HANG LUNG PROPERTIES

Our Journey to NET ZERO

Our Scenarios and Actions to Reduce Greenhouse Gas Emissions to 2050

March 2025

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About Hang Lung Properties

Hang Lung Properties Limited ("the Company" or "Hang Lung Properties," stock code: 00101) and its subsidiaries (collectively known as "Hang Lung") is the property arm of Hang Lung Group Limited ("Hang Lung Group," stock code: 00010).

Headquartered in Hong Kong, Hang Lung Properties develops and manages a diversified portfolio of world-class properties in Hong Kong and the nine Mainland cities of Shanghai, Shenyang, Jinan, Wuxi, Tianjin, Dalian, Kunming, Wuhan, and Hangzhou (listed by opening year). With its luxury positioning under the "66" brand, the Group's Mainland portfolio has established its leading position as the "Pulse of the City." Hang Lung Properties is also recognized for leading the way in enhancing sustainability initiatives in the real estate industry.

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Executive Summary

This paper presents Hang Lung's first effort to analyze and communicate scenarios, challenges, and opportunities on our path to achieving net zero greenhouse gas (GHG) emissions across our value chain. We conducted this exercise to gain a better understanding of our long-term challenges and opportunities in decarbonization, guided by our commitment to reach net zero by 2050.

In **Chapter One**, we begin with our 2023 emissions profile of almost one million tonnes of CO_2 equivalent across all scopes of emissions. We find that we are well positioned to reduce our emissions between now and 2030, partly due to our proactive decarbonization efforts and also because we will significantly reduce our construction activity in the latter half of this decade.

In **Chapter Two**, we consider scenarios for the 2030–2050 period, where there is more uncertainty. We introduce our detailed, bottom-up decarbonization model with more than 1,000 data inputs from multiple sources, including two scenarios for potential emissions reduction pathways. The first scenario includes moderately optimistic assumptions ("Light Green Scenario"), and the other features more optimistic assumptions ("Dark Green Scenario"). To establish a baseline for each, we assess the potential emissions if no new construction were to occur after 2030. We then consider the potential emissions impact if we were to expand our total floor area with 1% annual growth between 2030 and 2050. This analysis is **not** a prediction—it is simply an assumed growth rate that allows us to assess the potential impact of new construction.

The scenarios generated five key findings, with three of them related to new construction:

1. Without new construction, our emissions would drop sharply.

2. With new construction, achieving the desired reductions for 2040 and 2050 would be challenging. The reduction pathways would need to contend with potentially significant additional emissions from construction materials, particularly aluminum, concrete, and steel. In 2040 and 2050, new construction would increase our total emissions by 32–35% and 38–46%, respectively, compared to the baseline with no new construction during those years.

3. In the more optimistic scenario, we could expand by a much larger physical footprint while still achieving deeper emissions reductions. More specifically, the Dark Green Scenario, with an average rate of 2% expansion per year, has lower emissions through to 2050 than the Light Green Scenario at 1% expansion.

Our two other important findings are as follows:

4. Without any new construction, some of our smaller Scope 3 emissions categories (e.g., purchased services and operational waste) are expected to grow in relative importance over time, increasing from around 15% of Scope 3 emissions today to possibly as much as 92–94% in 2050.

5. While the electricity grid would decarbonize substantially under both scenarios, market-based accounting (in which we can account for emissions reductions from our power purchase agreements) indicates much faster decarbonization than location-based accounting (in which we can only report the local grid emissions factors).

After considering the above scenarios and variables, we find that our emissions have the potential to decline from almost 1,000,000 tonnes of CO_2 equivalent in 2023 to below 100,000 or as low as 16,000 tonnes in 2050 (before considering any possible offsets for our residual emissions).

Scenario	Light Green – New Construction (1% per year)	Light Green – No New Construction	Dark Green – New Construction (1% per year)	Dark Green – No New Construction
Tonnes of CO_2 equivalent in 2050	79,000	54,000	22,000	16,000

In Chapter Three, we discuss the broader implications of our analysis and findings. First, we must be fully aware of the impact of business expansion as we work to reduce our emissions. Second, greenhouse gas emissions accounting principles (e.g., whether we evaluate our progress using location- or market-based accounting and whether, how soon,

and under what circumstances offsets can be included) would significantly impact our decarbonization trajectory. Third, there are areas in which emissions are overlooked or deserve more attention, namely, emissions from tenants' interior fitouts and refrigerants. We are committed to examining and, where warranted, accounting for these neglected sources of emissions, even if doing so would make our path to net zero more challenging.

We also examine key trends and technologies that may help accelerate our progress—potential game changers such as artificial intelligence (AI) technologies to optimize energy efficiency and promising innovations in concrete, steel, and aluminum. We note that momentum is growing in key areas, that China's carbon emissions are expected to start declining in the near future, and that China is a global leader in numerous decarbonization technologies. There are, therefore, grounds for cautious optimism.

We conclude by discussing key actions we will actively pursue, including:

1. **Advancing energy efficiency:** We will enhance energy efficiency through asset-level benchmarking, retro-commissioning, and AI technologies.
2. **Procuring more renewable energy:** We are expanding renewable energy procurement in mainland China and will explore similar options in Hong Kong.
3. **Improving material efficiency:** We aim to optimize material use in construction, including by leveraging AI technologies, to reduce overbuilding and emissions.
4. **Reducing the GHG intensity of construction materials:** We are exploring low carbon and even carbon-negative materials, and we are using low carbon concrete bricks and low carbon emissions steel in our development projects.
5. **Collaboration with suppliers:** We will work closely with suppliers to identify and apply low carbon construction materials.
6. **Pursuing opportunities for adaptive reuse:** We are investigating adaptive reuse strategies to minimize embodied carbon emissions.
7. **Lifecycle refrigerant management:** We are improving our lifecycle refrigerant management practices and will issue a white paper with recommendations in 2025.
8. **Collaboration with tenants:** We have introduced both energy use benchmarking and embodied carbon benchmarking for tenants to promote tracking, reporting, and reducing emissions in line with a 'whole building' approach to decarbonization.

To summarize, with consistent effort and sustained focus—including collaboration with suppliers, use of innovative technologies, and potentially some offsets—we **can** achieve net zero by 2050.

INTRODUCTION

This paper outlines Hang Lung's first effort to assess and communicate scenarios, challenges, and opportunities on our journey toward achieving net zero greenhouse gas emissions across our value chain. We have developed a detailed, bottom-up decarbonization model that examines the Company's key sources of emissions from today until 2050, pathways for reductions in those sources, and the factors that could influence the pace of the reductions.

Our aim in preparing and publishing this paper is to achieve several objectives:

First, as with most companies, the majority of our decarbonization efforts are focused on the near term. We want to take a step back and gain a better understanding of **the longer term** and how our progress could speed up or slow down under various scenarios.

Second, we intend to gain clarity on **the challenges we need to overcome and the initiatives we should accelerate**.

Third, consistent with Hang Lung's value of openness, we hope our paper will **contribute to discussion and mutual learning** among stakeholders.

It is important to note several caveats at the outset. First, given the lengthy timelines and the many internal and external factors that impact our business, reality will almost certainly differ from our scenarios. Therefore, the scenarios in this paper should not be confused with predictions or commitments. Second, emissions accounting is not an exact science, and the methods used to allocate emissions might change in the next quarter century.

As the British statistician George Box famously commented, "All models are wrong, but some are useful." What we learn from scenario modeling is the sensitivity and potential impact of various factors as we progress toward our targets. We can identify those that are likely to have the greatest impact on our emissions trajectory, enabling us to focus our efforts accordingly. Additionally, because we look all the way to 2050—far beyond the typical time scope considered in our annual sustainability reporting—we can uncover how the relative contributions of different factors may change over time. Some that have little impact in the short term could become more significant in the long term. Since we are aiming to reach net zero emissions, any persistent emissions, even if relatively small today, would need to be understood and eliminated.

The paper is organized as follows:

Chapter 1: Where We Are Today. We provide a detailed overview of our 2023 emissions and discuss how we expect to progress toward our 2030 targets.

Chapter 2: Decarbonization Scenarios. We introduce the key inputs and assumptions to our decarbonization model and examine how we would decarbonize our business through two scenarios. We also consider new construction as a key factor and share six core findings.

Chapter 3: Implications and Looking Ahead. We examine broader issues arising from the previous chapters, including the challenges of new construction, matters regarding carbon accounting, potential 'game changers' that could accelerate our progress, and key actions we are pursuing.

We also include a list of sources and suggested publications for further reading; please see **Sources and Recommended Reading.**

CHAPTER 1
Where We Are Today

Over the past several years, Hang Lung has made consistent efforts to advance our journey toward net zero greenhouse gas emissions. In **December 2020**, we formulated a goal to reduce our carbon footprint in line with science by 2030. In **December 2021**, we established 25 targets to be achieved by the end of 2025 ("25 × 25"), including five related to decarbonization. In **December 2022**, Hang Lung became the first real estate company in Hong Kong and mainland China to obtain approval from the Science Based Target initiative (SBTi) for our near- and long-term company-wide emissions reduction targets in line with SBTi's Net-Zero Standard, as outlined in Table 1 below.

