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A new way to decarbonize buildings can lower emissions—profitably

An AI-informed approach makes it faster, easier, and cheaper to decarbonize real estate. Here's how.

This article is a collaborative effort by Brodie Boland, Daniel Cramer, Alastair Green, Darya Guettler, Focko Imhorst, and Marita Winslade, representing views from McKinsey' Real Estate Practice.

Real estate companies are increasingly accepting the imperative to decarbonize buildings, but they frequently find the task difficult, laborious, and expensive.

Owners with portfolios of many unique buildings often have no centralized inventory that indicates the conditions inside or the types of equipment they contain. What's more, physical energy audits and building-by-building net-zero plans are lengthy, costly, and enjoy no benefits of scale. Due to these limitations, the traditional approach to decarbonization has created a widespread impression that decarbonizing buildings is significantly unprofitable.

But thanks to improvements in the quantity and quality of data and analytic methods, there is a better approach. It is now possible to use a combination of data from satellites, geospatial analytics, regulations, labor and equipment costs, building characteristics, energy, and other sources to rapidly create a high-fidelity picture of the current state of an individual building without ever stepping foot inside.

By applying machine learning, AI, and physics-based modeling, portfolio owners can quickly identify building decarbonization opportunities. This includes the current type and estimated capacity of heating and cooling systems, the site-specific potential for solar or geothermal power, and where insulation and efficiency levels are substandard. Advanced evolutionary optimization algorithms can then determine the optimal set of solutions and sequence of actions for each building—and the portfolio as a whole—to reach net zero on a given timeline.

These capabilities can quickly generate a set of financially optimized plans for each building in a portfolio based on the building's unique starting point, regulatory environment, lease structure, and many other factors. These plans—which can be generated for a full portfolio in a matter of weeks—can include a set of time-bound actions, associated capital costs, and documentation of the effect on emissions and operating costs. For large portfolios, this novel approach to reaching net zero represents a more than 100-fold increase in the pace and scale of decarbonization planning compared with the traditional approach of conducting energy audits and net-zero studies. It also eliminates the need to rely on vague building archetypes or general marginal abatement cost curves, which often lead to poorer plans and higher costs. This system yields specific, detailed, actionable plans with faster abatement and better economics.

By developing the full path to net zero, real estate organizations can plan ahead instead of reacting. They can integrate decarbonization cost insights when deciding which buildings to move into or acquire. Because this new approach can rapidly generate a plan for every building, owners and occupiers can decide where to invest limited capital and coordinate equipment procurement, design, and project management to minimize costs.

Additionally, owners can aggregate building-level plans across the portfolio to develop capital plans and reporting. Building-level plans for energy efficiency and electrification allow owners and occupiers to estimate and procure required volumes of renewable power, increase the potential to take advantage of government incentives, and make building managers' jobs easier.

This article begins by exploring the importance of adopting a more efficient way to decarbonize buildings. Next, we describe how this new approach often makes it possible for real estate portfolios to achieve net zero at a net present value (NPV) that is neutral to positive. For example, we highlight a company that recently developed a net-zero pathway plan that's projected to cost roughly $85 million less than a traditional-approach plan would have cost. Finally, we describe the seven features of a credible building decarbonization plan.

Decarbonization efforts are challenging, but a faster, more economical way of accomplishing the real estate industry's decarbonization goals provides an opportunity to meaningfully accelerate actions required to limit global warming.

Building owners, operators, and occupiers have obligations to decarbonize

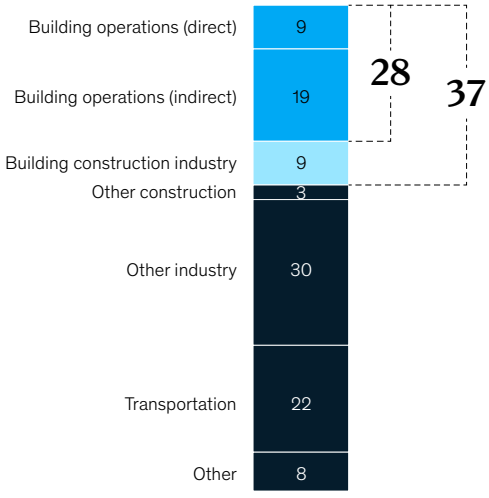
The real estate industry accounts for approximately 40 percent of global combustion-related emissions, of which 28 percentage points come from building operations and 12 from embodied carbon—that is, emissions from building materials and construction (Exhibit 1).[1] To keep global warming within approximately 1.5°C and to reach a net-zero-carbon building stock by 2050, the IEA estimates direct building emissions (such as from onsite gas or oil boilers) will need to be reduced by 50 percent and indirect emissions by

[1] *2022 Global status report for buildings and construction*, United Nations Environment Programme, November 9, 2022.

