In collaboration with McKinsey & Company

WORLD ECONOMIC FORUM

Circularity in the Built Environment: Unlocking Opportunities in Retrofits

WHITE PAPER

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Images: Getty Images

Contents

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Foreword

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The transition to a sustainable built environment is essential for conserving natural ecosystems, reducing emissions in line with the Paris Agreement and mitigating the effects of climate change. Rapid urbanization intensifies environmental and climate pressures, with the United Nations reporting that the world constructs the equivalent of a city the size of Paris every week.[1]

As global society strives to create a sustainable and resilient built environment, the necessity of retrofitting existing structures has become increasingly evident. Ageing buildings, often energy inefficient and resource intensive, present both a challenge and an opportunity. Retrofitting can conserve resources, reduce carbon emissions and enhance the quality of life for residents.

Retrofits can use readily available technologies and solutions and often achieve net-zero emissions in a financially neutral or positive way.[2] Given that the built environment is responsible for almost 40% of global energy-related carbon dioxide (CO_2) emissions, with over 25% coming from building operations,[3] retrofitting is a critical step towards decarbonizing the building and construction sector. And given the scale of the built environment, the cost-effectiveness of decarbonizing existing buildings may even surpass that of the broader energy transition.

Retrofitting is relevant to a wide range of stakeholders, including real-estate owners, designers, manufacturers and renovators. However, the industry has yet to determine how to sustainably source the materials required for the increasing number of retrofits. Promising circular approaches to retrofitting – which involve retaining, reusing and recycling materials to minimize the extraction of virgin resources – promote efficient resource reuse and reduce CO_2 emissions.

A previous white paper published by the World Economic Forum in collaboration with McKinsey & Company explored the potential for circularity in the built environment to simultaneously create business value and reduce CO_2 emissions with regard to six crucial materials.[4] This paper examines circularity in retrofitting as a vital submarket and outlines potential actions for stakeholders.

We thank all community members and Forum initiative leaders for their valuable contributions. We hope this report will guide and inspire public- and private-sector leaders to adopt circular practices in the expanding building retrofit market.

Executive summary

The expanding retrofit market is expected to face challenges sourcing materials sustainably, making circularity essential.

This white paper underscores the vital role of retrofits, as well as the added benefits of circularity in retrofits, in conserving natural resources and achieving rapid decarbonization. It quantifies the volumes of materials needed to retrofit existing buildings by 2030 and 2050 in line with International Energy Agency (IEA) net-zero targets. The paper also examines the potential to recirculate materials extracted during retrofits and outlines key themes stakeholders can consider to transition to a circular value chain.

The findings reveal the retrofit market needs to grow from $500 billion today to approximately $2.9 trillion in 2030 and $3.9 trillion in 2050 to meet IEA net-zero targets. From 2023 to 2030, nearly 8 billion tonnes of materials could be required for retrofits alone. From 2023 to 2050, this number increases to nearly 40 billion tonnes. Glass, steel, concrete, aluminium, brick and plastic are expected to be in greatest demand for use in retrofit components including windows, cladding and roofing. Other essential retrofit materials, commonly used in insulation replacements and upgrades, include fibreglass, mineral wool, foam board and spray foam.

Circularity helps ensure that as more building stock is retrofitted to meet net-zero targets, consumption of raw virgin materials does not increase proportionally. In fact, the model for this report shows that, on average, 50% of materials removed from buildings during retrofits from 2023 to 2050 could be recirculated in the value chain. In 2030 and 2050, respectively, this would correspond to an annual reduction of around 200 million and 500 million metric tonnes of CO_2 equivalent (CO_2e) and divert from landfill materials with a value of $500 billion and $600 billion.[5]

Implementing circularity in retrofits will vary geographically, with Europe making earlier progress than other regions primarily because of its mature adoption of circular design principles and advanced take-back programmes. However, it is crucial to establish a foundation for circularity in retrofits and new buildings now to ensure long-term sustainability targets are met.

This report highlights the opportunities circularity presents for stakeholders including real-estate owners, designers, manufacturers, upgraders, renovators, and logistics and waste handlers. Within these segments, materials and parts manufacturers, upgraders and renovators are best positioned to capture the largest share of new value across the circular value chain. They could add revenue streams from service-based business models, and from horizontal and vertical integration in the value chain, with specialists in circular retrofits emerging as market leaders.

Achieving scale in circularity in retrofits requires a compelling business case and a clear return on investment. To achieve economically viable circular retrofits, it will be essential to minimize costs – including those involved in reducing, reusing and recycling materials – while keeping the costs of landfilling high. Simultaneously, incentives such as tax exemptions and decarbonization subsidies will be crucial.

Embracing circularity in retrofits not only contributes to environmental goals but also creates economic opportunities, positioning market leaders to capitalize on emerging demand and propelling innovation in the built environment.

Introduction

The retrofit market is projected to grow by 8% annually until 2050, with materials dominating the spend.

The building and construction sector consumes approximately 40% of global raw materials and contributes almost 40% of energy-related CO_2 emissions.[6] With the global population projected to reach nearly 10 billion by 2050,[7] demand for construction materials is expected to surge, depleting available resources. Overall global resource use has tripled over the past 50 years,[8] and use of raw materials with commensurate CO_2 emissions could double by 2060 in some regions.[9]

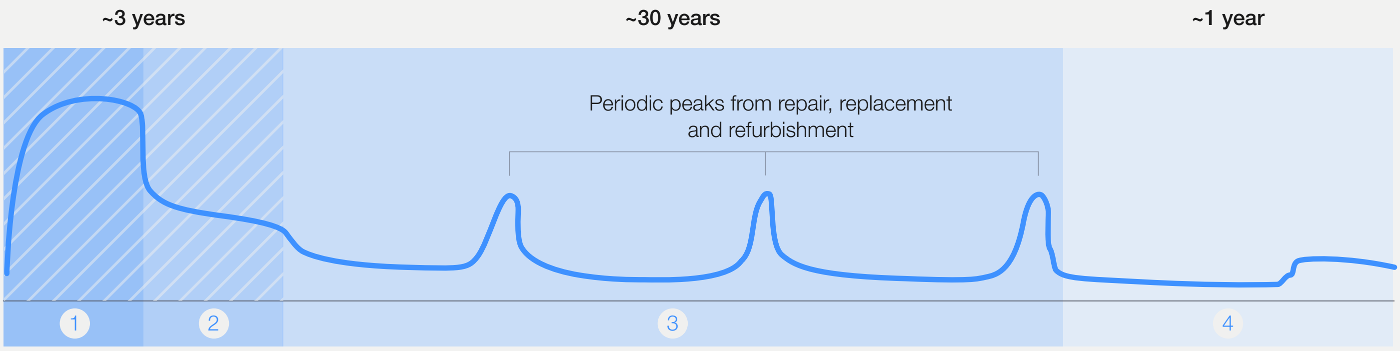
In part due to escalating emissions from the construction sector, the world is not on track to achieve the goal enshrined in the Paris Agreement to limit warming to well below 2°C.[10] Therefore, it is imperative that industry stakeholders act now to adopt strategies to reduce carbon emissions from the built environment.

The retrofitting opportunity

Embodied carbon accounts for up to 50% of a building's emissions over its life cycle.[11] This includes the CO_2 emitted from construction material extraction and manufacturing processes, and the transport of materials and equipment to project sites and construction operations (Figure 1). Extending the life of built assets through retrofitting could reduce their total carbon emissions by 50 to 75% compared with new construction.[12]

FIGURE 1

Carbon dioxide-equivalent (CO_2e) emissions, embodied and operational



1
Construction material procurement
Driven by carbon-intensive manufacturing processes for bulk materials

2
On-site construction
Driven by fuel consumed by heavy construction vehicles and other Scope 3 emissions

3
Operations
Driven by heating, water and electricity consumption, along with other Scope 3 emissions

4
End of life
Driven by demolition and waste processing

Embodied carbon before start of operations (typically under-reported)

Notes: Emissions can vary widely based on asset class, geography and an individual project's environmental, social and governance (ESG) approach, among other factors

Source: "Embodied carbon and the industry's role in reducing global emissions", AECOM, 2022; "Methodology to calculate embodied carbon of materials", Royal Institution of Chartered Surveyors (RICS), February 2015; "Whole life carbon assessment for the built environment", RICS, November 2017

Retrofitting could reduce the total cost of ownership and typically shortens construction times compared with new buildings. In fact, retrofits could save up to 77% of costs compared with fully new buildings.[13] Retrofitting entails upgrading existing buildings to improve energy efficiency and reduce carbon emissions. Measures include improving insulation, upgrading building envelopes, and replacing heating, ventilation and cooling (HVAC) systems, appliances and lighting. Retrofitting also strives to preserve and retain much of the existing building structure, typically composed of steel and concrete, which are the biggest sources of embodied carbon.

