the research will validate these optimizations in real-world scenarios by testing live websites before and after implementing suggested improvements. Through these initiatives, we aim to produce actionable, scalable strategies that help bridge the gap between practical web development needs and mounting climate concerns.

This proposal is structured to document the entire process from literature review and data collection to template creation, pilot testing, analysis, and dissemination of results. Ultimately, the research is poised to deliver tangible reductions in website-related emissions and to promote an ethos of sustainability throughout the web development community.

## Problem Statements

The rising carbon footprint of websites and other online assets has emerged as a **significant contributor to global energy usage**. Data centers are proliferating, network traffic is growing, and end-users are continually upgrading to more advanced devices all of which demand further electrical power. Although frameworks exist that promise greener solutions for website creation, their adoption is minimal when compared to the dominance of legacy or widely recognized platforms.

A substantial challenge stems from the **lack of integrated sustainability features** in mainstream platforms like PHP, WordPress, and Wix. Many developers are unaware that each file request, each plugin, and every media asset can cumulatively raise a website's emissions. Even when developers do recognize the need for more efficient designs, **practical barriers** such as limited documentation, time constraints, or fear of compromising the user experience often delay or deter implementation.

Furthermore, current measurements of a website's carbon emissions frequently underscore **disparities in performance**. The gap between a highly optimized site and a standard site can be measured in grams of CO<sub>2</sub> per page load. For websites with high traffic volume, these differences magnify, resulting in hundreds or thousands of kilograms of CO<sub>2</sub> emissions per year. Research indicates that a single website might produce up to **211 kilograms of CO<sub>2</sub>** annually for 10,000 page views. Extended to the global scale, these statistics reveal an increasingly **urgent need for standardized, low-carbon design practices** that can be adopted easily, without sacrificing usability or brand identity.

## Research Objectives

The primary objective of this research is to **develop a standardized, low-carbon website template** and a comprehensive set of **platform-specific guidelines** tailored for PHP, WordPress, and Wix. Additionally, insights from emerging energy-efficient frameworks such as Qwik and Astro will be leveraged to illustrate how improved architecture can have a direct positive influence on sustainability.

1. **Establish Emissions Benchmarks:** Quantify current emissions from a representative sample of websites built on different platforms.
2. **Identify Key Carbon Contributors:** Determine the most impactful design elements, such as high-resolution images, bulky scripts, and unoptimized hosting choices, that inflate a site's carbon footprint.
3. **Develop a Sustainable Framework Template:** Create a sample website template incorporating green web best practices (e.g., lazy loading, optimized media, minimal code) to serve as a resource for developers.
4. **Apply Findings to Dominant Platforms:** Formulate guidelines specific to PHP, WordPress, and Wix installations, detailing how to replicate or approximate the efficiency gains offered by green frameworks.

## Research scopes

This study confines itself to **technological, design, and implementation** layers that directly affect a website's carbon footprint. By focusing on both the front-end (e.g., HTML, CSS, JavaScript, images) the project aims to produce holistic sustainability strategies. While the potential scope of digital sustainability is vast extending into hardware manufacturing, device usage patterns, and broader network infrastructure, this research will keep its core attention on **web development practices** and **hosting solutions** that can be controlled or influenced by developers and website owners.

1. Emissions Measurement - Tools such as Website Carbon Calculator, Ecograder, and Digital Beacon will be employed to track baseline and improved CO<sub>2</sub> outputs.
2. Framework Analysis - Qwik and Svelte will be examined for their effectiveness in reducing data transfer and CPU usage, highlighting how their architectural choices differ from traditional platforms.
3. Platform-Specific Guidance - The study will produce step-by-step manuals for optimizing PHP, WordPress, and Wix websites, considering constraints like plugin architecture, theme design, or limited configurability in hosted solutions.
4. Awareness and Advocacy - Building on the data collected, the research will develop materials (e.g., a PDF guide, online tutorials) to raise awareness among developers, hosting providers, and other stakeholders about the importance and feasibility of sustainable web design.