Exhibit 1

Thirty-seven percent of global energy emissions are related to buildings, with 28 percentage points of that due to building operations.

Global energy and process emissions by source, 2021, %



Source: UNEP 2022 Global Status Report for Buildings and Construction

60 percent (for example, through energy efficiency measures and grid decarbonization) by 2030.[2] However, the world's buildings are not currently on track to achieve these goals.

Some progress has been made and more is within reach

Real estate companies across the ecosystem are increasingly making net-zero commitments.[3] Meanwhile, regulators and governing bodies are working to implement a mix of incentives and regulations, including the European Commission's Energy Performance of Buildings Directive, the United Kingdom's Minimum Energy Efficiency Standards, and the US Securities and Exchange Commission's proposed climate disclosure. Adding to momentum are investors who are increasingly allocating capital to support the transition.

Progress is within reach. Unlike in some areas that are addressing decarbonization (such as heavy industry and shipping), our work in real estate has shown us that the technology already exists to replace the use of fossil fuels and dramatically improve energy efficiency in most buildings around the globe. If companies deploy the most efficient approaches, a large share of buildings (and an even larger share of building portfolios) can be decarbonized with neutral or positive financials[4] within the existing technology, policy, supply chain, and energy market environment.

Fulfilling the industry's obligations for the climate transition while creating value is possible. However, it requires that building owners do things differently.

[2] "Building sector emissions hit record high, but low-carbon pandemic recovery can help transform sector – UN report," United Nations Environment Programme, December 16, 2020.

[3] "Companies taking action," Science Based Targets initiative dashboard, August 2023.

[4] "Sustainability upgrades are driving a vacancy gap in offices," JLL, January 16, 2023.

Building decarbonization can be economical today

In detailed decarbonization work covering approximately 20,000 buildings, more than 15 megatons of CO_2 equivalent annual emissions, and various property types and geographies, we have come to a notable conclusion: using the new approach, it is often possible for real estate portfolios to achieve net zero with neutral to positive returns on investment as savings meet or exceed costs over time. This conclusion is valid with conservative assumptions, including no green premiums on rent or property valuation, no incremental future regulations or carbon pricing, and no new or significantly improved technology. By executing energy efficiency and electrification measures for each building's full path to net zero and optimizing renewable-power procurement at the portfolio level, building owners and occupants typically can recoup their investments through energy savings, capital cost optimization, and avoidance of existing regulatory penalties.

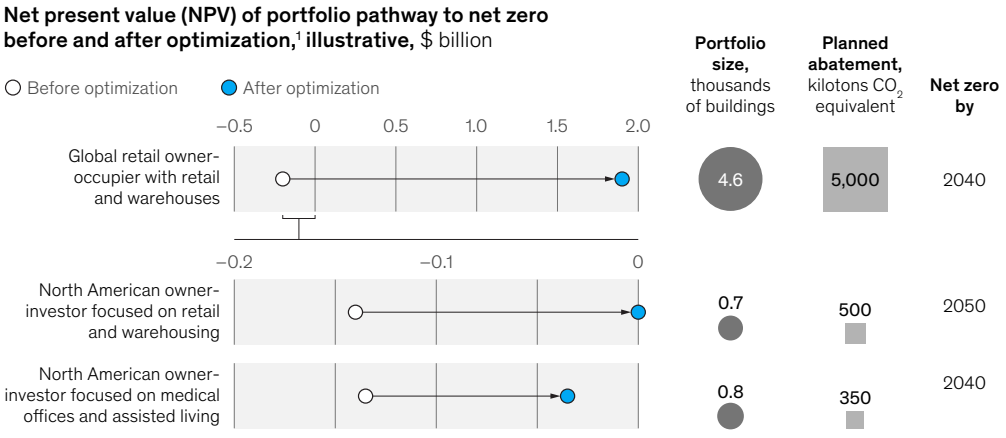
A diverse cohort of real estate portfolios used the new approach to dramatically improve the NPV of reducing their operational emissions to net zero (Exhibit 2). These plans were verified through testing and refinement with engineers and facility managers and from the approval of business cases and capital plans by finance departments, executives, and boards.

A real estate investor improved the NPV of its net-zero pathway by roughly $85 million

A US real estate investor with roughly $20 billion in assets under management across multiple property types recently used the modern approach to develop asset-level decarbonization plans for more than 750 buildings. Developing the initial plans took less than eight weeks and improved the NPV of the real estate investment trust's net-zero pathway by about $85 million, to a near-neutral NPV (see sidebar, "A company's optimized approach"). This investor's net-zero journey could pay for itself due to lower

Exhibit 2

Building decarbonization can be economical today.