BOX 1

Smart surfaces

Smart surfaces are advanced materials or coatings that can adapt and respond to environmental conditions, providing improved building efficiency through higher surface albedo, reflecting more sunlight. These surfaces can be implemented as part of a retrofit, further limiting the consumption of energy in a building and its environmental impact.

For example, the Smart Surfaces Coalition and the city of Baltimore have estimated that implementing smart surfaces city-wide could reduce carbon emissions by 17 million tonnes over 30 years, while delivering an estimated net present value of $13.5 billion.

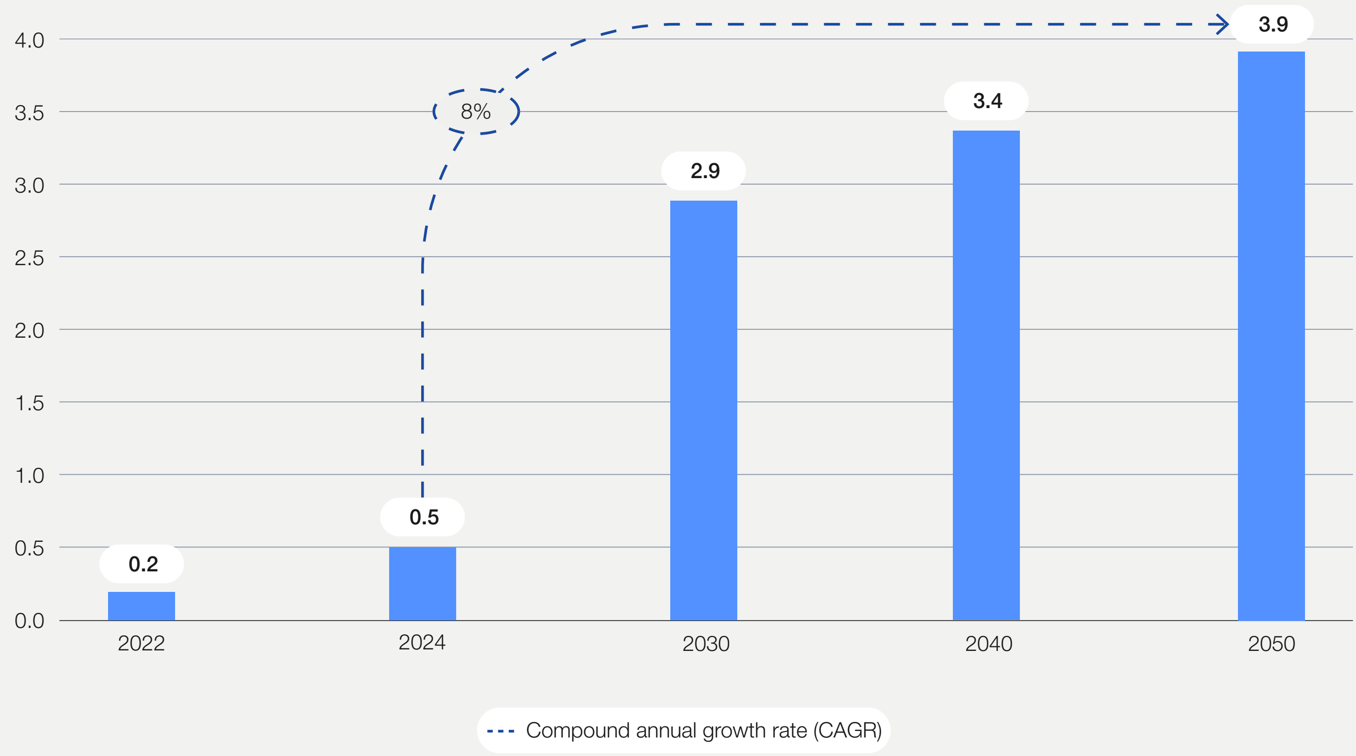
Source: Smart Surfaces Coalition[14]

The IEA pathway to net-zero emissions states that 20% of existing building stock needs to be zero-carbon ready by 2030, 50% by 2040 and more than 85% by 2050. Achieving these targets would require retrofit rates to increase to approximately 3% annually by 2030 and 4% by 2050 (from less than 1% in 2024).[15]

Today, roughly 75% of building stock in the European Union is energy inefficient.[16] In other regions, the share of energy-inefficient buildings is probably similar or higher, though a lack of readily available data makes it difficult to say with certainty. In line with the IEA target of annual retrofit rates of 4% by 2050, the global retrofit market is projected to grow by 8% per year from 2024 to 2050, increasing in value from $500 billion to $3.9 trillion[17] (Figure 2). This growth rate surpasses that of the overall construction market, which is projected to grow at 4% annually during the same period.

FIGURE 2

Projected global retrofit market size (2022-2050) to meet IEA net-zero targets, in $ trillion



Notes: The European retrofit market has been extrapolated to the global market

Retrofit rates required to meet IEA net-zero scenario by 2050:

North America 3% by 2030, 4% by 2050
Europe 3% by 2030, 4% by 2050
Asia-Pacific 3% by 2030, 4% by 2050
Latin America 2.3% by 2030, 3% by 2050
Middle East and Africa 2.3% by 2030, 3% by 2050

Share of global assets: North America 7%, Europe 11%, Asia-Pacific 60%, Latin America 8%, Middle East and Africa 14%

Source: McKinsey analysis

The importance of circularity in retrofitting

About 60% of overall retrofit costs are estimated to come from materials. If the retrofit market is projected to reach $3.9 trillion by 2050, then the materials market will amount to roughly $2.3 trillion, underscoring the critical role materials and parts play in retrofitting.

Retrofitting, while essential for reducing energy consumption, presents two challenges: the extraction of virgin raw materials and the generation of waste from removing and replacing materials that could still have functional life. According to the Global Resources Outlook of the UN Environment Programme, "Material resource extraction could increase by almost 60% from 2020 levels to 2060, from 100 billion to 160 billion tonnes," far exceeding Sustainable Development Goals (SDGs), particularly Goal 12, which focuses on "Responsible Consumption and Production."[18]

Circularity, including retaining, reusing, recycling and repurposing existing materials, can reduce the extraction of virgin raw materials and generation of waste, thereby increasing material utilization and efficiency. In addition to clear sustainability benefits, a more circular approach to retrofits can reduce asset downtime, and lower costs – by using "salvaged" materials and localized supply chains that are more resilient – compared to more traditional retrofits.

Circular retrofit projects can also create local job opportunities in asset maintenance, on-site material recovery and local refurbishment.[19] It is estimated that more than 2 million new jobs and more than 141 million job years could be created as part of the transition to net-zero buildings across North America and Europe alone.[20] This would stimulate local economies and support workforce development.

Additionally, new buildings often require the demolition of existing structures, resulting in mixed-materials waste that is time- and cost-intensive to sort. Retrofitting with circularity could be easier to achieve and less disruptive to the local environment. Components such as appliances, lighting, heating and cooling systems, and roofing can be individually removed, allowing for a simpler sorting process.

1

Recirculating extracted materials for retrofits

Until 2050, up to 40 billion tonnes of materials will be required for global retrofits, with the potential to recirculate 50%.

