CIRCULAR ECONOMY IN THE STATES: AN ANALYSIS OF CURRENT POLICIES, STANDARDS, AND BEST PRACTICES

Author: Sean Trambley, Vice President, Public Policy, US Circular Economy Coalition

Abstract

This report provides a comprehensive examination of circular economy initiatives across five leading U.S. states, California, New York, North Carolina, Colorado, and Washington, highlighting state-level policies, best practices, and industry adaptations shaping the transition from linear to circular production and consumption systems. Focusing on sectors including waste management, construction and manufacturing, technology, energy, food and organics, logistics, and local governance, the analysis identifies both successes and systemic challenges in advancing material circularity, waste diversion, and resource efficiency. As the federal government has deprioritized sustainability and circularity, states are demonstrating their crucial role in implementing policies to achieve circular outcomes.

Across the five states, extended producer responsibility (EPR) frameworks, organic waste diversion mandates, and renewable material innovation have become major policy drivers. California's SB 54 on plastic pollution reduction, Washington's Clean Materials Bill, and New York's growing EPR and packaging weight reduction programs demonstrate regulatory leadership, while North Carolina and Colorado offer emerging models focused on construction material reuse, bioenergy generation, and landfill methane reduction. Each policy area reveals tensions between mandated recycling targets and market realities, particularly in sectors reliant on global material flows and complex supply chains. These state laws also raise some questions about consistency from state to state as corporations try to meet new standards.

The report benchmarks corporate circularity practices against evolving international standards, including ISO 59004 (Framework and Principles), ISO 59010 (Guidelines for Business Models and Value Chains), and ISO 59020 (Performance Measurement). It assesses the alignment between these standards and real-world implementation, revealing gaps where sector-specific standards, such as those for batteries, construction materials, or packaging, diverge from ISO guidance or remain under development. Companies in all five states demonstrate growing sophistication in lifecycle analysis, product redesign, and supply chain circularity, yet many initiatives remain driven by cost and efficiency gains rather than formal circular economy alignment.

A proposed "Circular Economy Playbook" synthesizes state and sector insights into actionable strategies: embedding lifecycle thinking, designing for modularity and reuse, implementing traceable materials management, and engaging in policy partnerships. The report shows that while a standards-based approach provides essential structure, successful circularity depends on flexible, cross-sector collaboration and pragmatic integration of standards with economic and operational realities. The ongoing decoupling of waste generation from population and GDP growth, particularly through innovations in packaging, renewable construction materials, and bioenergy, illustrates both the promise and complexity of circular transition pathways in the United States.

Introduction

Across the United States, the concept of the *circular economy*, a system that designs out waste, keeps materials in use, and regenerates natural systems, is gaining traction as a response to rising material consumption, environmental pressures, and global resource volatility. States and industries are beginning to recognize that circularity is not only an environmental imperative but also a driver of innovation, resilience, and economic competitiveness. Yet, the pathways to implementation vary widely across sectors and jurisdictions. This report explores how five states, **California, New York, North Carolina, Colorado, and Washington**, are shaping the circular transition through distinct policies, standards, and industry practices. Together, they represent a cross-section of geographic, economic, and policy diversity, offering a snapshot on how circular principles can be operationalized in the U.S. context.

The circular economy's relevance cuts across industries. Waste management agencies and recycling firms are redefining diversion strategies to handle emerging waste streams, from organics and construction debris to electronic and battery components. Manufacturers and builders are integrating recycled concrete, modular building materials, and low-carbon cement into their supply chains. Technology companies are closing material loops through device

take-back programs and battery recovery systems, while energy firms are scaling biofuel production and integrating circular feedstocks into energy generation. In parallel, local governments and utilities are leveraging procurement policies, landfill diversion targets, and data-driven tracking to enable circular markets. Academic and research institutions, meanwhile, play a crucial role in developing lifecycle assessment frameworks and training the workforce needed for this transformation.

However, the circular economy is not simply an extension of recycling or waste reduction. It represents a structural shift in how value is created—through designing for reuse, repair, remanufacture, and regeneration. The evolution from early recycling initiatives to comprehensive circular systems is evident in the policies and practices examined in this report. **Extended Producer Responsibility (EPR)** programs, for example, are transforming product stewardship in California and New York, while **organic waste diversion mandates** in California and Washington are reshaping municipal composting and bioenergy infrastructure. **Tech-adjacent circular policies**—such as those governing battery recovery and rare earth mineral reuse—are rapidly emerging as critical enablers for both sustainability and supply chain security.

