

Emerging Trends in Green Best Practices and the Impact on Government Policy

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ABSTRACT

While it is commonly accepted that climate change needs to be addressed to protect both human and environmental health, it is not widely understood what steps need to be taken to accomplish this daunting task. Additionally, there is currently no formal definition of what constitutes a ‘green’ company or ‘green’ best practice, despite the rising usage of the term. We found that companies that are considered ‘green’ have well-documented, quantifiable improvements in their sustainability plans and initiatives. These plans are published yearly in publicly available progress reports. Multi-year goals, with progress mapped from year to year, follow trends in the following areas: reduction in carbon emissions, energy obtained through renewable energy sources, amount of waste diverted from landfills, third-party certifications for buildings, water conservation, increasing ‘green’ requirements from suppliers, and sustainable fleet management. To address the gap between industry and government practices, and to capitalize on recent interest and investment in ‘green’, we recommend that all U.S. government agencies formalize and publicly release sustainability policies with quantifiable goals, identify practices to be implemented, and define metrics to measure progress. To effectively develop and implement these plans, we recommend: (1) each agency evaluate their current organization to develop a baseline, (2) define milestones and targets using the baseline as a starting point such that industry standards can be reached, and (3) release a finalized, publicly available sustainability plan.

1. Introduction

The Fourth National Climate Assessment defines climate change as the “changes in average weather conditions that persist over multiple decades or longer” and “encompasses both increases and decreases in temperature, as well as shifts in precipitation, changing risk of certain types of severe weather events, and changes to other features of the climate system” [1]. Over the last decade, climate change has become a central research area with interest and investment across both government and industry. While it is commonly accepted that climate change needs to be addressed to protect both human and environmental health, it is not widely understood what steps need to be taken to accomplish this daunting task. Inconsistencies in sustainability plans and policies between U.S. government and industry showcase the confusion and misunderstanding within the ‘green’ space. To properly address this issue, the government needs information on what proven and effective ‘green’ practices exist. With this, various approaches can be unified under a single definition to enact widespread change.

This work expands upon work previously done by the authors, going into a more detailed survey of the exploding popularity of the term ‘green’ [2]. In this survey, we both demonstrate and evaluate the lack of recognized, concrete definitions or metrics for this term and provide recommendations for action through policy. We will lay out what ‘green’ practices the U.S. government has already adopted, and, in contrast, what state-of-the-art sustainability practices are being implemented by industry. The authors will analyze the differences between the two groups, using the results as the baseline for developing the set of policy-based recommendations. The guiding research questions we will explore include: who are the industry leaders in the ‘green’ field; what are the ‘green’ best practices being utilized by these leaders; and, finally, what quantifiable metrics or features make a company ‘green’?

2. Background

2.1. Key Definitions

After assessing the terminology across industry and government, a few key definitions must be articulated to describe

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‘green’ best practices. It should be noted that there is no formalized, universally accepted definition for ‘green’. Here, ‘green’ will refer to anything that is accepted to be sustainable or environmentally friendly, including products, practices, technologies, etc. Table 1 below gives an overview of the key terms referenced throughout this paper.

Table 1: Key Definitions in Green Policy

Term	Definition
Green	Anything that is commonly accepted to be sustainable or environmentally friendly
Sustainability	The ability for a community to maintain environmental, health, and economic stability over an extended period. It should be noted that ‘green’ and sustainable are sometimes used interchangeably in media
Renewable Energy	Energy sources that are derived from sources that are naturally replenishing. These include solar, wind, geothermal, hydropower, and biomass (ex. wood, landfill/biogas, ethanol, biodiesel)
Non-Renewable Energy	Energy sources that once they are depleted, they cannot be replaced. These include petroleum, coal, nuclear, diesel, etc.
Clean Energy	Non-pollutant producing energy sources, including solar, wind, hydropower, geothermal, bioenergy, nuclear, and hydrogen/fuel cells. It should be noted that clean energy sources are not always renewable (ex. nuclear)

2.2. Best Practices

‘Green’ best practices are a set of actions that can be implemented to improve environmental impact, such as reducing greenhouse gas emissions, minimizing waste, saving water, etc. We observed six main categories of these practices, including renewable energy, sustainable buildings, fleet management, waste reduction, water conservation, and sustainable purchasing. Table 2 below provides a few examples of each category.