Although retrofitting with either circular materials or virgin materials entails dismantling and replacing old materials, circular retrofits allow for greater resource utilization and efficiency. Circular retrofits can either directly recirculate materials by reusing them on-site or recirculate them through an aftermarket. The following points highlight the key differences between the two processes:

- **Materials selection:** Circular retrofits prioritize material retention and sourcing of recycled or reclaimed materials, which can involve more complex procurement processes that include re-certifying existing materials and have stringent "green" requirements.

- **Dismantling versus demolition:** Circular retrofits emphasize careful but time-consuming dismantling to salvage reusable components, whereas traditional retrofits often prioritize speed of deconstruction and can generate more waste.

- **On-site reuse:** Circular retrofits prioritize the direct retention or reuse of materials, such as refurbishing and reinstalling facades on site,[21] or reusing existing structures,[22] which requires additional capabilities, techniques and labour. Additional re-certification may be required to ensure materials are fit for purpose. At the same time, a circular approach can reduce the logistics associated with transporting demolished waste away from the building site and bringing new materials in, though finding space for on-site storage, refurbishing and recycling is often challenging in dense urban areas.

- **Design considerations:** Circular retrofits entail designing for material life cycle, modularity and adaptability, unlike traditional designs that generally optimize for immediate functionality and cost.

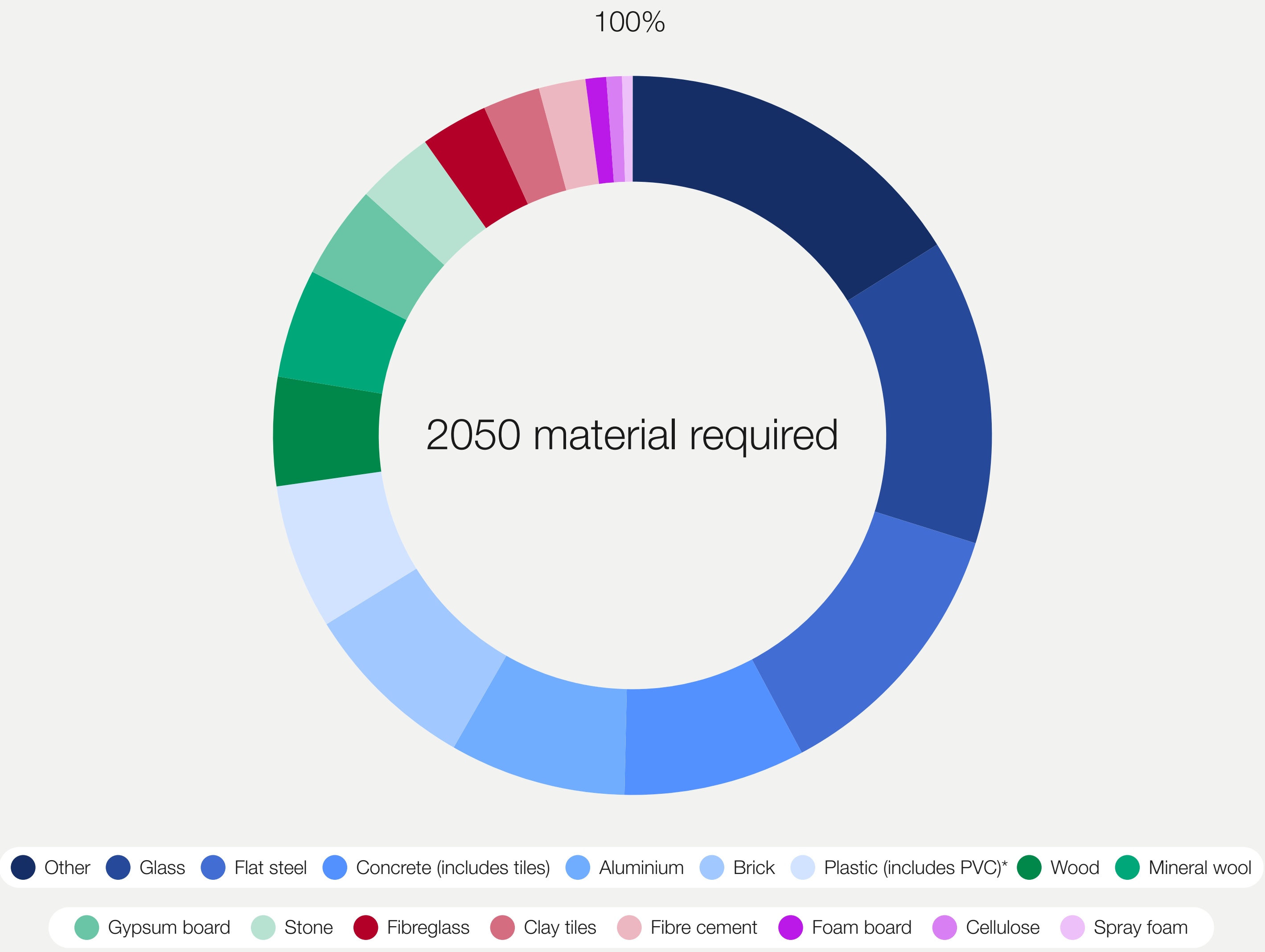
- **Digital technologies:** Circular retrofits use tools such as digital materials passports and digital twins to create transparency into secondary materials and the overall materials life cycle. Spatial mapping technology can provide 3D models of existing assets to support circular retrofits by providing important geometric and material information to designers earlier in the project life cycle.

Despite the necessity and many benefits of retrofits, the pathway to achieving net-zero targets is complicated by the substantial volumes of materials – approximately 40 billion tonnes from 2023 to 2050 – that are required.

In 2050, the highest demand by volume (in cubic metres) will come from materials such as fibreglass, mineral wool, foam board, spray foam, wood and cellulose. In weight (in tonnes), glass, steel, concrete, aluminium, brick and plastic will dominate, especially for performance upgrades such as in windows, cladding and roofing (Figure 3). In the future, innovations or architectural movements could replace these materials with more environment-friendly alternatives.

Over 90% of the materials required for retrofits will be allocated to envelope improvements, including insulation, roofing and window upgrades. The remaining portion will be used for energy-efficient system upgrades, such as new HVAC systems. Consequently, the materials footprint for system upgrades is considerably smaller, even as these upgrades contribute significantly to reducing operating emissions

FIGURE 3 **Material required (in tonnes) for retrofit in 2050 to meet IEA net-zero targets**



Note: * Polyvinyl chloride

Source: McKinsey analysis

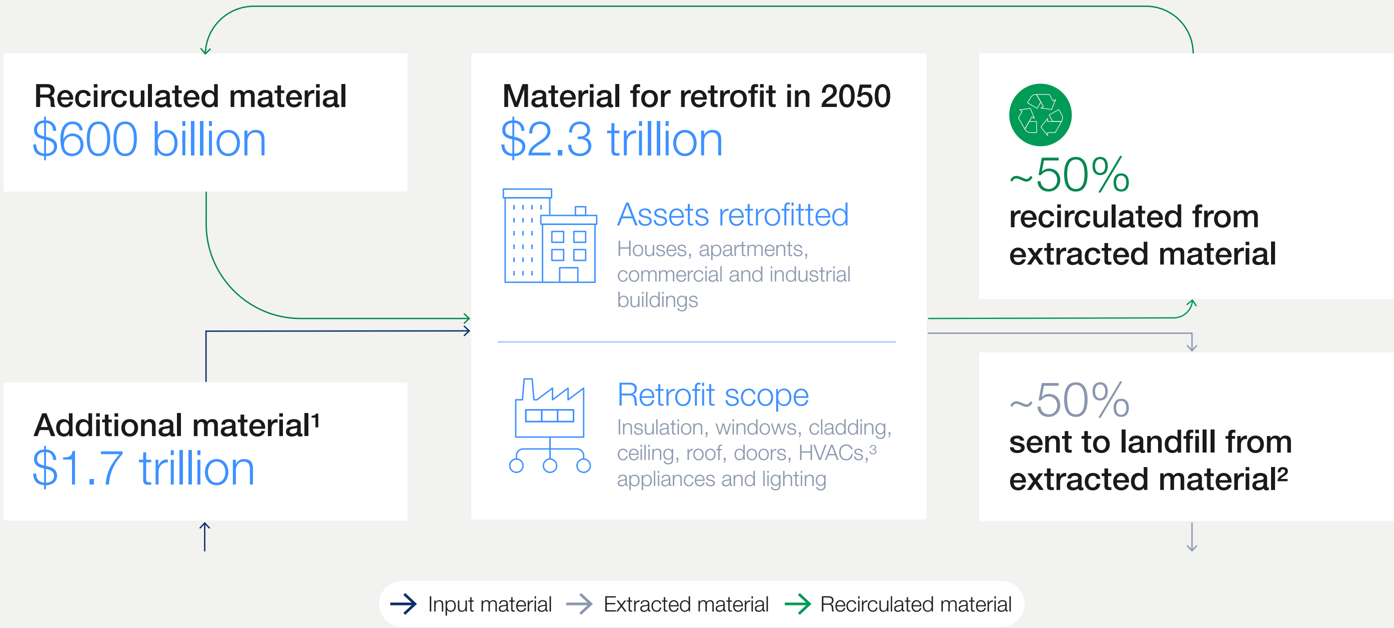
According to the analysis for this report, the Asia-Pacific, Europe and North America could require 3% of their existing building stock to be retrofitted annually by 2030. This corresponds to approximately 40 million buildings in the Asia-Pacific, eight million in Europe and five million in North America. Latin America and the Middle East and Africa are expected to have retrofitting rates of 2.3% each by 2030, or approximately 4 million and 7 million buildings, respectively.