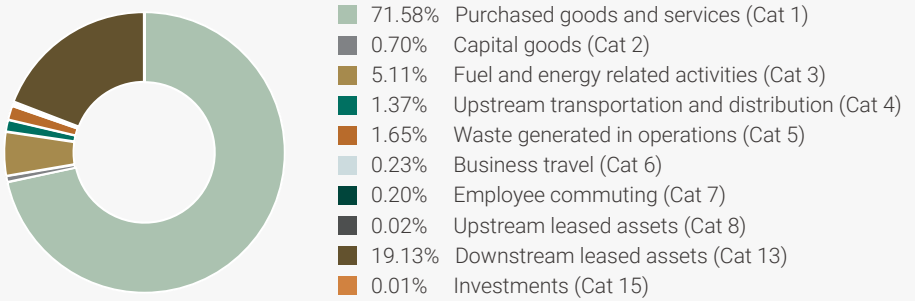
Table 1: Hang Lung's SBTi targets

Type of Target	Scope 1 & 2 GHG Emissions	Scope 3 Emissions
Overall Net-Zero Target	Commits to reaching net-zero GHG emissions across the value chain by 2050	
Near-Term Targets	Commits to reducing absolute GHG emissions by 46.6% by 2030 from a 2019 base year	Commits to reducing absolute GHG emissions from purchased goods and services and downstream leased assets by 25% by 2030 from a 2020 base year
Long-Term Targets	Commits to reducing absolute GHG emissions by 99.6% by 2050 from a 2019 base year	Commits to reducing absolute GHG emissions by 99.6% by 2050 from a 2020 base year

A. Overview of Our 2023 Emissions

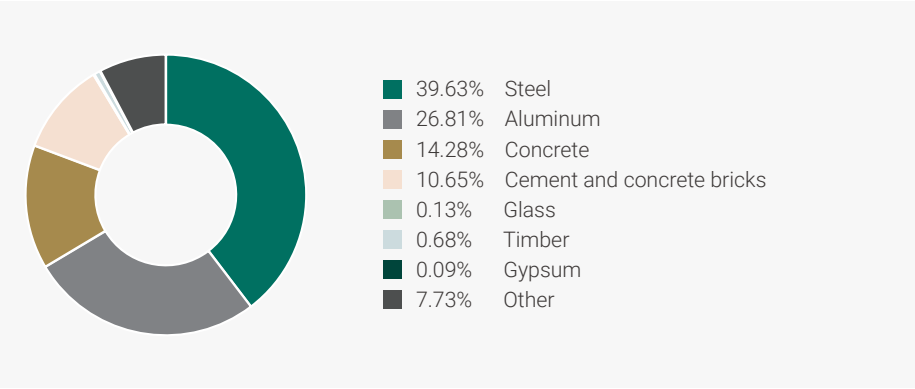
In 2023, we generated almost **one million tonnes** of CO_2 equivalent across our value chain – or 977,035 tonnes to be precise, with the breakdown of carbon emissions by scope as follows: **Scope 1:** 0.4% of emissions (refrigerant emissions, diesel, and natural gas) ; **Scope 2:** 16.4% of emissions (purchased energy); and **Scope 3:** 83.2% of emissions (indirect emissions throughout our value chain). Our Scope 3 emissions are divided into multiple categories, with two areas comprising the most significant sources: 71.6% of our Scope 3 emissions were from purchased goods and services (principally embodied carbon from building materials), and 19.1% were from downstream leased assets (i.e., tenants' electricity consumption). When combined, these two categories contributed over 90% of our Scope 3 emissions in 2023.

Figure 1: Breakdown of Scope 3 emissions by category in 2023



For our purchased goods and services, embodied carbon (Category 1a) from materials used in building construction represented approximately 92.1% of the 71.6%. In 2023, our three largest sources of embodied carbon emissions in our building materials were steel, aluminum, and concrete, in that order. The considerable contribution of aluminum over concrete reflects the fact that our large-scale projects—such as Westlake 66—were at advanced stages of construction in 2023, when aluminum was heavily used in elements like alloy windows and curtain walls for the main structure, among other applications.

Figure 2: Hang Lung's building materials embodied carbon emissions in 2023



B. Progress Towards Our 2030 Targets

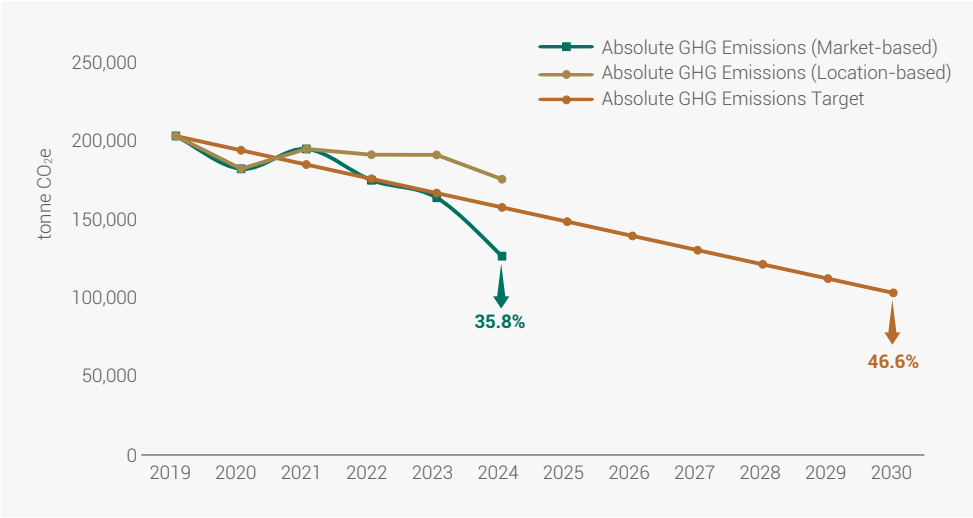
Although our 2023 emissions were significantly higher than our SBTi base year emissions (2019 and 2020), we are well on track to meet our 2030 SBTi targets. Through a combination of factors, we are likely to achieve—and maintain—the required 2030 percentage reductions ahead of schedule.

Scope 1 and 2 Target: 46.6% Reduction by 2030 Relative to 2019

Three main factors contribute to expected reductions in our Scope 1 and 2 emissions by 2030: energy efficiency, renewable energy procurement, and grid decarbonization.

By the end of 2024, we had already achieved a 35.8% reduction compared with our 2019 baseline, primarily through renewable energy procurement. The chart below illustrates the reductions in our Scope 1 and 2 emissions achieved in 2024, and the contrast between location-based and market-based accounting.

Figure 3: Scope 1 & 2 SBTi target and absolute GHG emissions from 2019 to 2024



Energy efficiency. We recognize that energy efficiency is critical for reducing emissions and accelerating the energy transition. As real estate companies become more efficient, the limited supply of clean energy can meet more demand, so high emissions sources of power generation, such as coal and gas plants, can be phased out earlier. While some of our energy efficiency investment plans for the next five years are already under development, we are committed to advancing more energy efficiency improvement projects, including retro-commissioning, upgrades and replacements of chiller plants and pumps, and utilizing AI technologies.

Renewable energy. Renewable energy procurement will contribute the most to our Scope 1 and 2 emissions reduction efforts. Since it will take time for the grids in mainland China and Hong Kong to decarbonize, we have already secured renewable energy through power purchase agreements (PPAs) for five of our 10 Mainland properties (when Westlake 66 opens in 2025, we will have 11 Mainland properties). If nine out of 11 properties have PPAs by 2030, our PPAs alone would contribute to a 46% reduction (almost achieving our 2030 target). Assuming 10 out of 11 properties procure renewable energy via PPAs by 2030, we can expect a 61.8% reduction in our Scope 1 and 2 emissions relative to the 2019 baseline.

Grid decarbonization: Naturally, grid decarbonization will play a role in reducing emissions. As more clean energy sources are integrated into the grid, we anticipate a significant reduction in emissions in both Hong Kong and mainland China. Even if we do not procure any PPAs, grid decarbonization should cumulatively contribute to a 16% reduction in emissions from our 2019 baseline. Since we will procure PPAs for most of our Mainland properties, the actual contribution from grid decarbonization will be smaller, but it will still facilitate reductions in emissions for any properties dependent on the local grid, including all our properties in Hong Kong.

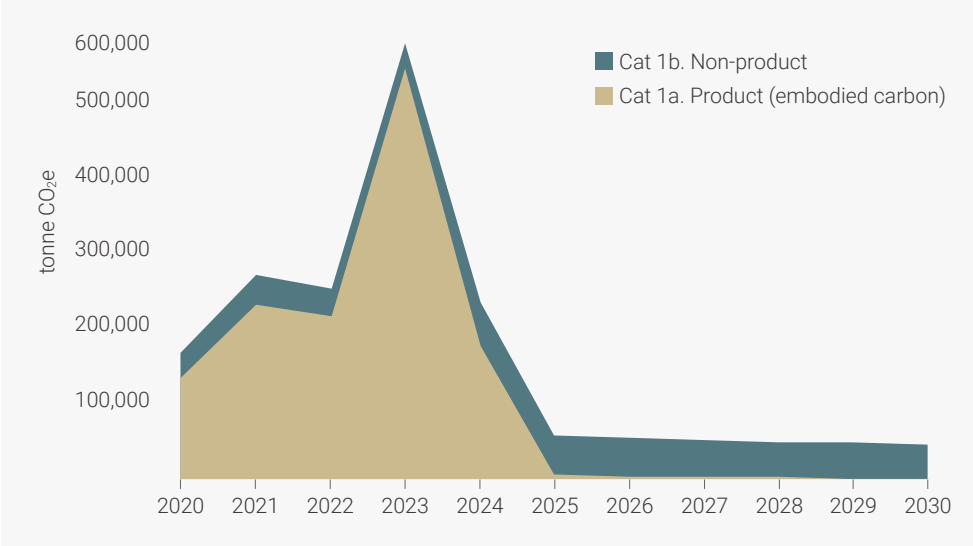
Scope 3 Target: 25% Reduction by 2030 Relative to 2020

We also expect to achieve our Scope 3 target of 25% reductions, covering our Scope 3 emissions from Category 1: purchased goods and services, and Category 13: downstream leased assets.