Table 2: Overview of Green Best Practices

Best Practice	Example
Renewable Energy	Increasing use of solar, wind, hydropower, and geothermal energy, purchasing of renewable energy credits (RECs)
Sustainable Buildings	Requirements for new constructions to incorporate sustainable design plans, ‘green’ building certification
Fleet Management	Develop a vehicle fleet with more fuel efficient vehicles, or vehicles that use biofuels/renewable energy
Waste Reduction	Reducing demolition and construction waste, composting, paper reduction, increased recycling
Water Conservation	Installing dual plumbing for incorporating non-potable water sources, reducing landscaping costs, monitoring consumption to better understand use
Sustainable Purchasing	Committing to purchasing recycled, biobased, and other sustainable products

3. Benefits of ‘Green’ Practices for Government Agencies

In addition to environmental impact, there are many other benefits of implementing ‘green’ best practices. Some of the key benefits include: cost savings, improved safety and security, and

public health. The section below will provide an overview of each of these benefits and how they can impact government agencies.

3.1. Cost Savings

One of the biggest benefits of implementing ‘green’ practices is the cost-savings, particularly on long term investments. Renewable energy is a great example of substantial cost-savings over time. Many renewable sources, such as solar, wind, or hydropower, do not require fuel costs. Traditional fossil fuel sources, like coal and oil, require not only high material costs, but often involve costly transportation fees as well. The cost of solar photovoltaics (PV) systems has fallen dramatically over the past decade [3] and currently wind is “either competitive with, or less expensive than, coal-generated electricity – and it is a form of Clean Energy. Ongoing cost reduction will soon make wind energy the least expensive source of electricity, perhaps within a decade” [4].

In addition to decreasing energy costs, there are other economic impacts from the implementation of sustainable practices. For example, studies have demonstrated that renewable energy policies within the Rust Belt have the potential to reduce air pollution to such a degree that the savings from improved human health would exceed the costs of the policies by 2030, with more stringent implementation having an even more pronounced cost-savings effect [5]. The decreased energy costs as well as health-related savings makes implementation of ‘green’ best practices a favorable financial decision for the U.S. government.

3.2. Safety

From a military perspective, safety is a major benefit of ‘green’ practices. There are direct relationships between increased safety to soldiers through the implementation of these best practices. One example is the use of more energy efficient vehicles. In active war zones, refueling missions are high risk. In Afghanistan, for example, oil refueling operations document one casualty for every 24 field-resupply convoys [6]. More fuel-efficient vehicles not only decrease fossil fuel use and carbon emissions, but can reduce the number of refueling missions required, saving soldiers’ lives.

Extending beyond the military, implementing ‘green’ practices can increase safety for the entire nation. The National Climate Assessment (NCA) report states that “Climate change creates new risks and exacerbates existing vulnerabilities in communities across the United States, presenting growing challenges to human health and safety, quality of life, and the rate of economic growth” and notes that future impacts of climate change are “expected to further disrupt many areas of life, exacerbating existing challenges to prosperity posed by aging and deteriorating infrastructure, stressed ecosystems, and economic inequality” [1]. The report also emphasizes that vulnerable communities, lower-income, historically marginalized, etc., may experience greater impacts [1]. Wide-scale implementation of ‘green’ practices protects both military and civilian lives.

3.3. Security

‘Green’ practices are a unique opportunity to fortify national security. Researchers from the National Renewable Energy Lab (NREL) note that “renewable energy can support energy security by adding diversity to an overall electricity generation portfolio...

A more spatially diverse generation and storage energy portfolio can better withstand shocks to the system. With more resources across different geographic areas, such diversity could power infrastructure during disasters, cyberattacks, or other extreme events” [7]. With wider use of these energy sources, there is a decreased dependency on fossil fuels. Disruptions in the supply chain could lead to disastrous effects for both the nation and our military. Transitioning to renewable-energy sources not only addresses supply chain risk but can also increase the physical security of the energy generation process by decreasing reliance on centralized production and subsequent distribution. Many renewable sources can be implemented on-site, such as at military installations, strengthening the resiliency of the that location’s energy supply. The electrical grid is particularly susceptible to attacks, both cyber as well as physical, which could disrupt operation at critical facilities [6]. Localized power on-site using renewable sources decreases these risks and thus greatly improves security.

In addition, climate change is a critical driver of military investment in ‘green’ practices. Rising sea levels, for example, are a particular concern for the Navy. There is an expected increase in the demand for the Navy’s military and humanitarian services in response to the effects of climate change. Both domestic and global bases and ports will be at high risk as sea levels rise and weather patterns become more severe [6]. Slowing the rate of climate change not only gives the Navy and other military branches more time to prepare for these challenges but can also prevent some of these concerns from even becoming a reality.

3.4. Public Health

Implementing these practices will also impact public health through the reduction in greenhouse gas emissions. The National Climate Assessment report notes that the “health and well-being of Americans are already affected by climate change, with the adverse health consequences projected to worsen with additional climate change” due to the effects of “exposures to heat waves, floods, droughts, and other extreme events; vector-, food- and waterborne infectious diseases; changes in the quality and safety of air, food, and water; and stresses to mental health and well-being” [1].