Despite progress, challenges persist. Many state-level programs encounter practical constraints in market readiness, cost structures, and data tracking. For instance, mandated recycling rates often outpace the availability of secondary markets, and efforts to reduce packaging weight can conflict with product protection or consumer expectations. Furthermore, the economic motivation for circular practices frequently stems from **efficiency and cost reduction** rather than an explicit commitment to circularity principles—highlighting a recurring tension between ideal standards and operational feasibility.

To evaluate progress, this report situates state and industry practices within the evolving international standards framework, particularly **ISO 59004 (Framework and Principles for Circular Economy), ISO 59010 (Guidelines for Circular Business Models and Value Chains),** and **ISO 59020 (Measurement and Performance Evaluation)**. These standards aim to harmonize definitions, metrics, and methodologies, offering a shared foundation for circular implementation. Yet, as the report explores, the standards community and the realities of industry practice are not always aligned. Competing or sector-specific frameworks—such as ASTM standards for recycled construction materials or emerging battery lifecycle standards from SAE and IEC—often address narrower functional needs that diverge from ISO's systemic view.

Through analysis of major companies and public programs in each of the five focus states, the report identifies where firms have successfully integrated circularity into product and process design, and where alignment with formal standards remains aspirational. For example, California's technology and construction sectors show strong alignment with lifecycle assessment principles, while Washington's clean energy and packaging policies demonstrate integrated cross-sector collaboration. North Carolina's industrial base illustrates pragmatic circularity driven by cost and material scarcity rather than policy mandates, offering a contrasting model rooted in business adaptation.

Building on these insights, the report introduces a conceptual framework for a **"Circular Economy Playbook"**—a practical guide for companies and agencies seeking to operationalize circular strategies. The playbook outlines scalable actions: integrating lifecycle thinking into procurement, designing modular and recoverable products, adopting traceable material data systems, and aligning internal goals with emerging policy and standards frameworks.

Ultimately, this report argues that successful circular transition requires **policy coherence, standards alignment, and pragmatic innovation**. While the ISO 59000 series offers valuable structure, its effectiveness depends on adaptive, sector-specific application. States like California and Washington illustrate how regulatory ambition can catalyze market transformation, but broader national progress will hinge on the ability of industries and local governments to translate circular principles into achievable, economically viable action. The following sections examine each state's approach in detail—identifying the policies, partnerships, and performance metrics that are defining the next generation of circular economy leadership in the United States.

International Standards Framework for Circular Economy Sets Precedent

The International Organization for Standardization (ISO) released three foundational circular economy standards in May 2024, marking a pivotal step toward standardizing circular business practices globally [8,9]. These standards, ISO 59004, ISO 59010, and ISO 59020, provide a comprehensive toolkit for circular economy implementation, ranging from principles to measurement, and represent the first time ISO standards have offered a shared understanding of vocabulary, implementation, business models, value networks, and performance evaluation for the circular economy [10]. ISO 59004:2024 establishes the vocabulary, principles, and framework of the circular economy [3]. This standard lays the foundation for understanding what a circular economy is and how organizations can begin to integrate circular principles into their operations. It outlines key concepts such as product life extension, resource efficiency, waste minimization, and systems thinking.

One of the critical aspects of ISO 59004 is its emphasis on value retention, encouraging organizations to view waste as a resource and adopt strategies that enable products and materials to circulate in the economy longer [11]. The standard is based on six complementary and interconnected principles: systems thinking, value creation, value sharing, resource management, resource tracking, and ecosystem resilience [12]. Building on the framework set by ISO 59004, ISO 59010:2024 provides detailed guidelines on circular business models and strategies [4]. It focuses on how organizations can integrate circularity into their business models to create economic, social, and environmental value. This standard introduces various circular business models, including product-as-a-service, sharing models, leasing, and collaborative consumption [11]. By adopting these models, organizations can shift from the traditional sell-and-forget approach to a system where products are designed for reuse, remanufacturing, and recycling. ISO 59010 also highlights the importance of stakeholder engagement, transparency, and collaboration in driving the circular economy forward [13]. Measuring progress is crucial to the successful implementation of circular economy practices, which is where ISO 59020:2024 comes into play [5]. This standard sets forth requirements and guidance for organizations to measure and assess their circularity performance within defined economic systems. Through this standard, ISO aims to standardize the process by which organizations collect and calculate data using mandatory and optional circularity indicators, ensuring consistent and verifiable results [14]. ISO 59020 is structured to oversee targets and actions (of reduction, repair, reuse, recycling), measure resource flows (including inflows, outflows, and losses), and assess sustainability impacts (social, environmental, and economic) [12].