Category 1: Purchased goods and services

Embodied carbon. By far, the biggest contributor to lowering emissions for our purchased goods and services is an expected reduction in emissions from embodied carbon (Category 1a). As noted earlier, embodied carbon from materials used in building construction was responsible for more than 90% of our purchased goods and services emissions in 2023. We expect 2023 to be our peak year for construction-related emissions for at least the next six years. Even if we were to start new projects later in this decade, it would take several years before our construction activities would add substantial emissions from embodied carbon.

Figure 4: Scope 3 Category 1 emissions: 2020–2030



We can see from the fluctuations in Figure 4 how critical embodied carbon from construction is to our progress—not only for our purchased goods and services but for our Scope 3 as a whole. Since Hang Lung has no additional construction planned for the latter part of this decade, 2030 should see a 46% reduction from our 2020 base year, significantly exceeding our target reduction of 25%.

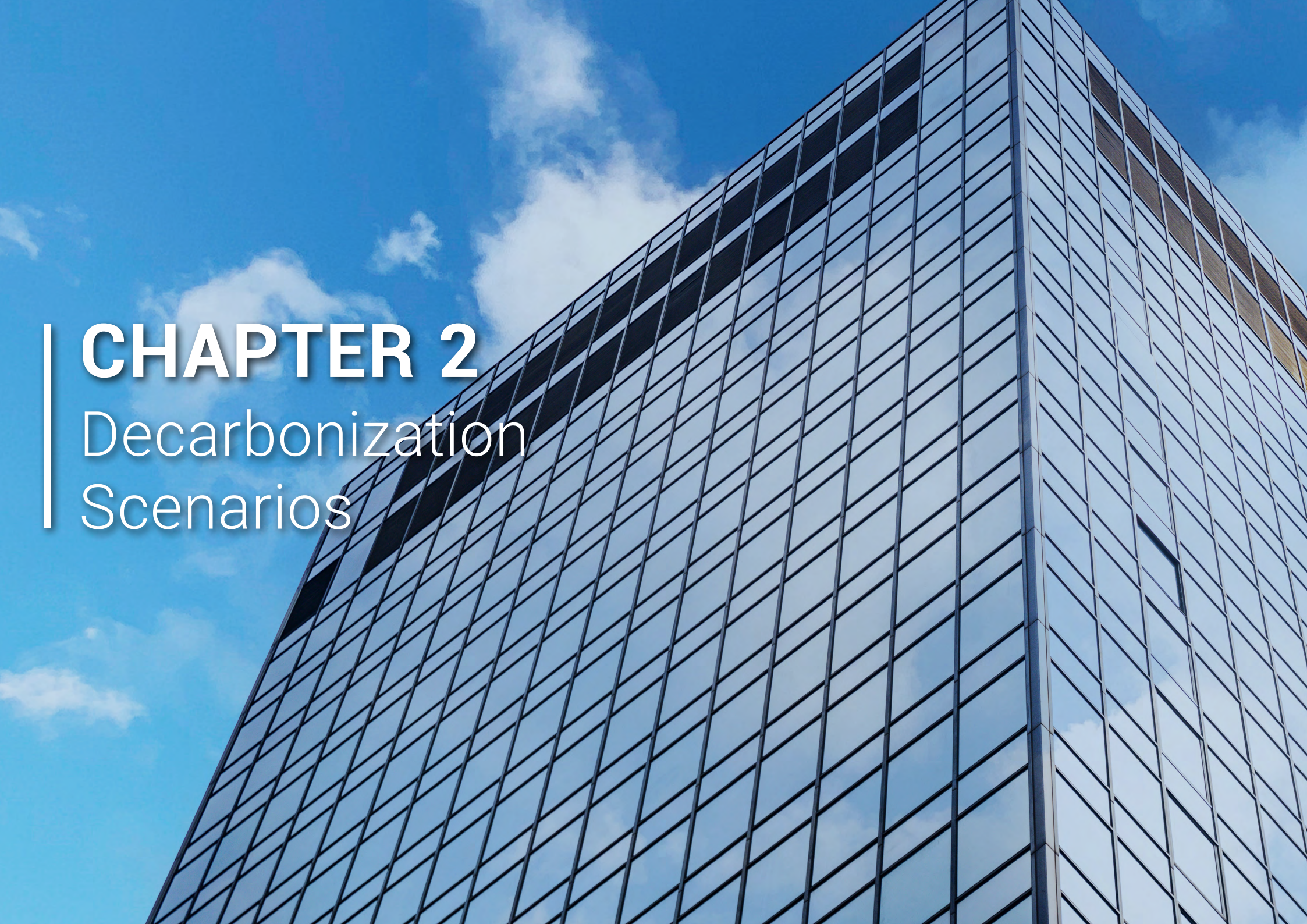
As discussed later in this paper, we are also making efforts to reduce both the carbon intensity of the construction materials we procure and the material efficiency of our projects (i.e., the quantity of materials needed per square meter). While these are vitally important initiatives to support our longer-term reduction targets, their contributions to our 2030 reduction target will be relatively minor and limited to specific applications in our construction projects before they are concluded.

Category 13: Downstream leased assets

The factors that will reduce our downstream leased assets emissions are the same as those for Scope 1 and 2 emissions: energy efficiency, renewable energy procurement, and grid decarbonization. Similar to Scope 1 and 2 emissions, additional PPAs will already bring substantial reductions. Grid decarbonization will also make a significant contribution to our Hong Kong properties and those that do not have PPAs. Lastly, we are taking numerous steps to partner with tenants to improve their energy efficiency. With all these factors combined, emissions from our downstream leased assets should meet or exceed the required reductions by 2030.

Conclusion

Hang Lung is well positioned to reduce our emissions between now and 2030. Our anticipated decline in emissions over the next five years is a result of our continued progress across the value chain, particularly our leadership efforts in procuring renewable energy. Candidly, however, an even greater contributor to this expected reduction is that we plan to carry out significantly less construction in the second half of this decade. Therefore, we embark on our path to net zero with some wind in our sails. As we look to the medium and long term, however, the decarbonization journey becomes more complex. The next chapter provides an overview of the scenarios and factors that will impact this journey over less familiar waters.



CHAPTER 2
Decarbonization Scenarios

As we consider Hang Lung's potential progress toward net zero by 2050 under various scenarios and assumptions, we start with our 2023 emissions profile and the factors contributing to those emissions, and then project potential emissions reduction pathways for 2030, 2040, and 2050. The scenarios we have applied in our evaluation of Hang Lung's potential progress toward net zero are primarily based on the International Energy Agency's (IEA's) recently published Global Energy and Climate Model results. Our analysis also draws on multiple additional data sources, including the China Iron and Steel Association (CISA), Carbon Risk Real Estate Monitor (CRREM), McKinsey & Company, Energy Foundation, data from government departments and local utilities, and expert input (please see Sources and Recommended Reading).

The two main scenarios are as follows:

- **Light Green Scenario.**

  This scenario loosely corresponds with the IEA's "Announced Pledges Scenario" and reflects a moderately optimistic view on improvements in emissions reduction through material and electricity intensity changes and other factors. For example, we assume that the electricity grid in China reaches zero emissions in 2060 in accordance with its carbon neutrality target.

- **Dark Green Scenario.**

  This is roughly aligned with the IEA's "Net Zero Emissions by 2050 Scenario" and offers a more optimistic view, assuming greater policy support for key initiatives, with faster reductions in material and electricity intensities and other key drivers. For example, the electricity grid in China achieves zero emissions in 2050, moving ahead of its official target. We also assume that China will actively lead in other real estate and construction-related reduction trends.

Our analysis also compares our potential progress under these scenarios with a theoretical target line that we would follow if we made steady year-on-year progress in reducing emissions toward zero in 2050.

Through these comparisons, we are able to gain insights into where and when we may fall short and how our total quantity of emissions might be reduced over time. We can also assess how potential new construction expansions would impact our total emissions. To establish a baseline for both scenarios, we assume that no new Hang Lung construction activity will occur after 2030. We then consider the emissions impact if we expanded our total floor area through new construction at an average rate of 1% annually between 2030 and 2050.

While 1% may sound like a modest increase, upon closer examination, it would still represent a significant expansion of our total floor area for new construction projects. For clarity, an average of 1% each year between 2030 and 2050 would extend our total floor area by roughly 1,050,000 square meters. The average floor area of our existing Mainland properties (shopping mall and office) is about 230,000 square meters, so this rate of growth assumes the complete construction cycle will take place for about five new commercial complexes over the relevant time frame. Given the extent of urbanization that has occurred in China, China's aging population, and Hang Lung's business model, which focuses on owning prime real estate that targets luxury consumers in tier one and two cities, this scenario would already represent a vigorous expansion.