Implementing ‘green’ practices and enacting sustainability-focused policies has the potential to reduce the risks and impacts from climate-sensitive health outcomes, and researchers project that “additional benefits to health arise from explicitly accounting for climate change risks in infrastructure planning and urban design” [1]. The report claims that “reducing greenhouse gas emissions would benefit the health of Americans in the near and long term” and that “thousands of American lives could be saved and hundreds of billions of dollars in health-related economic benefits gained each year under a pathway of lower greenhouse gas emissions” [1].

4. Methodology

As described above, the benefits of ‘green’ practices are undeniable, particularly from a government perspective. The goal of this work was to provide an overview of the different definitions of ‘green’, highlight the emerging trends, and illustrate gaps

between government and industry practices. In this process, we illustrate the growing need to set goals, assign priorities, establish regulations, and make investments as well as guidance for where to focus these efforts. This is intended to provide foundational information for implementing green policy, as well as identified resources for where to look for more information when setting or writing future sustainability policies.

The team conducted a survey of ‘green’ practices and policies across both government and industry. To assess the current state of the government sustainability efforts, the authors reviewed government agency sustainability plans and published ‘green’ goals, ‘green’ focused legislation and executive orders (EOs), as well as the timeline of when and how these documents were put into effect. For industry, key players were identified based on a combination of publicly released policies, data, and status on third-party ‘green’ rankings. The publicly released ‘green’ initiatives and policies of these companies were then compiled as a list of best practices as well as analyzed for industry-wide trends. The results of these evaluations were then used to identify gaps within current government ‘green’ efforts. Based on these findings, recommendations were made for what steps the government should take moving forward, as well as what research still needs to be done to properly implement these actions.

4.1. Sustainability Evaluation

While there are plenty of organizations with sustainability practices already in place, it can be challenging to compare different companies to one another. To help with this, several third-party organizations have developed sustainability certifications and rankings to help consumers better understand leaders in industry. These accolades have considerable impact on a company, affecting everything from brand image to product success. Having a high sustainability ranking or ‘green’ certified products and facilities can attract talent and generate new business. Pew Research studies have shown that adults under 50 believe protecting environment and increasing reliance on renewable energy sources should be a high priority for America’s energy policies [8] and adults under 30 place a high priority on protecting the environment [9]. Additionally, both Glassdoor and Forrester Research observe that both job seekers and consumers are gravitating towards companies whose mission and culture align with their values [10] [11]. In addition, as today’s consumers become more concerned about the environmental impact of their purchasing decisions, these certifications and rankings can influence purchasing decisions.

4.2. Sustainability Certifications

Sustainability certifications are third-party evaluations that assess the sustainability of a building, business, product, etc. These programs often provide both an assessment of the current sustainability practices or designs in place as well as what steps need to be taken to make further improvements. Additionally, many certifications have varying levels (ex. gold, silver, etc.) that indicate what that particular service has achieved. Table 3 gives an overview of available programs in each of the main certification categories.

Table 3: Sustainability Certification Overview

Category	Certification	Summary
Buildings	LEED	Leadership in Energy and Environmental Design (LEED), certification for buildings based on sustainable design features [12]
	WELL	Building Standard to create buildings and originations with thoughtful and intentional spaces that enhance human health and well-being [13]
	EDGE	Building certification focused on making buildings more resource-efficient [14]
	ParkSmart	Certification program for developing sustainable parking garages [15]
	Energy Star	Certification for products and buildings following standards set by the EPA; Energy Star buildings must save energy, money, and help protect the environment through limited generation of greenhouse gas emissions [16]
	SITES	Sustainability-focused framework for landscape design (reduce water demand, reduce energy consumption, improve air quality, etc.) [17]
	Living Building Challenge Certification	Certification program with a goal to create buildings that generate more energy than they use, capture and treat all water on site, and are built using healthy materials. Several different certifications available: Core Green Building Certification, Zero Energy Certification, and Zero Carbon Certification [18]
	Green Building Initiative	Certification program (Green Globe Certification) designed to allow building owners to select which sustainability features best fit their building and its occupants, creating a custom-tailor approach that helps from the most sustainable outcomes [19]
	BREEAM	Building Research Establishment Environmental Assessment Method (BREEAM); method of assessing, rating, and certifying the sustainability of buildings [20]
Businesses	Green Business Bureau Seal	Online green business certification program using the Green Business Bureau (GBB)'s Eco Assessment tool [21]
	Green America Certified Business	Certification that evaluates companies according to principles of social justice and environmental sustainability [22]
Products/ Materials	Energy Star	Certification for products as well as buildings following standards set by the EPA; products must reach a defined set of criteria, applicable for computers, servers, appliances, heating and cooling systems, electronics, lighting, etc. [16]
	WaterSense	Voluntary partnership program sponsored by the EPA, products and services are certified to use at least 20 percent less water, save energy, and perform as well as or better than regular models [23]
	EPEAT	Certification for electronics; leading ecolabel covering products and services from the electronics sector [24]
	Safer Choice	Certification through the EPA Pollution Prevention which identifies products that are both high performing and contain ingredients that are safer for human health and the environment [25]
	USDA Organic	U.S. certification for foods to be labeled organic according to federal guidelines on soil quality, animal raising practices, pest control, and use of additives [26]
	Fair Trade Certified	Certification evaluating a company's use of equitable trade practices across their supply chain, ensuring fair treatment, prices, and environmental impact [27]
	Green Seal	Green Seal Verification confirms that a raw material, concentrate, formula, or parent roll is proven to meet human and environmental health standards [28]
Other	PEER	Certification for the power and energy sector [29]
	GRESB	Global Real Estate Sustainability Benchmark Certification, assesses the sustainability and ethical impact of real estate and infrastructure [30]
	WasteWise	Program through the EPA to encourage companies to reduce waste, practice environmental stewardship, and incorporate sustainable materials management into their waste-handling processes [31]