Sector-Specific Standards and State-by-State Policy Analysis

While the ISO 59000 series provides a comprehensive framework, various industries have developed or are developing sector-specific standards that address unique operational needs. In construction, ASTM standards govern recycled concrete and building materials. For batteries and electronic components, emerging standards from SAE International and the International Electrotechnical Commission (IEC) focus on lifecycle management, material recovery rates, and critical mineral reuse. These sector-specific frameworks often diverge from ISO's systemic approach, prioritizing functional requirements over holistic circular principles. The number of competing standards creates challenges for organizations operating across multiple sectors or jurisdictions. Companies must navigate overlapping requirements, reconcile different measurement methodologies, and balance compliance costs with circular ambitions. This fragmentation underscores a critical tension: while standardization aims to create coherence, the diversity of industry contexts demands flexibility. The most successful circular implementations often blend ISO principles with pragmatic, sector-specific adaptations.

California: Leading Through Comprehensive Regulation

California has emerged as the most ambitious state in circular economy policy, leveraging its economic scale and regulatory authority to drive systemic change. The state's approach combines mandated diversion targets, producer responsibility frameworks, and substantial public investment in circular infrastructure. Two landmark pieces of legislation (SB 54 and SB 1383) demonstrate California's comprehensive regulatory strategy [1,7]. SB 54: Plastic Pollution Prevention and Packaging Producer Responsibility Passed in June 2022, Senate Bill 54, also known as the Plastic Pollution Prevention and Packaging Producer Responsibility Act, is the first law to tackle the plastic pollution crisis at the source by requiring fewer single-use plastics in the first place [15]. The law establishes a new Extended Producer Responsibility (EPR) program to manage packaging and single-use plastic food service ware products across every sector of the economy [1]. Under this framework, producers are responsible for ensuring that packaging and plastic food service ware sold in California is recyclable or compostable, with primary responsibility for managing products after their useful life transferred to producers who can design and market products to be more easily reused or recycled [1]. SB 54 mandates a 25% reduction in single-use plastic packaging and foodware by 2032, aiming to achieve a recycling rate of 65% for these materials [16]. The law also requires all single-use packaging and plastic

foodware to be recyclable or compostable, as defined by California law, by 2032 [16]. Specifically, the source reduction requirement mandates that producers reduce single-use plastic packaging and foodware by at least 25% by both weight and number, with at least 10% of that reduction coming from eliminating single-use plastic without replacing it with another material, including 4% through transitioning to reuse and refill systems [15]. The implementation of SB 54 has been complex and politically contentious. On January 8, 2024, the California Department of Resources Recycling and Recovery (CalRecycle) selected the Circular Action Alliance (CAA) as the state's inaugural Producer Responsibility Organization (PRO) [6]. However, on March 7, 2025, Governor Gavin Newsom directed CalRecycle to restart regulations for SB 54, citing concerns about excessive costs and burdens on businesses [17]. This decision to reopen rulemaking introduced a period of review, though CAA remained prepared to adapt its implementation strategy as needed [6]. Despite implementation challenges, SB 54's environmental benefits are substantial. The 25% source reduction requirement will prevent approximately 23 million tons of single-use plastic waste over the coming decade [15]. The reduction in plastics is projected to lead to 115 million tons less CO2-equivalent greenhouse gas emissions over the next decade, equivalent to shutting down 28 coal-fired power plants [15]. Additionally, the law requires producers to spend $5 billion over ten years to support affected communities, including low-income and rural communities, and restore ecosystems affected by plastic pollution [16]. SB 1383: Organic Waste Diversion and Short-Lived Climate Pollutants California's SB 1383, signed into law in September 2016, establishes methane emissions reduction targets in a statewide effort to reduce emissions of short-lived climate pollutants [7]. The law sets ambitious targets: a 50% reduction in organic waste disposal from 2014 levels by 2020 and a 75% reduction by 2025 [18]. Additionally, SB 1383 requires that not less than 20% of edible food currently disposed be recovered for human consumption by 2025 [18]. The rationale for SB 1383 is clear: organic waste in landfills emits 20% of the state's methane, a climate super pollutant 84 times more potent than carbon dioxide over a 20-year period [19]. Organic materials, including food scraps, yard trimmings, paper, and cardboard, make up half of what Californians send to landfills [19]. Meeting the 75% reduction goal requires the diversion of up to 27 million tons of organic waste annually by 2025 [18]. SB 1383 implementation has required substantial infrastructure investment and behavioral change. The state estimates it needs 50 to 100 new organic material recycling facilities to process the diverted waste [18]. Jurisdictions must provide universal collection service to all generators, with most implementing curbside organics collection that combines green waste and food waste [18]. The average single-family household has seen a $3 to $5 increase in monthly collection bills (approximately 13% increase), while commercial businesses face an average increase of $70 to $90 per month [18]. Implementation challenges have led some to question the program's viability. In 2023, the Little Hoover Commission, a California state oversight agency, called for a pause on implementing SB 1383 to allow more time for education and infrastructure development [20]. However, rather than abandoning the program's ambitions, the legislature has passed laws to loosen certain procurement and collection requirements while maintaining core targets [20]. This approach reflects stakeholder commitment to making the program work rather than abandoning its goals.