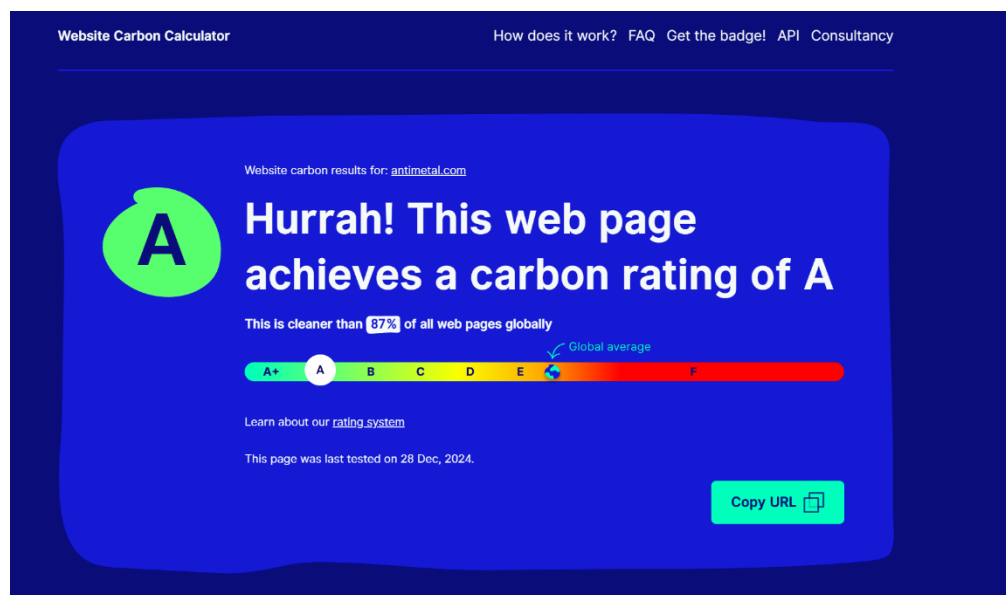


Figure 1 shows *antimetal.com* achieves a carbon rating of A, which means it is cleaner than 87% of all web pages globally.