4.3. Sustainability Rankings

In addition to various certifications, ranking systems have also come about for the top sustainable companies. The leading classifier is the Global 100, an annual ranking of corporate sustainability performance performed by Corporate Knights (CK). This list is released each January at the World Economic Forum in Davos and is considered the gold standard for sustainability ranking evaluations. For companies to be eligible for the Global 100, they must meet several eligibility requirements. Only publicly listed companies with a gross revenue of a minimum of one billion dollars can be considered. From this initial list, all industries and locations are eligible before screening [32].

CK uses only publicly disclosed data, such as financial filings and sustainability reports, to evaluate 21 different key performance indicators (KPIs) which cover resource management, employee management, clean revenue, and supplier performance. Out of this list, all companies are evaluated on the eight universal KPIs: percentage tax paid, pension fund status, supplier sustainability, women in executive management, women on boards, sustainability pay link score, sanctions deductions, and clean revenue. Other KPIs are considered based on a company's corresponding CK Industry Group. It should be noted that there are automatic disqualifiers such as companies that produce weapons, tobacco, or lobby to block climate change policy [32].

5. Sustainability Policies and Legislation within the United States Government

5.1. Federal Government

Before the early 2020s, the U.S. federal government made minimal steps toward implementing sustainability policy. There was over a decade lull where, for example, no major law regarding sustainability was passed between the mid-2000s through the early 2020s. The Energy Policy Act of 2005 [33] introduced tax incentives and loan guarantees for various energy sources, while the Energy Independence and Security Act of 2007 [34] aimed to move the U.S. toward greater energy independence and security through the increase of clean renewable fuels.

During this lull, only a handful of Executive Orders (EO) and government guidelines were released for implementing sustainable practices. In 2015, a comprehensive document, Planning for Federal Sustainability in the Next Decade [35], was put into effect, outlining the federal government's 10-year plan for implementing more sustainable practices. Following this, several other guidelines were released, including Executive Order 13834, Efficient Federal Operations [36] in 2018 and the Guiding Principles for Sustainable Federal Buildings and Associated Instructions [37] in 2020. EO 13834 "affirms that it is the policy of the United States that agencies meet energy and environmental performance statutory requirements in a manner that increases efficiency, optimizes performance, eliminates unnecessary use of resources, and protects the environment" and that "agencies are tasked to prioritize actions that reduce waste, cut costs, enhance the resilience of federal infrastructure and operations, and enable more effective accomplishment of its mission. Additionally, EO 13834 has been revoked by Executive Order 13990, Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis, which "directs all executive departments and agencies to

immediately review and, as appropriate and consistent with applicable law, take action to address the promulgation of federal regulations and other actions during the last 4 years that conflict with these important national objectives, and to immediately commence work to confront the climate crisis" [38].

A major shift in 'green' policy has been seen in the early 2020s, with multiple examples of legislation focused on climate change and sustainability going into effect in just a few short years. This change will be discussed later in this section, but it should be noted that a need still exists to further develop legislation, policy, and regulations to make substantial impact on a 'greener' nation.

5.2. Military Agencies

Many of the benefits of 'green' best practices are valuable to the U.S. military. As discussed above, these practices can help to improve safety for soldiers in the field and increase security of military bases, all while decreasing operational costs. For these reasons, the Department of Defense (DOD) has released yearly Sustainability Reports and Implementation Plans (SRIP), and branches of the military have already identified sustainability as an organization-wide goal. For example, the Navy, Army, Air Force, and National Guard, all have sustainability policies already in place, though these policies largely only reference goals and plans outlined in EOs and the DOD SRIP.