Washington: The Recycling Reform Act

On May 17, 2025, Washington Governor Bob Ferguson signed the Recycling Reform Act (Senate Bill 5284) into law, calling it the 'biggest overhaul of our recycling system in decades' [21]. Washington became the seventh U.S. state to adopt a packaging extended producer responsibility (EPR) law, following Maine, Oregon, California, Colorado, Minnesota, and Maryland [21]. With this move, the entire U.S. West Coast is now covered by packaging EPR programs. The Recycling Reform Act creates an extended producer responsibility program for most kinds of paper and packaging [22]. It establishes a statewide recycling collection list and calls for adding curbside recycling for all homes that already have curbside trash service [22]. The law requires producers of residential packaging and paper products to join and fund a nonprofit Producer Responsibility Organization (PRO) [2]. Using funds provided by producers, the PRO will invest in recycling system improvements including expanded access for curbside recycling and more convenient drop-off locations. Starting in 2030, the PRO will reimburse at least 90% of the recycling system cost to service providers who collect and process residential packaging and paper products [2]. Reimbursements for recycling service providers will be phased in over time: 50% by February 15, 2030, 75% by the same date in 2031, and 90% by 2032 [22]. The Washington State Department of Ecology, which will oversee the program, estimates the bill will expand recycling services to an additional 500,000 homes in Washington, most notably in rural areas and multi-family residences [23]. The law includes specific timeline requirements for producer compliance. By July 1, 2026, producers must be members of a PRO [21]. By March 1, 2026, producers and PROs must register with the Washington State Department of Ecology [24]. By March 2029, producers who are not members of a PRO or registered with the state could not sell their products in Washington [24]. The PRO must submit a draft plan by October

2028, with full implementation set for 2030 [25]. Economic benefits of the law are significant. Under the legislation, packaging producers will be primarily responsible for the costs of collecting recyclable waste, and residents will see that reflected as a reduction in their utility bills [23]. Cities have been supportive of this policy because they have struggled with increased recycling costs, which have been passed on to residents. In recent years, residents have seen their recycling utility bills increase by over 30%, and the Recycling Reform Act aims to reverse this trend [23]. The law also addresses equity concerns. Starting in 2029, the PRO will provide grants for packaging refill and reuse infrastructure [2]. An equity study is due to the legislature in 2032 to assess the program's impact on different communities [21]. By creating harmonized lists of recyclable materials accepted throughout the state, the law aims to reduce recycling confusion and ensure that materials put in blue recycling bins are actually recycled into new consumer products [2].

Colorado: Market-Driven Circular Development

Colorado has taken a distinct approach to circular economy development, focusing on market creation and infrastructure development rather than mandated diversion targets. In June 2022, the Colorado legislature passed HB22-1159, establishing the Circular Economy Development Center (CEDC) [26]. The purpose of the CEDC is to grow existing markets, create new markets, and provide necessary infrastructure, systems, logistics, and marketing to create a sustainable circular economy for recycled commodities in Colorado [27]. The rationale for the CEDC stems from Colorado's recycling challenges. Colorado has one of the lowest recycling rates in the country, recycling and composting only 15% of its municipal solid waste in 2020, less than half the national average of 32% [28]. Moreover, Colorado lacks local recycling markets for most major recyclable materials. Nearly all of the paper, metal, and plastic that Colorado collects for recycling is shipped out of state before being made into new products [28]. The cost of transporting recyclable materials creates a huge burden on local communities, especially in rural areas, and is a real obstacle to expanding recycling programs around the state. The CEDC is funded through the Colorado Circular Communities (C3) Enterprise housed at the Colorado Department of Public Health and Environment [27]. The center's mandate includes supporting and expanding existing end-market businesses, including companies that recycle glass, electronics, and compost; developing incentives for manufacturers to incorporate recycled materials into their products; and attracting remanufacturers and entrepreneurs to the state [28]. The CEDC conducted a statewide end-market gap analysis and opportunity assessment, with a final report submitted to the department by August 1, 2024 [26]. The center is required to submit annual progress reports to the department each September, which are included in the department's presentation to the general assembly pursuant to the State Measurement for Accountable, Responsive, and Transparent (SMART) Government Act [26]. The CEDC is scheduled for sunset review by the department of regulatory agencies before its repeal on September 1, 2030. Colorado's approach offers an alternative model to California and Washington's regulatory frameworks. Rather than mandating producer responsibility or diversion targets, Colorado focuses on removing market barriers and creating economic incentives for circular practices. This pragmatic approach recognizes that circular transition requires not just policy mandates but also viable markets for secondary materials and business models that make circularity economically attractive. The center's emphasis on infrastructure, logistics, and marketing addresses the practical obstacles that have historically limited Colorado's recycling performance.