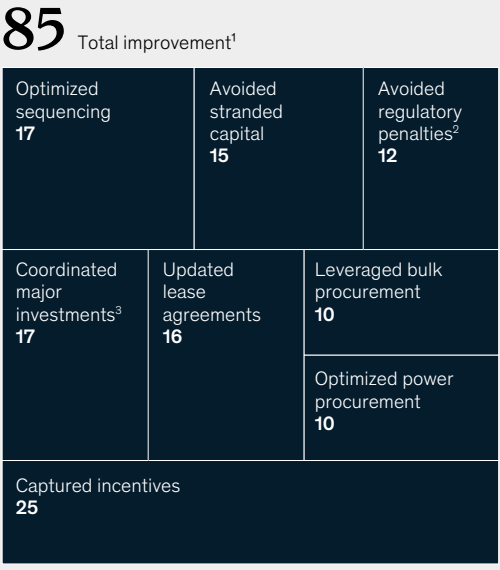


[1]The NPV values given are calculated without considering green premiums, future regulations, or step change improvements in technology performance or costs; were they included, NPV would likely increase.

A company's optimized approach

Eight ways a large real estate owner-investor improved the net present value of its path to net zero.

Net present value improvement, real estate investor,
$ million



[1]An additional $35 million could be achieved through incentives and lease structure changes.
[2]Also reduces the risk of last-minute, more expensive actions required to react to future regulations. Only existing regulations were considered for the purposes of calculating net present value (NPV) optimization potential. Avoided penalties from last-minute action/fines from future regulations are considered further upside.
[3]Only applied where roof and rooftop HVAC systems have similar expected end-of-life dates.

Total NPV improvement. To produce a conservative estimate, the NPV improvement figure does not include additional upside potential from rental or cap rate premia, increases in occupancy, the ability to capture local incentives, and/or the avoidance of future regulations.

Optimized sequencing. Used evolutionary optimization to determine the highest value set of actions to reach net zero; eg, the company installed efficiency measures early to maximize operating-expense savings and reduce capital expenditures required to electrify later.

Avoided stranded capital. Acted immediately to ensure that near-term capital investments across the portfolio were aligned with long-term decarbonization plans. (Because roofs and major equipment often have useful lives of 10 to >25 years, missed opportunities to electrify at end-of-life is likely to result in stranded capital or the need to retire equipment before the end of its useful life.)

Avoided regulatory penalties. Developed plans to help ensure that fossil-fuel-powered assets are replaced before the required dates in applicable regions.

Coordinated major investments. Coordinated major renovations and equipment upgrades (eg, roof replacements, insulation upgrades, and electrification of rooftop heating, ventilation, and air-conditioning [HVAC] systems) to reduce installation costs by sharing labor, project management, design, crane, and other costs.

Updated lease agreements. Reviewed leases to ensure current templates allow for capital recoveries for investments that yield energy savings for tenants. This allows landlords to align costs and benefits across parties and avoid the "split-incentive problem." (For nonserviced leases, landlords may wish to consider metered-efficiency structures that can allow owners to receive a share of energy savings.)

Leveraged bulk procurement. Developed plans that provide long-term visibility into all major HVAC and building envelope needs to negotiate bulk discounts and secure delivery timelines for major equipment and materials.

Optimized power procurement. Developed an optimized power procurement strategy tied to an electrification timeline. The goal was to reduce the risk of signing large contracts at higher costs right before net-zero target dates.

Captured incentives. Created a plan to apply for incentives available for net-zero-related electrification and energy efficiency measures. (These incentives were treated as an upside and were not factored into the NPV improvement estimate.)

utility bills, avoided existing regulatory penalties, and reduced capital costs (by coordinating projects and negotiating bulk procurement pricing, for example). Changes in these factors, such as a new price on carbon in a certain jurisdiction or green premiums, are likely to result in positive economics over the long run.

Traditional approaches are typically slower and more costly

Traditionally, owners have taken a project-by-project approach across their portfolios, focusing on discrete actions with clear stand-alone payback periods, such as installing high-efficiency equipment, lighting, and automated building controls.

Marginal abatement cost curves, or MACC curves, have historically been used to identify and prioritize stand-alone payback period projects by calculating the average industry costs, or savings, per ton of carbon abated for that type of project. MACCs have been a useful prioritization tool in the past and remain so for highly standardized industries where site-specific optimization is not yet available. However, for real estate portfolios, an optimized approach that uses data and analytics can yield significantly improved results.

To illustrate the relative benefit of the optimized approach, take, for example, a building following an average commercial building MACC curve that would yield an NPV of negative $1.1 million to reach net zero. The same building, by optimizing the pathway for the specific building conditions via the new approach, could yield an NPV of positive $100,000 to reach net zero, representing a $1.2 million NPV improvement compared with the alternative method.