The DOD Sustainability plan released in 2020 identifies four major priorities: energy resilience, water efficiency, sustainable acquisition, and electronics stewardship [39]. When detailing the progress and goals for energy resilience, the report emphasizes goals to reduce energy consumption, while noting that there are goals in place for the DOD "to produce or procure greater than or equal to 25% of the total quantity of facility energy DOD consumes within its facilities during FY 2025 and each fiscal year thereafter from renewable energy sources," but that in 2019, only "6.0% of facility electricity consumption was procured from renewable energy sources" [39]. Although the Department does not have specific water efficiency goals, DOD is successfully using innovative approaches to conserve water, save costs, and assure access to an adequate water supply for mission success [39].

DOD policies and guidance encourage the construction of high performance and sustainable buildings. Policy requires "new construction and major renovations to adhere to the Guiding Principles for Federal Sustainable Buildings" and instructs DOD buildings to obtain "at least the LEED silver level (when cost effective)" [39]. DOD policies also outline quantifiable goals for waste reduction, such as "2% reduction in non-hazardous solid waste generated in FY21 from FY20 40% diverted and 60% sent to treatment and disposal facilities in FY21" [39]. While the report contains quantifiable goals for reducing waste sent to landfills as well as reducing energy consumption and, the report mentions the goal for "continuous improvement" for other 'green' practice adoption goals [39].

In addition to implementing sustainability plans, many military branches have achieved impressive feats in implementing best practices. For example, the Weed Army Community Hospital in Irwin, California has been awarded the LEED Platinum standard, the highest level given. The facility is both carbon neutral and has net zero energy output, meaning that all electricity is generated

onsite from renewable energy sources [40]. While the military is beginning to take steps to make their facilities, fleets, and operations more sustainable, more resources, education, and support is required to make substantial lasting change across the entire organization.

5.3. Environmental Agencies

The leading U.S. government organization focused on the environment is the Environmental Protection Agency (EPA), whose mission is to protect both human health and the environment. In 2018, the EPA published Working Together: FY 2018-2022 U.S. EPA Strategic Plan [41], which gave three goals for accomplishing the above mission. These are outlined in Table 4.

Table 4: EPA FY2018-2022 Strategic Plan Goals Overview [41]

Number	Overview	Description
Goal 1	A cleaner, healthier environment	Deliver a cleaner, safer, and healthier environment for all Americans and future generations by carrying out the Agency’s core mission
Goal 2	More effective partnerships	Provide certainty to states, localities, tribal nations, and the regulated community in carrying out shared responsibilities and communicating results to all Americans
Goal 3	Greater certainty, compliance, and effectiveness	Increase certainty, compliance, and effectiveness by applying the rule of law to achieve more efficient and effective agency operations, service delivery, and regulatory relief

In addition to the EPA, the Department of Energy (DOE) does considerable work related to sustainability in the energy sector. The mission of the DOE is to “ensure America’s security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions” [42]. The DOE helps to fund research and development of clean energy technologies, collaborating across industry, academia, and government to produce new and innovative approaches to the energy crisis. Recently, the DOE announced two renewable energy investments, one with the goal to “cut the cost of solar energy by 60% within the next ten years, in addition to nearly \$128 million in funding to lower costs, improve performance, and speed the deployment of solar energy technologies” and one with the goal to deploy 30 gigawatts (GW) of offshore wind by 2030 [43]. In addition, the DOE has 17 labs where they operate research topics like climate change. Within the DOE, the Office of Energy Efficiency and Renewable Energy (EERE) focuses specifically on renewable and clean energy.

5.4. Increased Government Sustainability

As stated above, there was minimal investment in ‘green’ before the early 2020s. No major laws and only few sustainability-focused EOs were implemented over a 15-year period. Beyond just legislation, several climate initiatives were canceled in the late

2010s, such as the Navy’s Climate Task Force, and the U.S. officially withdrew from the Paris Climate Agreement in 2020 [44].

Beginning in 2021, however, drastic changes were made across the government that showcased their commitment to creating a more sustainable nation. Not only did the U.S. re-enter the Paris Climate Agreement [45], but many climate change focused EOs were put into place: Executive Order 13990: Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis [38], Executive Order 14008: Tackling the Climate Crisis at Home and Abroad [46], and Executive Order 14013: Rebuilding and Enhancing Programs to Resettle Refugees and Planning for the Impact of Climate Change on Migration [47]. These orders not only established various environmental policies but made a strong statement about the government’s stance on the environment moving forward. For example, EO 13990 revoked the permit for the controversial Keystone XL Pipeline [38].