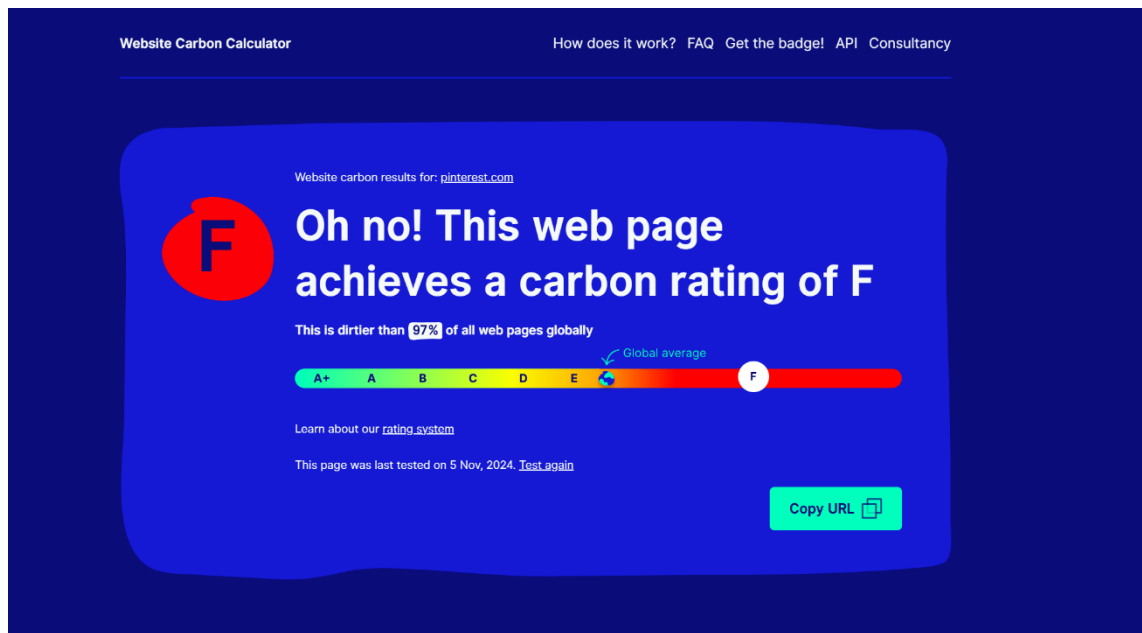


Figure 2 shows *pinterest.com* achieves a carbon rating of *F*, which means it is dirtier than 97% of all web pages globally.



## Hypothesis

Websites designed using optimized frameworks and **sustainable web practices** can **significantly reduce carbon emissions** without compromising user experience, performance, or brand integrity. Adopting best practices such as lazy loading, code minification, renewable energy hosting, and resource-efficient frameworks yields a positive effect on both the **environmental footprint** and the **overall user satisfaction**.

## Literature Review

### 7.1 Growth and Emissions in the ICT Sector

Multiple studies highlight that the ICT sector now accounts for a considerable portion of global greenhouse gas emissions, ranging from **1.5% to 4%**, depending on estimation methods. Major sources include energy-intensive data centers, which store and serve content, and the networks that shuttle data to end-users worldwide. As the web continues to expand, both in terms of the number of websites and the richness of content, the energy demands, and hence carbon emissions, are projected to grow proportionally.

### 7.2 Impact of Website Architecture on Carbon Footprint

In the context of web architecture, **page size** and **rendering complexity** serve as vital indicators of energy consumption. Each kilobyte of data transferred requires network resources that, in turn, rely on electricity. Research indicates that web pages with extensive images, libraries, or animations can emit up to **12g of CO<sub>2</sub> per minute** of browsing, illustrating the interplay between design decisions and environmental impact. Tools like the **Sustainable Web Design Model** and the **Sustainable Web Manifesto** have sought to unify best practices, emphasizing the synergy between fast-loading sites and reduced carbon emissions.

### 7.3 Existing Green Frameworks

Frameworks such as **Qwik**, **Astro**, and **Svelte** demonstrate that a meticulously **optimized loading strategy**, such as partial hydration or server-side rendering can drastically reduce the amount of JavaScript executed on the client side, which in turn decreases CPU usage and power consumption. However, these frameworks remain underutilized due to limited awareness, documentation gaps, or the inertia of established workflows.

### 7.4 Conventional Platforms: PHP, WordPress, and Wix

By contrast, **PHP** (particularly versions powering WordPress) and **Wix**-style drag-and-drop services command a vast share of the web market. They are prized for their simplicity and widespread community support but rarely incorporate sustainability or performance best practices by default. Consequently, site owners often add heavy plugins, images, or themes, creating pages that may load slowly and produce

disproportionately high emissions. Scholarly and industry literature on green web design consistently underscores the untapped potential in optimizing these popular platforms.

## 7.5 Benefits of Sustainable Web Design

Existing studies report a dual benefit of adopting green web design principles. First, a **reduced environmental impact**, as measured by annual CO<sub>2</sub> savings and lowered energy usage. Second, **improved user experience**, given that many of the same optimizations that reduce emissions, such as efficient code, smaller images, and better caching, also enhance site speed and responsiveness. Additionally, organizations that emphasize social and environmental responsibility can bolster their brand reputation and secure consumer loyalty by showcasing such efforts.

## 7.6 Challenges and Opportunities

Despite the promising outlook, challenges persist. Measuring a site's true carbon footprint is complex, given the countless variables: user hardware efficiency, data center location, CDN usage, and more. Additionally, persuading developers to retool their workflow requires tangible incentives and straightforward guidelines. Nonetheless, the emerging ecosystem of tools (e.g., **Website Carbon Calculator**, **Digital Beacon**, **Ecograder**) offers a structured approach for baseline and post-optimization comparisons, thus making it feasible to quantify progress.