The largest volume of materials required for retrofits will likely be in the Asia-Pacific, with approximately 25 billion tonnes needed from 2023 to 2050. Europe will require around 5 billion tonnes of materials during the same period.

Additionally, the analysis shows the potential size of the materials market by segment (Figure 4). By 2050, the retrofit materials market is projected to reach approximately $2.3 trillion. During retrofitting, a portion of the material is extracted and replaced, while the majority remains intact. The model used in this analysis estimates that roughly 50% of the extracted material could be reused or recycled, significantly reducing waste. The remaining 50% is projected to be sent to landfill. By 2050, materials valued at $600 billion could be diverted from landfill and recirculated.

This diversion not only confers an environmental benefit but also represents a major economic opportunity within the circular economy.

FIGURE 4 | **Potential market for recirculated materials in 2050**



Notes: Illustrative example

1. Includes both the replacement for materials removed and sent to landfill and any additional materials needed, such as double-glazed to replace single-pane windows **2.** Material sent to landfill is assumed to be part of non-material retrofit market (labour and other) **3.** Heating, ventilation and cooling systems

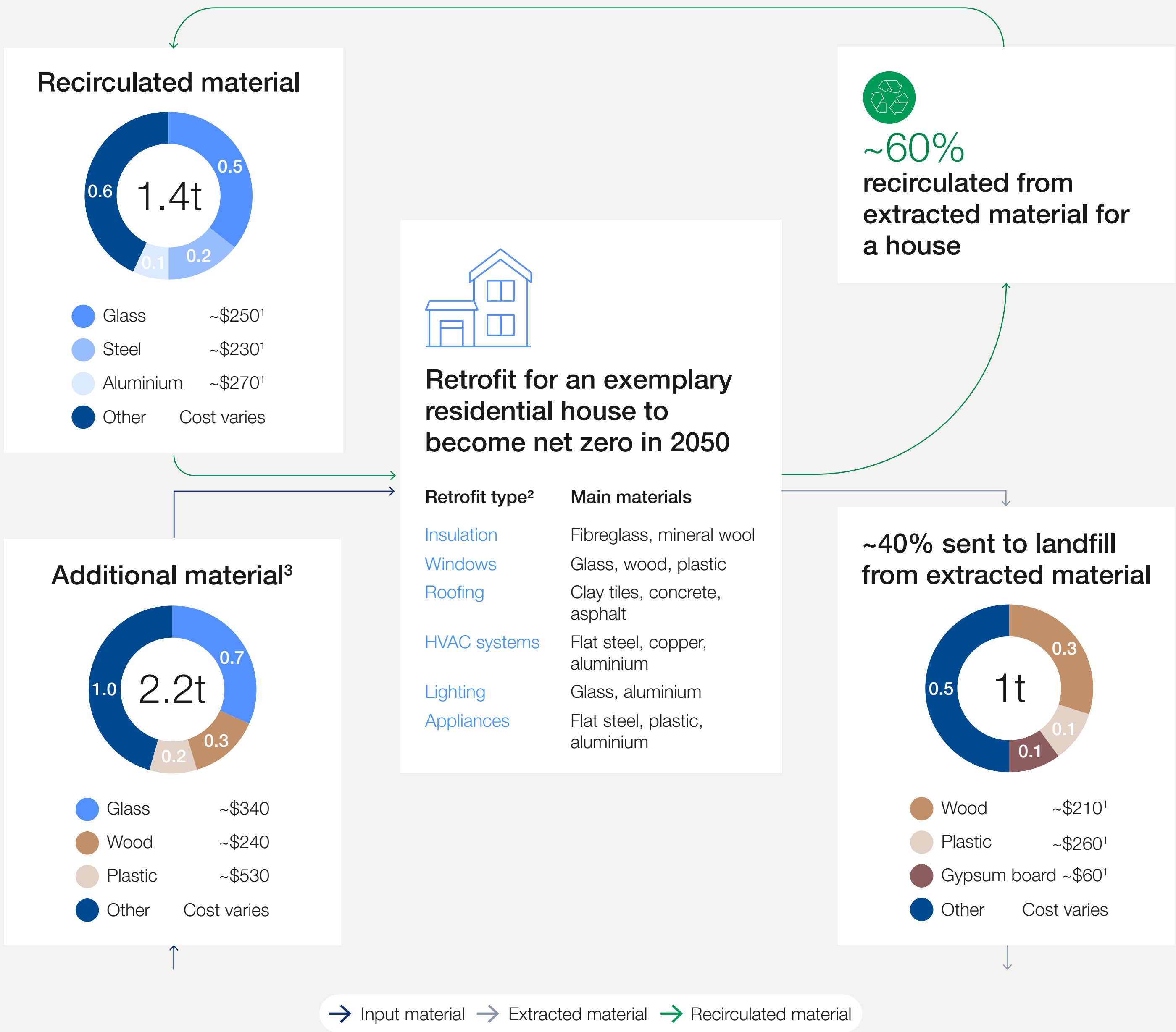
Source: McKinsey analysis

In addition, recirculating materials could prevent the release of up to 200 million metric tonnes of CO_2e in 2030 and up to 500 million metric tonnes of CO_2e in 2050, compared to the production and transportation of new materials. In terms of weight, these materials will predominantly include glass, steel and mineral wool. The insulation sector will be among those most affected by retrofitting as demand will increase for conventional materials such as fibreglass, mineral wool and alternative, bio-based materials.

Recirculation rates of specific materials will likely vary based on the ease of deconstruction, reuse and recycling. Aluminium, for example, is projected to have a recirculation rate of approximately 95% by 2050, supported by initiatives such as the European Union's Circular Aluminium Action Plan.[23] In contrast, materials such as plastics, concrete and gypsum board are likely to have lower recirculation rates because of sorting challenges, additives and the process of downcycling, which results in recycled products that are not as structurally strong as the original product. Differences in materials handling and recycling infrastructure will also contribute to variable recirculation rates.

The volume of material and associated costs for a circular retrofit in the residential housing sector helps illustrate materials demand and recirculation (Figure 5). The recirculation rate for single-family buildings is higher than the average for all building types combined, mostly because of the higher potential to reuse materials with high recycling rates. Steel, glass and aluminium account for the highest volumes being circulated, with aluminium having the highest material value.

FIGURE 5 **Recirculated materials in an illustrative single-family house retrofit**



Notes: Illustrative example of residential house in **2050.** Material values are highly indicative.