These initiatives grew beyond just EOs and several pieces of legislation focusing on climate change and sustainability have been put into effect. In 2021, the Infrastructure Investment and Jobs Act [48] addressed climate change concerns, specifically on its impact to the transportation system. Furthermore, the Inflation Reduction Act of 2022 [49] marked billions of dollars for climate change and energy research and development, making it the largest U.S. government investment in climate change to date. This trend was seen throughout government activities during 2022. For example, the National Strategy for Advanced Manufacturing [50] stressed the need to invest in sustainable manufacturing to further address the climate crisis.

As a nation, we need to continue this trend and continue to develop further legislation, policy, and regulations to make substantial impact on a ‘greener’ nation. With this increased investment in sustainability, now is the time to harmonize government ‘green’ policy to make lasting, impactful changes. By developing sustainability plans and practices like those used by industry, the U.S. can become a leader in the international ‘green’ space. By actively working on climate change and global warming issues at the national level, the government can influence other nations and make world-wide impact.

6. Industry Sustainability Trends

The observed key players in industry are considered ‘green’ leaders due to the publicity surrounding their environmental initiatives and publicly available sustainability policies. These yearly sustainability reports contain the company’s short and long-term goals, current metrics and measurements, as well as documented progress. This showcases both their sustainability efforts and effort to cultivate the culture of sustainability, in addition to asserting the company’s influence in the ‘green’ space.

6.1. Renewable Energy

All industry leaders investigated in this study place strong emphasis on renewable energy adoption and carbon emission reduction. Google, for example, has achieved carbon neutral-status for the last 12 years and has purchased enough renewable energy to match 100% of their global electricity consumption since 2017 [51]. Similarly, starting in 2018, Apple announced its global facilities (including retail stores, offices, data centers and co-located facilities in 43 countries) are powered with 100%

renewable energy. These renewable energy projects include Apple Park, Apple's headquarters in Cupertino, which is powered by 100% renewable energy. Power comes from multiple sources, including a 17-megawatt onsite rooftop solar installation and four megawatts of biogas fuel cells, all controlled by a microgrid with battery storage [52]. Currently, Starbucks purchases enough renewable energy to power 100% of its company-operated stores in the U.S., Canada, and the U.K. as well as making strategic investments in solar and wind farms [53].

6.2. Circular Economy

The observed industry leaders' sustainability policies also place a strong emphasis on reducing waste through a shift towards a "circular economy", one that benefits businesses, society, and the environment [54]. Google, for example, states that their goal is to "design out waste and pollution", with the aim being to eliminate release of greenhouse gases, the use of toxic and hazardous substances, the pollution of air, land, and water, and landfilling and incineration of waste at the design phase. Their designs aim to maximize product use and reuse: designing for durability, repair, reuse, remanufacturing, and ultimately recycling. Through these more durable and recyclable products, Google seeks to "create demand for recycled materials in order to accelerate the transition to a circular economy" [55]. Similarly, Apple has expanded their refurbished devices program over recent years in their shift towards a "circular economy" mentality. More than 11 million devices were sent by Apple to be refurbished for new users in 2019, a 42% increase from the previous year [53]. While Starbucks does not focus on explicitly implementing the 'circular economy' concept within their business practices, they do set goals to "reduce waste sent to landfills from stores and manufacturing by 50%, driven by a broader shift toward a circular economy" [56].

6.3. Sustainable Buildings

These companies are not only redesigning their products and packaging, but also the buildings that house their operations. By the end of 2019, over 1.4 million square meters (13 million square feet) of Google office facilities had achieved LEED certification [51]. Moving beyond LEED certification, Google is also pursuing the Living Building Challenge (LBC) Materials Petal certification for its facilities, which would certify that every building product on-site has been vetted against the LBC's Red List of worst-in-class chemicals that pose human and environmental health concerns. Similarly, "more than 50 Apple sites have received LEED or BREEAM (Building Research Establishment Environmental Assessment Method) certifications" [53]. Apple facilities feature many 'green' practices such as natural ventilation systems to highly efficient hydronic radiant heating and cooling, smart LED lighting, and high-efficiency water-cooled chillers, low-flow fixtures, and an irrigation system that uses 90% recycled water help to optimize water consumption [53]. Starbucks has similarly built more than 1,600 LEED-certified stores, but intends to go "beyond LEED, expanding the scope and breadth of [their] greener stores commitment with an open-source Greener Stores framework for design, construction and operation" [57].

6.4. Fostering a Sustainable Culture

Industry leaders are changing not only the company's buildings, but also the culture within their organization. For

example, Google recognized that "reducing single-use beverages relied on behavior science insights in order to raise the desirability of sustainable and healthy options", and that a broader "culture change also matters" [55]. Similarly, Starbucks provides 'green' education materials and has "14,800 Greener Apron partners" with their goal to "empower 10,000 partners to be sustainability champions by the end of 2020" [57].