New York: Comprehensive Urban Circularity

New York has developed a multi-faceted approach to circular economy implementation, combining regulatory initiatives with innovative pilot programs and cross-sector partnerships. The state's efforts are particularly notable in the built environment, where New York City has emerged as a laboratory for circular construction practices. The New York City Economic Development Corporation (NYCEDC) has led the development of Circular Design & Construction Guidelines aimed at reducing waste and embodied carbon in New York City's built environment through innovative solutions and policy implementation. These guidelines complement the broader Green Economy Action Plan (GEAP), unveiled by Mayor Eric Adams and NYCEDC, which outlines 63 commitments to bolster the green economy, create jobs, and promote public-private partnerships to support the climate transition. The New York Circular City Initiative unites city officials, businesses, foundations, and academic institutions to transform New York's economy towards sustainability through cross-sector solutions. This collaborative framework has enabled innovative programs such as Project Closed Circuit, focused on EV battery circularity, which aims to make New York a leading hub for battery innovation, investment, and safe deployment. New York State's Solid Waste Management Plan serves as a guide for waste reduction and promotes the shift to a circular economy across the state, with a goal of 85% waste reduction by 2050. The plan emphasizes material reuse, recycling system improvements, and the development of markets for recycled materials. Supporting this effort, the Center for the Circular Economy at Closed

Loop Partners focuses on innovation, research, and cross-sector collaboration to advance circular practices throughout the region.

North Carolina: Emerging Circular Infrastructure

North Carolina's approach to circular economy development has been more incremental, driven primarily by the North Carolina Department of Environmental Quality. The state has focused on building foundational recycling infrastructure, promoting industrial symbiosis, and supporting bioenergy generation from organic waste. While North Carolina has not enacted comprehensive EPR legislation comparable to California or Washington, its industrial base has embraced circular practices driven by cost savings and material scarcity. The state's manufacturers, particularly in the furniture, textile, and construction sectors, have increasingly adopted closed-loop systems and material recovery programs as pragmatic business adaptations rather than regulatory compliance measures.

Industry Sector Analysis and Circular Practices

Waste Management and Recycling

Waste management companies and municipal agencies represent the front line of circular economy implementation. These entities must operationalize policy mandates, manage evolving waste streams, and develop infrastructure to process diverted materials. The sector faces significant challenges in balancing mandated diversion targets with market realities for secondary materials. In California, implementation of SB 1383 has required waste haulers to add organics collection services across residential and commercial sectors. This necessitates significant capital investment in new collection vehicles, processing facilities, and education programs. Contamination monitoring (a key requirement of SB 1383) adds operational complexity, requiring route inspections and customer outreach to maintain stream purity. Many jurisdictions have struggled to achieve compliance while keeping rate increases manageable for ratepayers. Washington's Recycling Reform Act promises to shift financial burden from ratepayers and municipalities to producers through the PRO reimbursement structure. However, the phased implementation timeline means waste service providers must continue to manage costs during the transition period. The law's requirement for harmonized recycling lists aims to reduce operational complexity by creating consistency across jurisdictions, but achieving this standardization while accommodating local market conditions presents ongoing challenges.

Construction and Manufacturing

The construction and manufacturing sectors are critical to circular economy success given the massive material flows they manage. Construction and demolition debris represents a significant portion of the waste stream, while manufacturing processes generate substantial quantities of scrap materials and byproducts that can be recovered and reprocessed. New York's Circular Design & Construction Guidelines have catalyzed innovation in material reuse and low-carbon building practices. Pilot projects have demonstrated the viability of modular construction, which facilitates disassembly and component reuse, and increased use of recycled concrete and steel. However, adoption remains limited by cost considerations, supply chain constraints for recycled materials, and building codes that were designed for virgin material specifications. Manufacturers in Colorado and North Carolina have embraced circular practices primarily as cost-saving measures. Industrial symbiosis programs, where one facility's waste becomes another's raw material, have emerged organically rather than through regulatory mandate. These market-driven adaptations demonstrate that circular practices can be economically attractive when infrastructure and logistics enable efficient material exchange. However, scaling these successes requires broader policy support and investment in material tracking systems.