As noted earlier, however, this analysis is not a prediction. It is simply an exercise to help us understand the potential emissions impact if we experience this floor area growth rate from 2030 onward.

A. Model Assumptions and Limitations

With nearly 1,000 inputs in total, our model builds on a three-year Scope 3 forecast for 2024–2026 provided to Hang Lung by Carbon Mind, a Beijing-based consultancy, in combination with multiple external sources and expert opinions. We interpolate Carbon Mind's results for the period from 2026–2030 as the starting point for our Light Green and Dark Green scenarios, but our focus below is from 2030–2050. The model inputs apply to Hang Lung specifically; we do not form a view about the extent to which they would potentially apply to all real estate entities in China.

Some of the most significant inputs and assumptions are as follows:

Table 2: Decarbonization model assumptions

Key Inputs	Scope	Light Green Scenario	Dark Green Scenario
Refrigerants	Scope 1	40% reduction in emissions by 2050 compared to 2030	80% reduction in emissions by 2050 compared to 2030
Gas	Scope 1	We assume no change in gas	50% reduction in emissions by 2050 compared to 2023
Diesel	Scope 1	We assume no change in diesel, used for backup generation	We assume limited change in diesel use, given its current marginal use as a backup power source
Electricity Intensity	Scope 2, Scope 3 Category 13: downstream leased assets, and Scope 3 Category 11: use of sold products	1% annual reduction in electricity intensity after 2025 (a more moderate path than the Carbon Risk Real Estate Monitor (CRREM, 2024) pathway for China)	2% annual reduction in electricity intensity after 2025, aligned with the CRREM 2024 pathway for China
Renewable Energy Procurement Through Bundled PPAs	Scope 2 and Scope 3 Category 13: downstream leased assets	All Mainland properties have bundled PPAs by 2035, none in Hong Kong	All Mainland properties have bundled PPAs by 2030, none in Hong Kong
Heat Emissions	Scope 2	35% reduction in emissions by 2050 compared to 2023, mainly through electrification (including heat pump) and fuel switching; based on a forecast in a report prepared by the International Energy Agency (IEA) and the Tsinghua University Building Energy Research Center (BERC) (2024)	70% reduction in emissions by 2050 compared to 2023, mainly through electrification (including heat pump) and fuel switching; based on a forecast in a report prepared by the International Energy Agency (IEA) and the Tsinghua University Building Energy Research Center (BERC) (2024)
Grid Emissions Factor	Scope 2 and Scope 3 Category 13: downstream leased assets	Based on the IEA's Announced Pledges Scenario, the grid emissions intensities in China would decrease moderately in this scenario and decline to zero by 2060	Based on the IEA's Net Zero Emissions by 2050 Scenario, the grid emissions intensities in China would decrease more rapidly in this scenario and decline to zero by 2050
Leased Assets	Scope 3 Category 13: downstream leased assets	We assume, based on the current arrangement, that 45% of our Hong Kong gross floor area would be leased assets and 38% of our Mainland gross floor area would be leased assets	
Material GHG Intensity (Concrete)	Scope 3 Category 1: purchased goods and services	Based on the IEA's Announced Pledges Scenario (2024), the GHG intensity for concrete is aligned with the improvement rate for cement: 55% by 2050 compared to 2023	Based on the IEA's Net Zero Emissions by 2050 Scenario (2024), the GHG intensity for concrete is aligned with the improvement rate for cement: 97% by 2050 compared to 2023
Material GHG Intensity (Steel)	Scope 3 Category 1: purchased goods and services	Based on a decarbonization roadmap released by CISA (2022), total CO_2 emissions from the Chinese steel industry will be zero by 2060. The GHG intensity for steel will decrease by 80% by 2050 compared to 2023	Based on a China steel sector decarbonization roadmap published by McKinsey (Woetzel, et al., 2021a); the sector will reduce emissions by 99% by 2050, assuming all reduction gaps are addressed. The GHG intensity for steel will decrease by 90% by 2050 compared to 2023
Material GHG Intensity (Aluminum)	Scope 3 Category 1: purchased goods and services	Based on the IEA's Announced Pledges Scenario (2024), the GHG intensity for aluminum will decrease by 81% by 2050 compared to 2023	Based on the IEA's Net Zero Emissions by 2050 Scenario (2024), the GHG intensity for aluminum will decrease by 97% by 2050 compared to 2023
Material Efficiency (Concrete)	Scope 3 Category 1: purchased goods and services	1% annual reduction in tonne/m^2 for new construction from 2023	2% annual reduction in tonne/m^2 for new construction from 2023
Material Efficiency (Steel)	Scope 3 Category 1: purchased goods and services	1% annual reduction in tonne/m^2 for new construction from 2023	2% annual reduction in tonne/m^2 for new construction from 2023
Material Efficiency (Aluminum)	Scope 3 Category 1: purchased goods and services	1% annual reduction in tonne/m^2 for new construction from 2023	2% annual reduction in tonne/m^2 for new construction from 2023

This model has some notable limitations. First, it does not account for two variables that may impact total electricity consumption: higher demand for summer cooling driven by rising temperatures, and increases in landlord and/or tenant consumption from electric vehicle charging. Second, as CRREM and other stakeholders have pointed out, the real estate sector may have underestimated lifecycle emissions from refrigerants and Hang Lung is no exception. Finally, the model does not account for embodied carbon emissions from tenant fitouts and renovations. This third area is also a relevant omission for the real estate sector as a whole. Experts like GIGA (RESET) and the Rocky Mountain Institute (RMI) have found that, over the life of a building, embodied carbon from interiors can be equivalent to or even greater than embodied carbon from the building's structure and substructure (Wallis., 2021; Esau, et al., 2021). We discuss the second and third issues further in chapter three.

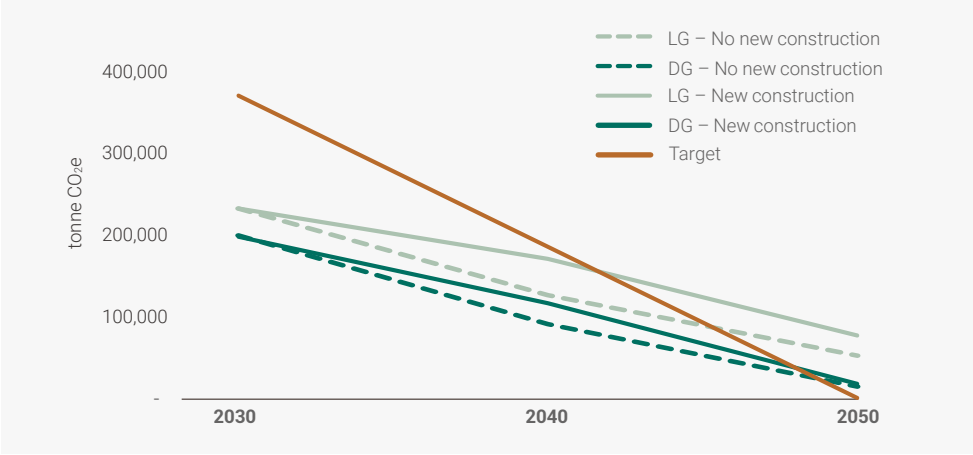
B. Scenarios and Key Findings

Some distinctive patterns emerge from the four scenarios—Light Green and Dark Green, both with and without new construction—as captured in the charts below.

Table 3: Absolute emissions in 2050 under different scenarios

Scenario	Light Green – New Construction (1% per year)	Light Green – No New Construction	Dark Green – New Construction (1% per year)	Dark Green – No New Construction
Tonnes of CO_2 equivalent	79,000	54,000	22,000	16,000

Figure 5: Absolute emissions under different scenarios



Notable findings are as follows:

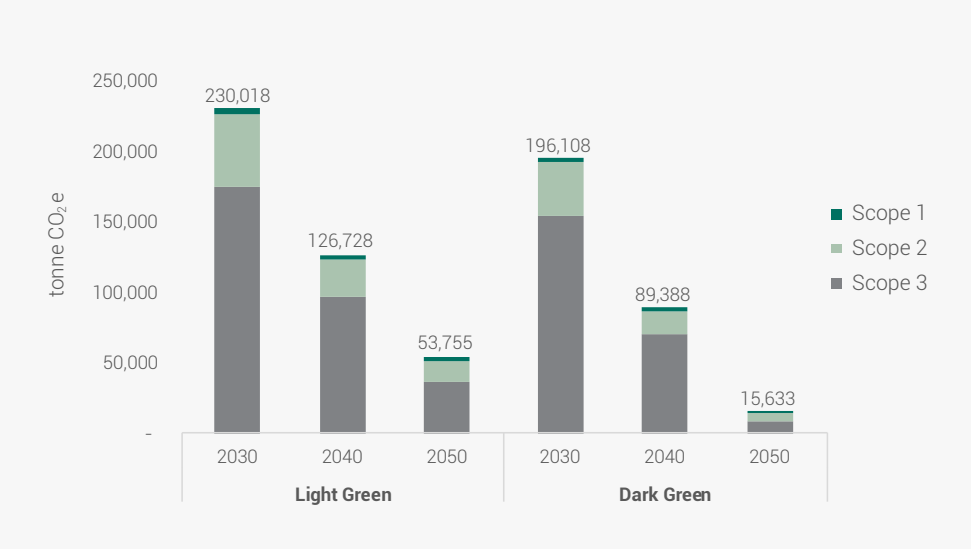
Finding #1: Without new construction, our emissions would drop sharply

From a starting point of almost 1,000,000 tonnes of CO_2e, with no new construction occurring, emissions would drop under both the Light Green and Dark Green Scenarios since embodied carbon constitutes such a substantial share of our overall emissions.