1. Initial material value **2.** Additional retrofit types include door, ceiling and cladding **3.** Includes both the replacement for materials removed and sent to landfill and any additional materials needed, such as double glazing to replace single-pane windows

Source: McKinsey analysis

BOX 2

About the analysis

The goal of the analysis in this white paper is to quantify the material (in tonnes and cubic metres) required for retrofits and determine the portion that could be recirculated. This was achieved through a bottom-up approach, estimating detailed material requirements for different assets. The analysis is based on the materials needed to retrofit the current building stock from 2023 to 2050, following an accelerated scenario to meet IEA net-zero targets by 2050. The model also calculates the associated carbon abatement from the recirculated materials.

Parameters: The model considers four types of assets: residential housing, residential apartments, commercial buildings and industrial buildings. It also considers the components that would be upgraded during a typical retrofit, including insulation, roofing, cladding, ceiling tiles, doors, windows, HVACs, lighting and appliances. Retrofits that change how a building is used (such as turning an office into a hotel) or increase its footprint (such as increasing the number of floors) are excluded from this analysis.

Calculations: Average weight is assumed based on the type of asset for retrofit, which is then scaled by the number of retrofits needed to achieve net-zero targets within one year. For each component and asset type, required materials are considered to estimate how much can be recirculated in 2024, 2030 and 2050.

2

Assessing the global uptake of circular retrofits

Implementing circularity in retrofits demands a comprehensive systems approach and will vary by region.

Implementing circularity in retrofits will be largely influenced by reuse and recycling infrastructure, capabilities and knowledge of circular practices, regulatory frameworks, materials used and commitment to sustainability (Figure 6). The quality of the building stock and the evolution of cities are also crucial considerations. In the near future, circular retrofits – and retrofits in general – are likely to be concentrated in Europe, North America, parts of the Asia-Pacific, and metropolitan areas in the Middle East, Africa and Latin America.

To effectively scale circular practices in retrofits, a comprehensive systems approach with the necessary supporting infrastructure – take-back mechanisms, a steady supply of circular materials and a workforce skilled in circular retrofit techniques, at the city or regional level – is essential. Applying these practices to individual buildings or projects yields limited benefits. Emerging economies with relatively young building stock can incorporate circular practices into all new designs.

FIGURE 6 **Overview of global uptake of circular retrofits by region**

North America — High-to-medium

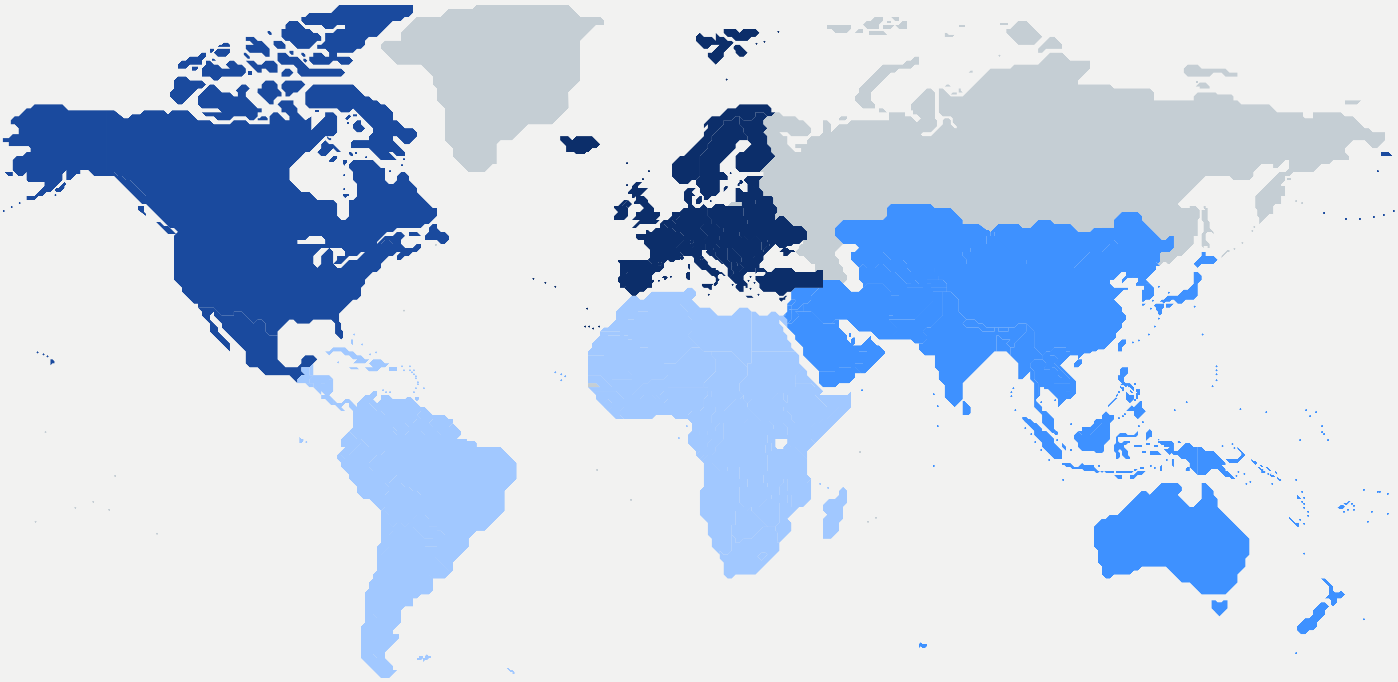
- **Established incentive programmes** (e.g. RetrofitNY)
- **Reverse logistics** (e.g. Building Materials Reuse Association)
- However, **no consistent structure** in place for **payment for end-of-life waste**

Europe — High

- Mature **circular design principles** (e.g. designing for disassembly)
- Advanced **take-back programmes** and logistics (e.g. urban mining hubs)
- **Specialized training programmes** to promote circular practices

Asia-Pacific — Medium

- Rapidly improving **logistics networks supporting circularity** (e.g. China's circular economy zones)
- **Emerging innovative design practices** facilitating circularity in retrofits (e.g. modular construction in Japan)



Comparative maturity High ● ● ● ● Low

Latin America — Low

- **Fragmented supply chains** (e.g. local recycling cooperatives)
- **Gradual adoption of circular design** (e.g. bioclimatic architecture)
- **Emerging expertise in circular practices** (e.g. university partnerships)

Africa — Low

- **Limited financial incentives** to promote circular retrofits
- **Limited access to advanced technology** (e.g. basic material tracking systems)
- **Early stages of circular design** (e.g. pilot green building projects)

Middle East — Medium

- Continuous efforts for **landfill diversion** (e.g. waste-to-energy plants)
- Recent launch of **Circular Economy Council** in the UAE
- But, **lack of widespread mandatory waste segregation** and internationalization of waste costs

Source: McKinsey analysis

Europe typically leads the way in circularity because of its mature adoption of circular design principles, advanced take-back programmes and specialized training. With an ageing building stock (approximately 35% of buildings are more than 50 years old),[24] the European Union has implemented rigorous energy-efficiency and waste-management standards, facilitating smoother integration of circular materials. For instance, the European Commission's Renovation Wave strategy aims to renovate 35 million buildings by 2030, prioritizing the use of recycled and sustainable materials.[25]

BOX 3 BlueCity project in Rotterdam

The BlueCity project in Rotterdam, Netherlands, transformed a large swimming pool into a hub for circular entrepreneurs. The retrofit includes the reuse of existing structures and materials, with the commercial wing composed of 90% reclaimed materials. In addition, circular principles were applied all through the retrofit process.[26]

In contrast, North America's building stock, with an average commercial building age of around 30 years,[27] presents challenges including suburban sprawl, fewer incentive programmes for circularity or retrofits and less stringent regulations. The region also has a higher proportion of single-family homes, complicating systems-wide retrofitting approaches. In the United States specifically, there is no national framework for end-of-life waste payment, recycling rates vary by state and landfill accounts for about 50% of municipal waste disposal.[28] That said, selected incentives and reverse logistics are being implemented and initiatives such as the New York Circular City Initiative show promise.