Technology and Electronics

Technology companies face unique circular economy challenges due to rapid product obsolescence, complex supply chains, and the presence of valuable but difficult-to-recover materials in electronic components. Battery recovery and rare earth mineral reuse have emerged as critical areas for circular innovation, driven by both sustainability goals and supply chain security concerns. New York's Project Closed Circuit exemplifies a comprehensive approach to EV battery circularity, bringing together automakers, battery manufacturers, recyclers, and policymakers to create integrated systems for battery collection, testing, second-life applications, and recycling. Similar initiatives in California focus on establishing domestic supply chains for critical minerals recovered from end-of-life batteries and consumer electronics. These efforts align with ISO 59010's emphasis on circular business models but also highlight gaps where sector-specific technical standards are needed to ensure safe handling and optimize recovery processes.

Energy and Biofuels

The energy sector plays a dual role in circular economy implementation: as a consumer of circular feedstocks (such as biogas from organic waste digestion) and as a facilitator of energy recovery from materials that cannot be recycled. Anaerobic digestion of food waste and agricultural residues produces renewable natural gas that can displace fossil fuels in transportation and electricity generation. California's organics diversion programs have spurred investment in anaerobic digestion facilities that convert food waste into biogas. These facilities provide a market for diverted organics while contributing to the state's renewable energy targets and greenhouse gas reduction goals. However, the economics of biogas production remain dependent on renewable fuel incentives and avoided disposal costs. Market volatility for renewable fuel credits creates uncertainty for long-term infrastructure investment.

Circular Economy Playbook: 7-Step Framework

Drawing from the experiences of the five focus states and the frameworks established by ISO 59004, 59010, and 59020 [3,4,5], this section synthesizes key strategies into a practical playbook for organizations seeking to operationalize circular economy principles. The playbook emphasizes adaptive, pragmatic approaches that balance standards alignment with operational insight into five core principles: (1) embed lifecycle thinking in decision making, (2) design for modularity, durability, and disassembly, (3) implement traceable materials management, (4) engage in policy partnerships and industry collaboration, (5) balance ambition and pragmatic implementation, (6) circularity indicators, (7) lifecycle assessment and environmental impact.

1. Embed Lifecycle Thinking in Decision-Making

Circular economy success requires fundamental shifts in how organizations approach design, procurement, and operations. Lifecycle thinking, considering materials and products from extraction through end-of-life, must be integrated into all business decisions. This aligns with ISO 59004's systems thinking principle [3], which emphasizes understanding interconnections and dependencies across economic, social, and environmental systems. Practical steps include conducting lifecycle assessments for major products and processes, incorporating circular criteria into vendor selection and procurement policies, and training staff across functions on circular principles. Organizations should map their material flows to identify opportunities for waste reduction, reuse, and recovery. New York's construction sector guidelines exemplify this approach, requiring lifecycle carbon assessments and material tracking from design through demolition.

2. Design for Modularity, Durability, and Disassembly

Product design is the most powerful lever for circularity. ISO 59010's emphasis on circular business models [4] highlights the importance of products designed for multiple use cycles through remanufacturing, refurbishment, or component recovery. Design strategies include modular architecture that enables easy repair and upgrade, material selection prioritizing recyclability and non-toxic composition, standardized components that facilitate reuse across product lines, and clear labeling to support proper sorting at end-of-life. Technology companies implementing device take-back programs have learned that design for disassembly dramatically improves material recovery rates and reduces processing costs. Construction materials designed for deconstruction rather than demolition enable component reuse and reduce waste generation. These practices require upfront investment in design processes but generate long-term value through reduced material costs and improved brand reputation.

3. Implement Traceable Materials Management

Effective circular economy implementation requires robust data systems for tracking material flows, measuring performance, and demonstrating compliance. ISO 59020's measurement framework [5] provides guidance on circularity indicators and data collection methodologies. Organizations should establish systems to track resource inflows and outflows, monitor circularity performance against targets, document secondary material quality and provenance, and report progress to stakeholders and regulators. Digital technologies including blockchain, RFID tagging, and materials passports can enhance traceability. California's SB 54 reporting requirements have driven development of producer data management systems that track packaging materials from sale through collection and processing. Colorado's CEDC emphasizes materials tracking as essential infrastructure for circular markets. Investment in these systems enables both compliance and business intelligence about circular opportunities.

4. Engage in Policy Partnerships and Industry Collaboration

Circular economy transition requires collaboration across value chains and between private and public sectors. ISO 59010 emphasizes stakeholder engagement and network transformation [4]. Organizations should participate in policy development processes to ensure regulations are practical and effective, join industry consortia and PROs to share best practices and achieve economies of scale, partner with municipalities on collection and processing infrastructure, and collaborate with academic institutions on research and workforce development. Washington's Recycling Reform Act benefited from years of stakeholder engagement that refined program design. New York's Circular City Initiative demonstrates the value of cross-sector partnerships in developing integrated solutions. Colorado's market-oriented approach relies on public-private collaboration to overcome infrastructure gaps. These examples illustrate that circular economy success depends on collective action rather than individual firm initiatives.