In 2030, under the Light Green Scenario, our emissions would fall to 230,018 tonnes, while the Dark Green Scenario would see a decrease to 196,108 tonnes. In 2040, the Light Green Scenario would drop further to 126,728 tonnes and the Dark Green Scenario to 89,388 tonnes.

With no new construction projects, Hang Lung's total emissions under the Light Green Scenario would remain below our target line until 2045, whereas the Dark Green Scenario would extend this below-target period until as late as 2048.

Figure 6: Emissions trajectories under both scenarios with no new construction

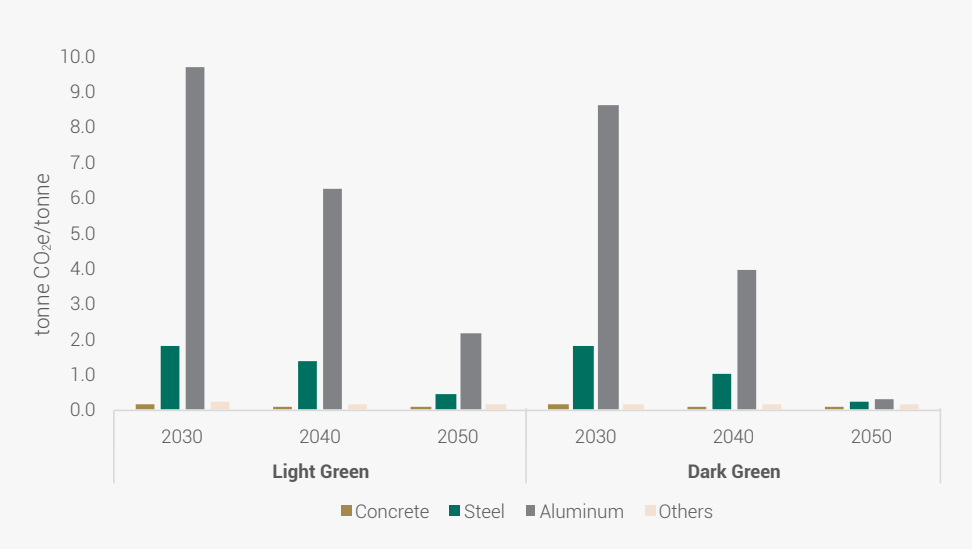


Finding #2: New construction would substantially impact the reduction path for 2040 and 2050

Assuming growth of 1% each year between 2031 and 2050, we would need to contend with significant additional emissions from construction materials, especially concrete, steel, and aluminum, reflecting both their intensity and volume (see Figures 7 and 8 below). Potential emissions should also be considered from other construction materials (summarized as "Others" in Figures 7 and 8), including concrete bricks, timber, and glass.

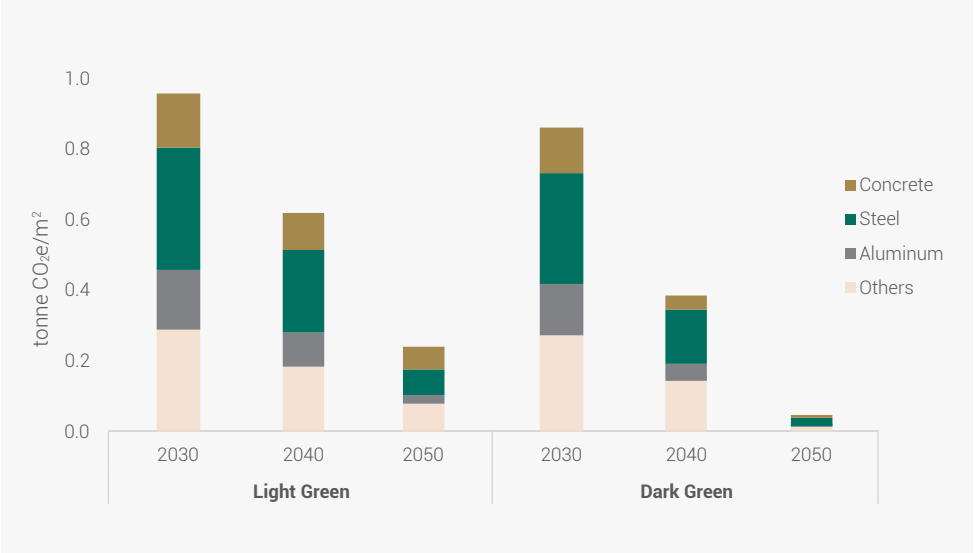
Material GHG intensity. In terms of the embodied intensity of the material itself, or CO_2e/tonne, aluminum would pose the greatest challenge, retaining between 0.4 and 2.3 tonnes of CO_2e/tonne by 2050 (for Dark Green and Light Green, respectively).

Figure 7: Material GHG intensity of major materials used in building construction: 2030–2050



Carbon intensity. From a carbon intensity perspective, or tonne CO_2e/m^2, in the Dark Green Scenario, steel accounts for the highest share of emissions in 2030, 2040, and 2050. Similarly, in the Light Green Scenario, steel has the largest share of emissions in 2030 and 2040; however, by 2050, various other materials—captured in the chart below as "Others"—have overtaken it.

Figure 8: Carbon intensity for new construction projects 2030–2050

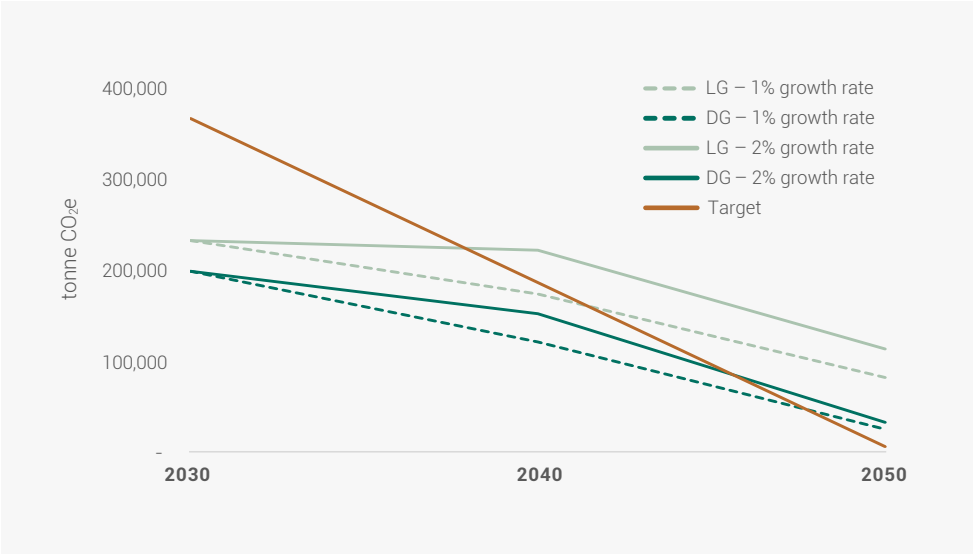


To allow room for new construction, these emissions will be a key issue that Hang Lung—and real estate developers in general—will need to address as we progress toward 2050.

Finding #3: The Dark Green Scenario could double the floor area expansion of the Light Green Scenario and still have lower emissions

To further understand the impact of new construction on emissions, we also examined how the emissions profile would change if we assumed an average of 2% growth annually in floor area between 2031 and 2050. This pace of expansion would increase our total floor area by roughly 2,300,000 square meters—equivalent to the entire construction cycle of ten new commercial complexes over the relevant time frame. The chart below compares the 1% and 2% floor area growth rates for both the Light Green and Dark Green Scenarios. The findings indicate that the Dark Green Scenario, with 2% expansion, has lower emissions through to 2050 than the Light Green Scenario, with 1% expansion.

Figure 9: Comparison of absolute emissions with 1% and 2% growth rates under the two scenarios



With consistent improvements in the efficiency and carbon intensity of our materials, we could double the rate of our floor area expansion while still achieving lower emissions.

Note, however, that the 1% and 2% scenarios above are theoretical cases that present steady average annual rates of expansion for our projects when, in reality, real estate construction follows broader economic cycles. Any new construction that Hung Lung undertakes will be based on pursuing relevant opportunities as they arise. Therefore, our emissions trajectory to 2050 would likely look more like a jagged line than a straight line, with potential expansions and pauses along the way.

For further context, imagine that Hang Lung decides to build a new commercial complex in the late 2030s that is 200,000 square meters (i.e., roughly the size of our Plaza 66 property), and 2040 represents 50% of the project's embodied carbon (in our recent construction projects, embodied carbon accounted for 40–80% of their emissions in the peak year). Just one new project in the Light Green Scenario with peak construction in 2040 would add about half the embodied carbon emissions we experienced in 2023 (our peak year for carbon emissions). The chart below demonstrates the benefits of a lower emissions pathway: the Dark Green Scenario could see three new projects with less than double the emissions of one new project under the Light Green Scenario.