BOX 4 New York Circular City Initiative

This initiative aims to create "a city where no waste is sent to landfill, environmental pollution is minimized and thousands of good jobs are created through the intelligent use of products and raw materials."[29] The initiative estimates that $11 billion in economic benefits, more than 11,000 new jobs and the reduction of waste sent to landfill to zero can be achieved. Today, roughly 60% of the total solid waste generated in the city comes from construction and demolition alone.[30]

Developing regions in the Asia-Pacific experiencing rapid urbanization present a different scenario. By 2050, more than half of the global urban population is expected to be concentrated in Asia.[31] Much of the current building stock in this region is young compared with North America and Europe, and new construction is often more economically viable than retrofits. While countries in Europe are poised for a renovation wave, similar large-scale efforts in Asia may take longer to emerge. However, the region has an opportunity to establish a foundation for circularity now. Economically advanced cities in countries such as China, Japan, the Republic of Korea and Singapore already collect 100% of waste and have achieved high recycling rates.[32] Shanghai launched a three-year initiative aimed at reducing the construction sector's environmental footprint.[33]

The building stock in the Middle East is characterized by a diverse mix of traditional and modern structures, reflecting the region's rapid urbanization and economic growth. Countries such as Qatar, Saudi Arabia and the United Arab Emirates (UAE) have experienced growth in high-rise buildings and large-scale commercial developments, driven by economic prosperity and ambitious urban planning initiatives. These modern structures often incorporate advanced engineering and sustainable design principles, with varying levels of focus on retrofitting. For example, Dubai aims to retrofit 30,000 buildings by 2030.[34] Across the Middle East, continuous efforts are being made to divert waste from landfill. Specifically, in the UAE, a Circular Economy Council was established in 2021 to promote sustainable practices. Increasing mandatory waste segregation and raising awareness of waste costs could accelerate circularity in the region.

In many African countries, a substantial proportion of the building stock comprises informal settlements and low-rise construction, for example in urban areas experiencing a rapid annual population growth rate of 1.1% (compared with 0.3% in other regions).[35] Despite efforts to improve the quality and sustainability of the building stock through various national and international programmes, additional investment in dedicated socio-economic programmes and infrastructure is needed.

The building stock in Latin America is undergoing transformation through urban renewal projects and sustainable construction practices including retrofitting of existing structures. Incentive programmes encourage stakeholders to eliminate low-quality housing, reduce CO_2 emissions and improve sewage treatment. Despite these initiatives, overall retrofit maturity remains comparatively low because of fragmented supply chains and variable regulations.

These disparities underscore the opportunity for stakeholders to consider region-specific strategies to effectively implement circularity in retrofits based on local building-stock quality, evolution of cities, regulatory environments and infrastructure. Europe can serve as a model, but success in other regions will possibly require customized approaches that account for existing building stock, urban growth patterns and supporting infrastructure, among other factors.

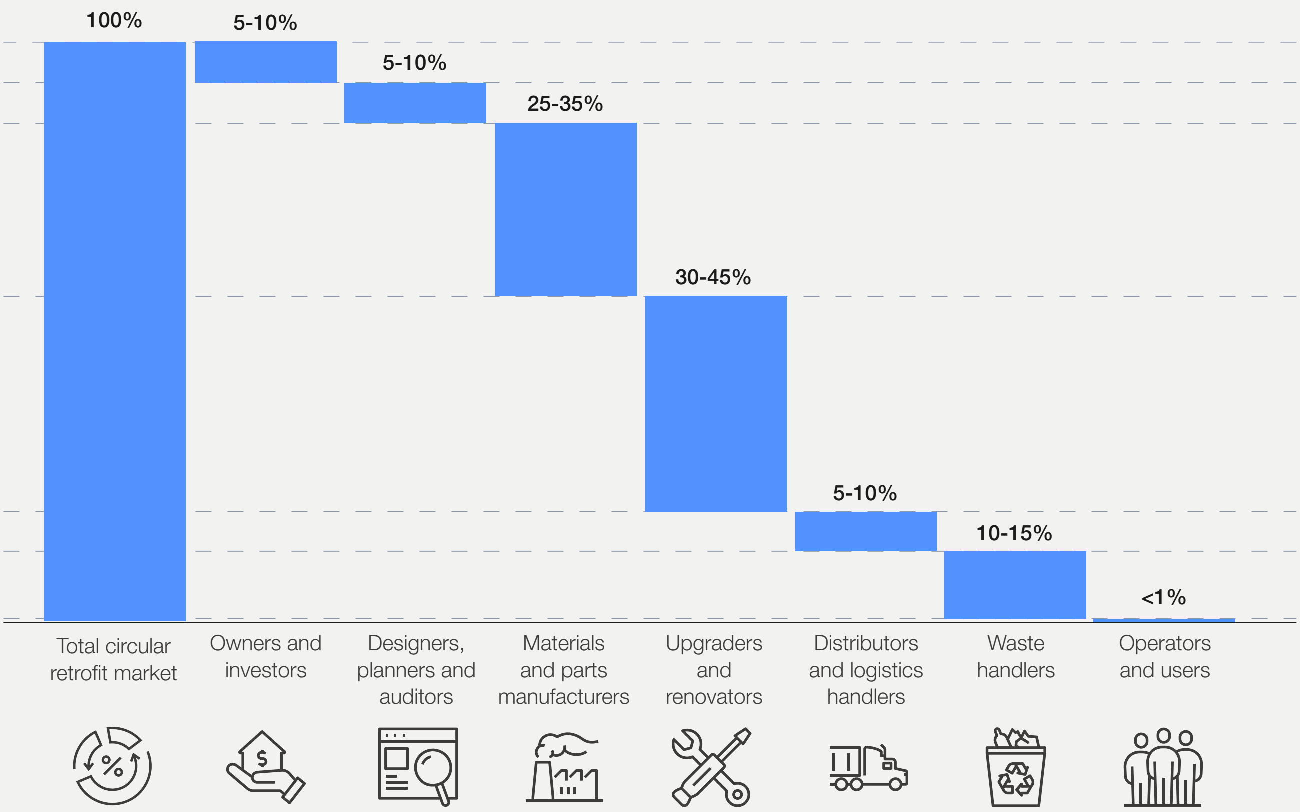
3 Transitioning to a circular value chain

Key themes for stakeholders include conducting whole life-cycle assessments, using technology and establishing effective reverse logistics.

Transitioning to a circular value chain requires a systems view, considering all interconnections and interactions among the diverse set of stakeholders involved. Each stakeholder must take coordinated actions to ensure circular principles are embedded from the early stages of design to the end of a building's life cycle.

Compared with new buildings, the retrofit value chain places greater emphasis on services, with upgraders, renovators and materials and parts manufacturers poised to capture the largest share of value pools (Figure 7).

FIGURE 7 **Illustrative value pool split (value add)[36] across the circular retrofit value chain**



Notes: Value add is the economic value that is added to goods or services at each stage of the value chain

Source: McKinsey analysis

BOX 5 | **Value chain stakeholders**

Owners including homeowners, business entities and governments identify the need for retrofits and set specific goals for energy efficiency improvements and the use of circular materials.

Investors provide funding options such as loans for retrofits and can prioritize circularity within their investment portfolios. Together, owners and investors are estimated to hold a value pool share of 5-10% in the circular retrofit market.

Designers and planners such as retrofit architects design solutions to retain and salvage as many materials and as much existing structure as possible and quantify embodied and operational carbon emissions through whole life-cycle analysis. They also help ensure new buildings enable future circular retrofits.

Materials and parts manufacturers such as insulation producers capture up to 35% of the value of the retrofit value pool. These stakeholders play critical roles in providing supply of circular materials and parts to meet demand. According to a 2024 survey, almost 60% of decision-makers are willing to pay an additional premium for green materials, assuming these are in deficit by 2030.[37]

Upgraders and renovators such as HVAC installers capture the largest value pool share of the circular retrofit market (30-45%). They are responsible for assessing existing building conditions to identify areas for improvement, implementing energy-efficient technologies and enhancing structural integrity.

Distributors and logistics handlers such as lighting and controls distributors coordinate the transportation and handling of materials, including the removal and transportation of retrofit waste to reuse or recycling facilities.

Waste handlers manage and recycle construction and demolition waste to ensure valuable materials are recovered and reintegrated into the supply chain, reducing environmental impact.