6.5. External Sustainable Investments

Companies are also making strategic investments outside of their organization. For example, Google committed to "invest roughly \$150M into renewable energy projects in key manufacturing regions" to further reduce carbon emissions. These investments are not limited to just renewables - the company also "requires the highest ethical standards throughout [their] supply chain" and is "working to promote meaningful improvements in the communities in which [they] operate" [58]. Similarly, Apple has made strategic investments in renewable energy technologies. Apple not only runs its facilities on 'green' power (including solar roofs) but has "also convinced 23 companies in its supply chain to sign a pledge to get to 100% renewable energy for the portion of their business relating to Apple products" [59].

Additionally, industry leaders are creating and contributing to funds that will invest in the restoration and protection of forests and natural ecosystems globally. Apple has made several steps in this effort, including creating "a fund in partnership with Conservation International" with the goal to 'help protect and restore the world's forests, wetlands, and grasslands to remove excess carbon from our atmosphere" [53] in addition to working with the Alliance for Water Stewardship, "investing in their work to raise awareness throughout the Asia-Pacific region on this issue, to build tools and training for the AWS certification process, and to increase support for suppliers working to be certified" while encouraging suppliers to pursue AWS certifications [53].

Starbucks has stated a commitment to ethically sourced products [60] marked by their 'Coffee and Farmer Equity (C.A.F.E.) Practices, one of the coffee industry's first set of sustainability standards, verified by third-party experts', which was developed in collaboration with Conservation International (CI), and 'includes over 400,000 coffee farmers in 28 countries that are committed to improving working conditions and spanning more than a million hectares of land committed to sustainable growing practices', recognizing that the 'longevity of the coffee industry is directly linked to the social, economic and environmental conditions of coffee communities' [61]. Starbucks has also invested in reforestation efforts with '40 million trees distributed since 2015' and the goal to provide '100 million coffee trees to farmers by 2025' [57], and links social responsibility to 'green' practices, and notes in their sustainability report that the company sells "99% ethically sourced tea" and have contributed "\$46 million invested in farmer loans" [57].

7. Emerging Trends

Across industry, companies are investing in renewable energy to reduce their carbon emissions and transition away from fossil fuels. At a more granular level, companies are implementing 'green' practices in their buildings using new technologies, such as water conservation techniques, natural ventilation systems, and

smart LED lighting. Companies are pursuing LEED certification for their buildings, as well as new, more rigorous certifications. We also observe a focused shift towards a “circular economy” that reuses materials where possible. Each company investigated had a strong focus on employee engagement and fostering a culture that emphasizes sustainable practices. Many of these companies are also exerting their influence on suppliers and making strategic investments (both domestic and abroad) to shape ‘green’ practice adoption, such as reforestation efforts and renewable energy microgrids.

It should be noted that ‘green’ work goes beyond industry efforts. Research is being conducted across academia to develop new technologies and practices, as well as identify areas where further ‘green’ work needs to be done. One example of this is data centers, which have been identified as a major contributor to carbon emissions. These centers contribute exorbitantly to power consumption and their continued growth will be unsustainable such that the energy needed to power these capabilities might be infeasible, contribute greatly to greenhouse gasses, or both. Research is currently being done to assess the state of the art in sustainable computing, as well as identifying and characterizing challenges and potential solutions [62] [63].

8. Conclusions and Research Findings

This work provides an overview of the many different definitions of ‘green’, in addition to highlighting emerging trends and illustrating the growing gaps between government and industry practices. These findings demonstrate the need to set goals, assign priorities, promulgate regulations, and make investments, as well as guidance for where to focus these efforts. This work is intended to provide foundational information for implementing green policy, as well as identify resources for where to look for more information when creating sustainability policies.

One of the first steps in enacting ‘green’ practices across the government is to formalize a single definition for the term ‘green’. The EOs enacted in 2021 emphasize a need for a “whole-of-government approach to combatting the climate crisis” (which would require coordinated and deliberate approach) as well as a need to “leverage the federal government’s footprint and buying power to lead by example” (which would require a consistent example and well understood priorities to follow) [46]. With a formalized definition and articulated ‘green’ priorities, the combined “whole of government” approach with the federal government’s buying power provides unique opportunities to evaluate the national benefits and costs of pursuing more nationwide transformational ‘green’ initiatives. Examples of these actions could include incentivizing a large-scale transition to all-electric vehicles and a large-scale shift to a decentralized power grid by using renewable energy based DERs and microgrids.

The phenomenon of “greenwashing,” where corporations mislead consumers about their environmental performance or the environmental benefits of a product or service [64], has become increasingly widespread [65] and has eroded consumers and citizens’ trust [66]. These incontinences around the term ‘green’ have created a misunderstanding of the true benefits of implementing more sustainable practices in the government and across the U.S. We recommend the federal government enact a top-down ‘green’ definition as well as ‘green’ priorities that will

standardize how environmental suitability and planning is approached.