Figure 10: Embodied carbon emissions in 2040 with new construction

Finding #4: Even without new construction, some emissions categories may not reach zero

Some emissions categories represent a relatively minor share of total emissions today but could be significant contributors to our residual emissions as we move toward 2050. For example, among Scope 3 emissions in 2023, there are several smaller subcategories that together contributed 121,430 tonnes or about 15% of our total Scope 3 emissions in that year. The categories are summarized in Table 4 below.

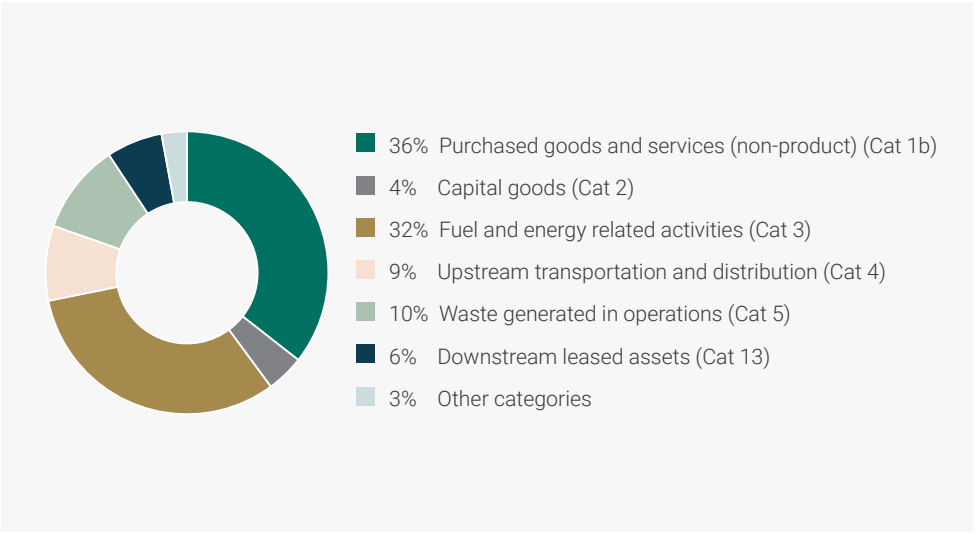
Table 4: Potential changes to Scope 3 categories with smaller share of emissions today

Category and Examples	% of Scope 3 Emissions				
	2023	Light Green Scenario		Dark Green Scenario	
		2030	2050	2030	2050
1b. Purchased goods and services (non-product) (e.g., cleaning services)	5.7%	26%	36%	29%	65%
2. Capital goods (e.g., assets purchased or leased for new development projects)	0.7%	3%	4%	4%	8%
3. Fuel and energy-related activities (not included in Scope 1 or Scope 2) (e.g., upstream emissions of purchased electricity, transmission and distribution losses)	5.1%	23%	32%	25%	0%
4. Upstream transportation and distribution (e.g., transportation of building materials to construction sites, such as concrete, steel, and glass)	1.4%	6%	9%	7%	0%
5. Waste generated in operations (e.g., construction waste, operational waste)	1.7%	8%	10%	8%	19%
Other Categories					
6. Business travel (e.g., air travel, taxi and car rental, hotel stays)	0.5%	2%	3%	2%	0%
7. Employee commuting (e.g., employee car commutes, public transportation, telecommuting)					
8. Upstream leased assets (e.g., leased office spaces and vehicles)					
15. Investments (e.g., project finance emissions related to construction and operation of properties funded by Hang Lung in joint ventures)					

In the above table, a value of 0% in 2050 in the Dark Green Scenario may indicate that the amount of the respective item is considered very small rather than zero. Due to their insignificance, these negligible contributions have been rounded down to 0%. For business travel in the Dark Green Scenario, we assume that ground transportation entails zero emissions, mainly through electrification and grid decarbonization. For air travel, the scenario assumes that the aviation sector will achieve its 2050 net zero target (IATA, 2021).

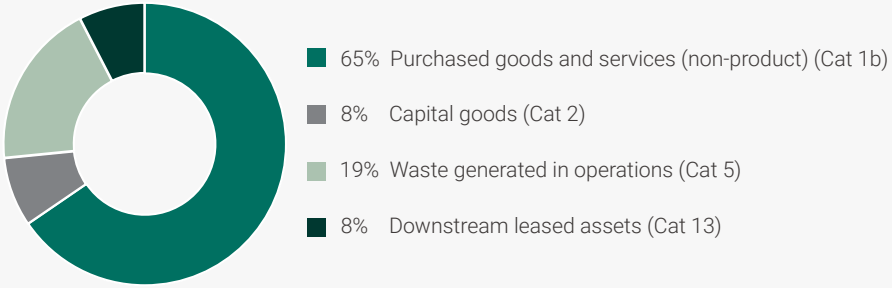
Under the Light Green Scenario (and with no new construction), these categories could potentially still generate 34,000 tonnes of emissions in 2050. Figure 11 shows the distribution of emissions in all categories in 2050, with 6% from downstream leased assets, and 94% from all the other Scope 3 emissions categories in 2050 (where these categories collectively only contributed 9.29% to our Scope 3 emissions in 2023).

Figure 11: Scope 3 emissions in 2050 under the Light Green Scenario without new construction



Under the Dark Green Scenario, emissions would drop due to progress in some of these categories that are small today—most notably Category 3: fuel and energy-related activities, along with five minor categories (see Table 4). However, roughly 7,300 tonnes of emissions could remain in Scope 3 existing property categories, especially purchased services and operational waste, as shown in Figure 12.

Figure 12: Scope 3 emissions in 2050 under the Dark Green Scenario without new construction



To get to zero without relying on offsets, we would need to ensure that all purchased goods and services are non-emitting and avoid any emissions from fuel energy, waste, and investments. We must also identify innovative solutions and conduct comprehensive lifecycle assessments for all suppliers, infrastructure, and investments. In short, there is a difference between getting mostly to zero and getting all the way there. The latter would require systematic shifts in manufacturing and transportation, as well as improved data, scrutiny, and stakeholder engagement across all aspects of our business.

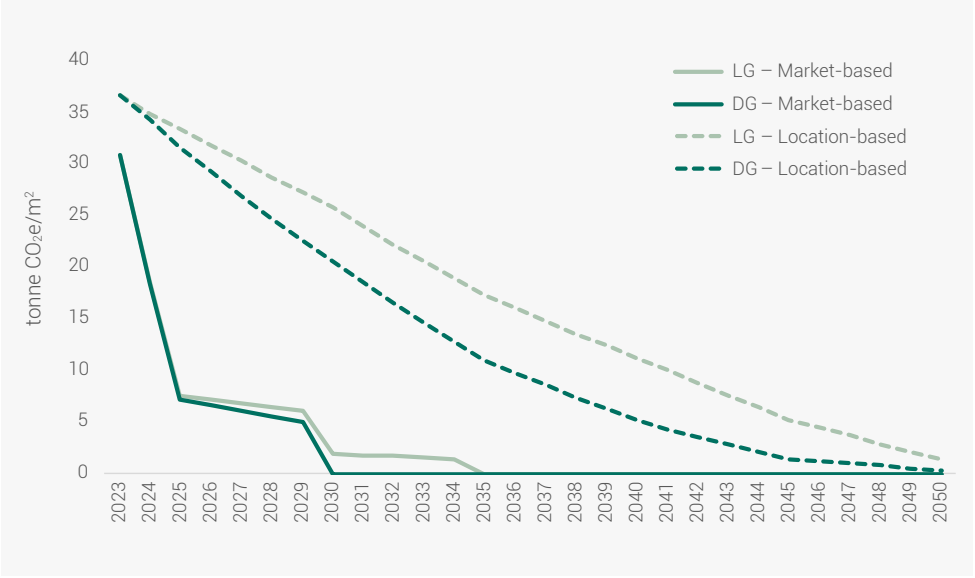
Finding #5: Market-based accounting shows much faster decarbonization than location-based accounting

Under location-based accounting, our electricity emissions would be determined by the average emissions intensity of the grids from which our properties obtain electrons.

With market-based accounting, our emissions would reflect our contractual arrangements with electricity suppliers (i.e., PPAs). Hang Lung's purchased electricity would decarbonize much faster following market-based rather than location-based accounting. Through market-based accounting, even the Light Green Scenario could achieve zero Scope 2 emissions for our Mainland properties by 2035. In contrast, the more optimistic Dark Green Scenario may not achieve zero emissions under the location-based accounting method, even by 2050, as China's grid may not fully decarbonize until later.

The chart below highlights the difference in results for the two accounting methods for our Scope 2 emissions. Since we have adopted a 'whole building' approach for all our PPAs to date—meaning they cover the entirety of the landlord's and tenants' consumption—the same logic and contrast would apply to the potential pace of decarbonization for our Scope 3 downstream leased assets (our tenants' consumption).