# Research Methodology

## 8.1 Overview

The methodology designed for this research consists of **benchmarking**, **template creation**, **real-world application**, and **analysis** to validate the effectiveness of sustainable web practices. The outcome is expected to be a robust, data-driven set of guidelines that websites can employ to minimize their carbon footprints.

### Phase 1: Data Collection

A representative set of websites will be identified, including:

- Sites built on **traditional platforms** (PHP, WordPress, Wix).
- **Green framework** demonstrations (Qwik, Astro).

Parameters such as hosting type (shared hosting, green hosting, cloud hosting), data center location, and average monthly traffic will be recorded. Tools like the **Website Carbon Calculator** and **Ecograder** will establish an emissions baseline for each site.

### Phase 2: Emissions Benchmarking

Each selected website will be evaluated against several key metrics:

- **Page load time:** measured with standard performance tools (e.g., GTmetrix, PageSpeed Insights).
- **Page size:** total bytes transferred for core assets (HTML, CSS, JavaScript, images).
- **Emissions:** grams of CO<sub>2</sub> per page view, extrapolated to annual figures based on visitor data.

Comparison across different frameworks and hosting environments will illuminate the magnitude of potential improvements through advanced optimization strategies.

### Phase 3: Sustainable Template Design

Building on insights from Qwik, Astro, and existing green guidelines, a **prototype template** will be developed. Key features include:

- **Lazy loading** of images and videos, ensuring only visible assets are fetched.
- **Optimized image formats** (e.g., WebP, SVG) and compression settings to minimize file size without sacrificing quality.
- **Code minification and bundling** to reduce load times.
- **Responsive design** to scale media based on screen size, further cutting unnecessary downloads.
- **Efficient hosting** that uses renewable energy sources or is otherwise certified by the Green Web Foundation.

Once finalized, the template will serve as a reference for integrating similar optimizations on traditional platforms.

### Phase 4: Platform Optimization Guidelines

Recognizing the widespread use of PHP, WordPress, and Wix, this research will adapt the principles from the newly developed template to produce a more accessible **step-by-step guide**. This guidance will encompass:

- **Plugin recommendations** for caching, image compression, and script minimization.
- Strategies for selecting low-impact themes or templates, focusing on minimal bloat and efficient code structure.
- Methods to implement partial hydration or conditional loading of scripts where feasible.

For Wix, a proprietary platform, emphasis will be on **configuration tips** (e.g., controlling image uploads, minimizing usage of third-party add-ons that can slow performance, and selecting templates designed with efficiency in mind).

## Phase 5: Real-World Case Study Implementation

To test real-world applicability, volunteer websites from small businesses, nonprofits, or personal portfolios will adopt the optimized template or guidelines. Baseline data will be collected, after which the improvements will be applied. Emissions and performance metrics will be re-measured under the same testing conditions.

## Phase 6: Emissions Comparison and Evaluation

Post-implementation data will be compared to initial benchmarks to measure **quantitative improvements**. Alongside these figures, qualitative assessments, developer feedback, user satisfaction will be gathered to gauge the feasibility of ongoing maintenance and potential trade-offs between aesthetics and efficiency.

## Phase 7: Documentation and Dissemination

Finally, a fully documented **guide and downloadable template** will be published. The dissemination strategy includes:

- An **online repository** hosting code snippets and best practices.
- Presentations at web development meetups and sustainability-focused conferences.
- Collaboration with hosting companies and content management system communities to promote these green practices.

## Expected Outcomes

By following the outlined methodology, several tangible outcomes are anticipated:

1. **Demonstrable Reduction in Website Emissions**

Through rigorous before-and-after comparisons, website owners can expect **reduced CO<sub>2</sub> emissions** per page view. Data centers hosting optimized sites may also see lowered resource usage over time, translating into additional cost benefits and smaller environmental footprints.