Users can choose to occupy retrofitted buildings that have employed circular strategies. Along with users, **operators** such as facility managers are key stakeholders in influencing energy consumption patterns in retrofitting and are therefore crucial to realizing emissions reductions.

Although circular retrofits present opportunities, they also introduce certain obstacles that must be overcome. Limited availability of data on existing built assets can lengthen the time required to run building-mapping and materials-testing exercises. Mechanisms for disassembly are not yet commonly integrated into existing buildings, making it challenging to remove or recondition materials without causing damage. And accountability for re-certification or warranty extension of existing materials is not clear across the range of retrofit stakeholders.

With these points in mind, stakeholders can address seven key themes to unlock the value of circularity in retrofits (Figure 8). The relevance of each theme varies by stakeholder. High relevance indicates that addressing the theme is crucial for a stakeholder to transition to a circular value chain. For example, designers play a key role in changing design practices, while owners and investors demand these changes.

Lower relevance means that, although the theme is important, the stakeholder's role is more supportive than primary. For instance, manufacturers can indirectly support circular design by ensuring an adequate supply of innovative circular materials. Some themes are broadly relevant across the built environment while others are specific to retrofits. A detailed list of actions by stakeholder is provided in the Appendix.

FIGURE 8 | **Key areas for transitioning to a circular value chain**

Themes	Owners and investors	Designers, planners and auditors	Materials and parts manufacturers	Upgraders and renovators	Distributors and logistics handlers	Waste handlers	Operators and users
Design and specifications	●	●	○	○			●
Technology, equipment and tools		●	●	●	○	○	○
Reuse and recycling infrastructure			●	○	●	●	
Capabilities and professionals	●	●	●	●	○	●	
Financial mechanisms	●	○	○	○			○
Certifications and assurance	●	●	●	●		○	○
Partnerships and collaboration	●	●	●	●	●	●	●

● High relevance ○ Lower relevance

Source: McKinsey analysis

3.1 Design and specifications

From a systems perspective, it is crucial that all new buildings be designed with materials reuse, recyclability, asset adaptability and multipurpose use in mind. Likewise, designing for disassembly is important as traditional construction methods often hinder material removal and reuse. For instance, adhesive insulation blown into a cavity wall is difficult to reclaim, whereas insulation systems with reversible connections, such as mechanically attached panels, allow for easy removal and reuse of materials.

Owners, investors, operators and users all play a role in driving demand for innovative and sustainable design approaches. As owners of large numbers of buildings, governments in particular can prioritize circular materials in public projects, thus acting as powerful demand drivers and encouraging the broader adoption of sustainable practices in the construction industry.

BOX 6

Retrofit-specific design for circularity

Decision-making in retrofit design can be supported by conducting whole life-cycle assessments. These assessments calculate carbon emissions resulting from the retrofit, including upfront embodied emissions and operational emissions across the entire asset life cycle. This holistic view enables more informed and sustainable retrofit design choices.

3.2 Technology, equipment and tools

Measuring and tracking the impact of materials is crucial to scaling circular practices. While initiatives like the Science Based Targets initiative (SBTi) provide frameworks to effectively measure Scope 1 and 2 emissions, there remains an opportunity to enhance monitoring of the environmental effects of construction, including virgin material consumption, water and land use, pollution and effects on biodiversity.

By adopting digital materials passports, designers, manufacturers and upgraders could establish transparency in materials impact. These passports create a comprehensive record of the materials and parts used in a building and can increase the residual value of materials, creating opportunities for logistics and waste handlers.

The extent to which building materials passports have been adopted around the world and the approaches being taken are not well documented. The Global Alliance for Buildings and Construction (GlobalABC) has introduced a Digital Construction Material Passport, an open-source tool designed for global use.[38] At the same time, national frameworks are emerging. In Germany, the German Sustainable Building Council (DGNB) has launched a digital building resource passport aimed at enhancing transparency. This passport includes information on the use of circular materials, life-cycle greenhouse gas emissions, non-renewable energy demand and the feasibility of deconstruction.[39]

BOX 7

Retrofit-specific technologies for circularity

Three-dimensional (3D) scanning technology can convert existing buildings into digital twins using point clouds, enabling the integration and use of Building Information Technology systems. This provides greater clarity into the existing building design and aids designers in planning and renovators in conducting effective circular retrofits.

3.3 Reuse and recycling infrastructure

Efficient logistics networks and take-back programmes that ensure that quality salvaged materials can be reconditioned and reused are the backbone of a circular value chain. Manufacturers can set up take-back mechanisms and collaborate with other materials and parts manufacturers to recirculate materials from deconstruction and extract valuable materials. For example, aluminium and glass manufacturers can partner to recirculate materials salvaged from building facades.

Distributors and logistics handlers, together with manufacturers and waste handlers, can establish a network of disassembly, storage and recycling hubs, ideally located near densely populated areas or construction sites. For example, the Dutch government is exploring the use of urban mining hubs to bolster the circular built environment by 2050.[40] Digital platforms for waste materials and reusable components can streamline the identification, tracking and management of these materials, while also serving as a marketplace for their exchange and sale.

Transporting salvaged materials presents opportunities for non-construction companies to generate new revenue streams. For instance, Swiss Post has successfully entered this market by providing construction-site logistics services, demonstrating the feasibility for new players to penetrate and thrive in this sector.[41] These handlers could even explore the potential to sell salvaged materials back to manufacturers for the purpose of recycling.

BOX 8

Retrofit-specific reuse and recycling infrastructure for circularity

There are three main logistics steps in a circular retrofit: extracting material from the building, sorting materials and either transporting them to refurbish, recycling and storage facilities or reusing them on-site. If sorting on site is feasible, circularity offers a social benefit by creating new jobs, for example, for unskilled workers who could tear out and sort retrofit waste.

3.4 Capabilities and professionals

Building a workforce with the necessary skills and expertise is important to support circularity, especially for designers, upgraders, waste handlers and manufacturers. Manufacturers can build capabilities in processing circular materials and parts to ensure sufficient supply. This can be achieved by developing "green parts" with high levels of recycled materials and setting up dedicated lines to remanufacture used parts. Some organizations have secured 15-30% price premiums for circular, climate-friendly and net-zero products.[42]

Manufacturers can also diversify their core operations by adopting service-based models such as "material-as-a-service" (MaaS) or "energy-as-a-service" (EaaS). These models enable construction companies and owners to lease materials or equipment, ensuring their return and recycling, thereby reducing environmental impact. Service-based models not only provide a steady revenue stream but also enhance long-term customer retention.

Additionally, manufacturers can horizontally integrate by using "waste" as feedstock for other industries, generating supplementary revenue streams. At the same time, vertical integration can be used to establish reverse logistics and take-back mechanisms, thereby increasing revenues from recycling services offered to other companies.

Another strategic option entails launching a digital marketplace that connects supply and demand for recirculated materials. A digital marketplace could also match employers with workers needed to disassemble, transport and recondition salvaged materials, thus helping optimize workforce productivity and creating new jobs.

BOX 9

Retrofit-specific capabilities and professionals for circularity

For designers, upgraders and renovators, specializing in circular retrofits requires developing proficiency in assessing existing structures for potential reuse and prioritizing careful disassembly over demolition. These professionals can also focus on recycling materials or parts on site to reduce logistics costs and vulnerability to supply-chain interruptions. Beyond their primary services, upgraders and renovators can benefit financially from circularity by salvaging and selling materials recovered during the retrofit process. These salvaged materials can be repurposed and sold for other projects, creating an additional revenue stream while reducing waste and promoting resource efficiency.

3.5 Financial mechanisms

Real-estate investors focused on circularity have several financing options tailored to different strategies and scales of investment, ranging from single circular building projects to large-scale circular ecosystems. Financing options include preferential loans, green bonds and revenue-sharing mechanisms that incentivize collaboration. Grants and subsidies from institutional financing bodies can offset the higher upfront costs of sustainable construction. For example, the New York State Energy Research and Development Authority (NYSERDA) encourages project owners to prioritize sustainability through performance-based fees tied to energy savings. Traditional banks, often driven by track records, may require separate funds with different risk profiles to support circular economy developments.[43]

BOX 10 **Retrofit-specific financial mechanisms for circularity**

Circular retrofits can be financed through savings on energy costs, repairs and maintenance. For example, in the United Kingdom, a social housing company finances an Energiesprong retrofit[44] by combining savings on tenants' energy costs with repairs and maintenance savings.[45] This approach could also be applied for circular retrofits.