Why is this the case? For companies with a net-zero commitment, the MACC approach does not consider site specifics (such as if the building envelope is leaky) or interdependencies and coordination opportunities between decarbonization levers. Accordingly, it often pushes costly actions into the future. Real estate owners could then be forced to implement more expensive initiatives at later, nonoptimal times, leading to wasted capital (due to issues such as oversize systems or equipment that has to be retired before end of life) and lost energy savings.

Other owners have traditionally worked from the bottom-up, conducting building-by-building energy audits and engineering studies to examine issues including insulation, current heating, ventilation, and air-conditioning (HVAC) systems, and onsite solar potential, and then developing bespoke decarbonization plans. This approach often takes months per building and can result in a series of individual reports, making it difficult to aggregate plans, understand portfolio-wide costs, avoid wasted capital such as by having to strip out equipment before end of life, comply with regulations or targets, or find portfolio-level efficiencies (such as through bulk procurement).

How to get started: The seven features of a credible building decarbonization plan

While a range of building owners and occupants are making commitments to achieve net zero, many lack comprehensive plans. Given what is now possible with evolving data and AI and the significant effects they could have on the pace of building decarbonization and profitability, major building owners and occupiers have a new set of options for developing credible plans. Optimal plans will require the following seven components:

- *Portfolio lens to net zero.* Many building owners or occupants have hundreds or thousands of buildings in their portfolios. Plans for decarbonizing these buildings are often patchwork, starting with a subset of buildings based on emissions (for example, some take the "worst first" approach), regulations (some only create plans where regulations already exist), or other factors (some assets fall within certain divisions where there is an enthusiastic sustainability leader). Under the new approach, owners can capture value by making building plans across the portfolio work together, such as through joint procurement, coordination, and smart sequencing. Until there is a plan for every building, the plan is not complete.

- *Asset-specific plans.* For optimized financials, general lists of levers (such as LED lights, heat pumps, and on-site solar), archetypes, and MACC curves fall short. To maximize decarbonization impact per dollar spent, each building needs its own plan that considers its specific starting point (such as type of insulation, current equipment and systems, and building layout), conditions (including local climate, geological conditions, and local solar radiation), and asset strategies, including lease types, tenant composition, and operating objectives.

- *A full pathway to net zero.* Companies are wise to avoid plans that only get part of the way to net zero, such as plans to reach 30 percent energy-efficiency improvements in the next two years without visibility past that point. This kind of short-term view can significantly compromise long-term decarbonization outcomes and costs. For instance, some insulation measures that don't meet the short-term hurdle rate could reduce future HVAC sizing requirements and expenses. Companies that make only short-term decisions—or wait until regulations require them—may end up spending more in the long run.

- *Linked Scope 1 and 2 plans.* Plans for Scope 1, such as electrification measures, and for Scope 2, such as renewable-power purchasing, often are created separately. For example, facilities managers might handle retrofits, while procurement departments might take on renewable-energy purchasing. This approach doesn't take advantage of

interdependencies between Scopes 1 and 2, such as demand estimates that consider the sometimes-opposing effects of energy efficiency and electrification actions. The result can be slower and more expensive renewable-energy procurement.

- *Actionable steps.* Plans for each building should include specific steps that a building's facility manager can implement. (For example: "Replace gas-fired system with air source heat pump and auxiliary electric resistance backup as needed. Additional natural gas backup with condensing boiler can be implemented to mitigate temperatures below –10°F.") Building personnel should be able to quickly send these instructions to vendors or facilities management teams for execution.

- *Quantified plans.* Plans should be specific enough to inform financial planning at a building and portfolio level. Leaders need to understand the exact financials of achieving net zero, including the required changes in capital investment and operating costs, the potential costs of additional debt or the implications of front-loading capital expenditures, and how both costs and benefits will accrue to either building owners or tenants.

- *Net-zero-oriented decision making.* Owners and operators can embed decarbonization plans into operations across the entire organization, including processes, incentives, and governance structures. Fortunately, decarbonizing buildings' operational emissions can often be accomplished with small tweaks to existing processes rather than an entirely new campaign. "Business as usual" should come to include updating capital-planning processes to consider the decarbonization plans for each building, creating funds and allocating capital (which often can have a positive return) for low-emissions systems, and incorporating decarbonization analyses into the process of acquiring new assets.

The real estate industry faces daunting challenges as it works to decarbonize: it needs to scale supply chains to meet new demand, train millions of skilled workers to deploy retrofits, and upgrade grid generation and storage capacity to accommodate electrification. The good news is that developing decarbonization plans has recently become much simpler, faster, and cheaper, making it easier for the industry to get moving.

Most important, real estate companies that make use of the AI-backed, full-life-cycle approach to decarbonization can make a genuine dent in building-related emissions. Given the profound decarbonization challenges across sectors, this new approach could be an important part of global efforts to minimize climate change. It is possible and necessary. The time to start is now. Q

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