Figure 13: Scope 2 electricity carbon intensity comparison (Mainland properties): market-based vs. location-based



CHAPTER 3
Implications and Looking Ahead

In this final section, we discuss some of the key implications of our findings and highlight several necessary actions we are pursuing to support our journey to net zero over the next 25 years. We believe that many of the issues explored here are also relevant to our peers and the broader real estate sector. We hope that transparent discussion of these issues may invite further dialogue and collaborative actions with like-minded stakeholders.

A. A Tradeoff Between Meeting Reduction Targets and Expansion?

Our scenarios suggest that, until input materials are sufficiently decarbonized by the middle of this century, new construction may cause us to fall short of our target of net zero emissions by 2050, even in a Dark Green Scenario.

This reality is not only a Hang Lung challenge but affects other real estate developers and standard-setters for decarbonization. The real estate sector must formulate a strategy for managing the apparent tradeoff between emissions reduction and real estate expansion. Scope 3 building materials emissions will increase in relative importance with every cyclical upswing. One possibility is to revisit how we collectively evaluate and report progress in our emissions reductions. Another is for real estate developers to take more aggressive action to try and accelerate the decarbonization of construction materials and focus on refurbishing older buildings or structures. Both ideas are discussed further below.

B. Choices to Be Made in Future Carbon Accounting

In the real estate sector, Scope 1 emissions—the only emissions entirely under our control—represent only approximately 3% (Robeco, 2023) of total value chain emissions. Under such circumstances, we depend more on accounting logic and principles than sectors with a larger share of Scope 1 emissions, such as the industrial sector, where onsite fossil fuels still constitute a substantial component of overall emissions. Three topics play a critical role here.

Market-based vs. location-based accounting

With regard to the renewable energy transactions we undertake in China, we believe that market-based accounting is important. First, our bundled PPAs—combining electrons and attributes in a single transaction—are aligned with relevant and credible government policies in China, including the *Rules for the Issuance and Trading of Green Electricity Certificates* (rules which, among other things, guard against double counting). In 2024, the Central Government published emission factor information reflecting market-based accounting principles—an important signal of support for this approach (see here). Second, our PPAs are consistent with the requirements of RE100, a global initiative that unites businesses committed to renewable energy. These transactions empower us and our tenants to support an accelerated energy transition rather than remaining passive. Our example has also led some peers to expand their own renewable energy procurement efforts, signaling rising demand in the market. As one China-based renewable energy expert commented, "The market-based approach to decarbonization is crucial and underpins the very foundation for corporate climate action (otherwise, we'd all just wait around without creating any demand-side signal)." For full transparency, however, we will continue reporting on our Scope 2 and Scope 3 purchased energy using both market-based and location-based accounting.

Base-year emissions vs. intensity benchmarks

As we have seen, the SBTi methodology is shaped around target reductions relative to base-year emissions. While this approach has the benefit of being relatively straightforward to understand, measure, and implement for targets, it also has limitations. In Hang Lung's case, our 2023 emissions were higher than our SBTi base year for Scope 3 (2020), and 2023 is likely to be our peak year for carbon emissions for at least six years, reflecting our construction cycle. Even if we only have very limited construction underway, we—and other real estate developers—should be incentivized to focus on alternate methods for driving emissions reductions. A real estate company making progress in material GHG intensity or material efficiency should be recognized for these achievements. One solution would be introducing material GHG intensity and material efficiency benchmarks for new buildings alongside base-year target reductions. Real estate companies that expand their portfolio in a more sustainable manner would be able to offer insight into their efforts, even if they did not fully achieve their target reductions relative to their base years. Conversely, companies with minimal new construction projects would also need to show how they are working on material GHG intensity and material efficiency.

Carbon removal projects

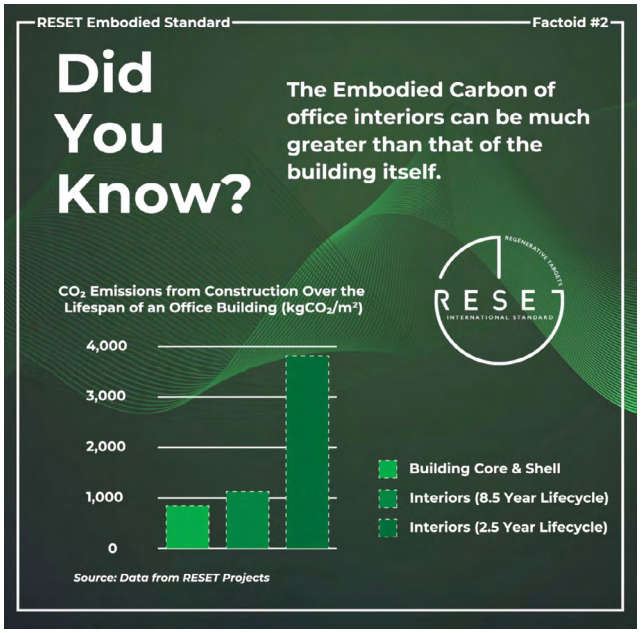
Hang Lung may have opportunities to apply carbon removal measures within our value chain—for instance, by incorporating biochar in concrete or nature-based solutions in landscaping. We are also evaluating options for how we might structure and account for carbon removal or negative emissions projects that reach beyond our value chain. If we treat a carbon removal project as an offset, it could count against our residual emissions that might otherwise be difficult to eliminate. This approach, therefore, gives us more flexibility on how we can achieve zero emissions (the 'net' in net zero). The topic of offsets is controversial, however, both among SBTi stakeholders and in the broader community (Romm, 2023). A carbon removal project could also be structured and reported as a **beyond value chain mitigation** (BVCM) contribution (SBT, n.d.). Although doing so might be viewed as an example of leadership, it would not reduce the burden of our value chain emissions reduction. While we are open to considering both options, we will proceed with caution. Any offset project we contemplate would need to offer credible, durable, additional, verified, and cost-effective emissions reductions.

C. Overlooked Emissions

Tenant fitouts

This substantial source of greenhouse gas emissions in real estate has been largely neglected by the sector for several reasons. First, following the GHG Protocol methodology, emissions from tenants' fitouts and renovations fall outside the landlord's minimal Scope 3 reporting boundaries. Second, calculating emissions from interiors is a highly complex exercise requiring data from a large number of suppliers. Third, there are inconsistencies in the calculation boundaries and methods used for lifecycle assessments. However, it is vital that the sector addresses this blind spot, as tenant emissions from interiors across a building's lifetime may significantly exceed those of the building's core and shell, as illustrated by the figure below.

Figure 14: CO_2 emissions from office interiors vs. building core and shell



Refrigerant emissions

Cooling is essential for human health, comfort, and safety and is rapidly increasing in usage due to a warming planet, economic growth, and urbanization. However, refrigerant gases—such as hydrofluorocarbons (HFC), used for cooling and refrigeration—are potent greenhouse gases that threaten to worsen the climate crisis. Accurate data on the emission volume of these gases remains difficult to obtain, but the topic is likely to attract more attention in the coming years as stakeholders become more aware of its significance.

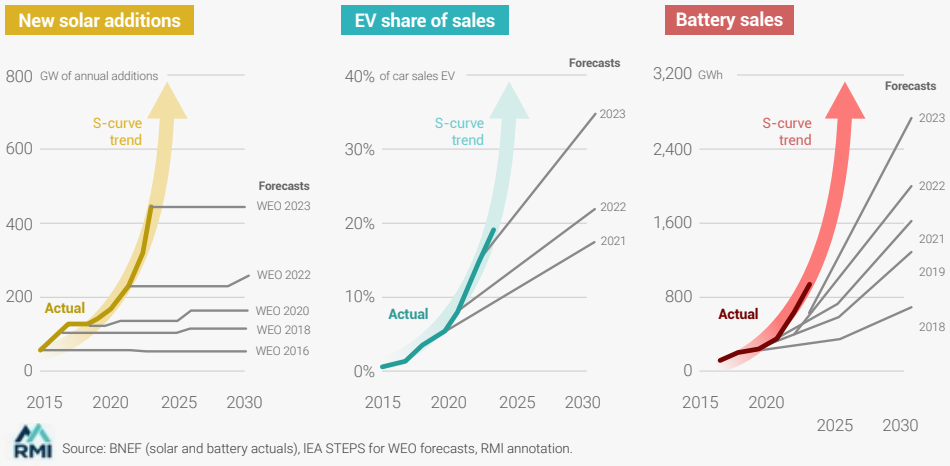
Buildings today account for around half of all HFC emissions and are expected to persist as the primary contributor for future HFC emissions. Vast 'banks' of HFCs exist in buildings worldwide, which slowly leak and are often vented when the cooling equipment reaches the end of its life. Governments are starting to take notice of the issue, and regulation is already in place in many countries to control production of the most highly potent gases, following the Kigali Amendment to the Montreal Protocol. There are also growing indications that refrigerant emissions may have been significantly understated in real estate. For example, a recent study of German food retail warehouses (Kuenzle et al., 2023) found that fluorinated gases arising from refrigerant leakages "account for 40% of total building emissions and nearly 45% of cumulative emissions until 2050." Confronting this challenge may require real estate stakeholders to expand the scope of our decarbonization efforts, but it is also an opportunity to make rapid progress in avoiding future emissions. It will be important for developers to prioritize careful selection of air conditioning systems and refrigerants and work with tenants on this issue.