2. **Standardized Sustainable Website Template**

A user-friendly template built on energy-efficient principles along with code samples and documentation will be made available for the developer community. This resource will allow those unfamiliar with green frameworks to jumpstart a more sustainable build process.

3. **Platform-Specific Guidelines**

The research will culminate in an in-depth but accessible set of recommendations for **PHP**, **WordPress**. This is critical for mass adoption because these platforms occupy a large share of the global website ecosystem.

4. **Heightened Awareness of Sustainability Principles**

The publication of findings, case studies, and best practices will encourage **wider industry conversations** about sustainability. Organizations, developers, and clients may begin to view **environmentally responsible design** as a core web development requirement, not merely an optional enhancement.

5. **Community-Based Collaborative Growth**

With open-source templates and transparent guidelines, contributors from around the world can further refine, adapt, and enhance these solutions. The synergy of collective collaboration can continuously improve the sustainability posture of web design as a whole.

## Milestones and Timelines for Completion

Milestone	Timeline	Outcome
Literature Review	Month 1-3	A thorough deep-dive into existing studies, frameworks, and tools will solidify the knowledge base on sustainable web design. <i>Outcome:</i> A comprehensive compilation of current gaps, opportunities, and recognized best practices.
Benchmarking Website Emissions	Month 3-5	Representative websites from both green frameworks and traditional platforms will undergo energy usage evaluations. <i>Outcome:</i> Baseline emissions data, clarifying the primary carbon contributors.
Template Development	Month 6-9	The sustainable web template leveraging Qwik, Astro, or similarly efficient architecture will be created and refined. <i>Outcome:</i> An initial prototype of a low-carbon, high-performance website design.
Platform Optimization Guidelines	Month 9-12	Adapting the lessons learned from the template to PHP, WordPress, and Wix contexts, with step-by-



		<p>step instructions.</p> <p><i>Outcome:</i> Practical documentation for site owners and developers, bridging the gap between advanced frameworks and mainstream platforms.</p>
Validation through Case Studies	Month 12-15	<p>Test websites of willing participants will adopt the recommended optimizations, allowing for real-world data collection on pre- and post-implementation emissions.</p> <p><i>Outcome:</i> Empirical confirmation of the effectiveness of the proposed strategies.</p>
Documentation and Dissemination	Month 15-18	<p>The final stage includes presenting research findings in a synthesized guide, along with public talks, academic articles, or online workshops.</p> <p><i>Outcome:</i> A published, peer-review-ready report and open-source template, facilitating broad adoption.</p>

## Conclusion

The exponential expansion of digital content has serious implications for global energy consumption and environmental sustainability. Each click, page load, and data packet has an associated carbon cost, albeit invisible to most users. The research proposed here aims to systematically address this challenge by benchmarking existing websites, formulating a unified sustainable web design template, and demonstrating platform-specific optimizations for the most prevalent web ecosystems.

By examining a representative set of sites built with Qwik, Astro, PHP, WordPress, and Wix, this study's multi-phased approach not only quantifies the scope of current emissions but also offers data-driven solutions. These solutions, ranging from code-level optimizations to broader hosting strategies, underscore that sustainability and user experience are not mutually exclusive objectives. On the contrary, many green practices—like lazy loading, minified scripts, and efficient caching—also produce faster-loading, more user-friendly pages.

Ultimately, the outcomes of this research have the potential to catalyze a shift in developer mindsets by embedding sustainability within standard web development workflows. If developers, hosting providers, and organizations adopt even a fraction of the proposed best practices, the cumulative impact on reducing global carbon emissions could be profound. This work also highlights the crucial role of community engagement: by making the low-carbon template and guidelines open-source, we encourage continuous refinement and broad-scale collaboration. As the digital landscape continues to expand, sustainable web design stands out as a vital frontier for environmentally responsible innovation.

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