To capture the findings from our survey of ‘green’ best practices, we provide answers to our original research questions in the following sections.

8.1. What quantifiable metrics or features make a company ‘green’?

This work observed that companies considered ‘green’ have well-documented, quantifiable improvements in their sustainability initiatives. These are published in yearly, publicly available progress reports that often include multi-year goals as well as progress over time. The goals could include reduction in carbon emissions, amount of energy obtained through renewable sources as opposed to traditional fossil fuel sources, amount of waste diverted from landfills compared to previous years and obtaining third-party certifications for sustainable buildings. We also observed quantifiable goals and developments in the areas of fleet management, water conservation techniques, and increasing ‘green’ requirements for suppliers.

8.2. What are ‘green’ best practices?

The U.S. government identifies ‘green’ best practices as practices that improve energy resilience, water efficiency, sustainable acquisition and lifecycle management, and electronics stewardship [39]. As mentioned, the DOD has goals to source greater than 25% of facility energy from renewable energy sources, as well as goals to incorporate innovative approaches to conserve water. DOD policies also prioritize high performance and sustainable buildings that target at least the LEED silver level. DOD policies also outline quantifiable ‘green’ goals for waste reduction, including quantifiable reduction in waste generated, as well as quantifiable goals for increasing the percentage waste diverted from landfills.

Industry leaders identify ‘green’ best practices as those that target carbon emissions, focusing on investments in both renewable energy and developing a ‘circular economy’ business approach. Companies are also implementing more granular ‘green’ practices such as water conservation techniques (including dual-plumbing systems to leverage non-potable water source where possible), natural air circulation ventilation systems, and smart LED lighting. Additionally, industry leaders emphasize employee engagement and culture shifts to promote a company culture that implements ‘green’ practices. Many of these companies have also invested in ways to shape ‘green’ practice adoption outside of their direct organization, such as reforestation efforts and renewable energy microgrids.

As discussed in Section 4.2, third-party certifications help identify ‘green’ best practices in the areas of sustainable buildings, business values, product manufacturing, and water use. Beyond this, third-party rankings use key performance indicators such as resource management, employee management, clean revenue, and supplier performance to grade companies. Using the well-regarded Corporate Knights method, companies are evaluated on the eight universal KPIs: percentage tax paid, pension fund status, supplier sustainability, women in executive management, women on boards, sustainability pay link score, sanctions deductions, and clean revenue.

8.3. Who are the industry leaders in the 'green' field?

Through our survey, Google, Apple, and Starbucks were identified as viable case studies for 'green' leaders in industry. It should be noted that Disney, IBM, and Dell also appear on sustainability rankings lists but were not used as the primary focus in this investigation [32]. The three chosen companies are not only acknowledged as leading 'green' institutions, but also offer publicly available sustainability reports that could both be reviewed for the purpose of this investigation but can be used as examples for other organizations developing their own plans.

9. Recommendations

To be competitive with industry and international partners, we recommend that all U.S. government agencies formalize and publicly release sustainability policies with (1) quantifiable goals aligned with the major areas industry leaders are targeting, (2) identified 'green' practices the agency plans to implement to meet these goals, and (3) metrics the agency plans to use to measure sustainable progress. As a first step to develop these goals, we recommend each agency evaluate their current organization as a baseline for improvements. The major sustainability areas discussed in this paper (renewable energy use, sustainable building, fleet management, waste reduction, water conservation, and sustainable purchasing) should be included in this investigation. Existing evaluation methods, such as the Corporate Knights ranking procedure, should be used as a guideline during the process. Once the baseline is determined, milestones and targets should be planned such that the government can meet industry standards for sustainable practices (carbon neutral, net-zero to landfill, buildings maintaining LEED certification, etc.). A new EO that standardizes agency green practices across the U.S. government would help catalyze individual agency efforts. Further U.S. government funded research on how 'green' best practices slow climate change and its adverse societal consequences, improve public health, and enhance environmental protection is also recommended.

10. Future Work

While this report outlines the changing landscape of 'green' practices, we recognize that there are a multitude of barriers inhibiting wider-spread adoption of these practices and an evaluation needs to be performed to determine what these barriers are and how to best address them. These barriers include, but are not limited to, the following: perceived cost, conflicting codes and guidelines, and lack of government resources. One of the most widely documented barriers to 'green' practice adoption is the upfront expense for implementation. Additionally, we observed that LEED certification conflicts with certain COVID guidelines, specifically for ventilation.

The next step for this research is to formally investigate these barriers to adoption to propose novel solutions to remove those barriers and enable implementation of 'green' practices and climate mitigation strategies. The authors completed an initial investigation to these barriers specially for solar photovoltaics [67] and are continuing the research.

Conflict of Interest

The authors declare no conflict of interest.

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