D. Game Changers

As we have seen, even if we include optimistic assumptions in our scenarios, Hang Lung cannot be certain of achieving net zero by 2050. However, with 25 years still ahead, there is considerable time for progress. Even though the real estate sector moves relatively slowly compared to many others, we can take inspiration from notable technologies in other industries that began slowly and gained momentum much faster than predicted, such as solar energy, battery storage, and electric vehicles—all of which accelerated in China. The chart from RMI below is a helpful reminder of how such trends have been underestimated.

Figure 15: Incumbents have underestimated the speed of change

Even neutral actors modeled in linear terms. But change has been exponential



(Bond et al., 2024)

Several technologies and trends are fueling optimism in real estate. For example, there is the potential for **AI technologies to make significant energy efficiency improvements in buildings.** This would occur through real-time optimization of the building management system, leading to substantial improvements in heating, ventilation, and air conditioning (HVAC) performance. One leading international solution, Brainbox AI, is already achieving substantial operational carbon reductions through its technology. Considering that AI is a priority area for economic and technological growth in China, similar solutions may emerge and scale up in the China market.

Second, there is the potential for low carbon or even **negative-carbon cement.** While various early-stage technologies are under development in China and globally, one of the most remarkable examples is Brimstone. Brimstone cement meets the American Society for Testing and Materials Standard Specification for Portland Cement (ASTM C150), the type of cement used in virtually all concrete construction today. Its breakthrough is that it makes industry-standard cement with carbon-free calcium silicate rock instead of limestone. Brimstone claims that "its process also removes CO_2 from the air because its rocks contain magnesium, which can passively and permanently capture atmospheric carbon dioxide" (Purton, 2024). It may only be a matter of time before Brimstone and other leading low carbon cement and concrete solutions are deployed on a commercial scale in China.

Third, the lagging steel sector in China, with higher emissions than the global average, could leap ahead and emerge as **a leader in low carbon emissions steel.** The Central Government recently announced a moratorium on opening new coal plants to support steel production, and analysts expect supply to increase from scrap and EAF-produced steel in the years ahead (Shen, et al., 2024). Steel companies in China are also investing in demonstration projects for innovative low carbon emissions steel technologies like hydrogen-based direct reduction iron (H2-DRI), and abundant supplies of renewable energy will also support steel decarbonization. As one recent paper summed it up: "China could win the race to be the top green primary steel producer by 2030 based on its competitive advantages in renewable electricity and green hydrogen production." (Zuo, et al., 2023).

In terms of aluminum, China is the world's largest producer, and its aluminum sector is responsible for around 5% of the country's carbon emissions, mainly due to its reliance on coal-fired electricity. **Using clean energy in aluminum production** can reduce emissions by up to 85%, and expanding recycling measures can further accelerate decarbonization since recycling aluminum uses 95% less energy than producing it from raw materials.

The State Council of China has launched an action plan to decarbonize the non-ferrous metals sector. The plan requires that the electrolytic aluminum sector uses renewable sources for at least 25% of its energy consumption by 2025 and tightly controls the expansion of aluminum production capacity. To meet the country's climate goals and strengthen resilience against European regulations, producers in China will need to broaden their use of renewable energy sources and invest in increased recycling (see Aluminium China, n.d.; Liu, 2024; Thomson, 2024; Yin et al., 2024). Leveraging the rapid expansion of renewable energy in China could deliver even faster results for aluminum emission reductions.

In addition to these promising efforts, RMI has provided a detailed analysis of carbon reduction technologies in China's building sector, including numerous examples that can help accelerate the transition. In short, **various favorable trends and technological breakthroughs** could make a dramatic difference in Hang Lung's decarbonization journey. Technologies do not need to be fully scaled to make a meaningful contribution to our decarbonization pathway; they simply need to be viable options at a reasonable cost.

E. Key Actions We Are Pursuing

Below are eight selected measures we are currently examining to support our long-term journey to net zero.

Action one: Advancing energy efficiency

Energy efficiency is essential for decarbonization, not only for Hang Lung but for the real estate sector in general. We will conduct asset-level energy use intensity and electricity intensity benchmarking in 2025, which will help us develop plans, prioritize our investments (with consideration of expected returns), and establish asset-level electricity and energy intensity targets for 2030 in support of our decarbonization efforts.

We are also implementing several key initiatives to enhance our energy performance. Since 2022, we have been conducting retro-commissioning at our properties in Hong Kong and mainland China in phases, and we plan to continue doing so for our remaining existing properties. Additionally, we are expanding the use of AI technologies to optimize energy efficiency in our buildings, ensuring that we leverage innovative solutions to reduce our carbon footprint effectively.

We support the CRREM initiative and its efforts to establish global benchmarks for monitoring energy efficiency progress among real estate assets. Regular engagement with stakeholders is also part of our ongoing commitment to help ensure that CRREM develops feasible and appropriate energy efficiency pathways for China.

Action two: Procuring more renewable energy

We are expanding our renewable energy procurement endeavors in mainland China. We would also like to work with relevant stakeholders in Hong Kong to explore options for commercial users to obtain renewable energy locally. One approach might be to enable PPAs for commercial users in Hong Kong to purchase renewable energy from resources in Guangdong Province.

Action three: Improving material efficiency

We are examining ways to enhance material efficiency, including design improvements. For example, one startup, Structure Pal, utilizes AI to reduce overbuild in concrete by optimizing and automating concrete structure designs, claiming that it can reduce associated construction CO_2 emissions by up to 30%.

Action four: Reducing the GHG intensity of construction materials

We are studying applications for low carbon and even carbon-negative building materials (materials that capture more CO_2 over their lifecycle than they emit). At Westlake 66 in Hangzhou, we have led the way as the first commercial development in Hong Kong and the Mainland to use low carbon concrete bricks in a small-scale pilot project. In collaboration with CLEANCO2—a startup that applies carbon capture, utilization, and storage (CCUS) technology—the bricks cover around 17,000 square meters of partition walls in the basement and will reduce embodied carbon emissions by 87.5% compared with conventional shale bricks. At our flagship Plaza 66 mall in Shanghai, we are using nearly 100% low carbon emissions steel for all above-ground structural plates and reinforcing bars in the Pavilion Extension, reducing the total embodied carbon emissions from steel by 35%. We also continually examine innovations in the market, such as carbon-negative products for plaster and plasterboard.

Action five: Supplier collaboration on low carbon construction materials

We intend to collaborate with suppliers to identify and apply low carbon construction materials, especially proven solutions related to steel, concrete, and aluminum. In September 2024, we hosted a Real Estate & Decarbonization Summit in Beijing that brought together suppliers and other stakeholders to identify how we can accelerate progress by joining forces. You can find a summary of the key ideas discussed here. We are also proud to be one of the principal supporters of China's recently launched real estate steel low carbon emissions steel collaboration initiative.

Action six: Pursuing opportunities for adaptive reuse

We will continue to investigate opportunities to expand our real estate portfolio while reducing embodied carbon emissions through the adaptive reuse of existing properties. We are already implementing this idea to some extent with our Shouson Hill project in Hong Kong. As a leading international example, Arup employed an "adaptive, circular retrofit design" at the Quay Quarter Tower, a landmark building in Sydney's Circular Quay. The building "retained 65% of the original building's existing floorplates and structure and 98% of the original structural walls and core, equating to a saving of approximately 12,000 tonnes of embodied carbon."

Action seven: Lifecycle refrigerant management

We will review and look for opportunities to improve our lifecycle refrigerant management (LRM) practices, including leakage detection, refrigerant condition monitoring, reclaim and refill processes for end-of-life refrigerant management, and the adoption of new alternative technologies and design practices.

We also recently launched an initiative with the Carbon Containment Lab and other stakeholders to study LRM in commercial real estate complexes in several Asian cities, including Hong Kong and Shanghai. We intend to issue a white paper with key recommendations in 2025.

Action eight: Collaboration with tenants to reduce emissions

Regarding tenant fitouts, Hang Lung is among the first landlords—if not the first globally—to introduce embodied carbon benchmarking for tenants, and one of the first landlords in China to reuse and recycle materials such as gypsum board. It is our hope that the sector will make collective progress in tracking, benchmarking, and reporting these emissions in the next several years, consistent with a 'whole building' approach to emissions abatement. We are also working with our tenants to encourage them to reduce emissions from their energy use and enable energy efficiency benchmarking through an innovative platform that we are launching in 2025.

Conclusion

These are among the most critical actions we are pursuing to support our long-term ambition of net zero emissions in 2050—but they are not all of them. Our annual sustainability report, published in March each year, provides additional details. While our business will undoubtedly evolve as the years unfold, the analysis in this paper has helped us improve our understanding of the most fundamental and pressing issues we need to address in our decarbonization journey.

As an overall conclusion, the Company **can** achieve net zero by 2050: it is an ambitious goal, but one that is potentially achievable. China is already the undisputed global leader in many decarbonization technologies, and we are excited that momentum is growing in key areas. We must be prepared to leverage advancements in technologies as they emerge. Arriving at this destination will also require effort and sustained focus, and strategic collaboration with our suppliers will be an indispensable component of our success. Lastly, offsets may play a role in getting us across the finish line.

Having identified the conditions for success, we will steadfastly pursue the actions discussed in this paper, together with our stakeholders, and we will continue to learn and adapt. The climate crisis asks nothing less of us.

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