5. Balance Ambition with Pragmatic Implementation

The most successful circular initiatives balance ambitious goals with pragmatic, phased implementation. California's experience with SB 1383 and SB 54 illustrates the risks of mandates that outpace infrastructure readiness and market development. Washington's phased PRO reimbursement schedule allows gradual system adjustment. Colorado's focus on market creation before mandates represents another viable approach. Organizations should set clear circular targets aligned with ISO frameworks but develop realistic timelines with interim milestones, anticipate and address market constraints and infrastructure gaps, build internal capacity and stakeholder buy-in progressively, and remain flexible to adjust strategies based on experience and evolving contexts.

6. Core Circularity Indicators

ISO 59020 establishes both mandatory and optional circularity indicators [5]. Core metrics include material circularity rate (percentage of materials that cycle within the economy), resource productivity (value created per unit of material input), waste generation intensity (waste produced per unit of output), recycling rate (proportion of waste that is recycled), and secondary material utilization rate (proportion of inputs from recycled or reused materials). These indicators can be calculated at multiple levels (product, organizational, inter-organizational, and regional). Organizations should select indicators that align with their circular priorities and stakeholder expectations. California's SB 54 tracks plastic reduction by weight and component count. Washington's Recycling Reform Act establishes recycling rate targets. These policy metrics provide examples of how circular performance can be quantified and tracked over time.

7. Lifecycle Assessment and Environmental Impact

Circularity metrics must be complemented by lifecycle environmental impact assessments to ensure that circular strategies deliver genuine sustainability benefits. Some circular practices may reduce waste but increase energy consumption or generate other environmental burdens. Comprehensive measurement requires assessing greenhouse gas emissions across the lifecycle, energy and water consumption, toxic substance use and exposure, ecosystem impacts including biodiversity effects, and social impacts including worker health and community effects. California's emphasis on methane reduction through organics diversion exemplifies the integration of circular and climate metrics [7]. The state tracks both diversion rates and associated greenhouse gas reductions, ensuring that circular programs contribute to broader environmental goals. Organizations should similarly link circularity metrics to environmental performance indicators to demonstrate holistic sustainability progress.

Other works demonstrate five guiding principles for circular economy (CE) implementation [29]: (1) determine and implement top management CE strategies, (2) plan CE activities aiming at environmental sustainability, (3) anticipate and create a value co-creation ecosystem, (4) plan and manage a product lifecycle with VRPs, and (5) plan and manage transformation of the organization. Whereby this work emphasizes internal organizational transformation through top management strategy, lifecycle planning with value recovery processes, and value co-creation ecosystems. The 7-step framework provides an operationally-focused framework approach that integrates external collaboration, practical implementation tools like materials tracking and circularity indicators, and emphasizes balancing ambitious goals with pragmatic, phased implementation.

Conclusions

The emergence of international circular economy standards through ISO 59004, 59010, and 59020 represents a critical foundation for global circular transition, yet the diverse approaches taken by the five U.S. states reveal that successful implementation requires adaptation to local contexts, market conditions, and industrial ecosystems. California's comprehensive regulatory mandates through SB 54 and SB 1383 demonstrate both the potential and challenges of ambitious policy frameworks, with significant environmental benefits tempered by implementation complexities and political resistance. Washington's Recycling Reform Act offers a more collaborative model that shifts financial responsibility to producers while maintaining stakeholder engagement, while Colorado's market-driven approach through the CEDC prioritizes infrastructure development and economic viability over regulatory mandates. New York's multi-faceted strategy, combining construction guidelines with cross-sector initiatives, illustrates how circular principles can be tailored to specific urban and industrial contexts. These varied pathways underscore a fundamental insight: while international standards provide essential common language and measurement frameworks, effective circular economy implementation depends on pragmatic adaptations that balance regulatory ambition with market readiness, infrastructure capacity, and stakeholder buy-in.

The seven-step playbook synthesized from these experiences, embedding lifecycle thinking, designing for circularity, implementing traceable materials management, engaging in collaborative partnerships, balancing ambition with pragmatism, establishing robust circularity indicators, and conducting comprehensive lifecycle assessments, provides organizations with actionable guidance for navigating this complex transition. Success requires simultaneous attention to multiple dimensions: technical standards that ensure product quality and safety, policy frameworks that create economic incentives for circular practices, infrastructure investments that enable material recovery and reprocessing, and measurement systems that track progress and demonstrate value. As more jurisdictions adopt circular economy policies and as ISO standards gain international traction, organizations that proactively integrate these principles into their operations will be better positioned to comply with evolving regulations, access emerging circular markets, and contribute to the systemic transformation necessary to address resource constraints and environmental challenges. The circular economy is not merely an environmental imperative but an economic opportunity for those prepared to reimagine value creation in an increasingly resource-constrained world. Key areas for future research include analyzing other states such as Maryland and identifying case studies whereby an industry demonstrates business models and comprehensive market development of clear circular economy practices.