3.6 Certifications and assurance

Certifications and assurance are important enablers for the transition to a circular value chain and are likely to become more widely used in the years ahead. For designers, manufacturers and renovators, adopting recognized certification schemes ensures the credibility and quality of circular projects. Certifications such as the Leadership in Energy and Environmental Design (LEED), Passive House, German Sustainable Building Council (DGNB) and Building Research Establishment Environmental Assessment Method (BREEAM) can be used as practical guides to meet high energy-efficiency and sustainability standards. Even though each certification scheme has its own criteria and focus areas, all aim to promote environmentally responsible building practices.

3.7 Partnerships and collaboration

Establishing strategic partnerships across the value chain is necessary for fostering a systems approach to circularity. Collaboration among stakeholders allows for pooling of resources, expertise and financing. As highlighted in a previous white paper,[46] the built environment is characterized by a decentralized and fragmented landscape, necessitating extensive coordination to close resource loops. Many participants in this sector lack traditional linear supply-chain relationships, making integration, partnerships and standardized requirements for circular materials vital. By working together, stakeholders can overcome these challenges and promote sustainable practices throughout the industry.

Conclusion

The retrofit market is poised to play a crucial role in reducing the environmental impact of the built environment. Given that more than 80% of today's built environment will exist in 2050,[47] it is imperative for stakeholders to act now, with first movers increasing their chances of long-term success.

Stakeholders could consider prioritizing retrofits over new builds when existing structures can be feasibly upgraded to meet current performance and sustainability standards. This is particularly relevant in urban areas where space is limited, buildings have cultural and historical value, and the environmental impact of demolishing and constructing new buildings is substantial. Retrofits are often more cost-effective and less time-consuming than new construction, making them a practical choice for property owners looking to improve energy efficiency without the extensive resources required for new buildings.[48] Furthermore, retrofitting can create more new jobs than new low-carbon buildings, contributing to GDP growth and enhancing economic stability by increasing household income and consumption, in turn stimulating demand in other sectors.

Retrofitting, however, will create vast material demands, thereby diminishing its overall sustainability gains. Circularity can address material demands by promoting the retention, reuse, recycling and repurposing of existing materials, thereby reducing virgin resource extraction and minimizing waste. Further analysis will be needed to understand the impact of circular processes on environmental factors such as air pollution, water usage and contamination.

The transition to a circular value chain

Transitioning to a circular value chain in retrofits presents opportunities including reduced asset downtime, more resilient supply chains and the creation of local job opportunities. Circular approaches provide various pathways to capture value such as service-based business models and horizontal or vertical integration in the value chain. The question remains: how can stakeholders scale circular retrofit practices to encompass entire ecosystems?

Implementing circularity requires a systems view and collaboration among stakeholders including real-estate owners, designers, manufacturers, renovators, and logistics and waste handlers. Focusing on entire cities' circularly – not just individual projects – ensures the principles of a circular economy are integrated at scale into urban planning and development.

Addressing key themes along the retrofit value chain – designing for reuse and disassembly, conducting whole life-cycle assessments and using technology such as space mapping – will be essential to widespread adoption of circularity. The success of circular retrofits hinges on access to circular materials, necessitating the establishment of efficient logistics and robust take-back mechanisms. Building specialized capabilities, providing financial incentives and fostering strategic partnerships and collaboration are essential enablers for circular retrofits, as are collaboration and capability development, a theme of a previous white paper.[49]

The economic viability of circular retrofits

The economic viability of circular retrofits is key to scaling circular practices across the retrofit value chain but requires further exploration. Although retrofits undoubtedly lower operational costs by reducing energy consumption, initially implementing circular practices can incur higher upfront costs. These costs arise from labour-intensive processes such as careful dismantling, advanced sorting and transportation to specialized reuse and recycling facilities, and actual reuse and recycling.

Furthermore, these costs are influenced by space constraints in dense urban areas where storage and recycling facilities are limited. While green energy investments such as solar panels have an average payback period of six to 10 years,[50] retrofit payback periods are more variable (more than 10 years for insulation, for example, compared to only about six years on average for appliances).[51]

Looking ahead, the minimum cost of circular retrofits needs to be assessed to identify the most cost-efficient pathways for transitioning to a circular value chain. To encourage circular approaches, landfill costs must remain high or continue to rise, while reuse and recycling costs must decline through economies of scale, improved efficiencies and advances in technologies. Additionally, regulatory mechanisms such as tax exemptions, decarbonization subsidies and carbon-pricing schemes can bolster the business case for circular approaches. For instance, Europe will introduce a separate emissions trading system for buildings and road transport in 2027.[52]

In conclusion, while circular retrofits offer long-term benefits, their economic viability depends on a combination of cost assessments, technological advancements and regulatory support. Additionally, it is crucial to evaluate whether achieving circularity in retrofitting is more feasible than in new buildings, given the potential to retain existing materials and components. By addressing these factors and clearly quantifying and communicating the cost-effectiveness of circular retrofits, stakeholders can unlock the full potential of circularity in retrofits and the built environment, paving the way for a more sustainable and resilient future.

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Appendix

FIGURE 9 **Concrete actions per stakeholder to transition to a circular retrofit value chain**

Owners and investors

- Set material reuse goals for the supply chain
- Mandate pre-demolition audits to evaluate the retain/reuse potential
- Introduce internal carbon pricing to support decision-making
- Promote understanding that circular retrofits uphold quality
- Demonstrate circular retrofits at scale through the public sector
- Finance circular retrofits via energy cost savings
- Maximize asset utilization through multi-use, flexible spaces
- Pioneer building codes promoting circular construction practices
- Secure green financing for circular retrofits based on carbon saving

Designers, planners and auditors

- Deploy modular, interoperable designs for easier disassembly
- Integrate digital material passports incorporating whole life-cycle information
- Prioritize retention and reuse of existing structure and materials
- Leverage space-mapping technology to create three-dimensional (3D) models of existing assets
- Incorporate best practice waste management plans in designs
- Build capabilities to integrate circular practices in design
- Adhere to building codes promoting circular strategies

Materials and parts manufacturers

- Ensure sufficient supply of circular materials and parts
- Expand business to new service-based business models (material-as-a-service, energy-as-a-service)
- Integrate vertically to offer retrofit services (e.g. concrete strengthening) and take-back programmes
- Provide whole life-cycle information for most important products including embodied carbon (e.g. environmental product declarations)
- Strengthen circular materials and parts processing capabilities through dedicated line of reused parts
- Partner with other manufacturers for reverse logistics of building components (e.g. aluminium and glass manufacturers)

Upgraders and renovators

- Specialize in circular retrofit upgrading and renovation
- Create a marketplace for secondary materials instead of sending them to landfill
- Upskill and train for disassembly and deconstruction
- Develop on-site recycling capabilities
- Offer warranties on installations of circular materials and parts used in circular retrofit
- Integrate horizontally to valorize waste as feedstock for other industries

Distributors and logistics handlers

- Establish a network of disassembly, recycling and storage hubs
- Employ unskilled workers to tear out and directly sort retrofit waste on-site
- Develop reverse logistics networks and temporary storage/remediation facilities
- Provide material management and sorting services
- Establish secondary material and parts marketplaces

Waste handlers

- Prioritize reuse, recycling and recovery by bringing sorted materials to recycling hubs or manufacturers (zero waste to landfill approach)
- Deploy technology for advanced sorting (e.g. near-infrared)
- Develop capabilities for sorting and segregation of material through training
- Develop standardized sorting and deconstruction guidelines

Operators and users

- Mobilize demand by leasing retrofit buildings with a circular strategy
- Establish platforms among asset operators to exchange knowledge on circular initiatives
- Ensure energy savings from circular retrofits are captured through sustainable building operations

Source: McKinsey analysis

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