Acknowledgements

We would also like to thank Mike Van Brunt, Chair of the Circular Economy Coalition and VP of Sustainability at ReWorld Waste, and Dave Vollero, CEC Board Member and Executive Director of the York County Solid Waste and Refuse Authority, for their perspectives shared during broader coalition discussions that helped inform our thinking with this paper. We would also like to thank Michelle Torelli, Policy Advisor for her contributions.

References

[1] California Department of Resources Recycling and Recovery, https://calrecycle.ca.gov/packaging/packaging-epr/, 2025

[2] Washington State Department of Ecology, https://ecology.wa.gov/waste-toxics/reducing-recycling-waste/strategic-policy-and-planning/recycling-reform-act, 2025

[3] International Organization for Standardization, https://www.iso.org/standard/80648.html, 2024

[4] International Organization for Standardization, https://www.iso.org/standard/80648.html, 2024

[5] International Organization for Standardization, https://www.iso.org/standard/80648.html, 2024

[6] Circular Action Alliance, https://circularactionalliance.org/california, 2025

[7] California Department of Resources Recycling and Recovery, https://calrecycle.ca.gov/organics/slcp/, 2025

[8] Antaris Consulting, https://antarisconsulting.com/new-circular-economy-standards/, 2024

[9] Groupe AFNOR, https://www.afnor.org/en/news/circular-economy-three-standards-iso-passing-to-action/, 2024

[10] Materia Rinnovabile,https://www.renewablematter.eu/en/new-iso-standards-circular-economy, 2024

[11] GECA,https://www.geca.eco/blog/iso-launches-comprehensive-standards-for-a-circular-economy, 2024

[12] Indeed Innovation, https://www.indeed-innovation.com/the-mensch/iso-circular-economy-standards-guide/, 2025

[13] EarthShift Global, https://earthshiftglobal.com/blog/three-newly-published-iso-standards-a-pivotal-step-toward-adoption-of-circular-business-practices, 2024

[14] PivIT Global, https://info.pivitglobal.com/blog/iso-59004-guide-infrastructure-circular-economy-standard, 2024

[15] Ocean Conservancy, https://oceanconservancy.org/wp-content/uploads/2024/02/24.02.25-OC-SB-54-Source-Reduction-Fact-Sheet.pdf, 2024

[16] DLA Piper, https://www.dlapiper.com/en/insights/publications/2024/04/californias-next-step-in-implementing-landmark-plastic-pollution-law, 2024

[17] Beveridge & Diamond, https://www.bdlaw.com/publications/calrecycle-reissues-draft-sb-54-regulations-targeting-californias-plastic-packaging-epr-program/, 2025

[18] BioCycle,https://www.biocycle.net/sb-1383-revolution-organic-waste/, 2020

[19] LegalClarity,https://legalclarity.org/california-sb-1383-goals-and-effects-on-waste-management/, 2024

[20] Waste Dive, https://www.wastedive.com/news/sb-1383-laws-changes-procurement-collection-requirements/727990/, 2024

[21] Product Stewardship Institute, https://productstewardship.us/washington-adopts-packaging-epr-law-marking-major-recycling-reform/, 2025

[22] Waste Dive, https://www.wastedive.com/news/washington-governor-ferguson-signs-packaging-epr-law/748416/, 2025

[23] Washington Senate Democrats, ,https://senatedemocrats.wa.gov/lovelett/2025/03/07/senate-approves-plan-to-modernize-states-recycling-system/, 2025

[24] Washington State Standard, https://washingtonstatestandard.com/2025/03/07/recycling-system-overhaul-bill-clears-washington-senate/, 2025

[25] National Caucus of Environmental Legislators, https://ncel.net/articles/washington-state-passes-epr-for-packaging/, 2025

[26] Colorado General Assembly, https://leg.colorado.gov/bills/hb22-1159, 2022

[27] Colorado Circular Communities, https://coloradocircularcommunities.org/cedc, 2025

[28] Eco-Cycle, https://ecocycle.org/content/uploads/2022/05/Fact-Sheet_Vote-for-Developing-a-Circular-Economy-in-Colorado-HB22-1159.pdf**,** 2022

[29] Implementing circular economy activities in manufacturing for environmental sustainability, CIRP Annals, https://doi.org/10.1016/j.cirp.2024.06.002., 2024